SYS68K/CPU-6
User's Manual

Edition No. 4
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P/N 200119
FORCE COMPUTERS Inc./GmbH

INTRODUCTION

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1.0 GENERAL INFORMATION ON THE SYS68K/CPU-6

The SYS68K/CPU-6 series of processor boards uses a 68000 or a 68010 CPU and the 68881 Floating Point Coprocessor (only on CPU-6VB).

To provide fast CPU operation in a local RAM area at a CPU clock frequency of 8 or 12.5 MHz, a 512 Kbyte dynamic RAM is installed on every CPU board. Zero or one wait state is required for each DRAM access (8 or 12.5 MHz operation).

Three serial I/O interfaces are provided on the board to communicate to a terminal, printer, host computer or any other equipment which is RS232 compatible.

Up to 512 Kbytes of EPROM can be used on the four 28-pin sockets to allow effective usage of the SYS68K/CPU-6 boards in high performance applications.

A Real Time Clock with on-board battery backup and a parallel interface completes the SYS68K/CPU-6.

Features of the 68000/68010

- 8 Data Registers (32 bits wide)
- 7 Address Registers (32 bits wide)
- 1 User Stack Pointer (32 bits wide)
- 1 Supervisor Stack Pointer (32 bits wide)
- 14 Addressing Modes
- 56 Powerful Instruction Types
- 16 Mbyte Direct Addressing Range using a fully asynchronous Bus Interface
- 16 Bit Data Bus

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2.0 THE FLOATING POINT COPROCESSOR

The 68881 Floating Point Coprocessor (FPCP) is a full implementation of the IEEE Standard for Binary Floating Point Arithmetic (IEEE 754).

The FPCP instruction set supports all the addressing modes of the 68000 family. The FPCP is installed on the SYS68K/CPU-6VB as a coprocessor with access from the 68010 via the local bus.

Features of the 68881

- 16.7 MHz clock frequency.
- 8 general purpose floating point data registers supporting 80 bit extended precision of real data. (64 bit mantissa, 15 bit exponent, and one sign bit).
- 3 registers for control, status and instruction address.
- 67 bit arithmetic unit
- 67 bit barrel shifter
- 46 instructions with 35 arithmetic operations.
- IEEE 754 compatible including all requirements and suggestions.
- Full set of trigonometric and transcended functions.
- 7 data types:
  - Byte Integer
  - Word Integer
  - Long Word Integer
  - Single Precision Real
  - Double Precision Real
  - Extended Precision Real
  - Packed Decimal Strings
- 22 constants available in the on-chip ROM, including Pi, e, and powers of 10.
- Virtual memory/machine operations
- Efficient mechanism for procedure calls, context switches and interrupt handling.

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3.0 THE MONITOR OF SYS68K/CPU-6

Every CPU-6 board contains VMEPROM, a realtime multitasking monitor debugger. It consists of a powerful realtime kernel, a file manager and a monitor/debugger with 68000/68010 line assembler/disassembler.

The monitor/debugger includes all functions to control the realtime kernel and file manager as well as all tools required for program debugging such as breakpoints, tracing, memory display, memory modify and host communication.

VMEPROM supports several memory and I/O boards on the VMEbus to take full advantage out of the file manager and the kernel functions.

A built-in selftest checks all on-board devices together with the on-board memory. This allows the detection of all failures on the board.

Memory initialization and test commands offers easy installation of global memory in the environment on the VMEbus.

The one line assembler/disassembler is 68000/68010 compatible and supports all commands in the original mnemonic.

For reference to the I/O devices of VMEPROM please see register 8, entitled "BIOS Source Code Listing".

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4.0 DEVELOPMENT SYSTEMS WITH SYS68K/CPU-6

For software development with the SYS68K/CPU-6 series of boards, FORCE COMPUTERS offers a development/target system with SYS68K/CPU-6 as a CPU board, and the Real Time Operating System PDOS*.

The multiuser Real Time Operating System includes an Assembler for the 68000/68010 as well as the following programming languages as an option:

C
FORTRAN 77
PASCAL

All of these compilers generate efficient code to optimize the run time of the programs.

Further details are listed in the data sheet of the miniFORCE series of development/target systems.

PDOS* is a trademark of Eyring Research Laboratories.

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5.0 HISTORY OF MANUAL REVISIONS

REVISION	DESCRIPTION	DATE OF LAST CHANGE
Rev. 1	1. VMEPROM description for Version 2.53 included. 2. Chapter 6.5, "The Programmable Reset Option" has been added. 3. Default Jumpersetting of B23 has been corrected.	NOV/28/1989
Rev. 2	Appendix F, "Front Panel Switches", has been removed from Section 7, "Appendix to the Introduction to VMEPROM".	JUL/25/1990
Rev. 3	Appendix H,"Generation of Application in EPROM" has been removed from Section 7, "Appendix to the Introduction to VMEPROM".	OCT/07/1992
Rev. 4	Corrected chapter 4.2.3, "Access Time Selection"	AUG/06/1996

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INSTALLATION

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PLEASE READ THE COMPLETE INSTALLATION PROCEDURE BEFORE THE BOARD IS INSTALLED IN A VMEBUS ENVIRONMENT TO AVOID MALFUNCTIONS AND COMPONENT DAMAGES.

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1.0 GENERAL OVERVIEW

Easy installation of the SYS68K/CPU-6 products is provided because the memory map, the I/O devices and their interfaces are configured to communicate to a standard terminal with RS232 interface.

The monitor (VMEPROM) boots up automatically without any modifications to the boards.

1.1 The Function Switch Positions

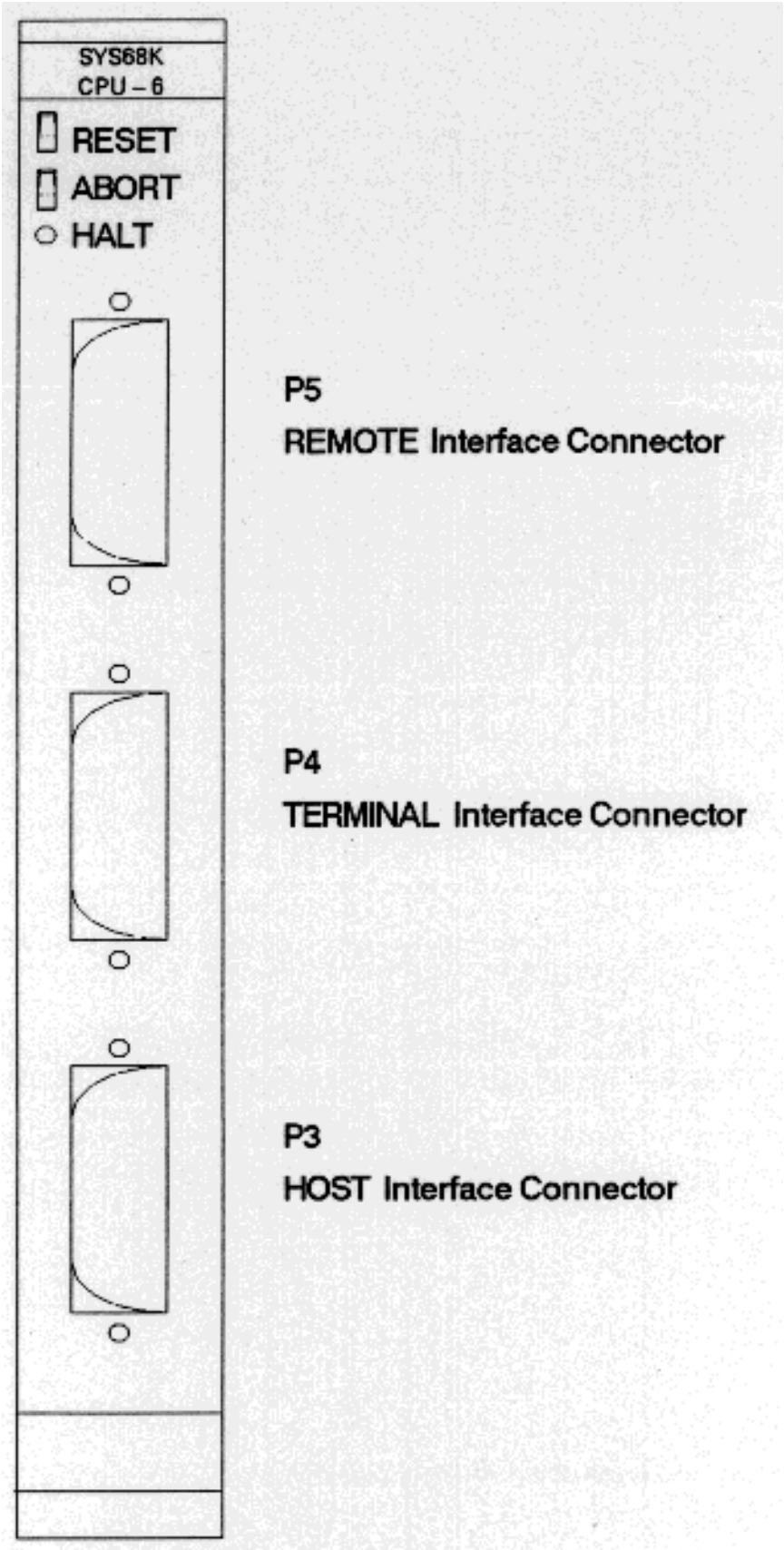
The SYS68K/CPU-6 contains two toggle switches with a default parking position.

The RESET and the ABORT switches move automatically back into the "DOWN" position after having been switched into the "UP" position.

Please toggle the switch sometime before installing the board into the rack, to detect any switches which may have been damaged during transportation.

For reference, Figure 1-1 shows the Front Panel of SYS68K/CPU-6 in detail.

Figure 1-1: The Front Panel of SYS68K/CPU-6



1.2 Connection of the Terminal

The terminal must be connected to the terminal interface connector, found in the middle of the front panel (P4).
The following communication setup is used for interfacing the terminal:

No Parity
8 Bits per character
1 Stop Bit
9600 Baud
Asynchronous Protocol

Please configure the terminal to this setup.

The hardware interface is RS232 compatible and the following signals are supported:

Signal	PIN	Input	Output	Common
Protective GND	1			
RxD	2	x		
TxD	3		x	
DTR	5		x	
GND	7			x
CTS	20	x		

CAUTION: The terminal used must not drive a signal line which is marked to be an output of SYS68K/CPU-6.

All signals marked as "Input" or "Common" have to be supported from the terminal to enable the transmission.

If the terminal is configured to the setup listed above, please connect the 25 pin D-sub connector to the terminal with a cable which supports all of the listed signals.

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2.0 THE DEFAULT HARDWARE SETUP

All VMEbus and local interfaces are configured to be used immediately without any changes.

This results in a default hardware setup which may conflict with other boards also installed in the rack.

2.1 The VMEbus Setup

The following signals are driven/received from the SYS68K/CPU-6:

	Driven	Received	From
SYSCLK	x		Clock Module
BR3*	x	x	Requester Logic to Single Level Arbiter
BG3OUT*	x		DTB Arbitration
ACFAIL*			Local PI/T and Jumperfield
SYSFAIL*			Local PI/T and Jumperfield
SYSRESET*	x	x	Power Monitor and RESET Generator

CAUTION: The on-board single level arbiter is enabled and reacts on every BR3*.

SYS68K/CPU-6 is configured as a slot 1 board.

2.2 The Local Setup

The local DRAM is initialized from location $8 to $4000. This area is under the control of, and reserved for the VMEPROM firmware which is installed on each SYS68K/CPU-6 board.

All other RAM cells (on the local DRAM and on the VMEbus) will not be accessed and will remain unmodified. The initialization and test of memory areas can be carried out via VMEPROM commands.

All local devices, the serial I/O interfaces, the Real Time Clock and the PI/T are initialized after boot up. The VMEPROM is configured to work independent of hardware connections to the REMOTE and HOST ports, as well as to the Parallel Interface.

All jumpers of the different SYS68K/CPU-6 board versions are set during manufacturing so that no jumper setting change is required in order to boot the board.

3.0 INSTALLATION IN THE RACK

All SYS68K/CPU-6 boards are preset to the default condition and can be mounted immediately into a VME rack only at slot 1.

CAUTION: A) Switch off power before installing the board, to avoid electrical damages of the components.

B) The board contains a special ejector on the front panel.

To ensure proper installation, the board must be plugged in and the screws of the front panel must be turned.

C) Unplug every other VMEbus or VMXbus board to avoid conflicts.

D) Remove all connections on the P2 backplane to avoid conflicts.

3.1 Power On

If the board is correctly installed, the switches are in the correct positions, the terminal is correctly configured and under power; the power for the VMEbus rack can be switched on.

First, the HALT LED must show a red light; then, after one to three seconds, it must change to a green light.

At the same time, the following message is displayed on the terminal:

```
************************************************************
*                                                          *
*                     V M E P R O M  (TM)                  *
*                                                          *
*           SYS68K/CPU-6   Version 2.1   24-MAY-88         *
*                                                          *
*          (c) FORCE COMPUTERS and Eyring Research         *
*                                                          *
************************************************************
```

The next entry on the terminal keyboard may be some carriage returns, which will result in a display of an equivalent number of question marks (?).

3.2 Correct Operation

To test the correct operation of the CPU-6 the following command has to be typed in:

```
? SELFTEST
```

After a matter of a few seconds, the following messages will appear on the screen:

```
Memory test passed

I/O test passed

Clock test passed
```

Any errors will be reported as they are designated.

If an error message is displayed, please refer to register 6, "Introduction to VMEPROM" and the command description "SELFTEST".

The next steps are under User’s direction.

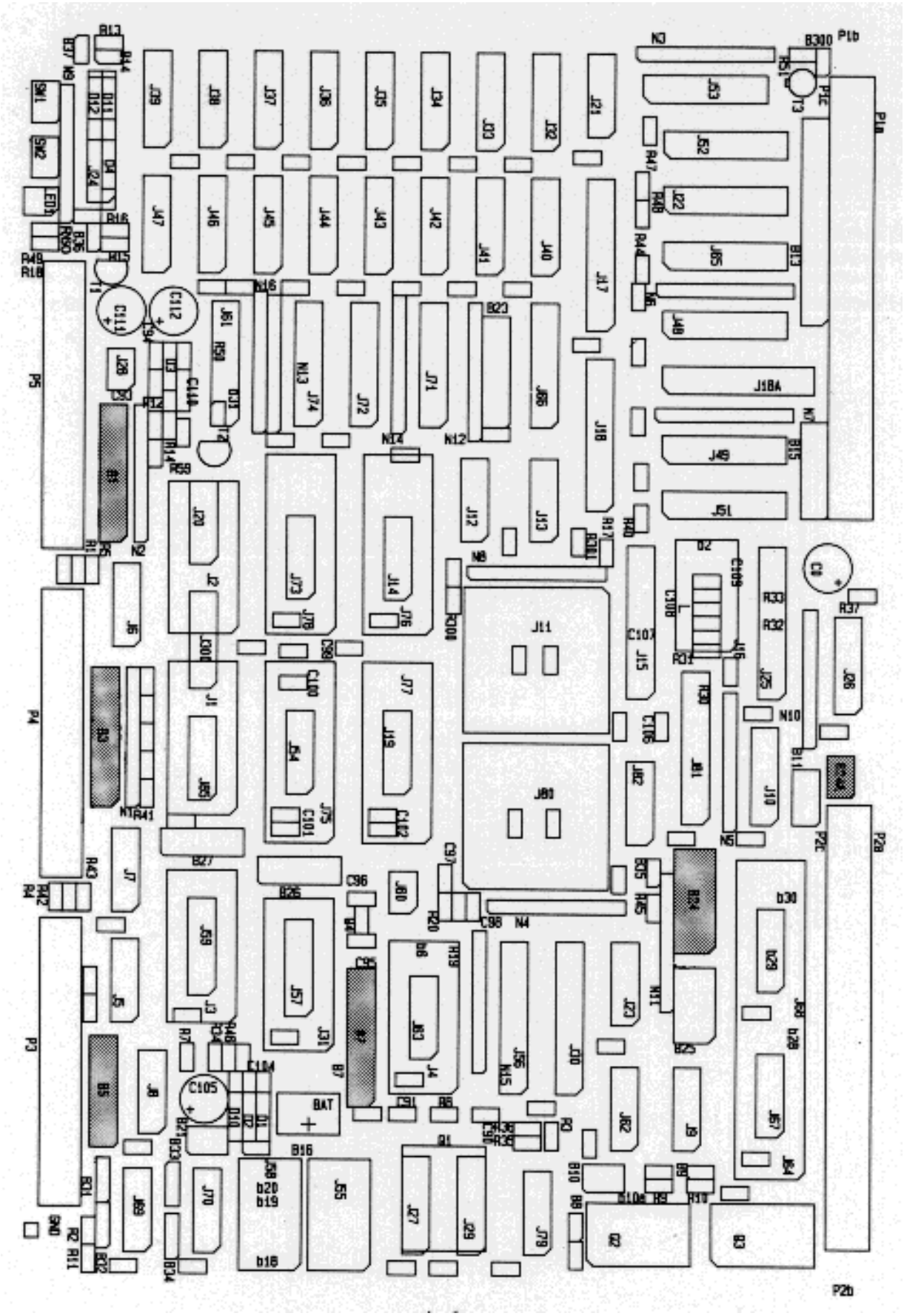
4.0 JUMPERS SETTINGS ON THE SYS68K/CPU-6

Jumper field	Coordinate	Page Description	Jumper field	Coordinate	Page Description
B1	1-B1	E-2	B23	7-C1	E-4
B3	1-B4	E-2	B24	7-A4	E-2
B5	1-D1	E-2	B24A	7-B3	E-2
B7	1-D3	E-2	B25	7-C3	E-6
B8	2-A1	E-6	B26	8-C3	E-6
B9	2-A3	E-6	B27	8-D3	E-6
B10	2-A2	E-6	B31	7-D2	E-6
B11	2-B4	E-6	B32	7-D2	E-6
B13	3-D1	E-4	B33	7-D3	E-6
B14	4-B3	E-4	B34	7-D3	E-6
B15	4-D1	E-4	B35	3-A2	E-6
B16	4-A4	E-6	B36	4-A2	E-4
B21	6-C2	E-6	B37	4-A1	E-4

4.1 System and User I/O Jumpers

Jumper-field	Description	Default	Schematics	See Page
B1	Serial I/O Interface configuration for remote	2 - 19 3 - 18 4 - 17 5 - 16 7 - 8 10 - 11 6 - 13	1 - B1	4-31
B3	Serial I/O Interface configuration for terminal	2 - 19 3 - 18 4 - 17 5 - 16 7 - 8 10 - 11 6 - 13	1 - B3	4-24
B5	Serial I/O Interface configuration for host	2 - 15 3 - 14 4 - 13 5 - 12 7 - 10 8 - 9	1 - D1	4-38
B7	Baud Rate Control	1 - 20 3 - 18 5 - 16 10 - 11	1 - D3	4-17
B24	Parallel Interface	1 - 2 3 - 6 4 - 5 7 - 8 10 - 11 13 - 14 16 - 17 19 - 20	7 - A4	4-47
B24A	Parallel Interface	1 - 6 2 - 5 3 - 4	7 - B3	4-47

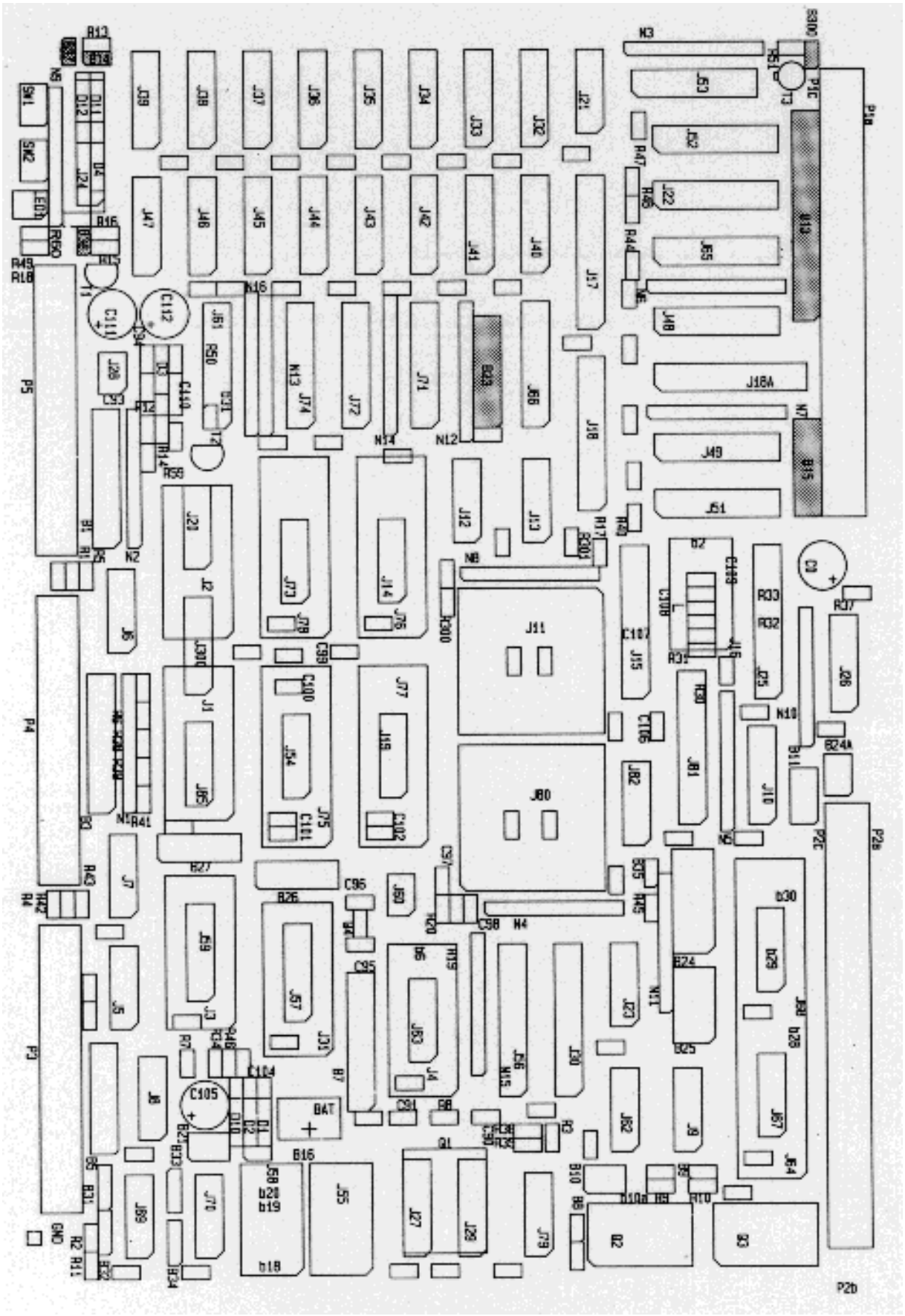
4.2 Jumper Location Diagram of the System and User I/O Configuration Jumpers



4.3 VMEbus Configuration Jumpers

Jumper-field	Description	Default	Schematics	See Page
B14 B36 B37 B300	Reset Generator	--- --- --- 1 - 2	4 - B3 4 - A2 4 - A2 4 - B2	6-1
B13	Bus Request Bus Grant SYSCLK BCLR	2 - 3 4 - 27 6 - 25 7 - 24 8 - 9 10 - 21 11 - 20 13 - 18 14 - 17	3 - D1	5-21
B15	Bus IRQ enable	1 - 14 2 - 13 3 - 12 4 - 11 5 - 10 6 - 9 7 - 8	4 - D1	5-32
B23	Short I/O Address Modifier	--- --- --- --- --- --- --- ---	7 - C1	5-9

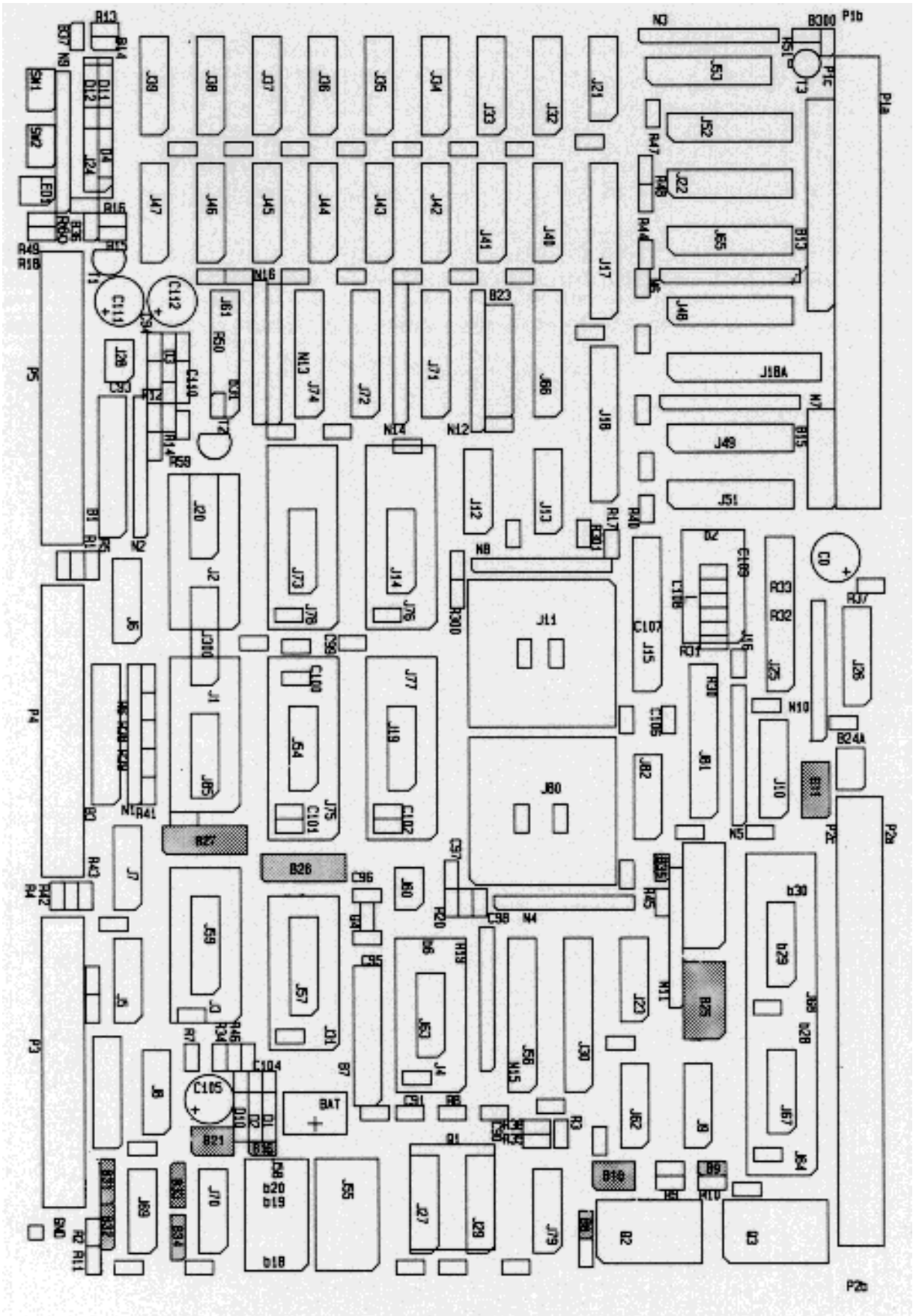
4.4 Jumper Location Diagram of the VMEbus Configuration Jumpers



4.5 Local Configuration Jumpers

Jumper-field	Description	Default	Schematics	See Page
B25	Error Timer	7 - 10 11 - 14	7 - C3	4-83
B33	Error Timer	1 - 2	7 - D3	
B34	Error Timer	-		
B25	Bus Mastership Timer	5 - 8	7 - C2	5-21
B31		2 - 3	7 - D2	
B32		-		
B8	Clock Selectors	1 - 2	2 - A1	--
B9		1 - 2	2 - A3	--
B10	8MHz	2 - 3 4 - 5	2 - A2	3-1
B10	12.5MHz	1 - 2 5 - 6		
B11	EPROM Access Time Selection	1 - 8 4 - 5	2 - B4	4-14
B26	EPROM Size Selection	1 - 12 10 - 11 4 - 9 7 - 8	8 - C3	4-2
B27		1 - 12 3 - 10 4 - 9 6 - 7	8 - D3	4-8
B21	DTACK Generated for RAM 8MHz 12.5MHz	1 - 5 4 - 5	6 - C2	3-1
B16	Battery (STDBY)	-	4 - A4	4-56
B35	Read-Modify-Write	-	3 - A2	--

4.6 Jumper Location Diagram of the Local Configuration Jumpers



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5.0 WARNINGS

A) If the board does not boot up correctly, please do not remove any jumpers.

B) If an error has been found by VMEPROM, please refer to the VMEPROM User's Manual for a detailed error description.

C) If the terminal does not display the described text, the terminal setup may be wrong. Please check this setup.

D) If the board does not boot up correctly, please do not place the board back into the plastic box without replacing the metal foil on the back or putting the board into an antistatic bag, or components may be destroyed.

E) Please do not install other VMEbus boards into a rack which includes the following functions, before the jumper settings have been changed: SYSCLK Driver, Arbiter.

F) Please do not solder the battery (included in the shipment) into the PCB prior to reading the installation paragraph, and prior to testing the board functions with the SELFTEST command.

G) Please do not connect I/O signals at P2 connector prior to cross checking the SYS68K/CPU-6 P2 I/O signal assignment to avoid component damages.

H) The RESET instruction of the local CPU does not reset the local I/O devices, only the VMEbus SYSRESET will be forced if the jumper setting is in the default condition.

SYS68K/CPU-6

HARDWARE USER'S MANUAL

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1.0 GENERAL INFORMATION

The SYS68K/CPU-6 series of processor boards combines the powerful 16/32 bit microprocessor, the 68000/68010 with 512 Kbytes of dynamic RAM and a VMEbus interface.

The on-board Real Time Clock, the three serial I/O interfaces and the parallel I/O and timer offer a powerful combination to accomplish a wide variety of applications.

Easy access to the installed devices is provided through the ROM resident monitor called VMEPROM. This powerful software package is based on a realtime kernel and file manager and can be used for program development and debugging of application programs.

The usage of the SYS68K/CPU-6 series of boards in critical real time applications is provided through the high CPU clock rate (up to 12.5 MHz) and the fast on-board DRAM (only 1 wait state at 12.5 MHz).

Figure 1-1: Photo of SYS68K/CPU-6

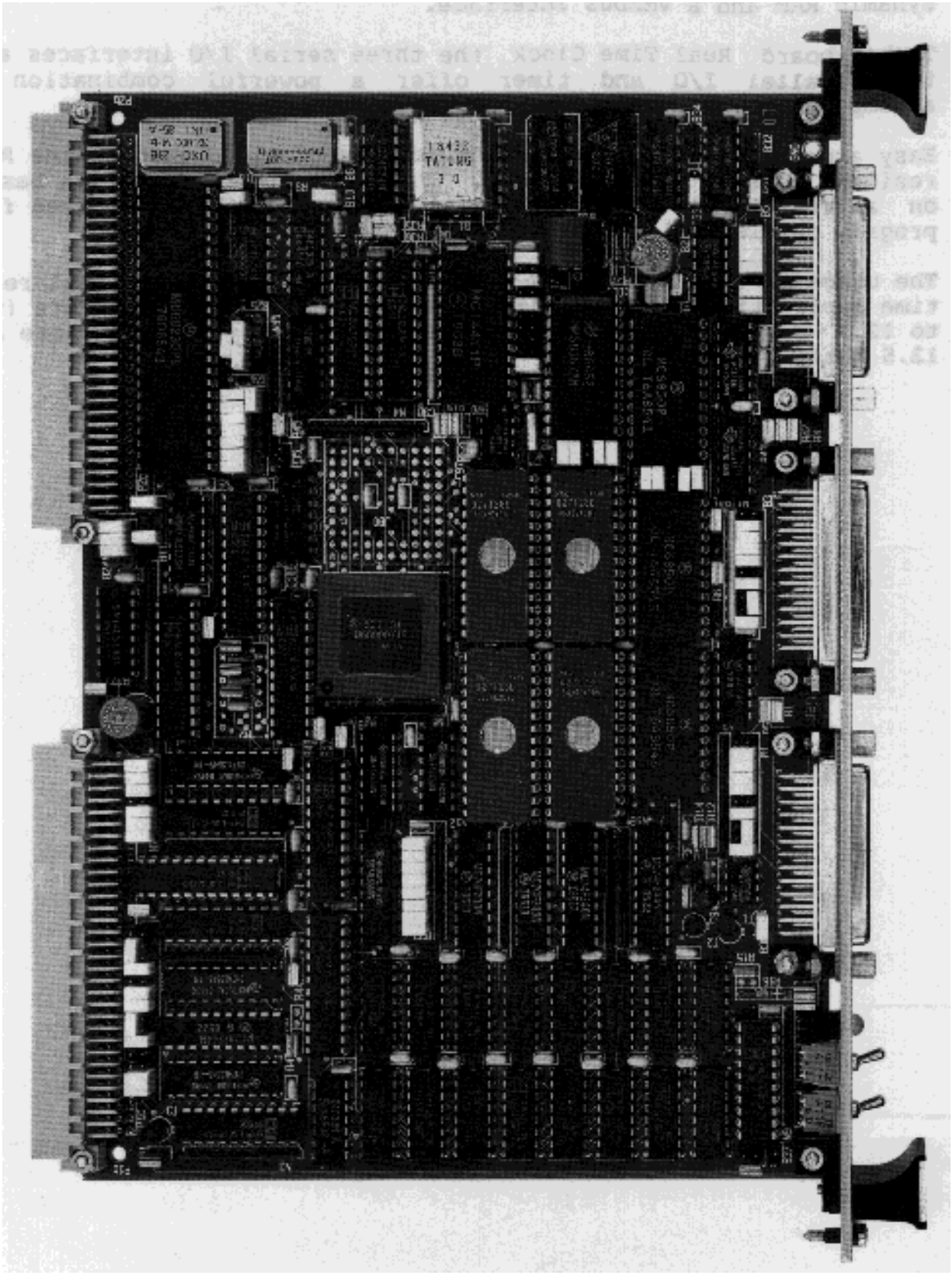
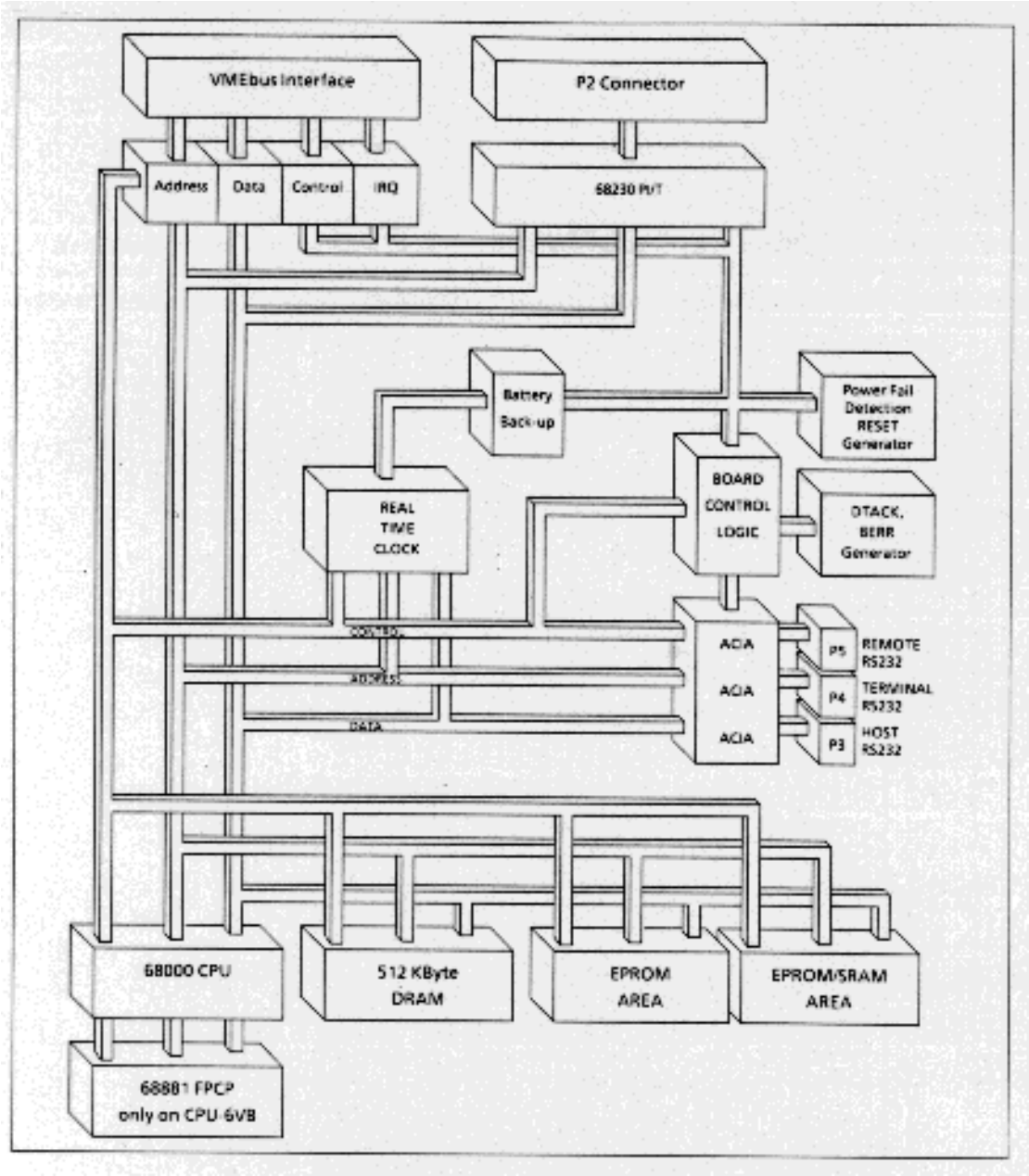


Figure 1-2: Block Diagram of the SYS68K/CPU-6



2.0 HARDWARE OVERVIEW

The SYS68K/CPU-6 boards contain the powerful 68000/68010 CPU with 512 Kbytes of dynamic RAM, a maximum of 256 Kbytes of EPROM and powerful I/O devices.

One RS232 interface (Port 2 connector P4) is used in conjunction with a standard terminal to enter and debug user programs under the control of VMEPROM. A second RS232 interface (Port 1 connector P3) may be used for up/download of user programs and data. The third RS232 interface (Port 3 connector P5) is a universal port to support an additional terminal, printer or other device.

A Parallel Interface and Timer Chip (PI/T 68230) is used to interface various hardware on the P2 connector and to work as the time base for VMEPROM.

In addition, the Real Time Clock (RTC 58167A) provides a constant time base because of its on-board battery backup.

The SYS68K/CPU-6VB contains a Floating Point Coprocessor (FPCP 68881) with 12.5 MHz clock rate to support floating point applications.

All of the I/O devices, the DRAM, and the EPROM areas are located on the local bus. Memory and I/O extension is provided using the VMEbus interface. The block diagram of SYS68K/CPU-6 shows the functional areas in detail.

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3.0 THE 68000/68010 MICROPROCESSOR DESCRIPTION

The 68000/68010 contains seventeen 32 bit registers, two 32 bit program counters and a 16 bit status register.

The first eight registers are used as data registers (D0-D7) for byte (8 bit), word (16 bit), and long word (32 bit) operations.

The seven address registers (A0-A6), the supervisor, and the user stack pointer may be used as base address registers or as software stack pointers, where word and long word operations are supported.

All of the 17 registers described may be used for word and for long word address operations or as index registers.

Table 3-1 lists the clock frequencies for each of the SYS68K/CPU-6 versions, the processor type, and the corresponding jumper settings.

Table 3-1: CPU-Clock Frequency

Version	CPU Type	Clock Frequency	Jumper Settings at B10
CPU-6A	68000	12.5 MHz	Mode A
CPU-6V	68010	8.0 MHz	Mode B
CPU-6VA	68010	12.5 MHz	Mode A
CPU-6VB	68010	12.5 MHz	Mode A

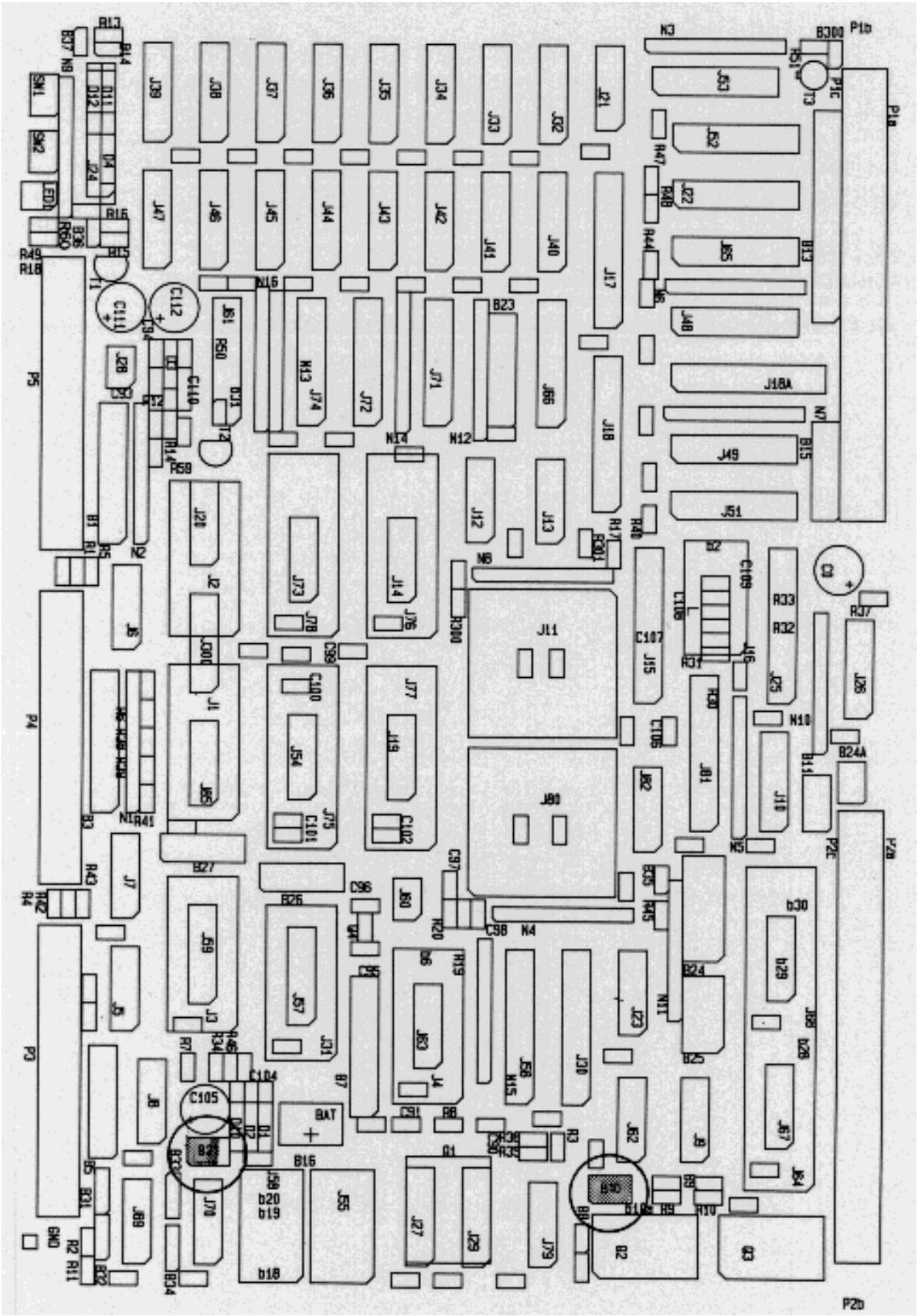
Figure 3-1: CPU Clock Speed Jumper Settings

Mode A CPU-6A
CPU-6VA
CPU-6VB

Mode B CPU-6V

Caution: No other jumper settings are allowed. Any other jumper setting than those shown can cause component damage and/or other malfunctions.

Figure 3-2: Location Diagram of the CPU Clock Speed Jumperfields B10 and B21



3.1 The 68000 Hardware Description

The 68000 provides 23 address signals, 16 data signals and 10 control signals which build the fully asynchronous bus interface.

A Data Transfer Acknowledge (DTACK) and a Bus Error (BERR) input signals the CPU if a bus cycle can be aborted correctly or if an error has been detected.

Seven interrupt request signals are encoded and driven to the CPU to provide fast and effective interrupt acknowledgment for real time applications.

Features of the 68000

- 8 data registers (32 bit)
- 7 address registers (32 bit)
- 32 bit supervisor stack pointer
- 32 bit user stack pointer
- 16 bit status register
- 16 Mbyte direct addressing space
- Hardware signals provide detection of program and data fetches, as well as of supervisor and user mode
- 56 powerful instruction types with 14 addressing modes
- 5 main data types
- Memory mapped I/O
- Asynchronous bus interface

3.2 The Vector Table of the 68000

Vector No.(s)	Address Dec	Hex	Space	Assignment
0	0	000	SP	Reset:Initial SSP
-	4	004	SP	Reset:Initial PC
2	8	008	SD	Bus Error
3	12	00C	SD	Address Error
4	16	010	SD	Illegal Instruction
5	20	014	SD	Zero Divide
6	24	018	SD	CHK Instruction
7	28	01C	SD	TRAPV Instruction
8	32	020	SD	Privilege Violation
9	36	024	SD	Trace
10	40	028	SD	Line 1010 Emulator
11	44	02C	SD	Line 1111 Emulator
12*	48	030	SD	(Unassigned,reserved)
13*	52	034	SD	(Unassigned,reserved)
14*	56	038	SD	(Unassigned,reserved)
15	60	03C	SD	Uninitialized Interrupt Vector
16-23	64	04C	SD	(Unassigned,reserved)
	95	05F		-
24	96	060	SD	Spurious Interrupt
25	100	064	SD	Level 1 Interrupt Autovector
26	104	068	SD	Level 2 Interrupt Autovector
27	108	06C	SD	Level 3 Interrupt Autovector

The Vector Table of the 68000 cont.

Vector No.(s)	Address Dec	Hex	Space	Assignment
28	112	070	SD	Level 4 Interrupt Autovector
29	116	074	SD	Level 5 Interrupt Autovector
30	120	078	SD	Level 6 Interrupt Autovector
31	124	07C	SD	Level 7 Interrupt Autovector
32-47	128	080	SD	TRAP Instruction Vectors
	191	0BF		
48-63*	192	0C0	SD	(Unassigned,reserved)
	255	0FF		-
64-255	256	100	SD	User Interrupt Vectors
	1023	3FF		-

***** Vector numbers 12,13,14,16 through 23, and 48 through 63 are reserved for future enhancements. No user peripheral devices should be assigned these numbers.

3.3 The 68010 Hardware Description

The 68010 contains the same features as those in the 68000 description in paragraph 3.1, except for the following enhancements.

A vector base register is used to determine the location of the exception vector table in memory to support multiple vector tables and to allow a variable memory map.

On SYS68K/CPU-6 VMEPROM, the vector base register is not altered, which results in the same address map as used for the 68000 version.

The Function Code Register allows the supervisor to access user data and program space to emulate CPU space cycles and/or modify data.

During a Bus Error exception processing sequence, the following information is placed on the supervisor stack:

A) Status Register

B) Program Counter (2 to 5 words)

C) Frame format and vector offset

D) Internal register information (22 words)

Storage of this information allows recovery from a bus error and enables the program to be continued from where the bus error occurred.

3.4 The Vector Table of the 68010

Vector No.(s)	Address Dec	Hex	Space	Assignment
0	0	000	SP	Reset:Initial SSP
-	4	004	SP	Reset:Initial PC
2	8	008	SD	Bus Error
3	12	00C	SD	Address Error
4	16	010	SD	Illegal Instruction
5	20	014	SD	Zero Divide
6	24	018	SD	CHK Instruction
7	28	01C	SD	TRAPV Instruction
8	32	020	SD	Privilege Violation
9	36	024	SD	Trace
10	40	028	SD	Line 1010 Emulator
11	44	02C	SD	Line 1111 Emulator
12*	48	030	SD	(Unassigned,reserved)
13*	52	034	SD	(Unassigned,reserved)
14*	56	038	SD	(Unassigned,reserved)
15	60	03C	SD	Uninitialized Interrupt Vector
16-23	64	04C	SD	(Unassigned,reserved)
	95	05F		-
24	96	060	SD	Spurious Interrupt
25	100	064	SD	Level 1 Interrupt Autovector
26	104	068	SD	Level 2 Interrupt Autovector
27	108	06C	SD	Level 3 Interrupt Autovector

Vector No.(s)	Address Dec	Hex	Space	Assignment
28	112	070	SD	Level 4 Interrupt Autovector
29	116	074	SD	Level 5 Interrupt Autovector
30	120	078	SD	Level 6 Interrupt Autovector
31	124	07C	SD	Level 7 Interrupt Autovector
32-47	128	080	SD	TRAP Instruction Vectors
	191	0BF		
48-63*	192	0C0	SD	(Unassigned,reserved)
	255	0FF		-
64-255	256	100	SD	User Interrupt Vectors
	1023	3FF		-

* Vector numbers 12,13,14,16 through 23, and 48 through 63 are reserved for future enhancements. No user peripheral devices should be assigned these numbers.

3.5 The Address Map of SYS68K/CPU-6

The memory map of SYS68K/CPU-6 is outlined in Table 3.5-1.

All memory and I/O areas are identical for all SYS68K/CPU-6 products except for the memory map of the Floating Point Co-Processor. A bus error will be generated on SYS68K/CPU-6A, 6V and 6VA if an access to the not installed FPCP is initiated.

To detect the end of the onboard DRAM area via software, the addresses $80000 to $80007 are not decoded, and a bus error will occur.

Table 3.5-1: Memory Map of SYS68K/CPU-6

000 000 :	ROM Initialization Vectors from SYSTEM EPROM
000 007	
000 008 :	On-Board DRAM (512 Kbytes)
07F FFF	
080 008 :	SYSTEM EPROM Area (128 Kbytes)
09F FFF	
0A0 000 :	USER EPROM Area (128 Kbytes) or SRAM (64 Kbytes)
0BF FFF	
0C0 041 :	RS 232 Interface (Host) P3 connector
0C0 043	
0C0 080 :	RS 232 Interface (Terminal) P4 connector
0C0 082	
0C0 101 :	RS 232 Interface (Remote) P5 connector
0C0 103	
0C0 401 :	RTC (Real Time Clock)
0C0 42F	
0E0 001 :	PI/T (Parallel Interface/Timer)
0E0 035	
0E0 200 :	FPCP (Floating Point Coprocessor)
0E0 300	Reset off
0E0 380	Reset on
100 000 :	VMEbus (A24:D16, D8)
FEF FFF	
FF0 000 :	VMEbus (A16:D16, D8)
FFF FFF	

4.0 THE LOCAL BUS

Each of the SYS68K/CPU-6 products contains a local bus driven and controlled only by the 68000/68010 CPU.

All of the memory, the I/O devices and the FPCP communicate to the CPU via this bus.

The VMEbus interface, described in Chapter 5 of this manual is also connected to this local bus and fully controlled by the CPU.

Detailed information about the functional groups is given in the subsequent chapters. For reference, a block diagram of the SYS68K/CPU-6 is provided at Figure 4.0-1.

The SYS68K/CPU-6 consists of four sockets for JEDEC compatible devices. Two different memeory banks (with two sockets each) are used; one for boot up, and one for user application programs.

4.1 EPROM Area 1

During the power up phase, the 68000 CPU reads two vectors from this EPROM area; one is the Initial Stack Pointer (Address $000000 - $000003) and one is the Initial Program Counter (Address $000004 - $000007).

The data signals D0-D7 are used on the socket J75 (Lower byte) and the data signals D8-D15 are connected to the socket J76 (Upper byte).

4.1.1 Memory Organization of EPROM Area 1

For proper initialization, the first eight addresses of EPROM Area 1 are downmapped to address $0 to $8.

Figure 4.1-2 shows the location diagram of the EPROM Area 1.

4.1.2 Usable Device Types of EPROM Area 1

EPROM Area 1 can be configured for the listed device types if the connections described in Table 4.1-1 are made.

