VMIVME-3136A

High Resolution, Isolated Analog-to-Digital Converter Board

Product Manual

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500-103126-000 Rev. D

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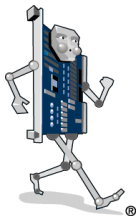

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Introduction

The VMIVME-3126A High Resolution, Isolated Analog-to-Digital Converter board has 16 independent isolated input channels with 16-bit resolution. Each input has a dedicated Analog-to-Digital Converter (ADC), input conditioning, reference, and power supply. Each channel is isolated with opto-isolators from the VMEbus and the digital circuitry. Self-test is initiated by a VMEbus system reset or by execution of a software command. A Digital Signal Processor (DSP) provides control and software correction data. An Electrically Erasable Programmable Read-Only Memory (E^2PROM) loads offset and gain coefficients into the DSP during a reset condition. The offset and gain coefficients can be recalculated by the user by entering the Calibration Mode. Software filtering is also done by the DSP to a user-defined cut off frequency.

The following brief overview of principal features illustrates the flexibility and performance that is available with the VMIVME-3126A board:

- 16-Analog input channels:
  (1) Input-to-input and input-to-VMEbus isolation
  (2) ADC per channel
- RTD Excitation Source (200 µA / 400 µA) per channel
- Open transducer detector per channel
- Full board or user-selected channel calibration
- Unipolar / Bipolar full-scale ADC ranges from 5 mV to 10 V
- Self-Test:
  (1) Initiated on power-up or any reset condition
  (2) Extensive onboard diagnostic testing capability
  (3) Status to user-accessible register

Related Documents

For a detailed explanation of the VMEbus and its characteristics, the publication *The VMEbus Specification* is available from:

VITA
VMEbus International Trade Association
7825 East Gelding Drive No.104
Scottsdale, AZ 85260
(602) 951-8866
FAX: (602) 951-0720
Internet: http://www.vita.com/
EMAIL: info@vita.com

For detailed information concerning the physical description and specifications of the VMIVME-3126A High Resolution, Isolated Analog-to-Digital Converter board, refer to *VMIC's Specification No. 800-103126-000*. This document is availble from:

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Safety Summary

The following general safety precautions must be observed during all phases of the operation, service, and repair of this product. Failure to comply with these precautions or with specific warnings elsewhere in this manual violates safety standards of design, manufacture, and intended use of this product.

VME Microsystems International Corporation assumes no liability for the customer's failure to comply with these requirements.

Ground the System

To minimize shock hazard, the chassis and system cabinet must be connected to an electrical ground. A three-conductor AC power cable should be used. The power cable must either be plugged into an approved three-contact electrical outlet or used with a three-contact to two-contact adapter with the grounding wire (green) firmly connected to an electrical ground (safety ground) at the power outlet.

Do Not Operate in an Explosive Atmosphere

Do not operate the system in the presence of flammable gases or fumes. Operation of any electrical system in such an environment constitutes a definite safety hazard.

Keep Away from Live Circuits

Operating personnel must not remove product covers. Component replacement and internal adjustments must be made by qualified maintenance personnel. Do not replace components with power cable connected. Under certain conditions, dangerous voltages may exist even with the power cable removed. To avoid injuries, always disconnect power and discharge circuits before touching them.

Do Not Service or Adjust Alone

Do not attempt internal service or adjustment unless another person, capable of rendering first aid and resuscitation, is present.

Do Not Substitute Parts or Modify System

Because of the danger of introducing additional hazards, do not install substitute parts or perform any unauthorized modification to the product. Return the product to VME Microsystems International Corporation for service and repair to ensure that safety features are maintained.

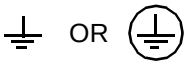
Dangerous Procedure Warnings

Warnings, such as the example below, precede only potentially dangerous procedures throughout this manual. Instructions contained in the warnings must be followed.

WARNING: Dangerous voltages, capable of causing death, are present in this system. Use extreme caution when handling, testing, and adjusting.

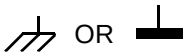
Safety Symbols Used in This Manual

Indicates dangerous voltage (terminals fed from the interior by voltage exceeding 1000 V are so marked).



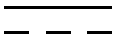
Protective conductor terminal. For protection against electrical shock in case of a fault. Used with field wiring terminals to indicate the terminal which must be connected to ground before operating equipment.

Low-noise or noiseless, clean ground (earth) terminal. Used for a signal common, as well as providing protection against electrical shock in case of a fault. Before operating the equipment, terminal marked with this symbol must be connected to ground in the manner described in the installation (operation) manual.



Frame or chassis terminal. A connection to the frame (chassis) of the equipment which normally includes all exposed metal structures.

Alternating current (power line).



Direct current (power line).

Alternating or direct current (power line).

STOP: informs the operator that a practice or procedure should not be performed. Actions could result in injury or death to personnel, or could result in damage to or destruction of part or all of the system.

WARNING: denotes a hazard. It calls attention to a procedure, a practice, or condition which, if not correctly performed or adhered to, could result in injury or death to personnel.

CAUTION: denotes a hazard. It calls attention to an operating procedure, a practice, or a condition, which, if not correctly performed or adhered to, could result in damage to or destruction of part or all of the system.

NOTE: denotes important information. It calls attention to a procedure, a practice, a condition or the like, which is essential to highlight.

CHAPTER

1

Theory of Operation

Contents

Introduction

The VMIVME-3126A High Resolution, Isolated Analog-to-Digital Converter board provides 16-independent, fully isolated input channels. This capability is attained by the principal hardware functions listed below (see Figure 1-1 on page 19 for a block diagram of these functions).

- VMEbus Interface
- Digital Signal Processor
- EPROM
- E^2PROM
- Control Logic
- Analog Inputs

VMEbus Interface

The VMIVME-3126A High Resolution, Isolated Analog-to-Digital Converter board responds to word (D16) or byte (D08[EO]) data accesses. Nonprivileged, supervisory, or both access modes are supported along with short and standard address modes.

Control and Status Registers (CSRs)

The VMIVME-3126A contains several registers available to the user for control and status of the board. A brief description of the registers is shown in Table 1-1 on page 20. The registers are explained in detail in Chapter 3 “Programmingg”. The Control and Status registers begin at offset address $XX00.

Data Registers

The Data Registers’ offset address begins at $XX40. Each channel has a unique location in this 16-word deep buffer. The data format for unipolar inputs is binary and the format for bipolar is either offset binary or two’s complement as programmed in each Channel Control Status Register. A Data Ready Flag is set in the Board Control Register (BCR) indicating when new data is available from the data registers.

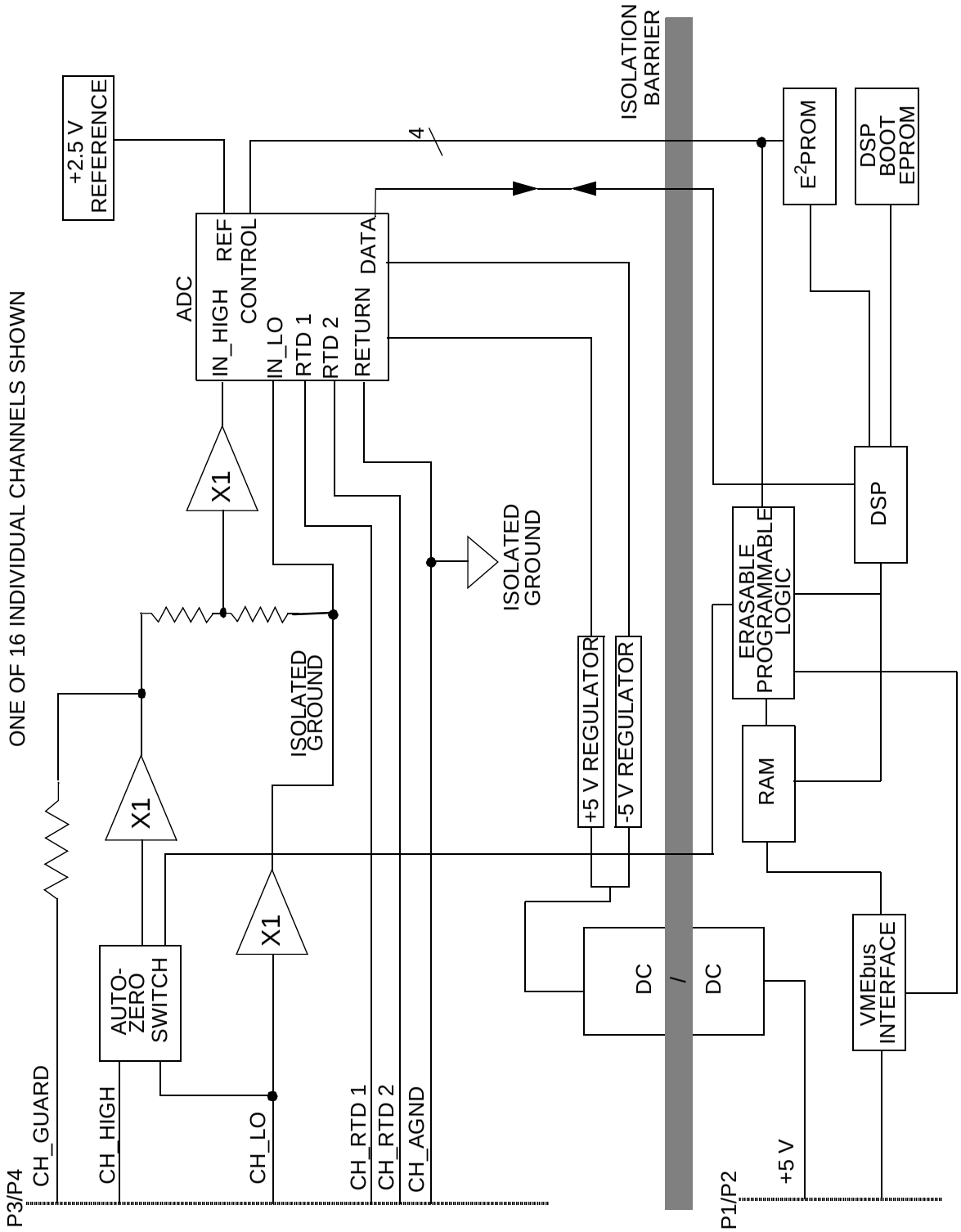


Figure 1-1 VMIVME-3126A High Resolution, Isolated Analog-to--Digital Converter Board's Block Diagram

Table 1-1 Control and Status Registers

Register	Mnemonic	Description
Board ID Register	BIR	Contains code identifying the board as a VMIVME-3126A
Board Ready Register	BRR	Status indicating when the board can be accessed for read / write operations
Board Control Register	BCR	Control functions for board operation
Select Channel Register	SCR	User-select of channels for calibration or reconfiguration
Pass / Fail Status Register	PFS	Status of channels following self-test
Target Calibration Voltage Register High	TCVH	Upper 16-bits of calibration value - entered by the user for calibration
Target Calibration Voltage Register Low	TCVL	Lower 16-bits of calibration value - entered by the user for calibration
Firmware Revision Register	FRR	Contains current revision level of DSP code
EEPROM Writes Register	EWR	Contains the number of times the EEPROM has been written
Channel Control Status Register	CSR	Provides control of range, data format, input format, and filter cut-off frequency for each channel

Modes of Operation

The VMIVME-3126A High Resolution, Isolated Analog-to-Digital Converter board operates in several different modes. Each mode is enabled by the user through the Board Control Register (BCR). The operating modes are described below.

