Cambridge Microprocessor Systems Limited

FlashModule Hardware

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1. Introduction

This section of the documentation describes the hardware side of the FlashModule product range. This manual is split into five main sections. The first section covers the FlashModule family in general, detailing features that are common to all FlashModule products. The next three sections describe the features particular to each product in the range. The final section gives details on the Flash Formatter product, which is a utility board available for all controllers in the product range. This document refers to the 307 User Manual, which is supplied as part of the documentation for these products. This document is published by Motorola and they are responsible for the contents of that manual.

1.1. General Features

The following is a list of features available on all FlashModule products in the range. The items in this list are detailed in this section of the manual.

- 68307 Controller
- 14.7456 MHz clock speed
- 512 k-byte Flash memory
- 512 k-byte Static RAM
- 2 RS232 serial ports
- 1 RS232/485 serial port
- Real Time Calendar Clock
- Battery Backed Static RAM
- 2 16-bit timer/counters
- Software watchdog
- M-Bus (I^2C bus)
- Digital I/O
- Watch dog
- Power Fail Detect
- Module Expansion Bus (compatible with 307-Module etc)

1.2. Memory Map

The memory map for all the FlashModule products is as shown in the table below.

	Start Address	End Address	Notes
Flash Memory	$000000	$0FFFFF	1 M-byte *
	$000000	$07FFFF	512 k-byte
Reserved	$100000	$11FFFF	Do not use
Peripherals	$120000	$120FFF	4 k-bytes
Reserved	$121000	$127FFF	Do not use
External Peripherals	$128000	$129FFF	
L C D Port	$12A000	$12AFFF	+
12-bit ADC	$12B000	$12B7FF	+♣
External Peripherals	$12B800	$12FFEF	
Serial ':S1' & ':S2'	$12FFF8	$12FFFF	
External Expansion	$130000	$6FFFFF	
Static RAM	$700000	$0F7FFFF	8.5 M-bytes *
	$F00000	$F7FFFF	512 k-byte

* Using Expansion Boards only (see section 5)
\+ Not available on FlashModule FM200
♣ Not available on FlashModule FM400

It is important that addresses shown as used in the memory map above are not used for expanding any FlashModule products. These addresses are used for configuration on FlashModule products that do not support the feature. The LCD and Keypad interface expansion card (K-020) when used with a FM200 controller is an exception to this rule. The following M-Bus addresses are also use on the FlashModule product range, again they should not be used in any expansion. The addresses used are: $20, $21, $22 , $23, $48, $49, $50.

1.3. Controller

The heart of the system is a 68307 micro controller. This device is a 68000 code compatible central processor unit (CPU) with a UART, M-Bus (I^2C) port, two 16-bit timer counters, software watchdog facility and a number of TTL/CMOS digital I/O ports. Full details on the micro controller can be found in the 307 User Manual documentation supplied separately. The Minos operating system configures the controller registers to be addressed at $12000. This base address is referred to as 'MBAR' in the 307 User Manual and should be added to most register addresses given in this document. The FlashModule range use the processor clocked at 14.7456 MHz. This gives a stable frequency for use with the serial port.

The table below is a memory map of the internal CPU registers. It also gives the page number in the 307 User Manual where further details can be found. Most of the registers are 16-bits wide. Where they are not the size of the register is quoted in the table. The addresses for most registers in this table assume that the MBAR register is set to $0120 to place the base address for the on chip peripherals at $120000.

Register Name		Address	307 User
System Configuration Registers			
Reserved		$00000F0	
Module Base Address Register	MBAR	$00000F2	5-22
System Control Register (32-bit)	SCR	$00000F4	5-23
		$00000F6	
Reserved		$00000F8	
Reserved		$00000FA	
Reserved		$00000FC	
Reserved		$00000FE	
SIM Module – External Bus Interface Registers			
Port A Control (8-bit)	PACNT	$120011	5-34
Port A Data Direction (8-bit)	PADDR	$120013	5-35
Port A Data Register (8-bit)	PADAT	$120015	5-35
Port B Control	PBCNT	$120016	5-36

Port B Data Direction	PBDDR	$120018	5-36
Port B Data Register	PBDAT	$12001A	5-37
SIM Module – Interrupt Controller Registers			
Latched Interrupt Control 1	LICR1	$120020	5-38
Latched Interrupt Control 2	LICR2	$120022	5-38
Peripheral Interrupt Control	PICR	$120024	5-39
Programmable Interrupt Vector (8-bit)	PIVR	$120027	5-40
SIM Module – Chip Select Registers			
Base Register 0	BR0	$120040	5-30
Option Register 0	OR0	$120042	5-32
Base Register 1	BR1	$120044	5-30
Option Register 1	OR1	$120046	5-32
Base Register 2	BR2	$120048	5-30
Option Register 2	OR2	$12004A	5-32
Base Register 3	BR3	$12004C	5-30
Option Register 3	OR3	$12004E	5-32
SIM Module – UART Module Registers (all 8-bit)			
Mode Register 1	UMR1	$120101	8-15
Mode Register 2	UMR2	$120101	8-17
Status Register (Read)	USR	$120103	8-19
Clock Select Register (Write)	UCSR	$120103	8-21
Command Register (Write)	UCR	$120105	8-23
Receiver Buffer (Read)	URB	$120107	8-25
Transmitter Buffer (Write)	UTB	$120107	8-25
Input Port Change (Read)	UIPCR	$120109	8-26
Auxiliary Control (Write)	UACR	$120109	8-26
Interrupt Status (Read)	UISR	$12010B	8-27
Interrupt Mask (Write)	UIMR	$12010B	8-28
Timer Upper Preload (Write)	UBG1	$12010C	8-29
Timer Lower Preload (Write)	UBG2	$12010E	8-29
Interrupt Vector Register	UIVR	$120119	8-29
Input Port Register (Read)	UIP	$12011B	8-29
Output Port Register 1 (Write)	UOP1	$12011D	8-30
Output Port Register 0 (Write)	UOP0	$12011F	8-30
SIM Module – Timer Module Registers			

Timer Mode Register 1	TMR1	$120120	6-4
Timer Reference Register 1	TRR1	$120122	6-5
Timer Capture Register 1	TCR1	$120124	6-5
Timer Counter 1	TCN1	$120126	6-5
Timer Event 1 (8-bit)	TER1	$120129	6-6
Watchdog Reference Register	WRR	$12012A	6-7
Watchdog Counter Register	WCR	$12012C	6-7
Timer Mode Register 2	TMR2	$120130	6-4
Timer Reference Register 2	TRR2	$120132	6-5
Timer Capture Register 2	TCR2	$120134	6-5
Timer Counter 2	TCN2	$120136	6-5
Timer Event 2 (8-bit)	TER2	$120139	6-6
SIM Module – M-Bus (I^2C) Module Registers (all 8-bit)			
M-Bus Address Register	MADR	$120141	7-6
M-Bus Frequency Divider	MFDR	$120143	7-6
M-Bus Control Register	MBCR	$120145	7-7
M-Bus Status Register	MBSR	$120147	7-9
M-Bus Data I/O Register	MBDR	$120149	7-10

1.3.1. Timer / Counters

The two 16-bit timer/counters are located within the 68307 controller. For details on these devices please refer to the 307 User Manual. If the Minos Real Time Multi tasking operating system is used Timer 1 is set up to generate 100 Hz interrupt on level 6. These interrupts are used by the multi tasking features to switch tasks and perform other timing functions. The timers are accessed using the timer/counter registers directly.