	Device	Organization	Capacity
EPROM	2764	8K x 8	16 Kbytes total
EPROM	27128	16K x 8	32 Kbytes total
EPROM	27256	32K x 8	64 Kbytes total
EPROM	27512	64K x 8	128 Kbytes total

Figure 4.0-1: Block Diagram of SYS68K/CPU-6

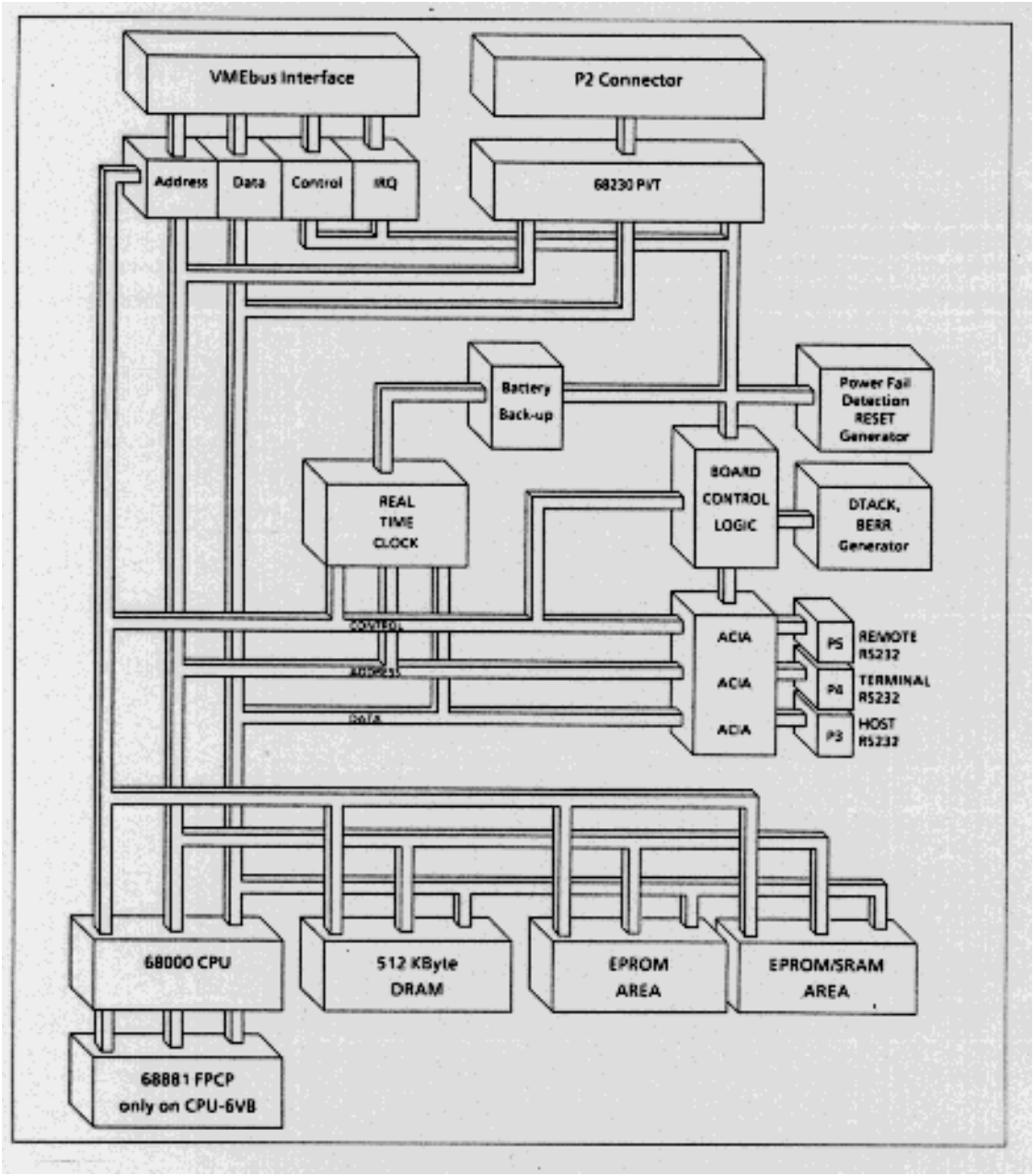


Figure 4.1-2: Location Diagram of the EPROM Area 1

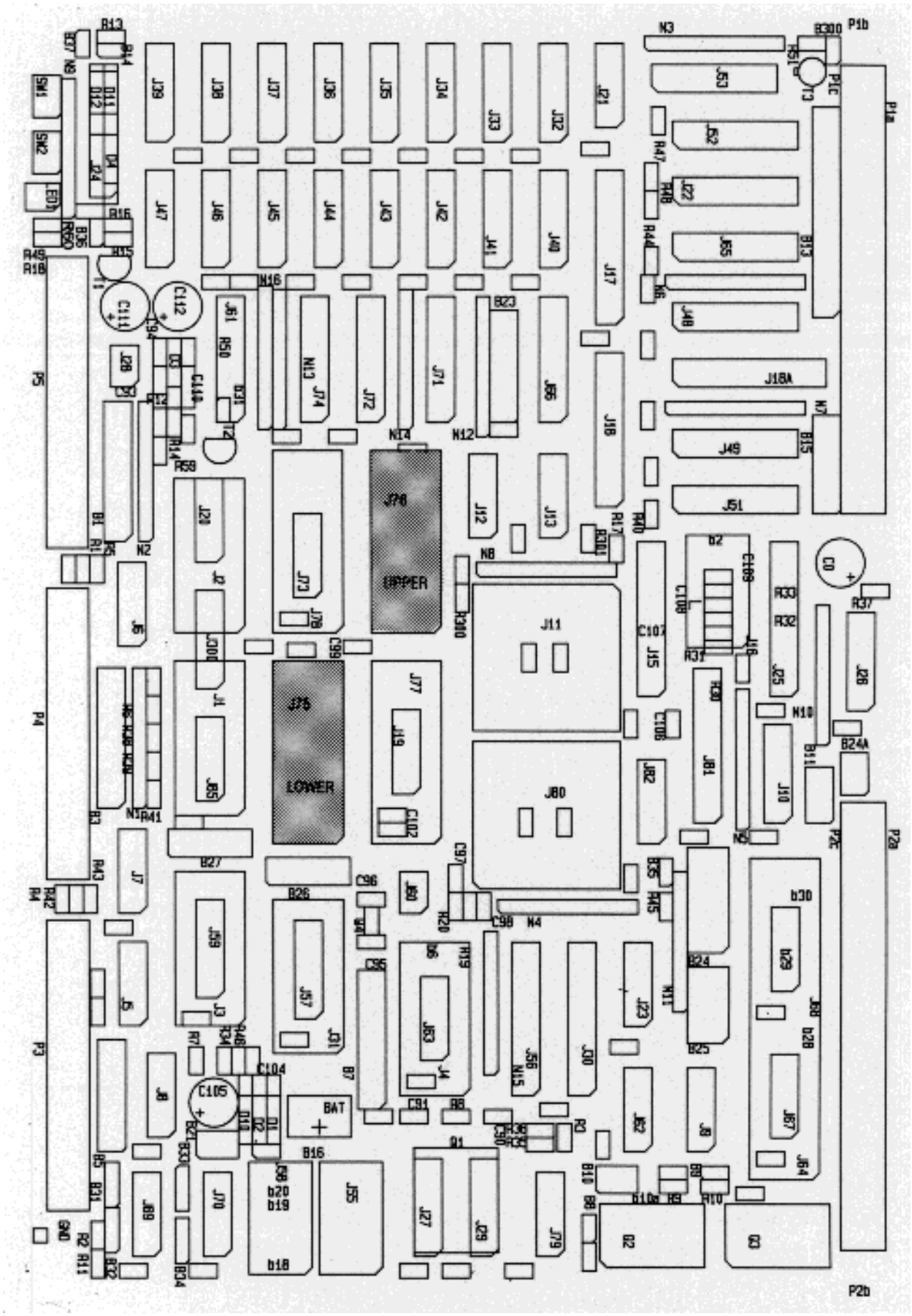
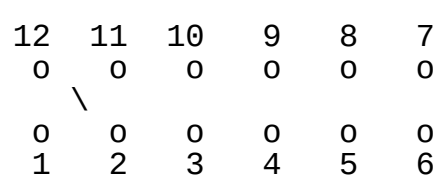
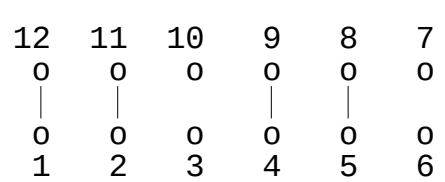
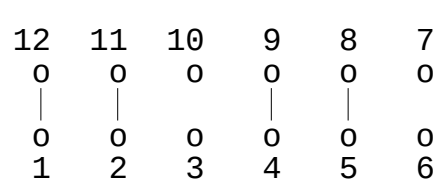
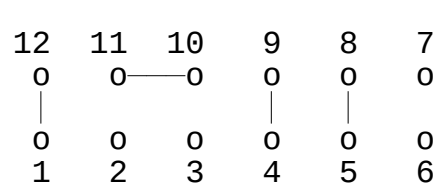
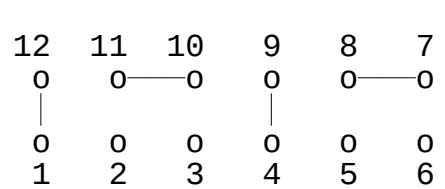
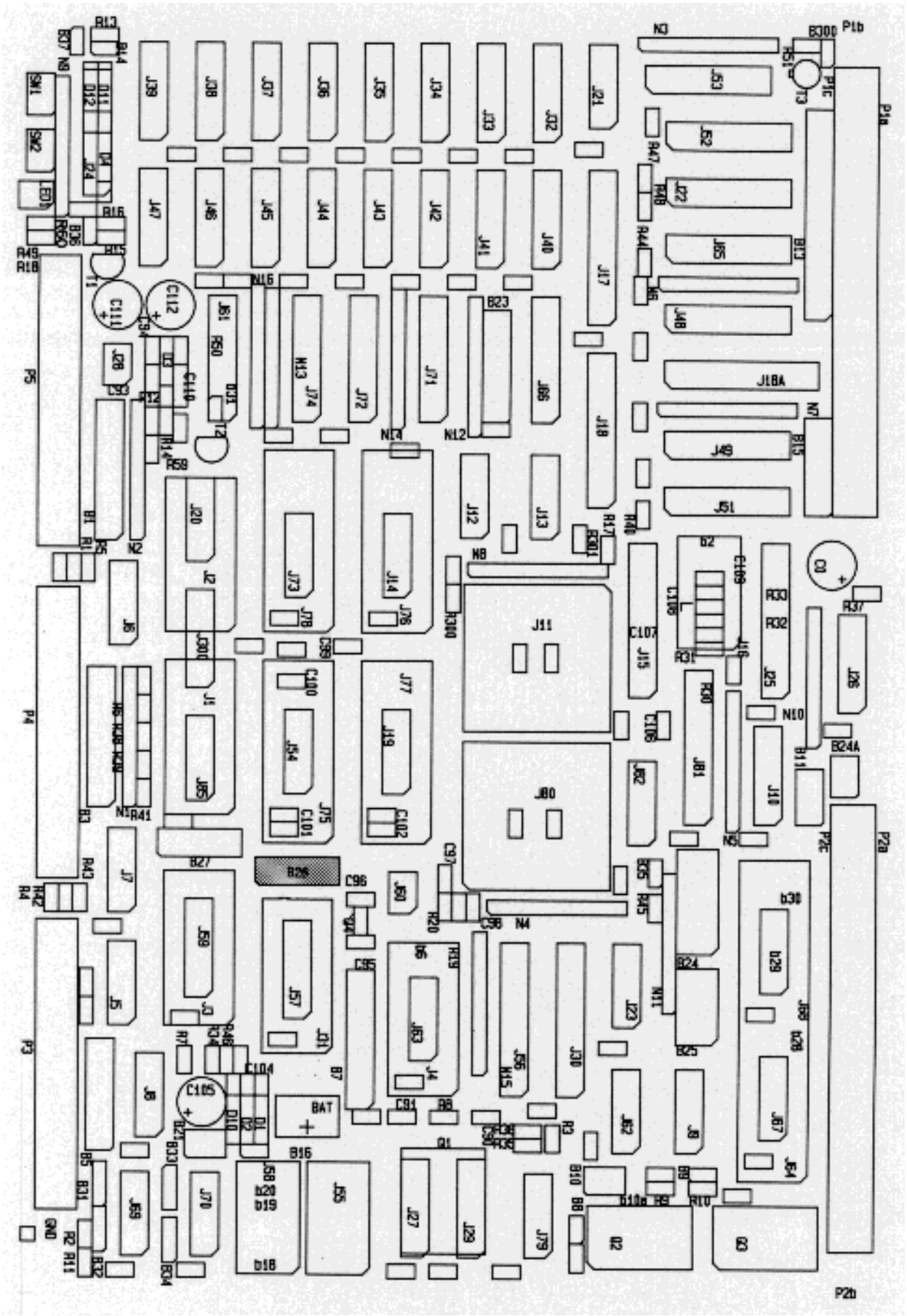


Table 4.1-1: EPROM Area 1 Jumper Settings

Type	Jumper B26
2732	
2764	
27128	
27256	
27512 *	

* Default condition during manufacturing

Figure 4.1-3: Location Diagram of the Jumperfield B26



4.1.3 Access Timer Selection of EPROM Area 1

To enable the use of fast and slow devices, the EPROM areas have a selectable access time.

This jumperfield provides different jumper settings as listed in Table 4.2-2.

Figure 4.2-2 shows the location diagram of the speed selectors.

4.1.4 Insertion of Devices into EPROM Area 1

The SYS68K/CPU-6 contains two 28-pin DIP sockets. The assignment is shown in Appendix D of this manual (Register 4).

4.1.5 Address Map of EPROM Area 1

The start address of the EPROM Area 1 is fixed mapped via a decoding PAL. The size of the memory area depends on the memory capacity of the used devices.

Table 4.1-2 lists the address map for the different usable device types.

Table 4.1-2: Address Map of EPROM Area 1

Start Address	End Address	Used Device	Total Capacity
080 008	083 FFF	2764	16K Byte
080 008	087 FFF	27128	32K Byte
080 008	08F FFF	27256	64K Byte
080 008	09F FFF	27512	128K Byte

4.1.6 Summary of EPROM Area 1

Start Address	$080008
End Address	$09FFFF
Boundary	$020000
Boot Address	$000000 to $000007
Access Modes	Byte or Word Read Only accesses supported
Default Access Time	250ns (max)

4.2 The EPROM Area 2

For user application programs or as a static RAM area, two 28 pin sockets are provided on the board.

4.2.1 Memory Organization of EPROM Area 2

The chip selection for the upper (D8-D15) and the lower socket (D0-D7) on the board is organized by byte. This allows byte manipulation if SRAM chips are installed.

Figure 4.2-1 shows the location diagram of the user area and the jumper configuration area.

This jumper configuration area defines which address/control signals are connected to the socket pairs.

4.2.2 Usable Device Types

The following device types are usable in User Area 2:

	Device	Organization	Capacity
EPROM	2764	8K * 8	16 Kbytes total
EPROM	27128	16K * 8	32 Kbytes total
EPROM	27256	32K * 8	64 Kbytes total
EPROM	27512	64K * 8	128 Kbytes total
SRAM	6264	8K * 8	16 Kbytes total
SRAM	62256	32K * 8	64 Kbytes total

Table 4.2-1 describes the jumper settings required for the different devices.

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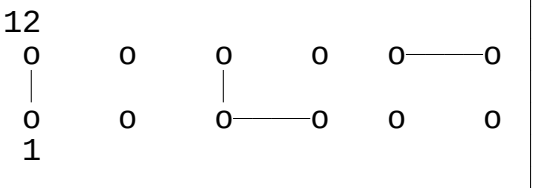
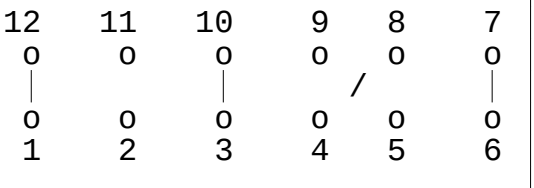
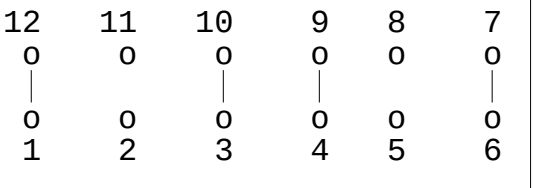
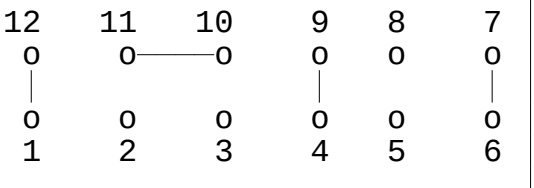
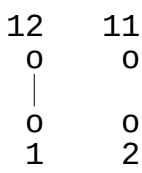
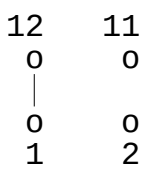
Table 4.2-1A: EPROM Area 2 Jumper Settings for EPROMs

Type	Jumperfield B27
2764	
27128	
27256	
* 27512	

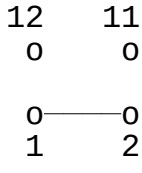
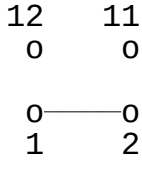
* Default condition during manufacturing

Table 4.2-1B: EPROM Area 2 Jumper Settings for SRAMs

No battery backup for the SRAMs

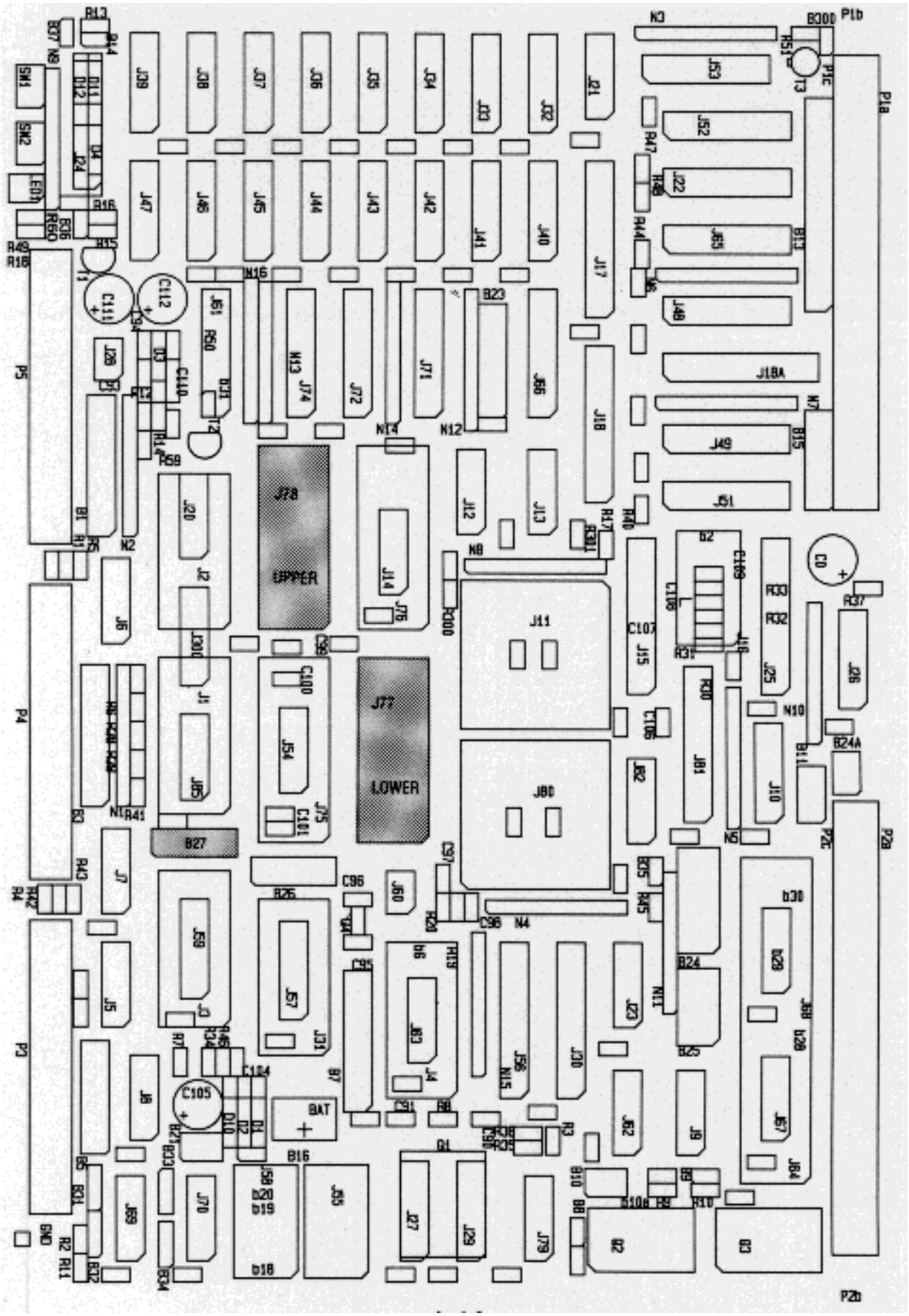
Type	Jumperfield B27
6264	
62256	

With on-board battery backup for the SRAMs

Type	Jumperfield B27
62LP64	
62LP256	

Note: If the on-board battery backup is used, only full CMOS devices may be installed. Otherwise, the battery will be destroyed.

Figure 4.2-1: Location Diagram of the EPROM Area 2



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4.2.3 Access Time Selection

To enable the use of fast and slow devices, the PROM/EPROM areas have a selectable access time speed selector.

This jumperfield provides different jumper settings, as listed in Table 4.2-2. Figure 4.2-2 shows the location diagram of the speed selectors.

Table 4.2-2: EPROM Speed Selection

Jumper Closed on B11	Jumper Closed on B11	Access Times (ns) Min.	Max.	Device Access Times (ns)
7 - 8	2 - 3	62	125	60
7 - 8	4 - 5	125	188	125
7 - 8	3 - 6	188	250	180
1 - 8	2 - 3	125	250	125
1 - 8	4 - 5	250	375	250 *
1 - 8	3 - 6	375	500	375

* Default connection at: Jumper B11

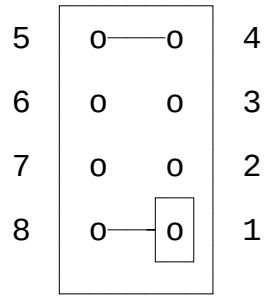
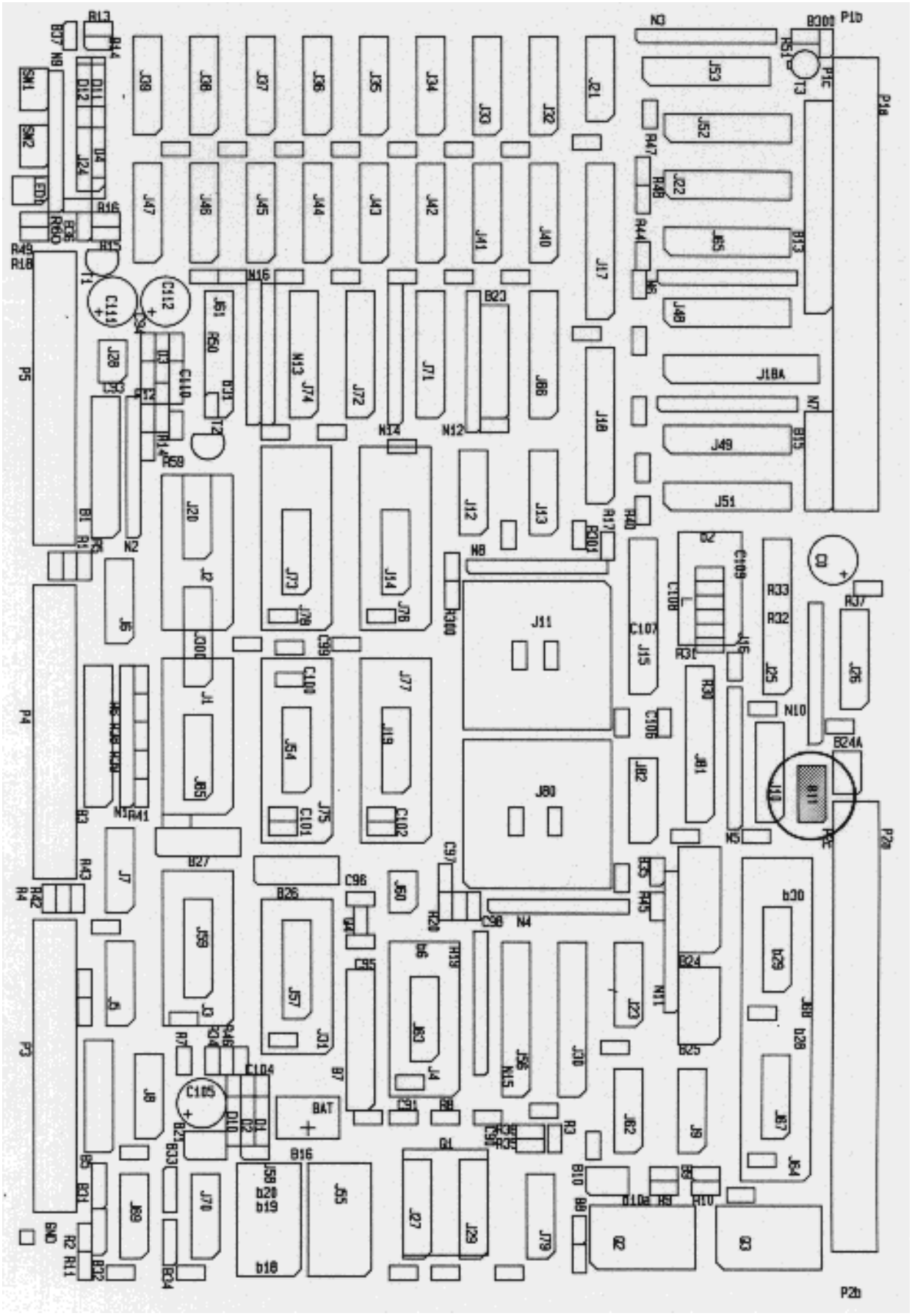


Figure 4.2-2: Location Diagram of the Speed Selectors



4.2.4 Address Map of EPROM Area 2

The start address of the EPROM Area 2 is fixed mapped via a decoding PAL. The size of this memory area depends on the memory capacity of the used devices.

Table 4.2-3 lists the address map for the different usable device types.

Table 4.2-3: Address Map of EPROM Area 2

Start Address	End Address	Used Device	Total Capacity
0A0 000	0A3 FFF	2764	16 Kbytes
0A0 000	0A7 FFF	27128	32 Kbytes
0A0 000	0AF FFF	27256	64 Kbytes
0A0 000	0BF FFF	27512	128 Kbytes
0A0 000	0A3 FFF	6264	16 Kbytes
0A0 000	0AF FFF	62256	64 Kbytes

4.2.5 The USER Area Summary

Start Address	$0A0000
End Address	$0BFFFF
Boundary	$020000
Access Modes	Byte or Word transfers Read or Write on SRAM Read only on EPROM
Usable Data Bits	D0-D7 and D8-D15
Default Access Time	250ns (max)

4.3 The Serial I/O Interfaces

The board contains three independent serial I/O channels with a separate strap selectable baud rate (110 to 38400 Baud). Each serial I/O interface has a jumperfield for easy I/O signal assignment changes to the 25 pin D-sub connectors (female).

All serial I/O control chips are 6850 devices (Asynchronous Communication Interface Adapter - ACIA).

4.3.1 The Baud Rate Selection

Each clock input for the transmit and receive baud rate of the three serial I/O channels is strap selectable to one of the nine different baud rate clocks driven by the 14411. The jumperfield B7 defines the baud rate of the terminal, host and the remote port. The connection at B7 between pins 10 and 11 defines the baud rate range and works as a prescaler. The receiver and transmitter baud rate of the three ports can be connected to the different baud rates as listed in Table 4.3-1.

B7 #20 Baud selector of the terminal port
B7 #18 Baud selector of the host port
B7 #16 Baud selector of the remote port

Each of the baud rate selection signals has to be connected to one of the listed baud rates.

Table 4.3-1: The Baud Rate Selection Jumper B7

PIN	Connection between #10 and #11	No Connection between #10 and #11
1,3,5	9600 Baud	38400 Baud
2,4,6	4800 Baud	19200 Baud
15,17,19	2400 Baud	9600 Baud
7	1200 Baud	4800 Baud
14	600 Baud	2400 Baud
8	300 Baud	1200 Baud
13	150 Baud	600 Baud
9	110 Baud	440 Baud
12	60 Baud	240 Baud

The baud rates of the terminal, host and remote interface are, in default during manufacturing, connected to 9600 Baud.

Figures 4.3-1 and 4.3-3 show the detailed hardware drawing and the jumper location diagram.

Figure 4.3-1: Hardware Drawing of the Baud Rate Selection Parts

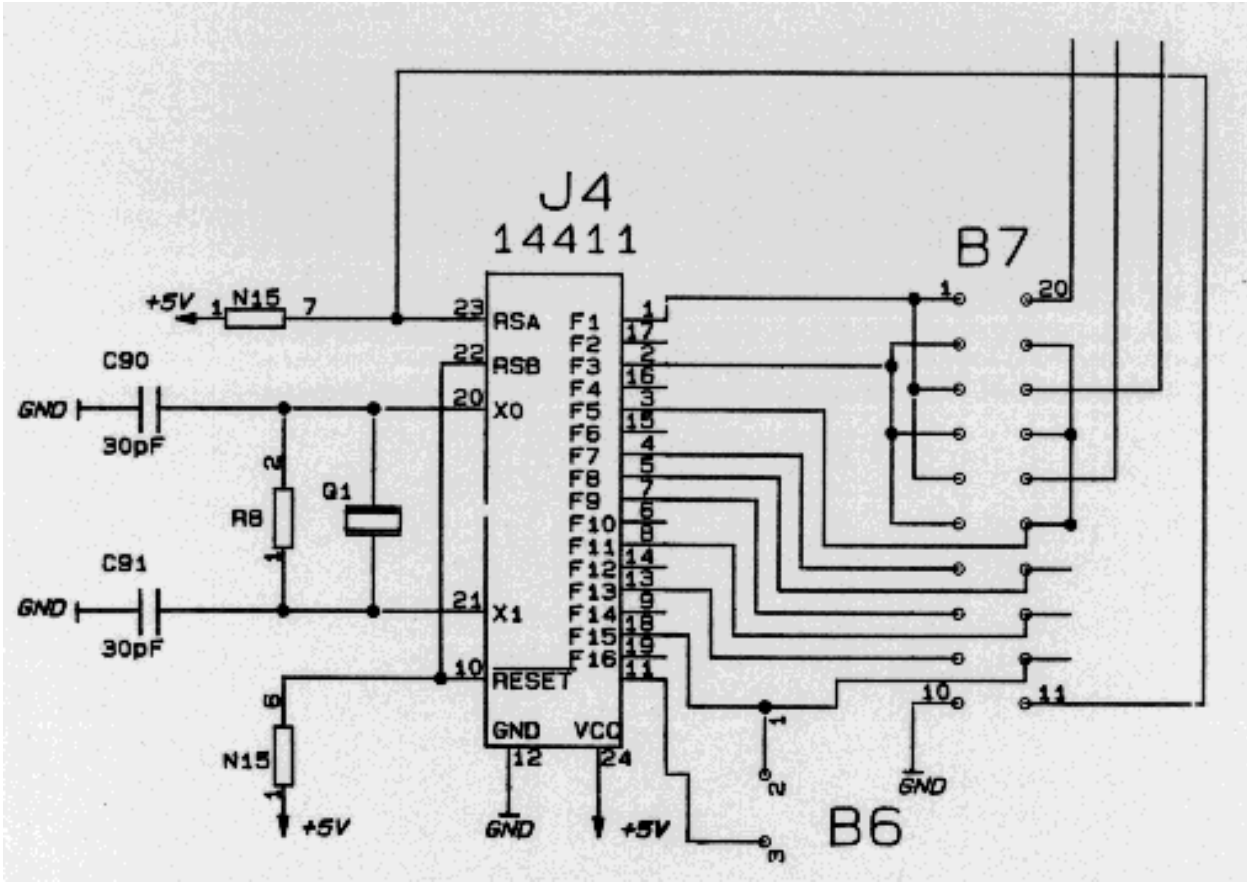


Figure 4.3-2: Default Jumper Settings of B7

10 - 11;

1 - 20;

3 - 18;

5 - 16

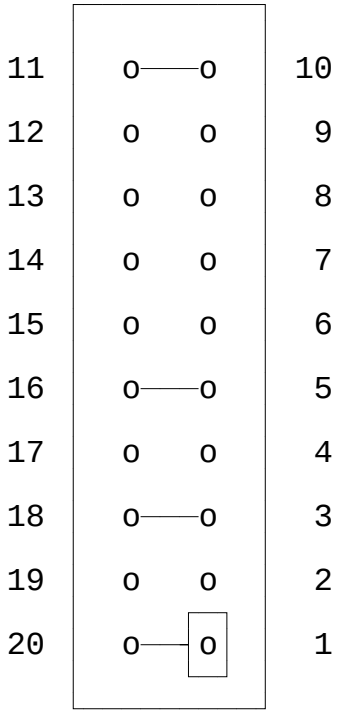
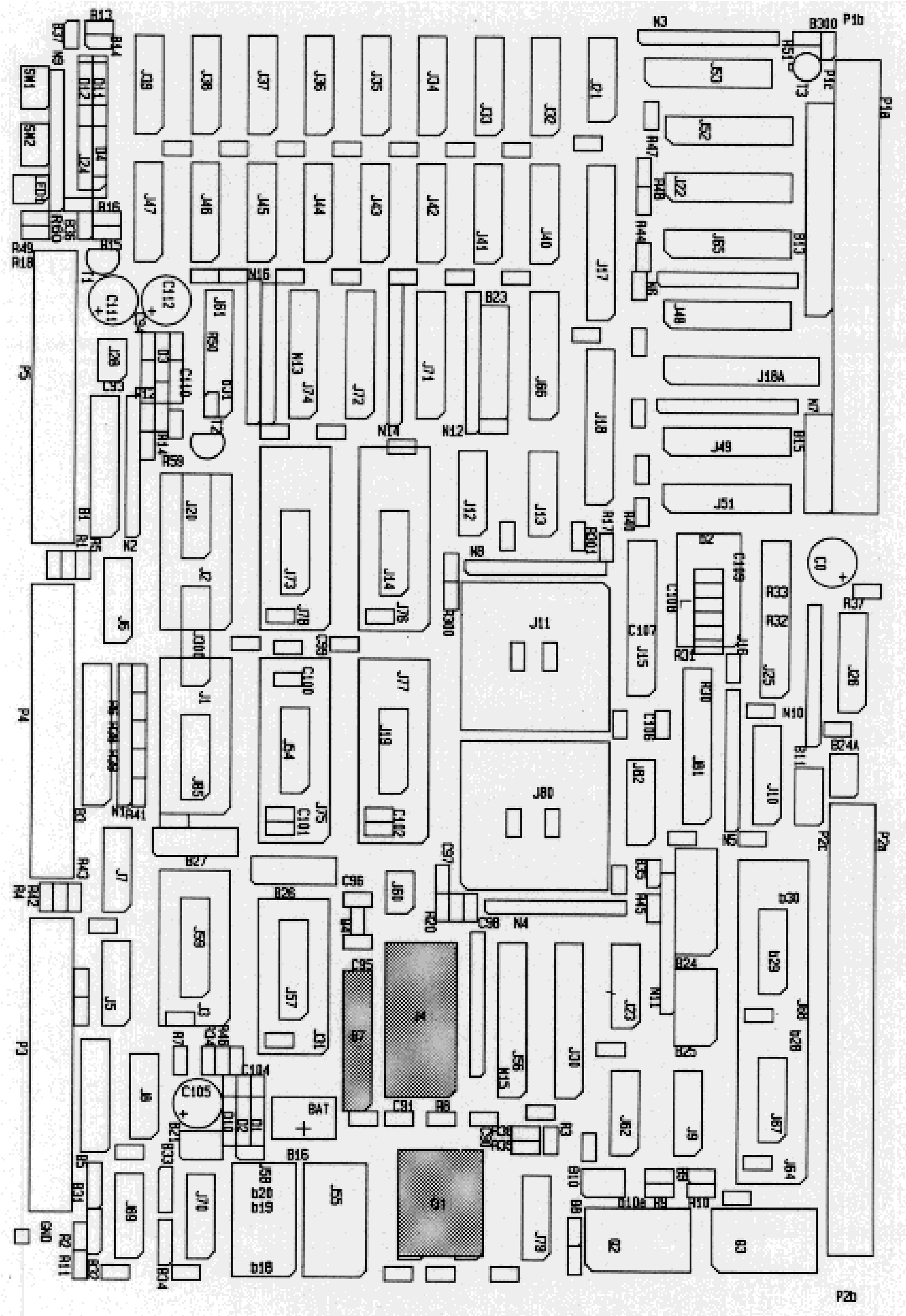


Figure 4.3-3: Location Diagram of the Baud Rate Selection Parts



4.3.2 Timing of the ACIAs

The ACIA is a controller device of the synchronous 6800 family. Therefore, the access cycle is controlled by the processor signals VMA*, VPA*, and the E signal.

To initiate the transfer, the processor must receive the VPA* signal from the decoding logic. When the CPU is synchronized to the E clock signal, the VMA* signal is asserted to signal the I/O devices that the transfer is beginning. The synchronization requires additional time (1000ns maximum).

The timing diagrams illustrating the best and worst cases are shown in Figures 4.3-4 and 4.3-5.

Tables 4.3-2 and 4.3-3 list the related values.

Table 4.3-2: ACIA Timing (best case)

No	Description	Min	Max	Unit
1	AS* low	800		ns
2	AS* asserted to VPA* asserted	30	80	ns
3	AS* inactive to VPA* inactive	30	80	ns
4a	VMA* asserted (8MHz Processor clock frequency)	850	1000	ns
4b	VMA* asserted (12.5MHz Processor clock frequency)	600	750	ns
5	VPA* to VMA* delay	-	150	

Table 4.3-3: ACIA Timing (worst case)

No	Description	Min	Max	Unit
1	AS* low	-	2000	ns
2	AS* asserted to VPA* asserted	30	80	ns
3	AS* inactive to VPA* inactive	30	80	ns
4a	VMA* asserted (8MHz Processor clock frequency)	850	1000	ns
4b	VMA* asserted (12.5MHz Processor clock frequency)	600	750	ns
5	VPA* to VMA* delay	-	1000	ns

Figure 4.3-4: ACIA Timing Diagram (best case)

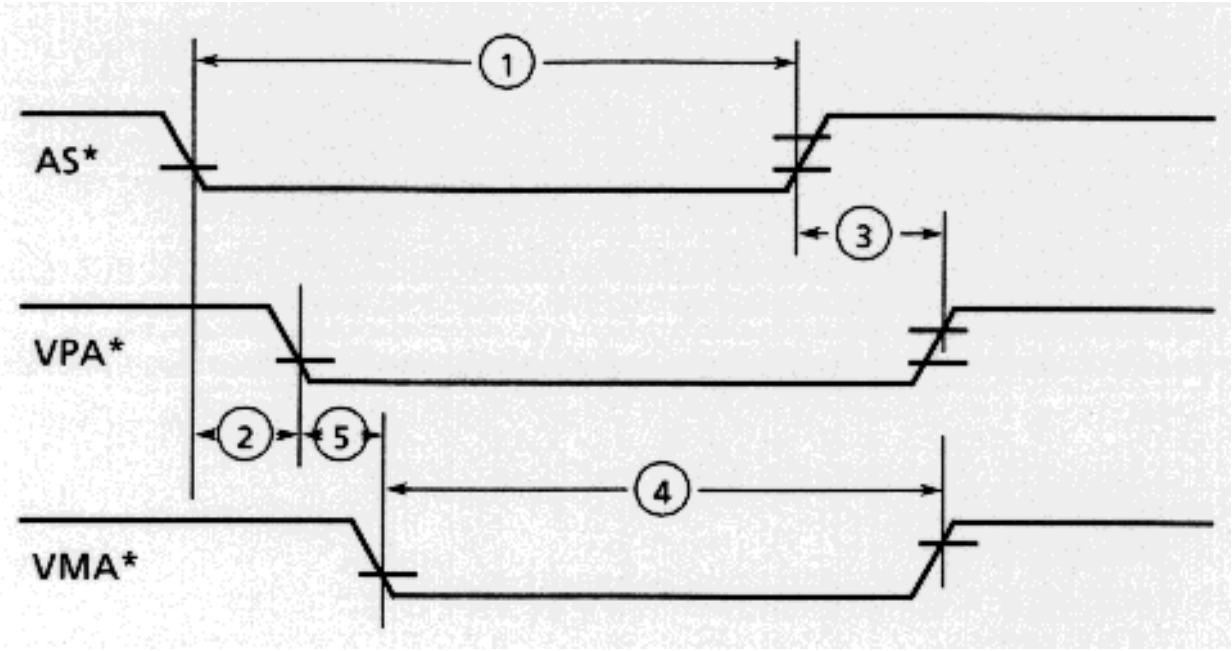
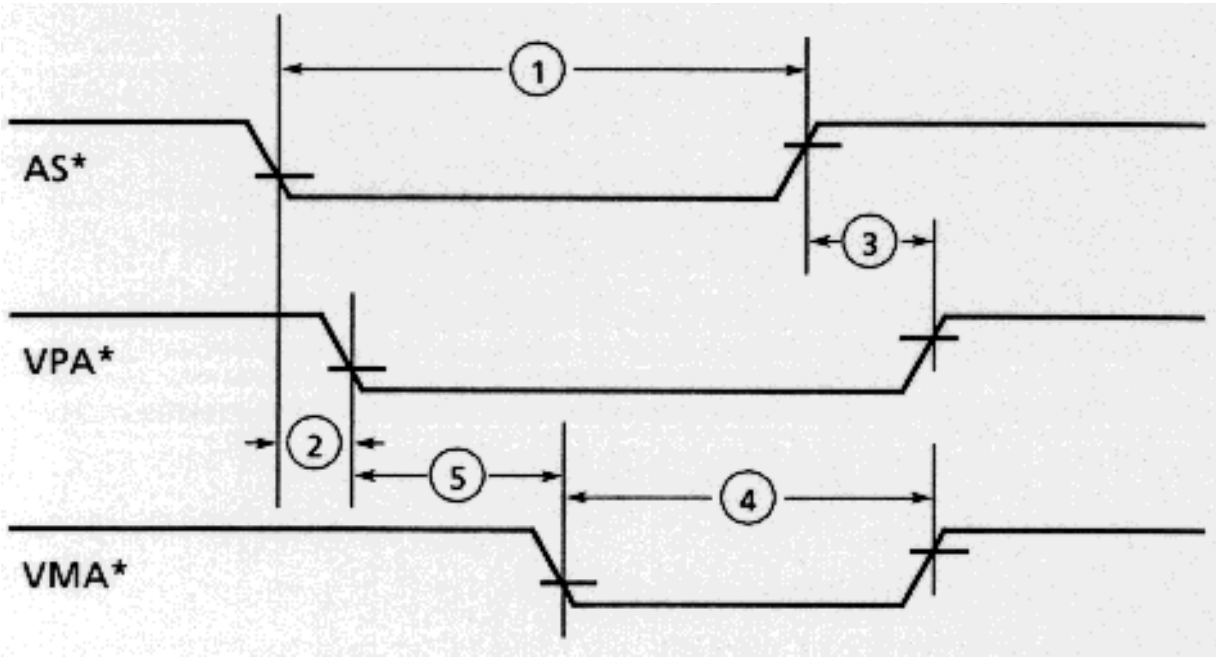


Figure 4.3-5: ACIA Timing Diagram (worst case)



4.3.3 The Terminal Port

The RS232 (C) interface is used to communicate via Port 1 (connector P4) with a standard terminal. The transmission format is initially preset as follows:

8 data bits
1 stop bit
No parity
Asynchronous protocol

The terminal must be set to these conditions.

The terminal interface can interrupt the 68000 CPU on level 4. The forced interrupt vector is the auto interrupt vector (#28/$000070).

4.3.3.1 The I/O Signal Assignment

Further details of control functions and port format changes are shown in the software manual of the used system monitor. The detailed hardware diagram of the interface is given in Figure 4.3-6.

The default signal assignments during manufacturing are listed in Table 4.3-4.

Figure 4.3-6: Hardware Diagram of the Terminal Port

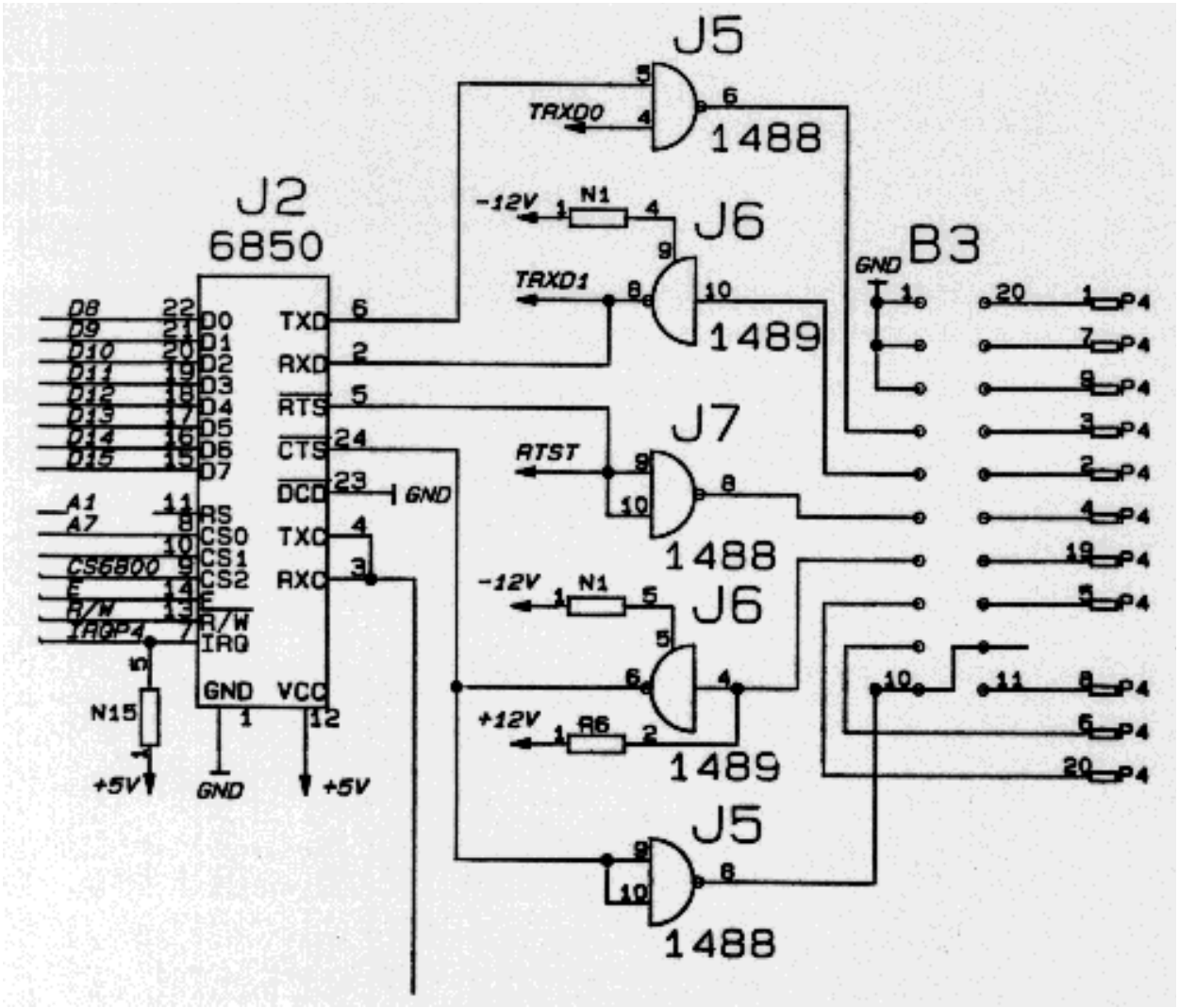


Table 4.3-4: Terminal Connector Signal Assignments

P4 PIN	INPUT	OUTPUT	SIGNAL
1			
2	X		Receive Data (RXD)
3		X	Transmit Data (TXD)
4			
5		X	Request to Send (RTS)
6			
7			Signal GND
8		X	Data Carrier Detect (DCD)
9			Signal GND
19			
20	X		Clear to Send (CTS)

The location diagram of the terminal interface parts is shown in Figure 4.3-7.

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Table 4.3-5: Default Jumper Setting at B3

2-19;

3-18;

4-17;

5-16;

7--8;

10-11;

6-13;

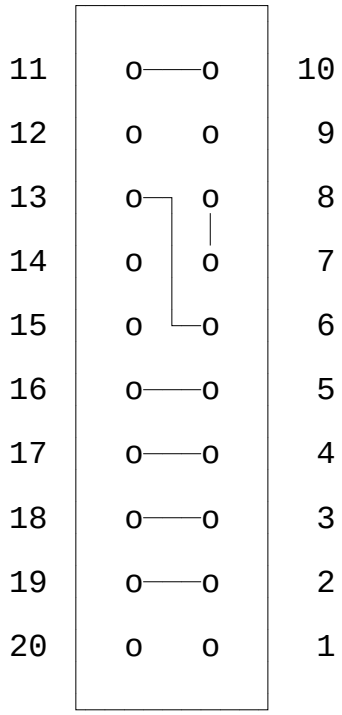
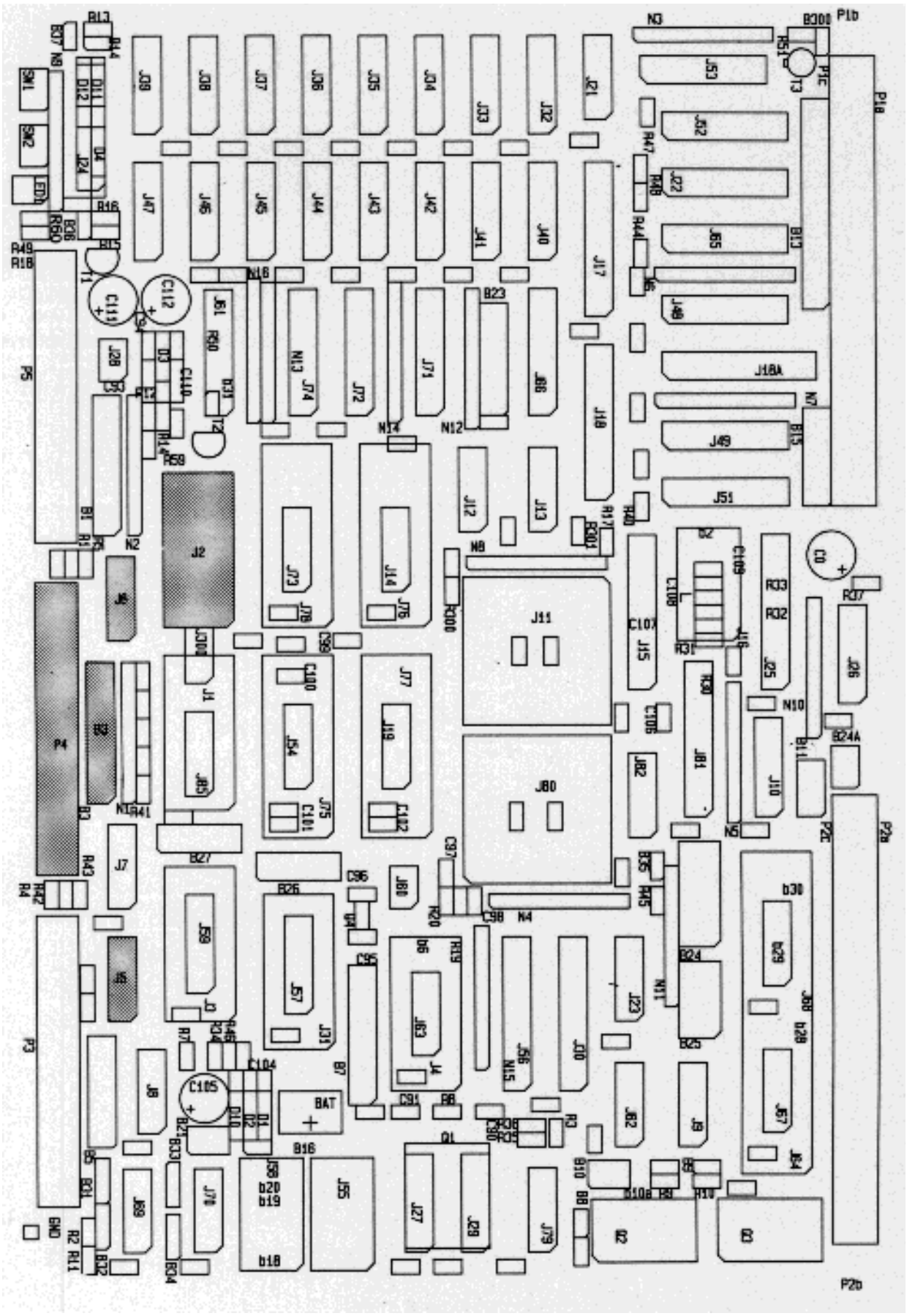


Figure 4.3-7: Location Diagram of the Terminal Port



4.3.3.2 Register Layout

Device: 6850 ACIA (Terminal)

Address	Mode	Description
0C0080	R	Status Register
0C0080	W	Control Register
0C0082	R	Receive Data Register
0C0082	W	Transmit Data Register

4.3.3.3 Baud Rate Selection

Please see chapter 4.3.1 "The Baud Rate Selection".

