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Reference Manual

VCM-DAS-1/2

Analog & Digital
Input/Output Module for
the PC/104 Bus

VERSALOGIC CORPORATION

VCM-DAS-1/2

Analog & Digital
Input/Output Module for
the PC/104 Bus

Model VCM-DAS-1/2

Analog & Digital Input/Output Module
for the PC/104 Bus

REFERENCE MANUAL

Doc. Rev. 4/9/2013

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Table of Contents

Other References

Burr-Brown Corp., (800) 548-6132, http://www.burr-brown.com/
ADS7805 16-Bit A/D Converter

Analog Devices Inc., (800) 262-5643, http://www.analog.com/
AD8522 12-Bit D/A Converter
AD976 16-Bit A/D Converter (alternate vendor)

Integrated Device Technology Inc., (800) 345-7015, http://www.idt.com
74FCT16652T Parallel Port Interface Chip

PC/104 Consortium, (650) 903-8304, http://www.controlled.com/pc104
PC/104 Resource Guide

VersaLogic Corporation, (800) 824-3163, http://www.versalogic.com
Embedded PCI (PC/104-Plus*) Specification. Available on web site.*

Overview 1

This chapter introduces the VCM-DAS-1/2 Analog and Digital I/O Module, lists its features and specifications, and provides a brief overview of the installation and configuration process.

Using This Manual

Each chapter in this manual corresponds to a step in the installation and operation of the module.

Chapter 1 – Overview

Lists basic information, specifications, and system requirements. Use this chapter to familiarize yourself with the module and it's capabilities.

Chapter 2 – Configuration

Describes how to jumper the module.

Chapter 3 – Installation

Describes how to install the VCM-DAS-1/2. Also provides information on the external connections.

Chapter 4 – Registers

Provides programming details and register descriptions.

Chapter 5 – Operation

Provides details on how to operate the Analog Input, Analog Output, Digital I/O, Digital Pots, and EEPROM circuits. Some software examples are given.

Chapter 6 – Calibration and Diagnostics

Describes the procedure for calibrating the module and running the included diagnostic software.

Appendix A – Schematics

Circuit diagrams.

Introduction

The VCM-DAS-1/2 module provides 16 single-ended analog input channels, featuring fast 10 µs conversion times and ±5V or ±10V input ranges. Throughput up to 200 kHz may be realized with repeat conversions on one channel; up to 67KHz when scanning from channel to channel.

The VCM-DAS-1/2 also includes two 12-bit analog output channels. These channels may be jumpered independently for 0 to 5V or 0 to 10V output at 5 ma each. Digital data is written in a serial fashion to update the analog values.

Digital pots are used for calibrating the analog circuits. A 1K EEPROM is included to store the calibration values, and there is plenty of extra space in the EEPROM for general purpose use. The digital pots must be initialized whenever the computer system is reset.

In addition to the analog sections, the module also includes 16 digital I/O lines. These digital lines feature TTL type outputs with readback, and are compatible with optically isolated modular I/O racks.

Features

GENERAL

- +5V and ±12V supplies required
- Uses four electronic digital adjustment pots instead of manual pots
- Digital Pot settings are stored in an on-board 128 x 16 EEPROM
- Compatible with the industry standard 5B series of signal conditioners

ANALOG INPUT

- 16 channels
- 16-bit input resolution
- Single ended, high impedance inputs
- Electronic digital calibration
- Up to 200K samples/second (VCM-DAS-2), up to 100K samples/second (VCM-DAS-1)
- ±5V and ±10V input ranges
- On board timer for periodic readings
- Auto retrigger mode
- Auto Channel Increment Mode
- DMA support
- Compatible with industry standard 5B01 series signal conditioners

ANALOG OUTPUT

- 2 channels
- 12-bit resolution
- Electronic digital calibration
- 0-5V and 0-10V output range
- 40 µS update time
- Short circuit proof, 5ma output current

DIGITAL I/O

- Two 8-bit ports
- ±24 ma output drive
- Programmable read-only or read/write
- Opto 22 compatible
- EEPROM storage for user data

Technical Specifications

Specifications are typical at 25°C with 5.0V supply unless otherwise noted.

