Created:January 3, 1995
Modified:April 4, 1995

**The Gemini Standard Controller**

# Hardware Installation

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Issue 1.1

**The document describes the VME hardware which makes up a Gemini Standard Controller.**

## 1.0 Introduction

This document describes the hardware for the Gemini Standard Controller, comprising the basic enclosure and VME cards needed to make up an EPICS system for use at the Gemini telescopes. This document will be used while specifying and costing the IOC, and also after the goods are delivered to set them up and perform a brief acceptance test.

### 1.1 Intended Readership

Engineers acting in a technical capacity for a Gemini workpackage.

### 1.2 Purpose

To provide information needed to specify and purchase a Gemini Standard Controller IOC.

To describe how to assemble the various parts once the equipment has been delivered, setting up and installing the VME cards, and some function testing for each module without the need for external software (i.e. vxWorks or EPICS).

### 1.3 How to use this Document

This document is divided into two chapters. The first is mainly for use during specification and purchasing of the hardware, and the second describes how to set up and test the cards once they have arrived. While all the necessary information should be provided in the appropriate chapters, readers should also be aware of the relevant sections of the other chapter as appropriate. Three appendices provide reference information.

### 1.4 Related Documents

There is a parallel Software Installation manual by the same author which will be utilised to install the Gemini software appropriate for the hardware described here.

The products described here are usually delivered with some form of users manual. Reference is made to these manuals when describing particular aspects of the hardware.

### 1.5 Contacting the Author


| | | |
|---|---|---|
| Andrew Johnson | Tel. | +44 (0)1223 374000 ext. 4823 |
| Royal Greenwich Observatory | or | +44 (0)1223 374823 direct |
| Madingley Road | Fax. | +44 (0)1223 374700 |
| CAMBRIDGE | email | anj@ast.cam.ac.uk |
| CB3 0EZ | | |
| England (UK) | | |


## 2.0 Gemini Standard VME Hardware

This section describes the VME hardware which Gemini have determined will provide much of the standard functionality required by most EPICS systems. The standard hardware list contains the following items:

- VME crate containing 12-slot card frame, VME backplane, power supply and cooling fans.
- IOC containing MC68040 processor, RAM, ROM, Ethernet, SCSI and 4 serial ports.
- Transition module connecting the IOC to external connectors.
- Gemini Time bus interface card.
- Gemini Synchro bus interface card.
- 8-channel DC Servo-motor controller card.
- 8-channel Stepper-motor controller card.
- 12-bit analogue input card, 32 channels single-ended or 16 channels differential.
- 12-bit analogue output card, 16 channels.
- TTL I/O card, 32 input bits, 32 output bits.
- Digital output module, 32 channels of 100mA 30V opto-isolated open-collector outputs.

These items are all supported by the EPICS database software, and should cover most of the I/O requirements for the Gemini Instrument Controller IOCs. Additional cards which already have EPICS driver software are listed in Appendix A, and these should be considered before selecting other similar I/O cards in order to reduce software development costs.

For each item described below, the important characteristics are given, along with a guide price (which does not include sales taxes but has typical discount rates applied), and a list of one or more suppliers for the items in both the US and the UK. Within the Specification subsections below, lines flagged with the character § are suitable for use in a purchase order for the relevant item.

For those with little or no experience of VME, *The VMEbus Handbook* by Wade D. Peterson, published by the VFEA International Trade Association is an excellent introductory text.

## 2.1 VME Crate

The VME Crate is the housing for the VME backplane and cards, power supply and cooling fans. The Heurikon crate specified for Gemini is designed to allow field-replacement of the internal components without requiring the crate to be removed from its rack. VME slots are arranged horizontally with slot 1 (the system controller slot which usually contains the IOC) at the bottom. The standard crate provides 12 slots, but if necessary a 21-slot crate can be used by agreement with GSCG.

### 2.1.1 Specifications

§ Heurikon MSE/12 Modular VME Enclosure, 12 slots

§ Heurikon HCE/21 VME Enclosure, 21 slots

TABLE 1. MSE/12 VME Crate Specifications

| | |
|---|---|
| **AC Input** | 115 Volts or 230 Volts auto-sensing, 47 to 63 Hz |
| **Input Power** | 800 Watts maximum @ 75% Efficiency |
| **DC Supply** | +5 Volts @ 8 to 80 Amps<br>+12 Volts @ 0 to 8 Amps<br>-12 Volts @ 0 to 8 Amps |
| **Rear Panel Connectors** | 2 off DB15 cut-outs, 50 off DB25 cut-outs, 4 off DB50 cut-outs<br>4 off BNC cut-outs, 1 off Centronics cut-out |
| **Dimensions** | 14.0” H x 17.0” W (19” with flanges) x 21.0” D |
| **Weight** | Approximately 40 Pounds |
| **Airflow** | 200 Cubic Feet per Minute, giving 3 CFM per slot minimum. |
| **Noise Level** | 55 dBA |
| **Operating Temperature** | 32˚ to 122˚ F<br>0˚ to 50˚ C |
| **Humidity** | 5% to 95% non-condensing |
| **Shock** | 11 ms duration, 15 G peak |
| **Approximate Price** | $ 4,000 (US) [HCE/21: $ 5,000]<br>£ 4,000 (UK) [HCE/21: £ 4,600] |

The crate is delivered with a hardware manual which describes the unit and contains set-up and installation instructions, maintenance and troubleshooting procedures and the wiring schematics.

### 2.1.2 US Supplier

| | | |
|---|---|---|
| Heurikon Corp. | Tel. | (800) 356-9602 |
| 8310 Excelsior Drive | or | (608) 831-0900 |
| Madison | Fax. | (608) 831-4249 |
| WI 53717 | email | info@heurikon.com |

### 2.1.3 UK Suppliers

Diamond Point used to be Heurikon's main UK distributor and can still supply, but Anglia have taken over and will probably provide a better price.

| | | |
|---|---|---|
| Anglia Technology Ltd. | Tel. | (01603) 789432 |
| 4 Hellesdon Hall Industrial Park | Fax. | (01603) 401158 |
| Hellesdon Park Road | | |
| Norwich | | |
| NR6 5DR | | |
| | | |
| Diamond Point International Ltd. | Tel. | (01634) 722390 |
| Unit 9, Enterprise Close | Fax. | (01634) 722398 |
| Medway City Estate | | |
| Rochester | | |
| Kent ME2 4LY | | |

## 2.2 IOC

A Motorola Single Board Computer card has been chosen for the standard IOC as it provides all the computing and basic I/O needs for an EPICS system. The MVME167 contains a 33 MHz MC68040 processor, 16 Mb of DRAM, 4 serial ports, EPROMs containing a debug monitor/boot ROM, SCSI and Ethernet interfaces, and also acts as the system controller module for the VMEbus.

### 2.2.1 Specifications

§ Motorola MVME167-033B, 33 MHz MC68040, 16 Mb ECC DRAM

TABLE 2. IOC Specifications

| | |
|---|---|
| **Input Power** | +5 Volts @ 3.5 Amps (typ.), 4.5 Amps (max.)<br>+12 Volts @ 1 Amp (max.)<br>-12 Volts @ 0.1 Amps (max.) |
| **Connections** | I/O is via the VMEbus P2 connector & TM1x7 module |
| **Dimensions** | 1 slot x 6U |
| **Forced Air Temperature** | 32° to 131° F<br>0° to 55° C |
| **Humidity** | 5% to 90% non-condensing |
| **Approximate Price** | $ 6,500 (US)<br>£ 4,100 (UK) |

§ User Documents for MVME167 Family

Documentation for the MVME167 is sold as a separately chargeable item ($125, £85). A 50-page Installation Guide is supplied with the card and contains sufficient information to set up, install and use the board, thus it should not be essential to purchase the extended document set. The additional documentation comprises the following items:

- MVME167 Single Board Computer User's Manual
  Similar to the Installation Guide, in slightly more detail.
- MVME167 Single Board Computer Support Information
  External signal connections, board parts list, full circuit diagrams.
- MVME166/167/187 Single Board Computer Programmer's Reference Guide
  Board-level hardware description, I/O chip register maps.
- MVME167BUG 167BUG Debugging Package User's Manual
  Description of diagnostics and built-in test software.
- Debugging Package for Motorola 68K CISC CPUs User's Manual
  Other debugger commands, system calls, booting etc.

### 2.2.2 US Supplier

Motorola, Inc. Tel. (800) 624-6449
Computer Systems Group
2900 South Diablo Way
Tempe
AZ 85282

### 2.2.3 UK Suppliers

As of July 1994, Motorola have two authorised distributors in the UK. Although they should quote a standard price, it should be possible to get a discount from one or both of these, so it is worth shopping around.

| | | |
|---|---|---|
| Gothic Crellon Ltd. | Tel. | (01734) 788878 |
| 3 The Business Centre | Fax. | (01734) 776095 |
| Molly Millars Lane | | |
| Wokingham | | |
| Berks. RG11 2EY | | |

| | | |
|---|---|---|
| Wordsworth Technology Ltd. | Tel. | (01732) 866988 |
| 6 Enterprise Way | Fax. | (01732) 863747 |
| Edenbridge | | |
| Kent TN16 1ET | | |

## 2.3 IOC Transition Module

The Transition module provides the connections from the J2 I/O pins of the MVME167 board. Motorola sell a transition module (the MVME712M) which also provides these connections, but their module has a 2-slot wide 6U high connector panel which would only fit into the Heurikon chassis by taking up two VME slots. The module chosen comprises a small PCB which plugs into the back of the VME J2 backplane and provides 5 IDC header plugs which are used to make ribbon-cable connections to the VME chassis back panel.

### 2.3.1 Specifications

§ Wordsworth TM1x7 Transition Board

TABLE 3. Transition Module Specifications

| | |
|---|---|
| **Input Power** | nil |
| **Connections** | DIN41612 96-way socket for connection to MVME167,<br>4 off EIA-232-D Serial ports via 2 off IDC50 connectors,<br>Ethernet via IDC20 connector, SCSI via IDC50 connector,<br>Centronics Printer via IDC36 connector. |
| **Dimensions** | 5.1” W x 4.6” D |
| **Approximate Price** | $ 150 (US)<br>£ 95 (UK) |

The cables needed to wire this unit up to the backpanel of the MSE/12 are described in Section 3.2 on page 18 below, with drawings and parts lists given in Appendix B.0.

