VMIVME-3413
32-Channel Signal Conditioning Board

Product Manual

A GE Fanuc Company

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500-003413-000 Rev. E

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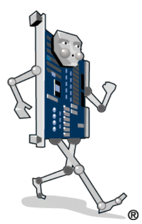

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Table of Contents

List of Figures

List of Tables

Overview

Contents

Introduction

With 32 channels of analog input signal conditioning, the VMIVME-3413 Board supports VMIC's extensive family of analog input/output products for the VMEbus. Low-level differential or single-ended inputs are accepted from temperature and pressure transducers, or from any other low-level analog signal source. Although the VMIVME-3413 Board can be used with any high-level analog multiplexer and digitizer, it is designed specifically as a companion to the VMIVME-3112/3113/3118 scanning A/D converter boards.

Individual channel voltage gain is selectable from x 1 to x 1000 and, when used with the VMIVME-3112/3113/3118 Boards, provides full scale ranges from 5 mV to 10 V. Thermocouple compensation can be selected for any or all channels, and excitation for RTDs and strain gages is provided from 2.5 to 10 VDC, with total load current up to 150 mA. Three-pole low pass input filters are available in frequency ranges of 10 Hz, 100 Hz, or 1000 Hz.

The broad range of system applications includes factory automation, process control, data acquisition systems, training simulators, and laboratory instrumentation. A brief overview of the board's principal features illustrates the flexibility and performance offered by the VMIVME-3413 Board:

- 32 differential or single-ended analog input channels
- Each input channel provides:
  - Gain selection of x1, x10, x100, or x1000
  - Configurable for RTDs, strain gage bridges, thermocouples, or direct analog inputs
  - Half-bridge completion for strain gage bridges
  - Provision for RTD excitation, 0.1 to 10 mA per channel, 32 mA total
  - Optional current loop termination resistors
- Buffered high-level analog outputs
- Isolation from the VMEbus; 500 VDC
- Optional analog current loop inputs

Features (Continued)

- Full scale input ranges from 5 mV to 10 V
- Strain gage excitation; 2.5, 5.0, or 10 V, at 150 mA total load
- Reference (cold) junction compensation for thermocouple types E, J, K, N, B, T, R, or S, with either local or remote sensing
- Output cable matches input connectors for VMIVME-3112 / 3113 / 3118 scanning A / D boards
- Discrete wire or insulation displacement (IDC) input connectors.

Functional Description

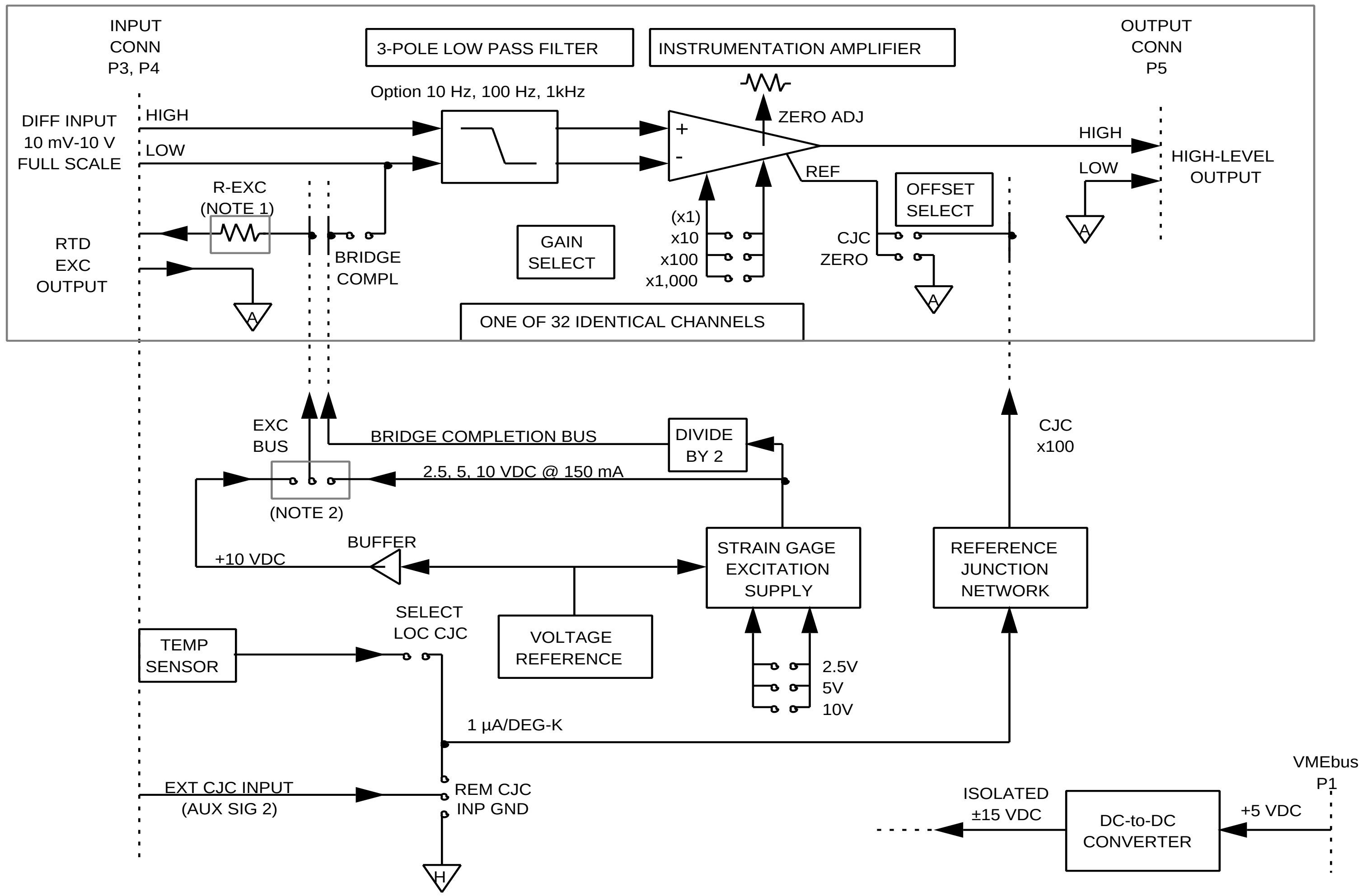
The VMIVME-3413 Board (Figure 1.2-1) is a 32-channel, single-ended or differential, low-level, analog input signal conditioner for the VMEbus. Channel voltage gain is individually selectable as x1, x10, x100, or x1,000, and produces full scale input ranges from ±5 mV to ±10 V. The output from each channel is a single-ended voltage source with a maximum full scale range of ±10 V.

Thermocouple compensation is available with either local (P3,P4) sensing or remote sensing, and can be selected individually for any or all channels. All thermocouple channels share the compensation selected for thermocouple types E, J, K, N, B, T, R, or S.

RTD and strain gage excitation outputs are provided for all channels. RTD excitation is selectable individually for each channel with a user-installed series resistor connected to a precision +10 VDC reference. Strain gage excitation is selectable as 2.5, 5.0, or 10 VDC, with remote sensing provided for both the positive and return connections. Total excitation output loading can be up to 32 mA for RTDs and up to 150 mA for strain gages. The strain gage excitation supply can also be used for RTD excitation.

Three-pole low pass input filters are supplied in one of three optional ranges of 10 Hz, 100 Hz, or 1 kHz.

Analog inputs are accepted through two front panel connectors, P3 and P4, which can be supplied to mate with either discrete wire or insulation displacement ribbon (IDC) 64-pin DIN connectors. The analog outputs are connected to the system through a 64-pin DIN connector (called P5) which is located near the conventional P2 position, and can be routed past the front panel with a ribbon cable, or from the rear of the board if a P2 backplane is not present. Electrical power is obtained from the +5 VDC bus through the P1 connector. The VMIVME-3413 Board uses the backplane only for electrical power and mechanical support, and has no VMEbus control functions.



NOTES:

1. Excitation resistors are installed on plug-in adapters: 8 to an adapter.
2. Each of four 8-channel R-EXC adapters is fed from an individual excitation selection jumper.

M3413/F1.2-1

Figure 1 VMIVME-3413 Functional Block Diagram

Reference Material List

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

VITA

VMEbus International Trade Association

10229 N. Scottsdale Road

Scottsdale, AZ 85253

(602) 951-8866

The following Application and Configuration Guides are available from VMIC to assist in the selection, specification, and implementation of systems which are based upon VMIC's products:

Title	Document No.
Digital Input Board Application Guide	825-000000-000
Change-of-State Application Guide	825-000000-002
Digital I/O (with Built-in-Test) Product Line Description	825-000000-003
Synchro/Resolver (Built-in-Test) Subsystem Configuration Guide	825-000000-004
Analog I/O Products (with Built-in-Test) Configuration Guide	825-000000-005
Connector and I/O Cable Application Guide	825-000000-006

Physical Description and Specifications, refer to *Product Specification, 800-003413-000* available 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.

VMIC 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 VMIC 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.

STOP: 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

STOP: This symbol informs the operator the 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: This sign denotes a hazard. It calls attention to a procedure, a practice, a condition, which, if not correctly performed or adhered to, could result in injury or death to personnel.

CAUTION: This sign 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: Calls attention to a procedure, a practice, a condition or the like, which is essential to highlight.

CHAPTER

1

Theory of Operation

Introduction

This section describes the internal organization of the VMIVME-3413 Board, and reviews the general principles of operation. Section 3.2 summarizes the major board functions, each of which is described in detail in a subsequent section.

Functional Organization

The VMIVME-3413 Board contains the following principal hardware functions, as shown in Figure 1 on page 16.

- Low pass input filters.
- Instrumentation amplifiers.
- Thermocouple reference junction compensation.
- Excitation power supply.
- RTD excitation.
- Strain gage excitation and bridge completion.
- DC-to-DC power converter.

Optional low pass input filters are available for cutoff frequencies at 10 Hz, 100 Hz, or 1 kHz. Programmable-gain instrumentation amplifiers provide 32 channels of signal conditioning for direct transducer analog inputs.

Reference junction compensation is provided for a variety of thermocouple types, and excitation is available for driving RTDs or strain gages. A single DC-to-DC converter provides isolated ±15 VDC for the board.

Analog inputs are connected to front panel connectors P3 and P4 through either ribbon cables or discrete wire cables. The output connector P5 is designed to cable directly to the 32-channel input connector of a VMIC scanning multiplexer/digitizer board through a standard 64-wire ribbon cable. A single 64-channel scanning multiplexer board, such as the VMIVME-3112 or VMIVME-3118, accommodates the outputs from two VMIVME-3413 Boards.