Size: 3.8" x 3.6" (PC/104 standard)
0.6" component height

Storage Temperature:
–40°C to 85°C

Free Air Operating Temperature:
0°C to +60°C

Power Requirements: *(all digital outputs low [no external load], both analog outputs sourcing or sinking 5 ma ea.)*
5V ±5% @ 510 ma typ.
±12V ±5% @ ±20 ma typ.

Analog Input:

Channels:	16
Resolution:	16 bits, no missing codes
Accuracy:	±0.003% (±3 LSBs)
Input Mode:	Single ended
Range:	±5V or ±10V (jumper selectable, all channels the same)
Conversion Time:	10 μS (VCM-DAS-1), 5 μS (VCM-DAS-2)
Settling Time:	5 μS (applies only when switching channels)
Protection:	±35V overvoltage protection
Impedance:	$>10^{10}\Omega$, 20 pF
Retrigger Timer:	Programmable 20 μS, 50 μS, 100 μS, 250 μS, 500 μS, or 1 mS
Access:	Direct I/O

Analog Output:

Channels:	2
Range:	0 to 5V or 0 to 10V (jumper selectable, each channel independent)
Resolution:	12 bits
Accuracy:	±1.5 LSB
Update Time:	40 μS
Output Drive:	5 ma, 200 pF (each channel)
Access:	Bitwise serial

Digital I/O:

Channels:	16 (non-inverting)
Input Threshold:	TTL compatible
Architecture:	Totem pole output with readback
Output Drive (H):	–24ma @ 2.4V
Output Drive (L):	+24ma @ 0.55V
Signal Direction:	Byte programmable as input or output with readback
Short Protection:	Short circuit to ground, indefinite duration
Access:	Direct I/O

Digital Pots:

Organization:	4 pots used to calibrate analog section
Resolution:	256 settings
Access:	Serial

EEPROM:

Organization:	Sixty-four 16-bit words
Allocation:	Two words used for digital pots, 62 words available for general purpose storage
Access:	Bitwise serial

Bus Interface:

I/O Ports:	Occupies 16 ports on any 16-bit address boundary
Interrupt Channel:	IRQ10, IRQ11, or IRQ12
DMA Channel:	DMA5, DMA6, or DMA7

External Connectors:

Analog In/Out:	26-pin .1" dual-row header
Opto 22:	34-pin .1" dual-row header

Compatibility:

PC/104:	Full compliance, 16-bit data bus

Specifications are subject to change without notice.

Technical Support

If you have problems that this manual can't help you solve, contact VersaLogic for technical support at **(800) 824-3163 or (503) 747-2261**. You can also reach VersaLogic by e-mail at Support@versalogic.com.

REPAIR SERVICE

If your product requires service, you must obtain a Returned Material Authorization (RMA) number by calling (800) 824-3163. Our standard turn-around time for repairs is five working days after we receive the product.

Please provide the following information:

- Your name, the name of your company, and your phone number
- The name of a technician or engineer who we can contact if we have questions
- Quantity of items being returned
- The model and serial number of each item (the serial number is a 5 digit bar code)
- A description of the problem
- Steps you have taken to resolve or repeat the problem
- The return shipping address

Warranty Repair All charges are covered, including UPS Ground shipping charges for return back to your facility.

Non-warranty Repair All non-warranty repairs are subject to diagnosis and labor charges, parts charges, and return shipping fees. We will need to know what shipping method you prefer for return back to your facility, and we will need to secure a purchase order number for invoicing the repair.

Note! Please mark the RMA number clearly on the outside of the box before returning.