4.3.3.4 Terminal Port Summary

Start Address End Address	$0C0080 $0C0082
Access Mode	Byte Only Read and Write
Usable Data Bits	D8-D15
Access Time	1000ns (min) 2000ns (max)
Interrupt Request Level	4
Interrupt Handling	fixed IRQ vector (#28) Address:$000070

4.3.4 The Remote Port

The second RS232 compatible interface is the Remote Interface.

The hardware drawing is shown in Figure 4.3-8 and the location diagram of the interface parts is outlined in Figure 4.3-9.

The Remote Interface can interrupt the 68000 CPU on level 3. The forced interrupt vector is the autovector (#27/$000006C).

4.3.4.1 The I/O Signal Assignment

Further details of control functions and port format changes are shown in the software manual of the system monitor used. The detailed hardware diagram of the interface is outlined in Figure 4.3-8.

The signal assignments are listed in Table 4.3-6 and the default signal assignments during manufacturing are listed in Table 4.3-7.

Figure 4.3-8: Hardware Diagram of the Remote Port

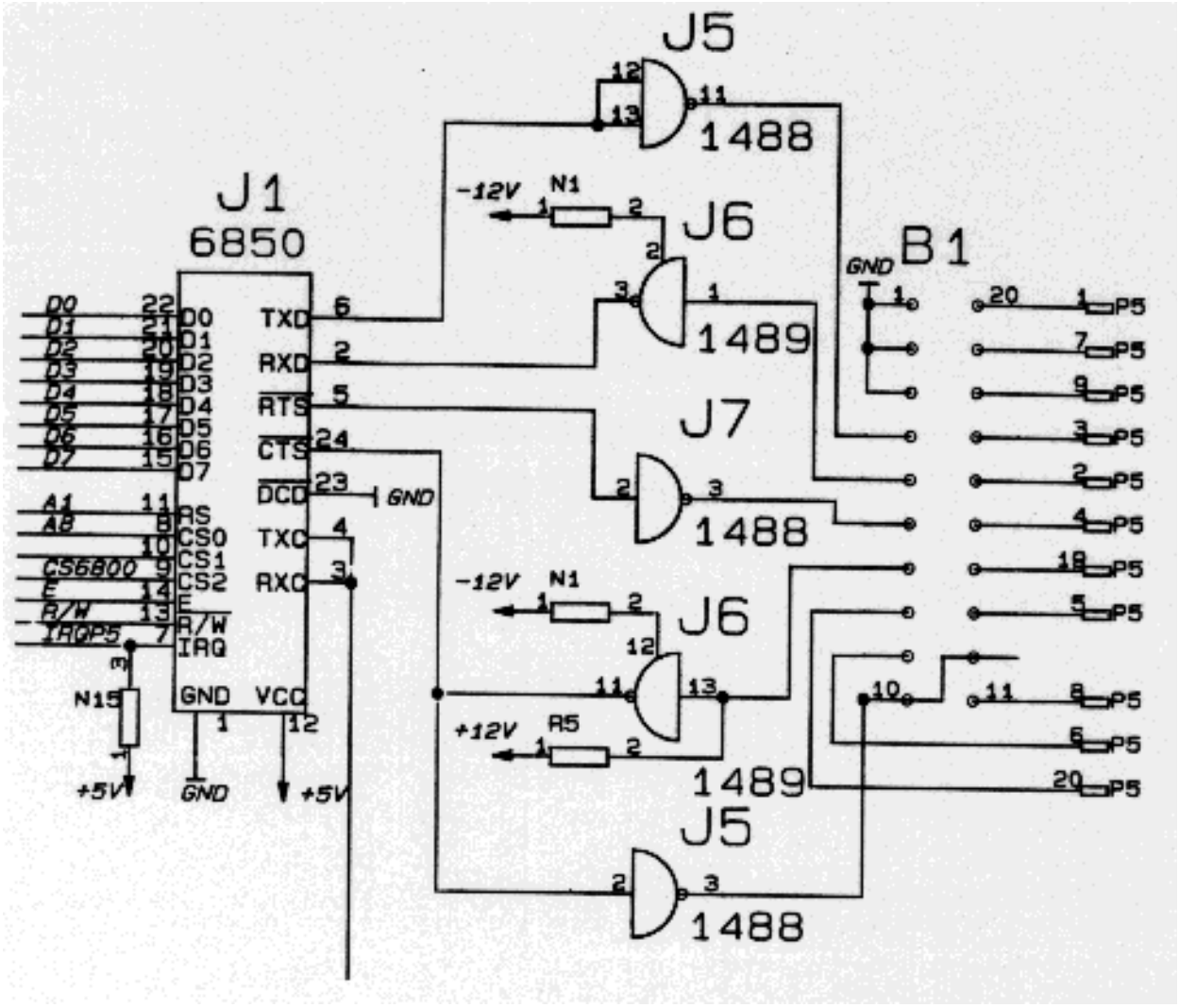


Figure 4.3-9: Location Diagram of the Remote Port

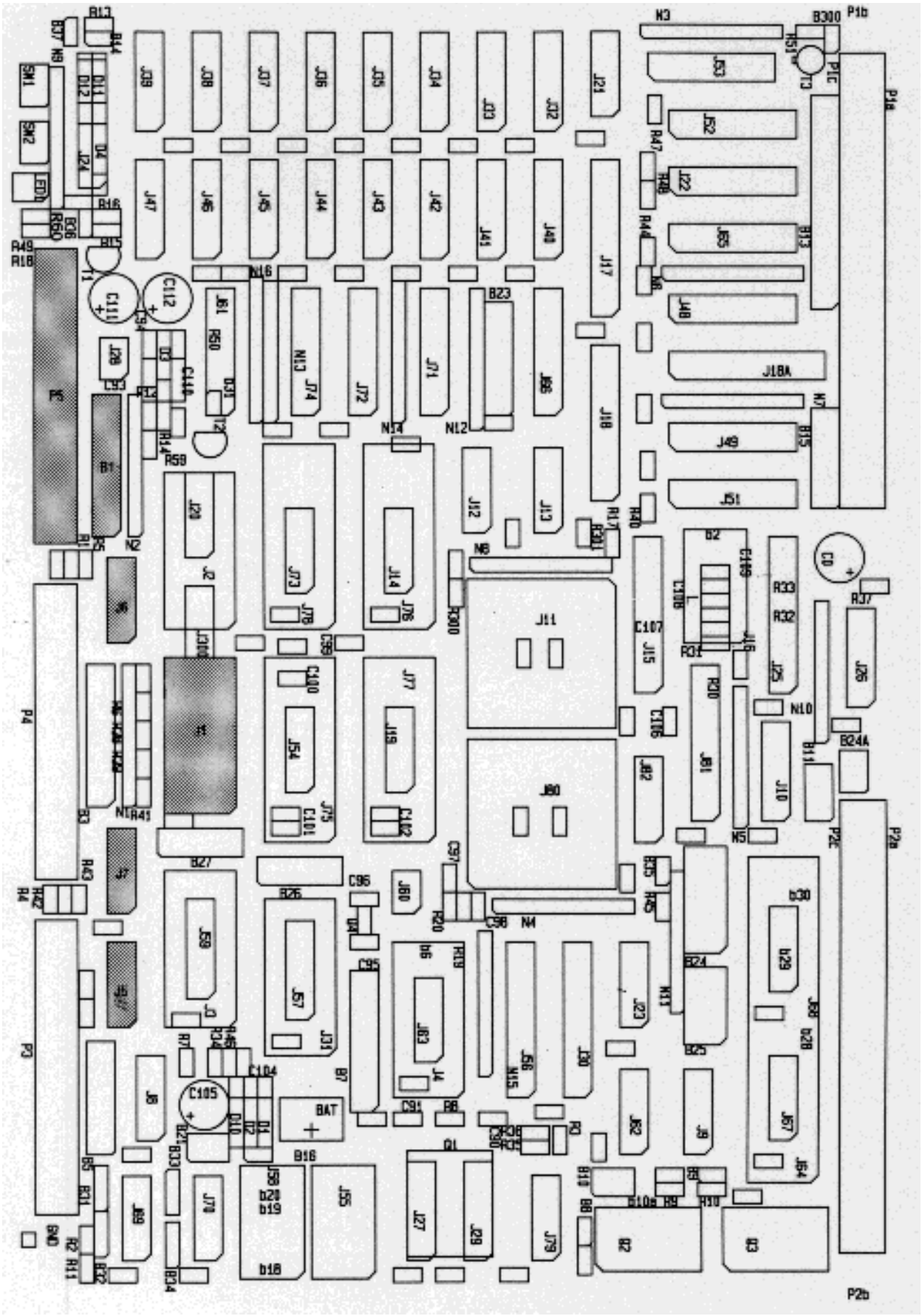
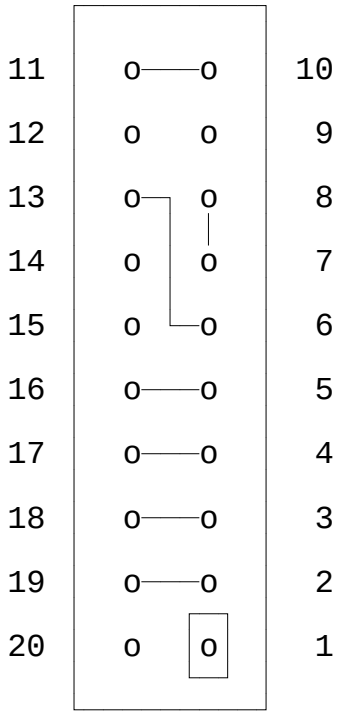


Table 4.3-6: Remote Connector Signal Assignments

P5 PIN	INPUT	OUTPUT	SIGNAL
1			
2	X		Receive Data (RXD)
3		X	Transmit Data (TXD)
4			
5		X	Request to Send (RTS)
6			
7			Signal GND
8		X	Data Carrier Detect (DCD)
9			Signal GND
19			
20	X		Clear to Send (CTS)

Table 4.3-7: Default Jumper Settings at B1

PIN 2-19;
3-18;
4-17;
5-16;
7-8;
10-11;
6-13;



4.3.4.2 Register Layout

Device: 6850 ACIA (Remote)

Address	Mode	Description
0C0101	R	Status Register
0C0101	W	Control Register
0C0103	R	Receive Data Register
0C0103	W	Transmit Data Register

4.3.4.3 Baud Rate Selection

Please see Chapter 4.3.1 "The Baud Rate Selection".

4.3.4.4 Remote Port Summary

Start Address	$0C0101
End Address	$0C0103
Access Mode	Byte Only Read and Write
Usable Data Bits	D0-D7
Access Time	1000ns (min) 2000ns (max)
Interrupt Request Level	3
Interrupt Handling	fixed IRQ vector (#27) Address:$00006C

4.3.5 The Host Port

The third on-board RS232(C) interface can be used in conjunction with a host computer. The detailed schematic is given in Figure 4.3-10.

A standard communication method to communicate between a terminal (connector P4) and a host computer (connector P3) is the Transparent Mode. When the Transparent Mode is used, all transmitted characters are sent directly from the terminal to the host computer and no correction or modification is carried out by the SYS68K/CPU-6 board. In a configuration like the one shown in Figure 4.3-11, both computers are configured to receive data on the Transmit Data Line (TXD) from the terminal and echo it via the Receive Data Line (RXD) back to the terminal. The SYS68K/CPU-6 board polls the terminal ACIA registers in the Transparent Mode. When the user types in the valid stop character sequence, the CPU recognizes it, stops the transmission of the following characters from the terminal to the host computer, and returns to the system monitor program. The stop character sequence is the last character sequence that the SYS68K/CPU-6 board sends to the host computer.

If the connected device cannot drive the CTS signal to high state, a connection from P3 pin 5 to pin 20 has to be hardwired.

The baud rate of each module (terminal, SYS68K/CPU-6 board terminal interface, and host computer interface) must be jumpered equally. The baud rate of the host ACIA remains unaltered because the Transparent Mode handling does not use this ACIA for the transfer.

A detailed description of the data format and the system monitor Dump/Load (DU/LO) commands is given in the Software User’s Manual.

The Host Interface can interrupt the 68000 CPU on level 2. The forced interrupt vector is the autointerrupt vector (#26/$000068).

Figure 4.3-10: Configuration with a Host Computer

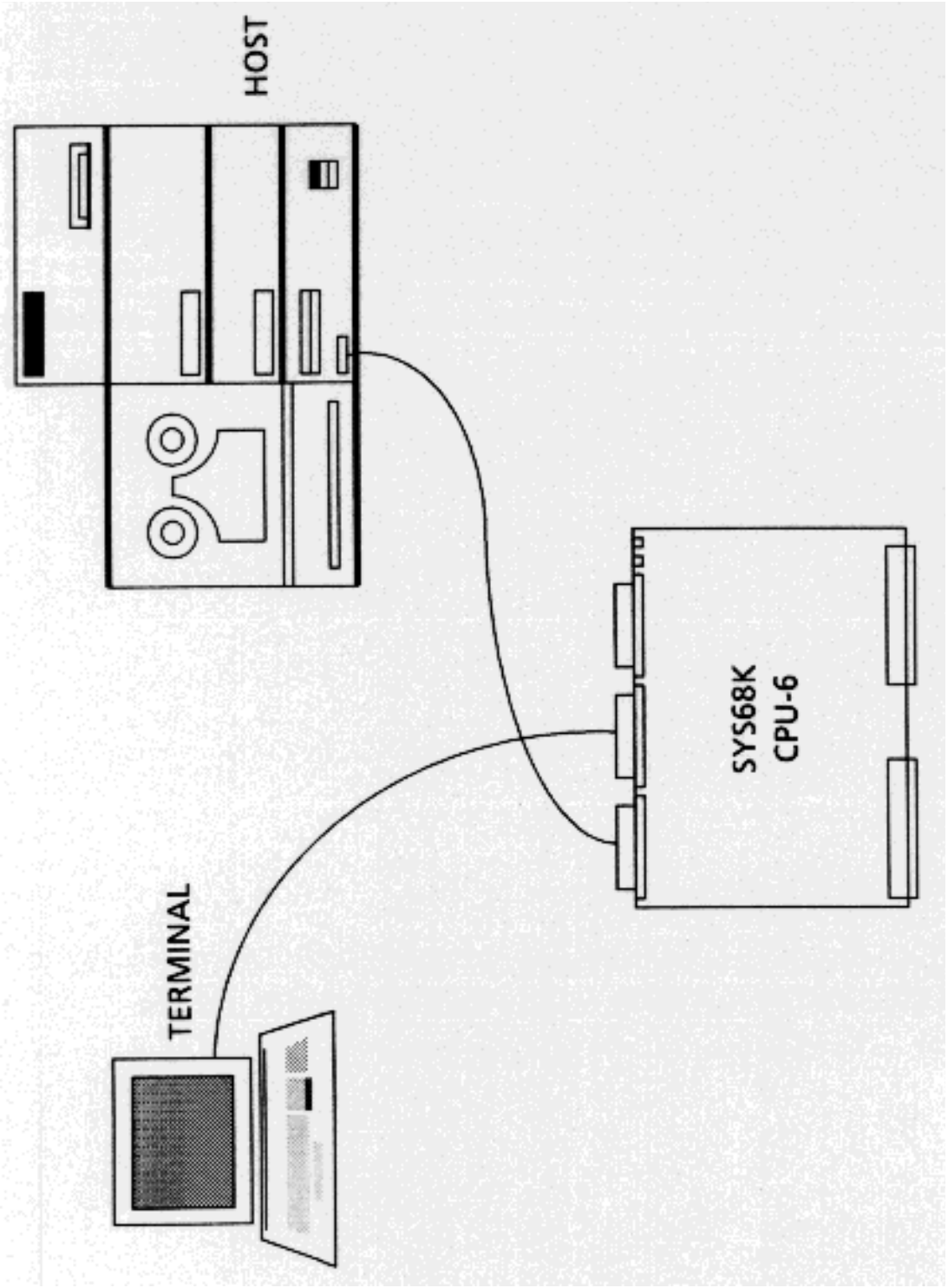
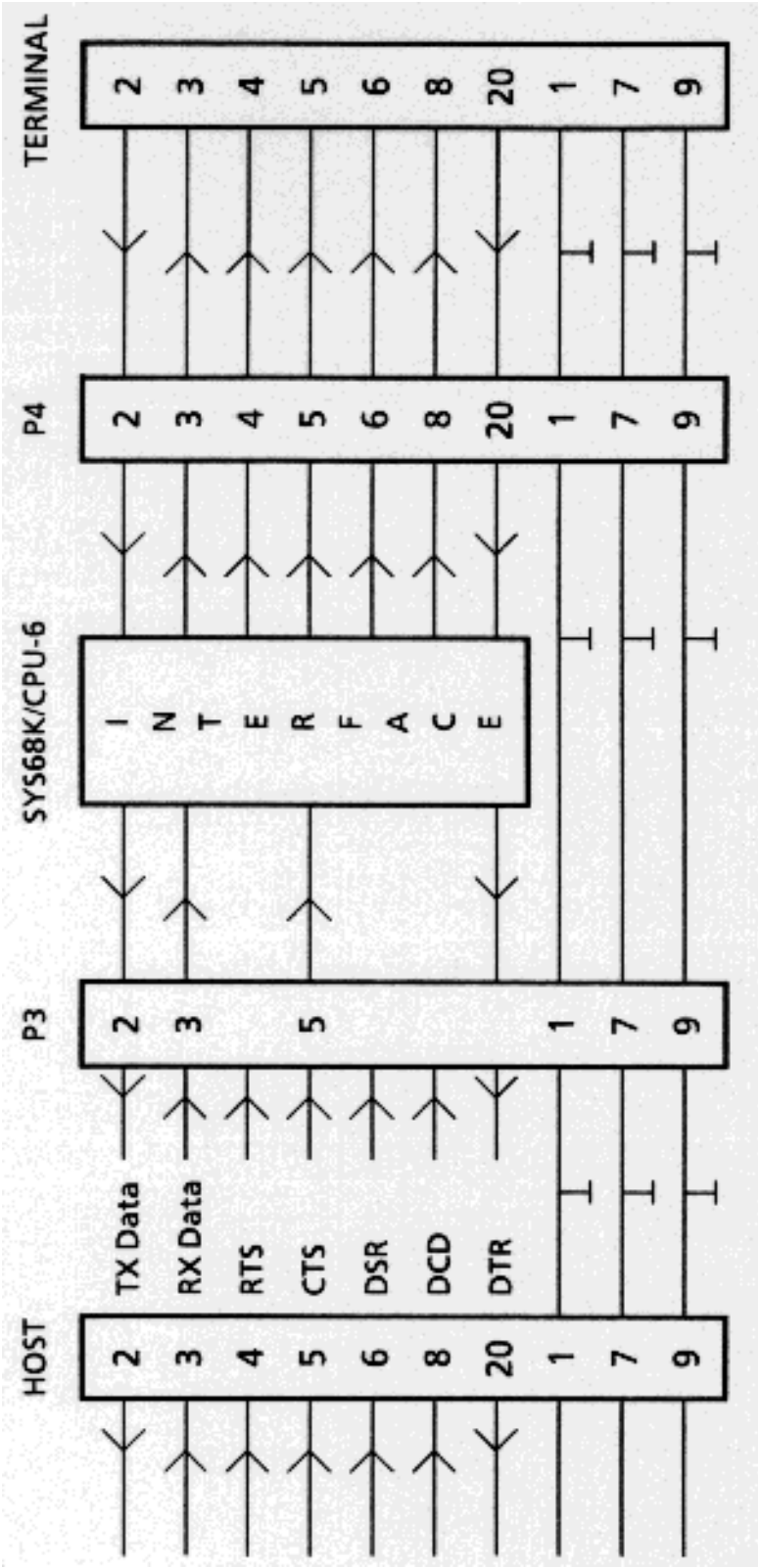


Figure 4.3-11: Interfacing to a Host Computer in the Transparent Mode



4.3.5.1 The I/O Signal Assignment

Further details of control functions and port format changes are shown in the VMEPROM user's manual of the system monitor used. The detailed hardware diagram of the interface is shown in Figure 4.3-12.

The signal assignments are outlined in Table 4.3-8.

The default signal assignments during manufacturing are listed in Table 4.3-9.

Table 4.3-8: Host Signal Assignments

P3 PIN	INPUT	OUTPUT	SIGNAL
1			Protective GND
2		X	Transmit Data (TXD)
3	X		Receive Data (RXD)
5	X		Clear to Send (CTS)
7	X	X	Signal GND
9	X	X	Signal GND
18			
20		X	Clear to Send (CTS)

Figure 4.3-12: Hardware Diagram of the Host Port

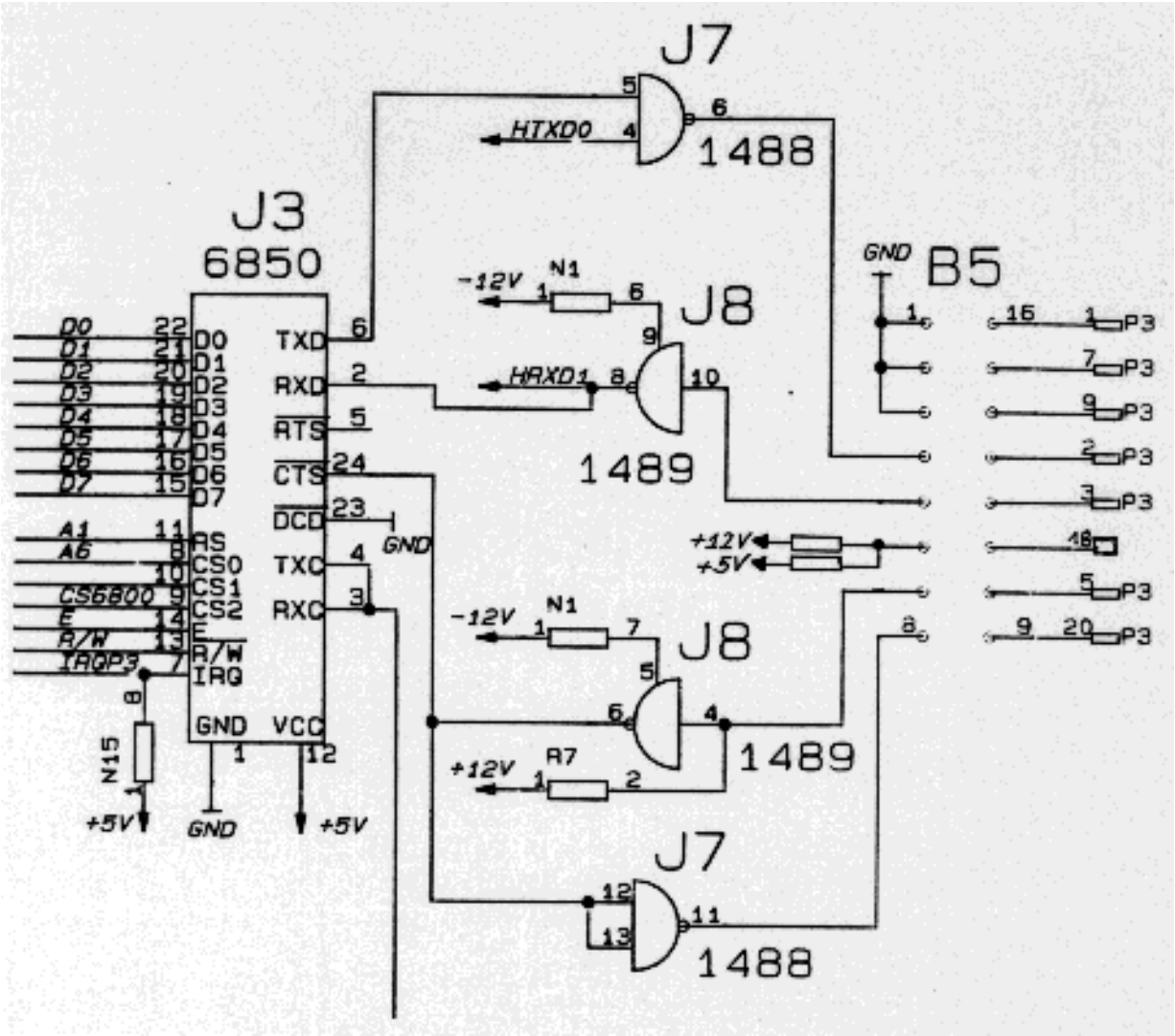


Table 4.3-9: Default Jumper Settings at B5

PIN 2-15;
3-14;
4-13;
5-12;
7-10;
8-9;

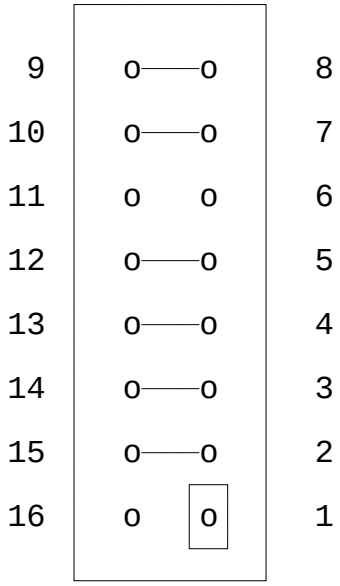
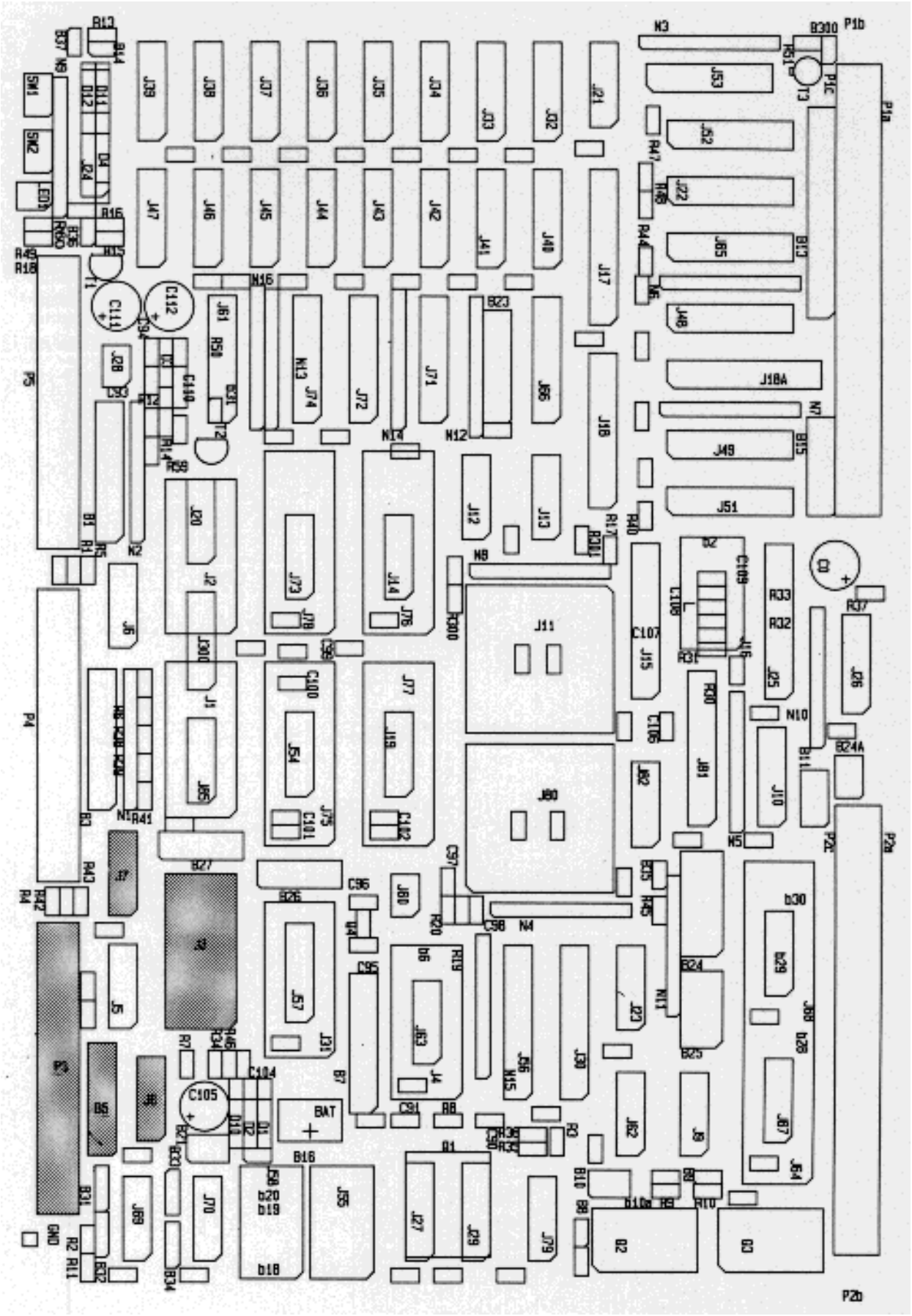


Figure 4.3-13: Location Diagram of the Host Port



4.3.5.2 Register Layout

Device: 6850 ACIA (Host)

Address	Mode	Description
0C0041	R	Status Register
0C0041	W	Control Register
0C0043	R	Receive Data Register
0C0043	W	Transmit Data Register

4.3.5.3 Baud Rate Selection

Please see Chapter 4.3.1 "The Baud Rate Selection".

4.3.5.4 Host Port Summary

Start Address End Address	$0C0041 $0C0043
Access Mode	Odd Byte Only Read and Write
Usable Data Bits	D0-D7
Access Time	1000ns (min) 2000ns (max)
Interrupt Request Level	2
Interrupt Handling	fixed IRQ vector (#26) Address:$000068

4.4 The Parallel Interface and Timer Chip

The Parallel Interface and Timer module (PI/T 68230) is used on the board to provide powerful asynchronous parallel I/O on the SYS68K/CPU-6 board.

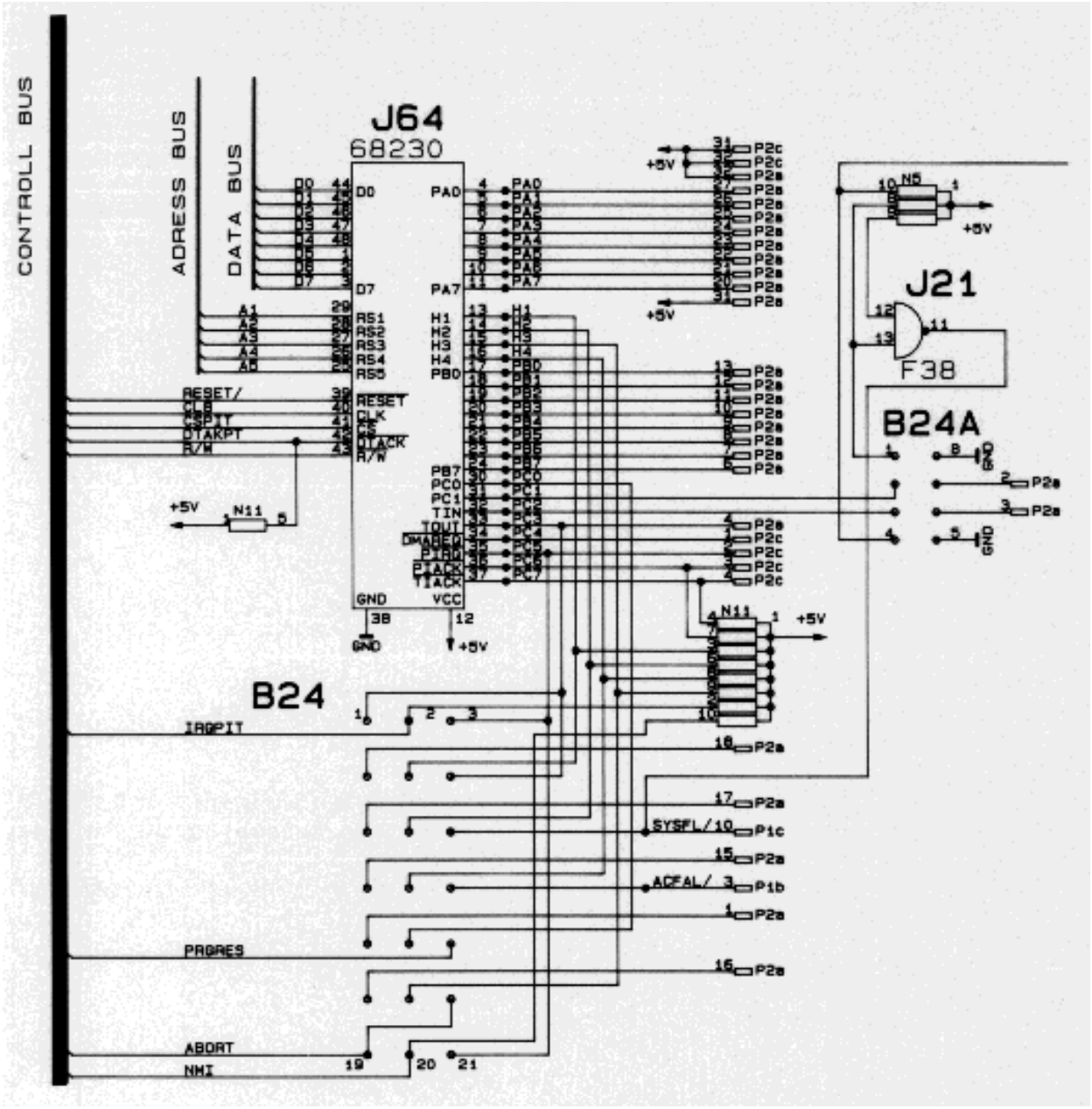
Easy access to the PI/T is provided by the asynchronous bus structure and the nonmultiplexed data/address bus. This allows effective communication to the PI/T.

Features of the PI/T 68230

- Port Modes include:
  - Bit I/O
  - Unidirectional 8 Bit and 16 Bit
  - Bidirectional 8 Bit and 16 Bit
- Selectable Handshaking Options
- 24 Bit Programmable Timer with 5 Bit Prescaler
- Software Programmable Timer Modes
- 2 Selectable Interrupt Sources
- Registers are readable and writeable
- All registers are directly addressable

The detailed hardware connection of the PI/T is outlined in Figure 4.4-1.

Figure 4.4-1: The Hardware Diagram of the PI/T



4.4.1 The PI/T Register Layout and Addressing

All of the PI/T registers are directly addressable and read/writeable as shown in Table 4.4-1.

The base address is $0E0000. Only single byte transfers to/from the PI/T on the data bits D0-D7 are allowed (odd addresses).

The absolute access address of the first register under the default conditions during manufacturing is $0E0001.

Caution: The Interrupt Vector Number Registers PIVR (address $0E000B) and TVIR (address $0E0023) are programmable, but no interrupt vector can be forced because of the auto interrupt vectoring.

The PI/T is used as an internal control device for steering and controlling of the local functions.

4.4.2 The Timer

The TIMER INTERRUPT function is performed by the timer module of the PI/T device. This independent part of the PI/T contains a 24 bit wide counter and a 5 bit prescaler.

The timer may generate periodic interrupts or a single interrupt after a programmable time period. It may be used as a watchdog timer or for elapsed time measurements. The timer is clocked by the 8 MHz frequency of the PI/T clock input.

Table 4.4-1: The PI/T Address Map

Base Address : $0E0000			
Offset	Reset Value	Label	Description
01	00	PITPGCR	Port General Control Register
03	00	PITPSRR	Port Service Request Register
05	00	PITPADDR	Port A Data Direction Register
07	00	PITPBDDR	Port B Data Direction Register
09	00	PITPCDDR	Port C Data Direction Register
0B	0F	PITPIVR	Port Interrupt Vector Register
0D	00	PITPACR	Port A Control Register
0F	00	PITPBCR	Port B Control Register
11	--	PITPADR	Port A Data Register
13	--	PITPBDR	Port B Data Register
15	--	PITPAAR	Port A Alternate Register
17	--	PITPBAR	Port B Alternate Register
19	--	PITPCDR	Port C Data Register
1B	--	PITPSR	Port Status Register
21	00	PITTCR	Timer Control Register
23	0F	PITTIVR	Timer Interrupt Vector Reg.
25	--	PITCPR	Counter Preload Register
27	--		
29	--		
2B	--		
2D	--	PITCNTR	Count Register
2F	--		
31	--		
33	--		
35	00	PITTSR	Timer Status Register

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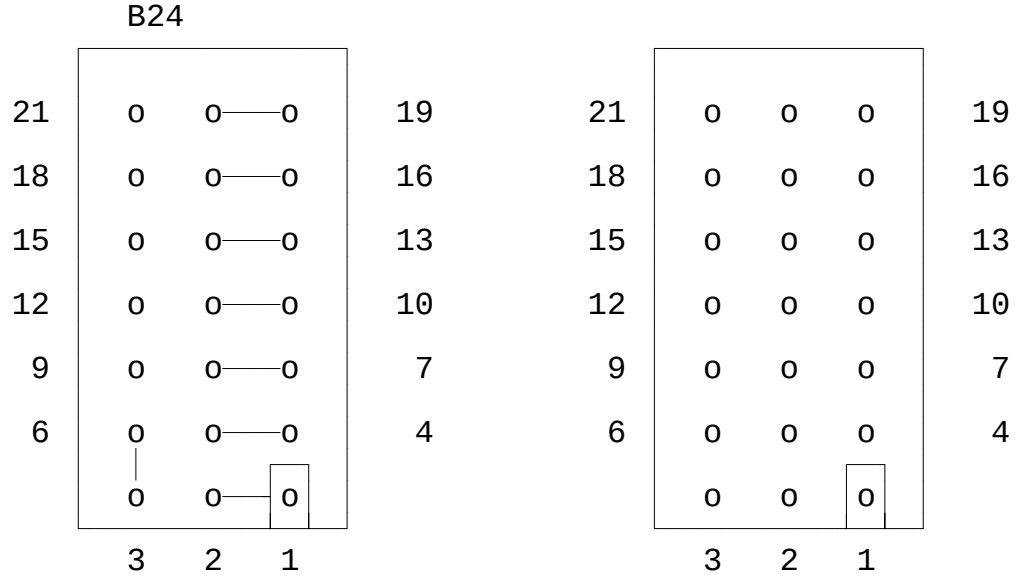
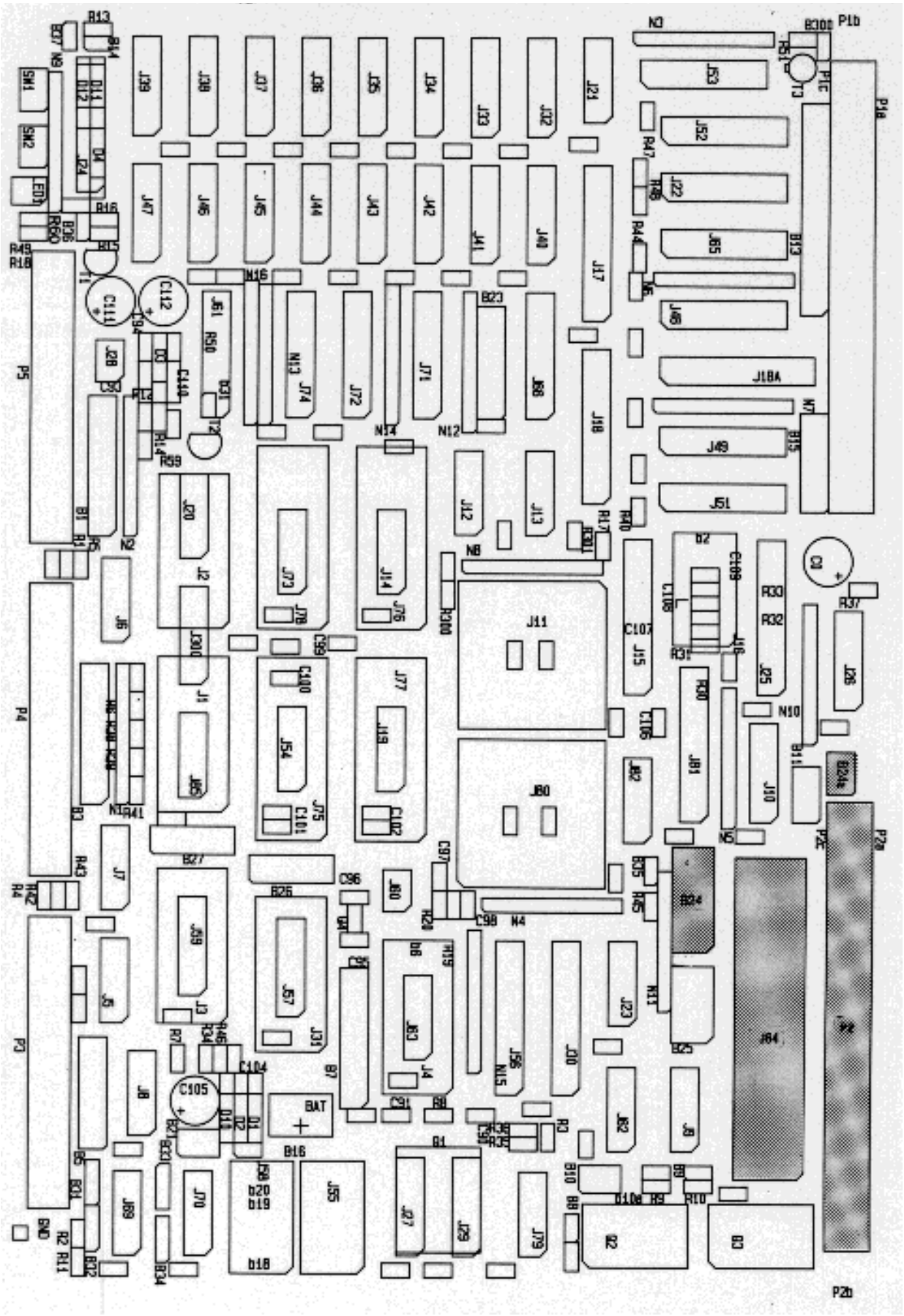
Table 4.4-2: Default Jumper Settings for B24 and B24A

B24: 1 - 2
3 - 6
4 - 5
7 - 8
10 - 11
13 - 14
16 - 17
19 - 20



B24A: 1 - 6
2 - 5
3 - 4

Figure 4.4-2: The Location Diagram of the PI/T and the Jumperfields



4.4.3 Interrupt Handling

The PI/T is able to force an interrupt to the CPU. This function allows the use of the included timer as a time base for multitasking software.

Figure 4.4-2 outlines the location diagram of the PI/T and the interrupt request jumper field.

The general purpose 24 bit timer with its 5 bit prescaler can be used as an output for programmable frequencies with internal or external clocks, as a watchdog and as a normal time base. The interrupt request level of both interrupt signal lines is level 5. The interrupt autovectoring is used on the board. Therefore, the fixed interrupt vector number for the PI/T is #29.

The address $000074 contains the start address of the PI/T interrupt handling routine. Please refer to the PI/T 68230 data sheet; it includes all the programming details that are important for the PI/T handling.

4.4.4 Summary of the PI/T

Access Address	:	$0E0001 - $0E0035
Access Mode	:	Odd Byte Only Read and Write transfer
Usable Data Bits	:	D0 - D7
Interrupt Level	:	5 (auto interrupt vectoring)
Interrupt Vector	:	Fixed: #29 Address: $000074

4.5 The Real Time Clock

The on-board Real Time Clock (RTC 58167A) can be used as a calendar, a real time counter and for time measurements.

Features of the Real Time Clock

- 1/10000 of a second through month counter
- 56 bits of RAM with comparator to compare the real time counter to the RAM data.
- Interrupt Output with 8 possible interrupt signals
- Power Down mechanism disables all input and output signals
- Status register to indicate rollover during a read cycle
- 32,768 Hz crystal oscillator
- Four year calendar (no leap year)
- 24 hour clock
- Battery backup during main power down

4.5.1 Register Layout

The access address of the RTC register is $0C0401 to $0C042F. Only single byte transfers to and from the RTC on the data bits D0-D7 are allowed. All of the RTC registers are directly addressable and read/writeable as shown in Table 4.4-1

4.5.2 Access Timing

The read/write timing diagram and the time values are given in Figures 4.5-1 and 4.5-2 and in Tables 4.5-2 and 4.5-3.

The RTC is a metal gate CMOS circuit which has an access time of approximately 1100ns. This requires a special delay of the DTACK* signal to the CPU by an access to/from the RTC.

4.5.3 The Battery Backup Mode

A lithium battery is included in the shipment. This battery is not soldered onto the board because of the use of aluminium foil for packing during shipping.

The location diagram of the position of the battery is outlined in Figure 4.5-3.

Table 4.5-1: Register Model of the RTC

Default Board Base Address: $0C0401				
Default Address HEX	Register Offset	Reset Value	Label	Description
0C0401	01	--	RTCCTTS	Counter - ten thousands of secs
0C0403	03	--	RTCCHTS	Counter - hundredths + tenths of secs
0C0405	05	--	RTCCSEC	Counter - seconds
0C0407	07	--	RTCCMIN	Counter - minutes
0C0409	09	--	RTCCHRS	Counter - hours
0C040B	0B	--	RTCCDOW	Counter - day of week
0C040D	0D	--	RTCCDOM	Counter - day of month
0C040F	0F	--	RTCCMON	Counter - month
0C0411	11	--	RTCRTTS	RAM - ten thousandths of secs
0C0413	13	--	RTCRHTS	RAM - hundredths + tenths of secs
0C0415	15	--	RTCRSEC	RAM - seconds
0C0417	17	--	RTCRMIN	RAM - minutes
0C0419	19	--	RTCRHRS	RAM - hours
0C041B	1B	--	RTCRDOW	RAM - day of week
0C041D	1D	--	RTCRDOM	RAM - day of month
0C041F	1F	--	RTCRMON	RAM - month
0C0421	21	--	RTCISR	Interrupt Status Register
0C0423	23	--	RTCICR	Interrupt Control Register
0C0425	25	--	RTCCRES	Counters reset
0C0427	27	--	RTCRRES	RAM reset
0C0429	29	--	RTCSTAT	Status bit
0C042B	2B	--	RTCGO	GO command
0C042D	2D	--	RTCSINT	Standby interrupt
0C042F	2F	--	RTCTEST	Test mode

Table 4.5-2: RTC Write Time Values

Number	Parameter	(Note A) Min.	Max.
1	Axx valid and IACK* high to AS* low	10	
3	AS* high	30	
4	AS* low to CSRTC active	0	
5	AS* active	0	
6	AS* invalid to UDS* high	0	40
7	AS* inactive to CSRTC inactive	0	40
8	AS* low to LDS* low (WRITE)	10	130
9	AS* low to DTACK* low	1000	2000
11	AS* inactive to DTACK inactive	15	45
12	AS* active to WRITE* low	10	150
13	AS* inactive to WRITE* inactive	10	70
14	Data valid to Data Strobes active	10	
15	As* inactive to Data invalid	10	45

Figure 4.5-1: RTC Write Cycle Timing Diagram

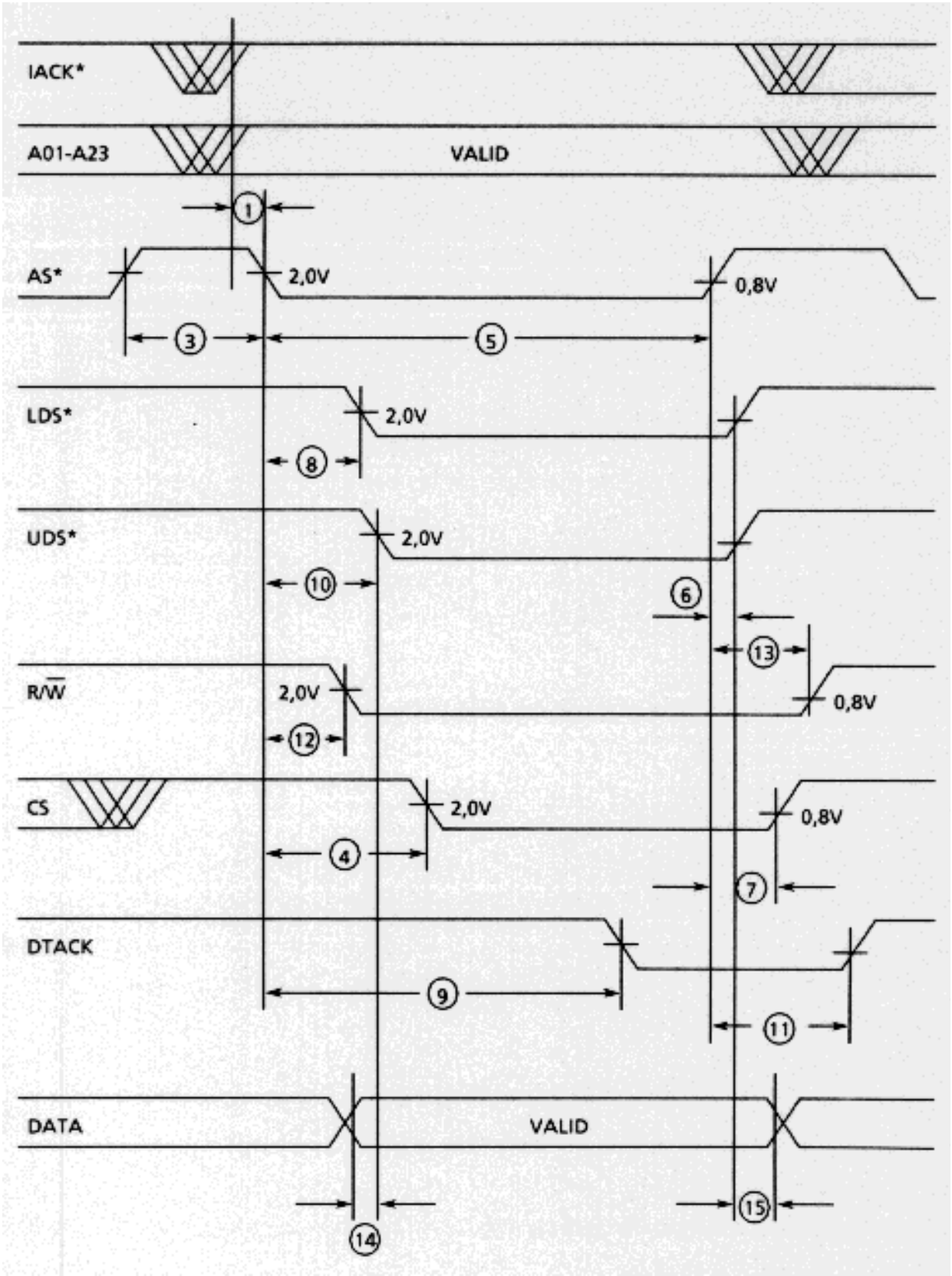
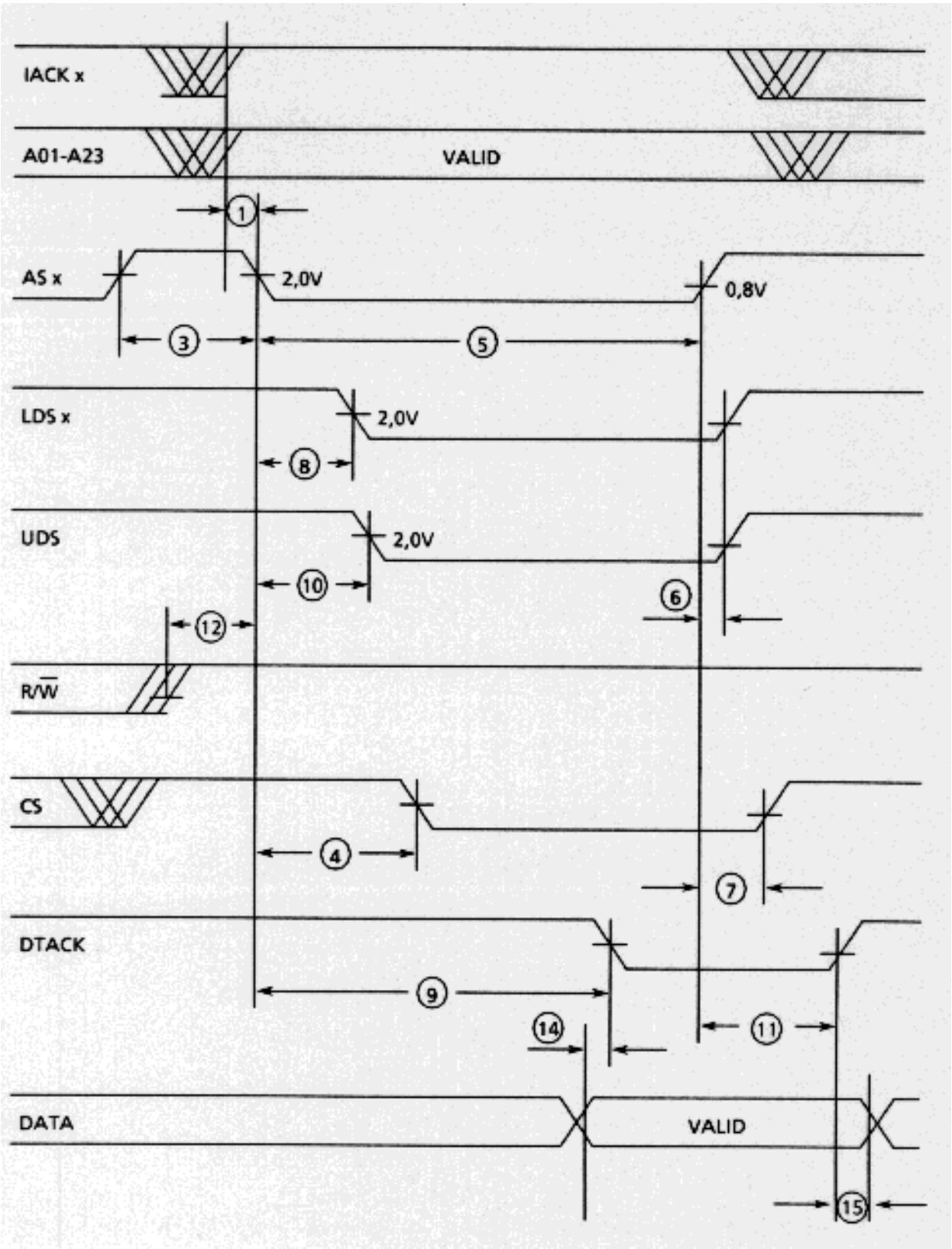


Table 4.5-3: RTC Read Time Values

Number	Parameter	(Note A) Min.	Max.
1	Axx valid and IACK* high to AS* low	10	
3	AS* high	30	
4	AS* active to CSRTC low	30	60
5	AS* low	1800	2500
6	AS* inactive to UDS* inactive	10	60
7	AS* inactive to CSRTC inactive	0	40
8	AS* active to LDS* valid	10	130
9	AS* low to DTACK low	1800	2500
11	AS* inactive to DTACK inactive	15	45
12	WRITE* high to AS* active	10	
14	Data valid to DTACK active	10	
15	DTACK inactive to Data invalid	10	60

Figure 4.5-2: RTC Read Cycle Timing Diagram



4.5.4 The Interrupt Assignment

The RTC can be used to force an interrupt to the on-board CPU. This is provided if a jumper is inserted in the jumperfield B200. Otherwise, no interrupt can be forced and the interrupt request line is always disabled. The RTC interrupt request level is fixed at level 6, the highest maskable interrupt level.