Low Pass Input Filters

Each channel input HIGH/LOW pair passes through a differential low pass filter before appearing at the input of an instrumentation amplifier (Figure 1-1 below). The filter is a 3-pole symmetric ladder which provides -3 dB cutoff frequencies at 10 Hz, 100 Hz, or 1 kHz. If the board is equipped with the Current Loop Terminator option (Section 3.3.2), the associated input filters are eliminated.

Filter Frequencies

Factory options provide three filter ranges with frequencies of 10 Hz, 100 Hz, or 1 kHz. A fourth filter option eliminates the filters and routes the input signal directly to the instrumentation amplifier.

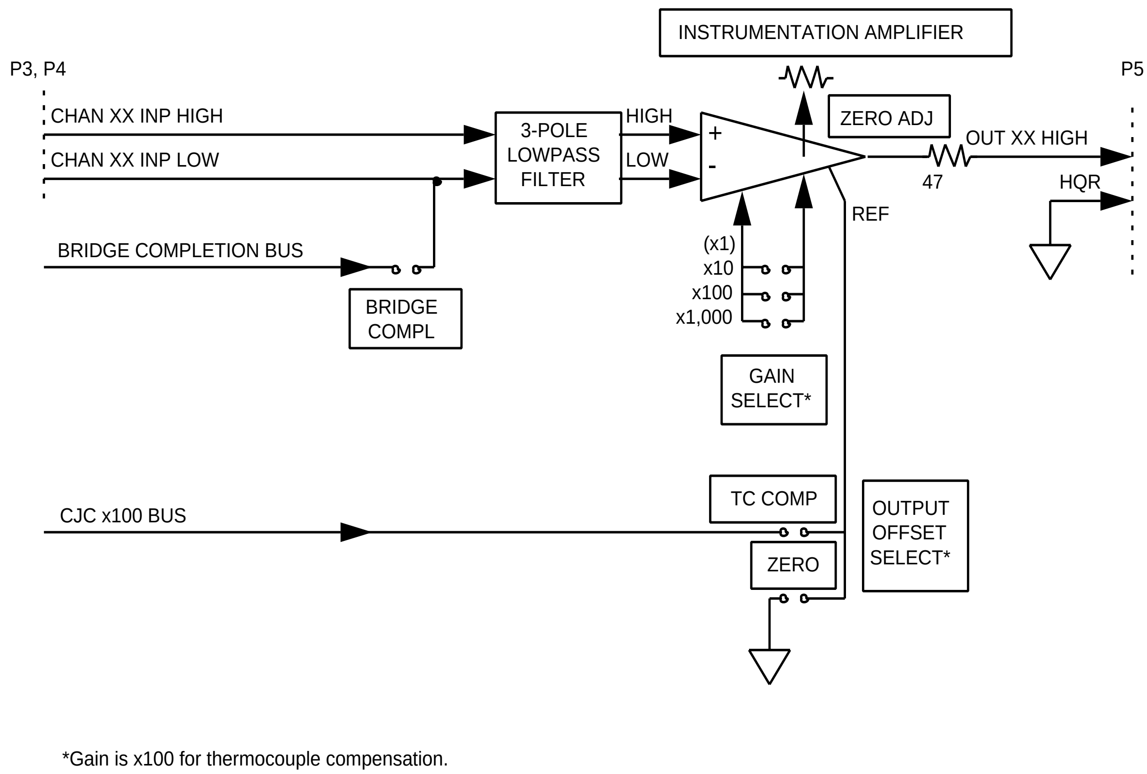


Figure 1-1 Input Filter and Amplifier

Configuration with Current Loop Terminators

A current loop terminator factory option replaces the input capacitor of each low pass filter with a 250 Ω, 0.01 percent, 1/4 watt precision resistor. The filter resistor SIP is installed as 22 Ω and produces a net input resistance of 294 Ω. Only the voltage developed across the precision resistor appears at the input of the instrumentation amplifier.

Configuration for Bridge Completion

Two-arm (half-bridge) strain gages generally require a passive two-arm bridge to *complete* the standard four-arm configuration. The passive bridge provides a reference voltage that equals the nominal "zero" output of the active half-bridge, and for symmetric gages equals one-half of the excitation voltage. The VMIVME-3413 Board simulates the passive half-bridge with the bridge completion bus shown in Figure 1-1 on page 22. The bridge completion bus voltage equals one-half of the selected strain gage excitation voltage.

Installation of the BRIDGE COMPL jumper establishes a simulated two-arm input at the channel inverting (LOW) input, the connector pin of which must be left disconnected. The output of the active bridge is connected to the noninverting (HIGH) input.

Instrumentation Amplifiers

Gain Control

The instrumentation amplifier in each channel is a high impedance differential amplifier with jumper-programmable gain and a single-ended output (Figure 1-1 on page 22). Each amplifier is programmable individually for a voltage gain of x1, x10, x100, or x1,000. An input offset adjustment potentiometer is provided for each amplifier.

Outputs

The single-ended output from the amplifier passes through a 47Ω resistor to the output connector P5, and has an operating range of ±10 V. The output resistor ensures that the output will remain stable if high capacitance loading is present at P5.

A voltage on the REF pin (see Figure 1-1 on page 22) is added to the output voltage, and produces a corresponding output offset. For thermocouple channels, the TC COMP jumper is installed and the voltage on the REF pin equals 100 times the required reference (cold) junction compensation potential. With the amplifier operating at a gain of x100, the compensation bus produces the equivalent input compensation for a specific thermocouple type. This arrangement permits any or all channels to share the same compensation network.

Thermocouple Reference Compensation

Thermocouple Signals

A thermocouple junction consists of two dissimilar materials which produce a *Seebeck* potential that responds repeatably to the temperature of the junction. The relationship between potential and temperature for various pairs of materials is tabulated in thermocouple tables which have been standardized generally throughout the industry.

While thermocouple conductors are dissimilar materials, the wires to the measurement device are identical materials, usually copper. The point at which the thermocouple wires are connected to the measurement wires is the *reference* or "cold" junction Figure 1-2 on page 26 (a)). The reference junction responds to temperature in the same manner as the thermocouple itself and consequently introduces an error into the thermocouple output. This error is eliminated by "cold junction compensation (CJC)" or "reference junction compensation."

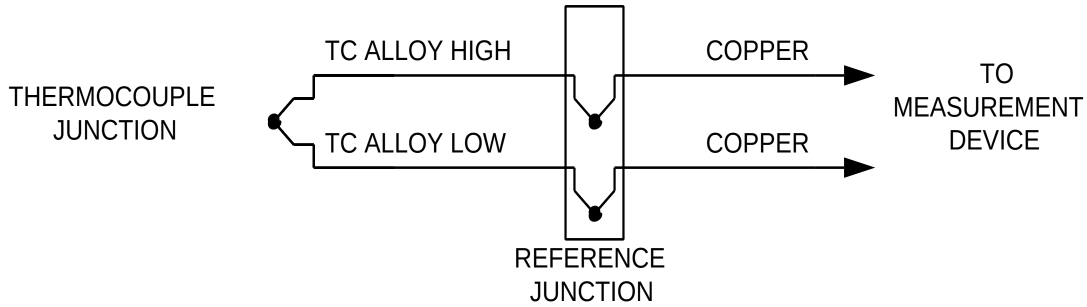
Standard thermocouple tables are determined with the reference junction at the freezing point of water (0 °C). If the reference junction is at a temperature other than 0 °C, the measured potential from the thermocouple will be in error by an amount equal to the Seebeck potential of the reference junction itself. The polarity of the error is such that a *higher* reference temperature produces a *lower* measured potential from the thermocouple. The error is eliminated by adding an equal "compensating" potential to the thermocouple output before measurement.

Compensation Network

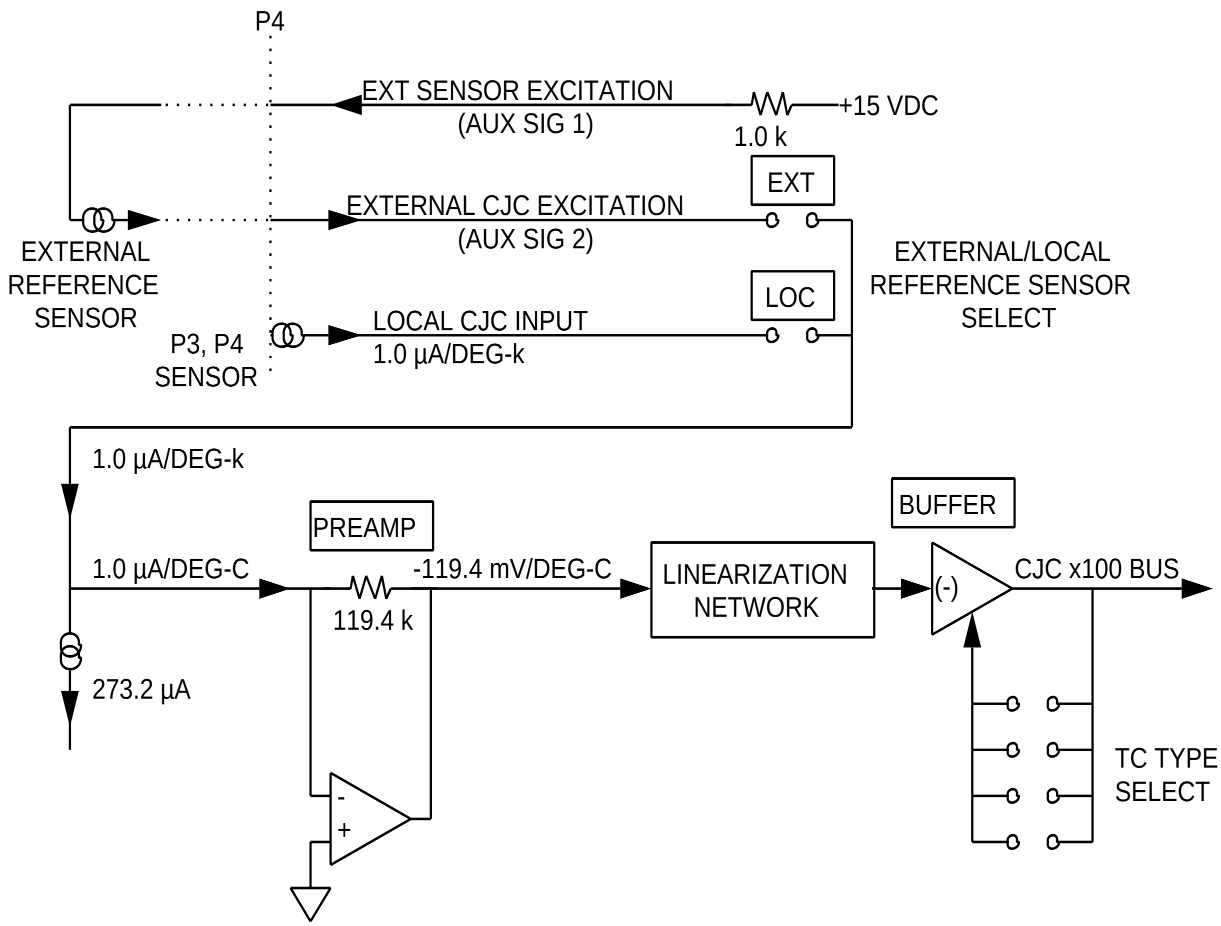
A thermocouple compensation voltage is generated by the VMIVME-3413 Board with the network shown in Figure 1-2 on page 26 (b). The temperature of the reference junction is converted by a temperature sensor into an analog current signal that is scaled as 1 microamp per degree Kelvin. If local sensing is selected, the current signal is produced by a temperature sensor that is in thermal contact with the input connectors P3 and P4. If the reference junction is located externally, the current signal is obtained through P4 from an external sensor.