Normal Mode

The board enters the Normal Mode after completing the power-on self-test routines. In this mode, each input is scanned, digitized, and stored in user-accessible RAM. When the onboard DSP is not processing data, it is reading the BCR to see if the user has changed operating modes.

Calibration Mode

The board enters the Calibration Mode when the `INIT CAL` bit in the BCR is set by the user. Entering this mode causes the board to stop processing data and await further input from the user. If jumper E10 is omitted, the front panel LED is illuminated for a visual indication of the change in modes from Normal Mode to Calibration Mode. The front panel field connections must be removed for calibration. During the calibration process, VMEbus access should be limited to reading and writing to the BRR, and writing to the TCVH and TCVL registers. The BRR's data appears as `$3B00` (`$3B01` for 8-channel option) while calibration is active. Prior to setting the `INIT CAL` bit, the user

must enter the channels to calibrate into the SCR and the digital representation of the expected result of the calibration voltage into the TCVH and TCVL. The DSP uses these values in determining the gain and offset coefficients. The equation for determining the digital representation of the expected result is given in the *Target Calibration Voltage Register (TVC)* section on page 56.

The DSP will read the SCR to determine which channels to calibrate. The channels selected will be digitized and stored in DSP memory. After all the selected channel's data has been stored for the present calibration voltage, the board sets the Chan Cal'd bit in the BCR.

NOTE: Polling of the **Chan Cal'd** bit during the calibration can reduce accuracy, particularly on the low ranges. From the time the **Init Cal** bit is set to the **Chan Cal'd** bit being set is approximatedly 22 seconds (90 seconds for ranges below 100 mV). The Chan Cal'd bit should be checked after allowing for this time.

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1. The user can enter another value into TCVH and TCVL and set the INIT CAL bit. This adds another point in the calibration curve for determining gain and offset coefficients. A minimum of three points is required for a successful calibration. Failure to enter three calibration voltages results in an error message to the BRR. A maximum of seven points is allowed. Attempting to enter more than seven calibration voltages results in an error message to the BRR. If this error occurs, set the CAL Done bit in the BCR or terminate calibration. During the calibration process, the BRR will read the board ID. If a calibration error occurs, as described above, the BRR will indicate the error per Table 3-4 on page 51.
2. If the user has entered at least the minimum and not greater than the maximum number of calibration points and is finished with calibrating, the Cal Done bit in the BCR must be set. This tells the DSP the user has finished calibration and to calculate the gain and offset coefficients. After the DSP is finished calculating the coefficients, the Cal Done bit is cleared, the front panel LED is turned OFF, and $0000 is written to the BRR. When a VMEbus read indicates $0000, the user knows the coefficients have been calculated and the board is accessible.

The Calibration Mode can be terminated up to the point preceeding the CAL Done bit being set without affecting the current coefficients. This is done by setting both the INIT CAL and CAL Done bits in the BCR. The DSP will recongnize this as the user terminating calibration and will return to the Normal Mode. Figure 1-2 on page 24 shows the calibration flowchart from the user's standpoint.

Reconfiguration Mode

The board enters the Reconfiguration Mode when the SYS RECONFIG bit in the BCR is set by the user. The board will stop processing data and the front panel LED will illuminate if Jumper E10 is omitted. During the reconfiguration process, VMEbus access should be limited to reading the Board Ready Register (BRR). The BRR's data appears as $3B00 ($3B01 for the 8-channel option) while reconfiguration is active. The user must enter the channels to be reconfigured in the SCR. Also, the CSR of each channel to be reconfigured must have the new information written to it prior to the SYS RECONFIG bit being set. After completing the reconfiguration of the indicated

channels, the SYS RECONFIG bit in the BCR will be cleared and $0000 written to the BRR. When a VMEbus read indicates $0000, the user knows the Reconfiguration Mode is complete and the board is accessible. Figure 1-3 on page 25 shows the reconfiguration flowchart from the user's standpoint. Reconfiguration of a single channel takes approximately 44 msec. Reconfiguring all 16 channels takes approximately 101 msec.

Autozero Mode

The board enters the Autozero Mode when the Autozero bit in the BCR is set by the user. An input switch disconnects the field inputs and connects analog ground to the inputs. The present range of each channel is still active. An average of 1024 samples are collected by the DSP and this value is compared to the expected reading for a grounded input. The offset coefficient is adjusted by the difference in the two values. The advantage of this mode of operation is correcting errors in offset due to temperature variations without having to invoke a calibration cycle.

The new offset coefficients are used by the DSP and are not written to the E^2PROM unless the user sets the WRITE COEF bit in the BCR after this mode is complete. The Autozero bit in the BCR is reset by the DSP when the new coefficients are determined, and is an indication that the board has resumed normal operation.

NOTE: Polling the Autozero bit in the BCR will adversely affect calculation of the new coefficients. The Autozero Operation takes approximately 11 seconds to complete. After this time elapse, read the BCR to check that the Autozero bit has been reset.

Digital Signal Processor (DSP)

The DSP is responsible for gathering data from the ADC and providing offset and gain correction along with filtering. The DSP and the Erasable Programmable Logic Device (EPLD) combine to control all board operations. During calibration, the DSP collects up to seven different sets of data from user defined inputs. A least mean square estimate of the channel transfer function is determined using this data. A gain and offset coefficient for each channel is calculated from this estimate and stored internally.

The data samples collected from the ADCs are corrected in real-time using the calculated gain and offset coefficients. All DSP math operations are performed in 32-bit format, thereby preserving the high resolution provided by the ADCs. Output data is truncated to 16 bits for consistency with reasonable limitations on linearity within the input channel circuitry. The Firmware Revision Register contains the current revision of the DSP code. A **Watchdog Timer** monitors the DSP to ensure the code is processing normally. The DSP clears the Watchdog Timer every 30 msec. If for some reason the DSP does not clear the timer, the timer times-out causing the `WDOG` bit in the BCR to be set. This alerts the user of a problem and requires the user to software reset the board through the BCR.