1.3.2. Watchdog Timer

This is a special function timer provided by the 68307 controller. This counter is loaded with a predetermined value following a reset. On the FlashModule the time out period is programmed to approximately 400ms. This time out period can be adjusted by software. The counter is decrement every clock pulse until it reaches zero. On the occurrence of this event the timer generates a reset pulse to reset the controller. To prevent the timer reaching the watchdog control register

must be written within the reset period. The high-level language support provided with the FlashModule products include a number of functions to access the watchdog directly from the application code. Please refer to the FlashModule User Manual for full details.

1.3.3. M-Bus (I^2C) Port

This is a serial interconnection bus designed to allow a number of devices to be connected using just two wires. Full details on the M-Bus port can be found in the 307 User Manual. The M-Bus is used on the FlashModule products to access the real time calendar clock, some of the digital I/O lines and some of the analogue I/O. As a result of this some M-Bus addresses are allocated and should not be used. Details of the allocated addresses can be found in section 1.2.

1.4. Serial Ports

The FlashModule products have three serial ports. The first serial port known on Minos systems as ':S0', is provided by the serial port in the controller. This is based on a 68681 type serial device. This serial port can be used in either RS232 mode or RS485 multi drop mode depending on the setting of the jumper on the serial port select link. If the jumper is fitted in the North direction the RS485 buffer is fully enabled. If the jumper is fitted in the South direction then the RS232 buffer is fully enabled. Data is transmitted from both ports regardless of the setting of the link, it will only be received by the selected port. When used in RS485 mode a terminating resistor should be placed across the transmission lines if the controller is at an end of the line. This is implemented by fitting a jumper on the RS485 terminator link. Full details on this serial port can be found in the 307 User Manual.

An 85C30 device provides the other two serial ports. The serial ports on this device are called ':S1' and ':S2'. The serial port ':S1' is also known as ':TERM' and it is the default serial port for all communications. Both these ports are configured for use with RS232 buffers. The device is set up to run in asynchronous mode only, with a PCLK frequency of 3.6864 MHz. The oscillator is fitted to port A (':S1') and is also set to 3.6864 MHz. Details on the registers within the

UART can be found in the 8530 User Manual which is supplied as a separate document in this package. These two serial ports use interrupt level 3 (INT8, PB15) for communication.

Utilities are provided in the high-level language support to enable baud rates, data size, number of stop bits and parity to be configured from the application program. For full details refer to the library section of the FlashModule User Manual.

1.5. Real Time Calendar Clock

The real time calendar clock is based on a Philips Semiconductors M-Bus device located at M-Bus address $50. This can be used to obtain the current time and date, and is year 2000 compliant. The real time clock returns the day, date, month, year and hours, minutes and seconds. The clock also has an alarm feature, which can be used to generate an interrupt at a particular time/date. The interrupts from the clock will generate a level 1 interrupt on Port B11. The clock is accurate to within ±2 seconds per month and the data in the clock is retained when the power is removed.

1.6. Flash Memory

The 512 k-bytes of flash memory are programmable on board. The 512 k-bytes are divided up into 8 sectors each of 64 k-bytes. Before data can be written to a sector the whole sector must first be erased. The lower sectors of the flash memory normally contain the operating system and so this should not be overwritten. The rest of the device is available for application programs. Utility programs are provided to save programs, data and other modules in the flash memory. Please refer to the FlashModule User Manual for details. To modify the operating system sectors a Flash Formatter (section 5.1) should be used. The devices used on these products are manufactured by AMD, and are programmed using only a 5 Volt supply. The flash memory operates with zero wait states.

Under normal operating conditions the flash memory is located in the address range $000000 and $07FFFF. By default the FlashModule

will boot from the code contained in this address space. The total amount of flash memory can be expanded up to 1 M-byte using the Flash Formatter as a memory expansion card.

1.7. Static RAM

There are 512 k-bytes of battery backed static RAM on all FlashModule's. The on board static RAM is located in the 512 k-bytes between $F00000 and $F7FFFF. By default the RAM is battery backed. To clear the contents of the RAM the power must be removed and the jumper fitted on the Battery Backup link should be moved South. The jumper should be left in this location for a few seconds before replacing it in the North ('B') position. This link should not be in the South position when power is applied to the board. In this condition the board could be damaged. The static RAM is a single surface mounted device and runs with zero wait states. The static RAM can be extended up to 8.5 M-bytes using a memory expansion board, please see section 5.2 for details.

1.8. Module Bus Expansion

This is a standard 68000 expansion bus which is used on a wide range of Cambridge Microprocessor Systems cards. This bus allows a number of peripheral cards to be connected directly to the FlashModule. The current range of compatible peripherals include analogue I/O, digital I/O, serial I/O, printer outputs, video outputs etc., for full details, and the latest products, please visit our peripherals catalogue on our website at http://www.cms.uk.com/periph.html.

The Module Bus uses two basic modes of operation, 68000 peripherals and 68000 memory. The Module Bus also supports five interrupt lines, four of which can be masked. When expanding the FlashModule products using the Module Bus care should be taken that you do not decode any devices into the memory map that clash with peripherals and memory devices already allocated. Full details on the memory map allocations for all FlashModule products can be found in section 1.2.

