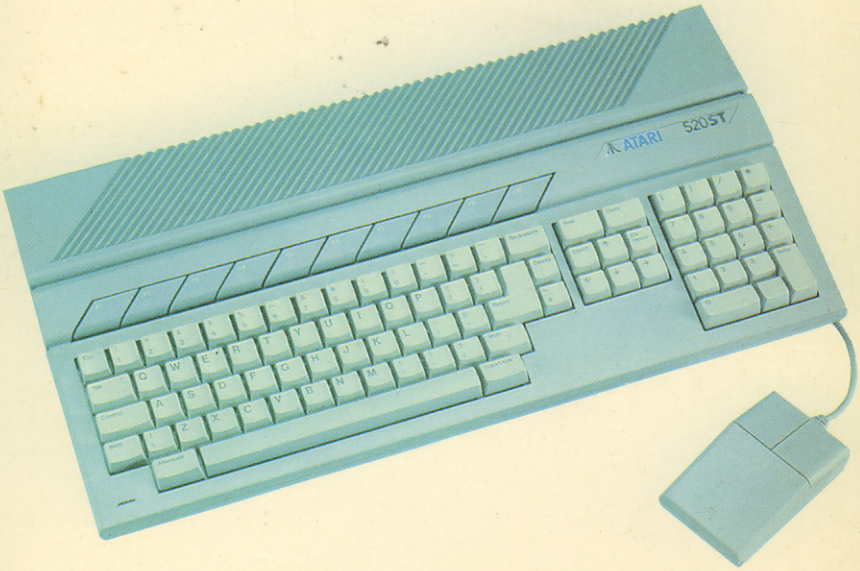
THE Anatomy OF THE ATARI ST



FIRST PUBLISHING LTD

ATARI ST INTERNALS

The authoritative insider's guide

By K. Gerits, L. Englisch, R. Bruckmann

A Data Becker Book

Published by

First Publishing Ltd
Unit 20B
Horseshoe Park
Pangbourne
Berks.

ISBN 0 948015 56X

Printed in Great Britain by
Paradigm Print, Gateshead, Tyne and Wear.

Table of Contents

List of Figures


Ex-Libris
α α α
Ω Ω
Arthur Missira
MCMXCVII

Chapter One

The Integrated Circuits

The Integrated Circuits

1.1 The 68000 Processor

The 68000 microprocessor is the heart of the entire Atari ST system. This 16-bit chip is in a class by itself; programmers and hardware designers alike find the chip very easy to handle. From its initial development by Motorola in 1977 to its appearance on the market in 1979, the chip was to be a competitor to the INTEL 8086/8088 (the processor used in the IBM-PC and its many clones). Before the Atari ST's arrival on the marketplace, there were no affordable 68000 machines available to the home user. Now, though, with 16-bit computers becoming more affordable to the *common* man, the 8-bit machines won't be around much longer.

What does the 68000 have that's so special? Here's a very incomplete list of features:

16 data bits
24 address bits (16-megabyte address range!!)
all signals directly accessible without multiplexer
hassle-free operation of "old" 8-bit peripherals
powerful machine language commands
easy-to-learn assembler syntax
14 different types of addressing
17 registers each having 32-bit widths

These specifications (and many yet to be mentioned here) make the 68000 an incredibly good microprocessor for home and personal computers. In fact, as the price of memory drops, you'll soon be seeing 68000-based 64K machines for the same price as present-day 8-bit computers with the same amount of memory.

1.1.1 The 68000 Registers

Let's take a look at 68000 design. Figure 1.1-1 shows the 17 onboard 32-bit registers, the program counter and the status register.

The eight data registers can store and perform calculations, as well as the normal addressing tasks. Eight-bit systems use the accumulators for this which limits the programmer to a total of 8 accumulators. Our 68000 data registers are quite flexible; data can be handled in 1-, 8-, 16- and 32- bit sizes. Even four-bit operations are possible (within the limits of Binary Coded Decimal counting). When working with 32-bit data, all 32 bits can be handled with a single operation. With 8- and 16-bit data, only the 8th or 16th bit of the data register can be accessed.

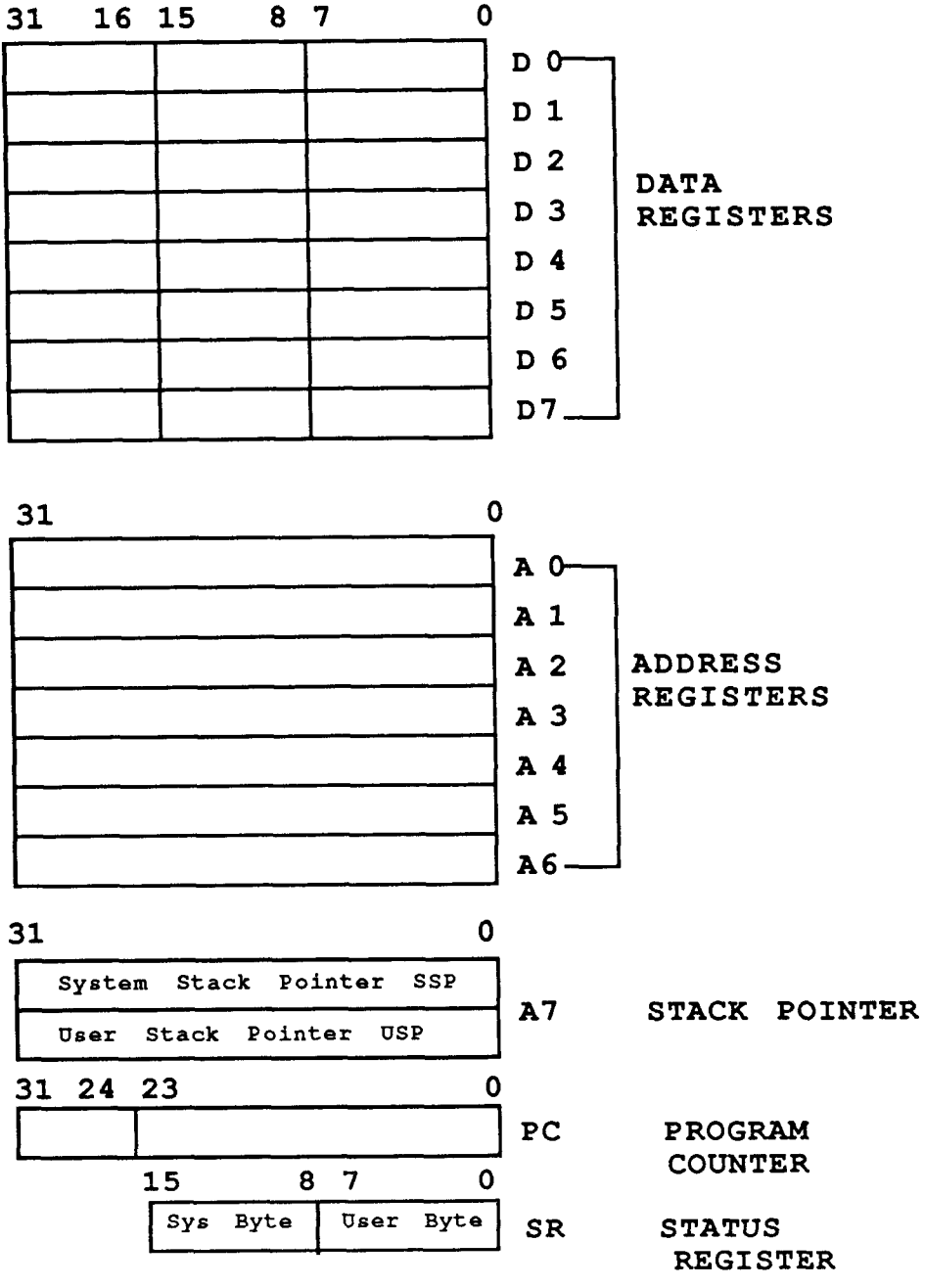
The address registers aren't as flexible for data access as are the data registers. These registers are for addressing, not calculation. Processing data is possible only with word (16-bit) and longword (32-bit) operations. The address registers must be looked at as two distinct groups, the most versatile being the registers A0-A6. Registers A7 and A7' fulfill a special need. These registers are used as the stack pointer by the processor. Two stack pointers are needed to allow the 68000 to run in USER MODE and SUPERVISOR MODE. Register A7 declares whether the system is in USER or SUPERVISOR mode. Note that the two registers work "under" A7, but the register contents are only available to the respective operating mode. We'll discuss these operating modes later.

The program counter is also considered a 32-bit register. It is theoretically possible to handle an address range of over 4 gigabytes. But the address bits A24-A31 aren't used, which "limits" us to 16 megabytes.

The 68000 status register comprises 16 bits, of which only 10 bits are used. This status register is divided into two halves: The lower eight bits (bits 0 to 4 proper) is the "user byte". These bits, which act as flags most of the time, show the results of arithmetical and comparative operations, and can be used for program branches hinging on those results. We'll look at the user byte in more detail later; for now, here is a brief list:

```
BIT 0 = Carry flag        BIT 1 = Overflow flag
BIT 2 = Zero flag         BIT 3 = Negative flag
BIT 4 = eXtend flag
```

Figure 1.1-1 68000 Registers



Bits 8-10, 13 and 15 make up the status register's system byte. Th remaining bits are unused. Bit 15 works as a trace bit, which lets you do software controlled single-step execution of any program. Bit 13 is th supervisor bit. When this bit is set, the 68000 is in supervisor mode. Thi is the normal operating mode; all commands are executed in this mode. I user mode, in which programs normally run, privileged instructions ar inoperative. A special hardware design allows access into the other memor range while in user mode (e.g., important system variables, I/O registers) The system byte of the status register can only be manipulated in supervisc mode; but there's a simple method of switching between modes.

Bits 8 and 10 show the interrupt mask, and run in connection with pin IPL0-IPL2.

The 68000 has great potential for handling interrupts. Seven differen interrupt priorities exist, the highest being the "non-maskable interrupt" NMI. This interrupt recognizes when all three IPL pins simultaneously rea low (0). If, however, all three IPL pins read high, there is no interrupt, anc the system operates normally. The other six priorities can be masked by appropriate setting of the system byte of the status register. For example, i bit I2 of the interrupt mask is set, while I0 and I1 are off, only levels 7, 6 and 5 (000, 001 and 010) are recognized. All other combinations from IPL0-IPL2 are ignored by the processor.

.1.2 Exceptions on the 68000

We've spoken of interrupts as if the 68000 behaves like other nicroprocessors. Interrupts, according to Motorola nomenclature, are an external form of an **exception** (the machine can interrupt what it's doing, lo something else, and return to the interrupted task if needed). The 68000 listinguishes between normal operation and exception handling, rather than between user and supervisor mode. One such set of exceptions is the nterrupts. Other things which cause exceptions are undefined opcodes, and word or longword access to a prohibited address.

To make exception handling quicker and easier, the 68000 reserves the first 1K of memory (1024 bytes, $000000-$0003FF). The exception table is located here. Exceptions are all coded as one of four bytes of a longword. Encountering an exception triggers the 68000, and the address of the corresponding table entry is output.

A special exception occurs on reset, which requires 8 bytes (two longwords); the first longword contains the standard initial value of the supervisor stack pointer, while the second longword contains the address of the reset routine itself. See Chapter 3.3 for the design and layout of the exception table.

1.1.3 The 68000 Connections

The connections on the 68000 are divided into eight groups (see Figure 1.1-3 on page 11).

The first group combines data and address busses. The data bus consists of pins D0-D15, and the address bus A1-A23. Address bit A0 is not available to the 68000. Memory can be communicated with words rather than bytes (1 word=2 bytes=16 bits, as opposed to 1 byte=8 bits). Also, the 68000 can access data located on odd addresses as well as even addresses. The signals will be dealt with later.

It's important to remember in connection with this, that by word access to memory, the byte of the odd address is treated as the low byte, and the even

address is the high byte. Word access shouldn't stray from even addresses That means that opcodes (whether all words or a single word) must alway be located at an even addresses.

When the data and address bus are in "tri-state" condition, a third conditio (in addition to high and low) exists, in which the pins offer high resistance and thus are inactive on the bus. This is important in connection with Direc Memory Access (DMA).

The second group of connections comprise the signals for asynchronou bus control. This group has five signals, which we'll now look a individually:

1) R/W (READ/WRITE)

The R/W signal is a familiar one to all microprocessors. This indicates to memory and peripherals whether the processor is writing to or reading data from the address on the bus.

2) AS (ADDRESS STROBE)

Every processor has a signal which it sends along the data lines signaling whether the address is ready to be used. On the 68000, this is known as the ADDRESS STROBE (low active).

3) UDS (UPPER DATA STROBE)
4) LDS (LOWER DATA STROBE)

If the 68000 could only process an entire memory word (two bytes) simultanesouly, this signal wouldn't be necessary. However, for individual access to the low-byte and high-byte of a word, the processor must be able to distinguish between the two bytes. This is the task performed by UDS and LDS. When a word is accessed, both strobes are activated simultaneously (active=low). Accessing the data at an odd address activates the Lower Data Strobe only, while accessing data atan even address activates the Upper Data Strobe.

Bit A0 from the address bus is used in this case. After every access when the system must distinguish between three conditions (word, even byte, odd byte), A0 determines how to complete the access.

LDS and UDS are tri-state outputs.

5) **DTACK**

The above signals (with the exception of UDS and LDS) are needed by an 8-bit processor. DTACK takes a different path; DTACK must be low for any write or read access to take place. If the signal is not low within a bus cycle, the address and data lines "freeze up" until DTACK turns low. This can also occur in a WAIT loop. This way, the processor can slow down memory and peripheral chips while performing other tasks. If no wait cycles are used on the ST, the processor moves "at full tilt".

The third group of connections, the signals VMA, VPA and E are for synchronous bus control. A computer is more than memory and a microprocessor; interfaces to keyboard, screen, printer, etc. must be available for communication. In most cases, interfacing is handled by special ICs, but the 68000 has a huge selection of interfaces chips onboard. For hardware designers we'll take a little time explaining these synchronous bus signals.

The signal E (also known as Φ2 or phi 2) represents the reference count for peripherals. Users of 6800 and 6502 machines know this signal as the system counter. Whereas most peripheral chips have a maximum frequency of only 1 or 2 mHz, the 68000 has a working speed of 8 mHz, which can increased to 10 by the E signal. The frequency of E in the ST is 800 kHz. The E output is always active; it is not capable of a TRI- STATE condition.

The signal **VPA** (Valid Peripheral Address) sends data over the synchronous bus, and delegates this transfer to specific sections of the chip. Without this signal, data transfer is performed by the asynchronous bus. VPA also plays a role in generating interrupts, as we'll soon see.

VMA (Valid Memory Address) works in conjunction with the VPA to produce the CHIP-select signal for the synchronous bus.

The fourth group of 68000 signals allows simple DMA operation in the 68000 system. DMA (Direct Memory Access) directly accesses the DMA controllers, which control computer memory, and which is the fastest method of data transfer within a computer system.

To execute the DMA, the processor must be in an inactive state. But for the processor to be signaled, it must be in a "sleep" state; the low BR signal

(Bus Request) accomplishes this. On recognizing the BR signal, the 68000's read/write cycle ends, and the BG signal (Bus Grant) is activated. Now the DMA-requested chip waits until the signals AS, DTACK and (when possible) BGACK are rendered inactive. As soon as this occurs, the BGACK (Bus Grant Acknowledge) is activated by the requested chip , and takes over the bus. All essential signals on the processor are made high; in particular, the data, address and control busses are no longer influenced by the processor. The DMA controller can then place the desired address on the bus, and read or write data. When the DMA chip is finished with its task, the BGACK signal returns to its inactive state, and the processor again takes over the bus.

The fifth group of signals on the 68000 control interrupt generation. The 68000's "user's choice" interrupt concept is one of its most extraordinary performing qualities; you have 199 (!) interrupt vectors from which to choose. These interrupt vectors are divided into 7 non-auto-vectors and 192 auto-vectors, plus 7 different priority lines.

Interrupts are triggered by signals from the three lines IPL0 to IPL2; these three lines give you eight possible combinations. The combination determines the priority of the interrupt. That is, if IPL0, IPL1 and IPL2 are all set high, then the lowest priority is set ("no interrupt"). However, if all three lines are low, then highest priority takes over, to execute a non-maskable interrupt. All the combinations in between affect special bits in the 68000's status register; these, in turn, affect program control, regardless of whether or not a chosen interrupt is allowable.

Wait -- what are auto-vectors and non-auto-vectors? What do these terms mean?

If requesting an interrupt on IPL0-IPL2 while VPA is active (low), the desired code is directly converted from the IPL pins into a vector number. All seven interrupt codes on the IPL pins have their own vectors, though. The auto-vector concept automatically gives the vector number of the IPL interrupt code needed.

When DTACK, instead of VPA, is active on an interrupt request, the interrupt is handled as a non-auto-vector. In this case, the vector number from the triggered chip is produced by DTACK on the 8 lowest bits of the data bus. Usually (though not important here), the vector number is placed into the user-vector range ($40--$FF).

'he sixth set of connections are the three "function code" outputs FC0 to 'C2. These lines handle the status display of the processor. With the help of these lines, the 68000 can expand to four times 16 megabytes (64 negabytes). This extension requires the MMU (Memory Management Jnit). This MMU does more than handle memory expansion on the ST; it lso recognizes whether access is made to memory in user or supervisor node. This information is conveyed to a memory range only accessible in upervisor mode. Also, the interrupt verification uses this information on he FC line. The figure below shows the possible combinations of unctions.

Figure 1.1-3

FC2	FC1	FC0	Status
0	0	0	unused
0	0	1	User-mode data access
0	1	0	User-mode program
0	1	1	unused
1	0	0	unused
1	0	1	Supervisor data access
1	1	0	Supervisor program
1	1	1	Interrupt verification

The seventh group contains system control signals. This group applies to the input CLK and BERR, as well as the bidirectional lines RESET and HALT.

The input CLK will generate the working frequency of the processor. The 68000 can operate at different speeds; but the operating frequency must be specified (4, 6, 8, 10, or even 12.5 mHz). The ST has 8 mHz built in, while the minimum operating frequency is 2 mHz. The ST's 8 mHz was chosen as a "middle of the road" frequency to avoid losing data at higher frequencies.

The RESET line is necessary to check for system power-up. The 68000's data page distinguishes between two different reset conditions. On power-up, RESET and HALT are switched low for at least 100 milliseconds, to set up a proper initialization. Every other initialization requires a low impulse of at least 4 "beats" on the 68K.

Here is what RESET does in detail. The system byte of the status register is loaded with the value $27. Once the processor is brought into supervisor

status, the Trace flag in the status register is cleared, and the interrupt leve is set to 7 (lowest priority, all lines allowable). Additionally, the supervisc stack pointer and program counter are loaded with the contents of the first bytes of memory, whereby the value of the program counter is set to th beginning of the reset routine.

However, since the RESET line is bi-directional, the processor can alsc have RESET under program control during the time the line is low. Thc RESET instruction serves this purpose, when the connection is low for 12- "beats". It's possible to re-initialize the peripheral ICs at any time, withou resetting the computer itself. RESET time puts the 68000 into a NOP state -- a reset is unstoppable once it occurs.

The HALT pin is important to the RESET line's existence (as we mentionec above), in order to initialize things properly. This pin has still more functions: when the pin is low while RESET is high, the processor goes into a halt state. This state causes the DMA pin to set the processor into the tri-state condition. The HALT condition ends when HALT is high again. This signal can be used in the design of single-step control.

HALT is also bi-directional. When the processor signals this line to become low, it means that a major error has occurred (e.g., doubled bus and address errors).

A low state on the BERR pin will call up exception handling, which runs basically like an external interrupt. In an orderly system, every access to the asynchronous bus quits with the DTACK signal. When DTACK is outputting, however, the hardware can produce a BERR, which informs the processor of any errors found. A further use for BERR is in connection with the MMU, to test for proper memory access of a specific range; this access is signaled by the FC pins. If protected memory is tried for in user mode, a BERR will turn up.

When both BERR and HALT are low, the processor will "re-execute" the instruction at which it stopped. If it doesn't run properly on the second "go-round", then it's called a *doubled* bus error, and the processor halts.

The eighth group of connections are for voltage and ground.

1.2 The Custom Chips

The Atari ST has four specially developed ICs. These chips (GLUE, MMU, DMA and SHIFTER) play a major role in the low price of the ST, since each chip performs several hundred overlapping functions. The first prototype of the ST was 5 X 50 X 30 cm. in size, mostly to handle all those TTL ICs. Once multiple functions could be crammed into four ICs, the ST became a saleable item. Then again, the present ST hasn't quite reached the ultimate goal -- it still has eight TTLs.

Naturally, since these chips were specifically designed by Atari for the ST, they haven't been publishing any spec sheets. Even without any data specs, we can give you quite a bit of information on the workings of the ICs.

An interesting fact about these ICs is that they're designed to work in concert with one another. For example, the DMA chip can't operate alone. It hasn't an address counter, and is incapable of addressing memory on its own (functions which are taken care of by the MMU). It's the same with SHIFTER -- it controls video screen and color, but it can't address video RAM. Again, MMU handles the addressing.

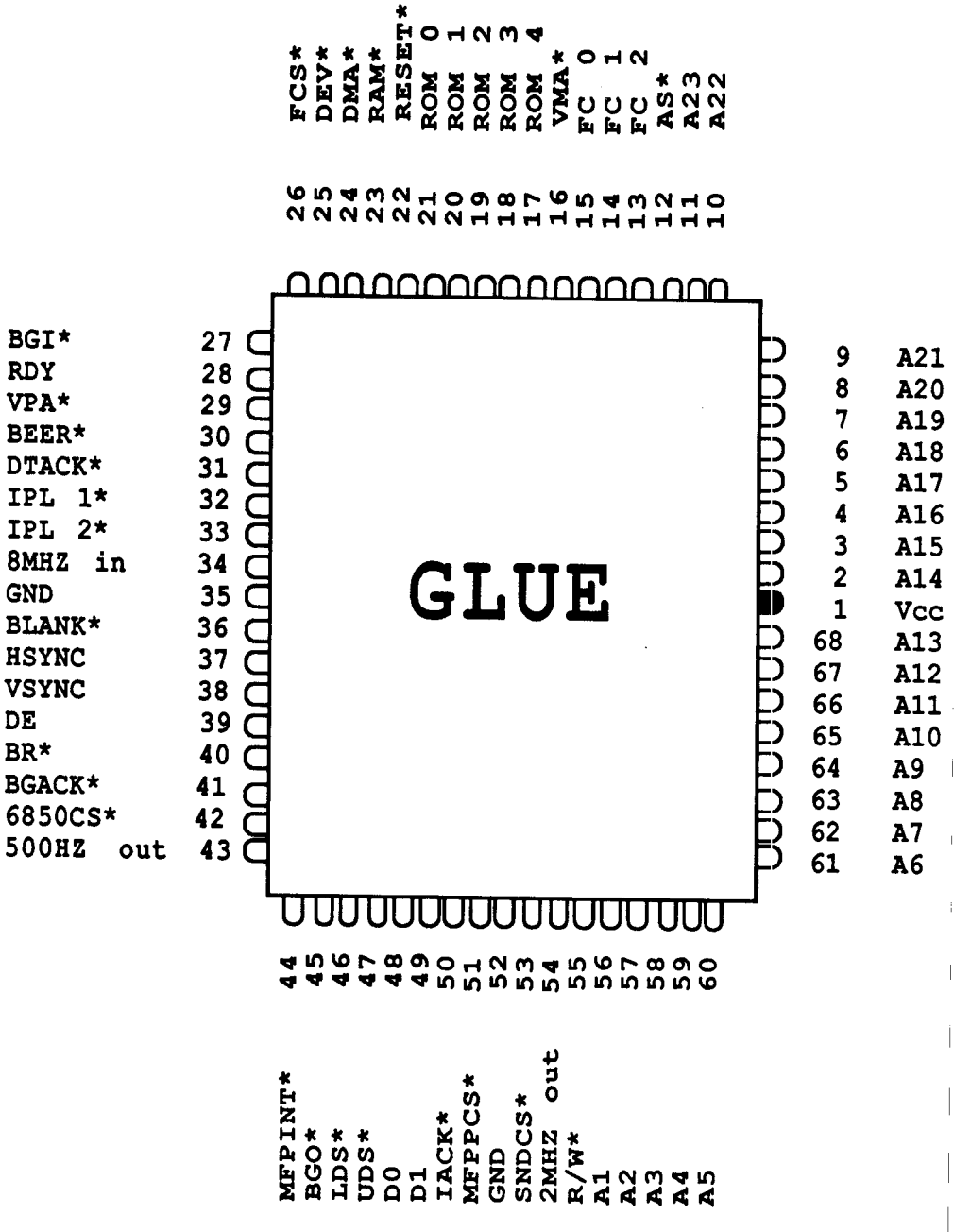
The system programmer can easily figure out which IC has which register. It is only essential to be able to recognize the address of the register, and how to control it. We're going to spend some time in this chapter exploring the pins of the individual ICs.

The most important IC of the "foursome" is GLUE. Its title speaks for the function -- a glue or paste. This IC, with its 68 pins, literally holds the entire system together, including decoding the address range and working the peripheral ICs.

Furthermore, the DMA handshake signals BR, BG and BGACK are produced/output by GLUE. The time point for DMA request is dictated by GLUE by the signal from the DMA controller. GLUE also has a BG (Bus Grant) input, as well as a BGO (Bus Grant Out).

The interrupt signal is produced by GLUE; in the ST, only IPL1 and IPL2 are used for this. Without other hardware, you can't use NMI (interrupt level 7). The pins MFPINT and IACK are used for interrupt control.

Figure 1.2-1 GLUE



The function code pins are guided by GLUE, where memory access tasks are performed (range testing and access authorization). Needless to say, the BERR signal is also handled by this chip. VPA is particularly important to the peripheral ICs and the appropriate select signals.

GLUE generates a timing frequency of 8 mHz. Frequencies between 2 mHz (sound chip's operating frequency) and 500 kHz (timing for keyboard and MIDI interface) can be produced.

HSYNC, VSYNC, BLANK and DE (Display Enable) are generated by GLUE for monitor operation. The synchronous timing can be switched on and off, and external sync-signals sent to the monitor. This will allow you to synchronize the ST's screen with a video camera.

The MMU also has a total of 68 pins. This IC performs three vital tasks. The most important task is coupling the multiplexed address bus of dynamic RAM with the processor's bus (handled by address lines A1 to A21). This gives us an address range totaling 4 megabytes. Dynamic RAM is controlled by RAS0, RAS1, CAS0L, CAS0H, CAS1L and CAS1H, as well as the multiplexed address bus on the MMU. DTACK, R/W, AS, LDS and UDS are also controlled by MMU.

We've already mentioned another important function of the MMU: it works with the SHIFTER to produce the video signal (the screen information is addressed in RAM, and SHIFTER conveys the information). Counters are incorporated in the MMU for this; a starting value is loaded, and within 500 nanoseconds, a word is addressed in memory and the information is sent over DCYC. The starting value of the video counter (and the screen memory position) can be shifted in 256-byte increments.

Another integrated counter in MMU, as mentioned earlier, is for addressing memory using the DMA. This counter begins with every DMA access (disk or hard disk), loading the address of the data being transferred. Every transfer automatically increments the counter.

The SHIFTER converts the information in video RAM into impulses readable on a monitor. Whether the ST is in 640 X 200 or 320 X 200 resolution, SHIFTER is involved.

Figure 1.2-2 MMU

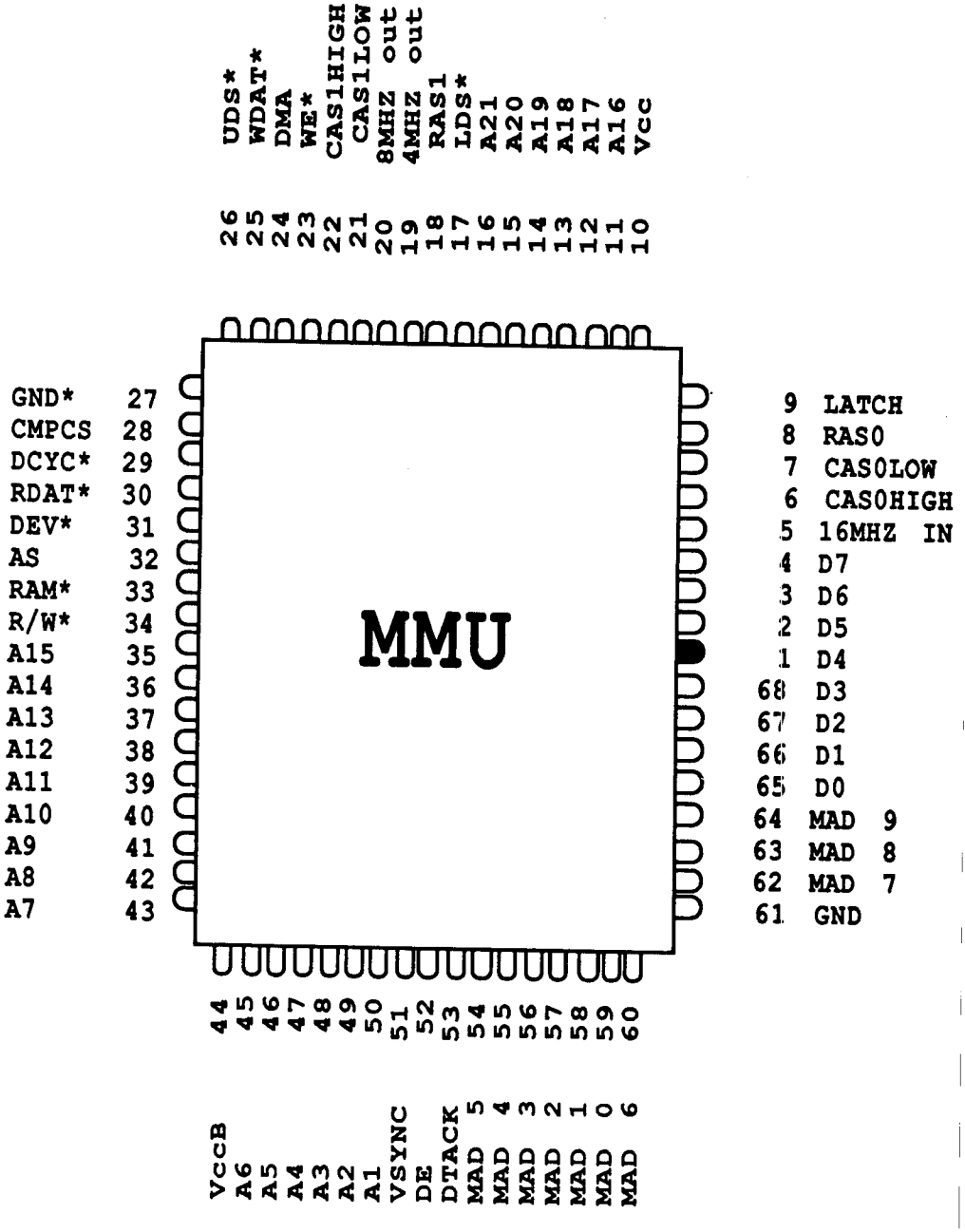
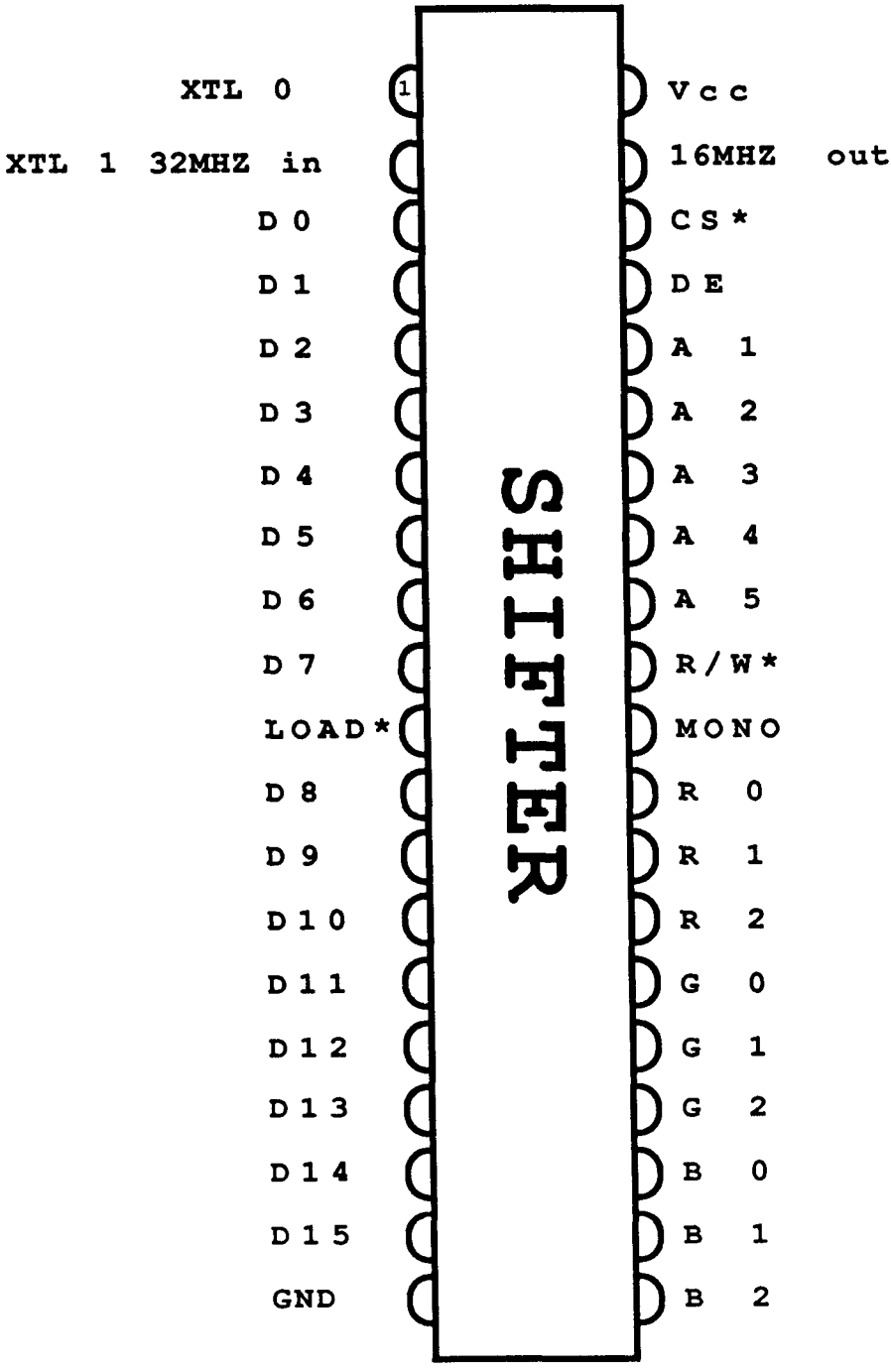


Figure 1.2-3 SHIFTER



The information from RAM is transferred to SHIFTER on the signa LOAD. A resolution of 640 X 400 points sends the video signal over th MONO connector. Since color is impossible in that mode, the RG connection is rendered inactive. The other two resolutions set MON output to inactive, since all screen information is being sent out the RG connection in those cases.

The third color connection works together with external equipment as digital/analog converter. Individual colors are sent out over different pins to give us color on our monitor. Pins R1- R5 on the address bus make u the "palette registers". These registers contain the color values, which ar placed in individual bit patterns. The 16 palette registers hold a total of 1 colors for 320 X 200 mode. Note, however, that since these are based o the "primary" colors red, green and blue, these colors can be adjusted in steps of brightness, bringing the color total to 512.

The DMA controller is like SHIFTER, only in a 40-pin housing; it is use to oversee the floppy disk controller, the hard disk, and any othe peripherals that are likely to appear.

The speed of data transfer using the floppy disk drive offers no problems t the processor. It's different with hard disks; data moves at such high spee that the 68000 has to send a "pause" over the 8 mHz frequency. This pac is made possible by the DMA.

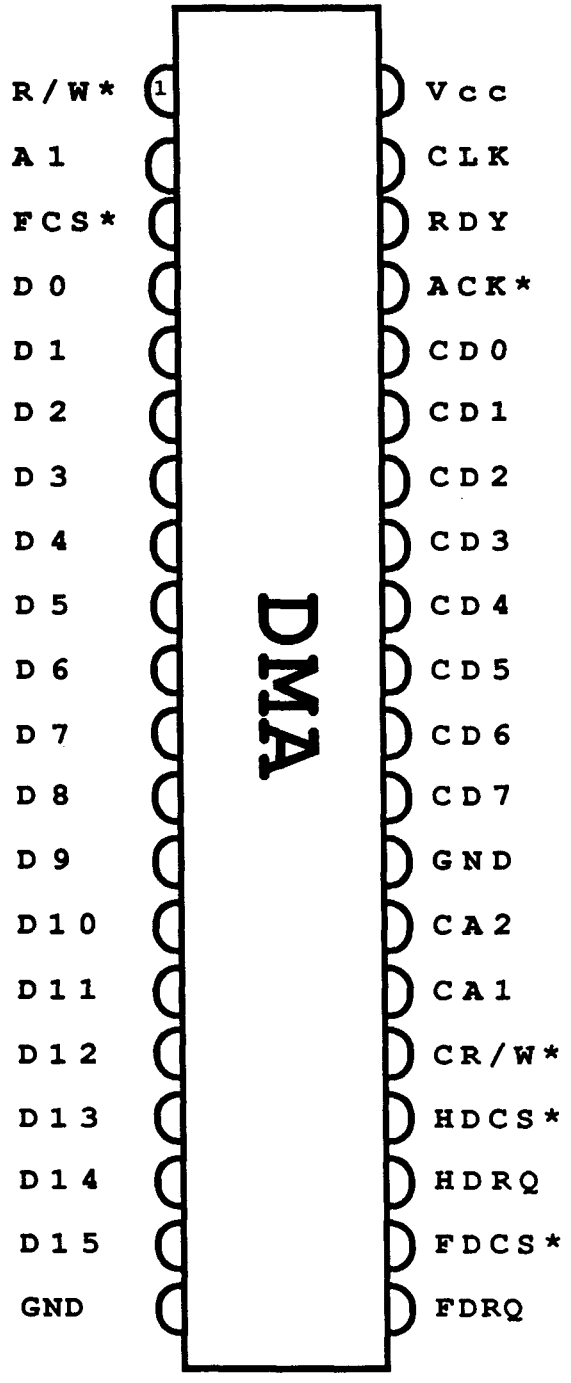
The DMA is joined to the processor's data bus to help transfer data. Tw registers within the machine act as a bi-directional buffer for data throug the DMA port; we'll discuss these registers later. One interesting point The processor's 16-bit data bus is reduced to 8 bits for floppy/hard dis work. Data transfer automatically transfers two bytes per word.

The signals CA1, CA2, CR/W, FDCS and FDRQ manage the floppy dis controller. CA1 and CA2 are signals which the floppy disk controlle (FDC) uses to select registers. CR/W determine the direction of data transfer from/to the FDC, and other peripherals connected to the DMA port.

The RDY signal communicated with GLUE (DMA-request) and MMU (address counter). This signal tells the DMA to transfer a word.

As you can see, these ICs work in close harmony with one another, and each would be almost useless on its own.

Figure 1.2-4 DMA



1.3 The WD 1772 Floppy Disk Controller

Although the 1772 from Western Digital has only 28 pins, this chip conta a complete floppy disk controller (FDC) with capabilities matching 40-p controllers. This IC is software-compatible with the 1790/2790 seri Here are some of the 1772's features:

Simple 5-volt current
Built-in data separator
Built-in copy compensation logic
Single and double density
Built-in motor controls

Although the user has his/her choice of disk format, e.g. sector lengt number of sectors per track and number of tracks per diskette, the "norma format is the optimum one for data transfer. So, Apple or Commodo diskettes can't be used.

Before going on to details of the FDC, let's take a moment to look at the pins of this IC.

1.3.1 1772 Pins

These pins can be placed in three categories. The first group consists of t power connections.

Vcc:

+5 volts current.

GND:

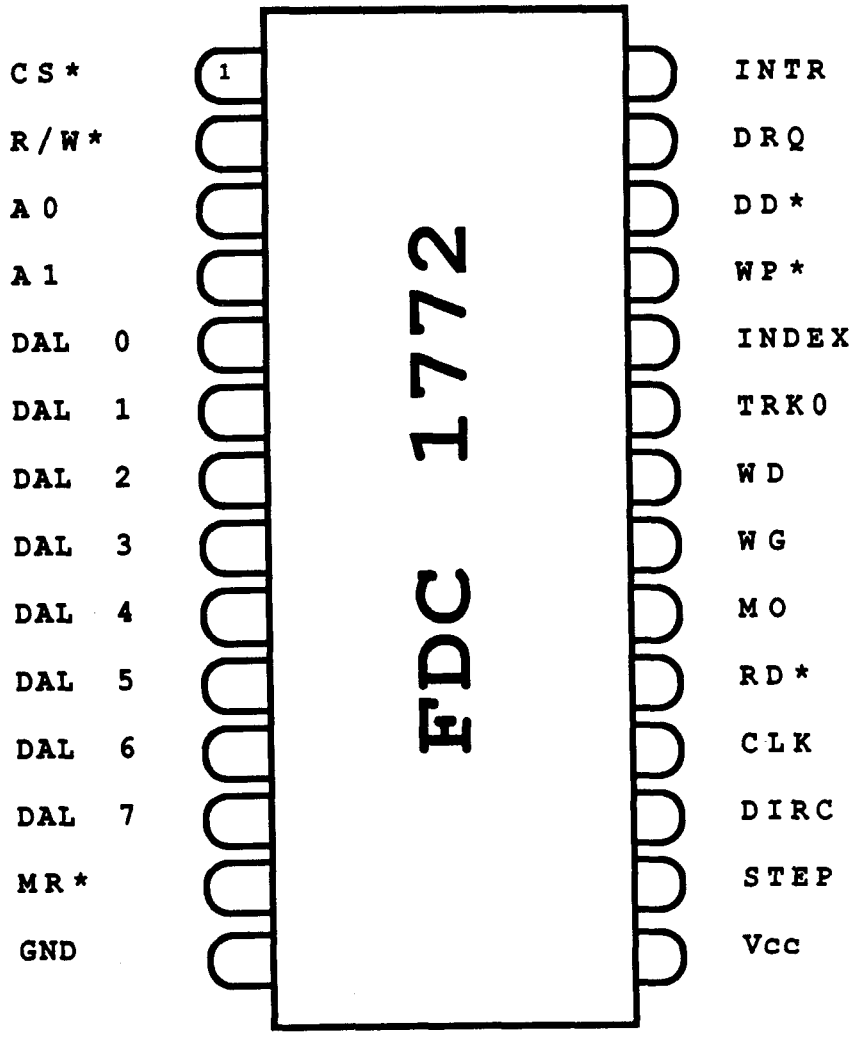
Ground connection.

MR:

Master reset. FDC reinitializes when this is low.

The second set are processor interface pins. These pins carry data betwe the processor and the FDC.

Figure 1.3-1 FDC 1772



D0-D7:

Eight-bit bi-directional bus; data, commands and stat information go between FDC and system.

CS:

FDC can only access registers when this line is low.

R/W:

Read/Write. This pin states data direction. HIGH= read by FD LOW=write from FDC.

A0,A1:

These bits determine which register is accessed (in conjunctio with R/W). The 1772 has a total of five registers which can bo read and write to some degree. Other registers can only read O write. Here is a table to show how the manufacturer designe them:

A1	A0	R/W=1	R/W=0
0	0	Status Reg.	Command Reg.
0	1	Track Reg.	Track Reg.
1	0	Sector Reg.	Sector Reg.
1	1	Data Reg.	Data Reg.

DRQ:

Data Request. When this output is high, either the data register full (from reading), and must be "dumped", or the data register empty (writing), and can be refilled. This connection aids th DMA operation of the FDC.

CLK:

Clock. The clock signal counts only to the processor bus. A input frequency of 8 mHz must be on, for the FDC's intern timing to work.

The third group of signals make up the floppy interface.

STEP:

Sends an impulse for every step of the head motor.

DIRC:

Direction. This connection decides the direction of the head; hig moves the head towards center of the diskette.

D:

Read Data. Reads data from the diskette. This information contains both timing and data impulses -- it is sent to the internal data separator for division.

IO:

Motor On. Controls the disk drive motor, which is automatically started during read/write/whatever operations.

VG:

Write Gate. WG will be low before writing to diskette. Write logic would be impossible without this line.

VD:

Write Data. Sends serial data flow as data and timing impulses.

'R00:

Track 00. This moves read/write head to track 00. TR00 would be low in this case.

P:

Index Pulse. The index pulses mark the physical beginnings of every track on a diskette. When formatting a disk, the FDC marks the start of each track before formatting the disk.

WPRT:

Write Protect. If the diskette is write-protected, this input will react.

)DEN:

Double Density Enable. This signal is confined to floppy disk control; it allows you to switch between single-density and double-density formats.

1.3.2 1772 Registers

CR (Command Register):
Commands are written in this 8-bit register. Commands shou only be written in CR when no other command is und execution. Although the FDC only understands 11 command we actually have a large number of possibilities for the commands (we'll talk about those later).

STR (Status Register):
Gives different conditions of the FDC, coded into individual bit Command writing depends on the meaning of each bit. Th status register can only be read.

TR (Track Register):
Contains the current position of the read/write head. Ever movement of the head raises or lowers the value of T appropriately. Some commands will read the contents of TR along with information read from the disk. The result affects th Status Register. TR can be read/written.

SR (Sector Register):
SR contains the number of sectors desired from read/wri operations. Like TR, it can be used for either operation.

DR (Data Register):
DR is used for writing data to/ reading data from diskette.

3.3 Programming the FDC

ɔgramming this chip is no big deal for a system programmer. Direct (and most cases, unnecessary) programming is made somewhat harder AND astically simpler by the DMA chip. The 11 FDC commands are divided o four types.

Type	Function
1	Restore, look for track 00
1	Seek, look for a track
1	Step, a track in previous direction
1	Step In, move head one track in (toward disk hub)
1	Step Out, move head one track out (toward edge of disk)
2	Read Sector
2	Write Sector
3	Read Address, read ID
3	Read Track, read entire track
3	Write Track, write entire track (format)
4	Force Interrupt

ype 1 Commands

hese commands position the read/write head. The bit patterns of these five ɔmmands look like this:

	BIT							
	7	6	5	4	3	2	1	0
Restore	0	0	0	0	H	V	R1	R0
Seek	0	0	0	1	H	V	R1	R0
Step	0	0	1	U	H	V	R1	R0
Step In	0	1	0	U	H	V	R1	R0
Step Out	0	1	1	U	H	V	R1	R0

All five commands have several variable bits; bits R0 and R1 give the ti between two step impulses. The possible combinations are:

R1	R0	STEP RATE
0	0	2 milliseconds
0	1	3 milliseconds
1	0	5 milliseconds
1	1	6 milliseconds

These bits must be set by the command bytes to the disk drive. The V-bi the so-called "verify flag". When set, the drive performs an automa verify after every head movement. The H-bit contains the spin- sequence. The system delays disk access until the disk motor has reach 300 rpm. If the H-bit is cleared, the FDC checks for activation of t motor-on pins. When the motor is off, this pin will be set high (motor o and the FDC waits for 6 index impulses before executing the command. the motor is already running, then there will be no waiting time.

The three different step commands have bit 4 designated a U- bit. Eve step and change of the head appears here.

Type 2 Commands

These commands deal with reading and writing sectors. They also ha individual bits with special meanings.

BIT	7	6	5	4	3	2	1	0
Read Sector	1	0	0	M	H	E	0	0
Write Sector	1	0	1	M	H	E	P	A0

The H-bit is the previously described start-up bit. When the E-bit is set, t FDC waits 30 milliseconds before starting the command. This delay important for some disk drives, since it takes time for the head to char tracks. When the E-bit reads null, the command will run immediately.

The M-bit determines whether one or several sectors are read one af another. On a null reading, only one sector will be read from/written Multi-sector reading sets the bit, and the FDC increments the counter at ea new sector read.

Bits 0 and 1 must be cleared for sector reading. Writing has its own spec meaning: the A0 bit conveys to bit 0 whether a cleared or normal d

ldress mark is to be written. Most operating systems don't use this option normal data address mark is written).

he P-bit (bit 1) dictates whether pre-compensation for writing data is rned on or off. Pre-compensation is normally set on; it supplies a higher egree of protection to the inner tracks of a diskette.

'ype 3 Commands

ead Address gives program information about the next ID field on the iskette. This ID field describes track, sector, disk side and sector length. ead Track gives all bytes written to a formatted diskette, and the data between sectors". Write Track formats a track for data storage. Here are ne bit patterns for these commands:

BIT	7	6	5	4	3	2	1	0
Read Address	1	1	0	0	H	E	0	0
Read Track	1	1	1	0	H	E	0	0
Write Track	1	1	1	1	H	E	P	0

The H- and E-bits also belong to the Type 2 command set (spin-up and head-settle time). The P-bit has the same function as in writing sectors.

Type 4 Commands

There's only one command in this set: Force Interrupt. This command can work with individual bits during another FDC command. When this command comes into play, whatever command was currently running is ended.

BIT	7	6	5	4	3	2	1	0
Force Interrupt	1	1	0	1	I3	I2	I1	I0

Bits I0-I3 present the conditions under which the interrupt is pressed. I0 and I1 have no meaning to the 1772, and remain low. If I2 is set, an interrupt will be produced with every index impulse. This allows for software controlled disk rotation. If I3 is set, an interrupt is forced immediately, and the currently-running command ends. When all bits are null, the command ends without interruption.

1.4 The MFP 68901

MFP is the abbreviation for Multi-Function Peripheral. This name is r exaggeration; wait until you see what it can do! Here's a brief list of th most noteworthy features:

8-bit parallel port
Data direction of every port bit is individually programmabl
Port bits usable as interrupt input
16 possible interrupt sources
Four universal timers
Built-in serial interface

1.4.1 The 68901 Connections

The 48 pins of the MFP are set apart in function groups. The first functio group is the power connection set:

GND, Vcc, CLK:

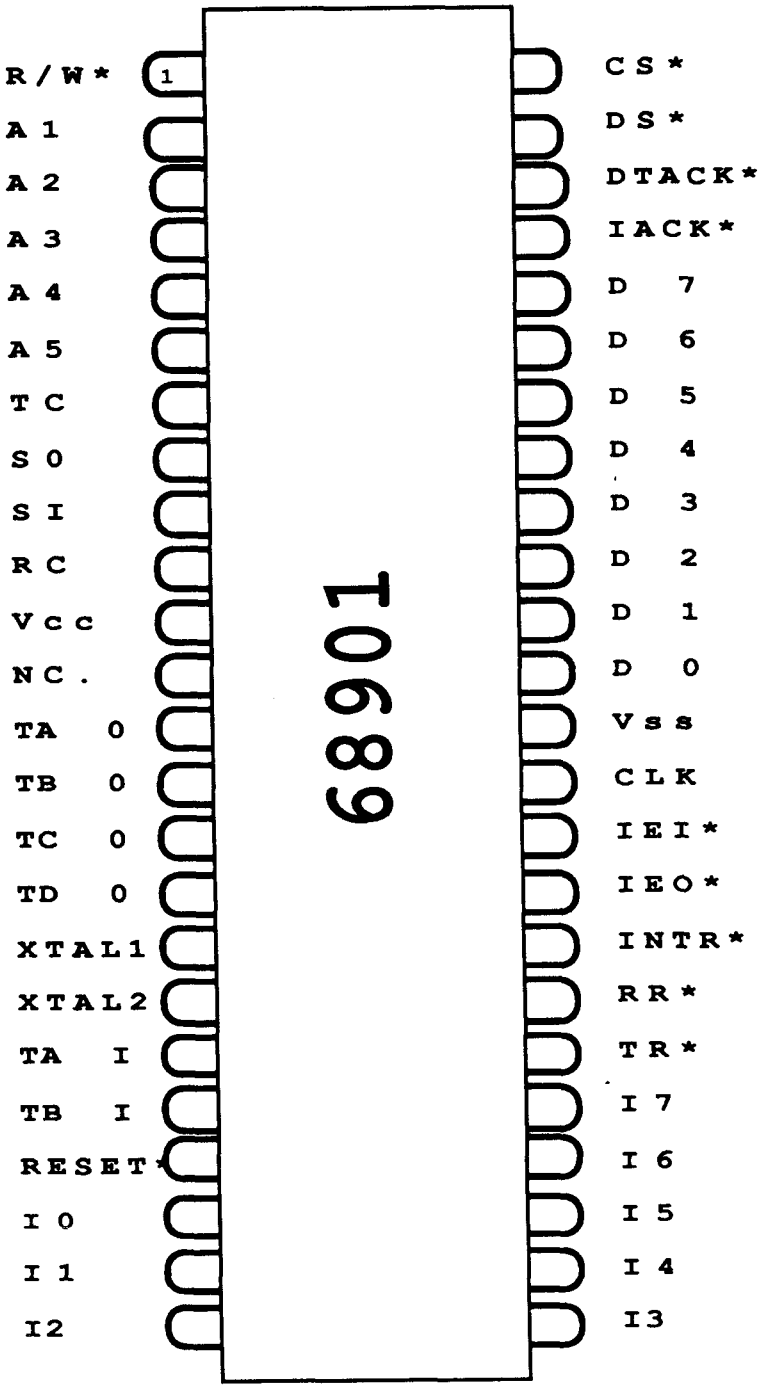
Vcc and GND carry voltage to and from the MFP. CLK is th clock input; this clock signal must not interfere with the syste timer of the processor. The ST's MFP operates at a frequency c 4 mHz.

Communication with the data bus of the processor is maintained wit D0-D7, DTACK, RS1-RS5 and RESET.

D0-D7:

These bi-directional pins normally work with the 8 lowest da bits of the 68000. It is also possible to connect with D8 throug D15, but it's impossible to produce non-auto interrupts. Thu interrupt vectors travel along the low order 8 data bits.

Figure 1.4-1 MFP 68901



CS (Chip Select):
This line is necessary to communication with the MFP. CS active when low.

DS (Data Strobe):
This pin works with either LDS or UDS on the processo Depending on the signal, MFP will operate either the lower upper half of the data bus.

DTACK (Data Transfer ACKnoledge):
This signal shows the status of the bus cycle of the process (read or write).

RS1-RS5 (Register Select):
These pins normally connect with to the bottom five address lin of the processor, and serve to choose from the 24 intern registers.

RESET:
If this pin is low for at least 2 microseconds, the MFP initialize This occurs on power-up and a system reset.

The next group of signals cover interrupt connections (IRQ, IACK, IEI ar IEO).

IRQ (Interrupt ReQuest):
IRQ will be low when an interrupt is triggered in the MFP. Th informs the processor of interrupts.

IACK (Interrupt ACKnowledge):
On an interrupt (IRQ and IEI), the MFP sends a low signal ov IACK and DS on the data lines. Since 16 different interru sources are available, this makes handling interrupts muc simpler.

IEI, IEO (Interrupt Enable In/ Out):
These two lines permit daisy-chaining of several MFPs, ar determine MFP priority by their positioning in this chain. I would work through the MFP with the highest priority. IEO the second MFP would remain unswitched. On an interrupt, signal is sent over IACK, and the first MFP in the chain wi acknowledge with a high IEO.

Next, we'll look at the eight I/O lines.

O0-7 (Input/Output):
These pins use one or all normal I/O lines. The data direction of each port bit is set up in a data direction register of its own. In addition, though, every port bit can be programmed to be an interrupt input.

The timer pins make up yet another group of connections:

XTAL1,2 (Timer Clock Crystal):
A quartz crystal can be connected to these lines to deliver a working frequency for the four timers.

TAI,TBI (Timer Input):
Timers A and B can not only be used as real counters differently from timers C and D with the frequency from XTAL1 and 2, but can also be set up for event counting and impulse width measurement. In both these cases, an external signal (Timer Input) must be used.

TAO,TBO,TCO,TDO (Timer Output):
Every timer can send out its status on each peg (from 01 to 00). Each impulse is equal to 01.

The second-to-last set of signals are the connections to the universal serial interface. The built-in full duplex of the MFP can be run synchronously or asynchronously, and in different sending and receiving baud rates.

SI (Serial Input):
An incoming bit current will go up the SI input.

SO (Serial Output):
Outgoing bit voltage (reverse of SI).

RC (Receiver Clock):
Transfer speed of incoming data is determined by the frequency of this input; the source of this signal can, for example, be one of the four timers.

TC (Transmitter Clock):
Similar to RC, but for adjusting the baud-rate of data being transmitted.

The final group of signals aren't used in the Atari ST. They are necessa when the serial interface is operated by the DMA.

RR (Receiver Ready):
This pin gives the status of the receiving data registers. If character is completely received, this pin sends current.

TR (Transmitter Ready):
This line performs a similar function for the sender section of th serial interface. Low tells the DMA controller that a ne character in the MFP must be sent.

1.4.2 The MFP Registers

As we've already mentioned, the 68901 has a total of 24 different register This large number, together with the logical arrangement, make programming the MFP much easier.

Reg 1 GPIP, General Purpose I/O Interrupt Port
This is the data register for the 8-bit ports, where data from th port bits is sent and read.

Reg 2 AER, Active Edge Register
When port bits are used for input, this register dictates whethe the interrupt will be a low-high- or high-low conversion. Zero i used in the high-low change, one for low-high.

Reg 3 DDR, Data Direction Register
We've already said that the data direction of individual port bit can be fixed by the user. When a DDR bit equals 0, the corresponding pin becomes an input, and 1 makes it an output Port bit positions are influenced by AER and DDR bits.

Reg 4,5 IERA,IERB, Interrupt Enable Register

Every interrupt source of the MFP can be separately switched on and off. With a total of 16 sources, two 8-bit registers are needed to control them. If a 1 has been written to IERA or IERB, the corresponding channel is enabled (turned on). Conversely, a zero disables the channel. If it comes upon a closed channel caused by an interrupt, the MFP will completely ignore it. The following table shows which bit is coordinated with which interrupt occurrence:

```
IERA
Bit 7: I/O port bit 7 (highest priority)
Bit 6: I/O port bit 6
Bit 5: Timer A
Bit 4: Receive buffer full
Bit 3: Receive error
Bit 2: Sender buffer empty
Bit 1: Sender error
Bit 0: Timer B

IERB
Bit 7: I/O port bit 5
Bit 6: I/O port bit 4
Bit 5: Timer C
Bit 4: Timer D
Bit 3: I/O port bit 3
Bit 2: I/O port bit 2
Bit 1: I/O port bit 1
Bit 0: I/O port bit 0, lowest priority
```

This arrangement applies to the IP-, IM- and IS-registers discussed below.

Reg 6,7 IPRA,IPRB, Interrupt Pending Register

When an interrupt occurs on an open channel, the appropriate bit in the Interrupt Pending Register is set to 1. When working with a system that allows vector creation, this bit will be automatically cleared when the MFP puts the vector number on the data bus. If this possibility doesn't exist, the IPR must be cleared using software. To clear a bit, a byte in the MFP will show the location of the specific bit.

The bit arrangement of the IPR is shown in the table for registers 4 and 5 (see above).

Reg 8,9 ISRA,ISRB,Interrupt In-Service Register

The function of these registers is somewhat complicated, an depends upon bit 3 of register 12. This bit is an S-bit, whic determines whether the 68901 is working in "Software End-o Interrupt" mode (SEI) or in "Automatic End-of-Interrupt" mod (AEI). AEI mode clears the IPR (Interrupt Pending Bit), whe the processor gets the vector number from the MFP during a IACK cycle. The appropriate In-Service bit is cleared at the sam time. Now a new interrupt can occur, even when the previou interrupt hasn't finished its work.

SEI mode sets the corresponding ISR-bit when the vecto number of the interrupt is requested by the processor. At th interrupt routine's end, the bit designated within the MFP mus be cleared. As long as the Interrupt In-Service bit is set, al interrupts of lower priority are masked out by the MFP. Once th Pending-bit of the active channel is cleared, the same sort o interrupt can occur a second time, and interrupts of lesser priorit can occur as well.

Reg 10,11 IMRA,IMRB Interrupt Mask Register

Individual interrupt sources switched on by IER can be masked with the help of this register. That means that the interrupt is recognized from within and is signalled in the IPR, even if the IRQ line remains high.

Reg 12 VR Vector Register

In the cases of interrupts, the 68901 can generate a vector number corresponding to the interrupt source requested by the processor during an Interrupt Acknowledge Cycle. All 16 interrupt channels have their own vectors, with their priorities coded into the bottom four bits of the vector number (the upper four bits of the vector are copied from the vector register). These bits must be set into VR, therefore.

Bit 3 of VR is the previously mentioned S-bit. If this bit is set (like in the ST), then the MFP operates in "Software End-of-Interrupt" mode; a cleared bit puts the system into "Automatic End-of-Interrupt" mode.

Reg 13,14 TACR,TBCR Timer A/B Control Register

Before proceeding with these registers, we should talk for a moment about the timer. Timers A and B are both identical. Every timer consists of a data register, a programmable feature and an 8-bit count-down counter. Contents of the counters will decrease by one every impulse. When the counter stands at 01, the next impulse changes the corresponding timer to the output of its pins. At the same time, the value of the timer data register is loaded into the timer. If this channel is set by the IER bit, the interrupt will be requested. The source of the timer beats will usually be those quartz frequencies from XTAL1 and 2. This operating mode is called delay mode, and is available to timers C and D.

Timers A and B can also be fed external impulses using timer inputs TAI and TBI (in event count mode). The maximum frequency on timer inputs should not surpass 1/4 of the MFP's operating frequency (that is, 1 mHz).

Another peculiarity of this operating mode is the fact that the timer inputs for the interrupts are I/O pins 13 and 14. By programming the corresponding bits in the AER, a pin-jump can be used by the timer inputs to request an interrupt. TAI is joined with pin 13, TBI by pin 14. Pins 13 and 14 can also be used as I/O lines without interrupt capability.

Timers A and B have yet a third operating mode (pulse-length measurement). This is similar to Delay Mode, with the difference that the timer can be turned on and off with TAI and TBI. Also, when pins 13 and 14 are used, the AER-bits can determine whether the timer inputs are high or low. If, say, AER-bit 4 is set, the counter works when TAI is high. When TAI changes to low, an interrupt is created.

Now we come to TACR and TBCR. Both registers only use the fifth through eighth bits. Bits 0 to 3 determine the operating mode of each timer:

```
BIT 3 2 1 0   Function

    0 0 0 0 Timer stop, no function executed
    0 0 0 1 Delay mode, subdivider divides by 4
    0 0 1 0 Delay mode, subdivider divides by 10
    0 0 1 1 Delay mode, subdivider divides by 16
    0 0 1 1 Delay mode, subdivider divides by 16
    0 1 0 0 Delay mode, subdivider divides by 50
    0 1 0 1 Delay mode, subdivider divides by 64
    0 1 1 0 Delay mode, subdivider divides by 100
    0 1 1 1 Delay mode, subdivider divides by 200
    1 0 0 0 Event Count Mode
    1 0 0 1 Pulse extension mode,subdivider divides by 4
    1 0 1 0 Pulse extension mode,subdivider divides by 10
    1 0 1 1 Pulse extension mode,subdivider divides by 16
    1 1 0 0 Pulse extension mode,subdivider divides by 50
    1 1 0 1 Pulse extension mode,subdivider divides by 64
    1 1 1 0 Pulse extension mode,subdivider divides by 10(
    1 1 1 1 Pulse extension mode,subdivider divides by 20(
```

Bit 4 of the Timer Control Register has a particular function This bit can produce a low reading for the timer being used with it at any time. However, it will immediately go high when the timer runs.

Reg 15 TCDCR Timers C and D Control Register

Timers C and D are available only in delay mode; thus, one byte controls both timers. The control information is programmed into the lower three bits of the nibbles (four- bit halves). Bits 0 and 2 arrange Timer D, Timer C is influenced by bits 4 and 6. Bits 3 and 7 in this register have no function.

```
Bit   2 1 0     Function - Timer D
Bit   6 5 4     Function - Timer C
      0 0 0     Timer Stop
      0 0 1     Delay Mode, division by 4
      0 1 0     Delay Mode, division by 10
      0 1 1     Delay Mode, division by 16
      1 0 0     Delay Mode, division by 50
      1 0 1     Delay Mode, division by 64
      1 1 0     Delay Mode, division by 100
      1 1 1     Delay Mode, division by 200
```

Reg 16-19 TADR,TBDR,TCDR,TDDR Timer Data Registers

The four Timer Data Registers are loaded with a value from the counter. When a condition of 01 is reached, an impulse occurs. A continuous countdown will stem from this value.

Reg 20 SCR Synchronous Character Register

A value will be written to this register by synchronous data transfer, so that the receiver of the data will be alerted. When synchronous mode is chosen, all characters received will be stored in the SCR, after first being put into the receive buffer.

Reg 21 UCR,USART Control Register

USART is short for Universal Synchronous/Asynchronous Receiver/Transmitter. The UCR allows you to set all the operating parameters for the interfaces. Parameters can also be coded in with the timers.

```
Bit 0      : unused
Bit 1      : 0=Odd parity
             1=Even parity

Bit 2      : 0=No parity (bit 1 is ignored)
             1=Parity according to bit 1

Bits 3,4   : These bis control the number of
             start- and stopbits and the
             format desired.
   Bit  4 3 Start Stop Format
        0 0   0     0   Synchronous
        0 1   1     1   Asynchronous
        1 0   1     1,5 Asynchronous
        1 1   1     2   Asynchronous

Bits 5,6   :  These bits give the
              "wordlength" of the data bits
              to be transferred.
   Bits 6 5 Word length
        0 0 8 bits
        0 1 7 bits
        1 0 6 bits
        1 1 5 bits
```

```
Bit 7      :  0=Frequency from TC and RC
                directly used as transfer
                frequency (used only for
                synchronous transfer)
                1=Frequency in TC and RC
                internally divided by 16.
```

Reg 22 RSR Receiver Status Register

The RSR gives information concerning the conditions of a receivers. Again, the different conditions are coded int individual bits.

Bit 0 Receiver Enable Bit

When this bit is cleared, receipt is immediately turned off All flags in RSR are automatically cleared. A set bit mean that the receiver is behaving normally.

Bit 1 Synchronous Strip Enable

This bit allows synchronous data transfer to determin whether or not a character in the SCR is identical to character in the receive buffer.

Bit 2 Match/Character in Progress

When in synchronous transfer format, this bit signals that character identical with the SCR byte would be received In asynchronous mode, this bit is set as soon as the startbi is recognized. A stopbit automatically clears this bit.

Bit 3 Found - Search/Break Detected

This bit is set in synchronous transfer format, when character received coincides with one stored in the SCR This condition can be treated as an interrupt over the receiver's error channel. Asynchronous mode will cause the bit to set when a BREAK is received. The break condition is fulfilled when only zeroes are received following a startbit. To distinguish between a BREAK from a "real" null, this line should be low.

Bit 4 Frame Error

A frame error occurs when a byte received is not a null, bu the stopbit of the byte IS a null.

Bit 5 Parity Error
The condition of this bit gives information as to whether parity on the last received character was correct. If the parity test is off, the PE bit is untouched.

Bit 6 Overrun Error
This bit will be set when a complete character is in the receiver floating range but not read into the receive buffer. This error can be operated as an interrupt.

Bit 7 Buffer Full
This bit is set when a character is transferred from the floating register to the receive buffer. As soon as the processor reads the byte, the bit is cleared.

Reg 23 TSR Transmitter Status Register
Whereas the RSR sends receiver information, the TSR handles transmission information.

Bit 0 Transmitter Enable
The sending section is completely shut off when this bit is cleared. At the same time the End-bit is cleared and the UE-bit is set (see below). The output to the receiver is set in the corresponding H- and L-bits.

Bits 1,2 High- and Low-bit
These bits let the programmer decide which mode of output the switched-off transmitter will take on. If both bits are cleared,the output is high. High-bit only will create high output; low-bit, low output. Both bits on will switch on loop-back-mode. This state loops the output from the transmitter with receiver input. The output itself is on the high-pin.

Bit 3 Break
The break-bit has no function in synchronous data transfer. In asynchronous mode, though, a break condition is sent when the bit is set.

Bit 4 End of Transmission

If the sender is switched off during running transmission the end-bit will be set as soon as the current character has been sent in its entirety. When no character is sent, the bi is immediately set.

Bit 5 Auto Turnaround

When this bit is set, the receiver is automatically switched on when the transmitter is off, and a character will eventually be sent.

Bit 6 Underrun Error

This bit is switched on when a character in the sender floating register will be sent, before a new character is written into the send buffer.

Bit 7 Buffer Empty

This bit will be set when a character from the send buffer will be transferred to the floating register. The bit is cleared when new data is written to the send buffer.

Reg 24 UDR, USART Data Register

Send/receive data is sent over this register. Writing sends data in the send buffer, reading gives you the contents of the receive buffer.

1.5 The 6850 ACIAs

ACIA is short for "Asynchronous Communications Interface Adapter". This 24-pin IC has all the components necessary for operating a serial interface, as well as error-recognizing and data-formatting capabilities. Originally for 6800-based computers, this chip can be easily tailored for 6502 and 68000 systems. The ST has two of these chips. One of them communicates with the keyboard, mouse, joystick ports, and runs the clock. Keyboard data travels over a serial interface to the 68000 chip. The second ACIA is used for operating the MIDI interface.

Parameter changes in the keyboard ACIA are not recommended: The connection between keyboard and ST can be easily disrupted. The MIDI interface is another story, though -- we can create all sorts of practical applications. Incidentally, nowhere else has it been mentioned that the MIDI connections can be used for other purposes. One idea would be to use the MIDI interfaces of several STs to link them together (for schools or offices, for example).

1.5.1 The Pins of the 6850

For those of you readers who aren't very well-acquainted with the principles of serial data transfer, we've included some fairly detailed descriptions in the pin layout which follows.

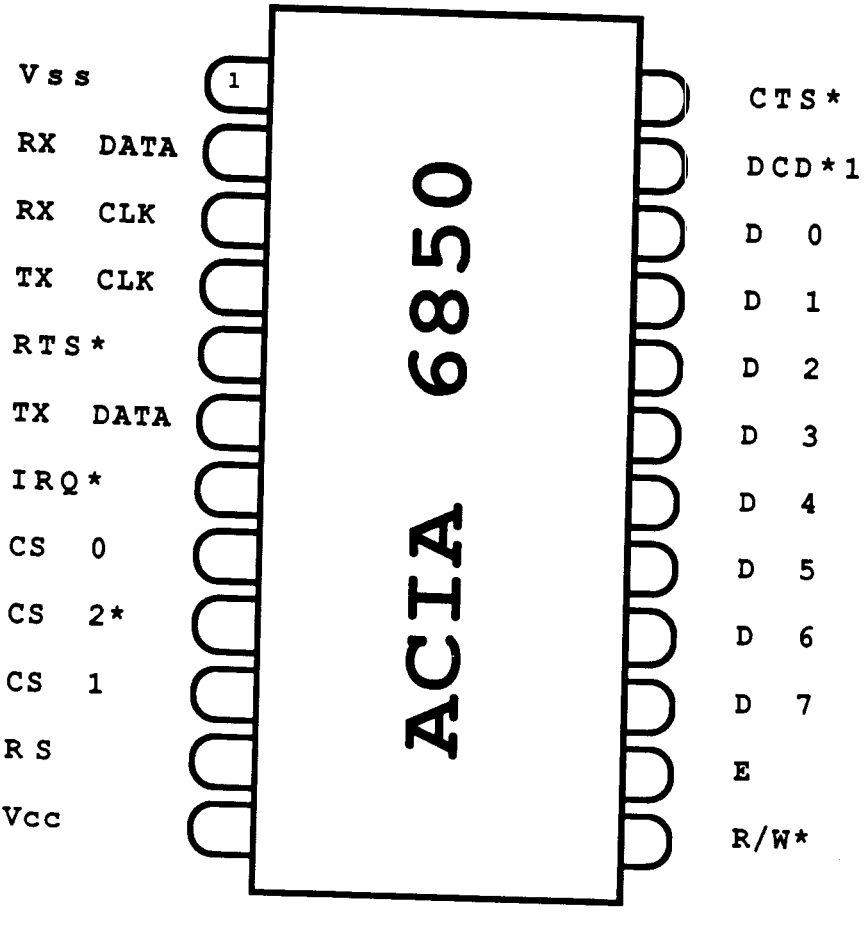
Vss

This connection is the "ground wire" of the IC.

RX DATA Receive Data

This pin receives data; a start-bit must precede the least significant data-bit before receipt.

Figure 1.5-1 ACIA 6850



RX CLK Receive Clock

This pin signal determines baud-rate (speed at which the data is received), and is synchronize to the incoming data. The frequency of RX CLK is patterned after the desired transfer speed and after the internally programmed division rate.

TX CLK Transmitter Clock

Like RX CLK, only used for transmission speed.

RTS Request To Send

This output signals the processor whether the 6850 is low or high; mostly used for controlling data transfer. A low output will, for example, signal a modem that the computer is ready to transmit.

TX DATA Transmitter Data

This pin sends data bit-wise (serially) from the computer.

IRQ Interrupt Request

Different circumstances set this pin low, signaling the 68000 processor. Possible conditions include completed transmission or receipt of a character.

CS 0,1,2 Chip Select

These three lines are needed for ACIA selection. The relatively high number of CS signals help minimize the amount of hardware needed for address decoding, particularly in smaller computer systems.

RS Register Select

This signal communicates with internal registers, and works closely with the R/W signal. We shall talk about these registers later.

Vcc Voltage

This pin is required of all ICs -- this pin gets an operating voltage of 5V.

R/W Read/Write

This tells the processor the "direction" of data traveling through the ACIA. A high signal tells the processor to read data, and low writes data in the 6850.

E Enable

The E-signal determines the time of reading/writing. Al read/write processes with this signal must be synchronous.

D0 - D7 Data

These data lines are connected to those of the 68000. Until th ACIA is accessed, these bidirectional lines are all high.

DCD Data Carrier Detect

A modem control signal, which detects incoming data. Whe DCD is high, serial data cannot be received.

CTS Clear To Send

CTS answers the computer on the signal RTS. Data transmissio is possible only when this pin is low.

1.5.2 The Registers of the 6850

The 6850 has four different registers. Two of these are read only. Two o them are write only. These registers are distinguished by R/W and RS after the table below:

R/W	RS	Register	Access
0	0	Control Register	write
0	1	Sender Register	write
1	0	Status Register	read
1	1	Receive Register	read

The sender/receiver registers (also known as the RX- and TX- buffers) ar for data transfer. When receiving is possible, the incoming bits are put in a shift register. Once the specified number of bits has arrived, the contents o the shift register are transferred to the TX buffer. The sender works i much the same way, only in the reverse direction (RX buffer to sender shif register).

The Control Register

The eight-bit control register determines internal operations. To solve the problem of controlling diverse functions with one byte, single bits are set up as below:

CR 0,1

These bits determine by which factor the transmitter and receiver clock will be divided. These bits also are joined with a master reset function. The 6850 has no separate reset line, so it must be accomplished through software.

CR1	CR0	
0	0	RXCLK/TXCLK without division
0	1	RXCLK/TXCLK by 16 (for MIDI)
1	0	RXCLK/TXCLK by 64 (for keyboard)
1	1	Master RESET

CR 2,3,4

These so-called Word Select bits tell whether 7 or 8 data-bits are involved; whether 1 or 2 stop-bits are transferred; and the type of parity.

CR4	CR3	CR2	
0	0	0	7 databits, 2 stopbits, even parity
0	0	1	7 databits, 2 stopbits, odd parity
0	1	0	7 databits, 1 stopbit, even parity
0	1	1	7 databits, 1 stopbit, odd parity
1	0	0	8 databits, 2 stopbit, no parity
1	0	1	8 databits, 1 stopbit, no parity
1	1	0	8 databits, 1 stopbit, even parity
1	1	1	8 databits, 1 stopbit, odd parity

CR 6,5

These Transmitter Control bits set the RTS output pin, and allow or prevent an interrupt through the ACIA when the send register is emptied. Also, BREAK signals can be sent over the serial output by this line. A BREAK signal is nothing more than a long sequence of null bits.

CR6	CR5	
0	0	RTS low, transmitter IRQ disabled
0	1	RTS low, transmitter IRQ enabled
1	0	RTS high, transmitter IRQ disabled
1	1	RTS low, transmitter IRQ disabled, BREAK sent

CR 7

The Receiver Interrupt Enable bit determines whether the receiver interrupt will be on. An interrupt can be caused by the DCD line changing from low to high, or by the receiver data buffer filling. Besides that, an interrupt can occur from an OVERRUN (a received character isn't properly read from the processor).

CR7	
0	Interrupt disabled
1	Interrupt enabled

The Status Register

The Status Register gives information about the status of the chip. It also has its information coded into individual bytes.

SR0

When this bit is high, the RX data register is full. The byte must be read before a new character can be received (otherwise an OVERRUN happens).

SR1

This bit reflects the status of the TX data buffer. An empty register sets the bit.

SR2

A low-high change on pin DCD sets SR2. If the receiver interrupt is allowable, the IRQ will be cancelled. The bit is cleared when the status register and the receiver register are read. This also cancels the IRQ. SR2 register remains high if the signal on the DCD pin is still high; SR2 registers low if DCD becomes low.

SR3

This line shows the status of CTS. This signal cannot be altered by a master reset, or by ACIA programming.

SR4

Shows "Frame errors". Frame errors are when no stop-bit is recognized in receiver switching. It can be set with every new character.

SR5

This bit displays the previously mentioned OVERRUN condition. SR5 is reset when the RX buffer is read.

SR6

This bit recognizes whether the parity of a received character is correct. The bit is set on an error.

SR 7

This signals the state of the IRQ pins; this bit makes it possible to switch several IRQ lines on one interrupt input. In cases where an interrupt is program-generated, SR7 can tell which IC cut off the interrupt.

The ACIAs in the ST

The ACIAs have lots of extras unnecessary to the ST. In fact, CTS, DCD and RTS are not connected.

The keyboard ACIA lies at the addresses $FFFC00 and $FFFC02. Built-in parameters are: 8-bit word, 1 stopbit, no parity, 7812.5 baud (500 kHz/64).

The parameters are the same for the MIDI chip, EXCEPT for the baud rate, which runs at 31250 baud (500 kHz/16).

1.6 The YM-2149 Sound Generator

The Yamaha YM-2149, a PSG (programmable sound generator) in the same family as the General Instruments AY-3-8190, is a first-class sound synthesis chip. It was developed to produce sound for arcade games. The PSG also has remarkable capabilities for generating/altering sounds. Additionally, the PSG can be easily controlled by joysticks, the computer keyboard, or external keyboard switching. The PSG has two bidirectional 8-bit parallel ports. Here's some general data on the YM-2149:

- three independently programmable tone generators
- a programmable noise generator
- complete software-controlled analog output
- programmable mixer for tone/noise
- 15 logarithmically raised volume levels
- programmable envelopes (ASDR)
- two bidirectional 8-bit data ports
- TTL-compatible
- simple 5-volt power

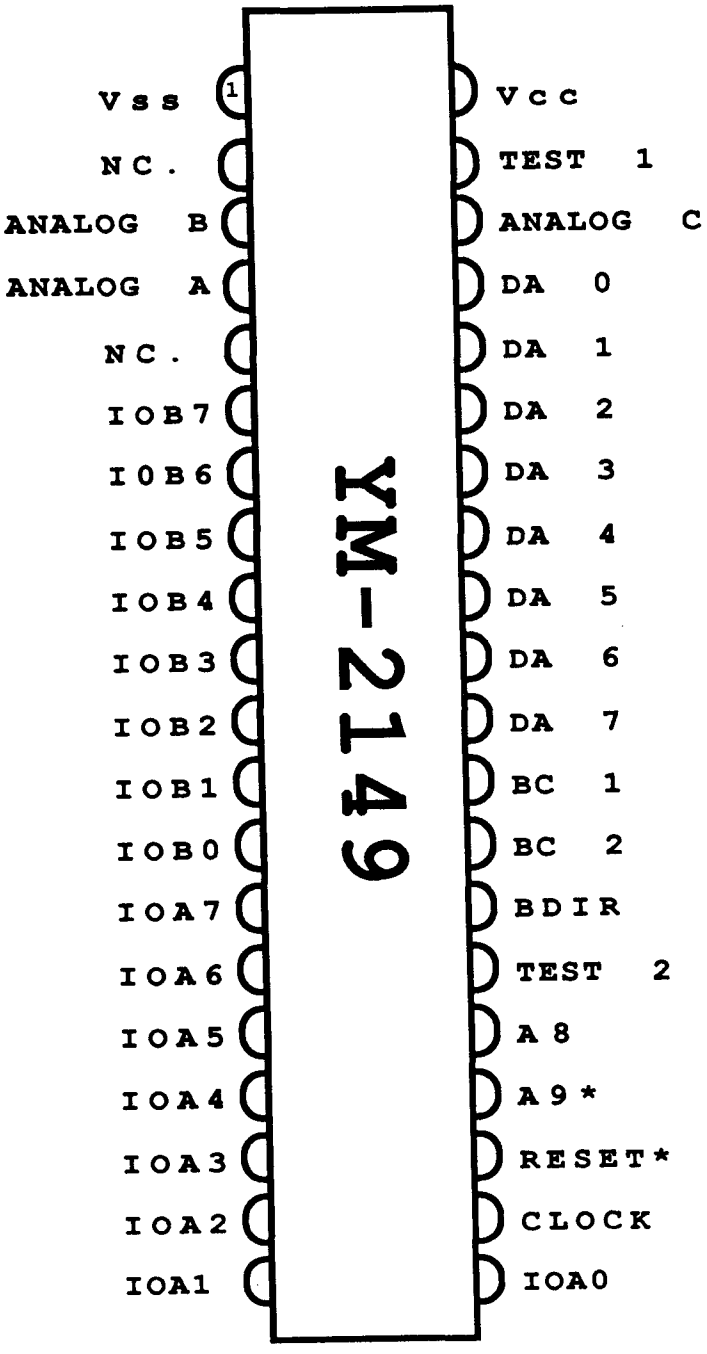
The YM-2149 has a total of 16 registers. All sound capabilities are controlled by these registers.

The PSG has several "functional blocks" each with its own job. The tone generator block produces a square-wave sound by means of a time signal. The noise generator block produces a frequency-modulated square-wave signal, whose pulse-width simulates a noise generator. The mixer couples the three tone generators' output with the noise signal. The channels may be coupled by programming.

The amplitude control block controls the output volume of the three channels with the volume registers; or creates envelopes (Attack, Decay, Sustain, Release, or ADSR), which controls the volume and alters the sound quality.

The D/A converter translates the volume and envelope information into digital form, for external use. Finally one function block controls the two I/O ports.

Figure 1.6-1 Sound chip YM-2149



1.6.1 Sound Chip Pins

Vss:

This is the PSG ground connection.

NC.:

Not used.

ANALOG B:

This is the channel B output. Maximum output voltage is 1 vss.

ANALOG A:

Works like pin 3, but for channel A.

NC.:

Not used.

IOB7 - 0:

The IOB connections make up one of the two 8-bit ports on the chip. These pins can be used for either input or output. Mixed operation (input and output combined) is impossible within one port, however both ports are independent of one another.

IOA7 - 0:

Like IOB, but for port A.

CLOCK:

All tone frequencies are divided by this signal. This signal operates at a frequency between 1 and 2 mHz.

RESET:

A low signal from this pin resets all internal registers. Without a reset, random numbers exist in all registers, the result being a rather unmusical "racket".

A9:

This pin acts as a chip select-signal. When it is low, the PSG registers are ready for communication.

A8:

Similar to A9, only it is active when high.

TEST2:

Test2 is used for testing in the factory, and is unused in normal operation.

BDIR & BC1,2:

The BDIR (Bus DIRection), BC1 and BC2 (Bus Control) pins control the PSG's register access.

BDIR	BC2	BC1	PSG function
0	0	0	Inactive
0	0	1	Latch address
0	1	0	Inactive
0	1	1	Read from PSG
1	0	0	Latch address
1	0	1	Inactive
1	1	0	Write to PSG
1	1	1	Latch address

Only four of these combinations are of any use to us; those with a 5+ voltage running over BC2. So, here's what we have left:

BDIR	BC1	Function
0	0	Inactive, PSG data bus high
0	1	Read PSG registers
1	0	Write PSG registers
1	1	Latch, write register number(s)

DA0 - 7:

These pins connect the sound chip to the processor, through the data bus. The identifier DA means that both data and (register) addresses can be sent over these lines.

ANALOG C:

Works with channel C (see ANALOG B, above).

TEST1:

See TEST2.

Vcc:

+5 volt pin.