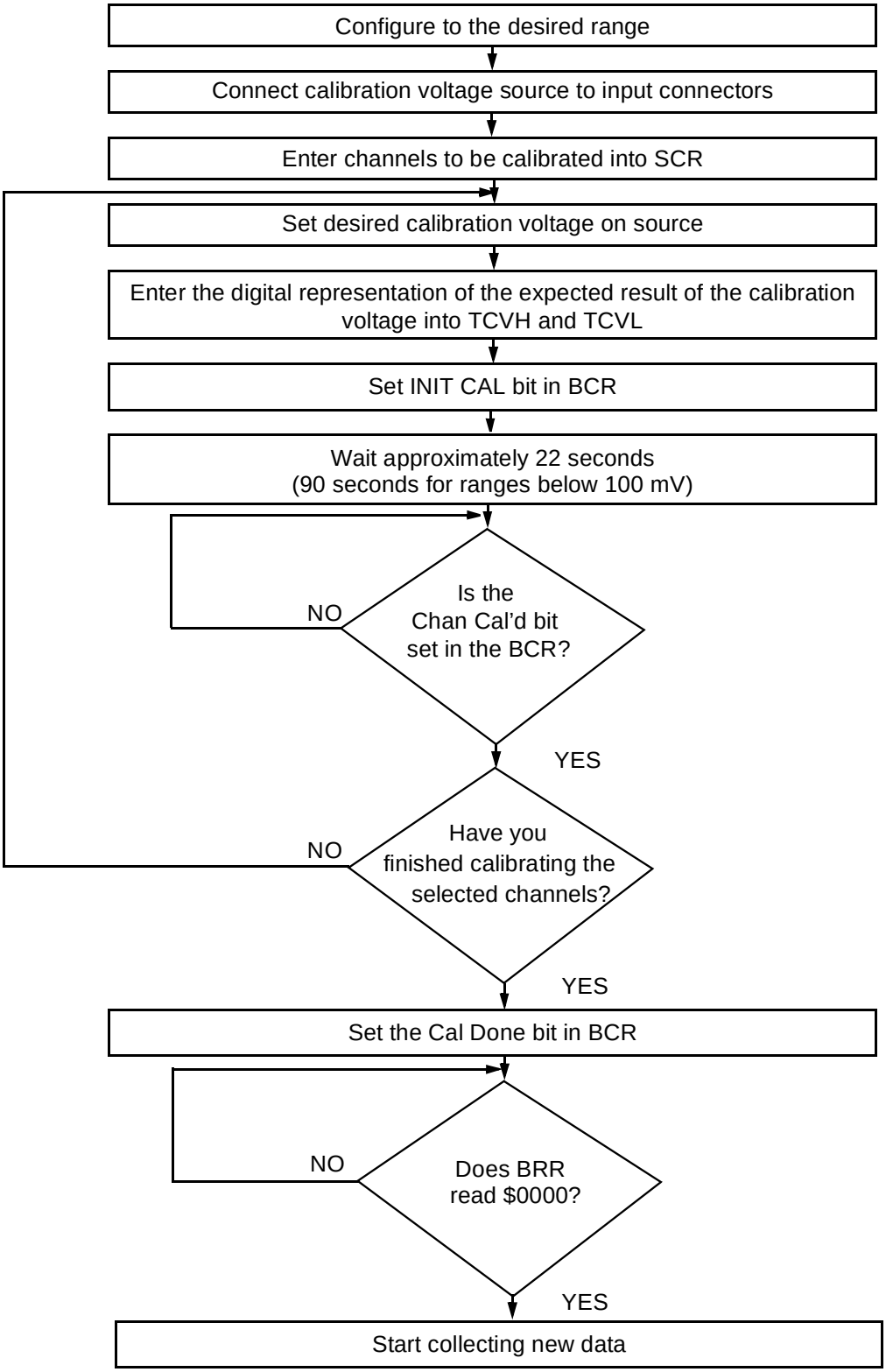


Figure 1-2 User's Calibration Flowchart

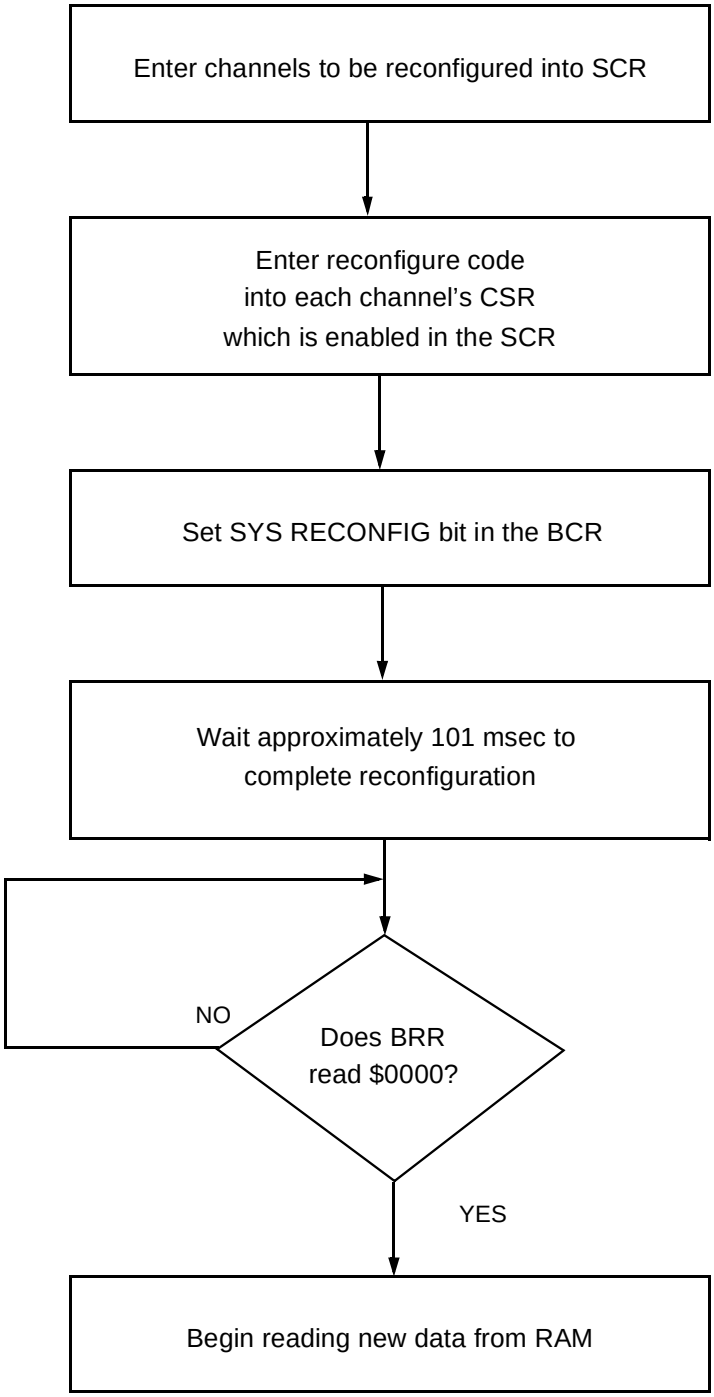


Figure 1-3 Channel Reconfiguration Flowchart

Electrically Programmable Read-Only Memory (EPROM)

The DSP firmware is stored in the EPROM. There are four main boot pages stored in the EPROM. These are the **power-up/reset** boot page, the **main routine** boot page, the **calibration** boot page, and the **reconfiguration** boot page. Each boot page contains code specifically written for the particular function.

Electrically Erasable Programmable Read-Only Memory (E^2PROM)

The gain and offset coefficients calculated in the Calibration Mode can be stored in the E^2PROM. The board is shipped with factory determined coefficients. When the user initiates a calibration, newly calculated coefficients are stored in the DSP for use in real-time correction. The new coefficients are not automatically stored in the E^2PROM. The bit in the BCR allows the user control over writing the results to the E^2PROM, which writes over any coefficients that were present. The DSP uses the range code in each channel's CSR to determined where the coefficients is written. This allows the user to run new correction coefficients (from the DSP) but not corrupt coefficients stored in the E^2PROM. Most commercially available E^2PROM's have a guaranteed 100,000 write cycles lifetime. An EEPROM Writes Register (EWR) is available to the user indicating how many writes have occurred. If this number becomes close to the 100,000 limit, it is suggested the E^2PROM be replaced so data is not lost or corrupted. Writing coefficients to the E^2PROM once a day would not reach the limit of 100,000 write cycles for over twenty five years.

CAUTION: An inadvertent write to this bit will result in the coefficients currently in the DSP to be written to the E^2PROM. Previously stored coefficients will be written over.

Control Logic

The control logic consists of the logic required to read and write the RAM and E^2PROM, initiate ADC conversions, and arbitrate between the board and the VMEbus. The control logic consists of an EPLD.

Analog Inputs

The VMIVME-3126A High Resolution, Isolated Analog-to-Digital Converter board can accept bipolar and unipolar signals in the ranges stated in the specification. To ensure accuracy and reduce noise, proper grounding techniques and the use of twisted shielded pair cable is strongly recommended for the low-level ranges. The inputs provide a high impedance in the power on or off condition. This is critical so that the board does not load the signal source. The inputs are also over-voltage protected with diodes connected to the power rails.

Analog-to-Digital Converter (ADC)

The Analog-to-Digital Converter (ADC) uses a sigma-delta conversion technique to digitize input signals with up to 24-bits of no missing code performance. The ADC also provides internal gain and digital filtering. There is one ADC per channel with all channels updating their output registers simultaneously. A **Sigma-Delta ADC** uses a 1-bit analog-to-digital conversion at a very fast sample rate. This sample rate is many times greater than the analog signal sampling frequency (oversampling). Oversampling spreads the quantization noise over a wider frequency than the band of interest. The noise in the passband is reduced by filtering and moving the noise energy to frequencies outside this passband.

Programmable Gain Amplifier (PGA)

The ADC contains an internal PGA with software controlled gains of 1 to 128 in seven binary steps. The DSP automatically selects the appropriate gain required for the range selected.

RTD Excitation

The VMIVME-3126A is capable of supplying excitation current to Resistance Temperature Detectors (RTDs). The excitation current is enabled under software control by writing to the RTD bit in the desired channel's CSR. The actual current supplied to the RTD is determined by the connections made at the P3 or P4 input connectors. There are two pins per channel for RTD excitation. The current on each pin is 200 µA. Wiring the two pins together yields 400 µA of current excitation.

An RTD is essentially a resistor whose resistance value changes with temperature. A constant excitation current produces a voltage corresponding to the resistance of the RTD. This voltage is measured and digitized by the board. Using the digitized results, the user can calculate the temperature knowing the temperature of the coefficient of the RTD.

Application and configurations for RTD control are discussed in *Configuration and Installation* section of this manual.

Open Transducer Detection

The ADC supplies software controlled open transducer detection. Open transducer detection allows the user to check if an input transducer is still connected or an open condition has occurred. This function only works on ranges from ±1 V (0-to-1 V) to ±5 mV (0-to-5 mV). If the transducer connection has opened, the output for that channel will read positive full-scale (`0xFFFF` in offset binary or `0x7FFF` in two's complement). The user sets the `Open Sensor` bit in the desired CSR's and follows the rule for reconfiguration. The DSP will determine if the selected channels have open sensors. Status will be displayed in the PFS register and the `Open Sensor` bit reset in each CSR.

Filtering

Digital filtering is done in the DSP. The filter setting in each channel's CSR is stored and used to restore the proper filter coefficients which are applied in real-time.

The filter approximates a 6^{th} order bessel response. For the best performance, use the lower filter settings on the lower ranges. For example, using the 0.05 Hz filter on the ±50 mV scale considerably reduces the noise spread.

The digital filter for each channel is zeroed after a reconfiguration of that channel. This puts the filter in a known state and eliminates illegal filter states. Depending on the selected frequency, there will be a delay after reconfiguration while the filter settles to the signal present on the inputs.

OPTO Isolation

Optical Isolation is provided on every signal going to or coming from each channel. These signals consist of the ADC control signal, ADC output, and the input autozero switch.

DC-to-DC Power Converters

Each channel has a dedicated DC-to-DC Converter. The DC-to-DC Converters are powered by the VMEbus +5 VDC power bus at the P1 and P2 connectors. The output of each converter is 33 mA at ±15 V. Input-to-output isolation of >1500 VDC maintains channel to VMEbus isolation.

Current Loop Termination Option

For the current loop termination option, a 400 Ω resistor is added between the HI and LO inputs on the board. The resulting voltage from the current flowing through the resistor is digitized and stored in RAM. The actual current would then be determined by the user, converting the digitized code into a voltage for the range selected and dividing by 400.

CAUTION: Currents greater than 25 mA are not supported and could cause component failure.

Calibration for the current option is similar to regular calibration as described in the *Calibration Mode* section on page 20 and the *Target Calibration Voltage Register (TVC)* section, but with one difference. The value entered in the TCVH and TCVL must be expressed as a voltage. Therefore, to find the input voltage applied, multiply the calibration current times 400 and use this value in the equation in the *Target Calibration Voltage Register (TVC)* section.

CHAPTER
2

Configuration and Installation

Contents

Introduction

The following sections explain the proper unpacking and installation procedures for the VMIVME-3126A High Resolution, Isolated Analog-to-Digital Converter board. Address and node configurations are also discussed.

Unpacking Procedures

CAUTION: Some of the components assembled on VMIC's products may be sensitive to electrostatic discharge and damage may occur on boards that are subjected to a high-energy electrostatic field. When the board is placed on a bench for configuring, etc., it is suggested that conductive material should be inserted under the board to provide a conductive shunt. Unused boards should be stored in the same protective boxes in which they were shipped.

Upon receipt, any precautions found in the shipping container should be observed. All items should be carefully unpacked and thoroughly inspected for damage that might have occurred during shipment. The board(s) should be checked for broken components, damaged printed circuit board(s), heat damage, and other visible contamination. All claims arising from shipping damage should be filed with the carrier and a complete report sent to VMIC together with a request for advice concerning the disposition of the damaged item(s).

Physical Installation

CAUTION: Do not install or remove the board while power is applied.

De-energize the equipment and insert the board into an appropriate slot of the chassis. While ensuring that the board is properly aligned and oriented in the supporting board guides, slide the board smoothly forward against the mating connector until firmly seated.