1.8.1. Bus Width Considerations

The 68000 memory and peripheral modes both use the full 16 bit data bus on the 68000. This means that as the address increases bytes are read alternatively from ‘D8’-‘D15’ and ‘D0’-‘D7’. This is not a problem with memory as two 8 bit devices can be used, one for each half of the data bus. However peripheral devices which have only 8 bit data busses must multiplex between ‘D8’-‘D15’ and ‘D0’-‘D7’. The simplest, and most common, solution is to connect the peripheral to ‘D0’-‘D7’ and connect ‘A1’ on the bus to ‘A0’ on the peripheral etc. This offset in the address lines mean that the peripheral would only be accessible at alternate addresses. Using ‘D0’-‘D7’ means that the registers are accessible on odd addresses only and gives a degree of compatibility with 68000 systems which also use ‘D0’-‘D7’ for interrupt vector fetches. The 68000 instruction set has a group of instructions (movep) which are designed to read and write multiple bytes to peripheral devices connected in this way. On the FlashModule it is possible to program the expansion bus to be an 8-bit bus. This is not recommended for compatibility because, when using the 8 bit bus width of the MC68307, the peripheral must be connected to the UPPER ‘D8’-‘D15’ data lines not the lower ‘D0’-‘D7’ as with standard 68000 bus peripheral cycles.

1.8.2. Asynchronous Operation

The 68000 bus uses an asynchronous mode of operation to access peripherals and memory. This means that the speed of each bus cycle is determined dynamically during each bus cycle. The processor starts a bus cycle by supplying the address and data followed by some control signals to say that they are valid. The participating peripheral must then wait until it has accepted the CPUs data (write cycle) or provided data for the CPU (read cycle) before asserting the ‘DTACK’ (data transfer acknowledge) signal to tell the CPU to complete the cycle.

The FlashModule can generate the ‘DTACK’ internally after a programmed number of wait states after a chip select has been asserted if required. This is not recommended, and is not used on

Minos systems, when accessing the Module Bus peripherals as all expansion boards on the bus will generate their own ‘DTACK’ signal when they are ready.

1.8.3. Memory Expansion

The memory expansion mode is used to add large blocks of external memory to the Module Bus. In this mode all the external Module Bus address lines must be decoded and the ‘AS’ signal should be used to enable the decoders. The memory may be read or written 8 or 16 bits at a time with the size controlled by the ‘DS0’ and ‘DS1’ signals. If ‘DS0’ only is asserted then a data byte is to be transferred on ‘D0’ to ‘D7’ only. If ‘DS1’ is asserted on it own then the data byte is transferred on ‘D8’ to ‘D15’. If both ‘DS0’ and ‘DS1’ are asserted at the same time then it is a 16 bit transfer with all data lines used. A simple OR gate and inverter can be used with ‘DS0’, ‘DS1’ and Write to produce separate strobe lines for the two halves of the data bus.
<$&strobe[-]>
Figure 4 and figure 5 are timing diagrams for 68000 read and write cycles.
<$&68000read[-]>
<$&68000write[-]>

1.8.4. Peripheral Expansion

The peripheral expansion mode is used to add I/O devices to the 68000 bus. Transfers can be made in 8 or 16 bits but if 8 bit devices are used they should be connected to ‘D0’-‘D7’ and should have the address lines offset (see Bus Width Considerations). The address decoding only needs to include ‘A14’ downwards and the decoder should be enabled with the ‘PAS’ signal.

1.8.5. Interrupts

The Module Bus includes a number of interrupt inputs which can be used freely by expansion boards. Three of the lines correspond to levels 3, 4 and 7. The other line can not be masked and will always generate an interrupt level 7. The interrupt lines are edge sensitive

and should be driven with open collector drivers. They are pulled up on the controller board.

1.9. Power On LED

The FlashModule range has a red LED, D1, located near the power input terminals which will be illuminated while power is applied to the board.

1.10. Halt LED

A red LED, D2, is fitted to the controller cards. This LED will be illuminated if the processor enters the halt state. This will occur if the processor crashes in any way.

1.11. General LED

A third red LED, D4, is fitted on the controller cards that can be flashed under program control. This is used as one of the demonstration programs to show that the board is functioning. This LED will also be flashed as the FlashModule starts up.

1.12. Reset Switch

This is a small switch located in the top left-hand corner of the controller board. If this button, SW1, is pressed and held down for a short time the controller will be reset. After the reset the controller registers will take up their default values and the program will start to run from the reset vector. The button has to be held down for a short period as this button is debounced using a power supervisor device. If the button is held down for a long period, reset pulses will be generated.

1.13. Mode Switch

The Mode switch is a slide switch that is used to determine the operating mode of the controller. The switch connects to port B8 on the processor. If the switch SW2 is in the ‘D’ (Debug) position the controller will run a standard terminal environment to allow programs

to be downloaded, run and debugged under user control. In the ‘R’ (Run) position the controller will run the user defined program from reset. For further details on this switch please refer to the FlashModule User Manual.

2. FlashModule FM200

This is the entry level controller in the FlashModule range. Most of the features of this controller have been covered in the previous section. The only exception to this is the 10 digital I/O channels. This section will give details of the digital I/O, connectors and specification only.

2.1. Digital I/O

The FlashModule FM200 has 10 CMOS/TTL digital I/O ports. The digital channels are taken directly from the micro controller. Channels 0 to 7 are connected directly to Port A 0 to 7 respectively. Channel S0 is connected to Port B6 (T1in) and channel S1 to Port B7 (T2in). Channels 0 to 7 can be accessed as either individual channels or as an 8-bit port. The other 2 channels can only be accessed as individual channels. None of these I/O channels can be used to generate interrupts. External connections to these digital channels are provided on the Digital I/O connector, please see section 2.2.3 for full details.

2.2. FlashModule FM200 Connectors

2.2.1. Power Input, PL1

This is a two way terminal block. Power is applied to the board by connecting an external power supply between these two terminals. The dc power supply must be in the range 4.8 Volts to 5.2 Volts. A supply outside this range could cause irreparable damage to the board. Care should also be taken that the power supply is connected with the correct polarity, the positive wire should be connected to the west terminal.

2.2.2. Module Bus Expansion, PL2

This connector has a total of 64 connections. It allows the FlashModule to be expanded by adding additional cards. The Flash Formatter card is also plugged into this connector. Most of the CPU bus signals are available from this connector. There are also five interrupt lines. Row 'a' is nearest the edge of the board. The +12 Volts and –12 Volts will only be present if a separate supply is used. They are not required to power the board.