1.6.2 The 2149 Registers and their Functions

Now let's look at the functions of the individual registers. One point c interest: the contents of the address register remain unaltered unti reprogrammed. You can use the same data over and over, without havin to send that data again.

Reg 0,1:

These register determine the period length, and the pitch o ANALOG A. Not all 16 bits are used here; the eight bits o register 0 (set frequency) and the four lowest bits of register (control step size). The lower the 12-bit value in the register, th higher the tone.

Reg 2,3:

Same as registers 0 and 1, only for channel B.

Reg 4,5:

Same as registers 0 and 1, only for channel C.

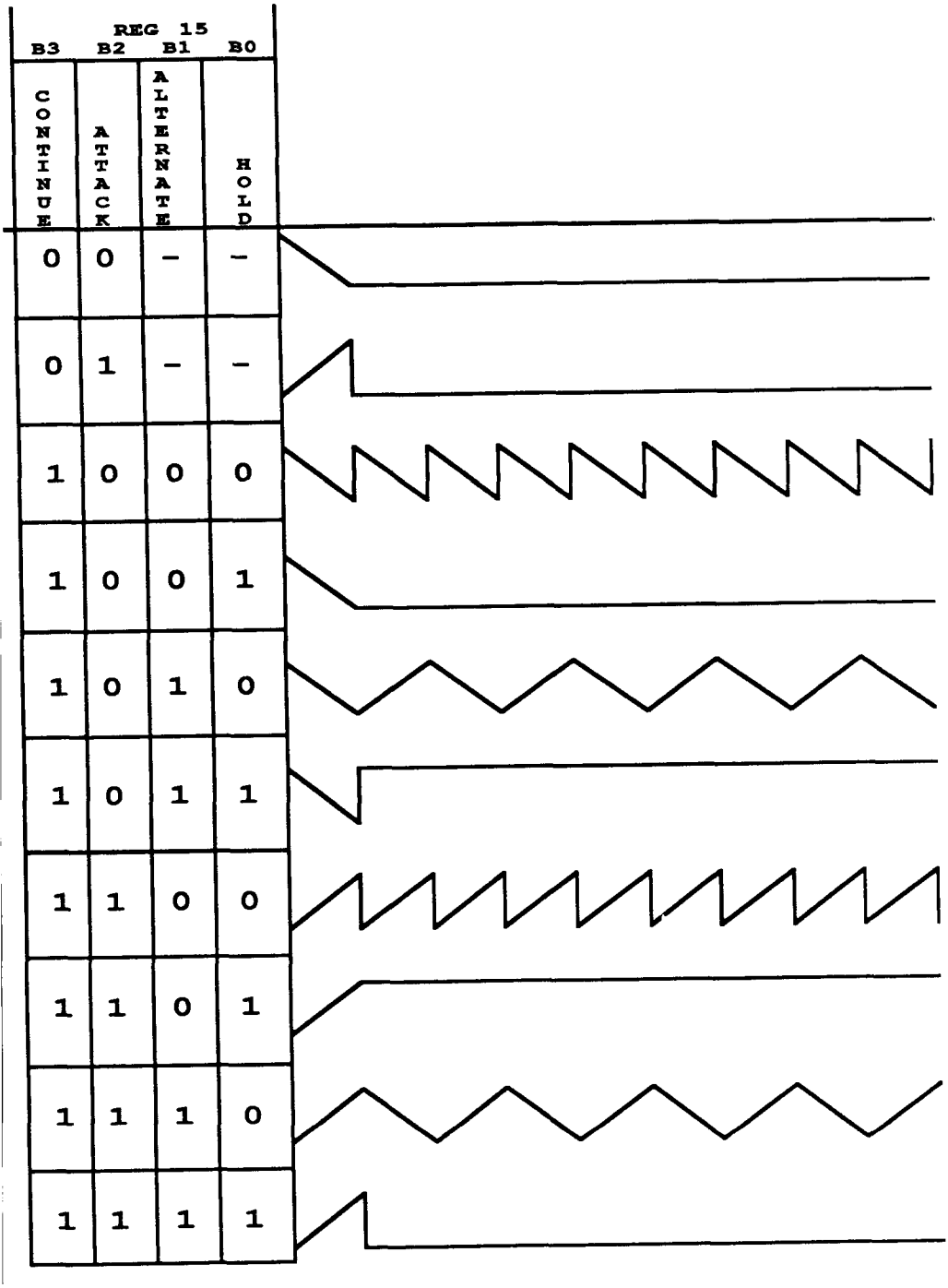
Reg 6:

The five lowest bits of this register control the noise generato Again, the smaller the value, the higher the noise "pitch".

Reg 7:

```
Bit 0:Channel A tone on/off        0=on /1=of
Bit 1:Channel B tone on/off        0=on /1=of
Bit 2:Channel C tone on/off        0=on /1=of
Bit 3:Channel A noise on/off       0=on /1=of
Bit 4:Channel B noise on/off       0=on /1=of
Bit 5:Channel C noise on/off       0=on /1=of
Bit 6:Port A in/output             0=in /1=ou
Bit 7:Port B in/output             0=in /1=ou
```

Figure 1.6-2 Envelopes of the PSG



REG 15 B3	B2	B1	B0
CONTINUE	ATTACK	ALTERNATE	HOLD
0	0	–	–
0	1	–	–
1	0	0	0
1	0	0	1
1	0	1	0
1	0	1	1
1	1	0	0
1	1	0	1
1	1	1	0
1	1	1	1

Reg 8:

Bits 0-3 of this register contrrol the signal volume of channel A When bit 4 is set, the envelope register is being used and th contents of bits 0-3 are ignored

Reg 9:

Same as register 8, but for channel B.

Reg 10:

Same as register 8, but for channel C.

Reg 11,12:

The contents of register 11 are the low-byte and the contents o register 12 are the high-byte of the sustain.

Reg 13:

Bits 0-3 determine the waveform of the envelope generator. Th possible envelopes are pictured in Figure 1.6-2.

Reg 14,15:

These registers comprise the two 8-bit ports. Register 14 i connected to Port A and register 15 is connected to Port B. I these ports are programmed as output (bits 7 and 8 of register 7 then values may be sent through these registers.

1.7 I/O Register Layout in the ST

The entire I/O range (all peripheral ICs and other registers) is controlled by a 32K address register -- $FF8000 - $FFFFFF. Below is a complete table of the different registers. CAUTION: The I/O section can be accessed only in supervisor mode. Any access in user mode results in a bus-error.

```
$FF8000   Memory configuration
$FF8200   Video display register
$FF8400   Reserved
$FF8600   DMA/disk controller
$FF8800   Sound chip
$FFFA00   MFP 68901
$FFFC00   ACIAs for MIDI and keyboard
```

The addresses given refer only to the start of each register, and supply no hint as to the size of each. More detailed information follows.

$FF8000 Memory Configuration

There is a single 8-bit register at $FF8001 in which the memory configuration is set up (four lowest bits). The MMU-IC is designed for maximum versatility within the ST. It lets you use three different types of memory expansion chips: 64K, 256K, and the 1M chips. Since all of these ICs are bit-oriented instead of byte-oriented, 16 memory chips of each type are required for memory expansion. The identifier for 16 such chips (regardless of memory capacity) is BANK. So, expansion is possible to 128 Kbyte, 512 Kbyte or even 2 Megabytes.

MMU can control two banks at once, using the RAS- and CAS- signals. The table on the next page shows the possible combinations:

$FF8001	Bit	Memory configuration	
	3-0	Bank 0	Bank 1
	0000	128K	128K
	0001	128K	512K
	0010	128K	2 M
	0011	reserved	
	0100	512K	128K
	0101	512K	512K
	0100	512K	2 M,normally reserved
	0100	reserved	
	1000	2M	128K
	1001	2M	512K
	1010	2M	2M
	1011	reserved	
	11XX	reserved	

The memory configuration can be read from or written to.

$FF8200 Video Display Register

This register is the storage area that determines the resolution and the colo palette of the video display.

```
$FF8201    8-bit  Screen memory position (high-byte)
$FF8203    8-bit  Screen memory position (low-byte)
```

These two read/write registers are located at the beginning of the 32K video RAM.

In order to relocate video RAM, another register is used. This register is three bytes long and is located at $FF8205. Video RAM can be relocated in 256-byte incremeents. Normally the starting address of video RAM is $78000.

```
$FF8205    8-bit  Video address pointer (high-byte)
$FF8207    8-bit  Video address pointer (mid-byte)
$FF8209    8-bit  Video address pointer (low-byte)
```

These three registers are read ONLY. Every three microseconds, the contents of these registers are incremented by 2.

```
$FF820A BIT       Synchronization mode
        1 0
        : :-- 0=internal,1=external synchronization
        :---- 0=60 Hz, 1=50Hz screen frequency
```

The bottom two bits of this register control synchronization mode; the remaining bits are unused. If bit 0 is set, the HSync and VSync impulses are shut off, which allows for screen synchronization from external sources (monitor jack). This offers new realm of possibilities in video, synchronization of your ST and a video camera, for example.

Bit 1 of the sync-mode register handles the screen frequency. This bit is useful only in the two "lowest" resolutions. High-res operation puts the ST at a 70 Hz screen frequency.

Sync mode can be read/written.

```
$FF8240   16-bit    Color palette register 0
$FF8242   16-bit    Color palette register 1
   :         :              :
   :         :      Color palette registers 2-13
   :         :              :
$FF825C   16-bit    Color palette register 14
$FF825E   16-bit    Color palette register 15
```

Although the ST has a total of 512 colors, only 16 different colors can be displayed on the screen at one time. The reason for this is that the user has 16 color pens on screen, and each can be one of 512 colors. The color palette registers represent these pens. All 16 registers contain 9 bits which affect the color:

```
FEDCBA9876543210
.....XXX.XXX.XXX
```

The bits marked X control the registers. Bits 0-2 adjust the shade of blue desired; 4-6, green hue; and 8-A, red. The higher the value in these three bits, the more intense the resulting color.

Middle resolution (640 X 200 points) offers four different colors; colors 4 through 15 are ignored by the palette registers.

When you want the maximum of 16 colors, it's best to zero-out the contents of the palette registers.

High-res (640 X 400 points) gives you a choice on only one "color"; bit of palette register 0 is set to the background color. If the bit is cleared, the the text is black on a light background. A set bit reverses the screen (ligh characters, black background). The color register is a read/write register.

```
$FF8260    Bit   Resolution
           1 0
           0 0   320 X 200 points, four focal planes
           0 1   640 X 200 points, two focal planes
           1 0   640 X 400 points, one focal planes
```

This register sets up the appropriate hardware for the graphic resolutio desired.

$FF8600 DMA/Disk Controller

```
$FF8600                  reserved
$FF8602                  reserved

$FF8604    16-bit        FDC access/sector count
```

The lowest 8 bits access the FDC registers. The upper 8 bits contain n information, and consistently read 1. Which register of the FDC is used depends upon the information in the DMA mode control register a $FF8606. The FDC can also be accessed indirectly.

The sector count-register under $FF8604 can be accessed when the appropriate bit in the DMA control register is set. The contents of these addresses are both read/write.

```
$FF8606    16-bit        DMA mode/status
```

When this register is read, the DMA status is found in the lower three bits o the register.

```
Bit 0   0=no error, 1=DMA error
Bit 1   0=sector count = null, 1=sector count<>null
Bit 2   Condition of FDC DATA REQUEST signal
```

Write access to this address controls the DMA mode register.

```
Bit 0      unused
Bit 1      0=pin A0 is low
           1=pin A0 is high
Bit 2      0=pin A1 is low
           1=pin A1 is high
Bit 3      0=FDC access
           1=HDC access
Bit 4      0=access to FDC register
           1=access to sector count register
Bit 5      0, reserved
Bit 6      0=DMA on
           1=no DMA
Bit 7      0=hard disk controller access (HDC)
           1=FDC access
Bit 8      0=read FDC/HDC registers
           1=write to FDC/HDC registers
```

```
$FF8609   8-bit     DMA basis and counter high-byte
$FF860B   8-bit     DMA basis and counter mid-byte
$FF860D   8-bit     DMA basis and counter low-byte
```

DMA transfer will tell the hardware at which address the data is to be noved. The initialization of the three registers must begin with the low-byte of the address, then mid-byte, then high-byte.

$FF8800 Sound Chip

The YM-2149 has 16 internal registers which can't be directly addressed. Instead, the number for the desired register is loaded into the select register. The chosen registers can be read/write, until a new register number is written to the PSG.

```
$FF8800   8-bit     Read data/Register select
```

Reading this address gives you the last register used (normally port A), by which disk drive is selected. This can be accomplished with write-protect signals, although these protected contents can be accessed by another register. Port A is used for multiple control functions, while port B is the printer data port.

```
PORT A
  Bit 0      Page-choice signal for double-sided
             floppy drive
  Bit 1      Drive select signal -- floppy drive 0
  Bit 2      Drive select signal -- floppy drive 1
  Bit 3      RS-232 RTS-output
  Bit 4      RS-232 DTR output
  Bit 5      Centronics strobe
  Bit 6      Freely usable output (monitor jack)
  Bit 7      reserved
```

When $FF8800 is written to, the select register of the PSG is alerted. Tl information in the bottom four bits are then considered as register numbe The necessary four-bit number serves for writing to the PSG.

```
$FF8802    8-bit      Write data
```

Attempting to read this address after writing to it will give you $FF onl while BDIR and BC1 are nulls.

Writing register numbers and data can be performed with a single MOVE instruction.

$FFFA00 MFP 68901

The MFP's 24 registers are found at uneven addresses fro $FFFA01-$FFFA2F:

```
$FFFA01    8-bit      Parallel port
$FFFA03    8-bit      Active Edge register
$FFFA05    8-bit      Data direction
$FFFA07    8-bit      Interrupt enable A
$FFFA09    8-bit      Interrupt enable B
$FFFA0B    8-bit      Interrupt pending A
$FFFA0D    8-bit      Interrupt pending B
$FFFA0F    8-bit      Interrupt in-service A
$FFFA11    8-bit      Interrupt in-service B
$FFFA13    8-bit      Interrupt mask A
$FFFA15    8-bit      Interrupt mask B
$FFFA17    8-bit      Vector register
$FFFA19    8-bit      Timer A control
$FFFA1B    8-bit      Timer B control
```

```
FFFA1D   8-bit      Timer C & D control
FFFA1F   8-bit      Timer A data
FFFA21   8-bit      Timer B data
FFFA23   8-bit      Timer C data
FFFA25   8-bit      Timer D data
FFFA27   8-bit      Sync character
FFFA29   8-bit      USART control
FFFA2B   8-bit      Receiver status
FFFA2D   8-bit      Transmitter status
FFFA2F   8-bit      USART data
```

See the chapter on the MFP for details on the individual registers.

```
I/O Port
Bit 0      Centronics busy
Bit 1      RS-232 data carrier detect - input
Bit 2      RS-232 clear to send - input
Bit 3      reserved
Bit 4      keyboard and MIDI interrupt
Bit 5      FDC and HDC interrupt
Bit 6      RS-232 ring indicator
Bit 7      Monochrome monitor detect
```

Timers A and B each have an input which can be used by external timer control, or send a time impulse from an external source. Timer A is unused in the ST, which means that the input is always available, but it isn't connected to the user port, so the Centronics busy pin is connected instead. You can use it for your own purposes.

Timer B is used for counting screen lines in conjunction with DE (Display Enable).

The timer outputs in A-C are unused. Timer D, on the other hand, sends the timing signal for the MFP's built-in serial interface.

$FFFC00 Keyboard and MIDI ACIAs

The communications between the ST, the keyboard, and music instruments are handled by two registers in the ACIAs.

```
$FFFC00    8-bit      Keyboard ACIA control
$FFFC02    8-bit      Keyboard ACIA data
$FFFC04    8-bit      MIDI ACIA control
$FFFC06    8-bit      MIDI ACIA data
```

Figure 1.7-1 I/O Assignments

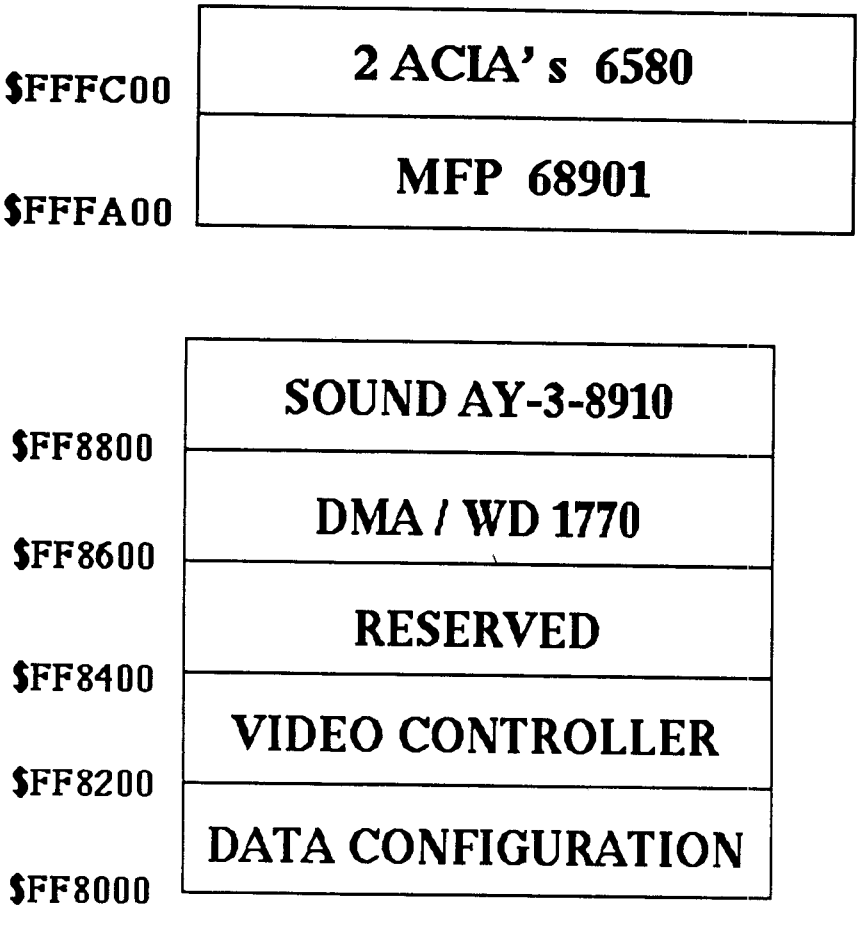
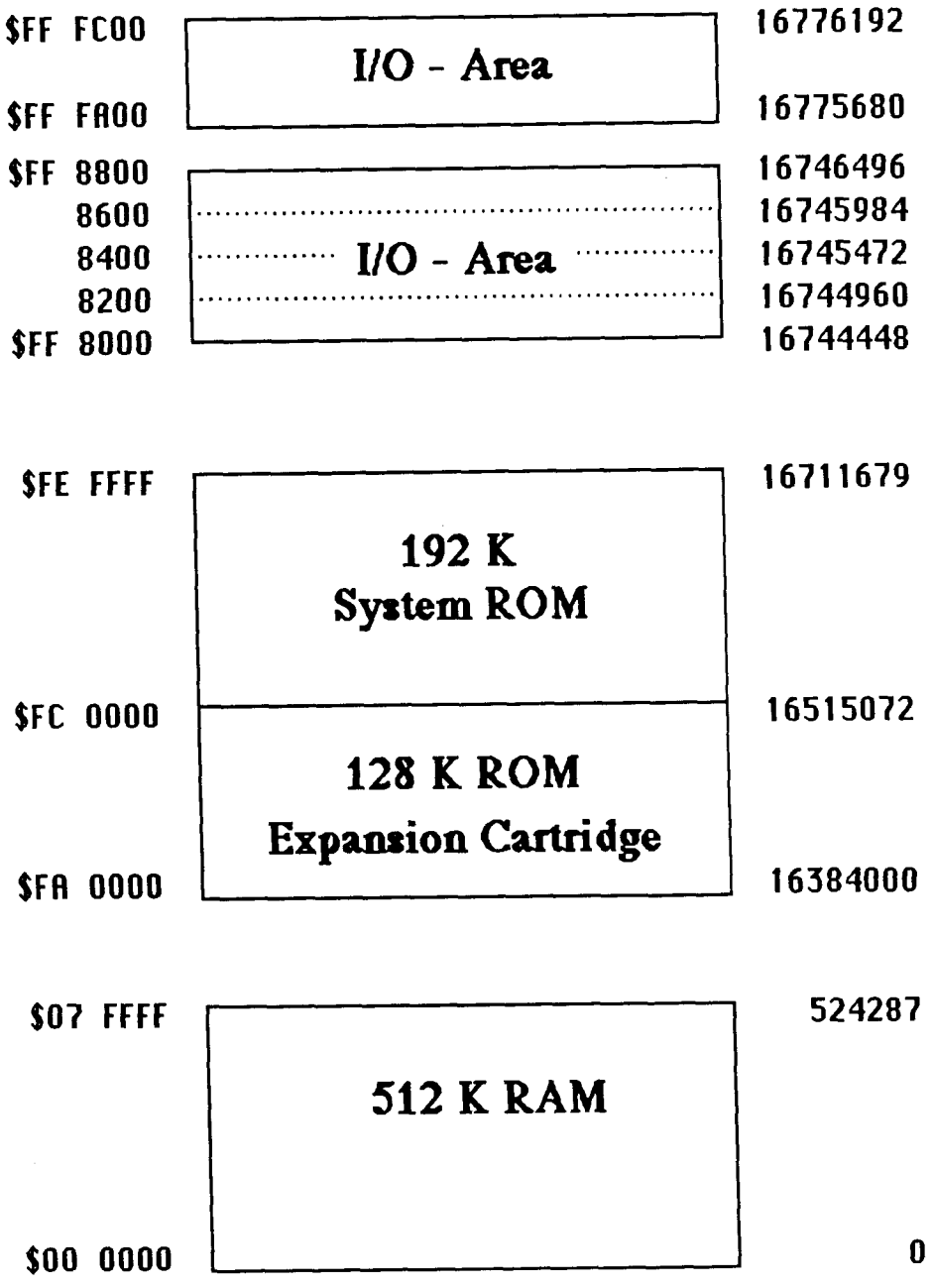


Figure 1.7-2 Memory Map of the ATARI ST



Chapter Two

The Interfaces

The Interfaces

2.1 The Keyboard

Do you think it's really necessary to give a detailed report on something as trivial as the keyboard, since keyboards all function the same way? Actually the title should read "Keyboard Systems" or something similar. The keyboard is controlled by its own processor. You will soon see how this affects the assembly language programmer.

The keyboard processor is single-chip computer (controller) from the 6800 family, the 6301. Single chip means that everything needed for operation is found on a single IC. In actuality, there are some passive components in the keyboard circuit along with the 6301.

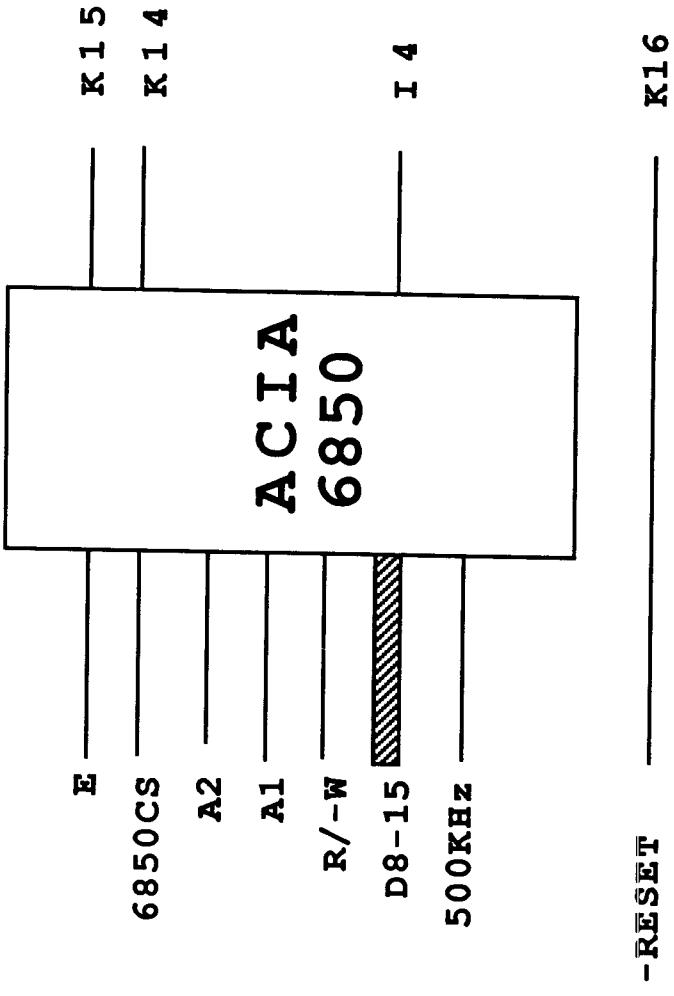
The 6301 has ROM, RAM, some I/O lines, and even a serial interface on the chip. The serial interface handles the traffic to and from the main board.

The advantage of this design is easy to see. The main computer is not burdened by having to continually poll the keyboard. Instead it can dedicate itself completely to processing your programs. The keyboard processor notifies the system if an event occurs that the operating system should be aware of.

The 6301 is not only responsible for the relatively boring task of reading the keyboard, however. It also takes care of the rather complicated tasks required in connection with the mouse. The main processor is then fed simply the new X and Y coordinates when the mouse is moved. Naturally, anything to do with the joysticks is also taken care of by the keyboard controller.

In addition, this controller contains a real-time clock which counts in one-second increments.

Figure 2.1-1 6850 Interface to 68000



n Figure 2.1-1 is an overview of the interface to the 68000. As you see, the nain processors is burdened as little as possible. The ACIA 6850 ensures hat it is disturbed only when a byte has actually been completely received rom the keyboard. The ACIA, by the way, can be accessed at addresses FFFC00 (control register) and $FFFC02 (data register). The individual onnection to the keyboard takes place over lines K14 and K15. K indicates he plug connection by which the keyboard is connected to the main board.

The signal that the ACIA has received a byte is first sent over line 14 to the MFP 68901 which then generates an interrupt to the 68000. The clock frequency of 500KHz comes from GLUE. From this results the "odd" transfer rate of 7812.5 baud.

In case you were surprised that data can also be sent *to* the keyboard processor, you will find the solution to the puzzle in Chapter 2.1.2.

The block diagram of the keyboard circuit is found in Figure 2.1-2. The function is as simple as the figure is easy to read. The processor has 4K of ROM available. The 128 bytes of RAM is comparitively small, but it is used only as a buffer and for storing pointers and counters.

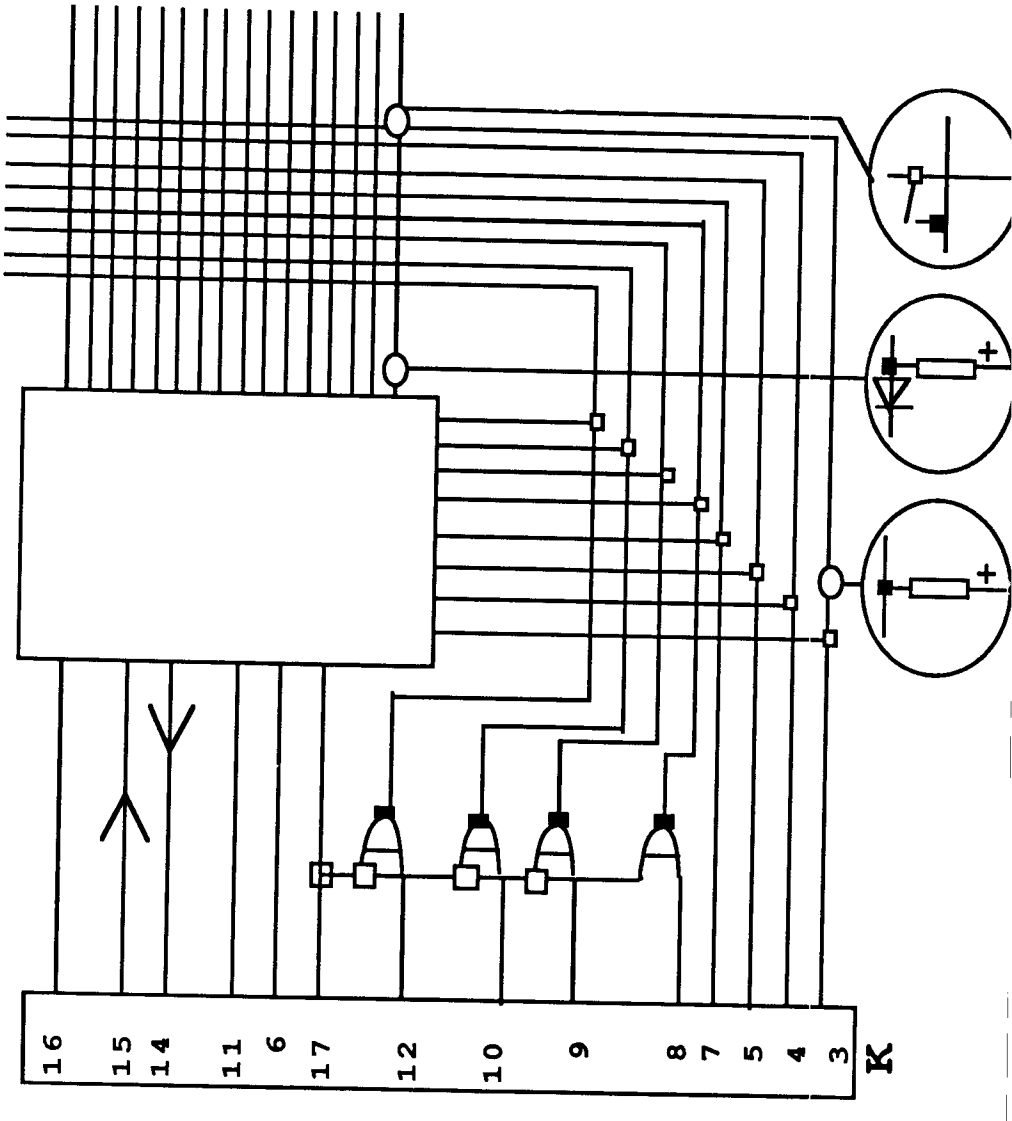
The lines designated with K are again the plug connections assigned to the main board. With few exceptions, the connections for the joystick and mouse are also put through. K16 is the reset line from the 68000. K15 carries the send data from the 6850, K14 the send data from the 6301.

The I/O ports 1(0-7), 3(1-7), and 4(0-7) are responsible for reading the keyboard matrix. One line from ports 3 and 4 is pulled low in a cycle. The state of port 1 is the checked. If a key is pressed, the low signal comes through on port 1.

Each key can be identified from the combination of value placed on ports 3 and 4 and the value read from port 1.

If none of the lines of Port 3 and 4 are placed low and a bit of port 1 still equals zero, a joystick is active on the outer connecter 1. The data from outer connector 0, to which a mouse or a joystick can be connected, does not come through by chance since it must first be switched through the NAND gate with port 2 (bit 0). The buttons on the mouse or the joystick then arrive at port 2 (1 and 2).

Figure 2.1-2 Block Diagram of Keyboard Circuit



The assignments of the K lines to the signal names on the outer connecter are found in the next section.

The processor 6301 is completely independent, but it can also be configured so that it works with an external ROM. Some of the port lines are then reconfigured to act as address lines. The configuration the processor assumes (one of eight possibilities) depends on the logical signal placed on port 2 (bits 0-2) during the reset cycle. All three lines high puts the processor in mode 7, the right one for the task intended here. But bits 1 and 2 depend on the buttons on the mouse. If you leave the mouse alone while powering-up, everything will be in order. If you hold the two buttons down, however, the processors enters mode 1 and makes a magnificent belly-flop, since the hardware for this operating mode is not provided. You notice this by the fact that the mouse cursor does not move on the screen if you move the mouse. Only the reset button will restore the processor.

2.1.1 The Mouse

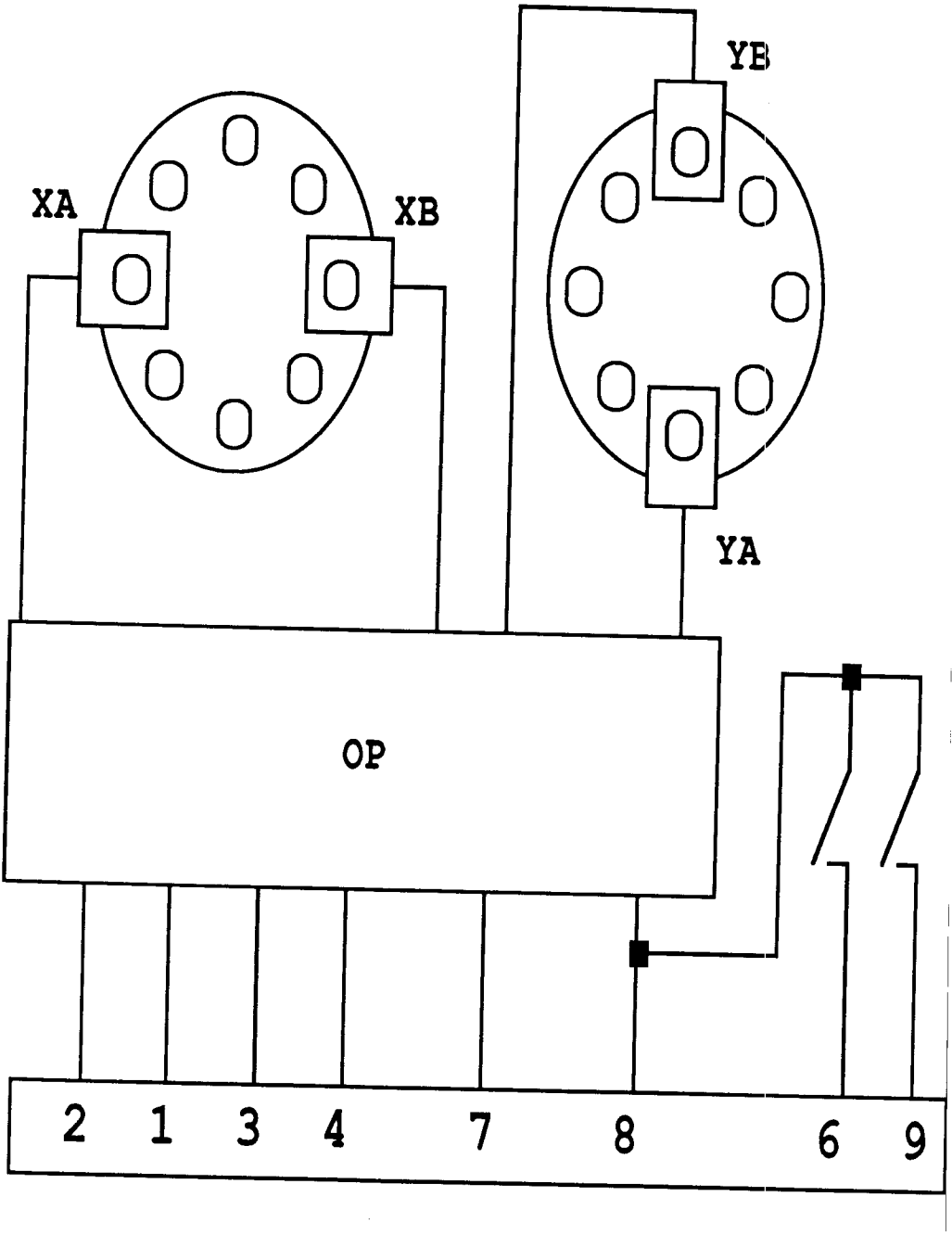
The construction of this little device is quite simple, but effective. Essentially, it consists of four light barriers, two encoder wheels, and a drive mechanism.

The task of the mouse is to give the computer information about its movements. This information consists of the components: direction on the X-axis, direction on the Y-axis, and the path traveled on each axis.

In order to do this, the rubber-covered ball visible from the outside drives two encoder wheels whose drive axes are at angle of 90 degrees to each other. The one or the other axis rotates more or less, forwards or backwards, depending on the direction the mouse is moved.

It is no problem to determine the absolute movement on each axis. The encoder wheels alternately interrupt the light barriers. One need only count the pulses from each wheel to be informed about the path traveled on each axis.

Figure 2.1.1-1 The Mouse



It is more difficult when the direction of movement is also required. The designers of the mouse used a convenient trick for this. There are not one, but two light barriers on each encoder wheel. They are arranged such that they are not shielded by the wheel at precisely the same time, but one shortly after the other. This arrangement may not be so clear in Figure 2.1.1-1, so we'll explain it in more detail The direction can be determined by noticing which of the two light barriers is interrupted first. This is why the pulses from both light barriers are sent out, making a total of four. Corresponding to their significance they carry the names XA, XB, YA, YB.

The two contacts which you see on the picture represent the two buttons.

The large box on the picture is a quad operational amplifier which converts the rather rough light-barrier pulses into square wave signals.

In Figure 2.1.1-2 is the layout of the control port on the computer, as you see it when you look at it from the outside. The designation behind the slash applies when a joystick is connected and the number in parentheses is the pin number of the keyboard connector.

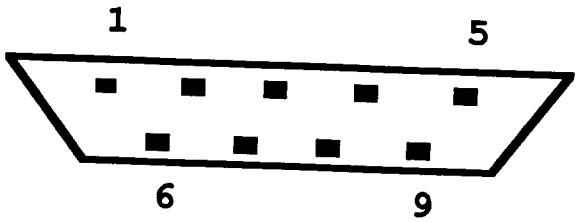
Port 0

1	XB/UP	(K12)
2	XA/DOWN	(K10)
3	YA/LEFT	(K9)
4	YB/RIGHT	(K8)
6	LEFT BUTTON/FIRE	(K11)
7	+5V	(K13)
8	GND	(K1)
9	RIGHT BUTTON	(K6)

Port 1

1	UP	(K7)
2	DOWN	(K5)
3	LEFT	(K4)
4	RIGHT	(K3)
5	Port 0 enable	(K17)
6	FIRE	(K6)
7	+5V	(K13)
8	GND	(K1)

Figure 2.1.1-2 Mouse control port



2.1.2 Keyboard commands

The keyboard processor "understands" some commands pertaining to such things as how the mouse is to be handled, etc. You can set the clock time, read the internal memory, and so on. You can find an application example in the assembly language listing on page 80 (after command $21).

The "normal" action of the processor consists of keeping an eye on the keyboard and announcing each keypress. This is done by outputting the number of the key when the key is pressed. When the key is released the number is set again, but with bit 7 set. The result of this is that no key numbers greater than 127 are possible. You can find the assignment of the key numbers to the keys at the end of this section in figure 2.1.2-1. In reality these numbers only go up to 117 because values from $F6 up are reserved for other purposes. There must be a way to pass more information than just key numbers to the main processor, information such as the clock time or the current position of the mouse. This cannot be handled in a single byte but only in something called a package, so the bytes at $F6 signal the start of a package. Which header comes before which package is explained along with the individual commands.

A command to the keyboard processor consists of the command code (a byte) and any parameters required. The following description is sorted according to command bytes.

$07
Returns the result of pressing one of the two mouse buttons. A parameter byte with the following format is required:

```
Bit 0   =1:  The absolute position is returned when a
             mouse button is pressed. Bit 2 must =0.
Bit 1   =1:  The absolute position is returned when a
             mouse button is released. Bit 2 must =0.
Bit 2   =1:  The mouse buttons are treated like
             normal keys. The left button is key
             number $74, the right is $75.
Bits 3-7     must always be zero.
```

$08

Returns the relative mouse position from now on. This command tells the keyboard processor to automatically return the relative position (the distance from the previous position) whenever the mouse is moved. A movement is given when the number of encoder wheel pulses has reached a given threshold. See also $0B. A relative mouse package looks like this:

```
1 byte   Header in range $F8-$FB. The two lowest
         bits of the header indicate the condition
         of the two mouse buttons.
1 byte   Relative X-position (signed!)
1 byte   Relative Y-position (signed!)
```

If the relative position changes substantially between two packages so that the distance can no longer be expressed in one byte, another package is automatically created which makes up for the remainder.

$09

Returns the absolute mouse position from now on. This command also sets the coordinate maximums. The internal coordinate pointers are at the same time set to zero. The following parameters are required:

```
1 word   Maximum X-coordinate
1 word   Maximum Y-coordinate
```

Mouse movements under the zero point or over the maximums are not returned.

$0A

With this command it is possible to get the key numbers of the cursor keys instead of the coordinates. A mouse movement then appears to the operating system as if the corresponding cursor keys had been pressed. These parameters are necessary:

```
1 byte  Number of pulses (X) after which the key
        number for cursor left (or right) will be
        sent.
1 byte  Number of pulses (Y) after which the key
        number for cursor up (or down) will be sent.
```

$0B

This command sets the trigger threshold, above which movements will b announced. A certain number of encoder pulses elapse before a package i sent. This functions only in the relative operating mode. The following ar the parameters:

```
1 byte    Threshold in X-direction
1 byte    Threshold in Y-direction
```

$0C

Scale mouse. Here is determined how many encoder pulses will go b before the coordinate counter is changed by 1. This command is valid onl in the absolute. The following parameters are required:

```
1 byte    X scaling
1 byte    Y scaling
```

$0D

Read absolute mouse position. No parameters are required, but a package o the following form is sent:

```
1 byte    Header = $F7
1 byte    Button status
      Bit 0 = 1:  Right button was pressed since the
                  last read
      Bit 1 = 1:  Right button was not pressed
      Bit 2 = 1:  Left button was pressed since the
                  last read
      Bit 3 = 1:  Left button was not pressed
```

From this strange arrangement you can determine that the state of a butto has changed since the last read if the two bits pertaining to it are zero.

```
1 word Absolute X-coordinate
1 word Absolute Y-coordinate
```

$0E
Set the internal coordinate counter. The following parameters are required:

```
1 byte    =0 as fill byte
1 word    X-coordinate
1 word    Y-coordinate
```

$0F
Set the origin for the Y-axis is down (next to the user).

$10
Set the origin for the Y-axis is up.

$11
The data transfer to the main processor is permitted again (see $13). Any command other than $13 will also restart the transfer.

$12
Turn mouse off. Any mouse-mode command ($08, $09, $0A) turns the mouse back on. If the mouse is in mode $0A, this command has no effect.

$13
Stop data transfer to main processor.
NOTE: Mouse movements and key presses will be stored as long as the small buffer of the 6301 allows. Actions beyond the capacity of the buffer will be lost.

$14
Every joystick movement is automatically returned. The packages sent have the following format:

```
1 byte    Header = $FE or $FF for joystick 0/1
1 byte    Bits 0-3 for the position (a bit for each
          direction), bit 7 for the button
```

$15
End the automatic-return mode for the joystick. When needed, a package must be requested with $16.

$16
Read joystick. After this command the keyboard sends a package as described above.

$17
Joystick duration message. One parameter is required.

```
1 byte    Time between two messages in 1/100 sec.
```

From this point on, packages of the following form are sent continuously (as long as no other mode is selected):

```
1 byte    Bit 0 for the button on joystick 1, bit 1
          for that of joystick 0
1 byte    Bits 0-3 for the position of joystick 1,
          bits 4-7 for the position of joystick 0
```

NOTE: The read interval should not be shorter than the transfer channel needs to send the two bytes of the package.

$18
Fire button duration message. The condition of the button in joystick 1 (!) is continually tested and the result packed into a byte. This means that a message byte contains 8 such tests, whereby bit 7 is the most recent. The keyboard controller determines the time between byte fetches by the main processor. This time is divided into eight equal intervals in which the button is polled. The polling then takes place as regularly as possible. This mode remains active until another command is received.

$19
Cursor key simulation mode for joystick 0 (!). The current position of the joystick is sent to the main processor as if the corresponding cursor keys had been pressed (as often as necessary). To avoid having to explain the same things for the following parameters, here are the most important: All times are assumed to be in tenths of seconds. R indicates the time, when reached, cursor clicks will be sent in intervals of T. After this the interval is V. If R=0, only V is responsible for the interval. Naturally, this mechanism comes into play only when the joystick is held in the same position for longer than T or R.

```
1 byte    RX
1 byte    RY
1 byte    TX
1 byte    TY
1 byte    VX
1 byte    VY
```

$1A
Turn off joysticks. Any other joystick command turns them on again.

$1B
Set clock time. This command sets the internal real-time clock in the keyboard processor. The values are passed in packed BCD, meaning a digit 0-9 for each half byte, yielding a two-digit decimal number per byte. The following parameters are necessary:

```
1 byte     Year, two digit (85, 86, etc.)
1 byte     Month, two digit (12, 01, etc.)
1 byte     Day, two digit (31,01,02, etc.)
1 byte     Hours, two digit
1 byte     Minutes, two digit
1 byte     Seconds, two digit
```

Any half byte which does not contain a valid BCD digit (such as F) is ignored. This makes it possible to change just part of the date or clock time.

$1C
Read clock time. After receiving this command the keyboard processor returns a package having the same format as the one described above. A header is added to the package, however, having the value $FC.

$20
Load memory. The internal memory of the keyboard processor (naturally only the RAM in the range $80 to $FF makes sense) can be written with this command. It is not clear to us of what use this is since according to our investigations (we have disassembled the operating system of the 6301), no RAM is available to be used as desired. Perhaps certain parameters can be changed in this manner which are not accessible through "legal" means. Here are the parameters:

```
1 word     Start address
1 byte     Number of bytes (max. 128)
Data bytes (corresponding to the number)
```

The interval at which the data bytes will be sent must be less than 20 msec.

$21

Read memory. This command is the opposite of $20. These parameters are required:

```
1 word     Address at which to read
```

A package having the following format is returned:

```
1 byte     Header 1 =$F6. This is the status header
           which precedes all packages containing any
           operating conditions of the keyboard
           processor. We will come to the general
           status messages shortly.
1 byte     Header 2 =$20 as indicator that this
           package carries the memory contents.
6 bytes    Memory contents starting with the address
           given in the command.
```

Here is a small program which we used to read the ROM in the 6301 and output it to a printer. Here you also see how the status packages arrive from the keyboard. These are normally thrown away by the 68000 operating system. Section 3.1 contains information about the GEMDOS and XBIOS calls used.

```
 1
 2
 3
 4
 5
 6
 7
 8
 9
10
11
12 00000000 3F3C0022
13 00000004 4E4E
14 00000006 548F
15 00000008 41F900000000
16 0000000E 43F9000000D6
17 00000014 23C000000104
18 0000001A 23F0000C00000100
19 00000022 2189000C
```

```
prt     equ     0
chout   equ     3
gemdos  equ     1
bios    equ     13
xbios   equ     14
stvec   equ     12
rdm     equ     $21
wrkbd   equ     25
kbdvec  equ     34
term    equ     0
start:
        move.w  #kbdvec,-(a7)
        trap    #xbios
        addq.l  #2,a7
        lea     0,a0
        lea     keyin,a1
        move.l  d0,savea
        move.l  stvec(a0,d0),save
        move.l  a1,stvec(a0,d0)
```

```
20 00000026 383CF000
21
22 0000002A 33C40000010A
23 00000030 61000084
24
25 00000034 0C390000000000F8
26 0000003C 67F6
27 0000003E 3C3C0006
28 00000042 610A
29 00000044 5C44
30 00000046 0C44FFFF
31 0000004A 6DDE
32 0000004C 6052
33
34 0000004E 49F9000000F9
35
36 00000054 101C
37 00000056 6106
38 00000058 5306
39 0000005A 66F8
40 0000005C 4E75
41
42 0000005E 3240
43 00000060 E808
44 00000062 02800000000F
45 00000068 47F90000000E8
46 0000006E 14330000
47 00000072 E14A
48 00000074 3009
49 00000076 02800000000F
50 0000007C 14330000
51 00000080 3002
52 00000082 3F02
53 00000084 E048
54 00000086 6108
55 00000088 301F
56 0000008A 6104
57 0000008C 103C0020
58
59 00000090 3F00
60 00000092 3F3C0000
61 00000096 3F3C0003
62 0000009A 4E4D
63 0000009C 5C8F
64 0000009E 4E75
65
66 000000A0 307900000104
```

```
        move.w  #$f000,d4
loop:
        move.w  d4,tbuf+1
        bsr     keyout
wait:
        cmpi.b  #0,rbuf
        beq     wait
        move.w  #6,d6
        bsr     bufout
        addq.w  #6,d4
        cmpi.w  #$ffff,d4
        blt     loop
        bra     exit
bufout:
        lea     rbuf+1,a4
bytout:
        move.b  (a4)+,d0
        bsr     hexout
        subq.b  #1,d6
        bne     bytout
        rts
hexout:
        movea.w d0,a1
        lsr.b   #4,d0
        andi.l  #15,d0
        lea     table,a3
        move.b  0(a3,d0),d2
        lsl.w   #8,d2
        move.w  a1,d0
        andi.l  #15,d0
        move.b  0(a3,d0),d2
        move.w  d2,d0
        move.w  d2,-(a7)
        lsr.w   #8,d0
        bsr     chrout
        move.w  (a7)+,d0
        bsr     chrout
        move.b  #" ",d0
chrout:
        move.w  d0,-(a7)
        move.w  #prt,-(a7)
        move.w  #chout,-(a7)
        trap    #bios
        addq.l  #6,a7
        rts
exit:
        movea   savea,a0
```

```
 67 000000A6 203900000100
 68 000000AC 2140000C
 69 000000B0 3F3C0000
 70 000000B4 4E41
 71
 72 000000B6 13FC0000000000F8
 73 000000BE 487900000109
 74 000000C4 3F3C0002
 75 000000C8 3F3C0019
 76 000000CC 4E4E
 77 000000CE DFFC00000008
 78 000000D4 4E75
 79
 80 000000D6 103C0008
 81 000000DA 43F9000000F8
 82
 83 000000E0 12D8
 84 000000E2 5300
 85 000000E4 66FA
 86 000000E6 4E75
 87
 88 000000E8 3031323334353637
 88 000000F0 3839414243444546
 89 000000F8
 90 00000100
 91 00000104
 92 00000108
 93 00000109 21
 94 0000010A
 95 0000010C
```

```
        move.l  save,d0
        move.l  d0,stvec(a0)
        move.w  #term,-(a7)
        trap    #gemdos
keyout:
        move.b  #0,rbuf
        pea     tbuf
        move.w  #2,-(a7)
        move.w  #wrkbd,-(a7)
        trap    #xbios
        adda.l  #8,a7
        rts
keyin:
        move.b  #8,d0
        lea     rbuf,a1
repin:
        move.b  (a0)+,(a1)+
        subq.b  #1,d0
        bne     repin
        rts
table:
        dc.b    "0123456789ABCDEF"

rbuf:   ds.b    8
save    ds.l    1
savea   ds.l    1
dummy   ds.b    1
tbuf    dc.b    rdm
        ds.b    2
        .end
```

$22

Execute routine. With this command you can execute a subroutine in the 6301. Naturally, you must know exactly what it does and where it is located, so long as you have not transferred it yourself to RAM with $20 (assuming you found some free space). The only required parameters are:

```
1 word  Start address
```

Status messages

You can at any time read the operating parameters of the keyboard by simply adding $80 to the command byte with which you would to set the operating mode (whose parameters you want to know). You then get a status package back (header=$F6), whose format corresponds exactly to those which would be necessary for setting the operating mode.

An example makes it clearer: you want to know how the mouse is scaled. So you send as the command the value $8C (since $0C sets the scaling). You get the following back:

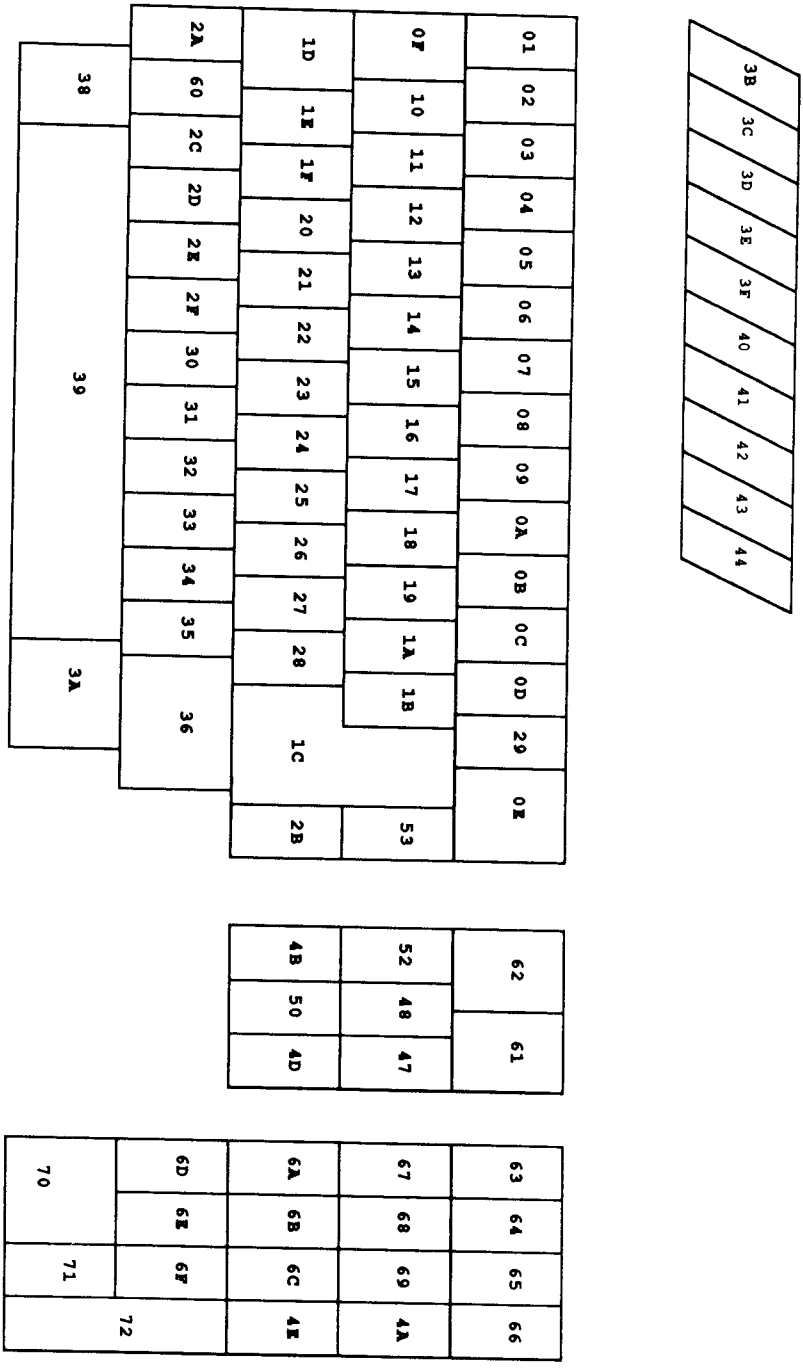
```
1 byte Status header =$F6
1 byte X-scaling
1 byte Y-scaling
```

This is the same format which would be necessary for the command $0C. For commands which do not require parameters, you get the evoked command back as such. For example, say you want to know what operating mode the joystick is in ($14 or $15). You send the value $94 (or $95, it makes no difference). As status package you receive, in addition to the header, either $14 or $15 depending on the operating mode of the joystick handler.

Allowed status checks are: $87, $88, $89, $8A, $8B, $8C, $8F, $90, $92, $94, $99, and $9A.

In conclusion we have a tip for those for whom the functions of the keyboard are too meager and who want to give it more "intelligence". The processor 6301 is also available in "piggy-back" version, the 63P01 (Hitachi). This model does not have ROM built in, but has a socket on the top for an EPROM of type 2732 or 2764 (8K!). You can then realize your own ideas and, for example, use the two joystick connections as universal 4-bit I/O ports, for which you can also extend the command set in order to access the new functions from the XBIOS as well.

Figure 2.1.2-1 ATARI ST Key Assignments



2.2 The Video Connection

Without this, nothing would be displayed. You would be tapping in the dark in the truest sense of the word. Conspicuous are the many pins on the connection. Naturally more lines are required for hooking up an RGB monitor than for a monochrome screen, but seven would be enough. There is also something special about the remaining lines. In Figure 2.2-1 you find a block diagram in which you can see how the video connection is tied to the system. The numbering of the pins is given on the figure on the next page, as you can see, when you look at the connector from the outside. Here is the pin layout:

1 AUDIO OUT. This connection comes from the amplifier connected to the output of the sound chip. A high-impedance earphone can be attached here if you do not use the original monitor.

2 Not used

3 GPO, General Purpose Output. This connection is available for your use. The line has TTL levels and comes from I/O port A bit 6 of the sound chip.

4 MONOCHROME DETECT. If this line, which leads to the I7 input of the MFP 68901, is low, the computer enters the high-resolution monochrome mode. If the state of the line changes during operation, a cold start is generated.

5 AUDIO IN leads to the input of the amplifier described in 1 and is there mixed with the output of the sound chip.

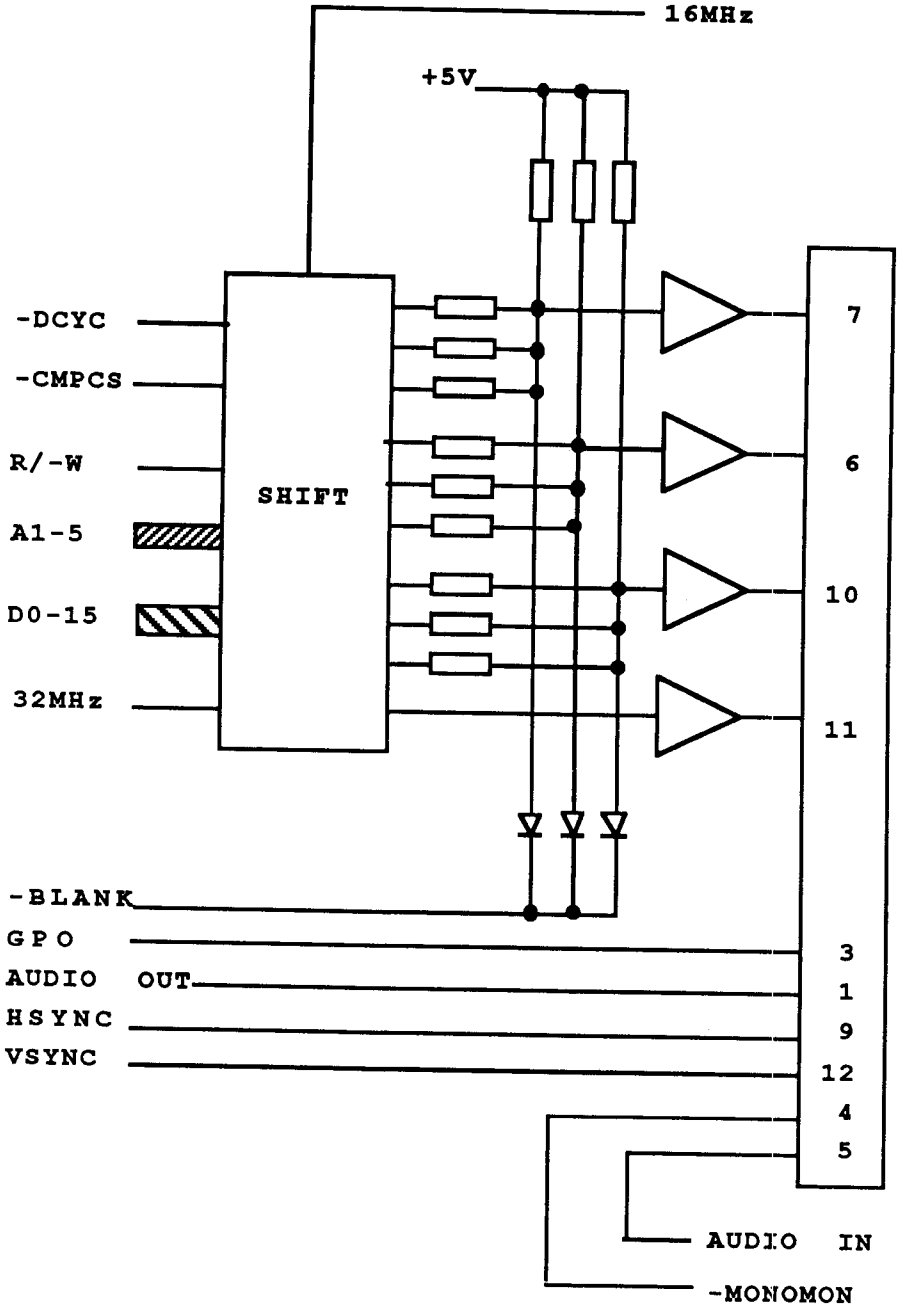
6 GREEN is the analog green output of the video shifter.

7 RED. Red output.

8 GROUND.

9 HORIZONTAL SYNC is responsible for the horizontal beam return of the monitor.

Figure 2.2-1 Diagram of Video Interface



10 BLUE is the analog blue output of the video shifter.

11 MONOCHROME provides a monochrome monitor with the intensity signal.

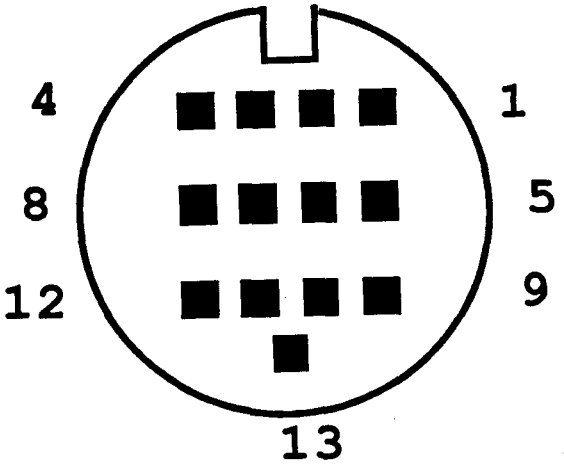
12 VERTICAL SYNC takes care of the beam return at the end of the screen.

13 GROUND.

A tip for the hardware hobbyist:

A plug to fit this connector is not available. If you want to make a plug for connecting other monitors, simply use a piece of perf board in which you have soldered pins, since the pins are fortunately organized in a 1/10" array. Pin 13 is out of order, but it is not needed since pin 8 is also available for ground.

Figure 2.2-2 Monitor Connector



2.3 The Centronics Interface

A standard Centronics parallel printer can be connected to this interface provided that you have the proper cable. As you can see in Figure 2.3-2, th connection to the system is somewhat unusual. The data lines and the strob of the universal port of the sound chip are used. So you find these too o the picture, in which the other lines, which will not be described in the section, will not disturb you. They belong to the disk drive and RS-232 interface and are handled there.

Here is the pin description:

1 -STROBE indicates the validity of the byte on the data lines to the connected device by a low pulse.

2-9 DATA

11 BUSY is always placed high by the printer when it is not able to receive additional data. This can have various causes. Usually the buffer is full or the device is off line.

18-25 GROUND.

All other pins are unused.

A tip for making a cable. Get flat-cable solderless connectors. You need a type D25-subminiature, a Cinch 36-pin (3M,AMP) and the appropriate length of 25-conductor flat ribbon cable. You squeeze the connectors on the cable so that pins 1 match up on both sides (they are connected together). The other connections then match automatically. Note that there will naturally be some pins free on the printer side.

Figure 2.3-1 Printer Port Pins

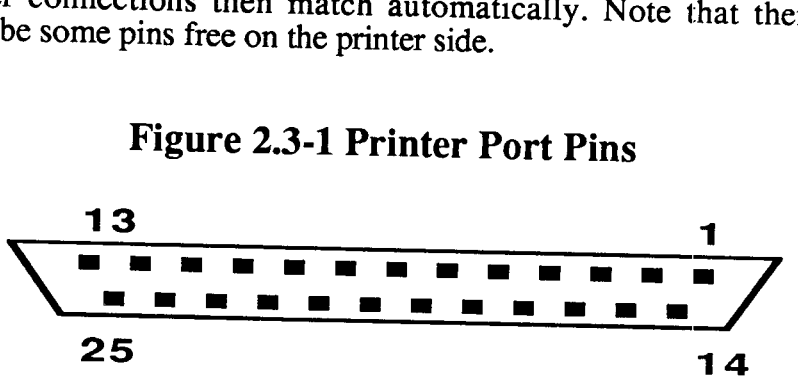
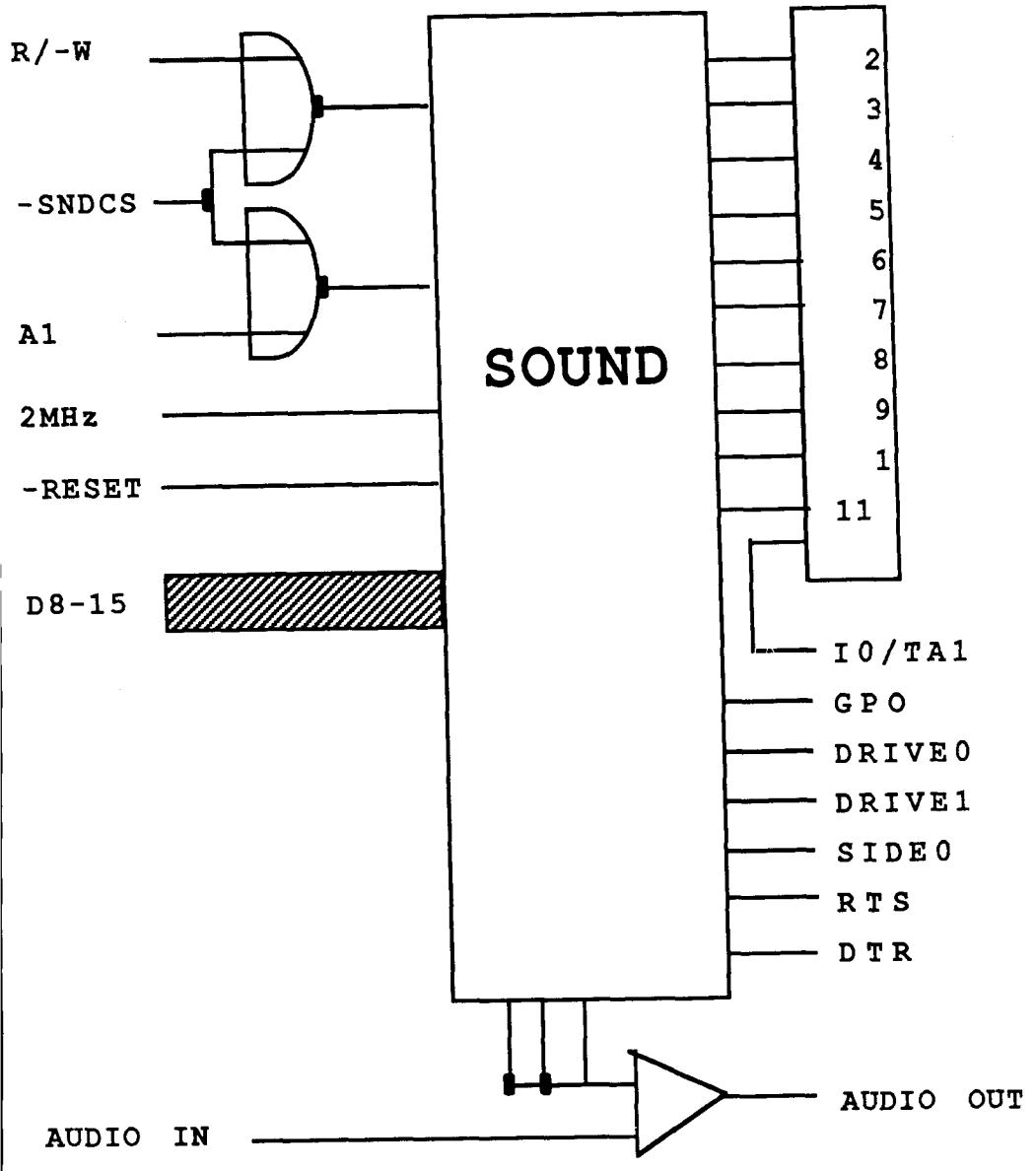


Figure 2.3-2 Centronics Connection



2.4 The RS-232 Interface

This interface usually serves for communication with other computers and modems. You can also connect a printer here. Note the description of pin 5!

Figure 2.4-1 shows the connection to the system. Normally you don't have to do any special programming to use this interface. It is taken care of by the operating system. Here the control of the interface is not controlled by a special IC (UART) as is usually the case, but the lines are serviced more or less "by hand." The shift register in the MFP is used for this purpose. The handshake lines however come from a wide variety of sources. Note this in the following pin description:

1 CHASSIS GROUND (shield)
This is seldom used.

2 TxD
Send data

3 RxD
Receive data

4 RTS
Ready to send comes from I/O port A bit 3 of the sound chip and is always high when the computer is ready to receive a byte. On the Atari, this signal is first placed low after receiving a byte and is kept low until the byte has been processed.

5 CTS
Clear to send of a connected device is read at interrupt input I2 of the MFP. At the present time this signal is handled improperly by the operating system. Therefore it is possible to connect only devices which "rattle" the line after every received byte (like the 520ST with RTS). It goes to input I2 of the MFP, but unfortunately is there tested only for the signal edge. You will not have any luck connecting a printer because they usually hold the CTS signal high as long as the buffer is not full. There is no signal edge after each byte, which means that only the first byte of a text is transmitted, and then nothing.

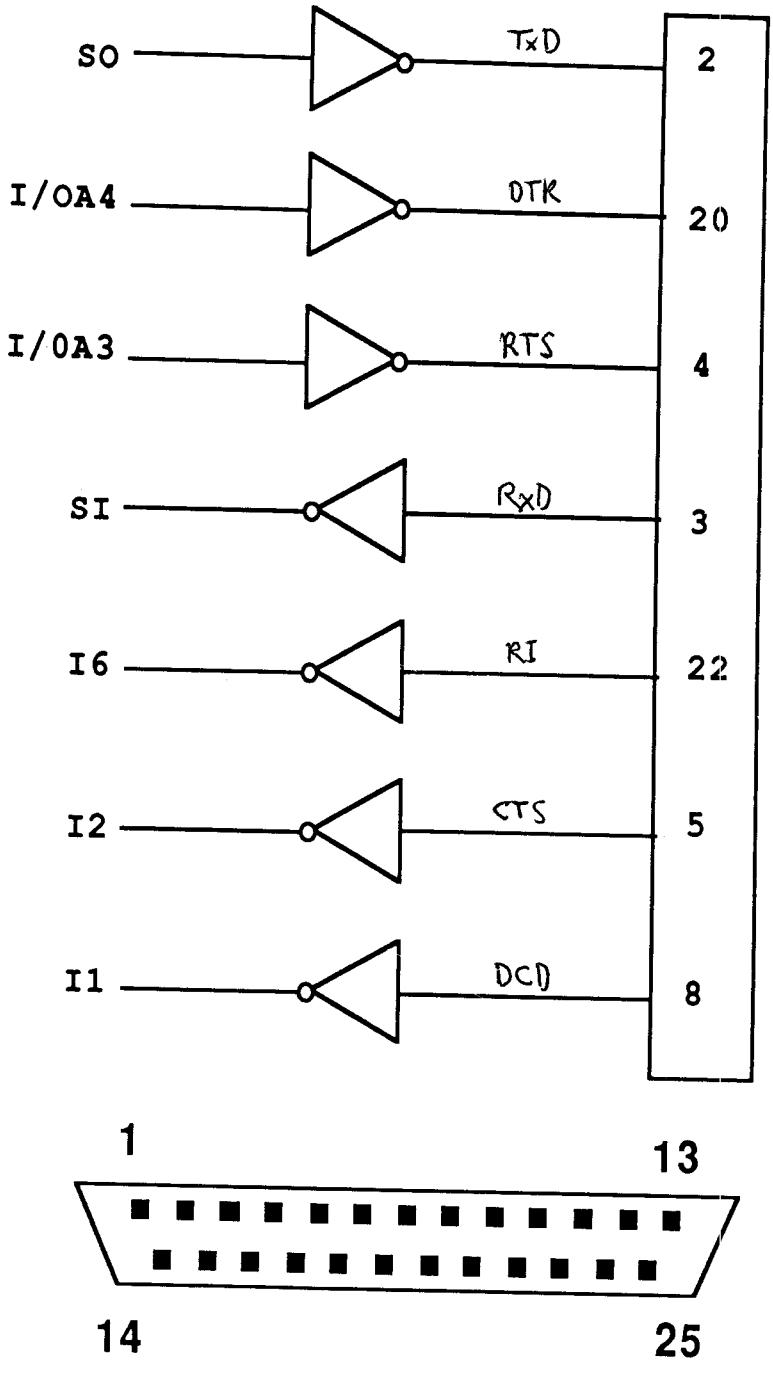
GND
Signal ground.

DCD
Carrier signal detected. This line, which goes to interrupt input I1 of the MFP, is normally serviced by a modem, which tells the computer that connection has been made with the other party.

20 DTR
Device ready. This line signals to a device that the computer is turned on and the interface will be serviced as required. It comes from I/O port A bit 4 of the sound chip.

22 RI
Ring indicator is a rather important interrupt on I6 of the MFP and is used by a modem to tell the computer that another party wishes connection, that is, someone called.

Figure 2.4-1 RS-232 Connection



.5 The MIDI Connections

The term MIDI is probably unknown to many of you. It is an abbreviation nd stands for Musical Instrument Digital Interface, an interface for musical nstruments.

t is certainly clear that we can't simply hook up a flute to this port. So first little history. Music professionals (more precisely: keyboardists, nusicians who play the synthesizer) demanded agreement between the arious manufacturers to interface computers to musical instruments. They ound it absurd to connect complicated set-ups with masses of wire. The dea was to service several synthesizers from one keyboard.

The tone created was basically analog (and still is, to a degree), so that the manafacturers agreed that a control voltage difference of 1V corresponded to a difference in tone of 1 octave. This way one could play several devices under "remote control," but not service them.

This changed substantially when the change was made to digital tone creation. Here one didn't have to turn a bunch of knobs, there were buttons to press, whereby the basis for digital control was created.

Some manufacturers got together and designed a digital interface, the basic commands of which would be the same throughout, but which would still support the additional features of a given device.

The device is based on the teletype, the current-loop principle, which is not very susceptible to noise, but significantly faster. The transfer rate is 31250 baud (bits per second). The data format is set at one start bit, eight data bits, and one stop bit.

An IC can therefore be used for control which would otherwise be used for RS-232 purposes. You see the connection to the system in figure 2.5-1.

Logically, MIDI is multi-channel system, meaning that 16 devices can be serviced by one master, or a device with 16 voices. These devices are all connected to the same line (bus principle). To identify which device or which voice is intended, each data packet is preceded by the channel number. The device which recognizes this number as its own then executes the desired action.

You may now ask what such an interface is doing in a computer. Qui simple: A computer, because of its high speed and memory capacity, is ver well suited to providing an entire arsenal of synthesizers with settings c complete melodies (sequencer) or to record and store such things from keyboard.

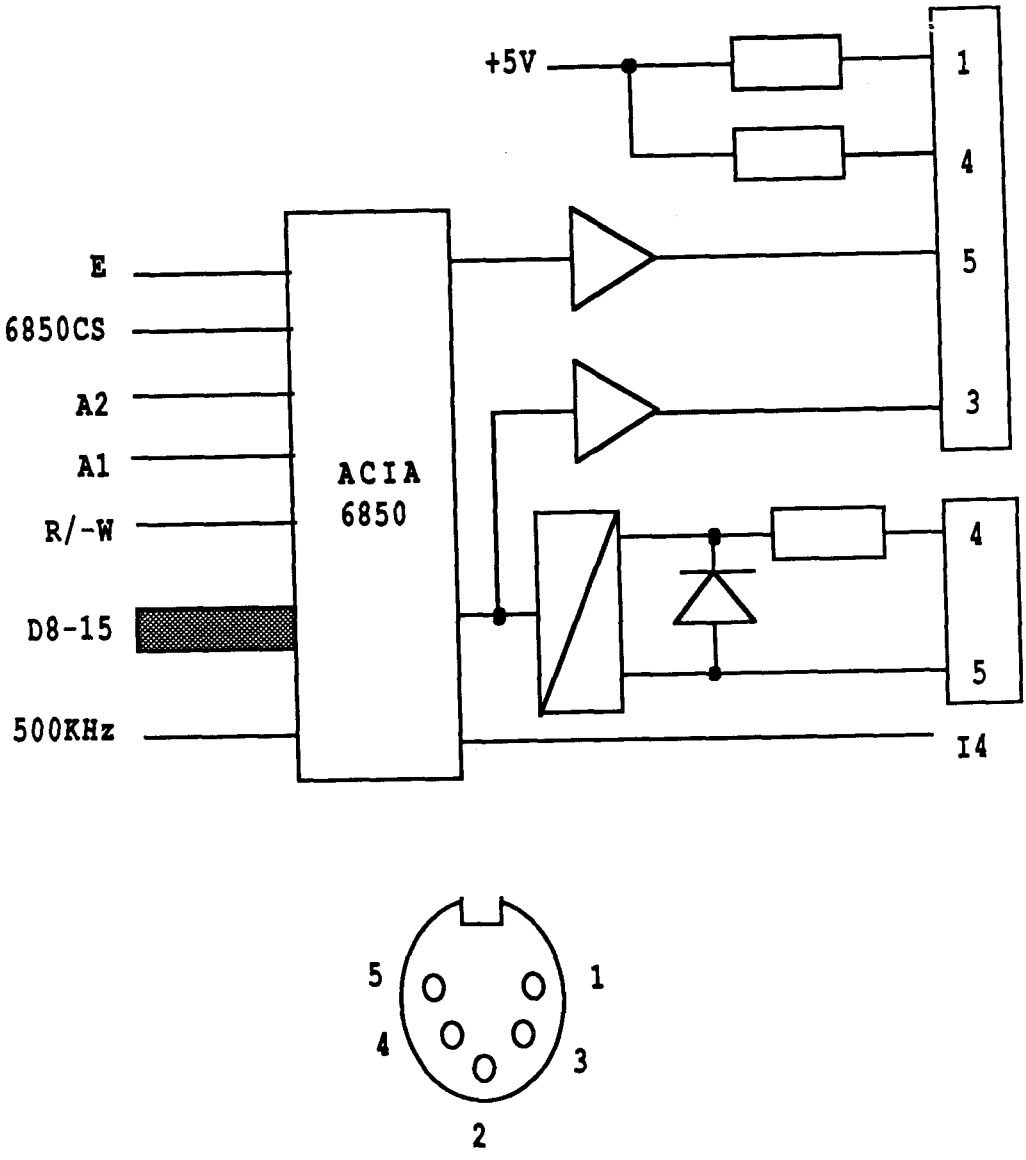
For this purpose the ST has the interfaces MIDI-IN and MIDI-OUT. Th interfaces are even supported by the XBIOS so you don't have to worr about their actual operation.

The current loop travels on pins 4 and 5, out through pin 4 (+) o MIDI-OUT and in at 5, when a device is connected.

For MIDI-IN the situation is reversed because the current flows in througl pin 4 and back out through pin 5. It goes though something called ar optocoupler which electrically isolates the computer from the sender.

The receive data are looped back to MIDI-OUT (pins 1 and 3), whicl implements the MIDI-THRU function, although not entirely according to the standard.

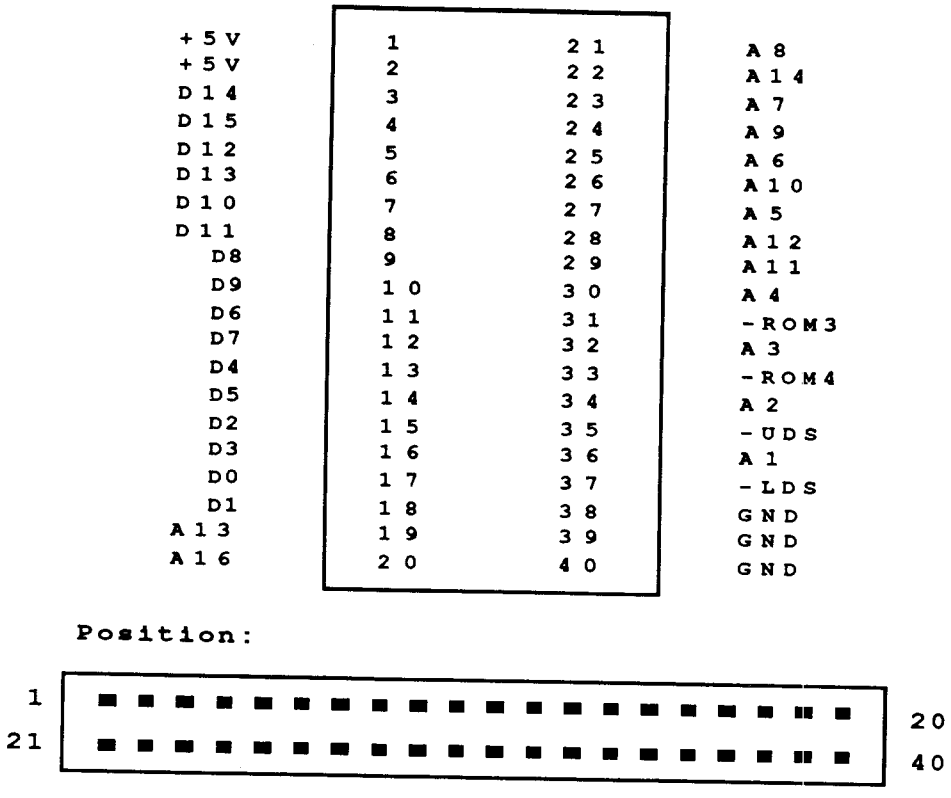
Figure 2.5-1 MIDI System Connection



2.6 The Cartridge Slot

The cartridge slot can be used *exclusively* for inserting ROM cartridges. U to 128K in the address space $FA0000 to $FBFFFF can be addressed. Th reason we stressed the exclusivity of the read access is the following. W thought it would be practical to outfit a cartridge with RAM and then loa programs into it after the system start which would still remain after a rese In order to try this we brought the R/-W signal to the outside. Th experience taught us, however, that a write access to these addresses create a bus error. The GLUE takes care of this. As you see, nothing is left t chance in the Atari.

Figure 2.6-1 The Cartridge Slot



2.7 The Floppy Disk Interface

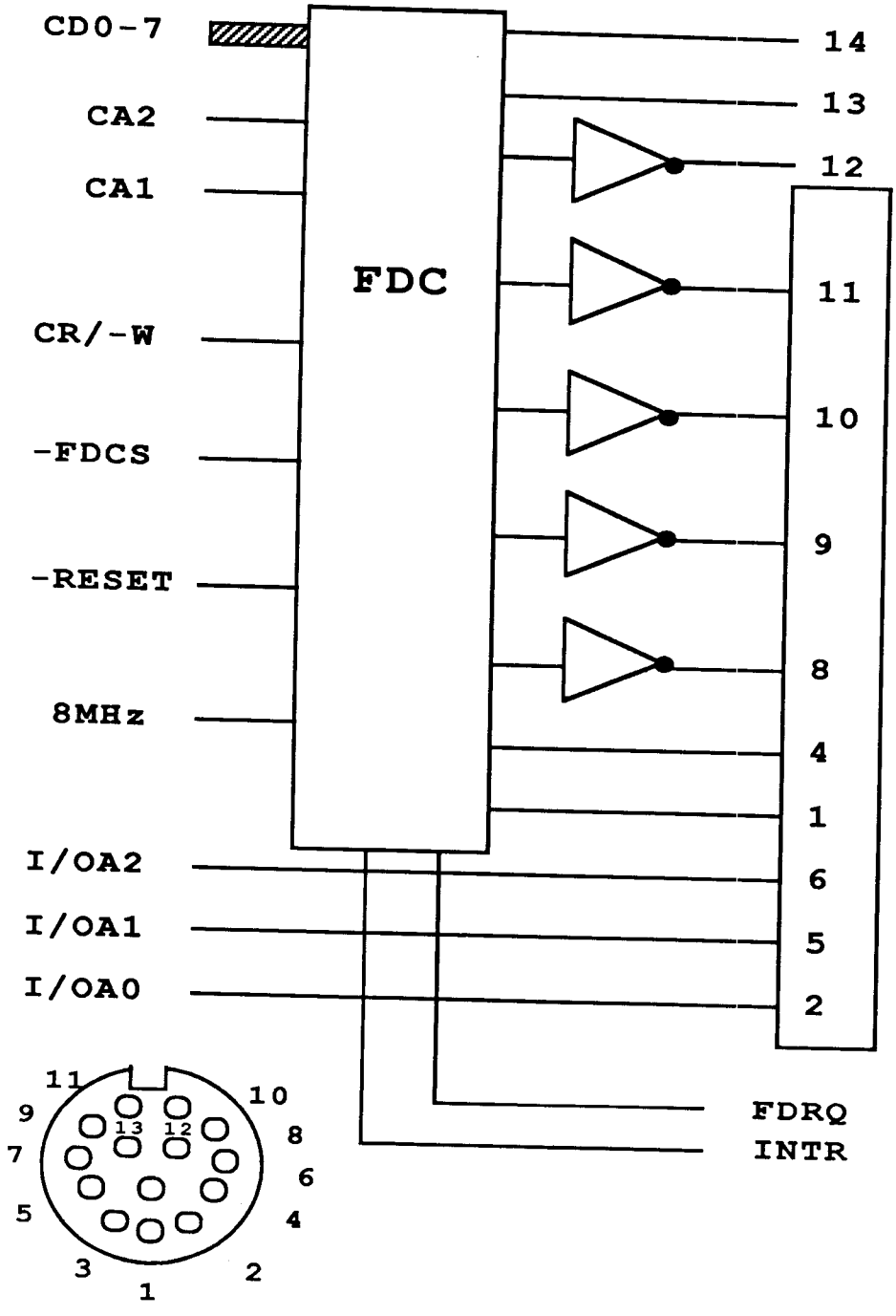
The interface for floppy disk drives is conspicuous because of the unusual connector, a 14-pin DIN connector. All of the signals required for the operation of two disk drives are available on it.