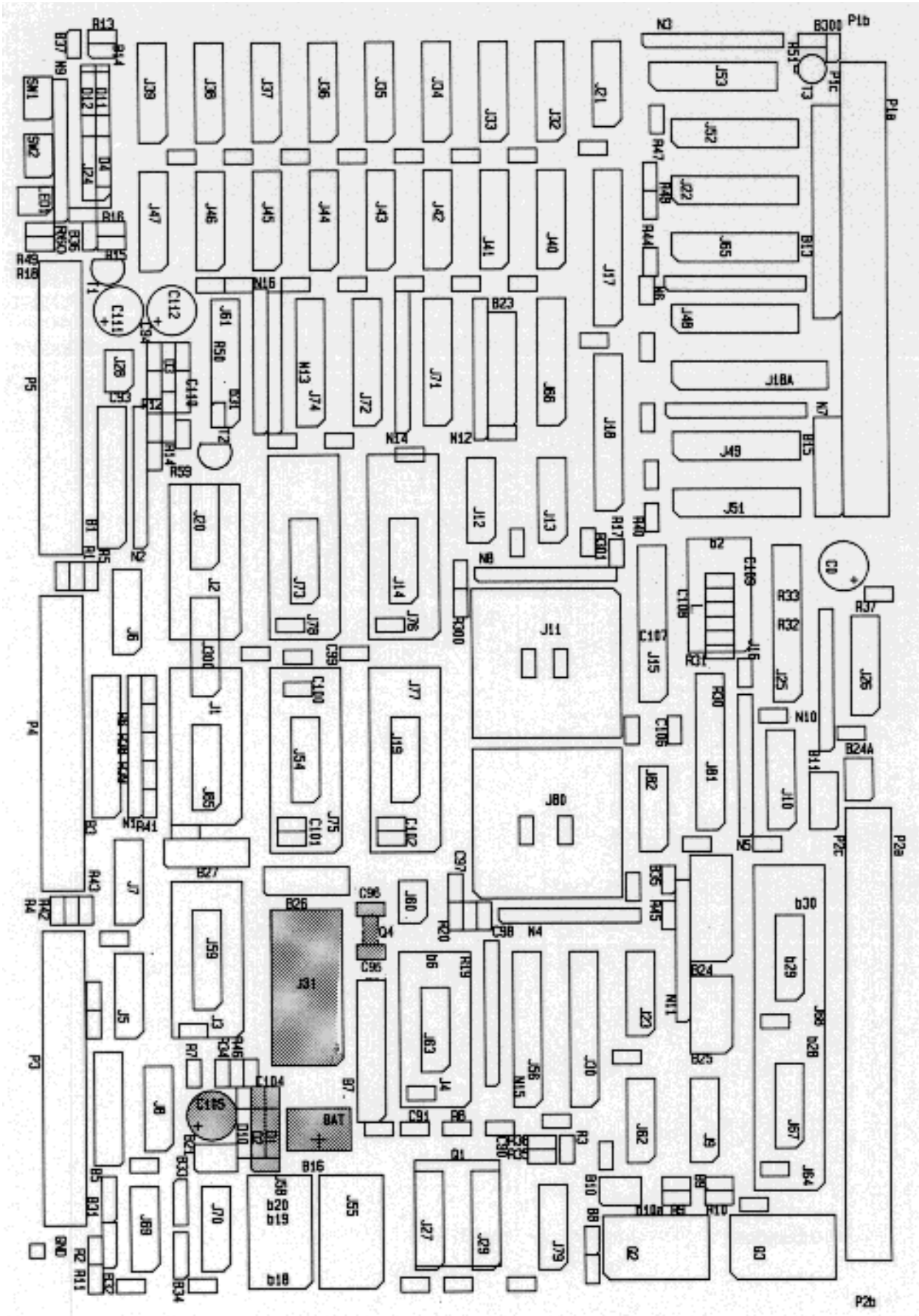
The jumper location diagram of the RTC circuit is shown in Figure 4.5-3.

The interrupt control logic on the board decodes the RTC Interrupt Request level (IRQ6) and forces the autointerrupt vector after the interrupt has been acknowledged on that level. This vector is fixed and reserved on the board specially for the RTC. The long word stored at address $000078 (vector no. 30) represents the RTC interrupt handling routine start address.

4.5.5 Summary of the RTC

Access Address	:	$0C0401 - $0C042F
Access Mode	:	Odd Byte Only Read and Write cycles
Usable Data Bits	:	D0 - D7
Interrupt Level	:	6 (auto interrupt vectoring)
Interrupt Vector	:	Fixed: #30 Address: $000078

Figure 4.5-3: The Location Diagram of the RTC



4.6 The Dynamic RAM

The on-board RAM area is used for the CPU's exception vector table, as scratch pad for the system monitor, called SYS68K/CPU-6, and for the user program/data. The dynamic RAM area consists of 512 Kbytes on the SYS68K/CPU-6.

The DRAM has an access time of 150ns (typical) if no refresh cycle is under execution.

4.6.1 Address Map and Capacity

Address	
000 000 : 000 007	ROM Initialization Vectors from System EPROM
000 008 : 007 FFF	SYSTEM DRAM Area Reserved
008 000 : 07F FFF	USER DRAM Area 512 Kbytes

4.6.2 Access Timing of the DRAM

This paragraph describes all of the timings to/from the DRAMs.

In general, the DRAMs are 120ns devices which operate at an effective access time of 150ns.

A fully asynchronous control logic drives the access cycles as well as the refresh cycles.

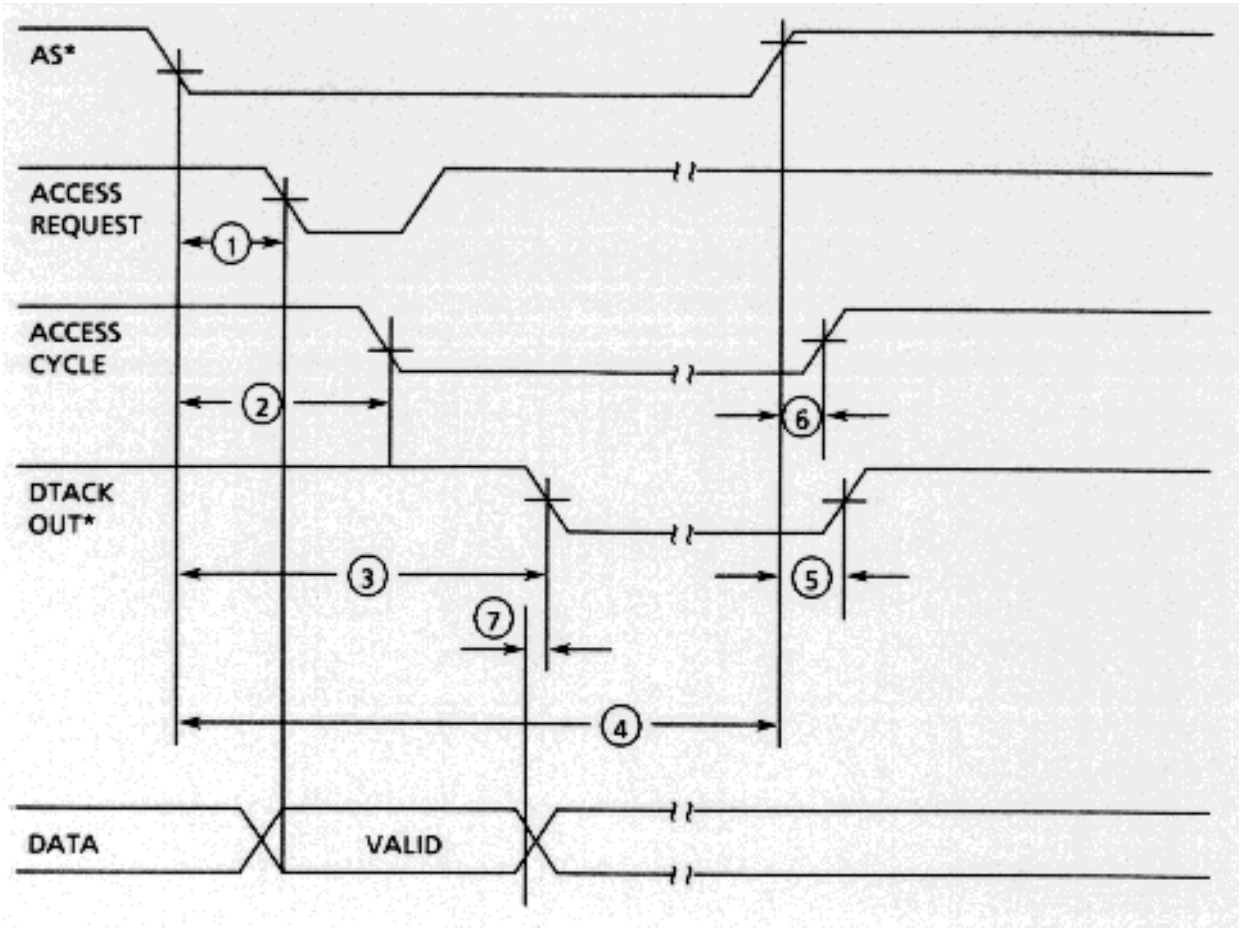
The refresh circuitry generates one refresh cycle every 15 microseconds. Therefore, the board can be used to operate in high end real time applications.

The detailed timing diagram is shown in Table 4.6-1 and Figure 4.6-1.

Table 4.6-1: Time Values for an Access Cycle without Refresh Request

SIGNAL DESCRIPTION	(ns) Min.	(ns) Max.
1. AS* active to Access Request active	10	33
2. AS* active to Access Cycle start	33	66
3. AS* active to DTACKOUT* asserted	285	328
4. AS* active to AS* inactive	285	14000
5. AS* inactive to DTACKOUT* inactive	30	45
6. AS* inactive to Access Cycle inactive	15	25
7. Data valid before DTACK* asserted	10	-

Figure 4.6-1: Access Cycle without Refresh Request



4.6.3 Refreshing of the DRAMs

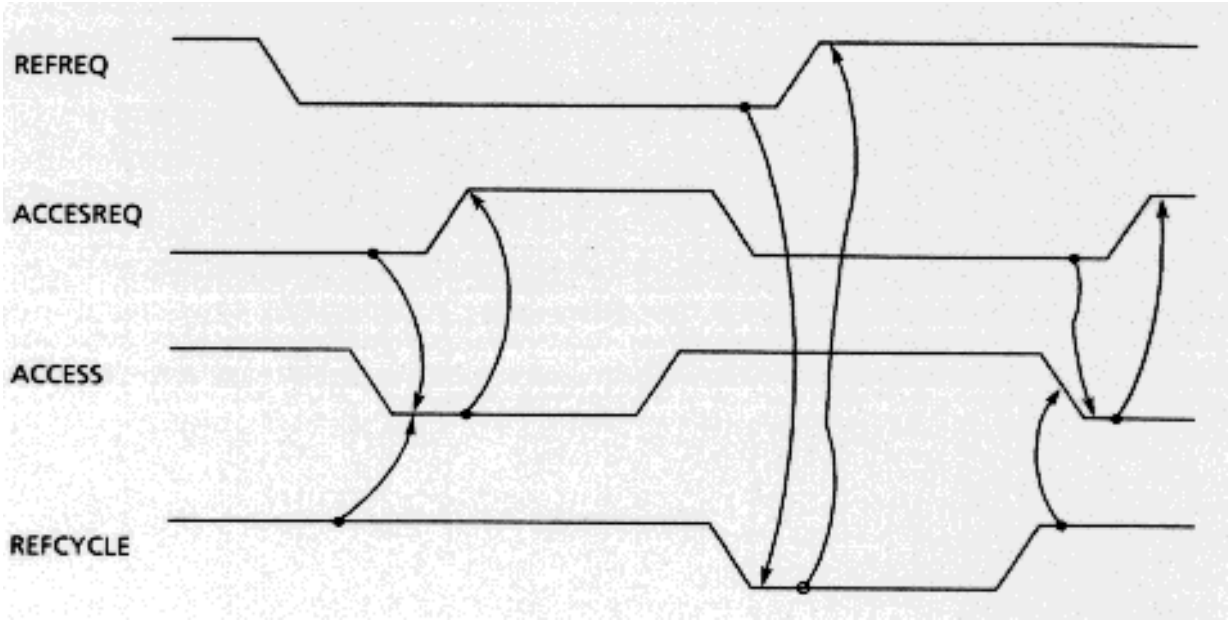
The Dynamic RAM refresh is accomplished by performing a memory cycle at each of the 128 row addresses at an interval of 2ms. The "RAS Only Refresh" results in a substantial reduction of operating power. For real time operations, the refresh is fully asynchronous to the LOCAL and VMEbus accesses.

A maximum delay of 300ns for an access is required, when a refresh request is pending at the same time as an access request, because the refresh has the highest priority.

The refresh is organized in 128 steps every 2ms. This requires a minimum time delay, if access requests are pending and refresh is in process. The repetition rate for a refresh cycle is 15 microseconds.

The detailed timing diagram of the refresh is shown in Figure 4.6-2.

Figure 4.6-2: The Global Refresh Timing Diagram



4.6.4 The Summary of the DRAM

Start Address	$000008
End Address	$07FFFF (512K bytes)
Boundary	$080000
Access Modes	Byte or Word
	Read or Write
Usable Data Bits	D0-D7 and D8-D15
Access Time	150ns (min)
	165ns (typ)
	520ns (max) with Refresh

4.7 The Floating Point Coprocessor 68881 (FPCP)

The 68881 FPCP is designed to operate as a coprocessor with the 68020 microprocessor or as a peripheral device with the 68000/68010 microprocessors. There is a software handshake defined for intercommunication between the CPU and the FPCP. This procedure is performed by the 68020 on its own, while 680x0 microprocessors need a software package to run the handshake. The procedure is described in the 68020 User's Manual (the 68020 coprocessor interface handshake protocol). The specific application of the protocol is described in the 68881 User's Manual.

The offset of the FPCP to the I/O Area Base Address is $200, so the base address of the FPCP is $0E0200.

The 68881 data sheet is included in Appendix H.

The 68881 Floating Point Coprocessor operating at 12.5 MHz clock frequency is a full implementation of the IEEE Standard P754 for Floating Point Arithmetic (Draft 10.0)

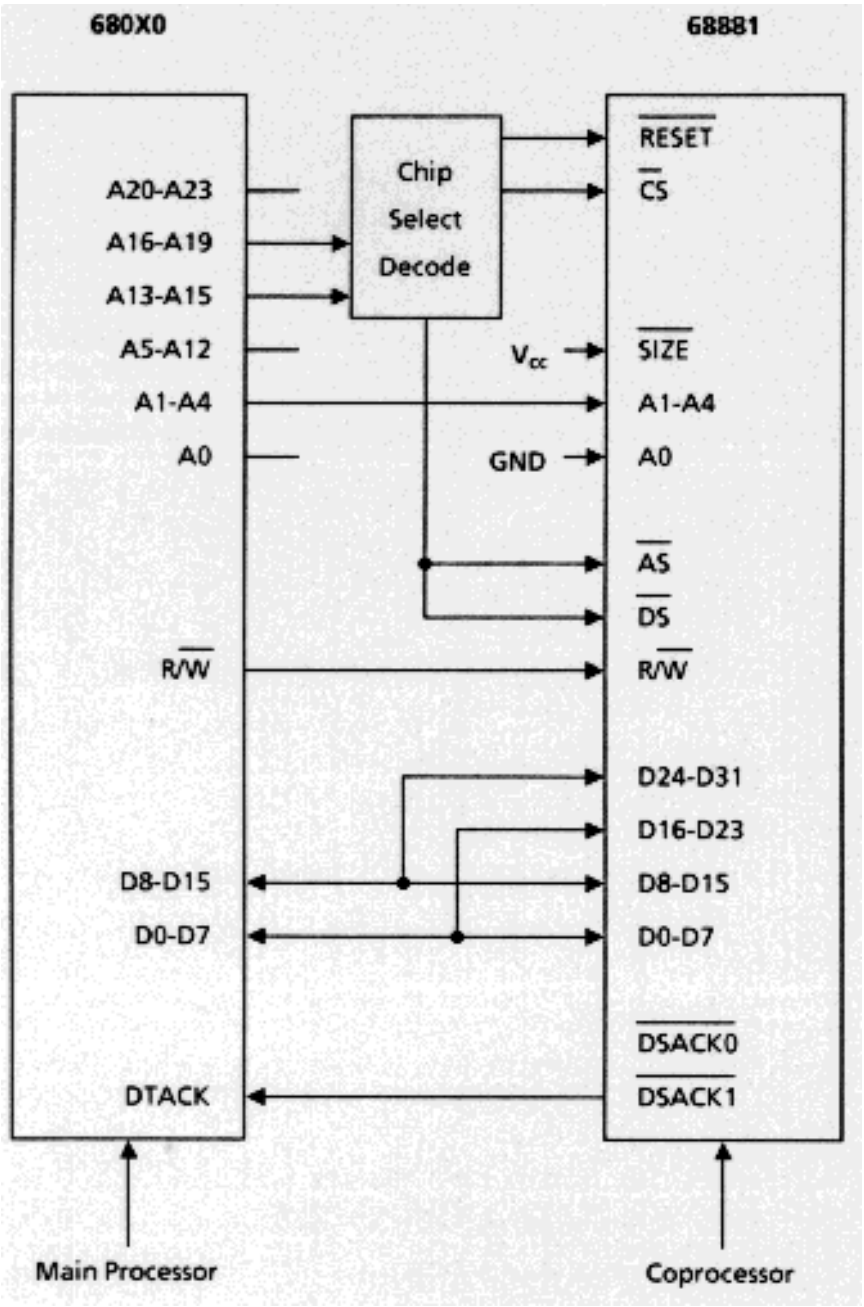
A set of eight general Floating Point Data Registers, supporting full 80 bit extended precision are available for arithmetic operations such as:

Add
Subtract
Multiply
Divide
Compare
Scale Exponent
Modulo
Conditional Branches
Absolute Value
Sin, cosine, hyperbolic sin and cosine
Tangent, cotangent, hyperbolic tangent and cotangent
e EXP(x)
e EXP(x-1)
E EXP(xtract(4))
ln(x), ln(x+1)
log 10(x), log 2(x)
2 EXP(x), 10 EXP(x)
Square root
Conditional Trap (32)

The FPCP supports the following data types:

Word and Long Integers
Single, Double and Extended Precision Real Numbers
Packed BCD String Real Numbers

4.7.1 Interfacing to the 68881



4.7.2 The Data Format of the 68881

The 68881 contains seven data types supported by all arithmetic and transcendal operations.

Example:

```
FADD.B    #0,FP0                    Byte Integer (B)
FADD.W    D2,FP3                    Word Integer (W)
FADD.L    BIGINT,FP7                Long Word Integer (L)
FADD.S    #3.14159,FP5              Single Precision Real (S)
FADD.D   (SP)+,FP6                  Double Precision Real (D)

FADD.X    [(TEMP_PTR,A7)],FP3       Extended Precision Real(X)
FADD.P    #1.23E25,FP0              Packed Decimal Real (P)
```

Figure 4.7-1 outlines the data format summary of the 68881 and Figure 4.7-2 shows the register layout of the internal register of the 68881.

Please refer to the 68881 User's Manual for further details.

Figure 4.7-1: Data Format Summary of the 68881

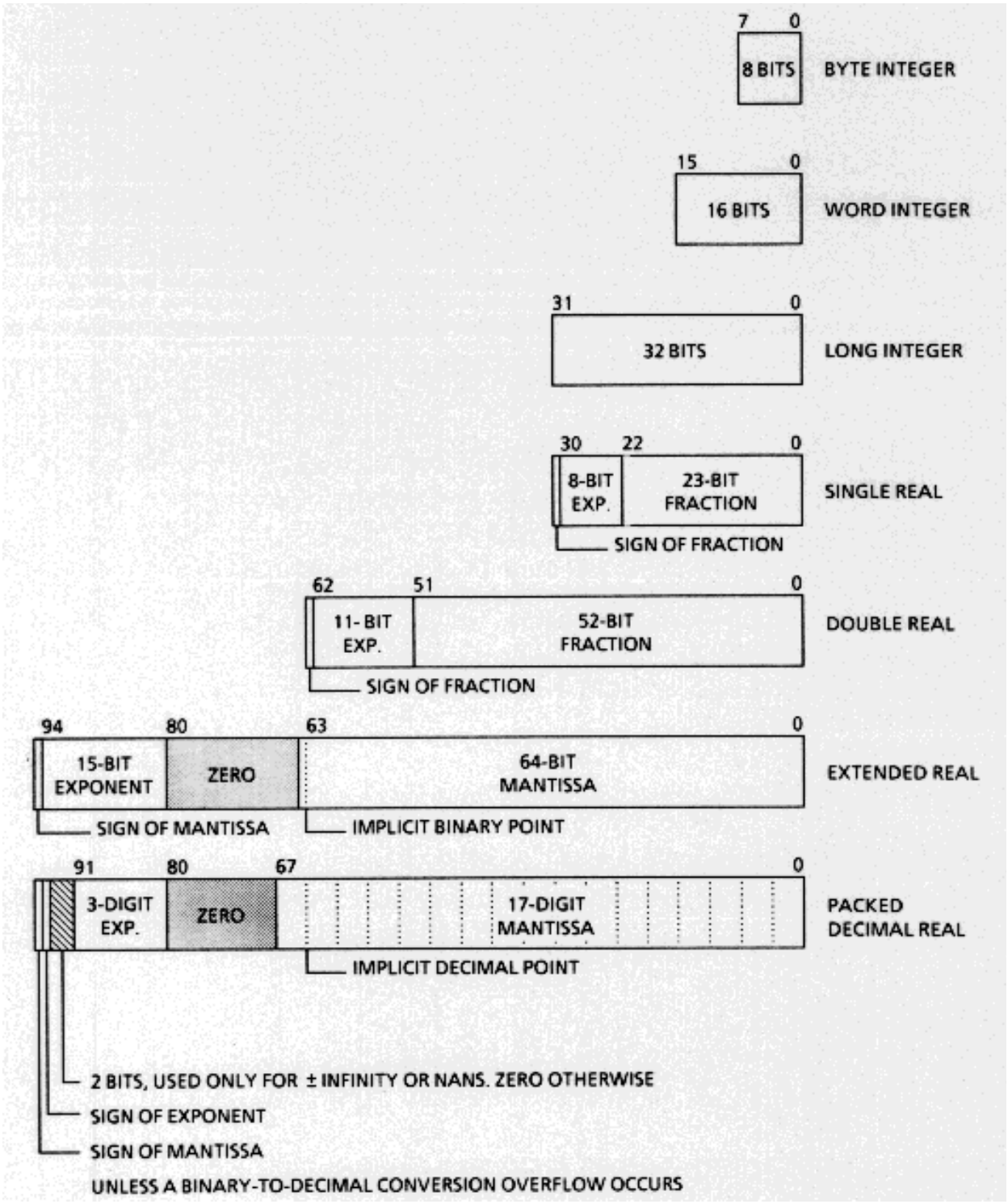
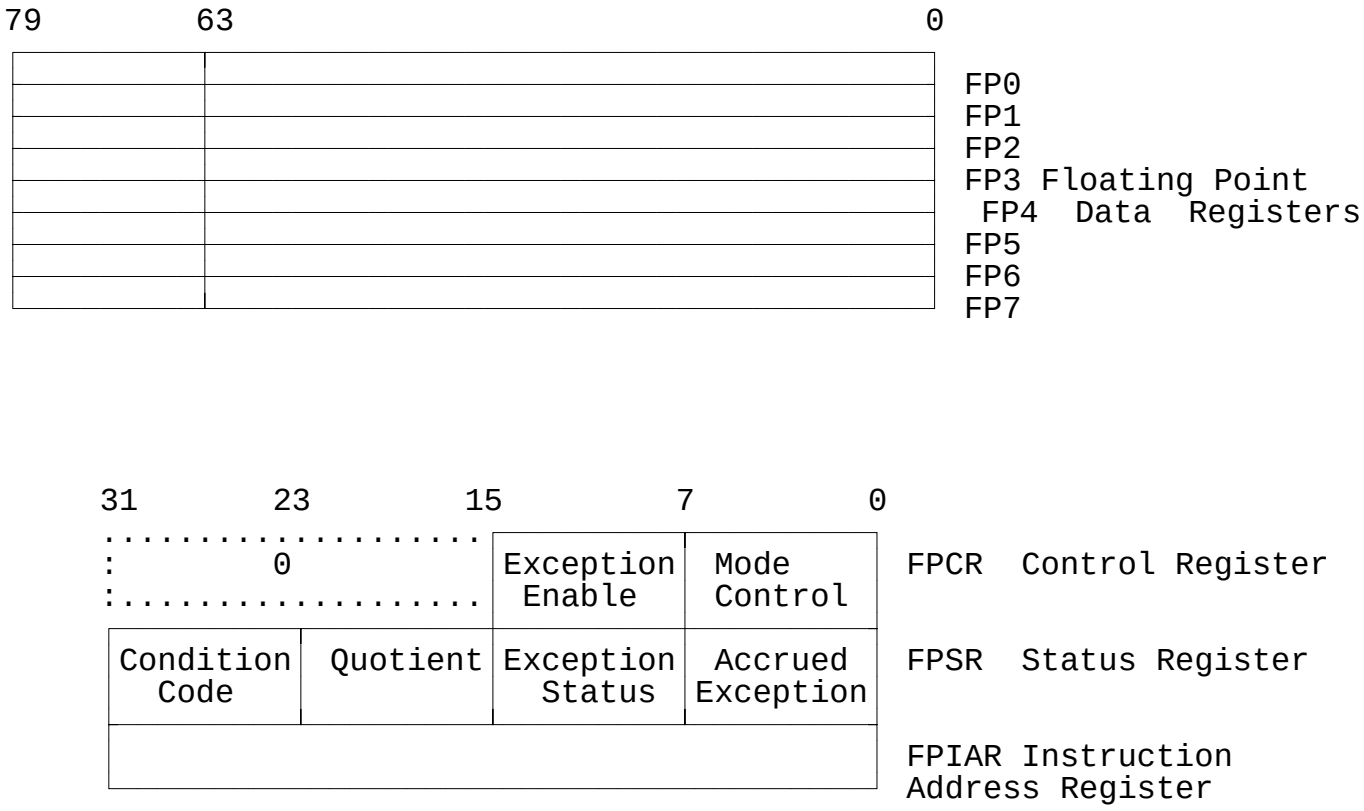


Figure 4.7-2: Register Model of the 68881



4.7.3 The 68881 Instruction Set

The 68881 instruction set is organized into six major classes:

1) Moves between the 68881 (in and out),
2) Move multiple registers (in and out),
3) Monadic operations,
4) Dyadic operations,
5) Branch, set, or trap conditionally, and
6) Miscellaneous.

4.7.4 Addressing of the 68881

The 68881 is addressed via a part of the address signals.

The coprocessor address is $0E02XX.

The Coprocessor Interface Register Map

	31 15 0	
00	RESPONSE	CONTROL
04	SAVE	RESTORE
08	OPERATION	COMMAND
0C	(RESERVED)	CONDITION
10	OPERAND	
14	REGISTER SELECT	(RESERVED)
18	INSTRUCTION ADDRESS	
1C	OPERAND ADDRESS	

4.7.5 Detection of the 68881

The sense pin of the FPCP is not connected.

Should an address of a nonpresent FPCP be addressed ($0E02XX) then a bus error will occur.

4.7.6 RESET of the FPCP

The FPCP can be RESET by executing the following small program:

```
FPCP: MOVE.W  #$100,D0
      MOVE.W  #$0,$0E0380     INIT RESET
LOOP: SUBQ.W  #$1,D0
      BNE.S   LOOP
      MOVE.W  #$0,$0E0300     TURN RESET OFF
      END
```

The RESET instruction of the 68000/68010 does not reset the FPCP in a proper way so that the software RESET has to be used. The RESET has to be activated for at least 100us.

4.7.7 Summary of the 68881

Coprocessor address	$0E0200
Usable Data Bits	D0 - D15
Supported Transfer Types	Byte Word
Reset Function	Reset on: write word to $0E0380 (min 100us) Reset off: write word to $0E0300

4.8 Local Interrupt Handling

The on-board CPU is able to handle seven different prioritized interrupt request levels. The interrupt daisy chain on the VMEbus allows an unlimited number of peripheral devices to interrupt the CPU.

Interrupt priority levels are numbered from one to seven, level seven being the highest priority. The status register contains a three bit mask which indicates the current priority of the processor. Interrupts for all priority levels less than or equal to the current processor priority are ignored.

Interrupt requests arriving at the processor do not force immediate exception processing. Pending interrupts are detected between instruction executions. If the priority of the pending interrupt request is lower than or equal to the current processor priority, the execution continues with the next instruction and no interrupt exception processing is started.

If the priority of the pending interrupt is greater than the current processor priority, then the exception processing sequence is started.

After the start of the interrupt exception sequence, a copy of the Status Register (SR) is saved on the stack, the privilege state of the processor is set to supervisor, and the processor priority level is set to the level of the interrupt being acknowledged.

The processor fetches the vector number from the interrupting device, classifying the reference as an interrupt acknowledge and displaying the level number of the interrupt being acknowledged on the address bus using the address signals A1, A2 and A3 as listed in Table 4.8-1.

Table 4.8-2 shows the conversion of the interrupt vector into the address under which the start address of the interrupt service routine is stored.

Table 4.8-1: The Interrupt Acknowledge Level Code

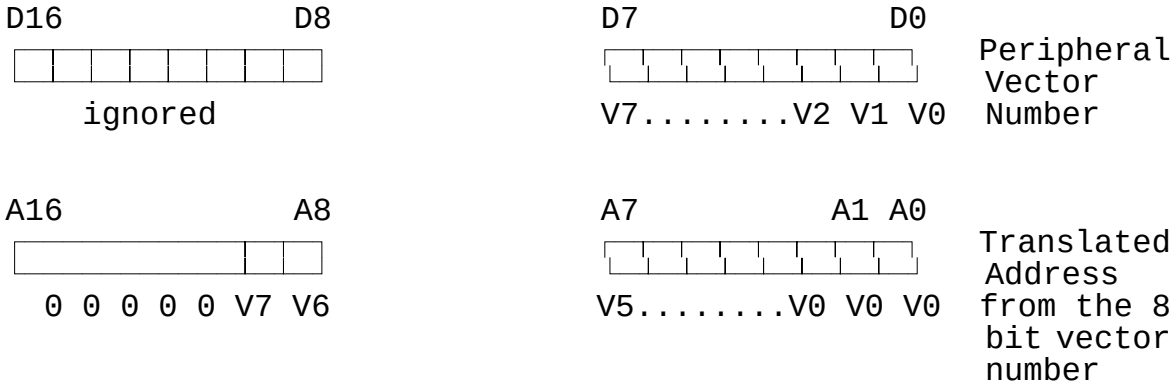
IRQ Level	A3	A2	A1	FC0	FC1	FC2	Note
7	1	1	1	1	1	1	
6	1	1	0	1	1	1	
5	1	0	1	1	1	1	
4	1	0	0	1	1	1	
3	0	1	1	1	1	1	
2	0	1	0	1	1	1	
1	0	0	1	1	1	1	
-	0	0	0	1	1	1	A

Note A) Not assigned.

The content of the interrupt vector whose vector number was fetched and translated is loaded into the program counter to start the interrupt handling routine.

The vector that was moved from the interrupting device onto the data bits D0-D7 is translated by the CPU into an address which contains the start address of the interrupt handling routine.

Table 4.8-2: The Interrupt Vector Conversion



4.8.1 Interrupt Level Assignment

The SYS68K/CPU-6 board contains six on-board interrupt sources, the three serial I/O Controllers (ACIAs), the ABORT function switch, the Parallel Interface and the Real Time Clock.
Table 4.8-1 lists the combinations of the on-board devices and the corresponding interrupt level as well as the default set auto-interrupt vectors.

Table 4.8-3: The On-Board Devices Interrupt Scheme

On-Board Device	Interrupt Level	Autointerrupt Vectoring	Default Vector	Address
ABORT Switch	7	YES	31	$00007C
RTC 58167A	6	YES	30	$000078
PI/T 68230	5	YES	29	$000074
ACIA Terminal	4	YES	28	$000070
ACIA Remote	3	YES	27	$00006C
ACIA Host	2	YES	26	$000068
ACFAIL, SYSFAIL	5 a)	YES	29	$000074

Note: On request, this signal from the VMEbus can be used to generate an Interrupt. (Please refer to Chapter 5.7.2)

4.8.2 Usage of the Auto Vectors

Table 4.8-4 lists the vector numbers for the autointerrupt scheme and the spurious interrupt.

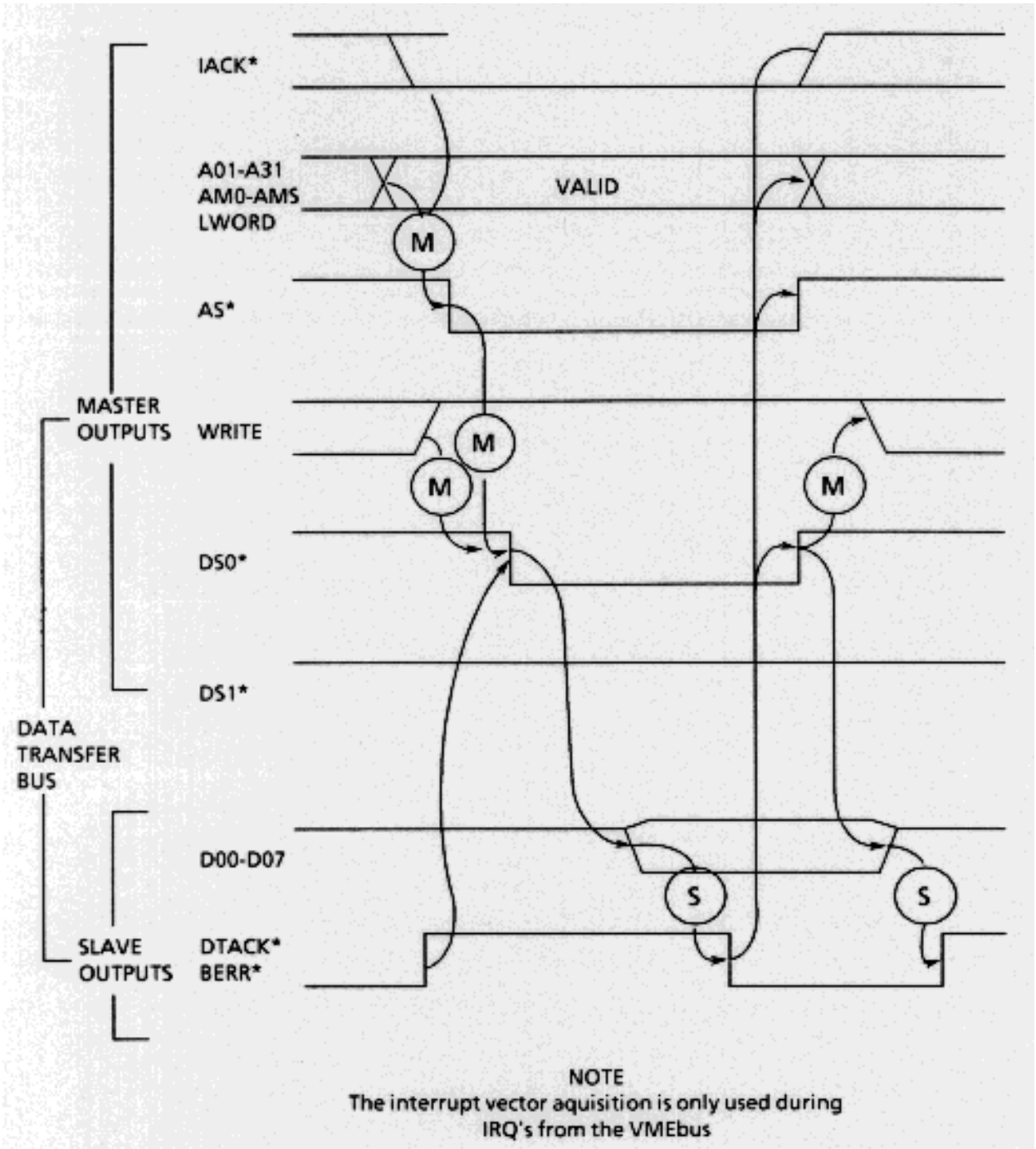
Table 4.8-4: The Autointerrupt Vector Table

Absolute Address	Vector Number	Corresponding Interrupt Level
$000060	# 24	Spurious Interrupt
$000064	# 25	Level 1 Interrupt Autovector
$000068	# 26	" 2 " "
$00006C	# 27	" 3 " "
$000070	# 28	" 4 " "
$000074	# 29	" 5 " "
$000078	# 30	" 6 " "
$00007C	# 31	" 7 " "

A global timing diagram of the interrupt vector acquisition is shown in Figure 4.8-1.

The priority level seven is a special case. Level seven interrupts cannot be disabled by the interrupt priority mask. The IRQ 7 is a "non-maskable interrupt"

Figure 4.8-1: The Global Interrupt Vector Acquisition



4.8.3 Summary of the Local Interrupts

Device	Type	IRQ Level	IRQ Vector	Address
ABORT Switch	--	7	31	$00007C
58167A	RTC	6	30	$000078
68230	PI/T	5	29	$000074
68B50	ACIA Terminal	5	28	$000070
68B50	ACIA Remote	3	27	$00006C
68B50	ACIA Host	2	26	$000068

4.9 The BERR Generator

To provide an error function, if a device or memory on the bus has not responded within a maximum time, a time-out counter is used on the board.

This time-out counter generates a Bus Error Signal (BERR*) after a user-supplied time limit (up to 15ms). The CPU aborts the current cycle if the BERR* signal has been recognized, and forces the exception routine.

Figure 4.8-1 shows the detailed diagram of an access cycle aborted via BERR* with the default set values.

Table 4.9-1 lists the usable time-out values and the equivalent jumper settings. Figure 4.9-2 outlines the location diagram of the jumperfields.

If the board is the current VMEbus master, and an external VMEbus card generates a BERR*, then the cycle will be aborted in the same way.

For example, an external BERR* signal can be generated by a dynamic memory card by using an Error Detection and Correction Logic (EDC) and detection of a non-correctable data pattern.

Figure 4.9-1: Timing Diagram of a BERR Cycle

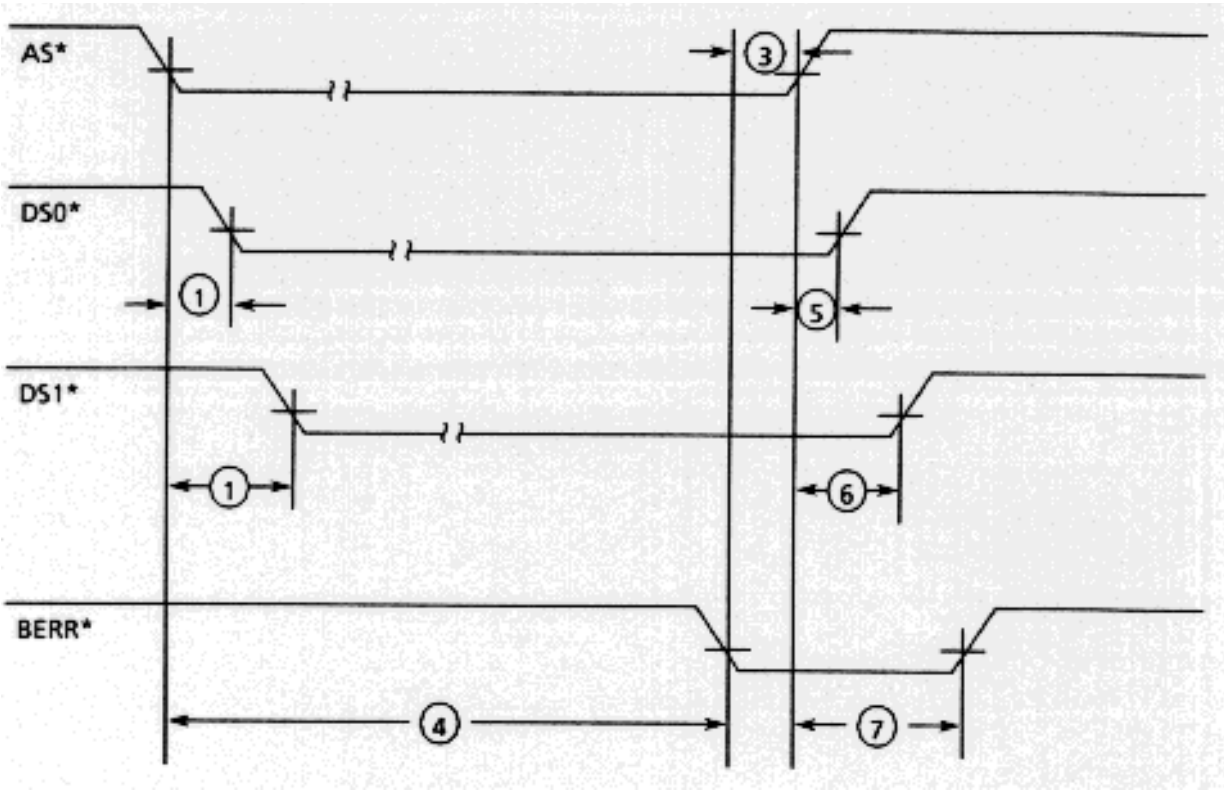
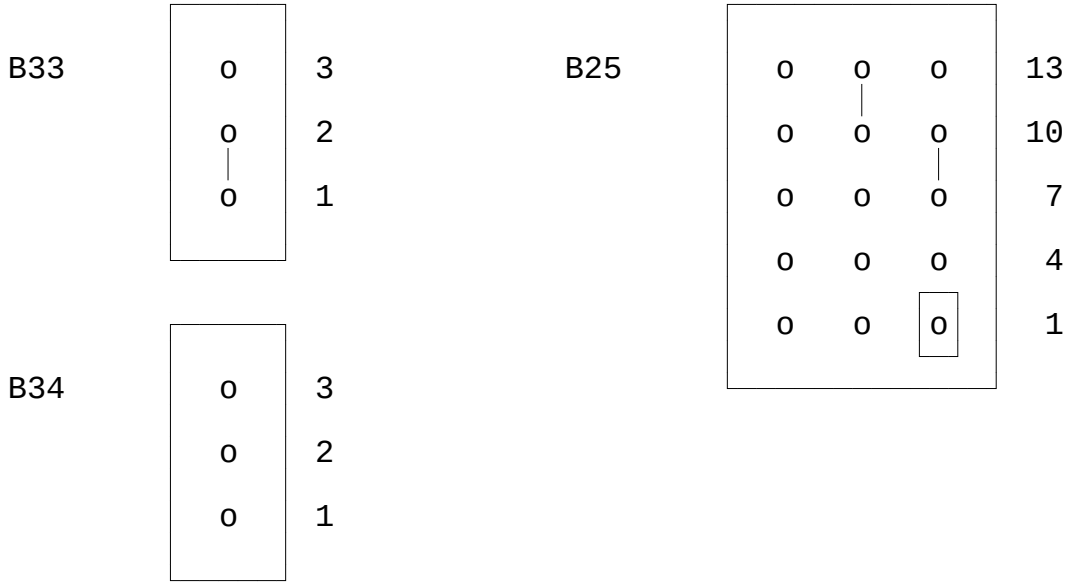
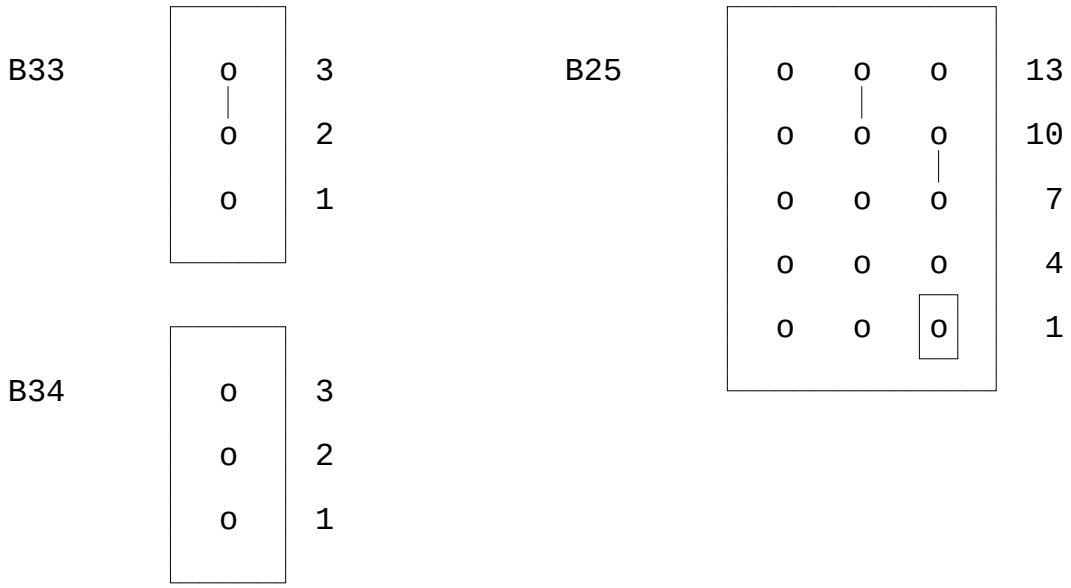


Table 4.9-1: BERR Jumper Settings A



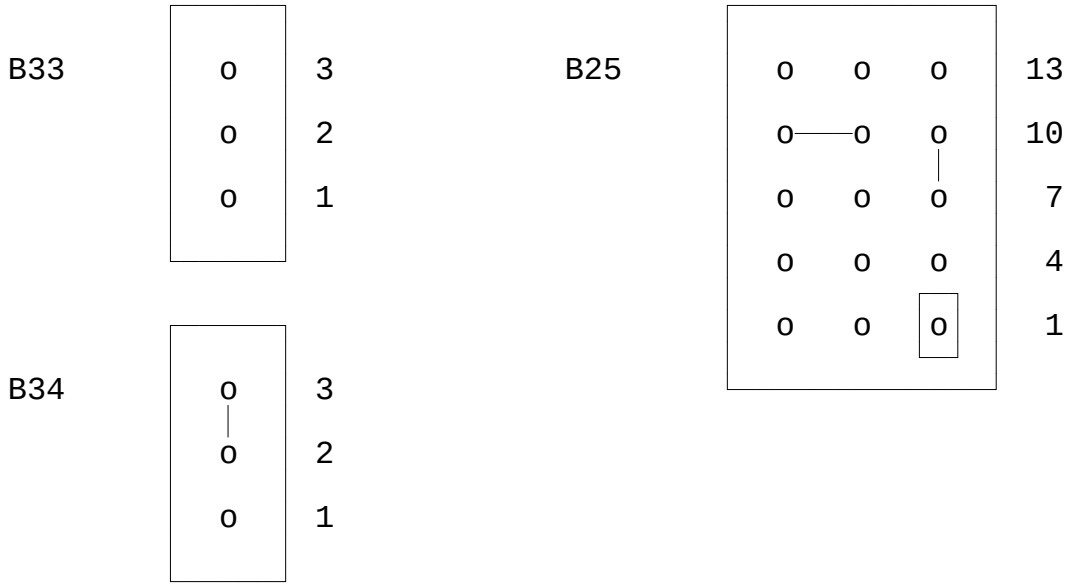
Time Out Min 24ms Default setting during manufacturing
Max 32ms

Table 4.9-2: BERR Jumper Settings B



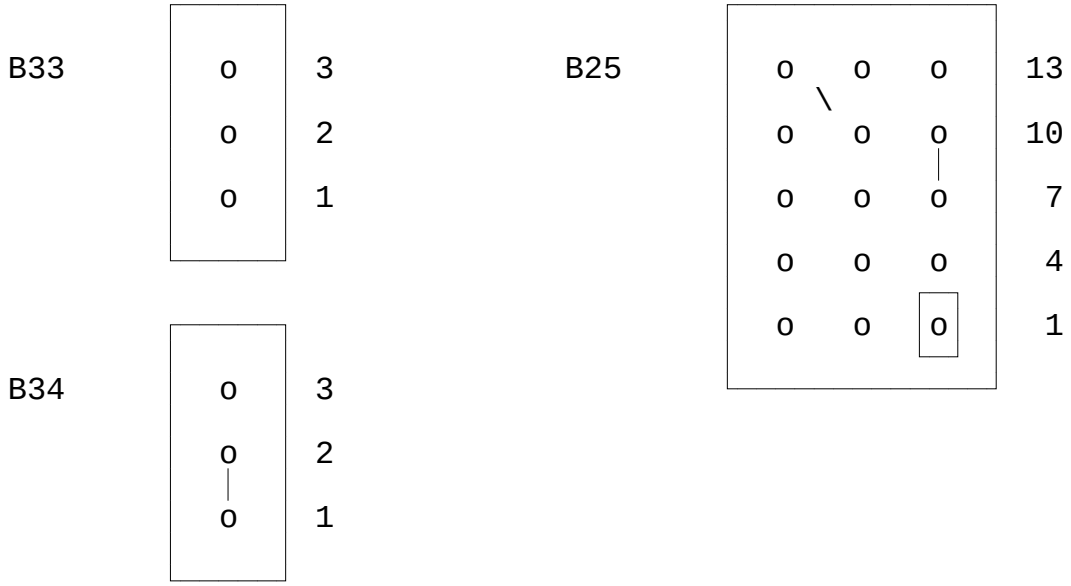
Time Out Min 8ms
Max 16ms

Table 4.9-3: BERR Jumper Settings C



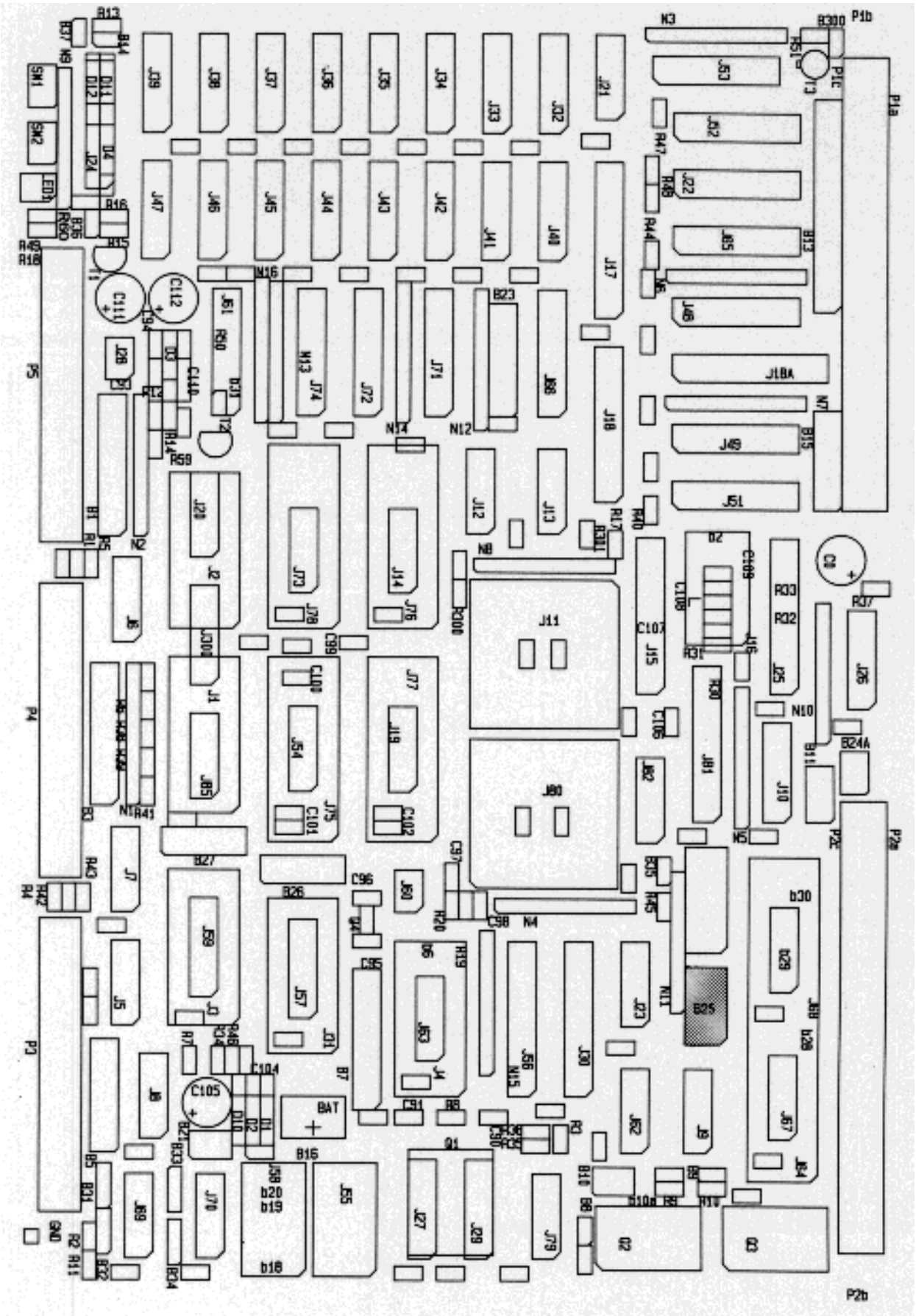
Time Out	Min	2.5ms
	Max	3.0ms

Table 4.9-4: BERR Jumper Settings D



Time Out	Min	224ms
	Max	256ms

Figure 4.9-2: Location Diagram of the BERR Jumperfield



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5.0 THE VMEbus INTERFACE

The SYS68K/CPU-6 board contains a VMEbus interface which allows the following transfer modes:

A24 : D16, D8

A16 : D16, D8

The standard addressing (A24) and the short I/O (A16) are controlled via hardware because the A16 mode is only a subset of the A23 mode. The address range of the short I/O is the upper end of the address range of the 68000/68010.