Base Address Configuration

There are 20 jumper positions to establish the Base Address, Address Mode, and Access Mode. The Address Mode can be configured for standard or short address space. The Base Address is determined by the presence (address bit compared to logic zero [0]) or absence (address bit compared to logic one [1]) of a jumper shunt at each appropriate address jumper position. For Short and Standard Address Mode configurations, the address jumper positions which must be configured are A[15:8] or A[23:8], respectively. The Access Mode can be configured for supervisory, nonprivileged, or for both supervisory and nonprivileged access.

Jumper functions are illustrated in Figure 2-1 below and Figure 2-2 on page 36. Figure 2-3 belowshows the location of user configurable jumpers. Omission of a jumper shorting plug produces a HIGH (logic one [1]) requirement for the associated control bit. Installation of the jumper shorting plug produces a LOW (logic zero [0]) requirement. The factory configuration for the board is: Standard Address Mode, Supervisory and Nonprivileged Access Mode, and base address set at `0XFB00 0000`.

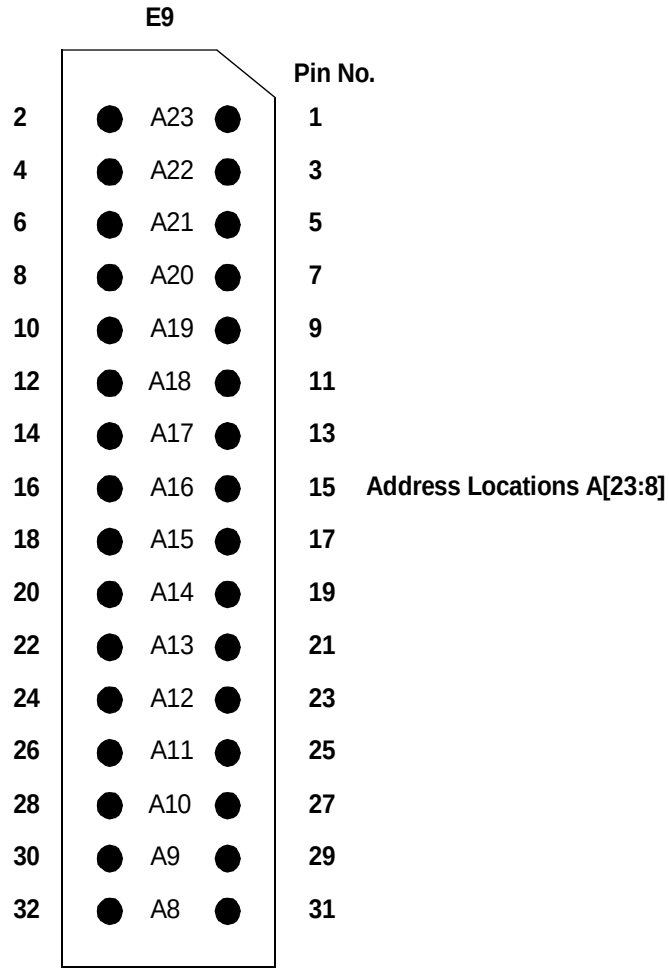
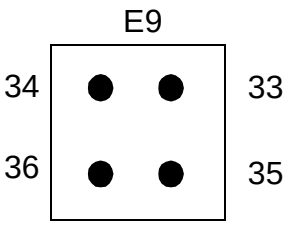
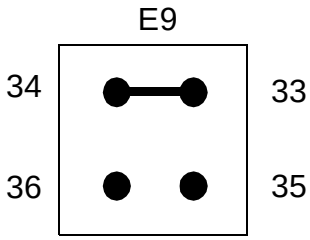


Figure 2-1 Address Locations and Configuration

ACCESS MODE CONFIGURATIONS



Supervisory



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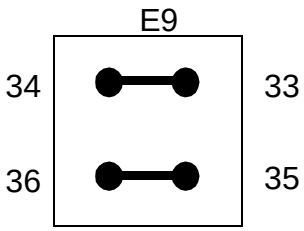
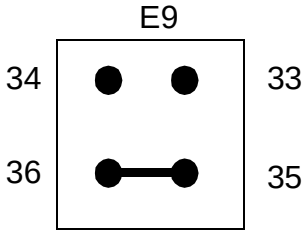
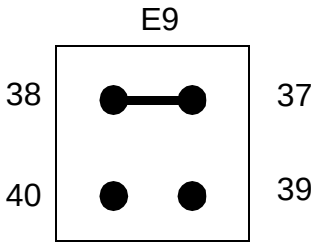


Either Supervisory or Nonprivileged

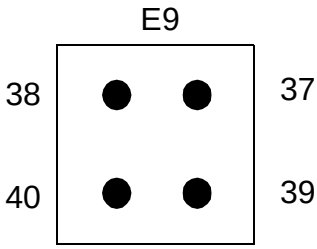


Nonprivileged

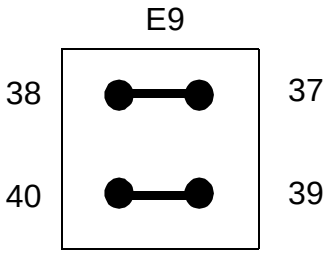
ADDRESS MODE CONFIGURATIONS



Short I/O Addressing (A16)



OR



Standard Addressing (A24)

Figure 2-2 Access and Address Mode Configurations

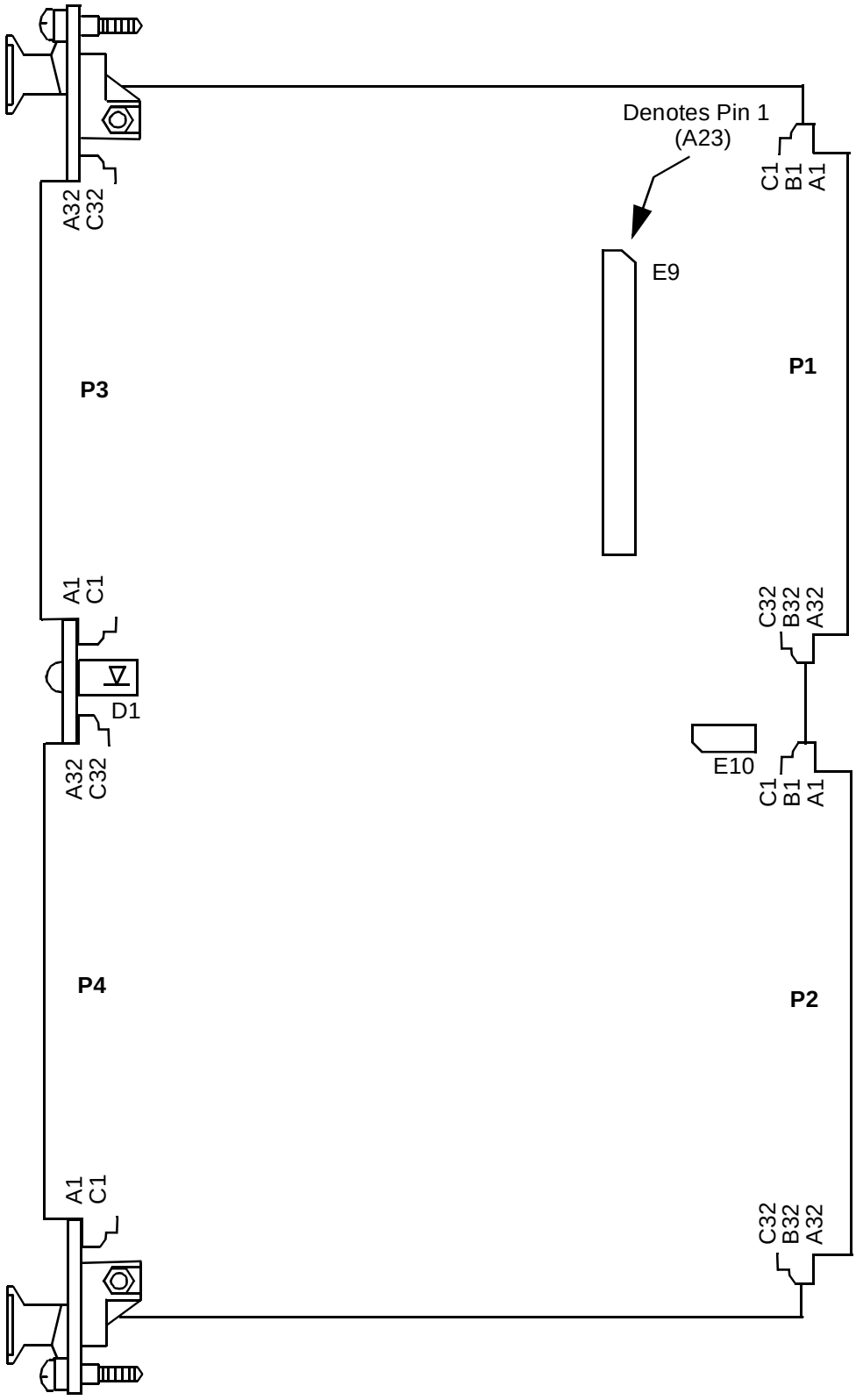


Figure 2-3 Location of User Configuration Jumpers

UIOC Jumper

The UIOC jumper alerts the DSP if the board is being used with VMIC's I/O controllers. This jumper is labelled E10. If the jumper is installed, the DSP recognizes that the board is controlled by the I/O controller. It is the responsibility of the UIOC to extinguish the front panel LED. The DSP will not extinguish the front panel LED after completing self-test. If the jumper is not installed, the DSP will extinguish the front panel LED after completing self-test. The factory configuration for this jumper is installed.

System Connections

Table 2-1 on page 40 and Table 2-2 on page 41 list the P3 and P4 connector inputs. The connectors are shown in Figure 2-4 below. Each connector is a 64-pin DIN type connector, which contains eight analog inputs. P1 and P2 are 96-pin DIN connectors.