After subtraction of an icepoint current that is equivalent to 273.2 °K (0 °C), the sensor signal is converted by an inverting preamp into a voltage level of -119.4 mV per °C. The voltage level is linearized to compensate for nonlinearities in the thermocouple response, and then is scaled for a specific thermocouple type by an inverting buffer. The output of the buffer is scaled to 100 times the thermocouple of the reference junction, and is routed to all 32 instrumentation amplifiers as the "CJC x100 BUS."

The CJC x100 bus offsets the outputs of all jumper-selected thermocouple channels by an amount equal to 100 times the reference junction error. Because each thermocouple channel operates with a gain of x100, the reference junction error is amplified by 100 and is canceled by the CJC x100 offset.



a. Thermocouple Circuit



b. Reference Compensation Generator

Figure 1-2 Thermocouple Reference Compensation

Excitation Power Supply

Excitation for RTDs and strain gages is generated by the voltage reference and power amplifier shown in Figure 1-3 on page 28. RTD excitation for all channels is derived from the +10 V bus which can supply up to 32 mA of total RTD current. The excitation power bus for strain gages consists of the STRN EXC HI and STRN EXC LO lines, and can supply a maximum load current of 150 mA. The STRN EXC HI line is routed to all channels for jumper-selection as an excitation output. Excitation current is returned to the STRN EXC LO line through the input COMM pins in selected groups of eight channels. The strain gage excitation voltage is jumper-selected as +2.5, +5.0, or +10 VDC.

Remote Sensing

Remote sensing compensates for the voltage drop encountered in long excitation lines and ensures that the selected excitation voltage is delivered to the load. The POS SENSE and NEG SENSE lines from P4 provide remote sensing of the excitation voltage delivered at a remotely located strain gage. Installation of the DISABLE SENSE jumpers disables the remote sensing feature and permits the associated P4 pins to be used externally as ground pins.

Bridge Completion

The bridge completion bus voltage is generated by a precision 2:1 attenuator across the excitation supply, and can be jumpered to the inverting input of any or all channels.

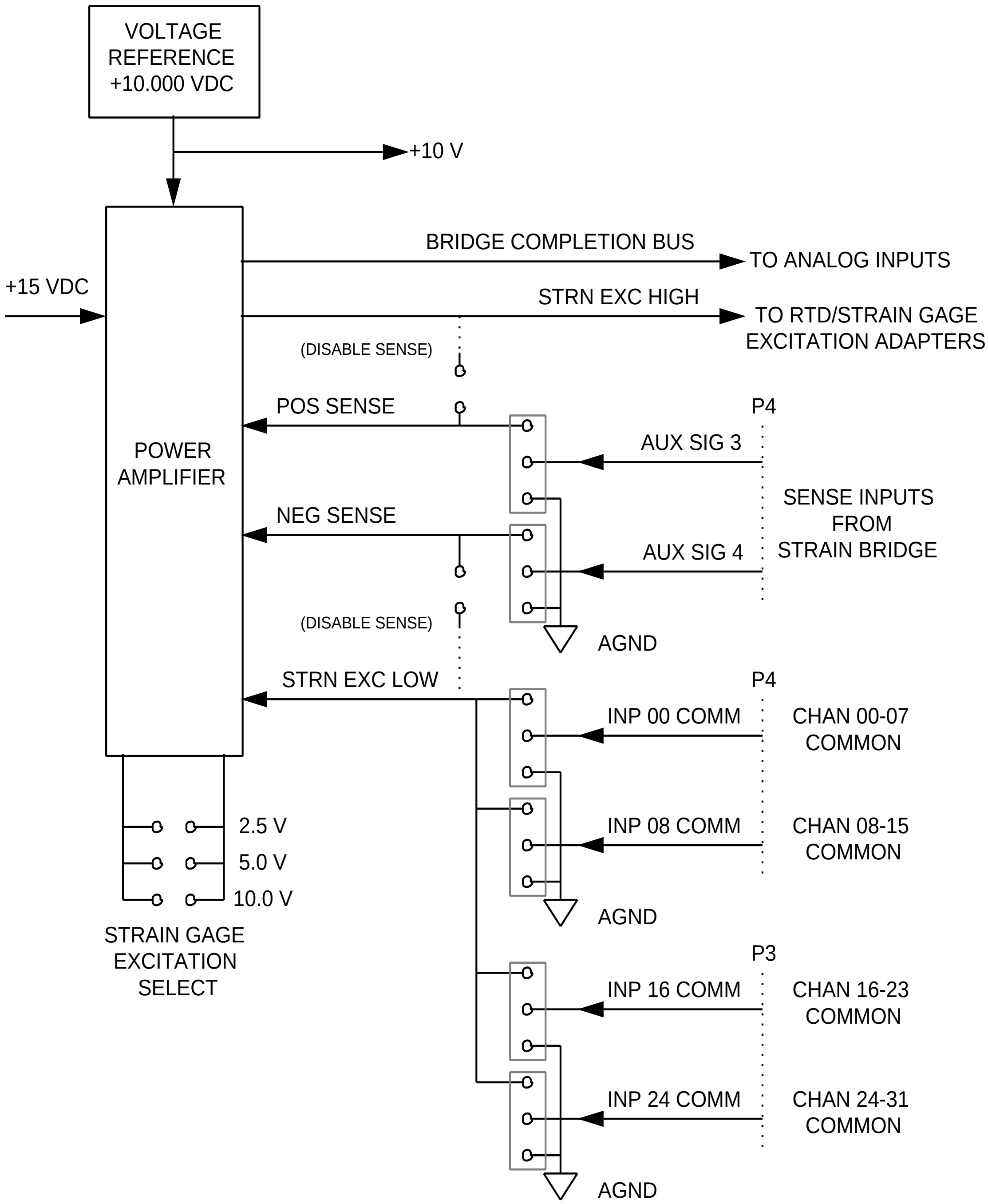


Figure 1-3 Excitation Power Supply

Excitation Outputs

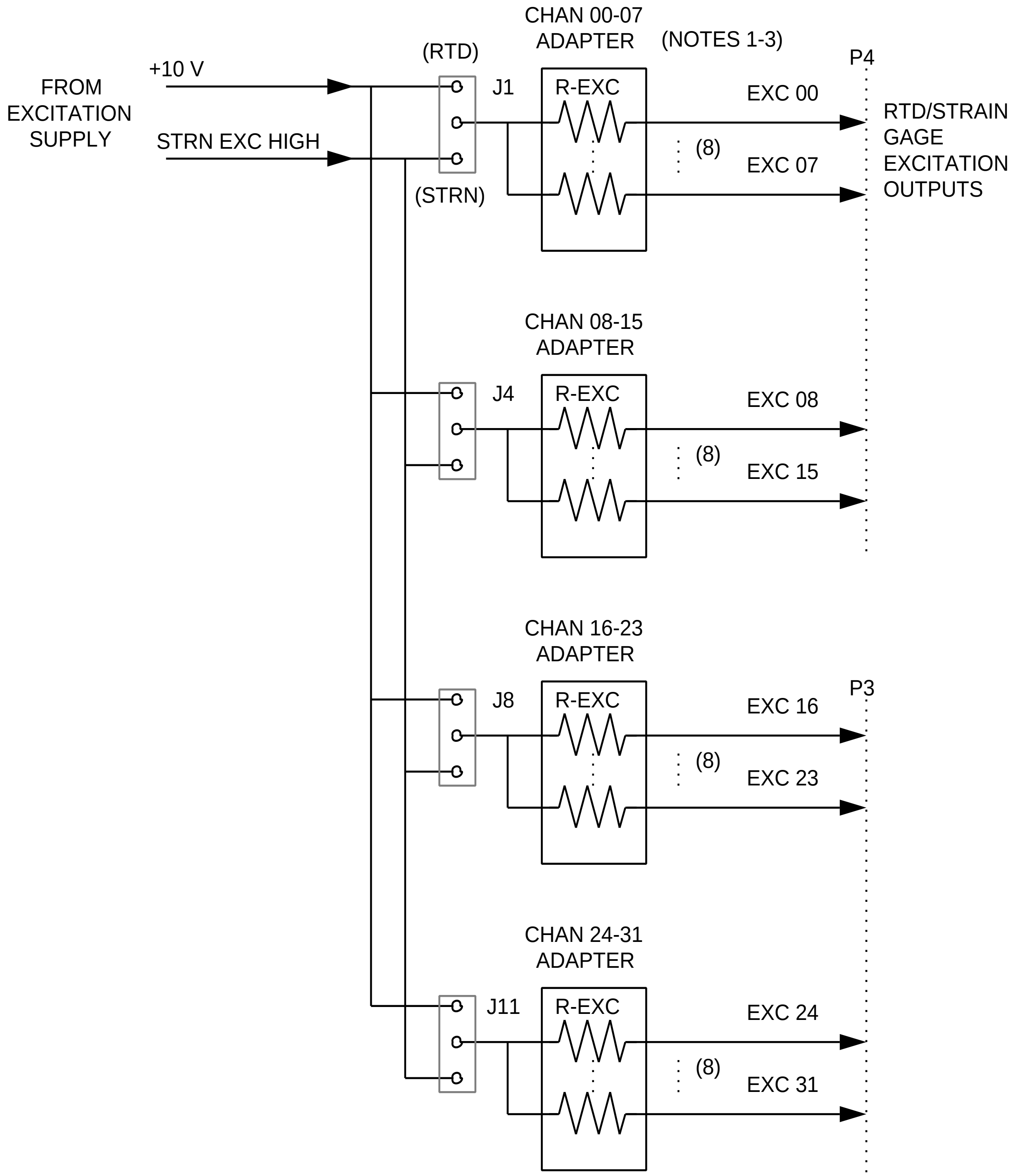
RTD and strain gage excitation are controlled with the adapters and jumper blocks shown in Figure 1-4 on page 30. Each group of eight channels can be jumper-designated for either RTD or strain gage excitation. All adapters are configured at the factory with jumpers in the R-EXC positions.