You know most of the signals from the description of the disk controller 1772, since nine of the available connections are directly or via a buffer connected to the controller. Only the drive select 1 and drive select 2 signals and the side 0 select are not derived from the disk controller. These signals come from port A of the sound chip.

Pinout of the disk connector:

```
1 READ DATA              8 MOTOR ON
2 SIDE 0 SELECT          9 DIRECTION IN
3 GND                   10 STEP
4 INDEX                 11 WRITE DATA
5 DRIVE 0 SELECT        12 WRITE GATE
6 DRIVE 1 SELECT        13 TRACK 00
7 GND                   14 WRITE PROTECT
```

Figure 2.7-1 Disk Connection



2.8 The DMA Interface

Up to 8 external devices can be connected to this 19-pin subminiature D connector. Such devices include hard disks, networks, and also coprocessors. The communication between the external devices and the ST runs at speeds up to 1 million bytes per second. Unfortunately, no experiments with DMA devices could be performed at the time this was printed. For this reason we cannot make the following statements with one hundred percent certainty.

The RESET line on pin 12 permits devices to be reset by the Atari. If this pin is low, as is the case when the Atari is turned on or when executing a RESET command, external devices are placed in a defined power-up state, without having to individually turn each device off and then on again.

Since most of the external devices will use a controller IC, the signal CS, Chip Select on pin 9, must also be available. The signal A1 is also to be seen in connection with this, because it is then important if the controller has more than just one register. This signal can distinguish between two registers.

The data transfer takes place over the bidirectional data bus on pins 1 to 8. The R/W line on the DMA bus determines the direction of the data transfer. The DMA chip can either write data to the bus (R/W is high), or read data from the bus (R/W is low). Data can be read or written only on the request of the external device. The release of a transfer is signaled by the signal DRQ (pin 19).

The ACK signal on pin 14 appears to be a purely hardware-dependent confirmation of the DRQ signal. The actual significance could not be checked however.

The last signal on the DMA port is the INT input. A low on this connection can generate an interrupt. The hard disk, for example, signals the end of the command through a low. The interrupt uses the same interrupt input on the MFP as the disk controller. This is input I/O 5. This means the at the floppy disk drive and the hard disk cannot transfer data together. The DMA is also not in such a position since it has only one DMA channel available.

The interrupt of this input is disabled in the MFP internally because the floppy as well as the hard disk routines check the port bit in a loop in order

to determine the end of the command. This simplifies the implementation c the time out, which is always generated when the floppy or hard disk ha not reacted to the command within a certain length of time.

Figure 2.8-1 DMA Port

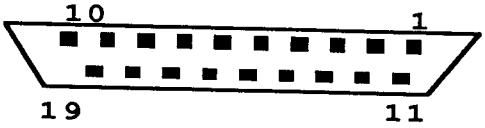
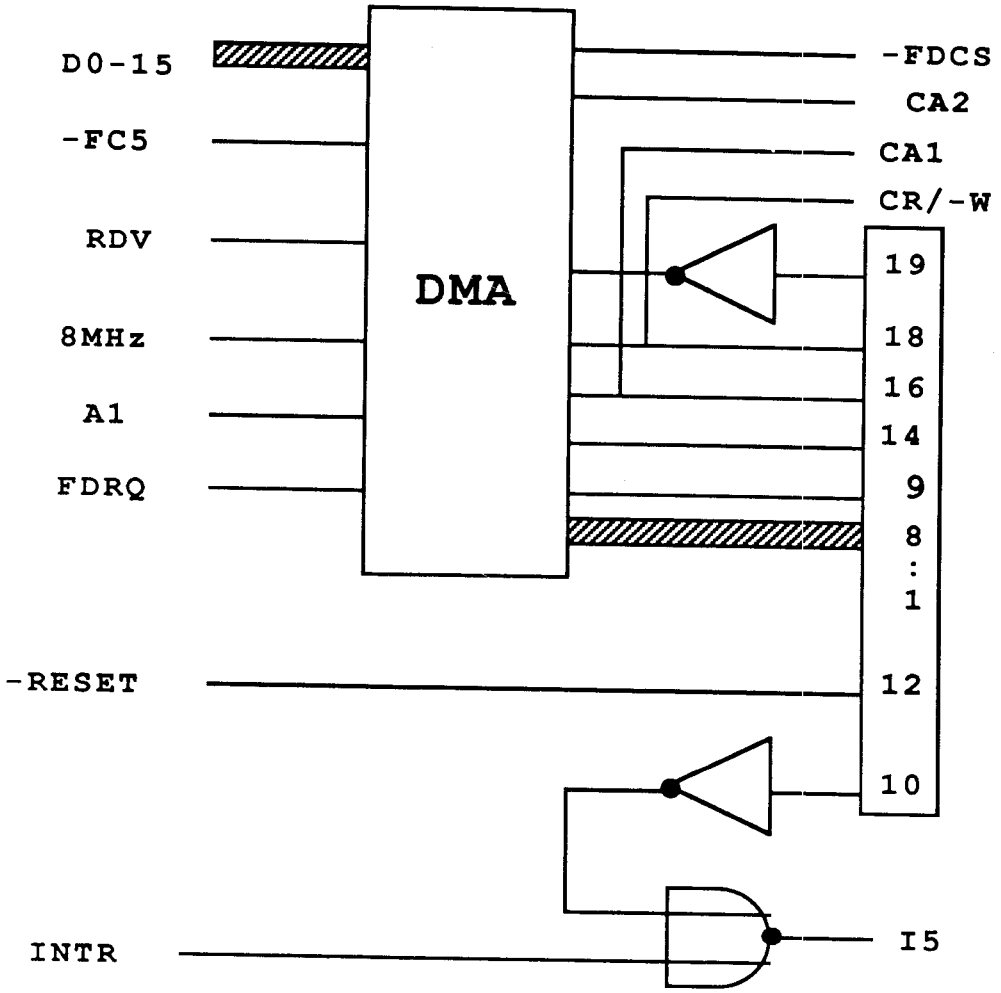


Figure 2.8-2 DMA Connections



Chapter 3

The ST Operating System

The ST Operating System

GEMDOS--what is it? Is it in the ST? The operating system is supposed to be TOS, though. Or CP/M 68K? Or what?

This question can be answered with few words. The operating system in the ST is named TOS--Tramiel Operating System--after the head of Atari. This TOS, in contrast to earlier information has nothing to do with CP/M 68K from Digital Research. At the start of development of the ST, CP/M 68K was implemented on it, but this was later changed because CP/M 68K is not exactly a model of speed and efficiency. A 68000 running at 8MHz and provided with DMA would be slowed considerably by the operating system.

At the beginning of 1985, Digital Research began developing a new operating system for 68000 computers, which would include a user-level interface. This operating system was named GEMDOS. It is exactly this GEMDOS which makes up the hardware-independent part of TOS. Like CP/M, TOS consists of a hardware-dependent and a hardware-independent part. The hardware-dependent part is the BIOS and the XBIOS, while the hardware-independent part is called GEMDOS. A large number of functions are built into GEMDOS, through which the programmer can control the actual input/output functions of the computer. Functions for keyboard input, text output on the screen or printer, and the operation of the various other interfaces are all present. Another quite important group contains the functions for file handling and for logical file and disk management.

3.1 The GEMDOS

When you look at the functions available under GEMDOS, you wi eventually come to the conclusion that the whole thing is not really new. A the functions in GEMDOS are very similar to the functions of the MS-DO operating system. Even the functions numbers used correspond to those c MS-DOS. But not all MS-DOS functions are implemented in GEMDOS Especially in the area of file management, only the UNIX compatibl functions are implemented in GEMDOS. The "old" block-oriente functions which are included in MS-DOS to maintain compatibility wit CP/M are missing from GEMDOS. Also, special functions relating to th hardware of MS-DOS computers (8088 processor) are missing.

Another essential difference between MS-DOS and GEMDOS is that fo GEMDOS calls as well as for the BIOS and XBIOS, the function numbe the number of the desired GEMDOS routine, and the required parameter are placed on the stack and are not passed in the registers. The 68000 i particularly suited to this type of parameters passing. GEMDOS is calle with `TRAP #1` and the function is executed according to the contents o the parameter list. After the call, the programmer must put the stack back i order himself, by clearing the parameters from memory.

The basic call of GEMDOS functions differs from the BIOS and XBIOS calls only in the trap number.

In regard to all GEMDOS calls, it must be noted that registers D0 and A0 are changed in all cases. If a value is returned, it is returned in D0, or D0 may contain an error number, and after the call A0 (usually) points to the stack address of the function number. Any parameters required in D0 or A0 must be placed there before GEMDOS is called.

The remainder of this section describes the individual GEMDOS functions.

$00 TERM

Calling GEMDOS with function number 0 ends the running program and returns to the program from which it was started. For applications, programs started from the desktop, program control is returned to the desktop. If the program was called from a different program, execution is passed back to the calling program. This point is important for chaining program segments.

```
CLR.W  -(SP)
TRAP
```

$01 CONIN

CONIN fetches a single character from the keyboard. The routine waits until a character is available. The result, the character read from the keyboard, is returned in the D0 register. The ASCII code of the pressed key is returned in the low byte of the low word, while the low byte of the high word of the register contains the scan code returned from the keyboard. This is important when reading keys which have no ASCII code. This applies to the 10 function keys or the keys of the cursor block, for example. These keys return the ASCII value zero when pressed.

If needed, the scan code can be used to determine if the digits on the keypad or the main keyboard were pressed, since these keys have identical ASCII codes, but return different scan codes.

```
.
MOVE.W #1,-(SP)    * Function number on the stack
TRAP   #1          * Call GEMDOS
ADDQ.L #2,SP       * Correct stack
.
```

$02 CONOUT

CONOUT represents the simplest and most primitive character output o GEMDOS. With this function only one character is printed on the screen The character to be displayed is placed on the stack as the first word. The ASCII value of the character to be printed must be in the low byte of the word and the high byte should be zero.

The character printed by CONOUT is outputted to device number 2, the normal console output. Control characters and escape sequences are interpreted normally.

```
MOVE.W #'A',-(SP)   * Output an A
MOVE.W #2,-(SP)     * CONOUT
TRAP   #1           * Call GEMDOS
ADDQ.L #4,SP        * Correct stack
```

$03 AUXILLIARY INPUT

Under the designation "auxilliary port" is the RS-232 interface of the ST. A character can be read from the interface with the function CAUXIN. The function returns when a character has been completely received. The character is returned in the lower eight bits of register D0.

$04 AUXILLIARY OUTPUT

Similar to the input of characters via the serial interface, a character can be sent with this function. With this function the programmer should clear the upper eight bits of the word and pass the character to be sent in the lower eight bits.

$05 PRINTER OUTPUT

PRINTER OUTPUT is the simplest method of operating a printer connected to the Centronics interface. One character is printed with each call.

An important part of PRINTER OUTPUT is the return value in D0. If the character was sent to the printer, the value -1 ($FFFFFFFF) is returned in D0. If, after 30 seconds, the printer was unable to accept the character (not turned on, OFF LINE, no paper, etc.), GEMDOS returns a time out to the program. D0 then contains a zero.

```
MOVE.W #'A',-(SP)   * Output an A
MOVE.W #5,-(SP)     * Function number
TRAP   #1           * Call GEMDOS, output character
ADDQ.L #4,SP        * Correct stack
TST.W  D0           * Affect flags
BEQ    printererror
```

$06 RAWCONIO

RAWCONIO is a somewhat unusual mixture of keyboard input and screen output and receives a parameter on the stack.

With a function value of $FF the keyboard is tested. If a character is present, the ASCII code and scan code are passed in D0 as described for CONIN. But if no key value is present, the value zero is passed as both the ASCII code and the scan code in D0. The call to RAWCONIO with parameter $FF is comparable to the BASIC INKEY$ function.

If a value other than $FF is passed to the function, the value is interpreted as a character to be printed and it is output at the current cursor position. This output also interprets the control characters and escape sequences properly.

```
START:

MOVE.W  #$FF,-(SP)    * Function value test keyboard
MOVE.W  #6,-(SP)      * Function number
TRAP    #1            * Call GEMDOS, test keyboard
ADDQ.L  #4,SP         * Correct stack
TST.W   D0            * Character arrived?
BEQ     START         * Not yet
CMP.B   #3,D0         * ^C selected as the end marker
BEQ     END
MOVE    D0,-(SP)      * Character for output on the stack
MOVE    #6,-(SP)      * Function number
TRAP    #1            * Call GEMDOS, test keyboard
ADDQ.L  #4,SP         * Correct stack
BRA     START         * Get new character
```

$07 DIRECT CONIN WITHOUT ECHO

The function $07 differs from $01 only in that the character received from the keyboard is not displayed on the screen. It waits for a key just as does CONIN.

$08 CONIN WITHOUT ECHO

Function $08 does not differ from function $07. Both function calls have exactly the same effect. The reason for this seemingly nonsensical behavior lies in the mentioned compatibility to MS-DOS. Under MS-DOS the two functions are different in that with $08, certain keys not present on the ATARI are evaluated correctly, while this evaluation does not take place with function $07.

$09 PRINT LINE

You have already become familiar with functions to output individual characters on the screen with CONOUT and RAWCONIO. PRINT LINE offers you an easy way to output text. An entire string can be printed at the current cursor position with this function. To do this, the address of the string is placed on the stack as a parameter. The string itself is concluded with a zero byte. Escape sequences and control characters can also be evaluated with this function.

After the call, D0 contains the number of characters which were printed. The length of the string is not limited.

```
MOVE.L  #text,-(SP)   * Address of the string on the stack
MOVE    #$09,-(SP)    * Function number PRT LINE
TRAP    #1            * Call GEMDOS
ADDQ.L  #6,SP         * "Clean up" the stack
.
.
text    .DC.B 'This is the string to be printed',$0D,$0A,0
```

$0A READLINE

READLINE is a very easy-to-use function for reading characters from the keyboard. In contrast to the "simpler" character-oriented input functions, an entire input line can be fetched from the keyboard with READLINE. The characters entered are displayed on the screen at the same time.

The address of an input buffer is passed to the function as the parameter. The value of the first byte of the input buffer determines the maximum length of the input line and must be initialized before the call. At the end of the routine, the second byte of the buffer contains the number of characters entered. The characters themselves start with the third byte.

The routine used by READLINE for keyboard input is quite different from the character-oriented console inputs. Escape sequences are not interpreted during the output. Only control characters like control-H (backspace) and control-I (TAB) are recognized and handled appropriately. The following control characters are possible:

```
^C   Ends input AND program (!)
^H   Backspace one position
^I   TAB
^J   Linefeed, end input
^M   CR, end input
^R   Entered line is printed in new line
^U   Don't count line, start new line
^X   Clear line, cursor at start of line
```

A function like ^H, deleting a character entered, is useful, but for large programs you should write your own input routine because ^C is very "dangerous." Unlike CP/M, the program will be ended even if the cursor is not at the very start of the input line.

If more characters are entered than were indicated in the first byte of the buffer at the initialization, the input is automatically terminated. If the input is terminated by ENTER, ^J, or ^M, the terminating character will not be put in the buffer.

After the input, D0 contains the number of characters entered, excluding ENTER, which can be found at buffer+1.

$0B CONSTAT

All key actions are first stored in a buffer in the operating system. This storage is 64 bytes in length. The key values stored there are taken from the buffer when a call to a GEMDOS output routine is made.

CONSTAT can be used to check if characters are stored in the keyboard buffer. After the call, D0 contains the value zero or $FFFF. A zero in D0 indicates that no characters are available.

$0E SETDRV

The current drive can be determined with the function SETDRV. A 16-bit parameter containing the drive specification is pased to the routine. Drive A is addressed with the number 0 and drive B with the number 1.

After the call, D0 contains the number of the drive active before the call.

$10 CONOUT STAT

CONOUT STAT returns the status of the console in D0. If the value $FFFF is returned, a character can be displayed on the screen. If the returned value is zero, however, no character output is possible on the screen at that time. Incidently, all attempts to create a not-ready status at the console failed. The only imaginable possibility for the not-ready status would be if the output of the individual bit pattern of a character was interrupted and the interrupt routine itself tried to output a character. This case could not, however, be created.

$11 PRTOUT STAT

This function returns the status, the condition of the Centronics interface. If no printer is connected (or turned off, or off line), D0 contains the value zero after the call to indicate "printer not available." If, however, the printer is ready to receive, D0 contains the value $FFFF.

$12 AUXIN STAT

By calling AUXIN STAT you can determine if a character is available from the receiver of the serial interface ($FFFF) or not ($0000). As with all other functions, the value is returned in D0.

$13 AUXOUT STAT

AUXOUT STAT gives information about the state of the serial bus. A value of $FFFF indicates that the serial interface can send a character, while zero indicates that no characters can be sent at this time.

$19 CURRENT DISK

For many applications it is necessary to know which drive is currently active. The current drive can be determined by the function $19. After the call, D0 contains the number of the drive. The significance of the drive numbers is the same as for $0E, SET DRIVE (0=A, 1=B).

$1A SET DISK TRANSFER ADDRESS

The disk transfer address is the address of a 44-byte buffer required for various disk operations (especially directory operations). Along with the GEMDOS functions SEARCH FIRST and SEARCH NEXT are examples for using the DTA.

```
MOVE.L #DTADDRESS,-(SP)  * Address of the 44-byte DTA buffer
MOVE.W #$1A,-(SP)        * Function number SET DTA
TRAP   #1                * Set DTA
ADDQ.L #6,SP             * Clean up the stack
```

$20 SUPER

This function is especially interesting for programmers who want to access the peripheral components or system variables available only in the supervisor mode while running a program in the user mode. After calling this function from the user mode, the 68000 is placed in the supervisor mode. In contrast to the XBIOS routine for enabling the supervisor mode, additional GEMDOS, BIOS, and XBIOS calls can be made after a successful SUPER call.

First we will look at the case in which the SUPER function is called from a program in the user mode with a value of zero on the stack. In this case the program finds itself in the supervisor mode after the call. The supervisor stack pointer is set to the value of the user stack pointer and the original value of the supervisor stack pointer is returned in D0. This value should be stored by the program in order to get back into the user mode later.

If a value other than zero is passed to the SUPER function the first time it is called, this value is interpreted as the desired value of the supervisor stack pointer. In this case as well, D0 contains the original value of the supervisor stack pointer, which the program should save.

Before a program ends, the user mode should be reenabled. This change of operating modes requires the address acquired the first time the routine was called in order to set the supervisor stack pointer back to its original value.

The SUPER function differs from all other GEMDOS functions in one very important respect. Under certain circumstances, this call can also change the contents of A1 and D1. If you store important values in these registers, you must save the values somewhere before calling the SUPER function.

```
                          * The 6800 is in the user mode
CLR.L  -(SP)              * User stack becomes supervisor stack
MOVE.W #$20,-(SP)         * Call SUPER
TRAP   #1                 * The supervisor mode is active
                          * after the TRAP
ADD.L  $6,SP              * D0 = old supervisor stack
MOVE.L D0,_SAVE_SSP       * Save value
.
.
.
.  Here processing can be done in the supervisor mode
.
.
.
MOVE.L _SAVE_SSP,-(SP)  * Old supervisor stack pointer
MOVE.W #$20,-(SP)       * Call SUPER
TRAP   #1               * Now we are back in the user mode
ADD.L  #6,SP
.
.
.
```

$2A GET DATE

You have no doubt experimented with the status field at one time or another. In addition to various other functions, the status field contains a clock with clock time and date. It can be useful for some applications to have the data available. The date can be easily determined by the GET DATE function. This function call requires no parameters and makes the date available in the low word of register D0. It is rather thoroughly encoded, though, so that the result in D0 must be prepared in order to get the correct date.

The day in the range 1 to 31 is coded in the lower five bits. Bits 5 to 8 contain the month in the value range 1 to 12, and the year is contained in

bits 9 to 15. The value range in these "year bits" goes from 0 to 119. The value of these bits must be added to the value 1980 in order to get the actual year. The date 12/12/1992, for example, would result in $198C in D0. This can be represented in binary as %0001100.1100.01100. The lengths of the three fields are marked with periods.

$2B SET DATE

The clock time and date can also be set from application programs. This is particularly interesting for programs which use the date and/or clock time. An example of this would be invoice processing in which the current date is inserted in the invoice. Such programs can then ask the user to enter the date. This avoids the problems that occur if the user forgets to set the date and clock time on the status field beforehand.

The date must be passed to the function SET DATE in the same format as it is received from GET DATE, bits 0-4 = day, bits 5-8 = month, bits 9-15 = year-1980.

```
MOVE.W #%101101011001,-(SP)   * Set date to 10/25/1985
MOVE.W #$2A,-(SP)             * Function number of SET DATE
TRAP   #1                     * Set date
ADDQ.L #6,SP                  * Repair stack
```

$2C GET TIME

The function GET TIME returns the current (read: set) time from the GEMDOS clock. Similar to the date, the clock time is coded in a special pattern in individual bits of the register D0 after the call. The seconds are represented in bits 0-4. But since only values from 0 to 31 can be represented in 5 bits, the internal clock runs in two second increments. In order to get the correct seconds-result the contents of these five bits must be multiplied by two. The number of minutes is contained in bits 5 to 10, while the remaining bits 11-15 give information about the hour (in 24-hour format).

$2D SET TIME

It is also possible to set the clock time under GEMDOS. The function SET TIME expects a 16-bit value (word) on the stack, in which the time is coded in the same form as that in which GET TIME returns the clock time.

```
MOVE.W #%1000101010111101,-(SP) * Clock time 17:21:58
MOVE.W #$2D,-(SP)               * Function # of GET TIME
TRAP   #1                       * Set date
ADDQ.L #6,SP                    * Repair stack
```

$2F GET DTA

The function $2F is the counterpart of function $1A, SET DTA. A call to this function returns the address of the current disk transfer buffer in D0. An exact explanation of this buffer is found together with the functions SEARCH FIRST and SEARCH NEXT.

$30 GET VERSION NUMBER

Calling this function returns in D0 the version number of GEMDOS. In the version of GEMDOS currently in release, this question is always answered with $0D00, corresponding to version 13.00. Official Atari documentation claims that a value of $0100 should be returned for this version, though perhaps the value should indicate that the present GEMDOS version is the $D = diskette version.

$31 KEEP PROCESS

This function is comparable to the GEMDOS function TERM $00. The program is also ended after a call to this function. $31 does differ from $00 in several important points.

After processing `TRAP #1`, like TERM, control is passed back to the program which started the program just ended. In contrast to TERM, a termination condition can be communicated to the caller. While TERM

returns the termination value zero (no error), zero or one may be selected a the termination value for $31. A value other than zero means that an erro occurred during program processing.

Another essential point lies in the memory management of GEMDOS. Whe a program is started, the entire available memory space is made available t it. If the program is ended with TERM, the memory space is released an made available to GEMDOS. The entire area of memory released is als cleared, filled with zeros. The program actually physically disappears fron the memory. With function $31, however, an area of memory can b protected at the start address of the program. This memory area is no released when the program is ended and it is also not cleared. The program could be restarted without having to load it in again.

KEPP PROCESS is called with two parameters. The example programs shows the parameter passing.

```
MOVE.W  #0,-(SP)        * Error code no error, else 1
MOVE.L  #$1000,-(SP)    * Protect $1000 bytes at program start
MOVE.W  #$31,-(SP)      * Function number, end program
TRAP    #1              *                                  now
```

$36 GET DISK FREE SPACE

It can be very important for disk-oriented programs to determine the amount of free space on the diskette. Then you have the ability to request that the user change disks at the appropriate time. "Disk full" messages or even data loss can then be avoided.

Function $36 returns exactly this information. The number of the desired disk drive and the address of a 16-byte buffer must be passed to the function. If the value 0 is passed as the drive number, the information is fetched from the active drive, a 1 takes the information from drive A, and a 2 from drive B.

The information passed in the buffer is divided into four long words. The first long word contains the number of free allocation units. Each file, even if it is only eight bytes long, requires at least one such allocation unit.

The second long word gives information about the number of allocation units present on the disk, regardless of whether they are already used or are still free. For the "small," single-sided diskettes this value is $15C or 351, while the double-sided disks have $2C7 = 711 allocation units. The third long word contains the size of a disk sector in bytes. For the Atari this is always 512 bytes ($200 bytes).

In the last word is the number physical sectors belonging to an allocation unit. This is normally 2. Two sectors form one allocation unit.

The number of available bytes of disk space can easily be calculated from this information.

```
MOVE.W #0,-(SP)          * Information from the active drive
MOVE.L #BUFFER,-(SP)     * Address of the 16-byte buffer
MOVE   #$36,-(SP)        * Function number
TRAP   #1
ADDQ.L #8,SP             * Clean up stack
.
.
.
.bss
BUFFER:
freal: .ds.l   1         * Free allocation units
total: .ds.l   1         * Total allocation units
bps:   .ds.l   1         * Bytes/physical sector
pspal: .ds.l   1         * Phys. sectors/alloc. unit
```

$39 MKDIR

A subdirectory can be created from the desktop with the menu option "NEW FOLDER". Such a subdirectory can also be created from an application program with a call to $39.

In order to create a new folder, the function $39 is given the address of the folder name, also called the pathname. This name may consist of 8 characters and a three-character extension. The same limitations apply to pathnames as do to filenames. The pathname must be terminated with a zero byte when calling MKDIR.

After the call, D0 indicates whether the operation was performe successfully. If D0 contains a zero, the call was successful. Errors ar indicated through a negative number in D0. At the end of this chapter yo will find an overview of all of the error messages occurring on connectio with GEMDOS functions.

```
MOVE.L #pathname        * Address of the pathname
MOVE   #$39,-(SP)       * Function number
TRAP   #1
ADDQ.L #6,SP            * Repair stack
TST.W  D0               * Error occurred?
BNE    error            * Apparently
.
.
.
pathname:
       .dc.b  'private.dat',0
```

$3A RMDIR

A subdirectory created with MKDIR can be removed again with $3A. As before, the pathname, terminated with a zero, is passed to RMDIR. The error messages also correspond to those for MKDIR, with zero for success or a negative value for errors. An important error message should be mentioned at this point. It is the message -36 ($FFFFFFCA). This is the error message you get when the subdirectory you are trying to remove contains files.

Only empty subdirectories can be removed with RMDIR. In the event of the described error message, one must first erase all of the files in the directory with UNLINK ($41) and then call RMDIR again.

$3B CHDIR

The system of subdirectories available under GEMDOS is exactly the same form available under UNIX. This system is now running on systems with diskette drives, but its advantages become noticeable first when a large mass storage device such as a hard disk with several megabytes of storage capacity is connected to the system. After a while, most of the time would probably be spent looking for files in the directory.

To better organize the data, subdirectories can be placed within subdirectories. It can therefore become necessary to specify several subdirectories until one has the directory in which the desired file is stored. An example might be:

```
/hugos.dat/cfiles.s/csorts.s/cqsort.s
```

Translated this would mean: load the file `cqsort.s` from the subdirectory `csorts.s`. This subdirectory `csorts.s` is found in the subdirectory `cfiles.s`, which in turn is a subdirectory of `hugos.dat`. If the whole expression is given as a filename, the desired file will actually be loaded (assuming that the file and all of the subdirectories are present). If you want to access another file via the same path (do you understand the term pathname?), the entire path must be entered again. But you can also make the subdirectory specified in the path into the current directory, by calling CHDIR with the specification of the desired path. After this, all of the files in the selected subdirectory can be accessed just by the filenames. The path is set by the function.

```
MOVE.L  #path,-(SP)      * Address of the path
MOVE.W  #$3B,-(SP)       * Function number
TRAP    #1
ADDQ.L  #6,SP            * Repair stack
TST.W   D0               * Error occurred?
BNE     error            * Apparently
.
.
.
path:
        .dc.b   '/hugos.dat/private.dat/',0
```

$3C CREATE

In all operating systems, the files are accessed through the sequence c opening the file, accessing the data, (reading or writing), and then closir the file. This "trinity" also exists under GEMDOS, although there is a exception. Under CP/M, for example, a non-existing file can also b opened. When a file which does not exist is opened, it is created. Unde GEMDOS, the file must first be created. The call $3C, CREATE, is use for this purpose. Two parameters are passed to this GEMDOS function: th address of the desired filename, and an attribute word.

If a zero is passed as the attribute word, a normal file is created, a file whic can be written to as well as read from. If the value 1 is passed as th attribute, the file will only be able to be read after it is closed. This is a typ of software write-protect (which naturally cannot prevent the file fron disappearing if the disk is formatted).

Other possible attributes are $02, $04, and $08. Attribute $02 creates a "hidden" file and attribute $02 a "hidden" system file. Attribute $08 create a file with a "volume label." The volume label is the (optional) name whic a disk can be given when it is formatted. The disk name is then created fron the maximum of 11 characters in the name and the extension. Files with one of the last three attributes are excluded from the normal directory search. Or the ST, however, they do appear in the directory.

When the function CREATE is ended, a file descriptor, also called a file handle, is returned in D0. All additional accesses to the file take place over this file handle (a numerical value bewteen 6 and 45). The handle must be given when reading, writing, or closing files. A total of $28 = 40 files can be opened at the same time.

If CREATE is called and a file with this name already exists, it is cut off a zero length. This is equivalent to the sequence delete the old file and create a new file with the same name, but it goes much faster.

If after calling CREATE you get a handle number back in D0, the file need not be opened again with $3D OPEN.

```
MOVE.W #$0,-(SP)          * File should have R/W status
MOVE.L #filename,-(SP)    * Address of the filename on stack
MOVE.W #$3C,-(SP)         * Function number
TRAP   #1                 * Call GEMDOS
ADDQ.L #8,SP              * Clean up stack
TST    D0                 * Error occurred?
BMI    error              * It appears so
MOVE   D0,handle          * Save file handle
.
.
.
filename:                 * Don't forget zero byte
       .dc.b  'myfile.dat',0
.
handle:
       .ds.w  1
```

$3D OPEN

You can create only new files with CREATE, or shorten existing files to length zero. But you must be able to process existing files further as well. To do this, such files must be opened with the OPEN function.

The first parameter of the OPEN function is the mode word. With a zero in the mode word, the opened file can only be read, with one it can only be written. With a value of 2, the file can be read as well as written. The filename, terminated with zero byte in the usual manner, is passed as the second parameter.

The OPEN function returns the handle number in D0 as the result if the file is present and the desired access mode is possible. Otherwise D0 contains an error number. See the end of the chapter for a list of the error numbers.

```
MOVE.W #$2,-(SP)        * File read and write
MOVE.L #filename        * Address of the filename on the stac
MOVE.W #$3D,-(SP)       * Function number
TRAP   #1               * Call GEMDOS
ADDQ.L #8,SP            * Clean up the stack
TST.W  D0               * Error occurred?
BMI    error            * Apparently
MOVE   D0,handle        * Save file handle for later accesses
.
.
.
filename:               * Don't forget zero byte!
       .dc.b   'myfile.dat',0
.
handle:
       .ds.w   1
```

$3E CLOSE

Every opened file should be closed when it will no longer be accessed within a program, or when the program itself is ended. Especially when writing, files must absolutely be closed before the program ends or data may be lost.

Files are closed by a call to CLOSE, to which the handle number is passed as a parameter. The return value will be zero if the file was closed correctly.

```
MOVE.W handle,-(SP)     * Handle number
MOVE.W #$3E,-(SP)       * Function number
TRAP   #1               * Call GEMDOS
ADDQ.L #4,SP            * Error occurred?
BMI    error            * Apparently
.
.
handle:
       .ds.w   1
```

3F READ

)pening and closing files is naturally only half of the matter. Data must be :ored and the retrieved later. Reading such files can be done in a very legant manner with the function READ. READ expects three parameters: rst the address of a buffer in which the data is to be read, then the number f bytes to be read from the file, and finally the handle number of the file. 'his number you have (hopefully) saved from the previous OPEN.

Ve mentioned the possible handle numbers in conjunction with CREATE. Vhat we didn't mention, however, is why the first handle number is six. 'he cause of this is that things called devices, like the keyboard, the screen, ie printer, and the serial interface, are also accessed via handle numbers for READ and WRITE operations. The device assignments are:

```
0 = Console input
1 = Console output
2 = RS-232
3 = Printer
```

Numbers 4 and 5 also function as console input and output. When using hese handle numbers, the system sometimes returns "invalid handle number". The correct programming and the exact purpose of these two numbers is not known.

As return value, D0 contains either an error number (hopefully not) or the number of bytes read without error. No message regarding the end of the file is returned. This is not necessary, however, since the size of the file is contained in the directory entry (see SEARCH FIRST/SEARCH NEXT). If the file is read past the logical end, no message is given. The reading will be interrupted at the end of the last occupied allocation unit of the file. The number of bytes read in this case is always divisible by $400.

```
MOVE.L #buffer,-(SP)    * Address of the data buffer
MOVE.L #$100,-(SP)      * Read 256 bytes
MOVE.W handle,-(SP)     * Space for the handle number
MOVE.W #$3F,-(SP)       * Function number
TRAP   #1
ADD.L  #12,SP
TST.L  D0               * Did an error occur
BMI    error            * Apparently
.
.
handle:
       .ds.w  1         * Space for the handle number
.
buffer:
       .ds.b  $100      * Suffices in our example
```

$40 WRITE

Writing to a file is just as simple as reading from it. The parameters required are also the same as those required for reading. The file descriptors from OPEN and CREATE calls can be used as the handle, but the device numbers listed for READ can also be used. The output of a program can be sent to the screen, the printer, or in a file just by changing the handle number.

$41 UNLINK

Files which are no longer needed can be deleted with UNLINK. To do this the address of the filename or, if necessary, the complete pathname must be passed to the function. If the D0 register contains a zero after the call, the file has been deleted. Otherwise D0 will contain an error number.

```
IOVE.L pathname,-(SP)   * Address of the data buffer
IOVE.W #$41,-(SP)       * Function number
'RAP   #1
ADD.L  #6,SP
'ST.W  D0               * Did an error occur?
3MI    error            * Apparently
.
.
.
pathname:
       .dc.b   '/rolli/private/pacman.prg',0
```

$42 LSEEK

Up to now we have become acquainted only with sequential data accesses. We can read through any file from the beginning until we come the desired information. An internal file pointer which points to the next byte to be read goes along with each read. We can only move this pointer continusouly in the direction of the end of file by reading. A few bytes forward or backward, setting the pointer as desired, is not something we can do. This is required for many applications, however.

LSEEK offers an extraordinarily easy-to-use method of setting the file pointer to any desired byte within the file and to read or write at this point.This UNIX-compatible option of GEMDOS is much easier to use that the methods available under CP/M for relative file management, for instance.

A total of three parameters are passed to the LSEEK function. The first parameter specifies the number of bytes by which the pointer should be moved. An additional parameter is the handle number of the file. The last parameter is a mode word which describes how the file is to be moved. A zero as the mode moves the pointer to the start of the file and from there the given number of bytes toward the end of the file. Only positive values may be used as the number. With a mode value of 1, the pointer is moved the desired positive or negative amount from the current position, and a 2 as the mode value means the distance specified is from the end of the file. Only negative values are allowed in this mode.

After the call, D0 contains the absolute position of the pointer from the sta of the file, or an error message.

```
MOVE.W #1,-(SP)        * Relative from the current file ptr
MOVE.W handle,-(SP)    * File handle
MOVE.L #$-20,-(SP)     * 32 bytes back
MOVE.W #$42,-(SP)      * Function number
TRAP   #1
ADD.L  #10,SP
TST.W  D0              * Did an error occur?
BMI    error           * Apparently
.
.
handle:
       .ds.w  1        * Space for the handle number
```

$43 CHANGE MODE (CHMOD)

With the CREATE function a file can be assigned a specific attribute. This attribute can be determined and subsequently changed only with the function CHANGE MODE. The name of the file must be known because the address of the name or the complete pathname must be passed to CHMOD. Another parameter word specifies whether the file attribute is to be read or set. Moreover, a word must be passed which contains the new attribute. When reading the attribute of a file this word is not necessary, but should be passed to the routine as a dummy value. We indicated the possible file attributes in our discussion of the function CREATE, but here they are again in a table:

```
$00 = normal file status, read/write possible
$01 = File is READ ONLY
$02 = "hidden" file
$04 = system file
$08 = file is a volume label, contains disk name
$10 = file is a subdirectory
$20 = file is written and closed correctly
```

Attributes $10 and $20 cannot be specified when the file is created. Attribute $20 is granted by the operating system, while the GEMDOS function

MKDIR is used to create a subdirectory. The MKDIR function creates not only the directory entry with the appropriate attribute, it also arranges the subdirectory on the disk physically.

After the call, D0 will contain the current attribute value, which will be the new value after setting the attribute, or, as with all other function calls, a negative error number.

First example:

```
MOVE.W #1,-(SP)          * Give file READ ONLY attribute
MOVE.W #1,-(SP)          * Set attribute
MOVE.L #pathname,-(SP)   * We also need the pathname
MOVE.W #$43,-(SP)        * Function number
TRAP   #1
ADD.L  #10,SP
TST.W  D0                * Did an error occur?
BMI    error             * Apparently
.
.
.
pathname:                * Don't forget zero byte at end!
       .dc.b  'killme.not',0
```

Second example:

```
MOVE.W #0,-(SP)          * Dummy value, not actually required
MOVE.W #0,-(SP)          * Read attribute
MOVE.L #pathname,-(SP)   * and the pathname
MOVE.W #$43,-(SP)        * Function number
TRAP   #1
ADD.L  #10,SP
TST.W  D0                * Did an error occur?
BMI    error             * Apparently
.
.
.
pathname:                * Don't forget zero byte at the end!
       .dc.b  'what-am.i',0
```

$45 DUP

As mentioned in connection with the functions READ and WRITE, th devices console, line printer, and RS-232 are also available to th programmer. This permits input and output to be redirected to these device One of the devices can be assigned a file handle number with the DU function. After the call the next free handle number is returned.

$46 FORCE

The FORCE function allows further manipulation of the handle numbers. I in a program the console input and output are used exclusively via th READ and WRITE functions with the handle numbers 0 and 1, the input o output can be redirected with a call to this function. Screen outputs ar written to a file, inputs are not taken from the keyboard, but from a previously-opened file.

$47 GETDIR

A given subdirectory can be made into the current directory with the function $37. All file accesses with a pathname then run only in the set subdirectory. Under certain presumptions it can be possible to determine the pathname to the current subdirectory. This is accomplished by the function call GETDIR, $47. This call requires the designation of the desired disk drive (0=current drive, 1=drive A, 2=drive B, etc.) and a pointer to a 64-byte buffer. The complete pathname to the current directory will be placed in this buffer. The pathname will be terminated by a zero byte. If the function is called when the main directory is active, no pathname will be returned. In this case, the first byte in the buffer will contain zero. After the call, D0 must contain the value zero. If the value is negative, an error occurred, for example if an incorrect drive number was passed.

```
MOVE.W #0,-(SP)        * Get pathname of the current drive
MOVE.L #buffer,-(SP)   * Address of the 64-byte buffer
MOVE.W #$47,-(SP)      * Function number
TRAP   #1
ADDQ.L #8,SP
TST.L  D0              * Error?
BNE    error           * D0<>0 if error
.
.
.
buffer:
       .ds.b   64      * Buffer for pathname
```

$48 MALLOC

The MALLOC function and the two that follow it, MFREE and SETBLOCK, are concerned with the memory organization of GEMDOS. As already mentioned in conjunction with function $31, KEEP PROCESS, a program is assigned all of the entire memory space available after it is loaded. This is uncritical in many cases, because only a single program is running. But there are applications under GEMDOS in which such organization is not sensible. An accessory such as the VT-52 emulator may be called from within a program, for example. Such a program also requires memory space, but the memory might not be available. No further program modules can be loaded if the entire memory is occupied. For this reason, each program should reserve only the space which it actually needs for the program and data. The memory not required can be given back to GEMDOS.

If the program should need some of the memory it gave back, it can request memory from GEMDOS via the function MALLOC (memory allocate). The number of bytes required is passed to MALLOC. After the call, D0 contains the starting address of the memory area reserved by the call or an error message if an attempt is made to reserve more memory than is actually available.

If -1L is passed as the number of bytes to be allocated, the number of bytes available is returned in D0.

First example:

```
MOVE.L #-1,-(SP)        * Determine number of free bytes
MOVE.W #$48,-(SP)       * Function number
TRAP   #1
ADDQ.L #6,SP            * Number of free bytes in D0
.
.
```

Second example:

```
MOVE.L #$1000,-(SP)   * Get hex 1000 bytes for the program
MOVE.W #$48,-(SP)     * Function number
TRAP   #1
ADDQ.L #6,SP
TST.W  D0             * Error or address of memory?
BMI    error          * Negative long word = error!
MOVE.L D0,mstart      * Else start addr of the reserved area
.
.
mstart:
       .ds.l   1
```

$49 MFREE

An area of memory reserved with MALLOC can be released at any time with MFREE. To do this, GEMDOS is passed the address of the memory to be released. The value will usually be the address returned by MALLOC.

If a value of zero is returned in D0, the memory was released by GEMDOS without error. A negative values indicates errors.

```
MOVE.L mstart,-(SP)   * Addr of a previously allocated area
MOVE.W #$49,-(SP)      * Function number
TRAP   #1
ADDQ.L #6,SP           * Number of free bytes in D0
TST.L  D0              * Error?
BNE    error           * D0<>0 is error!
.
.
mstart:
       .ds.l  1
```

$4A SETBLOCK

In contrast to the MALLOC function, a specific area of memory can be reserved with the function SETBLOCK. The memory beginning at the specified address is returned to GEMDOS, even if it was reserved before. This function can be used to reserve the actual memory requirements of a program and release the remaining memory.

The parameters the function requires are the starting address and the length of the area to be reserved. The area specified with these parameters is then reserved by GEMDOS and is not released again until the end of the program or after calling the MFREE function.

Usually programs will begin with the following command sequence or something similar. After the call, D0 must contain zero, otherwise an error occurred.

```
MOVE.L A7,A5          * Save stack pointer in A5
MOVE.L #USTCK,A7      * Set up stack for the program
MOVE.L 4(A5),A5       * A5 now points to the base-page start
                      * exactly $100 bytes below the prg start
MOVE.L $C(A5),D0      * $C(A5) contains length of the prg area
ADD.L  $14(A5),D0     * $14(A5) containg the length of the
                      * initialized data area
ADD.L  $1C(A5),D0     * $1C(A5) contains length of the
                      * uninitialized data area
ADD.L  #$100,D0       * Reserve $100 bytes base page
MOVE.L D0,-(SP)       * D0 contains the length of the area
                      * to be reserved
MOVE.L A5,-(SP)       * A5 contains the start of the area
                      * to be reserved
MOVE.W #0,-(SP)       * Meaningless word, but still necessary!
MOVE.W #$4A,-(SP)     * Function number
TRAP   #1
ADD.L  #12,SP         * Clean up the stack as usual
TST.L  D0             * Did an error occur?
BNE    error          * Stop
.                     * Here the program continues...
.
```

$4B EXEC

The EXEC function permits loading and chaining programs. If desired, the program loaded can be automatically started. In addition to the function number, the addresses of three strings and a mode word are expected on the stack.

The first address is a pointer to something called an "environment" string, a string which describes the "environment." If the environment is not set, the address of a null string, the address of a zero byte, will suffice.

The second pointer contains a command line for the program being called. A command line is comparable to the line which may be entered from the command mode when you have selected the point "TOS -takes parameters" from the option "Options".

The third pointer points to the filename or pathname of the file. All three strings must be terminated with a zero byte or consist of only a zero byte.

The mode word can be either zero or three. The standard value zero starts the loaded program automatically, while a three loads the program without automatically executing it. In this last case, either the address of the base page or an error message is returned in D0.

```
MOVE.L  #env,-(SP)      * Environment
MOVE.L  #com,-(SP)      * Command line
MOVE.L  #fil,-(SP)      * Filename
MOVE.W  #0,-(SP)        * Load and start, please
MOVE.W  #$4B,-(SP)      * Function number
TRAP    #1
ADD.L   #14,SP          * Here we come to the end of the
.                       * chained program or postloaded module
.
fil:                    * Load sort routine
        .dc.b   'qsort.prg',0
com:                    * Sort the file in ascending order
        .dc.b   'up data.asc',0
env:                    * No environment
        .dc.b   0
.
```

$4C TERM

TERM $4C represents the third method, after TERM $00 and TERM $31, of ending a program. TERM $4C automatically makes the memory used by the program available to GEMDOS again. Different from TERM $00, however, a programmer-defined return value other than zero can be returned to the caller. This allows a short message to be passed back to the calling program.

```
MOVE.W #37,-(SP)      * Any 2-byte value
MOVE.W #$4C,-(SP)     * End program
TRAP   #1             *              now
.                     * We never get here
```

$ 4E SFIRST

The SFIRST function can be used to check to see if a file with the given name is present in the directory. If a file with the same name is found, the filename, the file attribute, data and time of creation, and the size of the file in bytes is returned. This information is placed in the DTA buffer, whose address is set with the SETDTA function, by GEMDOS.

One feature of this function is that the filename need not be specified in its entirety. Individual characters in the filename can be exchanged for a question mark "?", but entire groups of letters can also be replaced by a "*". In the extreme form a filename would be reduced to the string "*.*". In this case the first file in the directory would satisfy the conditions and the filename would appear in the DTA buffer along with the other information.

In addition to the filename, the SFIRST function must also be given a search attribute. The possible parameters of the search attribute correspond to the attributes which can be specified in CHMOD function:

```
$00 = Normal access, read/write possible
$01 = Normal access, write protected
$02 = Hidden entry (ignored by the ST desktop)
$04 = Hidden system file (ignored like $02)
$08 = Volume label, diskette name
$10 = Subdirectory
$20 = File will be written and closed
```

The following rules apply when searching for files:

> If the attribute word is zero, only normal files are recognized.
> System files or subdirectories are not recognized.
> System files, hidden files, and subdirectories are found when the corresponding attribute bits are set. Volume labels are not recognized, however.

In order to get the volume label, this option must be expressly set in the attribute word. All other files are then ignored. After the call, D0 contains the value zero if a corresponding file has been found. In this case the 44-byte DTA buffer is constructed as follows:

Bytes	0-20	Reserved for GEMDOS
Byte	21	File attribute
Bytes	22-23	Clock time of file creation
Bytes	24-25	Date of file creation
Bytes	26-29	File size in bytes (long)
Bytes	30-43	Name and extension of the file

If, however, no file is found which corresponds to the specified search string, the error message -33, file not found, is returned.

```
MOVE.L #dta,-(SP)       * Set up DTA buffer
MOVE.W #1A,-(SP)        * Function number SETDTA
TRAP   #1
ADDQ.L #6,SP
MOVE.W #attrib,-(SP)    * Attribute value
MOVE.L #filnam,-(SP)    * Name of file to search for
MOVE.W #$4E,-(SP)       * Function number
TRAP   #1
ADDQ.L #8,SP
TST    D0               * File found?
BNE    notfound         * Apparently not
.
.
attrib:
       .dc.b  0         * Search for normal files only
filnam:
       .dc.b  '*.*',0   * Search for the 1st possible file
.
.
dta:
       .ds.b  44          * Space for the DTA buffer
```

$4F SNEXT

The SNEXT function (Search next) can be used to see if there are other files on the disk which match the filename given. To do this, only the function number need be passed; SNEXT does not require any parameters. All of the parameters are set from the SFIRST call.

If the search string is very global, as in the previous example, all of the files on a diskette can be determined and displayed one after the other with SFIRST and SNEXT. This makes it rather easy to display a directory within a program. The SNEXT function is called repeatedly and the contents of D0 are check afterwards. If D0 contains a value other than zero, either an error occurred, or all of the directory entries have been searched.

$56 RENAME

A RENAME function is found in almost every disk-oriented operating system in one form or another, since renaming files is required fairly often. Under GEMDOS, files are renamed with the RENAME function, which requires two pointer to file or pathnames. The first pointer points to the new name, with the specification of the pathname of the file if necessary, and the second pointer points to the previous name. A 2-byte parameter is required in addition to the two pointers. We were not able to determine the significance of the additional word parameter. Different values had no (recognizable) effect.

As a return value, D0 contains either zero, meaning that the name was changed correctly, or an error code.

```
MOVE.L  #newnam,-(SP)     * New filename
MOVE.L  #oldname,-(SP)    * File to rename
MOVE.W  #0,-(SP)          * Dummy?
MOVE.W  #$56,-(SP)        * Function number
TRAP    #1
ADD.L   #12,SP
TST.L   D0                * Test for error
.
.
oldnam:                   * Don't forget zero byte at end!
        .dc.b   'oldfile.dat',0
newnam:
        .dc.b   'newname.dat',0
.
.
```

$57 GSDTOF

If the directory is displayed as text rather than icons on the desktop, the date and time of file creation as well as the size of the file in bytes is shown. The time and date can either be set or read with function $57. To do this it is necessary that the file be already opened with OPEN or CREATE. The handle number obtained at the opening must be passed to the function. Additional parameters are a word which acts as a flag as to whether the time and data are to be set (0) or read (1), and a pointer to a 4-byte buffer which either contains the result data or will be provided with the required data before the call.

This date buffer contains the time in the first two byes and the date in the last two. The format of the data is identical to that of the functions for setting/reading the time and date.

Example 1:

```
MOVE.W #1,-(SP)          * Read time and date
MOVE.W #handle,-(SP)     * File must first be opened
MOVE.L #buff,-(SP)       * 4 byte buffer
MOVE.W #$57,-(SP)        * Function number
TRAP   #1
ADD.L  #10,SP
.
.
handle:
       .ds.b  2
buff:
       .ds.b  4
.
.
```

Example 2:

```
MOVE.W #0,-(SP)          * Set time and date
MOVE.W #handle,-(SP)     * File must first be opened
MOVE.L #buff,-(SP)       * 4 byte buffer
MOVE.W #$57,-(SP)        * Function number
TRAP   #1
ADD.L  #10,SP
.
.
handle:
       .ds.b  2
buff:
       .ds.b  4
.
.
```

3.1.1 GEMDOS error codes and their meaning

The GEMDOS functions return a value giving information about whether or not an error occurred during the execution of the function. A value of zero means no error; negative values have the following meanings:

```
-32  Invalid function number
-33  File not found
-34  Pathname not found
-35  Too many files open (no more handles left)
-36  Access not possible
-37  Invalid handle number
-39  Not enough memory
-40  Invalid memory block address
-46  Invalid drive specification
-49  No more files
```

In addition to these error messages, the BIOS error messages may occur. These error messages have numbers -1 to -31 and are described in section 3.3

3.2 The BIOS Functions

The software interface between the GEMDOS and the hardware of the computer is the BIOS (Basic Input Output System). The BIOS, as the name suggests, is concerned with the fundamental input/output functions. This includes screen output, keyboard input, printer output, as well as the RS-232 interface and, of course, input/output to the disk.

The BIOS functions are also available to user programs. The `TRAP` instruction of the 68000 processor is used to call them. Any data required is passed through the stack and the result of the function is returned in the D0 register. The machine language programmer should be aware that the contents of D0-D2 and A0-A2 are changed when calling BIOS functions; the remaining registers remain unchanged.

BIOS function calls are even simpler if you program in C. Here you can use simple function calls with the corresponding parameter lists. The function calls are stored as macros in an include file. In the examples, the definition of the function and its parameters in C will be shown. For assembly language programmers, the use is described in an example.

`TRAP #13` is reserved for the BIOS functions.

0 getmpb *get memory parameter block*

```
C: void getmpb(pointer)
   long pointer;
```

Assembler:

```
move.l  pointer,-(SP)
move.w  #0,-(SP)
trap    #13
addq.l  #6,sp
```

This function fills a 12-byte block whose address is contained in `pointer` with the memory parameter block. This block contains three pointers itself:

```
long   mfl          Memory free list
long   mal          Memory allocated list
long   rover        Roving pointer
```

The structures to which each pointer points are constructed as follows:

```
long   link         Pointer to next block
long   start        Start address of the block
long   length       Length of the block in bytes
long   own          Process descriptor
```

Example:

```
move.l #buffer,-(sp)  Buffer for MPB
move.w #0,-(sp)       getmpb
trap   #13            Call BIOS
addq.l #6,sp          Stack correction
```

We get the values $48E, 0, and $48E. The following data are at address $48E:

```
link   0              No additional block
start  $3B900         Start address of the free memory
length $3C700         Length of the free memory
own    0              No process descriptor
```

1 bconstat

return input device status

```
C: int bconstat(dev)
   int dev;
```

Assembler:

```
   move.w dev,-(sp)
   move.w #1,-(sp)
   trap   #13
   addq.l #4,sp
```

This function returns the status of an input device which is defined as follows:

```
Status 0        No characters ready
Status -1       (at least) one character ready
```

The parameter dev specifies the input device:

```
dev     Input device
 0      PRT:, Centronics interface
 1      AUX:, RS-232 interface
 2      CON:, Keyboard and screen
 3      MIDI, MIDI interface
 4      IKBD, Keyboard port
```

The following table lists the allowed accesses to these devices:

Operation	PRT:	AUX:	CON:	MIDI	IKBD
Input status	no	yes	yes	yes	no
Input	yes	yes	yes	yes	yes
Output status	yes	yes	yes	yes	yes
Output	yes	yes	yes	yes	yes

This example waits until a character from the RS-232 interface is ready.

```
wait move.w #1,-(sp)        RS-232
     move.w #1,-(sp)        bconstat
     trap   #13
     addq.l #4,sp
     tst    d0              character available?
     beq    wait            no, wait
```

2 conin

read character from device

```
C: long conin(dev)
   int dev;
```

Assembler:

```
move.w dev,-(sp)
move.w #2,-(sp)
trap   #13
addq.l #4,sp
```

This function fetches a character from an input device. The parameter `dev` has the same meaning as in the previous function. The function does not return until a character is ready.

The character received is in the lowest byte of the result. If the input device was the keyboard (`con`, 2), the key scan code is also returned in the lower byte of the upper word (see description of the keyboard processor).

Example:

```
move.w  #2,-(sp)        con
move.w  #2,-(sp)        bconin
trap    #13
addq.l  #4,sp
```

3 bconout

write character to device

```
C: void bconout(dev, c)
   int dev, c;
```

Assembler:

```
move.w c,-(sp)
move.w dev,-(sp)
move.w #3,-(sp)
trap   #13
addq.l #6,sp
```

This function serves to output a character "c" to the output device dev (meaning is the same as for the previous function). The function returns when the character has been outputted.

Example:

```
move.w #'A',-(sp)
move.w #0,-(sp)        PRT:
move.w #3,-(sp)        bconout
trap   #13
addq.l #6,sp
```

The example outputs the letter "A" to the printer.

4 rwabs *read and write disk sector*

```
C: long rwabs(rwflag, buffer, number, recno,dev)
   long buffer;
   int rwflag, number, recno, dev;
```

Assembler:

```
move.w dev,-(sp)
move.w recno,-(sp)
move.w number,-(sp)
move.l buffer,-(sp)
move.w rwflag,-(sp)
move.w #4,-(sp)
trap   #13
add.l  #14,sp
```

This function serves to read and write sectors on the disk. The parameters have the following meaning:

rwflag	Meaning
0	Read sector
1	Write sector
2	Read sector, ignore disk change
3	Write sector, ignore disk change

The parameter `buffer` is the address of a buffer into which the data will be read from the disk or from which the data will be written to the disk. The buffer should begin at an even address, or the transfer will run very slowly.

The parameter `number` specifies how many sectors should be read or written during the call. The parameter `recno` specifies which logical sector the process will start with.

The parameter `dev` determines which disk drive will be used:

dev	Drive
0	Drive A
1	Drive B
2	Hard disk

The function returns an error code as the result. If this value is zero, the operation was performed without error. The returned value will be negative if an error occurred. The error code has the following meaning:

```
 0  OK, no error
-1  General error
-2  Drive not ready
-3  Unknown command
-4  CRC error
-5  Bad request, invalid command
-6  Seek error, track not found
-7  Unknown media (invalid boot sector)
-8  Sector not found
-9  (No paper)
-10 Write error
-11 Read error
-12 General error
-13 Diskette write protected
-14 Diskette was changed
-15 Unknown device
-16 Bad sector (during verify)
-17 Insert diskette (for connected drive)
```

Example:

```
    move.w #0,-(sp)         Drive A
    move.w #10,-(sp)        Start at logical sector 10
    move.w #2,-(sp)         Read 2 sectors
    move.l #buffer,-(sp)    Buffer address
    move.w #0,-(sp)         Read sectors
    move.w #4,-(sp)         rwabs
    trap   #13
    add.l  #14,sp
    ...
buffer    ds.b  2*512
```

5 setexec *set exception vectors*

```
C: long setexec(number, vector)
   int  number;
   long vector;
```

Assembler:

```
   move.l vector,-(sp)
   move.w number,-(sp)
   move.w #5,-(sp)
   trap   #13
   addq.l #8,sp
```

The function `setexec` allows one of the exception vectors of the 68000 processor to be changed. The number of the vector must be passed in `number` and the address of the routine pertaining to it in `vector`. The function returns the old vector as the result. If you just want to read the vector, pass the value -1 as the new address. The 256 processor vectors as well as 8 vectors for GEM, which numbers $100 to $107 (address $400 to $41C) can be changed with this function.

Example:

```
   move.l #buserror,-(sp)
   move.w #2,-(sp)
   move.w #5,-(sp)
   trap   #13
   addq.l #8,sp
   ...
buserror  ...
```

6 tickcal *return millisecond per tick*

```
C: long tickcal()
```

Assembler:

```
move.w #6,-(sp)
trap   #13
addq.l #2,sp
```

This function returns the number of milliseconds between two system timer calls.

Example:

```
move.w #6,-(sp)
trap   #13
addq.l #2,sp
```

Result: 20 ms

7 getbpb *get BIOS parameter block*

```
C: long getbpb(dev)
   int dev;
```

Assembler:

```
move.w dev,-(sp)
move.w #7,-(sp)
trap   #13
addq.l #4,sp
```

This function returns a pointer to the BIOS Parameter Block of the drive `dev` (0=drive A, 1=drive B).

The BPB (BIOS Parameter Block) is constructed as follows:

```
int   recsiz   Sector size in bytes
int   clsiz    Cluster size in sectors
int   clsizb   Cluster size in bytes
int   rdlen    Directory length in sectors
int   fsiz     FAT size in sectors
int   fatrec   Sector number of the second FAT
int   datrec   Sector number of the first data cluster
int   numcl    Number of data clusters on the disk
int   bflags   Misc. flags
```

The function returns the address $3E3E for drive A and the address $3E5E for drive B. An address of zero indicates an error.

Example:

```
move.w #0,-(sp)      Drive A
move.w #7,-(sp)      getbpb
trap   #13
addq.l #4,sp
```

Here are the BPB data for 80 track single and double-sided disk drives:

Parameter	80 track SS	80 track DS
recsiz	512	512
clsiz	2	2
clsizb	1024	1024
rdlen	7	7
fsiz	5	5
fatrec	6	6
datrec	18	18
numcl	351	711

8 bcostat

return output device status

```
C: long bcostat(dev)
   int  dev;
```

Assembler:

```
move.w dev,-(sp)
move.w #8,-(sp)
trap   #13
addq.l #4,sp
```

This function tests to see if the output device specified by `dev` is ready to output the next character. `dev` can accept the values which are described in function one. The result of this function is either -1 if the output device is ready, or zero if it must wait.

Example:

```
move.w #0,-(sp)        Printer ready?
move.w #8,-(sp)        bcostat
trap   #13
addq.l #4,sp
```

9 mediach *inquire media change*

```
C: long mediach(dev)
   int dev;
```

Assembler:

```
move.w dev,-(sp)
move.w #9,-(sp)
trap   #13
addq.l #4,sp
```

This function determined if the disk was changed in the meantime. The parameter dev, the drive number (0=drive A, 1=drive B), must be passed to the routine. One of three values can occur as the result:

```
0    Diskette was definitely not changed
1    Diskette may have been changed
2    Diskette was definitely changed
```

Example:

```
move.w #1,-(sp)       Drive B
move.w #9,-(sp)       mediach
trap   #13
addq.l #4,sp
```

10 drvmap *inquire drive status*

```
C: long drvmap()
```

Assembler:

```
move.w #10,-(sp)
trap   #13
addq.l #2,sp
```

This function returns a bit vector which contains the connected drives. The bit number n is set if drive n is available (0 means A, etc.). Even if only one drive is connected, %11 is still returned, since two logical drives are assumed.

Example:

```
move.w #10,-(sp)        drvmap
trap   #13
addq.l #2,sp
```

11 kbshift

inquire/change keyboard status

```
C: long kbshift(mode)
   int mode;
```

Assembler:

```
move.w mode,-(sp)
mode.w #11,-(sp)
trap   #13
addq.l #4,sp
```

With this function you can change or determine the status of the special keys on the keyboard. If `mode` is -1, you get the status, a positive value is accepted as the status. The status is a bit vector which is constructed as follows:

Bit	Meaning
0	Right shift key
1	Left shift key
2	Control key
3	ALT key
4	Caps Lock on
5	Right mouse button (CLR/HOME)
6	Left mouse button (INSERT)
7	Unused

Example:

```
move.w #-1,-(sp)      Read shift status
move.w #11,-(sp)      kbshift
trap   #13
addq.l #4,sp
```

3.3 The XBIOS

To support the special hardware features of the Atari ST, there are extended BIOS functions, which are called via a `TRAP #14` instruction. The functions, like the normal BIOS functions, can be called from assembly language as well as from C. When calling from C, a small TRAP handler in machine language is again necessary, which can look like this:

```
trap14:
        move.l  (sp)+,retsave   Save return address
        trap    #14             Call XBIOS
        move.l  retsave,-(sp)   Restore return address
        rts

        .bss
retsave  ds.l  1                Space for the return address
```

Macro functions can be used in C which allow the extended BIOS functions (eXtended BIOS, XBIOS) to be called by name. The appropriate function number and TRAP call will be created when the macro is expanded.

When working in assembly language, the function number of the XBIOS routine need simply be passed on the stack. The XBIOS has 40 different functions whose signficance and use are described on the following pages.

0 initmous *initialize mouse*

```
C: void initmous(type, parameter, vector)
   int type;
   long parameter, vector;
```

Assembler:

```
move.l vector,-(sp)
move.l parameter,-(sp)
move.w type,-(sp)
move.w #0,(-sp)
trap   #14
add.l  #12,sp
```

This XBIOS function initializes the routines for mouse processing. The parameter `vector` is the address of a routine which will be executed following a mouse-report from the keyboard processor. The parameter `type` selects from among the following alternatives:

```
type
 0      Disable mouse
 1      Enable mouse, relative mode
 2      Enable mouse, absolute mode
 3      unused
 4      Enable mouse, keyboard mode
```

This allows you to select if mouse movements are to be reported and in what manner this will occur.

The parameter `parameter` points to a parameter block, which is constructed as follows:

```
char topmode
char buttons
char xparam
char yparam
```

The parameter `topmode` determines the layout of the coordinate system. A 0 means that Y=0 lies in the lower corner, 1 means that Y=0 lies in the upper corner.

The parameter `buttons` is a parameter for the command "set mouse buttons" of the keyboard processor (see description of the IKBD, intelligent keyboard).

The parameters `xparam` and `yparam` are scaling factors for the mouse movement. If you have selected 2 as the `type`, the absolute mode, the parameter block determines four more parameters:

```
int  xmax
int  ymax
int  xstart
int  ystart
```

These are the X and Y-coordinates of the maximal value which the mouse position can assume, as well as the start value to which the mouse will be set.

Example:

```
    move.l #vector,-(sp)       Address of the mouse position
    move.l #parameter,-(sp)    Address of the parameter block
    move.w #1,-(sp)            Enable relative mouse mode
    move.w #0,-(sp)            Init mouse
    trap   #14
    add.l  #12,sp
    ...
parameter dc.b ......
    ...
vector    ...                  Mouse interrupt routine
```

1 ssbrk

save memory space

```
C: long ssbrk(number)
   int number;
```

Assembler:

```
move.w number,-(sp)
move.w #1,-(sp)
trap   #14
addq.l #4,sp
```

This function reserves memory space. The number of bytes must be passed in `number`. The memory space is prepared at the upper end of memory. The function returns the address of the reserved memory area as the result. This function must be called before initializing the operating system, meaning that is must be called from the boot ROM, before the operating system is loaded.

Example:

```
move.w #$400,-(sp)      Reserve 1K
move.w #1,-(sp)         ssbrk
trap   #14
addq.l #4,sp
```

2 physbase

return screen RAM base address

```
C: long physbase()
```

Assembler:

```
move   #2,-(sp)
trap   #14
addq.l #2,sp
```

This function returns the base of the physical screen RAM. The physical screen RAM is the area of memory which is displayed by the video shifter. The result is a long word.

Example:

```
$78000, base address of the screen for 512K RAM
```

3 logbase

set logical screen base

```
C: long logbase()
```

Assembler:

```
move    #3,-(sp)
trap    #14
addq.l  #2,sp
```

The logical screen base is the address which is used for all output functions as the screen base. If the physical and logical screen bases are different, one screen will be displayed while another picture is being constructed in a different area of RAM, which will be displayed later. The result of this function call is again a longword.

Example:

```
$78000, base address of the screen for 512K RAM
```

4 getrez

return screen resolution

C: `int getrez()`

Assembler:

```
move.w #4,-(sp)
trap   #14
addq.l #2,sp
```

This function call returns the screen resolution:

```
0 :=  Low resolution, 320*200 pixels, 16 colors
1 :=  Medium resultion, 640*200 pixels, 4 colors
2 :=  High resolution, 640*400, pixels, monochrome
```

Example:

```
2, monochrome
```

5 setscreen

set screen parameters

```
C: void setscreen(logadr, physadr, res)
   long logadr, physadr;
   int res;
```

Assembler:

```
move.w res,-(sp)
move.l physadr,-(sp)
move.l logadr,-(sp)
move.w #5,-(sp)
trap   #14
add.l  #12,sp
```

This function changes the screen parameters which can be read with the previous three functions. If a parameter should not be set, a negative value must be passed. The parameters are set in the next VBL routine so that no disturbances appear on the screen.

Example:

Set the physical and the logical screen address to $70000, retain the resolution.

```
move.w #-1,-(sp)          Retain resolution
move.l #$70000,-(sp)      Physical base
move.l #$70000,-(sp)      Logical base
move.w #5,-(sp)           setscreen
trap   #14
add.l  #12,sp
```

6 setpalette *set color palette*

```
C: void setpalette(paletteptr)
   long paletteptr;
```

Assembler:

```
   move.l paletteptr,-(sp)
   move.w #6,-(sp)
   trap   #14
   addq.l #6,sp
```

A new color palette can be loaded with this function. The parameter `paletteptr` must be a pointer to a table with 16 colors (each a word). The address of the table must be even. The colors will be loaded at the start of the next VBL. Example:

```
   move.l #palette,-(sp)     Address of the new color palette
   move.w #6,-(sp)           set palette
   trap   #14
   addq.l #6,sp
   ....
palette   dc.w  $777,$700,$070,$007,$111,$222,$333,$444,
                $555,$000,$001,$010,$100,$200,$020,$002,
                $123,$456
```

7 setcolor *set color*

```
C: int setcolor(colornum, color)
   int colornum, color
```

Assembler:

```
move.w color,-(sp)
move.w colornum,-(sp)
move.w #7,-(sp)
trap   #14
addq.l #6,sp
```

This function allows just one color to be changed. The color number (0-15) and the color belonging to it (0-$777) must be specified. If -1 is given as the color, the color is not set but the previous color is returned.

Example:

```
move.w #$777,-(sp)        Color white
move.w #1,-(sp)           As color number 1
move.w #7,-(sp)
trap   #14
addq.l #6,sp
```

8 floprd *read diskette sector*

```
C: int floprd(buffer, filler, dev, sector, track, side,
count)
   long buffer, filler;
   int  dev, sector, track, side, count;
```

Assembler:

```
   move.w count,-(sp)
   move.w side,-(sp)
   move.w track,-(sp)
   move.w sector,-(sp)
   move.w dev,-(sp)
   clr.l  -(sp)
   move.l buffer,-(sp)
   move.w #8,-(sp)
   trap   #14
   add.l  #20,sp
```

This function reads one or more sectors in from the diskette. The parameters have the following meaning:

`count:` Specifies how many sectors are to be read. Values between one and nine (number of sectors per track) are possible.

`side:` Selects the diskette side, zero for single-sided drives and zero or one for double-sided drives.

`track:` Determines the track number (0-79 for 80-track drives or 0-39 for 40-track drives).

`sector:` The sector number of the first sector to be read (0-9).

`dev:` Determine drive number, 0 for drive A and 1 for drive B.

`filler:` Unused long word.

`buffer:` Buffer in which the diskette data should be written. The buffer must begin on a word boundary and be large enough for the data to be read (512 bytes times the number of sectors).

The function returns an error code which has the following meaning:

```
 0  OK, no error
-1  General error
-2  Drive not ready
-3  Unknown command
-4  CRC error
-5  Bad request, invalid command
-6  Seek error, track not found
-7  Unknown media (invalid boot sector)
-8  Sector not found
-9  (No paper)
-10 Write error
-11 Read error
-12 General error
-13 Diskette write protected
-14 Diskette was changed
-15 Unknown device
-16 Bad sector (during verify)
-17 Insert diskette (for connected drive)
```

Example:

```
    move.w #1,-(sp)          Read a sector
    move.w #0,-(sp)          Page zero
    move.w #0,-(sp)          Track zero
    move.w #1,-(sp)          Sector one
    move.w #1,-(sp)          Drive B
    clr.l  -(sp)
    move.l #buffer,-(sp)
    move.w #8,-(sp)          floprd
    trap   #14
    add.l  #20,sp
    tst    d0                Did error occur?
    bmi    error             yes
    ...
buffer  ds.b 512             Buffer for a sector
```

9 flopwr *write diskette sector*

```
C: int floprd(buffer, filler, dev, sector, track, side,
              count)
   long buffer, filler;
   int  dev,sector,track,side,count;
```

Assembler:

```
   move.w count,-(sp)
   move.w side,-(sp)
   move.w track,-(sp)
   move.w sector,-(sp)
   move.w dev,-(sp)
   clr.l  -(sp)
   move.l buffer,-(sp)
   move.w #9,-(sp)
   trap   #14
   add.l  #20,sp
```

One or more sectors can be written to disk with this XBIOS function. The parameters have the same meaning as for the function 8 *floprd*. The function returns an error code which also has the same meaning as for reading sectors. Example:

```
   move.w #3,-(sp)          Write three sectors
   move.w #0,-(sp)          Side zero
   move.w #7,-(sp)          Track seven
   move.w #1,-(sp)          Sector one
   move.w #0,-(sp)          Drive A
   clr.l  -(sp)
   move.l #buffer,-(sp)     Address of the buffer
   move.w #9,-(sp)          flopwr
   trap   #14
   add.l  #20,sp
   tst    d0                Did an error occur?
   bmi    error             yes
   ...
buffer  ds.b 3*512          Buffer for three sectors
```

10 flopfmt *format diskette*

```
C: int flopfmt(buffer, filler, dev, spt, track, side,
               interleave, magic, virgin)
   long buffer, filler, magic;
   int  dev, spt, track, side, interleave, virgin;
```

Assembler:

```
move.w virgin,-(sp)
move.l magic,-(sp)
move.w interleave,-(sp)
move.w side,-(sp)
move.w track,-(sp)
move.w spt,-(sp)
move.w dev,-(sp)
clr.l  -(sp)
move.l buffer,-(sp)
move.w #10,-(sp)
trap   #14
add.l  #26,sp
```

This routine serves to format a track on the diskette. The parameters have the following meanings:

`virgin:` The sectors are formatted with this value. The standard value is $E5E5. The high nibble of each byte may not contain the value $F.

`magic:` The constant $87654321 must be used as magic or formatting will be stopped.

`interleave:` Determines in which order the sectors on the disk will be written, usually one.

`side:` Selects the disk side (0 or 1).

`track:` The number of the track to be formatted (0-79).

`spt:` Sectors per track, normally 9.

`dev:` The drive, 0 for A and 1 for B.

`filler:` Unused long word.

`buffer:` Buffer for the track data; for 9 sectors per track the buffer mst be at least 8K large.

The function returns an error code as its result. The value -16, bad sectors, means that data in some sectors could not be read back correctly. In this case the buffer contains a list of bad sectors (word data, terminated by zero). You can format these again or mark the sectors as bad.

Example:

```
    move.w #$E5E5,-(sp)         Initial data
    move.l #$87654321,-(sp)     magic
    move.w #1,-(sp)             interleave
    move.w #0,-(sp)             side 0
    move.w #79,-(sp)            track 79
    move.w #9,-(sp)             9 sector per track
    move.w #0,-(sp)             drive A
    clr.l  -(sp)
    move.w #buffer,-(sp)
    move.w #10,-(sp)            flopfmt
    trap   #14
    add.l  #26,sp
    tst    d0
    bmi    error

buffer  ds.b  $2000         8K buffer
```

11 unused

12 midiws

write string to MIDI interface

```
C: void midiws(count, ptr)
   int  count;
   long ptr;
```

Assembler:

```
   move.l ptr,-(sp)
   move.w count,-(sp)
   move.w #12,-(sp)
   trap   #14
   addq.l #8,sp
```

With this function it is possible to output a string to the MIDI interface (MIDI OUT). The parameter `ptr` must point to a string, count must contain the number of characters to be sent minus 1.

Example:

```
   move.l #string,-(sp)                  Address of the string
   move.w #stringend-string-1,-(sp) Length
   move.w #12,-(sp)                      midiws
   trap   #14
   addq.l #8,sp

   ....

string    dc.b 'MIDI data"
stringend equ  *
```

13 mfpint *initialize MFP format*

```
C: void mfpint(number, vector)
   int  number;
   long vector;
```

Assembler:

```
   move.l vector,-(sp)
   move.w number,-(sp)
   move.w #13,-(sp)
   trap   #14
   addq.l #8,sp
```

This function initializes an interrupt routine in the MFP. The number of the MFP interrupt is in `number` while `vector` contains the address of the corresponding interrupt routine. The old interrupt vector is overwritten.

Example:

```
   move.l #busy,-(sp)        Busy interrupt routine
   move.w #0,-(sp)           Vector number 0
   move.w #13,-(sp)          mfpint
   trap   #14
   addq.l #8,sp
   ....
busy:
```

14 iorec

return record buffer

```
C: long iorec(dev)
   int dev;
```

Assembler:

```
move.w dev,-(sp)
move.w #14,-(sp)
trap   #14
addq.l #4,sp
```

This function fetches a pointer to a buffer data record for an input device. The following input devices can be specified:

dev	Input device
0	RS-232
1	Keyboard
2	MIDI

The buffer record for an input device has the following layout:

```
long  ibuf     Pointer to an input buffer
int   ibufsize Size of the input buffer
int   ibufhd   Head index
int   ibuftl   Tail index
int   ibuflow  Low water mark
int   ibufhi   High water mark
```

The input buffer is a circular buffer; the `head index` specifies the next write position (the buffer is filled by an interrupt routine) and the `tail index` specifies from where the buffer can be read. If the head and tail indices are the same, the buffer is empty. The low and high marks are used in connection with the communications status for the RS-232 (XON/XOFF or RTS/CTS). If the input buffer is filled up to the `high water mark`, the sender is informed via XON or CTS that the computer cannot receive any more data. When data received by the computer can be processed again, so that the buffer contents sink below the `low water mark`, the transfer is resumed.

There is an identically-constructed buffer record for the RS-232 output which is located directly behind the input record.

Example:

```
move.w #1,-(sp)      Buffer record for keyboard
move.w #14,-(sp)     iorec
trap   #14
addq.l #4,sp
...
```

Result: $9F2

The following table contains the data for all devices:

	RS-232 input	RS-232 output	Keyboard	MIDI
Address	$9D0	($9DE)	$942	$A00
Buffer address	$6D0	$7D0	$8D0	$950
Buffer length	$100	$100	$80	$80
Head index	0	0	0	0
Tail index	0	0	0	0
Low water mark	$40	$40	$20	$20
High water mark	$C0	$C0	$20	$20

Head and tail indices are naturally dependent on the current operating mode. High and low water marks are set at 3/4 and 1/4 of the buffer size. They have significance only for XON/XOFF or RTS/CTS in connection with RS-232.

15 rsconf *set RS-232 configuration*

```
C: void rsconf(baud, ctrl, ucr, rsr, tsr, scr)
   int baud, ctrl, ucr, rsr, tsr, scr;
```

Assembler:

```
move.w scr,-(sp)
move.w tsr,-(sp)
move.w rsr,-(sp)
move.w ucr,-(sp)
move.w ctrl,-(sp)
move.w baud,-(sp)
move.w #15,-(sp)
trap   #14
add.l  #14,sp
```

This XBIOS function serves to configure the RS-232 interface. The parameters have the following signifcance:

```
scr:  Synchronous Character Register in the MFP
tsr:  Transmitter Status Register in the MFP
rsr:  Receiver Status Register in the MFP
ucr:  USART Control Register in the MFP
ctrl: Communications parameters
baud: Baud rate
```

See the section on the MFP 68901 for information on the MFP registers. If one of the parameters is -1, the previous value is retained. The handshake mode can be selected with the `ctrl` parameter:

```
ctrl  Meaning
  0   No handshake, default after power-up
  1   XON/XOFF
  2   RTS/CTS
  3   XON/XOFF and RTS/CTS (not useful)
```

The baud parameter contains an indicator for the baud rate:

baud	Baud rate
0	19200
1	9600
2	4800
3	3600
4	2400
5	2000
6	1800
7	1200
8	600
9	300
10	200
11	150
12	134
13	110
14	75
15	50

Example:

```
move.w  #-1,-(sp)
move.w  #-1,-(sp)       Don't change MFP registers
move.w  #-1,-(sp)
move.w  #-1,-(sp)
move.w  #1,-(sp)        XON/XOFF
move.w  #9,-(sp)        300 baud
move.w  #15,-(sp)       rsconf
trap    #14
add.l   #14,sp
```

16 keytbl

set keyboard table

```
C: long keytbl(unshift, shift, capslock)
   long unshift, shift, capslock;
```

Assembler:

```
   move.l capslock,-(sp)
   move.l shift,-(sp)
   move.l unshift,-(sp)
   move.w #16,-(sp)
   trap   #14
   addi.l #14,sp
```

With this function it is possible to create a new keyboard layout. To do this you must pass the address of the new tables which contain the key codes for normal keys (without shift), shifted keys, and keys with caps lock. The function returns the address of the vector table in which the three keyboard table pointers are located. If a table should remain unchanged, -1 must be passed as the address. A keyboard table must be 128 bytes long. It is addressed via the key scan code and returns the ASCII code of the given key.

Example:

```
   move.l #-1,-(sp)       Don't change caps lock
   move.l #shift,-(sp)    Shift table
   move.l #unshift,-(sp) Table without shift
   move.w #16,-(sp)
   trap   #14
   addi.l #14,sp

   ....
shift:   ...
unshift: ...
```

17 random *return random number*

```
C: long random()
```

Assembler:

```
move.w #17,-(sp)
trap   #14
addq.l #2,sp
```

This function returns a 24-bit random number. Bits 24-31 are zero. With each call you receive a different result. After turning on the computer a different seed is created.

Example:

```
move.w #17,-(sp)      random
trap   #14
addq.l #2,sp
```

18 protobt

produce boot sector

```
C: void protobt(buffer, serialno,disktype, execflag)
   long buffer, serialno;
   int  disktype, execflag;
```

Assembler:

```
move.w execflag,-(sp)
move.w disktype,-(sp)
move.l serialno,-(sp)
move.l buffer,-(sp)
move.w #18,-(sp)
trap   #14
add.l  #14,sp
```

This function serves to create a boot sector. A boot setor is located on track 0, sector 1 on side 0 of a diskette and gives the DOS information about the disk type. If the boot sector is executable, it can be be used to load the operating system. With this function you can create a new boot sector, for a different disk format or to change an existing boot sector. The parameters:

`execflag`: determines if the boot sector is executable.

```
 0 not executable
 1 executable
-1 boot sector remains as it was
```

The disk type can assume the following values:

```
 0  40 track, single sided (180 K)
 1  40 track, double sided (360 K)
 2  80 track, single sided (360 K)
 3  80 track, double sided (720 K)
-1  Disk type remains unchanged
```

The parameter `serialno` is a 24-bit serial number which is written in the boot sector. If the serial number is greater than 24 bits ($01000000), a random serial number is created (with the above function). A value of -1 means that the serial number will not be changed.

The parameter `buffer` is the address of a 512-byte buffer which contains the boot sector or in which the boot sector will be created.

A boot sector has the following construction:

Address	40 track SS	40 track DS	80 track SS	80 track DS
0- 1	Branch instruction to boot program if executable			
2- 7	'Loader'			
8-10	24-bit serial number			
11-12	BPS 512	512	512	512
13	SPC 1	2	2	2
14-15	RES 1	1	1	1
16	FAT 2	2	2	2
17-18	DIR 64	112	112	112
19-20	SEC 360	720	720	1440
21	MEDIA 252	253	248	249
22-23	SPF 2	2	5	5
24-25	SPT 9	9	9	9
26-27	SIDE 1	2	1	2
28-29	HID 0	0	0	0
510-511	CHECKSUM			

The abbreviations have the following meanings:

`BPS:` Bytes per sector. The sector size is 512 bytes for all formats

`SPC:` Sectors per cluster. The number of sectors which are combined into one block by the DOS, 2 sectors equals 1K.

`RES:` Number of reserved sectors at the start of the disk including the boot sector.

`FAT:` The number of file allocation tables on the disk.

`DIR:` The maximum number of directory entries.

`SEC:` The total number of sectors on the disk.

`MEDIA:` Media descriptor byte, not used by the ST-BIOS.

`SPF:` Number of sectors in each FAT.

`SPT:` Number of sectors per track.

SIDE: Number of sides of the diskette.

HID: Number of hidden sectors on the disk.

The boot sector is compatible with MS-DOS 2.x. This is why all 16-bit words are stored in 8086 format (first low byte, then high byte).

If the checksum of the whole boot sector is $1234, the sector is executable. In this case the boot program is located at address 30. Example:

```
    move.w  #-1,-(sp)       Don't change executability
    move.w  #3,-(sp)        80 tracks DS
    move.l  #-1,-(sp)       Don't change serial number
    move.l  #buffer,-(sp)
    move.w  #18,-(sp)       protobt
    trap    #14
    add.l   #14,sp

buffer ds.b 512
```

This example program can be used to adapt an existing boot sector for 80 tracks, double sided.

19 flopver *verify diskette sector*

```
C: int flopver(buffer, filler, dev, sector, track, side,
                count)
   long buffer, filler;
   int  dev, sector, track, side, count;
```

Assembler:

```
move.w count,-(sp)
move.w side,-(sp)
move.w track,-(sp)
move.w sector,-(sp)
move.w dev,-(sp)
clr.l  -(sp)
move.l buffer,-(sp)
move.w #19,-(sp)
trap   #14
add.l  #16,sp
```

This function serves to verify one or more sectors on the disk. The sectors are read from the disk and compared with the buffer contents in memory. The parameters have the same meaning as for reading and writing sectors. If the sector and buffer contents agree, the result of the function will be zero. If an error occurs, the error number will be returned in D0 that has the following meaning:

```
 0  OK, no error
-1  General error
-2  Drive not ready
-3  Unknown command
-4  CRC error
-5  Bad request, invalid command
-6  Seek error, track not found
-7  Unknown media (invalid boot sector)
-8  Sector not found
-9  (No paper)
-10 Write error
-11 Read error
-12 General error
-13 Diskette write protected
-14 Diskette was changed
-15 Unknown device
```

```
-16 Bad sector (during verify)
-17 Insert diskette (for connected drive)
```

In the case of an error, the buffer will contain a list of erroneous sectors (16-bit values), terminated by a zero word. If the BIOS function 4 *rwabs* was used to write the sectors and if the variable *fverify* ($444) is set, the sectors will automatically be verified after they are written.