### 2.3.2 Supplier

The module manufacturer is one of the two UK Motorola distributors. No US-based supplier is available, the module must be ordered direct from the manufacturer.

| | | |
|---|---|---|
| Wordsworth Technology Ltd. | Tel. | +44 1732 866988 |
| 6 Enterprise Way | Fax. | +44 1732 863747 |
| Edenbridge | | |
| Kent TN16 1ET | | |
| England, UK | | |

## 2.4 Time Bus Module

Any IOC which needs to know the absolute time to an accuracy better than a few milliseconds or to be able to time events to better than a 16 milliseconds resolution will need to have a Time Bus card installed. This connects to the Gemini master time server over the IRIG-B Time Bus, giving an absolute time accuracy of the order of ±10µs and a resolution of 100ns. The GPS Satellite Receiver card is an enhanced version of the standard card which adds external synchronisation via a GPS, although this function may be provided for Gemini by other hardware not discussed here.

### 2.4.1 Specifications

§ Bancomm bc635VME, disciplined oscillator, IRIG-B I/O

§ Bancomm bc637GPS, Satellite Receiver, disciplined oscillator, IRIG-B I/O

TABLE 4. Time Bus Module Specifications

| | |
|---|---|
| **Input Power** | +5 Volts @ 1.5 Amps<br>+12 Volts @ 0.05 Amps<br>12 Volts @ 0.03 Amps |
| **Connections** | 2 off BNC sockets for IRIG-B timecode Input and Output,<br>DB15 socket for various clock and event signals,<br>High-Density DB15 plug for GPS receiver module connection.<br>Non-GPS signals are also available via the P2 backplane connector. |
| **Dimensions** | 1 slot x 6U |
| **Operating Temperature** | 32˚ to 158˚ F<br>0˚ to 70˚ C |
| **Humidity** | 5% to 90% non-condensing |
| **Approximate Price** | $ 2,000 (US) [bc637VME: $ 4,000]<br>£ 2,000 (UK) |

Documentation is provided with the card in the form of an Operation and Technical Manual describing the card's features, installation and set-up instructions, programming model, hardware interfaces, and circuit diagrams and a parts list for the board. The GPS receiver has an additional manual describing its extra functions.

### 2.4.2 US Supplier

Datum Inc. — Tel. (408) 578-4161
Bancomm Division — or (800) 348-0648
6541 Via del Oro — Fax. (408) 578-4165
San Jose
CA 95119

### 2.4.3 UK Supplier

Dean Microsystems — Tel. (01344) 727269
Acal Electronics house — Fax. (01344) 727279
Wokingham Road
Bracknell
Berks. RG12 1ND

## 2.5 Synchro Bus Module

IOCs which require fast, deterministic communication with other IOCs using the Synchro Bus will need a Reflective Memory card from VMIC. At the Gemini telescopes all nodes will be connected together in a single ring of fibre-optic cable. For development purposes where only a single node is available it is essential to connect the card's fibre transmitter to its receiver to obtain correct operation of the software.

It will be necessary to install a pair of bulkhead connectors on the back panel of the VME crate and two short cables (1 metre should be sufficient, depending on the location of the Reflective Memory card and the back panel connectors) from the card to these connectors.

### 2.5.1 Specifications

§ VMIVME-5578-000, 256 Kbyte Reflective Memory, 512 byte Transfer FIFO

TABLE 5. Synchro Bus Module Specifications

| | |
|---|---|
| **Input Power** | +5 Volts @ 5 Amps (max.) |
| **Connections** | 2 off 2.5 mm ST bayonet sockets for input and output fibres. Maximum 1,000 ft fibre between nodes. |
| **Dimensions** | 2 slots x 6U |
| **Operating Temperature** | 32˚ to 113˚ F<br>0˚ to 45˚ C |
| **Humidity** | 20% to 80% non-condensing |
| **Approximate Price** | $ 7,600 (US)<br>£ 5,800 (UK) |

Each card is supplied with a Product Manual which describes the card and its programming interface, card installation and set-up, VMIC's warranty and repair policy, and a complete parts list and circuit diagram.

§ VMICBL-000-F3-0*xx*, Fibre cable assembly

Fibre cables for the Reflective Memory cards can be obtained from VMIC at the same time as buying the cards, using the above part number. The *xx* in the number should be replaced by a length code obtained from the table below. These cables are U.L./NEC rated OFNP and comprise a multi-mode single fibre

| ***xx*** | **Cable Length** | | ***xx*** | **Cable Length** | |
|---|---|---|---|---|---|
| | **Feet** | **Metres** | | **Feet** | **Metres** |
| 01 | 5 | 1.5 | 06 | 200 | 60.9 |
| 02 | 25 | 7.6 | 07 | 350 | 106.7 |
| 03 | 50 | 15.2 | 08 | 500 | 152.4 |
| 04 | 100 | 30.4 | 09 | 1,000 | 304.8 |
| 05 | 150 | 45.7 | | | |

with a 62.5 Micron core and a 2.5 mm ST style bayonet connector on each end. The transmitters operate at 860 nm at 1 Gbaud, and the maximum attenuation between Reflective Memory nodes is 6 dB. Any alternative cables should be equivalent to the above specification.

### 2.5.2 US Supplier

| | | |
|---|---|---|
| VME Microsystems International Corp. | Tel. | (800) 322-3616 |
| 12090 South Memorial Parkway | or | (205) 880-0444 |
| Huntsville | Fax. | (205) 882-0859 |
| AL 35803 | | |

### 2.5.3 UK Supplier

| | | |
|---|---|---|
| Dean Microsystems | Tel. | (01344) 727269 |
| Acal Electronics house | Fax. | (01344) 727279 |
| Wokingham Road | | |
| Bracknell | | |
| Berks. RG12 1ND | | |

## 2.6 DC Servo Motors

The DC servo controller card utilises a DSP56001 CPU to control up to 8 motors simultaneously, although channels 5 to 8 are an add-on option. The firmware on the card is highly configurable to achieve control of many different types and configurations of motors and encoders, although how this will be achieved from EPICS is TBD.

### 2.6.1 Specifications

§ DeltaTau PMACVME/4, DC Servo Controller, 4 channels

§ DeltaTau PMACVME/8, DC Servo Controller, 8 channels

TABLE 6. DC Servo Controller Specifications

| | |
|---|---|
| **Input Power** | +5 Volts @ 1.5 Amps<br>+12 Volts @ 0.3 Amps<br>-12 Volts @ 0.25 Amps |
| **Connections** | IDC plugs on front panel for various connections.<br>Motors and encoders connect via VMEbus P2 connector(s). |
| **Dimensions** | 2 slots x 6U |
| **Operating Temperature** | 32˚ to 140˚ F<br>0˚ to 60˚ C |
| **Humidity** | 10% to 95% non-condensing |
| **Approximate Price** | $ 3,200 (US) [8 channel: $ 4,000], [DPRAM: +$ 400]<br>£ 2,900 (UK) |

The documentation for the PMAC consists of a 2 inch thick Users Manual plus an addendum which document the firmware, and a 41 page hardware reference covering the external connections and jumper settings, optional accessories, and circuit-diagrams.

### 2.6.2 US Supplier

Delta Tau Data Systems — Tel. (818) 998-2095
21119 Osborne Street — Fax. (818) 998-7807
Canoga Park
CA 91304

### 2.6.3 UK Supplier

Baldor ASR UK Ltd. — Tel. (01255) 673607
Holland Cottage — Fax. (01255) 850744
Kirby Road
Great Holland
Essex CO13 0HZ

## 2.7 Stepper Motors

EPICS provides support for stepper motors using the Oregon Microsystems VME cards. There are several cards in the family which share a common command language, and the EPICS driver works with a number of these. The standard card supports 8 channels, with each channel comprising 8 I/O signals:

- Motor Step and Direction Outputs
- Auxiliary Output
- Positive and Negative Limit Inputs
- Home Input
- +5V and Ground

### 2.7.1 Specifications

§ Oregon Microsystems VME8-8 Intelligent Motion Controller

TABLE 7. Stepper Motor Controller Specifications

| | |
|---|---|
| **Input Power** | +5 Volts @ 3 Amps (max.) |
| **Connections** | via VMEbus P2 connector. |
| **Dimensions** | 1 slot x 6U |
| **Operating Temperature** | 32˚ to 122˚ F<br>0˚ to 50˚ C |
| **Humidity** | 0% to 90% non-condensing |
| **Approximate Price** | $ 1,900 (US)<br>£ 1,800 (UK) |

The OMS card comes with a User's Manual which describes the card, jumper settings and external connections, the programming interface and firmware command structure, Oregon's warranty and repair procedures and a full circuit diagram.

### 2.7.2 US Supplier

| | | |
|---|---|---|
| Oregon Micro Systems, Inc. | Tel. | (503) 629-8081 |
| Twin Oaks Business Center | or | (503) 644-4999 |
| 1800 NW 169th Place, Suite C100 | Fax. | (503) 629-0688 |
| Beaverton | | |
| OR 97006 | | |

### 2.7.3 UK Supplier

| | | |
|---|---|---|
| Naples Coombe Ltd. | Tel. | (01488) 638488 |
| Main Street | Fax. | (01488) 638802 |
| Chaddleworth | | |
| Berks. RG16 0EH | | |

## 2.8 TTL I/O

Most digital I/O will interface through TTL-level signals (see section 2.9 below for a card with higher voltage and current outputs). Under EPICS, this card provides 32 input and 32 output channels — the card has some other I/O signals but these are not supported by the standard device interface software. I/O interrupts are supported via a software scanning task at 30 Hz, although there are some limitations in the use of I/O interrupts with this card.

### 2.8.1 Specifications

§ XYCOM XVME-240, Digital Input/Output Module

TABLE 8. TTL I/O Specifications

| | |
|---|---|
| **Input Power** | +5 Volts @ 2.7 Amps (typ.), 4.2 Amps (max.). |
| **Connections** | 2 off IDC50 plugs on front panel. |
| **Output Characteristics** | Vol = 0.5 Volts @ 48 mA, 0.4 Volts @ 16 mA<br>Voh = 2.0 Volts @ 15 mA, 2.4 Volts @ 3 mA |
| **Dimensions** | 1 slot x 6U |
| **Operating Temperature** | 32˚ to 149˚ F<br>0˚ to 65˚ C |
| **Humidity** | 5% to 95% non-condensing |
| **Approximate Price** | $ 700 (US)<br>£ 600 (UK) |

The card is supplied with a manual which describes the connections and jumper settings, programming interface and full circuit diagrams.