RTD Excitation

The excitation current for RTDs is determined by user-installed resistors on the excitation adapters shown in Figure 1-4 on page 30. RTD configurations and calculation of the R-EXC adapter resistor values are described in Section 5. If the total RTD excitation requirement exceeds 32 mA, additional current up to 150 mA can be supplied from the strain gage excitation bus.

Strain Gage Excitation

Strain gages usually are voltage driven, and require jumpers instead of resistors on the R-EXC adapters. The adapters are configured at the factory with jumpers in all R-EXC positions.



NOTES:
1. Each adapter contains locations for eight R-EXC excitation resistors.
2. R-EXC is zero (jumpered) for strain gage operation.
3. Adapters are factory-configured for strain gage operation (R-EXC = jumper).

Figure 1-4 RTD and Strain Gage Excitation

Power Converter

Electrical power for the VMIVME-3413 Board is supplied by a DC-to-DC converter which converts the 5 V logic power input from the P1 connector into isolated ±15 VDC at 400 mA.

CHAPTER 2

Configuration and Installation

Contents

Introduction

This chapter describes the installation and configuration of the board. Cable configuration, jumper/switch configuration and board layout are illustrated in this chapter.

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

NOTE: Do not install or remove boards 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 card guides. Slide the board smoothly forward against the mating connector until firmly seated.

Before Applying Power: Checklist

Before applying power to the VMEbus chassis in which the board is installed, execute the following checklist to ensure that the board has been prepared correctly for operation.

1. The configuration instructions in *System Considerations* on page 53 have been reviewed and applied to system requirements. _____
2. All I/O cables are properly terminated for the input/output connectors. Refer to *Connector Description* on page 50 for connector descriptions. _____
3. Installation has been completed as described in *Operational Configuration* on page 35. _____
4. All system cable connections are correct. _____

Operational Configuration

VMIVME-3413 Board functions and configurations are controlled by field replaceable jumpers. This section describes the use of these jumpers and their effects on board performance. Locations and functions of all jumpers are shown in Figure 2-1 on page 36, Table 2-1 on page 37, and Table 2-2 on page 38. The jumpers are arranged numerically on the board from bottom to top and from left to right. Jumper J1 is located near the bottom of the board by the P4 connector. Subsequent jumpers (J2, ...) proceed toward the top of the board. Pin 1 of multiple-position jumpers is oriented toward the front panel.

NOTE: The factory installed jumpers set the board up for applications where the on-board thermocouple compensation is not used. For applications using the on-board thermocouple compensation, the appropriate jumpers need to be selected and the board calibrated

Factory Installed Jumpers

Each VMIVME-3413 Board is configured at the factory with the specific jumper arrangement shown in Table 2-2 on page 38. The *factory configuration* establishes the following functional baseline for the VMIVME-3413 Board, and ensures that all essential jumpers are installed.

Channel configuration:

1. Voltage gain is x100 (x1 for current-loop inputs)
2. Zero output offset (thermocouple compensation disabled)
3. Input common is internal AGND
4. Bridge completion not selected
5. Strain gage excitation selected

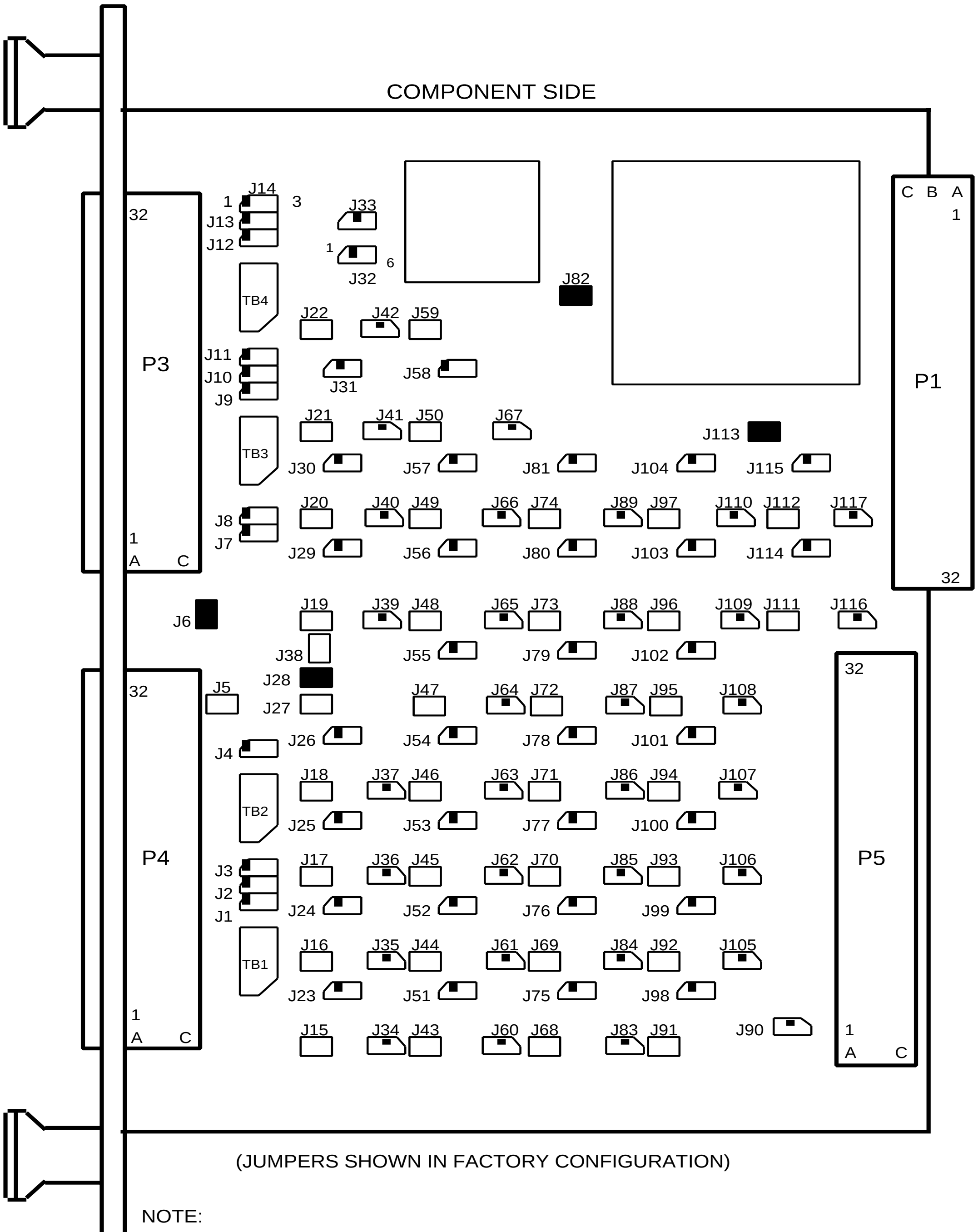
Strain Gage excitation:

1. +2.5 VDC output
2. Remote sensing disabled

Thermocouple compensation:

1. Type J thermocouple
2. Local reference sensing (P3, P4)

Auxiliary inputs (AUX 1, 2, 3, 4) connected to internal Signal Return (AGND).



NOTE:
1. The jumpers are arranged numerically on the board from bottom to top and from left to right. Jumper J1 is located near bottom of board at P4 connector. Subsequent jumpers (J2, ...) proceed toward the top of the board.

Figure 2-1 VMIVME-3413 Jumper Locations

Table 2-1 Channel Configuration Jumpers and Resistors

CH	Voltage Gain * JPRB LK	Gain Position x10	Gain Position x100	Gain Position x1,000	Output Offset * JPRB LK	Offset Position Zero **	Offset Position THMCPL	Bridge COMPL *	Excitation Resistor*
00	J23	1,2	3,4	5,6	J34	1,2	2,3	J15	TB1-1,16
01	J51	1,2	3,4	5,6	J60	1,2	2,3	J43	TB1-2,15
02	J75	1,2	3,4	5,6	J83	1,2	2,3	J68	TB1-3,14
03	J98	1,2	3,4	5,6	J90	1,2	2,3	J91	TB1-4,13
04	J24	1,2	3,4	5,6	J35	1,2	2,3	J16	TB1-5,12
05	J52	1,2	3,4	5,6	J61	1,2	2,3	J44	TB1-6,11
06	J76	1,2	3,4	5,6	J84	1,2	2,3	J69	TB1-7,10
07	J99	1,2	3,4	5,6	J105	1,2	2,3	J92	TB1-8,9
08	J25	1,2	3,4	5,6	J36	1,2	2,3	J17	TB2-1,16
09	J53	1,2	3,4	5,6	J62	1,2	2,3	J45	TB2-2,15
10	J77	1,2	3,4	5,6	J85	1,2	2,3	J70	TB2-3,14
11	J100	1,2	3,4	5,6	J106	1,2	2,3	J93	TB2-4,13
12	J26	1,2	3,4	5,6	J37	1,2	2,3	J18	TB2-5,12
13	J54	1,2	3,4	5,6	J63	1,2	2,3	J46	TB2-6,11
14	J78	1,2	3,4	5,6	J86	1,2	2,3	J71	TB2-7,10
15	J101	1,2	3,4	5,6	J107	1,2	2,3	J94	TB2-8,9
16	J55	1,2	3,4	5,6	J64	1,2	2,3	J47	TB3-1,16
17	J29	1,2	3,4	5,6	J39	1,2	2,3	J19	TB3-2,15
18	J79	1,2	3,4	5,6	J87	1,2	2,3	J72	TB3-3,14
19	J102	1,2	3,4	5,6	J108	1,2	2,3	J95	TB3-4,13
20	J56	1,2	3,4	5,6	J65	1,2	2,3	J48	TB3-5,12
21	J80	1,2	3,4	5,6	J88	1,2	2,3	J73	TB3-6,11
22	J103	1,2	3,4	5,6	J109	1,2	2,3	J96	TB4-7,10
23	J114	1,2	3,4	5,6	J116	1,2	2,3	J111	TB3-8,9
24	J30	1,2	3,4	5,6	J40	1,2	2,3	J20	TB4-1,16
25	J57	1,2	3,4	5,6	J66	1,2	2,3	J49	TB4-2,15
26	J81	1,2	3,4	5,6	J89	1,2	2,3	J74	TB4-3,14
27	J104	1,2	3,4	5,6	J110	1,2	2,3	J97	TB4-4,13
28	J115	1,2	3,4	5,6	J117	1,2	2,3	J112	TB4-5,12
29	J31	1,2	3,4	5,6	J41	1,2	2,3	J21	TB4-6,11
30	J58	1,2	3,4	5,6	J67	1,2	2,3	J50	TB4-7,10
31	J32	1,2	3,4	5,6	J42	1,2	2,3	J22	TB4-8,9

NOTES: Factory Configuration
GAIN = x100 (x1 for current-loop terminated inputs Channel Gain is x1 if jumper is omitted.
OUTPUT OFFSET = ZERO
BRIDGE COMPL = Jumper Omitted
FILTER RESISTOR = 1.5 kΩ
EXCITATION RESISTOR Jumper
**ZERO position is used for Type B thermocouples.
THMCPL position is used for all other thermocouple types.