Short I/O address range : $FF0000 to $FFFFFF

All address modifier signals, as well as the interrupt request lines are supported by the SYS68K/CPU-6.

5.1 Data Transfer Size

If this board is the current VMEbus master (low driven BBSY* signal) and the current access address is higher or equal to $100.000, then a VMEbus transfer is initiated. Figures 5.1-1 and 5.1-2 show the detailed timing diagrams of a read cycle and a write cycle. Tables 5.1-1 and 5.1-2 list all of the time values.

Table 5.1-1: Read Cycle followed by Write Cycle

NUMBER	PARAMETER	NOTE MIN.	NOTE MAX.	NOTES
1	Axx and AMx valid and IACK* high to AS* low	35		B
2	DTACK* low to invalid address or IACK* low	0		C
3	AS* high	40		B
4	DTACK* low to AS* high	0		C
5	AS* to DS"A"* skew	0		B
6	WRITE* valid to DS"A"* low	35		B
7	DS"B"* high to invalid WRITE*	10		B
8	DTACK* high to active data bus	0		C
9	Dxx valid to DS"A"* low	35		B
10	DTACK* low to invalid data	0		C
11	DS"A"* to DS"B"* skew	0	10	B
12	DTACK*/BERR* low to DS"A"* high	0		C
13	DS"A"* high	40		B
14	DS"B"* high to DS"A"* low	40		B
15	DS"B"* high	40		B
16	DS"B"* high to DTACK* high	0		D
17	DTACK*/BERR* low to DS"B"* high	0		C
18	DS"A" low to DTACK* or BERR asserted	0		E

A. All times given in nanoseconds.

B. The MASTER must guarantee this timing between two of its outgoing signal transitions.

C. The MASTER must wait for the incoming signal edge from the SLAVE before changing the level of its outgoing signal.

D. This is a guarantee that the SLAVE will not change the incoming signal until the SLAVE changes its outgoing signal.

E. The MASTER is guaranteed this timing between two of its incoming signal transitions.

Figure 5.1-1: Read Cycle Followed by Write Cycle

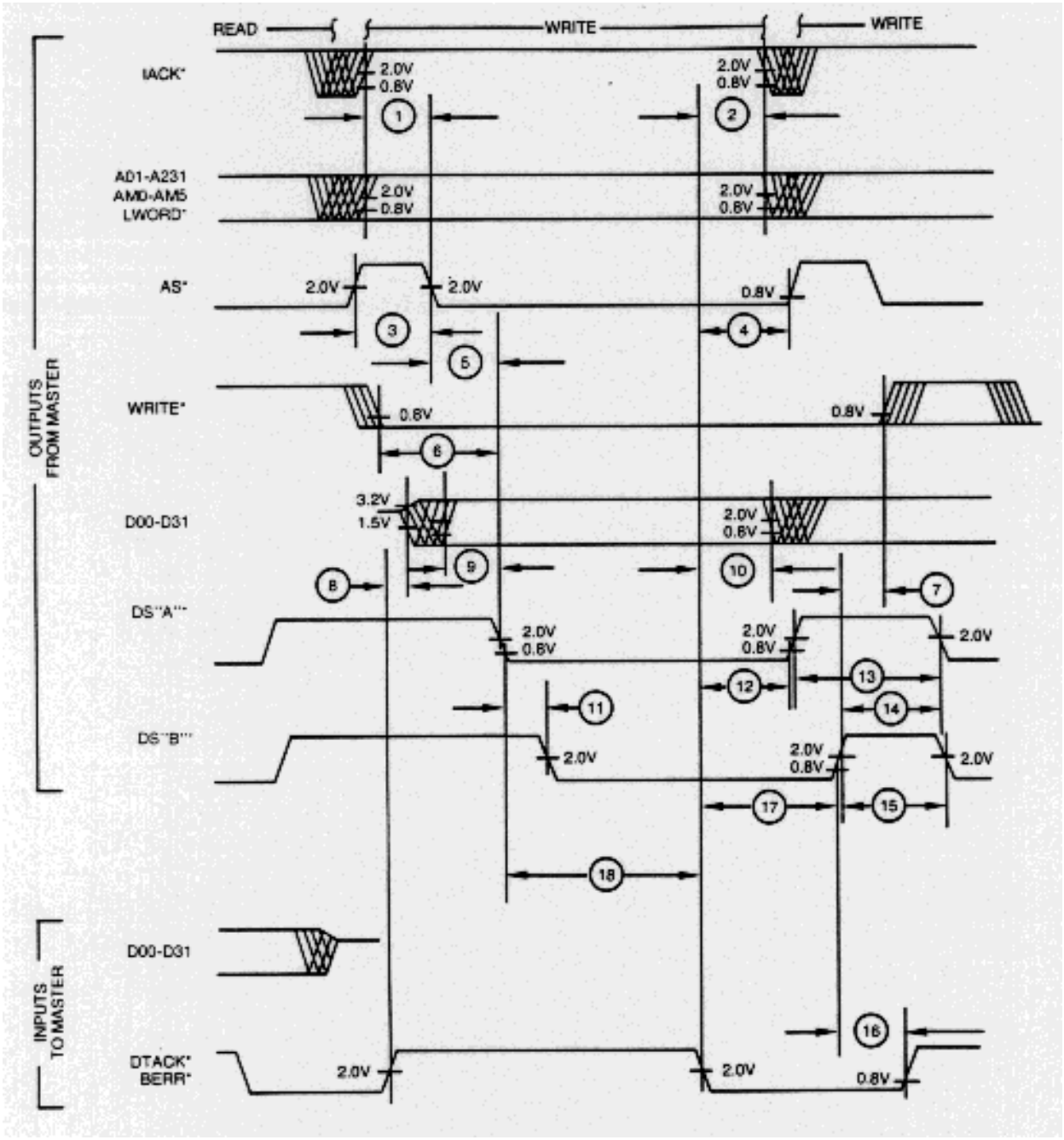


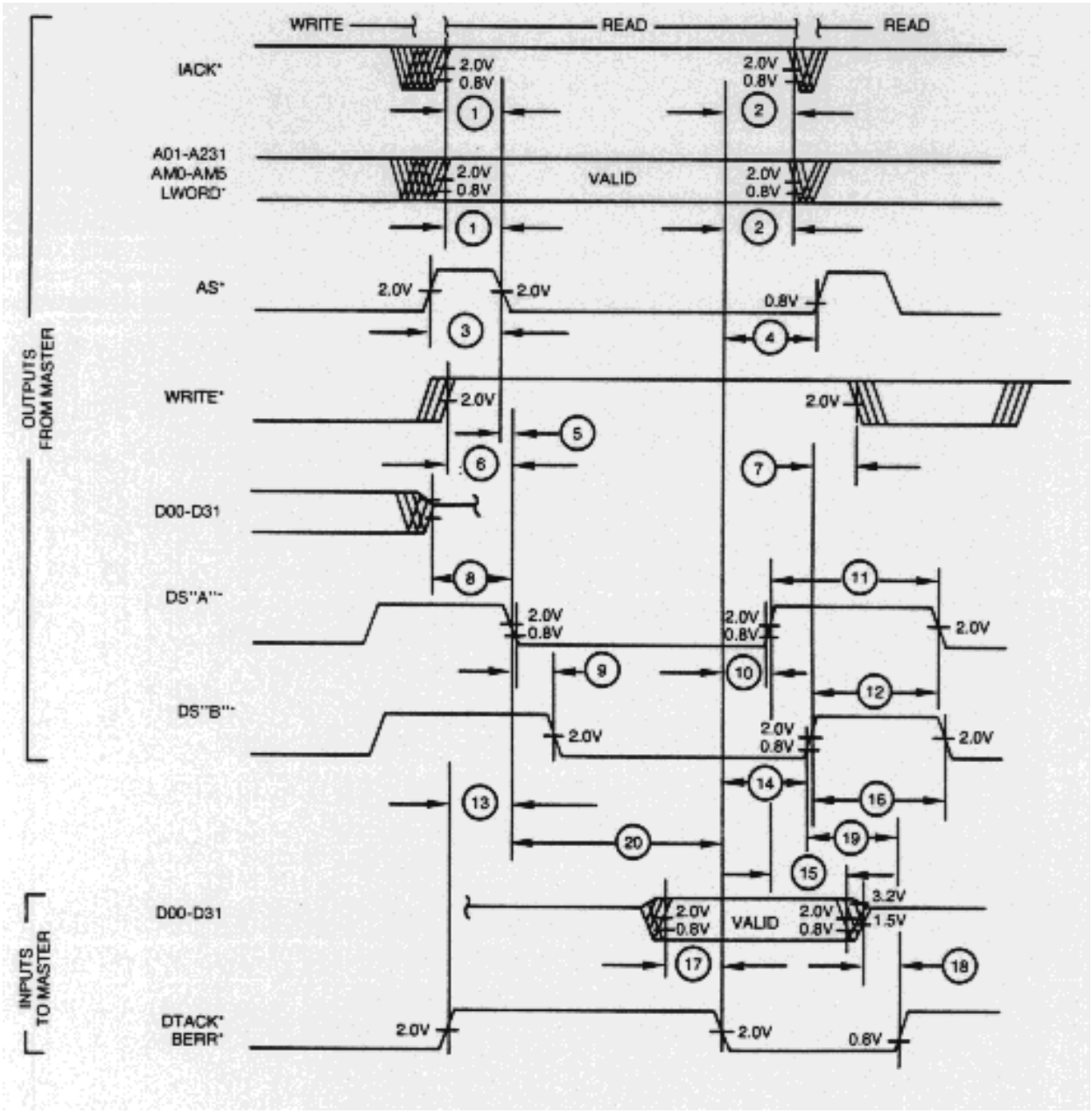
Table 5.1-2: Write Cycle followed by Read Cycle

NUMBER	PARAMETER	NOTE MIN.	NOTE MAX.	NOTES
1	Axx and AMx valid and IACK* high to AS* low	35		B
2	DTACK* low to invalid address or IACK* low	0		C
3	AS* high	40		B
4	DTACK* low to AS* high	0		C
5	AS* to DS"A"* skew	0		B
6	WRITE* valid to DS"A"* low	35		B
7	DS"B"* high to invalid WRITE*	10		B
8	Data release to DS"A" low	0		B
9	DS"A"* to DS"B" skew		10	B
10	DTACK* low to DS"A"* high	0		C
11	DS"A"* high	40		B
12	DS"B"* high to DS"A" low	40		B
13	DTACK*/BERR* high to DS"A"* low	0		C
14	DTACK* low to DS"B"* high	0		C
15	DS"A"* high to invalid data	0		D
16	DS"B"* high	40		B
17	Dxx valid to DTACK* low	-25		E
18	Data released to DTACK*/BERR* high	0		E
19	DS"B"* high to DTACK*/BERR* high	30		B

NOTES:

A. All times given in nanoseconds.
B. The MASTER must guarantee this timing between two of its outgoing signal transitions.
C. The MASTER must wait for the incoming signal edge from the SLAVE before changing the level of its outgoing signal.
D. This is a guarantee that the SLAVE will not change the incoming signal until the MASTER changes its outgoing signal.
E. The MASTER is guaranteed this timing between two of its incomingsignal transitions.

Figure 5.1-2: Write Cycle Followed by Read Cycle



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5.2 The Address Modifier Implementation

The 68000 CPU contains three function code signals which indicate the state of the processor (USER or SUPERVISOR mode) and the cycle type currently being executed (PROGRAM or DATA access).

The next table lists all the states and types of the 680x0 CPU.

The CPU Function Codes

FC2	FC1	FC0	CYCLE TYPE
LOW	LOW	LOW	Reserved
LOW	LOW	HIGH	User Data
LOW	HIGH	LOW	User Program
LOW	HIGH	HIGH	Reserved
HIGH	LOW	LOW	Reserved
HIGH	LOW	HIGH	Supervisor Data
HIGH	HIGH	LOW	Supervisor Program
HIGH	HIGH	HIGH	Interrupt Acknowledge

The Function Code Assignment to the AM Codes:

The function code signal FC0, FC1 and FC2 from the CPU and the DMAC are connected to the VMEbus via a transceiver. The assignment to the AM-codes is listed below:

FC0	->	AM0
FC1	->	AM1
FC2	->	AM2
+5V	->	AM3
Short I/O Range	->	AM4
+5V	->	AM5

Therefore, all AM codes which are defined in the VME specifications are supported.

Table 5.2-1: The Address Modifier Codes

HEXADECIMAL CODE	ADDRESS MODIFIER 5	4	3	2	1	0	FUNCTION	DEFINED BY
3F	H	H	H	H	H	H	Standard Supervisory Ascending Access	VMEbus Spec.
3E	H	H	H	H	H	L	Standard Supervisory Program Access	VMEbus Spec.
3D	H	H	H	H	L	H	Standard Supervisory Data Access	VMEbus Spec.
3C	H	H	H	H	L	L	Undefined	Reserved
3B	H	H	H	L	H	H	Standard Non-Privileged Ascending Access	VMEbus Spec.
3A	H	H	H	L	H	L	Standard Non-Privileged Program Access	VMEbus Spec.
39	H	H	H	L	L	H	Standard Non-Privileged Data Access	VMEbus Spec.
38	H	H	H	L	L	L	Undefined	Reserved
30–37	H	H	L	X	X	X	Undefined	Reserved
2F	H	L	H	H	H	H	Undefined	Reserved
2E	H	L	H	H	H	L	Undefined	Reserved
2D	H	L	H	H	L	H	Short Supervisory I/O Access	VMEbus Spec.
2C	H	L	H	H	L	L	Undefined	Reserved
2B	H	L	H	L	H	H	Undefined	Reserved
2A	H	L	H	L	H	L	Undefined	Reserved
29	H	L	H	L	L	H	Short Non-Privileged I/O Access	VMEbus Spec.
28	H	L	H	L	L	L	Undefined	Reserved
20–27	H	L	L	X	X	X	Undefined	Reserved
10–1F	L	H	X	X	X	X	Undefined	User
OF	L	L	H	H	H	H	Extended Supervisory Ascending Access	VMEbus Spec.
OE	L	L	H	H	H	L	Extended Supervisory Program Access	VMEbus Spec.
OD	L	L	H	H	L	H	Extended Supervisory Data Access	VMEbus Spec.
OC	L	L	H	H	L	L	Undefined	Reserved
OB	L	L	H	L	H	H	Extended Non-Privileged Ascending Access	VMEbus Spec.
OA	L	L	H	L	H	L	Extended Non-Privileged Program Access	VMEbus Spec.
09	L	L	H	L	L	H	Extended Non-Privileged Data Access	VMEbus Spec.
08	L	L	H	L	L	L	Undefined	Reserved
00–07	L	L	L	X	x	X	Undefined	Reserved

5.2.1 The Short I/O Address Modifier Code

To select a 64 Kbyte range out of the on-board 68000 CPUs 16 Mbyte address space, an address comparator IC (J66) is used on the board.

This 64 Kbyte range is jumper selectable in the range from $100.000 to $FFFFFF. The jumper field B23 is used to define the address range.

Figure 5.2-1 outlines the AM4 decoder in detail.

For valid decoding, the following jumper settings are possible:

OUT means that the corresponding address signal must be high (1)

IN means that the corresponding address signal must be low (0)

Table 5.2-2 lists the jumper positions and the corresponding address signals as well as the jumper settings in the default conditions during manufacturing.

Figure 5.2-2 outlines the location diagram of the short I/O parts.

Figure 5.2-1: The Short I/O Comparator

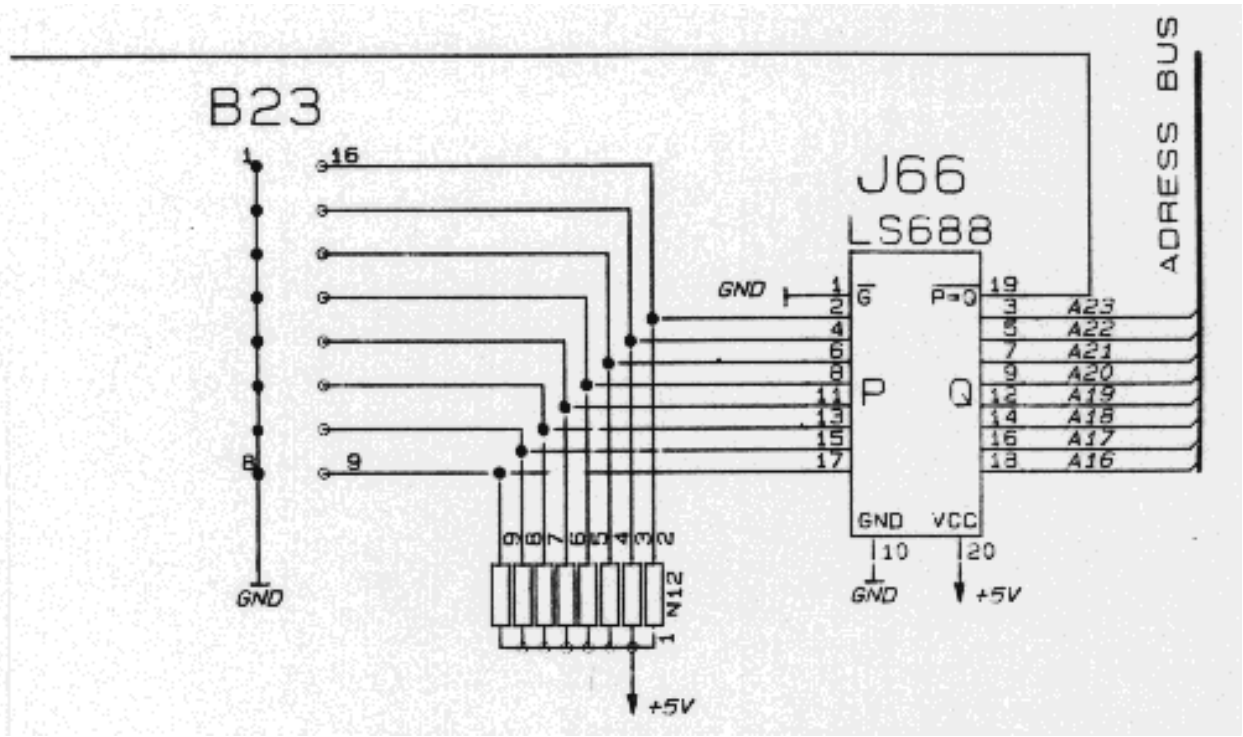
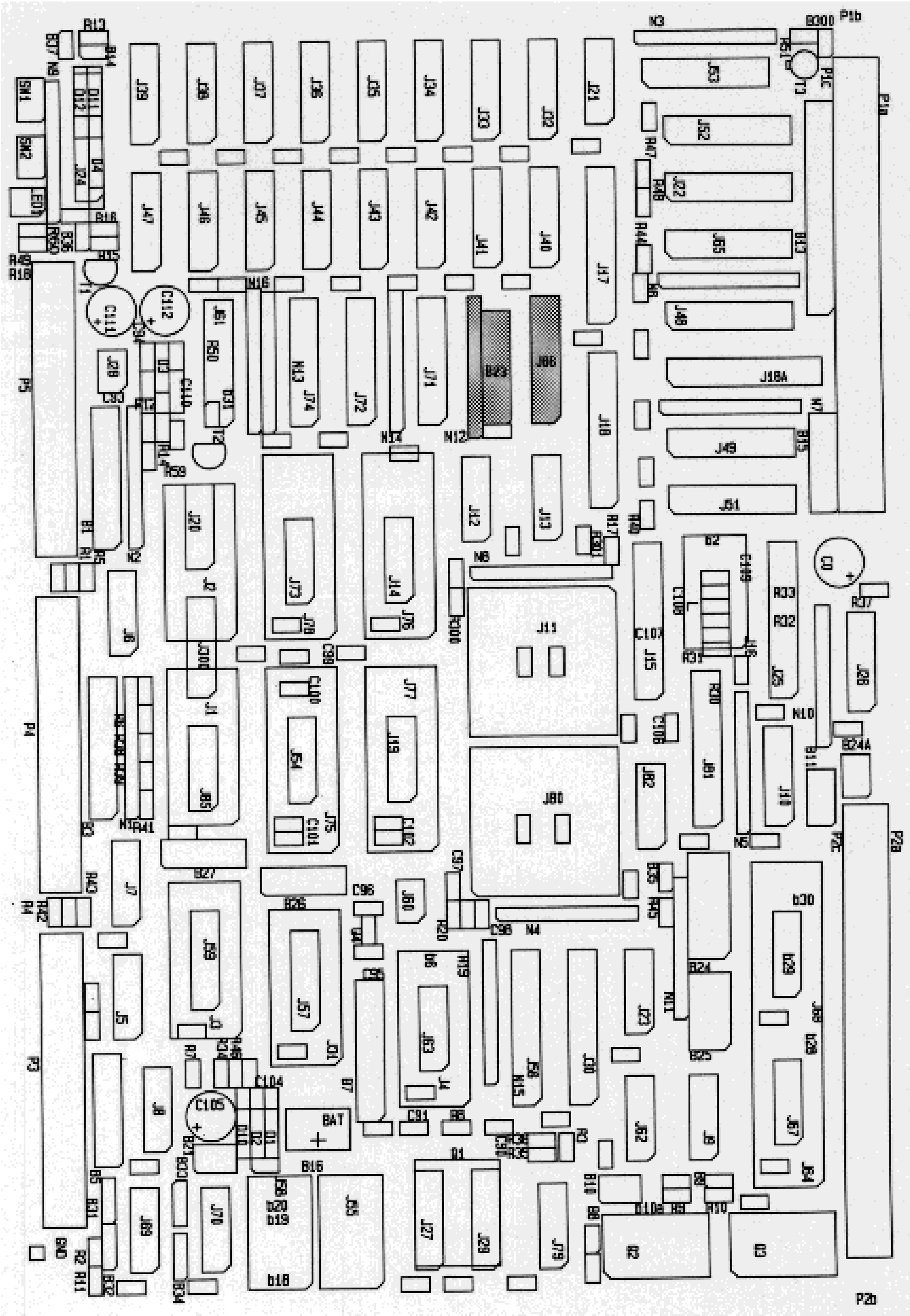


Table 5.2-2: The Short I/O Jumper Settings

Jumper Positions B23	Corresponding Address Signal	Default Jumper Setting
9 8 o o	A23	OUT
o o	A22	OUT
o o	A21	OUT
o o	A20	OUT
o o	A19	OUT
o o	A18	OUT
o o	A17	OUT
o o 16 1	A16	OUT

Start Address Short I/O	$ FF0000
End Address Short I/O	$ FFFFFF

Figure 5.2-2: Location Diagram of the Short I/O Parts



5.3 The VMEbus Arbitration

The VMEbus is designed to allow multimaster and multiprocessor application. Only the current VMEbus master is able to force read or write transfers to and from other VME modules. This requires a special handshake scheme to control which VME module receives bus mastership.

This controller module is the VMEbus arbiter. The arbiter resides only in slot number one of each VMEbus environment, because the bus arbitration is daisy chained from slot 1 to 2 to 3 and so on. Each system has only one arbiter. The arbiter may be on a special card or it may be located on a CPU board.

To provide a minimal system overhead, there are three different arbiters defined in the VMEbus specification.

a) The Four Level Bus Arbiter with a Priority Scheme

b) The Four Level Bus Arbiter with a Round Robin Scheme

c) The One Level Bus Arbiter

A global description of an arbitration scheme is given in the next chapter.

5.3.1 The Arbiter Options

The arbiter is used to control the DTB arbitration system. There are three options :

a) An option PRI (Priority) Arbiter always assigns the bus on a fixed priority basis where each of the four different Bus Request (BRX*) signals are assigned fixed priorities from the highest (BR3*) to the lowest (BR0*).

b) An option RRS (Round Robin Select) Arbiter assigns the bus on a rotating priority basis. If the current DTB Master is level "n", then the highest priority will be given to level "n-1" and proceed sequentially from there.

c) A Single Level Arbiter only honors requests on BR3* and relies on the daisy chain structure for priority determination.

The bus grant daisy chain structure is outlined in Figure 5.3-1, while Figure 5.3-2 shows the global DTB timing.

Figure 5.3-1: The Bus Grand Daisy Chain

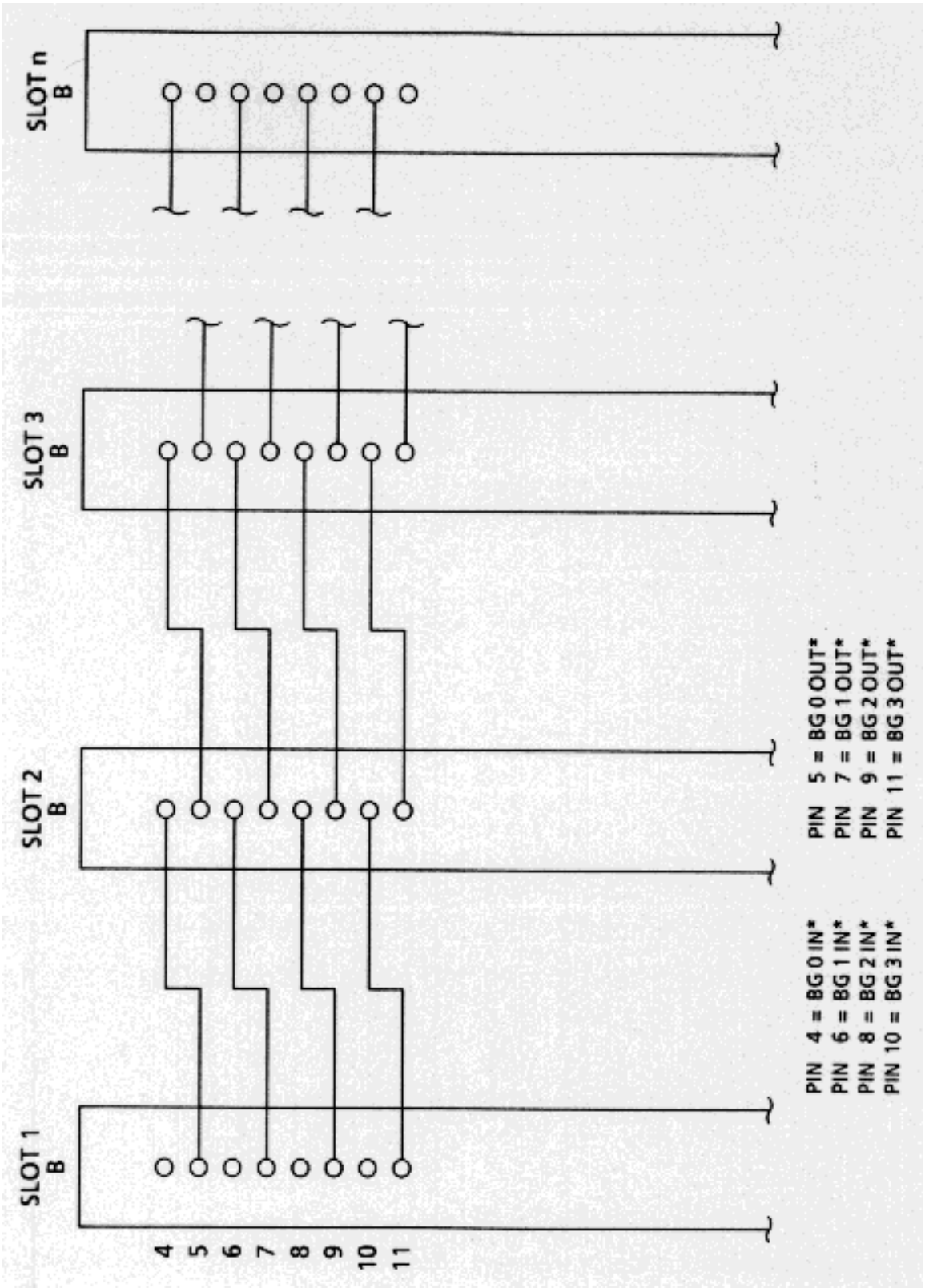
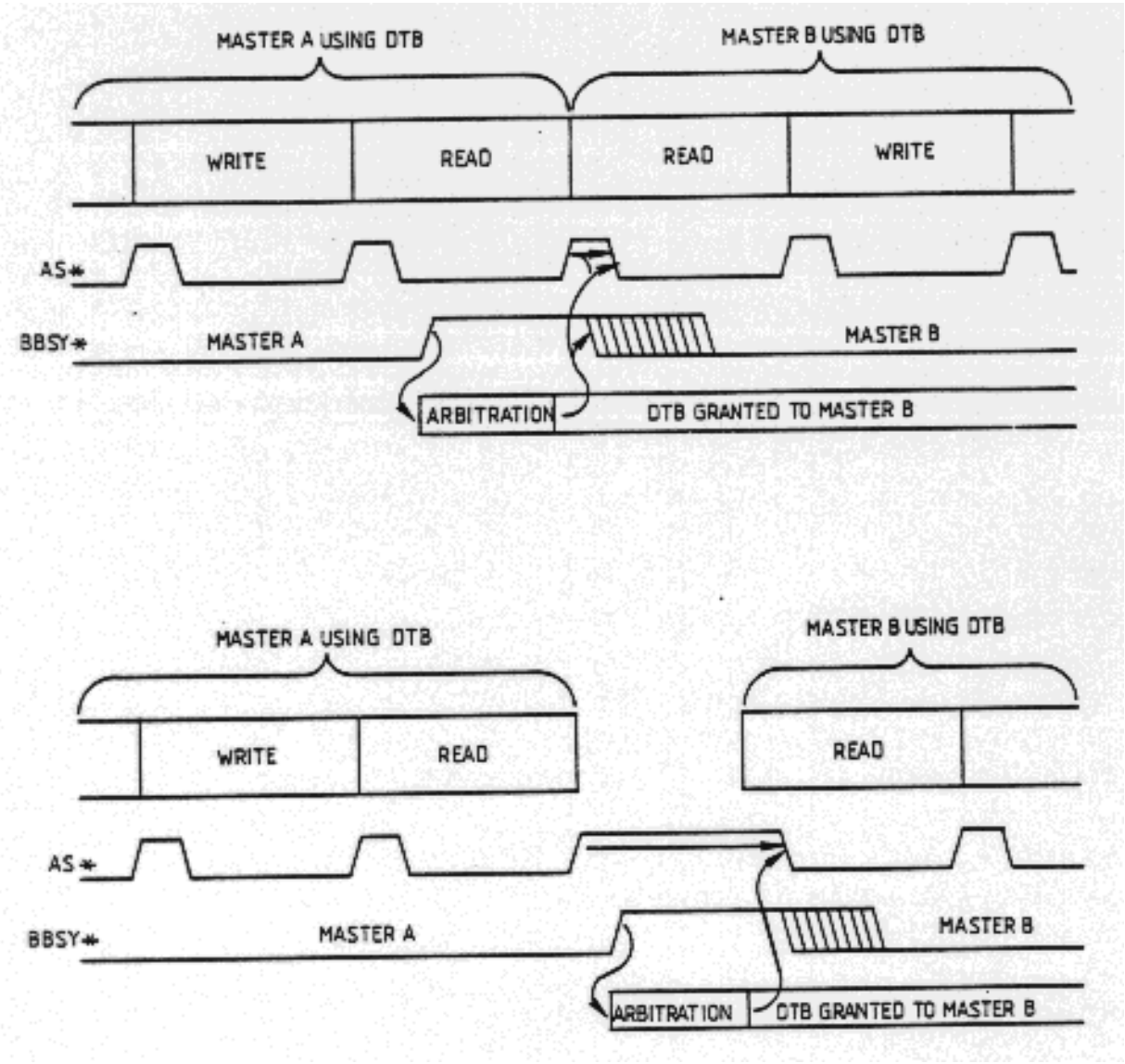


Figure 5.3-2: Global DTB Arbitration Timing



5.3.2 The On-Board DTB Slave Bus Arbitration

A full DTB slave arbitration is provided on the board to allow the usage of the SYS68K/CPU-6 in multimaster and multiprocessor environments. The board control logic generates a Bus Request (BRx*) on a selectable level (0-3) if an off-board transfer is initiated and the board is not the current DTB master.

After a received BGXIN* signal at the equivalent level, the control logic drives the BBSY* signal low to inform the Bus Arbiter that the arbitration is completed, and releases its Bus Request signal.

Figures 5.3-4 and 5.3-5 outline the BRx*, BGxIN* and BGxOUT jumper fields and Figure 5.3-6 shows the location diagram.

The Bus Request level and the Bus Grant level must be equal for proper operation. The default Bus Request level during manufacturing is 3. Therefore, the connections to be made are as listed in Figure 5.3-5.

The detailed timing diagram if an arbitration cycle is outlined in Figure 5.3-3. Table 5.3-1 lists the time values.

Table 5.3-1: Time Values of the Slave Bus Arbitration

No.	Description	Min.	Max.
1	BGXIN* low to BBSY* active	25	65
2	BBSY* low to BRX active	10	65
3	BBSY* low to BGOUT* inactive	10	45
4	BGXIN* low to BGXOUT* low	35	50

NOTE : All times given in nanoseconds.

Figure 5.3-3: Bus Arbitration Timing Diagram

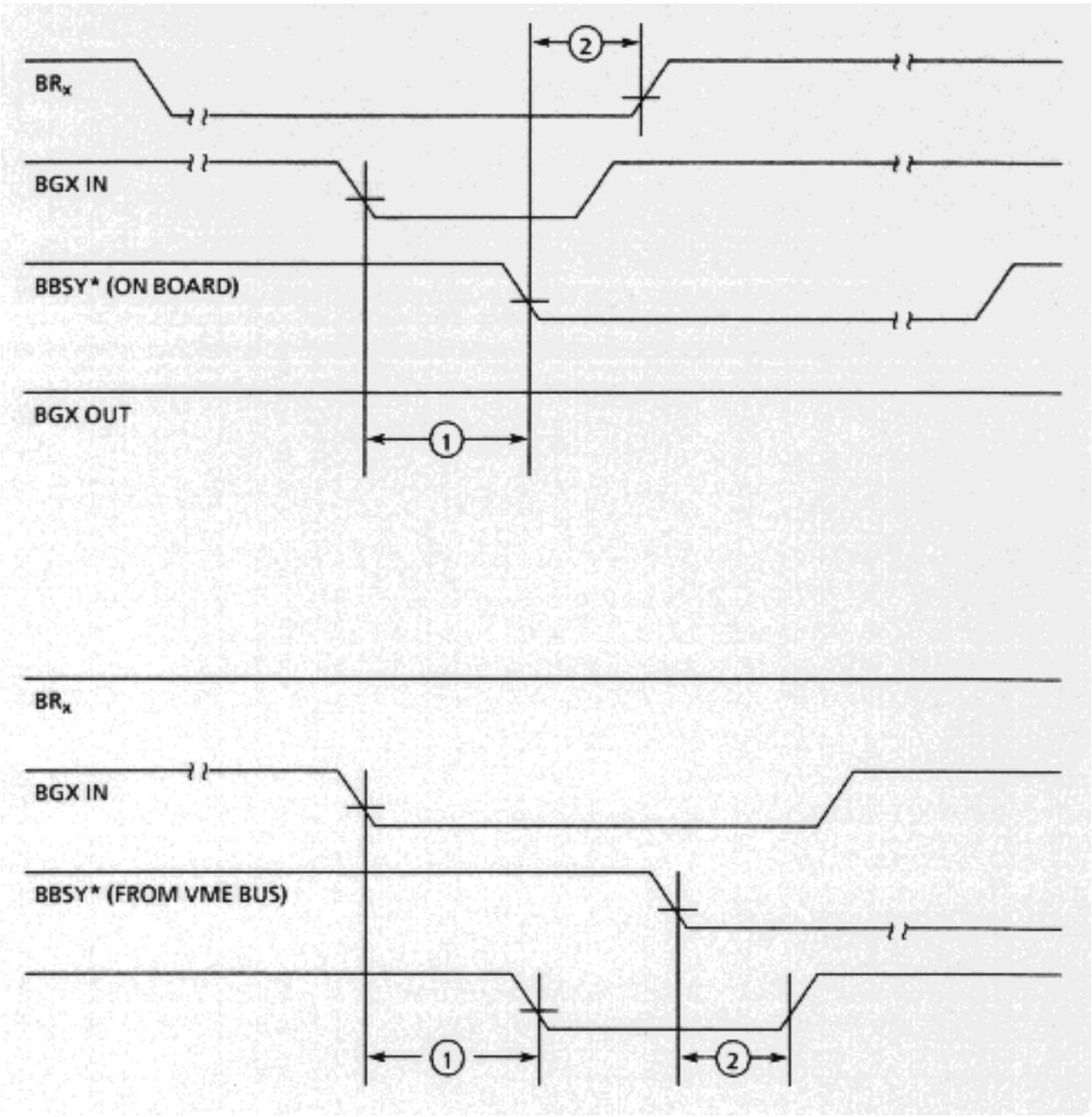


Figure 5.3-4: The Jumperfield for the Bus Arbitration

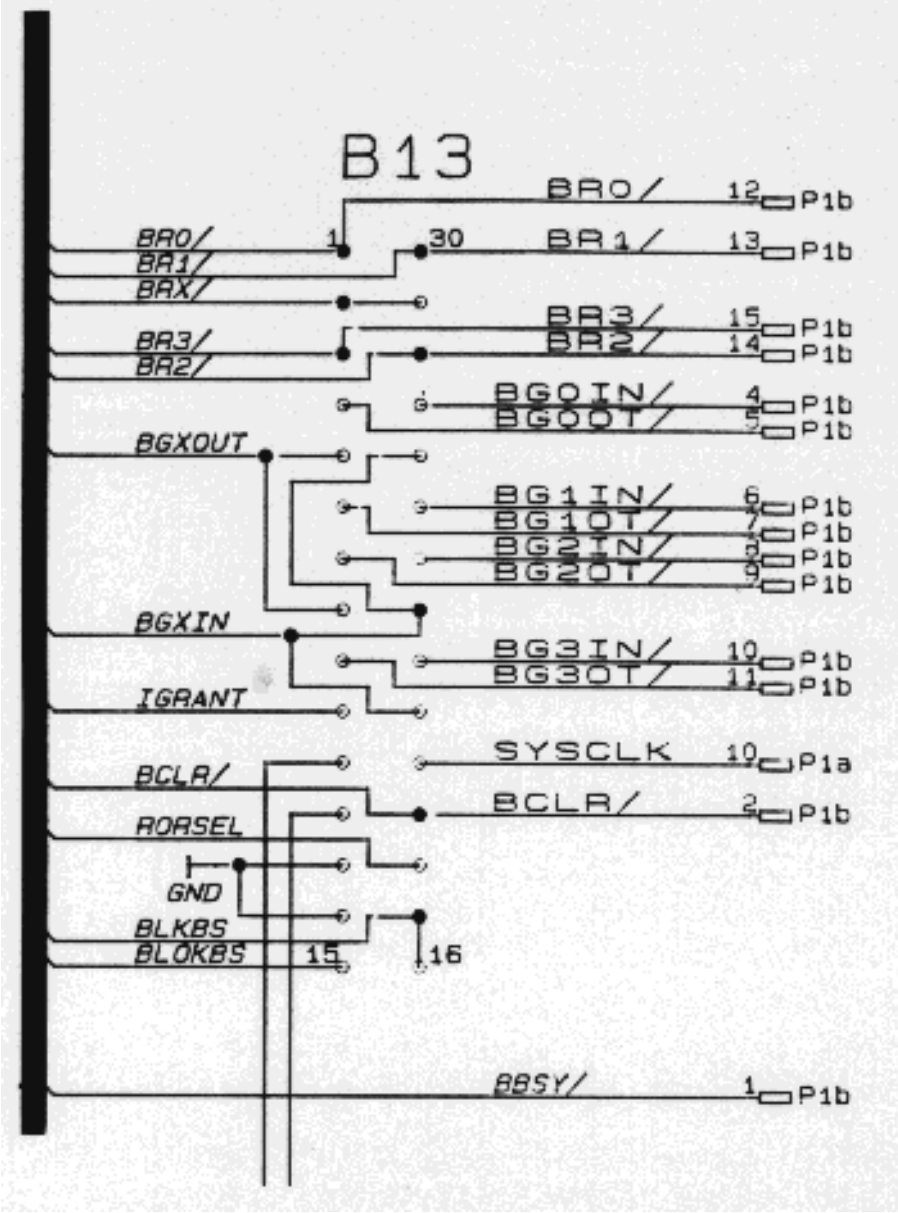


Figure 5.3-5: Arbiter and Bus Request Level Jumper Selection on B13 with External Arbiter

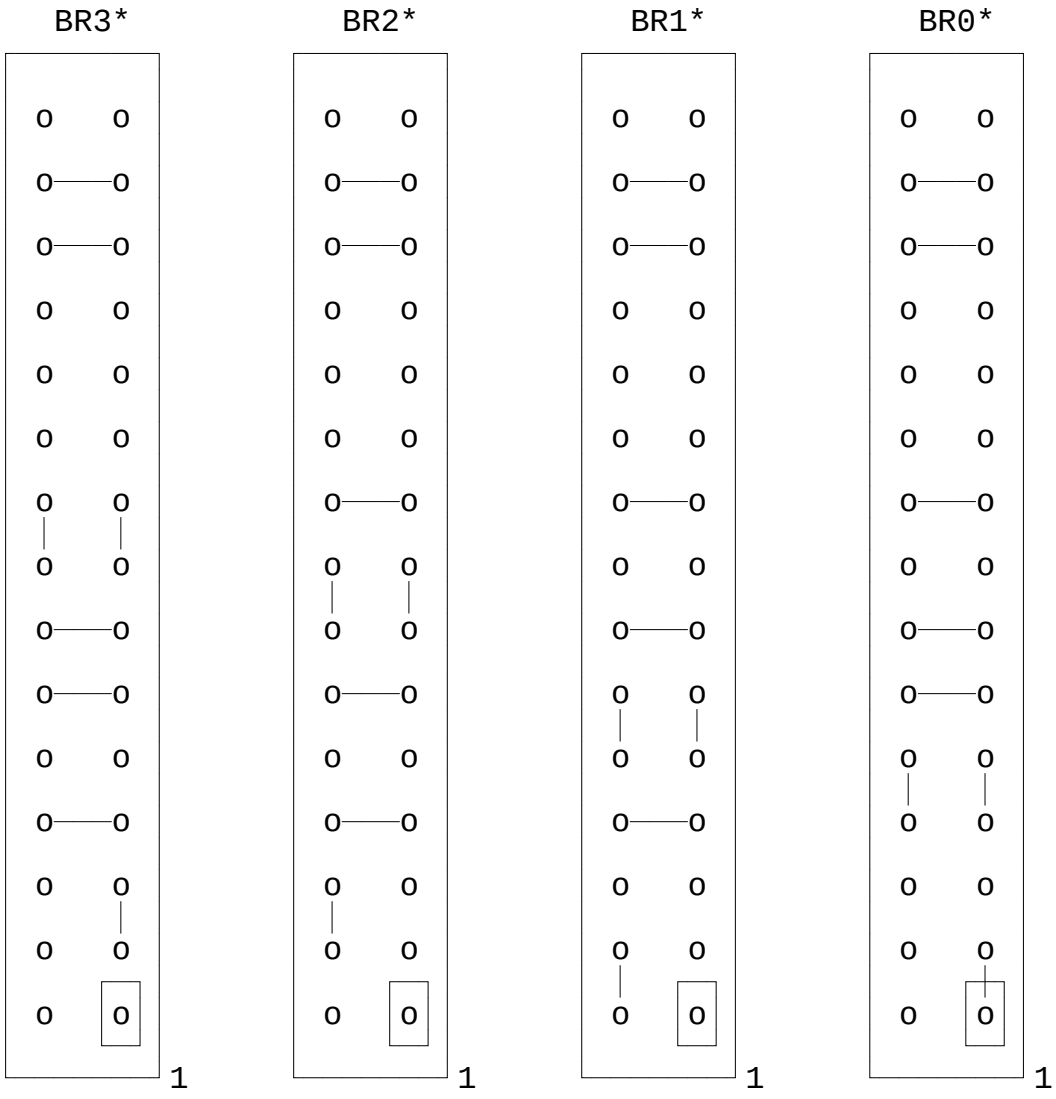
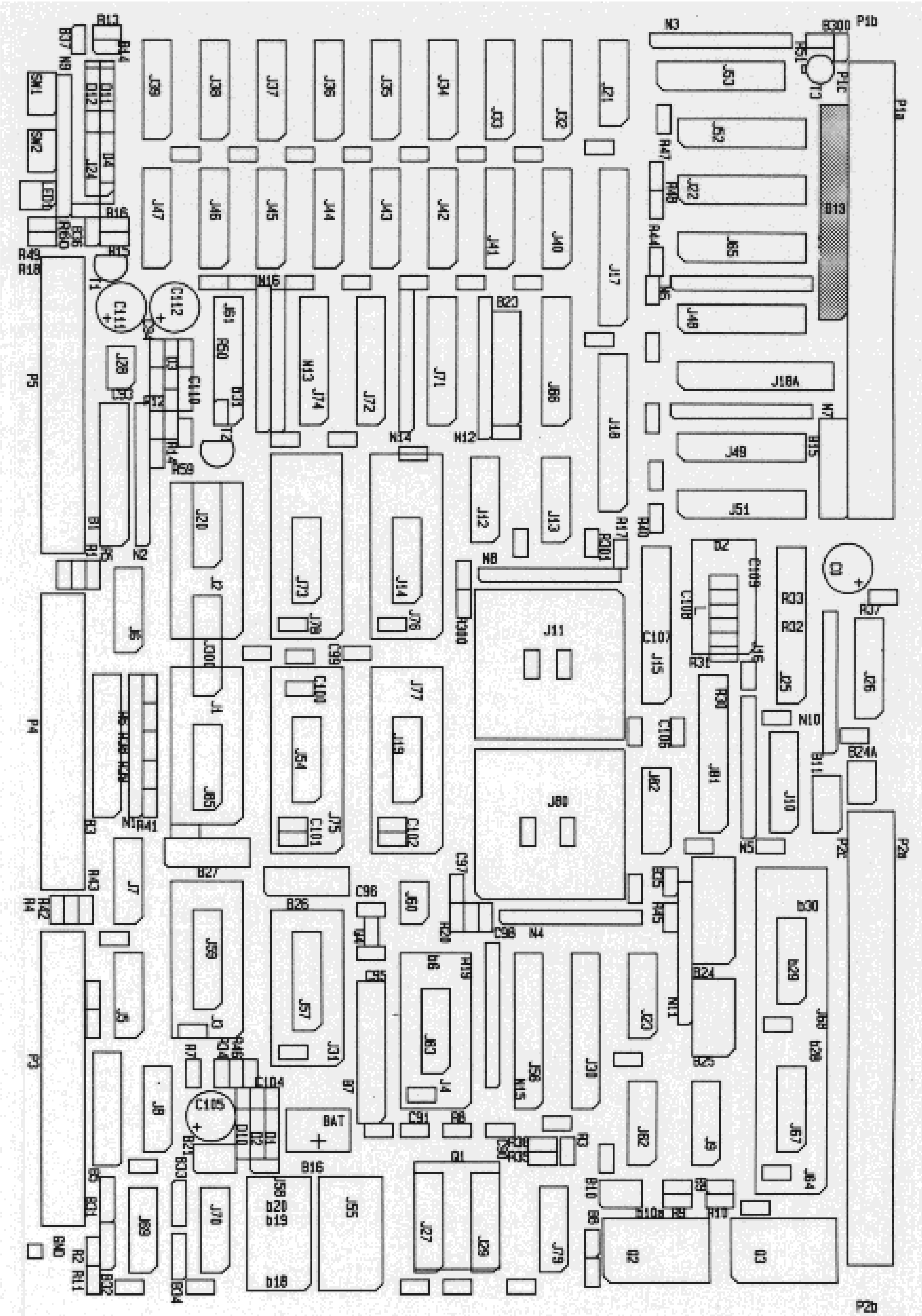


Figure 5.3-6: The Location Diagram of the Slave Bus Arbitration



5.4 The Single Level Bus Arbiter

The SYS68K/CPU-6 board contains a Single Level Bus Arbiter for multimaster environments.