2 Configuration

This chapter describes how to configure the on-board options for the VCM-DAS-1/2 module. Configuration involves both hardware (jumper) and software configuration. The jumpers set the base address for the module and configure the analog circuitry for various modes of operation. Software configuration completes the process by initializing the analog calibration pots every time the card is reset.

Warning! The VCM-DAS-1/2 module requires +5V, +12V, and –12V for normal operation. These voltages must be supplied through the PC/104 connector. Damage to on-board components will occur if all three voltages are not present at the same time.

Hardware Jumper Summary

Hardware option configuration is accomplished by installing or removing jumper plugs. In this chapter, the term “in” is used to indicate an installed jumper and “out” is used to indicate a removed jumper.

Use the following key to interpret the jumper diagrams used in this manual:

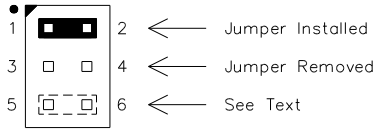


Figure 1. Jumpering Key

JUMPER BLOCK LOCATIONS

Note Jumpers are shown in as-shipped configuration.

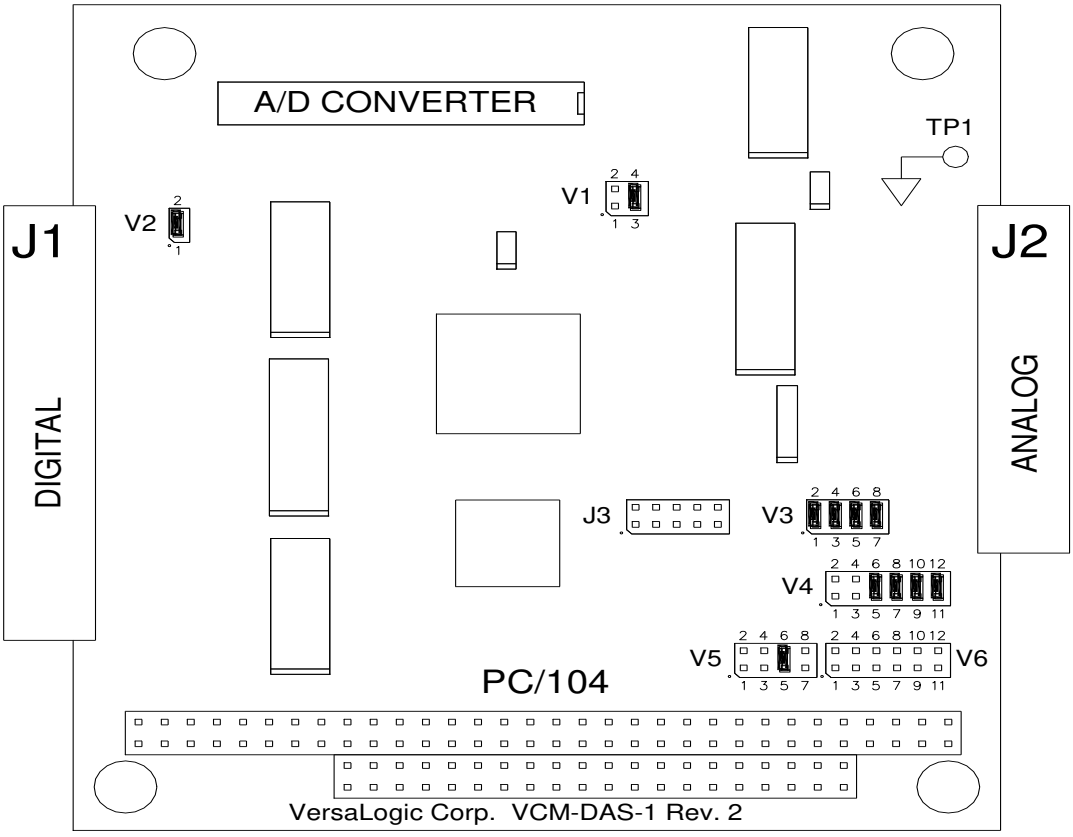
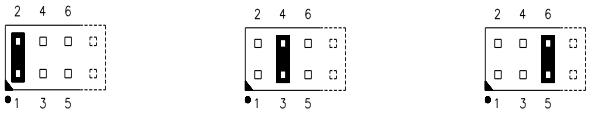
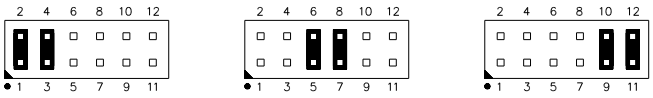