Table 2-2 Excitation and Compensation Jumper Functions

Excitation Outputs and Input Common		
Jumper IDENT	**Function (Installed)**	**Factory CONFIG**
J1-1,2	CH00-07 Strain Excitation	Installed
J1-2,3	CH00-07 RTD Excitation	Omitted
J2-1,2	CH00-07 Common is Grounded (AGND)	Installed
J2-2,3	CH00-07 Common is Excitation Return	Omitted
J4-1,2	CH08-15 Strain Excitation	Installed
J4-2,3	CH08-15 RTD Excitation	Omitted
J3-1,2	CH08-15 Common is Grounded (AGND)	Installed
J3-2,3	CH08-15 Common is Excitation Return	Omitted
J8-1,2	CH16-23 Strain Excitation	Installed
J8-2,3	CH16-23 RTD Excitation	Omitted
J7-1,2	CH16-23 Common is Grounded (AGND)	Installed
J7-2,3	CH16-23 Common is Excitation Return	Omitted
J11-1,2	CH24-31 Strain Excitation	Installed
J11-2,3	CH24-31 RTD Excitation	Omitted
J10-1,2	CH24-31 Common is Grounded (AGND)	Installed
J10-2,3	CH24-31 Common is Excitation Return	Omitted
J12-1,2	AUX SIG 3 = Signal Return (AGND)	Installed
J12-2,3	AUX SIG 3 = Excitation POS Sense	Omitted
J13-1,2	AUX SIG 4 = Signal Return (AGND)	Installed
J13-2,3	AUX SIG 4 = Excitation NEG Sense	Omitted
J33-2,3	2.5 VDC Bridge Excitation	Installed
J33-1,2	10 VDC Bridge Excitation	Omitted
J59	10 VDC or 5 VDC Bridge Excitation	Omitted
J82	Excitation NEG Sense Disabled	Installed
J113	Excitation POS Sense Disabled	Installed

Thermocouple Compensation		
Jumper IDENT	**Function (Installed)**	**Factory CONFIG**
J6	Local (P3, P4) Reference Sensor	Installed
J9-2,3	AUX SIG 1 = Remote Sensor Excitation	Omitted
J9-1,2	AUX SIG 1 = Signal Return (AGND)	Installed
J14-1,2	AUX SIG 2 = Signal Return (AGND)	Installed
J14-2,3	AUX SIG 2 = Remote Sensor Input	Omitted
J5	Thermocouple Types K, N, T	Omitted
J27	Thermocouple Type N	Omitted
J28	Thermocouple Type J	Installed
J38	Thermocouple Types R,S	Omitted
	(Omit J5,27,28,38 for Types B and E)	

Input Gain and Voltage Range

The input voltage gain of each channel is jumper-selectable individually as x1, x10, x100, or x1,000, as shown in Table 2-1 on page 37. Unity gain (x1) is selected by removing the gain selection jumper completely. The factory configuration provides a gain of x100 for all channels.

When used with a multiplexing A / D board such as the VMIVME-3112 or VMIVME-3118, the effective full scale voltage range is the range of the A / D board divided by the gain of the VMIVME-3413 Board.

NOTE: Effective Input Range = A / D Board Range ÷ VMIVME-3413 Gain.

For example, a voltage gain of x100 produces an effective input voltage range of ±100 mV with an A / D board range of ±10 V.

Output Offset

The Output Offset jumper listed in Table 2-1 on page 37 is placed in the factory configured ZERO position for all channels except those with thermocouple inputs of types E, J, K, N, R, S, or T. For these thermocouples, the jumper is placed in the THERMCPL position. The ZERO position is used for Type B thermocouples.

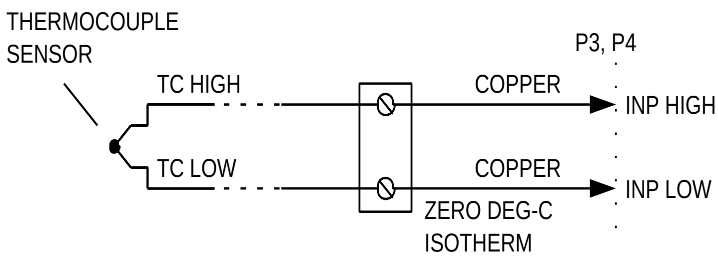
Thermocouple Inputs

Thermocouples which have external reference (cold) junction compensation do not require compensation on the VMIVME-3413 Board, and can be treated like any low-level input device (Figure 2-2 on page 40 (a)). The Output Offset jumper is placed in the ZERO position for externally compensated thermocouple inputs.

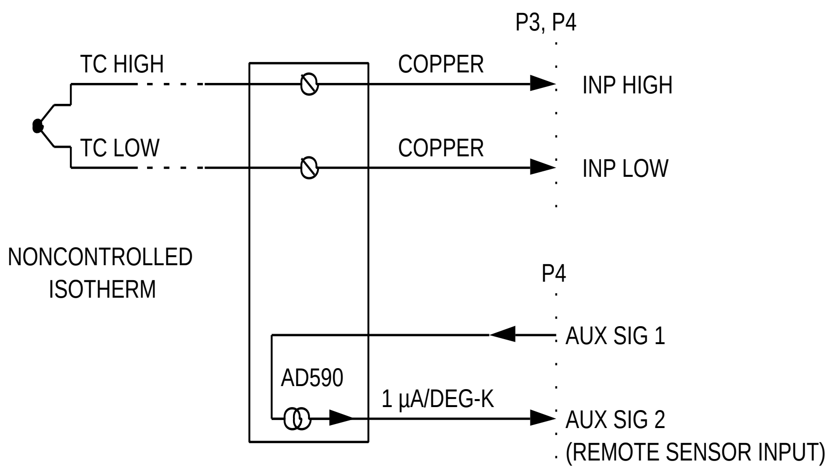
On-board reference junction compensation is available for thermocouple types E, J, K, N, R, S, or T. Type B thermocouples do not require compensation for the range of reference junction temperatures encountered in the VMEbus environment. Compensation is selected for each channel by placing the associated Output Offset jumper in the THERMCPL position.

Thermocouple channels which use the on-board compensation operate with a voltage gain of x100, and share the same compensation network. Although a single compensation response is selected for all thermocouple channels, certain responses apply for more than one thermocouple type. Reference junction compensation is selected with jumpers J5, J27, J28, and J38, as shown in Table 2-2 on page 38.

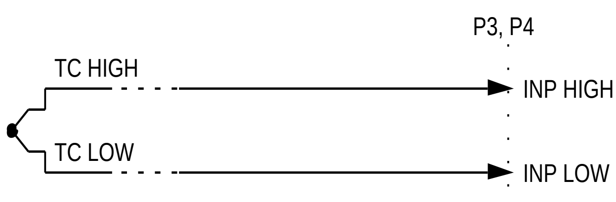
For systems in which thermocouples are terminated at a remote location, the temperature of the termination block can be conveyed to the VMIVME-3413 Board through the AUX SIG 2 pin in the P4 connector, as shown in Figure 2-2 on page 40 (b). The temperature signal from a remote sensor must be scaled as +1 microamp per degree Kelvin, and can be generated with an AD590 or equivalent temperature sensor. Excitation for the remote sensor is available at the AUX SIG 1 pin in the P4 connector.



a. Externally Compensated Thermocouple



b. Internally Compensated Thermocouple with Remote Sensor



c. Internally Compensated Thermocouple with Local Sensor

Figure 2-2 Thermocouple Connections

RTD Inputs

Excitation for Resistance Temperature Detectors (RTDs) is implemented by connecting the RTD as shown in Figure 2-3 on page 42, and by:

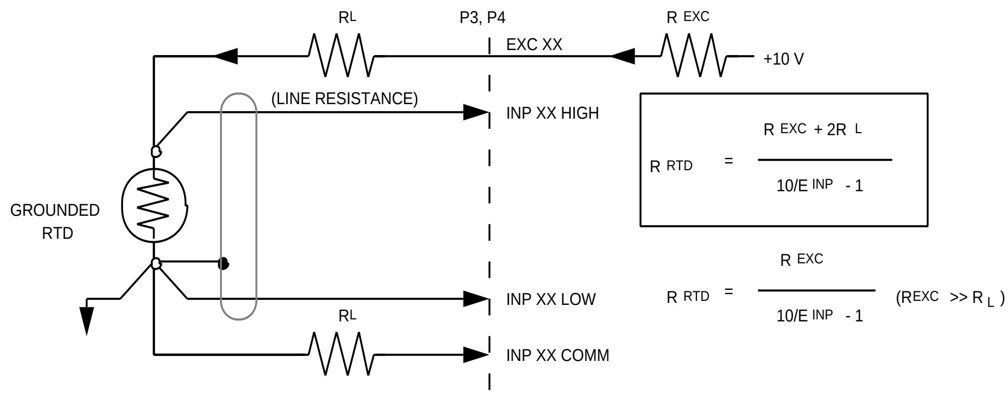
1. Installing the correct value of R_{EXC} excitation resistor, as shown in Figure 2-3 on page 42 and Table 2-1 on page 37
2. Configuring the associated jumpers J1,2,3,4,7,8,10,11, as shown in Table 2-2 on page 38

For example, if a 100 Ω platinum RTD is assigned as the input device for Channel 05, and requires an excitation current of 0.400 mA:

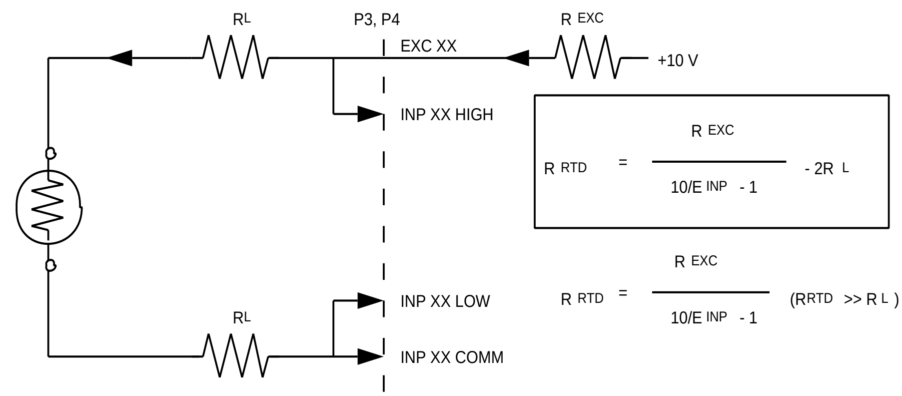
1. Connect the RTD to the Channel 05 inputs as shown in Figure 2-3 on page 42 (a).
2. Install jumpers J1-2,3 (RTD excitation) and J2-2,3 (Excitation return), as shown in Table 2-2 on page 38.
3. Calculate the excitation resistor R_{EXC} as (assume zero line resistance): R_{EXC} = (10.0 Volts ÷ 0.0004 Amps) - 100 Ohms = 24.9 KΩ.
4. Install R_{EXC} between pins 6 and 11 of TB1 (Table 2-1 on page 37)
5. Select the channel gain that produces the highest channel output without exceeding full scale over the expected measurement temperature range. (A 100 Ω platinum RTD with 0.4 mA excitation current will have a sensitivity of approximately 154 µV / °C at 0 °C, and a total output of over 120 mV at 600 °C.)