Example:

```
move.w #1,-(sp)          A sector
move.w #0,-(sp)          Side zero
move.w #39,-(sp)         Track 39
move.w #1,-(sp)          Sector 1
move.w #0,-(sp)          Drive A
clr.l  -(sp)
move.l #buffer,-(sp)     Buffer address
move.w #19,-(sp)         flopver
trap   #14
add.l  #16,sp
tst    d0                Error?
bmi    error
```

20 scrdmp *output screen dump*

```
C: void scrdmp()
```

Assembler:

```
move.w #20,-(sp)
trap   #14
addq.l #2,sp
```

This function outputs a hardcopy of the screen to a connected printer. The previously-set printer parameters ("desktop Printer setup") are used. You can also perform this function by simultaneously pressing the ALT and HELP keys or from the desktop through "Print Screen" from the "Options" menu.

Example:

```
move.w #20,-(sp)        Hardcopy
trap   #14              Call XBIOS
addq.l #2,sp
```

21 cursconf *set cursor configuration*

```
C: int cursconf(function, rate)
   int function, rate;
```

Assembler:

```
move.w rate,-(sp)
move.w function,-(sp)
move.w #21,-(sp)
trap   #14
addq.l #6,sp
```

This XBIOS function serves to set the cursor function. The parameter `function` can have a value from 0-5, which have the following meanings:

function	Meaning
0	Disable cursor
1	Enable cursor
2	Flash cursor
3	Steady cursor
4	Set cursor flash rate
5	Get cursor flash rate

You can use this function to set whether the cursor is visible, and whether it is flashing or steady. Thie XBIOS function returns a result only if you fetch the old baud rate. The unit of the flash frequency is dependent on the screen frequency: It is 70 Hz for a monochrome monitor or 50 Hz for a color monitor. You can set a new flash rate with function number 5. You need only use the parameter `rate` if you want to pass a new flash rate.

Example:

```
move.w #20,-(sp)        20/70 seconds
move.w #4,-(sp)         Set flash rate
move.w #21,-(sp)        cursconf
trap   #14
addq.l #6,sp
```

22 settime *set clock time and date*

```
C: void settime(time)
   long time;
```

Assembler:

```
move.l time,-(sp)
move.w #22,-(sp)
trap   #14
add.l  #6,sp
```

This function is used to set the clock time and date. The time is passed in the lower word of `time` and the date in the upper word. The time and date are coded as follows:

```
bits  0- 4  Seconds in two-second increments
bits  5-10  Minutes
bits 11-15  Hours

bits 16-20  Day 1-31
bits 21-24  Month 1-12
bits 25-31  Year (minus offset 1980)
```

Example:

```
move.l #%10110011000001000000000000000,-(sp)
move.w #22,-(sp)      settime
trap   #14
addq.l #6,sp
```

This call sets the date to the 16th of September, 1985, and the clock time to 8 o'clock.

23 gettime

return clock time and date

```
C: long gettime()
```

Assembler:

```
move.w #23,-(sp)
trap   #14
addq.l #2,sp
```

This function returns the current date and the clock time in the following format:

```
bits  0- 4  Seconds in two-second increments
bits  5-10  Minutes
bits 11-15  Hours

bits 16-20  Day 1-31
bits 21-24  Month 1-12
bits 25-31  Year (minus offset 1980)
```

Example:

```
move.w #23,-(sp)     gettime
trap   #14
addq.l #2,sp
move.l d0,time       Save time and date
```

24 bioskeys *restore keyboard table*

```
C: void bioskeys()
```

Assembler:

```
move.w #24,-(sp)
trap   #14
addq.l #2,sp
```

If you have selected a new keyboard layout with the XBIOS function 16, *keytbl*, this function will restore the standard BIOS keyboard layout. You can call this function, for example, before exiting a program of your own which changed the keyboard layout.

Example:

```
move.w #24,-(sp)     bioskeys
trap   #14
addq.l #2,sp
```

25 ikbdws *intelligent keyboard send*

```
C: void ikbdws(number, pointer)
   int  number;
   long pointer;
```

Assembler:

```
   move.l pointer,-(sp)
   move.w number,-(sp)
   move.w #25,-(sp)
   trap   #14
   addq.l #8,sp
```

This XBIOS function serves to transmit commands to the keyboard processor (intelligent keyboard). The parameter `pointer` is the address of a string to be sent, `number` is the length of a string minus 1.

Example:

```
   move.l #string,-(sp)            Address of the string
   move.w #strend-string-1,-(sp)   Length minus 1
   move.w #25,-(sp)                ikbdws
   trap   #14
   addq.l #8,sp
   ...
string    dc.b  $80,1
strend    equ   *
```

26 jdisint *disable interrupts on MFP*

```
C: void jdisint(number)
   int number;
```

Assembler:

```
   move.w number,-(sp)
   move.w #26,-(sp)
   trap   #14
   addq.l #4,sp
```

This function makes it possible to selectively disable interrupts on the MFP 68901. The parameter is the MFP interrupt number (0-15). The significance of the individual interrupts is described in the section on interrupts.

Example:

```
   move.w #10,-(sp)     Disable RS-232 transmitter interrupt
   move.w #26,-(sp)     Disable interrupt
   trap   #14
   addq.l #4,sp
```

27 jenabint *enable interrupts on MFP*

```
C: void jenabint(number)
   int number;
```

Assembler:

```
move.w number,-(sp)
move.w #27,-(sp)
trap   #14
addq.l #4,sp
```

This function can be used to re-enable an interrupt on the MFP. The parameter is again the number of the interrupt, 0-15.

Example:

```
move.w #12,-(sp)      Enable RS-232 receiver interrupt
move.w #27,-(sp)      Enable interrupt
trap   #14
addq.l #4,sp
```

28 giaccess *access GI sound chip*

```
C: char giaccess(data, register)
   char data;
   int  register;
```

Assembler:

```
move.w #register,-(sp)
move.w #data,-(sp)
move.w #28,-(sp)
trap   #14
addq.l #6,sp
```

This function allows access to the registers of the GI sound chip. `register` must contain the register number of the sound chip (0-15). The meaning of the individual registers is given in the hardware description of the sound chip. Bit 7 of the register number determines whether the specified register will be written or read:

```
Bit 7  0: Read
       1: Write
```

When writing, an 8-bit value is passed in `data`; when reading, the function returns the contents of the corresponding register.

Example:

```
move.w #$80+3,-(sp)      Write register 3
move.w #$50,-(sp)        Value to write
move.w #28,-(sp)
trap   #14
addq.l #6,sp
```

29 offgibit

reset Port A GI sound chip

```
C: void offgibit(bitnumber)
   int bitnumber;
```

Assembler:

```
move.w #bitnumber,-(sp)
move.w #29,-(sp)
trap   #14
addq.l #4,sp
```

A bit of port A of the sound chip can be selectively set with this function call. Port A is an 8-bit output port in which the individual bits have the following funtion:

```
Bit 0:  Select disk side 0/side 1
Bit 1:  Select drive A
Bit 2:  Select drive B
Bit 3:  RS-232 RTS (Request To Send)
Bit 4:  RS-232 DTR (Data Terminal Ready)
Bit 5:  Centronics strobe
Bit 6:  General Purpose Output
Bit 7:  unused
```

Example:

```
move.w #4,-(sp)      DTR bit
move.w #29,-(sp)     offgibit
trap   #14
addq.l #4,sp
```

30 ongibit

clear Port A of GI sound chip

```
C: void ongibit(bitnumber)
   int bitnumber;
```

Assembler:

```
move.w #bitnumber,-(sp)
move.w #30,-(sp)
trap   #14
addq.l #4,sp
```

This function is the counterpart of the previous function. With this it is possible to clear a bit of port A in the sound chip.

Example:

```
move.w #4,-(sp)      DTR bit
move.w #30,-(sp)     ongibit
trap   #14
addq.l #4,sp
```

31 xbtimer

start MFP timer

```
C: void xbtimer(timer, control, data, vector)
   int  timer, control, data;
   long vector;
```

Assembler:

```
move.l vector,-(sp)
move.w data,-(sp)
move.w control,-(sp)
move.w timer,-(sp)
move.w #31,-(sp)
trap   #14
add.l  #12,sp
```

This function allows you to start a timer in the MFP 68901 and assign an interrupt routine to it. `timer` is the number of the timer in the MFP:

```
Timer A : 0
Timer B : 1
Timer C : 2
Timer D : 3
```

The parameters `data` and `control` are the values which are placed in the corresponding control and data registers of the timer. We refer you to the hardware description of the MFP 68901.

The parameter `vector` is the address of the interrupt routine which will be executed when the timer runs out. The four timers in the MFP are already partly used by the operating system:

```
Timer A:  Reserved for the end user
Timer B:  Horizontal blank counter
Timer C:  200 Hz system timer
Timer D:  RS-232 baud rate generator
          (the interrupt vector is free)
```

Example:

```
move.l #vector,-(sp)     Interrupt routine
move.w data,-(sp)        Data and
move.w control,-(sp)     Control registers
move.w #0,-(sp)          Timer A
move.w #31,-(sp)         xbtimer
trap   #14
add.l  #12,sp
```

32 dosound

set sound parameters

```
C: void dosound(pointer)
   long pointer;
```

Assembler:

```
   move.l pointer,-(sp)
   move.w #32,-(sp)
   trap   #14
   addq.l #6,sp
```

This function allows for easy sound processing. The parameter `pointer` must point to a string of sound commands. The following commands can be used:

Commands: $00-$0F
: These commands are interpreted as register numbers of the sound chip. A byte following this is loaded into the corresponding register.

Command $80
: An argument follows this command which will be loaded into a temporary register.

Command $81
: Three arguments must follow this command. The first argument is the number of the register in the sound chip in which the contents of the temporary register will be loaded. The second argument is a two's-complement value which will be added to the temporary register. The third argument contains an end criterium. The end is reached when the content of the temporary register is equal to the end criterium.

Commands $82-$FF
: One argument follows each of these commands. If this argument is zero, the sound processing is halted. Otherwise this argument specifies the number of timer ticks (20ms, 50Hz) until the next sound processing.

Example:

```
   move.l #pointer,-(sp)     Pointer to sound command
   move.w #32,-(sp)          dosound
   trap   #14
   addq.l #6,sp
   ....
pointer   dc.b 0,10,1,50,...
```

33 setprt

set printer configuration

```
C: void setptr(config)
   int config;
```

Assembler:

```
   move.w config,-(sp)
   move.w #33,-(sp)
   trap   #14
   addq.l #4,sp
```

This function allows the printer configuration to be read or changed. If `config` contains the value -1, the current value is returned, otherwise the value is accepted as the new printer configuration. The printer configuration is a bit vector with the following meaning:

Bit number	0	1
0	matrix printer	daisy-wheel
1	monochrome printer	color printer
2	Atari printer	Epson printer
3	Test mode	Quality mode
4	Centronics port	RS-232 port
5	Continuous paper	Single-sheet
6-14	reserved	
15	always 0	

Example:

```
   move.w #%000100,-(sp)     Epson printer
   move.w #33,-(sp)          setprt
   trap   #14
   addq.l #4,sp
```

34 kbdvbase *return keyboard vector table*

```
C: long kbdvbase()
```

Assembler:

```
move.w #34,-(sp)
trap   #14
addq.l #2,sp
```

This XBIOS function returns a pointer to a vector table which contains the address of routines which process the data from the keyboard processor. The table is constructed as follows:

```
long  midivec     MIDI input
long  vkbderr     Keyboard error
long  vmiderr     MIDI error
long  statvec     IKBD status
long  mousevec    Mouse routines
long  clockvec    Clock time routine
long  joyvec      Joystick routines
```

The parameter `midivec` points to a routine which writes data received from the MIDI input (byte in D0) to the MIDI buffer.

The parameters `vkbderr` and `vmiderr` are called when an overflow is signaled by the keyboard or MIDI ACIA.

The remaining four routines `statvec`, `mousevec`, `clockvec`, and `joyvec` process the corresponding data packages which come from the keyboard ACIA. A pointer to the packaged received is passed to these routines in A0. The mouse vector is used by GEM. If you want to use your own routine, you must terminate it with RTS and it may not require more than one millisecond of processing time.

Example:

```
move.w #34,-(sp)     kbdvbase
trap   #14
addq.l #2,sp
```

We get $A0E as the result. The vector field contains the following values:

A0E	midivec	$79C6
A12	vkbderr	$759C
A16	vmiderr	$759C
A1A	statvec	$7034
A1E	mousevec	$15296
A22	clockvec	$6A46
A26	joyvec	$7034
A2A	MIDI	$7556
A2E	keyboard	$7568

35 kbrate

set keyboard repeat rate

```
C: int kbrate(delay, repeat)
   int delay, repeat;
```

Assembler:

```
move.w repeat,-(sp)
move.w delay,-(sp)
move.w #35,-(sp)
trap   #14
addq.l #6,sp
```

The keyboard repeat can be controlled with this function. The parameter `delay` specifies the delay time after a key is pressed before the key will automatically be repeated. The parameter `repeat` determines the time span after which the key will be repeated again. These values can be changed from the desktop by means of the two slide controllers on the control panel. The times are based on the 50 Hz system clock. If -1 is specified for one of the parameters, the corresponding value is not set. The function returns the previous values as the result; bits 0-7 contain the `repeat` value and bits 8-15 the value of `delay`.

Example:

```
move.w #-1,-(sp)      Read old values
move.w #-1,-(sp)
move.w #35,-(sp)      kbrate
trap   #14
addq.l #6,sp
```

Result: D0 = $0B03

36 prtblk

output block to printer

```
C: void prtblk(parameter)
   long parameter;
```

Assembler:

```
   move.l parameter,-(sp)
   move.w #36,-(sp)
   trap   #14
   addq.l #6,sp
```

This function resembles the function *scrdmp*(20) and is used by it. The function expects a parameter list, however, whose address is passed to it. This list is constructed as follows:

```
   long  blkprt   Address of the screen RAM
   int   offset
   int   width    Screen width
   int   height   Screen height
   int   left
   int   right
   int   scrres   Screen resolution (0, 1, or 2)
   int   dstres   Printer resultion (0 or 1)
   long  colpal   Address of the color palette
   int   type     Printer type (0-3)
   int   port     Printer port (0=Centronics, 1=RS232)
   long  masks    Pointer to half-tone mask
```

Assembler:

```
   move.l #parameter,-(sp)   Address of the parameter block
   move.w #36,-(sp)          prtblk
   trap   #14
   addq.l #6,sp
   ...
parameter dc.l ...
```

37 wvbl *wait for video*

```
C: void wvbl()
```

Assembler:

```
move.w #36,-(sp)
trap   #14
addq.l #2,sp
```

This function waits for the next picture return. It can be used to synchronize graphic outputs with the beam return, for example.

Example:

```
move.w #36,-(sp)      wait for wvbl
trap   #14
addq.l #2,sp
```

38 supexec

set supervisor execution

```
C: void supexec(address)
   long address;
```

Assembler:

```
   move.l address,-(sp)
   move.w #38,-(sp)
   trap   #14
   addq.l #6,sp
```

If a routine is to be executed in the supervisor mode of the 68000 processor, you can accomplish this with this function. Simply pass the address of the routine to the function. Example:

```
   move.l #address,-(sp)
   move.w #38,-(sp)
   trap   #14
   addq.l #6,sp
   ...
address   move.l $400,00
   ...
```

39 puntaes *disable AES*

```
C: void puntaes()
```

Assembler:

```
move.w #39,-(sp)
trap   #14
addq.l #2,sp
```

The AES can be disabled with this function, provided it is not in ROM.

Example:

```
move.w #39,-(sp)
trap   #14
addq.l #2,sp
```

3.4 The Graphics

Next to the high processing speed and the large memory available, the graphics capability is certainly the most fascinating aspect of the ST. With the standard monochrome monitor and the resolution of 640x400 points, it creates a whole new price/performance class for itself. But also in the color resoultion the ST can display 16 colors with 320x200 screen points.

In this chapter we want to explain how the graphics are organized and how you can create fast and effective graphics without using the GEM graphics package, which is rather complicated for beginners. The ST offers the programmer (assembler and C) very useful routines, with whose help graphics programming isn't quite child's play, but they can take away a good deal of the programming work. Unfortunately, some of these functions are so comprehensive that a detailed description would exceed the scope of this book. We have therefore had to limit ourselves to the simpler, but no less interesting functions.

These graphics routines are called in a very elegant manner. The software developers have made use of the fact that there are two groups of opcodes in the 68000 which the 68000 does not "understand" and which generate a trap, or software interrupt, when they are encountered in a program. These are the two groups of opcodes which begin with $Axxx and $Fxxx. In the ST, the $Axxx opcode trap is used in order to access the graphics routines. The trap handler, the program called by the trap, checks the lowest byte of the "command" to see what value it has. Values between zero and $E are permissable here. This gives a total of 14 graphics routines, which should first be presented in an overview. Later we will talk about the actual commands in detail.

```
$A000 Determine address of required variable range
$A001 Set point on the screen
$A002 Determine color of a screen point
$A003 Draw a line on the screen
$A004 Draw a horizontal line (very fast!)
$A005 Fill rectangle with color
$A006 Fill polygon line by line
$A007 Bit block transfer
$A008 Text block transfer
$A009 Enable mouse cursor
$A00A Disable mouse cursor
```

```
$A00B Change mouse cursor form
$A00C Clear sprite
$A00D Enable sprite
$A00E Copy raster form
```

These routines are the ground work for the hardware-dependent part of GEM. All GEM graphic and text output is performed by the routines of the $Axxx opcodes. The set of A-opcodes are very useful in games. In games windows are needed only in the rarest cases. Another important point is the speed of the A-instructions. Using the graphic routines directly is clearly faster than if the output is handled by GEM. Before we describe the individual commands in detail, we will take a brief look at the construction of graphics in the various graphic modes of the ST.

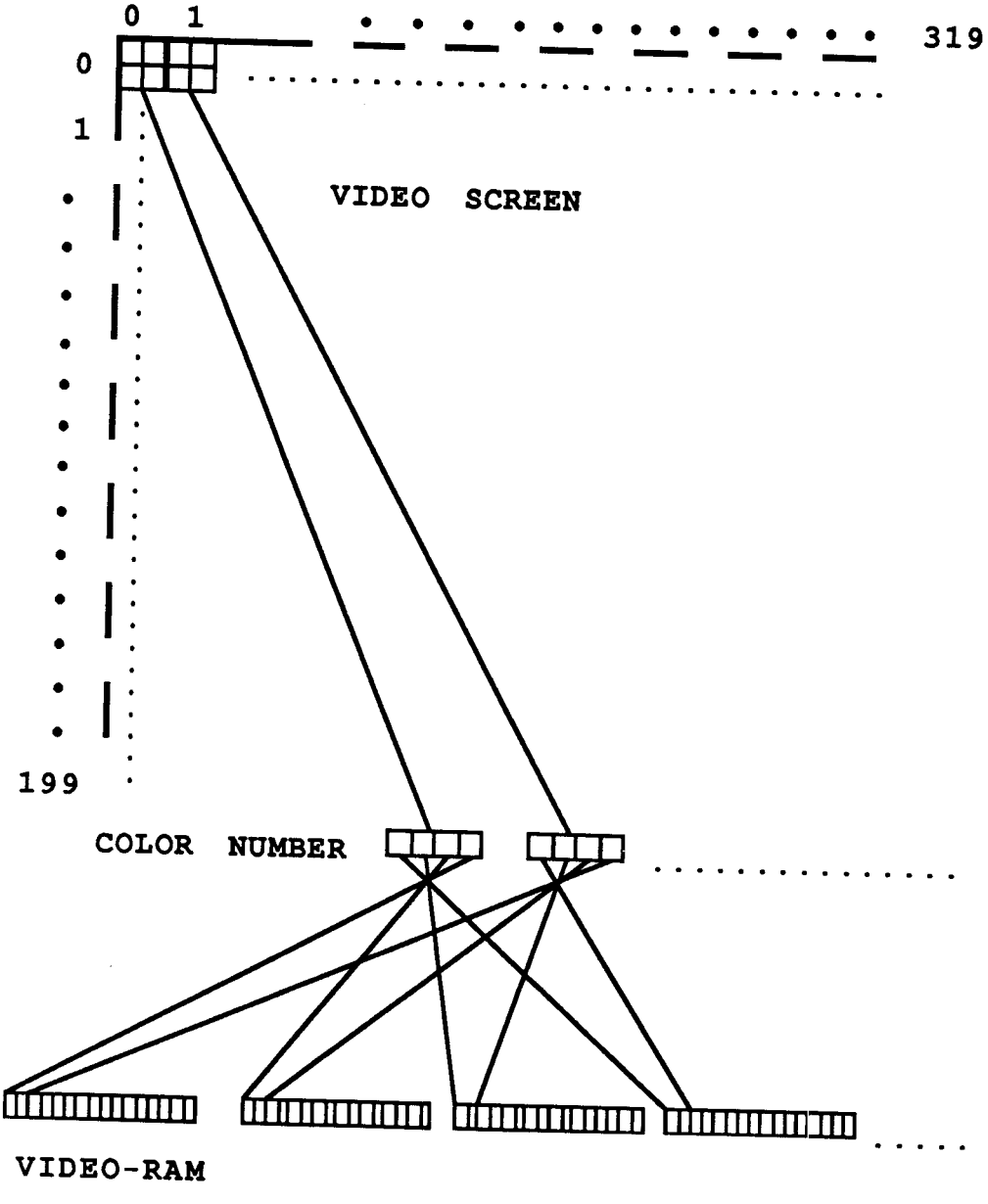
Immediately after turning the ST on, an area of 32K bytes is initialized at the upper memory border as the video RAM. In normal operation this results in addresses $78000 to $7FFFF acting as the screen RAM. This video RAM can be viewed as a window in the ST. We will start with the simplest mode, the 640x400 mode. In this case each 80 bytes, or better, each 40 words forms one screen line. The word with the lowest address is displayed on the left edge of the screen, the additional words are displayed in order from left to right. Within a word, the highest-order bit lies at the left and the lowest-order bit at the right.

With this data, any point on the screen can be easily controlled or read. For example, to set the first screen point, the value $8000 must be written into memory location $78000. Therefore you might store $8000 into memory location $78000. But this isn't recommended.

You might recall that the screen RAM in the ST can be moved quite easily. Then the absolute address of $78000 is no longer correct, of course. For this reason, it is usually more advantageous to set the the point with the "A" function $A001. Function $A001 assumes an X-Y coordinate system with origin in the upper left-hand corner, and determines the position of the video RAM itself in order to set the point at the proper screen location.

In this resolution mode, each screen point is represented by a bit. If the bit is set, the point appears dark, or bright if the the inverse display mode is selected in color palette register 0. The screen consists of only one bit plane. Different colors cannot be represented with just one plane, however. This is why when the resolution increases in the color modes, the number of displayable colors decreases.

Figure 3.4-1 LO-RES-MODE (0)



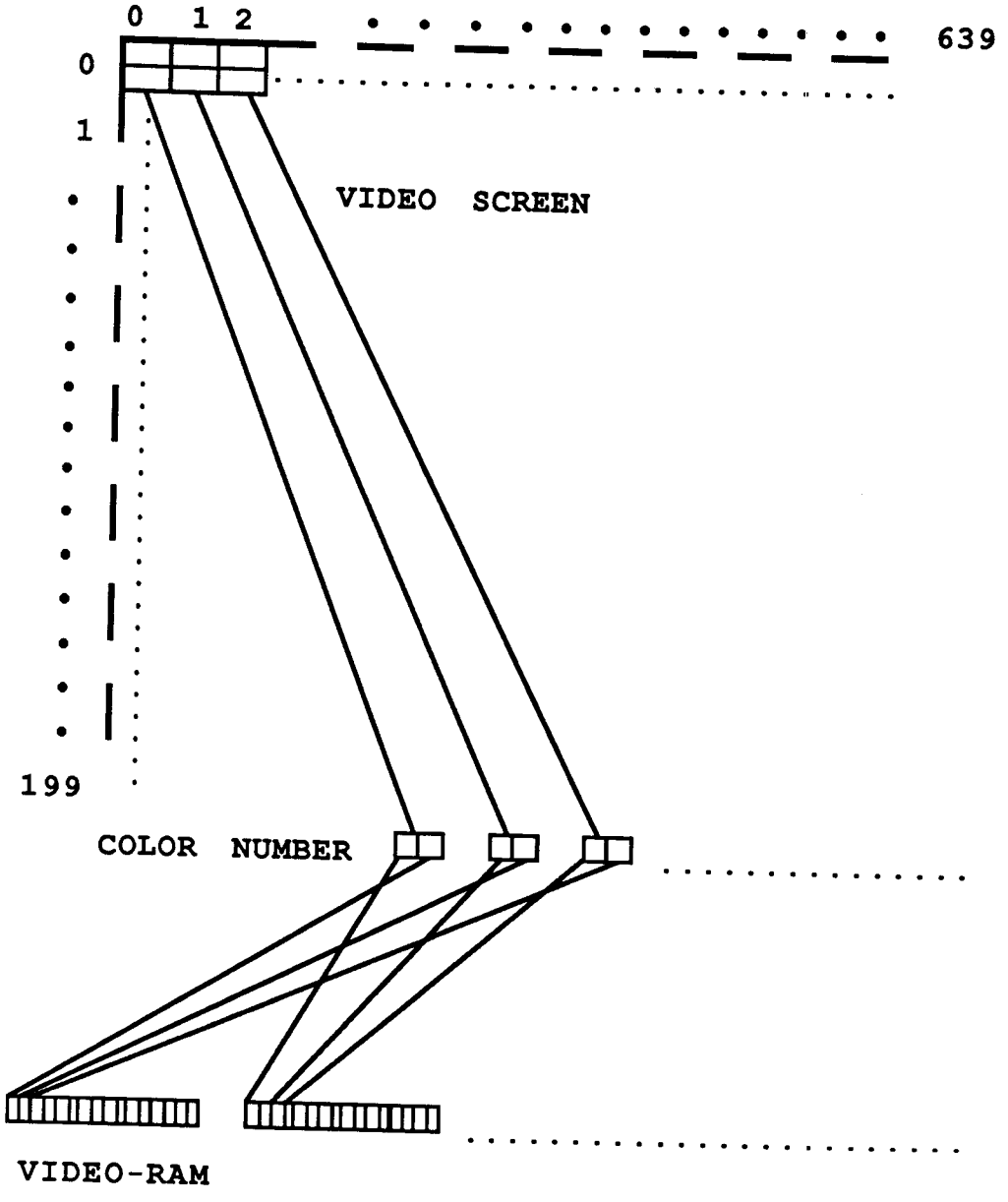
Four colors possible in the 640x200 resolution mode. In this mode, two contiguous memory words form a single logical entity. The color of a point is determined by the value of the two corresponding bits in the two words. If both bits are zero, the background color results. Therefore two sequential words are used together for pixel representation. For the colors, however, all odd words belong to a plane. The second plane is made up of the even words. In this mode, there are two planes available.

Things become quite colorful in the mode with "only" 320x200 points. In this operating mode, 4 contiguous memory words form one entity which detemines the color of the 16 pixels. To stick to the example we used before: in order to set the point in the upper left-hand corner, the topmost bits of words $78000, $78002, $78004, and $78006 must be manipulated. The desired color results from the bit pattern in the words. It naturally requires some computer time to set a point in the desired color, independent of the mode. All of this work is handled by the $A001 routine, however. This routine sets all of the pertaining bits for the desired color in the current resolution. Naturally, all four planes are present in this mode. The first plane, keeping to our example, made up of the words at address $7F000, $7F008, $7F010, ..., and the other planes are composed of the other addresses correspondingly.

Another point to be clarified concerns the fonts or character sets. Since the ST does not have a text mode, only a graphics mode, the text output is created in high-resolution graphics. There are three different fonts built into the ST. You can load additional fonts from disk. Each font has a header which contains important information about the displayable characters. Since the important data are contained in the font header, there are unusually few limits for display. The characters can be arbitrarily high or wide. The age of the 8x8 matrix for character output is over. Genuine proportional type on the screen (!) is even possible.

The three built-in fonts use relatively few of the many possibilities which GEM allows for character generation. All three fonts are mono-spaced fonts, meaning they have a fixed defined size in pixels and a defined pitch. The smallest font has a matrix of 6x6. With a resolution of 640x400 points, 66 lines of 106 characters each can be displayed. This font is only accessible for output under GEM, not for output under TOS, and is used in the output of the directory in the icon form, for example. The next-largest type is composed of 8x8 points. This type is used when a color monitor is connected to the ST, while the third and largest font is used for the normal black-and-white mode. This font uses a matrix of 8x16 points.

Figure 3.4-2 MEDIUM-RES-MODE (1)



The exact layout of the font header is found under command $A008, which represents a very versatile text output which goes far beyond what is possible with the routine of the BIOS and GEMDOS.

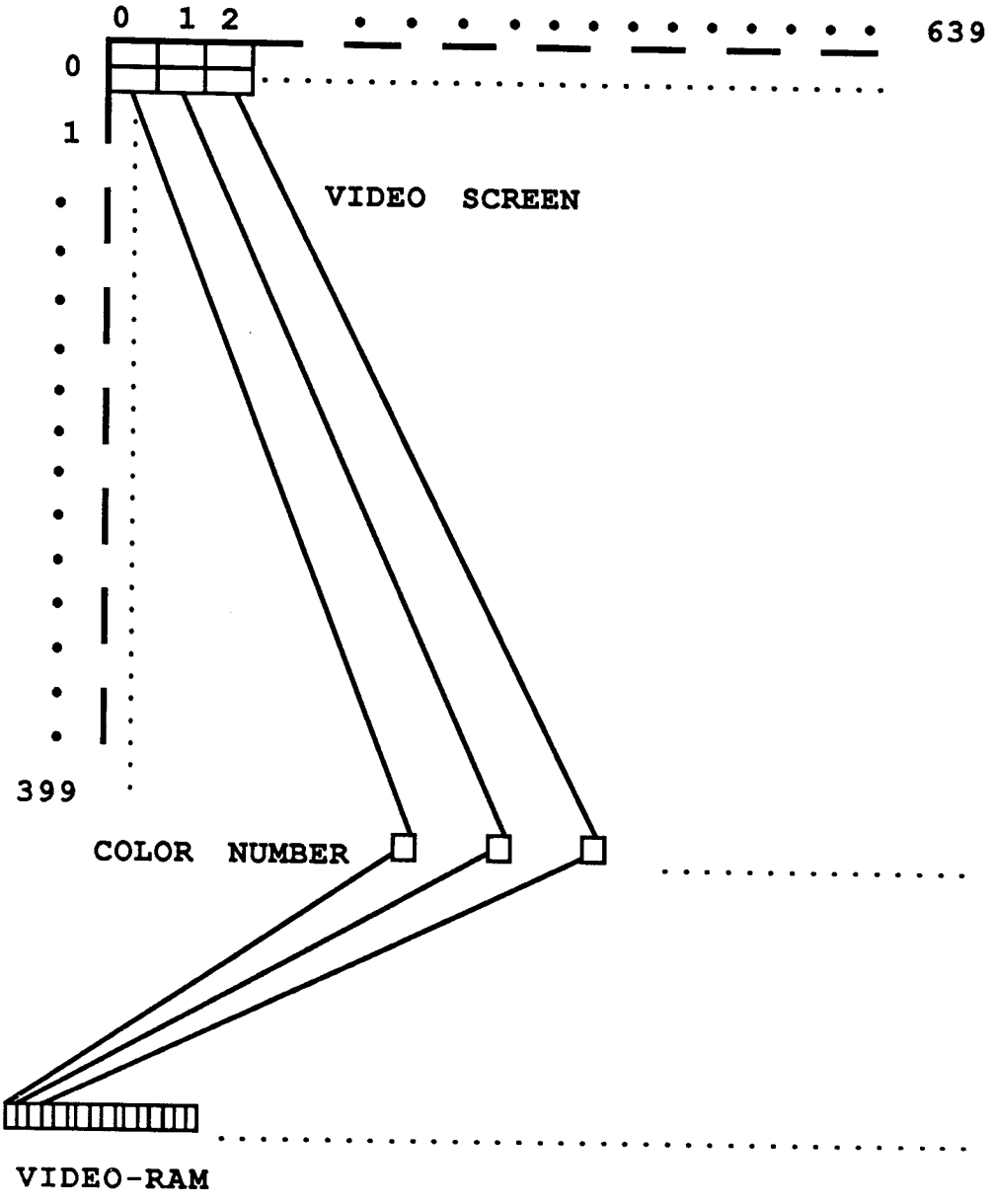
Finally, we must clarify some of the terms which will come up often in the following descriptions, whose meaning may not be so clear. These are the terms CONTRL array, INTIN array, INTOUT array, PTSIN array and PTSOUT array. These arrays are mainly used by GEM to pass parameters to individual GEM functions or to store results from these functions. But line-A functions use parts of these arrays to pass parameters also. The arrays are defined in memory as data areas, whereby each element in the array consists of 2 bytes.

For GEM functions, the CONTRL array always contains the number desired in the first element (CONTRL(0)). This parameter is not used by the line-A commands, however. CONTRL(1) contains the number of XY coordinates required for the function. These coordinates must be placed in the PTSIN array before the call. The element CONTRL(2) is not supplied before the call. After the call it contains the number of XY coordinates in the PTSOUT array. CONTRL(3) specifies how many parameters will be passed to the function in the INTIN array, while CONTRL(4) contains the number of parameters in the INTOUT array after the call. The additional parameters of the CONTRL array are not relevant for users of the line A.

Unfortunately, not all of the parameters for the A opcodes can be in these arrays. For this reason there is another memory area which used as a variable area for (almost) all graphic outputs. The function and use of these over 50 variables is found in a table at the end of this chapter. Important variables are also explained in conjunction with the functions which require them.

By the way, you should be aware that registers D0 to D2 and A0 to A2 are changed by calling the functions. Important values contained in these registers should be saved before a call.

Figure 3.4-3 HI-RES-MODE (2)



$A000 Initialize

Initialize is really the wrong expression for this function. After the call, the addresses of the more important data areas are returned in registers D0 and A0 to A2. This function does not require input parameters.

The program is informed of the starting address of the line-A variables in D0 and A0. After the call, A1 points to a table with three addresses. These three addresses are the starting address of the three system font headers. Register A2 points to a table with the starting addresses of the 15 line-A routines.

This opcode destroys (at least) the contents of registers D0 to D2 and A0 to A2. Important values should be saved before the call.

$A001 PUT PIXEL

This opcode sets a point at the coordinates specified by the coordinates in `PTSIN(0)` and `PTSIN(1)`. The color is passed in `INTIN(0)`. `PTSIN(0)` contains X-coordinate, `PTSIN(1)` the Y-coordinate.

The coordinate system used has its origin in the upper left corner. The possible range of the X and Y coordinates is naturally set according to the graohic mode enabled. Overflows in the X range are not handled as errors. Instead, the Y coordinate is simply incremented by the appropriate amount. No output is made if the Y range is exceeded.

The color in `INTIN(0)` is dependent on the mode used. When driving the monochrome monitor, only bit zero of the value of `INTIN(0)` is evaluated.

$A002 GET PIXEL

The color of a pixel can be determined with this opcode. As with $A001, the XY coordinates are passed in `PTSIN(0)` and `PTSIN(1)`; the color value is returned in the D0 register.

$A003 LINE

With the LINE opcode a line can be drawn bewteen the points with coordinates x1,y1 and x2,y2. The parameters for this function are not passed via the parameter arrays, but must be transferred to the line-A variables before the call. The variables used are:

```
_X1       = x1 coordinate
_Y1       = y1 coordinate
_X2       = x2 coordinate
_Y2       = y1 coordinate
_FG_BP_1  = Plane 1 (all three modes)
_FG_BP_2  = Plane 2 (640x200, 320x200)
_FG_BP_3  = Plane 3 (only 320x200)
_FG_BP_4  = Plane 4 (only 320x200)
_LN_MASK  = Bit pattern of the line
            For example: $FFFF = filled
                         $CCCC = broken
_WRT_MOD  = Determines the write mode
_LSTLIN   = This variable should be set to -1 ($FFFF)
```

One point to be noted for some applications is the fact that when drawing a line, the highest bit of the line bit pattern is always set on the left screen edge. The line is always drawn from left to right and from top to bottom, not from x1,y1 to x2,y2.

Range overflows are handled as for PUT PIXEL. If an attempt is made to draw a line from 0,0 to 650,50, a line is actually drawn from, 0,0 to 639,48. The "remainder" results in an additional line from 0,49 to 10,50.

A total of four different write modes, with values 0 to 3, are available for drawing lines. With write mode zero, the original bit pattern "under" the line is erased and the bit pattern determined by _LN_MASK is put in its place (replace mode). In the transparent mode (_WRT_MOD=1), the background, the old bit pattern, is ORed with the new line pattern so only additional points are set. In the XOR mode (_WRT_MOD=2), the background and the line pattern are exclusive-ored. The last mode (_WRT_MOD=3) is the so-called "inverse transparent mode." As in the transparent mode, it involves an OR combination of the foreground and background data, in which the foreground data, the bit pattern determined by _LN_MASK, are inverted before the OR operation.

$A004 HORIZONTAL LINE

This function draws a line from x1,y1 to x2,y1. Drawing a horizontal line is significantly faster than when a line must be drawn diagonally. Diagonal lines are also created with this function, in which the line is divided into multiple horizontal lines segments. The parameters are entered directly into the required variables.

```
_X1       = x1 coordinate
_Y1       = y1 coordinate
_X2       = x2 coordinate
_FG_BP_1  = Plane 1 (all three modes)
_FG_BP_2  = Plane 2 (640x200, 320x200)
_FG_BP_3  = Plane 3 (only 320x200)
_FG_BP_4  = Plane 4 (only 320x200)
_WRT_MOD  = Determines the write mode
_patptr   = Pointer to the line pattern to use
_patmsk   = "Mask" for the line pattern
```

The valid values in _WRT_MOD also lie between 0 and 3 for this call. The contents of the variable _patptr is the address at which the desired line pattern or fill pattern is located. The H-line function is very well-suited to creating filled surfaces. The variable _patmsk plays an important role in this. The number of 16-bit values at the address in _patptr is dependent on the its value. If, for example, _patmsk contains the value 5, six 16-bit values should be located at the address in _patptr as the line pattern. If a horizontal line with the Y-coordinate value zero is to be drawn, the first bit pattern is taken as the line pattern. The second word is taken as the pattern for a line drawn at Y-coordinate 1, and so on. The pattern for a line with Y-coordinate 6 is again determined by the first value in the bit table. In this manner, very complex fill patterns can be created with relatively little effort.

$A005 FILLED RECTANGLE

The opcode $A005 represents an extension, or more exactly a special use, of opcode $A004. It is used to created filled rectangles. The essential parameters are the coordinates of the upper left and lower right corners of the of the rectangle.

```
_X1       = x1 coordinate, left upper
_Y1       = y1 coordinate
_X2       = x2 coordinate, right lower
_Y2       = y2 coordinate
_FG_BP_1  = Plane 1 (all three modes)
_FG_BP_2  = Plane 2 (640x200, 320x200)
_FG_BP_3  = Plane 3 (only 320x200)
_FG_BP_3  = Plane 4 (only 320x200)
_WRT_MOD  = Determines the write mode
_patptr   = Pointer to the fill pattern used
_patmsk   = "Mask" for the fill pattern
_CLIP     = Clipping flag
_XMN_CLIP = X minimum for clipping
_XMX_CLIP = X maximum for clipping
_YMN_CLIP = Y minimum for clipping
_YMX_CLIP = Y maximum for clipping
```

We have already explained all of the variables except the "clipping" variables. What is clipping? Clipping creates extracts or clippings of the total picture. If the clipping flag is set to one (or any value not equal to zero), the rectangle, drawn by $A005, is displayed only in the area defined by the clipping-area variables. An example may explain this behavior better: The values 100,100 and 200,200 are specified as the coordinates. The clip flag is 1 and the clip variables contain the values 150,150 for XMN_CLIP and YMN_CLIP as well as 300,300 for XMX_CLIP and YMX_CLIP. The value $FFFF will be chosen as the fill value for all of the lines. With these values, the rectangle will have the coordinate 150,150 as the upper left corner and 200,200 as the lower right. The "missing" area is not drawn because of the clip specifications. Clearing the clip flag draws the rectangle in the originally desired size.

$A006 FILLED POLYGON

$A006 is also an extension of $A004. Arbitrary surfaces can be filled with a pattern with this function. The entire surface is not filled with the call: just one raster line is filled, a horizontal line with a width of one point. The result is that there are significantly more options for influencing the fill pattern.

The necessary variables are:

```
PTSIN      = Array with the XY coordinates
CONTRL(1)  = Number of coordinate pairs
_Y1        = y1 coordinate
_FG_BP_1   = Plane 1 (all three modes)
_FG_BP_2   = Plane 2 (640x200, 320x200)
_FG_BP_3   = Plane 3 (only 320x200)
_FG_BP_3   = Plane 4 (only 320x200)
_WRT_MOD   = Determines the write mode
_patptr    = Pointer to the fill pattern used
_patmsk    = "Mask" for the fill pattern
_CLIP      = Clipping flag
_XMN_CLIP  = X minimum for clipping
_XMX_CLIP  = X maximum for clipping
_YMN_CLIP  = Y minimum for clipping
_YMX_CLIP  = Y maximum for clipping
```

Basically, all of the parameters here are to be set exactly as they might be for a call to $A005. Only the first three coordinates are different. The XY coordinates are stored in the `PTSIN` array. It is important you specify the start coordinate again as the last coordinate as well. In order to fill a triangle, you must, for example, enter the coordinates (320,100), (120,300), (520,300), and (320,100). The number of effective coordinate pairs, three in our example, must be placed in `CONTRL(1)`, the second element of the array. With a call to the $A006 function you must also specify the Y-coordinate of the line to be drawn. Naturally you can fill all Y-coordinates from 0 to 399 (0 to 199 in the color modes) in order. But it is faster to find the largest and smallest of the XY values and call the funtion with only these as the range.

$A007 BITBLT

The bit block transfer is used by the text block transfer, $A008, and copy raster form, $A00E. Register A6 must contain a pointer to a parameter table Unfortunately, the construction of this parameter table could not be determined definitively. Our attempts led to classic system crashes about 70% of the time. For this reason, we cannot say much about the function.

$A008 TEXTBLT

A character from any desired text font can be printed at any graphic position with the TEXT BLock Transfer function. In addition, the form of the character can be changed. The character can be displayed in italics, boldface, outlines, enlarged, or rotated. These things cannot be achieved with the "normal" character outputs via the BIOS or GEMDOS. But to do this, a large number of parameters must be set and controlled. A rather complicated program must be written in order to output text with this function. If the additional options are not absolutely necessary, it is advisable not to use this function. But please decide for yourself.

Before we produce a character on the screen, we must first concern ourselves with the organization of the fonts. We must take an especially close look at the font header because the font is describe in detail by the information contained in it.

Basically, a font consists of four sets of data: font header, font data, character offset table, and horizontal offset table. The font header contains general data about the font, such as its name and size, the number of characters it contains, and various other aspects. This information takes up a total of 88 bytes. The font data contains the bit pattern of the existing, displayable characters. These data are organized so as to save as much space as possible.

In order to be able to better describe the organization, we will imagine a font with only two characters, such as "A" and "B". These characters are to be displayed in a 9x9 matrix. The font data are now in memory so that the bit pattern of the top scan line of the "A" is stored starting at a word boundary.

Since our font is 9 pixels = 9 bits wide, one byte is completely used, but only the top bit of the following byte. 7 bits must be wasted if the top scan line of the "B" is also to begin on a word boundary. This is not so, however, and the first scan line of the "B" starts with bit 6 of the second

byte of the font data. Only the data of the second and further scan lines always start on a word boundary. In this manner, almost no bits are wasted in the font. Only the start of the scan lines of the first character actually begin on a word boundary; all other scan lines can begin at any bit position.

Because of this space-saving storage, the position of each character within the font must be calculated. The calculation of the scan-line positions is possible through the character offset table. This table contains one entry for each displayable character. For our example, such a table would contain the entries $0000, $0009, $0012. Through the direction of this table, it is possible to create true proportional type on the screen since the width of each character can be calculated. One subtracts the entry of the character to be displayed from the entry of the next character. The last entry is present so that the width of the last character can also be determined, although it is not assigned to a character.

In addition to the character offset table there is the horizontal offset table. This table is not used by most of the fonts, however. The fonts present in the ST do not use all the possibilities of this table either. If this table were present, it would contain a positive or negative offset value for each character, in order to shift the character to the right or left during output.

At the end of the description of the font construction are the meanings of the variables in the font header.

```
Bytes  0- 1 :Font identifier. A number which describes the
             font.      1=system font
Bytes  2- 3 :Font size in points (point is a measure used
             in type-setting).
Bytes  4-35 :The name of the font as an ASCII string.
Bytes 36-37 :The lowest ASCII value of the displayable
             characters.
Bytes 38-39 :The highest ASCII value of the displayable
             characters.
Bytes 40-49 :Relative distances of top, ascent, half,
             descent, and bottom line from the base line.
Bytes 50-51 :Width of the broadest character in the font.
Bytes 52-53 :Width of the broadest character cell. The cell
             is always at least one pixel wider than the
             actual character so that two characters next
             to each other are separated from each other.
Bytes 54-55 :Linker offset.
```

Bytes 56-57 : Right offset. The two offset values are only used for displaying the font in italics (skewing).

Bytes 58-59 : Thickening. If a character is to be displayed in boldface, the value of this variable is used.

Bytes 60-61 : Underline. Contains the height of the underline in pixels.

Bytes 62-63 : Lightening mask. "Light" characters are found on the desktop when an option on a pull-down menu is not available. This light grey character consists of masking the bits with the lightening mask. Usually the value is $5555.

Bytes 64-65 : Skewing mask. As before, only for displaying characters in italics.

Bytes 66-67 : Flag. Bit 0 is set if the font is a system font.
Bit 1 must be set if the horizontal offset table is present.
Bit 2 is the so-called byte-swap flag. If it is set, the bytes in memory are in 68000 format (low byte-high byte). A cleared swap flag signals that the data is in INTEL format, reversed in memory. With this bit the fonts from the IBM version of GEM can be used on the ST and vice versa.
Bit 3 is set if the width of all characters in the font is equal.

Bytes 68-71 : Pointer to the horizontal offset table or zero.

Bytes 72-75 : Pointer to the character offset table.

Bytes 76-79 : Pointer to the font data.

Bytes 80-81 : Form width. This variable contains the sum of widths of all the characters. The value represents the length of the scan lines of all of the characters and thereby the start of the next line.

Bytes 82-83 : Form height. This variable contains the number of scan lines for this font.

Bytes 84-87 : Contain a pointer to the next font.

After so much talk, we should now list the parameters which must be noted or prepared for the $A008 opcode.

```
_WRT_MODE     = Write mode
_TEXT_FG      = Text foreground color
_TEXT_BG      = Text background color
_FBASE        = Pointer to the start of the font data
_FWIDTH       = Width of the font
_SOURCEX      = X-coordinate of the char in the font
_SOURCEY      = Y-coordinate of the char in the font
_DESTX        = X-coordinate of the char on the screen
_DESTY        = Y-coordinate of the char on the screen
_DELX         = Width of the character in pixels
_DELY         = Height of the character in pixels
_STYLE        = Bit-wise coded flag for special effects
_LITEMASK     = Bit pattern used for "lightening"
_SKEWMASK     = Bit pattern used for skewing
_WEIGHT       = Factor for character enlargement
_R_OFF        = Right offset of the char for skewing
_L_OFF        = Left offste of the char for skewing
_SCALE        = Flag for scaling
_XACC_DDA     = Accumulator for scaling
_DDA_INC      = Scaling factor
_T_SCLSTS     = Scaling direction flag
_CHUP         = Character rotation vector
_MONO_STATUS  = Flag for monospaced type
_scrtchp      = Pointer to buffer for effects
_scrpt2       = Offset scaling buffer in _scrtchp
```

The five clip variables are also evaluated.

As you can see, an enormous number of variables are evaluated for the output of graphic text. Here we can go into only the essential (and those we explored) variables.

The write mode allows the output of characters in the four known modes, replace, OR, XOR, and inverse OR. There are 16 other modes available whose effects are not yet known. The variable _TEXT_FG is in connection with first four write modes. They form the foreground color used for display. The background color _TEXT_BG plays a role only with the 16 additional modes. It is clear that the additional modes are relevant only in connection with a color screen.

The variables _FBASE and _FWIDTH are set according to the desired font You can find the start of the font data from the header of the desired fon (bytes 76-79 in the header). _FWIDTH must be loaded with the contents o the bytes 80 and 81 of the header.

The parameter _SOURCEX determines which character you output. It should contain the ASCII value of the desired character.

The parameter _SOURCEY is usually zero because the character is to be generated from the top to the bottom scan line.

The parameter _DELX can be be calculated as the width of the character in which the entry in the character offset table of the desired character is subtracted from the next entry. The result is the width of the character in pixels. _DELY must be loaded with the value of byte 82-83 of the header.

The _STYLE is something special. Here you can specify if characters should be displayed normally or changed. The possible changes are boldface (thicken, bit 0), shading (lighten, bit 1), italic (bit 2), and outline (bit 4). The given change is enabled by setting the corresponding bit. Another change is scaling. The size of a character can be changed through scaling. Unfortunately, characters can only be enlarged on the ST.

If the scaling flag is cleared (zero), the character is displayed in its original size. The _T_SCLSTS flag determines if the font is to be reduced or enlarged. A value other than zero must be placed here for enlarging. _DDA_INC should contain the value of the enlargement or reduction. An enlargement could be produced only with a value of $FFFF.

Another interesting variable is _CHUP. With the help of this variable, characters can be rotated on the screen. The angle must be given in the range 0 to 360 degrees in tenths of a degree. A restriction must also be made for this function. Usuable results are obtainable only with rotations by 90 degrees. The values are $0000 for normal, $0384 for 90-degree rotation, $0704 (upside-down type), and $0A8C for 270 degrees.

To work with the effects, _scrchp must contain a pointer to a buffer in which TEXTBLT can store temporary values. The exact size of this buffer is not known, but we always found a buffer of 1K to be sufficient. Another buffer must be specified for enlargement (_scrtpt2). An offset is passed as a parameter which refers to the start of the _scrtchp buffer. A value of $4C proved to be sufficient here.

$A009 SHOW MOUSE

Calling this opcode enables the display of the mouse cursor. The cursor follows the mouse when it is moved. If the mouse cursor is disabled, the mouse can be used in programs which abandon the user interface GEM. This option is particularly useful for games.

The parameters required are passed in the INTIN and CONTRL arrays. CONTRL(1) should be cleared before the call and CONTRL(3) set to one. INTIN(0) has a special significance. The routine for managing the mouse cursor counts the number of calls to remove and enable the cursor. If the cursor is disabled twice, two calls must be made to re-enable it before it will actually appear on the screen. This behavior can be changed by clearing INTIN(0). With this parameter the cursor is immediately set independent of the number of previous HIDE CURSOR calls. If the value in INTIN(0) is not equal to zero the actually required number of $A009 calls must be made in order to make the cursor visible.

$A00A HIDE CURSOR

This functions hides the cursor. If this function is called repeatedly, the number is recorded by the operating system and determines the number of calls of SHOW CURSOR before the cursor actually appears.

$A00B TRANSFORM MOUSE

Is the arrow unsuited as a mouse cursor for games? Simply make your own cursor. How would it be if a little car moved across the screen instead of an arrow? The opcode $A00B gives your fantasy free reign, at least as far as it concerns the mouse cursor.

The parameters must be passed in the INTIN array. A total of 34 words are necessary. The following table gives information about the use and possible values:

```
INTIN(3) Mask color index, normally 0
INTIN(4) Data color index, normally 1
INTIN(5) to INTIN(20) contain 16 words of the cursor mask
INTIN(21) to INTIN (36) contain 16 words of cursor data
```

The form of the cursor is determined by the cursor data. Each 1 in the data creates a point on the screen. If a cursor is placed over a letter or pattern on the screen, the border between the cursor and the background cannot be determined. The mask enters at this point. Each set bit in the mask clears the background at the given location. This permits a light border to be drawn around the cursor. Take a look at the normal arrow cursor in order to see the operation of the mask.

$A00C UNDRAW SPRITE

This opcode is related to $A00D, DRAW SPRITE. The ST actually has no hardware sprites in sense in which sprite is used on something like the Commodore 64. The ST sprites are organized purely in software. Each sprite is 16x16 pixels large. One example of an ST sprite is the mouse cursor. It is created with this function.

In order to clear a previously-drawn sprite, the address of a buffer in which the background was saved when the sprite was drawn is passed in register A2. The opcode simply transfers the contents of the background buffer to the right spot on the screen. The buffer itself must be 64 bytes large for each plane. Another 10 bytes are used, independent of the number of planes. For monochrome display, the buffer is a total of 74 bytes long, while in the 320x200 pixel resolution (for planes), it is 4x64+10=266 bytes large.

$A00D DRAW SPRITE

This function draws the desired sprite on the screen. Parameters must be passed in the D0, D1, A0, and A2 registers.

D0 and D1 contain the X and Y-coordinates of the position of the sprite on the screen, called the hot spot. A0 is a pointer to the so-called sprite definition block and A2 contains the address of the sprite buffer in which the backgroud will be saved for erasing the sprite later.

The sprite definition block must have the following construction:

```
Word 1 : X offset to hot spot
Word 2 : Y offset to hot spot
Word 3 : Format flag 0=VDI format, 1=XOR format
Word 4 : Background color (bg)
Word 5 : Foreground color (fg)
```

Following this are 32 words which contain the sprite pattern. The pattern must be in memory in the following order:

```
Word 6 : Background pattern of the top line
Word 7 : Foreground pattern of the top line
Word 8 : Background pattern of the second line
Word 9 : Foreground pattern of the second line
etc.
```

The information in the format flag has the following significance:

VDI Format

fg	bg	Result
0	0	The background appears
0	1	The color in word 4 appears
1	0	The color in word 5 appears
1	1	The color in word 5 appears

XOR Format

fg	bg	Result
0	0	The background appears
0	1	The color in word 4 appears
1	0	The pixel on the screen is XORed with the fb bit
1	1	The color in word 5 appears

$A00E COPY RASTER FORM

Arbitrary areas of the screen can be copied with the $A00E opcode. Not only areas within the screen, but also from the screen into free RAM, and even more important, from the RAM to the screen. Even complete screen pages can be copied very quickly with the COPY RASTER opcode. The name RASTER FORM does express one limitation of the function, however. Each raster form to be copied must begin on a word boundary and must be a set of words.

The parameters are quite numerous and are passed in the CONTRL, PTSIN, and INTIN arrays. In addition, two "memory fom definition" blocks must be in memory for COPY RASTER. We will start with the MFD blocks. Since a copy operation must always have a source and a destination, one block describes the source memory range and the second describes the destination. Each block consists of 10 words. The address of the memory

described by the block is contained in the first two words. The third word specifies the height of the form in pixels. Word 4 determines the width of the form in words. Word 6 should be set to 1 and word 7 specifies the number of planes of which the form is composed. The remaining words should be set to zero because they are reserved for future extensions.

3.4.1 An overview of the "line-A" variables

After the initialization $A000, D0 and A0 contain the address of a variable area which contains more than 50 line-A variables. The essential variables have been described along with the various calls, but not the location of the variables within the variable block. We will present this list shortly. When naming the variables we have remained with the names used in the official Atari documentation.

Offset is the value which must be given to access the value register relative. Variables supplied with a question mark could not be definitively explained.

Offset	Name	Size	Function
0	v_planes	word	Number of planes
2	v_lin_wr	word	Bytes per scan line
4	CONTRL	long	Pointer to the CONTRL array
8	INTIN	long	Pointer to the INTIN array
12	PTSIN	long	Pointer to the PTSIN array
16	INTOUT	long	Pointer to the INTOUT array
20	PTSOUT	long	Pointer to the PTSOUT array
24	_FG_BP_1	word	Plane 0 color value
26	_FG_BP_2	word	Plane 1 color value
28	_FG_BP_2	word	Plane 2 color value
28	_FG_BP_2	word	Plane 3 color value
32	_LSTLIN	word	Should be -1 ($FFFF) (?)
34	_LN_MASK	word	Line pattern for $A003
36	_WRT_MODE	word	Write mode (0=write mode 1=transparent 2=XOR mode 3=Inverse trans.)
38	_X1	word	X1-coordinate
40	_Y1	word	Y1-coordinate
42	_X2	word	X2-coordinate
44	_Y2	word	Y2-coordinate

46	_patptr	long	Pointer to the fill pattern (see $A004)
50	_patmsk	word	Fill pattern "mask" (see $A004)
52	_multifill	word	0=fill pattern is only for one plane 1=fill pattern is for multi-plane
54	_CLIP	word	0=no clipping (see $A005) not 0=clipping
56	_XMN_CLIP	word	and
58	_YMN_CLIP	word	define upper left corner of the visible area for clipping
60	_XMX_CLIP	word	and
62	_YMX_CLIP	word	define lower right corner of the visible area for clipping
64	_XACC_DDA	word	Should be set to $8000 before each call to TXTBLT (?)
66	_DDA_INC	word	Enlargement/reduction factor $FFFF for enlargement, reduction doesn't work (?)
68	_T_SCLSTS	word	0=reduction (?) 1=enlargement
70	_MONO_STATUS	word	1=not proportional font 0=proportional type or width of character changed by bold or italics
72	_SOURCEX	word	X-coordinate of char in font
74	_SOURCEY	word	Y-coord of char in font (0)

Note:
SOURCEX is the value of the character from the horizontal offset table (HOT) and can be calculated witht he following formula:
SOURCEX = HOT-element (ASCII value minus FIRST ADE)
The variable FIRST ADE is contained in bytes 36,37 of the font header (see example)

76	_DESTX	word	X-position of char on screen
78	_DESTY	word	Y-position of char on screen
80	_DELX	word	Width of the character
82	_DELY	word	Height of the character

Note:
DELX can be calculated with this formula:
DELX = SOURCEX+1 minus SOURCEX
(see $A008)
DELY is the value FORM height from bytes 82,83 of the font header.

84	_FBASE	long	Pointer to start of font data
88	_FWIDTH	long	Width of font form
90	_STYLE	word	Flags for special effects (see $A008)
92	_LITEMASK	word	Mask for shading
94	_SKEWMASK	word	Mask for italic type
96	_WEIGHT	word	Number of bits by which the character will be expanded
98	_R_OFF	word	Offset for italic type
100	_L_OFF	word	Offset for italic type

Note:
The above five variables should be loaded with the corresponding values from the font header.

102	_SCALE	word	0=no scaling 1=scaling (enlarge/reduce)
104	_CHUP	word	Angle for character rotation 0=normal char representation $384=rotated 90 degrees $708=rotated 180 degrees $A8C=rotated 270 degrees
106	_TEXT_FG	word	Foreground color for text display
108	_scrtchp	long	Address of buffer required for creating special text effects
112	_scrpt2	word	Offset of the enlargement buffer in the scrtchp buffer
114	_TEXT_BG	word	Background color for text rep
116	_COPYTRAN	word	(?)

3.4.2 Examples for using the line-A opcodes

In order to ease your first experiments with the line-A opcodes, we have given a few examples which can serve as a starting-point for you. In the first example, a point is set on the screen with $A001, and then the color of the point is determined with $A002.

```
*******************************************************
*           Demo of the $A000,$A001 and $A002 functions
*
*           rbr 09/28/85
*******************************************************

intin       equ       8
ptsin       equ       12

init        equ       $a000
setpix      equ       $a001
getpix      equ       $a002


start:
            .dc.w     init                  * call $A000
            move.l    intin(a0),a3          * address of INTIN-arrays
            move.l    ptsin(a0),a4          * address of PTSIN-arrays

            move      #300,(a4)             * X coordinate
            move      #100,2(a4)            * Y coordinate

            move      #1,(a3)               * color set, pixel set
*                                             0 erase pixel

            .dc.w     setpix                * pixel set

            move      #300,(a4)             * X coordinate
            move      #100,2(a4)            * y coordinate

            .dc.w     getpix                * get color value

*            d0 contains prersent color value
```

Only color values zero and one make sense for a monochrome monitor. Other values can be entered when working in one of the color modes, however.

The next example shows how a triangle can be drawn on the screen with the function FILLED POLYGON.

```
************************************************
*
*
*           a006 - filled pologyn
*
*
************************************************

contrl      equ       4
ptsin       equ       12

fg_bp1      equ       24
fg_bp2      equ       26
fg_bp3      equ       28
fg_bp4      equ       30
wrt_mod     equ       36

y1          equ       40

patptr      equ       46
patmsk      equ       50
multifill   equ       52
clip        equ       54
xmn_clip    equ       56
ymn_clip    equ       58
xmx_clip    equ       60
ymx_clip    equ       62


init        equ       $a000
polygon     equ       $a006


            .dc.w     init              * address of variable block
*                                         from A0

            move.w    #1,fg_bp1(a0)     *set colors for monochrome
            clr.w     fg_bp2(a0)
            clr.w     fg_bp3(a0)
            clr.w     fg_bp4(a0)

            move.w    #2,wrt_mod(a0)    * replace mode
```

```
            move.l    #fill,patptr(a0)  * pointer of the fill pattern
            move.w    #4,patmsk(a0)     * four fill patterns
            clr.w     multifill(a0)     * for monochrome
            clr.w     clip(a0)          * no clipping

            move.l    contrl(a0),a6     * adddress of CONTRL array
*                                         from A6
            addq.l    #2,a6             * A6 > CONTRL(1)
            move.w    #3,(a6)           * the XY pair in PTSIN

            move.l    ptsin(a0),a6      * address PTSIN array from A6
            move.l    #tab,a5           * table of coordinates
            move.w    #8,d3             * recieve 8 coordinates
loop        move.w    (a5)+,(a6)+
            dbra      d3,loop

            move.w    #100,d3           * first scanline
loop1       move.w    d3,y1(a0)         * from Y1
            move.l    a0,-(sp)          * restore address variable bloc

            dc.w      polygon           * fill scanline, A0 destroyed

            move.l    (sp)+,a0          * A0 restored
            addq.w    #1,d3             * calculate next sacanline
            cmp.w     #301,d3           * last scan line?
            bne       loop1             * no, next scanline

            move.w    #1,-(sp)          * Code CONIN wait for keypress
            trap      #1                * Call GEMDOS
            addq.l    #2,sp             * stack correction

            rts                         * all done


fill:
            dc.w      %1100110011001100
            dc.w      %0110110110110110
            dc.w      %0011001100110011
            dc.w      %1001100110011001


tab:
            dc.w      320,100
            dc.w      120,320
            dc.w      520,300
            dc.w      320,100
```

The next example shows how the mouse form can be manipulated and how the mouse can be enabled. The example waits for a key press before returning.

```
*********************************************************
*
*
*           show mouse - transform mouse
*
*
*********************************************************


intin       equ       8

init_a      equ       $a000
show_mouse  equ       $a009
transmouse  equ       $a00b


start:
            .dc.w     init_a          * address INIT from A5

            move.l    intin(a0),a5
            move      #0,6(a5)        * INTIN (3) = mask color value
            move      #1,8(a5)        * INTIN (4) = data color value

            add.l     #10,a5          * a5 > INTIN (5)

            lea       maus,a4         * data for new cursor
            move      #16,d0          * 32 words = 16 longs

loop:
            move.l    (a4)+,(a5)+     * transfer INTIN array
            dbra      d0,loop

            .dc.w     transmouse      * and set form

            .dc.w     init_a

            move.l    intin(a0),a0
            clr.w     (a0)            * Number Hide Cursor -ignore call

            .dc.w     show_mouse      * now the new cursor
```

```
            move.w    #1,-(sp)          * Code CONIN wait for keypress
            trap      #1                * Call GEMDOS
            addq.l    #2,sp             * stack correction

            rts

maus:
maske:
            .dc.w     %0000000110000000
            .dc.w     %0000011111100000
            .dc.w     %0001111111111000
            .dc.w     %0111111111111110
            .dc.w     %1111111111111111
            .dc.w     %1111001111001111
            .dc.w     %1111001111001111
            .dc.w     %1111001111001111
            .dc.w     %0000001111000000
            .dc.w     %0000001111000000
            .dc.w     %0000001111000000
            .dc.w     %0000001111000000
            .dc.w     %0000001111000000
            .dc.w     %0000001111000000
            .dc.w     %0000000000000000
daten:
            .dc.w     %0000000000000000
            .dc.w     %0000000000000000
            .dc.w     %0000000110000000
            .dc.w     %0000011001100000
            .dc.w     %0110000110000110
            .dc.w     %0110000110000110
            .dc.w     %0000000110000000
            .dc.w     %0000000110000000
            .dc.w     %0000000110000000
            .dc.w     %0000000110000000
            .dc.w     %0000000110000000
            .dc.w     %0000000110000000
            .dc.w     %0000000000000000
            .dc.w     %0000000000000000
```

3.5 The Exception Vectors

The first 1024 bytes in the address range of the 68000 processor are reserved for the exception vectors. Here the addresses are stored for the routines which lead to exception handling under certain circumstances.

A condition which leads to an exception can come either from the processor itself or from the peripheral components and controls units connected to it. The interrupts, described in the next section, belong to the class of external events. In addition, a so-called bus error can be created externally.

A bus error can be created by many circumstances. For one, certain memory areas can be protected from unauthorized access by it. As you may already know, the 68000 can run in one of two operating modes. The operating system is driven at the first level, the *supervisor mode*. The *user mode* is intended for user programs. In order that a user program not be able to access important system variables as well as the system components in an uncontrolled fashion, such an access in the user mode leads to a bus error. If such an error occurs, the processor stops execution of the instruction, saves the program counter and status register on the stack, and branches to a routine, the address of which it fetches from the lowest 1024 bytes of memory. In the case of the bus error, the address is at memory location 8 (one long word). What happens in this routine?

First the vector number of the interrupt is determined. In the case of a bus error, this is 2. Mushroom clouds are then displayed on the screen. The user can determine the vector number by counting the number of mushroom pictures. Execution then returns to the GEM desktop.

The following table contains all of the exception vectors.

Vector number	Address	Exception vector meaning
0	$000	Stack pointer after reset
1	$004	Program counter after reset
2	$008	Bus error
3	$00C	Address error
4	$010	Illegal instruction
5	$014	Division by zero
6	$018	CHK instruction
7	$01C	TRAPV instruction
8	$020	Priviledge violation
9	$024	Trace
10	$028	Line A emulator
11	$02C	Line F emulator
12-14	$030-$038	reserved
15	$03C	Uninitialized interrupt
16-23	$040-$05C	reserved
24	$060	Spurious interrupt
25	$064	Level 1 interrupt
26	$068	Level 2 interrupt
27	$06C	Level 3 interrupt
28	$070	Level 4 interrupt
29	$074	Level 5 interrupt
30	$078	Level 6 interrupt
31	$07C	Level 7 interrupt
32	$080	TRAP #0 instruction
33	$084	TRAP #1 instruction
34	$088	TRAP #2 instruction
35	$08C	TRAP #3 instruction
36	$090	TRAP #4 instruction
37	$094	TRAP #5 instruction
38	$098	TRAP #6 instruction
39	$09C	TRAP #7 instruction
40	$0A0	TRAP #8 instruction
41	$0A4	TRAP #9 instruction
42	$0A8	TRAP #10 instruction
43	$0AC	TRAP #11 instruction
44	$0B0	TRAP #12 instruction
45	$0B4	TRAP #13 instruction
46	$0B8	TRAP #14 instruction
47	$0BC	TRAP #15 instruction
48-63	$0C0-$0FC	reserved
64-255	$100-$3FC	User interrupt vectors

The following vectors are used on the ST:

Line A emulator	$EB9A
Level 2 interrupt	$543C
Level 4 interrupt	$5452
TRAP #1 GEMDOS	$965E
TRAP #2 GEM	$2A338
TRAP #13 BIOS	$556C
TRAP #14 XBIOS	$5566

The vector for division by zero points to `rte` and returns directly to the interrupted program. Vectors 64-79 are reserved for the MFP 68901 interrupts. All other vectors point to $5838 which outputs the vector number and ends the program as described for the bus error.

All of the unused vectors can be used for your own purposes, such as the line F emulator or the 12 unused traps.

3.5.1 The interrupt structure of the ST

The interrupt possibilities which the 6800 microprocessor offers are put to good use in the ST. As you may have already gathered from the hardware description of the processor, the processor has seven interrupt levels with different priorities. The interrupt mask in the system byte of the status register determines which levels can generate an interrupt. An interrupt can only be generated by a level higher than the current contents of the mask in the status register. A interrupt of a certain priority is communicated to the processor by the three interrupt priority level inputs. The following assignment results:

Level	IPL 2	1	0
7 (NMI)	0	0	0
6	0	0	1
5	0	1	0
4	0	1	1
3	1	0	0
2	1	0	1
1	1	1	0
0	1	1	1

If all three lines are 1 (interrupt level 0), no interrupt is present. Interrupt level 7 is the NMI (non-maskable interrupt), which is executed even if the interrupt mask in the status register contains seven. Which interrupt is assigned which vector (that is, the address of the routine which will process the interrupt) depends on the peripheral component which generates the interrupt. For auto-vectors, the processor itself derives the interrupt number from the interrupt level. The following table is used in this process:

Level	Vector number	Vector address
IPL 1	25	$64
IPL 2	26	$68
IPL 3	27	$6C
IPL 4	28	$70
IPL 5	29	$74
IPL 6	30	$78
IPL 7	31	$7C

Only lines IPL 1 and IPL 2 are used on the Atari ST; Line IPL is permanently set to a 1 level so that only levels 2, 4 and 6 are available. The results in the following assignment:

```
IPL 2        HBL, horizontal blank, line return
IPL 4        VBL, vertical blank, picture return
IPL 6        MFP 68901
```

The HPL interrupt is generated on each line return from the video section. It is generated every 50 to 64 µs depending on the monitor connected (monochrome or color). It occurs very often and is normally not permitted by an interrupt mask of three. The standard HBL routine therefore only has the task of setting the interrupt mask to three if it is zero and allows the HBL interrupt so that no more HBL interrupts will occur. One use of the HBL interrupt could be for special screen effects. With the help of this routine, you know exactly which line of the screen has just been displayed. Of much greater importance, however, is the VBL interrupt, which is generated on each picture return. This occurs 50, 60, or 70 times per second depending on the monitor.

The vertical blank interrupt (VBL) routine accomplishes a whole set of a tasks which must be periodically executed or which concern the screen display. When entering the routine, the frame counter `frclock` ($466) is first incremented. Next, a test is made to see if the VBL interrupt is software-disabled. This is the case if `vblsem` ($452) (vertical blank semaphor) is zero or negative. In this case the routine is exited immediately

and execution returns to the interrupted program. Otherwise, all of the registers are saved on the stack and the counter `vbclock` (\$462), which counts the executed VBL routines, is incremented. Next, a check is made to see if a different monitor has been connected in the meantime. If a change was made from a monochrome to color monitor, the video shifter is reprogrammed accordingly. This is necessary because the high screen frequency of 70 Hz of the monochrome monitor could damage a color monitor. The routine to flash the cursor is called next. If you load a new color palette via the appropriate BIOS functions or want to change the screen address, this happens here in the VBL routine. Since nothing is displayed at this time, a change can be made here without disturbing anything else. If `colorptr` (\$45A) is not equal to zero, it is interpreted as a pointer to a new color palette, and this is loaded into the video shifter. The pointer is then cleared again. If `screenptr` is set, this value is used as the new base address of the screen. This takes care of the screen specific portions.

Now the floppy VBL routine is called, which with help the of the write protect status, determines if a diskette was changed. An additional task of this routine is to deselect the drives after the disk controller has turned the drive motor off.

Now comes the most interesting part for the programmer, the processing of the VBL queue. There is a way to tell the operating system to execute your own routines within the VBL interrupt. The maximum number of routines possible is in `nvbls` (\$454). This value is normally initialized to 8, but it can be increased if required. Address `vblqueue` (\$456) contains a pointer to a vector array which contains the (8) addresses of the VBL routines. Each address is tested within the VBL routine and the corresponding routine executed if the address is not zero.

If you want to install your own VBL routine, check the 8 entries until you find one which contains a zero. At this address you can write a pointer to your routine which from now on will be executed in every VBL interrupt. In all 8 entries are already occupied, you can copy the entries into a free area of memory, append the address of your routine, and redirect `vblqueue` to point to the new vector array. Naturally, you must not forget to increment `vbls`, the number of routines, correspondingly. Your routine may change all registers with the exception of the USP.

As soon as the VBL routine is done, the `dmpflg` (\$4EE) is checked. If this memory location is zero, a hardcopy of the screen is outputted. The flag is set in the keyboard interrupt routine if the keys ALT and HELP are pressed

at the same time. Finally, the register contents are restored, `vblsem` is released and execution returns to the interrupted routine.

The MFP 68901 occupies interrupt level six in our previous table. This component is in the position to create interrupt vectors on its own. These are referred to non-auto vectors in contrast to the auto vectors used above, because the processor does not generate the vector itself. In the Atari ST, the MFP 68901 works as the interrupt controller. It manages the interrupt requests of all peripheral components including its own.

The MFP can manage sixteen interrupts which are prioritized in reference to each other, similar to the seven levels of the processor. All MFP interrupts appear on level 6 to the 68000, therefore prioritized higher than HBL and VBL interrupts. The following table contains the assignments within the MFP.

Level	Assignment
15	Monochrome monitor detect
14	RS-232 ring indicator
13	System clock timer A
12	RS-232 receive buffer full
11	RS-232 receive error
10	RS-232 transmit buffer empty
9	RS-232 transmit error
8	Line return counter, timer B
7	Floppy controller and DMA
6	Keyboard and MIDI ACIAs
5	Timer C
4	RS-232 baud rate generator, timer D
3	unused
2	RS-232 CTS
1	RS-232 DCD
0	Centronics busy

Not all of these possible interrupt sources are enabled, however. Some signals are processed through polling. The following is a description of the interrupts which are used by the operating system.

Level 2, RS-232 CTS, Address $73C0

This interrupt is generated every time the RS-232 interface is informed via the CTS line that a connected receiver is ready to receive additional data. The routine then sends the next character from the RS-232 transmit buffer.

Level 5, Timer C, Address $7C5C

This timer runs at 200 Hz. The 200 Hz counter at $4BA is first incremented in the interrupt routine. The next actions are performed only every fourth call to the interrupt routine, that is, only every 20ms (50 Hz). First a routine is called which handles the sound processing. Another task of this interrupt is the keyboard repeat when a key is pressed and initial repeat. Finally, the `evt` timer routine of GEM is called, which is accessed via vector $400.

Level 6, Keyboard and Midi, Address $752A

Two peripheral components are connected to this interrupt level of the MFP, the two ACIAs which receive data from the keyboard and the MIDI interface. In order to decide which of the two components has requested an interrupt, the interrupt request bits in the status registers of the ACIAs are tested and the received byte is fetched if required. If it comes from the keyboard, the scan code is converted to the ASCII code by means of the keyboard table and written into the receive buffer, which happens immediately for MIDI data. Mouse and joystick data also come from the keyboard ACIA and are also prepared accordingly.

Level 9, RS-232 transmit error, Address $7426

If an error occurs while sending RS-232 data, this interrupt routine is activated. Here the transmitter status register is read and the status is saved in the RS-232 parameter block.

Level 10, RS-232 transmit buffer empty, Address $7374

Each time the MFP has completely outputted a data byte via the RS-232 interface, it generates this interrupt. It is then ready to send the next byte. If data is still in the transmit buffer, the next byte is written into the transmit register, which can now be shifted out according to the selected baud rate.

Level 11, RS-232 receive error, Address $7408

If an error occurs when receiving RS-232 data, this interrupt routine is activated. This may involve a parity error or an overflow. The routine only clears the receiver status register and then returns.

Level 12, RS-232 receive buffer full, Address $72C0

If the MFP has received a complete byte, this interrupt occurs. Here the character can be fetched and written into the receive buffer (if there is still room). This routine takes into account the active handshake mode (sending XON/XOFF or RTS/CTS).

The other interrupt possibilities of the MFP are not used, but they can be used for your own routines. For example, interrupt level 0, Centronics strobe, can be used for buffered printer output.

3.6 The Atari ST VT52 Emulator

There are two options for text output on the ST. You can work with the GEMDOS functions by means of `TRAP #1` or a direct BIOS call with `TRAP #13`. The other possibility consists of using the VDI functions.

You have special possibilities for screen control with both variants. We will first take a look at output using the normal DOS or BIOS calls. Here a terminal of type VT52, which offers a wide variety of control functions, is emulated for screen output. These control characters are prefixed with a special character, the escape code. Escape, also shortened to ESC, has ASCII code 27. Following the escape code is a letter which determines the function, as well as additional parameters if required. The following list contains all of the control codes and their significance.

ESC A Cursor up
This function moves the cursor up one line. If the cursor was already on the top line, nothing happens.

ESC B Cursor down
This ESC sequence positions the cursor one line down. If the cursor is already on the bottom line, nothing happens.

ESC C Cursor right
This sequence moves the cursor one column to the right.

ESC D Cursor left
Moves the cursor one position to the left. This function is identical to the control code backspace (BS, ASCII code 8). If the cursor is already in the first column, nothing happens.

ESC E Clear Home
This control sequence clears the entire screen and positions the cursor in the upper left corner of the screen (home position).

ESC H Cursor home
With this function you can place the cursor in the upper left corner of the screen without erasing the contents of the screen.

ESC I Cursor up
This sequence moves the cursor one line towards the top. In contrast to ESC A, however, if the cursor is already in the top line, a blank line is inserted and the remainder of the screen is scrolled down a line correspondingly. The column position of the cursor remains unchanged.

ESC J Clear below cursor
By means of this function, the rest of the screen below the current cursor position is cleared. The cursor position itself is not changed.

ESC K Clear remainder of line
This ESC sequence clears the rest of the line in which the cursor is found. The cursor position itself is also cleared, but the position is not changed.

ESC L Insert line
This makes it possible to insert a blank line at the current cursor position. The remainder of the screen is shifted down; the lowest line is then lost. The cursor is placed at the start of the new line after the insertion.

ESC M Delete line
This function clears the line in which the cursor is found and moves the rest of the screen up one line. The lowest screen line then becomes free. After the deletion, the cursor is located in the first column of the line moved up to take the place of the old one.

ESC Y Position cursor

This is the most important function. It allows the cursor to be positioned at any place on the screen. The function needs the cursor line and column as parameters, which are expected in this order with an offset of 32. If you want to set the cursor to line 7, column 40, you must output the sequence ESC Y CHR$(32+7) CHR$(32+40). Lines and columns are counter starting at zero; for an 80x25 screen the lines are numbered from 0 to 24 and the columns from 0 to 79.

The additional ESC sequences of the VT52 terminal start with a lower case letter.

ESC b Select character color

With this function you can select the character color for further output. With a monochrome monitor you have choice between just 0=white and 1=black. For color display you can select from 4 or 16 colors depending on the mode. Only the lowest four bits of the parameters are evaluated (mod 16). You can use the digit "1" for the color 1 as well as the letters "A" or "a" in addition to binary one.

ESC c Select background color

This function serves to select the background color in a similar manner. If you choose the same color for character and background, you will, of course, not be able to see text output any more.

ESC d Clear screen to cursor position

This sequence causes the screen to be erased starting at the top and going to the current position of the cursor, inclusive. The position of the cursor is not changed.

ESC e Enable cursor

Through this escape sequence the cursor becomes visible. The cursor can, for example, be enabled when waiting for input from the user.

ESC f Disable cursor

Turns the cursor off again.

ESC j Save cursor position
If you want to save the current position of the cursor, you can use this sequence to do so.

ESC k Set cursor to the saved position
This is the counterpart of the above function. It sets the cursor to the position which was previously saved with ESC j.

ESC l Clear line
Clears the line in which the cursor is located. The remaining lines remain unaffected. After the line is cleared, the cursor is located in the first column of the line.

ESC o Clear from start
This clears the current cursor line from the start to the cursor position, inclusive. The position of the cursor remains unchanged.

ESC p Reverse on
The reverse (inverted) output is enabled with this sequence. For all further output, the character and background colors are exchanged. With a monochrome monitor you get white type on a black background.

ESC q Reverse off
This sequence serves to re-enable the normal character display mode.

ESC v Automatic overflow on
After executing this sequence, an attempted output beyond the end of line will automatically start a new line.

ESC w Automatic overflow off
This deactivates the above sequence. An attempt to write beyond the line will result in all following characters being written in the last column.

Similar functions are available to you under VDI. The VDI escape functions (opcode 5) serve this purpose. The appropriate screen function is selected by choosing the proper function number. Note, however, that under VDI the line and column numbering does not begin with zero but with one.

Under VDI there is also a function which outputs a string at specific screen coordinates. If necessary, you can use the ESC functions of the VT52 emulation in addition.

The output of "unprintable" control characters

The three system fonts of the ST have also been supplied with characters for the ASCII codes zero to 31, which are normally interpreted as control codes. On the ST, only codes 7 (BEL), 8 (BS backspace), 9 (TAB), as well as 10, 11, and 12 (LF linefeed, VT vertical tab, and FF form feed all generate a linefeed) plus 13 (CR carriage return) have effect, in addition to ESC. The remaining codes have no effect. How does one access the characters below 32?

To do this, an additional device number is provided in the BIOS function 3 "conout". Normally number 2 "con" serves for output to the screen. If one selects number 5, however, all the codes from, 0 to 255 are outputted as printable characters, control codes are no longer taken into account.

In the appendix you find the three ST system fonts pictured.

3.7 The ST System Variables

The ST uses a set of system variables whose significance and addresses will not change in future versions of the operating system. If you use other variables, such as those from the BIOS listing which are not listed here, you should always remember that these could have a different meaning in a new version of the operating system. The system variables are in the lower RAM area directly above the 68000 exception vectors, at address $400 to 1024. The address range from 0 to $800 (2048) can be accessed only in the supervisor mode. An access in the user mode of the 68000 leads to a bus error.

In the following listing we will use the original names from Atari. In addition to the address of the given variable, typical contents and the significance will be described.

```
Address length name     Sample contents
```

$400 L etv_timer $F526

This is the event timer vector of the GEM. It takes care of the periodic tasks of GEM.

$404 L etv_critic $5562

Critical error handler. Under GEM this pointer points to $2A156. There an attempt is made to correct disk errors, such as if a another disk is requested in a single-drive system.

$408 L etv_term $5328

This is the GEM vector for ending a program.

$40C 5L etv_xtra

Here is space for 5 additional GEM vectors, which at the time are not yet used.

$420 L memvalid $752019F3

If the memory location contains the given value, the configuration of the memory controller is valid.

$424 W memctrl $0400

This is a copy of the configuration value in the memory controller. The value given applies for a 512K machine.

$426 L resvalid $31415926

If the given value is located here, a jump is made at a reset via the reset vector in address $42A.

$42A L resvector $FC0008

See above.

$42E L phystop $80000

This is the physical end of the RAM memory; $80000 for a 512K machine.

$432 L _membot $3B900

The user memory begins here (TPA, transient program area).

$436 L _memtop $78000

This is the upper end of the user memory.

$43A L memval2 $237698AA

This "magic" value together with "memvalid" declares the memory configuration valid.

$43E W flock 0

If this variable contains a value other than zero, a disk access is in progress and the VBL disk routine is disabled.

$440 W seekrate 3

The seek rate (the time it takes to move the read/write head to the next track) is determined according to the following table:

Seek rate	Time
0	6 ms
1	12 ms
2	2 ms
3	3 ms

$442 W _timer_ms $14, 20 ms

The time span between two timer calls, 20 ms corresponds to 50 Hz.

$444 W _fverify $FF

If this memory location contains a value other than zero, a verify is performed after every disk write access.

$446 W _bootdev 0

Contains the device number of the drive from the operating system was loaded.

$448 W palmode 0

If this variable contains a value other than zero, the system is in the PAL mode (50 Hz); if the value is zero, it means the NTSC mode.

$44A W defshiftmod 0

If the Atari is switched from monochrome to color, it gets the new resolution from here (0=low, 1 medium resolution).

$44C W sshiftmod $200

Here is a copy of the register contents for the screen resolution.

```
0   320x200, low resolution
1   640x200, medium resolution
2   640x400, high resolution
```

$44E L _v_bas_ad $78000

This variable contains a pointer to the video RAM (logical screen base). The screen address must always begin on a 256 byte boundary.

$452 W vblsem 1

If this variable is zero, the vertical blank routine is not executed.

$454 W nvbls 8

Number of vertical blank routines.