### 2.8.2 US Supplier

| | | |
|---|---|---|
| XYCOM Inc. | Tel. | (313) 429-4971 |
| 750 North Maple Road | or | (800) AT-XYCOM |
| Saline | Fax. | (313) 429-1010 |
| MI 48176 | | |

### 2.8.3 UK Suppliers

Two UK distributors are available. Quarndon may give a lower price because they claim to do a larger volume of business with XYCOM so have better margins.

| | | |
|---|---|---|
| Quarndon Electronics Ltd. | Tel. | (01332) 32651 |
| Slack Lane | Fax. | (01332) 360922 |
| Derby | | |
| DE3 3ED | | |

| | | |
|---|---|---|
| Dean Microsystems | Tel. | (01344) 727269 |
| Acal Electronics house | Fax. | (01344) 727279 |
| Wokingham Road | | |
| Bracknell | | |
| Berks. RG12 1ND | | |

## 2.9 Digital Outputs

A Digital Output card is also available for driving higher voltage or power outputs, typically to operate relays or solenoids. This card provides 32 opto-isolated open-collector outputs.

### 2.9.1 Specifications

§ XYCOM XVME-220, Digital Output Module

TABLE 9. Digital Output Specifications

| | |
|---|---|
| **Input Power** | +5 Volts @ 1.62 Amps (typ.). |
| **Connections** | 2 off IDC50 plugs on front panel. |
| **Output Characteristics** | Iol = 100 mA max.<br>Voh = 30 Volts max. |
| **Dimensions** | 1 slot x 6U |
| **Operating Temperature** | 32˚ to 149˚ F<br>0˚ to 65˚ C |
| **Humidity** | 5% to 95% non-condensing |
| **Approximate Price** | $ 700 (US)<br>£ 600 (UK) |

The card is supplied with a manual which describes the connections and jumper settings, programming interface and full circuit diagrams.

### 2.9.2 US Supplier

| | | |
|---|---|---|
| XYCOM Inc. | Tel. | (313) 429-4971 |
| 750 North Maple Road | or | (800) AT-XYCOM |
| Saline | Fax. | (313) 429-1010 |
| MI 48176 | | |

### 2.9.3 UK Suppliers

| | | |
|---|---|---|
| Quarndon Electronics Ltd. | Tel. | (01332) 32651 |
| Slack Lane | Fax. | (01332) 360922 |
| Derby | | |
| DE3 3ED | | |

| | | |
|---|---|---|
| Dean Microsystems | Tel. | (01344) 727269 |
| Acal Electronics house | Fax. | (01344) 727279 |
| Wokingham Road | | |
| Bracknell | | |
| Berks. RG12 1ND | | |

## 2.10 Analogue Inputs

An Analogue input module which supports either 32 channels of Single-ended inputs or 16 channels of Differential inputs, and performs one conversion to 12 bit resolution and accuracy every 10µs. The EPICS driver causes the channels to be converted serially, so each channel is updated approximately every 320µs for the single-ended setting, 160µs for differential.

### 2.10.1 Specifications

§ XYCOM XVME566, High Performance Analogue Input Module.

TABLE 10. Analogue Input Specifications

| | |
|---|---|
| **Input Power** | +5 Volts @ 2.1 Amps. |
| **Connections** | IDC50 plug on front panel. |
| **Inputs** | 0 to +10 Volts, 10 MΩ min., 100 pF max. |
| **Conversion** | 12 bits, linearity  0.5 LSB, accuracy  0.01% FSR max., temperature drift 40 ppm/˚C max. |
| **Dimensions** | 1 slot x 6U |
| **Operating Temperature** | 32˚ to 149˚ F<br>0˚ to 65˚ C |
| **Humidity** | 5% to 95% non-condensing |
| **Approximate Price** | $ 1,400 (US)<br>£ 1,300 (UK) |

The card is supplied with two manuals, for the card and the AMD Am9513 chip which it uses for conversion sequencing. The card manual describes the module and its connections, installation and jumper settings, programming, and the calibration procedure, and also includes full circuit diagrams.

### 2.10.2 US Supplier

| | | |
|---|---|---|
| XYCOM Inc. | Tel. | (313) 429-4971 |
| 750 North Maple Road | or | (800) AT-XYCOM |
| Saline | Fax. | (313) 429-1010 |
| MI 48176 | | |

### 2.10.3 UK Suppliers

| | | |
|---|---|---|
| Quarndon Electronics Ltd. | Tel. | (01332) 32651 |
| Slack Lane | Fax. | (01332) 360922 |
| Derby | | |
| DE3 3ED | | |

| | | |
|---|---|---|
| Dean Microsystems | Tel. | (01344) 727269 |
| Acal Electronics house | Fax. | (01344) 727279 |
| Wokingham Road | | |
| Bracknell | | |
| Berks. RG12 1ND | | |

## 2.11 Analogue Outputs

There are two models of the Analogue Output card, according to the voltage range required at the output. A High Accuracy version of each model is also available but will not be described here.

### 2.11.1 Specifications

§ VMIC VMIVME-4100-040, 16 channel, 12 bit Analogue Output,  10 V olts

§ VMIC VMIVME-4100-140, 16 channel, 12 bit Analogue Output, 0 to +10 Volts

TABLE 11. Analogue Output Specifications

| | |
|---|---|
| **Input Power** | +5 Volts @ 2.5 Amps (typ.), 3.6 Amps (max.). |
| **Connections** | Panduit plug on front panel, test I/O via VMEbus P2 |
| **Outputs** | 10 V olts (-040) or 0 to +10 Volts (-140) @ 5 mA max. |
| **Conversion** | Gain error  0.05% FSR typ., Of fset  0.025% FSR,<br>Linearity  0.25 LSB typ., T emperature drift  10 ppm/°C |
| **Dimensions** | 1 slot x 6U |
| **Operating Temperature** | 32° to 131° F<br>0° to 55° C |
| **Humidity** | 20% to 80% non-condensing |
| **Approximate Price** | $ 2,400 (US)<br>£ 2,000 (UK) |

The card is supplied with an Instruction Manual which describes the module and its connections, gives configuration and installation instructions including calibration, describes the programming interface and VMIC's warranty and repair procedures, and also contains full circuit diagrams and parts lists.

### 2.11.2 US Supplier

VME Microsystems International Corp. Tel. (800) 322-3616
12090 South Memorial Parkway or (205) 880-0444
Huntsville Fax. (205) 882-0859
AL 35803

### 2.11.3 UK Supplier

Dean Microsystems Tel. (01344) 727269
Acal Electronics house Fax. (01344) 727279
Wokingham Road
Bracknell
Berks. RG12 1ND

# 3.0 Installation

This section describes how to set up and test the hardware when it arrives. These steps do not require the use of EPICS or even VxWorks, thus they can be done before any host workstation hardware is available if necessary. Installation should be done in the order

1. Enclosure
2. Transition Module
3. CPU card
4. Other VME cards

## 3.1 Heurikon MSE/12

When unpacked, inspect the enclosure inside and out for shipping damage. The captive bolts holding the back cover may be too tight to undo using a Phillips #1 screwdriver, and in this case a pair of pliers with a pipe grip may be used on the knurling to loosen them.

Although the internal power supply automatically switches according to the mains voltage applied, a different input fuse is required for 240 Volt mains as against the US 110 Volt supply. The fuse-holder just below the mains inlet should be oriented correctly for the local supply voltage — see pp 4-2 and 4-3 of the Hardware Manual for details of replacement fuses.

The MSE/12 chassis is delivered with a US-style power cable. Note that as well as being fitted with a US plug, the cable is not rated for European mains voltage, thus it should only be used with 110 Volt mains — a different IEC mains cable is required for 240 Volt operation.

Before installing any cards into the chassis, it is recommended that the power supply output be checked, although step 6 below may be omitted if the necessary equipment or suitably knowledgeable personnel are not available.

1. Remove the back panel.
2. Ensure both the DC Enable switch on the front panel and the AC power switch on the back are in the OFF position.
3. Insert the power cable and plug it into the mains supply.
4. Turn on the AC power switch on the back panel. The power supply fan should start.
5. Turn on the DC Enable switch on the front panel. The DC OK LED should light, and the two 12V LED's glow although not necessarily at full brightness. The RESET LED will flash briefly on power-up, and the card-cage fans will start. The DC OK glows faintly to indicate if the 5 Volt supply goes out of tolerance.
6. Using a multimeter, check that there is 5 Volts 0.25 V olt between the two large backplane busbars. Take care not to short these with the probes while measuring, and be aware that there are mains voltages inside the enclosure.

The 12 V olt supplies may not be within specification if there is no load on the 5 Volt rail, indicated by the relevant LED's glowing faintly. For this reason there is little to be gained in measuring these voltage rails unless there is a particular reason to suspect the PSU. If desired a suitable load resistor (I used a 50 Watt 0.5 Ohm load) can be connected between the busbars to draw at least 8 Amps from the 5 Volt supply, at which the 12 Volt rails should be within range ( 5%).

This completes the testing of the enclosure. Switch the unit off, unplug from the mains and remove any testing apparatus.

## 3.2 Wordsworth TM1x7

The Transition Module will be installed in the back of the enclosure and provides the connections from the IOC to the outside world. It connects to the IOC via rows A and C of the VMEbus P2 connector which are available to the VME module designer for I/O connections and are not connected along the bus at all. The TM1x7 has a right-angle DIN41612 socket on one edge which plugs into the backplane, and several IDC plugs for serial, Ethernet, printer and SCSI cables. At a minimum it will be necessary to construct two cables, for the Serial ports and the Ethernet transceiver. Assembly drawings and parts lists for these two cables are given in Appendix B.

There are 7 sets of jumpers on the TM1x7 board, labelled X1 to X8. Jumpers X1 to X4 are used to configure serial ports 1 to 4 for DCE or DTE operation. Port 1 does not support the DTR or DCD signals so +12 Volt pull-up resistors are provided for these instead. The jumpers should be set as required for the device to be communicated with  to connect a port directly to a VT220 terminal or a desktop SPARCstation, use the DCE setting and a cable with direct pin-to-pin connections.

TABLE 12. TM1x7 Jumpers X1 to X4

| Pin | Signal | Pin | Signal | DTE Setting | DCE Setting |
|---|---|---|---|---|---|
| 1 | TXD | 2 | Port pin 2 | 1-2 | 1-3 |
| 3 | Port pin 3 | 4 | RXD | 3-4 | 2-4 |
| 5 | RTS | 6 | Port pin 4 | 5-6 | 5-7 |
| 7 | Port pin 5 | 8 | CTS | 7-8 | 6-8 |
| 9 | DTR | 10 | Port pin 20 | 9-10 | 9-11 |
| 11 | Port pin 8 | 12 | DCD | 11-12 | 10-12 |

Jumper X6 allows configuration of the Transmit and Receive clock lines for Serial Port 4. The other ports do not support these signals, which are only needed for synchronous devices which require an external clock signal to be connected. Jumpers J9 and J10 on the MVME167 card are used to set the direction of the clock signals.