Figure 2. Jumper Block Locations

Table 1: Jumper Summary

Jumper Block	Description	As Shipped	Page
V1[1-2]	**Input Voltage Range** In — ±5V Input Range Out — ±10V Input Range	Out	9
V1[3-4]	**Input Low Pass Filter** In — Enabled Out — Disabled	In	9
V2	**Opto 22 I/O Rack Power** In — I/O rack power provided by analog board Out — I/O rack power provided externally	In	13
V3[1-2]	**Analog Loopback (Channel 0)** In — Connects DAC 0 output to ADC 14 input for diagnostic loopback Out — Circuits operate independently	In	11
V3[3-4]	**Analog Output 0 Voltage Range** In — 0 to 10V Out — 0 to 5V	In	10
V3[5-6]	**Analog Output 1 Voltage Range** In — 0 to 10V Out — 0 to 5V	In	10
V3[7-8]	**Analog Loopback (Channel 1)** In — Connects DAC 1 output to ADC 15 input for diagnostic loopback Out — Circuits operate independently	In	11
V4	**Address Select (A4 – A9)** V4[1-2] In – A9 Decoded Low Out – A9 Decoded High V4[3-4] In – A8 Decoded Low Out – A8 Decoded High V4[5-6] In – A7 Decoded Low Out – A7 Decoded High V4[7-8] In – A6 Decoded Low Out – A6 Decoded High V4[9-10] In – A5 Decoded Low Out – A5 Decoded High V4[11-12] In – A4 Decoded Low Out – A4 Decoded High	300h	8
V5[1-2] V5[3-4] V5[5-6]	**Interrupt Request Select** IRQ 10 IRQ 11 IRQ 12 	IRQ 12	14
V5[7-8]	**Shared Interrupt Configuration** In — Shared interrupts Out — Normal interrupts	Out	
V6	**DMA Channel Select** DMA 5 DMA 6 DMA 7 	None	16

Module Addressing

As shipped, the module is configured for a base address of 300h. The card occupies 16 consecutive I/O addresses (0300h to 030Fh). Ten of these addresses are mapped to control, data, and status registers. The remaining six addresses occupy positions in I/O space, but are not assigned to registers. See the Registers description section on page 23 for further register information.

The base address can range from 000h to 3F0h on any 10h address boundary. Use the table below to select the jumpering for the appropriate upper and middle hex digits of the three digit base address (i.e., "1" and "4" = 140h).

Note The lower digit is always "0".