Signal	Row B	Row A	Signal
D0	1	1	D8
D1	2	2	D9
D2	3	3	D10
D3	4	4	D11
D4	5	5	D12
D5	6	6	D13
D6	7	7	D14
D7	8	8	D15
GND	9	9	GND
CLK	10	10	SCL
GND	11	11	A17
DS1	12	12	NRST
DS0	13	13	A18
WRITE	14	14	A19
A20	15	15	A0
DTACK	16	16	A21
GND	17	17	A22
PAS	18	18	NMI (IRQ7)
AS	19	19	I6 (PB12)
A23	20	20	I5 (PB13)
IACK	21	21	I4 (PB14)
A16	22	22	I3 (PB15)
SDA	23	23	A15
A7	24	24	A14
A6	25	25	A13
A5	26	26	A12

A4	27	27	A11
A3	28	28	A10
A2	29	29	A9
A1	30	30	A8
-12 Volts	31	31	+12 Volts
+5 Volts	32	32	+5 Volts

2.2.3. Digital I/O Connector, PL3

This connector is a 16 way vertical boxed header. The +12 Volts and –12 Volts will only be present if an external power supply is used. They are not required for the board to function.

Signal	Pin	Pin	Signal
+5 Volts	16	15	+5 Volts
+12 Volts	14	13	-12 Volts
S1 (PB7)	12	11	S0 (PB6)
CH7 (PA7)	10	9	CH6 (PA6)
CH5 (PA5)	8	7	CH4 (PA4)
CH3 (PA3)	6	5	CH2 (PA2)
CH1 (PA1)	4	3	CH0 (PA0)
GND	2	1	GND

2.2.4. Serial Port ':S0', PL4

This connector is a 10 pin vertical boxed header. The 'A' and 'B' signals are the +ve and –ve signals for the RS485 network port. The other signals are at RS232 levels.

Signal	Pin	Pin	Signal
A (+ve)	10	9	GND
B (-ve)	8	7	N/C
RTS	6	5	RXD
CTS	4	3	TXD
+5 Volts	2	1	N/C

2.2.5. Serial Port ':S1' & ':S2', PL5 & PL6

Signal	Pin	Pin	Signal
N/C	10	9	GND
N/C	8	7	N/C
RTS	6	5	RXD
CTS	4	3	TXD
+5 Volts	2	1	N/C

2.2.6. M-Bus (I^2C) Port, PL7

This connector is a 4 way pin strip. Pin 1 is north.

Pin	Signal
1	+5 Volts
2	SCL
3	SDA
4	GND

2.3. Links

There are only four user configurable links on the FlashModule FM200.

2.3.1. Reset, LK1

This link is a two way pin strip. By connecting the two pins together the system can be reset. It is connected in parallel with SW1.

2.3.2. Serial Port Select, LK2

This link is a 3 way pin strip. It is used to determine the serial input format for serial port ':S0'. If this link is fitted in the 'North' position then the serial port will receive data from the RS485 network port. If the link is fitted 'South' then data will be received from the RS232 port. Data will be transmitted using both formats.

2.3.3. RS485 Termination, LK3

This is a 2 way pin strip. If the FlashModule is at the end of a RS485 transmission line then the line should be terminated on this board to prevent reflections. By fitting this link a 100Ω resistor is placed across the two signal lines.

2.3.4. Battery Backed Link, LK4

This is a 3 way pin strip. It is used to disable the battery backup on the static RAM. When power is applied to the board, this link should be fitted 'West'. To clear the contents of the RAM the power must be removed and this link moved 'East'. The link must be returned to the 'West' location before power is restored. If power is applied to the board while this link is fitted 'East' the static RAM could be damaged. The Real Time Calendar Clock is always battery backed so this link will have no affect on the data stored in the real time clock.

2.4. FlashModule FM200 Specification

Processor
68307 Controller
68000 Code Compatible
14.7456 MHz clock speed

Memory
512 k-bytes Flash Memory (expandable off board up to 1 M-bytes)
512 k-bytes Battery Backed Static RAM (expandable off board up to 8.5 M-bytes)

Battery
VL2020 20mAh
Vanadium Lithium compound

Serial Ports
RS232/RS485 Serial Port
2 RS232 Serial Ports
Up to 57600 baud communications
RS232 full hardware handshaking

RS485 network port

Real Time Calendar Clock
Day, date, month, year
Hours, minutes, seconds
Alarm feature
Year 2000 compliant

Digital I/O
10 TTL/CMOS I/O channels
1 8-bit port

Two 16-bit timer/counters
External Input & Output
Count or Timer modes
Watchdog timer

Power Supply
Single 5Volt ± 0.2V supply
Current consumption 150 mA (typ.)
Switching the processor to one of its low power modes can reduce the current consumption. Please refer to the 68307 User Manual for full details.

Physical
100 x 80 mm
Maximum component height is 12mm. A further 10mm should be allowed for cable entry.
Relative humidity 0 – 90% (non condensing)
Operating temperature range 0 – 70 °C

3. FlashModule FM400

This is the middle controller in the FlashModule range. It adds some extra digital I/O lines, eight channels of 8-bit analogue inputs, 2 channels of 8-bit analogue output, an alphanumeric LCD port and a 16 way matrix keypad port to the features already present on the FM200 product.

3.1. Digital I/O

The FM400 has up to 26 digital I/O channels. All the channels can be accessed as individual ports or in three groups of 8-bit ports. Port A of the processor provides channels 0 to 7 (port 0) as well as the two special channels S0 (port B6) and S1 (port B7). Two I^2C devices provide the other 16 channels, which are configured as channels 8 – 23 and ports 1 and 2 using devices $20 and $21. Ports 1 and 2 can also be configured as a matrix keypad port. Please see section 3.2 for details.

All 26 digital I/O channels are TTL/CMOS compatible. A change of state on either ports 3 or 4 can generate an interrupt on channel I4 (port B14). By configuring the digital channels to generate an interrupt the processor will be able to respond quickly when a change is detected rather than having to poll the ports waiting for a change of state to occur. This interrupt is used when the keypad is in use, or it can be user programmed when these channels are used as general purpose I/O lines. The other 10 digital channels have no interrupt capability. Full details on the external connections to the digital I/O channels on the FM400 can be found in sections 3.5.5 and 3.5.7.

3.2. Keypad Port

The keypad port on the FlashModule products is designed to accept a wide range of matrix keypads. The port connects to two of the M-bus digital I/O chips (device $20 & $21). When the keypad port is in use any key press will generate an interrupt on I4 (PB14). The Minos driver will intercept this interrupt and read the character represented from the keypad. This character is stored in the input buffer. The operating system software allows all keypads up to 64 keys to be uniquely defined by entering the row and column masks. Details on the keypad connector are in section 3.5.8. A list of compatible keypads can be found in section 6.2.