TABLE 13. TM1x7 Jumper X6

| Pin | Signal | Pin | Signal | Setting |
|---|---|---|---|---|
| 1 | TRXC4 (P2.A28) | 2 | Port 4 pin 15 | out |
| 3 | Port 4 pin 17 | 4 | RTXC4 (P2.A32) | out |
| 5 | TRXC4 (P2.A28) | 6 | Port 4 pin 24 | out |

Jumper X7 allows connections to be made to the serial port Protective Ground lines (pin 1). These may be required for correct earthing of serial cable screens, although for development purposes they can usually be left unconnected. The Common signal is not connected anywhere other than to this jumper, and can be grounded using 9-10, or connected to some other ground source if required.

TABLE 14. TM1x7 Jumper X7

| Pin | Signal | Pin | Signal | Setting |
|---|---|---|---|---|
| 1 | Port 1 pin 1 | 2 | Common | out |
| 3 | Port 2 pin 1 | 4 | Common | out |
| 5 | Port 3 pin 1 | 6 | Common | out |
| 7 | Port 4 pin 1 | 8 | Common | out |
| 9 | GND | 10 | Common | out |

Jumper X8 is designed for special configuration of the printer port. It should only be necessary to install the jumpers shown if there is a need to use this port and the printer needs the ground return connections on pins 19 to 21.

TABLE 15. TM1x7 Jumper X8

| Pin | Signal | Pin | Signal | Setting |
|---|---|---|---|---|
| 1 | Printer pin 19 | 2 | GND | [1-2] |
| 3 | Printer pin 20 | 4 | GND | [3-4] |
| 5 | PRFAULT* | 6 | INPRIME* | out |
| 7 | GND | 8 | Printer pin 21 | [7-8] |

If a VME crate is to be installed on the telescope and thus be subject to alignment away from the horizontal, it may be desirable to bolt the Transition Module into the rack. A retainer has been designed for this purpose (see drawing in Appendix B.3, 2 off required), which attaches the board to the rear of the backplane. If these are to be used, the IOC must be installed in the bottom slot, as the other slots do not allow access to suitable mounting screw holes.

The module incorporates a single LED, which indicates that the +12 Volt supply is present. This supply is obtained from the MVME167 card however, so the IOC must also be installed for it to illuminate.

If retainers are to be used, remove the bolts adjacent to the P2 connector of the bottom slot which attach the VME backplane to the chassis, and attach the retainers to the transition module as shown in the assembly drawing. Plug the serial port and Ethernet cables into the relevant IDC plugs on the board. The module plugs into the slot 0 backplane connector, and if used the retaining bolts can be screwed home. Fit the other ends of the cables into their relevant holes in the back panel and attach using the relevant panel mounting kit. Note that Port 1 is the system Console, and should use the relevant back panel cut-out.

## 3.3 Motorola MVME167

Before installation all VME cards should be visually inspected for damage, taking precautions over Static Electricity while handling the cards — the VME crate includes a static earthing wristband which is useful for this purpose, but ensure the crate is plugged into the mains first (Power does not have to be applied to make the Earth connection). Inspection should include examining the pins inside the VMEbus connectors to ensure these have not been bent out of alignment.

Page 2-3 of the MVME167 SBC User’s Manual gives a location diagram for the jumpers on the card; these should be left at their factory default settings, which are also given below.

TABLE 16. MVME167 Jumper Settings

| Jumper | Settings | Location |
|---|---|---|
| J1 | 1-2, 3-4, 5-6, 7-8, 9-10, 11-12, 13-14, 15-16 | Near LED’s |
| J2 | 1-2 | Near LED’s |
| J6 | 2-3 | Near P2 connector |
| J7 | 2-3 | Near P2 connector |

Exceptions to the above settings are:

- J1 1-2 will be removed if vxWorks is booted using bootp and tftp from the debug monitor rather than using the vxWorks boot proms (see the *Gemini Standard Controller Software Installation Manual* for details).
- If some other card is installed in slot 0 as the VMEbus system controller, jumper J2 should be removed.
- J6 and J7 configure the direction of the two clock lines for serial port 4. These may need to be altered if this is used as a synchronous port.

The testing procedure is as follows:

1. Switch off the enclosure DC supply.
2. Remove the front panel, and put on the anti-static wrist strap.
3. Install the card in the bottom VME slot. Note that for the first few insertions it may be quite hard to push cards completely home because the DIN41612 connectors are new, but they should free up after about 3 or 4 insertion cycles. Make sure the two retaining bolts on the card front panel are free before applying much force. Push only against the card handles or the central front panel bolt, the remainder of the front panel should not be stressed. The card is fully inserted when the front panel is flush with the sides of the card cage.
4. When the card has been pushed home, the retaining bolts can be screwed home, although during development it may be desirable to leave these loose to make the card quicker to extract. Do not fit the enclosure front panel while testing any of the VME cards as it is useful to be able to see the various indicator LED’s which appear on the card fronts.
5. Plug a terminal or computer which has terminal software into the Console port. The connections for the cable to be used here depend on the device to be used and the way in which the Transition Module jumpers have been set for the particular port (see Section 3.2 on page 18 above).

6. Set up the terminal for the following serial parameters:
- 9600 Baud
- 8 Bits
- 1 Stop bit
- No Parity
- XON/XOFF or RTS/CTS flow control (XON/XOFF and 3-wire connections recommended)

7. Turn on the VME rack. The following should happen:
- All MVME167 LED's illuminate until the VMEbus RESET* line is released.
- STAT, LAN, SCSI and VME LED's extinguish, and the following should be displayed on the terminal:

```
Copyright Motorola Inc. 1988-1994, All Rights Reserved

MVME167 Debugger/Diagnostics Release Version 2.2 - 01/14/94
COLD Start
```

- After a short pause:

```
Local Memory Found =01000000 (&16777216)
```

- Another short pause, then:

```
MPU Clock Speed =33Mhz

167-Bug>
```

- The FAIL LED also extinguishes just before the debugger prompt is displayed.

If the LED sequence is as described but no text appears on the terminal, the most likely cause is the RS232 connections. The use of an RS232 diagnostic box or a Magic Cable is recommended in the event of any problems, as there are so many different ways of interpreting the standard. Also examine the Transition Module cabling, especially the DB25 IDC sockets, and if necessary check the continuity of the connections back to the Transition Module itself.

If the `167-Bug>` prompt is not displayed and the board goes straight into the self-tests, it has been left in System mode. To switch back to the normal Bug mode, press the ABORT button on the MVME167 front panel, and type the commands shown in **`bold type`** below, *including the full stop.* All punctuation in the screen displays is significant and often essential to the test.

```
167-Diag>ENV
Bug or System environment [B/S] = S? B
Field Service Menu Enable [Y/N] = N? N.

Update Non-Volatile RAM (Y/N)? Y

Reset Local System (CPU) (Y/N)? Y
```

after which the system will reset as shown in step 7 above.

The debug monitor contains extensive self-test software for the devices built into the card. To run the self-tests, type the commands shown in **`bold type`** below. The full list of tests has been omitted, and normally the results of all tests appear on the same display line, overwriting the previous test result. The full self-test can take quite a long time (worth a break for coffee while it completes!).

```
167-Bug>SD
167-Diag>ST
RAM      QUIK: Quick Write/Read........... Running --->
```

and concluding with

```
NCR      IRQ: NCR53C710 Interrupts......... Running ---> PASSED
167-Diag>
```

The tests performed are described in detail in the MVME167BUG User's Manual, and do not require any external hardware to run. The manual also lists some extra tests which can be performed but take a long time to execute, require external hardware or which just display extended diagnostic information. If any of the normal self-tests fail, contact your Motorola supplier.

The tests on the remaining cards will be performed using the facilities of the debug monitor, thus it is not necessary to install vxWorks or EPICS on the host workstation before checking the hardware. The points described above about static precautions, card inspection and installation apply to all cards, and will not be repeated.

Although the VMEbus makes no distinction between which slot a card can be installed in, there are a number of signals which are daisy-chained along the bus, thus it makes sense to populate the chassis in order, starting with the slot next to the MVME167 card. If a slot is to be left empty for any reason and there are cards installed further away from the CPU it is essential to install jumpers in the backplane to allow these daisy-chain signals to propagate beyond the gap. Some of the cards described below are 2 slots wide but only make connections to the VMEbus from the first of these slots, and for these cards backplane jumpers must be installed in the second slot. The position of these jumpers is described in the Enclosure Hardware manual, pages 3-4 and 3-5.

## 3.4 Bancomm bc635VME

The Time Bus card is configured using a combination of DIP switches and jumpers (see chapter 2 of the Operation and Technical manual for location diagrams). The switches set the board base address within the VMEbus A16 address space, and should be set to 0x4000 as follows (On = switch closed):

TABLE 17. bc635VME Switch Settings

| Switch | Sets | Setting | Switch | Sets | Setting |
|---|---|---|---|---|---|
| SW1-1 | A6 | On | SW2-1 | A14 | Off |
| SW1-2 | A7 | On | SW2-2 | A15 | On |
| SW1-3 | A8 | On | SW2-3 | Bus Type | On |
| SW1-4 | A9 | On | SW2-4 | Bus Type | On |
| SW1-5 | A10 | On | | | |
| SW1-6 | A11 | On | | | |
| SW1-7 | A12 | On | | | |
| SW1-8 | A13 | On | | | |

The jumpers select various I/O options associated with the external connections to the card. The default settings are used:

TABLE 18. bc635VME Jumper Settings

| Jumper | Configures | Setting |
|---|---|---|
| JP1 | Modulated IRIG-B Timecode | 3-4 |
| JP2 | Single Ended GPS 1PPS input | 1-2 |
| JP3 | GPS Receiver Type | 1-2 |
| JP4 | Auxiliary RS422 Output | 3-4, 5-6 |
| JP5 | RS422 Input Termination | 1-2 |

1. Install the card in a suitable slot and switch on. The displays may initially show a random number, but should immediately change to all segments on for about a second, then start counting the time from 00:00:00.