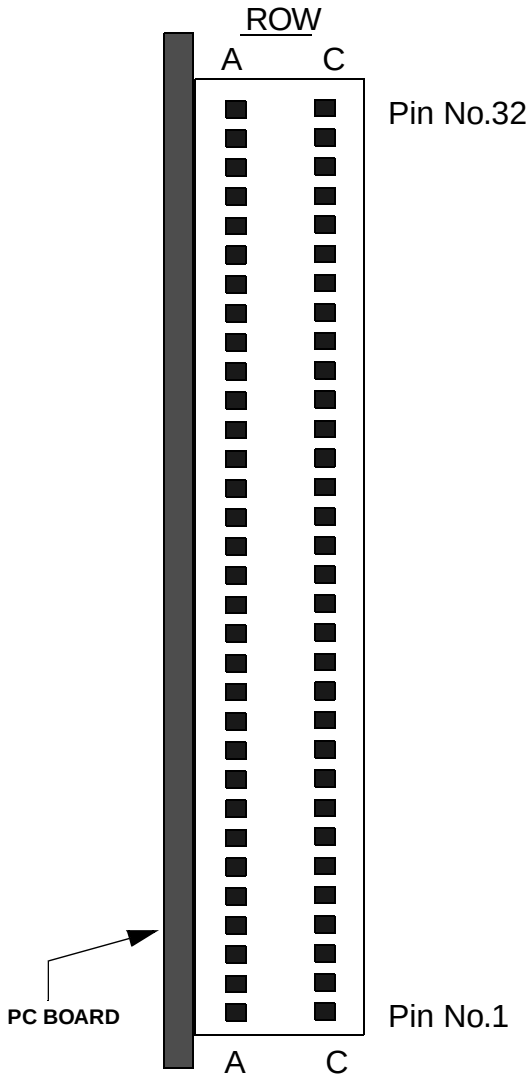


Figure 2-4 P3 and P4, 64-Pin DIN Type Connector

Table 2-1 P3 Connector Assignments

Pin No.	Row A	Row C
32	Ch15_High	RTD2_Ch15
31	Ch15_Guard	RTD1_Ch15
30	Ch15_Low	Ch15_AGND
29		
28	Ch7_High	RTD2_Ch7
27	Ch7_Guard	RTD1_Ch7
26	Ch7_Low	Ch7_AGND
25		
24	Ch14_High	RTD2_Ch14
23	Ch14_Guard	RTD1_Ch14
22	Ch14_Low	Ch14_AGND
21		
20	Ch6_High	RTD2_Ch6
19	Ch6_Guard	RTD1_Ch6
18	Ch6_Low	Ch6_AGND
17		
16	Ch13_High	RTD2_Ch13
15	Ch13_Guard	RTD1_CH13
14	Ch13_Low	Ch13_AGND
13		
12	Ch5_High	RTD2_Ch5
11	Ch5_Guard	RTD1_Ch5
10	Ch5_Low	Ch5_AGND
9		
8	Ch12_High	RTD2_Ch12
7	Ch12_Guard	RTD1_Ch12
6	Ch12_Low	Ch12_AGND
5		
4	Ch4_High	RTD2_Ch4
3	Ch4_Guard	RTD1_Ch4
2	Ch4_Low	Ch4_AGND
1	P2_CAL_High	P2_CAL_Return

Table 2-2 P4 Connector Assignments

Pin No.	Row A	Row C
32	Ch11_High	RTD2_Ch11
31	Ch11_Guard	RTD1_Ch11
30	Ch11_Low	Ch11_AGND
29		
28	Ch3_High	RTD2_Ch3
27	Ch3_Guard	RTD1_Ch3
26	Ch3_Low	Ch3_AGND
25		
24	Ch10_ High	RTD2_Ch10
23	Ch10_Guard	RTD1_Ch10
22	Ch10_Low	Ch10_AGND
21		
20	Ch2_High	RTD2_Ch2
19	Ch2_Guard	RTD1_Ch2
18	Ch2_Low	Ch2_AGND
17		
16	Ch9_High	RTD2_Ch9
15	Ch9_Guard	RTD1_Ch9
14	Ch9_Low	Ch9_AGND
13		
12	Ch1_High	RTD2_Ch1
11	Ch1_Guard	RTD1_Ch1
10	Ch1_Low	Ch1_AGND
9		
8	Ch8_High	RTD2_Ch8
7	Ch8_Guard	RTD1_Ch8
6	Ch8_Low	Ch8_AGND
5		
4	Ch0_High	RTD2_Ch0
3	Ch0_Guard	RTD1_Ch0
2	Ch0_Low	Ch0_AGND
1	P2_CAL_High	P2_CAL_Return

The inputs can be connected as differential or single-ended. In either case, the main pins to connect at the board are **High**, **Low**, and **AGND**. Below, Figure 2-5 and Figure 2-6 show examples for the connections for differential and single-ended inputs.

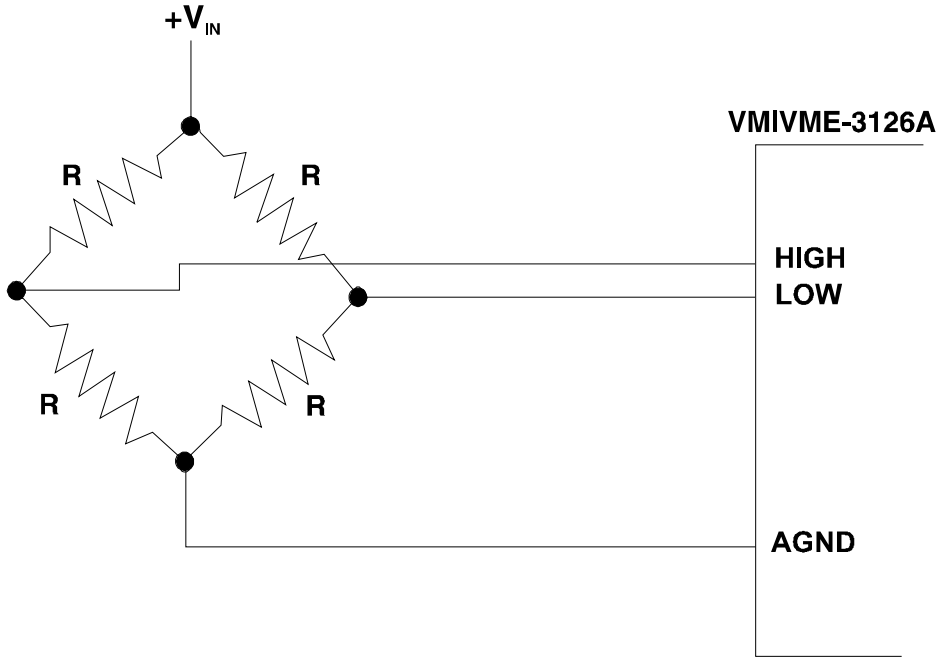


Figure 2-5 Differential Input Connection

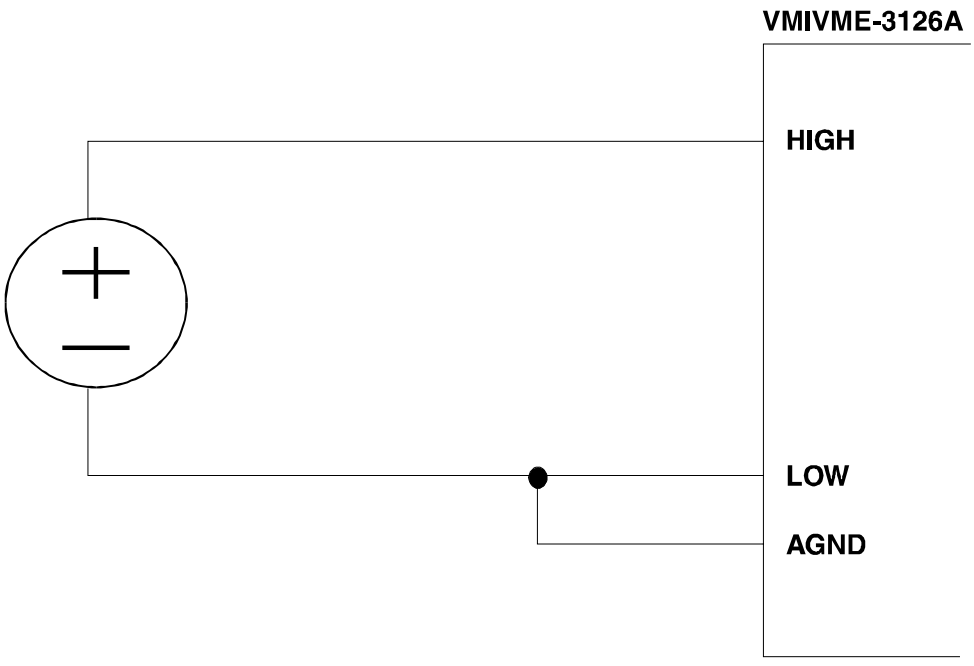


Figure 2-6 Single-Ended Input Connection

Calibration

Before delivery from the factory, the VMIVME-3126A High Resolution, Isolated Analog-to-Digital Converter board is fully calibrated for each range and conforms to all specifications.

The calculated gain and offset coefficients are only as good as the source used for calibration. The calibration source should have very little noise. Although the calibration routine takes an average of the input samples, a low noise source is essential on the lower ranges to get maximum results. If the accuracy of the source is in question, a precision multimeter can be connected to the board's input to measure the exact input voltage. This reading would then be used in computing the value to enter into the TCVH and TCVL registers.

A recommended source is the Hewlett-Packard HP3245A Universal Source. In addition to the accurate, low noise output, this source also has a General-Purpose Instrumentation Bus (GPIB) interface. This enables calibration to be handled entirely by a PC, commanding the source which determines the voltage to output. A recommended multimeter is the Hewlett-Packard HP3458A. This meter also has a GPIB interface to aid in automating the calibration process.

The voltages used for calibration do not need to be symmetrical around ground for bipolar or mid-scale for unipolar scales. Due to the presence of noise in any system, the voltages used should not be very close to positive or negative full-scale. If voltages near the extremes were used, noise could cause the value to clip to full-scale and degrade the accuracy. With this in mind, Table 2-3 below shows a guideline to follow for the calibration voltages.

Table 2-3 Calibration Guidelines

Input Scale	3-Point, %Full-Scale	5-Point, %Full-Scale	7-Point, %Full-Scale
Unipolar	75%, 50%, 25%	80%, 60%, 50%, 40%, 20%	80%, 70%, 60%, 50%, 40%, 20%, 10%
Bipolar	±75%, 0%	±75%, ±25%, 0%	±75%, ±50%, ±25%, 0%

RTD Applications and Configurations

The two main configurations for RTDs are the three- and four-wire interfaces. Each of these configurations will be described, along with figures showing the necessary connections.

Three-Wire RTD Configuration

In the three-wire configuration, shown in Figure 2-7 below, lead resistances will result in errors in the measurement if only one of the RTD excitation currents is used. This is because the current will flow through R_{L1} developing a voltage error between inputs CH_H and CH_L. The second RTD excitation current is used to compensate for this error by suppling the same current through R_{L2}. Assuming the lead resistances are equal, due to being the same material and same length, and the RTD sources match, the error voltages generated will match and no error voltage will be developed between the input pins. Twice the voltage is developed across R_{L3} as a common-mode voltage and will not introduce any errors.