3.3. Analogue I/O

The FM400 has eight channels of 8-bit analogue input and two channels of 8-bit analogue output. This analogue I/O is provided by two M-Bus devices at that occupy addresses $48 and $49. The reference voltage is generated on board and is factory calibrated to 2.560 Volts by adjusting the variable resistor VR2. The reference voltage is present on test point TP1. The both the input and output range is 0.00 ($00) to 2.55 ($FF) Volts.

3.4. LCD Port

The LCD port on the FlashModule FM400 allows a wide range of alphanumeric liquid crystal displays to be connected directly to the board. All compatible liquid crystal displays are 5 Volt only displays, with a contrast voltage between 0 and 5 Volts and a XXXX HD44680 compatible controller fitted. There are two LCD connectors on the FM400, these are intended for different pin outs of the LCD and only one LCD should be used at a time. A number of compatible displays are listed in section 6.1. When using alphanumeric liquid crystal displays it is important that link LK4 is fitted in the ‘A’ position.

The LCD is memory mapped into the controller between addresses $12A000 and $12AFFF. Minos drivers are provided for the displays allowing them to be directly accessed from the applications program. Most four line and all compatible two line LCDs have two controllers, one for the top two lines and one for the lower two lines. For this type of display the standard LCD driver can be used, drlcd. Other displays, particularly four line by twenty character displays have a single controller, for these displays a different controller drld4x20 is provided.

A range of graphic liquid crystal displays with a HD61830 compatible controller can be interfaced to the FlashModule FM400 using a simple adapter board. When these are used the link LK4 must be in the ‘G’ position. The adapter board modifies the pin out of connector PL3 to that of the graphics panel and produces a range of LCD contrast voltages and drive voltages. Compatible LCD panels can be found in section 6.1.

3.5. FlashModule FM400 Connectors

The FlashModule FM400 shares the same printed circuit board as the FM600 product.

3.5.1. Power Input, PL1

This is a two way terminal block. Power is applied to the board by connecting an external power supply between these two terminals. The power supply must be in the range 4.8 Volts to 5.2 Volts. A supply outside this range could cause severe damage to the board. Care should also be taken that the power supply is connected with the correct polarity, the positive wire should be connected to the west terminal.

3.5.2. Alphanumeric LCD, PL2

This is a 16 way 0.1” pin strip. It is designed to allow a range of 4 line by 20 character displays to be connected directly to the FlashModule. Some of these displays are available with a 5 Volt LED back light. If the display has a back light, many of them can be powered by a different supply. If this is the case then the back light can be turned on by connecting LK1 west. The back light can be turned off by connecting LK1 east. A list of 5 Volt only compatible displays can be found in section 6.1.

Pin	Signal
1	GND
2	+5 Volts
3	Vcont
4	RS
5	R/W
6	E
7	D0
8	D1
9	D2
10	D3
11	D4

12	D5
13	D6
14	D7
15	BL +ve
16	BL –ve

3.5.3. LCD Display Port, PL3

This is an alternative to the alphanumeric LCD connector detailed in section 3.5.2. It is a 16 way vertical boxed header. Only one LCD should be fitted at any time. A range of graphics displays can also be connected to this LCD port using a simple adapter board.

Signal	Pin	Pin	Signal
E2	16	15	E1
D7	14	13	D6
D5	12	11	D4
D3	10	9	D2
D1	8	7	D0
E	6	5	R/W
RS	4	3	Vcont
+5 Volts	2	1	GND

3.5.4. Module Bus Expansion, PL4

This connector has a total of 64 connections. It allows the FlashModule to be expanded by adding additional cards. The Flash Formatter card is also plugged into this connector. Most of the CPU bus signals are available from this connector. There are also five interrupt lines. Row ‘a’ is nearest the edge of the board. The +12 Volts and –12 Volts will only be present if a separate supply is used. They are not required to power the board.

Signal	Row B	Row A	Signal
D0	1	1	D8
D1	2	2	D9
D2	3	3	D10

D3	4	4	D11
D4	5	5	D12
D5	6	6	D13
D6	7	7	D14
D7	8	8	D15
GND	9	9	GND
CLK	10	10	SCL
GND	11	11	A17
DS1	12	12	NRST
DS0	13	13	A18
WRITE	14	14	A19
A20	15	15	A0
DTACK	16	16	A21
GND	17	17	A22
PAS	18	18	NMI (IRQ7)
AS	19	19	I6 (PB12)
A23	20	20	I5 (PB13)
IACK	21	21	I4 (PB14)
A16	22	22	I3 (PB15)
SDA	23	23	A15
A7	24	24	A14
A6	25	25	A13
A5	26	26	A12
A4	27	27	A11
A3	28	28	A10
A2	29	29	A9
A1	30	30	A8
-12 Volts	31	31	+12 Volts
+5 Volts	32	32	+5 Volts

3.5.5. Digital I/O Connector, PL5

This connector is a 50 way vertical boxed header. Channels CH24 to CH39 are only available on the FM600 product. The +12 Volts and –12 Volts will only be present if an external power supply is used. They are not required for the board to function.

Signal	Pin	Pin	Signal
+5 Volts	50	49	+5 Volts
+12 Volts	48	47	-12 Volts
CH35	46	45	CH34
CH33	44	43	CH32
CH39	42	41	GND
CH31	40	39	CH30
CH29	38	37	CH28
CH27	36	35	CH26
CH25	34	33	CH24
CH38	32	31	GND
CH23	30	29	CH22
CH21	28	27	CH20
CH19	26	25	CH18
CH17	24	23	CH16
CH37	22	21	GND
CH15	20	19	CH14
CH13	18	17	CH12
CH11	16	15	CH10
CH9	14	13	CH8
CH36	12	11	GND
CH7	10	9	CH6
CH5	8	7	CH4
CH3	6	5	CH2
CH1	4	3	CH0
GND	2	1	GND

3.5.6. Analogue I/O, PL6

This is a 26 way vertical boxed header. Channels ADC8 to ADC15 are 12-bit resolution and are available only on the FM600 product. Channels ADC0 to ADC7 and DAC0 to DAC1 are all 8-bit resolution and are available on both FM400 and FM600 products. The +12 Volts and –12 Volts will only be present if an external power supply is used.

Signal	Pin	Pin	Signal

+5 Volts	26	25	+5 Volts
+12 Volts	24	23	-12 Volts
DAC1	22	21	DAC0
ADC15	20	19	ADC14
ADC13	18	17	ADC12
ADC11	16	15	ADC10
ADC9	14	13	ADC8
GND	12	11	GND
ADC7	10	9	ADC6
ADC5	8	7	ADC4
ADC3	6	5	ADC2
ADC1	4	3	ADC0
GND	2	1	GND

3.5.7. Special I/O Connector, PL7

This is a 4 way pin strip. It allows the two I/O channels S0 (port B6) and S1 (Port B7) to be accessed.