The timing diagram of the on-board single level bus arbiter is shown in Figure 5.4-1.

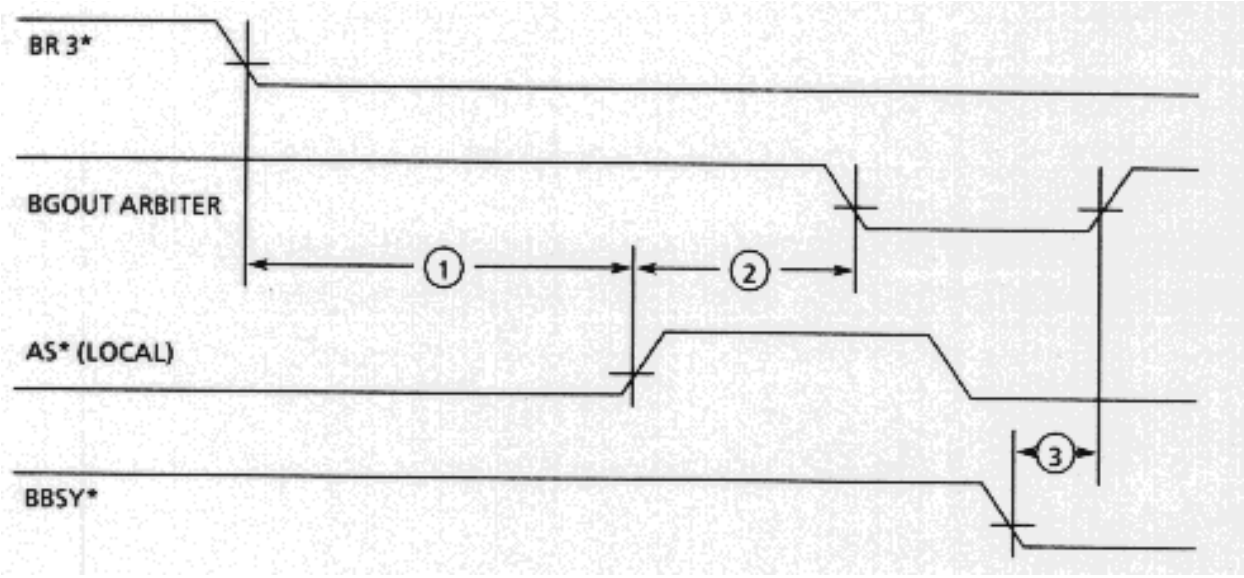
Table 5.4-1 lists the time values.

In the default condition during manufacturing, the board is configured to use the on-board single level Bus Arbiter.

Table 5.4-1: Time Values of the Single Level Bus Arbiter

No.	Description	Min.	Max.
1	BR3* active to AS* inactive	10	--
2	AS* high to BGOUTARBITER	25	55

Figure 5.4-1: Timing Diagram of the One Level Bus Arbiter



5.5 VMEbus Release Functions

If the SYS68K/CPU-6 board has become bus master on the VMEbus, then it must be able to release Bus Mastership under different conditions. There are three conditions for releasing bus mastership.

A) Timeout Counter Condition (RAT)
B) BCLR* Signal of the VMEbus (RBCLR)
C) Release On Request (ROR)

The influence of the conditions can be switched on and off via jumpers.

5.5.1 Release On Request (ROR)

The ROR mode limits the effect of the RAT function. With the ROR mode disabled, the Release After Timeout function terminates bus mastership as soon as the timeout condition is entered. If the ROR mode is enabled, then bus mastership will be released if the timeout condition is entered and a Bus Request is pending. With ROR enabled, very short timeout can be selected without losing bus access efficiency.

Jumper B13 Pin 13-18

IN : ROR is enabled
OUT: ROR is disabled

Default condition is: ROR is enabled

5.5.2 Release on Bus Clear (RBCLR)

The RBCLR function allows the release of the bus mastership if an external arbiter drives the BCLR signal active.

5.5.3 Release After Time-Out (RAT)

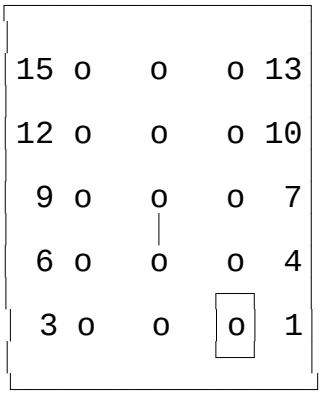
A timer chip with a changeable clock rate is installed on the SYS68K/CPU-6 to provide a release of bus mastership at latest after timeout.

The maximum contiguous time available for the bus master state is defined by jumper settings at the jumperfields B25, B31 or B32.

For the RAT times see Table 5.5-1. The location diagram of the RAT jumperfields are outlined in Figure 5.5-1.

Table 5.5-1: Jumper Settings of B25, B31 and B32 for RAT

Time	Connection at Jumperfield B25
0.25us	1 - 5
0.5 us	2 - 5
1.0 us	3 - 5
2.0 us	6 - 5
4.0 us	4 - 5
* 32.0 us	8 - 5



* default setup during manufacturing

The minimum and maximum timings must be calculated as follows:

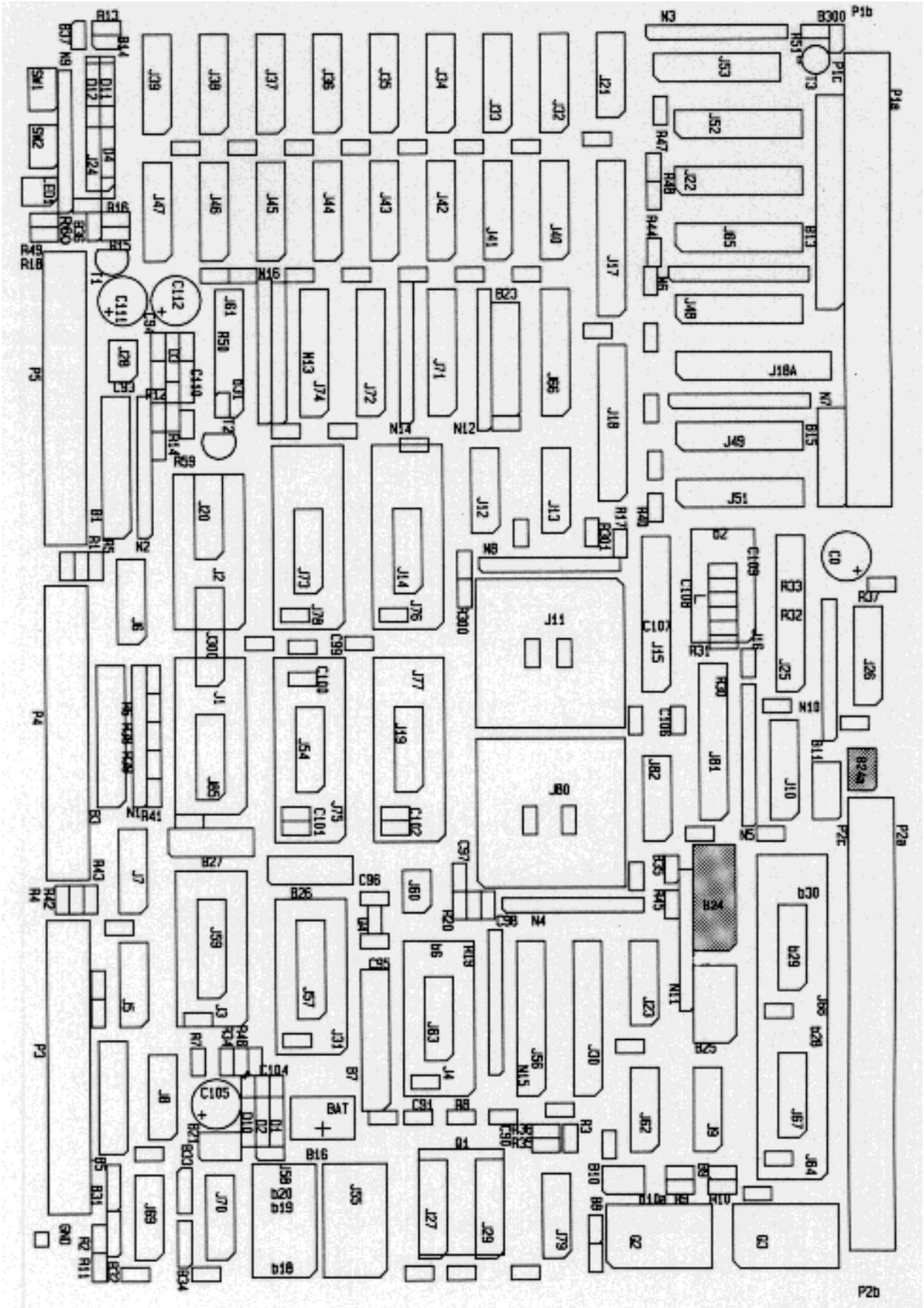
Only one jumper can be set at B31 and B32 to define the multiplication factor to the times listed.

Connection	Multiplication factor min	Multiplication factor max	Note
B31 #1 - #2	x1	x2	
B31 #3 - #2	x3	x4	*
B32 #3 - #2	x5	x6	
B32 #1 - #2	x7	x8	

* Default setting during manufacturing

Calculation example: minimum timeout : 32us x 3 = 96us
maximum timeout : 32us x 4 = 128us

Figure 5.5-1: Location Diagram of the RAT Jumperfield



5.6 The Slot 1 Functions

5.6.1 The SYSCLK Driver

If the SYS68K/CPU-6 board is used as the slot 1 controller/master board, the SYSCLK signal of the VMEbus must be driven. This signal is a fully asynchronous 16 MHz clock signal which can be enabled if a jumper on jumperfield B13 is installed between Pin 11 and Pin 20. (Default condition during manufacturing). If there is no connection, no SYSCLK signal is driven from the SYS68K/CPU-6.

Figure 5.6-2 outlines the jumperfield of the SYSCLK Signal.

By default, the jumper between pin 11 and pin 20 is installed and the SYSCLK signal is driven.

5.6.2 ACFAIL

The VMEbus signal ACFAIL can be connected to the H4 input of the PI/T to initiate an interrupt on level 5.

A handling routine has to be written for proper handling of the ACFAIL condition (application dependent).

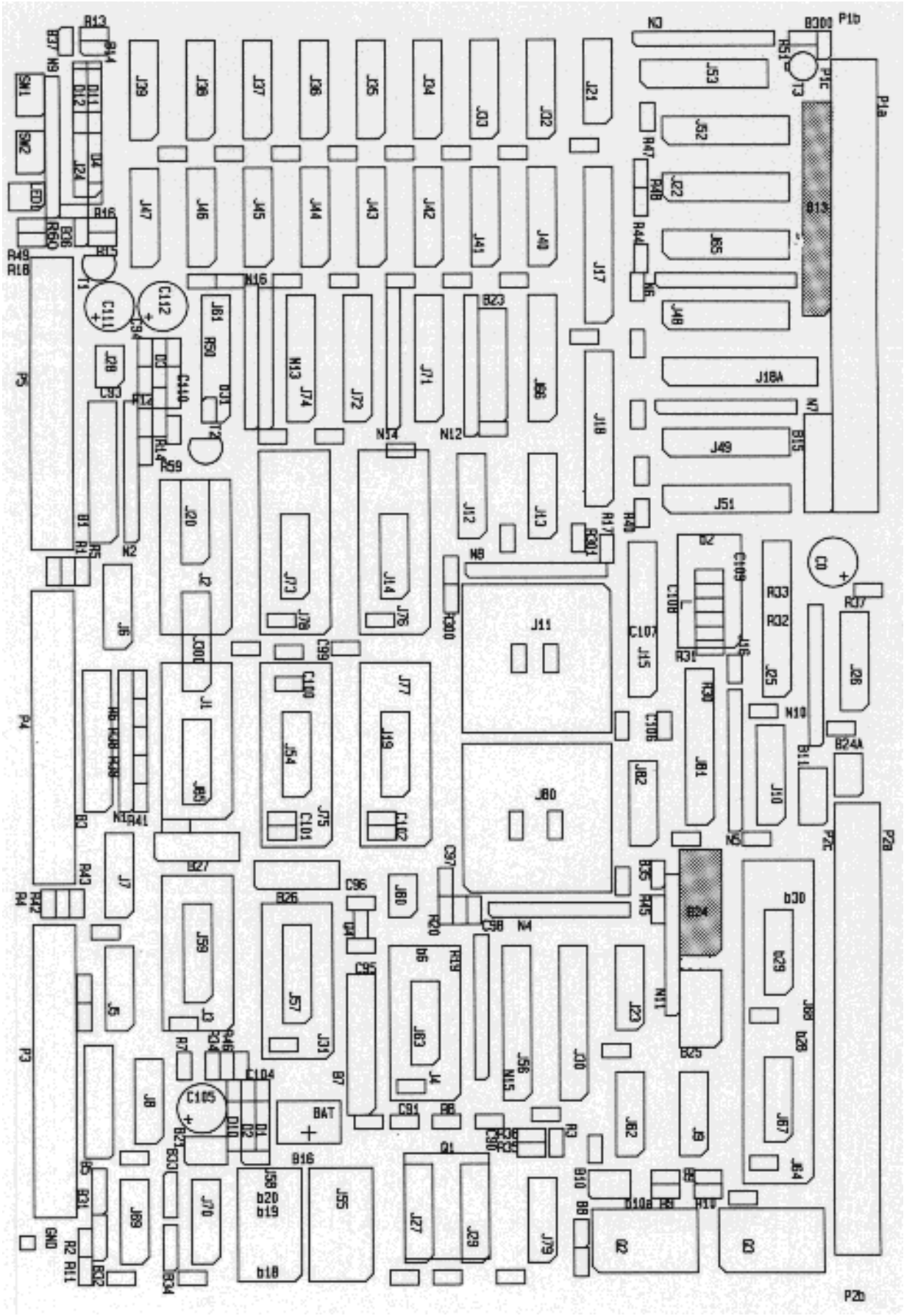
The connection of the ACFAIL signal to the PI/T can be made by inserting a jumper at jumperfield B24 between pin 11 and pin 12. The location diagram of the jumperfield is outlined in Figure 5.6-2.

5.6.3 SYSFAIL

The SYSFAIL signal can be connected to the H2 input of the PI/T to force an interrupt on level 5 to the CPU.

The connection of the SYSFAIL signal to the H2 input is provided if a jumper is installed at jumperfield B24 between pin 8 and pin 9. The location diagram of the SYSFAIL is shown in Figure 5.6-2.

Figure 5.6-2: Location Diagram of the Special Function Jumpers



5.7 The VMEbus Interrupt Handler

The VMEbus specification defines seven interrupt request signals (IRQ1* - IRQ7*) and three special control signals which allow an unlimited number of interrupt sources in the system.

Each of the seven VMEbus IRQ signals may be shared by two or more interrupter modules. The Interrupt Acknowledge (IACK-) Daisy Chain is used to ensure that only one of the unlimited number of interrupt modules places its interrupt vector onto the data bits D0-D7.

An active Interrupt Acknowledge signal (IACK*) informs all of the VMEbus cards in the system that the current read cycle is an interrupt vector acquisition of the current VMEbus master. This signal is connected at slot 1 to the Interrupt Acknowledge In signal (IACKIN*) as shown in Figure 5.8-1. The IACKIN* signal passes through each board on the VMEbus. If a board receives an active IACKIN* signal and has not produced an interrupt on the decoded IRQ level, the board control logic must bypass the IACKIN* signal through its own IACKOUT* signal to inform the next board (if it is the interrupt requester), that it can place the interrupt vector onto the data bus.

A function diagram of the Interrupt Acknowledge Daisy Chain is given in Figure 5.7-2, and a global signal timing of an Interrupt Acknowledge Cycle with an Interrupt Vector Acquisition is given in Figure 5.7-3. The related time values are given in Table 5.7-1.

5.7.1 The On-Board IACK Daisy Chain

To provide full VMEbus compatibility, the IACK* signal is driven as an output signal if the SYS68K/CPU-6 board is the current VMEbus master, and if no on-board interrupt is pending. This allows full multiprocessing in high performance systems because of the transparent interrupt handling of the on-board and off-board IRQs.

The low driven IACK* signal is wired to slot one of the VME motherboards and runs down the IACK daisy chain.

Figure 5.7-1: The Interrupt Acknowledge Daisy Chain

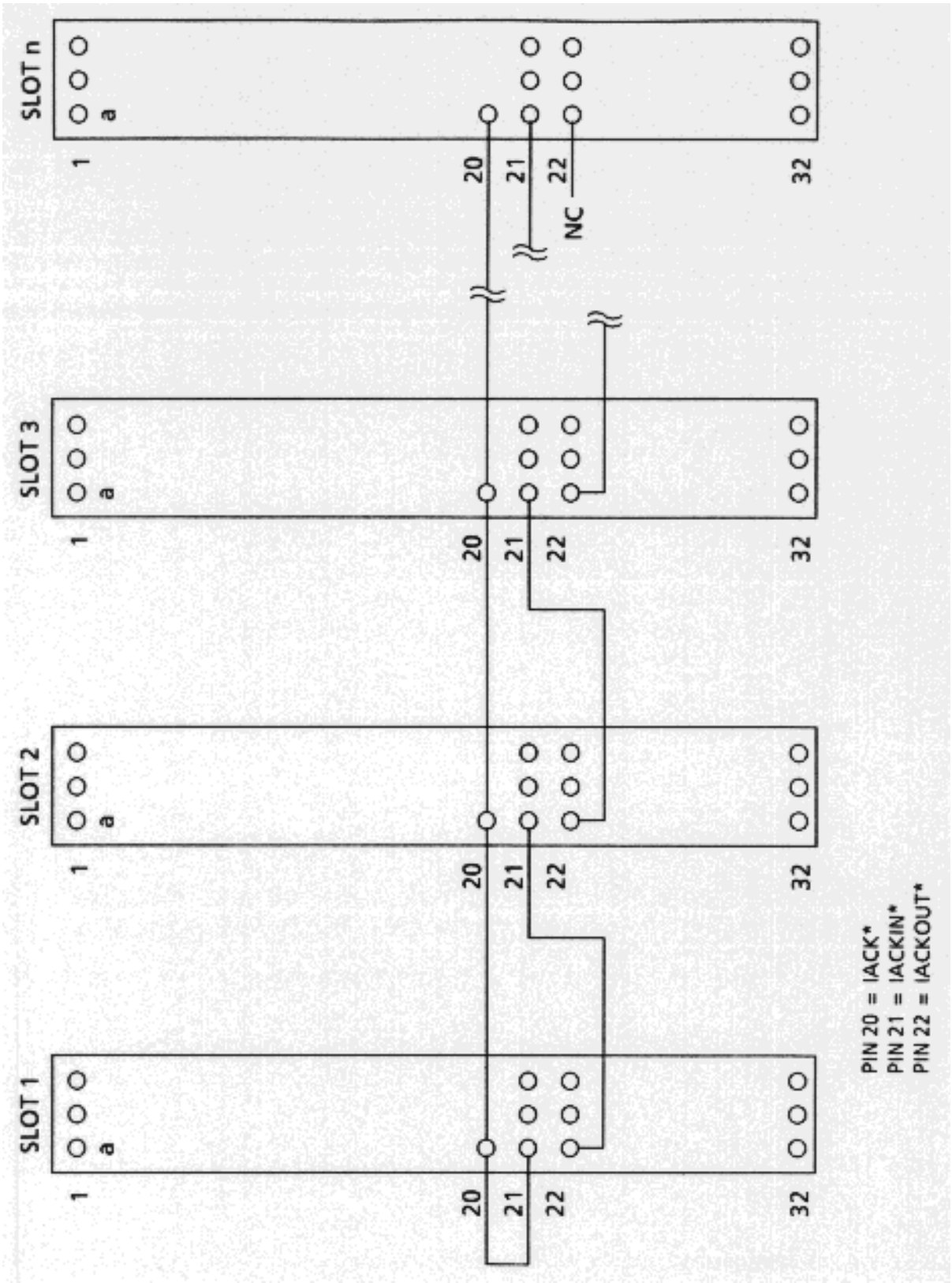


Figure 5.7-2: Functional Diagram of the Interrupt Acknowledge Daisy Chain Scheme

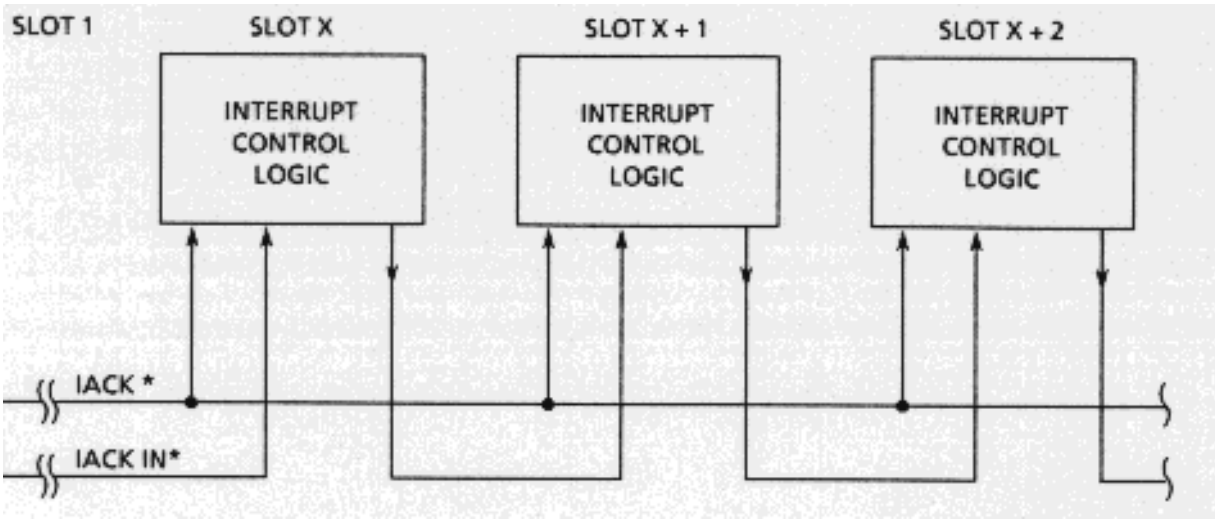


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Table 5.7-1: Time Values of the Interrupt Vector Acquisition

NUMBER	PARAMETER	NOTE MIN.	NOTE MAX.	NOTES
1	Axx valid and IACK* low to AS* low	35		B
2	DTACK* low to invalid address or IACK* high	0		C
3	AS* high	40		B
4	DTACK* low to AS* high	0		C
5	AS* to DS0* skew	0		B
6	WRITE* valid to DS0* low	35		B
7	DS0* high to invalid WRITE*	10		B
8	Data release to DTACK* high	0		E
9	Dxx valid to DTACK* low	-25		E
10	DTACK* low to DS0* high	0		C
11	DS0* high	40		B
12	DS0* high to invalid data	0		D
13	DTACK* high to DS0* low	0		C
14	DS0* high to AS* low	30		B

NOTES:

A. All times given in nanoseconds.

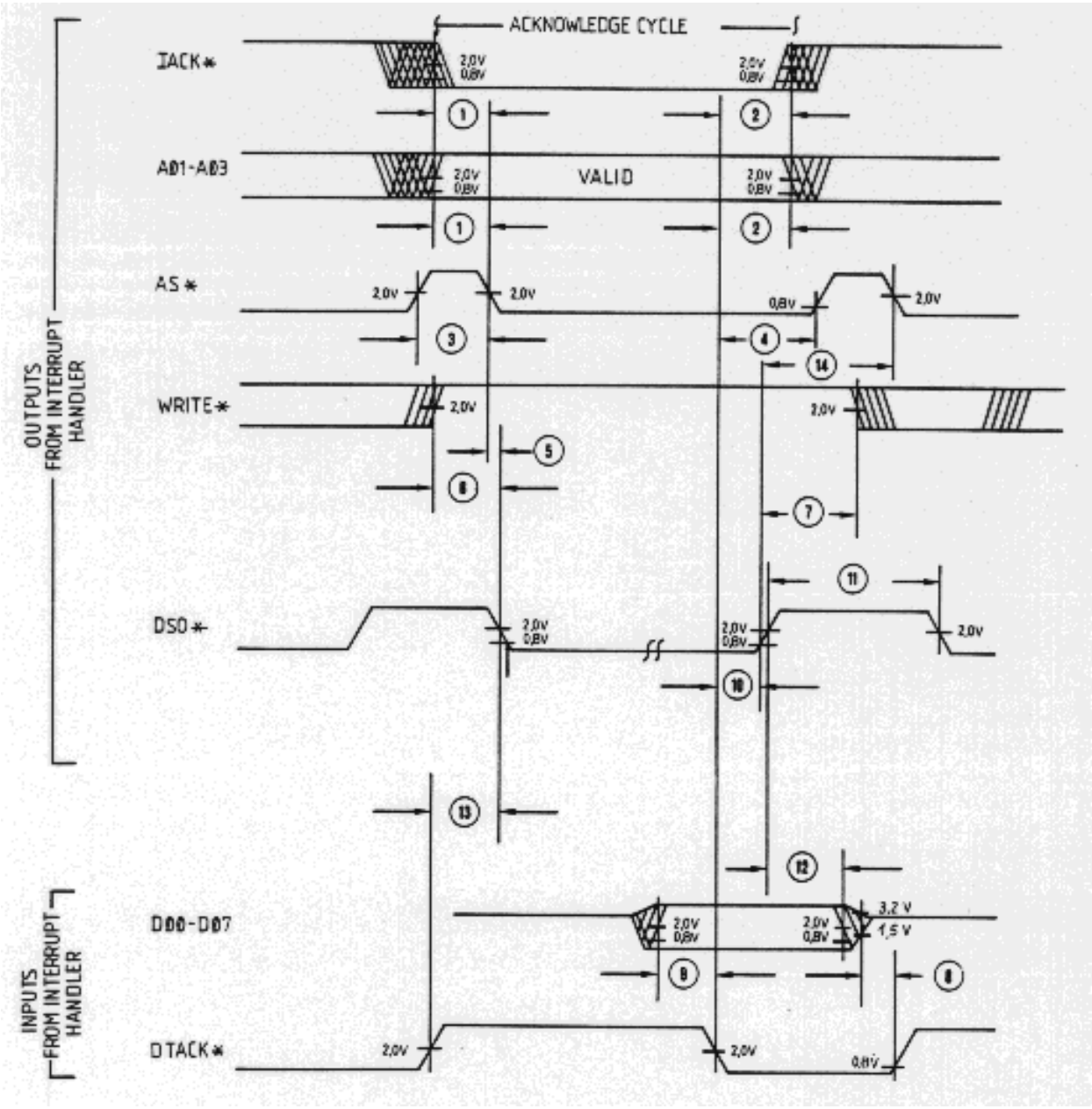
B. The INTERRUPT HANDLER must guarantee this timing between two of its outgoing signal transitions.

C. The INTERRUPT HANDLER must wait for the incoming signal edge from the INTERRUPTER before changing the level of its outgoing signal.

D. This is a guarantee that the INTERRUPTER will not change the incoming signal until the INTERRUPT HANDLER changes its outgoing signal.

E. The INTERRUPT HANDLER is guaranteed this timing between two of its incoming signal transitions.

Figure 5.7-3: The Interrupt Vector Acquisition Timing Diagram



5.7.2 The VMEbus Interrupt Handling

All of the on-board interrupts have a higher priority in the internal interrupt acknowledge daisy chain than the VMEbus interrupts at the same interrupt level.

The VMEbus interrupt signals IRQ1-IRQ7 from the VMEbus are received continuously. A special jumperfield (B15) as shown in Figure 5.8-4 (Figure 5.8-5 outlines the location diagram) is used to enable/disable each IRQ signal separately.

Table 5.8-2 shows the combinations of the jumper settings.

An inserted jumper means that the incoming IRQ signal from the VMEbus will be acknowledged by the on-board CPU. Therefore, a noninserted jumper is equivalent to a disabled IRQ signal.

Figure 5.7-4: The VMEbus Interrupt Hardware Diagram

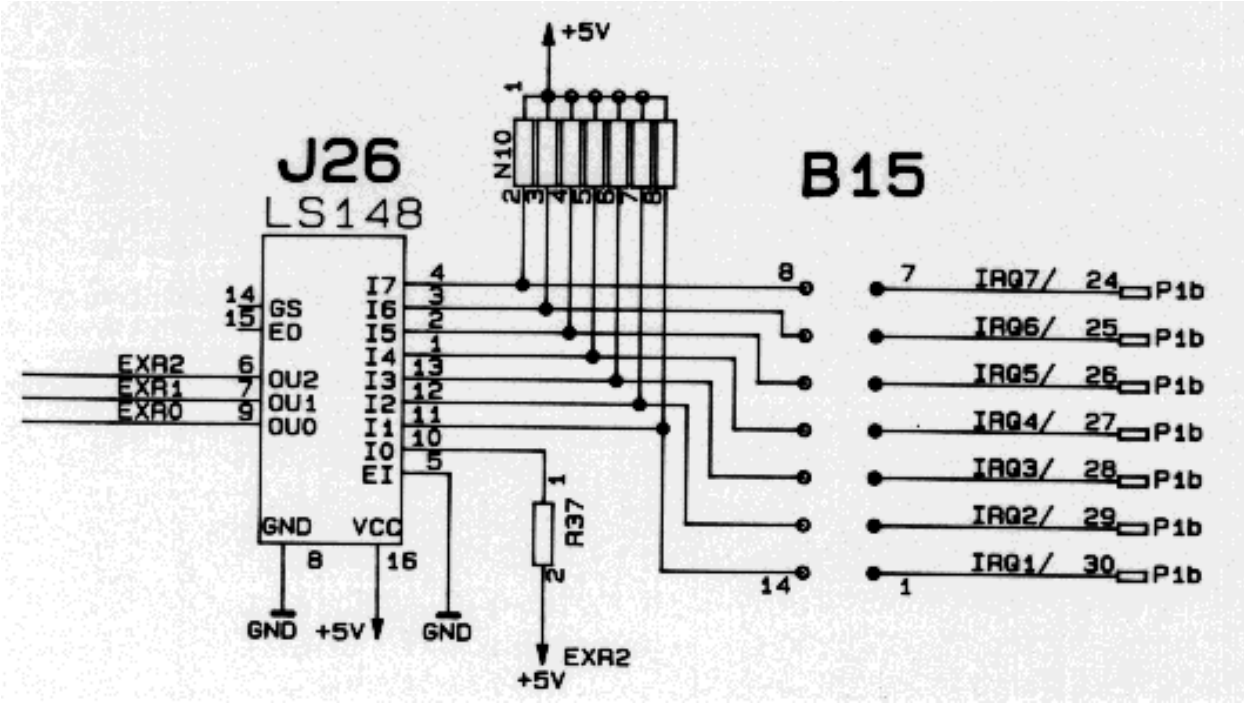


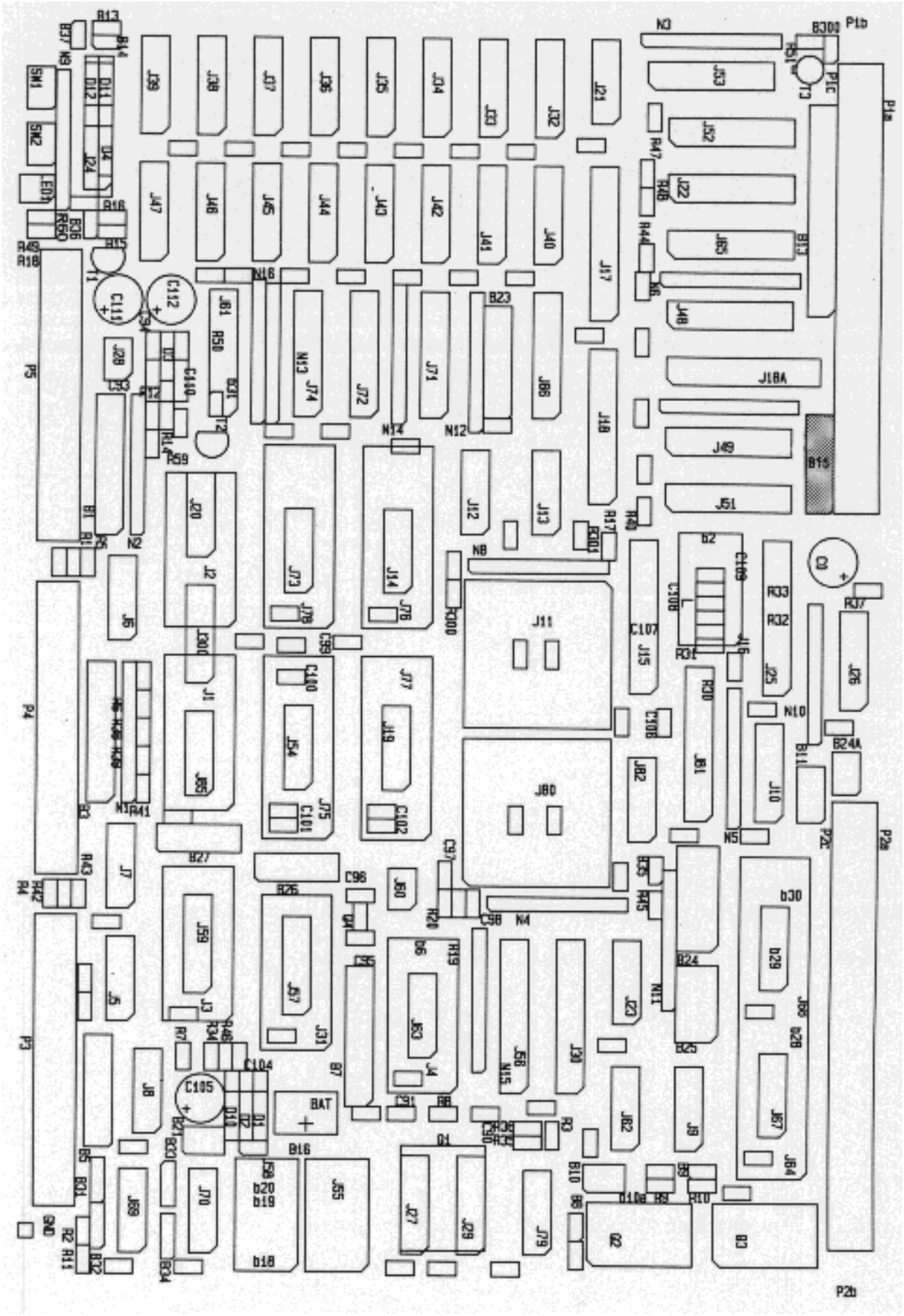
Table 5.7-2: The VMEbus Interrupt Jumper Settings

Jumper B15	Interrupt Request Level	Default Jumper Setting
8 7 o o	IRQ7	IN
o o	IRQ6	IN
o o	IRQ5	IN
o o	IRQ4	IN
o o	IRQ3	IN
o o	IRQ2	IN
o o 14 1	IRQ1	IN

Note: In the default conditions, all IRQ signals from the VMEbus will be acknowledged by the on-board CPU.

By default, all jumpers are installed.

Figure 5.7-5: Location Diagram of the VMEbus Interrupt Parts



5.7.3 The ABORT Function Switch

The second switch on the front panel of the SYS68K/CPU-6 is used to generate a nonmaskable interrupt at level 7 to the 680x0 CPU.

This interrupt forces the autointerrupt vector (#31).

The switch can be used for debugging purposes (please refer to the Software User's Manual) or for selftests, if special routines are built in.

5.8 Summary of the VMEbus Interface

Data Transfer Modes: A24: D16, D8

VMEbus	(A24)	(A16)
Start Address	100 000	FF0 000
End Address	FEF FFF	FFF FFF

Interrupt Handler: Any (1 to 7 stat.)

Arbitration: Single level bus arbiter

Specials: SYSCLK driver
Bus Requester (level 0 to 3 stat.)
Power Monitor

6.0 THE RESET STRUCTURE

There is a SYSRESET driver installed on the SYS68K/CPU-6 board. The RESET generator circuitry is operable if the power supply VCC is at least three volts.

The SYSRESET signal can be asserted (low) on any one of the following conditions:

a) Front panel RESET switch toggled

b) Voltage sensor detects VCC below limit

c) Programmable RESET signal asserted

d) Execution of the RESET instruction by the microprocessor on the board

The asserted SYSRESET signal will be held low for at least 200 milliseconds after removing the trigger condition in cases a) and b). Cases c) and d) keep SYSRESET active only during the time the trigger signal is active.

6.1 The Voltage Sensor

The RESET generator has a voltage sensor included. Power up reset is provided by this sensor, as soon as the supply voltage VCC has reached three volts.

SYSRESET will be asserted if VCC is less than 4.8 volts on the board, when the jumper B36 is removed. This jumper is inserted at delivery. When the jumper at B36 is inserted, SYSRESET will be asserted if VCC is less than 4.5 volts.

SYSRESET will stay asserted at least 200 milliseconds after the supply voltage reaches 4.8 volts (with jumper B36 inserted).

B36 should be inserted for normal operation, it can be removed for test purposes.

6.2 The SYSRESET Condition

The on-board RESET generator drives the IEEE 1014 bus SYSRESET signal if the jumper connection at B300 pin 1 and 2 is inserted.

The SYS68K/CPU-6 board monitors the SYSRESET backplane signal if B37 is not inserted (default condition). The following reactions will be performed if SYSRESET is sensed asserted (low):

- The board stops driving bus signals (except for SYSRESET)
- The arbiter will be reset
- The processor and peripherals installed on the board will be reset (special case with the RESET instruction).

When SYSRESET is cleared (high), normal operation will begin.

The jumper at B300, connecting pins 1 and 2, is inserted on delivery. The local reset option obtained by removing this jumper is for test purposes. A local reset asserted during a bus access can lead to a bus error or other malfunctions.

The local reset does not reset the on-board arbiter. In further explanations, the jumper is presumed inserted and the RESET generator drives the SYSRESET signal, according to the default configuration. If the jumper B14 is inserted, then the RESET signal is suppressed. This option is for test purposes only.

6.3 The Reset Instruction of the CPU

The RESET instruction of the 68000 and 68010 microprocessors is designed to reset peripherals under program control, without resetting the processor itself. This instruction is fully supported by the SYS68K/CPU-6 board, and the SYSRESET signal will be driven active for 512 CPU clock cycles when B37 is inserted.

The RESET jumperfields are outlined in Figure 6.4-1.

6.4 The Reset Function Switch

The upper switch on the front panel of the SYS68K/CPU-6 board (see Figure 6.4-2) is the RESET switch. Toggling it provides a reset of all on-board devices, independent from the jumper options.

A reset of the board must be performed by toggling the RESET switch or by asserting the SYSRESET backplane signal. The red HALT LED turned on signals the HALT state of the processor. This state will be entered e.g. if a double bus fault occurs. The HALT LED is also on while the RESET generator drives the RESET and HALT input signals of the processor to low. After reset, the red light must turn off and the green LED will turn on.

The RESET jumperfields are shown in Figure 6.4-1, and Figure 6.4-2 outlines the front panel of CPU-6.

6.5 The Programmable Reset Option

With the jumper B37 inserted the SYSRESET signal will be driven low (without effecting the local devices) as long as the signal PRGRES connected to B24 pin 15 will be held low.

Figure 6.4-1: The Location Diagram of the Reset Signal

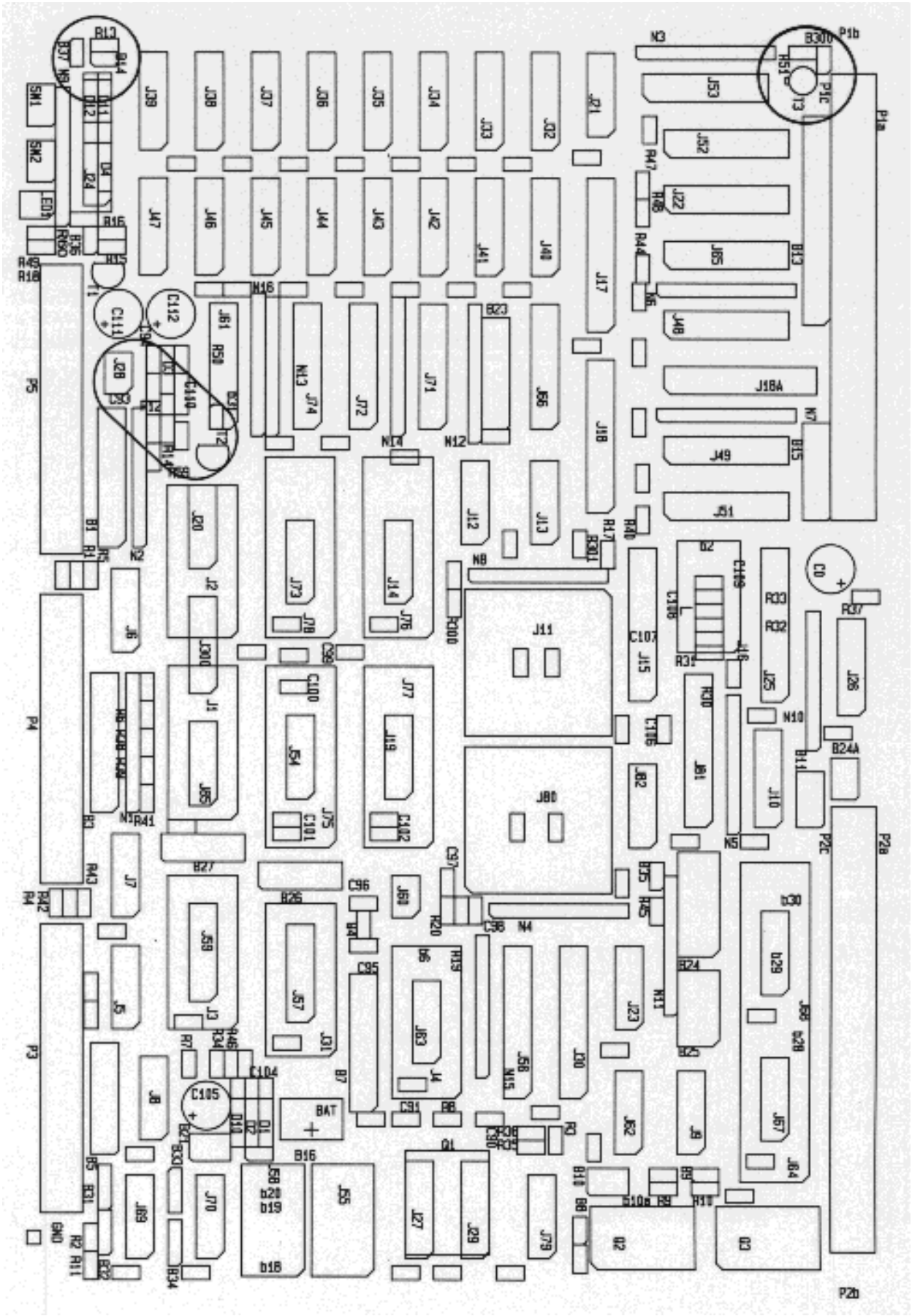
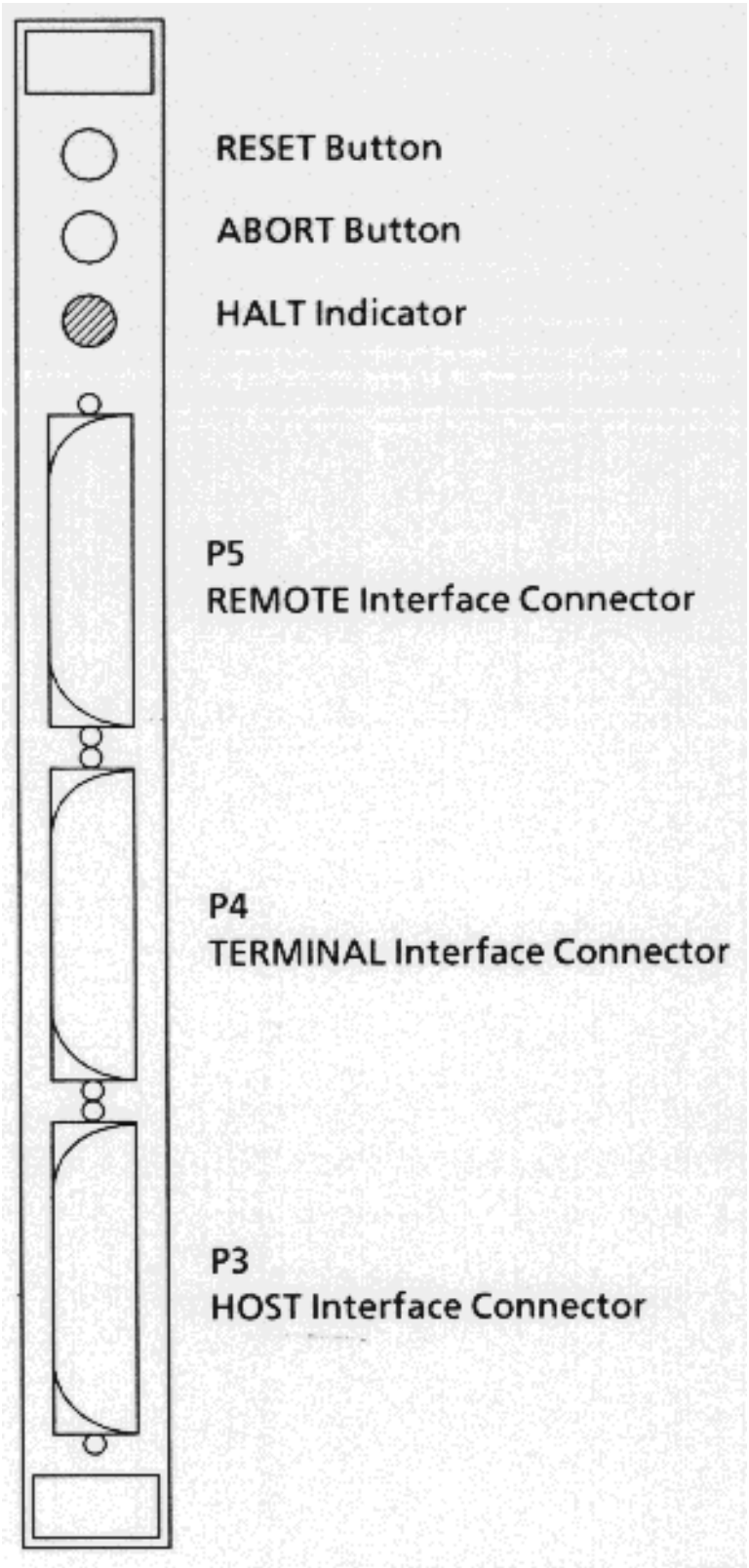


Figure 6.4-2: The Front Panel of the CPU-6



6.6 The Run/Halt Indication LED

- In Halt condition or during RESET, the LED will be illuminated in red.

- During run condition on the board without VMEbus accesses, the LED is green.

- During run condition on the board with VMEbus access, the LED is lit to dark green (when the bus is busy). When waiting for the bus, the LED can become dark.

APPENDIX TO THE

HARDWARE USER’S MANUAL

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A P P E N D I C E S

A. Specification of the SYS68K/CPU-6 Products

B. Memory Map of the SYS68K/CPU-6 Products

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D. Component Part List of the SYS68K/CPU-6
(For Internal Use Only)

E. Jumper Settings on the SYS68K/CPU-6

F. Circuit Schematics

G. Connector PIN Assignment of the SYS68K/CPU-6

H. Glossary of VMEbus Terms (P1014)

I. Literature References

J. Product Error Report

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APPENDIX A

Specification of the SYS68K/CPU-6

Microprocessor:	68000, 8.0 MHz CPU-6 68000, 12.5 MHz CPU-6A 68010, 12.5 MHz CPU-6VA 68010, 12.5 MHz CPU-6VB
Floating Point:	68881 FPCP (12.5 MHz) only on CPU-6VB
DRAM:	512 Kbyte dynamic RAM 0 Wait State at 8 MHz 1 Wait State at 12.5 MHz Distributed Hardware Refresh
EPROM:	128 Kbytes for the SYSTEM Area 128 Kbytes for the USER Area
Serial I/O: (ACIA)	3 RS232 interfaces built with 68B50 devices Strap selectable baud rate from 110-19200 baud Strap selectable I/O signal assignment to the 3 25 pin D-Sub Connectors.
Parallel I/O:	68230 PI/T with 24 I/O signals connected to P2 connector
Timer:	24 bit timer included in the PI/T
Real Time Clock:	58167 RTC with on-board battery backup
Interrupts:	All on-board devices are capable of generating interrupts to the CPU on a fixed IRQ level. Local interrupts do not cause a VMEbus request.
VMEbus Interface:	Jumper selectable VMEbus request level (0-3) Transfer Modes A16: D8, D16 A24: D8, D16 Interrupt Handler (1-7 stat.) Single Level Arbiter SYSCLK Driver Power Monitor RESET Generator Bus Release Options: ROBCLR, RAT, REC
Firmware:	VMEPROM installed on each CPU-6 product
Power Requirements:	+5V / 3.4A +12V / 0.2A -12V / 0.2A
Operating Temp.	0 to 60 Degrees C
Storage Temp.	-50 to +85 Degrees C
Relative Humidity	0 - 95% (non-condensing)
Board Dimensions	Double Eurocard 234x160mm (9.2 x 6.3")

APPENDIX B
Memory Map of the SYS68K/CPU-6 Products

000 000 : 000 007	ROM Initialization Vectors from SYSTEM EPROM
000 008 : 07F FFF	On-Board DRAM (512 Kbytes)
080 008 : 09F FFF	SYSTEM EPROM Area (128 Kbytes)
0A0 000 : 0BF FFF	USER EPROM Area (128 Kbytes) or SRAM (64 Kbytes)
0C0 041 : 0C0 043	RS 232 Interface (Host) P3 connector
0C0 080 : 0C0 082	RS 232 Interface (Terminal) P4 connector
0C0 101 : 0C0 103	RS 232 Interface (Remote) P5 connector
0C0 401 : 0C0 42F	RTC (Real Time Clock)
0E0 001 : 0E0 035	PI/T (Parallel Interface/Timer)
0E0 200 : 0E0 300 0E0 380	FPCP (Floating Point Coprocessor) Reset off Reset on
100 000 : FEF FFF	VMEbus (A24: D16, D8)
FF0 000 : FFF FFF	VMEbus (A16: D16, D8)

APPENDIX C

Address Assignment and Register Layout of the I/O Devices

Address	I/O Device
$0C0 041	ACIA 1 68B50
$0C0 080	ACIA 2 68B50
$0C0 101	ACIA 3 68B50
$0C0 401	RTC MM58167A
$0E0 001	PI/T 68230
$0E0 200	FPCP 68881

DEVICE: 6850 ACIA (Terminal)

Address	Mode	Description
0C0080	R	Status Register
0C0080	W	Control Register
0C0082	R	Receive Data Register
0C0082	W	Transmit Data Register

DEVICE: 6850 ACIA (Host)

Address	Mode	Description
0C0041	R	Status Register
0C0041	W	Control Register
0C0043	R	Receive Data Register
0C0043	W	Transmit Data Register

DEVICE: 6850 ACIA (REMOTE)

Address	Mode	Description
0C0101	R	Status Register
0C0101	W	Control Register
0C0103	R	Receive Data Register
0C0103	W	Transmit Data Register

DEVICE 68230 PI/T (Parallel Interface/Timer)

Address	Mode	Affected by Reset	Affected by Read Cycle	Using:
0E0001	R/W	Y	N	Port General Control Register (PGCR)
0E0003	R/W	Y	N	Port Service Request Register (PSRR)
0E0005	R/W	Y	N	Port A Data Direction Register (PADDR)
0E0007	R/W	Y	N	Port B Data Direction Register (PBDDR)
0E0009	R/W	Y	N	Port C Data Direction Register (PCDDR)
0E000B	R/W	Y	N	Port Interrupt Vector Register (PIVR)
0E000D	R/W	Y	N	Port A Control Register (PACR)
0E000F	R/W	Y	N	Port B Control Register (PBCR)
0E0011	R/W	N	**	Port A Data Register (PADR)
0E0013	R/W	N	**	Port B Data Register (PBDR)
0E0015	R	N	N	Port A Alternate Register (PAAR)
0E0017	R	N	N	Port B Alternate Register (PBAR)
0E0019	R/W	N	N	Port C Data Register (PCDR)
0E001B	R/W*	Y	N	Port Status Register (PSR)
0E0021	R/W	Y	N	Timer Control Register (TCR)
0E0023	R/W	Y	N	Timer Interrupt Vector Register (TVIR)

DEVICE 68230 PI/T (Parallel Interface/Timer) cont.