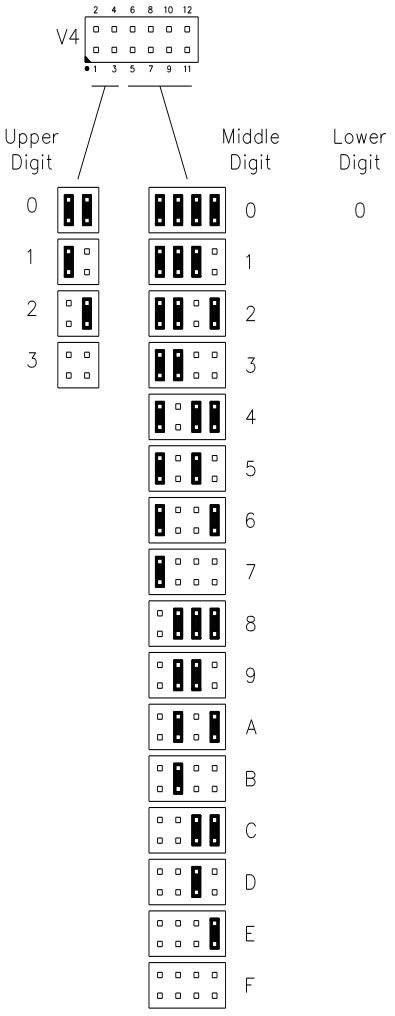


Figure 3. Jumper Block Locations

Analog Input Configuration

INPUT RANGE

The module may be operated with an input range of ±5 volts or ±10 volts. To achieve the maximum digital resolution and to prevent saturation, the range which most closely matches the input signal should be chosen. All channels operate with the same input range.

As shipped, the board is configured for ±5 volt input.

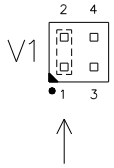


Table 2: Input Range Jumper

Jumper Block	Description	As Shipped
V1[1-2]	**Input Voltage Range** In — ±5V Input Range Out — ±10V Input Range	Out

LOW PASS FILTER

A 1 MHz low pass filter between the instrumentation amplifier and the A/D converter can be selected to reject high frequency noise.

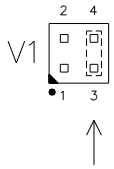


Table 3: Low Pass Filter Jumper

Jumper Block	Description	As Shipped
V1[3-4]	**Input Low Pass Filter** In — Enabled Out — Disabled	In

Analog Output Configuration

The VCM-DAS-1/2 module features two unipolar analog output channels. Both channels are single-ended and are referenced to analog ground. The digital data format is straight binary.

OUTPUT RANGE

Each output channel can be configured independently to produce a unipolar output voltage range of 0-5 volts or 0-10 volts as shown below.

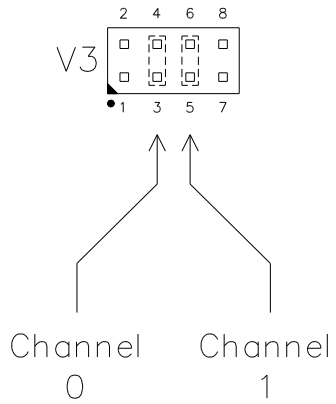


Table 4: Output Range Jumpers

Jumper Block	Description	As Shipped
V3[3-4]	**Analog Output Voltage Range (Channel 0)** In — 0 to 10V Out — 0 to 5V	In
V3[5-6]	**Analog Output Voltage Range (Channel 1)** In — 0 to 10V Out — 0 to 5V	In

ANALOG LOOPBACK

The two output channels can be connected (looped back) to two input channels for a direct readback of the voltage, or to provide analog output to a 5B01 signal conditioning rack. Analog loopback is also useful for diagnostic and calibration purposes.

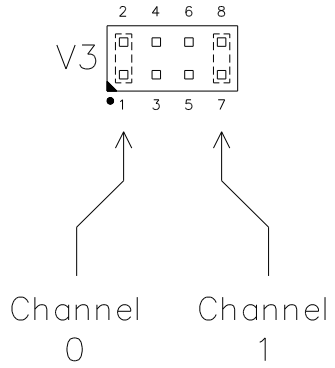


Table 5: Analog Loopback Jumpers

Jumper Block	Description	As Shipped
V3[1-2]	**Analog Loopback (Channel 0)** In — Connects DAC 0 output to ADC 14 input for diagnostic loopback Out — Circuits operate independently	In
V3[7-8]	**Analog Loopback (Channel 1)** In — Connects DAC 1 output to ADC 15 input for diagnostic loopback Out — Circuits operate independently	In

5B01 Analog Signal Conditioning Rack

When using a 5B01 series analog signal conditioning rack, the input range should be set to ±5V. If output channels are used, the Analog Loopback jumpers must be inserted and the output range configured for ±5V operation.