Pin	1	2	3	4
Signal	+5 Volts	S1 (PB7)	S0 (PB6)	GND

3.5.8. Matrix Keypad Port, PL8

This is a 16 way pin strip. It is designed to take a wide range of matrix keypads up to a maximum of 64 keys. Section 6.2 contains a list of compatible keypads for this port. If the keypad is less than an 8 x 8 matrix then pin 1 on the keypad should be connected to pin 1 (west) on the connector.

Pin	Signal
1	CH23
2	CH22
3	CH21
4	CH20
5	CH19
6	CH18
7	CH17

8	CH16
9	CH15
10	CH14
11	CH13
12	CH12
13	CH11
14	CH10
15	CH9
16	CH8

3.5.9. Serial Port ':S0', PL9

This connector is a 10 pin vertical boxed header. The 'A' and 'B' signals are the +ve and –ve signals for the RS485 network port. The other signals are at RS232 levels.

Signal	Pin	Pin	Signal
A (+ve)	10	9	GND
B (-ve)	8	7	N/C
RTS	6	5	RXD
CTS	4	3	TXD
+5 Volts	2	1	N/C

3.5.10. Serial Port ':S1' & ':S2', PL10 & PL11

Signal	Pin	Pin	Signal
N/C	10	9	GND
N/C	8	7	N/C
RTS	6	5	RXD
CTS	4	3	TXD
+5 Volts	2	1	N/C

3.5.11. M-Bus (I^2C) Port, PL12

This connector is a 4 way pin strip. Pin 1 is north.

Pin	Signal

1	+5 Volts
2	SCL
3	SDA
4	GND

3.6. Links

There are five user configurable links on the two FlashModule products, FM400 and FM600.

3.6.1. Back light Enable, LK1

This link is a three way pin strip. Some of the 4 x 20 character LCDs have an LED back light. If this link is fitted west then +5 Volts is applied to the BL +ve pin. This will turn the back light on. If this link is fitted east the back light is turned off. This feature is offered as the LED back light will increase the current consumption of the board considerably.

3.6.2. Reset, LK2

This link is a two way pin strip. By connecting the two pins together the system can be reset. It is connected in parallel with SW1.

3.6.3. Serial Port Select, LK3

This link is a 3 way pin strip. It is used to determine the serial input format for serial port ':S0'. If this link is fitted in the 'North' position then the serial port will receive data from the RS485 network port. If the link is fitted 'South' then data will be received from the RS232 port. Data will be transmitted using both formats.

3.6.4. LCD Select, LK4

This is a three way link. If this link is set in the 'A' position then a compatible alphanumeric LCD can be connected directly to either one of the LCD port connectors. If this link is set in the 'G' position then a range of graphic LCDs can be used with an adapter board.

3.6.5. Battery Backed Link, LK5

This is a 3 way pin strip. It is used to disable the battery backup on the static RAM. When power is applied to the board, this link should be fitted ‘West’. To clear the contents of the RAM the power must be removed and this link moved ‘East’. The link must be returned to the ‘West’ location before power is restored. If power is applied to the board while this link is fitted ‘East’ the static RAM could be damaged.

3.6.6. RS485 Termination, LK6

This is a 2 way pin strip. If the FlashModule is at the end of a RS485 transmission line then the line should be terminated on this board to prevent reflections. By fitting this link a 100Ω resistor is placed across the two signal lines.

3.7. Test Points

3.7.1. TP1 8-Bit Analogue Reference

This test point is used when calibrating the reference voltage for the 8-bit analogue inputs and outputs. It is factory calibrated to 2.560 Volts.

3.7.2. TP2 Ground Reference

This test point is used as a reference point for the calibration of the analogue I/O. It is connected to the analogue ground plane and it can also be used as a reference for digital ground.

3.8. FlashModule FM400 Specification

Processor
68307 Controller
68000 Code Compatible
14.7456 MHz clock speed

Memory
512 k-bytes Flash Memory (expandable off board up to 1 M-bytes)

512 k-bytes Battery Backed Static RAM (expandable off board up to 8.5 M-bytes)

Battery
VL2020 20mAh
Vanadium Lithium compound

Serial Ports
RS232/RS485 Serial Port
2 RS232 Serial Ports
Up to 57600 baud communications
RS232 full hardware handshaking
RS485 network port

Real Time Calendar Clock
Day, date, month, year
Hours, minutes, seconds
Alarm feature
Year 2000 compliant

Digital I/O
26 TTL/CMOS I/O channels (16 shared with keypad)
3 8-bit ports
Change of state detection
Interrupt generation

Keypad Port
16 TTL/CMOS I/O channels
Up to 8 x 8 matrix with 64 keys
User configurable
Interrupt on key press

Two 16-bit timer/counters
External Input & Output
Count or Timer modes
Watchdog timer

Analogue I/O

8 8-bit analogue inputs
Input range 0 to 2.55 Volts
2 8-bit analogue outputs
Output range 0 to 2.55 Volts
Precision 2.56 ± 0.001 Volt reference

Power Supply
Single 5 Volt ± 0.2V supply
Current consumption 200 mA (typ.)
Switching the processor to one of its low power modes can reduce the current consumption. Please refer to the 68307 User Manual for full details.

Physical
100 x 160 mm
Maximum component height is 12mm. A further 10mm should be allowed for cable entry.
Relative humidity 0 – 90% (non condensing)
Operating temperature range 0 – 70 ^{o}C

4. FlashModule FM600

The FlashModule FM600 is the top product in the range. It adds an eight channel 12-bit analogue to digital acquisition system and 16 digital I/O channels to the FM400 product.

4.1. Digital I/O

The FM600 has up to 42 digital I/O channels. All the channels can be accessed as individual ports or in three groups of 8-bit ports. Port A of the processor provides channels 0 to 7 (port 0) as well as the two special channels S0 (port B6) and S1 (port B7). Four I^2C devices provide the other 32 channels, which are configured as channels 8 – 39 and ports 1 and 4 using devices $20 - $23. Ports 1 and 2 can also be configured as a matrix keypad port. Please see section 4.2 for details.

All 42 digital I/O channels are TTL/CMOS compatible. A change of state on either ports 1 or 2 can generate an interrupt on channel I4 (port B14) and a change in state on ports 3 or 4 can generate an interrupt on channel I1 (port B9). By configuring the digital channels to generate an interrupt the processor will be able to respond quickly when a change is detected rather than having to poll the ports waiting for a change of state to occur. Interrupt I4 is used when the keypad is in use, or it can be user programmed when these channels are used as general purpose I/O lines. The other 10 digital channels have no interrupt capability. Full details on the external connections to the digital I/O channels on the FM600 can be found in sections 3.5.5 and 3.5.7.