Very large resistance ranges or very long lines may require additional compensation for these effects in order to achieve maximum accuracy. For precise measurement of the RTD resistance (R_{RTD}), use the appropriate equations in Figure 2-3 on page 42.

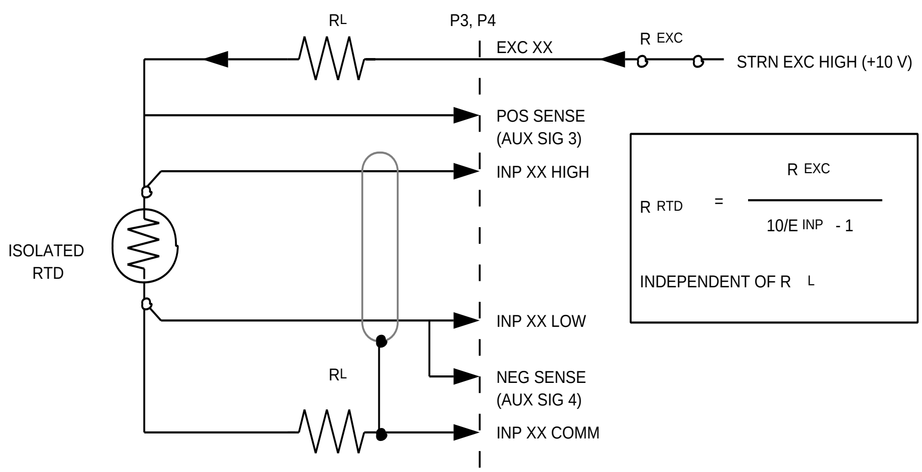
RTDs normally use low excitation currents of less than 1 mA, to avoid self-heating errors. However, very low resistance RTDs, such as those composed of copper wire, may require more current than can be supplied from the +10 VDC RTD excitation bus. If the total RTD excitation requirement exceeds 32 mA, additional current up to 150 mA can be supplied from the strain gage excitation bus as shown in Figure 2-3 on page 42 (c).



a. Four-Wire RTD Connection (Preferred Approach)



b. Two-Wire RTD Connection



c. Four-Wire RTD Connection with Remote Excitation Resistor

Figure 2-3 RTD Configuration

Strain Gage Characteristics

Strain gages respond accurately and repeatably to very small changes in surface dimensions, and consequently are used extensively in sensors which produce these changes, such as transducers for force, pressure, and torque. The response of a strain gage is affected by a number of external factors, including orientation, temperature, and the relative expansion coefficients of the gage and the surface to which it is attached. However, for a properly installed strain gage these effects are minimal and the response (E_G) is equal to:

$E_G = E_{EXC}$ x STRAIN x GAGE FACTOR x NUMBER OF ACTIVE ARMS ÷ 2

where:E_{EXC} = Excitation Voltage

STRAIN = Elongation Factor (Elongation ÷ Length)

GAGE FACTOR = Geometric Factor, usually 2.0

NUMBER OF ACTIVE ARMS = 1, 2, 3, or 4

Commercially available strain gages generally are specified more simply by combining the gage factor and number of active arms into a single "gage sensitivity" parameter:

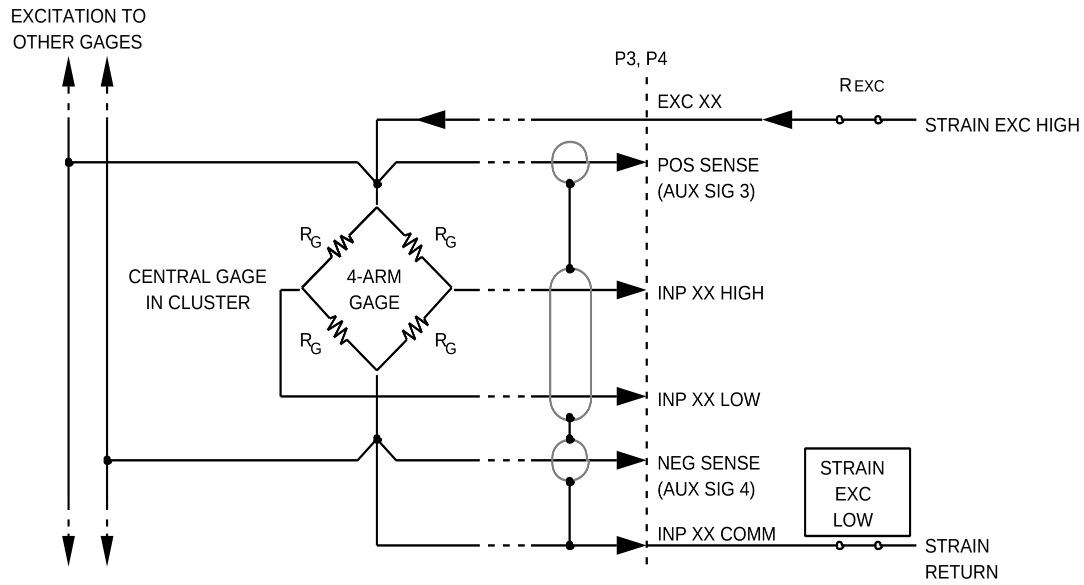
$E_G = E_{EXC}$ x STRAIN x GAGE SENSITIVITY

Typical full scale values for strain vary from 0.001 to 0.002 (1,000 to 2,000 1microstrain), while gage sensitivity usually is between 1 and 4 for conventional gages. So the full scale output level is typically between 0.001 and 0.008 times the excitation voltage, or from 10 to 80 mV with 10 VDC excitation. High output semiconductor gages can produce greater output voltages, but generally are considered to be less accurate and less reliable than conventional gages.

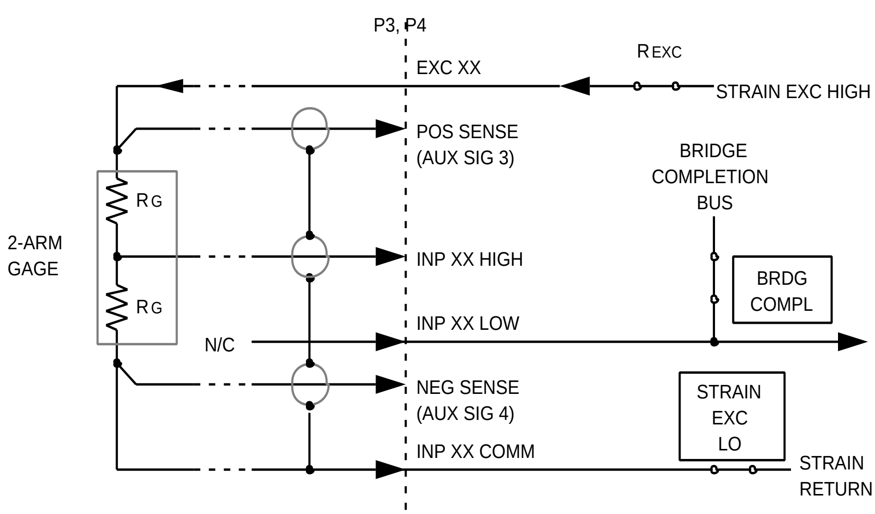
Strain Channel Inputs

Strain gage channels typically are operated with a voltage gain of x100, to produce a full scale output range from ±1 to ±10 V. The output of a four-arm gage can be connected directly to the differential input of a channel, as shown in Figure 2-4 on page 44 (a). Two-arm (half bridge) gages, however, have only a single output and the full bridge must be "completed" with another half bridge.

A half bridge is simulated on the VMIVME-3413 Board by dividing the excitation voltage precisely in half and by providing a jumper to connect this "bridge completion" bus to the inverting input of any or all channels (Figure 2-4 on page 44 (b)). Inverting inputs of channels which use the bridge completion jumpers must be left disconnected.



a. Four-Arm Strain Gage Bridge with Remote Excitation Sensing



b. Two-Arm Strain Gage with Remote Excitation Sensing

Figure 2-4 Strain Gage Configurations

Strain Bridge Excitation

The internal excitation supply can provide up to 150 mA of excitation for strain gages (or for RTDs), at 2.5, 5.0, or 10.0 VDC. Jumpers are installed in the R_{EXC} excitation resistor positions for channels which use strain gage excitation. Remote sensing permits strain gages to be "clustered" remotely without introducing errors due to line losses. Positive and negative sensing connections are provided through the AUX SIG 3 and AUX SIG 4 pins in the P4 connector, as shown in Figure 2-4 on page 44 (a).

Conventional strain gages can vary in resistance from a few ohms to several Kohms, but more common values are 120, 240, 350, and 700 Ω. The internal excitation supply has a load capacity of 150 mA, and is not intended to provide excitation for strain gages on all channels, which could require several amperes of excitation current. High current strain gage excitation should be provided by an external precision power supply.

Single-Ended Inputs

Single-ended operation is obtained by connecting the INP XX LOW input pin of each single-ended channel to the associated INP XX COMM pin. The input signal then is connected to the INP XX HIGH input pin.

Current Loop Termination

Current loop terminators are available as an ordering option for all 32 channels. The current loop option provides a 250 Ω, 0.01 percent, 1/4 W precision resistor at the input of each current loop channel, and omits the input filter. Total input resistance is 294 Ω, but only the voltage developed across the precision resistor appears at the input of the instrumentation amplifier.