$456 L _vblqueue $4CE

Pointer to a list of `nvbls` routines which will be executed during the VBL.

$45A L colorptr 0

If this value is not zero, it is interpreted as a pointer to a color palette which will be loaded at the next VBL.

$45E L screenpt 0

This is a pointer to the start of the video RAM, which will be set during the next VBL (zero if no new address is to be set).

$462 L _vbclock $2D26A

Counter for the number of VBL interrupts.

$466 L _frclock $2D267

Number of VBL routines executed (not disabled by vblsem).

$46A L hdv_init $5AE8

Vector for hard disk initialization.

$46E L swv_vec $501E

Vector for changing the screen resolution. A branch is made via this vector with the screen resolution is changed (default is reset).

$472 L hdv_bpb $5B6E

Vector to fetch the BIOS parameter block for a hard disk.

$476 L hdv_rw $5D88

Read/write routine for a hard disk.

$47A L hdv_boot $60B2

Vector to a routine to reboot the hard disk.

$47E L hdv_mediach $5D1E

Media change routine for hard disk.

$482 W _comload 0

If this variable is set to a value other than zero by the boot program, an attempt will be made to load a program called "COMMAND.PRG" after the operating system is loaded.

$484 B conterm 6

Attribute vector for console output

```
Bit  Meaning
 0   Key click on/off
 1   Key repeat on/off
 2   Tone after CTRL G on/off
 3   "kbshift" is retured in bits 24-31 for the
     BIOS function "conin"
```

$485 B unused, reserved

$486 L trp14ret 0

Return address for TRAP #14 call.

```
$48A   L     criticret     0
```

Return address of the critical error handler

```
$48E   4L    themd         0
```

Memory descriptor, filled out by the BIOS function `getmpb`.

```
$49E   2W    ____md        0
```

Space for additional memory descriptors.

```
$4A2   L     savptr        $5CE
```

Pointer to a save area for the processor registers after a BIOS call.

```
$4A6   W     _nflops       2
```

Number of connected floppy disk drives.

```
$4A8   L     con_state     $8AEE
```

Vector for screen output; set by ESC functions to the appropriat routine, for example.

```
$4AC   W     save_row      0
```

Temporary storage for cursor line when positioning the cursor wit ESC Y.

```
$4AE   L     sav_context   0
```

Pointer to a temporary areas for exception handling.

```
$4B2   2L    _bufl         $4F9E,  $4FB2
```

Pointer to two buffer list headers of GEMDOS. The first header i responsible for data sectors, the second for the FAT (file allocatio table) and the directory. Each buffer control block (BCB) i constructed as follows:

```
        long   BCB     $4F8A, pointer to next BCB
        int    drive   -1,    drive number or -1
        int    type    2      buffer type
        int    rec     $41C   record number in this buffer
        int    dirty   0      dirty flag (buffer changed)
        long   DMD     $2854  pointer to drive media descriptor
        long   buffer  $4292  pointer to the buffer itself
```

$4BA L _hz_200 $71280

Counter for 200 Hz system clock

$4BC 4B the_env 0

Default environment string, four zero bytes.

$4C2 L _drvbits 3

32-bit vector for connected drives. Bit 0 stands for drive A, bit 1 for drive B, and so on.

$4C6 L _dskbufp $12BC

Pointer to a 1024-byte disk buffer. The buffer is used for GSX graphic operations and should not be used by interrupt routines.

$4CA L _autopath 0

Pointer to autoexecute path.

$4CE 8L _vbl_list $15398,0,0...

List of the standard VBL routines.

$4EE W _dumpflg $FFFF

This flag is incremented by one when the ALT and HELP keys are pressed simultaneously. A value of one generates a hardcopy of the screen on the printer. A hardcopy can be interrupted by pressing ALT HELP again.

```
$4F0    W     _prtabt        0
```

Printer abort flag due to time-out.

```
$4F2    L     _sysbase       $5000
```

Pointer to start of the operating system.

```
$4F6    L     _shell_p       0
```

Global shell information.

```
$4FA    L     end_os         $3B900
```

Pointer to the end of the operating system in RAM, start of the TPA.

```
$4FE    L     exec_os        $1EB00
```

Pointer to the start of the AES. Normally branched to after the initialization of the BIOS.

3.8 The 68000 Instruction Set

If you are already familiar with the machine language of some 8-bit processor: Forget everything you know. If you do, it will make it easier to understand the following material!

The 68000 processor is fundamentally different in construction and architecture from previous processors (including the 8086!). The essential difference does not lie in the fact that the standard processing width is 16 and not 8 bits (which is sometimes a drawback and can lead to programming errors), but in the fact that, with certain exceptions, the internal registers are not assigned to a specific purpose, but can be viewed as general-purpose registers, with which almost anything is possible.

In eariler processors, the accumulator was always the destination for arithmetic operations, but it is completely absent in the 68000. There are eight data registers (D0-D7) with a width of 32 bits, and as a general rule, at least one of these is involved in an operation. There are also eight address registers (A0-A7), each with 32 bits, which are usually used for generating complex addresses. Register A7 has a set assignment--it serves as the stack pointer. It is also present twice, once as the user stack pointer (USP) and once as the supervisor stack pointer (SSP). The distinction is made because there are also two operating modes, namely the user mode and the supervisor mode.

These two are not only different in that they use different stack pointers, but in that certain instructions are not legal in the user mode. These are the so-called priviledged instructions (see also instruction description), with whose help an unwary programmer can easily "crash" the system rather spectacularly. This is why these instructions create an exception in the user mode. An exception, by the way, is the only way to get from the user mode to the supervisor mode.

In addition there is the status register, the upper half of which is designated as the system byte because it contains such things as the interrupt mask, things which do not concern the "normal" user, making access to this byte also one of the priviledged instructions. The lower byte, the user byte, contains the flags which are set or cleared based on the result of operations, such as the carry flag, zero flag, etc. As a general rule, the programmer works with these flags indirectly, such as when the execution of a branch is made conditional on the state of a flag.

Two things should be mentioned yet: Multi-byte values (addresses o operands) are not stored in memory as they are with 8-bit processors, in th order low byte/high byte, but the other way around. Four-byte expression (long word) are stored in memory (and the registers of course) with th highest-order byte first.

The second is that unsupported opcodes do not lead to a crash, but cause a special exception, whose standard handling must naturally be performed by the operating system.

3.8.1 Addressing modes

This is probably the most interesting theme of the 68000 because the enormous capability first takes effect through the many various addressing modes.

The effective address (the address which, sometimes composed of several components, finally determines the operand) is fundamentally 32 bits wide, even if one or more the components specified in the instruction is shorter. These are always sign-extended to the full 32-bit width.

The charm of the addressing lies in the fact that almost all instructions (naturally with exceptions), both the source and destination operands, can be specified with one of the addressing modes. This means that even memory operations do not necessarily have to use one of the registers; memory-to-memory operations are possible.

In the assembler syntax, the source operand is given first, followed by the destination operand (behind the comma).

Register Direct

The operand is located in a register. There are two kinds of register direct addressing: data register direct and address register direct.

In the first case, the operand may be bit, byte, word, or long word-oriented; in the second case a word or long word is required, in case the address register is the destination of the operation.

Example: `ADD.B D0,D1 or ADDA.W D0,A2`

Absolute Data Addressing

The operand is located in the address space of memory. This can also be a peripheral component, naturally (see `MOVEP`). The address is specified in absolute form.

This can have a width of a a long word, whereby the entire address space can be accessed, or it can be only one word wide. In this case is sign-extended (the sign being the highest-order bit) to 32 bits. For example, the word $7FFF becomes the long word $00007FFF, while $FFFF becomes $FFFFFFFF. Only the lower 32K and the upper 32K of the address space can be accessed with the short form. This addressing mode is often used in the operating system of the ST because important system variables are stored low in memory and all peripheral components are decoded at the top.

Example: `MOVE.L $7FFF,$01234567`

Instructions in which both operands are addressed with a long word are the longest instructions in the set, consisting of 10 bytes.

Program Counter Relative Addressing

This addressing mode allows even constants to be addressed in a completely relocatable program, since the base of the address calculation is the current state of the program counter.

The are two variations. In the first, a 16-bit signed offset is added to the program counter, and in the second, the contents of a register (sign-extended if only one word is specified) are also added in, though here the offset may be only 8 bits long.

Example: `MOVE.B $1234(PC),$12(PC,D0.W)`

Register Indirect Addressing

There are several variations of this, and they will be discussed individually.

Register Indirect

Here the operand address is located in an address register.

Example: `CLR.L (A0)`

Postincrement Register Indirect

The operand is addressed as above, but the contents of the address register are then incremented by the length of the operand, by 1 for xxx.B or 4 for xxx.L.

Example: `BSET.B #0,(A0)+` or `BCLR.L #23,(A1)+`

Predecrement Register Indirect

Here the address register is decrement by the length of the operand before the addressing.

Example: `EOR.L D0,$1234(A4)`

Indexed Register Indirect with Offset

As above, but the contents of another register (address or data) are also added in, taking the sign into account. The offset may have a width of 8 bits here, however.

Example: `MOVE.W $12(A5,A6.L),D1`

Immediate Addressing

Here the operand is contained as such in the instruction itself. Naturally, an operand specified in this manner can serve only as a source. The immediate operands can, as a general rule, be any of the allowed widths.

Example: `ADDI.W #$1234,D5`

In the variant QUICK, the constant may be only 3 bits long, therefore having a value from 0-7. An exception is the MOVE command, where the constant may have 8 bits, but in which only a data register is allowed as the destination.

Example: `ADDQ.L #1,A0 or MOVEQ #123,D1`

Implied Register

This addressing mode is mentioned only for the sake of completeness and in it, an operand address is already determined by the instruction itself. The operands are either in the program counter, in the status register, or the system stack pointer.

Example: `MOVE SR,D6`

Regarding the offsets, it should be noted that they are signed numbers in two's complement. Their highest-order bit forms the sign. With an 8-bit value, an offset of +127/-128 is possible, and about ±32K with 16 bits.

3.8.2 The instructions

In the following instruction description, the individual bit patterns are not listed since this would lead to far in this connection. Additonal information can be gathered from books like the *M68000 16/32-Bit Microprocessor Programmer's Reference Manual* (Motorola).

The instructions are also explained only in their base form and variations are mentioned only in name. We will briefly explain what the individual variations can look like here.

The variations are indicated by letter after the operand. This can be one of the following:

A indicates that the destination of the operation is an address register. Word operations are sign-extended to 32 bits.

I indictaes an immediate operand as the source of the operation. I operands may assume all widths as a general width.

Q means quick and represents a special form of immediate addressing. Such an operand is usually three bits wide, corresponding to a value range of 0 to 7. This limited range has the advantage that the operand will fit into the opcode. Since there is no special command for incrementing a register, something like ADDQ.L #1,A0 works well in its place. An exception is MOVEQ. Here the operand may have a value of 0-255.

X indicates arithmetic operations which use the X flag. This flag has a special significance. It is set equal to the carry flag for all arithmetic operations. The carry flag, however, is also affected by transfer operations while the X flag is not so that it remains available for further calculations. This is especially useful for computations with higher precision than the standard 32 bits, where temporary results must first be saved, and where the carry flag can be changed as a result.

All instructions have a suffix after the opcode of the form .B, .W, or .L. This suffix indicates the processing width of the operation. Although a data register, for example, has a width of 32 bits = 4 bytes = 1 long word, the instruction CLR.B D0 clears only the lowest-order byte of the register. For registers, .W specifies the lower word. The higher-order word is not

explicitly addressable. If the operand is in memory, it is imporant to know that .W and .L operands must begin on an even address. The same applies for the opcode as such, which also always comprises one word.

If the destination of an operation is an address register, only operands of type .W and .L are allowed, whereby the first is sign-extended to a long word.

Some listings contain instructions of the form MOVE.L #27,D0. The programmer then assumes that the assembler will produce #$0000001B from #27.

Now to the individual instructions:

ABCD Add Decimal with Extend
There is one data format which we have not yet discussed: the BCD format. This means nothing more than "Binary-Coded Decimal" and it uses digits in the range 0-9. Since this information requires only 4 bits, a byte can store a two-digit decimal number. The instruction ABCD can then add two such numbers. The processing width is always 8 bits.

ADD Add Binary
This instruction simply adds two operands.
Variations are *ADDA, ADDQ, ADDI,* and *ADDX.*

AND Logical AND
Two operand are logically combined with each other according the AND function.
Variation: ANDI

ASL Arithmetic Shift Left
The operand is shifted to the left byte by the number of positions given, whereby the highest-order bit is copied into the C and X flags. A 0 is shifted in at the right. If a data register is shifted, the processing width can be any. The number of places to be shifted is either specified as an I operand (3 bits) or is placed in an additional register. If a memory location is shifted, the processing width is always one word. A counter is then not given; it is always =1.

ASR Arithmetic Shift Right
The operand is shifted to the right, whereby the lowest bit is copied to C and X. The sign bit is shifted over from the left. See ASL for information about processing width and counter.

Bcc Branch Conditionally

The branch destination is always a relative address which is either one byte or one word long (signed!). Correspondingly, the branch can jump over a range of +127/-128 bytes or +32K-1/-32K. The point of reference is the address of the following instruction.

Whether or not this instruction is actually executed depends on the required condition, which is verified by means of the flags. Here are the variations and their conditions. A minus sign before a flag indicates that it must be cleared to satisdy the condition. Logical operations are indicated with "*" for AND and "/" for OR.

BRA	Branch Always	no condition
BCC	Branch Carry Clear	-C
BCS	Branch Carry Set	C
BEQ	Branch Equal	Z
BGE	Brangh Greater or Equal	N*V/-N*-V
BGT	Branch Greater Than	N*V*-Z/-N*-V*-Z
BHI	Branch Higher	-C*-Z
BLE	Branch Less or Equal	Z/N*-V/-N*V
BLS	Branch Lower or Same	C/Z
BLT	Branch Less Than	N*-V/-N*V
BMI	Branch Minus	N
BNE	Branch Not Equal	-Z
BPL	Branch Plus	-N
BVC	Branch Overflow Clear	-V
BVS	Branch Overflow Set	V

BCHG Bit Test and Change

The specified bit of the operand will be inverted. The original state can be determined from the Z flag. The operand is located either in memory (width=.B) or in a data register (width=.L). The bit number is given either as an I operand or is located in a data register.

BCLR Bit Test and Clear

The specified bit is cleared. Everything else is handled as per BCHG.

BSET Bit Test and Set

The specified bit is set. Boundary conditions are per BCHG.

BSR Branch to Subroutine

This is an unconditional branch to a subroutine. Branch distances as for Bcc.

BTST Bit Test
The bit is only checked as to its condition. Everything else as per BCHG.

CHK Check Register Against Boundaries
A data register is checked to see if its contents are less than zero or greater than the operand. Should this be the case, the processor executes an exception. The program is continued at the address in memory location $18 (vector 6). Otherwise no action is taken. The processing width is only word.

CLR Clear Operand
The specified operand is cleared (set to zero).

CMP Compare
The first operand is subtracted from the second without changing either of the two operands. Only the flags are set, according to the result.
Variations: *CMPA* and *CMPI*
Both operands are addresses with the addressing mode (Ax)+ with the variant CMPM.

DBcc Test Condition, Decrement and Branch
A data register is decremented and the flags are checked for the specified condition. A branch is performed if either the condition is fulfilled or the register is -1. Branch conditions and ranges as per Bcc.

DIVS Divide Signed
The second operand is divided by the first operand, taking the sign into account. Afterwards the second operand contains the integer quotient in the lower word and the remainder in the upper word, which has the same sign as the quotient. The data width of the first operand is set at .W and at .L for the second.

DIVU Divide Unsigned
Operation as above, but the sign is ignored.

EOR Exclusive OR
The two operands are logically combined according to the rules of EXOR.
Variations: *EORI*

EXG Exchange Registers
The two registers specified are exchanged with each other.

EXT Sign Extend
The operand is filled to the given processing width with its bit 7 (in the case of .B) or bit 15 (.W).

JMP Jump
Unconditional jump to the specified address. The difference between this and BRA is that here the address is not relative but absolute, that is, the actual jump destination.

JSR Jump to Subroutine
Jump to a subroutine. The difference from BSR is as above.

LEA Load Effective Address
This often-misunderstood instruction loads an address register not with the contents of the specified operand address as is normal for the other instructions, but *with the address as such*!

LINK Link Stack
This instruction first places the given address register on the stack. The contents of the stack pointer (A7) are then placed in this register and the offset specified is added to the stack pointer.

With this practical instruction, data areas can be reserved for a subroutine, without having to make room in the program itself, which would also be impossible in programs which run in ROM. The C-compiler makes extensive use of this capability for local variables.

LSL Logical Shift Left
Function and limitations as per ASL.

LSR Logical Shift Right
Function and limitations as per ASR, except here the sign is not shifted in on the left, but a 0.

MOVE
The first operand is transferred to the second.
Variations: *MOVEA, MOVEQ*

MOVEM Move Mulitple Registers
Here an operand can consist of a list of registers. This can be used to place all of the registers on the stack, for instance.
Example: MOVEM.L A0-A6/D0-D7,-(A7)

MOVEP Move Peripheral Data
This speciality is made expressly for the operation of peripheral components. As a general rule, these work only with an 8-bit data bus, and are are then connected only to the upper or lower 8 bits of the 68000's data bus. If a word or long word is to be transferred, the bytes must be passed over either the upper or lower byte of the data bus, depending on whether the address is even or odd. The address is then always incremented by two so that the transfer always continues on the same half of the data bus on which it was begun. Corresponding to the purpose of this instruction, one operand is always a data register, and the other is always of type register indirect with offset.

MULS Multiply Signed
Signed multiplication of two operands.

MULU Multiply Unsigned
Multiplication of two operands, ignoring the sign.

NBCD Negate Decimal with Extend
A BCD operand is subjected to the operation 0-operand X.

NEG Negate Binary
The operand is subjected to the treatment 0-operand.
Variations: *NEGX*

NOP No Operation
As the name says, this instruction doesn't do anything.

NOT One's Complement
The operand is inverted.

OR Logical OR
The two operands are combined according to the rule for logical OR.

PEA Push Effective Address
The address itself, not its contents, is placed on the stack.

RESET Reset External Devices
The reset line on the 68000 is bidirectional. Not only can the processo. be externally reset, but it can also use this instruction to reset all of the peripheral devices connected to the reset line.
This is a priviledged instruction!

ROL Rotate Left
The operand is shifted to the left, whereby the bit shifted out on the left will be shifted back in on the right and the carry flag is affected. Processing widths and shift counter as per ASL.

ROR Rotate Right
As above, but shift from left to right.

ROXL Rotate Left with Extend
As ROL, but the shifted bit is first placed in the X flag, the previous value of which is shifted in on the right.

ROXR Rotate Right with Extend
As above, but reversed shift direction.

RTE Return from Exception
Return from an exception routine to the location at which the exception occurred.

RTS Return from Subroutine
Return froma subroutine to the location at which it was called.

RTR Return and Restore
As above, but the CC register (the one with the flags) is first fetched from the stack (on which it *must* have first been placed, because otherwise execution will not return to the proper address.

SBCD Subtract Decimal with Extend
The first operand is subtracted from the second. Refer to ABCD for information on the data format.

Scc Set Conditionally
The operand (only .B) is set to $FF if the condition is fulfilled. Otherwise it is cleared. Refer to Bcc for the possible condition codes.

STOP
The processor is stopped and can only be called back to life through an external interrupt.
This is a priviledged instruction!

SUB Subtract Binary
The first operand is subtracted from the second.

SWAP Swap Register Halves
The two halves of a data register are exchanged with each other.

TAS Test and Set Operand
The operand (only .B) is checked for sign and 0 (affecting the C and N flags). Bit 7 is then set to 1.

TRAP
The applications programmer uses this instruction when he wants to call functions of the operating systems. This instruction generates an exception, which consists of continuing the program at the address determined by the given vector number. See the chapter on the BIOS and XBIOS for the use of this instruction.

TRAPV Trap on Overflow
If the V flag is set, an exception is generated by this instruction, resulting in program execution continuing at the address in vector 7 ($1C).

TST Test
Action like TAS, but the operand is not changed.

UNLK Unlink
This instruction is the counterpart of LINK. The stack pointer (A7) is loaded with the given address register and this is supplied with the last stack entry. In this manner the area reserved with LINK is released.

Addendum to the condition codes: The conditions listed under Bcc are not complete, because the additional conditions do not make sense at that point. But the instrutions DBcc and Scc have the additional variations T (DBT, ST) and F (DBF, SF). T stands for true and means that the condition is always fulfilled. F stands for false and is the opposite: the condition is never fulfilled.

```
*****************************************************
005000 601C                     bra     $501E           ATARI ST BIOS
005002 0100                     dc.b    1,0             To program start
005004 0000501E                 dc.l    $501E           Version 1
005008 00005000                 dc.l    $5000           Reset address
00500C 00019C00                 dc.l    $19C00          Start of the operating system
005010 0000501E                 dc.l    $501E           End of the operating system
005014 00019BF4                 dc.l    $19BF4          Reset address
005018 06201985                 dc.l    $06201985

00501C 0000                     dc.w    0               Creation date 6/20/1985
00501E 46FC2700                 move.w  #$2700,SR       Supervisor mode, no interrupts
005022 23F90000501E0000042A     move.l  $501E,$42A      Load resvector
00502C 23FC3141592600000426     move.l  #$31415926,$426 Resmagic to resvalid
005036 41F9FFFF8800             lea     $FFFF8800,A0    Address of the sound chip
00503C 10BC0007                 move.b  #7,(A0)         Port A and B
005040 117C00C00002             move.b  #$C0,2(A0)      To output
005046 10BC000E                 move.b  #$E,(A0)        Select port A
00504A 117C00070002             move.b  #7,2(A0)        Deselect floppies
005050 083A0000FFC8             btst    #0,$501A(PC)
005056 6708                     beq     $5060
005058 13FC0002FFFF820A         move.b  #2,$FFFF820A    Syncmode
005060 43F9FFFF8240             lea     $FFFF8240,A1    Address color0
005066 303C000F                 move.w  #$F,D0          16 colors
00506A 41FA03B0                 lea     $541C(PC),A0    Address of the color table
00506E 32D8                     move.w  (A0)+,(A1)+     Load color palette
005070 51C8FFFC                 dbra    D0,$506E        Next color
005074 9BCD                     sub.l   A5,A5           Clear A5
005076 307C05FC                 move.w  #$5FC,A0        End of the operating system variables
00507A 327C5000                 move.w  #$5000,A1       Start of the operating system
00507E 7000                     moveq.l #0,D0           Clear D0
005080 30C0                     move.w  D0,(A0)+        Clear memory range
005082 B3C8                     cmp.l   A0,A1           End reached ?
```

```
005084 66FA              bne      $5080
005086 206D042E          move.l   $42E(A5),A0
00508A 91FC00008000      sub.l    #$8000,A0
005090 2B48044E          move.l   A0,$44E(A5)
005094 13ED044FFFFF8201  move.b   $44F(A5),$FFFF8201
00509C 13ED0450FFFF8203  move.b   $450(A5),$FFFF8203
0050A4 323C07FF          move.w   #$7FF,D1
0050A8 20C0              move.l   D0,(A0)+
0050AA 20C0              move.l   D0,(A0)+
0050AC 20C0              move.l   D0,(A0)+
0050AE 20C0              move.l   D0,(A0)+
0050B0 51C9FFF6          dbra     D1,$50A8
0050B4 207AFF5E          move.l   $5014(PC),A0
0050B8 0C9087654321      cmp.l    #$87654321,(A0)
0050BE 6704              beq      $50C4
0050C0 41FAFF46          lea      $5008(PC),A0
0050C4 23E80004000004FA  move.l   4(A0),$4FA
0050CC 23E80008000004FE  move.l   8(A0),$4FE
0050D4 2B7C00005AE8046A  move.l   #$5AE8,$46A(A5)
0050DC 2B7C00005D880476  move.l   #$5D88,$476(A5)
0050E4 2B7C00005B6E0472  move.l   #$5B6E,$472(A5)
0050EC 2B7C00005D1E047E  move.l   #$5D1E,$47E(A5)
0050F4 2B7C000060B2047A  move.l   #$60B2,$47A(A5)
0050FC 2B6D044E0436      move.l   $44E(A5),$436(A5)
005102 2B6D04FA0432      move.l   $4FA(A5),$432(A5)
005108 4FF900003E2A      lea      $3E2A,A7
00510E 3B7C00080454      move.w   #8,$454(A5)
005114 50ED0444          st       $444(A5)
005118 3B7C00030440      move.w   #3,$440(A5)
00511E 2B7C000012BC04C6  move.l   #$12BC,$4C6(A5)
005126 3B7CFFFF04EE      move.w   #$FFFF,$4EE(A5)
00512C 2B7C0000500004F2  move.l   #$5000,$4F2(A5)
```

```
No
Phystop, end of RAM
Minus 32 K
As video address v bs ad
Dbaseh, video address for hardware
Dbasel
($7FF+1)*16 = 32 K video RAM


Clear screen

Next 16 K bytes



End os
Exec os
Hdv init
Hdv rw
Hdv bpb
Hdv mediach
Hdv boot
V bs ad as memory top
End os as memory bottom
Initialize stack pointer
Nvbls, number of VBL routines
Fverify, Floppy Verify after write
Seekrate for floppy to 3 ms
Dskbufp to $12BC, disk buffer
Clear dumpflg for hardcopy
Sysbase, start of the operating system
```

```
005134 2B7C000005FC04A2      move.l  #$5FC,$4A2(A5)          Savptr for TRAPs to $5FC
00513C 2B7C00005328046E      move.l  #$5328,$46E(A5)         Hdv dsb auf rts
005144 47FA03FC              lea     $5542(PC),A3            Pointer to rte
005148 49FA01DE              lea     $5328(PC),A4            Pointer to rts
00514C 0CB9FA52235F00FA0000  cmp.l   #$FA52235F,$FA0000      Cartbase, Diagnostic cartrige inserted?
005156 6726                  beq     $517E                   Yes, don't initialize vectors
005158 43FA06DE              lea     $5838(PC),A1            Terminate process
00515C D3FC02000000          add.l   #$2000000,A1            Vector number is in bits 24-31
005162 41F900000008          lea     $8,A0                   Start with bus error
005168 303C003D              move.w  #$3D,D0                 Number of vectors
00516C 20C9                  move.l  A1,(A0)+                Set vector
00516E D3FC01000000          add.l   #$1000000,A1            Increment number in bits 24-31
005174 51C8FFF6              dbra    D0,$516C                Next vector
005178 23CB00000014          move.l  A3,$14                  'Division by zero' to rte
00517E 2B7C000054520070      move.l  #$5452,$70(A5)          Vertical Blank Interrupt, IPL4
005186 2B7C0000543C0068      move.l  #$543C,$68(A5)          Horizontal Blank Interrupt, IPL2
00518E 2B4B0088              move.l  A3,$88(A5)              TRAP #2 to rte
005192 2B7C0000556C00B4      move.l  #$556C,$B4(A5)          TRAP #13 vector
00519A 2B7C0000556600B8      move.l  #$5566,$B8(A5)          TRAP #14 vector
0051A2 2B7C0000EB9A0028      move.l  #$EB9A,$28(A5)          LINE A vector
0051AA 2B4C0400              move.l  A4,$400(A5)             Etv timer to rts
0051AE 2B7C000055620404      move.l  #$5562,$404(A5)         Etv critic vector
0051B6 2B4C0408              move.l  A4,$408(A5)             Etv term to rts
0051BA 41ED04CE              lea     $4CE(A5),A0             Vbl list
0051BE 2B480456              move.l  A0,$456(A5)             As pointer to vblqueue
0051C2 303C0007              move.w  #7,D0                   8 vectors
0051C6 4298                  clr.l   (A0)+                   Clear list
0051C8 51C8FFFC              dbra    D0,$51C6                Next vector
0051CC 61001D14              bsr     $6EE2                   Initialize MFP
0051D0 7002                  moveq.l #2,D0                   Bit number
0051D2 6100012A              bsr     $52FE                   Cart scan, test cartridge
0051D6 9BCD                  sub.l   A5,A5                   Clear A5
```

```
0051D8 6100036A             bsr     $5544
0051DC 61000366             bsr     $5544
0051E0 103C0002             move.b  #2,D0
0051E4 08390007FFFFFA01     btst    #7,$FFFFFA01
0051EC 670C                 beq     $51FA
0051EE 102D044A             move.b  $44A(A5),D0
0051F2 B03C0002             cmp.b   #2,D0
0051F6 6D02                 blt     $51FA
0051F8 4200                 clr.b   D0
0051FA 1B40044C             move.b  D0,$44C(A5)
0051FE 13C0FFFF8260         move.b  D0,$FFFF8260
005204 B03C0001             cmp.b   #1,D0
005208 660A                 bne     $5214
00520A 33F9FFFF825EFFFF8246 move.w  $FFFF825E,$FFFF8246
005214 4EB90000F6C4         jsr     $F6C4
00521A 2B7C0000501E046E     move.l  #$501E,$46E(A5)
005222 33FC000100000452     move.w  #1,$452
00522A 4240                 clr.w   D0
00522C 610000D0             bsr     $52FE
005230 46FC2300             move.w  #$2300,SR
005234 7001                 moveq.l #1,D0
005236 610000C6             bsr     $52FE
00523A 61004234             bsr     $9470
00523E 610000B0             bsr     $52F0
005242 4A7900000482         tst.w   $482
005248 6718                 beq     $5262
00524A 61003C64             bsr     $8EB0
00524E 610006FE             bsr     $594E
005252 487A0099             pea     $52ED(PC)
005256 487A0095             pea     $52ED(PC)
00525A 487A007E             pea     $52DA(PC)
00525E 4267                 clr.w   -(A7)
```

```
Wvbl, wait for next picture return
Wvbl, wait for next picture return
Default resolution to monochrome
Test MFP gpip monochrome detect
No monochrome monitor ?
Get defshiftmd
Color mode ?
Yes
Otherwise select low resolution
Save sshiftmd
Shiftmd, program shifter
Medium resolution ?
No
Copy color 15 (black) to color 3
Initialize screen output
Hdv dsb
Vblsem, free VBL
Bit number 0
Cartscan, test cartridge
IPL to 3
Bit number 1
Cartscan, test cartridge
Initialize DOS
Dskboot
Cmdload, load shell from disk ?
No
Enable cursor
Auto exec
Null name
Null name
'COMMAND.PRG'
```

```
005260 605C                    bra     $52BE
005262 610006EA                bsr     $594E
005266 41FA0066                lea     $52CE(PC),A0
00526A 327C0502                move.w  #$502,A1
00526E 0C100023                cmp.b   #35,(A0)        '#' drive indicator ?
005272 6602                    bne     $5276           No
005274 2449                    move.l  A1,A2           Address of the drive indicator
005276 12D8                    move.b  (A0)+,(A1)+     Copy drive number
005278 6AF4                    bpl     $526E           Copy entire string
00527A 103900000446            move.b  $446,D0         Bootdev
005280 D03C0041                add.b   #$41,D0         'A', calculate drive number
005284 1480                    move.b  D0,(A2)         Insert in filename
005286 487900000502            pea     $502            Enviroment string
00528C 4879000052ED            pea     $52ED           Null name
005292 487A0059                pea     $52ED(PC)       Null name
005296 3F3C0005                move.w  #5,-(A7)
00529A 3F3C004B                move.w  #$4B,-(A7)      Exec, load program
00529E 4E41                    trap    #1              GEMDOS call
0052A0 DEFC000E                add.w   #$E,A7          Correct stack pointer
0052A4 2040                    move.l  D0,A0           Save base page address
0052A6 2179000004FE0008        move.l  $4FE,8(A0)      Exec os
0052AE 487900000502            pea     $502
0052B4 2F08                    move.l  A0,-(A7)
0052B6 487A0035                pea     $52ED(PC)
0052BA 3F3C0004                move.w  #4,-(A7)
0052BE 3F3C004B                move.w  #$4B,-(A7)      Exec, load program
0052C2 4E41                    trap    #1              GEMDOS call
0052C4 DEFC000E                add.w   #$E,A7          Correct stack
0052C8 4EF90000501E            jmp     $501E           If return, then Reset
0052CE 504154483D00            dc.b    'PATH=',0:1=92
0052D4 233A5C00FF              dc.b    '#:1',0,$FF
0052DA 434F4D4D414E442E5052    dc.b    'COMMAND.PRG',0
```

```
0052E4 4700
0052E6 47454D2E505247          dc.b    'GEM.PRG'

0052ED 000000                  dc.b    0,0,0

*************************************************      Dskboot, boot from disk
0052F0 7003                    moveq.l #3,D0           Bit number 3
0052F2 610A                    bsr     $52FE           Test cartridge
0052F4 20790000047A            move.l  $47A,A0         Hdv boot, load boot vector
0052FA 4E90                    jsr     (A0)            And start attempt
0052FC 4E75                    rts

*************************************************      Test cartridge
0052FE 41F900FA0000            lea     $FA0000,A0      Cartbase
005304 0C98ABCDEF42            cmp.l   #$ABCDEF42,(A0)+ User cartridge inserted ?
00530A 661A                    bne     $5326           No
00530C 01280004                btst    D0,4(A0)        Initialization ?
005310 670E                    beq     $5320           No
005312 48E7FFFE                movem.l D0-D7/A0-A6,-(A7) Save registers
005316 20680004                move.l  4(A0),A0        Address of the init routine
00531A 4E90                    jsr     (A0)            Perform initialization
00531C 4CDF7FFF                movem.l (A7)+,D0-D7/A0-A6 Restore registers
005320 4A90                    tst.l   (A0)            Additional application in cartridge ?
005322 2050                    move.l  (A0),A0         Get link address
005324 66E6                    bne     $530C           Initialization next application
005326 4E75                    rts

*************************************************
005328 4E75                    rts                     Default vector

*************************************************      Memory test
00532A D1C1                    add.l   D1,A0           Add offset to base address
```

```
00532C 4240              clr.w   D0              Clear test pattern
00532E 43E801F8          lea     $1F8(A0),A1     End address of the test
005332 B058              cmp.w   (A0)+,D0        Test memory contents
005334 6608              bne     $533E           Unequal, terminate
005336 D07CFA54          add.w   #$FA54,D0       Create next test pattern
00533A B3C8              cmp.l   A0,A1           End address reached ?
00533C 66F4              bne     $5332           No, continue test
00533E 4ED5              jmp     (A5)            Back to the calling address

*****************************************************
005340 9BCD              sub.l   A5,A5
005342 0CAD752019F30420  cmp.l   #1965038067,$420(A5)  Memvalid
00534A 6608              bne     $5354
00534C 0CAD237698AA043A  cmp.l   #594974890,$43A(A5)   Memval2
005354 4ED6              jmp     (A6)

*****************************************************
005356 00000000
00535A 00000000
00535E 00000000
005362 00000000

*****************************************************
005366 1839FFFF8260      move.b  $FFFF8260,D4    Shiftmd, Get video resolution
00536C C87C0003          and.w   #3,D4           Isolate bits 0 and 1
005370 D844              add.w   D4,D4           Double value for word table
005372 B1FC00008000      cmp.l   #$8000,A0
005378 6220              bhi     $539A
00537A B1FC00000000      cmp.l   #0,A0
005380 6604              bne     $5386
005382 307B4086          move.w  $530A(PC,D4.w),A0
005386 4280              clr.l   D0
```

```
005388 1039FFFF8201          move.b  $FFFF8201,D0        Dbaseh
00538E E148                  lsl.w   #8,D0
005390 1039FFFF8203          move.b  $FFFF8203,D0        Dbasel
005396 E188                  lsl.l   #8,D0
005398 D1C0                  add.l   D0,A0
00539A 7E0F                  moveq.l #15,D7
00539C 3C3B4078              move.w  $5416(PC,D4.w),D6
0053A0 3605                  move.w  D5,D3
0053A2 2448                  move.l  A0,A2
0053A4 D4FB406A              add.w   $5410(PC,D4.w),A2
0053A8 1011                  move.b  (A1),D0
0053AA 4BFA0004              lea     $53B0(PC),A5
0053AE 6042                  bra     $53F2
0053B0 3202                  move.w  D2,D1
0053B2 10290001              move.b  1(A1),D0
0053B6 4BFA0004              lea     $53BC(PC),A5
0053BA 6036                  bra     $53F2
0053BC 3011                  move.w  (A1),D0
0053BE 4EFB4002              jmp     $53C2(PC,D4.w)
0053C2 6004                  bra     $53C8               Low resolution
0053C4 600C                  bra     $53D2               Medium resolution
0053C6 6014                  bra     $53DC               High resolution

****************************************************     Low resolution
0053C8 30C0                  move.w  D0,(A0)+
0053CA 30C0                  move.w  D0,(A0)+
0053CC 30C0                  move.w  D0,(A0)+
0053CE 30C0                  move.w  D0,(A0)+
0053D0 600E                  bra     $53E0

****************************************************     Medium resolution
0053D2 30C1                  move.w  D1,(A0)+
```

```
0053D4 30C1                move.w  D1,(A0)+
0053D6 30C2                move.w  D2,(A0)+
0053D8 30C2                move.w  D2,(A0)+
0053DA 6004                bra     $53E0

*************************************************     High resolution
0053DC 30C1                move.w  D1,(A0)+
0053DE 30C2                move.w  D2,(A0)+
0053E0 51CBFFC6            dbra    D3,$53A8
0053E4 204A                move.l  A2,A0
0053E6 51CEFFB8            dbra    D6,$53A0
0053EA 5449                addq.w  #2,A1
0053EC 51CFFFAE            dbra    D7,$539C
0053F0 4ED6                jmp     (A6)
0053F2 2643                move.l  D3,A3
0053F4 7400                moveq.l #0,D2
0053F6 7607                moveq.l #7,D3
0053F8 E310                roxl.b  #1,D0
0053FA 40E7                move.w  SR, -(A7)          Save carry flag
0053FC E352                roxl.w  #1,D2
0053FE 46DF                move.w  (A7)+,SR           Restore carry flag
005400 E352                roxl.w  #1,D2
005402 51CBFFF4            dbra    D3,$53F8
005406 260B                move.l  A3,D3
005408 4ED5                jmp     (A5)               Back to call

*************************************************
00540A 3EC8                dc.w    16072
00540C 3EC8                dc.w    16072
00540E 3EA4                dc.w    16036
005410 00A0                dc.w    160
005412 00A0                dc.w    160
```

```
005414 0050                dc.w    80
005416 0000                dc.w    0
005418 0000                dc.w    0
00541A 0001                dc.w    0

************************************************  Color palatte
00541C 0777                dc.w    $777           White
00541E 0700                dc.w    $700           Red
005420 0070                dc.w    $070           Green
005422 0770                dc.w    $770           Yellow
005424 0007                dc.w    $007           Blue
005426 0707                dc.w    $707           Magenta
005428 0077                dc.w    $077           Blue-green
00542A 0555                dc.w    $555           Light grey
00542C 0333                dc.w    $333           Grey
00542E 0733                dc.w    $733           Light red
005430 0373                dc.w    $373           Light green
005432 0773                dc.w    $773           Light yellow
005434 0337                dc.w    $337           Light blue
005436 0737                dc.w    $737           Light magenta
005438 0377                dc.w    $377           Light blue-gree
00543A 0000                dc.w    $000           black

************************************************  HBL interrupt
00543C 3F00                move.w  D0,-(A7)       Save D0
00543E 302F0002            move.w  2(A7),D0       Get status from stack
005442 C07C0700            and.w   #$700,D0       Isolate IPL mask
005446 6606                bne     $544E          Not equal to zero ?
005448 006F03000002        or.w    #$300,2(A7)    Otherwise IPL tp 3
00544E 301F                move.w  (A7)+,D0       Restore D0
005450 4E73                rte
```

```
************************************************  VBL interrupt
005452 52B900000466          addq.l  #1,$466      Increment frclock
005458 537900000452          subq.w  #1,$452      Vblsem
00545E 6B0000DC              bmi     $553C        VBL interrupt disabled ?
005462 48E7FFFE              movem.l D0-D7/A0-A6,-(A7)  Save registers
005466 52B900000462          addq.l  #1,$462      Increment vbclock erh\hen
00546C 9BCD                  sub.l   A5,A5        Clear A5
00546E 1039FFFF8260          move.b  $FFFF8260,D0 Load shiftmd
005474 C03C0003              and.b   #3,D0
005478 B03C0002              cmp.b   #2,D0        High resolution ?
00547C 6C10                  bge     $548E        Yes
00547E 08390007FFFFFA01      btst    #7,$FFFFFA01 Mfp gpip, monochrome detect
005486 662C                  bne     $54B4        No color monitor
005488 103C0002              move.b  #2,D0        High resolution
00548C 6016                  bra     $54A4
00548E 08390007FFFFFA01      btst    #7,$FFFFFA01 Mfp gpip, monochrome detect
005496 671C                  beq     $54B4        Monochrome monitor ?
005498 102D044A              move.b  $44A(A5),D0  Defshiftmd, get color resolution
00549C B03C0002              cmp.b   #2,D0        Monochrome ?
0054A0 6D02                  blt     $54A4        No
0054A2 4200                  clr.b   D0           Else low resolution
0054A4 1B40044C              move.b  D0,$44C(A5)  Save sshiftmd
0054A8 13C0FFFF8260          move.b  D0,$FFFF8260 Shiftmd, program shifter
0054AE 206D046E              move.l  $46E(A5),A0  Vector for resolution change
0054B2 4E90                  jsr     (A0)         Execute routine
0054B4 61003B42              bsr     $8FF8        Flash cursor
0054B8 9BCD                  sub.l   A5,A5        Clear A5
0054BA 4AAD045A              tst.l   $45A(A5)     Colorptr, reload color palette ?
0054BE 6718                  beq     $54D8        No
0054C0 206D045A              move.l  $45A(A5),A0  Colorptr, address of the new palette
0054C4 43F9FFFF8240          lea     $FFFF8240,A1 Color0, address in the video shifter
0054CA 303C000F              move.w  #$F,D0       16 colors
```

```
0054CE 32D8          move.w   (A0)+,(A1)+      Copy
0054D0 51C8FFFC      dbra     D0,$54CE         Next color
0054D4 42AD045A      clr.l    $45A(A5)         Clear colorptr again
0054D8 4AAD045E      tst.l    $45E(A5)         Screenpt, new video address ?
0054DC 671A          beq      $54F8            No
0054DE 2B6D045E044E  move.l   $45E(A5),$44E(A5) Copy screenpt tp v bs ad
0054E4 202D044E      move.l   $44E(A5),D0      V bs ad
0054E8 E048          lsr.w    #8,D0            Bits 8-15
0054EA 13C0FFFF8203  move.b   D0,$FFFF8203     To dbasel
0054F0 E048          lsr.w    #8,D0            Bits 16-24
0054F2 13C0FFFF8201  move.b   D0,$FFFF8201     To dbaseh
0054F8 610011EA      bsr      $66E4            VBL routine for floppies
0054FC 3E3900000454  move.w   $454,D7          Nvbls, number of VBL routines
005502 6720          beq      $5524            No vectors ?
005504 5387          subq.l   #1,D7            Convert to dbra counter
005506 207900000456  move.l   $456,A0          Address of the vblqueue
00550C 2258          move.l   (A0)+,A1         Get vector
00550E B3FC00000000  cmp.l    #$0,A1           Zero ?
005514 670A          beq      $5520            Don't execute routine
005516 48E70180      movem.l  D7/A0,-(A7)      Save registers
00551A 4E91          jsr      (A1)             Execute routine
00551C 4CDF0180      movem.l  (A7)+,D7/A0      Restore registers
005520 51CFFFEA      dbra     D7,$550C         Test next vector
005524 9BCD          sub.l    A5,A5            Clear A5
005526 4A6D04EE      tst.w    $4EE(A5)         Dumpflg, hardcopy desired ?
00552A 660C          bne      $5538            No
00552C 61000532      bsr      $5A60            Hardcopy
005530 33FCFFFF000004EE move.w #$FFFF,$4EE     Clear dumpflg again
005538 4CDF7FFF      movem.l  (A7)+,D0-D7/A0-A6 Restore registers
00553C 527900000452  addq.w   #1,$452          Vblsem, restore VBL again
005542 4E73          rte
```

```
*************************************************       Wvbl, wait for next V-sync
005544 40E7                 move.w  SR, -(A7)           Save status
005546 027CF8FF             and.w   #$F8FF,SR           IPL 0, allow interrupts
00554A 203900000466         move.l  $466,D0             Load frclock
005550 B0B900000466         cmp.l   $466,D0             Frclock
005556 67F8                 beq     $5550               Still equal ?
005558 46DF                 move.w  (A7)+,SR            Restore status
00555A 4E75                 rts

*************************************************       Critical error handler
00555C 2F3900000404         move.l  $404,-(A7)          Etv critic
005562 70FF                 moveq.l #-1,D0
005564 4E75                 rts

*************************************************       TRAP #14
005566 41FA0084             lea     $55EC(PC),A0        Address of the TRAP #14 routines
00556A 6004                 bra     $5570

*************************************************       TRAP #13
00556C 41FA004C             lea     $55BA(PC),A0        Address of the TRAP #13 routines
005570 2279000004A2         move.l  $4A2,A1             Savptr, pointer to save area
005576 301F                 move.w  (A7)+,D0            Status register to D0
005578 3300                 move.w  D0,-(A1)            Save in save area
00557A 231F                 move.l  (A7)+,-(A1)         Save PC
00557C 48E11F1F             movem.l D3-D7/A3-A7,-(A1)   And save C register
005580 23C9000004A2         move.l  A1,$4A2             Update savptr
005586 0800000D             btst    #13,D0              Call from supervisor mode ?
00558A 6602                 bne     $558E               Yes
00558C 4E6F                 move.l  USP,A7              Else use USP
00558E 301F                 move.w  (A7)+,D0            Get function number from stack
005590 B058                 cmp.w   (A0)+,D0            Compare with maximal number
005592 6C10                 bge     $55A4               Too large, stop
```

```
005594 E548                lsl.w   #2,D0
005596 20300000            move.l  0(A0,D0.w),D0
00559A 2040                move.l  D0,A0
00559C 6A02                bpl     $55A0
00559E 2050                move.l  (A0),A0
0055A0 9BCD                sub.l   A5,A5
0055A2 4E90                jsr     (A0)
0055A4 2279000004A2        move.l  $4A2,A1
0055AA 4CD9F8F8            movem.l (A1)+,D3-D7/A3-A7
0055AE 2F19                move.l  (A1)+,-(A7)
0055B0 3F19                move.w  (A1)+,-(A7)
0055B2 23C9000004A2        move.l  A1,$4A2
0055B8 4E73                rte

*************************************************
0055BA 000C                dc.w    12
0055BC 0000572E            dc.l    $572E
0055C0 00005694            dc.l    $5694
0055C4 0000569A            dc.l    $569A
0055C8 000056A6            dc.l    $56A6
0055CC 80000476            dc.l    $476+$80000000
0055D0 0000575A            dc.l    $575A
0055D4 00005772            dc.l    $5772
0055D8 80000472            dc.l    $472+$80000000
0055DC 000056A0            dc.l    $56A0
0055E0 8000047E            dc.l    $47E+$80000000
0055E4 00005716            dc.l    $5716
0055E8 0000571C            dc.l    $571C
```

```
Convert number ot long counter
Get address of the routine
To A0
Bit 31 cleared ?
Else use address indirectly
Clear A5
Execute routine
Get savptr
Restore registers
PC on stack
Status on stack
Update savptr
Back to call

Addresses of the TRAP #13 calls
Number of routines
0, getmpb
1, bconstat
2, bconin
3, bconout
4, (indirect) rwabs
5, setexec
6, tickcal
7, (indirect) getbpb
8, bcostat
9, (indirect) mediach
10, drvmap
11, shift
```

```
*****************************************************
0055EC 0028                dc.w    40
0055EE 00007AC0            dc.l    $7AC0
0055F2 00005328            dc.l    $5328
0055F6 0000577A            dc.l    $577A
0055FA 0000578E            dc.l    $578E
0055FE 00005794            dc.l    $5794
005602 000057A0            dc.l    $57A0
005606 000057EE            dc.l    $57EE
00560A 000057F6            dc.l    $57F6
00560E 000062D2            dc.l    $62D2
005612 000063B0            dc.l    $63B0
005616 00006468            dc.l    $6468
00561A 00005B64            dc.l    $5B64
00561E 00006B74            dc.l    $6B74
005622 00007138            dc.l    $7138
005626 00007440            dc.l    $7440
00562A 00007468            dc.l    $7468
00562E 00007BC6            dc.l    $7BC6
005632 00006062            dc.l    $6062
005636 0000614A            dc.l    $614A
00563A 00006602            dc.l    $6602
00563E 00005A4E            dc.l    $5A4E
005642 00009024            dc.l    $9024
005646 00006AAA            dc.l    $6AAA
00564A 00006A90            dc.l    $6A90
00564E 00007BF2            dc.l    $7BF2
005652 00006CE6            dc.l    $6CE6
005656 00007162            dc.l    $7162
00565A 0000719C            dc.l    $719C
00565E 00007A30            dc.l    $7A30
005662 00007A9A            dc.l    $7A9A
```