Note: It is important to configure your 5B01 signal conditioning rack so that analog ground on the rack is connected to the eight analog ground signals on the interface connector. Most racks include a jumper or cutable trace for this purpose, which must be installed (shown as "A" below).

To prevent ground loops, it is important that analog and digital grounds be connected together at only one point in the system. The VCM-DAS-1/2 brings these grounds together on the module circuitry itself, therefore any external connections between the two ground systems must be avoided. Most racks include a jumper or cutable trace that must be removed (shown as "D" below).

Warning! To prevent analog output channel 0 from shorting to ground, it is very important to properly configure your 5B01 signal conditioning rack so that pin 25 is disconnected. Most racks include jumpers or cuttable traces that must be removed to leave pin 25 floating (shown as "B" and "C" below).

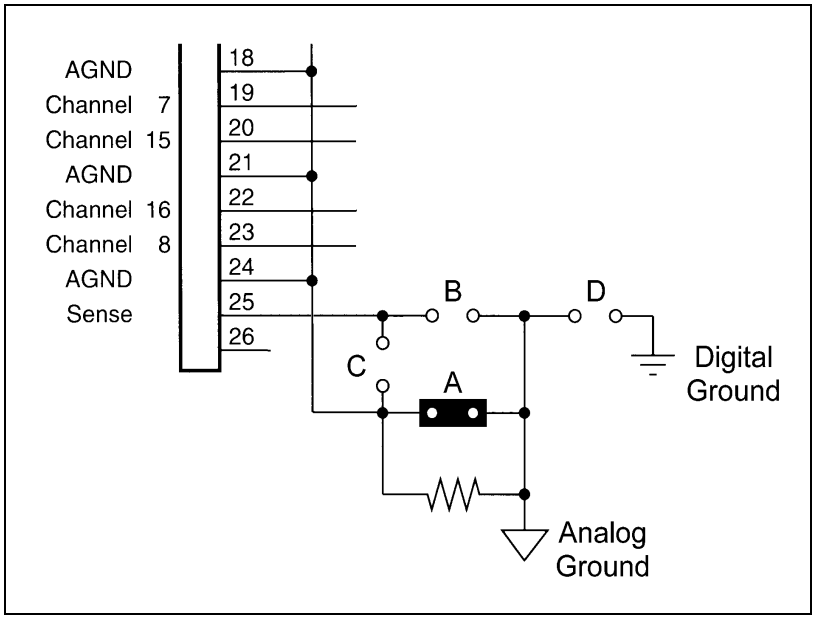


Figure 4. 5B01 Analog Signal Conditioning Rack

Digital Input/Output Configuration

The VCM-DAS-1/2 has 16 digital I/O lines that can be programmed in groups of eight as inputs or outputs with readback. The I/O connector is compatible with 8 and 16 position modular I/O racks.

RACK POWER CONTROL

The VCM-DAS-1/2 module includes provisions for powering the external I/O rack assembly with +5 volts at 500 ma.

When jumper V2 is installed, the I/O rack power line (I/O rack pin 49) is connected directly to +5 volts on the PC/104 Bus. If the I/O rack is powered by a separate external supply, either a jumper from the I/O rack or the V2 jumper must be removed.

Warning! The +5 volt power output from the VCM-DAS-1/2 card can be shorted to ground if the connector is not correctly oriented at either end of the interface cable. The use of keys in the connectors, or very clear markings on the connectors, is recommended to prevent backwards connection of the cable.