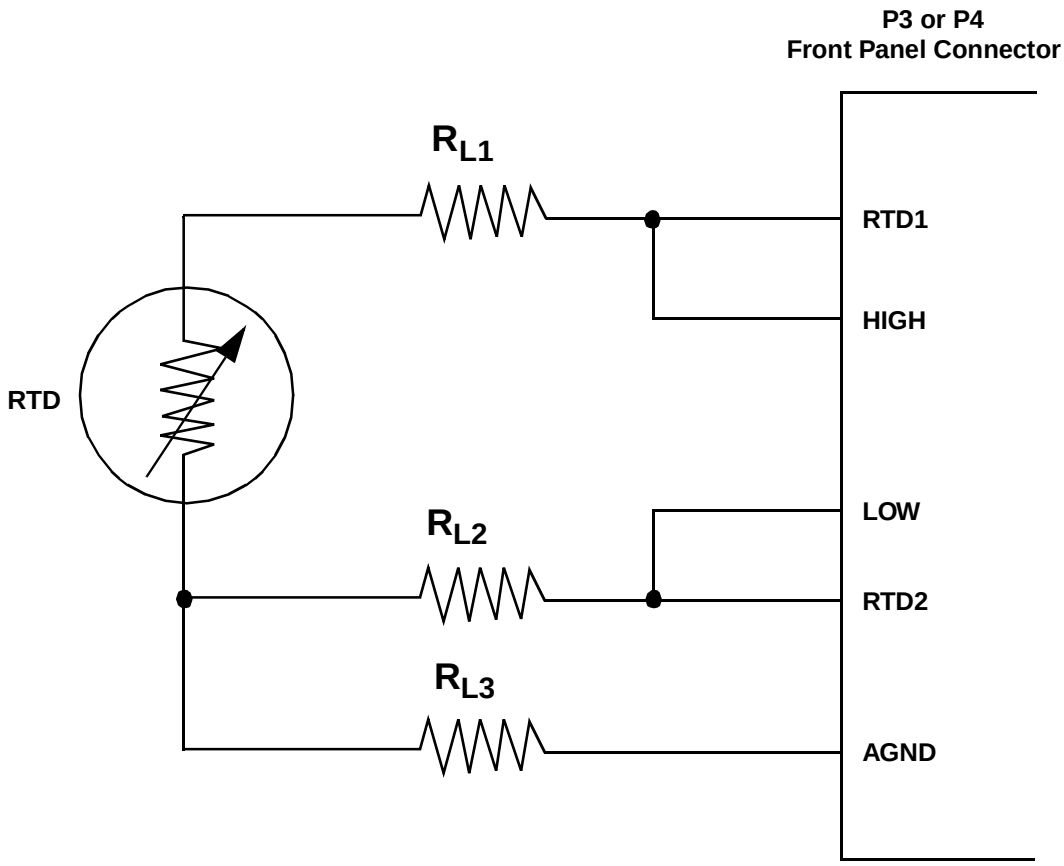


Figure 2-7 Three-Wire RTD Configuration

Four-Wire RTD Configuration

The RTD has to be connected to the board using wire. Almost certainly, there will be an impedance mismatch between the HIGH and LOW sides. This impedance mismatch can result in significant errors in the temperature measurement. The four-wire configuration, shown in Figure 2-8 below, eliminates any errors associated with lead resistances because no current flows in the measurement leads. The board measures only the voltage dropped across the RTD and is insensitive to the length of the lead wires.

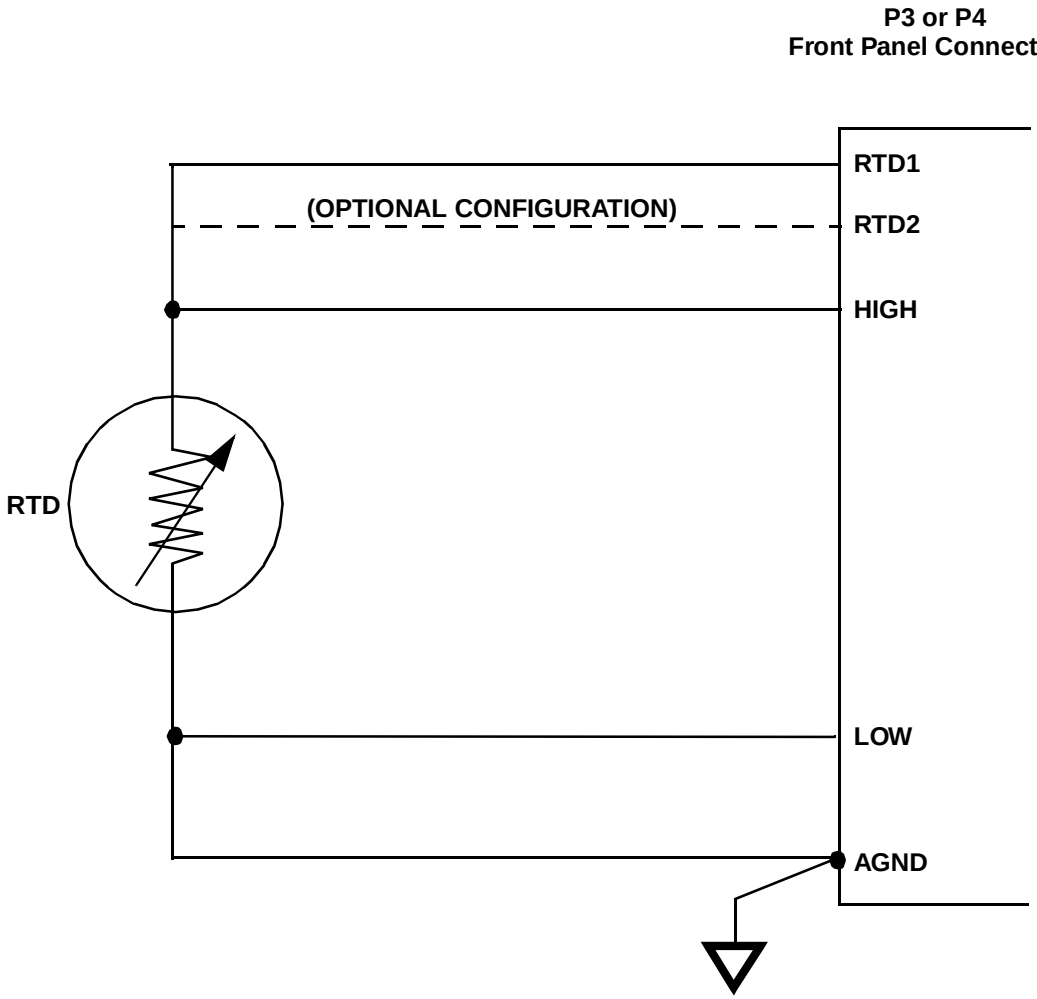


Figure 2-8 Four-Wire RTD Configuration

CHAPTER

3

Programming

Contents

Introduction

This section describes the programming operations necessary for controlling the VMIVME-3126A High Resolution, Isolated Analog-to-Digital Converter board. The VMEbus slave interface is summarized first and followed by a detailed description of the VMIVME-3126A register set.

VMEbus communication takes place through several registers, which can be jumpered in either the A16 short I/O space or the A24 standard space.

The board automatically enters self-test on powerup. This self-test consists of writing and reading the onboard RAM, verifying that each ADC is functioning correctly, and loading the default range calibration coefficients from the E^2PROM.

Digitized input data is accumulated in a data buffer which consists of 16 data words, where each data word contains the 16-bit digitized value of a single analog input channel.

General Control Features

Addressing Modes and Board Locations

Programmable address jumpers permit the VMIVME-3126A High Resolution, Isolated Analog-to-Digital Converter board to be located in either short I/O (A16) space or in standard (A24) space.

The board can be located on any 256-byte boundary. Access privilege is jumper selectable for either supervisory, nonprivileged, or both supervisory and nonprivileged.

Data Transfers

The VMIVME-3126A High Resolution, Isolated Analog-to-Digital Converter board responds to both D8 (E0) and D16 data transfers.

Reset Operations and Initialization

All control registers are reset by either a VMEbus system reset or a software reset caused by writing to a bit in the BCR. Either reset operation will initialize the self-test mode which will perform the following:

1. Auto-detect 8- or 16-channel option and write the Board ID to the BRR
2. Read/write test of the onboard RAM
3. Self-test each ADC and check the digitized value against a constant to ensure proper function
4. Load channel gain and offset calibration coefficients from E^2PROM
5. Write results from Step 2 above to BRR
6. Write results from Step 3 above to the PFS register and BRR
7. Extinguish LED after successful self-test

Control Registers

Register designations and location are summarized in Table 3-1 below.

NOTE: Registers designated as read access should **only** be read. Do not write to read-only access registers.

Table 3-1 VMIVME-3126A Board's Register Map

Register Address (HEX)	Register Designation	Abbrev	Access
$0000	Board Identification Register	BIR	Read Only
$0002	Board Ready Register	BRR	Read Only
$0004	Board Control Register	BCR	Read / Write
$0006	Select Channel Register	SCR	Read / Write
$0008	Channel Pass / Fail Status	PFS	Read Only
$000A	Target Calibration Voltage Hi	TCVH	Read / Write
$000C	Target Calibration Voltage Lo	TCVL	Read / Write
$000E	Firmware Revision Register	FRR	Read Only
$0010	EEPROM Writes Register 1	EWR1	Read Only
$0012	EEPROM Writes Register 2	EWR2	Read Only
$0014 to $001F	Reserved	-	N / A
$0020 to $003F	Control Status Registers	CSR0 - 15	Read / Write
$0040 to $005F	Data Registers	0 - 15	Read / Write
$0060 to $007F	Reserved	-	N / A
$0080 to $00BF	Offset Coefficients		Read / Write
$00C0 to $00FF	Gain Coefficients		Read / Write

Board Identification Register (BIR)

The Board Identification Register is a fixed, read-only data register. The contents of this register identifies the VMIVME-3126A High Resolution, Isolated Analog-to-Digital Converter board. The Board ID for the VMIVME-3126A 16-channel option is $3B00, and $3B01 for the 8-channel option.

Table 3-2 Board ID Register's Bit Map

Board ID Register (Offset $0000) Read Only, Byte/Word							
Bit 15	**Bit 14**	**Bit 13**	**Bit 12**	**Bit 11**	**Bit 10**	**Bit 09**	**Bit 08**
0	0	1	1	1	0	1	1

Bit 07	**Bit 06**	**Bit 05**	**Bit 04**	**Bit 03**	**Bit 02**	**Bit 01**	**Bit 00**
0	0	0	0	0	0	0	BIR0

Powerup / Reset Default = $3B00 - 16-CH
$3B01 - 8-CH

Board Identification Register Bit Definitions

Bits 15 through 08: These bits contain the Board ID ($3B00).

