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VMIVME-3101A

12-bit HIGH-SPEED ANALOG-TO-DIGITAL CONVERTER BOARD WITH 32 SINGLE-ENDED OR 16 DIFFERENTIAL CHANNELS

INSTRUCTION MANUAL

DOCUMENT NO. 500-103101-000

Revised July 29, 1992

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RECORD OF REVISIONS

REVISION LETTER	DATE	PAGES INVOLVED	CHANGE NUMBER
A	10/30/91	Release per ECO	91-0285
B	03/17/92	Cover, page ii, and Appendix A	92-0010
C	03/17/92	Cover, page ii, and Appendix A	92-0064
D	07/29/92	Cover, pages ii, v, vii, viii, 3-12, 5-8, 5-10, Sections 2, 6, and Appendix A	92-0271

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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.

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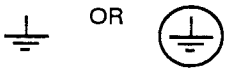
GENERAL DEFINITIONS OF SAFETY SYMBOLS USED IN THIS MANUAL



Instruction manual symbol: the product is marked with this symbol when it is necessary for the user to refer to the instruction manual in order to protect against damage to the system.



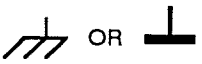
Indicates dangerous voltage (terminals fed from the interior by voltage exceeding 1000 volts are so marked).



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.



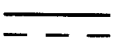
Low-noise or noiseless, clean ground (earth) terminal. Used for a signal common, as well as providing protection against electrical shock in case of a fault. Before operating the equipment, terminal marked with this symbol must be connected to ground in the manner described in the installation (operation)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

WARNING

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

CAUTION

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

NOTE:

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VMIVME-3101A

12-bit HIGH-SPEED ANALOG-TO-DIGITAL CONVERTER BOARD WITH 32 SINGLE-ENDED OR 16 DIFFERENTIAL CHANNELS

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A Assembly Drawing, Parts List, and Schematic

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SECTION 1

GENERAL DESCRIPTION

1.1 INTRODUCTION

The 3101A A/D Converter Board (VMIVME-3101A) provides high performance 12-bit digitizing of analog signals in VMEbus applications. In addition to accepting 32 single-ended or 16 differential analog inputs through a front panel connector, the VMIVME-3101A Board is compatible with the VMIC backplane analog multiplexer bus (AMXbus™). Offering optional capabilities such as built-in-test, autocalibration and precision voltage standards, the VMIVME-3101A simplifies the design of any system which requires high-speed analog measurements.

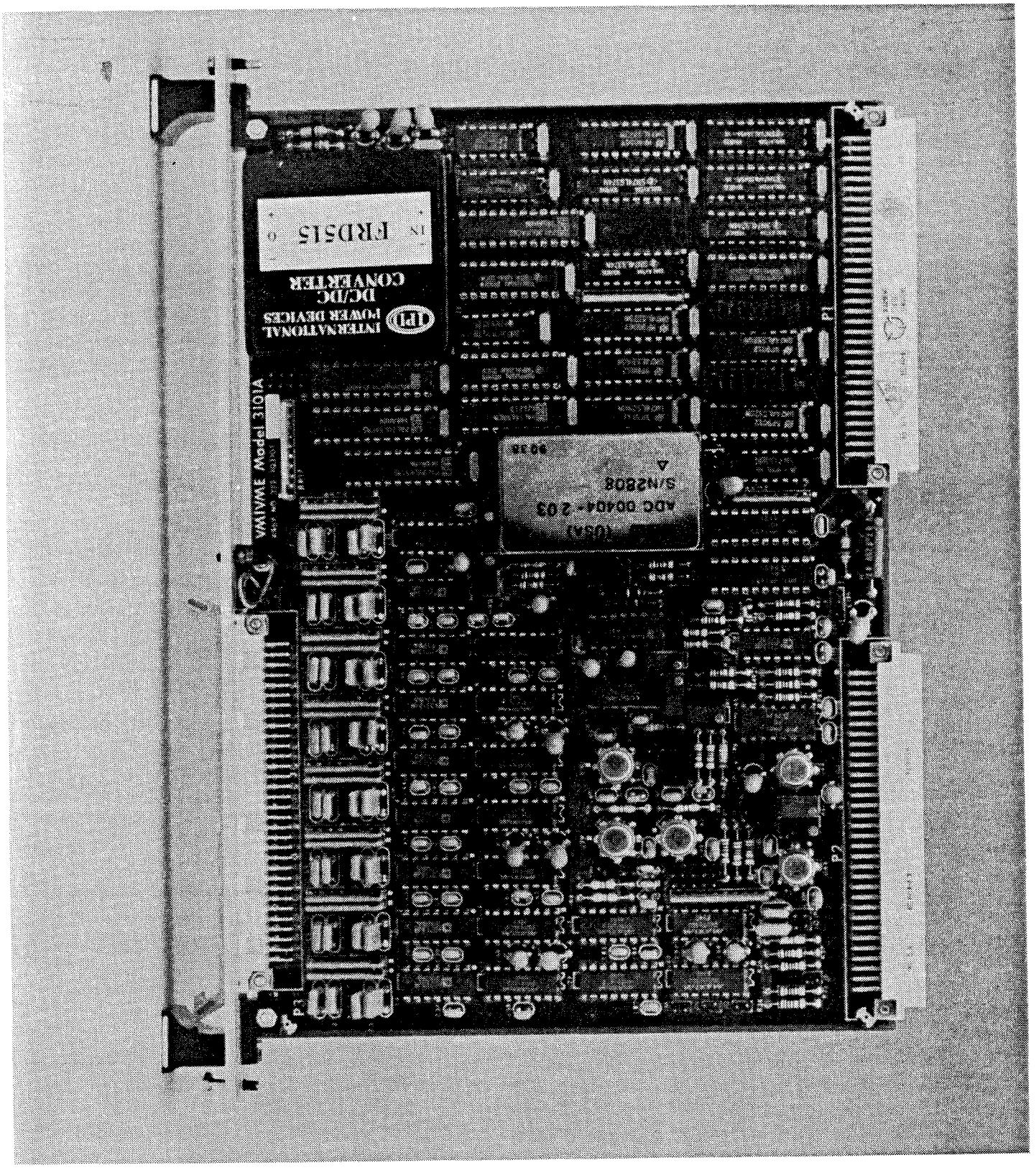
A brief overview of principal features illustrates the flexibility and performance available with the VMIVME-3101A Board:

a. 12-bit analog-to-digital conversion with sample-and-hold
b. 32 Single-ended (pseudo-differential) or 16 differential inputs
c. Full-scale input ranges are jumper selectable and offered in either 3 voltage ranges: 0 to +10 , ±5, ±10 V, or 5 voltage ranges: 0 to +5 V, 0 to +10, ±2.5, ±5 V, ±10 V
d. AMXbus™ input for testing VMIC analog output boards
e. AMXbus™ input for cost-effective expansion to 1,056 channels
f. Optional on-board precision voltage standards for Built-in-Test
g. Autocalibration option controls offset and gain errors to 1 LSB
h. On-board sequencer permits interleaved operation (acquisition of next channel during conversion); offers maximum throughput
i. External trigger input for synchronous measurement
j. Overvoltage protected inputs
k. Fail-safe with power off
l. Front panel Fail indicator
m. 3 µs conversion time
n. 8 µs acquisition time (shorter acquisition time is software selectable for maximum throughput)
o. Double Eurocard form factor

1.2 FUNCTIONAL DESCRIPTION

The VMIVME-3101A Board (Figure 1.2-1) is a member of the VMIC family of analog input boards, which is designed to support the VMIC analog multiplexer bus (AMXbus™). The AMXbus™ (Figure 1.2-2) enables various analog boards to be interconnected through the backplane, and allows the VMIVME-3101A to support as many as 16 Multiplexer Boards for high-density analog input expansion.

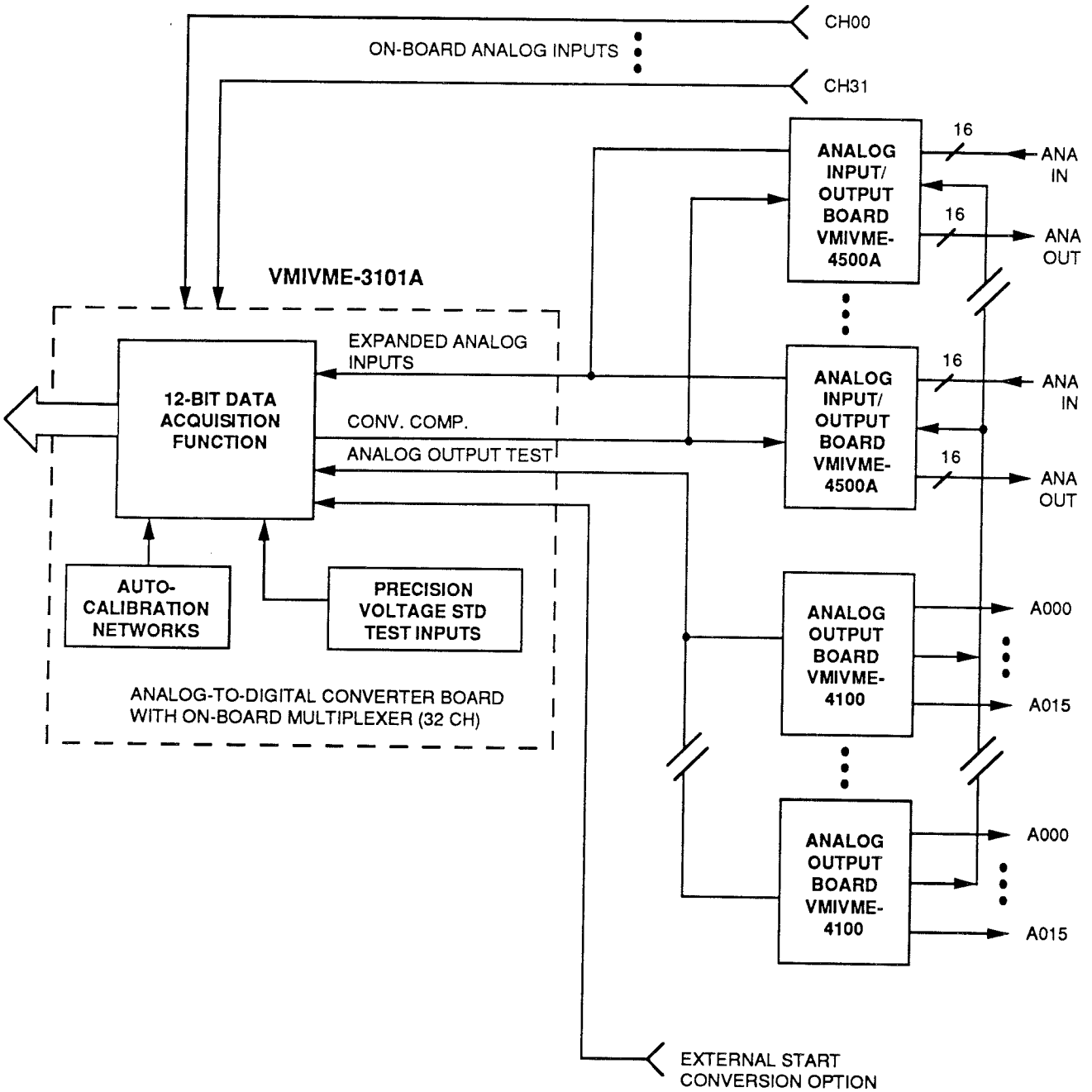
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M3101A/F1.2-1