Address	Mode	Affected by Reset	Affected by Read Cycle	Using:
0E0027	R/W	Y	N	Counter Preload Register High (CPRH)
0E0029	R/W	N	N	Counter Preload Register Middle (CPRM)
0E002B	R/W	N	N	Counter Preload Register Low (CPRL)
0E002F	R	N	N	Count Register High (CNTRH)
0E0031	R	N	N	Count Register Middle (CNTRM)
0E0033	R	N	N	Count Register Low (CNTRL)
0E0035	R/W	Y	N	Timer Status Register (TSR)

* A write to this register may perform a special status resetting operation

** Mode Dependent

DEVICE: 58167A RTC (Real Time Clock)

Address	Mode	Description
0C0401	R/W	Counter - Ten Thousands of Seconds
0C0403	R/W	Counter - Hundredths and Tenths of Sec.
0C0405	R/W	Counter - Seconds
0C0407	R/W	Counter - Minutes
0C0409	R/W	Counter - Hours
0C040B	R/W	Counter - Days of the Week
0C040D	R/W	Counter - Days of the Month
0C040F	R/W	Counter - Month
0C0411	R/W	RAM - Ten Thousands of Sec.
0C0413	R/W	RAM - Hundredths and Tenths of Sec
0C0415	R/W	RAM - Seconds
0C0417	R/W	RAM - Minutes
0C0419	R/W	RAM - Hours
0C041B	R/W	RAM - Days of the Week
0C041D	R/W	RAM - Days of the Month
0C041F	R/W	RAM - Month
0C0421	R	Interrupt Status Register
0C0423	R/W	Interrupt Control Register
0C0425	W	Counters Reset
0C0427	W	RAM - Reset
0C0429	R/W	Status Bit
0C042B	W	GO Command
0C042D	W	Standby - Interrupt
0C042F	W	Test Mode

APPENDIX D

Component Part List SYS68K/CPU-6

(For Internal Use Only)

APPENDIX E

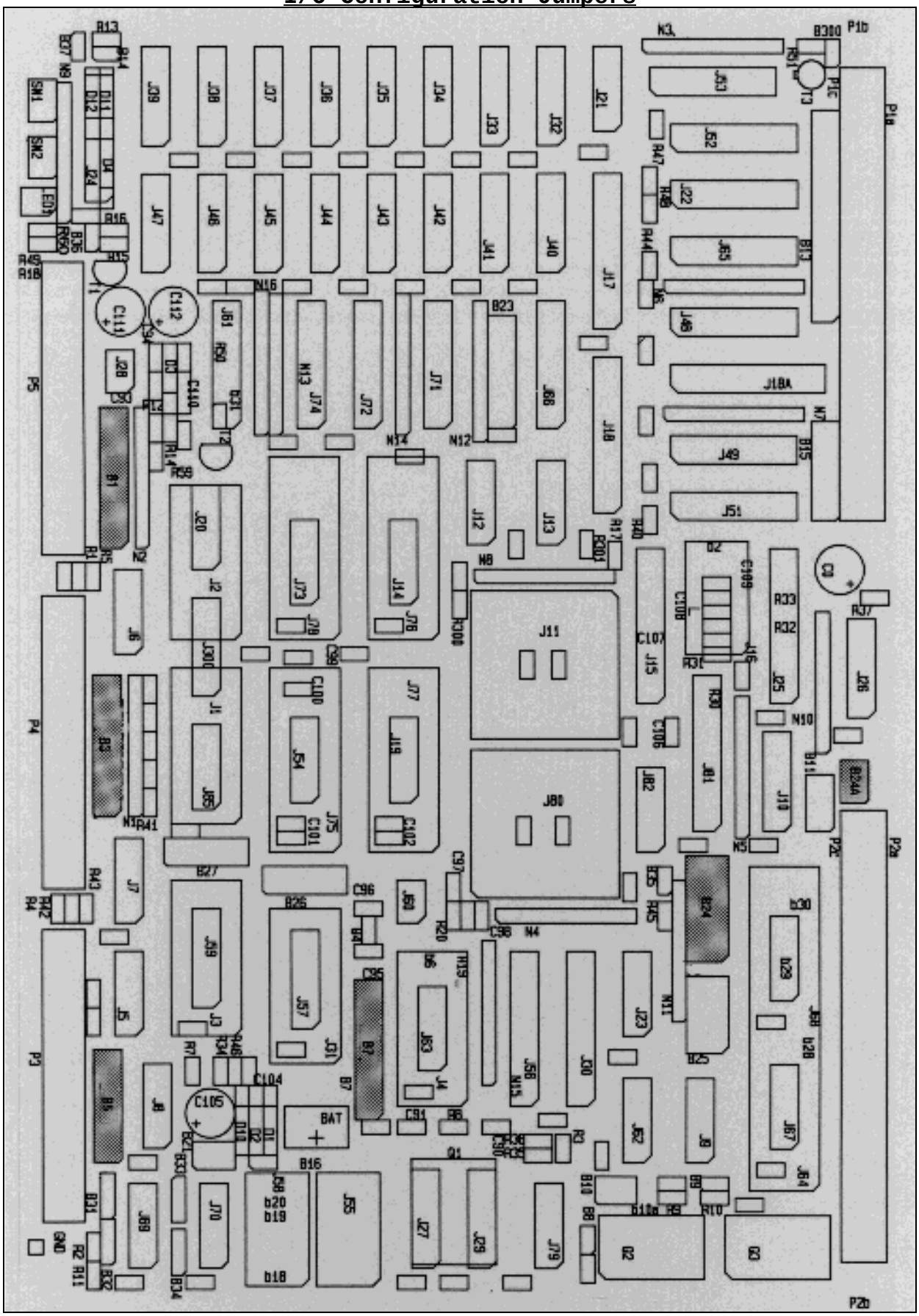
Jumper Settings on the SYS68K/CPU-6

Jumper field	Coordinate	Page Description	Jumper field	Coordinate	Page Description
B1	1-B1	E-2	B23	7-C1	E-4
B3	1-B4	E-2	B24	7-A4	E-2
B5	1-D1	E-2	B24A	7-B3	E-2
B7	1-D3	E-2	B25	7-C3	E-6
B8	2-A1	E-6	B26	8-C3	E-6
B9	2-A3	E-6	B27	8-D3	E-6
B10	2-A2	E-6	B31	7-D2	E-6
B11	2-B4	E-6	B32	7-D2	E-6
B13	3-D1	E-4	B33	7-D3	E-6
B14	4-B3	E-4	B34	7-D3	E-6
B15	4-D1	E-4	B35	3-A2	E-6
B16	4-A4	E-6	B36	4-A2	E-4
B21	6-C2	E-6	B37	4-A1	E-4

System and User I/O Jumpers

Jumper-field	Description	Default	Schematics	See Page
B1	Serial I/O Interface configuration for remote	2 - 19 3 - 18 4 - 17 5 - 16 7 - 8 10 - 11 6 - 13	1 - B1	4-31
B3	Serial I/O Interface configuration for terminal	2 - 19 3 - 18 4 - 17 5 - 16 7 - 8 10 - 11 6 - 13	1 - B3	4-24
B5	Serial I/O Interface configuration for host	2 - 15 3 - 14 4 - 13 5 - 12 7 - 10 8 - 9	1 - D1	4-38
B7	Baud Rate Control	1 - 20 3 - 18 5 - 16 10 - 11	1 - D3	4-17
B24	Parallel Interface	1 - 2 3 - 6 4 - 5 7 - 8 10 - 11 13 - 14 16 - 17 19 - 20	7 - A4	4-47
B24A	Parallel Interface	1 - 6 2 - 5 3 - 4	7 - B3	4-47

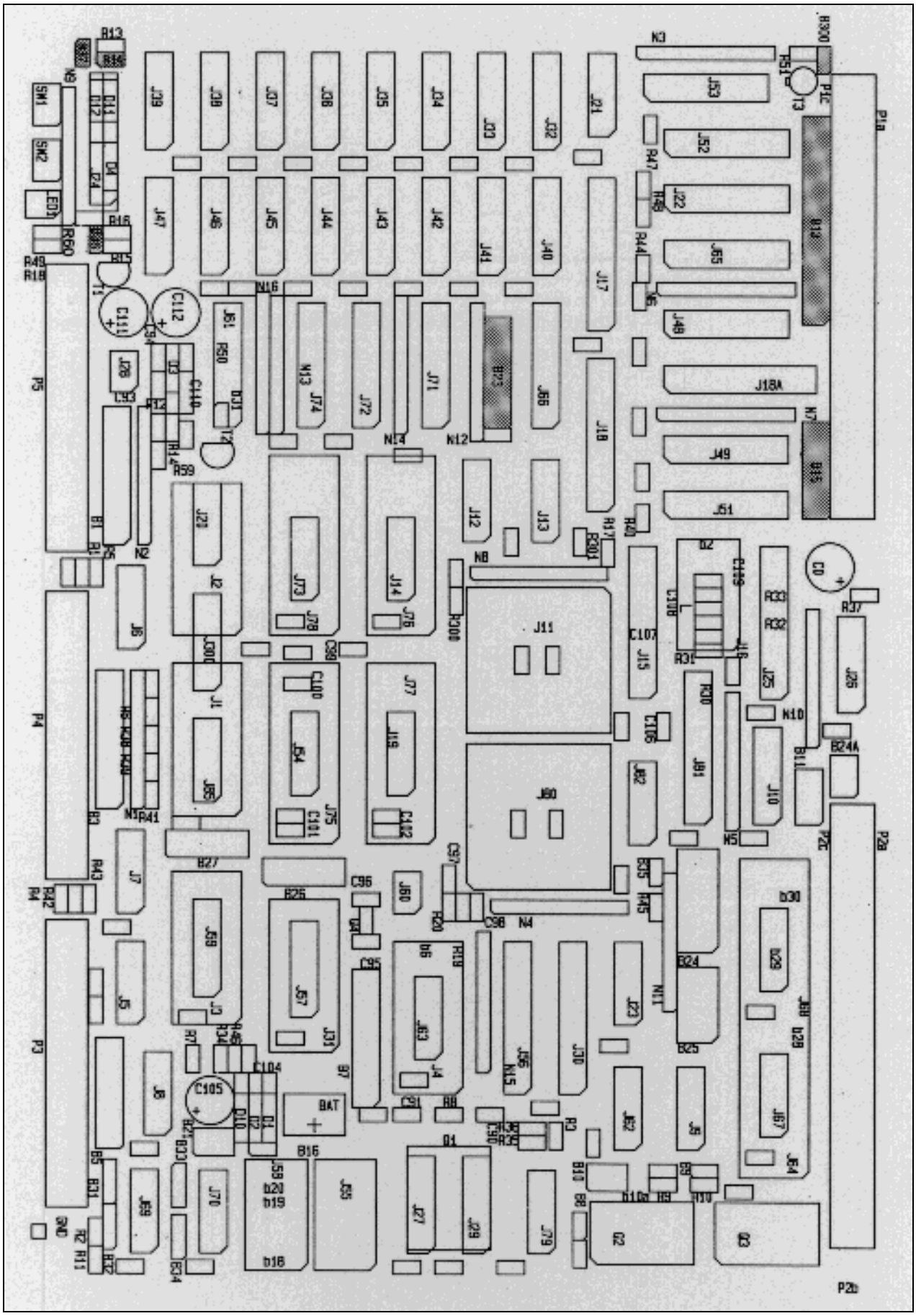
Jumper Location Diagram of the System and User I/O Configuration Jumpers



VMEbus Configuration Jumpers

Jumper-field	Description	Default	Schematics	See Page
B14 B36 B37 B300	Reset Generator	-- -- -- 1 - 2	4 - B3 4 - A2 4 - A2 4 - B2	6-1
B13	Bus Request Bus Grant SYSCLK BCLR	2 - 3 4 - 27 6 - 25 7 - 24 8 - 9 10 - 21 11 - 20 13 - 18 14 - 17	3 - D1	5-21
B15	Bus IRQ enable	1 - 14 2 - 13 3 - 12 4 - 11 5 - 10 6 - 9 7 - 8	4 - D1	5-32
B23	Short I/O Address Modifier	----- ----- ----- ----- ----- ----- ----- -----	7 - C1	5-9

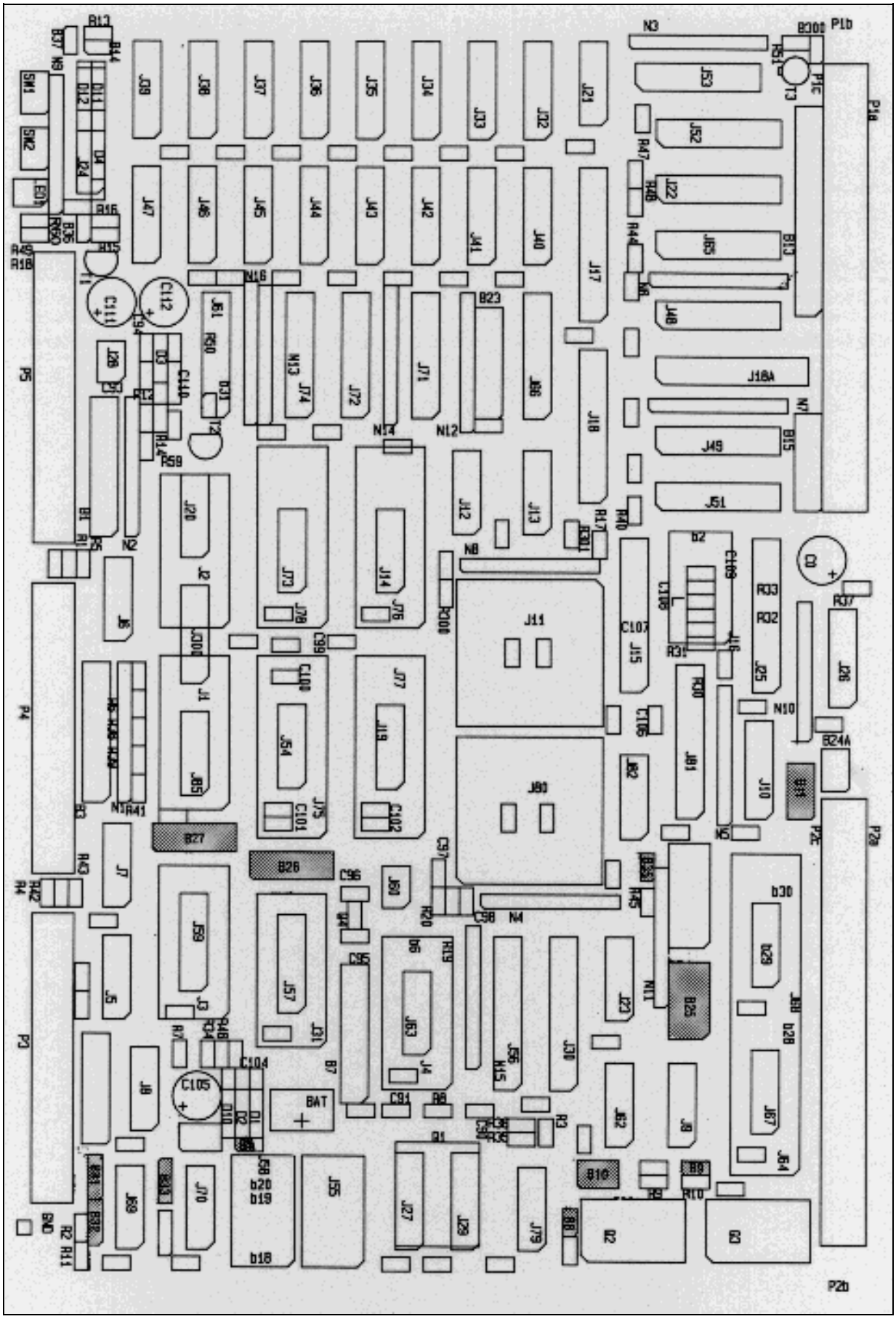
Jumper Location Diagram of the VMEbus Configuration Jumpers



Local Configuration Jumpers

Jumper-field	Description	Default	Schematics	See Page
B25	Error Timer	7 - 10 11 - 14	7 - C3	4-83
B33	Error Timer	1 - 2	7 - D3	
B34	Error Timer	-		
B25	Bus Mastership Timer	5 - 8	7 - C2	5-21
B31		2 - 3	7 - D2	
B32		-		
B8	Clock Selectors	1 - 2	2 - A1	--
B9		1 - 2	2 - A3	--
B10	8MHz	2 - 3 4 - 5	2 - A2	3-1
B10	12.5MHz	1 - 2 5 - 6		
B11	EPROM Access Time Selection	1 - 8 4 - 5	2 - B4	4-14
B26	EPROM Size Selection	1 - 12 10 - 11 4 - 9 7 - 8	8 - C3	4-2
B27		1 - 12 10 - 11 4 - 9 6 - 7	8 - D3	4-8
B21	DTACK Generated for RAM 8MHz 12.5MHz	1 - 5 4 - 5	6 - C2	3-1
B16	Battery (STDBY)	-	4 - A4	4-56
B35	Read-Modify-Write	-	3 - A2	--

Jumper Location Diagram of the Local Configuration Jumpers



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APPENDIX F

Circuit Schematics of the SYS68K/CPU-6

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APPENDIX G

Connector PIN Assignment of the SYS68K/CPU-6

P1 Connector Pin Assignments

PIN NUMBER	ROW A SIGNAL MNEMONIC	ROW B SIGNAL MNEMONIC	ROW C SIGNAL MNEMONIC
1	D00	BBSY*	D08
2	D01	BCLR*	D09
3	D02	ACFAIL*	D10
4	D03	BG0IN*	D11
5	D04	BG0OUT*	D12
6	D05	BG1IN*	D13
7	D06	BG1OUT*	D14
8	D07	BG2IN*	D15
9	GND	BG2OUT*	GND
10	SYSCLK	BG3IN*	SYSFAIL*
11	GND	BG3OUT*	BERR*
12	DS1*	BR0*	SYSRESET*
13	DS0*	BR1*	LWORD*
14	WRITE*	BR2*	AM5
15	GND	BR3*	A23
16	DTACK*	AM0	A22
17	GND	AM1	A21
18	AS*	AM2	A20
19	GND	AM3	A19
20	IACK*	GND	A18
21	IACKIN*		A17
22	IACKOUT*		A16
23	AM4	GND	A15
24	A07	IRQ7*	A14
25	A06	IRQ6*	A13
26	A05	IRQ5*	A12
27	A04	IRQ4*	A11
28	A03	IRQ3*	A10
29	A02	IRQ2*	A09
30	A01	IRQ1*	A08
31	-12V	+5V STDBY	+12V
32	+5V	+5V	+ 5V

P2 Connector PIN Assignments

PIN NUMBER	ROW A SIGNAL MNEMONIC	ROW B SIGNAL MNEMONIC	ROW C SIGNAL MNEMONIC
1	PC0	+5V	PC4
2	PC1	GND	PC5
3	PC2		PC6
4	PC3		PC7
5	GND		
6	PB7		
7	PB6		
8	PB5		
9	PB4		
10	PB3		
11	PB2		
12	PB1	GND	
13	PB0	+5V	
14	GND		
15	H4		
16	H3		
17	H2		
18	H1		
19	GND		
20	PA7		
21	PA6		
22	PA5	GND	
23	PA4		
24	PA3		
25	PA2		
26	PA1		
27	PA0		
28	GND		
29			
30			
31	+5V	GND	+5V
32	+5V		+5V

Terminal Connector Signal Assignments

P4 PIN	INPUT	OUTPUT	SIGNAL
1			Protective GND
2	X		Receive Data (RXD)
3		X	Transmit Data (TXD)
4			
5		X	Request to Send (RTS)
6			
7	X	X	Signal GND
8		X	Data Carrier Detect (DCD)
9	X	X	Signal GND
19			
20	X		Clear to Send (CTS)

Remote Connector Signal Assignments

P4 PIN	INPUT	OUTPUT	SIGNAL
1			Protective GND
2	X		Receive Data (RXD)
3		X	Transmit Data (TXD)
4			
5		X	Request to Send (RTS)
6			
7	X	X	Signal GND
8		X	Data Carrier Detect (DCD)
9	X	X	Signal GND
19			
20	X		Clear to Send (CTS)

Host Connector Signal Assignments

P4 PIN	INPUT	OUTPUT	SIGNAL
1			Protective GND
2		X	Transmit Data (TXD)
3	X		Receive Data (RXD)
5	X		Clear to Send (CTS)
7	X	X	Signal GND
9	X	X	Signal GND
18			
20		X	Clear to Send (CTS)

Pin Assignment for EPROM Area 1, Lower Byte

27512	27256	27128	2764	2732					2732	2764	27128	27256	27512
A16	VCC	VCC	VCC	NC		1	28	Vcc	NC	X	X	X	X
X	X	X	X	NC	A13	2	27		NC	VCC	VCC	A15	A15
X	X	X	X	X	A8	3	26		VCC	-	A14	A14	A14
X	X	X	X	X	A7	4	25	A9	X	X	X	X	X
X	X	X	X	X	A6	5	24	A10	X	X	X	X	X
X	X	X	X	X	A5	6	23	A12	X	X	X	X	X
X	X	X	X	X	A4	7	22	OE*	X	X	X	X	X
X	X	X	X	X	A3	8	21	A11	X	X	X	X	X
X	X	X	X	X	A2	9	20	CE*	X	X	X	X	X
X	X	X	X	X	A1	10	19	D7	X	X	X	X	X
X	X	X	X	X	D0	11	18	D6	X	X	X	X	X
X	X	X	X	X	D1	12	17	D5	X	X	X	X	X
X	X	X	X	X	D2	13	16	D4	X	X	X	X	X
X	X	X	X	X	GND	14	15	D3	X	X	X	X	X

Pin Assignment for EPROM Area 1, Upper Byte

27512	27256	27128	2764	2732					2732	2764	27128	27256	27512
A16	VCC	VCC	VCC	NC		1	28	Vcc	NC	X	X	X	X
X	X	X	X	NC	A13	2	27		NC	VCC	VCC	A15	A15
X	X	X	X	X	A8	3	26		VCC	-	A14	A14	A14
X	X	X	X	X	A7	4	25	A9	X	X	X	X	X
X	X	X	X	X	A6	5	24	A10	X	X	X	X	X
X	X	X	X	X	A5	6	23	A12	X	X	X	X	X
X	X	X	X	X	A4	7	22	OE*	X	X	X	X	X
X	X	X	X	X	A3	8	21	A11	X	X	X	X	X
X	X	X	X	X	A2	9	20	CE*	X	X	X	X	X
X	X	X	X	X	A1	10	19	D15	X	X	X	X	X
X	X	X	X	X	D8	11	18	D14	X	X	X	X	X
X	X	X	X	X	D9	12	17	D13	X	X	X	X	X
X	X	X	X	X	D1	13	16	D12	X	X	X	X	X
X	X	X	X	X	GND	14	15	D11	X	X	X	X	X

Pin Assignment for EPROM Area 2 (SRAM), Lower Byte

62256	6264	27xxx 512	256	128	64					64	128	256	512	6264	62256
														Batt	Batt or
A15	NC	A16	VCC	VCC	VCC		1	28	Vcc	X	X	X	X	X	X
X	X	X	X	X	X	A13	2	27		VCC	VCC	A15	A15	WE	WE
X	X	X	X	X	X	A8	3	26		-	A14	A14	A14	CS2	A14
X	X	X	X	X	X	A7	4	25	A9	X	X	X	X	X	X
X	X	X	X	X	X	A6	5	24	A10	X	X	X	X	X	X
X	X	X	X	X	X	A5	6	23	A12	X	X	X	X	X	X
X	X	X	X	X	X	A4	7	22	OE*	X	X	X	X	X	X
X	X	X	X	X	X	A3	8	21	A11	X	X	X	X	X	X
X	X	X	X	X	X	A2	9	20	CE*	X	X	X	X	X	X
X	X	X	X	X	X	A1	10	19	D7	X	X	X	X	X	X
X	X	X	X	X	X	D0	11	18	D6	X	X	X	X	X	X
X	X	X	X	X	X	D1	12	17	D5	X	X	X	X	X	X
X	X	X	X	X	X	D2	13	16	D4	X	X	X	X	X	X
X	X	X	X	X	X	GND	14	15	D3	X	X	X	X	X	X

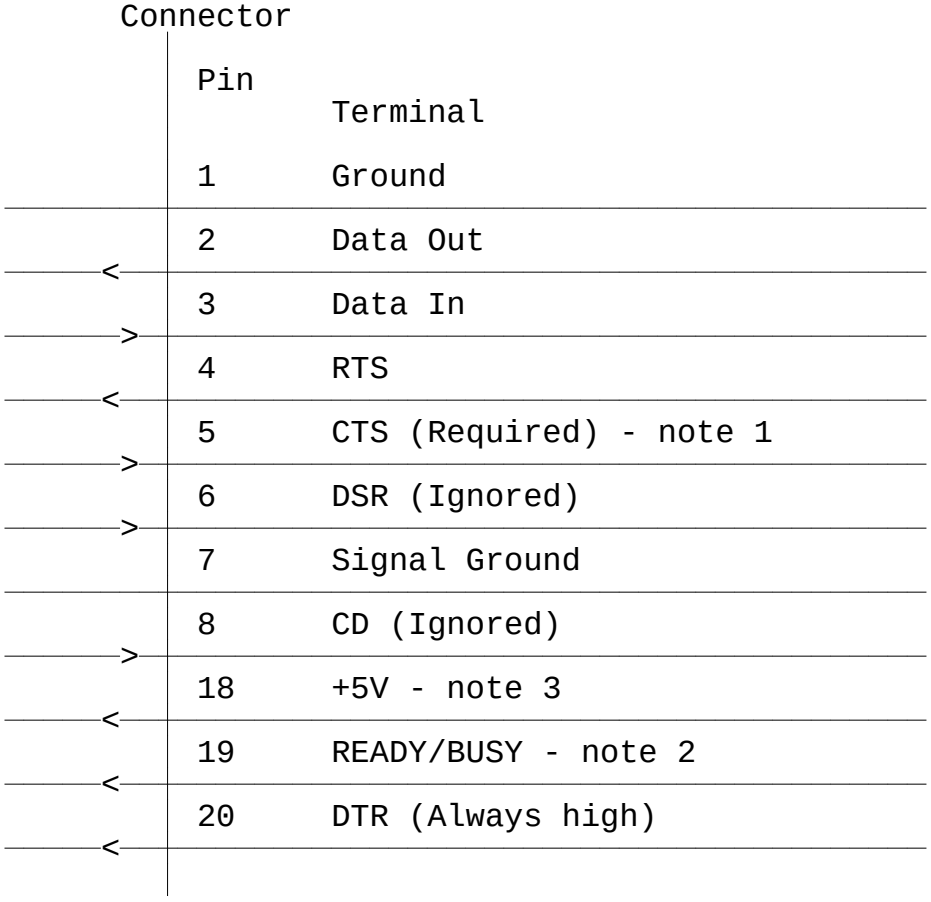
Pin Assignment for EPROM Area 2 (SRAM), Upper Byte

62256	6264	27xxx 512	256	128	64					64	128	256	512	6264	62256
A15	NC	A16	VCC	VCC	VCC		1	28	Vcc	X	X	X	X	X	X
X	X	X	X	X	X	A13	2	27		VCC	VCC	A15	A15	WE	WE
X	X	X	X	X	X	A8	3	26		-	A14	A14	A14	CS2	A14
X	X	X	X	X	X	A7	4	25	A9	X	X	X	X	X	X
X	X	X	X	X	X	A6	5	24	A10	X	X	X	X	X	X
X	X	X	X	X	X	A5	6	23	A12	X	X	X	X	X	X
X	X	X	X	X	X	A4	7	22	OE*	X	X	X	X	X	X
X	X	X	X	X	X	A3	8	21	A11	X	X	X	X	X	X
X	X	X	X	X	X	A2	9	20	CE*	X	X	X	X	X	X
X	X	X	X	X	X	A1	10	19	D15	X	X	X	X	X	X
X	X	X	X	X	X	D8	11	18	D14	X	X	X	X	X	X
X	X	X	X	X	X	D9	12	17	D13	X	X	X	X	X	X
X	X	X	X	X	X	D10	13	16	D12	X	X	X	X	X	X
X	X	X	X	X	X	GND	14	15	D11	X	X	X	X	X	X

Interface Information

V.24/RS232-C Communication Interface

The pin assignments for the 25-pin V.24/RS232-C communication connector on the rear of the terminal are as follows:



Notes:

1) CTS signal must be present at the terminal (high) before data can be sent to the host.

2) READY = High
BUSY = Low

but may be converted by jumper.

3) +5V for Facit 5165 current loop adapter (if strapped internally).

APPENDIX H

Glossary of VMEbus Terms (IEEE 1014)

A16
A type of module that provides or decodes an address on address line A01 through A15.

A24
A type of module that provides or decodes an address on address lines A01 through A23.

A32
A type of module that provides or decodes an address on address lines A01 through A31.

ARBITRATION
The process of assigning control of the DTB to a REQUESTER.

ADDRESS-ONLY CYCLE
A DTB cycle that consists of an address broadcast, but no data transfer. SLAVES do not acknowledge ADDRESS-ONLY cycles and MASTERS terminate the cycle without waiting for an acknowledgment.

ARBITER
A functional module that accepts bus requests from REQUESTER modules and grants control of the DTB to one REQUESTER at a time.

ARBITRATION BUS
One of the four buses provided by the 1014 backplane. This bus allows an ARBITER module and several REQUESTER modules to coordinate use of the DTB.

ARBITRATION CYCLE
An ARBITRATION CYCLE begins when the ARBITER senses a bus request. The ARBITER grants the bus to a REQUESTER, which signals that the DTB is busy. The REQUESTER terminates the cycle by taking away the bus busy signal which causes the ARBITER to sample the bus requests again.

BACKPLANE (1014)
A printed circuit (PC) board with 96 pin connectors and signal paths that bus the connector pins. Some 1014 systems have a single PC board, called the J1 backplane. It provides the signal paths needed for basic operation. Other 1014 systems also have an optional second PC board called a J2 backplane. It provides the additional 96 pin connectors and signal paths needed for wider data and address transfers. Still others have a single PC board that provides the signal conductors and connectors of both the J1 and J2 backplanes.

BACKPLANE INTERFACE LOGIC
Special interface logic that takes into account the characteristics of the backplane: its signal line impedance, propagation time, termination values, etc. The 1014 specification prescribes certain rules for the design of this logic based on the maximum length of the backplane and its maximum number of board slots.

BLOCK READ CYCLE
A DTB is cycle used to transfer a block of 1 to 256 bytes from a SLAVE to a MASTER. This transfer is done using a string of 1, 2, or 4 byte data transfers. Once the block transfer is started, the MASTER does not release the DTB until all of the bytes have been transferred. It differs from a string of read cycles in that the MASTER broadcasts only one address and address modifier (at the beginning of the cycle). Then the SLAVE increments this address on each transfer so that the data for the next cycle is retrieved from the next higher location.

BLOCK WRITE CYCLE
A DTB cycle used to transfer a block of 1 to 256 bytes from a MASTER to a SLAVE. The block write cycle is very similar to the block read cycle. It uses a string of 1, 2, or 4 byte data transfers and the MASTER does not release the DTB until all of the bytes have been transferred. It differs from a string of write cycles in that the MASTER broadcasts only one address and address modifier (at the beginning of the cycle). Then the SLAVE increments this address on each transfer so that the next transfer is stored on the next higher location.

BOARD
A printed circuit (PC) board, its collection or electronic components, and either one or two 96 pin connectors that can be plugged into 1014 backplane connectors.

BUS TIMER
A functional module that measures how long each data transfer takes on the DTB and terminates the DTB cycle if a transfer takes too long. If the MASTER tries to transfer data to or from a nonexistent SLAVE location it might wait forever. The BUS TIMER prevents this by terminating the cycle.

D08(0)
A SLAVE that sends and receives data eight bits at a time over D00-D07,
or
an INTERRUPT HANDLER that receives eight bit STATUS/IDs over D00-D07,
or
an INTERRUPTER that sends eight bit STATUS/IDs over D00-D07.

D08(E0)
A MASTER that sends or receives data eight bits at a time over either D00-D07 or D08-D15,
or
A SLAVE that sends and receives data eight bits at a time over either D00-D07 or D08-D15,
or
an INTERRUPT HANDLER that receives eight bit STATUS/IDs over D00-D07,
or
an INTERRUPTER that sends eight bit STATUS/IDs over D00-D07.

D16
A MASTER that sends and receives data 16 bits at a time over D00-D15,
or
A SLAVE that sends and receives data 16 bits at a time over D00-D15,
or
an INTERRUPT HANDLER that receives 16 bit STATUS/IDs over D00-D15,
or
an INTERRUPTER that sends 16 bit STATUS/IDs over D00-D15.

D32
A MASTER that sends and receives data 32 bits at a time over D00-D31,
or
A SLAVE that sends and receives data 32 bits at a time over D00-D31,
or
an INTERRUPT HANDLER that receives 32 bit STATUS/IDs over D00-D31,
or
an INTERRUPTER that sends 32 bit STATUS/IDs over D00-D31.

DAISY CHAIN
A special type of 1014 signal line that is used to propagate a signal level from board to board, starting with the first slot and ending with the last slot. There are four bus grant daisy chains and one interrupt acknowledge daisy chain on the 1014.

DATA TRANSFER BUS
One of the four buses provided by the 1014 backplane. The DATA TRANSFER BUS allows MASTERS to direct the transfer of binary data between themselves and SLAVES. (DATA TRANSFER BUS is often abbreviated to DTB).

DATA TRANSFER BUS CYCLE
A sequence of level transitions on the signal lines of the DTB that result in the transfer of an address or an address and data between a MASTER and a SLAVE. There are seven types of data transfer bus cycles.

DTB
An acronym for DATA TRANSFER BUS.

FUNCTIONAL MODULE
A collection of electronic circuitry that resides on one 1014 board and works together to accomplish a task.

IACK DAISY CHAIN DRIVER
A functional module which activates the interrupt acknowledge daisy chain whenever an INTERRUPT HANDLER acknowledges an interrupt request. This daisy chain ensures that only one INTERRUPTER will respond with its STATUS/ID when more than one has generated an interrupt request.

INTERRUPT ACKNOWLEDGE CYCLE
A DTB cycle, initiated by an INTERRUPT HANDLER that reads a "STATUS/ID" from an INTERRUPTER. An INTERRUPT HANDLER generates this cycle when it detects an interrupt request from an INTERRUPTER and it has control of the DTB.

INTERRUPT BUS
One of the four buses provided by the 1014 backplane. The INTERRUPT BUS allows INTERRUPTER modules to send interrupt requests to INTERRUPT HANDLER modules.

INTERRUPTER
A functional module that generates an interrupt request on the INTERRUPT BUS and then provides STATUS/ID information when the

INTERRUPT HANDLER requests it.

INTERRUPT HANDLER
A functional module that detects interrupt requests generated by INTERRUPTERS and responds to those requests by asking for STATUS/ID information.

LOCATION MONITOR
A functional module that monitors data transfers over the DTB in order to detect accesses to the locations it has been assigned to watch. When an access occurs to one of these assigned locations, the LOCATION MONITOR generates an on-board signal.

MASTER
A functional module that initiates DTB cycles in order to transfer data between itself and a SLAVE module.

OBO
A SLAVE that sends and receives data eight bits at a time over D00-D07.

POWER MONITOR MODULE
A functional module that monitors the status of the primary power source to the 1014 system and signals when that power has strayed outside the limits required for reliable system operation. Since most systems are powered by an AC source, the power monitor is typically designed to detect drop-out or brown-out conditions on AC lines.

READ CYCLE
A DTB cycle used to transfer 1, 2, or 4 bytes from a SLAVE to a MASTER. The cycle begins when the MASTER broadcasts and address and an address modifier. Each SLAVE captures this address and address modifier, and checks to see of it is to respond to the cycle. If so, it retrieves the data from its internal storage, places it on the data bus and acknowledges the transfer. Then the MASTER terminates the cycle.

READ-MODIFY-WRITE CYCLE
A DTB cycle that is used to both read from, and write to, a SLAVE location without permitting any other MASTER to access that location. This cycle is most useful in multiprocessing systems where certain memory locations are used to control access to certain systems resources. (For example, semaphore locations.)

REQUESTER
A functional module that resides on the same board as a MASTER or

INTERRUPT HANDLER and requests use of the DTB whenever its MASTER or INTERRUPT HANDLER needs it.

SERIAL CLOCK DRIVER
A functional module that provides a periodic timing signal that synchronizes operation of the VMSbus. (Although the 1014 specification defines a SERIAL CLOCK DRIVER for use with the VMSbus, and although it reserves two backplane signal lines for use by that bus, the VMSbus protocol is completely independent of the 1014.)

SLAVE
A functional module that detects DTB cycles initiated by a MASTER and, when those cycles specify its participation, transfers data between itself and the MASTER.

SLOT
A position where a board can be inserted into a 1014 backplane. If the 1014 system has both a J1 and a J2 backplane (or a combination J1/J2 backplane) each slot provides a pair of 96 pin connectors. If the system has only a J1 backplane, then each slot provides a single 96 pin connector.

SUBRACK
A rigid framework that provides mechanical support for boards inserted into the backplane, ensuring that the connectors mate properly and that adjacent boards do not contact each other. It also guides the cooling airflow through the system, and ensures that inserted boards do not disengage themselves from the backplane due to vibration or shock.

SYSTEM CLOCK DRIVER
A functional module that provides a 16 MHz timing signal on the UTILITY BUS.

SYSTEM CONTROLLER BOARD
A board which resides in slot 1 of a 1014 backplane and has a SYSTEM CLOCK DRIVER, a DTB ARBITER, an IACK DAISY CHAIN DRIVER, and a BUS TIMER. Some also have a SERIAL CLOCK DRIVER, a POWER MONITOR or both.

UAT
A MASTER that sends or receives data in an unaligned fashion,
or
a SLAVE that sends and receives data in an unaligned fashion.

UTILITY BUS

One of the four buses provided by the 1014 backplane. This bus includes signals that provide periodic timing and coordinate the power up and power down of 1014 systems.

WRITE CYCLE
A DTB cycle used to transfer 1, 2, or 4 bytes from a MASTER to a SLAVE. The cycle begins when the MASTER broadcasts an address and address modifier and places data on the DTB. Each SLAVE captures this address and address modifier, and checks to see if it is to respond to the cycle. If so, it stores the data and then acknowledges the transfer. The MASTER then terminates the cycle.

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APPENDIX I

Literature References

Please refer to the following books for further detailed information.

1) 68000 Assembly Language Programming,
ISBN 0-931988-62-4 (Osborne/McGraw Hill).

2) M68000 Familie-Teil 1 Grundlagen und Architektur,
ISBN 3-921803-16-0 (te-wi Verlag).

3) User's Manual of the 68881, including description of the instructions - MC68881 UM/AD.

4) VMEbus Specifications - 2618 S Shannon
Tempe Arizona 85282
(602) 966-5936

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APPENDIX J

Product Error Report

DEAR CUSTOMER,

WHILE FORCE COMPUTERS HAS ACHIEVED A VERY HIGH STANDARD OF QUALITY IN OUR PRODUCTS AND DOCUMENTATION, WE CONTINUALLY SEEK SUGGESTIONS FOR IMPROVEMENTS.

WE WOULD APPRECIATE ANY FEEDBACK YOU CARE TO OFFER.

PLEASE USE ATTACHED "PRODUCT ERROR REPORT" FORM FOR YOUR COMMENTS AND RETURN IT TO ONE OF OUR FORCE COMPUTERS OFFICES.

SINCERELY

FORCE COMPUTERS

INTRODUCTION TO VMEPROM
FOR USE WITH SYS68K/CPU-6

TABLE OF CONTENTS

List of Tables

1. GENERAL OVERVIEW

1.1 General Information

The SYS68K/CPU-6 operates under the control of VMEPROM, an EPROM resident real time multiuser, multitasking monitor program.

VMEPROM provides the user with a powerful debugging tool for single and multitasking real time applications for the high performance SYS68K/CPU-6 board. The 68881 Floating Point Coprocessor is not supported by VMEPROM.

This manual describes those parts of VMEPROM which are specific for the hardware of the CPU-6. All general commands and system calls are described in the VMEPROM User's Manual.

1.2 Features of VMEPROM

- Line assembler/disassembler with full support of all 68000/68010 instructions.

- Over 20 commands for program debugging, including breakpoints, tracing, processor register display and modify.

- S-record up/downloading from any port defined in the system.

- Time stamping of user programs.

- Built in Benchmarks.

- Disk support for RAM disk, floppy and Winchester disks. Either a SYS68K/WFC-1 or a SYS68K/ISCSI-1 may be used. VMEPROM also allows disk formatting and initialization.

- Serial I/O support for up to two SIO-1/2 or ISIO-1/2 boards in the system.

- EPROM programming utility using the SYS68K/RR-2/3 boards.

- Full Screen Editor.

- More than 30 commands to control the PDOS kernel and file manager.

- Complete task management.

- I/O redirection to files or ports from the command line.

- Over 100 system calls to the kernel are supported.

- Data conversion functions.

- Task management system calls.

- Terminal I/O functions.

- File management functions.

1.3 Power Up Sequence

After power up, the 68000/68010 retrieves the initial stack pointer and program counter from address locations $0 and $4. These locations are the first eight bytes of the system EPROM area. They are mapped down to address $0 for a defined start after reset or power up. Control is so transferred to the BIOS modules to perform all the necessary hardware initialization of the CPU-6. Next, the real time kernel is started and the user interface of VMEPROM is invoked as the first task.

If a terminal is connected to the terminal port of the CPU-6, the VMEPROM banner along with the VMEPROM prompt ("? ") will be displayed upon power up or reset.

The default terminal port setup is as follows:

Asynchronous communication
9600 Baud
8 data bits, 1 stop bit, no parity
Hardware handshake protocol

If the above message does not appear, check the following:

1) Baud rate and character format setting of the terminal (default upon delivery of the SYS68K/CPU-6 is 9600 Baud, 8 data bits, 1 stop bit, no parity).

2) Cable connection form the SYS68K/CPU-6 to the terminal (please refer to the Hardware User's Manual for the pinning of the D-Sub connector and the required handshake signals).

3) Power supply, +5V, +12V, -12V must be present. See the Hardware User's Manual for the power consumption of the SYS68K/CPU-6.

If everything goes well, the header and prompt are displayed on the terminal and VMEPROM is now ready to accept commands.

1.4 Front Panel Switches

1.4.1 RESET Switch

Pressing the RESET switch on the front panel causes all programs to terminate immediately and resets the processor and all I/O devices.

When the VMEPROM kernel is started, it overwrites the first word in the user memory after the task control block with an EXIT system call. If breakpoints were defined and a user program was running when the RESET button was pressed, the user program could possibly be destroyed.

Pressing reset while a program is running should only be used as a last resort when all other actions (such as pressing ^C twice) have failed.

1.4.2 ABORT Switch

The ABORT switch is defined by VMEPROM to cause a level 7 interrupt. This interrupt cannot be disabled and is therefore the appropriate way to terminate a user program and return to the command level of VMEPROM.

If ABORT is pressed while a user program is under execution, all user registers are saved at the current location of the program counter and the message "Aborted Task" is displayed along with the contents of the processor register.

If ABORT is pressed while a built in command is executed or the command interpreter is waiting for input, only the message is displayed and control is transferred to the command interpreter. The processor registers are not modified and are not displayed in this case.

1.4.3 Control Switches

There are no control switches on the front panel of the CPU-6; however, at address location $8 in EPROM, one byte is reserved to simulate the control switches. These switches, as simulated in the byte in EPROM, define the default behavior and actions of VMEPROM after power up.

Within this reserved byte, there is one bit for each control switch. For example, bit 7 simulates SW1, bit 6 simulates SW2, bit 5 simulates SW3, and so on. The bit is equal to one if the switch is off and equal to zero if the switch is on.

The switch settings are read in by VMEPROM after reset, and control various options. The following summary describes the software definition for each switch:

SW 1: If this switch is set to ON, the RAM disk is initialized as defined by switch 3 and 4 after reset. When the disk is initialized, all data on the disk is lost.

SW 2: Not used.

SW 3:
and
SW 4: These two switches define the RAM disk which is used by default.

See Table 1-1 for a detailed description of these switches.

The default definition of these switches can be patched in the EPROMs for the user’s convenience. Please refer to the Appendix of this manual for a description of the memory locations to be patched.

SW 5:
and
SW 6: These switches define which program is to be invoked after reset.

Please refer to Table 1-2 for a detailed description.

The default definition of these switches can be patched in the EPROMs for the user's convenience. Please refer to the Appendix of this manual for a description of the memory locations to be patched.

SW 7: If this switch is set to on, VMEPROM tries to execute a startup file after reset. The default filename is SY$STRT and the file must reside on disk 2.

SW 8: If this switch is set to on, VMEPROM checks the VMEbus for available hardware after reset. In addition VMEPROM waits for SYSFAIL to disappear from the VMEbus. The following hardware can be detected:
Contiguous memory starting at $80000
ASCU-1/2
ISIO-1/2
SIO-1/2
ISCSI-1
WFC-1.

Please refer to Section 4.2 of this manual for details.

Table 1-1 : RAM Disk Usage

SW 4	SW 3	
OFF	OFF	= RAM DISK AT TOP OF MEMORY (32 Kbyte)
OFF	ON	= RAM DISK AT $700000 (512 Kbyte)
ON	OFF	= RAM DISK AT $A0000 (32 Kbyte)
ON	ON	= RAM DISK AT $800000 (512 Kbyte)

Table 1-2 : Program After Reset

SW 6	SW 5	
OFF	OFF	= VMEPROM (OR USER PROGRAM at same location)
OFF	ON	= AUTOBOOT PDOS
ON	OFF	= USER PROGRAM AT $A0000
ON	ON	= USER PROGRAM AT $800000

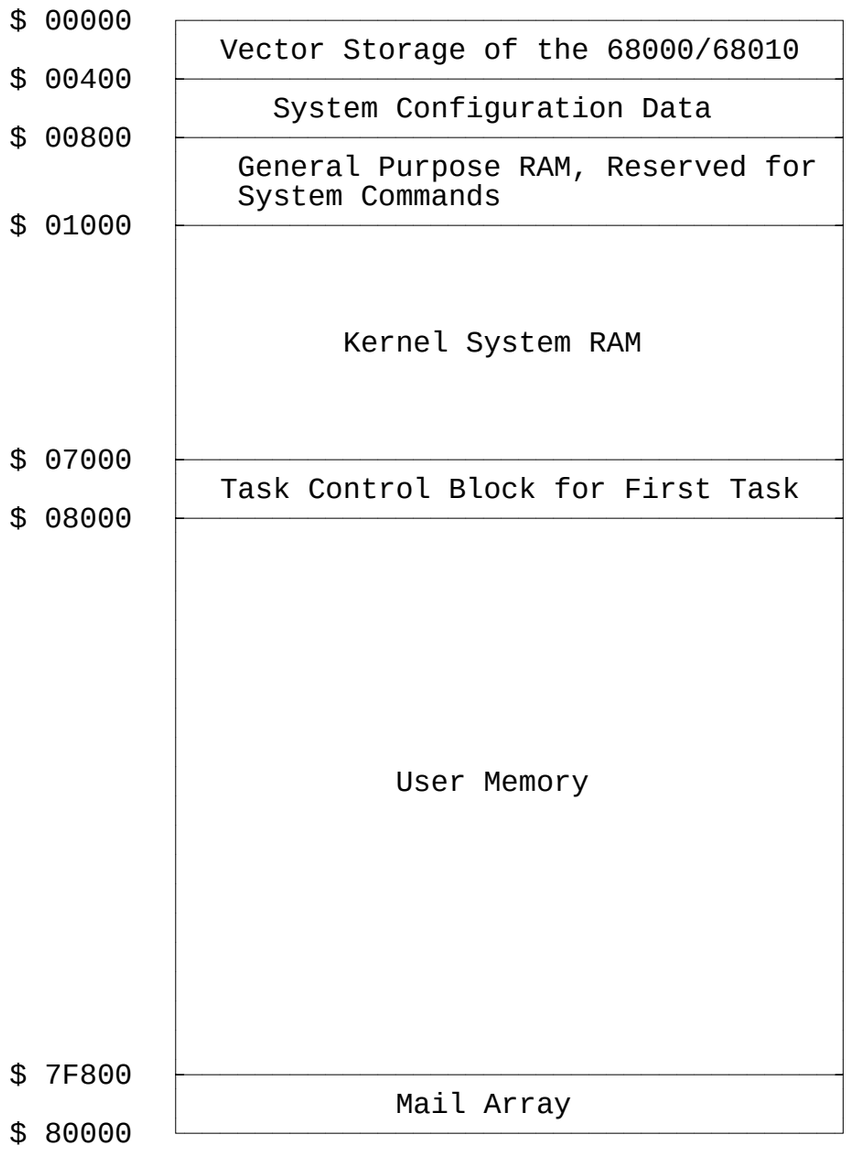
Table 1-3 : Default Control Switch Setting

Switch	Position	Function	Default
SW1	ON	Initialize RAM disk on RESET	OFF
	OFF	Use old RAM disk initialization	
SW2		Not used.	
SW3		RAM disk address	OFF
SW4			OFF
		SW4 SW3 OFF OFF RAM DISK AT TOP OF MEMORY (32KB) OFF ON RAM DISK AT $700000 (512KB) ON OFF RAM DISK AT $A0000 (32KB) ON ON RAM DISK AT $800000 (512KB)	
SW5		Startup program to be executed after RESET	OFF
SW6			OFF
		SW6 SW5 OFF OFF VMEPROM OFF ON AUTOBOOT PDOS ON OFF USER PROGRAM AT $A0000 ON ON USER PROGRAM AT $800000	
SW7	ON	Execute file SY$STRT on disk 2 after RESET	
	OFF	No startup file is executed Switch 7 has no effect if SW5 and SW6 are not set to OFF	OFF
SW8	ON	Hardware configuration on VMEbus is checked controllers are installed as they are found	
	OFF	The VMEbus is not checked for additional hardware	OFF

1.4.4 Default Memory Usage of VMEPROM

By default, VMEPROM uses the following memory assignment on CPU-6:

Memory Layout of the On-board RAM

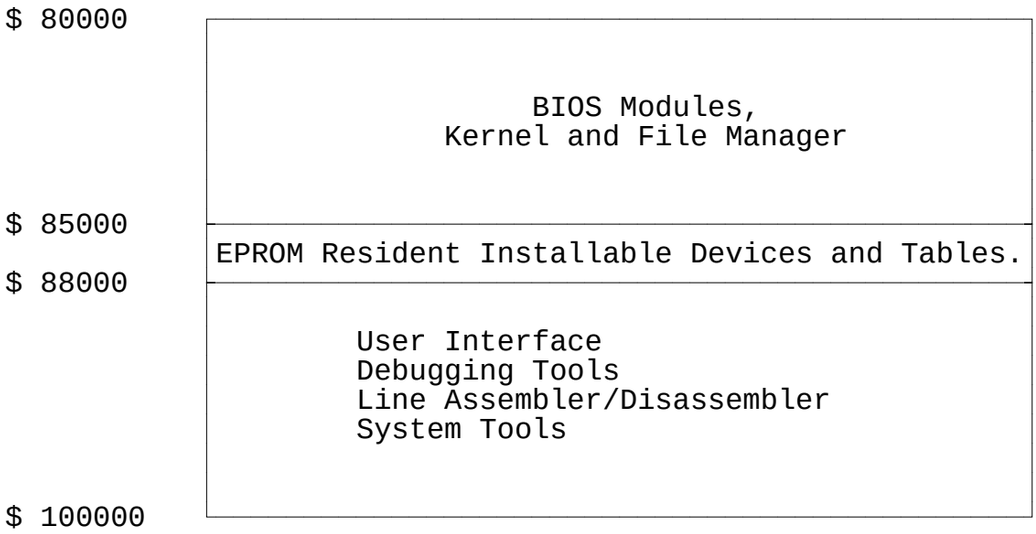


Note that VMEPROM only clears the memory from 0 to $8000 after reset. Additionally, after a reset has been made, the location at $8000 is overwritten with an XEXT system call to avoid a system crash because no program was loaded.