Addresses of the TRAP #14 calls
Number of routines
0, initmouse
1, rts
2, physbase
3, logbase
4, getrez
5, setscreen
6, setpalette
7, setcolor
8, floprd
9, flopwr
10, flopfmt
11, getdsb
12, midiws
13, mfpint
14, iorec
15, rsconf
16, keytrans
17, rand
18, protobt
19, flopver
20, dumpit
21, cursconf
22, settime
23, gettime
24, bioskeys
25, ikbdws
26, jdisint
27, jenabint
28, giaccess
29, offgibit

```
005666 00007A74             dc.l    $7A74           30, ongibit
00566A 00007B8A             dc.l    $7B8A           31, xbtimer
00566E 00007C0C             dc.l    $7C0C           32, dosound
005672 00007C20             dc.l    $7C20           33, setprt
005676 00007C54             dc.l    $7C54           34, ikbdvecs
00567A 00007C32             dc.l    $7C32           35, kbrate
00567E 00007D92             dc.l    $7D92           36, prtblk
005682 00005544             dc.l    $5544           37, wvbl
005686 0000568E             dc.l    $568E           38, supexec
00568A 0000581C             dc.l    $581C           39, puntaes

************************************************    supexec, routine in supervisor mode
00568E 206F0004             move.l  4(A7),A0        Get address from stack
005692 4ED0                 jmp     (A0)            Execute routine in supervisor mode

************************************************    bconstat, get input statis
005694 41FA0020             lea     $56B6(PC),A0    Status table
005698 6010                 bra     $56AA

************************************************    bconin, input
00569A 41FA0032             lea     $56CE(PC),A0    Input table
00569E 600A                 bra     $56AA

************************************************    bcostat, get output status
0056A0 41FA0044             lea     $56E6(PC),A0    Status table
0056A4 6004                 bra     $56AA

************************************************    bconout, output
0056A6 41FA0056             lea     $56FE(PC),A0
```

```
**************************************************      Conout
0056AA 302F0004            move.w  4(A7),D0            Get device number
0056AE E548                lsl.w   #2,D0               Times 4
0056B0 20700000            move.l  0(A0,D0.w),A0       Get address of the routine
0056B4 4ED0                jmp     (A0)                Execute routine

**************************************************      Input statis
0056B6 00005328            dc.l    $5328               Rts
0056BA 00006C70            dc.l    $6C70               RS 232 status
0056BE 00006CFA            dc.l    $6CFA               Console status
0056C2 00006B88            dc.l    $6B88               MIDI status
0056C6 00005328            dc.l    $5328               RTS
0056CA 00005328            dc.l    $5328               RTS

**************************************************      Input
0056CE 00006C3C            dc.l    $6C3C               Parallel port
0056D2 00006C86            dc.l    $6C86               RS 232 input
0056D6 00006D10            dc.l    $6D10               Console input
0056DA 00006BA4            dc.l    $6BA4               MIDI input
0056DE 00005328            dc.l    $5328               RTS
0056E2 00005328            dc.l    $5328               RTS

**************************************************      Output status
0056E6 00006C5C            dc.l    $6C5C               Centronics status
0056EA 00006C96            dc.l    $6C96               RS 232 status
0056EE 00006D46            dc.l    $6D46               Console status
0056F2 00006CBA            dc.l    $6CBA               Keyboard status
0056F6 00006B48            dc.l    $6B48               MIDI status
0056FA 00005328            dc.l    $5328               rts
```

```
**************************************************    Output
0056FE 00006BD4             dc.l    $6BD4             Centronics output
005702 00006CAE             dc.l    $6CAE             RS 232 output
005706 00008ADE             dc.l    $8ADE             Console output
00570A 00006B5A             dc.l    $6B5A             MIDI output
00570E 00006CCC             dc.l    $6CCC             Keyboard output
005712 00008AD2             dc.l    $8AD2             ASCII outout

**************************************************    Drvmap, get active floppies
005716 202D04C2             move.l  $4C2(A5),D0       Drvbits, get bit vector
00571A 4E75                 rts

**************************************************    Shift, keyboard status
00571C 7000                 moveq.l #0,D0
00571E 102D0A5D             move.b  $A5D(A5),D0       Kshift, get shift status
005722 322F0004             move.w  4(A7),D1          Get parameters from stack
005726 6B04                 bmi     $572C             Negative, then set
005728 1B410A5D             move.b  D1,$A5D(A5)       Accept as kbshift
00572C 4E75                 rts

**************************************************    Getmpb, Memory Parameter Block
00572E 206F0004             move.l  4(A7),A0          New MPB
005732 43ED048E             lea     $48E(A5),A1       Themd, Memory descriptor
005736 2089                 move.l  A1,(A0)           Mp mfl = address of the MD
005738 42A80004             clr.l   4(A0)             Mp mal = zero
00573C 21490008             move.l  A1,8(A0)          Mp rover = address of the MD
005740 4291                 clr.l   (A1)              Clear m link
005742 236D04320004         move.l  $432(A5),4(A1)    Membot as mstart
005748 202D0436             move.l  $436(A5),D0       Memtop
00574C 90AD0432             sub.l   $432(A5),D0       Minus membot
005750 23400008             move.l  D0,8(A1)          Length as m length
005754 42A9000C             clr.l   12(A1)            M own = zero
```

```
005758 4E75                rts

*************************************************      Setexc, set exception vector
00575A 302F0004            move.w  4(A7),D0            Get vector number
00575E E548                lsl.w   #2,D0               Times 4 equals address
005760 91C8                sub.l   A0,A0               Clear A0
005762 41F00000            lea     0(A0,D0.w),A0       Get address of the old vector
005766 2010                move.l  (A0),D0             Old vector to D0
005768 222F0006            move.l  6(A7),D1            New vector
00576C 6B02                bmi     $5770               Negative, then don't set
00576E 2081                move.l  D1,(A0)             Set vector
005770 4E75                rts

*************************************************      Tickcal, timer value in milliseconds
005772 4280                clr.l   D0
005774 302D0442            move.w  $442(A5),D0         Get timr ms
005778 4E75                rts

*************************************************      Physbase, physical video address
00577A 7000                moveq.l #0,D0
00577C 1039FFFF8201        move.b  $FFFF8201,D0        Dbaseh
005782 E148                lsl.w   #8,D0
005784 1039FFFF8203        move.b  $FFFF8203,D0        Dbasel
00578A E188                lsl.l   #8,D0               Video address in D0
00578C 4E75                rts

*************************************************      Logbase, logical video address
00578E 202D044E            move.l  $44E(A5),D0         Get v bs ad
005792 4E75                rts

*************************************************      Getrez, get video resolution
005794 7000                moveq.l #0,D0
```

```
005796 102D8260          move.b  $FFFF8260(A5),D0    Load shiftmd
00579A C03C0003          and.b   #$3,D0              Isolate bits 0 and 1
00579E 4E75              rts

*****************************************************
0057A0 4AAF0004          tst.l   4(A7)               Setscreen, set screen address
0057A4 6B06              bmi     $57AC               Logical address
0057A6 2B6F0004044E      move.l  4(A7),$44E(A5)      Negatice, don't set
0057AC 4AAF0008          tst.l   8(A7)               Set v bs ad
0057B0 6B10              bmi     $57C2               Physical address
0057B2 13EF0009FFFF8201  move.b  9(A7),$FFFF8201     Negative, don't set
0057BA 13EF000AFFFF8203  move.b  10(A7),$FFFF8203    Dbaseh
0057C2 4A6F000C          tst.w   12(A7)              Dbasel
0057C6 6B24              bmi     $57EC               Video resolution
0057C8 1B6F000D044C      move.b  13(A7),$44C(A5)     Negative, don't set
0057CE 6100FD74          bsr     $5544               Sshiftmd
0057D2 13ED044CFFFF8260  move.b  $44C(A5),$FFFF8260  Wvbl, wait for VBL
0057DA 426D0452          clr.w   $452(A5)            Sshiftmd to shiftmd
0057DE 4EB90000F6C4      jsr     $F6C4               Vblsem, VBL disabled
0057E4 33FC000100000452  move.w  #1,$452             Initialize screen output
0057EC 4E75              rts                         Vblsem, permit VBL again

*****************************************************
0057EE 2B6F0004045A      move.l  4(A7),$45A(A5)      Setpalette, load new color palette
0057F4 4E75              rts                         Set colorptr (execution in VBL)

*****************************************************
0057F6 322F0004          move.w  4(A7),D1            Setcolor, set single color
0057FA D241              add.w   D1,D1               Color number
0057FC C27C001F          and.w   #$1F,D1             Times 2
005800 41F9FFFF8240      lea     $FFFF8240,A0        Limit to valid number
005806 30301000          move.w  0(A0,D1.w),D0       Address color0
                                                     Get old color
```

```
00580A C07C0777                 and.w   #$777,D0        Clear irrelavant bits
00580E 4A6F0006                 tst.w   6(A7)           Test new color value
005812 6B06                     bmi     $581A           Negative, dont set
005814 31AF00061000             move.w  6(A7),0(A0,D1.w) Set new color
00581A 4E75                     rts

*****************************************************   Puntaes, clear AES and restart
00581C 207AF7F6                 move.l  $5014(PC),A0    os magic
005820 0C9087654321             cmp.l   #$87654321,(A0) Already there ?
005826 660E                     bne     $5836           No, done
005828 B1F90000042E             cmp.l   $42E,A0         In ROM ?
00582E 6C06                     bge     $5836           Yes, do nothing
005830 4290                     clr.l   (A0)            Clear magic
005832 6000F7EA                 bra     $501E           To reset
005836 4E75                     rts

*****************************************************   Term, interrupt running program
005838 6102                     bsr     $583C           PC on stack
00583A 4E71                     nop
00583C 23DF000003C4             move.l  (A7)+,$3C4      Save PC including vector number
005842 48F9FFFF00000384         movem.l D0-D7/A0-A7,$384 Save registers
00584A 4E68                     move.l  USP,A0          USP
00584C 23C8000003C8             move.l  A0,$3C8         Save
005852 303C000F                 move.w  #$F,D0          16 words
005856 41F9000003CC             lea     $3CC,A0         Save area
00585C 224F                     move.l  A7,A1           Get SP to A1
00585E 30D9                     move.w  (A1)+,(A0)+     Save word from stack
005860 51C8FFFC                 dbra    D0,$585E        Next word
005864 23FC1234567800000380     move.l  #$12345678,$380 Magic for saved registers
00586E 7200                     moveq.l #0,D1
005870 1239000003C4             move.b  $3C4,D1         Get vector number to D1
005876 5341                     subq.w  #1,D1           Convert in dbra counter
```

```
005878 6116                     bsr     $5890           Output appropriate # of  'mushrooms'
00587A 23FC000005FC000004A2     move.l  #$5FC,$4A2      Reset savptr for BIOS
005884 3F3C0001                 move.w  #1,-(A7)        Return code for error
005888 42A7                     clr.l   -(A7)           Terminate process
00588A 4E41                     trap    #1              GEMDOS call
00588C 6000F790                 bra     $501E           If return, then reset

*************************************************

005890 1E39FFFF8260             move.b  $FFFF8260,D7    Write 'mushrooms' on screen
005896 CE7C0003                 and.w   #3,D7           Shiftmd, get resolution
00589A DE47                     add.w   D7,D7           Isolate significant bits
00589C 4280                     clr.l   D0              Times 2 for word access
00589E 1039FFFF8201             move.b  $FFFF8201,D0
0058A4 E148                     lsl.w   #8,D0           Dbaseh
0058A6 1039FFFF8203             move.b  $FFFF8203,D0
0058AC E188                     lsl.l   #8,D0           Dbasel
0058AE 2040                     move.l  D0,A0           Screen address
0058B0 D0FB702A                 add.w   $58DC(PC,D7.w),A0  To A0
0058B4 43FA0038                 lea     $58EE(PC),A1    Plus offset for middle of screen
0058B8 3C3C000F                 move.w  #$F,D6          Address of bit pattern for "mushroom"
0058BC 3401                     move.w  D1,D2           16 raster lines
0058BE 2448                     move.l  A0,A2
0058C0 3A3B7020                 move.w  $58E2(PC,D7.w),D5  Save pointer to start of line
0058C4                          move.w  (A1),(A0)+      Number of words (screen planes)
0058C6 51CDFFFC                 dbra    D5,$58C4        Write a raster line
0058CA 51CAFFF4                 dbra    D2,$58C0        A complete mushroom
0058CE 5449                     addq.w  #2,A1           The next on the same line
0058D0 D4FB7016                 add.w   $58E8(PC,D7.w),A2  Next word of the bit pattern
0058D4 204A                     move.l  A2,A0           Next destination address
0058D6 51CEFFE4                 dbra    D6,$58BC        Restore start of the line
0058DA 4E75                     rts                     Next raster line
```

```
************************************************
0058DC 3E80                dc.w    100*160      Screen center
0058DE 3E80                dc.w    100*160      Low resolution
0058E0 3E80                dc.w    200*80       Mid resolution
                                                High resolution

************************************************
0058E2 0003                dc.w    3            Number of screen planes -1
0058E4 0001                dc.w    1            Low resolution
0058E6 0000                dc.w    0            Mid resolution
                                                High resolution

************************************************
0058E8 00A0                dc.w    160          Line length
0058EA 00A0                dc.w    160          Low resolution
0058EC 0050                dc.w    80           Mid resolution
                                                High resolution

************************************************
0058EE 07C0                dc.w    %0000011111000000   Bit pattern 'mushrooms'
0058F0 1FF0                dc.w    %0001111111110000
0058F2 3BF8                dc.w    %0011101111111000
0058F4 77F4                dc.w    %0111011111110100
0058F6 B7FA                dc.w    %1011011111111010
0058F8 BBFA                dc.w    %1011101111111010
0058FA DFF6                dc.w    %1101111111110110
0058FC 66FC                dc.w    %0110011011111100
0058FE 3288                dc.w    %0011001010001000
005900 0280                dc.w    %0000001010000000
005902 0440                dc.w    %0000010001000000
005904 0440                dc.w    %0000010001000000
005906 0540                dc.w    %0000010101000000
005908 0520                dc.w    %0000010100100000
00590A 0920                dc.w    %0000100100100000
00590C 0920                dc.w    %0000100100100000
```

```
00590E 1290              dc.w    %0001001010010000

*****************************************************   Fastcopy, copy disk sector
005910 206F0004          move.l  4(A7),A0              Source address
005914 226F0008          move.l  8(A7),A1              Destination address
005918 303C003F          move.w  #$3F,D0               (63+1)*8 = 512 bytes
00591C 12D8              move.b  (A0)+,(A1)+
00591E 12D8              move.b  (A0)+,(A1)+
005920 12D8              move.b  (A0)+,(A1)+
005922 12D8              move.b  (A0)+,(A1)+           Copy 8 bytes
005924 12D8              move.b  (A0)+,(A1)+
005926 12D8              move.b  (A0)+,(A1)+
005928 12D8              move.b  (A0)+,(A1)+
00592A 12D8              move.b  (A0)+,(A1)+
00592C 51C8FFEE          dbra    D0,$591C              Next 8 bytes
005930 4E75              rts
*****************************************************   Hard disk initialization
005932 2F390000046A      move.l  $46A,-(A7)            Hdv init on stack
005938 4E75              rts                           Jump to routine

*****************************************************
00593A 5C4155544F5C      dc.b    '1AUTO1'
005940 2A2E50524700      dc.b    '*.PRG',0
005946 123456789ABCDEF0  dc.l    $12345678, $9ABCDEF0

*****************************************************   Auto, start and execute a program
00594E 41FAFFEA          lea     $543 (PC),A0          Address of pathname
005952 43FAFFEC          lea     $5940(PC),A1          Address of filename '*.PRG'
005956 23DF000005FC      move.l  (A7)+,$5FC            Return address
00595C 9BCD              sub.l   A5,A5                 Clear A5
00595E 2B480600          move.l  A0,$600(A5)           Pathname
005962 2B490604          move.l  A1,$604(A5)           Filename
```

```
005966 202D04C2            move.l  $4C2(A5),D0     Drvbits, vector with active drives
00596A 323900000446        move.w  $446,D1         Bootdev
005970 0300                btst    D1,D0           Drive active ?
005972 6736                beq     $59AA           No, done
005974 41FAF977            lea     $52ED(PC),A0    Pointer to null name
005978 2F08                move.l  A0,-(A7)        Environment
00597A 2F08                move.l  A0,-(A7)        Command tail
00597C 2F08                move.l  A0,-(A7)        Shell name
00597E 3F3C0005            move.w  #5,-(A7)        Create PSP
005982 3F3C004B            move.w  #$4B,-(A7)      Exec, load program
005986 4E41                trap    #1              GEMDOS call
005988 DEFC0010            add.w   #$10,A7         Correct stack
00598C 2040                move.l  D0,A0           PSP
00598E 217C000059AC0008    move.l  #$59AC,8(A0)    PC for auto exec program
005996 2F0B                move.l  A3,-(A7)        Null string
005998 2F00                move.l  D0,-(A7)        PSP
00599A 2F0B                move.l  A3,-(A7)        Shell name
00599C 3F3C0004            move.w  #$4,-(A7)
0059A0 3F3C004B            move.w  #$4B,-(A7)      Exec, load program
0059A4 4E41                trap    #1              GEMDOS call
0059A6 DEFC0010            add.w   #$10,A7         Correct stack pointer
0059AA 4E75                rts

************************************************  Start auto exec program
0059AC 42A7                clr.l   -(A7)
0059AE 3F3C0020            move.w  #$20,-(A7)      super, enter supervisor mode
0059B2 4E41                trap    #1              GEMDOS call
0059B4 5C4F                addq.w  #6,A7           Correct stack pointer
0059B6 2840                move.l  D0,A4           Saved stack pointer
0059B8 2A6F0004            move.l  4(A7),A5        Base page address
0059BC 4FED0100            lea     $100(A5),A7     Space for base page
0059C0 2F3C00000100        move.l  #$100,-(A7)     $100 bytes
```

```
0059C6 2F0D              move.l  A5,-(A7)        Start of the memory area
0059C8 4267              clr.w   -(A7)
0059CA 3F3C004A          move.w  #$4A,-(A7)      Setblock
0059CE 4E41              trap    #1              GEMDOS call
0059D0 5C4F              addq.w  #6,A7           Correct stack pointer
0059D2 4A40              tst.w   D0              Error ?
0059D4 666A              bne     $5A40           Yes
0059D6 3F3C0007          move.w  #7,-(A7)        R/O, hidden and system files
0059DA 2F3900000600      move.l  $600,-(A7)      Filename
0059E0 3F3C004E          move.w  #$4E,-(A7)      Search first
0059E4 7E08              moveq.l #8,D7           Bytes for stack correction
0059E6 487900000608      pea     $608            DMA address for DOS
0059EC 3F3C001A          move.w  #$1A,-(A7)      Setdta
0059F0 4E41              trap    #1              GEMDOS call
0059F2 5C4F              addq.w  #6,A7           Correct stack pointer
0059F4 4E41              trap    #1              GEMDOS call
0059F6 DEC7              add.w   D7,A7           Correct stack pointer
0059F8 4A40              tst.w   D0              File found ?
0059FA 6644              bne     $5A40           No
0059FC 207900000600      move.l  $600,A0         Pathname
005A02 247900000604      move.l  $604,A2         Filename
005A08 43F900000634      lea     $634,A1         Auto name
005A0E 12D8              move.b  (A0)+,(A1)+     Copy path part
005A10 B5C8              cmp.l   A0,A2
005A12 66FA              bne     $5A0E
005A14 41F900000626      lea     $626,A0         Name from DMA buffer
005A1A 12D8              move.b  (A0)+,(A1)+     Append to path
005A1C 66FC              bne     $5A1A
005A1E 487AF8CD          pea     $52ED(PC)       Null name
005A22 487AF8C9          pea     $52ED(PC)       Null name
005A26 487900000634      pea     $634            Filename
005A2C 4267              clr.w   -(A7)           Load and start program
```

```
005A2E 3F3C004B            move.w  #$4B,-(A7)          Exec, load program
005A32 4E41                trap    #1                  GEMDOS call
005A34 DEFC0010            add.w   #$10,A7             Correct stack pointer
005A38 7E02                moveq.l #2,D7               Bytes for stack pointer
005A3A 3F3C004F            move.w  #$4F,-(A7)          Search next
005A3E 60A6                bra     $59E6               Next file
005A40 4FF900003E2A        lea     $3E2A,A7            Stack pointer back to start value
005A46 2F39000005FC        move.l  $5FC,-(A7)          Load return address
005A4C 4E75                rts

************************************************       Dumpit, screen hardcopy
005A4E 4279000004EE        clr.w   $4EE                Set dumpflg
005A54 610A                bsr     $5A60               Hardcopy
005A56 33FCFFFF000004EE    move.w  #-1,$4EE            Clear dumpflg
005A5E 4E75                rts

************************************************       Scrdmp, hardcopy
005A60 9BCD                sub.l   A5,A5               Clear A5
005A62 2B6D044E0654        move.l  $44E(A5),$654(A5)   v bs ad, screen output
005A68 426D0658            clr.w   $658(A5)            Offset to Null
005A6C 4240                clr.w   D0
005A6E 102D044C            move.b  $44C(A5),D0         Sshiftmd, screen resolution
005A72 3B400662            move.w  D0,$662(A5)         Save
005A76 D040                add.w   D0,D0               Times 2
005A78 41FA005A            lea     $5AD4(PC),A0        Table for screen resolution
005A7C 3B700000065A        move.w  0(A0,D0.w),$65A(A5) Get screen width
005A82 3B700006065C        move.w  6(A0,D0.w),$65C(A5) Get screen height
005A88 426D065E            clr.w   $65E(A5)            Left
005A8C 426D0660            clr.w   $660(A5)            And right to zero
005A90 2B7C00FF82400666    move.l  #$FF8240,$666(A5)   Address to color palette
005A98 426D066E            clr.w   $66E(A5)            Clear mask pointer
005A9C 322D0A8C            move.w  $A8C(A5),D1         Get printer configuration
```

```
005AA0 E649              lsr.w   #3,D1           Test / quality mode
005AA2 C27C0001          and.w   #1,D1           Isolate bit
005AA6 3B410664          move.w  D1,$664(A5)     And save
005AAA 322D0A8C          move.w  $A8C(A5),D1     Get printer configuration
005AAE 3001              move.w  D1,D0
005AB0 E848              lsr.w   #4,D0           Parallel / Serial
005AB2 C07C0001          and.w   #1,D0           Isolate
005AB6 3B40066C          move.w  D0,$66C(A5)     And save for hardcopy
005ABA C27C0007          and.w   #7,D1           Isolate printer type
005ABE 103B1020          move.b  $5AE0(PC,D1.w),D0  Get assignment from table
005AC2 33C00000066A      move.w  D0,$66A         And save for hardcop
005AC8 486D0654          pea     $654(A5)        Address of the parameter block
005ACC 610022C4          bsr     $7D92           Perform hardcopy
005AD0 584F              addq.w  #4,A7           Correct stack pointer
005AD2 4E75              rts

*****************************************

005AD4 014002800280      dc.w    320,640,640     Parameter table for hardcopy
005AD8 00C800C80190      dc.w    200,200,400     Screen widths
                                                 Screen heights

*****************************************

005AE0 00                dc.b    0               Printer types (-1 = not implemented)
005AE1 02                dc.b    2               ATARI B/W matrix
005AE2 01                dc.b    1               ATARI B/W daisy wheel
005AE3 FF                dc.b    -1              ATARI color matrix
005AE4 03                dc.b    3               (ATARI color daisy wheel ?)
005AE5 FF                dc.b    -1              Epson B/W matrix
005AE6 FF                dc.b    -1              (Epson B/W daisy wheel)
005AE7 FF                dc.b    -1              (Epson color matrix)
                                                 (Epson color daisy wheel)
```

```
*****************************************
005AE8 4E56FFF0                 link    A6,#-16
005AEC 23FC0000012C000025F6 move.l  #300,$25F6      maxacctim to 300*20 ms
005AF6 4240                     clr.w   D0
005AF8 33C0000004A6             move.w  D0,$4A6     nflops
005AFE 33C000004692             move.w  D0,$4692
005B04 3D40FFFE                 move.w  D0,-2(A6)   Start with drive A
005B08 604E                     bra     $5B58
005B0A 207C00003E2A             move.l  #$3E2A,A0   Address of the dsb
005B10 326EFFFE                 move.w  -2(A6),A1   Drive number
005B14 D1C9                     add.l   A1,A0
005B16 4210                     clr.b   (A0)
005B18 4257                     clr.w   (A7)
005B1A 4267                     clr.w   -(A7)
005B1C 4267                     clr.w   -(A7)
005B1E 3F2EFFFE                 move.w  -2(A6),-(A7)  Drive number
005B22 42A7                     clr.l   -(A7)
005B24 42A7                     clr.l   -(A7)
005B26 4EB90000628C             jsr     $628C       flopini
005B2C DFFC0000000E             add.l   #$E,A7      Correct stack pointer
005B32 3F00                     move.w  D0,-(A7)    Save error code
005B34 306EFFFE                 move.w  -2(A6),A0   Drive number
005B38 D1C8                     add.l   A0,A0
005B3A D1FC00004910             add.l   #$4910,A0
005B40 309F                     move.w  (A7)+,(A0)  Error code
005B42 6610                     bne     $5B54       Drive not present ?
005B44 5279000004A6             addq.w  #1,$4A6     Increment nflops
005B4A 00B9000000030000004C2 or.l   #3,$4C2     drvbits
005B54 526EFFFE                 addq.w  #1,-2(A6)   Increment drive number
005B58 0C6E0002FFFE             cmp.w   #2,-2(A6)   Not yet 2
005B5E 6DAA                     blt     $5B0A       Initialize next drive
005B60 4E5E                     unlk    A6
```

```
005B62 4E75                rts

*********************************************

005B64 4E56FFFC            link    A6,#-4
005B68 4280                clr.l   D0
005B6A 4E5E                unlk    A6
005B6C 4E75                rts

*********************************************

005B6E 4E56FFF4            link    A6,#-12
005B72 48E7070C            movem.l D5-D7/A4-A5,-(A7)
005B76 0C6E00020008        cmp.w   #2,8(A6)
005B7C 6D06                blt     $5B84
005B7E 4280                clr.l   D0
005B80 60000192            bra     $5D14:ln1:fp5
005B84 302E0008            move.w  8(A6),D0
005B88 EB40                asl.w   #5,D0
005B8A 48C0                ext.l   D0
005B8C 2A40                move.l  D0,A5
005B8E DBFC00003E3E        add.l   #$3E3E,A5
005B94 284D                move.l  A5,A4
005B96 3EBC0001            move.w  #1,(A7)
005B9A 4267                clr.w   -(A7)
005B9C 4267                clr.w   -(A7)
005B9E 3F3C0001            move.w  #1,-(A7)
005BA2 3F2E0008            move.w  8(A6),-(A7)
005BA6 42A7                clr.l   -(A7)
005BA8 2F3C000012BC        move.l  #$12BC,-(A7)
005BAE 4EB9000062D2        jsr     $62D2
005BB4 DFFC00000010        add.l   #$10,A7
005BBA 2D40FFF4            move.l  D0,-12(A6)
005BBE 4AAEFFF4            tst.l   -12(A6)
```

```
getdsb

Zero


getbpb, get BIOS parameter block

Save registers
Drive number
< 2, ok
Else zero

Drive number
Timers 32


Plus base address

Count, read a sector
Side 0
Track 0
Sector 1
Drive number
Filler
Sector buffer
Read sector
Correct stack pointer
Save error code
And test
```

```
005BC2 6C16          bge     $5BDA          ok ?
005BC4 3EAE0008      move.w  8(A6),(A7)     Drive number
005BC8 202EFFF4      move.l  -12(A6),D0     Error code
005BCC 3F00          move.w  D0,-(A7)
005BCE 4EB90000555C  jsr     $555C          Critical error handler
005BD4 548F          addq.l  #2,A7          Correct stack pointer
005BD6 2D40FFF4      move.l  D0,-12(A6)     Save error code
005BDA 202EFFF4      move.l  -12(A6),D0
005BDE B0BC00010000  cmp.l   #$10000,D0
005BE4 67B0          beq     $5B96          Read boot sector again
005BE6 4AAEFFF4      tst.l   -12(A6)
005BEA 6C06          bge     $5BF2          ok ?
005BEC 4280          clr.l   D0
005BEE 60000124      bra     $5D14

005BF2 2EBC000012C7  move.l  #$12C7,(A7)    Buffer+11, bytes per sector
005BF8 6100066C      bsr     $6266          u2i, convert 8086 integer to 68000 int
005BFC 3E00          move.w  D0,D7          Save bytes per sector
005BFE 670E          beq     $5C0E
005C00 1C39000012C9  move.b  $12C9,D6       Buffer+13, sectors per cluster
005C06 4886          ext.w   D6
005C08 CC7C00FF      and.w   #$FF,D6
005C0C 6606          bne     $5C14
005C0E 4280          clr.l   D0
005C10 60000102      bra     $5D14
005C14 3887          move.w  D7,(A4)        recsize
005C16 39460002      move.w  D6,2(A4)       clsiz
005C1A 2EBC000012D2  move.l  #$12D2,(A7)    Buffer+22, sectors per FAT
005C20 61000644      bsr     $6266          u2i, convert 8086 integer to 68000 int
005C24 39400008      move.w  D0,8(A4)       fsiz
005C28 302C0008      move.w  8(A4),D0
005C2C 5240          addq.w  #1,D0          plus 1
```

```
005C2E 3940000A   move.w  D0,10(A4)     fatrec
005C32 3014       move.w  (A4),D0       recsize
005C34 C1EC0002   muls.w  2(A4),D0      Times clsiz
005C38 39400004   move.w  D0,4(A4)      Yields clsizb
005C3C 2EBC000012CD move.l #$12CD,(A7)  Buffer+17, number of directory entries
005C42 61000622   bsr     $6266         u2i, convert 8086 integer to 68000 int
005C46 EB40       asl.w   #5,D0         Times 32
005C48 48C0       ext.l   D0
005C4A 81D4       divs.w  (A4),D0       Divided by recsiz
005C4C 39400006   move.w  D0,6(A4)      Yields rdlen
005C50 302C000A   move.w  10(A4),D0     fatrec
005C54 D06C0006   add.w   6(A4),D0      Plus rdlen
005C58 D06C0008   add.w   8(A4),D0      Plus fsiz
005C5C 3940000C   move.w  D0,12(A4)     Yields datrec
005C60 2EBC000012CF move.l #$12CF,(A7)  Buffer+19, number of sectors
005C66 610005FE   bsr     $6266         u2i, convert 8086 integer to 68000 int
005C6A 906C000C   sub.w   12(A4),D0     Minus datrec
005C6E 48C0       ext.l   D0
005C70 81EC0002   divs.w  2(A4),D0      Divided by clsiz
005C74 3940000E   move.w  D0,14(A4)     Yields numcl
005C78 2EBC000012D6 move.l #$12D6,(A7)  Buffer+26, number of sides
005C7E 610005E6   bsr     $6266         u2i, convert 8086 integer to 68000 int
005C82 3B400014   move.w  D0,20(A5)     dnsides
005C86 2EBC000012D4 move.l #$12D4,(A7)  Buffer+24, sector per track
005C8C 610005D8   bsr     $6266         u2i, convert 8086 integer to 68000 int
005C90 3B400018   move.w  D0,24(A5)     dspt
005C94 302D0014   move.w  20(A5),D0     dnsides
005C98 C1ED0018   muls.w  24(A5),D0     Times dspt
005C9C 3B400016   move.w  D0,22(A5)     Yields dspc
005CA0 2EBC000012D8 move.l #$12D8,(A7)  Buffer+28, number of hidden sectors
005CA6 610005BE   bsr     $6266         u2i, convert 8086 integer to 68000 int
005CAA 3B40001A   move.w  D0,26(A5)     dhidden
```

```
005CAE 2EBC000012CF     move.l  #$12CF,(A7)     Buffer+19, number of sectors on disk
005CB4 610005B0         bsr     $6266           u2i, convert 8086 integer to 68000 int
005CB8 48C0             ext.l   D0
005CBA 81ED0016         divs.w  22(A5),D0       Divided by dspc
005CBE 3B400012         move.w  D0,18(A5)       Yields dntracks
005CC2 4247             clr.w   D7              Counter to zero
005CC4 6016             bra     $5CDC           Jump to end of loop
005CC6 204D             move.l  A5,A0           Buffer pointer
005CC8 3247             move.w  D7,A1           Loop counter
005CCA D1C9             add.l   A1,A0           Plus BPB address
005CCC 3247             move.w  D7,A1           Loop counter
005CCE D3FC000012BC     add.l   #$12BC,A1       Plus buffer address
005CD4 11690008001C     move.b  8(A1),28(A0)    Copy byte of the serial number
005CDA 5247             addq.w  #1,D7           Next byte
005CDC BE7C0003         cmp.w   #3,D7           Three bytes already ?
005CE0 6DE4             blt     $5CC6           No
005CE2 207C00000676     move.l  #$676,A0        cdev
005CE8 326E0008         move.w  8(A6),A1
005CEC D1C9             add.l   A1,A0
005CEE 227C00000674     move.l  #$674,A1        wpstatus
005CF4 346E0008         move.w  8(A6),A2
005CF8 D3CA             add.l   A2,A1
005CFA 1091             move.b  (A1),(A0)
005CFC 6704             beq     $5D02
005CFE 7001             moveq.l #1,D0           Disk status uncertain
005D00 6002             bra     $5D04
005D02 4240             clr.w   D0              Status certain
005D04 227C00003E2A     move.l  #$3E2A,A1
005D0A 346E0008         move.w  8(A6),A2
005D0E D3CA             add.l   A2,A1
005D10 1280             move.b  D0,(A1)
005D12 200D             move.l  A5,D0           Address of BPB as result
```

```
005D14 4A9F              tst.l   (A7)+
005D16 4CDF30C0          movem.l (A7)+,D6-D7/A4-A5     Restore registers
005D1A 4E5E              unlk    A6
005D1C 4E75              rts

*****************************************************  mediach
005D1E 4E560000          link    A6,#0
005D22 48E70304          movem.l D6-D7/A5,-(A7)        Save registers
005D26 0C6E00020008      cmp.w   #2,8(A6)              Drive number
005D2C 6D04              blt     $5D32                 < 2?
005D2E 70F1              moveq.l #-15,D0               'unknown device'
005D30 604C              bra     $5D7E                 Error branch
005D32 3E2E0008          move.w  8(A6),D7              Drive number
005D36 3A47              move.w  D7,A5
005D38 DBFC00003E2A      add.l   #$3E2A,A5
005D3E 0C150002          cmp.b   #2,(A5)
005D42 6604              bne     $5D48
005D44 7002              moveq.l #2,D0
005D46 6036              bra     $5D7E
005D48 207C00000676      move.l  #$676,A0              wplatch
005D4E 4A307000          tst.b   0(A0,D7.w)
005D52 6704              beq     $5D58
005D54 1ABC0001          move.b  #1,(A5)
005D58 2039000004BA      move.l  $4BA,D0               hz 200
005D5E 3247              move.w  D7,A1
005D60 D3C9              add.l   A1,A1
005D62 D3C9              add.l   A1,A1
005D64 D3FC00000678      add.l   #$678,A1              acctim
005D6A 2211              move.l  (A1),D1
005D6C 9081              sub.l   D1,D0
005D6E B0B9000025F6      cmp.l   $25F6,D0              maxacctim
005D74 6C04              bge     $5D7A
```

```
005D76 4240              clr.w   D0
005D78 6004              bra     $5D7E
005D7A 1015              move.b  (A5),D0
005D7C 4880              ext.w   D0
005D7E 4A9F              tst.l   (A7)+
005D80 4CDF2080          movem.l (A7)+,D7/A5      Restore registers
005D84 4E5E              unlk    A6
005D86 4E75              rts

*************************************************  rwabs, read/write sector(s)
005D88 4E56FFFC          link    A6,#-4
005D8C 48E70F04          movem.l D4-D7/A5,-(A7)   Save registers
005D90 0C6E00020012      cmp.w   #2,18(A6)        Drive number
005D96 6D06              blt     $5D9E            < 2 ?
005D98 70F1              moveq.l #-15,D0          No, unknown device
005D9A 6000010E          bra     $5EAA            Error branch
005D9E 3C2E0012          move.w  18(A6),D6        Save drive number
005DA2 0C6E00020008      cmp.w   #2,8(A6)         rwflag
005DA8 6C0000CE          bge     $5E78
005DAC 3006              move.w  D6,D0
005DAE EB40              asl.w   #5,D0
005DB0 48C0              ext.l   D0
005DB2 2A40              move.l  D0,A5
005DB4 DBFC00003E3E      add.l   #$3E3E,A5
005DBA 3E86              move.w  D6,(A7)
005DBC 6100FF60          bsr     $5D1E            Test media change
005DC0 3E00              move.w  D0,D7            Save status
005DC2 BE7C0002          cmp.w   #2,D7            Disk changed ?
005DC6 660A              bne     $5DD2            No
005DC8 70F2              moveq.l #-14,D0          Media change error
005DCA 600000DE          bra     $5EAA            Error branch
```

```
005DCE 600000A8          bra     $5E78
005DD2 BE7C0001          cmp.w   #1,D7           Disk possibly changed ?
005DD6 660000A0          bne     $5E78           No
005DDA 3EBC0001          move.w  #1,(A7)         Read a sector (Boot sector)
005DDE 4267              clr.w   -(A7)           Side 0
005DE0 4267              clr.w   -(A7)           Track 0
005DE2 3F3C0001          move.w  #1,-(A7)        Sector 1
005DE6 3F06              move.w  D6,-(A7)        Drive number
005DE8 42A7              clr.l   -(A7)           Filler
005DEA 2F3C000012BC      move.l  #$12BC,-(A7)    Sector buffer
005DF0 4EB9000062D2      jsr     $62D2           floprd
005DF6 DFFC00000010      add.l   #$10,A7         Correct stack pointer
005DFC 2D40FFFC          move.l  D0,-4(A6)       Save error number
005E00 4AAEFFFC          tst.l   -4(A6)          And test
005E04 6C14              bge     $5E1A           Ok ?
005E06 3E86              move.w  D6,(A7)
005E08 202EFFFC          move.l  -4(A6),D0       Error
005E0C 3F00              move.w  D0,-(A7)
005E0E 4EB90000555C      jsr     $555C           Pass an critical error handler
005E14 548F              addq.l  #2,A7           Correct stack pointer
005E16 2D40FFFC          move.l  D0,-4(A6)
005E1A 202EFFFC          move.l  -4(A6),D0
005E1E B0BC00010000      cmp.l   #$10000,D0
005E24 67B4              beq     $5DDA           Read again
005E26 4AAEFFFC          tst.l   -4(A6)          Error number
005E2A 6C08              bge     $5E34           Ok ?
005E2C 202EFFFC          move.l  -4(A6),D0       Error number
005E30 60000078          bra     $5EAA           Error branch

005E34 4247              clr.w   D7              Clear media change status
005E36 601C              bra     $5E54
```

```
005E38 207C000012BC     move.l  #$12BC,A0       Address of the sector buffer
005E3E 10307008         move.b  8(A0,D7.w),D0   Serial number
005E42 4880             ext.w   D0
005E44 1235701C         move.b  28(A5,D7.w),D1  Compare
005E48 4881             ext.w   D1
005E4A B041             cmp.w   D1,D0           With previous value
005E4C 6704             beq     $5E52           Ok ?
005E4E 70F2             moveq.l #-14,D0         Media change
005E50 6058             bra     $5EAA           Error branch

005E52 5247             addq.w  #1,D7           Next byte of the serial number
005E54 BE7C0003         cmp.w   #3,D7           All 3 bytes tested ?
005E58 6DDE             blt     $5E38           No
005E5A 3046             move.w  D6,A0           Drive number
005E5C D1FC00000676     add.l   #$676,A0        wplatch
005E62 3246             move.w  D6,A1           Drive number
005E64 D3FC00000674     add.l   #$674,A1        wpstatus
005E6A 1091             move.b  (A1),(A0)
005E6C 660A             bne     $5E78
005E6E 3046             move.w  D6,A0
005E70 D1FC00003E2A     add.l   #$3E2A,A0
005E76 4210             clr.b   (A0)
005E78 4A79000004A6     tst.w   $4A6            nflops
005E7E 6604             bne     $5E84
005E80 70FE             moveq.l #-2,D0          Drive not ready
005E82 6026             bra     $5EAA           Error branch

005E84 0C6E00010008     cmp.w   #1,8(A6)        Drive number
005E8A 6F04             ble     $5E90
005E8C 556E0008         subq.w  #2,8(A6)        Drive number
005E90 3EAE000E         move.w  14(A6),(A7)     count
005E94 3F06             move.w  D6,-(A7)        Drive number
```

```
005E96 3F2E0010          move.w  16(A6),-(A7)        recno
005E9A 2F2E000A          move.l  10(A6),-(A7)        buffer
005E9E 3F2E0008          move.w  8(A6),-(A7)         rwflag
005EA2 6110              bsr     $5EB4               floprw
005EA4 DFFC0000000A      add.l   #$A,A7              Correct stack pointer
005EAA 4A9F              tst.l   (A7)+
005EAC 4CDF20E0          movem.l (A7)+,D5-D7/A5      Restore registers
005EB0 4E5E              unlk    A6
005EB2 4E75              rts

*************************************************    floprw, read/write sectors
005EB4 4E56FFFA          link    A6,#-6
005EB8 48E73F04          movem.l D2-D7/A5,-(A7)      Save registers
005EBC 302E0010          move.w  16(A6),D0           Drive number
005EC0 EB40              asl.w   #5,D0               Times 32
005EC2 48C0              ext.l   D0
005EC4 2A40              move.l  D0,A5
005EC6 DBFC00003E3E      add.l   #$3E3E,A5           Plus base address BPB
005ECC 082E0000000D      btst    #0,13(A6)           Buffer address not even ?
005ED2 6604              bne     $5ED8               Yes
005ED4 4240              clr.w   D0                  Clear oddflag
005ED6 6002              bra     $5EDA
005ED8 7001              moveq.l #1,D0               Set oddflag
005EDA 3D40FFFE          move.w  D0,-2(A6)           And save
005EDE 4A6D0016          tst.w   22(A5)              dspc set ?
005EE2 660A              bne     $5EEE               Yes
005EE4 7009              moveq.l #9,D0               Else take 9
005EE6 3B400016          move.w  D0,22(A5)           As dspt
005EEA 3B400018          move.w  D0,24(A5)           And dspc
005EEE 6000015E          bra     $604E
```

```
005EF2 4A6EFFFE     tst.w   -2(A6)          oddflag set ?
005EF6 6708         beq     $5F00           No
005EF8 203C000012BC move.l  #$12BC,D0       Sector buffer
005EFE 6004         bra     $5F04

005F00 202E000A     move.l  10(A6),D0       Get buffer address
005F04 2D40FFFA     move.l  D0,-6(A6)       And save
005F08 3C2E000E     move.w  14(A6),D6       recno, logical sector number
005F0C 48C6         ext.l   D6
005F0E 8DED0016     divs.w  22(A5),D6       Divided by dspc yields track number
005F12 382E000E     move.w  14(A6),D4       recno, logical sector number
005F16 48C4         ext.l   D4
005F18 89ED0016     divs.w  22(A5),D4       Divided by dspc, sector per track
005F1C 4844         swap    D4              Remainder of division as sector number
005F1E B86D0018     cmp.w   24(A5),D4       Compare with dspt
005F22 6C04         bge     $5F28           Greater than or equal ?
005F24 4245         clr.w   D5              Side 0
005F26 6006         bra     $5F2E
005F28 7A01         moveq.l #1,D5           Side 1
005F2A 986D0018     sub.w   24(A5),D4       Subtract dspt
005F2E 4A6EFFFE     tst.w   -2(A6)          oddflag set ?
005F32 6704         beq     $5F38           No
005F34 7601         moveq.l #1,D3           Set counter to 1
005F36 6018         bra     $5F50
005F38 302D0018     move.w  24(A5),D0       dspt
005F3C 9044         sub.w   D4,D0           Minus Sector number
005F3E B06E0012     cmp.w   18(A6),D0       Compare with number of sectors
005F42 6C08         bge     $5F4C           Greater or equal ?
005F44 362D0018     move.w  24(A5),D3       dspt
005F48 9644         sub.w   D4,D3           Minus sector number equals counter
005F4A 6004         bra     $5F50
005F4C 362E0012     move.w  18(A6),D3       Number of sectors as counter
```

```
005F50 5244              addq.w  #1,D4           Increment sector # (1st number is 1)
005F52 4A6E0008          tst.w   8(A6)           Test read-write flag
005F56 67000080          beq     $5FD8           Read
005F5A 202EFFFA          move.l  -6(A6),D0       Buffer pointer
005F5E B0AE000A          cmp.l   10(A6),D0       Equals buffer address
005F62 6710              beq     $5F74           Yes
005F64 2EAEFFFA          move.l  -6(A6),(A7)     Source address
005F68 2F2E000A          move.l  10(A6),-(A7)    Destination address
005F6C 4EB900005910      jsr     $5910           fastcpy, copy a sector
005F72 588F              addq.l  #4,A7           Correct stack pointer
005F74 3E83              move.w  D3,(A7)         Number of sectors
005F76 3F05              move.w  D5,-(A7)        Side
005F78 3F06              move.w  D6,-(A7)        Track
005F7A 3F04              move.w  D4,-(A7)        Sector
005F7C 3F2E0010          move.w  16(A6),-(A7)    Drive
005F80 42A7              clr.l   -(A7)           Filler
005F82 2F2EFFFA          move.l  -6(A6),-(A7)    Sector buffer
005F86 4EB9000063B0      jsr     $63B0           flopwr, read sector
005F8C DFFC00000010      add.l   #$10,A7         Correct stack pointer
005F92 2E00              move.l  D0,D7           Error code
005F94 4A87              tst.l   D7              Ok ?
005F96 663E              bne     $5FD6           No
005F98 4A7900000444      tst.w   $444            fverify, verify required ?
005F9E 6736              beq     $5FD6           No
005FA0 3E83              move.w  D3,(A7)         Number of sectors
005FA2 3F05              move.w  D5,-(A7)        Side
005FA4 3F06              move.w  D6,-(A7)        Track
005FA6 3F04              move.w  D4,-(A7)        Sector
005FA8 3F2E0010          move.w  16(A6),-(A7)    Drive
005FAC 42A7              clr.l   -(A7)           Filler
005FAE 2F3C000012BC      move.l  #$12BC,-(A7)    Sector buffer
005FB4 4EB900006602      jsr     $6602           flopver, verify sector
```

```
005FBA DFFC00000010      add.l   #$10,A7          Correct stack pointer
005FC0 2E00              move.l  D0,D7           Error code
005FC2 4A87              tst.l   D7              Ok ?
005FC4 6610              bne     $5FD6           No
005FC6 2EBC000012BC      move.l  #$12BC,(A7)     Sector buffer
005FCC 61000298          bsr     $6266           u2i, convert 8086 integer to 68000 int
005FD0 4A40              tst.w   D0              Bad sector list
005FD2 6702              beq     $5FD6           Sectors OK ?
005FD4 7EF0              moveq.l #-16,D7         Bad sectors
005FD6 603A              bra     $6012

005FD8 3E83              move.w  D3,(A7)         Number of sectors
005FDA 3F05              move.w  D5,-(A7)        Side
005FDC 3F06              move.w  D6,-(A7)        Track
005FDE 3F04              move.w  D4,-(A7)        Sector
005FE0 3F2E0010          move.w  16(A6),-(A7)    Drive
005FE4 42A7              clr.l   -(A7)           Filler
005FE6 2F2EFFFA          move.l  -6(A6),-(A7)    Sector buffer
005FEA 4EB9000062D2      jsr     $62D2           floprd, read sector
005FF0 DFFC00000010      add.l   #$10,A7         Correct stack pointer
005FF6 2E00              move.l  D0,D7           Save error code
005FF8 202EFFFA          move.l  -6(A6),D0       User buffer
005FFC B0AE000A          cmp.l   10(A6),D0       Equals desired buffer ?
006000 6710              beq     $6012           Yes
006002 2EAE000A          move.l  10(A6),(A7)     Source address
006006 2F2EFFFA          move.l  -6(A6),-(A7)    Destination
00600A 4EB900005910      jsr     $5910           fastcpy, copy sector
006010 588F              addq.l  #4,A7           Correct stack pointer
006012 4A87              tst.l   D7              Test error code
006014 6C12              bge     $6028           Ok ?
006016 3EAE0010          move.w  16(A6),(A7)     Drive number
00601A 2007              move.l  D7,D0           Error code
```

```
00601C 3F00              move.w  D0,-(A7)        On stack
00601E 4EB90000555C      jsr     $555C           Critical error handler
006024 548F              addq.l  #2,A7           Correct stack pointer
006026 2E00              move.l  D0,D7           Get error code
006028 BEBC00010000      cmp.l   #$10000,D7      Attempt again ?
00602E 6700FF22          beq     $5F52           Yes
006032 4A87              tst.l   D7              Error code
006034 6C04              bge     $603A           OK
006036 2007              move.l  D7,D0           Error code as result
006038 601E              bra     $6058

00603A 3003              move.w  D3,D0           Sector counter
00603C 48C0              ext.l   D0
00603E 7209              moveq.l #9,D1           Times 512
006040 E3A0              asl.l   D1,D0
006042 D1AE000A          add.l   D0,10(A6)       Increment buffer address
006046 D76E000E          add.w   D3,14(A6)       Logical sector number plus counter
00604A 976E0012          sub.w   D3,18(A6)       Decrement number of sectors to process
00604E 4A6E0012          tst.w   18(A6)          Sectors yet to read/write ?
006052 6600FE9E          bne     $5EF2           Yes
006056 4280              clr.l   D0              OK
006058 4A9F              tst.l   (A7)+
00605A 4CDF20F8          movem.l (A7)+,D3-D7/A5  Restore registers
00605E 4E5E              unlk    A6
006060 4E75              rts

************************************************  random, generate random number
006062 4E56FFFC          link    A6,#-4
006066 4AB9000025FA      tst.l   $25FA           Last random number
00606C 6616              bne     $6084           Not zero ?
00606E 2039000004BA      move.l  $4BA,D0         200 Hz counter
006074 7210              moveq.l #16,D1
```

```
006076 E3A0                asl.l   D1,D0           Bits 0-15 to 16-31
006078 80B9000004BA        or.l    $4BA,D0         Plus 200 Hz counter
00607E 23C0000025FA        move.l  D0,$25FA        Use as start value
006084 2F3CBB40E62D        move.l  #$BB40E62D,-(A7) 3141592621
00608A 2F39000025FA        move.l  $25FA,-(A7)     Last random value
006090 4EB9000094FA        jsr     $94FA           32 * 32 bit multiplication
006096 508F                addq.l  #8,A7           Correct stack pointer
006098 5280                addq.l  #1,D0           Result plus 1
00609A 23C0000025FA        move.l  D0,$25FA        As new start value
0060A0 2039000025FA        move.l  $25FA,D0
0060A6 E080                asr.l   #8,D0           Bits 31-8 to 23-0
0060A8 C0BC00FFFFFF        and.l   #$FFFFFF,D0     24-bit random number as result
0060AE 4E5E                unlk    A6
0060B0 4E75                rts

************************************************  bootload, load boot sector
0060B2 4E560000            link    A6,#0
0060B6 48E70300            movem.l D6-D7,-(A7)     Save registers
0060BA 4EB900005932        jsr     $5932           hdv init
0060C0 4A79000004A6        tst.w   $4A6            nflops
0060C6 6704                beq     $60CC           No drive connected ?
0060C8 7001                moveq.l #1,D0           'couldn't load'
0060CA 6002                bra     $60CE
0060CC 7002                moveq.l #2,D0           'no drive'
0060CE 3E00                move.w  D0,D7           Save errors
0060D0 4A79000004A6        tst.w   $4A6            nflops
0060D6 6744                beq     $611C
0060D8 0C79000200000446    cmp.w   #2,$446         bootdev
0060E0 6C3A                bge     $611C           No diskette ?
0060E2 3EBC0001            move.w  #1,(A7)         One sector
0060E6 4267                clr.w   -(A7)           Side 0
0060E8 4267                clr.w   -(A7)           Track 0
```

```
0060EA 3F3C0001          move.w  #1,-(A7)          Sector 1
0060EE 3F3900000446      move.w  $446,-(A7)        bootdev as drive number
0060F4 42A7              clr.l   -(A7)             Filler
0060F6 2F3C000012BC      move.l  #$12BC,-(A7)      Sector buffer
0060FC 4EB9000062D2      jsr     $62D2             floprd, read sector
006102 DFFC00000010      add.l   #$10,A7           Correct stack pointer
006108 4A80              tst.l   D0                Error ?
00610A 6604              bne     $6110             No
00610C 4247              clr.w   D7
00610E 600C              bra     $611C
006110 4A3900000674      tst.b   $674              wpstatus
006116 6604              bne     $611C
006118 7003              moveq.l #3,D0             'unreadable'
00611A 6024              bra     $6140

00611C 4A47              tst.w   D7
00611E 6704              beq     $6124             Get old error code
006120 3007              move.w  D7,D0
006122 601C              bra     $6140

006124 3EBC0100          move.w  #$100,(A7)        $100 words
006128 2F3C000012BC      move.l  #$12BC,-(A7)      Sector buffer
00612E 61000106          bsr     $6236             Calculate checksum
006132 588F              addq.l  #4,A7             Correct stack pointer
006134 B07C1234          cmp.w   #$1234,D0         Compare with checksum for boot sector
006138 6604              bne     $613E             Not equal ?
00613A 4240              clr.w   D0                OK
00613C 6002              bra     $6140
00613E 7004              moveq.l #4,D0             'not valid boot sector'
006140 4A9F              tst.l   (A7)+
006142 4CDF0080          movem.l (A7)+,D7          Restore registers
```

```
006146 4E5E                unlk    A6
006148 4E75                rts

*************************************************
00614A 4E56FFFA            link    A6,#-6          proto bt, generate boot sector
00614E 48E70704            movem.l D5-D7/A5,-(A7)

006152 4A6E0012            tst.w   18(A6)          Save registers
006156 6C1E                bge     $6176           Test execflg
006158 3EBC0100            move.w  #$100,(A7)      Maintain executability
00615C 2F2E0008            move.l  8(A6),-(A7)     $100 words
006160 610000D4            bsr     $6236           Address of the sector buffer
006164 588F                addq.l  #4,A7           Calculate checksum
006166 B07C1234            cmp.w   #$1234,D0       Correct stack pointer
00616A 6704                beq     $6170           Equals checksum for boot sector?
00616C 4240                clr.w   D0              Yes
00616E 6002                bra     $6172           Not executable

006170 7001                moveq.l #1,D0           Executable
006172 3D400012            move.w  D0,18(A6)       execflg to 1 = boot sector executable
006176 4AAE000C            tst.l   12(A6)          Serial number
00617A 6D3E                blt     $61BA           Negative, don't change
00617C 202E000C            move.l  12(A6),D0       Serial number
006180 B0BC00FFFFFF        cmp.l   #$FFFFFF,D0     > $FFFFFF ?
006186 6F08                ble     $6190           No
006188 6100FED8            bsr     $6062           rand, generate random number
00618C 2D40000C            move.l  D0,12(A6)       Save
006190 4247                clr.w   D7              Clear counter
006192 6020                bra     $61B4

006194 202E000C            move.l  12(A6),D0       Random number
006198 C0BC000000FF        and.l   #$FF,D0         Bits 0-7
00619E 3247                move.w  D7,A1           Pointer to next byte in buffer
```

```
0061A0 D3EE0008      add.l   8(A6),A1        Plus base address
0061A4 13400008      move.b  D0,8(A1)        Write byte of serial number in buffer
0061A8 202E000C      move.l  12(A6),D0       Random number
0061AC E080          asr.l   #8,D0           In order to shift 8 bits right
0061AE 2D40000C      move.l  D0,12(A6)       And save new value
0061B2 5247          addq.w  #1,D7           Increment counter
0061B4 BE7C0003      cmp.w   #$3,D7          Three bytes copied already ?
0061B8 6DDA          blt     $6194           No
0061BA 4A6E0010      tst.w   16(A6)          Diskette size
0061BE 6D28          blt     $61E8           Negative, don't change
0061C0 3C2E0010      move.w  16(A6),D6       Diskette size
0061C4 CDFC0013      muls.w  #$13,D6         Times 19 equals pointer to prototype BPB
0061C8 4247          clr.w   D7              Clear counter
0061CA 6016          bra     $61E2

0061CC 3047          move.w  D7,A0           Counter
0061CE D1EE0008      add.l   8(A6),A0        Plus address of the buffer
0061D2 3246          move.w  D6,A1
0061D4 D3FC00016D00  add.l   #$16D00,A1      Address of the prototype BPB
0061DA 1151000B      move.b  (A1),11(A0)     Copy BPB
0061DE 5246          addq.w  #1,D6
0061E0 5247          addq.w  #1,D7           Increment counter
0061E2 BE7C0013      cmp.w   #$13,D7         Already 19 ?
0061E6 6DE4          blt     $61CC           No
0061E8 426EFFFA      clr.w   -6(A6)
0061EC 2D6E0008FFFC  move.l  8(A6),-4(A6)    Buffer address
0061F2 600E          bra     $6202
0061F4 206EFFFC      move.l  -4(A6),A0
0061F8 3010          move.w  (A0),D0         Get word from buffer
0061FA D16EFFFA      add.w   D0,-6(A6)       Sum for checksum generation
0061FE 54AEFFFC      addq.l  #2,-4(A6)       Next word
```

```
006202 202E0008          move.l  8(A6),D0        Buffer address
006206 D0BC000001FE      add.l   #$1FE,D0        Plus $1FE
00620C B0AEFFFC          cmp.l   -4(A6),D0       Last word already

006210 62E2              bhi     $61F4
006212 303C1234          move.w  #$1234,D0       Checksum for boot sector
006216 906EFFFA          sub.w   -6(A6),D0       Subtract from previous value
00621A 226EFFFC          move.l  -4(A6),A1

00621E 3280              move.w  D0,(A1)         Checksum in buffer
006220 4A6E0012          tst.w   18(A6)          execflg
006224 6606              bne     $622C           Boot sector executable ?

006226 206EFFFC          move.l  -4(A6),A0
00622A 5250              addq.w  #1,(A0)         Increment checksum, not executable
00622C 4A9F              tst.l   (A7)+
00622E 4CDF20C0          movem.l (A7)+,D6-D7/A5  Restore registers
006232 4E5E              unlk    A6
006234 4E75              rts

************************************************
006236 4E560000          link    A6,#0           Calculate checksum
00623A 48E70300          movem.l D6-D7,-(A7)
00623E 4247              clr.w   D7              Save registers
006240 600C              bra     $624E           Clear sum

006242 206E0008          move.l  8(A6),A0        Address of the buffer
006246 3010              move.w  (A0),D0         Get word
006248 DE40              add.w   D0,D7           And sum
00624A 54AE0008          addq.l  #2,8(A6)        Pointer to next word
00624E 302E000C          move.w  12(A6),D0       Number of words
006252 536E000C          subq.w  #1,12(A6)       Minus 1
006256 4A40              tst.w   D0              All words added already ?
006258 66E8              bne     $6242           No
00625A 3007              move.w  D7,D0           Result to d0
00625C 4A9F              tst.l   (A7)+
```

```
00625E 4CDF0080          movem.l (A7)+,D7          Restore registers
006262 4E5E              unlk    A6
006264 4E75              rts

************************************************   u2i, convert 8086 number to 68000 number
006266 4E56FFFC          link    A6,#-4
00626A 206E0008          move.l  8(A6),A0          Address of the number
00626E 10280001          move.b  1(A0),D0          Get high byte
006272 4880              ext.w   D0                Extend to word
006274 C07C00FF          and.w   #$FF,D0           Isolate bits 0-7
006278 E140              asl.w   #8,D0             Shift in position 8-15
00627A 226E0008          move.l  8(A6),A1          Address of the number
00627E 1211              move.b  (A1),D1           Get low byte
006280 4881              ext.w   D1                Extend to word
006282 C27C00FF          and.w   #$FF,D1           Isolate bits 0-7
006286 8041              or.w    D1,D0             Combine with bits 8-15
006288 4E5E              unlk    A6
00628A 4E75              rts

************************************************   flopini, initialize drive
00628C 43F9000006C8      lea     $6C8,A1           dsb0, pointer to DSB drive A
006292 4A6F000C          tst.w   12(A7)            Drive A ?
006296 6706              beq     $629E             Yes
006298 43F9000006CC      lea     $6CC,A1           dsb1, take DSB from drive B
00629E 3379000004400002  move.w  $440,2(A1)        seekrate
0062A6 70FF              moveq.l #-1,D0            Default error number
0062A8 42690000          clr.w   0(A1)             Track number to zero
0062AC 610004BA          bsr     $6768             floplock, set parameters
0062B0 61000696          bsr     $6948             Select drive and side
0062B4 337CFF000000      move.w  #$FF00,0(A1)
0062BA 61000618          bsr     $68D4             restore
0062BE 7E06              moveq.l #6,D7
```

```
0062C0 610005A0            bsr     $6862
0062C4 6608                bne     $62CE
0062C6 6100060C            bsr     $68D4           Restore
0062CA 67000542            beq     $680E           flopok, no error
0062CE 60000530            bra     $6800           flopfail, error

************************************************   floprd, read sector(s) from disk
0062D2 6100071E            bsr     $69F2           Change, test for disk change
0062D6 70F5                moveq.l #-11,D0         Error number to read error
0062D8 6100048E            bsr     $6768           floplock, set parameters
0062DC 6100066A            bsr     $6948           Select drive and side
0062E0 610005CC            bsr     $68AE           go2track, search for track
0062E4 66000090            bne     $6376           Try again if error
0062E8 33FCFFFF000006A2    move.w  #-1,$6A2        currerr to default error
0062F0 3CBC0090            move.w  #$90,(A6)       Clear DMA status
0062F4 3CBC0190            move.w  #$190,(A6)
0062F8 3CBC0090            move.w  #$90,(A6)       Data direction to READ
0062FC 33ED068CFFFF8604    move.w  $68C(A5),$FFFF8604  ccount to dskctl, sector counter
006304 3CBC0080            move.w  #$80,(A6)       Read sector command for 1772
006308 3E3C0090            move.w  #$90,D7         Read multiple
00630C 610006B6            bsr     $69C4           wdiskctl, pass D7 to 1772
006310 2E3C00040000        move.l  #$40000,D7      Initialize timeout counter
006316 246D0692            move.l  $692(A5),A2     edma, destination address for DMA
00631A 08390005FFFFFA01    btst    #5,$FFFFFA01    mfp gpip, 1772 done ?
006322 6734                beq     $6358           Yes
006324 5387                subq.l  #1,D7           Decrement timeout counter
006326 6724                beq     $634C           Timed-out ?
006328 1B79FFFF8609069D    move.b  $FFFF8609,$69D(A5)  dmahigh
006330 1B79FFFF860B069E    move.b  $FFFF860B,$69E(A5)  dmamid
006338 1B79FFFF860D069F    move.b  $FFFF860D,$69F(A5)  dmalow
006340 B5ED069C            cmp.l   $69C(A5),A2     Current DMA address equal edma?
006344 6ED4                bgt     $631A           No, continue to wait
```

```
006346 610005E6          bsr     $692E           Reset, end transfer
00634A 600C              bra     $6358
00634C 3B7CFFFE06A2      move.w  #-2,$6A2(A5)    currerr to timeout
006352 610005DA          bsr     $692E           Reset, end transfer
006356 601E              bra     $6376           Start next attempt
006358 3CBC0090          move.w  #$90,(A6)       Select DMA status register
00635C 3016              move.w  (A6),D0         Read status
00635E 08000000          btst    #0,D0           DMA rrror ?
006362 6712              beq     $6376           Yes, try again
006364 3CBC0080          move.w  #$80,(A6)       Select 1772 status register
006368 6100066E          bsr     $69D8           rdiskctl, read register
00636C C03C0018          and.b   #$18,D0         RNF, isolate checksum und lost data
006370 6700049C          beq     $680E           flopok, no error
006374 6118              bsr     $638E           errbits, determine error number
006376 0C6D00010672      cmp.w   #1,$672(A5)     retrycnt to second attempt ?
00637C 6604              bne     $6382           No
00637E 610004FA          bsr     $687A           reseek, home and reseek
006382 536D0672          subq.w  #1,$672(A5)     retrycnt, decrement attempt counter
006386 6A00FF54          bpl     $62DC           Another attempt ?
00638A 60000474          bra     $6800           No, flopfail

**********************************************   errbits, 1772 status in error number
00638E 72F3              moveq.l #-13,D1         Write protect ?
006390 08000006          btst    #6,D0
006394 6614              bne     $63AA           Yes
006396 72F8              moveq.l #-8,D1          Record not found ?
006398 08000004          btst    #4,D0
00639C 660C              bne     $63AA           Yes
00639E 72FC              moveq.l #-4,D1          CRC error ?
0063A0 08000003          btst    #3,D0
0063A4 6704              beq     $63AA           Yes
0063A6 322D06A0          move.w  $6A0(A5),D1     deferror, take default error
```

```
0063AA 3B4106A2            move.w  D1,$6A2(A5)        As currerr
0063AE 4E75                rts

************************************************      flopwr, write sector(s) on disk
0063B0 61000640            bsr     $69F2              Change, test for disk change
0063B4 70F6                moveq.l #-10,D0            Default error to write wrror
0063B6 610003B0            bsr     $6768              floplock, set parameters
0063BA 302D0688            move.w  $688(A5),D0        csect, sector number 1?
0063BE 5340                subq.w  #1,D0
0063C0 806D0686            or.w    $686(A5),D0        ctrack, track number 0?
0063C4 806D068A            or.w    $68A(A5),D0        cside, side 0?
0063C8 6606                bne     $63D0              No, not boot sector
0063CA 7002                moveq.l #2,D0              Media change
0063CC 6100065C            bsr     $6A2A              Set to 'unsure'
0063D0 61000576            bsr     $6948              select, select drive and seide
0063D4 610004D8            bsr     $68AE              go2track, search for track
0063D8 6600007E            bne     $6458              Error, try again
0063DC 3B7CFFFF06A2        move.w  #-1,$6A2(A5)       currerr to default error
0063E2 3CBC0190            move.w  #$190,(A6)         Clear DMA status
0063E6 3CBC0090            move.w  #$90,(A6)
0063EA 3CBC0190            move.w  #$190,(A6)         Data direction to WRITE
0063EE 3E3C0001            move.w  #1,D7              Sector count register
0063F2 610005D0            bsr     $69C4              wdiskctl, D7 to 1772
0063F6 3CBC0180            move.w  #$180,(A6)         Selects1772
0063FA 3E3C00A0            move.w  #$A0,D7            Write Sector
0063FE 610005C4            bsr     $69C4              wdiskctl, D7 to 1772
006402 2E3C00040000        move.l  #$40000,D7         Timeout counter
006408 08390005FFFFFA01    btst    #5,$FFFFFA01       mfp, gpip, 1772 done ?
006410 670A                beq     $641C              Yes
006412 5387                subq.l  #1,D7              Decrement timeout counter
006414 66F2                bne     $6408              Not timed-out yet ?
006416 61000516            bsr     $692E              reset, end transfer
```

```
00641A 6034                bra     $6450
00641C 3CBC0180            move.w  #$180,(A6)
006420 610005B6            bsr     $69D8
006424 6100FF68            bsr     $638E
006428 08000006            btst    #6,D0
00642C 660003D2            bne     $6800
006430 C03C005C            and.b   #$5C,D0

006434 661A                bne     $6450
006436 526D0688            addq.w  #1,$688(A5)
00643A 06AD00000200068E    add.l   #512,$68E(A5)
006442 536D068C            subq.w  #1,$68C(A5)
006446 670003C6            beq     $680E
00644A 61000524            bsr     $6970
00644E 608C                bra     $63DC
006450 0C6D00010672        cmp.w   #1,$672(A5)
006456 6604                bne     $645C
006458 61000420            bsr     $687A
00645C 536D0672            subq.w  #1,$672(A5)
006460 6A00FF6E            bpl     $63D0
006464 6000039A            bra     $6800

************************************************
006468 0CAF876543210016    cmp.l   #$87654321,22(A7)
006470 6600038E            bne     $6800
006474 6100057C            bsr     $69F2
006478 70FF                moveq.l #-1,D0
00647A 610002EC            bsr     $6768
00647E 610004C8            bsr     $6948
006482 3B6F000E0696        move.w  14(A7),$696(A5)
006488 3B6F00140698        move.w  20(A7),$698(A5)
00648E 3B6F001A069A        move.w  26(A7),$69A(A5)
```

```
Select 1772 status register
rdiskctl, read 1772 registers
errbits, calculate error number
Write protect ?
flopfail, no further attempt
Write protect, RNF, checksum and lost data

Error, try again
csect, increment sector number
cdma, DMA address to next sector
ccount, decrement number of sectors
flopok, all sectors, then done
select1, sector number and DMA pointer
Write next sector without seek
retrycnt, second attempt ?
No
ressek, home and seek
retrycnt, decrement attempt counter
Another attempt ?
flopfail, error

flopfmt, format track
Magic number ?
No, flopfail
Change, test for disk change
Default error number
floplock, set parameters
select, select drive and side
spt, sectors per track
interlv, interleave factor
virgin, sector data for formatting
```

```
006494 7002              moveq.l #2,D0          'changed'
006496 61000592          bsr     $6A2A          Diskette changed
00649A 610003C0          bsr     $685C          hseek, search for track
00649E 66000360          bne     $6800          flopfail, not found
0064A2 336D06860000      move.w  $686(A5),0(A1) ctrack, write current track in DSB
0064A8 3B7CFFFF06A2      move.w  #-1,$6A2(A5)   currerr to default error
0064AE 6128              bsr     $64D8          Format track
0064B0 6600034E          bne     $6800          flopfail, error
0064B4 3B6D0696068C      move.w  $696(A5),$68C(A5) spt sectors per track as ccount counter
0064BA 3B7C00010688      move.w  #1,$688(A5)    csect, start with sector 1
0064C0 6100015C          bsr     $661E          verify, verify sector
0064C4 246D068E          move.l  $68E(A5),A2    cdma, list with bad sectors
0064C8 4A52              tst.w   (A2)           Bad sector ?
0064CA 67000342          beq     $680E          No
0064CE 3B7CFFF006A2      move.w  #-16,$6A2(A5)  currerr to 'Bad Sector'
0064D4 6000032A          bra     $6800          flopfail, error

*************************************************  fmtrack, format track
0064D8 3B7CFFF606A0      move.w  #-10,$6A0(A5)  deferror, default error number
0064DE 363C0001          move.w  #1,D3          Start with sector 1
0064E2 246D068E          move.l  $68E(A5),A2    cdma, buffer for track data
0064E6 323C003B          move.w  #$3B,D1        60 times
0064EA 103C004E          move.b  #$4E,D0        $4E, track header
0064EE 6100010A          bsr     $65FA          wmult, write in buffer
0064F2 3803              move.w  D3,D4          Save sector number
0064F4 323C000B          move.w  #$B,D1         12 times
0064F8 4200              clr.b   D0             0
0064FA 610000FE          bsr     $65FA          wmult, write in buffer
0064FE 323C0002          move.w  #2,D1          3 times
006502 103C00F5          move.b  #$F5,D0        $F5
006506 610000F2          bsr     $65FA          wmult, write in buffer
00650A 14FC00FE          move.b  #$FE,(A2)+     $FE, address mark
```

```
00650E 14F900000687    move.b  $687,(A2)+      Track
006514 14F90000068B    move.b  $68B,(A2)+      Side
00651A 14C4            move.b  D4,(A2)+        Sector
00651C 14FC0002        move.b  #2,(A2)+        Sector size (512 bytes)
006520 14FC00F7        move.b  #$F7,(A2)+      Write checksum
006524 323C0015        move.w  #$15,D1         22 times
006528 103C004E        move.b  #$4E,D0         $4E
00652C 610000CC        bsr     $65FA           wmult, write in buffer
006530 323C000B        move.w  #$B,D1          12 times
006534 4200            clr.b   D0              0
006536 610000C2        bsr     $65FA           wmult, write in buffer
00653A 323C0002        move.w  #2,D1           3 times
00653E 103C00F5        move.b  #$F5,D0         $F5
006542 610000B6        bsr     $65FA           wmult, write in buffer
006546 14FC00FB        move.b  #$FB,(A2)+      $FB, data block mark
00654A 323C00FF        move.w  #$FF,D1         256 times
00654E 14ED069A        move.b  $69A(A5),(A2)+  virgin, initial data in buffer
006552 14ED069B        move.b  $69B(A5),(A2)+
006556 51C9FFF6        dbra    D1,$654E        Next word
00655A 14FC00F7        move.b  #$F7,(A2)+      Write checksum
00655E 323C0027        move.w  #$27,D1         40 times
006562 103C004E        move.b  #$4E,D0         $4E
006566 61000092        bsr     $65FA           wmult, write in buffer
00656A D86D0698        add.w   $698(A5),D4     Add interlv, next sector
00656E B86D0696        cmp.w   $696(A5),D4     spt, largest sector number ?
006572 6F80            ble     $64F4           No, next sector
006574 5243            addq.w  #1,D3           Start sector plus one
006576 B66D0698        cmp.w   $698(A5),D3     interlv
00657A 6F00FF76        ble     $64F2           Next sector
00657E 323C0578        move.w  #$578,D1        1401 times (until track end)
006582 103C004E        move.b  #$4E,D0         $4E
006586 6172            bsr     $65FA           wmult, write in buffer
```

```
006588 13ED0691FFFF860D    move.b  $691(A5),$FFFF860D   dmalow
006590 13ED0690FFFF860B    move.b  $690(A5),$FFFF860B   dmamid
006598 13ED068FFFFF8609    move.b  $68F(A5),$FFFF8609   dmahigh
0065A0 3CBC0190            move.w  #$190,(A6)           Clear DMA status
0065A4 3CBC0090            move.w  #$90,(A6)
0065A8 3CBC0190            move.w  #$190,(A6)           Data direction to WRITE
0065AC 3E3C001F            move.w  #$1F,D7              Sector counter to 31
0065B0 61000412            bsr     $69C4                wdiskctl, D7 to 1772
0065B4 3CBC0180            move.w  #$180,(A6)           Select 1772
0065B8 3E3C00F0            move.w  #$F0,D7              Format track command
0065BC 61000406            bsr     $69C4                wdiskctl, D7 to 1772
0065C0 2E3C00040000        move.l  #$40000,D7           Timeout counter
0065C6 08390005FFFFFA01    btst    #5,$FFFFFA01         mfp gpip, 1772 done ?
0065CE 670C                beq     $65DC                Yes
0065D0 5387                subq.l  #1,D7                Decrement timeout counter
0065D2 66F2                bne     $65C6                Not yet timed-out ?
0065D4 61000358            bsr     $692E                reset, terminate
0065D8 7E01                moveq.l #1,D7                Clear Z-bit, error
0065DA 4E75                rts

0065DC 3CBC0190            move.w  #$190,(A6)           Select DMA status
0065E0 3016                move.w  (A6),D0              Read status
0065E2 08000000            btst    #0,D0                DMA error ?
0065E6 67F0                beq     $65D8                Yes
0065E8 3CBC0180            move.w  #$180,(A6)           Select 1772 status register
0065EC 610003EA            bsr     $69D8                rdiskctl, read registers
0065F0 6100FD9C            bsr     $638E                errbits, calculate error number
0065F4 C03C0044            and.b   #$44,D0              Test write protect and lost data
0065F8 4E75                rts

0065FA 14C0                move.b  D0,(A2)+             Write data in buffer
0065FC 51C9FFFC            dbra    D1,$65FA             Next byte
```

```
006600 4E75                rts

*********************************************
006602 610003EE            bsr     $69F2
006606 70F5                moveq.l #-11,D0
006608 6100015E            bsr     $6768
00660C 6100033A            bsr     $6948
006610 6100029C            bsr     $68AE
006614 660001EA            bne     $6800
006618 6104                bsr     $661E
00661A 600001F2            bra     $680E

*********************************************
00661E 3B7CFFF506A0        move.w  #-11,$6A0(A5)
006624 246D068E            move.l  $68E(A5),A2
006628 06AD00000200068E    add.l   #$200,$68E(A5)
006630 3B7C00020672        move.w  #2,$672(A5)
006636 3CBC0084            move.w  #$84,(A6)
00663A 3E2D0688            move.w  $688(A5),D7
00663E 61000384            bsr     $69C4
006642 13ED0691FFFF860D    move.b  $691(A5),$FFFF860D
00664A 13ED0690FFFF860B    move.b  $690(A5),$FFFF860B
006652 13ED068FFFFF8609    move.b  $68F(A5),$FFFF8609
00665A 3CBC0090            move.w  #$90,(A6)
00665E 3CBC0190            move.w  #$190,(A6)
006662 3CBC0090            move.w  #$90,(A6)
006666 3E3C0001            move.w  #1,D7
00666A 61000358            bsr     $69C4
00666E 3CBC0080            move.w  #$80,(A6)
006672 3E3C0080            move.w  #$80,D7
006676 6100034C            bsr     $69C4
00667A 2E3C00040000        move.l  #$40000,D7
```

```
flopver, verfiy sector(s)
Change, test for disk change
'read error', as default error
floplock, set parameters
Select
go2track, search for track
flopfail, error
verify1, verify sectors
flopok, done


deferror to 'read error'
cdma, DMA buffer for bad sector list
cdma to next sector
retrycnt, 2 attempts
Select sector register
csect, sector number
wdiskctl,to disk controller
dmalow
dmamid
dmahigh
Clear DMA status

Data direction to READ
Sector counter to 1
wdiskctl
Select 1772 command register
Read sector command
wdiskctl
Timeout counter
```

```
006680 08390005FFFFFA01     btst    #5,$FFFFFA01        mfp gpip, 1772 done ?
006688 670A                 beq     $6694               Yes
00668A 5387                 subq.l  #1,D7               Decrement timeout counter
00668C 66F2                 bne     $6680               Timed-out yet ?
00668E 6100029E             bsr     $692E               Reset 1772
006692 6036                 bra     $66CA               Next attempt

006694 3CBC0090             move.w  #$90,(A6)           Select DMA status register
006698 3016                 move.w  (A6),D0             Reat status
00669A 08000000             btst    #0,D0               DMA error ?
00669E 672A                 beq     $66CA               Yes, try again
0066A0 3CBC0080             move.w  #$80,(A6)           Select 1772 status register
0066A4 61000332             bsr     $69D8               rdiskctl, read status
0066A8 6100FCE4             bsr     $638E               errbits, calculate error number
0066AC C03C001C             and.b   #$1C,D0             Test RNF, CRC and lost data
0066B0 6618                 bne     $66CA               Error, next attempt
0066B2 526D0688             addq.w  #1,$688(A5)         csect, next sector
0066B6 536D068C             subq.w  #1,$68C(A5)         ccount, decrement sector counter
0066BA 6600FF74             bne     $6630               Another sector ?
0066BE 04AD00000200068E     sub.l   #$200,$68E(A5)      cdma, Reset DMA pointer
0066C6 4252                 clr.w   (A2)                bad sector list mit Null abschlie@en
0066C8 4E75                 rts

0066CA 0C6D00010672         cmp.w   #1,$672(A5)         retrycnt, 2ns attempt ?
0066D0 6604                 bne     $66D6               No
0066D2 610001A6             bsr     $687A               reseek
0066D6 536D0672             subq.w  #1,$672(A5)         Decrement retrycnt
0066DA 6A00FF66             bpl     $6642               Another attempt ?
0066DE 34ED0688             move.w  $688(A5),(A2)+      csect, sector number in bad sector list
0066E2 60CE                 bra     $66B2               Next sector
```

```
************************************************
0066E4 9BCD              sub.l   A5,A5           flopvbl, floppy vertical blank handler
0066E6 4DF9FFFF8606      lea     $FFFF8606,A6    Clear A5
0066EC 50ED0680          st      $680(A5)        Address of the floppy register
0066F0 4A6D043E          tst.w   $43E(A5)        Set motoron flag
0066F4 6670              bne     $6766           flock, disks busy ?
0066F6 203900000466      move.l  $466,D0         Yes, do nothing
0066FC 1200              move.b  D0,D1           frclock
0066FE C23C0007          and.b   #7,D1

006702 6638              bne     $673C           Calculate mod 8
006704 3CBC0080          move.w  #$80,(A6)       Not yet 8th interrupt ?
006708 E608              lsr.b   #3,D0           Select 1772 status register
00670A C07C0001          and.w   #1,D0           Use bit 4 as drive number
00670E 41ED0674          lea     $674(A5),A0

006712 D0C0              add.w   D0,A0           wpstatus, write protect status table
006714 B079000004A6      cmp.w   $4A6,D0         Index with drive number
00671A 6602              bne     $671E           nflops, number of floppies
00671C 4240              clr.w   D0

00671E 5200              addq.b  #1,D0           Drive select bit
006720 E308              lsl.b   #1,D0           Shift in position
006722 0A000007          eor.b   #7,D0           Invert for hardware
006726 6100026C          bsr     $6994           Select drive
00672A 3039FFFF8604      move.w  $FFFF8604,D0    dskctl, read 1772 status
006730 08000006          btst    #6,D0           Test write rpotect bit
006734 56D0              sne     (A0)            And save
006736 1002              move.b  D2,D0           Previous select status
006738 6100025A          bsr     $6994           Recreate
00673C 302D0674          move.w  $674(A5),D0     wpstatus
006740 816D0676          or.w    D0,$676(A5)     Write wplatch
006744 4A6D0682          tst.w   $682(A5)        deslflg, floppies already deselected?
006748 6618              bne     $6762           Yes
00674A 6100028C          bsr     $69D8           Raed 1772 status register
```

```
00674E 08000007            btst    #7,D0           Motor on bit set ?
006752 6612                bne     $6766           Yes, then don't deselect
006754 103C0007            move.b  #7,D0           Both drives
006758 6100023A            bsr     $6994           Deselect
00675C 3B7C00010682        move.w  #1,$682(A5)     Set deslflg
006762 426D0680            clr.w   $680(A5)        Clear motoron flag
006766 4E75                rts

*************************************************  floplock
006768 48F978F8000006A4    movem.l D3-D7/A3-A6,$6A4 regsave
006770 9BCD                sub.l   A5,A5           Clear A5
006772 4DF9FFFF8606        lea     $FFFF8606,A6    Address of the floppy register
006778 50F900000680        st      $680            Set motoron flag
00677E 3B4006A0            move.w  D0,$6A0(A5)     deferror
006782 3B4006A2            move.w  D0,$6A2(A5)     currerr
006786 3B7C0001043E        move.w  #1,$43E(A5)     flock, disable floppy-vbl routine
00678C 2B6F0008068E        move.l  8(A7),$68E(A5)  cdma
006792 3B6F00100684        move.w  16(A7),$684(A5) cdev
006798 3B6F00120688        move.w  18(A7),$688(A5) csect
00679E 3B6F00140686        move.w  20(A7),$686(A5) ctrack
0067A4 3B6F0016068A        move.w  22(A7),$68A(A5) cside
0067AA 3B6F0018068C        move.w  24(A7),$68C(A5) ccount
0067B0 3B7C00020672        move.w  #2,$672(A5)     retrycnt
0067B6 43ED06C8            lea     $6C8(A5),A1     dsb0
0067BA 4A6D0684            tst.w   $684(A5)        cdev
0067BE 6704                beq     $67C4           Drive 0 ?
0067C0 43ED06CC            lea     $6CC(A5),A1     dsb1
0067C4 7E00                moveq.l #0,D7
0067C6 3E2D068C            move.w  $68C(A5),D7     ccount, number of sectors
0067CA E14F                lsl.w   #8,D7           Times 512
0067CC E34F                lsl.w   #1,D7
0067CE 206D068E            move.l  $68E(A5),A0     cdma, start DMA address
```

```
0067D2 D1C7              add.l   D7,A0          Plus length of sector
0067D4 2B480692          move.l  A0,$692(A5)    edma, yields end DMA address
0067D8 4A690000          tst.w   0(A1)          dcurtrack, current track
0067DC 6A20              bpl     $67FE          >= 0 ?
0067DE 61000168          bsr     $6948          No, select
0067E2 42690000          clr.w   0(A1)          Set track to zero
0067E6 610000EC          bsr     $68D4          Restore, head to track zero
0067EA 6712              beq     $67FE          OK ?
0067EC 7E0A              moveq.l #10,D7
0067EE 6172              bsr     $6862          Seek track 10
0067F0 6606              bne     $67F8          Error ?
0067F2 610000E0          bsr     $68D4          Restore
0067F6 6706              beq     $67FE          OK ?
0067F8 337CFF000000      move.w  #$FF00,0(A1)   Recalibrate, error
0067FE 4E75              rts

*************************************************

006800 7001              moveq.l #1,D0          flopfail, error in floppy routine
006802 61000226          bsr     $6A2A          Media change to 'unsure'
006806 302D06A2          move.w  $6A2(A5),D0    Set
00680A 48C0              ext.l   D0             currerr
00680C 6002              bra     $6810

*************************************************

00680E 4280              clr.l   D0             flopok, error-free floppy routine
006810 2F00              move.l  D0,-(A7)
006812 3CBC0086          move.w  #$86,(A6)      ok
006816 3E290000          move.w  0(A1),D7       Select 1772
00681A 610001A8          bsr     $69C4          Get track number
00681E 3C3C0010          move.w  #$10,D6        wdiskctl, send to disk controller
006822 610000C6          bsr     $68EA          seek command
006826 303900000684      move.w  $684,D0        flopcms
                                                cdev, drive number
```

```
00682C E548                 lsl.w   #2,D0           As index
00682E 41F900000678         lea     $678,A0         acctim
006834 21AD04BA0000         move.l  $4BA(A5),0(A0,D0.w) 200 Hz counter as last access time
00683A 0C790001000004A6     cmp.w   #1,$4A6         nflops
006842 6606                 bne     $684A

006844 216D04BA0004         move.l  $4BA(A5),4(A0)  20 Hz counter for other drives
00684A 201F                 move.l  (A7)+,D0        Restore error number
00684C 4CF978F8000006A4     movem.l $6A4,D3-D7/A3-A6 regsave
006854 42790000043E         clr.w   $43E            Clear flock, release vbl routine
00685A 4E75                 rts

************************************************

00685C 3E3900000686         move.w  $686,D7         hseek, head to track
006862 33FCFFFA000006A2     move.w  #-10,$6A2       ctrack
00686A 3CBC0086             move.w  #$86,(A6)       currerr to 'seek error'
00686E 61000154             bsr     $69C4           Pass track number
006872 3C3C0010             move.w  #$10,D6         wdsikctl
006876 60000072             bra     $68EA           Seek command
                                                    flopcmds

************************************************

00687A 33FCFFFA000006A2     move.w  #-10,$6A2       ressek, home and seek
006882 6150                 bsr     $68D4           currerr to 'seek error'
006884 664C                 bne     $68D2           Restore
006886 42690000             clr.w   0(A1)           Error ?
00688A 3CBC0082             move.w  #$82,(A6)       Current track to zero
00688E 4247                 clr.w   D7              Select track register
006890 61000132             bsr     $69C4           Track zero
006894 3CBC0086             move.w  #$86,(A6)       wdiskctl
006898 3E3C0005             move.w  #5,D7           Select data register
00689C 61000126             bsr     $69C4           Track 5
0068A0 3C3C0010             move.w  #$10,D6         wdiskctl
0068A4 6144                 bsr     $68EA           Seek command
                                                    flopcmds
```

```
0068A6 662A                bne     $68D2          Error
0068A8 337C00050000        move.w  #5,0(A1)       Track number to 5

*************************************************
0068AE 33FCFFFA000006A2    move.w  #-10,$6A2      go2track, search for trak
0068B6 3CBC0086            move.w  #$86,(A6)      currerr to 'seek error'
0068BA 3E2D0686            move.w  $686(A5),D7    Select data register
0068BE 61000104            bsr     $69C4          ctrack, load track number
0068C2 7C14                moveq.l #$14,D6        wdiskctl
0068C4 6124                bsr     $68EA          Seek with verify command
0068C6 660A                bne     $68D2          flopcmds
0068C8 336D06860000        move.w  $686(A5),0(A1) Error
0068CE CE3C0018            and.b   #$18,D7        ctrack, Save track number
0068D2 4E75                rts                    Test RNF, CRC lost data


*************************************************
0068D4 4246                clr.w   D6             restore, seek track zero
0068D6 6112                bsr     $68EA          restore command
0068D8 660E                bne     $68E8          flopcmds
0068DA 08070002            btst    #2,D7          Error
0068DE 0A3C0004            eor.b   #4,SR          Test track zero bit
0068E2 6604                bne     $68E8          Z-Flag invertieren
0068E4 42690000            clr.w   0(A1)          nicht Track Null ?
0068E8 4E75                rts                    current Track auf Null


*************************************************
0068EA 30290002            move.w  2(A1),D0       flopcmds
0068EE C03C0003            and.b   #$3,D0         Seek rate
0068F2 8C00                or.b    D0,D6          Bits 0 and 1
0068F4 2E3C00040000        move.l  #$40000,D7     OR in command word
0068FA 3CBC0080            move.w  #$80,(A6)      Timeout counter
0068FE 610000D8            bsr     $69D8          Select 1772 register
                                                  rdiskctl
```

```
006902 08000007              btst    #7,D0          Motor on ?
006906 6606                  bne     $690E          Yes
006908 2E3C00060000          move.l  #$60000,D7     Else longer timeout
00690E 610000AA              bsr     $69BA          wdiskctl6, write command in D6
006912 5387                  subq.l  #1,D7          Decrement timeout counter
006914 6712                  beq     $6928          Timed-out ?
006916 08390005FFFFFA01      btst    #5,$FFFFFA01   mfp gpip, 1772 done ?
00691E 66F2                  bne     $6912          No, wait
006920 610000AC              bsr     $69CE          rdiskctl7
006924 4246                  clr.w   D6             OK
006926 4E75                  rts

006928 6104                  bsr     $692E          Reset 1772
00692A 7C01                  moveq.l #1,D6          Error
00692C 4E75                  rts

*************************************************
00692E 3CBC0080              move.w  #$80,(A6)      Reset 1772, reset floppy controller
006932 3E3C00D0              move.w  #$D0,D7        Select command register
006936 6100008C              bsr     $69C4          Reset command
00693A 3E3C000F              move.w  #$F,D7         wdiskctl
00693E 51CFFFFE              dbra    D7,$693E       Delay counter
006946 4E75                  rts                    Timed-out ? read status

*************************************************
006948 426D0682              clr.w   $682(A5)       select, select drive and side
00694C 302D0684              move.w  $684(A5),D0    Clear deslflg
006950 5200                  addq.b  #1,D0          cdev, drive number
006952 E308                  lsl.b   #1,D0
006954 806D068A              or.w    $68A(A5),D0    Calculate bit number
006958 0A000007              eor.b   #7,D0          cside, side in bit 0
00695C C03C0007              and.b   #7,D0          Invert bits for hardware
```

```
006960 6132                bsr     $6994              Set bits in sound chip
006962 3CBC0082            move.w  #$82,(A6)          Select track register
006966 3E290000            move.w  0(A1),D7           Get track number
00696A 6158                bsr     $69C4              wdskctl
00696C 422D069C            clr.b   $69C(A5)           tmpdma, clear bits 24-31
006970 3CBC0084            move.w  #$84,(A6)          Select sector register
006974 3E2D0688            move.w  $688(A5),D7        csect, get sector number
006978 614A                bsr     $69C4              wdiskctl
00697A 13ED0691FFFF860D    move.b  $691(A5),$FFFF860D dmalow
006982 13ED0690FFFF860B    move.b  $690(A5),$FFFF860B dmamid
00698A 13ED068FFFFF8609    move.b  $68F(A5),$FFFF8609 dmahigh
006992 4E75                rts

*************************************************     setporta, set port A in sound chip
006994 40E7                move.w  SR, -(A7)          Save status
006996 007C0700            or.w    #$700,SR           IPL 7
0069A2 1239FFFF8800        move.b  $FFFF8800,D1       Read port A
0069A8 1401                move.b  D1,D2              And to D20069AA C23C00F8
0069AA C23C00FA            and.b   #$F8,D1            Clear bits 0-2
0069AE 8200                or.b    D0,D1              Set new bits
0069B0 13C1FFFF8802        move.b  D1,$FFFF8802       Write result to port A
0069B6 46DF                move.w  (A7)+,SR           Restore status
0069B8 4E75                rts

*************************************************     wdiskct6
0069BA 6124                bsr     $69E0              Delay loop for disk controller
0069BC 33C6FFFF8604        move.w  D6,$FFFF8604       dskctl
0069C2 601C                bra     $69E0              Delay loop for disk controller

*************************************************     wdiskctl
0069C4 611A                bsr     $69E0              Delay loop for disk controller
0069C6 33C7FFFF8604        move.w  D7,$FFFF8604       dskctl
```

```
0069CC 6012                bra     $69E0              Delay loop for disk controller

*****************************************************  rdiskct7
0069CE 6110                bsr     $69E0              Delay loop for disk controller
0069D0 3E39FFFF8604        move.w  $FFFF8604,D7       dskctl
0069D6 6008                bra     $69E0              Delay loop for disk controller

*****************************************************  rdiskctl
0069D8 6106                bsr     $69E0              Delay loop for disk controller
0069DA 3039FFFF8604        move.w  $FFFF8604,D0       dskctl
0069E0 40E7                move.w  SR, -(A7)          Save status
0069E2 3F07                move.w  D7,-(A7)           Save D7
0069E4 3E3C0020            move.w  #$20,D7            Counter
0069E8 51CFFFFE            dbra    D7,$69E8           Delay loop
0069EC 3E1F                move.w  (A7)+,D7           D7 back
0069EE 46DF                move.w  (A7)+,SR           Status back
0069F0 4E75                rts

*************************************************    change, tets disk change
0069F2 0C790001000004A6    cmp.w   #1,$4A6            nflops
0069FA 662C                bne     $6A28              None or 2 floppies, done
0069FC 302F0010            move.w  16(A7),D0          Drive number
006A00 B07900004692        cmp.w   $4692,D0           Equals diskette number ?
006A06 671C                beq     $6A24              Yes
006A08 3F00                move.w  D0,-(A7)           Drive number
006A0A 3F3CFFEF            move.w  #-17,-(A7)         'insert disk'
006A0E 6100EB4C            bsr     $555C              Critical error handler
006A12 584F                addq.w  #4,A7              Correct stack pointer
006A14 33FCFFFF00000676    move.w  #$FFFF,$676        wplatch, Status for both drives unsure
006A1C 33EF001000004692    move.w  16(A7),$4692       Save diskette number
006A24 426F0010            clr.w   16(A7)             Drive number to zero
006A28 4E75                rts
```

```
*****************************************************
006A2A 41F900003E2A          lea     $3E2A,A0
006A30 1F00                  move.b  D0,-(A7)
006A32 302D0684              move.w  $684(A5),D0
006A36 119F0000              move.b  (A7)+,0(A0,D0.w)
006A3A 4E75                  rts

*****************************************************
006A3C AE                    dc.b    %10101110
006A3D D6                    dc.b    %11010110
006A3E 8C                    dc.b    %10001100
006A3F 17                    dc.b    %00010111
006A40 FB                    dc.b    %11111011
006A41 80                    dc.b    %10000000
006A42 6A                    dc.b    %01101010
006A43 2B                    dc.b    %00101011
006A44 A6                    dc.b    %10100110
006A45 00                    dc.b    0

*************************************************
006A46 4BF900000000          lea     $0,A5
006A4C 41ED0A43              lea     $A43(A5),A0
006A50 610000DE              bsr     $6B30
006A54 04000050              sub.b   #80,D0
006A58 1400                  move.b  D0,D2
006A5A E982                  asl.l   #4,D2
006A5C 610000D2              bsr     $6B30
006A60 D400                  add.b   D0,D2
006A62 EB82                  asl.l   #5,D2
006A64 610000CA              bsr     $6B30
006A68 D400                  add.b   D0,D2
```

setdmode, set drive change mode
Disk mode table
Save mode
cdev, get drive number
Set drive mode