   Note that the decimal points on the displays are used to indicate if time is available from an external source — the decimals are lit to indicate that the card is freewheeling. If the card is a bc637GPS unit and the satellite receiver is plugged in and can see the sky, there will be a delay of a few minutes while the receiver picks up the satellites, but eventually the display will change to show the current time (not necessarily local time though) and the decimal points will be extinguished.
2. Check that the card’s VME interface works:

```
167-Bug>MD FFFF4000:10
FFFF4000  FEF4 F350 XXXX XXXX  FFFF FFFF 0070 01HH
FFFF4010  MMSS XXXX XXXX 00FF  FFFF FFFF FFFF FFF0
```

In the above, `XXXX` can be any value, and the BCD digits `HH` and `MMSS` should be the same as the time displayed at the moment the memory dump was done. There are no more tests which can be performed without additional equipment or software, so providing the memory dump matches and the time display increments correctly the card should be assumed to be working satisfactorily.

### 3.5 VMIC VMIVME-5578

The Reflective Memory card is configured using a series of jumpers on both the mother and daughter boards which make up the module. Jumper locations are shown in the diagram on page 5-2 of the Product Manual, and should be set according to the table below:

TABLE 19. VMIVME5578 Jumper Settings

| Jumper | Configures | Setting | Jumper | Configures | Setting |
|---|---|---|---|---|---|
| E2 | A24 Address Space | Out | E1 | A31 to A24 | Any |
| E3 | Supervisor + User Access | 2-3 | E4 | A23 | In |
| E5 | System Reset | Out | | A22 | In |
| E6 | 26.1 Mbytes/second | Out | | A21 | Out |
| E7 | Transfer Error Interrupt | In | | A20 | In |
| E8 | Node ID | See Text | | A19 | In |
| E9 | Optic Control | Factory | | A18 | In |

The Node ID jumpers E8 must be set uniquely for every Reflective Memory card on the fibre ring. For development purposes where only a single node is available the setting does not matter, but for the delivered hardware the Node ID will be specified by the Gemini Software and Controls Group.

The 5578 is a double-width module which only makes connections to one of its VMEbus slots, thus when installing it the backplane daisy-chain jumpers must be installed for the second (upper) slot. It is good practice to do this even if there are no cards installed further down the rack in case one is added at a later stage.

1. Install the module, leaving the dust guards on the fibre transmitter and receiver units to begin with (no fibre cables connected). When power is applied, the red FAIL LED will be illuminated and the green STAT 1 LED should flash at about 1 Hz, STAT 2 remaining off.
2. Check that VMEbus access to the card can be achieved. FAIL will extinguish as soon as the zero value is written below:

```
167-Bug>M F0200005;B
F0200005 E1? 0=
**WARNING: NO MATCH**
F0200005 61? .
```

3. The next card test uses the software in the debug monitor to check the memory on the Reflective Memory card.

```
167-Bug>SD
167-Diag>CF
RAM Configuration Data:
Starting/Ending Address Enable [Y/N] =N ? Y
Starting Address =00000000 ? F0200040
Ending Address   =01000000 ? F023FFFC.
167-Diag>RAM
RAM   QUIK: Quick Write/Read.............. Running ---> PASSED
RAM   ALTS: Alternating Ones/Zeroes........ Running ---> PASSED
RAM   PATS: Patterns...................... Running ---> PASSED
RAM   ADR: Addressability................. Running ---> PASSED
```

```
RAM   CODE: Code Execution/Copy............ Running ---> PASSED
RAM   PERM: Permutations................... Running ---> PASSED
RAM   RNDM: Random Data.................... Running ---> PASSED
RAM   BTOG: Bit Toggle..................... Running ---> PASSED
RAM   PED: Local Parity Memory Detection... Running ---> BYPASS
RAM   REF: Memory Refresh.................. Running ---> PASSED
```

4. If any of these tests fail, turn the system off and check that the daughter board is properly seated on the mother board — it can come loose in transit. Run the memory test above again, not forgetting to set the start and end addresses using **CF** as shown above.
5. Plug in a single fibre-optic cable, looped back between the transmitter and receiver on the module (do not switch the power off while doing this). The STAT 2 LED should illuminate shortly after the fibre has been inserted, showing that the receiver has an incoming signal.

```
167-Diag>MD F0200000:3
F0200000  XX27 40XX NNE1                            .'@XX.
167-Diag>RAM
RAM      QUIK: Quick Write/Read................ Running ---> PASSED
RAM      ALTS: Alternating Ones/Zeroes......... Running ---> PASSED
RAM      PATS: Patterns........................ Running ---> PASSED
RAM      ADR: Addressability................... Running ---> PASSED
RAM      CODE: Code Execution/Copy............. Running ---> PASSED
RAM      PERM: Permutations.................... Running ---> PASSED
RAM      RNDM: Random Data..................... Running ---> PASSED
RAM      BTOG: Bit Toggle...................... Running ---> PASSED
RAM      PED: Local Parity Memory Detection.... Running ---> BYPASS
RAM      REF: Memory Refresh................... Running ---> PASSED
167-Diag>MD F0200000:3
F0200000  XX27 40XX NNE5                            .'@XX.
```

6. In the above, *XX* could be any random value, and *NN* is the node ID setting for this board read from the jumper E8. The `40` in the third byte indicates the receiver PLL is currently locked but has been out of synchronisation since power-up, and the change in the sixth byte from E1 to E5 indicates that the card has received data back which it originated. If the E5 does not appear, try using a different fibre cable and run the RAM test again.

The tests described here assume that only one Reflective Memory card is available. If a second card can be obtained then it is possible to test the communications between the two cards. This is easiest if a second enclosure and IOC are also used as it avoids the need to change the card addresses. Two cards can be tested in the same chassis, but the base address for the second card must be set to 600000, A00000 or E00000 or communication will not take place. Don't forget to set the Node IDs differently for the two cards. The memory area starts 64 bytes (40 hex) above the base address, F0200040 for the normally addressed card.

### 3.6 DeltaTau PMAC-VME

The PMAC does not use jumpers or switches to set its VME interface — the large number of jumpers are used to configure the external connections to the PMAC. All VME setting are controlled from software by the on-board MC56001 DSP chip and can be changed by attaching a terminal to the serial port. However the card defaults are sufficient to do a communications test which includes verification that the DSP is working. A more detailed system test is beyond the scope of this document and would require special software to be written.

1. Install the card (again, a double-width VME module so the backplane jumpers should be installed for the second slot) and switch on. The Green LED should be illuminated, indicating that the board is receiving a 5 Volt supply.
2. The following sends the command ‘VER’ to the card, which the DSP will respond to by returning the firmware version number. The order in which the characters are written to the PMAC is important, do not “correct” the operations below in any way.

```
167-Bug>M F07FA005;BA
F07FA005 00? 45
F07FA007 00? 52
F07FA009 00? 0D.
167-Bug>M F07FA001;BA
F07FA001 00? 56
F07FA003 00? 0.
167-Bug>M F07FA001;BA
F07FA001 0A?
F07FA003 31?
F07FA005 2E?
F07FA007 31?
F07FA009 35?
F07FA00B 44?
F07FA00D 20?
F07FA00E 20?
F07FA011 0D? .
```

3. The values which the DSP writes to the buffer are the ASCII codes for ‘1.15D’, which represents the firmware version for the PMAC card — the minor version number may vary slightly, so the values at addresses F07FA007 through F07FA00B could be different. To be able to accept and execute the VER command, the PMAC DSP must be running correctly and able to communicate via the VMEbus interface.

Having received a command and sent a reply, the DSP is now awaiting an interrupt acknowledge cycle from the host CPU before it will accept another command. It is not possible to handle interrupts using the debug monitor, so this is the limit of the testing which can be performed from the MVME167 without writing additional software.

Further tests including experimenting with direct PMAC commands can be done by building an RS232 cable and connecting the PMAC directly to a terminal or computer. The cable needs a 26-way IDC housing at one end which plugs into J4, and an IDC 25 way female D connector at the other, connecting pin 1 to pin 1. The result is a DCE serial connection, which runs at 9600 baud, 8 bits, no parity, 1 stop bit. These settings can be changed using jumpers on the board — see the PMAC-VME Hardware Reference Manual for details.

### 3.7 OMS VME8-8

Page 3-7 of the Users Manual contains a diagram which should be referred to when setting the jumpers to the following positions:

TABLE 20. OMS VME8-8 Jumper Settings

| Jumper | Configures | Setting | Jumper | Configures | Setting |
|---|---|---|---|---|---|
| J25 | A15 | Out | J15 | IRQ1 | Out |
| | A14 | Out | | IRQ2 | Out |
| | A13 | Out | | IRQ3 | Out |
| | A12 | Out | | IRQ4 | Out |
| | A11 | Out | | IRQ5 | In |
| | A10 | Out | | IRQ6 | Out |
| | A9 | In | | IRQ7 | Out |
| | A8 | In | J26 | J2 | Out |
| J27 | AM5 | Out | | J1 | In |
| | AM0 | Out | | J0 | Out |
| | AM1 | In | | USER | Out |
| | AM4 | In | J35 | SYNC1 | Out |
| | A7-A4 | See Text | | SYNC0 | Out |

Jumper J34 is not mentioned the table above because it is dependent on the particular application, setting the polarity of the limit inputs for the various motor axes.

The standard EPICS distribution can support up to 8 OMS cards, and the addresses for these are selected using the A7 to A4 pins of jumper J27. The test instructions below assume that the module is set to card 0; adjustments to the addresses given will be needed if a different card number is used. The different settings are as follows:

TABLE 21. OMS VME8-8 Jumper J27

| Card # | Base Address | J27 | | | |
|---|---|---|---|---|---|
| | | A7 | A6 | A5 | A4 |
| 0 | FC00 | In | In | In | In |
| 1 | FC10 | In | In | In | Out |
| 2 | FC20 | In | In | Out | In |
| 3 | FC30 | In | In | Out | Out |
| 4 | FC40 | In | Out | In | In |
| 5 | FC50 | In | Out | In | Out |
| 6 | FC60 | In | Out | Out | In |
| 7 | FC70 | In | Out | Out | Out |

The I/O connections to the OMS card are all made through the P2 backplane connector. The simplest way to make these connections is to use an IDC connector, 64 way DIN41612 using rows A+C. The IDC cable can be split into groups of 8 conductors with each group comprising the signals for one motor axis (see page 4-2 of the User's Manual for the pin assignments).

The module test for the OMS card presented here does not attempt to check the specialised functionality of the card at all, it just verifies that it is possible to send commands to the on-board CPU and that a sensible reply is returned.