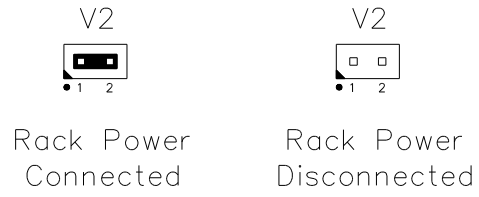


Table 6: Opto 22 Rack Power Jumper

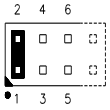
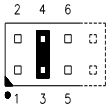
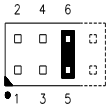
Jumper Block	Description	As Shipped
V2	**Opto 22 I/O Rack Power** In — I/O rack power provided by analog board Out — I/O rack power provided externally	In

Interrupt Configuration

IRQ SELECTION

Jumper V5 connects the interrupt request signal (analog input conversion complete) to one of three PC/104 Bus interrupt request lines. The choice of which jumper position to choose depends upon the capabilities of the CPU or interrupt controller used in the system.

Table 7: Interrupt Request Jumpers

Jumper Block	Description	As Shipped
V5[1-2] V5[3-4] V5[5-6]	**Interrupt Request Select** IRQ 10  IRQ 11  IRQ 12 	IRQ 12

SHARED INTERRUPT CONFIGURATION

Jumper V5[7-8] inserts a 1KΩ pull-down resistor into the IRQ circuit for applications using shared IRQs.

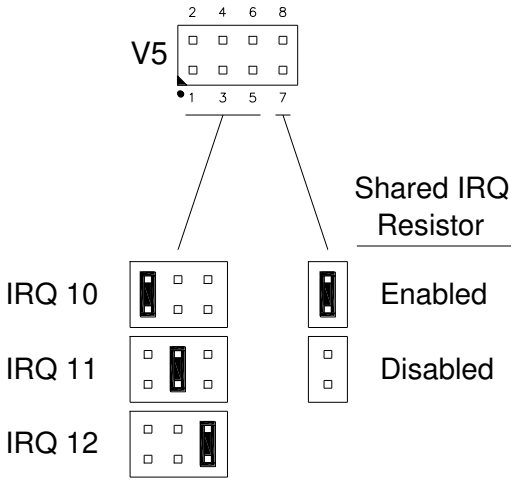


Table 8: Shared Interrupt Jumper

Jumper Block	Description	As Shipped
V5[7-8]	**Shared Interrupt Configuration** In — Shared interrupts Out — Normal interrupts	Out

ABOUT SHARED INTERRUPTS

REGULAR INTERRUPTS

- Sources are totem-pole drivers
- Interrupt controller is set to edge trigger mode
- Interrupts are requested by driving the IRQ line from low-to-high (positive edge triggering)
- The CPU has a 4.7K pull-up resistor on each IRQ line to prevent stray interrupts on unused inputs. Unused IRQ lines assume a high state.
- Only one interrupt source per IRQ line
- The IRQ line can be left in a high or low state when not requesting interrupts. It is common practice, however, to leave the line in the low state.
- A new interrupt is requested by lowering the IRQ line and raising it again

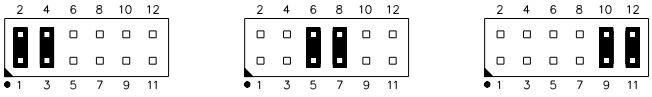
SHARED INTERRUPTS

- Sources are tri-statable, totem-pole drivers with the input tied high
- Interrupt controller is set to level trigger mode
- The CPU has a 4.7K pull-up resistor on each IRQ line to prevent stray interrupts on unused inputs. Unused IRQ lines assume a high state.
- Each source has a 1K pull-down resistor tied to the IRQ line through a series jumper. Only one shared device per IRQ line should have the jumper installed. The pull-down resistor fights against the 4.7K pull-up resistor on the CPU, but the 1K wins, causing the IRQ line to assume a low state.
- Interrupts are requested by enabling the tri-state driver. This drives the IRQ line from low-to-high.
- The source must work against the pull-down resistor
- Multiple sources are allowed per IRQ line. Software must distinguish which device made the interrupt request by polling the hardware within the Interrupt Service Routine.
- When not requesting an interrupt, the tri-statable driver must be disabled. This leaves the IRQ line in a low state, allowing other sources on the same IRQ line to make requests of their own.