Bits 07 through 01: **Reserved -** Forced to zeroes.

Bit 00: **BIR0 -** This bit indicates the number of channels. It is set to a logic zero (0) for the 16-channel option and is set to a logic one (1) for the 8-channel option.

Board Ready Register (BRR)

The Board Ready Register (BRR) tells the user when the board is able to be accessed from the VMEbus for read / write operations following a reset condition.

Table 3-3 Board Ready Register's Bit Map

Board Ready Register (Offset $0002) Read Only, Byte/Word							
Bit 15	**Bit 14**	**Bit 13**	**Bit 12**	**Bit 11**	**Bit 10**	**Bit 09**	**Bit 08**
BR15	BR14	BR13	BR12	BR11	BR10	BR9	BR8
Bit 07	**Bit 06**	**Bit 05**	**Bit 04**	**Bit 03**	**Bit 02**	**Bit 01**	**Bit 00**
BR7	BR6	BR5	BR4	BR3	BR2	BR1	BR0

Powerup / Reset Default = $0000

Board Ready Register Bit Definitions

Bits 15 through 00:

BR [15..0] - This code indicates the response of the local DSP after a reset condition has been processed and is interpreted as shown in Table 3-4 below:

Table 3-4 Board Ready Register's Bit Definitions (BR[15..0])

BR[15..0]	Function	Notes
$0000	Null (Self-Test / Calibration / Configuration not active)	
$3B00 / $3B01	Self-Test / Calibration / Configuration is active	1
$0001	RAM Self-Test has failed	2
$0002	ADC has failed self-test	3
$0003	Not enough calibration points entered	4
$0004	Attempted to enter more than seven (7) calibration voltages	5

NOTE: [1]The board is performing either self-test, calibration, or configuration of channels. The board is not available for VMEbus accesses. [2]The onboard RAM has failed the RAM test. The DSP has stopped processing the reset condition. Replace RAM or check to see that it is properly installed. [3]One or more ADCs has failed initial self-test. Refer to the Channel Pass / Fail Register to determine the status of each ADC. The board will function with the failed channel(s) but the data for the channel(s) will not be correct. [4]Minimum number of calibration voltages is three. An attempt to calibrate with fewer than three calibration voltages occurred. Either enter more calibration voltages or terminate calibration process. [5]Maximum number of calibration voltages is seven. An attempt to calibrate with more than seven calibration voltages occurred. After entering the maximum number of calibration voltages, the CAL Done bit must be set in the BCR to inform the DSP to calculate the coefficients.

Board Control Register (BCR)

The Board Control Register (BCR) contains status and control of the board's operations. The user can initiate channel reconfiguration, channel calibrations, autozeroing of channels, and a software reset.

Table 3-5 Board Control Register's Bit Map

Board Control Register (Offset $0004) Read/Write, Byte/Word							
Bit 15	**Bit 14**	**Bit 13**	**Bit 12**	**Bit 11**	**Bit 10**	**Bit 09**	**Bit 08**
LED	WDOG	WRITE COEF	COEF Status	Reserved			Reset_A

Bit 07	**Bit 06**	**Bit 05**	**Bit 04**	**Bit 03**	**Bit 02**	**Bit 01**	**Bit 00**
Reset_B	Autozero	Data Ready	USER COEF	SYS Reconfig	Chan Cal'd	INIT CAL	CAL Done

Powerup / Reset Default = $0000

Board Control Register Bit Definitions

Bit 15: **LED -** The front panel LED is turned ON by writing a logical one (1) to this bit. After successfully completing self-test, the LED will extinguish if the UIOC jumper (E10) is not installed. If the UIOC jumper is installed, the LED will remain ON after completing self-test. The user can extinguish the LED by writing a logical zero (0) to this bit.

Bit 14: **WDOG -** This is a status bit, informing the user that a **Watchdog Timeout** has caused a reset. The user must acknowledge this bit being set by writing a logical one (1) to the RESET_B bit located in this register. This will cause the DSP to initiate a board reset as described in *Reset Operations and Initialization* on page 48. The DSP resets this bit to a logical zero (0) after completing the board reset.

Bit 13: **WRITE COEF -** When this bit is set, the gain and offset coefficients stored in the DSP internal memory are written to the E^2PROM. This bit is automatically cleared after the coefficients are written to the E^2PROM.

Bit 12: **COEF Status -** This is a status bit, indicating, whether user-defined coefficients are being used in the offset and gain correction of data. This bit is set to a logical one (1) for user-defined coefficients. The bit is reset if the coefficients are written to the E^2PROM, or a reset condition occurs.

Bits 09 through 11: **Reserved -** These bits are reserved and should be written as logical zero (0).

Board Control Register Bit Definitions (Continued)

Bits 08 and 07:

Reset[A and B] - These bits cause the board to return to its powerup reset state. This reset is a two-step process to ensure fault tolerance. To initiate a proper reset, the following steps must be adhered to:

1. Write a logical one (1) to `RESET_A` and a logical zero (0) to `RESET_B` bit.
2. Wait for `RESET_A` bit to be reset by DSP.
3. Write a logical zero (0) to `RESET_A` bit and a logical one (1) to `RESET_B` bit. The maximum time allowed between setting `RESET_A` bit and setting `RESET_B` bit is approximately 2 seconds. If this time is exceeded, the reset sequence must be performed again. The `RESET_B` bit stays set indicating a reset did not occur.

Bit 06:

Autozero - When this bit is set to a logical one (1) by the user, the inputs from all channels are internally disconnected from the field and connected to the channel's analog ground. This bit is reset automatically by the DSP after new offset coefficients are determined.

Bit 05:

Data Ready - This is a status bit informing the user new data is available in the RAM. The user must reset this bit to a logical zero (0) after reading the new data.

NOTE: Polling the **Data Ready Flag** can cause an increase in noise. Data is updated to the RAM every 10 msec. The Data Ready Flag should be read after waiting for 10 msec.

Bit 04:

USER COEF - The user sets this bit if user-defined gain and offset coefficients are going to be used. This gives the user control of the gain and offset applied to the raw ADC data. The user must first write the gain and offset coefficients to the appropriate location (`$XX80` starting address of offset coefficients and `$XXC0` starting address for gain coefficients) for the channel(s) of interest. The gain and offset coefficients are 32 bits wide and must be entered in two's complement format. This requires two 16-bit registers. The coefficients must be entered: the Most Significant Word (MSW - first 16 bits) followed by the Least Significant Word (LSW - last 16 bits). For example, gain coefficients for Channel 0 would be entered MSW at `$XXC0` and the LSW at `$XXC2` (see Table 3-6 on page 54). The `USER COEF` bit is then set informing the DSP of pending changes. The DSP will load all the coefficients into its internal memory and use the values during the correction process. The user-defined values **will not** be written to the E^2PROM unless the user sets the `WRITE COEF` bit located in this register. This bit is reset after the DSP reads the last coefficient. Also, the `COEF Status` bit will be set indicating user-defined coefficients are being used. The DSP will have control of the internal bus for approximately 21 µsec to read in all the coefficients.

Board Control Register Bit Definitions (Continued)

Table 3-6 User Gain Coefficients MSW and LSW

Address	Word	Channel
$XXC0	MSW	0
$XXC2	LSW	0
$XXC4	MSW	1
$XXC6	LSW	1

Bit 03: **SYS Reconfig -** The user sets this bit to a logical one (1) whenever a change in channel configuration is desired (i.e., gain, frequency). The channel or channels reconfigured are entered into the Select Channel Register (SCR) prior to setting this bit. The DSP periodically polls this bit to determine if the configuration has changed. Sensing a change, the DSP reads the SCR and begins processing the new configurations. While the channel is being reconfigured, VMEbus activity should be limited to reading the BRR for an indication on when normal accesses can take place. The `SYS Reconfig` bit is reset after the channel has been reconfigured.

Bit 02: **Chan Cal'd -** This is a status bit set by the DSP after the data for the present calibration voltage is stored. This informs the user that additional calibration voltage can be entered. The bit is reset by the DSP after each `INIT CAL` or `CAL Done` operation.

Bit 01: **INIT CAL -** This bit is set to a logical one (1) by the user to initiate calibration. Also, this bit is set for each voltage entered for calibration. The bit is reset automatically by the calibration routine.

Bit 00: **CAL Done -** The user sets this bit to a logical one (1) upon completion of calibration. The DSP reads this bit to determine when the user is finished and proceeds calculating the gain and offset coefficients. The bit is reset to logical zero (0) after the DSP finishes its calculations.

Select Channel Register (SCR)

The Select Channel Register (SCR) selects the channels for calibration or reconfiguration. See Table 3-7 below for the Select Channel Register's bit map.

Table 3-7 Select Channel Register's Bit Map

Select Channel Register (Offset $0006) Read/Write, Byte/Word							
Bit 15	**Bit 14**	**Bit 13**	**Bit 12**	**Bit 11**	**Bit 10**	**Bit 09**	**Bit 08**
CH15	CH14	CH13	CH12	CH11	CH10	CH9	CH8
Bit 07	**Bit 06**	**Bit 05**	**Bit 04**	**Bit 03**	**Bit 02**	**Bit 01**	**Bit 00**
CH7	CH6	CH5	CH4	CH3	CH2	CH1	CH0

Powerup / Reset Default = $0000

Select Channel Register Bit Definitions

Bits 15 through 00:

CH [15...0] - A logical zero (0) written to the bit field inhibits that channel. logical one (1) written to the bit field enables that channel for calibration or reconfiguration. After calibration or reconfiguration is complete, the bit is reset to a logical zero (0). (Default is logic zero [0].)

Channel Pass/Fail Status Register (PFS)

The Channel Pass / Fail Status (PFS) register contains pass / fail status of the self-test performed on the ADCs during the powerup / reset condition. It also contains status after performing open sensor detection.

Table 3-8 Channel Pass/Fail Status Register's Bit Map

Channel Pass/Fail Status Register (Offset $0008) Read Only, Byte/Word							
Bit 15	**Bit 14**	**Bit 13**	**Bit 12**	**Bit 11**	**Bit 10**	**Bit 09**	**Bit 08**
CH15	CH14	CH13	CH12	CH11	CH10	CH09	CH08
Bit 07	**Bit 06**	**Bit 05**	**Bit 04**	**Bit 03**	**Bit 02**	**Bit 01**	**Bit 00**
CH7	CH6	CH5	CH4	CH3	CH2	CH1	CH0

Powerup / Reset Default = $0000

Channel Pass/Fail Status Register Bit Definitions

Bits 15 through 00:

CH [15...0] - A logical zero (0) indicates the channel has passed. A logical one (1) indicates the channel has failed. (Default is logic zero [0].)