dskf, disk flags

jdostime, IKBD format in DOS format
Clear A5
Pointer to clock-time buffer
bcdbin
Subtract offset of 80
Year
Shift in position
bcdbin
Add month
And shift in position
bcdbin
Add day

```
006A6A EB82              asl.l   #5,D2          And shift in position
006A6C 610000C2          bsr     $6B30          bcdbin
006A70 D400              add.b   D0,D2          Add hour
006A72 ED82              asl.l   #6,D2          And shift in position
006A74 610000BA          bsr     $6B30          bcdbin
006A78 D400              add.b   D0,D2          Add minute
006A7A EB82              asl.l   #5,D2          And shift in position
006A7C 610000B2          bsr     $6B30          bcdbin
006A80 E208              lsr.b   #1,D0          2-second resolution
006A82 D400              add.b   D0,D2          And add seconds
006A84 2B420A4C          move.l  D2,$A4C(A5)    Save new time
006A88 1B7C00000A8E      move.b  #$0,$A8E(A5)   Clear handshake flag
006A8E 4E75              rts

************************************************
006A90 1B7CFFFF0A8E      move.b  #-1,$A8E(A5)   gettime, get current clock time and date
006A96 123C001C          move.b  #$1C,D1        Request handshake flag for time
006A9A 61000234          bsr     $6CD0          get time of day command
006A9E 4A2D0A8E          tst.b   $A8E(A5)       Send
006AA2 66FA              bne     $6A9E          New time arrived ?
006AA4 202D0A4C          move.l  $A4C(A5),D0    No, wait
006AA8 4E75              rts                    Get time in D0

************************************************
006AAA 2B6F00040A50      move.l  4(A7),$A50(A5) settime, set clock time and date
                                                Pass time

************************************************
006AB0 41F900000A5A      lea     $A5A,A0        ikbdtime
006AB6 242D0A50          move.l  $A50(A5),D2    Pointer to end of time buffer
006ABA 1002              move.b  D2,D0          Get time to convert
006ABC 0200001F          and.b   #31,D0         To d0
006AC0 E300              asl.b   #1,D0          Isolate bits 0-4, seconds
                                                2-second resolution
```

```
006AC2 6154
006AC4 EA8A
006AC6 1002
006AC8 0200003F
006ACC 614A
006ACE EC8A
006AD0 1002
006AD2 0200001F
006AD6 6140
006AD8 EA8A
006ADA 1002
006ADC 0200001F
006AE0 6136
006AE2 EA8A
006AE4 1002
006AE6 0200000F
006AEA 612C
006AEC E88A
006AEE 1002
006AF0 0200007F
006AF4 6122
006AF6 06100080
006AFA 123C001B
006AFE 610001D0
006B02 7605
006B04 45F900000A54
006B0A 610001E4
006B0E 123C001C
006B12 610001BC
006B16 4E75
```

```
bsr     $6B18
lsr.l   #5,D2
move.b  D2,D0
and.b   #63,D0
bsr     $6B18
lsr.l   #6,D2
move.b  D2,D0
and.b   #31,D0
bsr     $6B18
lsr.l   #5,D2
move.b  D2,D0
and.b   #31,D0
bsr     $6B18
lsr.l   #5,D2
move.b  D2,D0
and.b   #15,D0
bsr     $6B18
lsr.l   #4,D2
move.b  D2,D0
and.b   #$7F,D0
bsr     $6B18
add.b   #$80,(A0)
move.b  #$1B,D1
bsr     $6CD0
moveq.l #5,D3
lea     $A54,A2
bsr     $6CF0
move.b  #$1C,D1
bsr     $6CD0
rts
```

```
Convert
Minute

Isolate bits 0-5
Convert
Hours

Isolate bits 0-4
Convert
Day

Isolate bits 0-4
Convert
Month

Isolate bits 0-3
Convert
Year

Isolate bits 0-7
Convert
Add offset
Set Time Of Day command
Send to IKBD
Number of bytes to send
Address of the parameter block
Send
Get Time Of Day command
Send to IKBD
```

```
************************************************
006B18 7200             moveq.l #0,D1           binbcd, convert byte to BCD
006B1A 760A             moveq.l #10,D3          Ten's counter
006B1C 9003             sub.b   D3,D0           Load 10
006B1E 6B04             bmi     $6B24           Subtract 10
006B20 5201             addq.b  #1,D1           Increment ten's counter
006B22 60F8             bra     $6B1C
006B24 0600000A         add.b   #10,D0          Generate one's counter
006B28 E901             asl.b   #4,D1           Tens in upper nibble
006B2A D001             add.b   D1,D0           And add ones
006B2C 1100             move.b  D0,-(A0)        Write result in buffer
006B2E 4E75             rts

************************************************
006B30 7000             moveq.l #0,D0           bcdbin, convert BCD to binary
006B32 1010             move.b  (A0),D0         BCD byte
006B34 E808             lsr.b   #4,D0           Ten's place
006B36 E308             lsl.b   #1,D0
006B38 1200             move.b  D0,D1
006B3A E500             asl.b   #2,D0
006B3C D001             add.b   D1,D0
006B3E 1218             move.b  (A0)+,D1
006B40 0241000F         and.w   #15,D1          Isolate one's place
006B44 D041             add.w   D1,D0           Plus ten's place
006B46 4E75             rts

************************************************
006B48 70FF             moveq.l #-1,D0          midiost, MIDI output status
006B4A 1439FFFFFC04     move.b  $FFFFFC04,D2    Default to OK
006B50 08020001         btst    #1,D2           Read MIDI-ACIA status
006B54 6602             bne     $6B58           And test
006B56 7000             moveq.l #0,D0           OK
                                                Status not OK
```

```
006B58 4E75                rts

*************************************************

006B5A 322F0006            move.w  6(A7),D1        midiwc, output character to MIDI
006B5E 43F9FFFFFC04        lea     $FFFFFC04,A1    Get character
006B64 14290000            move.b  0(A1),D2        Pointer to MIDI-ACIA
006B68 08020001            btst    #1,D2           Get MIDI status
006B6C 67F6                beq     $6B64           Test
006B6E 13410002            move.b  D1,2(A1)        Wait until OK
006B72 4E75                rts                     Output byte to ACIA

*************************************************

006B74 7600                moveq.l #0,D3           midiws, send string to MIDI
006B76 362F0004            move.w  4(A7),D3
006B7A 246F0006            move.l  6(A7),A2        Length of string -1
006B7E 121A                move.b  (A2)+,D1        Address of the string
006B80 61DC                bsr     $6B5E           Get byte from string
006B82 51CBFFFA            dbra    D3,$6B7E        Output to MIDI
006B86 4E75                rts                     Next byte

*************************************************

006B88 41ED0A00            lea     $A00(A5),A0     midstat, MIDI receiver status
006B8C 43F9FFFFFC04        lea     $FFFFFC04,A1    iorec for MIDI
006B92 70FF                moveq.l #-1,D0          Pointer to MIDI-ACIA
006B94 45E80006            lea     6(A0),A2        OK as default
006B98 47E80008            lea     8(A0),A3        Head Index
006B9C B54B                cmpm.w  (A3)+,(A2)+     Tail Index
006B9E 6602                bne     $6BA2           Uninterruptable test
006BA0 7000                moveq.l #0,D0           Not equal
006BA2 4E75                rts                     Not OK
```

```
************************************************
006BA4 61E2             bsr     $6B88           midin, get character from MIDI
006BA6 4A40             tst.w   D0              midstat
006BA8 67FA             beq     $6BA4           Character ready ?
006BAA 40E7             move.w  SR, -(A7)       No
006BAC 007C0700         or.w    #$700,SR        Save status
006BB0 32280006         move.w  6(A0),D1        IPL 7, disable interrupts
006BB4 B2680008         cmp.w   8(A0),D1        Head index
006BB8 6716             beq     $6BD0           Compare with tail index

006BBA 5241             addq.w  #1,D1           Increment head index
006BBC B2680004         cmp.w   4(A0),D1        Greater than buffer size ?
006BC0 6502             bcs     $6BC4           No
006BC2 7200             moveq.l #0,D1           Begin at buffer start again
006BC4 22680000         move.l  0(A0),A1        Pointer to MIDI buffer
006BC8 10311000         move.b  0(A1,D1.w),D0   Get character from buffer
006BCC 31410006         move.w  D1,6(A0)        Save new head index
006BD0 46DF             move.w  (A7)+,SR        Restore status
006BD2 4E75             rts

************************************************
006BD4 242D04BA         move.l  $4BA(A5),D2     lstout, output character to Centronics
006BD8 94AD0A80         sub.l   $A80(A5),D2     200 Hz counter
006BDC 0C82000003E8     cmp.l   #1000,D2        Minus printer timeout
006BE2 6518             bcs     $6BFC           Waited more than 5 seconds ?
006BE4 242D04BA         move.l  $4BA(A5),D2     Yes, time out
006BE8 6172             bsr     $6C5C           200 Hz counter, start time for this char
006BEA 4A40             tst.w   D0              Get bust status
006BEC 6618             bne     $6C06           And test
006BEE 262D04BA         move.l  $4BA(A5),D3     Printer ready ?
006BF2 9682             sub.l   D2,D3           200 Hz counter
006BF4 0C8300001770     cmp.l   #6000,D3        Minus start time
006BFA 6DEC             blt     $6BE8           30 seconds ?
                                                Not yet reached
```

```
006BFC 7000              moveq.l #0,D0          Flag for time out
006BFE 2B6D04BA0A80      move.l  $4BA(A5),$A80(A5)  200 Hz conter as last time-out time
006C04 4E75              rts
006C06 40C3              move.w  SR, D3         Save status
006C08 007C0700          or.w    #$700,SR       IPL 7, no interrupts
006C0C 7207              moveq.l #7,D1          Mixer
006C0E 61000E28          bsr     $7A38          Select registers
006C12 00000080          or.b    #$80,D0        Port B to output
006C16 7287              moveq.l #$87,D1        Write enable
006C18 61000E1E          bsr     $7A38
006C1C 46C3              move.w  D3,SR          Restore status
006C1E 302F0006          move.w  6(A7),D0       Character to output
006C22 728F              moveq.l #$8F,D1        Write to port B
006C24 61000E12          bsr     $7A38
006C28 610C              bsr     $6C36          Strobe low
006C2A 6104              bsr     $6C30          Strobe high
006C2C 70FF              moveq.l #-1,D0         Flag for OK
006C2E 4E75              rts

*********************************************
006C30 7420              moveq.l #$20,D2        Strobe high
006C32 60000E46          bra     $7A7A          Bit 5
                                                Set

*********************************************
006C36 74DF              moveq.l #$DF,D2        Strobe low
006C38 60000E66          bra     $7AA0          Bit 5
                                                Clear

*********************************************
006C3C 7207              moveq.l #7,D1          listin, Get character from parallel port
006C3E 61000DF8          bsr     $7A38          Mixer
006C42 0200007F          and.b   #$7F,D0        Select register
006C46 7287              moveq.l #$87,D1        Port B to input
```

```
006C48 61000DEE          bsr     $7A38
006C4C 61E2              bsr     $6C30          Strobe high = not busy
006C4E 610C              bsr     $6C5C          Get parallel port status
006C50 4A40              tst.w   D0
006C52 66FA              bne     $6C4E          Wait until character arrives
006C54 61E0              bsr     $6C36          Strobe low = busy
006C56 720F              moveq.l #15,D1         Select port B
006C58 60000DDE          bra     $7A38          Read byte from port

*********************************************
006C5C 41F9FFFFFA01      lea     $FFFFFA01,A0   lstostat, parallel port status
006C62 70FF              moveq.l #-1,D0         Address of the MFP
006C64 082800000000      btst    #0,0(A0)       Default to ok
006C6A 6702              beq     $6C6E          Test busy
006C6C 7000              moveq.l #0,D0          OK
006C6E 4E75              rts                    Still busy

*********************************************
006C70 41ED09D0          lea     $9D0(A5),A0    auxistat, RS232 input status
006C74 70FF              moveq.l #-1,D0         iorec for RS232
006C76 45E80006          lea     6(A0),A2       Default to ok
006C7A 47E80008          lea     8(A0),A3       Head index
006C7E B54B              cmpm.w  (A3)+,(A2)+    Tail Index
006C80 6602              bne     $6C84          Buffer leer ?
006C82 7000              moveq.l #0,D0          No
006C84 4E75              rts                    No character there

*********************************************
006C86 61E8              bsr     $6C70          auxin, get character RS-232
006C88 4A40              tst.w   D0             auxin, character ready ?
006C8A 67FA              beq     $6C86          No, wait
006C8C 610005D8          bsr     $7266          rs232get, get character
```

```
006C90 024000FF          and.w    #$FF,D0          Isolate bits 0-7
006C94 4E75              rts

*********************************************

006C96 41ED09D0          lea      $9D0(A5),A0      auxostat, RS232 output status
006C9A 70FF              moveq.l  #-1,D0           iorec for RS232
006C9C 34280016          move.w   22(A0),D2        Default to ok
006CA0 6100087C          bsr      $751E            Tail index
006CA4 B4680014          cmp.w    20(A0),D2        Test for wrap around
006CA8 6602              bne      $6CAC            Compare with head index
006CAA 7000              moveq.l  #0,D0            Not equal
006CAC 4E75              rts                       No more space in buffer

*********************************************

006CAE 322F0006          move.w   6(A7),D1         auxout, RS232 output routine
006CB2 61000556          bsr      $720A            Get data byte
006CB6 65F6              bcs      $6CAE            rs232put, and output
006CB8 4E75              rts                       Try again

*********************************************

006CBA 70FF              moveq.l  #-1,D0           ikbdost, IKBD output status
006CBC 1439FFFFFC00      move.b   $FFFFFC00,D2     Default to ok
006CC2 08020001          btst     #1,D2            IKBD ACIA status
006CC6 6602              bne      $6CCA            Test
006CC8 7000              moveq.l  #0,D0            OK
006CCA 4E75              rts                       Not ready

*********************************************

006CCC 322F0006          move.w   6(A7),D1         ikbdwc, send character to IKBD
006CD0 43F9FFFFFC00      lea      $FFFFFC00,A1     Get byte
006CD6 14290000          move.b   0(A1),D2         Address of the keyboard ACIA
006CDA 08020001          btst     #1,D2            Get status
                                                   Ready
```

```
006CDE 67F6              beq     $6CD6          No, wait
006CE0 13410002          move.b  D1,2(A1)       Output character
006CE4 4E75              rts

************************************************

006CE6 7600              moveq.l #0,D3          ikbdws, send string to keyboard
006CE8 362F0004          move.w  4(A7),D3       Number of characters -1
006CEC 246F0006          move.l  6(A7),A2       Address of the string
006CF0 121A              move.b  (A2)+,D1       Get byte from string
006CF2 61DC              bsr     $6CD0          And output
006CF4 51CBFFFA          dbra    D3,$6CF0       Next byte
006CF8 4E75              rts

************************************************

006CFA 41ED09F2          lea     $9F2(A5),A0    constat, keyboard input status
006CFE 70FF              moveq.l #-1,D0         iorec for keyboard
006D00 45E80006          lea     6(A0),A2       Default to ok
006D04 47E80008          lea     8(A0),A3       Head index
006D08 B54B              cmpm.w  (A3)+,(A2)+    Tail index
006D0A 6602              bne     $6D0E          Buffer leer ?
006D0C 7000              moveq.l #0,D0          No
006D0E 4E75              rts                    No characters there

************************************************

006D10 61E8              bsr     $6CFA          conin, get character from keyboard
006D12 4A40              tst.w   D0             constat, key pressed ?
006D14 67FA              beq     $6D10          No, wait
006D16 40E7              move.w  SR, -(A7)      Save status
006D18 007C0700          or.w    #$700,SR       IPL 7, disable interrupts
006D1C 32280006          move.w  6(A0),D1       Head index
006D20 B2680008          cmp.w   8(A0),D1       Compare with tail index
006D24 671C              beq     $6D42
```

```
006D26 5441              addq.w  #2,D1          Head index + 2
006D28 B2680004          cmp.w   4(A0),D1       Greater than or equal buffer size ?
006D2C 6502              bcs     $6D30          No
006D2E 7200              moveq.l #0,D1          Buffer pointer back to start
006D30 22680000          move.l  0(A0),A1       Pointer to keyboard buffer
006D34 7000              moveq.l #0,D0
006D36 30311000          move.w  0(A1,D1.w),D0  Get character and scan code
006D3A 31410006          move.w  D1,6(A0)       Save new head index
006D3E E188              lsl.l   #8,D0          Scancode to bits 16-23
006D40 E048              lsr.w   #8,D0          ASCII code to bits 0-7
006D42 46DF              move.w  (A7)+,SR       Restore status
006D44 4E75              rts

************************************************     conoutst, console output status
006D46 70FF              moveq.l #-1,D0         Always OK
006D48 4E75              rts

************************************************     ringbel, tone after CTRL G
006D4A 082D00020484      btst    #2,$484(A5)    Tone enabled ?
006D50 670E              beq     $6D60          No
006D52 2B7C00007D5A0A86  move.l  #$7D5A,$A86(A5) Pointer to sound table for bell
006D5A 1B7C00000A8A      move.b  #$0,$A8A(A5)   Start sound timer
006D60 4E75              rts

************************************************     Keyboard table, unshifted
006D62 001B313233343536  dc.b    $00,esc,'1','2','3','4','5','6'
006D6A 373839309E270809  dc.b    '7','8','9','0','@',''',bs ,tab
006D72 71776572747A7569  dc.b    'q','w','e','r','t','z','u','i'
006D7A 6F70812B0D006173  dc.b    'o','p','[','+',cr, $00,'a','s'
006D82 646667686A6B6C94  dc.b    'd','f','g','h','j','k','l','\'
006D8A 8423007E79786376  dc.b    ']','#',$00,'1','y','x','c','v'
006D92 626E6D2C2E2D0000  dc.b    'b','n','m',',','.','-',$00,$00
```

```
006D9A 0020000000000000     dc.b    $00,' ',$00,$00,$00,$00,$00,$00
006DA2 0000000000000000     dc.b    $00,$00,$00,$00,$00,$00,$00,$00
006DAA 00002D0000002B00     dc.b    $00,$00,'-',$00,$00,$00,'+',$00
006DB2 0000007F00000000     dc.b    $00,$00,$00,del,$00,$00,$00,$00
006DBA 0000000000000000     dc.b    $00,$00,$00,$00,$00,$00,$00,$00
006DC2 3C000028292F2A37     dc.b    '<',$00,$00,'8',')','/','*','7'
006DCA 3839343536313233     dc.b    '8','9','4','5','6','1','2','3'
006DD2 302E0D0000000000     dc.b    '0','.',cr, $00,$00,$00,$00,$00
006DDA 0000000000000000     dc.b    $00,$00,$00,$00,$00,$00,$00,$00

**************************************************     Keyboard table, shifted
006DE2 001B2122DD242526     dc.b    $00,esc,'!','"','1','$','%','&'
006DEA 2F28293D3F600809     dc.b    '/','(',')','=','?','1',bs, tab
006DF2 51574552545A5549     dc.b    'Q','W','E','R','T','Z','U','I'
006DFA 4F509A2A0D004153     dc.b    'O','P','[','*',cr, $00,'A','S'
006E02 444647484A5B4C99     dc.b    'D','F','G','H','J','K','L','\'
006E0A 8E5E007C59584356     dc.b    ']','^',$00,'1','Y','X','C','V'
006E12 424E4D3B3A5F0000     dc.b    'B','N','M',';',':','1',$00,$00
006E1A 0020000000000000     dc.b    $00,' ',$00,$00,$00,$00,$00,$00
006E22 0000000000000037     dc.b    $00,$00,$00,$00,$00,$00,$00,'7'
006E2A 38002D3400362B00     dc.b    '8',$00,'-','4',$00,'6','+',$00
006E32 3200307F00000000     dc.b    '2',$00,'0',del,$00,$00,$00,$00
006E3A 0000000000000000     dc.b    $00,$00,$00,$00,$00,$00,$00,$00
006E42 3E000028292F2A37     dc.b    '>',$00,$00,'(',')','/','*','7'
006E4A 3839343536313233     dc.b    '8','9','4','5','6','1','2','3'
006E52 302E0D0000000000     dc.b    '0','.',cr ,$00,$00,$00,$00,$00
006E5A 0000000000000000     dc.b    $00,$00,$00,$00,$00,$00,$00,$00

**************************************************     Keybaord table, Caps Lock
006E62 001B313233343536     dc.b    $00,esc,'1','2','3','4','5','6'
006E6A 373839309E270809     dc.b    '7','8','9','0','@',''',bs, tab
006E72 51574552545A5549     dc.b    'Q','W','E','R','T','Z','U','I'
```

```
006E7A 4F509A2B0D004153     dc.b    'O','P','[','+',cr, $00,'A','S'
006E82 444647484A4B4C99     dc.b    'D','F','G','H','J','K','L','\'
006E8A 8E23007E59684356     dc.b    ']','#',$00,'1','Y','X','C','V'
006E92 424E4D2C2E2D0000     dc.b    'B','N','M',',','.','-',$00,$00
006E9A 0020000000000000     dc.b    $00,' ',$00,$00,$00,$00,$00,$00
006E9E 0000000000000000     dc.b    $00,$00,$00,$00,$00,$00,$00,$00
006EA2 0000000000000000     dc.b    $00,$00,$00,$00,$00,$00,$00,$00
006EAA 00002D0000002B00     dc.b    $00,$00,'-',$00,$00,$00,'+',$00
006EB2 0000007F00000000     dc.b    $00,$00,$00,del,$00,$00,$00,$00
006EBA 0000000000000000     dc.b    $00,$00,$00,$00,$00,$00,$00,$00
006EC2 3C000028292F2A37     dc.b    '<',$00,$00,'(',')','/','*','7'
006ECA 3839343536313233     dc.b    '8','9','4','5','6','1','2','3'
006ED2 302E0D0000000000     dc.b    '0','.',cr ,$00,$00,$00,$00,$00
006EDA 0000000000000000     dc.b    $00,$00,$00,$00,$00,$00,$00,$00

*****************************************************
006EE2 41F9FFFFFA01         lea     $FFFFFA01,A0        initnfp, initialize MFP 68901
006EE8 7000                 moveq.l #0,D0               Address of the MFP
006EEA 01C80000             movep.l D0,0(A0)            Initialize registers with zero
006EEE 01C80008             movep.l D0,8(A0)            gpip to iera
006EF2 01C80010             movep.l D0,$10(A0)          ierb to isrb
006EF6 117C00480016         move.b  #$48,22(A0)         isrb to vr
006EFC 3B7C11110A84         move.w  #$1111,$A84(A5)     MFP Non-autovektor # to $48, set S-bit
006F02 3B7C00140442         move.w  #20,$442(A5)        Timer ms to 20 milliseconds
006F08 7002                 moveq.l #2,D0               Select timer C
006F0A 7250                 moveq.l #80,D1              /64 for 200 Hz
006F0C 343C00C0             move.w  #$C0,D2             192
006F10 6100017E             bsr     $7090               Initialize timer and interrupt vector
006F14 45F900007C5C         lea     $7C5C,A2            Timer C interrupt routine
006F1A 7005                 moveq.l #5,D0               Timer C interrupt number
006F1C 61000228             bsr     $7146               initint, install interrupt
006F20 7003                 moveq.l #3,D0               Select timer D
```

```
006F22 7201
006F24 7402
006F26 61000168
006F2A 203C00980101
006F30 01C80026
006F34 61000B3A
006F38 61000B2E
006F3C 41ED09D0
006F40 43F90000705E
006F46 7021
006F48 610000EC
006F4C 41ED0A00
006F50 43F900007050
006F56 700D
006F58 610000DC
006F5C 203C0000759C
006F62 2B400A12
006F66 2B400A16
006F6A 2B7C000079C60A0E
006F72 2B7C000075580A2A
006F7A 2B7C000075680A2E
006F82 13FC0003FFFFFC04
006F8A 13FC0095FFFFFC04
006F92 1B7C00070484
006F98 2B7C00006A460A22
006FA0 203C00007034
006FA6 2B400A1A
006FAA 2B400A1E
006FAE 2B400A26
006FB2 7000
006FB4 2B400A86
006FB8 1B400A8A
```

```
moveq.l #1,D1
moveq.l #2,D2
bsr     $7090
move.l  #$980101,D0
movep.l D0,$26(A0)
bsr     $7A70
bsr     $7A68
lea     $9D0(A5),A0
lea     $705E,A1
moveq.l #33,D0
bsr     $7036
lea     $A00(A5),A0
lea     $7050,A1
moveq.l #13,D0
bsr     $7036
move.l  #$759C,D0
move.l  D0,$A12(A5)
move.l  D0,$A16(A5)
move.l  #$79C6,$A0E(A5)
move.l  #$7558,$A2A(A5)
move.l  #$7568,$A2E(A5)
move.b  #3,$FFFFFC04
move.b  #$95,$FFFFFC04
move.b  #7,$484(A5)
move.l  #$6A46,$A22(A5)
move.l  #$7034,D0
move.l  D0,$A1A(A5)
move.l  D0,$A1E(A5)
move.l  D0,$A26(A5)
moveq.l #0,D0
move.l  D0,$A86(A5)
move.b  D0,$A8A(A5)
```

```
/4 for 9600 Baud
9600 baud
Initialize timer and interrupt vector
$00, $98, $01, $01
To scr, ucr, rsr, tsr
DTR on
RTS on
Pointer to iorec for RS232
Start data for iorec
34 bytes
Copy into RAM
Pointer to iorec MIDI
Start data for iorec
14 bytes
Copy into RAM
Keyboard and MIDI error vector
Pointer to error routine keyboard
Pointer to error routine MIDI
MIDI interrupt vector


MIDI-ACIA master reset
/16, 8 bit, 1 stop bit, no parity
Key click, repeat und bell enable
clockvec
joyvec & statvec



Clear sound variables
Sound pointer
Delay timer
```

```
006FBC 1B400A8B          move.b   D0,$A8B(A5)      Temp value
006FC0 2B400A80          move.l   D0,$A80(A5)      Printer timeout
006FC4 6100FC6A          bsr      $6C30            Strobe to high
006FC8 1B7C000F0A7E      move.b   #$F,$A7E(A5)
006FCE 1B7C00020A7F      move.b   #2,$A7F(A5)
006FD4 41ED09F2          lea      $9F2(A5),A0      Pointer to iorec to keyboard
006FD8 43F900007042      lea      $7042,A1         Start data for iorec
006FDE 700D              moveq.l  #13,D0           14 bytes
006FE0 6154              bsr      $7036            Copy into RAM
006FE2 61000C0E          bsr      $7BF2            Pointer to BIOS keyboard table
006FE6 13FC0003FFFFFC00  move.b   #3,$FFFFFC00     Reset keyboard ACIA
006FEE 13FC0096FFFFFC00  move.b   #$96,$FFFFFC00   /64, 8 bits, 1 top bit, no arity
006FF6 267C00007080      move.l   #$7080,A3        Pointer to MFP Interrupt vectors
006FFC 7203              moveq.l  #3,D1            Initialize four vectors
006FFE 2401              move.l   D1,D2
007000 2001              move.l   D1,D0            Interrupt number
007002 06000009          add.b    #9,D0            Plus offset
007006 E582              asl.l    #2,D2
007008 24732000          move.l   0(A3,D2.w),A2    Get vector from table
00700C 61000138          bsr      $7146            initint, install interrupt
007010 51C9FFEC          dbra     D1,$6FFE         Next vector
007014 45ED752A          lea      $752A(A5),A2     MIDI and keyboard vector
007018 7006              moveq.l  #6,D0            Vector number 6
00701A 6100012A          bsr      $7146            initint, install interrupt vector
00701E 45ED73C0          lea      $73C0(A5),A2     CTS interrupt routine
007022 7002              moveq.l  #2,D0            Vector number 2
007024 61000120          bsr      $7146            initint, install interrupt
007028 247C0000703E      move.l   #$703E,A2        Pointer to init data for IKBD
00702E 7603              moveq.l  #3,D3            4 bytes
007030 6100FCBE          bsr      $6CF0            Send string to IKBD
007034 4E75              rts
```

```
007036 10D9                move.b  (A1)+,(A0)+        Block move
007038 51C8FFFC            dbra    D0,$7036           Next byte
00703C 4E75                rts

************************************************
00703E 8001121A            dc.b    $80,$01,$12,$1A    Reset keyboard, disable mouse und joystick

************************************************    iorec for keyboard
007042 000008D0            dc.l    $8D0               Keyboard buffer
007046 0080                dc.w    128                Length of the keyboard buffer
007048 0000                dc.w    0                  Head index
00704A 0000                dc.w    0                  Tail index
00704C 0020                dc.w    32                 Low water mark, 1/4 buffer length
00704E 0060                dc.w    96                 High water mark, 3/4 buffer length

************************************************    iorec for MIDI
007050 00000950            dc.l    $950               MIDI buffer
007054 0080                dc.w    128                Length of the MIDI buffer
007056 0000                dc.w    0                  Head index
007058 0000                dc.w    0                  Tail index
00705A 0020                dc.w    32                 Low water mark, 1/4 buffer length
00705C 0060                dc.w    96                 High water mark, 3/4 buffer length

************************************************    iorec for RS232
00705E 000006D0            dc.l    $6D0               RS232 input buffer
007062 0100                dc.w    256                Length of the input buffer
007064 0000                dc.w    0                  Head index
007066 0000                dc.w    0                  Tail index
007068 0040                dc.w    64                 Low water mark, 1/4 buffer length
00706A 00C0                dc.w    192                High water mark, 3/4 buffer length
00706C 000007D0            dc.l    $7D0               RS232 output buffer
007070 0100                dc.w    256                Length of the output buffer
```

```
007072 0000              dc.w    0          Head index
007074 0000              dc.w    0          Tail index
007C76 0040              dc.w    64         Low water mark, 1/4 buffer length
007078 00C0              dc.w    192        High water mark, 3/4 buffer length
00707A 00                dc.b    0          rsrbyte, receiver status
00707B 00                dc.b    0          tsrbyte, transmitter status
00707C 00                dc.b    0          rxoff,
00707D 00                dc.b    0          txoff
00707E 01                dc.b    1          rsmode, XON/XOFF mode
00707F 00                dc.b    0          filler

************************************************  Interrupt vectors for MFP
007080 00007426          dc.l    $7426      #9,  transmitter error
007084 00007374          dc.l    $7374      #10, transmitter interrupt
007088 00007408          dc.l    $7408      #11, receiver error
00708C 000072C0          dc.l    $72C0      #12, receiver interrupt

************************************************  setimer, initialize timer in MFP
007090 48E7F8F0          movem.l D0-D4/A0-A3,-(A7)  Save registers
007094 207CFFFFFA01      move.l  #$FFFFFA01,A0      Address MFP
00709A 267C00007124      move.l  #$7124,A3
0070A0 247C00007128      move.l  #$7128,A2
0070A6 615A              bsr     $7102
0070A8 267C00007118      move.l  #$7118,A3
0070AE 247C00007128      move.l  #$7128,A2
0070B4 614C              bsr     $7102
0070B6 267C0000711C      move.l  #$711C,A3
0070BC 247C00007128      move.l  #$7128,A2
0070C2 613E              bsr     $7102
0070C4 267C00007120      move.l  #$7120,A3
0070CA 247C00007128      move.l  #$7128,A2
0070D0 6130              bsr     $7102
```

```
0070D2 267C0000712C          move.l  #$712C,A3
0070D8 247C00007130          move.l  #$7130,A2
0070DE 6122                  bsr     $7102
0070E0 C749                  exg     A3,A1
0070E2 47F900007134          lea     $7134,A3
0070E8 7600                  moveq.l #0,D3
0070EA 16330000              move.b  0(A3,D0.w),D3
0070EE 11823000              move.b  D2,0(A0,D3.w)        Write data in MFP
0070F2 B4303000              cmp.b   0(A0,D3.w),D2        And compare
0070F6 66F6                  bne     $70EE                Until match
0070F8 C749                  exg     A3,A1
0070FA 8313                  or.b    D1,(A3)
0070FC 4CDF0F1F              movem.l (A7)+,D0-D4/A0-A3    Restore registers
007100 4E75                  rts

007102 6106                  bsr     $710A
007104 1612                  move.b  (A2),D3
007106 C713                  and.b   D3,(A3)
007108 4E75                  rts

00710A 7600                  moveq.l #0,D3
00710C D6C0                  add.w   D0,A3
00710E 1613                  move.b  (A3),D3
007110 D688                  add.l   A0,D3
007112 2643                  move.l  D3,A3
007114 D4C0                  add.w   D0,A2
007116 4E75                  rts


************************************************
007118 06060808              dc.b    6,6,8,8
00711C 0A0A0C0C              dc.b    10,10,12,12
```

```
007120 0E0E1010          dc.b    14,14,16,16
007124 12121414          dc.b    18,18,20,20

007128 DFFEDFEF          dc.b    $DF,$FE,$DF,$EF
00712C 181A1C1C          dc.b    $18,$1A,$1C,$1C
007130 00008FF8          dc.b    0,0,$8F,$F8
007134 1E202224          dc.b    $1E,$20,$22,$24

************************************************
007138 302F0004          move.w  4(A7),D0        mfpint, set MFP interrupt vector
00713C 246F0006          move.l  6(A7),A2        Interrupt number
007140 02800000000F      and.l   #15,D0          Interrupt vector
                                                 Number 0-15, long word

************************************************
007146 48E7E0E0          movem.l D0-D2/A0-A2,-(A7)  initint, Set MFP interrupt vector
00714A 6120              bsr     $716C           Save registers
00714C 2400              move.l  D0,D2           Disable interrupts
00714E E542              asl.w   #2,D2           Vector number
007150 068200000100      add.l   #$100,D2        As index for long word
007156 2242              move.l  D2,A1           Plus base of the MFP vectors
007158 228A              move.l  A2,(A1)         Vector addres
00715A 614A              bsr     $71A6           Set new vector
00715C 4CDF0707          movem.l (A7)+,D0-D2/A0-A2  Enable interrupts
007160 4E75              rts                     Restore registers

************************************************
007162 302F0004          move.w  4(A7),D0        disint, disable MFP interrupts
007166 02800000000F      and.l   #15,D0          Get interrupt number
00716C 48E7C0C0          movem.l D0-D1/A0-A1,-(A7)  Convert to long word index
007170 41F9FFFFFA01      lea     $FFFFFA01,A0    Save registers
007176 43E80012          lea     18(A0),A1       Address the MFP
00717A 614A              bsr     $71C6           Address imra
                                                 Calculate bit number to clear
```

```
00717C 0391              bclr    D1,(A1)          And clear bit
00717E 43E80006          lea     6(A0),A1         Address iera
007182 6142              bsr     $71C6            Calculate bit number to clear
007184 0391              bclr    D1,(A1)          And clear bit
007186 43E8000A          lea     10(A0),A1        Address ipra
00718A 613A              bsr     $71C6            Calculate bit number to clear
00718C 0391              bclr    D1,(A1)          And clear bit
00718E 43E8000E          lea     14(A0),A1        Address isra
007192 6132              bsr     $71C6            Calculate bit number to clear
007194 0391              bclr    D1,(A1)          And clear bit
007196 4CDF0303          movem.l (A7)+,D0-D1/A0-A1 Restore registers
00719A 4E75              rts

*************************************************

00719C 302F0004          move.w  4(A7),D0         jenabint, enable MFP interrupts
0071A0 02800000000F      and.l   #15,D0           Vector number
0071A6 48E7C0C0          movem.l D0-D1/A0-A1,-(A7) In long word index
0071AA 41F9FFFFFA01      lea     $FFFFFA01,A0     Restore registers
0071B0 43E80006          lea     6(A0),A1         Address MFP
0071B4 6110              bsr     $71C6            Address iera
0071B6 03D1              bset    D1,(A1)          Calculate bit number to set
0071B8 43E80012          lea     18(A0),A1        And set bit
0071BC 6108              bsr     $71C6            Address imra
0071BE 03D1              bset    D1,(A1)          Calculate bit number to set
0071C0 4CDF0303          movem.l (A7)+,D0-D1/A0-A1 And set bit
0071C4 4E75              rts                      Restore registers

*************************************************

0071C6 1200              move.b  D0,D1            bselect, calculate bit and register number
0071C8 0C000008          cmp.b   #8,D0            Save interrupt number
0071CC 6D02              blt     $71D0            Greater than 8 ?
                                                  No
```

```
0071CE 5141              subq.w  #8,D1          Else subtract offset
0071D0 0C000008          cmp.b   #8,D0          Greater than 8 ?
0071D4 6C02              bge     $71D8          Yes
0071D6 5449              addq.w  #2,A1          Pointer from a to b register
0071D8 4E75              rts

************************************************

0071DA 41F9000009D0      lea     $9D0,A0        rs232ptr
0071E0 43F9FFFFFA01      lea     $FFFFFA01,A1   Pointer to RS232 iorec
0071E6 4E75              rts                    Pointer to MFP

************************************************

0071E8 34280008          move.w  8(A0),D2       rs232ibuf
0071EC 36280006          move.w  6(A0),D3       Tail index
0071F0 B443              cmp.w   D3,D2          Head index
0071F2 6204              bhi     $71F8          Head > tail ?
0071F4 D4680004          add.w   4(A0),D2       No
0071F8 9443              sub.w   D3,D2          Add buffer size
0071FA 4E75              rts                    Tail - head

************************************************

0071FC 082800010020      btst    #1,32(A0)      rtschk
007202 6704              beq     $7208          RTS/CTS mode ?
007204 61000862          bsr     $7A68          No
007208 4E75              rts                    rtson

************************************************

00720A 40E7              move.w  SR, -(A7)      rs232put, RS232 output
00720C 007C0700          or.w    #$700,SR       Save status
007210 61C8              bsr     $71DA          IPL 7, disable interrupts
007212 082800000020      btst    #0,32(A0)      rs232ptr, get buffer pointer
007218 6706              beq     $7220          XON/XOFF mode ?
                                                No
```

```
00721A 4A28001F          tst.b   31(A0)          XON active ?
00721E 6618              bne     $7238           Yes
007220 08290007002C      btst    #7,44(A1)       Is MFP still sending ?
007226 6710              beq     $7238           Yes
007228 34280014          move.w  20(A0),D2       Head index
00722C B4680016          cmp.w   22(A0),D2       Tail index
007230 6606              bne     $7238           Still characters in buffer?
007232 1341002E          move.b  D1,46(A1)       Pass byte to MFP
007236 601A              bra     $7252

007238 34280016          move.w  22(A0),D2       Tail index
00723C 610002E0          bsr     $751E           Test for wrap around
007240 B4680014          cmp.w   20(A0),D2       Compare with head index
007244 6716              beq     $725C           Same, buffer full
007246 2268000E          move.l  14(A0),A1       Get current buffer address
00724A 13812000          move.b  D1,0(A1,D2.w)   Write character in buffer
00724E 31420016          move.w  D2,22(A0)       Save new tail index
007252 61A8              bsr     $71FC           rtschk, set RTS ?
007254 46DF              move.w  (A7)+,SR        Restore status flag
007256 023C00FE          and.b   #254,SR         Clear carry flag
00725A 4E75              rts

00725C 619E              bsr     $71FC           rtschk, set RTS ?
00725E 46DF              move.w  (A7)+,SR        Restore status
007260 003C0001          or.b    #1,SR           Set carry flag, don't output char
007264 4E75              rts

************************************************

007266 40E7              move.w  SR, -(A7)       rs232get, RS232 input
007268 007C0700          or.w    #$700,SR        Save status
00726C 6100FF6C          bsr     $71DA           IPL 7, disable interrupts
007270 32280006          move.w  6(A0),D1        rs232ptr, get RS232 pointer
                                                 Head index
```

```
007274 B2680008          cmp.w    8(A0),D1        Tail index
007278 671A              beq      $7294           No character in buffer ?
00727A 61000296          bsr      $7512           Test for wrap around
00727E 22680000          move.l   0(A0),A1        Get buffer address
007282 7000              moveq.l  #0,D0

007284 10311000          move.b   0(A1,D1.w),D0   Get character from buffer
007288 31410006          move.w   D1,6(A0)        Set new head index
00728C 46DF              move.w   (A7)+,SR        Restore status
00728E 023C00FE          and.b    #254,SR         Clear carry flag, OK
007292 6006              bra      $729A

007294 46DF              move.w   (A7)+,SR        Restore status
007296 003C0001          or.b     #1,SR           Set carry flag, no character there
00729A 082800000020      btst     #0,32(A0)       XON/XOFF mode ?
0072A0 671C              beq      $72BE           No
0072A2 4A28001E          tst.b    30(A0)          XON active?
0072A6 6716              beq      $72BE           No
0072A8 6100FF3E          bsr      $71E8           Get input biffer length used
0072AC B468000A          cmp.w    10(A0),D2       Equal low water mark ?
0072B0 660C              bne      $72BE           No
0072B2 123C0011          move.b   #$11,D1         XON
0072B6 6100FF52          bsr      $720A           Send
0072BA 4228001E          clr.b    30(A0)          Clear XON flag
0072BE 4E75              rts

************************************************

0072C0 48E7F0E0          movem.l  D0-D3/A0-A2,-(A7)   rcvint, RS232 receiver interrupt routine
0072C4 6100FF14          bsr      $71DA           Save registers
0072C8 1169002A001C      move.b   42(A1),28(A0)   rs232ptr, get RS232 pointer
0072CE 08280007001C      btst     #7,28(A0)       Read receiver status register
0072D4 67000092          beq      $7368           Interrupt through receiver buffer full ?
0072D8 082800010020      btst     #1,32(A0)       No
                                                  RTS/CTS mode ?
```

```
0072DE 6704              beq     $72E4           No
0072E0 61000782          bsr     $7A64           rtsoff
0072E4 1029002E          move.b  46(A1),D0       Read data from receiver register
0072E8 082800010020      btst    #1,32(A0)       RTS/CTS mode ?
0072EE 6624              bne     $7314           Yes
0072F0 082800000020      btst    #0,32(A0)       XON/XOFF mode ?
0072F6 671C              beq     $7314           No
0072F8 0C000011          cmp.b   #17,D0          XON received ?
0072FC 6608              bne     $7306           No
0072FE 117C0000001F      move.b  #$0,31(A0)      Clear XOFF flag
007304 6062              bra     $7368           Character not in buffer

007306 0C000013          cmp.b   #19,D0          Receive XOFF ?
00730A 6608              bne     $7314           No
00730C 117C00FF001F      move.b  #$FF,31(A0)     Set XOFF flag
007312 6054              bra     $7368           Character not in buffer

007314 32280008          move.w  8(A0),D1        Tail index
007318 610001F8          bsr     $7512           Test for wrap around
00731C B2680006          cmp.w   6(A0),D1        Head equal tail ?
007320 6746              beq     $7368           Yes
007322 24680000          move.l  0(A0),A2        Get buffer address
007326 15801000          move.b  D0,0(A2,D1.w)   Received byte in buffer
00732A 31410008          move.w  D1,8(A0)        Save new tail index
00732E 6100FEB8          bsr     $71E8           Get input buffer length used
007332 B468000C          cmp.w   12(A0),D2       Equal high water mark ?
007336 6624              bne     $735C           No
007338 082800010020      btst    #1,32(A0)       RTS/CTS mode ?
00733E 6628              bne     $7368           Yes
007340 082800000020      btst    #0,32(A0)       XON/XOFF mode ?
007346 6714              beq     $735C           No
007348 4A28001E          tst.b   30(A0)          XOFF already sent ?
```

```
00734C 660E              bne     $735C           Yes
00734E 117C00FF001E      move.b  #$FF,30(A0)     Set flag for XOFF
007354 123C0013          move.b  #$13,D1         XOFF
007358 6100FEB0          bsr     $720A           Send
00735C 082800010020      btst    #1,32(A0)       RTS/CTS mode ?
007362 6704              beq     $7368           No
007364 61000702          bsr     $7A68           rtson
007368 08A90004000E      bclr    #4,14(A1)       Clear interrupt service bit
00736E 4CDF070F          movem.l (A7)+,D0-D3/A0-A2  Restore registers
007372 4E73              rte

************************************************  txrint, tramsmitter buffer empty
007374 48E720E0          movem.l D2/A0-A2,-(A7)  Save registers ?
007378 6100FE60          bsr     $71DA           rs232ptr, get RS232 pointer
00737C 082800010020      btst    #1,32(A0)       RTS/CTS mode ?
007382 6630              bne     $73B4           Yes, then use this interrupt
007384 082800000020      btst    #0,32(A0)       XON/XOFF mode ?
00738A 6706              beq     $7392           No
00738C 4A28001F          tst.b   31(A0)          XOFF active ?
007390 6622              bne     $73B4           Yes
007392 1169002C001D      move.b  44(A1),29(A0)   Save transmitter status register
007398 34280014          move.w  20(A0),D2       Head index
00739C B4680016          cmp.w   22(A0),D2       Compare with tail index
0073A0 6712              beq     $73B4           Send buffer empty
0073A2 6100017A          bsr     $751E           Test for wrap arround
0073A6 2468000E          move.l  14(A0),A2       Pointer to send buffer
0073AA 13722000002E      move.b  0(A2,D2.w),46(A1)  Pass byte to MFP for sending
0073B0 31420014          move.w  D2,20(A0)       Save new head index
0073B4 08A90002000E      bclr    #2,14(A1)       Clear interrupt service bit
0073BA 4CDF0704          movem.l (A7)+,D2/A0-A2  Restore registers
0073BE 4E73              rte
```

```
*****************************************************     ctsint, CTS interrupt routine
0073C0 48E720E0             movem.l D2/A0-A2,-(A7)      Save registers
0073C4 6100FE14             bsr     $71DA               rs232ptr, get RS232 pointer
0073C8 082800010020         btst    #1,32(A0)           RTS/CTS mode ?
0073CE 672A                 beq     $73FA               No, then ignore interrupt
0073D0 1169002C001D         move.b  44(A1),29(A0)       Save transmitter status
0073D6 08280007001D         btst    #7,29(A0)           Transmitter buffer empty ?
0073DC 67F8                 beq     $73D6               No, wait (must jump to $73D0!)
0073DE 34280014             move.w  20(A0),D2           Head index
0073E2 B4680016             cmp.w   22(A0),D2           Compare with tail index
0073E6 671E                 beq     $7406               Transmit buffer empty
0073E8 61000134             bsr     $751E               Test for wrap arround
0073EC 2468000E             move.l  14(A0),A2           Pointer to transmit buffer
0073F0 13722000002E         move.b  0(A2,D2.w),46(A1)   Pass byte to MFP for sending
0073F6 31420014             move.w  D2,20(A0)           Save new head index
0073FA 08A900020010         bclr    #2,16(A1)           Clear interrupt service bit
007400 4CDF0704             movem.l (A7)+,D2/A0-A2      Restore registers
007404 4E73                 rte

007406 60F2                 bra     $73FA               Transmit buffer empty

*****************************************************     rxerror, receive error
007408 48E780C0             movem.l D0/A0-A1,-(A7)      Save registers
00740C 6100FDCC             bsr     $71DA               rs232ptr, get RS232 pointer
007410 1169002A001C         move.b  42(A1),28(A0)       Save receiver status
007416 1029002E             move.b  46(A1),D0           Read data register (clears status)
00741A 08A90003000E         bclr    #3,14(A1)           Clear interrupt service bit
007420 4CDF0301             movem.l (A7)+,D0/A0-A1      Restore registers
007424 4E73                 rte

*****************************************************     txerror, transmit error
007426 48E700C0             movem.l A0-A1,-(A7)         Save registers
```

```
00742A 6100FDAE          bsr      $71DA          rs232ptr, get RS232 pointer
00742E 1169002C001D      move.b   44(A1),29(A0)  Save transmitter status
007434 08A90001000E      bclr     #1,14(A1)      Clear interrupt service bit
00743A 4CDF0300          movem.l  (A7)+/A0-A1    Restore registers
00743E 4E73              rte

*************************************************
007440 7200              moveq.l  #0,D1          iorec, get pointer to table
007442 322F0004          move.w   4(A7),D1       Get device number
007446 40E7              move.w   SR, -(A7)      Save status
007448 007C0700          or.w     #$700,SR       IPL 7, disable interrupts
00744C 45F90000745C      lea      $745C,A2       Base address of the table
007452 E581              asl.l    #2,D1          Times 4 for long word
007454 20321800          move.l   0(A2,D1.l),D0  Get pointer to iorec
007458 46DF              move.w   (A7)+,SR       Restore status
00745A 4E75              rts

*************************************************
00745C 000009D0          dc.l     $9D0           iorec table
007460 000009F2          dc.l     $9F2           RS232
007464 00000A00          dc.l     $A00           IKBD
                                                 MIDI

*************************************************
007468 007C0700          or.w     #$700,SR       rsconf, configure RS232
00746C 6100FD6C          bsr      $71DA          IPL 7, disable interrupts
007470 0F490028          movep.l  $28(A1),D7     rs232ptr, get RS232 pointer
007474 7000              moveq.l  #0,D0          Save ucr, rsr, tsr, scr
007476 1340002A          move.b   D0,42(A1)      Disable receiver
00747A 1340002C          move.b   D0,44(A1)      Disable transmitter
00747E 4A6F0006          tst.w    6(A7)          Mode
007482 6B0A              bmi      $748E          Negative, then don't set
007484 116F00070020      move.b   7(A7),32(A0)   Reset rsmode
```

```
00748A 7000          moveq.l #0,D0
00748C 7400          moveq.l #0,D2
00748E 4A6F0004      tst.w   4(A7)          Baud rate
007492 6B20          bmi     $74B4          Negativce, then don't change
007494 322F0004      move.w  4(A7),D1       Get baud rate number
007498 45F9000074F2  lea     $74F2,A2       Table for baud rate control
00749E 10321000      move.b  0(A2,D1.w),D0  Get value from table
0074A2 45F900007502  lea     $7502,A2       Table for baud rate data
0074A8 14321000      move.b  0(A2,D1.w),D2  Get value from table
0074AC 2200          move.l  D0,D1
0074AE 7003          moveq.l #3,D0          Pointer to timer D
0074B0 6100FBDE      bsr     $7090          Set timer D for new baud rate
0074B4 4A6F0008      tst.w   8(A7)          Set ucr ?
0074B8 6B06          bmi     $74C0          No
0074BA 136F00090028  move.b  9(A7),40(A1)   Set ucr
0074C0 4A6F000A      tst.w   10(A7)         Set rsr ?
0074C4 6B06          bmi     $74CC          No
0074C6 136F000B002A  move.b  11(A7),42(A1)  Set rsr
0074CC 4A6F000C      tst.w   12(A7)         Set tsr ?
0074D0 6B06          bmi     $74D8          No
0074D2 136F000D002C  move.b  13(A7),44(A1)  Set tsr
0074D8 4A6F000E      tst.w   14(A7)         Set scr ?
0074DC 6B06          bmi     $74E4          No
0074DE 136F000F0026  move.b  15(A7),38(A1)  Set scr
0074E4 7001          moveq.l #1,D0
0074E6 1340002A      move.b  D0,42(A1)      Enable receiver
0074EA 1340002C      move.b  D0,44(A1)      Enable transmitter
0074EE 2007          move.l  D7,D0          Old value of the control register
0074F0 4E75          rts

***********************************************  Timer values for RS-232 baud rates
0074F2 0101010101010101      dc.b    1,1,1,1,1,1,1  High byte
```

```
0074FA 0101010101010202      dc.b    1,1,1,1,1,2,2
007502 01020405080A0B10      dc.b    1,2,4,5,8,10,11,16     Low byte
00750B 204060808FAF4060      dc.b    32,64,96,128,143,175,64,96

************************************************  wrapin, test for wrap arround
007512 5241                  addq.w  #1,D1          Head index + 1
007514 B2680004              cmp.w   4(A0),D1       Equal to buffer size ?
007518 6502                  bcs     $751C          No
00751A 7200                  moveq.l #0,D1          Else start with zero again
00751C 4E75                  rts

************************************************  wrapout, test for wrap arround
00751E 5242                  addq.w  #1,D2          Tail index + 1
007520 B4680012              cmp.w   18(A0),D2      Equals buffer size ?
007524 6502                  bcs     $7528          No
007526 7400                  moveq.l #0,D2          Else start with zero again
007528 4E75                  rts

************************************************  midikey, keyboard + MIDI interrupt
00752A 48E7FFFE              movem.l D0-D7/A0-A6,-(A7)  Save registers
00752E 4BF900000000          lea     $0,A5          Clear A5
007534 246D0A2A              move.l  $A2A(A5),A2    mbufrec, $7558
007538 4E92                  jsr     (A2)           Interrupt from MIDI-ACIA ?
00753A 246D0A2E              move.l  $A2E(A5),A2    kbufrec, $7568
00753E 4E92                  jsr     (A2)           Interrupt vfromon Keyboard-ACIA ?
007540 08390004FFFFFA01      btst    #4,$FFFFFA01   Still interrupt ?
007548 67EA                  beq     $7534          Yes
00754A 08B90006FFFFFA11      bclr    #6,$FFFFFA11   Clear interrupt service bit
007552 4CDF7FFF              movem.l (A7)+,D0-D7/A0-A6  Restore registers
007556 4E73                  rte
```

```
**************************************************  MIDI interrupt
007558 41ED0A00              lea     $A00(A5),A0    iorec for MIDI
00755C 43F9FFFFFC04          lea     $FFFFFC04,A1   Address of the MIDI ACIA
007562 246D0A16              move.l  $A16(A5),A2    $759C, MIDI error routine
007566 600E                  bra     $7576

**************************************************  Keyboard interrupt
007568 41ED09F2              lea     $9F2(A5),A0    iorec for keyboard
00756C 43F9FFFFFC00          lea     $FFFFFC00,A1   Address of the keyboard-ACIA
007572 246D0A12              move.l  $A12(A5),A2    $759C, Keyboard error routine
007576 14290000              move.b  0(A1),D2       Get ACIA status
00757A 08020007              btst    #7,D2          Interrupt request ?
00757E 671C                  beq     $759C          No
007580 08020000              btst    #0,D2          Receiver buffer full ?
007584 670A                  beq     $7590          No
007586 48E720E0              movem.l D2/A0-A2,-(A7) Save registers
00758A 6112                  bsr     $759E          arcvint, get byte
00758C 4CDF0704              movem.l (A7)+,D2/A0-A2 Restore registers
007590 02020020              and.b   #$20,D2        Mark bit tested
007594 6706                  beq     $759C          No error
007596 10290002              move.b  2(A1),D0       Read data clear status
00759A 4ED2                  jmp     (A2)           Execute error routine
00759C 4E75                  rts

**************************************************  arcvint, get byte from ACIA
00759E 10290002              move.b  2(A1),D0       Get data from ACIA
0075A2 B1FC000009F2          cmp.l   #$9F2,A0       Keyboard ACIA ?
0075A8 66000416              bne     $79C0          No, MIDI
0075AC 4A2D0A32              tst.b   $A32(A5)       Keyboard state
0075B0 6654                  bne     $7606
0075B2 0C0000F6              cmp.b   #$F6,D0        Keypress ?
0075B6 650000F4              bcs     $76AC          Yes
```

```
0075BA 040000F6          sub.b   #$F6,D0          Subtract offset
0075BE 0280000000FF      and.l   #$FF,D0

0075C4 47F9000075F2      lea     $75F2,A3         Pointer to IKBD code table
0075CA 1B7300000A32      move.b  0(A3,D0.w),$A32(A5)  Save IKBD merken
0075D0 47F9000075FC      lea     $75FC,A3         Pointer to IKBD lengths table
0075D6 1B7300000A33      move.b  0(A3,D0.w),$A33(A5)  IKBD index
0075DC 064000F6          add.w   #$F6,D0          Add offset again
0075E0 0C0000F8          cmp.b   #$F8,D0          Mouse position record ?
0075E4 6D0A              blt     $75F0            No
0075E6 0C0000FB          cmp.b   #$FB,D0          Mouse position record ?
0075EA 6E04              bgt     $75F0            No
0075EC 1B400A40          move.b  D0,$A40(A5)      Save mouse position
0075F0 4E75              rts

*************************************************
0075F2 01020303030304050607                      IKBD parameter
0075FC 07050202020206020101                      Status codes
                                                 Lengths

*************************************************
007606 0C2D00060A32      cmp.b   #6,$A32(A5)      Joystick record ?
00760C 64000084          bcc     $7692            Yes
007610 45F900007656      lea     $7656,A2         Pointer to IKBD parameter table
007616 7400              moveq.l #0,D2
007618 142D0A32          move.b  $A32(A5),D2      Kstate
00761C 5302              subq.b  #1,D2            1 - 5 => 0 - 4
00761E E342              asl.w   #1,D2            Times 2
007620 D42D0A32          add.b   $A32(A5),D2      + 1
007624 5302              subq.b  #1,D2            1 - 5 => 0 - 4
007626 E542              asl.w   #2,D2            Times 4
007628 20722000          move.l  0(A2,D2.w),A0    IKBD record pointer
00762C 22722004          move.l  4(A2,D2.w),A1    IKBD index base
007630 24722008          move.l  8(A2,D2.w),A2    IKBD interrupt routine
```

```
007634 2452              move.l  (A2),A2          Get interrupt vector
007636 7400              moveq.l #0,D2
007638 142D0A33          move.b  $A33(A5),D2      Get IKBD index
00763C 93C2              sub.l   D2,A1            Minus base
00763E 1280              move.b  D0,(A1)
007640 532D0A33          subq.b  #1,$A33(A5)      IKBD index minus 1
007644 4A2D0A33          tst.b   $A33(A5)         Test index
007648 660A              bne     $7654
00764A 2F08              move.l  A0,-(A7)         Pass record pointer
00764C 4E92              jsr     (A2)             Execute interrupt routine
00764E 584F              addq.w  #4,A7            Correct stack pointer
007650 422D0A32          clr.b   $A32(A5)         Clear IKBD state
007654 4E75              rts

*********************************************      Parameter table for IKBD
007656 00000A34          dc.l    $A34
00765A 00000A3B          dc.l    $A3B
00765E 00000A1A          dc.l    $A1A
007662 00000A3B          dc.l    $A3B
007666 00000A40          dc.l    $A40
00766A 00000A1E          dc.l    $A1E
00766E 00000A40          dc.l    $A40
007672 00000A43          dc.l    $A43
007676 00000A1E          dc.l    $A1E
00767A 00000A43          dc.l    $A43
00767E 00000A49          dc.l    $A49
007682 00000A22          dc.l    $A22
007686 00000A49          dc.l    $A49
00768A 00000A4B          dc.l    $A4B
00768E 00000A26          dc.l    $A26

*********************************************
```

```
007692 223C00000A4A          move.l   #$A4A,D1
007698 D22D0A32              add.b    $A32(A5),D1
00769C 5D01                  subq.b   #6,D1
00769E 2441                  move.l   D1,A2
0076A0 1480                  move.b   D0,(A2)
0076A2 246D0A26              move.l   $A26(A5),A2      Joystick interrupt routine
0076A6 41ED0A49              lea      $A49(A5),A0      Address of joystick data
0076AA 609E                  bra      $764A

*************************************************
0076AC 122D0A5D              move.b   $A5D(A5),D1      Process received keyboard codes
0076B0 0C00002A              cmp.b    #$2A,D0          Load shift status
0076B4 6606                  bne      $76BC            Left shift key pressed ?
0076B6 08C10001              bset     #1,D1            No
0076BA 6074                  bra      $7730            Set bit for left shift key
0076BC 0C0000AA              cmp.b    #$AA,D0          Left shift key released ?
0076C0 6606                  bne      $76C8            No
0076C2 08810001              bclr     #1,D1            Clear bit for left shift key
0076C6 6068                  bra      $7730
0076C8 0C000036              cmp.b    #$36,D0          Right shift key pressed ?
0076CC 6606                  bne      $76D4            No
0076CE 08C10000              bset     #0,D1            Set bit for right shift key
0076D2 605C                  bra      $7730
0076D4 0C0000B6              cmp.b    #$B6,D0          Right shift key released ?
0076D8 6606                  bne      $76E0            No
0076DA 08810000              bclr     #0,D1            Clear bit for right shift key
0076DE 6050                  bra      $7730
0076E0 0C00001D              cmp.b    #$1D,D0          CTRL key pressed ?
0076E4 6606                  bne      $76EC            No
0076E6 08C10002              bset     #2,D1            Set bit for CTRL key
0076EA 6044                  bra      $7730
0076EC 0C00009D              cmp.b    #$9D,D0          CTRL key released ?
```

```
0076F0 6606              bne     $76F8          No
0076F2 08810002          bclr    #2,D1          Clear bit for CTRL key
0076F6 6038              bra     $7730
0076F8 0C000038          cmp.b   #$38,D0        ALT key pressed ?
0076FC 6606              bne     $7704          No
0076FE 08C10003          bset    #3,D1          Set bit for ALT key
007702 602C              bra     $7730
007704 0C0000B8          cmp.b   #$B8,D0        ALT key released ?
007708 6606              bne     $7710 .        No
00770A 08810003          bclr    #3,D1          Clear bit for ALT key
00770E 6020              bra     $7730
007710 0C00003A          cmp.b   #$3A,D0        CAPS LOCK key pressed ?
007714 6620              bne     $7736          No
007716 082D00000484      btst    #0,$484(A5)    Get console configuration
00771C 670E              beq     $772C          No key click
00771E 2B7C00007D780A86  move.l  #$7D78,$A86(A5) Addrss of the key click sound table
007726 1B7C00000A8A      move.b  #$0,$A8A(A5)   Start sound
00772C 08410004          bchg    #4,D1          Invert CAPS LOCK status
007730 1B410A5D          move.b  D1,$A5D(A5)    Save new shift status
007734 4E75              rts

007736 08000007          btst    #7,D0          Was key released ?
00773A 662A              bne     $7766          Yes
00773C 4A2D0A7B          tst.b   $A7B(A5)       Repeat ?
007740 6616              bne     $7758          Yes
007742 1B400A7B          move.b  D0,$A7B(A5)    Save key code for repeat
007746 1B7900000A7E0A7C  move.b  $A7E,$A7C(A5)  Delay 1
00774E 1B7900000A7F0A7D  move.b  $A7F,$A7D(A5)  Delay 2
007756 603A              bra     $7792
007758 1B7C00000A7C      move.b  #$0,$A7C(A5)   Clear delay counter
00775E 1B7C00000A7D      move.b  #$0,$A7D(A5)   Clear delay counter
```

```
007764 602C
007766 4A2D0A7B
00776A 670E
00776C 7200
00776E 1B410A7B
007772 1B410A7C
007776 1B410A7D
00777A 0C0000C7
00777E 6708
007780 0C0000D2
007784 66000238
007788 082D00030A5D
00778E 6700022E
007792 082D00000484
007798 670E
00779A 2B7C00007D780A86
0077A2 1B7C00000A8A
0077A8 2F08
0077AA 7200
0077AC 1200
0077AE 206D0A5E
0077B2 0240007F
0077B6 082D00040A5D
0077BC 6704
0077BE 206D0A66
0077C2 082D00000A5D
0077C8 6608
0077CA 082D00010A5D
0077D0 671A
```

```
bra     $7792
tst.b   $A7B(A5)
beq     $777A
moveq.l #0,D1
move.b  D1,$A7B(A5)
move.b  D1,$A7C(A5)
move.b  D1,$A7D(A5)
cmp.b   #$C7,D0
beq     $7788
cmp.b   #$D2,D0
bne     $79BE
btst    #3,$A5D(A5)
beq     $79BE
btst    #0,$484(A5)
beq     $77A8
move.l  #$7D78,$A86(A5)
move.b  #$0,$A8A(A5)
move.l  A0,-(A7)
moveq.l #0,D1
move.b  D0,D1
move.l  $A5E(A5),A0
and.w   #$7F,D0
btst    #4,$A5D(A5)
beq     $77C2
move.l  $A66(A5),A0
btst    #0,$A5D(A5)
bne     $77D2
btst    #1,$A5D(A5)
beq     $77EC
```

```
HOME key released ?
Yes
INSERT key released ?
No
ALTkey still pressed ?
No
Console status
No key click
Address of the sound table for key click
Start sound
Save iorec for keybaord

Scan code to D1
Address of the standard keyboard table

CAPS LOCK active ?
No
Address of the CAPS LOCK keyboard table
Right shift key pressed ?
Yes
Left shift key pressed ?
No
```

```
0077D2 0C00003B  cmp.b   #59,D0      Function key ?
0077D6 6510      bcs     $77E8       No
0077D8 0C000044  cmp.b   #68,D0      Function key ?
0077DC 620A      bhi     $77E8       No
0077DE 06410019  add.w   #25,D1      Add offset to GSX standard
0077E2 7000      moveq.l #0,D0
0077E4 600001B2  bra     $7998
0077E8 206D0A62  move.l  $A62(A5),A0  Address of the shift keyboard table
0077EC 10300000  move.b  0(A0,D0.w),D0 Get ASCII code from the table
0077F0 082D00020A5D btst  #2,$A5D(A5) CTRL key pressed ?
0077F6 6760      beq     $7858       No
0077F8 0C00000D  cmp.b   #13,D0      Carriage return
0077FC 6604      bne     $7802       No
0077FE 700A      moveq.l #10,D0      Convert to linefeed
007800 672A      beq     $782C
007802 0C010047  cmp.b   #$47,D1     CTRL HOME ?
007806 6608      bne     $7810       No
007808 06410030  add.w   #$30,D1     Add $30 to GSX standard
00780C 6000018A  bra     $7998
007810 0C01004B  cmp.b   #$4B,D1     CTRL cursor left ?
007814 6608      bne     $781E
007816 7273      moveq.l #$73,D1     Convert to GSX standard
007818 7000      moveq.l #0,D0
00781A 6000017C  bra     $7998
00781E 0C01004D  cmp.b   #$4D,D1     CTRL cursor right ?
007822 6608      bne     $782C
007824 7274      moveq.l #$74,D1     Convert to GSX standard
007826 7000      moveq.l #0,D0
007828 6000016E  bra     $7998
00782C 0C000032  cmp.b   #$32,D0
007830 6606      bne     $7838
007832 7000      moveq.l #0,D0
```

```
007834 60000162          bra     $7998
007838 0C000036          cmp.b   #$36,D0
00783C 6606              bne     $7844
00783E 701E              moveq.l #$1E,D0
007840 60000156          bra     $7998
007844 0C00002D          cmp.b   #$2D,D0
007848 6606              bne     $7850
00784A 701F              moveq.l #$1F,D0
00784C 6000014A          bra     $7998
007850 0240001F          and.w   #$1F,D0
007854 60000142          bra     $7998
007858 082D00030A5D      btst    #3,$A5D(A5)
00785E 67000138          beq     $7998
007862 0C01001A          cmp.b   #$1A,D1
007866 6618              bne     $7880
007868 103C0040          move.b  #$40,D0
00786C 142D0A5D          move.b  $A5D(A5),D2
007870 02020003          and.b   #3,D2
007874 67000122          beq     $7998
007878 103C005C          move.b  #$5C,D0
00787C 6000011A          bra     $7998
007880 0C010027          cmp.b   #$27,D1
007884 6618              bne     $789E
007886 103C005B          move.b  #$5B,D0
00788A 142D0A5D          move.b  $A5D(A5),D2
00788E 02020003          and.b   #3,D2
007892 67000104          beq     $7998
007896 103C007B          move.b  #$7B,D0
00789A 600000FC          bra     $7998
00789E 0C010028          cmp.b   #$28,D1
0078A2 6618              bne     $78BC
0078A4 103C005D          move.b  #$5D,D0
```

```
ALT key pressed ?
No
'Ü' ?
No
'@'
Shift status
Left and/or right shift key pressed?
No
'\'

'Ö' ?
No
'['
Shift status
Left and/or right shift key pressed?
No
'{'

'Ä' ?

''
```

```
0078A8 142D0A5D     move.b  $A5D(A5),D2     Shift status
0078AC 02020003     and.b   #3,D2           Left and/or right shift key pressed?
0078B0 670000E6     beq     $7998           No
0078B4 103C007D     move.b  #$7D,D0         '}'
0078B8 600000DE     bra     $7998
0078BC 0C010062     cmp.b   #$62,D1         ATL HELP ?
0078C0 660A         bne     $78CC           No
0078C2 526D04EE     addq.w  #1,$4EE(A5)     Set dumpflg for hardcopy
0078C6 205F         move.l  (A7)+,A0        Restore keyboard iorec
0078C8 600000F4     bra     $79BE           Done

0078CC 45F900007A2C lea     $7A2C,A2        Pointer to mouse scancode table
0078D2 7403         moveq.l #3,D2           Test 4 values
0078D4 B2322000     cmp.b   0(A2,D2.w),D1   Value found ?
0078D8 6700010E     beq     $79E8           Yes
0078DC 51CAFFF6     dbra    D2,$78D4        Next value
0078E0 0C010048     cmp.b   #$48,D1         Cursor up ?
0078E4 661C         bne     $7902           No
0078E6 123C0000     move.b  #0,D1           X offset for cursor up
0078EA 143CFFF8     move.b  #-8,D2          Y offset for cursor up
0078EE 102D0A5D     move.b  $A5D(A5),D0     Get shift status
0078F2 02000003     and.b   #3,D0           Left and/or right shift key pressed?
0078F6 6700010E     beq     $7A06           No
0078FA 143CFFFF     move.b  #-1,D2          Only one pixel up with shift
0078FE 60000106     bra     $7A06
007902 0C01004B     cmp.b   #$4B,D1         Cursor left ?
007906 661C         bne     $7924           No
007908 143C0000     move.b  #0,D2           Y offset for cursor left
00790C 123CFFF8     move.b  #-8,D1          X offset for cursor left
007910 102D0A5D     move.b  $A5D(A5),D0     Get shift status
007914 02000003     and.b   #3,D0           Left and/or right shift key pressed?
007918 670000EC     beq     $7A06           No
```

```
00791C 123CFFFF  move.b  #$-1,D1      Only one pixels left with shift
007920 600000E4  bra     $7A06
007924 0C01004D  cmp.b   #$4D,D1      Cursor right ?
007928 661C      bne     $7946        No
00792A 123C0008  move.b  #8,D1        X offset for cursor right
00792E 143C0000  move.b  #0,D2        Y offset for cursor right
007932 102D0A5D  move.b  $A5D(A5),D0  Shift status
007936 02000003  and.b   #3,D0        Left and/or right shift key pressed?
00793A 670000CA  beq     $7A06        No
00793E 123C0001  move.b  #1,D1        Only one pixel right with shift
007942 600000C2  bra     $7A06
007946 0C010050  cmp.b   #$50,D1      Cursor down ?
00794A 661C      bne     $7968        No
00794C 123C0000  move.b  #0,D1        X offset for cursor down
007950 143C0008  move.b  #8,D2        Y offset for cursor down
007954 102D0A5D  move.b  $A5D(A5),D0  Shift status
007958 02000003  and.b   #3,D0        Left and/or right shift key pressed?
00795C 670000A8  beq     $7A06        No
007960 143C0001  move.b  #1,D2        Only one pixel down with shift
007964 600000A0  bra     $7A06
007968 0C010002  cmp.b   #2,D1        '1'
00796C 650C      bcs     $797A        Not greater or equal
00796E 0C01000D  cmp.b   #$D,D1       '='
007972 6206      bhi     $797A        Not less or equal
007974 06010076  add.b   #$76,D1
007978 600C      bra     $7986
00797A 0C000041  cmp.b   #$41,D0      'A'
00797E 650A      bcs     $798A
007980 0C00005A  cmp.b   #$5A,D0      'Z'
007984 6204      bhi     $798A
007986 7000      moveq.l #0,D0
007988 600E      bra     $7998
```

```
00798A 0C000061          cmp.b   #$61,D0          'a'
00798E 6508              bcs     $7998
007990 0C00007A          cmp.b   #$7A,D0          'z'
007994 6202              bhi     $7998
007996 60EE              bra     $7986

007998 E141              asl.w   #8,D1            Scancode to bits 8-15
00799A D041              add.w   D1,D0            ASCII code to bits 0-7
00799C 205F              move.l  (A7)+,A0         Get iorec pointer
00799E 32280008          move.w  8(A0),D1         Tail index
0079A2 5441              addq.w  #2,D1            Plus 2
0079A4 B2680004          cmp.w   4(A0),D1         End of buffer reached ?
0079A8 6502              bcs     $79AC            No
0079AA 7200              moveq.l #0,D1            Buffer pointer back to buffer start
0079AC B2680006          cmp.w   6(A0),D1         Head equal tail ?
0079B0 670C              beq     $79BE            Yes, buffer full
0079B2 24680000          move.l  0(A0),A2         Buffer address
0079B6 35801000          move.w  D0,0(A2,D1.w)    Write data in buffer
0079BA 31410008          move.w  D1,8(A0)         New tail index
0079BE 4E75              rts

*************************************************  midibyte
0079C0 246D0A0E          move.l  $A0E(A5),A2      Pointer to MIDI interrupt handler
0079C4 4ED2              jmp     (A2)             Execute routine

*************************************************  sysmidi
0079C6 32280008          move.w  8(A0),D1         Tail index
0079CA 5241              addq.w  #1,D1            Increment
0079CC B2680004          cmp.w   4(A0),D1         End of buffer reached ?
0079D0 6502              bcs     $79D4            No
0079D2 7200              moveq.l #0,D1            Buffer pointer back to start
0079D4 B2680006          cmp.w   6(A0),D1         Head equal tail ?
0079D8 670C              beq     $79E6            Yes, buffer full
```

```
0079DA 24680000          move.l  0(A0),A2        Buffer address
0079DE 15801000          move.b  D0,0(A2,D1.w)   Write received byte in buffer
0079E2 31410008          move.w  D1,8(A0)        New tail index
0079E6 4E75              rts

*************************************************
0079E8 7605              moveq.l #5,D3           keymaus1
0079EA 08010004          btst    #4,D1           Accept right button
0079EE 6702              beq     $79F2
0079F0 7606              moveq.l #6,D3           is right button ($47/$C7)
0079F2 08010007          btst    #7,D1           left button
0079F6 6706              beq     $79FE           Pressed or released ?
0079F8 07AD0A5D          bclr    D3,$A5D(A5)     Pressed
0079FC 6004              bra     $7A02           Clear bit for key
0079FE 07ED0A5D          bset    D3,$A5D(A5)     Set bit for key
007A02 7200              moveq.l #0,D1
007A04 7400              moveq.l #0,D2

*************************************************
007A06 41ED0A5A          lea     $A5A(A5),A0     keymaus
007A0A 246D0A1E          move.l  $A1E(A5),A2     Pointer to mouse-emulator buffer
007A0E 4280              clr.l   D0              Mouse interrupt vector
007A10 102D0A5D          move.b  $A5D(A5),D0     Get status of the "mouse" buttons
007A14 EA08              lsr.b   #5,D0           Bit for right button to bit 0
007A16 060000F8          add.b   #$F8,D0         Plus relative mouse header
007A1A 11400000          move.b  D0,0(A0)        Byte in buffer
007A1E 11410001          move.b  D1,1(A0)        Store X value
007A22 11420002          move.b  D2,2(A0)        Store Y value
007A26 4E92              jsr     (A2)            Call mouse interrupt routine
007A28 205F              move.l  (A7)+,A0        Restore iorec for keyboard
007A2A 4E75              rts
```

```
*************************************************
007A2C 47C7                dc.b    $47,$C7,$52,$D2

*************************************************
007A30 302F0004            move.w  4(A7),D0
007A38 40E7                move.w  SR, -(A7)
007A3A 007C0700            or.w    #$700,SR
007A3E 48E76080            movem.l D1-D2/A0,-(A7)
007A42 41F9FFFF8800        lea     $FFFF8800,A0
007A48 1401                move.b  D1,D2
007A4A 0201000F            and.b   #15,D1
007A4E 1081                move.b  D1,(A0)
007A50 E302                asl.b   #1,D2
007A52 6404                bcc     $7A58
007A54 11400002            move.b  D0,2(A0)
007A58 7000                moveq.l #0,D0
007A5A 1010                move.b  (A0),D0
007A5C 4CDF0106            movem.l (A7)+,D1-D2/A0
007A60 46DF                move.w  (A7)+,SR
007A62 4E75                rts

*************************************************
007A64 7408                moveq.l #8,D2
007A66 6012                bra     $7A7A

*************************************************
007A68 74F7                moveq.l #$F7,D2
007A6A 6034                bra     $7AA0

*************************************************
007A6C 7410                moveq.l #16,D2
007A6E 600A                bra     $7A7A
```

```
muskey1
Scan code mouse substitute

giaccess, read/write sound chip
Data
Save status
IPL 7, disable interrupts
Save registers
Address of the sound chip
Get register number
Registers 0-15
Select register
Test read/write bit
Read
Write data byte in sound chip register

Read byte from sound chip register
Restore registers
Restore status


rts off, disable RTS

Set bit in port A

rts on, enable RTS

Clear bit in port A

dtr off, disable DTR

Set bit in port A
```

```
*************************************************
007A70 74EF                moveq.l #-17,D2
007A72 602C                bra     $7AA0

*************************************************
007A74 7400                moveq.l #0,D2
007A76 342F0004            move.w  4(A7),D2
007A7A 48E7E000            movem.l D0-D2,-(A7)
007A7E 40E7                move.w  SR, -(A7)
007A80 007C0700            or.w    #$700,SR
007A84 720E                moveq.l #14,D1
007A86 2F02                move.l  D2,-(A7)
007A88 61AE                bsr     $7A38
007A8A 241F                move.l  (A7)+,D2
007A8C 8002                or.b    D2,D0
007A8E 728E                moveq.l #$8E,D1
007A90 61A6                bsr     $7A38
007A92 46DF                move.w  (A7)+,SR
007A94 4CDF0007            movem.l (A7)+,D0-D2
007A98 4E75                rts

*************************************************
007A9A 7400                moveq.l #0,D2
007A9C 342F0004            move.w  4(A7),D2
007AA0 48E7E000            movem.l D0-D2,-(A7)
007AA4 40E7                move.w  SR, -(A7)
007AA6 007C0700            or.w    #$700,SR
007AAA 720E                moveq.l #14,D1
007AAC 2F02                move.l  D2,-(A7)
007AAE 6188                bsr     $7A38
007AB0 241F                move.l  (A7)+,D2
```

dtroff, enable DTR

Clear bit in port A

ongibit, set bit in sound chip port A

```
Get bit pattern
Save registers
Save status
IPL 7, disable interrupts
Port A
Save bit number
Select port A
Bit number back
Set bit(s)
Write to port A
Write new value
Restore status
Restore registers
```