Current loop channels have high-level inputs, and should be configured with a voltage gain of x1. Maximum continuous input current should not exceed ±40 mA, which will develop an input voltage of ±10 V. The current input mode will function in both the differential and single-ended modes. If the differential input mode is used, care must be exercised to ensure that neither input pin exceeds the specified signal range of ±11 V relative to the common input pin.

Calibration

Upon delivery from the factory, the VMIVME-3413 Board is fully calibrated. The factory calibration is done for applications not using the on-board thermocouple compensation. If the application calls for using the thermocouple compensation, the board must be recalibrated. Should recalibration be required, refer to the sections, and perform the indicated procedures in the order shown. The locations of test points and adjustments are shown in Figure 2-5 on page 47.

Equipment Required

a.	Digital Voltmeter (DVM)	100 mVDC to 10.000 VDC ranges; 5 or more digits; ±0.004 percent of reading measurement accuracy; 10 MΩ minimum input impedance.
b.	Digital Voltage Source	100 mVDC to 10.000 VDC ranges; ±0.004 percent setting resolution and accuracy. 10 Ω maximum source resistance.
c.	Chassis	VMEbus backplane or equivalent, with J1 connector, +5 ±0.1 VDC, 5 A power supply. One slot allocated for testing the VMIVME-3413 Board.
d.	Precision Resistor	20.000 kΩ, 0.01 percent, 1/4 W.
e.	Extender Board	VMEbus extender board; test leads.

NOTE: Do not install or remove this board with power applied to the system.

Excitation Supply Calibration

1. Connect the DVM between TP5 (+) and TP6 (-). Adjust R52 for a DVM indication of +10.000 ±0.002 VDC.
2. Install jumpers for J59, J82, J113 and J33-1,2. Connect the DVM between TP4 (+) and TP3 (-).
3. Adjust R31 for a DVM indication of +10.000 ±0.002 VDC.
4. Restore jumpers J59, J82, J113, and J33-1,2 to their original or factory positions.

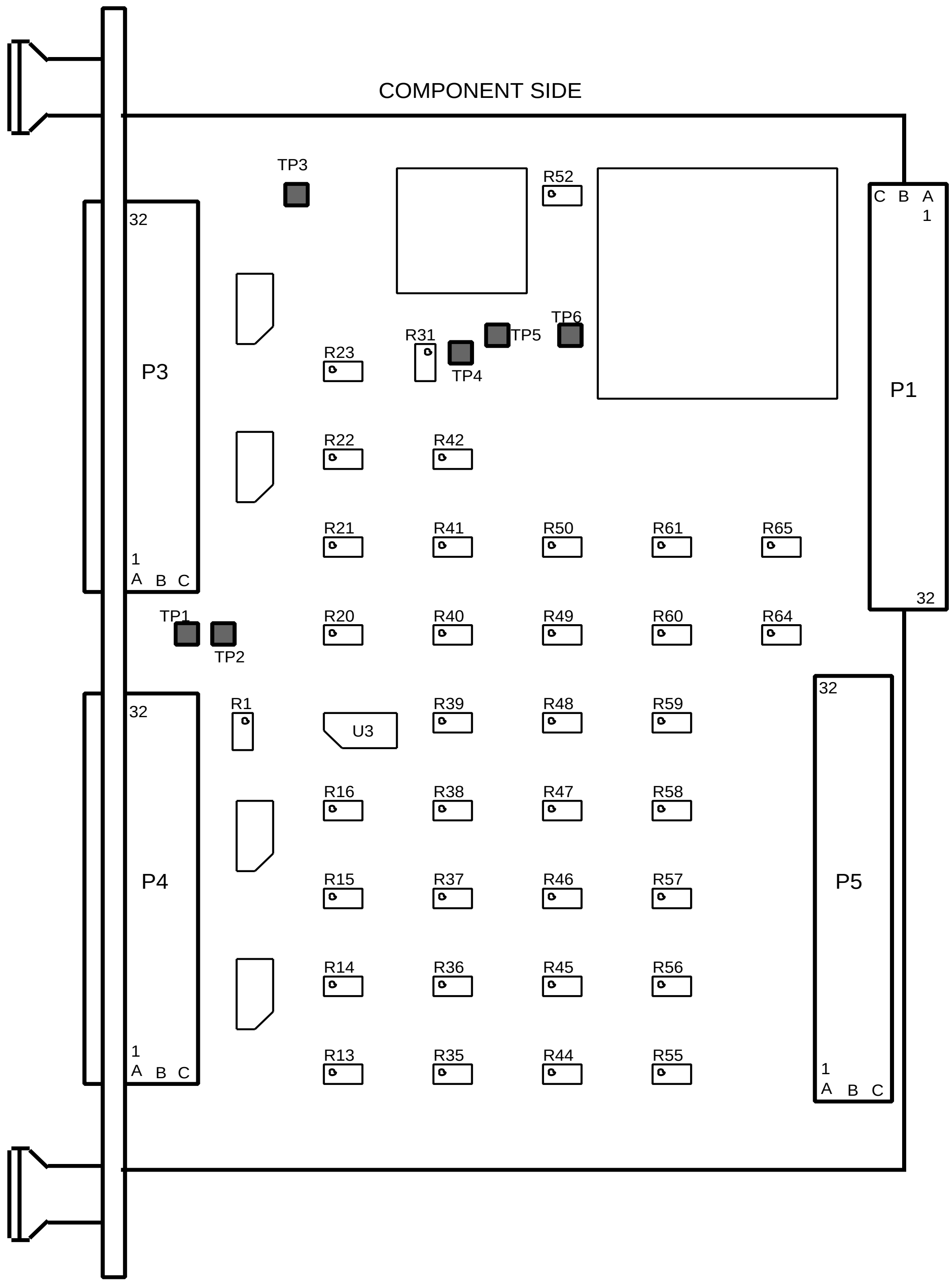


Figure 2-5 Locations of Test Points and Adjustments

Thermocouple Reference Calibration

1. a.Remove the jumpers from J5, J6, J14, J27, J28, and J38.
2. Connect the negative test lead of the digital voltage source to TP6. Connect the 20.000 kΩ 0.01 percent precision resistor between TP1 and the positive test lead of the digital voltage source.
3. Adjust the voltage source output to +5.463 VDC.
4. Connect the DVM between Pin 6 of U3 (+) and TP6 (-).
5. Adjust R1 for a DVM indication of 0.00 ±0.20 mVDC.
6. Restore jumpers J5, J6, J14, J27, J28, and J38 to their original or factory positions.

Channel Calibration

1. Install all program jumpers to conform to the application configuration. If the application configuration has not been defined or is not available, restore all program jumpers to the factory configuration, as shown in Table 2-2 on page 38.
2. Install the VMIVME-3413 board on an extender board in the VMEbus chassis.
3. Apply power to the chassis backplane. Allow a minimum warmup interval of ten minutes before proceeding.
4. Connect all input INP XX HIGH, INP XX LOW and INP XX COMM pins together at P3 and P4. Refer to Table 2-3 on page 49 for the pin assignments for these inputs.

NOTE: If the application includes thermocouple channels, these channels can be calibrated in the application configuration by substituting an "icepoint" thermocouple input signal for the shorted inputs. Channels calibrated in this manner must have the associated Output Offset jumpers in the THERMCPL position.

5. Connect the digital voltmeter between to the Channel 00 output pins at P5-A1(+) and P5-C1(-).
6. Adjust the Channel 00 adjustment potentiometer R13 for a DVM indication of 0.000 ±0.001 VDC.
7. Repeat Steps *5* and *6* for the remaining 31 channels. Refer to Table 2-3 on page 49 for the associated output pins and adjustment potentiometers.

Table 2-3 Channel Calibration Table

	INPUT PINS			OUTPUT PINS	ADJUSTMENT
CHANNEL XX	INP XX HIGH	INP XX LOW	INP XX COMM	OUT XX HIGH *	POTENTIOMETER
00	P4-A1	P4-C1	P4-C2	P5-A1	R13
01	P4-A3	P4-C3	P4-C4	P5-A2	R35
02	P4-A5	P4-C5	P4-C6	P5-A3	R44
03	P4-A7	P4-C7	P4-C8	P5-A4	R55
04	P4-A9	P4-C9	P4-C10	P5-A5	R14
05	P4-A11	P4-C11	P4-C12	P5-A6	R36
06	P4-A13	P4-C13	P4-C14	P5-A7	R45
07	P4-A15	P4-C15	P4-C16	P5-A8	R56
08	P4-A17	P4-C17	P4-C18	P5-A9	R15
09	P4-A19	P4-C19	P4-C20	P5-A10	R37
10	P4-A21	P4-C21	P4-C22	P5-A11	R46
11	P4-A23	P4-C23	P4-C24	P5-A12	R57
12	P4-A25	P4-C25	P4-C26	P5-A13	R16
13	P4-A27	P4-C27	P4-C28	P5-A14	R38
14	P4-A29	P4-C29	P4-C30	P5-A15	R47
15	P4-A31	P4-C31	P4-C32	P5-A16	R58
16	P3-A1	P3-C1	P3-C2	P5-A17	R39
17	P3-A3	P3-C3	P3-C4	P5-A18	R20
18	P3-A5	P3-C5	P3-C6	P5-A19	R48
19	P3-A7	P3-C7	P3-C8	P5-A20	R59
20	P3-A9	P3-C9	P3-C10	P5-A21	R40
21	P3-A11	P3-C11	P3-C12	P5-A22	R49
22	P3-A13	P3-C13	P3-C14	P5-A23	R60
23	P3-A15	P3-C15	P3-C16	P5-A24	R64
24	P3-A17	P3-C17	P3-C18	P5-A25	R21
25	P3-A19	P3-C19	P3-C20	P5-A26	R41
26	P3-A21	P3-C21	P3-C22	P5-A27	R50
27	P3-A23	P3-C23	P3-C24	P5-A28	R61
28	P3-A25	P3-C25	P3-C26	P5-A29	R65
29	P3-A27	P3-C27	P3-C28	P5-A30	R22
30	P3-A29	P3-C29	P3-C30	P5-A31	R42
31	P3-A31	P3-C31	P3-C32	P5-A32	R23

NOTE: * Use P5-C1 as the return (-) for output measurements.

Connector Description

Electrical connections to the VMIVME-3413 Board are made through four DIN connectors P1, P3, P4, and P5, which have the pin configurations shown in Figure 2-6 on page 51. Connector locations are shown in Figure 2-5 on page 47.

P1 is a 96-pin connector which supplies +5 VDC power to the board from the VME backplane and which provides mechanical support for the rear of the board. No other VME backplane functions are implemented and the conventional P2 connector is omitted.

NOTE: Common mode problems can be avoided by providing a *system ground* connected to analog ground (AGND) at the chassis, which interconnects all remote isolated grounds or commons. The system ground should not be used as a power return. A separate system ground connection is recommended for each VMIVME-3413 Board.