Target Calibration Voltage Register (TVC)

The Target Calibration Voltage (TCV) register consists of two registers. The user writes the digital value of the expected result for a given calibration input voltage. The Target Calibration Voltage HI Register contains the upper word of a 32-bit value. The Target Calibration Voltage LO Register contains the lower word of a 32-bit value. Table 3-9 below shows the HI register and Table 3-10 on page 57 shows the LO register. The gain and offset coefficients are determined using the values in these registers and the data from the ADC. A precision low noise voltage source should be used for the calibration process to ensure the accuracy of the final corrected data.

Table 3-9 Target Calibration Voltage Register HI's Bit Map

Target Calibration Voltage Register HI (Offset $000A) Read/Write, Byte/Word							
Bit 15	**Bit 14**	**Bit 13**	**Bit 12**	**Bit 11**	**Bit 10**	**Bit 09**	**Bit 08**
TVH15	TVH14	TVH13	TVH12	TVH11	TVH10	TVH9	TVH8

Bit 07	**Bit 06**	**Bit 05**	**Bit 04**	**Bit 03**	**Bit 02**	**Bit 01**	**Bit 00**
TVH7	TVH6	TVH5	TVH4	TVH3	TVH2	TVH1	TVH0

Powerup / Reset Default = $0000

Table 3-10 Target Calibration Voltage Register LO's Bit Map

Target Calibration Voltage Register LO (Offset $000C) Read/Write, Byte/Word							
Bit 15	**Bit 14**	**Bit 13**	**Bit 12**	**Bit 11**	**Bit 10**	**Bit 09**	**Bit 08**
TVL15	TVL14	TVL13	TVL12	TVL11	TVL10	TVL9	TVL8
Bit 07	**Bit 06**	**Bit 05**	**Bit 04**	**Bit 03**	**Bit 02**	**Bit 01**	**Bit 00**
TVL7	TVL6	TVL5	TVL4	TVL3	TVL2	TVL1	TVL0

Powerup / Reset Default = $0000

Target Calibration Voltage HI and Lo Registers' Bit Definitions

Bits 15 through 00:

TVH & TVL [15...0] - The user writes a digital value to this register which represents the expected result for the calibration voltage connected to the inputs. The digital value must be in two's complement format. Below is an example explaining the use of this register.

Example: Input +2.25 V for calibration on the ±5 V scale. The 32-bit code for the expected value can be determined by the following equation:

$E_{in} = E_{fsr} \times N_{adc} / 2^{32}$

where: E_{in} = Input voltage
E_{lo} = Lower end of Input Range
E_{fsr} = Full-scale Input Range
N_{adc} = A / D Converter reading

Solving for N_{adc} yields:

$$N_{adc} = \frac{E_{in} * 2^{32}}{E_{fsr}}$$

For the above example, N_{adc} = $3999 9999. This number is in two's complement format and would be entered in the TCV register as:

Target Calibration Voltage HI = $3999
Target Calibration Voltage LO = $9999

NOTE: Due to the way the DSP handles calibration, unipolar ranges must use E_{FSR} of their bipolar range. For example, a unipolar range of 0 to 10 V uses a E_{FSR} of ±10 V (20 V) in the aforementioned equation.

Firmware Revision Register (FRR)

The Firmware Revision Register (FRR) contains the revision of code for the DSP.

Table 3-11 Firmware Revision Register's Bit Map

Firmware Revision Register (Offset $000E) Read Only, Byte/Word							
Bit 15	**Bit 14**	**Bit 13**	**Bit 12**	**Bit 11**	**Bit 10**	**Bit 09**	**Bit 08**
MJR15	MJR14	MJR13	MJR12	MJR11	MJR10	MJR9	MJR8
Bit 07	**Bit 06**	**Bit 05**	**Bit 04**	**Bit 03**	**Bit 02**	**Bit 01**	**Bit 00**
MNR7	MNR6	MNR5	MNR4	MNR3	MNR2	MNR1	MNR0

Powerup / Reset Default = Depends on DSP

Firmware Revision Register Bit Definitions

Bits 15 through 08: **MJR[15...8] -** This code represents the code for the current revision for the DSP.

Bits 7 through 00: **MNR[7...0] -** This code represents the current minor revision for the DSP code. For example, a current revision of 1.07 would be displayed as $0107.

EPROM Writes Registers (EWR1 and EWR0)

The EEPROM Writes Register (EWR1 and EWR0) is a 32-bit number representing the number of times the E^2PROM has been written to. This 32-bit number is made from two 16-bit registers. EWR1 contains the upper 16 bits and EWR0 contains the lower 16 bits. Table 3-12 below and Table 3-13 on page 59 shows these registers.

Table 3-12 EEPROM Writes Register 1's Bit Map

EEPROM Writes Register 1 (Offset $0010) Read Only, Byte/Word							
Bit 15	**Bit 14**	**Bit 13**	**Bit 12**	**Bit 11**	**Bit 10**	**Bit 09**	**Bit 08**
EW1_15	EW1_14	EW1_13	EW1_12	EW1_11	EW1_10	EW1_9	EW1_8
Bit 07	**Bit 06**	**Bit 05**	**Bit 04**	**Bit 03**	**Bit 02**	**Bit 01**	**Bit 00**
EW1_7	EW1_6	EW1_5	EW1_4	EW1_3	EW1_2	EW1_1	EW1_0

EEPROM Write Register 1 Bit Definitions

Bits 15 through 00: **EW1 [15...0] -** The upper 16 bits represent the number of times the E^2PROM has been written to in hexadecimal format

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Table 3-13 EEPROM Writes Register 0's Bit Map

EEPROM Writes Register 0 (Offset $0012) Read Only, Byte/Word							
Bit 15	**Bit 14**	**Bit 13**	**Bit 12**	**Bit 11**	**Bit 10**	**Bit 09**	**Bit 08**
EW0_15	EW0_14	EW0_13	EW0_12	EW0_11	EW0_10	EW0_9	EW0_8

Bit 07	**Bit 06**	**Bit 05**	**Bit 04**	**Bit 03**	**Bit 02**	**Bit 01**	**Bit 00**
EW0_7	EW0_6	EW0_5	EW0_4	EW0_3	EW0_2	EW0_1	EW0_0

EEPROM Write Register 0 Bit Definitions

Bits 15 through 00: **EW0 [15...0] -** The lower 16 bits represent the number of times the E^2PROM has been written to in hexadecimal format.

Control and Status Register (Channel 0 Example)

This register contains information pertinent to Channel 0. Each channel has its own CSR, which is identical in operation to the one described in Table 3-14 below. The bit definitions are also shown below.

Table 3-14 Control and Status Register's Bit Map

Channel 0 Control and Status Register (Offset $0020) Read/Write, Byte/Word							
Bit 15	**Bit 14**	**Bit 13**	**Bit 12**	**Bit 11**	**Bit 10**	**Bit 9**	**Bit 8**
Format	RTD	Open Sensor	Reserved	Range Bit 3	Range Bit 2	Range Bit 1	Range Bit 0

Bit 07	**Bit 06**	**Bit 05**	**Bit 04**	**Bit 03**	**Bit 02**	**Bit 01**	**Bit 00**
Reserved					FC2	FC1	FC0

Powerup / Reset Default = $0807

Control and Status Register Bit Definitions

Bit 15: **Format -** This bit controls the format of the data written to the RAM. A logical zero (0) returns offset binary format. A logical one (1) returns two's complement format. The default is offset binary. This bit is ignored for unipolar ranges. For unipolar ranges, the output is always binary.

Bit 14: **RTD -** This bit enables the RTD Excitation supply when set to a logical one (1). The default condition is a logic zero (0).

Control and Status Register Bit Definitions (Continued)

Bit 13: **Open Sensor -** This bit enables the **Open Sensor** detection on the inputs when set to a logical one (1). The default condition is a logic zero (0). The range for the channel must be less than or equal to ±1 V (0 to 1 V) for open sensor detect to work properly. Refer to Table 3-15 below for the code to enter for these ranges. This bit is reset automatically by the DSP after the open-sensor detection has completed. Status of whether or not the sensor was open is reported in the PFS register.

Bit 12 and Bits 07 through 03: **Reserved -** Set these bits to a logical zero (0).

Bits 11 through 08: **Range Bits [3...0] -** This field determines the input range for the channel. The range code is used by the DSP to determine the channel gain. Table 3-15 below shows the range code and associated input voltage range.

Bits 02 through 00: **FC [2...0] -** This field is the channel's -3 dB cutoff frequency as shown in Table 3-16 on page 61 below. The default setting is 111.

Table 3-15 Input Range Control

Range Code (HEX)	Input Range	Notes
0	0-10 V	
1	0-5 V	
2	0-1 V	
3	0-500 mV	
4	0-100 mV	
5	0-50 mV	
6	0-20 mV	3
7	Reserved	
8	±10 V	1
9	±5 V	
A	±1 V	2
B	±500 mV	
C	±100 mV	
D	±50 mV	
E	±20 mV	3
F	±5 mV	3

NOTE: [1]Denotes default setting for a normal voltage board. [2]Denotes default setting for a low level voltage board. [3]Only available with the low level voltage option.

Table 3-16 Channel -3 dB Cutoff Frequency

-3 dB Frequency	FC2	FC1	FC0
0.05 Hz	0	0	0
0.12 Hz	0	0	1
0.30 Hz	0	1	0
0.70 Hz	0	1	1
1.7 Hz	1	0	0
4.0 Hz	1	0	1
10.0 Hz	1	1	0
*26.0 Hz	1	1	1
*Denotes default setting.			

Offset Coefficients

A copy of the offset coefficients determined during calibration are placed in locations $0080 to $00BC. The offset coefficients are in two's complement 32-bit wide integer format.

Gain Coefficients

A copy of the gain coefficients determined during calibration are placed in locations $00C0 to $00FC. The offset coefficients are in two's complement 32-bit wide integer format.

Data Register

The corrected and filtered data is placed in locations $0040 to $005F. Each location corresponds to each channel starting with Channel 0. The data is a 16-bit integer in the format selected in each CSR.

Maintenance

Maintenance

This section provides information relative to the care and maintenance of VMIC's products. If the products malfunction, verify the following:

- Software
- System configuration
- Electrical connections
- Jumper or configuration options
- Boards are fully inserted into their proper connector location
- Connector pins are clean and free from contamination
- No components of adjacent boards are disturbed when inserting or removing the board from the chassis
- Quality of cables and I/O connections

If products must be returned, contact VMIC for a Return Material Authorization (RMA) Number. **This RMA Number must be obtained prior to any return**.

Maintenance Prints

User level repairs are not recommended. The drawings and diagrams in this manual are for reference purposes only.