offgibit, clear bit in sound chip port A

```
Get bit pattern
Save registers
Save status
IPL 7, disable interrupts
Port A
Save bit pattern
Select port A
Restore bit pattern
```

```
007AB2 C002              and.b   D2,D0          Clear bit(s)
007AB4 728E              moveq.l #$8E,D1       Write to port A
007AB6 6180              bsr     $7A38         Write new value
007AB8 46DF              move.w  (A7)+,SR      Restore status
007ABA 4CDF0007          movem.l (A7)+,D0-D2   Restore registers
007ABE 4E75              rts

*************************************************
007AC0 4A6F0004          tst.w   4(A7)         initmouse
007AC4 6726              beq     $7AEC         Disable mouse ?
007AC6 2B6F000A0A1E      move.l  10(A7),$A1E(A5) Yes disable mouse
007ACC 266F0006          move.l  6(A7),A3      Mouse interrupt vector
007AD0 0C6F00010004      cmp.w   #1,4(A7)      Address of the paramater block
007AD6 6724              beq     $7AFC         Relative mouse ?
007AD8 0C6F00020004      cmp.w   #2,4(A7)      Yes
007ADE 6736              beq     $7B16         Absolute mouse ?
007AE0 0C6F00040004      cmp.w   #4,4(A7)      Yes
007AE6 6770              beq     $7B58         Keycode mouse ?
007AE8 7000              moveq.l #0,D0         Yes
007AEA 4E75              rts                   Error, invalid

*************************************************
007AEC 7212              moveq.l #$12,D1       Disable mouse
007AEE 6100F1E0          bsr     $6CD0         Disable mouse command
007AF2 2B7C00007BC00A1E  move.l  #$7BC0,$A1E(A5) Send to. IKBD
007AFA 6070              bra     $7B6C         Mouse interrupt vector to RTS

*************************************************
007AFC 45ED0A6A          lea     $A6A(A5),A2   Relative mouse
007B00 14FC0008          move.b  #$8,(A2)+     Transfer buffer pointer
007B04 14FC000B          move.b  #$B,(A2)+     Relative mouse
007B08 6166              bsr     $7B70         Relative mouse threshold x, y
                                               Set mouse paramaters
```

```
007B0A 7606              moveq.l #6,D3          Length of the strings - 1
007B0C 45ED0A6A          lea     $A6A(A5),A2    Transfer buffer pointer
007B10 6100F1DE          bsr     $6CF0          Send string to IKBD
007B14 6056              bra     $7B6C

*************************************************

007B16 45ED0A6A          lea     $A6A(A5),A2    Absolute mouse
007B1A 14FC0009          move.b  #9,(A2)+       Transfer buffer pointer
007B1E 14EB0004          move.b  4(A3),(A2)+    Absolute mouse
007B22 14EB0005          move.b  5(A3),(A2)+    xmax msb
007B26 14EB0006          move.b  6(A3),(A2)+    xmax lsb
007B2A 14EB0007          move.b  7(A3),(A2)+    ymax msb
007B2E 14FC000C          move.b  #$C,(A2)+      ymax lsb
007B32 613C              bsr     $7B70          Absolute mouse scale
007B34 14FC000E          move.b  #$E,(A2)+      Set mouse parameters
007B38 14FC0000          move.b  #0,(A2)+       Initial absolute mouse position
007B3C 14EB0008          move.b  8(A3),(A2)+    Fill byte
007B40 14EB0009          move.b  9(A3),(A2)+    Start position x msb
007B44 14EB000A          move.b  10(A3),(A2)+   Start position x lsb
007B48 14EB000B          move.b  11(A3),(A2)+   Start position y msb
007B4C 7610              moveq.l #16,D3         Start position y lsb
007B4E 45ED0A6A          lea     $A6A(A5),A2    String length -1
007B52 6100F19C          bsr     $6CF0          Transfer buffer pointer
007B56 6014              bra     $7B6C          Send string to IKBD
007B58 45ED0A6A          lea     $A6A(A5),A2
007B5C 14FC000A          move.b  #$A,(A2)+      Transfer buffer pointer
007B60 610E              bsr     $7B70          Mouse keycode mode
007B62 7605              moveq.l #5,D3          Set mouse parameters
007B64 45ED0A6A          lea     $A6A(A5),A2    Length of the string -1
007B68 6100F186          bsr     $6CF0          Transfer buffer pointer
007B6C 70FF              moveq.l #-1,D0         Send string to IKBD
007B6E 4E75              rts                    Flag for OK
```

```
*************************************************
007B70 14EB0002          move.b  2(A3),(A2)+      setmouse, set mouse parameters
007B74 14EB0003          move.b  3(A3),(A2)+      x threshold, scale, delta
007B78 7210              moveq.l #16,D1           y threshold, scale, delta
007B7A 922B0000          sub.b   0(A3),D1         Top/bottom ?
007B7E 14C1              move.b  D1,(A2)+
007B80 14FC0007          move.b  #7,(A2)+
007B84 14EB0001          move.b  1(A3),(A2)+
007B88 4E75              rts

*************************************************
007B8A 7000              moveq.l #0,D0            xbtimer, initialize timer
007B8C 7200              moveq.l #0,D1
007B8E 7400              moveq.l #0,D2
007B90 302F0004          move.w  4(A7),D0         Timer number (0-3 => A - D)
007B94 322F0006          move.w  6(A7),D1         Value for control register
007B98 342F0008          move.w  8(A7),D2         Value for data register
007B9C 6100F4F2          bsr     $7090            Set timer values
007BA0 4AAF000A          tst.l   10(A7)           Interrupt vector
007BA4 6B1A              bmi     $7BC0            Not used ?
007BA6 246F000A          move.l  10(A7),A2        Interrupt vector
007BAA 7200              moveq.l #0,D1
007BAC 43F900007BC2      lea     $7BC2,A1         Table for determining interrupt number
007BB2 0280000000FF      and.l   #$FF,D0
007BB8 10310000          move.b  0(A1,D0.w),D0    Get interrupt number
007BBC 6100F588          bsr     $7146            initint, set MFP interrupt
007BC0 4E75              rts

*************************************************
007BC2 0D080504          dc.b    13,8,5,4         Interrupt numbers of the MFP timers
```

```
*************************************************
007BC6 4AAF0004             tst.l   4(A7)
007BCA 6B06                 bmi     $7BD2
007BCC 2B6F00040A5E         move.l  4(A7),$A5E(A5)
007BD2 4AAF0008             tst.l   8(A7)
007BD6 6B06                 bmi     $7BDE
007BD8 2B6F00080A62         move.l  8(A7),$A62(A5)
007BDE 4AAF000C             tst.l   12(A7)
007BE2 6B06                 bmi     $7BEA
007BE4 2B6F000C0A66         move.l  12(A7),$A66(A5)
007BEA 203C00000A5E         move.l  #$A5E,D0
007BF0 4E75                 rts

*************************************************
007BF2 2B7C00006D620A5E     move.l  #$6D62,$A5E(A5)
007BFA 2B7C00006DE20A62     move.l  #$6DE2,$A62(A5)
007C02 2B7C00006E620A66     move.l  #$6E62,$A66(A5)
007C0A 4E75                 rts

*************************************************
007C0C 202D0A86             move.l  $A86(A5),D0
007C10 222F0004             move.l  4(A7),D1
007C14 6B08                 bmi     $7C1E
007C16 2B410A86             move.l  D1,$A86(A5)
007C1A 422D0A8A             clr.b   $A8A(A5)
007C1E 4E75                 rts

*************************************************
007C20 302D0A8C             move.w  $A8C(A5),D0
007C24 4A6F0004             tst.w   4(A7)
007C28 6B06                 bmi     $7C30
007C2A 3B6F00040A8C         move.w  4(A7),$A8C(A5)
```

```
keytrans, set keyboard table
Change standard table ?
No
Address of the standard table
Change shift table ?
No
Address of the shift table
Change CAPS LOCK table ?
No
Address of the CAPS LOCK table
Pointer to address of the table


bioskeys, set standard keyboard table
Standard table
Shift table
CAPS LOCK table


dosound, start sound
Get sound status
Address of the sound table
Negative, don't set
New sound table
Start sound table


setprt, set/get printer configuration
Get printer configuration
New value
Negative, don't set
Set printer configuration
```

```
007C30 4E75                rts

*************************************************      kbrate, set/get keyboard repeat
007C32 302D0A7E            move.w  $A7E(A5),D0         Delay before key repeat
007C36 4A6F0004            tst.w   4(A7)               Test new value
007C3A 6B16                bmi     $7C52               Negative, don't set
007C3C 322F0004            move.w  4(A7),D1
007C40 1B410A7E            move.b  D1,$A7E(A5)         Set new value
007C44 4A6F0006            tst.w   6(A7)               Repeat rate
007C48 6B08                bmi     $7C52               Negative, don't set
007C4A 322F0006            move.w  6(A7),D1
007C4E 1B410A7F            move.b  D1,$A7F(A5)         Set new value
007C52 4E75                rts

*************************************************      ikbdvecs, pointers to IKBD + MIDI vectors
007C54 203C00000A0E        move.l  #$A0E,D0            Address of the vector table
007C5A 4E75                rts

*************************************************      timercint, timer C interrupt
007C5C 52B9000004BA        addq.l  #1,$4BA             Increment 200 Hz counter
007C62 E7F900000A84        rol.w   $A84                Rotate divisor bit
007C68 6A4E                bpl     $7CB8               Not fourth interrupt, then done
007C6A 48E7FFFE            movem.l D0-D7/A0-A6,-(A7)   Save registers
007C6E 4BF900000000        lea     $0,A5               Clear A5
007C74 614C                bsr     $7CC2               Process sound
007C76 082D00010484        btst    #1,$484(A5)         Key repeat enabled ?
007C7C 672A                beq     $7CA8               No
007C7E 4A2D0A7B            tst.b   $A7B(A5)           Key pressed ?
007C82 6724                beq     $7CA8               No
007C84 4A2D0A7C            tst.b   $A7C(A5)           Counter for start delay
007C88 6706                beq     $7C90               Not active
007C8A 532D0A7C            subq.b  #1,$A7C(A5)         Decrement counter
```

```
007C8E 6618                bne     $7CA8          Not run out ?
007C90 532D0A7D            subq.b  #1,$A7D(A5)    Decrement counter for repeat delay
007C94 6612                bne     $7CA8          Not run out
007C96 1B6D0A7F0A7D        move.b  $A7F(A5),$A7D(A5)  Reload counter
007C9C 102D0A7B            move.b  $A7B(A5),D0    Key to repeat
007CA0 41ED09F2            lea     $9F2(A5),A0    Pointer to iorec keyboard
007CA4 6100FAEC            bsr     $7792          Key code in keyboard buffer
007CA8 3F2D0442            move.w  $442(A5),-(A7) 20 millseconds per call
007CAC 206D0400            move.l  $400(A5),A0    Get event timer vector
007CB0 4E90                jsr     (A0)           Execute routine
007CB2 544F                addq.w  #2,A7          Correct stack pointer
007CB4 4CDF7FFF            movem.l (A7)+,D0-D7/A0-A6  Restore registers
007CB8 08B90005FFFFFA11    bclr    #5,$FFFFFA11   Clear interrupt service bit
007CC0 4E73                rte

*************************************************  sndirq, sound interrupt routine
007CC2 48E7C080            movem.l D0-D1/A0,-(A7) Restore registers
007CC6 202D0A86            move.l  $A86(A5),D0    Pointer to sound table
007CCA 67000088            beq     $7D54          No sound active ?
007CCE 2040                move.l  D0,A0          Pointer to A0
007CD0 102D0A8A            move.b  $A8A(A5),D0    Load timer value
007CD4 6708                beq     $7CDE          New sound started ?
007CD6 5300                subq.b  #1,D0          Else decrement timer
007CD8 1B400A8A            move.b  D0,$A8A(A5)    And save value
007CDC 6076                bra     $7D54          Done

007CDE 1018                move.b  (A0)+,D0       Get sound command
007CE0 6B2E                bmi     $7D10          Bit 7 set, then special command
007CE2 13C0FFFF8800        move.b  D0,$FFFF8800   Select register in sound chip
007CE8 0C000007            cmp.b   #7,D0          Register 7?
007CEC 661A                bne     $7D08          No
007CEE 1218                move.b  (A0)+,D1       Data for register 7
```

```
007CF0 0201003F          and.b   #$3F,D1          Isolate bits 0 - 5
007CF4 1039FFFF8800      move.b  $FFFF8800,D0     Read mixer
007CFA 020000C0          and.b   #$C0,D0          Isolate bits 6-7
007CFE 8001              or.b    D1,D0            OR data
007D00 13C0FFFF8802      move.b  D0,$FFFF8802     Write byte in sound chip register
007D06 60D6              bra     $7CDE            New sound command
007D08 13D8FFFF8802      move.b  (A0)+,$FFFF8802  Write byte directly in sound chip
007D0E 60CE              bra     $7CDE            Next sound command

007D10 5200              addq.b  #1,D0            Was command $FF ?
007D12 6A32              bpl     $7D46            Yes
007D14 0C000081          cmp.b   #$81,D0          Was command $80 ?
007D18 6606              bne     $7D20            No
007D1A 1B580A8B          move.b  (A0)+,$A8B(A5)   Save byte for later
007D1E 60BE              bra     $7CDE            Next sound command

007D20 0C000082          cmp.b   #$82,D0          Command > $81 ?
007D24 6620              bne     $7D46            Yes, set timer
007D26 13D8FFFF8800      move.b  (A0)+,$FFFF8800  Select register
007D2C 1018              move.b  (A0)+,D0         Add increment-value
007D2E D12D0A8B          add.b   D0,$A8B(A5)
007D32 1018              move.b  (A0)+,D0         End value
007D34 13ED0A8BFFFF8802  move.b  $A8B(A5),$FFFF8802  Write value in sound chip register
007D3C B02D0A8B          cmp.b   $A8B(A5),D0      End value reached ?
007D40 670E              beq     $7D50            Yes
007D42 5948              subq.w  #4,A0            Sound pointer back to same command
007D44 600A              bra     $7D50
007D46 1B580A8A          move.b  (A0)+,$A8A(A5)   Next value as delay timer
007D4A 6604              bne     $7D50
007D4C 307C0000          move.w  #0,A0            Sound pointer to zero
007D50 2B480A86          move.l  A0,$A86(A5)      And save
007D54 4CDF0103          movem.l (A7)+,D0-D1/A0   Restore registers
```

```
007D58 4E75                rts

*************************************************     bellsnd, tone after CTRL G
007D5A 0034                dc.b    0,$34
007D5C 0100                dc.b    1,0
007D5E 0200                dc.b    2,0
007D60 0300                dc.b    3,0
007D62 0400                dc.b    4,0
007D64 0500                dc.b    5,0
007D66 0600                dc.b    6,0
007D68 07FE                dc.b    7,$FE           Envelope channel A
007D6A 0810                dc.b    8,$10
007D6C 0900                dc.b    9,0
007D6E 0A00                dc.b    10,0
007D70 0B00                dc.b    11,0
007D72 0C10                dc.b    12,$10
007D74 0D09                dc.b    13,9
007D76 FF00                dc.b    $FF,0

*************************************************     keyclk, key click
007D78 003B                dc.b    0,$3B
007D7A 0100                dc.b    1,0
007D7C 0200                dc.b    2,0
007D7E 0300                dc.b    3,0
007D80 0400                dc.b    4,0
007D82 0500                dc.b    5,0
007D84 0600                dc.b    6,0
007D86 07FE                dc.b    7,$FE
007D88 0810                dc.b    8,$10           Envelope channel A
007D8A 0D03                dc.b    13,3            Envelope single attack
007D8C 0B80                dc.b    11,$80
007D8E 0C01                dc.b    12,1
```

```
007D90 FF00                dc.b    $FF,0

*****************************************************  Hardcopy

007D92 4E560000            link    A6,#0
007D96 48E7070C            movem.l D5-D7/A4-A5,-(A7)    Save registers
007D9A 2A6E0008            move.l  8(A6),A5             Address if the parameter block
007D9E 287C00002600        move.l  #$2600,A4            Address of the working memory
007DA4 7E1E                moveq.l #30,D7               30 bytes
007DA6 6004                bra     $7DAC
007DA8 18DD                move.b  (A5)+,(A4)+          Put parameters in working memory
007DAA 5347                subq.w  #1,D7
007DAC 4A47                tst.w   D7                   Next byte
007DAE 6EF8                bgt     $7DA8
007DB0 4AB90000261A        tst.l   $261A                p masks, half-tone mask
007DB6 6708                beq     $7DC0                Not used ?
007DB8 20390000261A        move.l  $261A,D0             Load mask
007DBE 6006                bra     $7DC6
007DC0 203C00016D4C        move.l  #$16D4C,D0           Default mask
007DC6 23C00000261A        move.l  D0,$261A             p masks
007DCC 0C79000100002618    cmp.w   #1,$2618             p port
007DD4 6306                bls     $7DDC
007DD6 70FF                moveq.l #-1,D0               Set flag
007DD8 60000BC6            bra     $89A0                Error, stop

007DDC 4A7900002618        tst.w   $2618                p port
007DE2 6704                beq     $7DE8                Centronics ?
007DE4 4240                clr.w   D0                   0= RS232
007DE6 6002                bra     $7DEA
007DE8 7001                moveq.l #1,D0                1= Centronics
007DEA 13C0000025FE        move.b  D0,$25FE             Printer port
007DF0 4A7900002608        tst.w   $2608                Height
007DF6 6642                bne     $7E3A                Not zero ?
```

```
007DF8 6028              bra     $7E22
007DFA 4A79000004EE      tst.w   $4EE
007E00 6632              bne     $7E34
007E02 207900002600      move.l  $2600,A0
007E08 1010              move.b  (A0),D0
007E0A 4880              ext.w   D0
007E0C 3E80              move.w  D0,(A7)
007E0E 61000B9A          bsr     $89AA
007E12 52B900002600      addq.l  #1,$2600
007E18 4A40              tst.w   D0
007E1A 6706              beq     $7E22
007E1C 70FF              moveq.l #-1,D0
007E1E 60000B80          bra     $89A0

007E22 4240              clr.w   D0
007E24 303900002606      move.w  $2606,D0
007E2A 537900002606      subq.w  #1,$2606
007E30 4A40              tst.w   D0
007E32 66C6              bne     $7DFA
007E34 4240              clr.w   D0
007E36 60000B68          bra     $89A0

007E3A 0C79000300002616  cmp.w   #3,$2616
007E42 6306              bls     $7E4A
007E44 70FF              moveq.l #-1,D0
007E46 60000B58          bra     $89A0

007E4A 0C79000100002610  cmp.w   #1,$2610
007E52 6306              bls     $7E5A
007E54 70FF              moveq.l #-1,D0
007E56 60000B48          bra     $89A0
```

```
scrdump flag, ALT HELP pressed again?
Yes, stop
blkptr
Get byte from video RAM

On the stack
Output byte
Increment blkptr
Output OK ?
Yes
Set flag
Error, stop


width, screen width
Decrement width
Already zero ?
No, output next byte
Flag for OK
Done

p type, Epson B/W matrix

Set flag
Error, stop

dstres, printer resolution

Set flag
Error, stop
```

```
007E5A 0C7900020000260E    cmp.w   #2,$260E        srcres, screen resolution
007E62 6306                bls     $7E6A
007E64 70FF                moveq.l #-1,D0          Set flag
007E66 60000B38            bra     $89A0           Error, stop

007E6A 0C79000700002604    cmp.w   #7,$2604        Test offset
007E72 6306                bls     $7E7A
007E74 70FF                moveq.l #-1,D0          Set flag
007E76 60000B28            bra     $89A0           Error, stop

007E7A 4A790000260E        tst.w   $260E           srcres, screen resolutionm
007E80 6704                beq     $7E86           Low resolution ?
007E82 4240                clr.w   D0
007E84 6002                bra     $7E88
007E86 7001                moveq.l #1,D0
007E88 13C000004F82        move.b  D0,$4F82        Flag for low resolution
007E8E 0C7900010000260E    cmp.w   #1,$260E        srcres
007E96 6704                beq     $7E9C           Medium resolution ?
007E98 4240                clr.w   D0
007E9A 6002                bra     $7E9E
007E9C 7001                moveq.l #1,D0
007E9E 13C000004ED6        move.b  D0,$4ED6        Flag for medium resolution
007EA4 0C7900020000260E    cmp.w   #2,$260E        srcres, screen resolution
007EAC 6704                beq     $7EB2           High resolution ?
007EAE 4240                clr.w   D0
007EB0 6002                bra     $7EB4
007EB2 7001                moveq.l #1,D0
007EB4 13C000004ED8        move.b  D0,$4ED8        Flag for high resolution
007EBA 4A7900002610        tst.w   $2610           dstres, printer resolution
007EC0 6704                beq     $7EC6           Test mode ?
007EC2 4240                clr.w   D0              Quality mode
007EC4 6002                bra     $7EC8
```

```
007EC6 7001              moveq.l #1,D0
007EC8 13C000004EE8      move.b  D0,$4EE8
007ECE 0C79000100002616  cmp.w   #1,$2616
007ED6 6704              beq     $7EDC
007ED8 4240              clr.w   D0
007EDA 6002              bra     $7EDE
007EDC 7001              moveq.l #1,D0
007EDE 13C0000047CE      move.b  D0,$47CE
007EE4 0C79000200002616  cmp.w   #2,$2616
007EEC 6704              beq     $7EF2
007EEE 4240              clr.w   D0
007EF0 6002              bra     $7EF4
007EF2 7001              moveq.l #1,D0
007EF4 13C000004F84      move.b  D0,$4F84
007EFA 0C79000300002616  cmp.w   #3,$2616
007F02 6704              beq     $7F08
007F04 4240              clr.w   D0
007F06 6002              bra     $7F0A
007F08 7001              moveq.l #1,D0
007F0A 13C0000047D0      move.b  D0,$47D0
007F10 4A3900004F84      tst.b   $4F84
007F16 6706              beq     $7F1E
007F18 70FF              moveq.l #-1,D0
007F1A 60000A84          bra     $89A0

007F1E 4A39000047D0      tst.b   $47D0
007F24 670C              beq     $7F32
007F26 4A3900004EE8      tst.b   $4EE8
007F2C 6604              bne     $7F32
007F2E 7001              moveq.l #1,D0
007F30 6008              bra     $7F3A
007F32 103900004EE8      move.b  $4EE8,D0
```

```
Printer mode
p type, ATARI color matrix



ATARI color dot-matrix printer
p type, ATARI daisy wheel ?
Yes



Flag for ATARI daisy wheel printer
p type, Epson B/W Matrix ?
Yes



Flag for Epson B/W dot matrix
ATARI daisy wheel printer ?
No

Error, stop

Epson B/W dot-matrix printer ?
No
Printer test mode ?
No


Printer resolution
```

```
007F38 4880                ext.w   D0
007F3A 13C000004EE8        move.b  D0,$4EE8        Printer resolution
007F40 4A3900004F82        tst.b   $4F82           Low resolution ?
007F46 6726                beq     $7F6E           No
007F48 0C79014000002606    cmp.w   #320,$2606      width, 320 points per line
007F50 631C                bls     $7F6E
007F52 4240                clr.w   D0
007F54 303900002606        move.w  $2606,D0        width
007F5A D07CFEC0            add.w   #$FEC0,D0       -320
007F5E D1790000260C        add.w   D0,$260C        Plus right
007F64 33FC014000002606    move.w  #320,$2606      width, 320 points per line
007F6C 6024                bra     $7F92
007F6E 0C79028000002606    cmp.w   #640,$2606      width, 640 points per line
007F76 631A                bls     $7F92
007F78 4240                clr.w   D0
007F7A 303900002606        move.w  $2606,D0        width
007F80 D07CFD80            add.w   #$FD80,D0       -640
007F84 D1790000260C        add.w   D0,$260C        Plus right
007F8A 33FC028000002606    move.w  #640,$2606      Width to 640
007F92 4A3900004ED8        tst.b   $4ED8           High resolution ?
007F98 660001E6            bne     $8180           Yes
007F9C 4247                clr.w   D7              Clear color counter
007F9E 600001D8            bra     $8178:ln1
007FA2 207900002612        move.l  $2612,A0        colpal
007FA8 4240                clr.w   D0
007FAA 3010                move.w  (A0),D0         Get color
007FAC C07C0777            and.w   #$777,D0        Mask irrelavant bits
007FB0 33C0000047BA        move.w  D0,$47BA        Save color
007FB6 54B900002612        addq.l  #2,$2612        colpal pointer to next color
007FBC 0C790777000047BA    cmp.w   #$777,$47BA     Color equal white ?
007FC4 67000194            beq     $815A           Yes
007FC8 3039000047BA        move.w  $47BA,D0        Load color
```

```
007FCE C07C0007          and.w   #7,D0          Isolate blue level
007FD2 33C0000035C2      move.w  D0,$35C2       And save
007FD8 3039000047BA      move.w  $47BA,D0       Load color
007FDE E840              asr.w   #4,D0

007FE0 C07C0007          and.w   #7,D0          Isolate green level
007FE4 33C000004EDA      move.w  D0,$4EDA       And save
007FEA 3039000047BA      move.w  $47BA,D0       Load color
007FF0 E040              asr.w   #8,D0

007FF2 C07C0007          and.w   #7,D0          Isolate red level
007FF6 33C000004694      move.w  D0,$4694       And save
007FFC 4A39000047CE      tst.b   $47CE          ATARI color dot-matrix printer ?
008002 67000114          beq     $8118          No
008006 3047              move.w  D7,A0
008008 D1C8              add.l   A0,A0
00800A D1FC00004EEC      add.l   #$4EEC,A0
008010 30B900004694      move.w  $4694,(A0)     Red level
008016 3047              move.w  D7,A0
008018 D1C8              add.l   A0,A0
00801A 227C00004EEC      move.l  #$4EEC,A1
008020 30309800          move.w  0(A0,A1.l),D0
008024 B07900004EDA      cmp.w   $4EDA,D0       Green level
00802A 6F08              ble     $8034
00802C 303900004EDA      move.w  $4EDA,D0       Green level
008032 600E              bra     $8042
008034 3047              move.w  D7,A0
008036 D1C8              add.l   A0,A0
008038 227C00004EEC      move.l  #$4EEC,A1
00803E 30309800          move.w  0(A0,A1.l),D0
008042 3247              move.w  D7,A1
008044 D3C9              add.l   A1,A1
008046 D3FC00004EEC      add.l   #$4EEC,A1
00804C 3280              move.w  D0,(A1)
```

```
00804E 3047              move.w  D7,A0
008050 D1C8              add.l   A0,A0
008052 227C00004EEC      move.l  #$4EEC,A1
008058 30309800          move.w  0(A0,A1.l),D0
00805C B079000035C2      cmp.w   $35C2,D0          Blue level
008062 6F08              ble     $806C
008064 3039000035C2      move.w  $35C2,D0          Red level
00806A 600E              bra     $807A
00806C 3047              move.w  D7,A0
00806E D1C8              add.l   A0,A0
008070 227C00004EEC      move.l  #$4EEC,A1
008076 30309800          move.w  0(A0,A1.l),D0
00807A 3247              move.w  D7,A1
00807C D3C9              add.l   A1,A1
00807E D3FC00004EEC      add.l   #$4EEC,A1
008084 3280              move.w  D0,(A1)
008086 303900004694      move.w  $4694,D0          Red level
00808C 3247              move.w  D7,A1
00808E D3C9              add.l   A1,A1
008090 D3FC00004EEC      add.l   #$4EEC,A1
008096 3211              move.w  (A1),D1
008098 5241              addq.w  #1,D1
00809A 9041              sub.w   D1,D0
00809C 6E04              bgt     $80A2
00809E 4240              clr.w   D0
0080A0 6002              bra     $80A4
0080A2 7001              moveq.l #1,D0
0080A4 33C000004694      move.w  D0,$4694          Red level
0080AA 303900004EDA      move.w  $4EDA,D0          Green level
0080B0 3247              move.w  D7,A1
0080B2 D3C9              add.l   A1,A1
0080B4 D3FC00004EEC      add.l   #$4EEC,A1
```

```
0080BA 3211              move.w   (A1),D1
0080BC 5241              addq.w   #1,D1
0080BE 9041              sub.w    D1,D0
0080C0 6E04              bgt      $80C6
0080C2 4240              clr.w    D0
0080C4 6002              bra      $80C8
0080C6 7001              moveq.l  #1,D0
0080C8 33C000004EDA      move.w   D0,$4EDA        Green level
0080CE 3039000035C2      move.w   $35C2,D0        Red level
0080D4 3247              move.w   D7,A1
0080D6 D3C9              add.l    A1,A1
0080D8 D3FC00004EEC      add.l    #$4EEC,A1
0080DE 3211              move.w   (A1),D1
0080E0 5241              addq.w   #1,D1
0080E2 9041              sub.w    D1,D0
0080E4 6E04              bgt      $80EA
0080E6 4240              clr.w    D0
0080E8 6002              bra      $80EC
0080EA 7001              moveq.l  #1,D0
0080EC 33C0000035C2      move.w   D0,$35C2        Blue level
0080F2 303900004694      move.w   $4694,D0        Red level
0080F8 E540              asl.w    #2,D0
0080FA 323900004EDA      move.w   $4EDA,D1        Green level
008100 E341              asl.w    #1,D1
008102 D041              add.w    D1,D0
008104 D079000035C2      add.w    $35C2,D0        Blue level
00810A 3247              move.w   D7,A1
00810C D3C9              add.l    A1,A1
00810E D3FC00004698      add.l    #$4698,A1
008114 3280              move.w   D0,(A1)
008116 6040              bra      $8158
008118 303900004694      move.w   $4694,D0        Red level
```

```
00811E C1FC001E          muls.w  #$1E,D0          Times 30, 30% weighting
008122 323900004EDA      move.w  $4EDA,D1         Green level
008128 C3FC003B          muls.w  #$3B,D1          Times 59, 59% weighting
00812C D041              add.w   D1,D0
00812E 3239000035C2      move.w  $35C2,D1         Blue level
008134 C3FC000B          muls.w  #$B,D1           Times 11, 11% weighting
008138 D041              add.w   D1,D0
00813A 48C0              ext.l   D0
00813C 81FC0064          divs.w  #$64,D0          Divide by 100, scaling
008140 3247              move.w  D7,A1
008142 D3C9              add.l   A1,A1
008144 D3FC00004EEC      add.l   #$4EEC,A1
00814A 3280              move.w  D0,(A1)
00814C 3047              move.w  D7,A0
00814E D1C8              add.l   A0,A0
008150 D1FC00004698      add.l   #$4698,A0
008156 4250              clr.w   (A0)
008158 601C              bra     $8176:ln1
00815A 3047              move.w  D7,A0
00815C D1C8              add.l   A0,A0
00815E D1FC00004698      add.l   #$4698,A0
008164 30BC0007          move.w  #7,(A0)
008168 3047              move.w  D7,A0
00816A D1C8              add.l   A0,A0
00816C D1FC00004EEC      add.l   #$4EEC,A0
008172 30BC0008          move.w  #8,(A0)
008176 5247              addq.w  #1,D7            Increment color counter
008178 BE7C0010          cmp.w   #$10,D7          16 colors handled already ?
00817C 6D00FE24          blt     $7FA2            No, next color
008180 4A3900004F82      tst.b   $4F82            Low resolution ?
008186 6716              beq     $819E            No
008188 7004              moveq.l #4,D0
```

```
00818A 33C000004F0C     move.w  D0,$4F0C
008190 33C000004EE2     move.w  D0,$4EE2
008196 33C000004768     move.w  D0,$4768
00819C 6038             bra     $81D6
00819E 4A3900004ED6     tst.b   $4ED6
0081A4 6718             beq     $81BE
0081A6 7002             moveq.l #2,D0
0081A8 33C000004F0C     move.w  D0,$4F0C
0081AE 33C000004768     move.w  D0,$4768
0081B4 33FC000400004EE2 move.w  #4,$4EE2
0081BC 6018             bra     $81D6:ln1
0081BE 33FC000100004768 move.w  #1,$4768
0081C6 33FC000800004EE2 move.w  #8,$4EE2
0081CE 33FC000200004F0C move.w  #2,$4F0C
0081D6 4A39000047D0     tst.b   $47D0
0081DC 6706             beq     $81E4
0081DE 3F3C0002         move.w  #2,-(A7)
0081E2 6004             bra     $81E8
0081E4 3F3C0001         move.w  #1,-(A7)
0081E8 303900004F0C     move.w  $4F0C,D0
0081EE 48C0             ext.l   D0
0081F0 81DF             divs.w  (A7)+,D0
0081F2 33C000004F0C     move.w  D0,$4F0C
0081F8 4240             clr.w   D0
0081FA 30390000260A     move.w  $260A,D0
008200 D07900002606     add.w   $2606,D0
008206 D0790000260C     add.w   $260C,D0
00820C C0F900004768     mulu.w  $4768,D0
008212 E848             lsr.w   #4,D0
008214 33C000004696     move.w  D0,$4696
00821A 303900004696     move.w  $4696,D0
008220 C1F900004EE2     muls.w  $4EE2,D0
```

```
Medium resolution ?
No

Epson B/W dot-matrix printer ?
No

Left
Height
Right
```

```
008226 33C000003E80      move.w  D0,$3E80
00822C 203900002600      move.l  $2600,D0          blkptr
008232 C0BCFFFFFFFE      and.l   #$FFFFFFFE,D0     Create even address
008238 23C0000046B8      move.l  D0,$46B8          And save
00823E 203900002600      move.l  $2600,D0          blkptr
008244 B0B9000046B8      cmp.l   $46B8,D0
00824A 660A              bne     $8256
00824C 4240              clr.w   D0
00824E 303900002604      move.w  $2604,D0          Offset
008254 600A              bra     $8260
008256 4240              clr.w   D0
008258 303900002604      move.w  $2604,D0          Offset
00825E 5040              addq.w  #8,D0
008260 33C0000047BC      move.w  D0,$47BC
008266 4279000012EA      clr.w   $12EA
00826C 60000716          bra     $8984
008270 4A79000004EE      tst.w   $4EE              dumpflg, ALT HELP pressed again ?
008276 6600071E          bne     $8996             Yes, terminate
00827A 13FC000100003628  move.b  #1,$3628
008282 4240              clr.w   D0
008284 303900002606      move.w  $2606,D0          width
00828A C0F900004768      mulu.w  $4768,D0
008290 E848              lsr.w   #4,D0
008292 907900004768      sub.w   $4768,D0
008298 E348              lsl.w   #1,D0
00829A 4840              swap    D0
00829C 4240              clr.w   D0
00829E 4840              swap    D0
0082A0 D0B9000046B8      add.l   $46B8,D0          Pointer to video RAM
0082A6 23C000004EDC      move.l  D0,$4EDC
0082AC 700F              moveq.l #15,D0
0082AE 4241              clr.w   D1
```

```
0082B0 323900002606          move.w  $2606,D1          width
0082B6 C27C000F              and.w   #$F,D1
0082BA 9041                  sub.w   D1,D0
0082BC 33C000004F12          move.w  D0,$4F12
0082C2 33F90000260600003E2C  move.w  $2606,$3E2C       width
0082CC 60000124              bra     $83F2
0082D0 4240                  clr.w   D0
0082D2 303900002608          move.w  $2608,D0          height
0082D8 9079000012EA          sub.w   $12EA,D0
0082DE 4840                  swap    D0
0082E0 4240                  clr.w   D0
0082E2 4840                  swap    D0
0082E4 80F900004EE2          divu.w  $4EE2,D0
0082EA 6708                  beq     $82F4
0082EC 303900004EE2          move.w  $4EE2,D0
0082F2 600E                  bra     $8302
0082F4 4240                  clr.w   D0
0082F6 303900002608          move.w  $2608,D0          height
0082FC 9079000012EA          sub.w   $12EA,D0
008302 33C000004ED2          move.w  D0,$4ED2
008308 23F900004EDC0000493C  move.l  $4EDC,$493C
008312 4247                  clr.w   D7
008314 6000009E              bra     $83B4
008318 427900004F1A          clr.w   $4F1A
00831E 33FC000100004F0E      move.w  #1,$4F0E
008326 23F90000493C000047BE  move.l  $493C,$47BE
008330 4246                  clr.w   D6
008332 6030                  bra     $8364
008334 2079000047BE          move.l  $47BE,A0
00833A 3010                  move.w  (A0),D0
00833C 720F                  moveq.l #15,D1
00833E 927900004F12          sub.w   $4F12,D1
```

```
008344 E260              asr.w   D1,D0
008346 C07C0001          and.w   #1,D0
00834A C1F900004F0E      muls.w  $4F0E,D0
008350 D17900004F1A      add.w   D0,$4F1A
008356 54B9000047BE      addq.l  #2,$47BE
00835C E1F900004F0E      asl.w   $4F0E
008362 5246              addq.w  #1,D6
008364 BC7900004768      cmp.w   $4768,D6
00836A 6DC8              blt     $8334
00836C 4A3900004ED8      tst.b   $4ED8            High resolution ?
008372 6712              beq     $8386            No
008374 4A7900004F1A      tst.w   $4F1A
00837A 6708              beq     $8384
00837C 423900003628      clr.b   $3628
008382 603A              bra     $83BE
008384 601C              bra     $83A2
008386 307900004F1A      move.w  $4F1A,A0
00838C D1C8              add.l   A0,A0
00838E D1FC00004EEC      add.l   #$4EEC,A0
008394 0C500008          cmp.w   #8,(A0)
008398 6708              beq     $83A2
00839A 423900003628      clr.b   $3628
0083A0 601C              bra     $83BE
0083A2 303900004696      move.w  $4696,D0
0083A8 E340              asl.w   #1,D0
0083AA 48C0              ext.l   D0
0083AC D1B90000493C      add.l   D0,$493C
0083B2 5247              addq.w  #1,D7
0083B4 BE7900004ED2      cmp.w   $4ED2,D7
0083BA 6D00FF5C          blt     $8318
0083BE 4A3900003628      tst.b   $3628
0083C4 6736              beq     $83FC
```

```
0083C6 537900004F12      subq.w  #1,$4F12
0083CC 4A7900004F12      tst.w   $4F12
0083D2 6C18              bge     $83EC
0083D4 303900004768      move.w  $4768,D0
0083DA E340              asl.w   #1,D0
0083DC 48C0              ext.l   D0
0083DE 91B900004EDC      sub.l   D0,$4EDC
0083E4 33FC000F00004F12  move.w  #$F,$4F12
0083EC 537900003E2C      subq.w  #1,$3E2C
0083F2 4A7900003E2C      tst.w   $3E2C
0083F8 6E00FED6          bgt     $82D0
0083FC 3E3900003E2C      move.w  $3E2C,D7
008402 CFF900004F0C      muls.w  $4F0C,D7
008408 4A39000047D0      tst.b   $47D0
00840E 670A              beq     $841A
008410 3007              move.w  D7,D0
008412 48C0              ext.l   D0
008414 81FC0002          divs.w  #2,D0
008418 6002              bra     $841C
00841A 4240              clr.w   D0
00841C DE40              add.w   D0,D7
00841E 3007              move.w  D7,D0
008420 48C0              ext.l   D0
008422 81FC0100          divs.w  #$100,D0
008426 4840              swap    D0
008428 13C000003E86      move.b  D0,$3E86
00842E 3007              move.w  D7,D0
008430 48C0              ext.l   D0
008432 81FC0100          divs.w  #$100,D0
008436 13C000003E88      move.b  D0,$3E88
00843C 4279000047D2      clr.w   $47D2
008442 600004A6          bra     $88EA
```

```
Epson B/W dot-matrix printer ?
No
```

```
008446 427900004F88          clr.w    $4F88
00844C 60000450              bra      $889E
008450 4A39000047CE          tst.b    $47CE          ATARI color dot matrix printer ?
008456 675A                  beq      $84B2          No
008458 4A3900004ED8          tst.b    $4ED8          High resolution ?
00845E 6652                  bne      $84B2          Yes
008460 4A7900004F88          tst.w    $4F88
008466 6616                  bne      $847E
008468 2EBC00016D5E          move.l   #$16D5E,(A7)   ESC 'X' 6
00846E 6100058E              bsr      $89FE          Output string to the printer
008472 4A40                  tst.w    D0             Error ?
008474 6706                  beq      $847C          No
008476 70FF                  moveq.l  #-1,D0         Flag for error
008478 60000526              bra      $89A0          Error, terminate

00847C 6034                  bra      $84B2
00847E 0C79000100004F88      cmp.w    #1,$4F88
008486 6616                  bne      $849E
008488 2EBC00016D63          move.l   #$16D63,(A7)   ESC 'X' 5
00848E 6100056E              bsr      $89FE          Output string to printer
008492 4A40                  tst.w    D0             Error ?
008494 6706                  beq      $849C          No
008496 70FF                  moveq.l  #-1,D0         Flag for error
008498 60000506              bra      $89A0          Error, terminate

00849C 6014                  bra      $84B2
00849E 2EBC00016D68          move.l   #$16D68,(A7)   ESC 'X' 3
0084A4 61000558              bsr      $89FE          Output string to printer
0084A8 4A40                  tst.w    D0             Error ?
0084AA 6706                  beq      $84B2          No
0084AC 70FF                  moveq.l  #-1,D0         Flag for error
```

```
0084AE 600004F0          bra     $89A0          Error, terminate

0084B2 4A39000047D0      tst.b   $47D0          Epson B/W dot-matrix printer?
0084B8 6708              beq     $84C2          No
0084BA 2EBC00016D6D      move.l  #$16D6D,(A7)   ESC 'L', Bit image 960 points/line
0084C0 6006              bra     $84C8
0084C2 2EBC00016D71      move.l  #$16D71,(A7)   ESC 'Y', Bit image 960 points/line
0084C8 61000534          bsr     $89FE          Output string to printer
0084CC 4A40              tst.w   D0             Error ?
0084CE 6706              beq     $84D6          No
0084D0 70FF              moveq.l #-1,D0         Flag for error
0084D2 600004CC          bra     $89A0          Error, terminate

0084D6 103900003E86      move.b  $3E86,D0       Get byte
0084DC 4880              ext.w   D0             Low byte of the number
0084DE 3E80              move.w  D0,(A7)        On stack
0084E0 610004C8          bsr     $89AA          Output
0084E4 4A40              tst.w   D0             Error ?
0084E6 6706              beq     $84EE          No
0084E8 70FF              moveq.l #-1,D0         Flag for error
0084EA 600004B4          bra     $89A0          Error terminate

0084EE 103900003E88      move.b  $3E88,D0       Get byte
0084F4 4880              ext.w   D0             High byte of the number
0084F6 3E80              move.w  D0,(A7)        On stack
0084F8 610004B0          bsr     $89AA          Output
0084FC 4A40              tst.w   D0             Error ?
0084FE 6706              beq     $8506          No
008500 70FF              moveq.l #-1,D0         Flag for error
008502 6000049C          bra     $89A0          Error, terminate

008506 13FC000100004EEA  move.b  #1,$4EEA
```

```
00850E 23F9000046B800004EDC move.l  $46B8,$4EDC
008518 33F9000047BC00004F12 move.w  $47BC,$4F12
008522 4279000012E8         clr.w   $12E8
008528 6000034C             bra     $8876

00852C 4247                 clr.w   D7
00852E 600C                 bra     $853C
008530 3047                 move.w  D7,A0
008532 D1FC000047D4         add.l   #$47D4,A0
008538 4210                 clr.b   (A0)
00853A 5247                 addq.w  #1,D7
00853C BE7C0008             cmp.w   #8,D7
008540 6DEE                 blt     $8530
008542 4247                 clr.w   D7
008544 6010                 bra     $8556
008546 3047                 move.w  D7,A0
008548 D1C8                 add.l   A0,A0
00854A D1FC00003E8A         add.l   #$3E8A,A0
008550 30BC0007             move.w  #7,(A0)
008554 5247                 addq.w  #1,D7
008556 BE7C0004             cmp.w   #4,D7
00855A 6DEA                 blt     $8546
00855C 4240                 clr.w   D0
00855E 303900002608         move.w  $2608,D0        height.
008564 9079000012EA         sub.w   $12EA,D0
00856A 4840                 swap    D0
00856C 4240                 clr.w   D0
00856E 4840                 swap    D0
008570 80F900004EE2         divu.w  $4EE2,D0
008576 6708                 beq     $8580
008578 303900004EE2         move.w  $4EE2,D0
00857E 600E                 bra     $858E
```

```
008580 4240                    clr.w   D0
008582 303900002608            move.w  $2608,D0          height
008588 9079000012EA            sub.w   $12EA,D0
00858E 33C000004ED2            move.w  D0,$4ED2
008594 23F900004EDC0000493C    move.l  $4EDC,$493C
00859E 4247                    clr.w   D7
0085A0 600000F8                bra     $869A

0085A4 427900004F1A            clr.w   $4F1A
0085AA 33FC000100004F0E        move.w  #1,$4F0E
0085B2 23F90000493C000047BE    move.l  $493C,$47BE
0085BC 4246                    clr.w   D6
0085BE 6030                    bra     $85F0
0085C0 2079000047BE            move.l  $47BE,A0
0085C6 3010                    move.w  (A0),D0
0085C8 720F                    moveq.l #15,D1
0085CA 927900004F12            sub.w   $4F12,D1
0085D0 E260                    asr.w   D1,D0
0085D2 C07C0001                and.w   #1,D0
0085D6 C1F900004F0E            muls.w  $4F0E,D0
0085DC D179000C4F1A            add.w   D0,$4F1A
0085E2 54B9000047BE            addq.l  #2,$47BE
0085E8 E1F900004F0E            asl.w   $4F0E
0085EE 5246                    addq.w  #1,D6
0085F0 BC7900004768            cmp.w   $4768,D6
0085F6 6DC8                    blt     $85C0
0085F8 4A3900004ED8            tst.b   $4ED8             High resolution ?
0085FE 6722                    beq     $8622             No
008600 4A7900004F1A            tst.w   $4F1A
008606 670C                    beq     $8614
008608 20790000261A            move.l  $261A,A0          p masks
00860E 1010                    move.b  (A0),D0
```

```
008610 4880              ext.w   D0
008612 6002              bra     $8616
008614 4240              clr.w   D0
008616 3247              move.w  D7,A1
008618 D3FC000047D4      add.l   #$47D4,A1
00861E 1280              move.b  D0,(A1)
008620 6066              bra     $8688

008622 3047              move.w  D7,A0
008624 D1C8              add.l   A0,A0
008626 D1FC00003E8A      add.l   #$3E8A,A0
00862C 327900004F1A      move.w  $4F1A,A1
008632 D3C9              add.l   A1,A1
008634 D3FC00004698      add.l   #$4698,A1
00863A 3091              move.w  (A1),(A0)
00863C 3047              move.w  D7,A0
00863E D0C8              add.w   A0,A0
008640 D1FC000047D4      add.l   #$47D4,A0
008646 327900004F1A      move.w  $4F1A,A1
00864C D3C9              add.l   A1,A1
00864E D3FC00004EEC      add.l   #$4EEC,A1
008654 3251              move.w  (A1),A1
008656 D2C9              add.w   A1,A1
008658 D3F90000261A      add.l   $261A,A1        p masks
00865E 1091              move.b  (A1),(A0)
008660 3047              move.w  D7,A0
008662 D0C8              add.w   A0,A0
008664 D1FC000047D4      add.l   #$47D4,A0
00866A 327900004F1A      move.w  $4F1A,A1
008670 D3C9              add.l   A1,A1
008672 D3FC00004EEC      add.l   #$4EEC,A1
008678 3251              move.w  (A1),A1
```

```
00867A D2C9              add.w   A1,A1
00867C D3F90000261A      add.l   $261A,A1          p masks
008682 116900010001      move.b  1(A1),1(A0)
008688 303900004696      move.w  $4696,D0
00868E E340              asl.w   #1,D0
008690 48C0              ext.l   D0
008692 D1B90000493C      add.l   D0,$493C
008698 5247              addq.w  #1,D7
00869A BE7900004ED2      cmp.w   $4ED2,D7
0086A0 6D00FF02          blt     $85A4
0086A4 4A39000047CE      tst.b   $47CE             ATARI color dot-matrix printer ?
0086AA 670000DE          beq     $878A             No
0086AE 4A3900004ED8      tst.b   $4ED8             High resolution ?
0086B4 660000D4          bne     $878A             Yes
0086B8 4247              clr.w   D7
0086BA 600000C4          bra     $8780
0086BE 423900004EE0      clr.b   $4EE0
0086C4 4A7900004F88      tst.w   $4F88
0086CA 6624              bne     $86F0
0086CC 3047              move.w  D7,A0
0086CE D1C8              add.l   A0,A0
0086D0 227C00003E8A      move.l  #$3E8A,A1
0086D6 30309800          move.w  0(A0,A1.l),D0
0086DA 48C0              ext.l   D0
0086DC 81FC0002          divs.w  #$2,D0
0086E0 4840              swap    D0
0086E2 4A40              tst.w   D0
0086E4 6708              beq     $86EE
0086E6 13FC000100004EE0  move.b  #$1,$4EE0
0086EE 606C              bra     $875C
0086F0 0C79000100004F88  cmp.w   #1,$4F88
0086F8 664A              bne     $8744
```

```
0086FA 3047              move.w  D7,A0
0086FC D1C8              add.l   A0,A0
0086FE D1FC00003E8A      add.l   #$3E8A,A0
008704 0C500002          cmp.w   #2,(A0)
008708 6730              beq     $873A
00870A 3047              move.w  D7,A0
00870C D1C8              add.l   A0,A0
00870E D1FC00003E8A      add.l   #$3E8A,A0
008714 0C500003          cmp.w   #3,(A0)
008718 6720              beq     $873A
00871A 3047              move.w  D7,A0
00871C D1C8              add.l   A0,A0
00871E D1FC00003E8A      add.l   #$3E8A,A0
008724 0C500006          cmp.w   #6,(A0)
008728 6710              beq     $873A
00872A 3047              move.w  D7,A0
00872C D1C8              add.l   A0,A0
00872E D1FC00003E8A      add.l   #$3E8A,A0
008734 0C500007          cmp.w   #7,(A0)
008738 6608              bne     $8742
00873A 13FC000100004EE0  move.b  #$1,$4EE0
008742 6018              bra     $875C
008744 3047              move.w  D7,A0
008746 D1C8              add.l   A0,A0
008748 D1FC00003E8A      add.l   #$3E8A,A0
00874F 0C500003          cmp.w   #3,(A0)
008752 6F08              ble     $875C
008754 13FC000100004EE0  move.b  #$1,$4EE0
00875C 4A3900004EE0      tst.b   $4EE0
008762 671A              beq     $877E
008764 3047              move.w  D7,A0
008766 D0C8              add.w   A0,A0
```

```
008768 D1FC000047D4    add.l   #$47D4,A0
00876E 4210            clr.b   (A0)
008770 3047            move.w  D7,A0
008772 D0C8            add.w   A0,A0
008774 D1FC000047D4    add.l   #$47D4,A0
00877A 42280001        clr.b   1(A0)
00877E 5247            addq.w  #1,D7
008780 BE79000004ED2   cmp.w   $4ED2,D7
008786 6D00FF36        blt     $86BE
00878A 7E04            moveq.l #4,D7
00878C 60000086        bra     $8814
008790 4239000035BE    clr.b   $35BE
008796 33FC008000004F10 move.w  #$80,$4F10
00879E 4246            clr.w   D6
0087A0 603E            bra     $87E0
0087A2 207C000047D4    move.l  #$47D4,A0
0087A8 10306000        move.b  0(A0,D6.w),D0
0087AC 4880            ext.w   D0
0087AE 7207            moveq.l #7,D1
0087B0 9247            sub.w   D7,D1
0087B2 E260            asr.w   D1,D0
0087B4 C07C0001        and.w   #$1,D0
0087B8 C1F9000004F10   muls.w  $4F10,D0
0087BE 1239000035BE    move.b  $35BE,D1
0087C4 D200            add.b   D0,D1
0087C6 13C1000035BE    move.b  D1,$35BE
0087CC 303900004F10    move.w  $4F10,D0
0087D2 48C0            ext.l   D0
0087D4 81FC0002        divs.w  #$2,D0
0087D8 33C000004F10    move.w  D0,$4F10
0087DE 5246            addq.w  #1,D6
0087E0 BC7C0008        cmp.w   #$8,D6
```

```
0087E4 6DBC              blt     $87A2
0087E6 1039000035BE      move.b  $35BE,D0
0087EC 4880              ext.w   D0
0087EE 3E80              move.w  D0,(A7)
0087F0 610001B8          bsr     $89AA           Output
0087F4 4A40              tst.w   D0
0087F6 6706              beq     $87FE
0087F8 70FF              moveq.l #-1,D0
0087FA 600001A4          bra     $89A0           Error, terminate

0087FE 4A3900004EEA      tst.b   $4EEA
008804 6704              beq     $880A
008806 4240              clr.w   D0
008808 6002              bra     $880C
00880A 7001              moveq.l #1,D0
00880C 13C000004EEA      move.b  D0,$4EEA
008812 5247              addq.w  #1,D7
008814 303900004F0C      move.w  $4F0C,D0
00881A 5840              addq.w  #4,D0
00881C BE40              cmp.w   D0,D7
00881E 6D00FF70          blt     $8790
008822 4A39000047D0      tst.b   $47D0           Epson B/W dot-matrix printer ?
008828 6720              beq     $884A           No
00882A 4A3900004EEA      tst.b   $4EEA
008830 6718              beq     $884A
008832 1039000035BE      move.b  $35BE,D0
008838 4880              ext.w   D0
00883A 3E80              move.w  D0,(A7)
00883C 6100016C          bsr     $89AA           Output
008840 4A40              tst.w   D0              OK ?
008842 6706              beq     $884A           Yes
008844 70FF              moveq.l #-1,D0          Set flag
```

```
008846 60000158          bra     $89A0          Error, terminate

00884A 527900004F12      addq.w  #1,$4F12
008850 0C79000F00004F12  cmp.w   #15,$4F12
008858 6F16              ble     $8870
00885A 303900004768      move.w  $4768,D0
008860 E340              asl.w   #1,D0
008862 48C0              ext.l   D0
008864 D1B900004EDC      add.l   D0,$4EDC
00886A 427900004F12      clr.w   $4F12
008870 5279000012E8      addq.w  #1,$12E8
008876 3039000012E8      move.w  $12E8,D0
00887C B07900003E2C      cmp.w   $3E2C,D0
008882 6D00FCA8          blt     $852C
008886 3EBC000D          move.w  #$D,(A7)       CR
00888A 6100011E          bsr     $89AA          Output
00888E 4A40              tst.w   D0             OK ?
008890 6706              beq     $8898          Yes
008892 70FF              moveq.l #-1,D0         Set flag
008894 6000010A          bra     $89A0          Error, terminate

008898 527900004F88      addq.w  #1,$4F88
00889E 4A39000047CE      tst.b   $47CE          ATARI color dot-matrix printer ?
0088A4 670C              beq     $88B2          No
0088A6 4A3900004ED8      tst.b   $4ED8          High resolution ?
0088AC 6604              bne     $88B2          Yes
0088AE 7003              moveq.l #3,D0
0088B0 6002              bra     $88B4
0088B2 7001              moveq.l #1,D0
0088B4 B07900004F88      cmp.w   $4F88,D0
0088BA 6E00FB94          bgt     $8450
0088BE 2EBC00016D75      move.l  #$16D75,(A7)   ESC '3' 1, 1/216" line spacing
```

```
0088C4 61000138     bsr     $89FE       Output string to printer
0088C8 4A40         tst.w   D0
0088CA 6706         beq     $88D2
0088CC 70FF         moveq.l #-1,D0      Set flag
0088CE 600000D0     bra     $89A0       Error, terminate

0088D2 3EBC000A     move.w  #$A,(A7)    LF
0088D6 610000D2     bsr     $89AA       Output
0088DA 4A40         tst.w   D0          OK ?
0088DC 6706         beq     $88E4       Yes
0088DE 70FF         moveq.l #-1,D0      Set flag
0088E0 600000BE     bra     $89A0       Error, terminate

0088E4 5279000047D2 addq.w  #1,$47D2
0088EA 4A3900004EE8 tst.b   $4EE8       Printer resolution
0088F0 6704         beq     $88F6
0088F2 7001         moveq.l #1,D0
0088F4 6002         bra     $88F8
0088F6 7002         moveq.l #2,D0
0088F8 B079000047D2 cmp.w   $47D2,D0
0088FE 6E00FB46     bgt     $8446
008902 4A3900004EE8 tst.b   $4EE8       Printer resolution
008908 673E         beq     $8948
00890A 4247         clr.w   D7
00890C 6028         bra     $8936
00890E 2EBC00016D7A move.l  #$16D7A,(A7) ESC '3' 1, 1/216" line spacing
008914 610000E8     bsr     $89FE       Output string to printer
008918 4A40         tst.w   D0          Error on output ?
00891A 6706         beq     $8922       No
00891C 70FF         moveq.l #-1,D0      Set flag
00891E 60000080     bra     $89A0       Error, terminate
```

```
008922 3EBC000A          move.w   #$A,(A7)
008926 61000082          bsr      $89AA
00892A 4A40              tst.w    D0
00892C 6706              beq      $8934
00892E 70FF              moveq.l  #-1,D0
008930 6000006E          bra      $89A0

008934 5247              addq.w   #1,D7
008936 4A39000047D0      tst.b    $47D0
00893C 6704              beq      $8942
00893E 7002              moveq.l  #2,D0
008940 6002              bra      $8944
008942 7001              moveq.l  #1,D0
008944 BE40              cmp.w    D0,D7
008946 6DC6              blt      $890E
008948 2EBC00016D7F      move.l   #$16D7F,(A7)
00894E 610000AE          bsr      $89FE
008952 4A40              tst.w    D0
008954 6704              beq      $895A
008956 70FF              moveq.l  #-1,D0
008958 6046              bra      $89A0

00895A 3EBC000A          move.w   #$A,(A7)
00895E 614A              bsr      $89AA
008960 4A40              tst.w    D0
008962 6704              beq      $8968
008964 70FF              moveq.l  #-1,D0
008966 6038              bra      $89A0

008968 303900003E80      move.w   $3E80,D0
00896E E340              asl.w    #1,D0
008970 48C0              ext.l    D0
```

```
LF
Output
Error during output ?
No
Set flag
Error, terminate


Epson B/W dot-matrix printer ?
No



ESC '1', 7/72" line spacing
Output string to printer
Error during output ?
No
Set flag
Error, terminate

LF
Output
Error during output ?
No

Error, terminate
```

```
008972 D1B9000046B8          add.l   D0,$46B8
008978 303900004EE2          move.w  $4EE2,D0
00897E D179000012EA          add.w   D0,$12EA
008984 4240                  clr.w   D0
008986 303900002608          move.w  $2608,D0          height
00898C B079000012EA          cmp.w   $12EA,D0
008992 6200F8DC              bhi     $8270
008996 2EBC00016D83          move.l  #$16D83,(A7)      ESC '2', 1/6" line spacing
00899C 6160                  bsr     $89FE             Output string to printer
00899E 4240                  clr.w   D0                Flag for OK
0089A0 4A9F                  tst.l   (A7)+
0089A2 4CDF30C0              movem.l (A7)+,D6-D7/A4-A5 Restore registers
0089A6 4E5E                  unlk    A6
0089A8 4E75                  rts

*********************************************         Output a character
0089AA 4E56FFFC              link    A6,#-4
0089AE 4A39000025FE          tst.b   $25FE             Printer port
0089B4 6722                  beq     $89D8             RS232 ?
0089B6 102E0009              move.b  9(A6),D0          Character to output
0089BA 4880                  ext.w   D0                Extend to word
0089BC 3E80                  move.w  D0,(A7)           On the stack
0089BE 102E0009              move.b  9(A6),D0          Character to output
0089C2 4880                  ext.w   D0                Extend to word
0089C4 3F00                  move.w  D0,-(A7)          And back on stack (?)
0089C6 4EB900008A2C          jsr     $8A2C             Output via Centronics port
0089CC 548F                  addq.l  #2,A7             Correct stack pointer
0089CE 4A40                  tst.w   D0                OK ?
0089D0 6604                  bne     $89D6             Yes
0089D2 70FF                  moveq.l #-1,D0            Flag for error
0089D4 6024                  bra     $89FA             Done
0089D6 6020                  bra     $89F8             Error-free termination
```

```
0089D8 102E0009          move.b  9(A6),D0        Character to output
0089DC 4880              ext.w   D0              Extend to word
0089DE 3E80              move.w  D0,(A7)         And on stack
0089E0 102E0009          move.b  9(A6),D0        Character to output
0089E4 4880              ext.w   D0              Extend to word
0089E6 3F00              move.w  D0,-(A7)        And back on stack (?)
0089E8 4EB900008A46      jsr     $8A46           Output via RS-232
0089EE 548F              addq.l  #2,A7           Correct stack pointer
0089F0 4A40              tst.w   D0              OK ?
0089F2 6604              bne     $89F8           Yes
0089F4 70FF              moveq.l #-1,D0          Set error flag
0089F6 6002              bra     $89FA
0089F8 4240              clr.w   D0
0089FA 4E5E              unlk    A6
0089FC 4E75              rts

********************************************    Output string to printer
0089FE 4E56FFFC          link    A6,#-4
008A02 6018              bra     $8A1C
008A04 206E0008          move.l  8(A6),A0        Get string address
008A08 1010              move.b  (A0),D0         String character
008A0A 4880              ext.w   D0              Extend to word
008A0C 3E80              move.w  D0,(A7)
008A0E 619A              bsr     $89AA           Output character
008A10 52AE0008          addq.l  #1,8(A6)        Pointer to next character
008A14 4A40              tst.w   D0              Error-free output ?
008A16 6704              beq     $8A1C           Yes
008A18 70FF              moveq.l #-1,D0          Error
008A1A 600C              bra     $8A28           Terminate output
008A1C 206E0008          move.l  8(A6),A0        Pointer to string
008A20 0C1000FF          cmp.b   #$FF,(A0)       $FF as end indicator
```

```
008A24 66DE             bne     $8A04           Next character
008A26 4240             clr.w   D0              OK
008A28 4E5E             unlk    A6
008A2A 4E75             rts

*************************************************       Centronics output
008A2C 302F0006         move.w  6(A7),D0        Character to output
008A30 48E71F1E         movem.l D3-D7/A3-A6,-(A7)       Save registers
008A34 3F00             move.w  D0,-(A7)        Character to output
008A36 3F00             move.w  D0,-(A7)
008A38 9BCD             sub.l   A5,A5           Clear A5
008A3A 6100E198         bsr     $6BD4           Output character to Centronics port
008A3E 584F             addq.w  #4,A7           Correct stack pointer
008A40 4CDF78F8         movem.l (A7)+,D3-D7/A3-A6       Restore registers
008A44 4E75             rts

*************************************************       RS232 output
008A46 302F0006         move.w  6(A7),D0        Character to output
008A4A 48E71F1E         movem.l D3-D7/A3-A6,-(A7)       Save registers
008A4E 3F00             move.w  D0,-(A7)        Character to output
008A50 3F00             move.w  D0,-(A7)
008A52 9BCD             sub.l   A5,A5           Clear A5
008A54 6100E258         bsr     $6CAE           Output character via RS-232
008A58 584F             addq.w  #4,A7           Correct stack pointer
008A5A 4CDF78F8         movem.l (A7)+,D3-D7/A3-A6       Restore registers
008A5E 4E75             rts

*************************************************       VDI ESCAPE functions
008A60 207900002580     move.l  $2580,A0        Pointer to CONTRL array
008A66 3028000A         move.w  10(A0),D0       Function number
008A6A B07C0013         cmp.w   #$13,D0         Greater than 19 ?
008A6E 6236             bhi     $8AA6
```

```
008A72 307B000A          move.w   $8A7E(PC,D0.w),A0    Get relative address from table
008A76 D1FC00008C7A      add.l    #$8C7A,A0            Add base address
008A7C 4ED0              jmp      (A0)                 Execute routine

008A7E 0000              dc.w     $8C7A-$8C7A          0, rts
008A80 FFD8              dc.w     $8C52-$8C7A          1, Inquire addressable alpha character cells
008A82 0012              dc.w     $8C8C-$8C7A          2, Exit alpha mode
008A84 000C              dc.w     $8C86-$8C7A          3, Enter alpha mode
008A86 001A              dc.w     $8C94-$8C7A          4, Alpha cursor up
008A88 002E              dc.w     $8CA8-$8C7A          5, Alpha cursor down
008A8A 0048              dc.w     $8CC2-$8C7A          6, Alpha cursor right
008A8C 0062              dc.w     $8CDC-$8C7A          7, Alpha cursor left
008A8E 0076              dc.w     $8CF0-$8C7A          8, Home alpha cursor
008A90 007E              dc.w     $8CF8-$8C7A          9, Erase to end of alpha screen
008A92 00AA              dc.w     $8D24-$8C7A          10, Erase to end of alpha text line
008A94 0114              dc.w     $8D8E-$8C7A          11, Direct alpha cursor address
008A96 0128              dc.w     $8DA2-$8C7A          12, Output cursor addressable alpha text
008A98 014E              dc.w     $8DC8-$8C7A          13, Reverse video on
008A9A 0158              dc.w     $8DD2-$8C7A          14, Reverse video off
008A9C 0162              dc.w     $8DDC-$8C7A          15, Inquire current alpha cursor address
008A9E 018C              dc.w     $8E06-$8C7A          16, Inquire tablet status
008AA0 0002              dc.w     $8C7C-$8C7A          17, Hardcopy
008AA2 01A4              dc.w     $8E1E-$8C7A          18, Place graphic cursor at location
008AA4 01B4              dc.w     $8E2E-$8C7A          19, Remove last graphic cursor

*****************************************

008AA6 B07C0065          cmp.w    #101,D0              ESC VDI 101 ?
008AAA 670A              beq      $8AB6
008AAC B07C0066          cmp.w    #102,D0              ESC VDI 102 ?
008AB0 6700094E          beq      $9400                Yes, initialize font data
008AB4 4E75              rts
```

```
**************************************************      VDI ESC 101
008AB6 61000448             bsr     $8F00               Cursor off
008ABA 207900002584         move.l  $2584,A0            Pointer to INTIN array
008AC0 3010                 move.w  (A0),D0             Get paramaters
008AC2 C0F90000257E         mulu.w  $257E,D0            Times number of bytes per screen line
008AC8 33C00000255E         move.w  D0,$255E
008ACE 6000041E             bra     $8EEE

**************************************************      ascout
008AD2 322F0006             move.w  6(A7),D1            Get character from stack
008AD6 024100FF             and.w   #$FF,D1             Process only low byte
008ADA 600005D2             bra     $90AE               Output character

**************************************************      conout
008ADE 322F0006             move.w  6(A7),D1            Get character from stack
008AE2 024100FF             and.w   #$FF,D1             Process only low byte
008AE6 2079000004A8         move.l  $4A8,A0             Get conout vector
008AEC 4ED0                 jmp     (A0)                And execute routine

**************************************************      Standard conout
008AEE B27C0020             cmp.w   #$20,D1             Control code ?
008AF2 6C0005BA             bge     $90AE               No, output character
008AF6 B23C001B             cmp.b   #$1B,D1             ESC ?
008AFA 660C                 bne     $8B08               No, process other CTRL codes
008AFC 23FC00008B4A000004A8 move.l  #$8B4A,$4A8         Conout vector to ESC processing
008B06 4E75                 rts

**************************************************      Process CTRL codes
008B08 5F41                 subq.w  #7,D1               Less than 7 ?
008B0A 6B22                 bmi     $8B2E               Ingore, RTS
008B0C B27C0006             cmp.w   #6,D1               Greater than 13 ?
008B10 6E1C                 bgt     $8B2E               Ignore, RTS
```

```
008B12 E349                     lsl.w   #1,D1                   Bring to word processing
008B14 307B100A                 move.w  $8B20(PC,D1.w),A0       Get relative address from table
008B18 D1FC00008B30             add.l   #$8B30,A0               Add base address to it
008B1E 4ED0                     jmp     (A0)                    And execute corresponding routine

*****************************************************

008B20 0000                     dc.w    $8B30-$8B30             Jump table for control codes
008B22 01AC                     dc.w    $8CDC-$8B30             7, BEL
008B24 0004                     dc.w    $8B34-$8B30             8, BS
008B26 04AA                     dc.w    $8FDA-$8B30             9, TAB
008B28 04AA                     dc.w    $8FDA-$8B30             10, LF
008B2A 04AA                     dc.w    $8FDA-$8B30             11, VT
008B2C 049E                     dc.w    $8FCE-$8B30             12, FF
                                                                13, CR
*****************************************************

008B2E 4E75                     rts

*****************************************************

008B30 6000E218                 bra     $6D4A                   BEL
                                                                Output tone

*****************************************************

008B34 303900002560             move.w  $2560,D0                TAB
008B3A 0240FFF8                 and.w   #$FFF8,D0               Corsor column
008B3E 5040                     addq.w  #8,D0                   Convert to number divisable by 8
008B40 323900002562             move.w  $2562,D1                And add 8
008B46 60000764                 bra     $92AC                   Cursor line
                                                                Reset cursor

*****************************************************

008B4A 23FC00008AEE000004A8 move.l  #$8AEE,$4A8                 Process character after ESC
008B54 927C0041                 sub.w   #$41,D1                 conout vector back to standrad
008B58 6BD4                     bmi     $8B2E                   Minus 'A'
008B5A B27C000C                 cmp.w   #$C,D1                  Less, then ignore
                                                                'M'
```

```
008B5E 6F50                    ble     $8BB0           To ESC table for capital letters
008B60 B27C0018                cmp.w   #$18,D1         'Y' for set cursor ?
008B64 663C                    bne     $8BA2           No,test for lowercase letters
008B66 23FC00008B72000004A8 move.l  #$8B72,$4A8      conout vector for ESC Y
008B70 4E75                    rts

*****************************************************  Process line after ESC Y
008B72 927C0020                sub.w   #$20,D1         Subtract offset
008B76 33C1000004AC            move.w  D1,$4AC         And save line value
008B7C 23FC00008B88000004A8 move.l  #$8B88,$4A8      Process conout vector to column
008B86 4E75                    rts

*****************************************************  Process column after ESC Y
008B88 927C0020                sub.w   #$20,D1         Subtract offset
008B8C 3001                    move.w  D1,D0           Column value
008B8E 3239000004AC            move.w  $4AC,D1         And line
008B94 23FC00008AEE000004A8 move.l  #$8AEE,$4A8      conout vector back to standard
008B9E 6000070C                bra     $92AC           And set cursor

*****************************************************  Test for ESC lowercase
008BA2 927C0021                sub.w   #$21,D1         Subtract offset
008BA6 6B86                    bmi     $8B2E           Ignore lowercase 'b'
008BA8 B27C0015                cmp.w   #$15,D1         'w'
008BAC 6F10                    ble     $8BBE           Less than or equal, process sequence
008BAE 4E75                    rts

*****************************************************  ESC uppercase
008BB0 E349                    lsl.w   #1,D1           Code times 2 for word acces
008BB2 307B1058                move.w  $8C0C(PC,D1.w),A0  Get relative address from table
008BB6 D1FC00008B2E            add.l   #$8B2E,A0       Add base address
008BBC 4ED0                    jmp     (A0)            And execute routine
```

```
*****************************************************
008BBE E349                     lsl.w   #1,D1           ESC lowercase
008BC0 307B1064                 move.w  $8C26(PC,D1.w),A0  Code times 2 for word access
008BC4 D1FC00008B2E             add.l   #$8B2E,A0       Get relative address from table
008BCA 4ED0                     jmp     (A0)            Add base address
                                                        And execute routine
*****************************************************
008BCC 23FC00008BD8000004A8 move.l  #$8BD8,$4A8         ESC b  set character color
008BD6 4E75                     rts                     Set conout vector
*****************************************************
008BD8 23FC00008AEE000004A8 move.l  #$8AEE,$4A8         Set standrad conout vector
008BE2 927C0020                 sub.w   #$20,D1         Subtract offset
008BE6 3001                     move.w  D1,D0
008BE8 60000292                 bra     $8E7C           Set character color
*****************************************************
008BEC 23FC00008BF8000004A8 move.l  #$8BF8,$4A8         ESC c  set background color
008BF6 4E75                     rts                     Set conout vector
*****************************************************
008BF8 23FC00008AEE000004A8 move.l  #$8AEE,$4A8         Standard conout vector
008C02 927C0020                 sub.w   #$20,D1         Subtract offset
008C06 3001                     move.w  D1,D0
008C08 6000027E                 bra     $8E88           Set background color
*****************************************************
008C0C 0166                     dc.w    $8B2E-$8B2E     Address table for ESC upper case
008C0E 017A                     dc.w    $8B2E-$8B2E     ESC A
008C10 0194                     dc.w    $8B2E-$8B2E     ESC B
008C12 01AE                     dc.w    $8B2E-$8B2E     ESC C
008C14 0162                     dc.w    $8B2E-$8B2E     ESC D
                                                        ESC E
```

```
008C16 0000             dc.w    $8B2E-$8B2E         ESC F, rts
008C18 0000             dc.w    $8B2E-$8B2E         ESC G, rts
008C1A 01C2             dc.w    $8B2E-$8B2E         ESC H
008C1C 0306             dc.w    $8B2E-$8B2E         ESC I
008C1E 01CA             dc.w    $8B2E-$8B2E         ESC J
008C20 01F6             dc.w    $8B2E-$8B2E         ESC K
008C22 0320             dc.w    $8B2E-$8B2E         ESC L
008C24 033E             dc.w    $8B2E-$8B2E         ESC M

************************************************    Address table for ESC lowercase
008C26 009E             dc.w    $8B2E-$8B2E         ESC b
008C28 00BE             dc.w    $8B2E-$8B2E         ESC c
008C2A 0366             dc.w    $8B2E-$8B2E         ESC d
008C2C 0382             dc.w    $8B2E-$8B2E         ESC e
008C2E 03D2             dc.w    $8B2E-$8B2E         ESC f
008C30 0000             dc.w    $8B2E-$8B2E         ESC g, rts
008C32 0000             dc.w    $8B2E-$8B2E         ESC h, rts
008C34 0000             dc.w    $8B2E-$8B2E         ESC i, rts
008C36 03F2             dc.w    $8B2E-$8B2E         ESC j
008C38 040E             dc.w    $8B2E-$8B2E         ESC k
008C3A 0428             dc.w    $8B2E-$8B2E         ESC l
008C3C 0000             dc.w    $8B2E-$8B2E         ESC m, rts
008C3E 0000             dc.w    $8B2E-$8B2E         ESC n, rts
008C40 0446             dc.w    $8B2E-$8B2E         ESC o
008C42 029A             dc.w    $8B2E-$8B2E         ESC p
008C44 02A4             dc.w    $8B2E-$8B2E         ESC q
008C46 0000             dc.w    $8B2E-$8B2E         ESC r, rts
008C48 0000             dc.w    $8B2E-$8B2E         ESC s, rts
008C4A 0000             dc.w    $8B2E-$8B2E         ESC t, rts
008C4C 0000             dc.w    $8B2E-$8B2E         ESC u, rts
008C4E 048C             dc.w    $8B2E-$8B2E         ESC v
008C50 0496             dc.w    $8B2E-$8B2E         ESC w
```

```
************************************************
008C52 207900002580          move.l  $2580,A0
008C58 317C00020008          move.w  #2,8(A0)
008C5E 20790000258C          move.l  $258C,A0
008C64 303900002550          move.w  $2550,D0
008C6A 5240                  addq.w  #1,D0
008C6C 31400002              move.w  D0,2(A0)
008C70 303900002552          move.w  $2552,D0
008C76 5240                  addq.w  #1,D0
008C78 3080                  move.w  D0,(A0)
008C7A 4E75                  rts
```

VDI ESC 1, get screen size
Pointer to CONTRL array
2 result values
Pointer to INTOUT array
Maximum cursor column (79)
Plus 1 equals number of columns
As second result
Maximum cursor line (24)
Plus 1 equals number of lines
As first result

```
************************************************
008C7C 3F3C0014              move.w  #$14,-(A7)
008C80 4E4E                  trap    #14
008C82 548F                  addq.l  #2,A7
008C84 4E75                  rts
```

VDI ESC 17
Hardcopy

Put stack back in order

```
************************************************
008C86 6108                  bsr     $8C90
008C88 60000226              bra     $8EB0
```

VDI ESC 3, Enter alpha mode
ESC E, Clear Home
ESC e, Cursor on

```
************************************************
008C8C 61000272              bsr     $8F00
```

VDI ESC 2, Exit alpha mode
ESC f, Cursor off

```
************************************************
008C90 615E                  bsr     $8CF0
008C92 6064                  bra     $8CF8
```

ESC E, Clear Home
ESC H, Cursor Home
ESC J, Clear rest of screen

```
************************************************
008C94 323900002562          move.w  $2562,D1
008C9A 67DF                  beq     $8C7A
```

ESC A, Cursor up, VDI ESC 4
Cursor line
Zero, then done already

```
008C9C 5341              subq.w  #1,D1          Subtract one
008C9E 303900002560      move.w  $2560,D0       Get cursor column
008CA4 60000606          bra     $92AC          And set cursor

*************************************************

008CA8 323900002562      move.w  $2562,D1       ESC B, Cursor down, VDI ESC 5
008CAE B27900002552      cmp.w   $2552,D1       Cursor line
008CB4 67C4              beq     $8C7A          Compare to maximum cursor line
008CB6 5241              addq.w  #1,D1          Already in lowest line, done
008CB8 303900002560      move.w  $2560,D0       Increment by one
008CBE 600005EC          bra     $92AC          Cursor column
                                                Set cursor

*************************************************

008CC2 303900002560      move.w  $2560,D0       ESC C, Cursor right, VDI ESC 6
008CC8 B07900002550      cmp.w   $2550,D0       Cursor column
008CCE 67AA              beq     $8C7A          Compare with maximum value (79)
008CD0 5240              addq.w  #1,D0
008CD2 323900002562      move.w  $2562,D1       Increment by one
008CD8 600005D2          bra     $92AC          Get cursor line
                                                And set cursor

*************************************************

008CDC 303900002560      move.w  $2560,D0       ESC D, DEL, Cursor left, VDI ESC 7
008CE2 6796              beq     $8C7A          Cursor column
008CE4 5340              subq.w  #1,D0          Already zero ?
008CE6 323900002562      move.w  $2562,D1       Decrement by one
008CEC 600005BE          bra     $92AC          Cursor line
                                                Set cursor

*************************************************

008CF0 7000              moveq.l #0,D0          ESC H, Cursor Home, VDI ESC 8
008CF2 3200              move.w  D0,D1          Column
008CF4 600005B6          bra     $92AC          And line to zero
                                                Set cursor
```

```
************************************************
008CF8 612A                bsr     $8D24          ESC J, Clear rest of screen, VDI 9
008CFA 323900002562        move.w  $2562,D1       ESC K, Clear rest of line
008D00 B27900002552        cmp.w   $2552,D1       Cursor line
008D06 6700FF72            beq     $8C7A          Compare with maximum cursor line
008D0A 5241                addq.w  #1,D1
008D0C 4841                swap    D1
008D0E 323C0000            move.w  #0,D1          Maximum cursor line
008D12 343900002552        move.w  $2552,D2
008D18 4842                swap    D2             Maximum cursor column (79)
008D1A 343900002550        move.w  $2550,D2
008D20 60000436            bra     $9158

************************************************
008D24 08B9000300002576    bclr    #3,$2576       ESC K, Clear rest of line, VDI ESC 10
008D2C 40E7                move.w  SR, -(A7)      Clear flag for line overflow
008D2E 610001D0            bsr     $8F00          Save old value
008D32 610001EC            bsr     $8F20          ESC f, Cursor off
008D36 323900002560        move.w  $2560,D1       ESC j, Save cursor position
008D3C 08010000            btst    #0,D1          Cursor column
008D40 6716                beq     $8D58
008D42 B27900002550        cmp.w   $2550,D1       Compare with maximum value (79)
008D48 673A                beq     $8D84          In last column, then output space
008D4A 323C0020            move.w  #$20,D1        Space
008D4E 6100035E            bsr     $90AE          Output
008D52 323900002560        move.w  $2560,D1       Cursor column
008D58 4841                swap    D1
008D5A 323900002562        move.w  $2562,D1       Cursor line
008D60 3401                move.w  D1,D2
008D62 4841                swap    D1
008D64 4842                swap    D2
008D66 343900002550        move.w  $2550,D2       Maximum cursor column
```

```
008D6C 610003EA            bsr     $9158
008D70 44DF                move.w  (A7)+,CCR          Restore flag
008D72 6708                beq     $8D7C              Not set ?
008D74 08F9000300002576    bset    #3,$2576           Reset
008D7C 610001BE            bsr     $8F3C              ESC k, Restore cursor position
008D80 6000016C            bra     $8EEE              Re-enable cursor

008D84 323C0020            move.w  #$20,D1            Space
008D88 61000324            bsr     $90AE              Output
008D8C 60E2                bra     $8D70

************************************************      VDI ESC 11, Set cursor
008D8E 207900002584        move.l  $2584,A0           Pointer to INTIN array
008D94 3210                move.w  (A0),D1            Get line
008D96 5341                subq.w  #1,D1              Minus offset
008D98 30280002            move.w  2(A0),D0           Get column
008D9C 5340                subq.w  #1,D0              Minus offset
008D9E 6000050C            bra     $92AC              Set cursor

************************************************      VDI ESC 12, Text outout
008DA2 207900002580        move.l  $2580,A0           Pointer to CONTRL array
008DA8 30280006            move.w  6(A0),D0           Number of characters
008DAC 207900002584        move.l  $2584,A0           Pointer to INTIN array
008DB2 600E                bra     $8DC2

008DB4 3218                move.w  (A0)+,D1           Get pointer to D1
008DB6 48E78080            movem.l D0/A0,-(A7)        Restore registers
008DBA 6100FD26            bsr     $8AE2              Output character in D1
008DBE 4CDF0101            movem.l (A7)+,D0/A0        Registers back
008DC2 51C8FFF0            dbra    D0,$8DB4           Output next character
008DC6 4E75                rts
```

```
*********************************************
008DC8 08F9000400002576      bset    #4,$2576
008DD0 4E75                  rts

*********************************************
008DD2 08B9000400002576      bclr    #4,$2576
008DDA 4E75                  rts

*********************************************
008DDC 207900002580          move.l  $2580,A0
008DE2 317C00020008          move.w  #2,8(A0)
008DE8 20790000258C          move.l  $258C,A0
008DEE 303900002562          move.w  $2562,D0
008DF4 5240                  addq.w  #1,D0
008DF6 3080                  move.w  D0,(A0)
008DF8 303900002560          move.w  $2560,D0
008DFE 5240                  addq.w  #1,D0
008E00 31400002              move.w  D0,2(A0)
008E04 4E75                  rts

*********************************************
008E06 207900002580          move.l  $2580,A0
008E0C 317C00010008          move.w  #1,8(A0)
008E12 20790000258C          move.l  $258C,A0
008E18 30BC0001              move.w  #1,(A0)
008E1C 4E75                  rts

*********************************************
008E1E 207900002584          move.l  $2584,A0
008E24 30BC0000              move.w  #0,(A0)
008E28 4EF90000FF50          jmp     $FF50
```

ESC p, reverse on, VDI ESC 13
Set flag for reverse

ESC q, reverse off, VDI ESC 14
Clear flag for reverse

VDI ESC 15, Get cursor position
Pointer to CONTRL array
2 result values
Pointer to INTOUT array
Cursor line
Plus offset
As first result
Cursor column
Plus offset
As second result

VDI ESC 16, Inquire tablet status
Pointer to CONTRL array
A result value
Pointer to INTOUT array
Tablet available

Pointer to INTIN array
No result values
Set graphic cursor

```
************************************************      VDI ESC 19, Clear graphic cursor
008E2E 4EF90000FF78          jmp     $FF78

************************************************      ESC I, Cursor up,scroll if needed
008E34 323900002562          move.w  $2562,D1        Cursor line
008E3A 6600FE60              bne     $8C9C           Not in line 0, then cursor up
008E3E 3F3900002560          move.w  $2560,-(A7)     Save cursor column
008E44 6108                  bsr     $8E4E           ESC L, Insert line
008E46 301F                  move.w  (A7)+,D0        Restore cursor column
008E48 7200                  moveq.l #0,D1           Cursor line to zero
008E4A 60000460              bra     $92AC           Set cursor

************************************************      ESC L, Insert line
008E4E 610000B0              bsr     $8F00           ESC f, Cursor off
008E52 323900002562          move.w  $2562,D1        Cursor line
008E58 6100056E              bsr     $93C8           Shift remainder of screen down
008E5C 4240                  clr.w   D0              Cursor in column 0
008E5E 323900002562          move.w  $2562,D1        Cursor line
008E64 61000446              bsr     $92AC           Set cursor
008E68 60000084              bra     $8EEE           Re-enable cursor

************************************************      ESC M, Clear line
008E6C 61000092              bsr     $8F00           ESC f, Cursor off
008E70 323900002562          move.w  $2562,D1        Cursor line
008E76 61000508              bsr     $9380           Shift remainder of screen up
008E7A 60E0                  bra     $8E5C           See above

************************************************      Set character color
008E7C C07C000F              and.w   #$F,D0          mod 16, 0..15
008E80 33C000002558          move.w  D0,$2558        Save character color
008E86 4E75                  rts
```

```
************************************************
008E88 C07C000F                 and.w   #$F,D0
008E8C 33C000002556             move.w  D0,$2556
008E92 4E75                     rts

************************************************
008E94 610000DE                 bsr     $8F74
008E98 343900002562             move.w  $2562,D2
008E9E 67F2                     beq     $8E92
008EA0 5342                     subq.w  #1,D2
008EA2 4842                     swap    D2
008EA4 343900002550             move.w  $2550,D2
008EAA 7200                     moveq.l #0,D1
008EAC 600002AA                 bra     $9158

************************************************
008EB0 4A7900002422             tst.w   $2422
008EB6 67DA                     beq     $8E92
008EB8 427900002422             clr.w   $2422
008EBE 41F900002576             lea     $2576,A0
008EC4 08100000                 btst    #0,(A0)
008EC8 6618                     bne     $8EE2
008ECA 08D00002                 bset    #2,(A0)
008ECE 303900002560             move.w  $2560,D0
008ED4 323900002562             move.w  $2562,D1
008EDA 6100031C                 bsr     $91F8
008EDE 6000043E                 bra     $931E

008EE2 61EA                     bsr     $8ECE
008EE4 08D00001                 bset    #1,(A0)
008EE8 08D00002                 bset    #2,(A0)
008EEC 4E75                     rts
```

```
Set background color
mod 16, 0..15
Save background color


ESC d, Clear screen to cursor
ESC o, Clear line to cursor
Cursor line
Already zero, done


Maximum cursor column



ESC e, Cursor on
Cursor already on ?
Yes, done
Flag for cursor on



Cursor column
Cursor line
Calculate cursor position
Invert character at cursor position

Invert character at cursor position
```

```
************************************************
008EEE 4A7900002422          tst.w   $2422          Cursor enabled ?
008EF4 679C                  beq     $8E92          Yes, rts
008EF6 537900002422          subq.w  #1,$2422
008EFC 67C0                  beq     $8EBE          See above
008EFE 4E75                  rts

************************************************
008F00 527900002422          addq.w  #1,$2422       ESC f, Cursor off
008F06 41F900002576          lea     $2576,A0       Flag for cursor off
008F0C 08900002              bclr    #2,(A0)
008F10 6780                  beq     $8E92          Clear flag for cursor
008F12 08100000              btst    #0,(A0)        Cursor was already off, rts
008F16 67B6                  beq     $8ECE
008F18 08900001              bclr    #1,(A0)
008F1C 66B0                  bne     $8ECE
008F1E 4E75                  rts

************************************************
008F20 08F9000500002576      bset    #5,$2576       ESC j, Save cursor position
008F28 41F90000242E          lea     $242E,A0       Flag for cursor saved
008F2E 30F900002560          move.w  $2560,(A0)+    Address of the temp. storage
008F34 30B900002562          move.w  $2562,(A0)     Cursor column
008F3A 4E75                  rts                    Cursor line

************************************************
008F3C 08B9000500002576      bclr    #5,$2576       ESC k, Cursor to saved position
008F44 6700FDAA              beq     $8CF0          Was cursor position saved ?
008F48 41F90000242E          lea     $242E,A0       No
008F4E 3018                  move.w  (A0)+,D0       Address of the temp. stroage
008F50 3210                  move.w  (A0),D1        Cursor column
008F52 60000358              bra     $92AC          Cursor line
                                                    Set cursor
```

```
************************************************
008F56 61A8              bsr     $8F00
008F58 323900002562      move.w  $2562,D1
008F5E 3401              move.w  D1,D2
008F60 4841              swap    D1
008F62 4241              clr.w   D1
008F64 4842              swap    D2
008F66 343900002550      move.w  $2550,D2
008F6C 610001EA          bsr     $9158
008F70 6000FEEA          bra     $8E5C

************************************************
008F74 618A              bsr     $8F00
008F76 61A8              bsr     $8F20
008F78 343900002560      move.w  $2560,D2
008F7E 6730              beq     $8FB0
008F80 08020000          btst    #0,D2
008F84 6610              bne     $8F96
008F86 323C0020          move.w  #$20,D1
008F8A 61000122          bsr     $90AE
008F8E 343900002560      move.w  $2560,D2
008F94 5542              subq.w  #2,D2
008F96 4842              swap    D2
008F98 343900002562      move.w  $2562,D2
008F9E 3202              move.w  D2,D1
008FA0 4842              swap    D2
008FA2 4841              swap    D1
008FA4 4241              clr.w   D1
008FA6 610001B0          bsr     $9158
008FAA 6190              bsr     $8F3C
008FAC 6000FF40          bra     $8EEE
008FB0 323C0020          move.w  #$20,D1
```

ESC l, delete line
ESC f, turn cursor off
Cursor line

Maximum cursor column

Cursor in column zero

ESC o, Clear line to cursor
ESC f, Turn cursor off
ESC j, Save cursor position
Cursor column
Zero, then done

Space
Output
Cursor column

Cursor line

ESC k, Restore cursor position
And turn cursor back on
Space

```
008FB4 610000F8          bsr     $90AE          Output
008FB8 60F0              bra     $8FAA

*************************************************

008FBA 08F9000300002576  bset    #3,$2576       ESC v, New line at end of line
008FC2 4E75              rts                    Set flag

*************************************************

008FC4 08B9000300002576  bclr    #3,$2576       ESC w, No new line at end of line
008FCC 4E75              rts                    Clear flag

*************************************************

008FCE 323900002562      move.w  $2562,D1       CR, Cursor in column zero
008FD4 4240              clr.w   D0             Cursor line
008FD6 600002D4          bra     $92AC          Column to zero
                                                Set cursor

*************************************************

008FDA 303900002562      move.w  $2562,D0       LF, (VT, FF), Cursor down
008FE0 B07900002552      cmp.w   $2552,D0       Cursor line
008FE6 6600FCC0          bne     $8CA8          Compare with maximum cursor line
008FEA 6100FF14          bsr     $8F00          Not in lowest linme, just cursor down
008FEE 4241              clr.w   D1             ESC f, Turn cursor off
008FF0 6100038E          bsr     $9380          Scroll screen down
008FF4 6000FEF8          bra     $8EEE          And turn cursor back on

*************************************************

008FF8 41F900002576      lea     $2576,A0       Flash cursor
008FFE 08100002          btst    #2,(A0)        Address of the flag word
009002 671E              beq     $9022          Cursor on ?
009004 08100000          btst    #0,(A0)        No
009008 6718              beq     $9022          Cursor flashing ?
00900A 43F900002565      lea     $2565,A1       No
                                                Address of the flash counter
```

```
009010 5311              subq.b  #1,(A1)          Decrement counter
009012 660E              bne     $9022            Not yet run down ?
009014 12B900002564      move.b  $2564,(A1)       Reload flash counter
00901A 08500001          bchg    #1,(A0)          Invert cursor phase
00901E 6000FEAE          bra     $8ECE            Turn cursor off

009022 4E75              rts

*************************************************
009024 302F0004          move.w  4(A7),D0         Cursor configuration, XBIOS No. 21
009028 6BF8              bmi     $9022            Get number from stack
00902A B07C0005          cmp.w   #5,D0            Negative, ignore
00902E 6EF2              bgt     $9022            Greater than 5 ?
009030 E340              asl.w   #1,D0            Yes, ignore
009032 41F90000904A      lea     $904A,A0
009038 D0FB0004          add.w   $903E(PC,D0.w),A0 Base address of the table
00903C 4ED0              jmp     (A0)             Plus relative address
                                                  Execute function
*************************************************
00903E 0000              dc.w    $904A-$904A      Address of the routines
009040 0004              dc.w    $904E-$904A
009042 0008              dc.w    $9052-$904A
009044 0016              dc.w    $9060-$904A
009046 0024              dc.w    $906E-$904A
009048 002C              dc.w    $9076-$904A

*************************************************
00904A 6000FEB4          bra     $8F00            0
                                                  ESC f, Turn cursor off
*************************************************
00904E 6000FE60          bra     $8EB0            1
                                                  ESC e, Turn cursor on
```

```
*************************************************
009052 6100FEAC             bsr     $8F00
009056 08ED00002576         bset    #0,$2576(A5)
00905C 6000FE90             bra     $8EEE

*************************************************
009060 6100FE9E             bsr     $8F00
009064 08AD00002576         bclr    #0,$2576(A5)
00906A 6000FE82             bra     $8EEE

*************************************************
00906E 1B6F00072564         move.b  7(A7),$2564(A5)
009074 4E75                 rts

*************************************************
009076 7000                 moveq.l #0,D0
009078 102D2564             move.b  $2564(A5),D0
00907C 4E75                 rts

*************************************************
00907E 36390000256C         move.w  $256C,D3
009084 B243                 cmp.w   D3,D1
009086 6522                 bcs     $90AA
009088 B2790000256A         cmp.w   $256A,D1
00908E 621A                 bhi     $90AA
009090 207900002572         move.l  $2572,A0
009096 D241                 add.w   D1,D1
009098 32301000             move.w  (A0,D1.w),D1
00909C E649                 lsr.w   #3,D1
00909E 207900002566         move.l  $2566,A0
0090A4 D0C1                 add.w   D1,A0
0090A6 4243                 clr.w   D3
```

```
2
ESC f, Turn cursor off

Turn cursor back on

3
ESC f, Turn cursor off

Turn cursor back on

4
Set cursor flash rate


5

Load cursor flash rate


Calculate font data for character in D1
Smallest ASCCI code in font
Compare with character to output
Character not in font
Largest ASCII code in font
Character not in font
Load font offset pointer
Code times two
Yields bit number in font
Divided by 8 yields byte number
Pointer to font data
Yields pointer to data for this character
Flag for character in font
```

```
0090A8 4E75                 rts
0090AA 7601                 moveq.l #1,D3
0090AC 4E75                 rts

*************************************************

0090AE 61CE                 bsr     $907E
0090B0 6702                 beq     $90B4
0090B2 4E75                 rts

0090B4 22790000255A         move.l  $255A,A1
0090BA 3E3900002556         move.w  $2556,D7
0090C0 4847                 swap    D7
0090C2 3E3900002558         move.w  $2558,D7
0090C8 0839000400002576     btst    #4,$2576
0090D0 6702                 beq     $90D4
0090D2 4847                 swap    D7
0090D4 08B9000200002576     bclr    #2,$2576
0090DC 40E7                 move.w  SR, -(A7)
0090DE 61000160             bsr     $9240
0090E2 22790000255A         move.l  $255A,A1
0090E8 303900002560         move.w  $2560,D0
0090EE 323900002562         move.w  $2562,D1
0090F4 61000252             bsr     $9348
0090F8 6732                 beq     $912C
0090FA 303900002554         move.w  $2554,D0
009100 C0C1                 mulu.w  D1,D0
009102 22790000044E         move.l  $44E,A1
009108 D3C0                 add.l   D0,A1
00910A 4240                 clr.w   D0
00910C B27900002552         cmp.w   $2552,D1
009112 640A                 bcc     $911E
009114 D2F900002554         add.w   $2554,A1
```

```
Character not present in font


ascout, ignore control codes
Character present in font ?
Yes


Screen address of the character
Background color
In upper word
Character color in lower word
Reverse turned on ?
No
Exchange character and background colors

Save status
Calculate new position
Screen address
Cursor column
Cursor line
Calculate relative screen address

Number of bytes per character line

Address of the screen RAM


Compare with maximum cursor line

Plus number of bytes per character line
```

```
00911A 5241                addq.w  #1,D1
00911C 600E                bra     $912C
00911E 48E7C040            movem.l D0-D1/A1,-(A7)      Save registers
009122 7200                moveq.l #0,D1
009124 6100025A            bsr     $9380
009128 4CDF0203            movem.l (A7)+,D0-D1/A1      Restore registers
00912C 23C90000255A        move.l  A1,$255A            Screen address
009132 33C000002560        move.w  D0,$2560            Cursor column
009138 33C100002562        move.w  D1,$2562            Cursor line
00913E 44DF                move.w  (A7)+,CCR           Restore status
009140 6714                beq     $9156
009142 610001DA            bsr     $931E
009146 08F9000100002576    bset    #1,$2576
00914E 08F9000200002576    bset    #2,$2576
009156 4E75                rts

009158 9481                sub.l   D1,D2
00915A 3001                move.w  D1,D0
00915C 4841                swap    D1
00915E 61000098            bsr     $91F8               Calculate cursor position
009162 E242                asr.w   #1,D2
009164 36390000257C        move.w  $257C,D3            Number of screen planes (1,2 or 4)
00916A 0C430004            cmp.w   #4,D3
00916E 6602                bne     $9172
009170 5343                subq.w  #1,D3
009172 3202                move.w  D2,D1
009174 5241                addq.w  #1,D1
009176 E761                asl.w   D3,D1
009178 34790000257E        move.w  $257E,A2            Bytes per screen line
00917E 94C1                sub.w   D1,A2
009180 3202                move.w  D2,D1
009182 4842                swap    D2
```

```
009184 5242              addq.w  #1,D2
009186 C4F90000254E      mulu.w  $254E,D2      Times height of a character
00918C 5342              subq.w  #1,D2
00918E 4280              clr.l   D0
009190 3A3900002556      move.w  $2556,D5      Background color
009196 0C7900020000257C  cmp.w   #2,$257C      Number of screen levels
00919E 6B44              bmi     $91E4
0091A0 6728              beq     $91CA
0091A2 E245              asr.w   #1,D5
0091A4 4040              negx.w  D0
0091A6 4840              swap    D0
0091A8 E245              asr.w   #1,D5
0091AA 4040              negx.w  D0
0091AC 4283              clr.l   D3
0091AE E245              asr.w   #1,D5
0091B0 4043              negx.w  D3
0091B2 4843              swap    D3
0091B4 E245              asr.w   #1,D5
0091B6 4043              negx.w  D3
0091B8 3A01              move.w  D1,D5
0091BA 22C0              move.l  D0,(A1)+
0091BC 22C3              move.l  D3,(A1)+
0091BE 51CDFFFA          dbra    D5,$91BA
0091C2 D3CA              add.l   A2,A1
0091C4 51CAFFF2          dbra    D2,$91B8
0091C8 4E75              rts

0091CA E245              asr.w   #1,D5
0091CC 4040              negx.w  D0
0091CE 4840              swap    D0
0091D0 E245              asr.w   #1,D5
0091D2 4040              negx.w  D0
```

```
0091D4 3A01              move.w  D1,D5
0091D6 22C0              move.l  D0,(A1)+
0091D8 51CDFFFC          dbra    D5,$91D6
0091DC D3CA              add.l   A2,A1
0091DE 51CAFFF4          dbra    D2,$91D4
0091E2 4E75              rts

0091E4 E245              asr.w   #1,D5
0091E6 4040              negx.w  D0
0091E8 3A01              move.w  D1,D5
0091EA 32C0              move.w  D0,(A1)+
0091EC 51CDFFFC          dbra    D5,$91EA
0091F0 D3CA              add.l   A2,A1
0091F2 51CAFFF4          dbra    D2,$91E8
0091F6 4E75              rts

************************************************
0091F8 363900002550      move.w  $2550,D3        Calculate cursor position (D0/D1)
0091FE B640              cmp.w   D0,D3           Maximum cursor column
009200 6A02              bpl     $9204

009202 3003              move.w  D3,D0           Column value smaller ?
009204 363900002552      move.w  $2552,D3        Else use max value
00920A B641              cmp.w   D1,D3           Maximum cursor line
00920C 6A02              bpl     $9210

00920E 3203              move.w  D3,D1           Line value smaller ?
009210 36390000257C      move.w  $257C,D3        Else use maximum value
009216 3A00              move.w  D0,D5           Number of screen planes
009218 08850000          bclr    #0,D5           Column to D5
00921C C6C5              mulu.w  D5,D3

00921E 08000000          btst    #0,D0           Times maximum value
009222 6702              beq     $9226
009224 5283              addq.l  #1,D3
```

```
009226 3A3900002554     move.w  $2554,D5        Number of bytes per character line
00922C CAC1             mulu.w  D1,D5           Times line value
00922E 22790000044E     move.l  $44E,A1         Base address of the screen RAM
009234 D3C5             add.l   D5,A1           Plus offset for line
009236 D3C3             add.l   D3,A1           Plus offset for column
009238 D2F90000255E     add.w   $255E,A1        Plus number of bytes per raster line
00923E 4E75             rts

009240 34790000256E     move.w  $256E,A2        formwidth
009246 36790000257E     move.w  $257E,A3        Bytes per screen line
00924C 38390000254E     move.w  $254E,D4        Height of a character
009252 5344             subq.w  #1,D4
009254 3C390000257C     move.w  $257C,D6        Number of screen planes
00925A 5346             subq.w  #1,D6
00925C 3A04             move.w  D4,D5
00925E 2848             move.l  A0,A4
009260 2A49             move.l  A1,A5
009262 E287             asr.l   #1,D7
009264 0807000F         btst    #15,D7
009268 6706             beq     $9270
00926A 642A             bcc     $9296
00926C 76FF             moveq.l #-1,D3
00926E 6004             bra     $9274
009270 6512             bcs     $9284
009272 7600             moveq.l #0,D3
009274 1A83             move.b  D3,(A5)
009276 DACB             add.w   A3,A5
009278 51CDFFFA         dbra    D5,$9274
00927C 5449             addq.w  #2,A1
00927E 51CEFFDC         dbra    D6,$925C
009282 4E75             rts
```

```
009284 1A94              move.b   (A4),(A5)
009286 DACB              add.w    A3,A5
009288 D8CA              add.w    A2,A4
00928A 51CDFFF8          dbra     D5,$9284
00928E 5449              addq.w   #2,A1
009290 51CEFFCA          dbra     D6,$925C
009294 4E75              rts

009296 1614              move.b   (A4),D3
009298 4603              not.b    D3
00929A 1A83              move.b   D3,(A5)
00929C DACB              add.w    A3,A5
00929E D8CA              add.w    A2,A4
0092A0 51CDFFF4          dbra     D5,$9296
0092A4 5449              addq.w   #2,A1
0092A6 51CEFFB4          dbra     D6,$925C
0092AA 4E75              rts

*****************************************************
0092AC B07900002550      cmp.w    $2550,D0        Set cursor
0092B2 6306              bls      $92BA           Compare column with maximum value
0092B4 303900002550      move.w   $2550,D0        Smaller ?
0092BA B27900002552      cmp.w    $2552,D1        Else use maximum value
0092C0 6306              bls      $92C8           Compare line with maximum value
0092C2 323900002552      move.w   $2552,D1        Smaller ?
0092C8 33C000002560      move.w   D0,$2560        Else use maximum value
0092CE 33C100002562      move.w   D1,$2562        Save cursor column
0092D4 41F900002576      lea      $2576,A0        Save cursor line
0092DA 08100002          btst     #2,(A0)         Address of the cursor flag
0092DE 6732              beq      $9312
0092E0 08100000          btst     #0,(A0)         Character inverted at old position?
0092E4 670A              beq      $92F0           Yes
```

```
0092E6 08900002          bclr    #2,(A0)
0092EA 08100001          btst    #1,(A0)
0092EE 671E              beq     $930E
0092F0 22790000255A      move.l  $255A,A1        Screen address of old cursor
0092F6 6126              bsr     $931E           Invert character at cursor position
0092F8 6100FEFE          bsr     $91F8           Calculate new cursor address
0092FC 23C90000255A      move.l  A1,$255A        Screen address of the cursor
009302 611A              bsr     $931E           Invert character at cursor position
009304 08F9000200002576  bset    #2,$2576        Flag for character is inverted
00930C 4E75              rts

00930E 08D00002          bset    #2,(A0)
009312 6100FEE4          bsr     $91F8           Calculate new cursor position
009316 23C90000255A      move.l  A1,$255A        Screen address of the cursor position
00931C 4E75              rts

************************************************
00931E 34790000257E      move.w  $257E,A2        Invert character at cursor position
009324 38390000254E      move.w  $254E,D4        Bytes per screen line
00932A 5344              subq.w  #1,D4           Height of a screen line
00932C 3C390000257C      move.w  $257C,D6        As dbra counter
009332 5346              subq.w  #1,D6           Number of screen planes
009334 3A04              move.w  D4,D5           As dbra counter
009336 2849              move.l  A1,A4           Counter for raster lines
009338 4614              not.b   (A4)            Screen address of the character
00933A D8CA              add.w   A2,A4           Invert a raster line of the character
00933C 51CDFFFA          dbra    D5,$9338        Pointer to next raster line
009340 5449              addq.w  #2,A1           Next raster line
009342 51CEFFF0          dbra    D6,$9334        Next screen level
009346 4E75              rts

************************************************
```

```
009348 B07900002550          cmp.w   $2550,D0        Maximum cursor column
00934E 6612                  bne     $9362
009350 0839000300002576      btst    #3,$2576        Flag for line overflow set ?
009358 6604                  bne     $935E           Yes
00935A 4243                  clr.w   D3
00935C 4E75                  rts

00935E 7601                  moveq.l #1,D3
009360 4E75                  rts

009362 5240                  addq.w  #1,D0
009364 08000000              btst    #0,D0
009368 6706                  beq     $9370
00936A 5249                  addq.w  #1,A1
00936C 4243                  clr.w   D3
00936E 4E75                  rts

009370 36390000257C          move.w  $257C,D3        Number of screen levels
009376 E343                  asl.w   #1,D3
009378 5343                  subq.w  #1,D3
00937A D2C3                  add.w   D3,A1
00937C 4243                  clr.w   D3
00937E 4E75                  rts

************************************************    Scroll screen down at line D1
009380 26790000044E          move.l  $44E,A3         Address of the screen RAM
009386 363900002554          move.w  $2554,D3        Number of bytes per character line
00938C C6C1                  mulu.w  D1,D3           Multitply by number of lines
00938E 47F33000              lea     0(A3,D3.w).A3   Yields address of the line
009392 4441                  neg.w   D1              Current line
009394 D27900002552          add.w   $2552,D1        Maximum cursor line
00939A 363900002554          move.w  $2554,D3        Number of bytes per character line
```

```
0093A0 45F33000          lea     0(A3,D3.w),A2     Yields address of line 1
0093A4 C6C1              mulu.w  D1,D3             Number of bytes to move
0093A6 E443              asr.w   #2,D3             Number of long words
0093A8 6002              bra     $93AC
0093AA 26DA              move.l  (A2)+,(A3)+       Copy screen lines
0093AC 51CBFFFC          dbra    D3,$93AA
0093B0 323900002552      move.w  $2552,D1          Maximum cursor line
0093B6 3401              move.w  D1,D2
0093B8 4841              swap    D1
0093BA 4842              swap    D2
0093BC 4241              clr.w   D1
0093BE 343900002550      move.w  $2550,D2          Maximum cursor column
0093C4 6000FD92          bra     $9158

*************************************************
0093C8 26790000044E      move.l  $44E,A3           Scroll screen at line D1 up
0093CE 363900002552      move.w  $2552,D3          Address of the screen RAM
0093D4 C6F900002554      mulu.w  $2554,D3          Maximum cursor line
0093DA 47F33000          lea     (A3,D3.w),A3      Mult by number of bytes per character line
0093DE 363900002554      move.w  $2554,D3          Yields address of last character line
0093E4 45F33000          lea     (A3,D3.w),A2      Number of bytes per line
0093E8 3001              move.w  D1,D0             Yields address of line 1
0093EA 4440              neg.w   D0                Current line
0093EC D07900002552      add.w   $2552,D0          Add maximum cursor line
0093F2 C6C0              mulu.w  D0,D3
0093F4 E443              asr.w   #2,D3             Divide by 4 for long word transfer
0093F6 6002              bra     $93FA
0093F8 2523              move.l  -(A3),-(A2)       Copy screen lines
0093FA 51CBFFFC          dbra    D3,$93F8
0093FE 60B6              bra     $93B6
```

```
*****************************************************
009400 207900002584          move.l  $2584,A0
009406 2050                  move.l  (A0),A0
009408 30280052              move.w  82(A0),D0
00940C 33C00000254E          move.w  D0,$254E
009412 32390000257E          move.w  $257E,D1
009418 C2C0                  mulu.w  D0,D1
00941A 33C100002554          move.w  D1,$2554
009420 7200                  moveq.l #0,D1
009422 323900002578          move.w  $2578,D1
009428 82C0                  divu.w  D0,D1
00942A 5341                  subq.w  #1,D1
00942C 33C100002552          move.w  D1,$2552
009432 7200                  moveq.l #0,D1
009434 323900002570          move.w  $2570,D1
00943A 82E80034              divu.w  52(A0),D1
00943E 5341                  subq.w  #1,D1
009440 33C100002550          move.w  D1,$2550
009446 33E800500000256E      move.w  80(A0),$256E
00944E 33E800240000256C      move.w  36(A0),$256C
009456 33E800260000256A      move.w  38(A0),$256A
00945E 23E8004C00002566      move.l  76(A0),$2566
009466 23E8004800002572      move.l  72(A0),$2572
00946E 4E75                  rts
```

```
VDI ESC 102, initialize font parameters
Pointer to INTIN array
Address of the font header
formheight, height of a character
merken
Bytes per screen line
Times height of character
Yields bytes per character line

Number of raster lines on the screen
Divide by font height
Minus
Yields maximum cursor line

Screen width in bits
Divide by maximum character width
Minus 1
Yields maximum cursor column
formwidth, width of the font
Smallest ASCII code in font
Largest ASCII code in font
Pointer to font data
Pointer to offset table
```

```
*************************************************
00F6C4 10390000044C          move.b  $44C,D0
00F6CA C07C0003              and.w   #3,D0
00F6CE B07C0003              cmp.w   #3,D0
00F6D2 6604                  bne     $F6D8
00F6D4 303C0002              move.w  #2,D0
00F6D8 3F00                  move.w  D0,-(A7)
00F6DA 6100007E              bsr     $F75A
00F6DE 301F                  move.w  (A7)+,D0
00F6E0 41F900017EAA          lea     $17EAA,A0
00F6E6 B07C0002              cmp.w   #2,D0
00F6EA 6606                  bne     $F6F2
00F6EC 41F900018906          lea     $18906,A0
00F6F2 61009D14              bsr     $9408
00F6F6 33FCFFFF00002558      move.w  #$FFFF,$2558
00F6FE 7000                  moveq.l #0,D0
00F700 33C000002556          move.w  D0,$2556
00F706 33C000002560          move.w  D0,$2560
00F70C 33C000002562          move.w  D0,$2562
00F712 33C00000255E          move.w  D0,$255E
00F718 20790000044E          move.l  $44E,A0
00F71E 23C80000255A          move.l  A0,$255A
00F724 13FC000100002576      move.b  #1,$2576
00F72C 13FC001E00002565      move.b  #$1E,$2565
00F734 13FC001E00002564      move.b  #$1E,$2564
00F73C 33FC000100002422      move.w  #1,$2422
00F744 323C1F3F              move.w  #$1F3F,D1
00F748 20C0                  move.l  D0,(A0)+
00F74A 51C9FFFC              dbra    D1,$F748
00F74E 23FC00008AEE000004A8  move.l  #$8AEE,$4A8
00F758 4E75                  rts
```

```
Initialze screen output
sshiftmd, screen resolution
Isolate bits 0 and 1
3 ?
No
Replace with 2 (high resolution)
Save resolution
Set parameters for scren resolution
Restore resolution
Address of the 8x8 system font
High resolution ?
No
Address of the 8x16 system font
Initialize font data
Character color to black

Background color white
Cursor column zero
Cursor line zero

Address of the video RAM
As screen address of the cursor
Set cursor flag
Cursor flash counter to 30
Cursor flash rate to 30
Set flag for cursor on
8000 long words
Clear screen

conout vector to standard
```

```
*********************************************
00F75A 7200                 moveq.l #0,D1          Initialize screen output
00F75C 123B0030             move.b  $F78E(PC,D0.w),D1   D0 contains screen resolution
00F760 33C10000257C         move.w  D1,$257C       Get number of screen planes
00F766 123B0029             move.b  $F791(PC,D0.w),D1   And save
00F76A 33C10000257E         move.w  D1,$257E       Get bytes per screen line
00F770 33C10000257A         move.w  D1,$257A       And save
00F776 E340                 asl.w   #1,D0
00F778 323B001A             move.w  $F794(PC,D0.w),D1   Get screen height
00F77C 33C100002578         move.w  D1,$2578       And save
00F782 323B0016             move.w  $F79A(PC,D0.w),D1   Get screen height
00F786 33C100002570         move.w  D1,$2570       And save
00F78C 4E75                 rts

*************************************************
00F78E 040201               dc.b    4,2,1          Screen parameters
00F791 A0A050               dc.b    160,160,80     Number of screen planes
00F794 00C800C80190         dc.w    200,200,400    Bytes per screen line
00F79A 014002800280         dc.w    320,640,640    Screen heights
                                                   Screen widths
```

Note: This BIOS listing contains some of the most important sections of TOS Version 1. Later versions of TOS may have some minor differences, but this listing should still prove valuable.

Chapter Four

Appendix

4.1 The System Fonts

4.1 The System Fonts

The operating system contains three system fonts for character output.

The 6X6 font is used by the Icons, the 8X8 font is the standard font for output on the color monitor, and the 8X16 font is used for the monochrome monitor output. The chart on the next page includes the characters with the ASCII codes 1 to 255.

6X6 System Font

8X8 System Font

8X16 System Font

The Anatomy of the Atari ST

This **Anatomy** volume is a welcome addition to any ST programmer's library. Inside you'll find important hardware and programming information for your ST. Contains valuable information for the professional programmer and ST novice. Here is a short list of some of the things you can expect to read about:

- 68000 processor
- WD 1772 disk controller
- ACIA's 6850
- Centronics interface
- MIDI-interface
- GEMDOS
- Interrupt instructions
- BIOS listing
- Custom chips
- MFP 68901
- YM-2149 sound generator
- RS-232
- DMA controller
- BIOS & XBIOS
- Error codes

About the authors:
The authors, Klaus Gerits, Lothar Englisch and Rolf Bruckmann, are all part of the experienced Data Becker Product Development Team, based in Dusseldorf, W. Germany. They are all best selling computer book authors and very knowledgeable concerning the subjects presented in this book.

Other books in series:

First Atari ST Book
Tips & Tricks on the Atari ST
GEM on the Atari

A Data Becker Book from First Publishing Limited

1st
FIRST PUBLISHING LTD