4.2. Matrix Keypad Port

The keypad port on the FlashModule products is designed to accept a wide range of matrix keypads. The port connects to two of the M-bus digital I/O chips (device $20 & $21). When the keypad port is in use any key press will generate an interrupt on I4 (PB14). The Minos driver will intercept this interrupt and read the character represented from the keypad. This character is stored in the input buffer. The operating system software allows all keypads up to 64 keys to be uniquely defined by entering the row and column masks. Details on the keypad connector are in section 3.5.8. A list of compatible keypads can be found in section 6.2.

4.3. Analogue I/O

The FM600 has eight channels of 12-bit analogue input, eight channels of 8-bit analogue input and two channels of 8-bit analogue output.

4.3.1. 8-bit Analogue I/O

This analogue I/O is provided by two M-Bus devices at that occupy addresses $48 and $49. The reference voltage is generated on board and is factory calibrated to 2.560 Volts by adjusting the variable

resistor VR2. The reference voltage is present on test point TP1. The both the input and output range is 0.00 ($00) to 2.55 ($FF) Volts.

4.3.2. 12-bit Analogue Inputs

A complete 12-bit plus sign data acquisition device provides the 12-bit analogue inputs. The device used is the LM12485 manufactured by National Semiconductors, full details can be found in the data sheet that is included in this documentation. This is an advanced device with three main modes of operation. These modes are 12-bit plus sign, 8-bit plus sign and watchdog. As well as these modes the analogue inputs can be individually programmed as either single ended or differential. The input range is 0 to 2.50 Volts.

When a channel is read in watchdog mode a comparison is made between the 8-bit conversion and the two limits programmed into the instruction RAM with the RAM pointer set to ‘01’ and ‘10’. If any of the limits are exceeded a bit is set in the interrupt status register and an interrupt can be generated if enabled.

The device is clocked at 3.6864 MHz giving a full 12-bit + sign conversion time of 12us or an 8-bit + sign conversion time of 2us. As well as the analogue to digital converter the same device also contains an 8-channel multiplexer, a sample and hold amplifier, 32 word FIFO, 8 word instruction register and sequencer, precision 2.50 Volt band gap reference, self calibration and diagnostic modes. The acquisition time is programmable for each conversion to take into account the input impedance. The analogue device can generate an interrupt to the processor on a range of conditions including FIFO full, pre-programmed instruction reached, programmed limit exceeded etc. The interrupt output from the ADC will pull I5 (Port B13) low. If this channel is configured as an interrupt input then an interrupt will be generated. The service routine must check the source of the interrupt by reading the interrupt status register before resolving the interrupt.

The analogue device is located in the main memory map between addresses $12B000 and $12BFFF. The internal register map is

detailed below. Full descriptions of these registers can be found in the data sheet on the page given in the table.

Address	Description	Type	Data sheet page
$12B000 to $12B00F	Instruction RAM	R/W	21 – 24
$12B010	Configuration Register	R/W	24
$12B012	Interrupt Enable Register	R/W	26
$12B014	Interrupt Status Register	R	26
$12B016	Timer Register	R/W	27
$12B018	Conversion FIFO	R	27
$12B01A	Limit Status Register	R	26

Library support is provided for simple analogue input readings, please refer to the User Manual for full details. For those requiring the more advanced features of this device an interfacing applications note AN-906 is also included in this documentation. By programming this chip directly most modes are available. The exceptions to this are 'SYNC' input can not be configured as an input and the DMA mode is not available although an interrupt can be generated when the FIFO is full.

4.4. Alphanumeric LCD Port

The LCD port on the FlashModule FM400 allows a wide range of alphanumeric liquid crystal displays to be connected directly to the board. All compatible liquid crystal displays are 5 Volt only displays, with a contrast voltage between 0 and 5 Volts and a XXXX HD44680 compatible controller fitted. There are two LCD connectors on the FM400, these are intended for different pin outs of the LCD and only one LCD should be used at a time. A number of compatible displays are listed in section 6.1. When using alphanumeric liquid crystal displays it is important that link LK4 is fitted in the 'A' position.

The LCD is memory mapped into the controller between addresses $12A000 and $12AFFF. Minos drivers are provided for the displays allowing them to be directly accessed from the applications program. Most four line and all compatible two line LCDs have two controllers,

one for the top two lines and one for the lower two lines. For this type of display the standard LCD driver can be used, drlcd. Other displays, particularly four line by twenty character displays have a single controller, for these displays a different controller drld4x20 is provided.

A range of graphic liquid crystal displays with a HD61830 compatible controller can be interfaced to the FlashModule FM400 using a simple adapter board. When these are used the link LK4 must be in the 'G' position. The adapter board modifies the pin out of connector PL3 to that of the graphics panel and produces a range of LCD contrast voltages and drive voltages. Compatible LCD panels can be found in section 6.1

4.5. FM600 Connectors

The FM600 shares the same printed circuit board as the FM400 product. For full details on the connectors available on the FM600 please refer to section 3.5.

4.6. FM600 Links

The FM600 shares the same printed circuit board as the FM400 product. For full details on the connectors available on the FM600 please refer to section 3.6.

4.7. Test Points

4.7.1. TP1 8-Bit Analogue Reference

This test point is used when calibrating the reference voltage for the 8-bit analogue inputs and outputs. It is factory calibrated to 2.560 Volts. The 12-bit analogue input is not affected by this reference. The 12-bit reference is generated in the analogue to digital converter for stability and can not be adjusted.

4.7.2. TP2 Ground Reference

This test point is used as a reference point for the calibration of the analogue I/O. It is connected to the analogue ground plane and it can also be used as a reference for digital ground.