The CONFIG command can be used to install additional memory. It searches from address $100000 until a bus error occurs. Please note that the size of the first task can not be extended beyond the address $80000 (this would overwrite the Mail Array). However, the additional memory which can be installed may be used for data arrays or for creating new tasks. The maximum memory which may be used for tasking is 16 Mbytes. If more memory is available, it can only be used for data storage, but not for tasking memory.

1.4.5 Default EPROM Usage of VMEPROM

System EPROM Memory Layout



2. The SYS68K/CPU-6

2.1 Memory Layout

Address	Device
$000 000 : $000 007	System EPROM Boot Vectors
$000 008 : $07F FFF	512 Kbyte Local DRAM
$080 000 : $09F FFF	System EPROM Area
$0A0 000 : $0BF FFF	User EPROM Area
$0C0 000 : $0FF FFF	Local I/O Devices
$100 000 : $FFF FFF	VME Address Range

2.2 On-board I/O Devices

The following table shows the on-board I/O devices and their addresses:

Table 2-1 : On-board I/O Devices

Device	Address
Terminal ACIA	$0C0080
Host ACIA	$0C0041
Remote ACIA	$0C0101
RTC 58167A	$0C0401
PI/T 68230	$0E0001
68881	$0E0200

2.3 On-board Interrupt Sources

The following table shows the on-board interrupt sources and levels which are defined by VMEPROM.

Table 2-2: On-board Interrupt Sources

DEVICE	INTERRUPT LEVEL	INTERRUPT VECTOR
Abort Switch	7	AV7
RTC	6	AV6
PI/T	5	AV5
Terminal ACIA	4	AV4
Remote ACIA	3	AV3
Host ACIA	2	AV2

2.4 Off-board Interrupt Sources

VMEPROM supports several VMEbus boards. Since these boards are interrupt driven, the level and vectors must be defined for VMEPROM to work properly.

Table 2-3 shows the default setup of the interrupt levels and vectors of the supported hardware. For a detailed description of the hardware setup of the boards, please refer to the Appendix of this manual. The supported I/O boards together with the base addresses and the interrupt level and vector are summarized in this table. In order for these boards to work properly with VMEPROM, the interrupt vectors listed may not be used.

Table 2-3 : Off-board Interrupt Sources

Board	Interrupt Level	Interrupt Vector	Board Base Address
SIO-1	4	64-75	$B00000
ISIO-1/2	4	76-83	$960000
WFC-1	3	119	$B01000
ISCSI-1	4	119	$A00000
ASCU-1/2	7	31	$B02000

3. THE CONCEPT OF VMEPROM

3.1 Getting Started

After power up or after RESET has been pressed, VMEPROM prints a banner showing the version and revision being used and prints the prompt ("? ").

If the above message does not appear, check the following:

1) Baud rate and character format setting of the terminal (default upon delivery of the SYS68K/CPU-6 is 9600 Baud, 8 data bits, 1 stop bit, no parity).

2) Cable connection from the SYS68K/CPU-6 to the terminal (refer to the Hardware User's Manual for the pinning of the D-Sub connector and the required handshake signals).

3) Power supply, +5V, +12V, -12V must be present. See the Hardware User's Manual for the power consumption of the SYS68K/CPU-6.

If everything goes well, the header and prompt are displayed on the terminal and VMEPROM is now ready to accept commands.

3.2 Command Line Syntax

All valid VMEPROM commands consist of

? command<cr> or

? command parameters<cr>

where the underlined parts must be entered by the user. If more than one parameter has to be entered, they must be separated by a space or a comma.

For a detailed description of all functions of the command interpreter please refer to chapter 3 of the VMEPROM User's Manual.

3.3 VMEPROM Commands

VMEPROM supports more than 75 commands. All of these commands are EPROM resident and are available at any time. Most of these commands are common for all versions of VMEPROM. All of the common commands of VMEPROM are described in detail in chapter 3 of the VMEPROM User's Manual. Those commands which are CPU-6 hardware-specific are described in the following paragraphs of this manual.

For a short description of one or all VMEPROM commands, the HELP command can be used. Enter HELP<cr> for a description of all commands, or enter HELP command<cr> for a description of a particular command.

4. SPECIAL VMEPROM COMMANDS FOR CPU-6

The following commands are implemented on the CPU-6 in addition to those listed in Chapter 3 of the VMEPROM User’s Manual.

4.1 CONFIG - Search VMEbus for Hardware

Format: CONFIG

This command searches the VMEbus for available hardware. It is useful if VMEPROM is started and the simulated front panel switch #8 is set to off (for further information, please refer to section 1.4.3), so that VMEPROM does not check the configuration by default.

In addition, this command allows the user to install additional memory in the system. Additional memory can ONLY be installed with this command.

The following hardware is detected:

1. ASCU-1/2
2. ISIO-1/2
3. SIO-1/2
4. ISCSI-1
5. WFC-1
6. Contiguous memory starting at $100000.

The boards must be set to the default address for 16 bit systems. This setup is summarized for all supported boards in the Appendix of this manual.

Additional memory must be contiguous to the on-board memory of the CPU-6 (i.e., must start at $100000). This memory is cleared by the CONFIG command to allow DRAM boards with parity to be used.

The CONFIG command also installs Winchester disks in the system and initializes the disk controller (if available). Therefore, if a SYSFAIL is active on the VMEbus (which can come, for example, from the ISIO-1/2 or ISCSI-1 controller during selftest), the command is suspended until the SYSFAIL signal is no longer active.

Example:

```
? CONFIG<cr>

DISK DRIVER FORCE ISCSI1 INSTALLED
UART FORCE ISIO1/2 (U3) INSTALLED

ASCU-1/2 :  1 boards available
ISCSI-1  :  1 boards available
ISIO-1/2 :  1 boards available

? _
```

4.2 FUNCTIONAL - Perform Functional Test

Format: FUNCTIONAL

This command performs a functional test on the local memory and on the bus interface of the CPU board.

NOTE: This command is not designed for the user, but used instead for internal purposes by FORCE COMPUTERS.

4.3 SELFTEST - Perform On-board Selftest

Format: SELFTEST

This command performs a test of the on-board functions of the CPU-6.

It may only be run if no other tasks are created. If there are any other tasks no selftest will be made and an error will be reported. The selftest tests the memory of the CPU-6 board and all devices on the board.

The following tests are performed in this order:

1. I/O test

This function tests the access to and the interrupts from the MPCC. If the MPCC cannot generate interrupts an error will be reported.

2. Memory test on the memory of the current task.

The following procedures are performed:
1) Byte Test
2) Word Test
3) Long Word Test

All passes of the memory test perform pattern reading and writing as well as bit shift tests. If an error occurs while writing to or reading from memory it will be reported. This ensures that VMEPROM could initialize the PI/T 68230 properly and the interrupts from the PI/T are working.

3. Clock Test

If the CPU does not receive timer interrupts from the PI/T 68230 an error will be displayed.

CAUTION: During this process, all memory is cleared.

Example:

```
? SELFTEST

VMEPROM Hardware Selftest
-------------------------

I/O test ......... passed
Memory test ...... passed
Clock test ....... passed

?
```

5. RESTRICTIONS ON STANDARD COMMANDS

5.1 Baud Port

The BP command is not able to alter the baud rate of any on-board ports because the hardware does not allow it.

APPENDIX TO THE

INTRODUCTION TO VMEPROM

TABLE OF CONTENTS

APPENDIX A

A. VMEbus Board Setup

This appendix summarizes the changes which have to be made to the default setup of additional VMEbus boards so that they are VMEPROM compatible.

Sections A.2 through A.5 are available in EPROM, but are not installed. All drivers may be installed with the INSTALL command. When INSTALL is entered followed by a question mark, the information shown below will appear:

INSTALL? <cr>

THE FOLLOWING UARTS AND DISK DRIVERS ARE ALREADY IN EPROM:

UART TYPE 1	ONBOARD_6	ADR:	$85000
UART TYPE 2	FORCE SIO-1/2	ADR:	$85400
UART TYPE 3	FORCE ISIO-1/2	ADR:	$85800
DISK DRIVER	FORCE ISCSI-1	ADR:	$85C00
DISK DRIVER	FORCE WFC-1	ADR:	$86400

By typing in: INSTALL <file><address><cr>, a specific driver may be loaded in the system. The addressed file should be located in EPROM.

A.1 VMEbus Memory

In general, every FORCE memory board can be used together with VMEPROM.

The base address has to be set correctly in order to use the board within the tasking memory of VMEPROM.

The board base address of any additional memory must be set to be contiguous to the on-board memory. The start address is $100000. It is strongly recommended that only 16 bit memory boards are used because of speed considerations.

A.2 SYS68K/SIO-1/SIO-2

These two serial I/O boards are set to the base address $B00000 by default.

VMEPROM expects the first SIO-1/SIO-2 boards at $FCB00000. This is in the standard VME address range (A24, D16, D8) of address $B00000. So the address modifier decoder (AM-Decoder) of the SIO-1/2 boards must be set to:

Standard Privileged Data Access
Standard Nonpriviledged Data Access

Please refer to the User's Manual of your SIO boards to perform the necessary setup.

If a second SIO-1/2 board shall be used, the base address must be set

to $FCB00200. The same AM-decoder setup as described above must be used. Please refer to the User's Manual of your SIO board for the address setup of the second SIO board.

Before using the driver for the SIO-1/2 board, the driver must be installed by using the INSTALL command. The following must be entered:

? INSTALL U2,$85400

In order to install one of the ports of the SIO boards in VMEPROM the BP command can be used. The SIO-1/2 boards use the driver type 2. Therefore, to install the first port of an SIO board with a baud rate of 9600, the following command line can be used:

? BP 4, 9600, 2, $B00000

The port can then be used as port number 4. Please note that the hardware configuration must be detected before a port can be installed. This can be done with the CONFIG command or by setting a simulated front panel switch on the CPU-6 and RESET. Please refer to the command description in the VMEPROM User's Manual for a detailed description of the CONFIG and BP commands.

The base addresses of all ports of an SIO-1/2 board which must be specified with the BP command are as follows:

SIO port #	
1 (first SIO board)	$B00000
2	$B00040
3	$B00080
4	$B000C0
5	$B00100
6	$B00140
1 (second SIO board)	$B00200
2	$B00240
3	$B00280
4	$B002C0
5	$B00300
6	$B00340

VMEPROM supports up to two serial I/O boards. These can be either the SIO-1/2 board or the ISIO-1/2 board, or a mixture of both. Please note that the first board of every type must be set to the first base address. In using one SIO-1 board and one ISIO-1 board, the base address of the boards have to be set to:

SIO-1	$B00000
ISIO-1	$960000

A.3 SYS68K/ISIO-1/2

These serial I/O boards are set to the address $960000 in the standard VME address range by default.

VMEPROM anticipates this board at this address. This is to say that no changes need to be made to the default setup.

An optional second board may be used. The address must be set to $980000 when using the second board. Please refer to the SYS68K/ISIO-1/2 User's Manual for a description of the base address setup.

Before using the driver for the ISIO-1/2 board, the driver must be installed by using the INSTALL command. The following must be entered:

? INSTALL U3,$85800

In order to install one of the ports of an ISIO board in VMEPROM, the BP command can be used. The ISIO-1/2 boards are the driver type 3.

In order to install the first port of an ISIO board with a baud rate of 9600, the following commandline can be used:

? BP 4, 9600, 3, $968000

The port can then be used as port number 4. Please note that the hardware configuration must be detected before a port can be installed. This can be done with the CONFIG command or by setting a simulated front switch on the CPU-6 and pressing RESET. Please refer to the command description in the VMEPROM User's Manual for a detailed description of the CONFIG and BP commands.

The base address of all ports of an ISIO-1/2 board which must be specified with the BP command are as follows:

ISIO port #	
1 (first ISIO board)	$968000
2	$968020
3	$968040
4	$968060
5	$968080
6	$9680A0
7	$9680C0
8	$9680E0
1 (second ISIO board)	$988000
2	$988020
3	$988040
4	$988060
5	$988080
6	$9880A0
7	$9880C0
8	$9880E0

VMEPROM supports up to two serial I/O boards. These can be either the SIO-1/2 board or the ISIO-1/2 board or mixture of both. Please note that the first board of every type must be set to the first base address. In using one SIO-1 board and one ISIO-1 board, the base address of the boards have to be set to:

SIO-1	$B00000
ISIO-1	$9600000

A4. SYS68K/WFC-1 Disk Controller

VMEPROM supports up to two floppy disk drives and three Winchester drives together with the WFC-1 disk controller.

The floppy drives must be jumpered to drive select 3 and 4 and can be accessed as disk number 0 and 1 out of VMEPROM.
The floppy drives are installed automatically when a WFC-1 controller is detected by the CONFIG command or after RESET when the simulated front panel switch of the CPU-6 is set to detect the hardware configuration. Usable floppy drives must support 80 tracks/side, double sided and double density. The step rate used is 3 ms.

The Winchester drives are not installed automatically. The FRMT

command must be used for VMEPROM and for defining the following factors:

- The physical drive structure (i.e. number of heads, number of cylinders, drive select number etc.)
- The bad block of the Winchester drive
- The partitions to be used

If this setup procedure is performed once for a particular drive, the data is stored in the very first sector of the Winchester and is loaded automatically when the disk controller is installed in VMEPROM. The driver for the WFC-1 may be installed by using the INSTALL command. The following must be entered:

? INSTALL W,$86400

The default base address of the WFC-1 controller has to be set to $B01000. To do so, the address comparison for 24 bit address has to be enabled.

VMEPROM supports the termination interrupt of the WFC-1 controller. If you want to use the WFC-1 with interrupts, the corresponding jumper has to be set to enable the interrupt.

Please refer to the User's Manual of the WFC-1 controller for a detailed description of the address setup and the termination interrupt.

A5. SYS68K/ISCSI-1 Disk Controller

VMEPROM supports up to two floppy disk drives and three Winchester disk drives together with the ISCSI-1 disk controller.

The floppy drives have to be jumpered to drive select 3 and 4 and can be accessed as disk number 0 and 1 out of VMEPROM. The floppy drives are installed automatically when a ISCSI-1 controller is detected by the CONFIG command or after RESET when the simulated front panel switch of the CPU-6 is set to detect the hardware configuration. Usable floppy drives must support 80 tracks/side, and must be double sided/double density. The step rate used is 3 ms.

The Winchester drives are not installed automatically. The FRMT command must be used for VMEPROM, and for defining the following factors:

- The physical structure of the drive (i.e. number of heads, number of cylinders, drive select number, etc.)
- The bad block of the winchester drive
- The partitions to be used

If this setup procedure is performed once for a particular drive, the data is stored in the very first sector of the Winchester and is loaded automatically when the disk controller is installed in VMEPROM. The driver for the ISCSI-1 may be installed by using the INSTALL command. The following must be entered:

? INSTALL W,$85C00

The default base address of the ISCSI-1 controller is $A00000 in the standard VME address range.

The ISCSI-1 driver uses interrupts by default. This cannot be disabled. Please make sure that the interrupt daisy chain is closed so that the controller can work properly.

APPENDIX B

B. S-Record Formats

B1. S-Record Types

Eight types of S-records have been defined to accommodate the several needs of the encoding, transportation and decoding functions. VMEPROM supports S0, S1, S2, S3, S7, S8 and S9 records (S7 and S8 on load only).

An S-record format module may contain S-records of the following types:

S0 The header record for each block of S-records.

S1 A record containing code/data and the 2-byte address at which the code/data is to reside.

S2 A record containing code/data and the 3-byte address at which the code/data is to reside.

S3 A record containing code/data and the 4-byte address at which the code/data is to reside.

S5 A record containing the number of S1, S2 and S3 records transmitted in a particular block. The count appears in the address field. There is no code/data field. Not supported by VMEPROM.

S7 A termination record for a block of S3 records. The address field may optionally contain the 4-byte address of the instruction to which control is to be passed. There is no code/data field.

S8 A termination record for a block of S2 records. The address field may optionally contain the 3-byte address of the instruction to which control is to be passed. There is no code/data field.

S9 A termination record for a block of S1 records. The address field may optionally contain the 2-byte address of the instruction to which control is to be passed.

Only one termination record is used for each block of S-records. S7 and S8 records are usually used only when control is to be passed to a 3- or 4-byte address. Normally, only one header record is used, although it is possible for multiple header records to occur.

B2. S-Record Example

```
S214020000000004440002014660000CB241F8044CB1
S214020010203C0000020E428110C1538066FA487AE4
S214020020001021DF0008487A001221DF000C4E750E
S21402003021FC42555320003060082 1FC41444452C2
```

```
                                                XX.-  Check-sum
          XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX———  Data
    0200XX————————————————————————————————————  24 bit Address
  14————————————————————————————————————————————  Byte Count
S2————————————————————————————————————————————  Record Type
```

```
S9030000FC
```

```
        FC————————————————————————————————————  Check-sum
    0000————————————————————————————————————————  Data
  03————————————————————————————————————————————  Byte Count
S9————————————————————————————————————————————  Record Type
```

APPENDIX C

C. System RAM Definitions

```
/* SYRAM:H -- DEFINITION OF SYRAM BLOCK OF MEMORY
   05-Jan-88  Revised to correspond to PDOS 3.3
   BRIAN C. COOPER, EYRING RESEARCH INSTITUTE, INC.  Copyright 1985-1988
   last update: 23-Feb-88  H.K.  identical to MSYRAM:SR
 */
 #define  NT   64               /* number of tasks                    */
 #define  NM   ((NT+3)&0xFC)    /* number of task messages            */
 #define  NP   16               /* number of task message pointers    */
 #define  ND   ((NT+3)&0xFC)    /* number of delay events             */
 #define  NC   8                /* number of active  channel buffers  */
 #define  NF   64               /* number of file slots               */
 #define  NU   15               /* number of I/O UART ports           */
 #define  IZ   6                /* input buffer size (2^P2P)          */
 #define  MZ   0x1000000        /* maximum memory size (16M maximum)  */
 #define  TZ   64               /* task message size                  */
 #define  NTB  NT
 #define  NTM  NM
 #define  NTP  NP
 #define  NCB  NC
 #define  NFS  NF
 #define  NEV  ND
 #define  NIE  (ND/2)
 #define  NPS  (NU+1)
 #define  P2P  IZ
 #define  MMZ  MZ
 #define  TMZ  TZ

 #define  IMK  (0xFF>>(8-P2P))  /* input buffer wrap around mask      */
 #define  NCP  ((1<<P2P)+2)     /* (# characters/port) + 2            */
 #define  MPZ  2048             /* memory pagesize                    */
 #define  MBZ  (MMZ/MPZ)        /* memory bit map size                */
 #define  NMB  (MBZ/8)          /* number of map bytes                */
 #define  FSS  38               /* file slot size                     */
 #define  TQB  2                /* TCB index                          */
 #define  TQM  (TQB+4)          /* map index                          */
 #define  TQE  (TQM+2)          /* event #1 / event #2                */
 #define  TQS  (TQE+2)          /* scheduled event                    */
 #define  TBZ  (TQS+2+4)        /* TASK entry size                    */
 #define  BPS  256              /* bytes per sector                   */
 #define  NRD  4                /* number of RAM disks                */

 struct SYRAM{
 /*000*/    char *_bios;        /* address of bios rom                */
 /*004*/    char *_mail;        /* mail array address                 */
 /*008*/    unsigned int _rdkn; /* ram disk #                         */
 /*00A*/    unsigned int _rdks; /* ram disk size                      */
 /*00C*/    char *_rdka;        /* ram disk disk address              */
 /*010*/    char _bflg;         /* basic present flag                 */
 /*011*/    char _dflg;         /* directory flag                     */
 /*012*/    int  _f681;         /* 68000/68010 flag                   */
 /*014*/   char *_sram;         /* run module B$SRAM                  */
 /*018*/   int spare1;          /* reserved for expansion             */
```

C. System RAM Definitions (cont'd)

```
/*01A*/    int  _fcnt;          /* fine counter                          */
/*01C*/    long _tics;          /* 32 bit counter                        */
/*020*/    unsigned char _smon;/* month                                  */
/*021*/    unsigned char _sday;/* day                                    */
/*022*/    unsigned char _syrs[2];/* year                                */
/*024*/    unsigned char _shrs;/* hours                                  */
/*025*/    unsigned char _smin;/* minutes                                */
/*026*/    unsigned char _ssec[2];/* seconds                             */
/*028*/    char _patb[16];      /* input port allocation table           */
/*038*/    char _brkf[16];      /* input break flags                     */
/*048*/    char _f8bt[16];      /* port flag bits                        */
/*058*/    char _utyp[16];      /* port uart type                        */
/*068*/    char _urat[16];      /* port rate table                       */
/*078*/    char _evtb[10];      /* 0-79 event table                      */
/*082*/    char _evto[2];       /* 80-95 output events                   */
/*084*/    char _evti[2];       /* 96-111 input events                   */
/*086*/    char _evts[2];       /* 112-127 system events                 */
/*088*/    char _ev128[16];     /* task 128 events                       */
/*098*/    long _evtm[4];       /* events 112-115 timers                 */
/*0A8*/    long _bclk;          /* clock adjust constant                 */
/*0AC*/    char *_tltp;         /* task list pointer                     */
/*0B0*/    char *_utcb;         /* user tcb ptr                          */
/*0B4*/    int  _suim;          /* supervisor interrupt mask             */
/*0B6*/    int  _usim;          /* user interrupt mask                   */
/*0B8*/    char _sptn;          /* spawn task no. (** must be even **)   */
/*0B9*/    char _utim;          /* user task time                        */
/*0BA*/    char _tpry;          /* task priority (** must be even **)    */
/*0BB*/    char _tskn;          /* current task number                   */
/*0BC*/    char spare2;         /* reserved                              */
/*0BD*/    char _tqux;          /* task queue offset flag/no             */
/*0BE*/    char _tlck[2];       /* task lock/reschedule flags            */
/*0C0*/    char _e122;          /* batch task #                          */
/*0C1*/    char _e123;          /* spooler task #                        */
/*0C2*/    char _e124;
/*0C3*/    char _e125;
/*0C4*/    long _cksm;          /* system checksum                       */
/*0C8*/    int  _pnod;          /* pnet node #                           */
/*0CA*/   char bser[6];         /* bus error vector                      */
/*0D0*/   char iler[6];         /* illegal vector                        */
/*0D6*/   char ccnt[16];        /* control C count                       */
/*0E6*/    char *_wind;         /* window id's                           */
/*0EA*/    char *_wadr;         /* window addresses                      */
/*0EE*/    char *_chin;         /* input stream                          */
/*0F2*/    char *_chot;         /* output stream                         */
/*0F6*/    char *_iord;         /* i/o redirect                          */
/*0FA*/    char _fect;          /* file expand count                     */
/*0FB*/    char _pidn;          /* processor ident byte                  */
/*0FC*/    long *_begn;         /* abs addr of K1$BEGN table             */
/*100*/    int  _rwcl[14];      /* port row/col     1..15                */
/*11C*/    char *_opip[15];     /* output port pointers  1..15           */
/*158*/    char *_uart[16];     /* uart base addresses 1..15             */
/*198*/    long _mapb;          /* memory map bias                       */
/*                                                                       */
```

C. System RAM Definitions (cont'd)

```
/*  The following change with different configurations              */
/*  The configuration for VMEPROM is defined on top of file to:     */
/*  NT = 64, NF = 64 , MZ =$1000000 (16M)                           */
/*                                                                  */
/*  NOTE: The offset on top of each line is calculated only for this */
/*        configuration                                             */
/*                                                                  */
/*019C*/ char _maps[NMB];           /* system memory bit map        */
/*059C*/ char _port[(NPS-1)*NCP];   /* character input buffers      */
/*097A*/ char _iout[(NPS-1)*NCP];   /* character output buffers     */
/*0D58*/ char rdtb[16];             /* redirect table               */
/*0D68*/ int  _tque[NTB+1];         /* task queue                   */
/*0DEA*/ char _tlst[NTB*TBZ];       /* task list                    */
/*11EA*/ char _tsev[NTB*32];        /* task schedule event table    */
/*19EA*/ long _tmtf[NTM];           /* to/from/INDEX.W              */
/*1AEA*/ char _tmbf[TMZ*NTM];       /* task message buffers         */
/*2AEA*/ char _tmsp[NTP*6];         /* task message pointers        */
/*2B4A*/ char _deiq[2+8+NIE*10];    /* delay event insert queue     */
/*2C94*/ char _devt[2+NEV*10];      /* delay events                 */
/*2F16*/ int  _bsct[32];            /* basic screen command table   */
/*2F56*/ int  _xchi[NCB];           /* channel buffer queue         */
/*2F66*/ char _xchb[NCB*BPS];       /* channel buffers              */
/*3F66*/ char _xfsl[NFS*FSS];       /* file slots                   */
/*40E6*/ char _l2lk;          /* level 2 lock (file prims, evnt 120) */
/*40E7*/ char _l3lk;          /* level 3 lock (disk prims, evnt 121) */
/*40E8*/ char spare3[8];            /* reserved for PDOS INSTALL    */
/*40F0*/ int  _rdkl[NRD*4 + 1];     /* RAM disk list                */
};
```

APPENDIX D

D. Task Control Block Definitions

The following are Task Control Block (TCB) definitions:

```
#define MAXARG        10        /* max argument count of the cmd line */
#define MAXBP         10        /* max 10 breakpoints                 */
#define MAXNAME        5        /* max 5 names in name buffer         */
#define TMAX          64        /* Max number of tasks                */

/* special system flags for VMEPROM                                   */

#define    SOMEREG  0x0001      /*display only PC,A7,A6,A5            */
#define     T_DISP   0x0002     /*no   register   display   during
                                trace(TC>1)*/
#define     T_SUB    0x0004     /*trace over subroutine set           */
#define    T_ASUB   0x0008      /*trace over subroutine active        */
#define    T_RANG   0x0010      /*trace over range set                */
#define    REG_INI  0x0020      /*no register initialization if set   */

/* the 68020 regs are stored in the following order:                  */

#define     VBR       0
#define     SFC       1
#define     DFC       2
#define     CAAR      3
#define     CACR      4
#define     PC        5
#define     SR        6
#define     USTACK    7
#define     SSTACK    8
#define     MSTACK    9
#define     D0       10         /*  10-17  =  D0-D7                 */
#define     A0       18         /*  18-24  =  A0-A6                 */

#define N_REGS      25

#define     BYTE     unsigned char
#define     WORD     unsigned int
#define     LWORD    unsigned long
 struct     TCB{
/*000*/     char _ubuf[256];    /* 256 byte user buffer               */
/*100*/     char _clb[80];      /* 80 byte monitor command line buffer*/
/*150*/     char _mwb[32];      /* 32 byte monitor parameter buffer   */
/*170*/     char _mpb[60];      /* monitor parameter buffer           */
/*1AC*/     char _cob[8];       /* character out buffer               */
/*1B4*/     char _swb[508];     /* system work buffer/task pdos stack */
/*3B0*/     char *_tsp;         /* task stack pointer                 */
/*3B4*/     char *_kil;         /* kill self pointer                  */
/*3B8*/     long _sfp;          /* RESERVED FOR INTERNAL PDOS USE     */
/*3BC*/     char _svf;          /* save flag -- 68881 support (x881)  */
/*3BD*/    char _iff;           /* RESERVED FOR INTERNAL PDOS USE     */
```

D. Task Control Block Definitions (cont'd)

```
/*3BE*/    long _trp[16];      /* user TRAP vectors                    */
/*3FE*/    long _zdv;          /* zero divide trap                     */
/*402*/    long _chk;          /* CHCK instruction trap                */
/*406*/    long _trv;          /* TRAPV Instruction trap               */
/*40A*/    long _trc;          /* trace vector                         */
/*40E*/    long _fpa[2];       /* floating point accumulator           */
/*416*/    long *_fpe;         /* fp error processor address           */
/*41A*/    char *_clp;         /* command line pointer                 */
/*41E*/    char *_bum;         /* beginning of user memory             */
/*422*/    char *_eum;         /* end user memory                      */
/*426*/    char *_ead;         /* entry address                        */
/*42A*/    char *_imp;         /* internal memory pointer              */
/*42E*/    int  _aci;          /* assigned input file ID               */
/*430*/    int  _aci2;         /* assigned input file ID's             */
/*432*/    int  _len;          /* last error number                    */
/*434*/    int  _sfi;          /* spool file id                        */
/*436*/    BYTE _flg;          /* task flags(bit 8=command line echo)*/
/*437*/    BYTE _slv;          /* directory level                      */
/*438*/    char _fec;          /* file expansion count                 */
/*439*/    char  _spare1;      /* reserved for future use              */
/*43A*/    char _csc[2];       /* clear screen characters              */
/*43C*/    char _psc[2];       /* position cursor characters           */
/*43E*/    char _sds[3];       /* alternate system disks               */
/*441*/    BYTE _sdk;          /* system disk                          */
/*442*/    char *_ext;         /* XEXT address                         */
/*446*/    char *_err;         /* XERR address                         */
/*44A*/    char _cmd;          /* command line delimiter               */
/*44B*/    BYTE _tid;          /* task id                              */
/*44C*/    char _ecf;          /* echo flag                            */
/*44D*/    char _cnt;          /* output column counter                */
/*44E*/    char _mmf;          /* memory modified flag                 */
/*44F*/    char _prt;          /* input port #                         */
/*450*/    char _spu;          /* spooling unit mask                   */
/*451*/    BYTE _unt;          /* output unit mask                     */
/*452*/    char _u1p;          /* unit 1 port #                        */
/*453*/    char _u2p;          /* unit 2 port #                        */
/*454*/    char _u4p;          /* unit 4 port #                        */
/*455*/    char _u8p;          /* unit 8 port #                        */
/*456*/    char _spare2[26];   /* reserved for system use              */
/*****************************************************************/
/*         VMEPROM   variable area                               */
/*****************************************************************/
/*470*/    char  linebuf[82];  /* command line buffer                  */
/*4C2*/    char  alinebuf[82]; /* alternate line buffer                */
/*514*/    char  cmdline[82];  /* alternate cmdline for XGNP           */
/*566*/    int   allargs, gotargs;/* argc save and count for XGNP     */
/*56A*/    int   argc;         /* argument counter                     */
/*56C*/    char *argv[MAXARG];/* pointer to arguments of the cmd line*/
/*594*/    char  *odir, *idir; /* I/O redirection args from cmd line */
/*59C*/    int   iport,oport;  /* I/O port assignments                 */
/*5A0*/    char  *ladr;        /* holds pointer to line in _mwb        */
/*5A4*/    LWORD offset;       /* base memory pointer                  */
```

D. Task Control Block Definitions (cont'd)

```
/*5A8*/    int   bpcnt;         /* num of defined breakpoints         */
/*5AA*/    LWORD bpadr[MAXBP]; /* breakpoint address                  */
/*5D2*/    WORD  bpinst[MAXBP];/* breakpoint instruction              */
/*5E6*/    char  bpcmd[MAXBP][11];/* breakpoint command               */
/*654*/    int   bpocc[MAXBP]; /*# of times the breakpoint should be */
                               /* skipped                            */
/*668*/    int   bpcocc[MAXBP];/*# of times the breakpoint is already*/
                               /* skipped                            */
/*67C*/    LWORD bptadr;        /* temp. breakpoint address          */
/*680*/    WORD  bptinst;       /* temp. breakpoint instruction      */
/*682*/    int   bptocc;        /* # of times the temp. breakpoint   */
                               /* should be skipped                  */
/*684*/    int   bptcocc;       /* # of times the temp. breakpoint is */
                               /* already skipped                    */
/*686*/    char  bptcmd[11];    /* temp. breakpoint command          */
/*691*/    char  outflag;       /* output messages (yes - 1,no - 0)  */
/*692*/    char  namebn[MAXNAME][8]; /* Name buffer, name            */
/*6BA*/    char  namebd[MAXNAME][40];/* Name buffer, data            */
/*782*/    WORD  errcnt;        /* error counter for test ..         */
/*784*/    LWORD times,timee;   /* start/end time                    */
/*78C*/    LWORD pregs[N_REGS];/* storage area of processor regs     */
/*7F0*/    WORD  tflag;         /* trace active flag                 */
/*7F2*/    WORD  tcount;        /* trace count                       */
/*7F4*/    WORD  tacount;       /* active trace count                */
/*7F6*/    WORD  bpact;         /* break point active flag           */
/*7F8*/    LWORD savesp;        /* save VMEprom stack during GO/T etc */
/*7FC*/    char  VMEMSP[202];   /* Master stack, handle w/ care      */
/*8C6*/    char  VMESSP[802];   /* supervisor stack, handle w/ care  */
/*BE8*/    char  VMEPUSP[802]; /* vmeprom internal user stack        */
/*F0A*/    LWORD f_fpreg[3*8]; /* floating point data regs           */
/*F6A*/    LWORD f_fpcr;        /* FPCR reg                          */
/*F6E*/    LWORD f_fpsr;        /* FPSR reg                          */
/*F72*/    LWORD f_fpiar;       /* FPIAR reg                         */
/*F76*/    BYTE  f_save[0x3c]; /* FPSAVE for null and idle           */
/*FB2*/    BYTE  cleos[2];      /* clear to end of screen parameter  */
/*FB4*/    BYTE  cleol[2];      /* clear to end of line parameters   */
/*FB6*/    char  u_prompt[10]; /* user defined prompt sign           */
/*FC0*/    long  c_save;        /* save Cache control register       */
/*FC4*/    long  exe_cnt;       /* execution count                   */
/*FC8*/    BYTE  nokill;        /* kill tasks with no input port     */
/*FC9*/    BYTE  u_mask;        /* unit mask for echo                */
/*FCA*/    WORD  sysflg;        /* system flags used by VMEPROM      */
                               /* bit 0: display registers short form*/
                               /* bit 1: trace without reg. display  */
                               /* bit 2: trace over subroutine       */
                               /* bit 3: trace over subroutine active*/
                               /* bit 4: trace over range            */
/*FCC*/    LWORD t_range[2];   /* start/stop PC for trace over range */
/*FD4*/    LWORD ex_regs;       /* pointer to area for saved regs    */
/*FD8*/    BYTE sparend[0x1000-0xFD8]; /* make tcb size $1000 bytes  */
           char_tbe[0];         /* task beginning                    */
};
```

APPENDIX E

E. Interrupt Vector Table of VMEPROM

Vector Number/s	Vector HEX	Assignment
0	000	Reset: Initial Supervisor Stack Pointer
1	004	Reset: Initial Program Counter
2	008	Bus Error
3	00C	Address Error
4	010	Illegal Instruction
5	014	Zero Divide
6	018	CHK, CHK2 Instruction
7	01C	cpTRAPcc, TRAPcc, TRAPV Instructions
8	020	Privilege Violation
9	024	Trace
10	028	VMEPROM System Calls
11	02C	Coprocessor Instructions
12	030	(Unassigned, Reserved)
13	034	Coprocessor Protocol Violation
14	038	Format Error
15	03C	Uninitialized Interrupt
16 THROUGH 23	040 THROUGH 05C	--> (Unassigned, Reserved)
24	060	Spurious Interrupt
25	064	Level 1 Interrupt Auto Vector
26	068	Level 2 Interrupt Auto Vector
27	06C	Level 3 Interrupt Auto Vector
28	070	Level 4 Interrupt Auto Vector
29	074	PI/T Timer
30	078	Level 6 Interrupt Auto Vector
31	07C	Abort Switch
32 THROUGH 47	080 THROUGH OBC	--> TRAP #0-15 Instruction Vectors
48 THROUGH 63	0C0 THROUGH 0FC	--> Unassigned, Reserved

Interrupt Vector Table of VMEPROM cont.

Vector Number/s	Vector HEX	Assignment
64 THROUGH 75	100 THROUGH 12C	-> SIO-1/2 Interrupt Vectors
76 THROUGH 83	130 THROUGH 14C	-> ISIO-1/2 Interrupt Vectors
84 THROUGH 118	150 THROUGH ID8	-> User Defined
119	IDC	Disk Interrupt Vector
120 THROUGH 255	1E0 THROUGH 3FC	-> User Defined

APPENDIX F

F. Benchmark Source Code

```
*
* BENCH #1: DECREMENT LONG WORD IN MEMORY 10.000.000 TIMES
*
.BEN1BEG
        LEA.L   @010(PC),A0
        MOVE.L  #10000000,(A0)
@020    SUBQ.L  #1,(A0)
        BNE.S   @020
        RTS
@010    DS.L    1
.BEN1END
*
* BENCH #2: PSEUDO DMA 1K BYTES 50.000 TIMES
*
.BEN2BEG
        MOVE.L  #50000,D2    ; DO 50000 TRANSFERS
@001    MOVE.W  #$FF,D3      ; EACH IS 1K BYTES
        LEA.L   @010(PC),A1  ; A1 POINTS TO SOURCE AND DESTINATION
@002    MOVE.L  (A1),(A1)+
        DBRA    D3,@002
        SUBQ.L  #1,D2
        BNE.S   @001
        RTS
        NOP
@010    NOP
.BEN2END
        PAGE
*
* BENCH #3: SUBSTRING CHARACTER SEARCH 100.000 TIMES
*           TAKEN FROM EDN 08/08/85
*
*
.BEN3BEG
        MOVE.L  #100000,D4
@002    MOVE.L  #15,D0
        MOVE.L  #120,D1
        LEA.L   EDN1DAT(PC),A1
        LEA.L   EDN1DAT1(PC),A0
        BSR.S   EDN1
        SUBQ.L  #1,D4
        BNE.S   @002
        RTS
```

```
*
****** BEGIN EDN BENCH #1 *******
EDN1    MOVEM.L D3/D4/A2/A3,-(A7)
        SUB.W   D0,D1
        MOVE.W  D1,D2
        SUBQ.W  #2,D0
        MOVE.B  (A0)+,D3
@010    CMP.B   (A1)+,D3
@012    DBEQ    D1,@010
        BNE.S   @090
        MOVE.L  A0,A2
        MOVE.L  A1,A3
        MOVE.W  D0,D4
        BMI.S   @030
@020    CMP.B   (A2)+,(A3)+
        DBNE    D4,@020
        BNE.S   @012
@030    SUB.W   D1,D2
@032    MOVEM.L (A7)+,D3/D4/A2/A3
        RTS
@090    MOVEQ.L #-1,D2
        BRA.S   @032
******* END EDN BENCH #1 ******
EDN1DAT DC.B    '00000000000000000000000000000000'
        DC.B    '00000000000000000000000000000000'
        DC.B    'HERE000000000000000000000000000'
EDN1DAT1 DC.B   'HERE IS A MATCH0000000000000000'
.BEN3END
        PAGE
*
* BENCH #4: BIT TEST/SET/RESET 100.000 TIMES
*           TAKEN FROM EDN 08/08/85
*
*
.BEN4BEG
        RTS
.BEN4END
        PAGE
*
* BENCH #5: BIT MATRIX TRANSPOSITION 100.000 TIMES
*           TAKEN FROM EDN 08/08/85
*
.BEN5BEG
        RTS
.BEN5END
        PAGE
```

```
*
* BENCH #6: TEST - 128KB PROGRAM IS EXECUTED 1000 TIMES
*           CAUTION: THIS BENCHMARK NEEDS 128 KBYTE MEMORY
*
.BEN6BEG
        LEA.L   @010(PC),A2
        MOVE.L  #$203A0000,D1   ; OPCODE FOR MOVE.L ($0,PC),D0
        MOVE.L  #$20000/4,D2    ; LENGTH IS 128 KBYTE
@004    MOVE.L  D1,(A2)+        ; LOAD OPCODE TO MEMORY
        SUBQ.L  #1,D2
        BNE.S   @004
        MOVE.W  #$4E75,(A2)     ; APPEND RTS
* PROGRAM IS NOW LOADED -- START 1000 TIMES
        MOVE.L  #1000,D3
@008    BSR.S   @010
        SUBQ.L  #1,D3
        BNE.S   @008
        RTS
*
@010    DC.L    0               ; PROGRAM WILL START HERE
.BEN6END
        PAGE
*
* BENCH #7: FLOATING POINT 1.000.000 ADDITIONS
* not used on 68000/010 based systems
*
.BEN7BEG
        rts
.BEN7END
*
* BENCH #8: FLOATING POINT 1.000.000 SINUS
*
.BEN8BEG
        rts
.BEN8END
        PAGE
*
* BENCH #9: FLOATING POINT 1.000.000 MULTIPLICATIONS
*
.BEN9BEG
        RTS
.BEN9END
        page
*
* PDOS BENCHMARK #1: CONTEXT SWITCHES
*
.BEN10BEG
        MOVE.L  #100000,D6
@000    XSWP                    ;CONTEXT SWITCH
        SUBQ.L  #1,D6           ;DONE?
          BGT.S @000            ;N
        RTS
        PAGE
.BEN10END
```

```
*
* PDOS BENCHMARK #2: EVENT SET
*
.BEN11BEG
        MOVEQ.L #32,D1          ;SELECT EVENT 32
        MOVE.L  #100000,D6
*
@000    XSEV                    ;SET EVENT
        SUBQ.L  #1,D6           ;DONE?
          BGT.S @000            ;N
        RTS
.BEN11END
        PAGE
*
* PDOS BENCHMARK #3: CHANGE TASK PRIORITY
*
.BEN12BEG
        MOVEQ.L #-1,D0          ;SELECT CURRENT TASK
        MOVEQ.L #64,D1          ;SET PRIORITY TO 64
        MOVE.L  #100000,D6
*
@000    XSTP                    ;SET PRIORITY
        SUBQ.L  #1,D6           ;DONE?
          BGT.S @000            ;N
        RTS
.BEN12END
*
* PDOS BENCHMARK #4: SEND TASK MESSAGE
*
.BEN13BEG
        CLR.L   D0              ;SELECT TASK #0
        LEA.L   MES01(PC),A1    ;POINT TO MESSAGE
        MOVE.L  #100000,D6
*
@000    XSTM                    ;SEND MESSAGE
        XKTM                    ;READ MESSAGE BACK
        SUBQ.L  #1,D6           ;DONE?
          BGT.S @000            ;N
        RTS
MES01   DC.B    'BENCH #13',0
        EVEN
        PAGE
.BEN13END
*
* PDOS BENCHMARK #5: READ TIME OF DAY
*
.BEN14BEG
        MOVE.L  #100000,D6
@000    EQU     *
        XRTP
        SUBQ.L  #1,D6           ;DONE?
          BGT.S @000            ;N
        RTS
.BEN14END
        end
```

APPENDIX G

G. Special Locations

The following table describes some special locations in the EPROM. These locations define the default setup of the name of the startup file, user program location and RAM disk addresses. These options can be selected by front panel switches.

The locations shown in the table can be changed by the user to adapt VMEPROM to every environment. To make the necessary changes, please conduct the following steps:

1. Read the EPROMs with an EPROM programmer
2. Modify the code
3. Burn new EPROMs and keep the old ones in a safe location
4. Insert the new EPROMs in the CPU board and test the changes

User Alterable Memory Locations

$88000	DS.B 22	Name and disk of the startup file. There must be a zero terminated string. The default value is SY$STRT/2.
$88016	DS.W 2 DS.L 1 DS.W 2 DS.L 1 DS.W 2 DS.L 1	These are three entries for the default RAM disk. The first entry defaults to address $800000, the second to $700000 and the third to $A0000. The entries are: DC.W Disk number DC.W Number of 256 byte sectors DC.L Start address
$8802E	DS.B 8	This is the default of a RAM disk if it is initialized by the system. It must be a zero terminated string.
$88036	DS.L 4	These four entries contain the address which is jumpered to, after initialization of the kernel. The first long word holds $800000 by default, the second holds the address of the PDOS booter in EPROM, the third is $A0000 and the last one is the start address of VMEPROM.

APPENDIX H

H. Generation of Applications in EPROM

H1. General Information

In general, there are four ways to bind an application program in EPROMs to the VMEPROM kernel. In all cases the application program is executed in user mode. The XSUP system call can be used to switch to supervisor mode.

The first two ways keep the original EPROMs of VMEPROM. The application can be put into the User EPROM Area of the CPU-6 board or the application can reside on an external RR-2 or RR-3 board on the VMEbus. In both cases, the simulated front panel switches of the CPU-6 board have to be set so that the application program is stalled after VMEPROM is booted.

If you want to put your application on the CPU-6, the jumper settings and access times have to be changed to reflect the size and access times of the EPROMs used. Please refer to the Hardware User's Manual for a detailed description.

In both cases, the user stack is located at the top of the tasking memory and the supervisor stack is located within the task control block. The user stack has a size of 50 bytes. No register are predefined.

I1.1 Replacing the User Interface

The following section describes how an application program can be put into EPROMs replacing the user interface of VMEPROM.

This method gives nearly 96 Kbytes of EPROM space to the application. Two general ways are possible:

a. Removing All Setups:

If no setups are required, the application can be put into EPROMs at address $8000 (relative to the begin address of the EPROM). The entry address is $8046 which is the first byte after the tables described in Appendix H.

The cache of address $8046 is started in user mode directly after the kernel has been initialized. The supervisor stack is located in the tack control block (size is 500 bytes) and the user stack is located at the top of the task's memory. The task's memory has a size of approximately 490 Kbyte. Only the switches 2 and 8 on the front panel are used. All other are undefined. Switch 2 defines the databus width and Switch 8 is used to check for the hardware configuration on VMEbus.

b. Keep All Setups:

In order to keep all setups of VMEPROM, the user program can be located at address $8800 relative to the begin address of the EPROM (real address $88800).

In this case, the front panel switches are defined as described in the "Introduction to VMEPROM". Both the user and the supervisor stack are located in the task control block. The user stack has a reserved space of 800 bytes and the supervisor stack a space of 5600 bytes. The program is started in user mode. The following values are available on the stack:

4(A7)	Long word containing the begin address of the TCB
8(A7)	Long word containing the begin address of the system RAM (SYRAM).

A C-program at this address could look like this:

```
main (tcbp, syramp)

struct TCB *tcbp;

struct SYRAM *syramp;

{

     .
     .
     .
```

BIOS SOURCE CODE LISTINGS

TABLE OF CONTENTS

1. PI/T 68230 Initialization

```
*
*       Initialize PI/T timer as if System Clock
*

    LEA.L   PI_T,A0          ;POINT TO CHIP
    MOVE.B  #$08,PCDD(A0)    ;GET PC3 AS OUTPUT, LEAVE PC5 INPUT
    ST.B    PCDR(A0)         ;SET PC3 HIGH (NO INT)
    CLR.B   TMCR(A0)         ;ENABLE PC3 ON TOUT/PC3 PIN (FOR NO
                                 INTS)
    CLR.B   PSRR(A0)         ;SET FOR NO PIRQ
    MOVE.L  #TIMEC,D0        ;GET TIMER CONSTANT
    MOVEP.L D0,CPR(A0)       ;LOAD PRELOAD
    MOVEP.L D0,CNTR(A0)      ;LOAD COUNTER
*
    MOVE.B  #$E1,TMCR(A0)    ;ENABLE TIMER ON PI/T
```

2. RTC 58167 Initialization

```
*
*       Initialize RTC, INTS OFF
*

   LEA.L   RTC,A2           ;POINT TO RTC CHIP
   MOVE.B  #$00,SBI(A2)     ;RESET (& DISABLE) STANDBY INTERRUPT
   MOVE.B  #00,ICR(A2)      ;Turn OFF RTC compare int
```

3. ACIA 6850 Initialization

```
************************************************
*       BAUD PORT
*         D1.B = FHPI 8D_S
*        CMD.B =~Ih08 P001
*
BAUD    BSR.S   U1DC            ;CHECK FOR VALID BASE
        BSR.S   U1CMD           ;BUILD A COMMAND REG FROM D1.B
        MOVE.B  P$LEDB,CMD_1(A0) ;SET CONTROL CODE
        BRA.S   U1R_EQ          ;GOOD RETURN (SR=EQ)
*
ACIATB  DC.L    U.1ADR
        DC.L    U.2ADR
        DC.L    U.3ADR
        DC.W    0
************************************************
*       BUILD A 6850 COMMAND REG
*         IN:  D1.B = FHPI 8D_S
*        OUT: CMD.B =~Ih08 P001
*       SAVE IN P$LEDB
*
*                                   X 7654 3210
U1CMD   MOVEM.L D1/D2,-(A7)     ;D1:  FHPI 8D_S
        MOVEQ.L #$10,D2         ;D2:0 0001 0000
        LSR.B   #4,D1           ;D1:8 0000 FHPI
        ROXL.B  #1,D2           ;D2:0 0010 0008
        LSL.B   #7,D1           ;D1:P I000 0000
        ROXL.B  #4,D2           ;D2:  0008 P001
        TST.B   D1              ;ENABLE INTS?
        BMI.S   @010            ;N, LEAVE DISABLED
        TAS.B   D2              ;Y, SET UPPER BIT OF CMD.B
*
@010    MOVE.B  D2,P$LEDB       ;SAVE IN LOW MEMORY
        MOVEM.L (A7)+,D1/D2     ;POP WORKING
        RTS
*
************************************************
*       CHECK FOR VALID BASE ADDRESS
*
U1DC    MOVE.L  A1,-(A7)        ;SAVE A1
        LEA.L   ACIATB(PC),A1
*
U1DC00  TST.W   (A1)            ;DONE?
        BEQ.S   U1DC04          ;Y, SET .NE., POP OUT
        CMPA.L  (A1)+,A0        ;VALID?
        BNE.S   U1DC00          ;N
        MOVE.W  #20000,-(A7)    ;Y, ALLOW LAST CHAR TO CLEAR
*
U1DC02  SUBQ.W  #1,(A7)         ;LOOP
        BNE.S   U1DC02
        MOVE.B  #$03,CMD_1(A0)  ;ISSUE RESET TO THE ACIA
```

```
        MOVE.W  #20000,(A7)     ;NOW WAIT FOR AWHILE
*
U1DC03  SUBQ.W  #1,(A7)         ;WAIT FOR RESET
        BNE.S   U1DC03
        ADDQ.W  #2,A7           ;POP COUNTER
        MOVEA.L (A7)+,A1
        RTS                     ;RETURN
*
U1DC04  MOVEA.L (A7)+,A1
        ADDQ.W  #4,A7           ;POP RETURN ADDRESS
*
U1R_NE  CLR.W   -(A7)           ;SET STATUS .NE.
        RTR
*
U1R_EQ  CMP.B   D0,D0           ;RETURN .EQ.
        RTS
```

4. ACIA Receiver Interrupt Handler

```
************************************************
*
*       CPU-6 ACIA INTERRUPT HANDLER
*
        XDEF    BINT4
        XDEF    SPI1,SPI2,SPI3
*
BINT4
SPI1    MOVE.L  #U.1ADR,-(A7)   ;PUSH TERMINAL PORT ADDR
*
ACIA    MOVE.W  #B.PTMSK,SR     ;DISABLE INTS
        MOVE.L  (A7)+,P$UADR    ;POP PORT ADDR (AFTER INTS
                                    DISABLED, PLEASE)
        MOVEM.L D0-A6,-(A7)     ;SAVE REGS
        MOVEA.L P$UADR,A0       ;GET UART ADR
        BTST    #0,STS_1(A0)    ;DATA AVAILABLE?
        BEQ.S   ACIA04          ;N, ?????
        MOVE.B  DAT_1(A0),D0    ;Y, GET CHARACTER
        BRA.S   ACIA02          ;EXIT TO K2$CHRI
*
SPI2    MOVE.L  #U.2ADR,-(A7)   ;PUSH HOST PORT ADDR
        BRA.S   ACIA
*
SPI3    MOVE.L  #U.3ADR,-(A7)   ;PUSH REMOTE PORT ADDR
        BRA.S   ACIA
*
ACIA02  MOVEA.L B$SRAM,A5       ;LOAD UP SYSRAM PTR
        MOVEA.L  K1BEGN(A5),A1  ;KERNEL ENTRY POINT
        JMP     K2CHRI(A1)      ;TO ROUTINE K2$CHRI
*
ACIA04  MOVEM.L (A7)+,D0-A6     ;RESTORE REGS
        RTE                     ;RETURN & HOPE
```

5. ACIA Character Output Driver

```
*************************************************
*       PUT CHARACTER (FOR GOOD)
*
U1DP    BTST    #BDTR,D1        ;CHECK DTR?
        BEQ.S   U1DP2           ;N
        BTST    #3,STS_1(A0)    ;Y, DTR, CHECK PIN 20, (CTS-)
        BNE.S   U1R_NE          ;NOT CLEAR TO SEND
*
U1DP2   BTST.B  #1,STS_1(A0)    ;Y, CAN WE OUTPUT A CHAR?
        BEQ.S   U1R_NE          ;N
        MOVE.B  D0,DAT_1(A0)    ;Y, OUTPUT IT
        BRA.S   U1R_EQ          ;RETURN .EQ.
        PAGE
```