1. Demonstrate that the card registers respond to accesses from the VMEbus as follows. Note that the 50 byte at address FFFFFC07 reads 40 if the command is subsequently repeated.

```
167-Bug>MD FFFFFC00
FFFFFC00  FFFF FF00 FF00 FF50  FF00 FFFF FFFF FFFF  .......P........
```

2. Ask the card to report its model type and firmware revision number:

```
167-Bug>M FFFFFC01;B
FFFFFC01 FF? 'W'
**WARNING:NO MATCH**
FFFFFC01 FF? 'Y'
**WARNING:NO MATCH**
FFFFFC01 0A? =
FFFFFC01 0D?
FFFFFC01 56?
FFFFFC01 4D?
FFFFFC01 45?
FFFFFC01 38?
FFFFFC01 20?
FFFFFC01 76?
FFFFFC01 65?
FFFFFC01 72?
FFFFFC01 20?
FFFFFC01 32?
FFFFFC01 2E?
FFFFFC01 30?
FFFFFC01 39?
FFFFFC01 2D?
FFFFFC01 38?
FFFFFC01 0A?
FFFFFC01 0D? .
```

The string returned above is ASCII for 'VME8 ver 2.09-8'. There may be some difference in the firmware revision number reported in later cards, so the later characters returned may vary slightly. As with the PMAC, the fact that the CPU has interpreted the command correctly and responded implies that OMS card is probably working correctly  additional testing would require extra hardware and software and is probably not worth doing.

Chapter 7 of the User's Manual presents a simple demonstration program which can be used to type command strings directly to the card. The program presented is for the VMEPROM debug monitor; a version for the MVME167 card is given below. To use it, either type in the assembly code as shown (the assembler redisplays the instructions in a more verbose form after they are entered), or enter the hex instruction codes directly. The monitor contains a disassembler which should be used to check that the code entered is correct  the command **`DS E000:D`** lists the routine.

```
167-Bug>AS E000
0000E000 11FC0000 FC05      MOVE.B #0,FFFFFC05
0000E006 4E4F0001           SYSCALL .INSTAT
0000E00A 6712               BEQ.B E01E
0000E00C 08380006 FC07      BTST.B #6,FFFFFC07
0000E012 67F8               BEQ.B E00C
0000E014 558F               SUBQ.L #2,A7
0000E016 4E4F0000           SYSCALL .INCHR
0000E01A 11DFFC01           MOVE.B (A7)+,FFFFFC01
0000E01E 08380005 FC07      BTST.B #5,FFFFFC07
0000E024 67E0               BEQ.B E006
0000E026 1F38FC01           MOVE.B FFFFFC01,-(A7)
0000E02A 4E4F0020           SYSCALL .OUTCHR
0000E02E 60D6               BRA.B E006
```

To run the program type **G E000**. Use the terminal's Break key or the MVME167 ABORT button to return to the debug monitor. It is a good idea to type **ENWY** as the first commands. The **EN** will not be displayed (it is a request to the OMS to turn on command echoing), and the **WY** prints the model and revision string as in the previous test.

## 3.8 XYCOM XVME-240

The standard EPICS distribution defines 2 XVME-240 cards, which are set up using a combination of jumpers and switches. Page 2-2 of the manual is a diagram showing the positions of these components, which should be set as follows:

TABLE 22. XVME-240 Switch and Jumper Settings

| J/S | | Configures | Setting |
|---|---|---|---|
| S1 | 1 | IRQ0 | Closed |
| | 2 | IRQ1 | Closed |
| | 3 | IRQ2 | Closed |
| S2 | 1 | A10 | See Text |
| | 2 | A11 | Closed |
| | 3 | A12 | Open |
| | 4 | A13 | Closed |
| | 5 | A14 | Open |
| | 6 | A15 | Open |
| | 7 | User Mode Access | Closed |
| J2 | | Short Address | B |
| J3-10 | | Interrupt Inputs | Not Used |

Position 1 of Switch S2 should be closed for XVME-240 card 0, open for card 1. The tests below assume that card 0 is being tested (base address D000); for card 1, the base address is D400, and the addresses used will need to be modified to match.

All the I/O signals emerge from the two IDC plugs on the front panel  see manual pages 2-12 to 2-14 for the pin definitions. The EPICS device driver defines ports 0 to 3 as input signals (connector JK1), and ports 4 to 7 as outputs (JK2), and does not support the use of the Interrupt Input or Flag Output Lines.

1. At power-up, the FAIL LED will be on, and PASS off.
2. Check communication with the card and the operation of the PASS and FAIL LED's:

```
167-Bug>M FFFFD081;B
FFFFD081 00? 1=
```

- Both LED's off

```
FFFFD081 01? 2
```

- Both LED's on

```
FFFFD081 02? 3.
```

- PASS on, FAIL off

3. Read the card identifier block:

```
167-Bug>MD FFFFD000:20
FFFFD000  FF56 FF4D FF45 FF49  FF44 FF58 FF59 FF43  .V.M.E.I.D.X.Y.C
FFFFD010  FF32 FF34 FF30 FF20  FF20 FF20 FF20 FF31  .2.4.0. . . . .1
FFFFD020  FF20 FF31 FF31 FF20  FF00 FF00 FF00 FF00  . .1.1. ........
FFFFD030  FF00 FF00 FF00 FF00  FF00 FF00 FF00 FF00  ................
```

4. Test all bits in the Flag Output and Data Direction registers:

```
167-Bug>M FFFFD086
FFFFD086 0000? 1=
FFFFD086 0001? 2
FFFFD086 0002? 4
FFFFD086 0004? 8
FFFFD086 0008? 10
FFFFD086 0010? 20
FFFFD086 0020? 40
FFFFD086 0040? 80
FFFFD086 0080? 100
FFFFD086 0100? 200
FFFFD086 0200? 400
FFFFD086 0400? 800
FFFFD086 0800? 1000
FFFFD086 1000? 2000
FFFFD086 2000? 4000
FFFFD086 4000? 8000
FFFFD086 8000? FFFF
FFFFD086 FFFF? AAAA
FFFFD086 AAAA? 5555
FFFFD086 5555? 00FF.
```

- The last value, 00FF is important because it sets all ports to Outputs, required for the following tests.

5. Test all bits in the Port Data registers:

```
167-Bug>M FFFFD088
FFFFD088 0000? 1=
FFFFD088 0001? 2
FFFFD088 0002?
```

- Try all bits as in 4 above, then repeat for addresses FFFFD08A, FFFFD08C and FFFFD08E.

6. Set Data Direction register to Input, check Port Data registers:

```
167-Bug>M FFFFD086
FFFFD086 00FF? 0
FFFFD088 FFFF? 0
**WARNING:NO MATCH**
FFFFD088 FFFF?
FFFFD08A FFFF? 0
**WARNING:NO MATCH**
FFFFD08A FFFF?
FFFFD08C FFFF? 0
**WARNING:NO MATCH**
FFFFD08C FFFF?
FFFFD08E FFFF? 0
**WARNING:NO MATCH**
FFFFD08E FFFF? .
```

Additional tests could obviously be added using external hardware, but unfortunately a loop-back cable is not trivial to make because of the way the pinouts of the two connectors have been defined.

## 3.9 XYCOM XVME-220

Only a single XVME-220 card is assumed in the standard EPICS distribution. See the manual page 2-2 for a diagram giving the jumper and switch locations, which should be set as follows:

TABLE 23. XVME-220 Switch and Jumper Setting

| J/S | | Configures | Setting |
|---|---|---|---|
| S1 | 1 | A10 | Closed |
| | 2 | A11 | Open |
| | 3 | A12 | Closed |
| | 4 | A13 | Closed |
| | 5 | A14 | Open |
| | 6 | A15 | Open |
| | 7 | User Mode Access | Closed |
| | 8 | Short Address | Closed |
| J2 | | Short Address | B |

All I/O signals emerge from the front panel of the card. As these are Open-Collector, an external voltage must be applied if it is desired to monitor or test the outputs (section 2.9 of the manual gives an application example).

1. At power-up, the FAIL LED will be on, and PASS off.
2. Check communication with the card and the operation of the PASS and FAIL LED’s:

```
167-Bug>M FFFFC881;B
FFFFC881 00? 1=
```

- Both LED’s off

```
FFFFC881 01? 2
```

- Both LED's on

```
FFFFC881 02? 3.
```

- PASS on, FAIL off

3. Read the card identifier block:

```
167-Bug>MD FFFFC800:20
FFFFC800  FF56 FF4D FF45 FF49  FF44 FF58 FF59 FF43  .V.M.E.I.D.X.Y.C
FFFFC810  FF32 FF32 FF30 FF20  FF20 FF20 FF20 FF31  .2.2.0. . . . .1
FFFFC820  FF20 FF31 FF31 FF20  FF00 FF00 FF00 FF00  . .1.1. ........
FFFFC830  FF00 FF00 FF00 FF00  FF00 FF00 FF00 FF00  ................
```

4. Test the Data Output register:

```
167-Bug>M FFFFC882;L
FFFFC882 00000000? 1=
FFFFC882 00000001? 2
FFFFC882 00000002? 4
FFFFC882 00000004? 8
FFFFC882 00000008? 10
FFFFC882 00000010? 20
FFFFC882 00000020? 40
FFFFC882 00000040? 80
FFFFC882 00000080? 100
```

- etc. checking all bits, up to

```
FFFFC882 10000000? 20000000
FFFFC882 20000000? 40000000
FFFFC882 40000000? 80000000
FFFFC882 80000000? FFFFFFFF
FFFFC882 FFFFFFFF? AAAAAAAA
FFFFC882 AAAAAAAA? 55555555
FFFFC882 55555555? 0.
```

- Test 4 can be used in conjunction with some external hardware to check the functioning of the individual output bits if desired.

## 3.10 XYCOM XVME-566

The XVME-566 card can be used in either single-ended or differential input mode, EPICS supporting a maximum of 4 cards of each type in a system. In fact the card has several configuration jumpers which can be used to select from a number of different analogue conversion options, although not all of these will work properly with the EPICS driver. Page 2-2 of the manual gives a diagram showing the positions of the various jumpers, switches and calibration potentiometers. The following table contains the settings which are required for all XVME-566 cards:

TABLE 24. XVME-566 Settings — All Cards

| Switch | | Configures | Setting | Jumper | Configures | Setting |
|---|---|---|---|---|---|---|
| S1 | 1 | IRQ2 | Closed | J1 | Use IACK Daisy-Chain | B |
| | 2 | IRQ1 | Open | J2 | Use IACK Daisy-Chain | B |
| | 3 | IRQ0 | Open | J3 | Short Address Space | B |
| S3 | 7 | Short Address Space | Closed | J5 | A/D Format | In |
| | 8 | User Mode Access | Closed | J16 | A/D Format | B |

The following table shows the address switch settings, which vary by according to whether the card inputs are to be Single-Ended (SI) or Differential (DI), and also by the card number of each type. The card also has a Pseudo-Differential mode, which can be used and should be treated as another Single-Ended card.