4.8. FlashModule FM600 Specification

Processor
68307 Controller
68000 Code Compatible
14.7456 MHz clock speed

Memory
512 k-bytes Flash Memory (expandable off board up to 1 M-bytes)
512 k-bytes Battery Backed Static RAM (expandable off board up to 8.5 M-bytes)

Battery
VL2020 20mAh
Vanadium Lithium compound

Serial Ports
RS232/RS485 Serial Port
2 RS232 Serial Ports
Up to 57600 baud communications
RS232 full hardware handshaking
RS485 network port

Real Time Calendar Clock
Day, date, month, year
Hours, minutes, seconds
Alarm feature
Year 2000 compliant

Digital I/O
42 TTL/CMOS I/O channels (16 shared with keypad)
5 8-bit ports

Change of state detection
Interrupt generation

Keypad Port
16 TTL/CMOS I/O channels
Up to 8 x 8 matrix with 64 keys
User configurable
Interrupt on key press

Two 16-bit timer/counters
External Input & Output
Count or Timer modes
Watchdog timer

Analogue I/O
8 12-bit analogue inputs
Input range 0 to 2.50 Volts (12-bit)
Precision 2.50 ± 0.001 Volt reference (12-bit)
8 8-bit analogue inputs
Input range 0 to 2.55 Volts (8-bit)
2 8-bit analogue outputs
Output range 0 to 2.55 Volts (8-bit)
Precision 2.56 ± 0.001 Volt reference (8-bit)
Single Ended or Differential inputs
Watch dog mode (12-bit)
Programmable acquisition times (12-bit)

Power Supply
Single 5 Volt ± 0.2V supply
Current consumption 250 mA (typ.)
Switching the processor to one of its low power modes can reduce the current consumption. Please refer to the 68307 User Manual for full details.

Physical
100 x 160 mm
Maximum component height is 12mm. A further 10mm should be allowed for cable entry.

Relative humidity 0 – 90% (non condensing)
Operating temperature range 0 – 70 °C

5. Utility Products

5.1. Flash Formatter

The Flash Formatter allows the operating system sector of the controller's program memory to be reconfigured. There are two memory devices on the Flash Formatter. The first is a CMOS DIL EPROM, which is programmed by CMS with a set of default values. This is used to enable the controller memory to be reset should it become corrupted and stop functioning or to provide operating system upgrades. If the EPROM fitted is smaller than 512 k-bytes then the data contained in this device are repeated throughout the given address range. The other memory device is a 512 k-byte Flash memory. This device can be programmed with application code to enable the code to be transferred to the Flash device on the controller. Both memory devices occupy the same address and are selected using switch SW2.

The Flash Formatter can operate in two different modes. The FlashModule controllers detect if a memory expansion card is present at reset. If SW1 on the formatter is in the 'Form' (Format) location the memory map is configured on the FlashModule controller so that the Flash memory on the controller occupies the 512 k-bytes between $080000 and $0FFFFF. The selected memory device on the Flash Formatter occupies the 512 k-bytes between $000000 and $07FFFF. This means that the FlashModule controller will power up to run the code in the Flash Formatter. This will allow the Formatter to copy the data in the Flash Formatter device into the device on the FlashModule ('Formatting the device'). When this process has been completed the red LED, D1, on the Formatter will go out. The power should then be removed and the Flash Formatter can be removed.

If the switch SW1 is in the 'Store' location then the memory map is reversed, i.e. the memory on the controller is between $000000 and $07FFFF and the Flash Formatter device between $080000 and $0FFFFF. In this mode data can be stored in the memory on the Flash Formatter. The controller always boots from address $000000.

The Flash Formatter is also available with some battery backed RAM as well. For details of the RAM options please see section 5.2.

5.1.1. Flash Formatter Specification

512 K-bytes Flash EPROM
Up to 1 M-byte EPROM
Two map options (Switch Selectable)
Size 100 x XX mm
Power Supply 5V dc ± 0.25 Volts
Current Consumption 50 mA (max)
Operating Temperature 0 to 70 °C

5.2. Static Ram Expansion

This product plugs into the controller card and adds extra static RAM. Versions of this card can be configured to contain 2 M-bytes, 4 M-bytes or 8 M-bytes of battery backed static RAM. A feature on the FlashModule products is that on power up they determine how much RAM they have available and configure themselves accordingly. The more RAM that is added to the FlashModule the longer the start up routine takes. By default the static RAM on this card is battery backed so that data is retained when the power is removed. To clear the contents of the static RAM a link is fitted on the card. With the power OFF this link can be moved to the West location, leave it in this location for a few seconds before returning it to the East location (B). If this is done with the power on the board can be damaged. The battery is charged while the board is powered and when fully charged will retain the data in the RAM for up to 240 hours.

This product is also available with the Flash Formatter hardware fitted as detailed in section 5.1.

5.2.1. RAM Expansion Specification

Up to 8 M-byte Static RAM
Battery Backed memory
Vanadium Lithium compound battery
20 mAh capacity
Battery life 240 hours typ.
Auto configurable
Size 100 x XX mm
Power Supply 5V dc ± 0.25 Volts
Current Consumption 50 mA (max)
Operating Temperature 0 to 70 °C.

6. Appendix

6.1. Compatible LCD Displays

The following lists are some of the many liquid crystal displays that are compatible with the FlashModule LCD ports. The latest list of products is available on our website at http://www.cms.uk.com/comp_lcd.html.

6.2. Compatible Keypads

The following is a list of compatible matrix keypads for connecting directly to the FlashModule keypad port.

6.3. Expansion Peripheral Products

Cambridge Microprocessor Systems produce a wide range of expansion cards that are compatible with the FlashModule product range. Full details on this range are available in our online catalogue on our website at http://www.cms.uk.com/periph.html. Peripherals include:

- Analogue I/O
- Digital I/O
- Serial I/O
- Video Output

- Printer Ports

6.4. Signal Conditioning Boards

Cambridge Microprocessor Systems produce a range of signal conditioning products that are compatible with the FlashModule products. Products include:

- TTL Inputs
- Relay Outputs
- Opto Isolated inputs (ac & dc)
- Opto Isolated outputs (ac & dc)
- Active Inputs
- 4 – 20mA I/O
- Triac Outputs

Full details on these products, and many others, are available in the signal conditioning section of our online catalogue on our website at http://www.cms.uk.com/sig_cond.html.

6.5. Help!

All Cambridge Microprocessor Systems products are fully tested before release, however problems can occur in the lifetime of any product due to a wide range of reasons. If any of our products fail to function correctly, please check the following:

- The documentation supplied with your product.
- The board is plugged in correctly.
- The board is correctly powered – see specification section.
- The file NOTES in the installation directory.
- The file README.TXT in the installation directory.
- The product support pages on our website at http://www.cms.uk.com/support.html.

If your questions still have not been answered please email the details of your problem to support@cms.uk.com or facsimile on +44 (01371) 876077. If the problem is software related please supply all details including software release number, PC type, operating system, free

memory and any error messages reported. A small stand alone example program that demonstrates the problem may also be required (email or disc only). There is a Problem Report form at the end of this manual, which can be completed to report a problem.

6.6. Circuit Diagrams

This section contains a set of circuit diagrams of the FlashModule products.