DMA Configuration

The VCM-DAS-1/2 can be setup to generate a DMA transfer request upon analog input conversion complete. These requests can be routed to DMA channel 5, 6, or 7 depending upon the configuration of jumper V6.

Table 9: DMA Channel Selection Jumpers

Jumper Block	Description	As Shipped
V6	**DMA Channel Select** DMA 5 DMA 6 DMA 7 	None

Installation 3

Handling

After removing the module from its protective wrapper, place the module on a grounded, static-free surface, component side up. Use an anti-static foam pad if available. Do not slide the board over any surface.

The module should also be protected during shipment or storage with anti-static foam and conductive bubble wrap.

Warning! The VCM-DAS-1/2 is designed for reliability, however, electrostatic discharge (ESD) can damage on-board components. When handling the module, standard ESD procedures should be observed. If an ESD station is not available, you can provide some ESD protection by wearing a grounded antistatic wrist strap.

Arranging the PC/104 Stack

1. Turn the system power off. Installing or removing modules from the PC/104 stack while the power is on may damage the system.
2. The VCM-DAS-1/2 module can occupy any stack position, however, if the stack contains PC/104-Plus modules, the VCM-DAS-1/2 module should be plugged on top of these cards.
3. Additional stack-through modules can be stacked on top of the VCM-DAS-1/2. Up to six PC/104 modules can be added. If a non-stack-through module is used, it must be topmost module on the stack.

Signal Levels

Connector J1 is the digital input/output connector. Each circuit is a tri-statable totem-poll TTL driver with a 10K ohm pull up resistor to +5V. Input gates are attached to each output signal for read-back. Signal direction is determined by the DIRHI and DIRLO bits in the CONTROL register. External equipment attached to connector J1 must be able to sink 500 µA @ 5V per channel. The maximum non-destructive input voltage applied to any channel is +5V.

Connector J2 is the analog input and output connector. All analog input signals are single ended analog level signals measured with respect to analog ground. The maximum non-destructive input voltage applied to any of the inputs is ±16.5V. Each analog channel presents a minimum input impedance of 16K ohms.

External Connectors

CONNECTOR FUNCTIONS

Table 10: Connector Functions

Connector	Function
J1	Digital I/O Connector
J2	Analog I/O Connector

CONNECTOR LOCATIONS

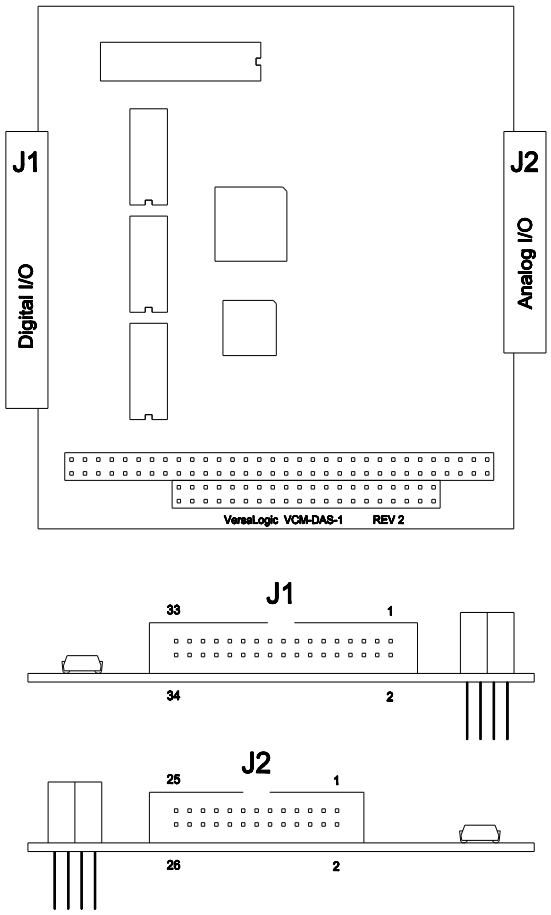


Figure 5. Connector Locations