TABLE 25. XVME-566 Address Switch Settings

| | | SI[0] | SI[1] | SI[2] | SI[3] | DI[0] | DI[1] | DI[2] | DI[3] |
|---|---|---|---|---|---|---|---|---|---|
| **Register Base** | | 6000 | 6400 | 6800 | 6C00 | 7000 | 7400 | 7800 | 7C00 |
| S3 | 1 | Closed | Closed | Closed | Closed | Closed | Closed | Closed | Closed |
| | 2 | Open | Open | Open | Open | Open | Open | Open | Open |
| | 3 | Open | Open | Open | Open | Open | Open | Open | Open |
| | 4 | Closed | Closed | Closed | Closed | Open | Open | Open | Open |
| | 5 | Closed | Closed | Open | Open | Closed | Closed | Open | Open |
| | 6 | Closed | Open | Closed | Open | Closed | Open | Closed | Open |
| **Memory Base** | | 000000 | 010000 | 020000 | 030000 | 040000 | 050000 | 060000 | 070000 |
| S2 | 1 | Closed | Closed | Closed | Closed | Closed | Closed | Closed | Closed |
| | 2 | Closed | Closed | Closed | Closed | Closed | Closed | Closed | Closed |
| | 3 | Closed | Closed | Closed | Closed | Closed | Closed | Closed | Closed |
| | 4 | Closed | Closed | Closed | Closed | Closed | Closed | Closed | Closed |
| | 5 | Closed | Closed | Closed | Closed | Closed | Closed | Closed | Closed |
| | 6 | Closed | Closed | Closed | Closed | Open | Open | Open | Open |
| | 7 | Closed | Closed | Open | Open | Closed | Closed | Open | Open |
| | 8 | Closed | Open | Closed | Open | Closed | Open | Closed | Open |

Finally the available analogue conversion options are as follows:

TABLE 26. XVME-566 Analogue Input Settings

| Parameter | Option | Settings |
|---|---|---|
| Input Type | Single-Ended | J9 A+C, J14 Out, J15 In |
| | Differential | J9 B, J14 Out, J15 Out |
| | Pseudo-DI | J9 A+D, J14 Out, J15 In |
| Range | 0-10 Volts | J8 A, J10 A |
| | 5 V olts | J8 A, J10 B |
| | 10 V olts | J8 B, J10 B |
| Gain | 1 | J7 A+B |
| | 4 | J7 C+D |
| | 10 | J7 E+F |

The card inputs are all connected to the front-panel connector JK1, for which the pinouts are listed in page 2-25 of the manual.

1. At power-up, the FAIL LED will be on, and PASS off.
2. Check communication with the card and the operation of the PASS and FAIL LED's:

```
167-Bug>M FFFF6081;B
FFFF6081 80? 81=
```

• Both Off.

```
FFFF6081 81? 82
```

• Both On.

```
FFFF6081 82? 83.
```

• PASS On, FAIL Off.

3. Read the card identifier block:

```
167-Bug>MD FFFF6000:20
FFFF6000  FF56 FF4D FF45 FF49  FF44 FF58 FF59 FF43  .V.M.E.I.D.X.Y.C
FFFF6010  FF35 FF36 FF36 FF20  FF20 FF20 FF20 FF31  .5.6.6. . . . .1
FFFF6020  FF20 FF31 FF31 FF20  FF00 FF00 FF00 FF00  . .1.1. ........
FFFF6030  FF00 FF00 FF00 FF00  FF00 FF00 FF00 FF00  ................
```

4. Check the 64 Kb of RAM on the card:

```
167-Bug>SD
167-Diag>CF
RAM Configuration Data:
Starting/Ending Address Enable [Y/N] =N ? Y
Starting Address =00000000 ? F0000000
Ending Address   =01000000 ? F000FFFC.
167-Diag>SRAM
SRAM     QUIK: Quick Write/Read..................... Running ---> PASSED
SRAM     ALTS: Alternating Ones/Zeroes.............. Running ---> PASSED
SRAM     PATS: Patterns............................ Running ---> PASSED
```

```
SRAM     ADR: Addressability........................ Running ---> PASSED
SRAM     CODE: Code Execution/Copy.................. Running ---> PASSED
SRAM     PERM: Permutations......................... Running ---> PASSED
SRAM     RNDM: Random Data.......................... Running ---> PASSED
SRAM     BTOG: Bit Toggle........................... Running ---> PASSED
SRAM     PED: Local Parity Memory Error Detection.... Running ---> BYPASS
SRAM     REF: Memory Refresh Test................... Running ---> BYPASS
```

It is not a simple matter to get the card to execute an analogue conversion, thus it is not possible to test or calibrate the card without additional software.

## 3.11 VMIC VMIVME-4100

EPICS supports up to 4 of these cards, with no differentiation between the two different versions. A diagram on page 5-5 of the Instruction Manual shows the locations of the jumpers and switches, which should be set as follows:

TABLE 27. VMIC 4100 Switch and Jumper Settings

| J/S | | Configures | Setting |
|---|---|---|---|
| S2 | 1 | A15 | Closed |
| | 2 | A14 | Open |
| | 3 | A13 | Closed |
| | 4 | A12 | Closed |
| | 5 | A11 | Closed |
| | 6 | A10 | Closed |
| | 7 | A9 | Closed |
| | 8 | A8 | Open |
| | 9 | A7 | Closed |
| JB | | Supervisor Mode Access | Out |
| JC | 1 | Async Updates, Ch 03 | Out |
| | 2 | Async Updates, Ch 47 | Out |
| | 3 | Async Updates, Ch 811 | Out |
| | 4 | Async Updates, Ch 1215 | Out |
| | 5 | Internal Update Trigger | Out |

The final address bits are set based on the card number as follows:

TABLE 28. VMIC 4100 Switch S1

| Card # | Base Address | S1 1 | 2 | 3 | 4 |
|---|---|---|---|---|---|
| 0 | 4100 | Closed | Closed | - | - |
| 1 | 4120 | Open | Closed | Not | |
| 2 | 4140 | Closed | Open | Used | |
| 3 | 4160 | Open | Open | - | - |

The P3 connector on the front panel provides all the analogue output signals, along with a ground line for each signal — the pin assignments are given on page 5-9 of the Instruction Manual. The connector itself is not a normal IDC format as it comprises 32 connections and the rows are spaced 0.2 inches apart. According to the manual, the cable connector required for this socket is manufactured by Panduit, part number 120-332-435E.

Testing of the 4100 card is limited by the simple interface which is presents to the programmer.

1. On power-up, the FAIL indicator is illuminated.

```
167-Bug>M FFFF4100
FFFF4100 0000? C100.
```

- FAIL extinguished. This also confirms that the board responds to accesses from the VMEbus, and enables the analogue outputs onto the P3 connector.

2. To set the output voltages for measurement using a multimeter, write a 16-bit value to the card using an address offset of twice the channel number:

```
167-Bug>MW FFFF410A 800
Effective address: FFFF4105
Effective data   : 0800
```

- Channel 5 set to zero Volts (half-way between 10 and +10 Volts).

```
167-Bug>MW FFFF411E FFF
Effective address: FFFF4105
Effective data   : 0FFF
```

- Channel 15 set to +9.9951 Volts (max. voltage).

The card uses the top data bit (D15) to differentiate between control and DAC data, with the top bit set to indicate control information as in 1 above. Use data values only in the range 0 to FFF.

## A.0 Other EPICS-supported VME cards

The information in the table below was extracted from a document available at the APS WWW-server, “Supported Hardware List” from the URL http://epics.aps.anl.gov/asd/controls/hardware.html

The primary technical contact at APS is listed by email address, add @aps.anl.gov to the contact username given. This data has not been updated since 1st December 1993, so may be somewhat out of date.

TABLE 29. Additional VME Hardware Supported by EPICS

| Supplier | Model | Function | Contact |
|---|---|---|---|
| Acromag | 9441 | Digital I/O - 16 I, 16 O with opto-isolation | gjn |
| Analogic | DVX 2502 | 16-bit high speed analog in, 200 kHz 8 channel | winans |
| Analogic | DVX 2503 | 16-bit high speed analog in, 400 kHz 8 channel | winans |
| APS | FOBO | Fibre Optic Binary Output, 16 channel | gjn |
| Burr Brown | MPV902 | Binary output module | mrk |
| Burr Brown | MPV910 | Binary input module | mrk |
| Data Cube | MaxVideo 20 | Integrated Image Processing system | djc |
| Data Cube | Digimax | Digitizer and Display Device | djc |
| Data Cube | Roi-store | Region-Of-Interest Storage Device | djc |
| ESRF | VAROC | Absolute Encoder 16 ch, (any Sync Serial Device) | coulter |
| Joerger | VTR-1 | Waveform analyzer | mrk |
| Mizar | 8310 | Counter/timer (200 nsec res), 10 delay channels | jbk |
| Motorola | MVME-162 | Intelligent IP carrier (not an IOC) | winans |
| National | 1014 | Single port GPIB controller | winans |
| Omnibyte | COMET | Waveform analyzer | mrk |
| Oregon | VMEX-6 | 6 axis stepper motor controller | jbk |
| Oregon | VMEX-4E | 4 axis stepper motor controller, 2 incremental encoder | jbk |
| Oregon | VME44-4E | 4 axis stepper motor controller, 4 incremental encoder | jbk |
| Pep Modular | 5230-1/5230-11 | VME Piggyback host and Bitbus Ctlr IP board | saunders |
| Xycom | XVME-210 | Digital input | mrk |
| Xycom | XVME-402 | BITBUS Controller | winans |

A more reliable source of information on drivers is the EPICS applications mailing list, as this is received by most EPICS developers. If you are searching for an interface to perform some particular functionality it is often worth asking if another group are already using something similar, as this is quite often the case. To subscribe to the list, send the request “ADD me@my.email.address epics_applications” in the body of an email to listserv@aps.anl.gov.

# B.0 TM1x7 Transition Module Drawings

The TM1x7 module requires several cables to be manufactured to make the various connections available at the enclosure back panel. The cables required are defined in the drawings and parts lists given here. Part numbers given are for RS Components Ltd., a UK distributor, but US equivalents should be easy to find. Also given is the design for the retainers which are required if the IOC is to be mounted on the telescope.