Analog Inputs

Analog inputs are connected to the board through front panel connectors P3 and P4. P4 contains the input pins for Channels 00 to 15, and P3 contains the input pins for Channels 16 to 31. Pin assignments for P3 and P4 are summarized in Table 2-4 on page 52. Refer to *Operational Configuration* on page 35 for the selection of input configurations.

P3 and P4 accept either mass terminated ribbon cable connectors or discrete-wire cable connectors. If ribbon cables are used, "VARITWIST" or equivalent twisted pair cables are recommended to minimize crosstalk and induced noise. Discrete wire cables should provide a twisted shielded wire pair for each channel input.

Analog Outputs

P5 is a 64-pin connector which provides single-ended analog outputs for all 32 channels, and which is pin-compatible with the input connectors for the VMIVME-3112/3118 scanning A/D converter boards. The ribbon cable from P5 can be routed past the front panel or, if no J2 backplane is present, to the rear of the chassis.

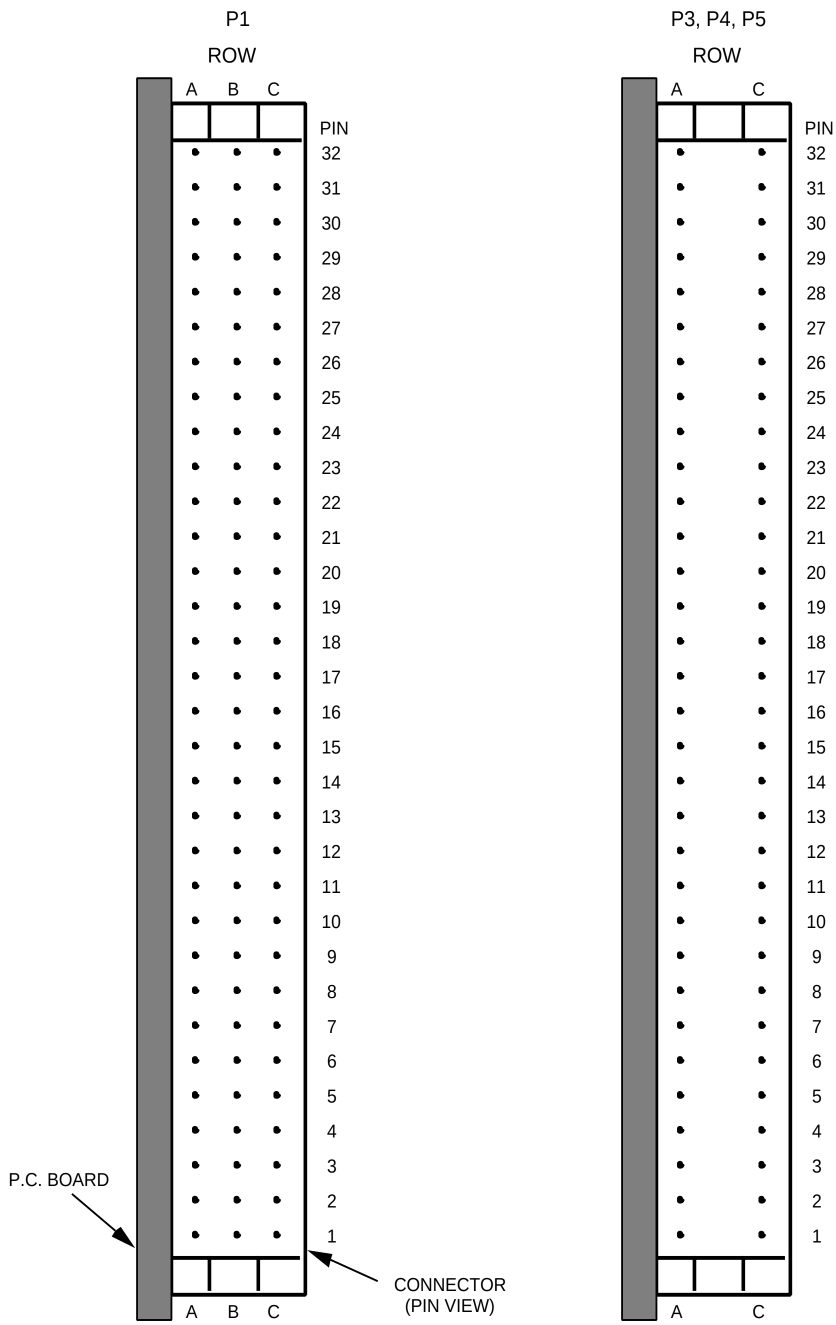


Figure 2-6 Connector Pin Configuration

Table 2-4 Input/Output Connector Pin Assignments

	P3,P4 Input Pins				P5 Output Pins	
Channel XX	**INP XX High**	**INP XX Low**	**Excitation**	**INP XX COMM**	**OUT XX High**	**OUT XX Low**
00	P4-A1	P4-C1	P4-A2	P4-C2	P5-A1	P5-C1
01	P4-A3	P4-C3	P4-A4	P4-C4	P5-A2	P5-C2
02	P4-A5	P4-C5	P4-A6	P4-C6	P5-A3	P5-C3
03	P4-A7	P4-C7	P4-A8	P4-C8	P5-A4	P5-C4
04	P4-A9	P4-C9	P4-A10	P4-C10	P5-A5	P5-C5
05	P4-A11	P4-C11	P4-A12	P4-C12	P5-A6	P5-C6
06	P4-A13	P4-C13	P4-A14	P4-C14	P5-A7	P5-C7
07	P4-A15	P4-C15	P4-A16	P4-C16	P5-A8	P5-C8
08	P4-A17	P4-C17	P4-A18	P4-C18	P5-A9	P5-C9
09	P4-A19	P4-C19	P4-A20	P4-C20	P5-A10	P5-C10
10	P4-A21	P4-C21	P4-A22	P4-C22	P5-A11	P5-C11
11	P4-A23	P4-C23	P4-A24	P4-C24	P5-A12	P5-C12
12	P4-A25	P4-C25	P4-A26	P4-C26(1)	P5-A13	P5-C13
13	P4-A27	P4-C27	P4-A28	P4-C28(2)	P5-A14	P5-C14
14	P4-A29	P4-C29	P4-A30	P4-C30(3)	P5-A15	P5-C15
15	P4-A31	P4-C31	P4-A32	P4-C32(4)	P5-A16	P5-C16
16	P3-A1	P3-C1	P3-A2	P3-C2	P5-A17	P5-C17
17	P3-A3	P3-C3	P3-A4	P3-C4	P5-A18	P5-C18
18	P3-A5	P3-C5	P3-A6	P3-C6	P5-A19	P5-C19
19	P3-A7	P3-C7	P3-A8	P3-C8	P5-A20	P5-C20
20	P3-A9	P3-C9	P3-A10	P3-C10	P5-A21	P5-C21
21	P3-A11	P3-C11	P3-A12	P3-C12	P5-A22	P5-C22
22	P3-A13	P3-C13	P3-A14	P3-C14	P5-A23	P5-C23
23	P3-A15	P3-C15	P3-A16	P3-C16	P5-A24	P5-C24
24	P3-A17	P3-C17	P3-A18	P3-C18	P5-A25	P5-C25
25	P3-A19	P3-C19	P3-A20	P3-C20	P5-A26	P5-C26
26	P3-A21	P3-C21	P3-A22	P3-C22	P5-A27	P5-C27
27	P3-A23	P3-C23	P3-A24	P3-C24	P5-A28	P5-C28
28	P3-A25	P3-C25	P3-A26	P3-C26	P5-A29	P5-C29
29	P3-A27	P3-C27	P3-A28	P3-C28	P5-A30	P5-C30
30	P3-A29	P3-C29	P3-A30	P3-C30	P5-A31	P5-C31
31	P3-A31	P3-C31	P3-A32	P3-C32	P5-A32	P5-C32

NOTES: 1. AUX SIG 1 or CJC Sensor Excitation.
2. AUX SIG 2 or CJC Sensor Input.
3. AUX SIG 3 or Strain Gage Excitation Positive Sense.
4. AUX SIG 4 or Strain Gage Excitation Negative Sense.

System Considerations

Applications with Scanning A/D Boards

A single 64-Channel VMIVME-3112 or VMIVME-3118 Scanning A/D Board can accommodate the outputs from two VMIVME-3413 Boards. In this configuration, each of the two 32-channel input connectors (P3,P4) on the A/D board is connected to the P5 output connector from one of the two VMIVME-3413 Boards. The A/D board is operated in either the pseudo-differential mode or single-ended mode, and usually is configured for minimum (x1) gain.

Low Level Applications

If inputs are obtained directly from low level remote sources, the grounding scheme can have a major effect on system performance. Each system has its own unique interference considerations, but the following general guidelines will apply in most cases.

1. **System Grounds:** Differential inputs are relatively immune to offset potentials between the various components of a system, but are only effective within a specific common mode range, usually ±11 V from their respective analog commons or grounds. If an input line exceeds this range, the corresponding channel will respond unpredictably.

2. **Long Input lines:** Long input lines (greater than 10 feet), or inputs from grounded sources (sources which are not floating), should be connected to *differential inputs*, and overall shields should be extended from the input sources to a point that is as close to the board as possible. *Single-ended inputs* are susceptible to ground loop errors, and should be used only with high level floating sources.

3. **Floating and Grounded Signal Sources:** The shield from a *floating signal source* (RTD, strain gage, etc.) should be connected to the LOW (negative) terminal at the source. For low impedance sources (less than 10 Ω), or for sources which are protected from interference fields, connect the board-end of the shield to analog return (AGND). For high impedance sources, connect all shield terminals of the sources together, and leave the shields disconnected at the board.

   Outputs of *grounded sources* (sources which are not floating) must be referenced to a common ground which ensures that the input voltage will not exceed the active input voltage range of the board. Shields from grounded sources should be connected to the LOW terminal of the sources, and should be left disconnected at the board.

4. **Source Impedance:** Use signal sources with the lowest available source impedances. Susceptibility to crosstalk and other interference increases as the source impedance increases.

5. **Unused Inputs:** The grounding of unused inputs is not essential, but can assist in minimizing susceptibility to system noise.

CHAPTER

3

Programming

Introduction

The VMIVME-3413 Board has no control interface with the VMEbus, and has no associated programming operations or functions. For operation in conjunction with the VMIVME-3112 or VMIVME-3118 which are Scanning Analog Input Boards, refer to the associated product manual for that board.

Maintenance

Maintenance

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

- System power
- 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**.

Contact VMIC Customer Service at 1-800-240-7782, or
E-mail: customer.service@vmic.com

Maintenance Prints

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