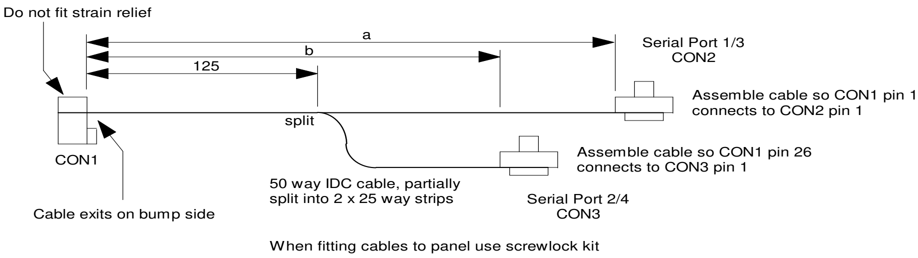
## B.1 Serial Cables

Only one of these serial cables is essential, for ports 1 (console) and 2. The second cable allows ports 3 and 4 to be used. The parts required for each cable are as follows:

TABLE 30. TM1x7 Serial Cable Parts List

| Reference | Qty | Description | RS Part |
|---|---|---|---|
| CON1 | 1 | 50 way IDC housing, bump polarised | 461-247 |
| CON2,3 | 2 | 25 way D female, IDC fitting | 470-847 |
| | 4 | Screwlock kit | 469-617 |
| | 1 | 50 way IDC ribbon cable, grey | |

The cables should be manufactured according to the following drawing:




Lengths a and b above are different for the two cables:

| Cable | Cut Cable | a | b |
|---|---|---|---|
| Ports 1/2 | 474 | 452 | 427 |
| Ports 3/4 | 450 | 427 | 402 |

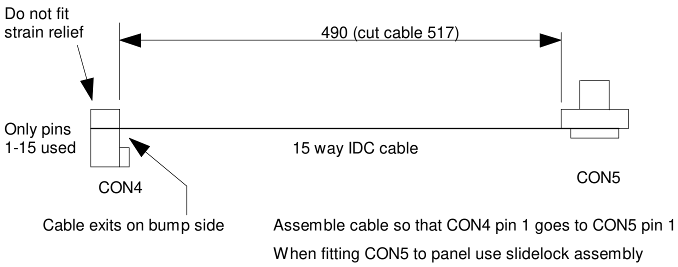
## B.2 Ethernet Drop Cable

An drop cable is needed for the IOC to be connected into an Ethernet network. The parts required are as follows:

TABLE 31. TX1x7 Ethernet Cable Parts List

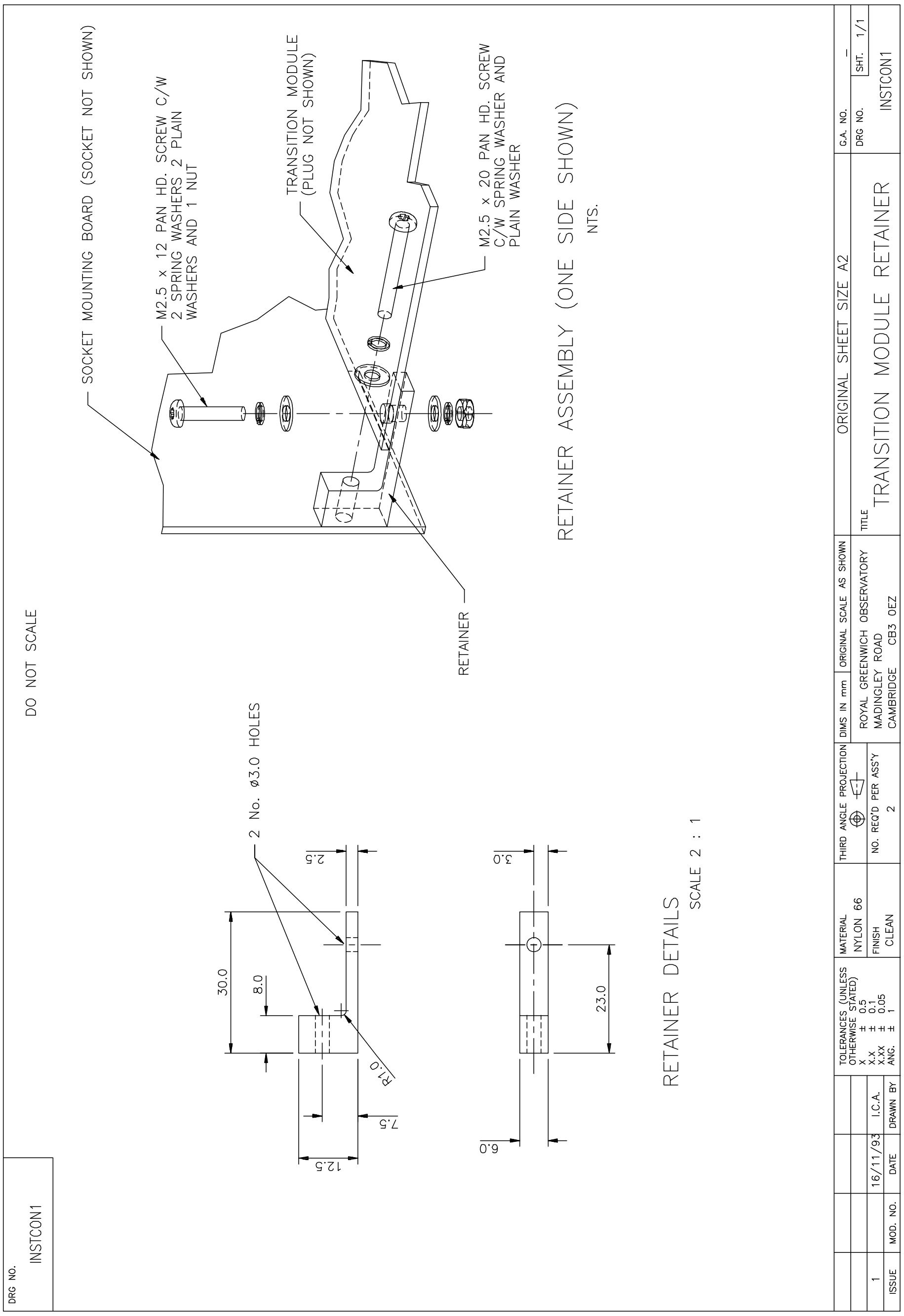
| Reference | Qty | Description | RS Part |
|---|---|---|---|
| CON4 | 1 | 20 way IDC housing, bump polarised | 461-203 |
| CON5 | 1 | 15 way female D connector - IDC fitting | 472-657 |
| (CON5) | 1 | Slidelock assembly for 15 way D | 472-102 |
| | 1 | 15 way IDC ribbon cable, grey | |

Manufacture the cable according to the following drawing:



## B.3 Transition Module Retainer

Two retainers hold the Transition Module into the chassis, manufactured and fitted thus:



## C.0 Address Maps

The VMEbus supports several independent address spaces which have different address widths — Short addresses are 16 bits wide, Standard are 24 bits and Extended 32. The addresses which EPICS expects to find the various cards at as set in **base/src/drv/module_types.c** are documented here for reference. These tables only show the Gemini standard VME modules described in this document. All addresses are given in hexadecimal.

## C.1 Short Address Space

The VME Short Address space uses 16 address bits. To access this address space from the MVME167 card, add 0xFFFF0000 to the short address.

TABLE 32. Standard Controller VME A16 Address Space

| Start | End | Card |
|---|---|---|
| | | |
| 4000 | 403F | BC635 |
| | | |
| 4100 | 411F | VMI4100[0] |
| 4120 | 413F | VMI4100[1] |
| 4140 | 415F | VMI4100[2] |
| 4160 | 417F | VMI4100[3] |
| | | |
| 6000 | 63FF | XY566SE[0] |
| 6400 | 67FF | XY566SE[1] |
| 6800 | 6BFF | XY566SE[2] |
| 6C00 | 6FFF | XY566SE[3] |
| 7000 | 73FF | XY566DI[0] |
| 7400 | 77FF | XY566DI[1] |
| 7800 | 7BFF | XY566DI[2] |
| 7C00 | 7FFF | XY566DI[3] |
| | | |
| C800 | CBFF | XY220 |
| CC00 | CC0F | MVME167[0] |
| | | |
| D000 | D3FF | XY240[0] |
| D400 | D7FF | XY240[1] |
| | | |
| FC00 | FC0F | OMS[0] |
| FC10 | FC1F | OMS[1] |
| FC20 | FC2F | OMS[2] |
| FC30 | FC3F | OMS[3] |
| FC40 | FC4F | OMS[4] |
| FC50 | FC5F | OMS[5] |
| FC60 | FC6F | OMS[6] |
| FC70 | FC7F | OMS[7] |
| | | |

## C.2 Standard Address Space

The VME Standard Address space uses 24 address bits. To access this address space from the MVME167 card, add 0xF0000000 to the standard address.

TABLE 33. Standard Controller VME A24 Address Space

| Start | End | Card |
|---|---|---|
| 000000 | 00FFFF | XY566SE[0] |
| 010000 | 01FFFF | XY566SE[1] |
| 020000 | 02FFFF | XY566SE[2] |
| 030000 | 03FFFF | XY566SE[3] |
| 040000 | 04FFFF | XY566DI[0] |
| 050000 | 05FFFF | XY566DI[1] |
| 060000 | 06FFFF | XY566DI[2] |
| 070000 | 07FFFF | XY566DI[3] |
| | | |
| 200000 | 23FFFF | VMI5578 |
| | | |
| 7FA000 | 7FA1FF | PMAC[0] |
| 7FA200 | 7FA3FF | PMAC[1] |
| 7FA400 | 7FA5FF | PMAC[2] |
| 7FA600 | 7FA7FF | PMAC[3] |
| | | |

## C.3 Extended Address Space

The VME Extended Address space uses 32 address bits. To access this address space from the MVME167 card, just use the extended address. Some extended VMEbus addresses cannot be seen by the MC68040 because the MVME167 decodes these areas for local RAM, I/O devices and the other VME address spaces. The table below gives the address space viewed from the MC68040; note that there are currently no standard Gemini EPICS VME modules which map into the Extended space, although several of the modules documented above can be made to do so.

TABLE 34. Standard Controller CPU A32 Address Space

| Start | End | Card |
|---|---|---|
| 00000000 | 00FFFFFF | MVME167 16 Mb DRAM |
| | | |
| F0000000 | F0FFFFFF | MVME167 VMEbus Standard Address Space |
| | | |
| FF800000 | FFEFFFFF | MVME167 ROM, SRAM |
| FFF00000 | FFFEFFFF | MVME167 Local I/O Devices |
| FFFF0000 | FFFFFFFF | MVME167 VMEbus Short Address Space |