Figure 1.2-1. VMIVME-3101A A/D Converter Board

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M3101A/F1.2-2

Figure 1.2-2. Functional Block Diagram of System Interconnect Scheme, Showing One VMIVME-3101A Board at Left, and Other AMXbus™ Compatible Boards at Right (VMIVME-4500A and VMIVME-4100)

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Front panel analog input filters are individually jumper-selectable either as single-ended pseudo-differential channels, or as differential-pair channels, and any odd-even pair can be configured independently of all other pairs. All front panel inputs are monitored for real-time verification of all active components.

Interleaved operation is available as a standard feature and, in high throughput applications, permits the acquisition settling time of each channel to begin while the conversion (digitizing) of the preceding channel is still in progress. This analog "pipelining" provides the highest possible throughput, or sample rate, without degrading accuracy.

For applications which require maximum accuracy, the Autocalibration Option places the adjustment of both gain and offset under software control. This option enables the VMIVME-3101A Board to be calibrated at any time, using highly stable on-board precision voltage standards.

1.3 REFERENCE MATERIAL LIST

The reader should refer to "The VMEbus Specification" for a detailed explanation of the VMEbus. "The VMEbus Specification" is available from the following source:

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 based in 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

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Refer to the following VMIC documents for a thorough description of the AMXbus™ built-in-test capabilities and subsystem configurations:

MODEL NO. (VMIVME-)	TITLE	VMIC DOCUMENT NO.
3100	16-Channel 12-Bit A/D Converter Board	500-003100-000
3200A	32-Channel Analog Input Multiplexer Board	500-000117-000
3210	64-Channel Analog Input Multiplexer	500-003210-000
4500A	16-Channel Analog I/O 12-Bit D/A (S&H) Outputs (16 Channels) Input Multiplexer (16 Channels)	500-000115-000
4100	16-Channel 12-Bit D/A Converter Board	500-004100-000
4116	8-Channel 16-Bit D/A Converter Board	500-004116-000
4105	8-Channel 12-Bit Multiplying D/A Converter Board	500-004105-000

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SECTION 2

PHYSICAL DESCRIPTION AND SPECIFICATIONS

REFER TO 800-103101-000 SPECIFICATION

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SECTION 3

THEORY OF OPERATION

3.1 INTRODUCTION

The VMIVME-3101A A/D Converter Board is designed with a 12-bit ADC and a 32-channel multiplexer which operates on the standard VMEbus. Representing a flexible system I/O element, the VMIVME-3101A provides built-in-test and calibration features not found in many other products. Compatibility with the VMIC analog expansion multiplexer bus (AMXbus™) enables the resident 32-channel multiplexer to be expanded to more than 1,000 analog input channels, by including VMIC expansion multiplexer boards such as the VMIVME-3210.

3.2 INTERNAL FUNCTIONAL ORGANIZATION

The VMIVME-3101A Board is divided into the following functional categories, as illustrated in the functional block diagram, Figure 3.2-1. Each category and its relationship to the other categories will be discussed throughout the remainder of this section.

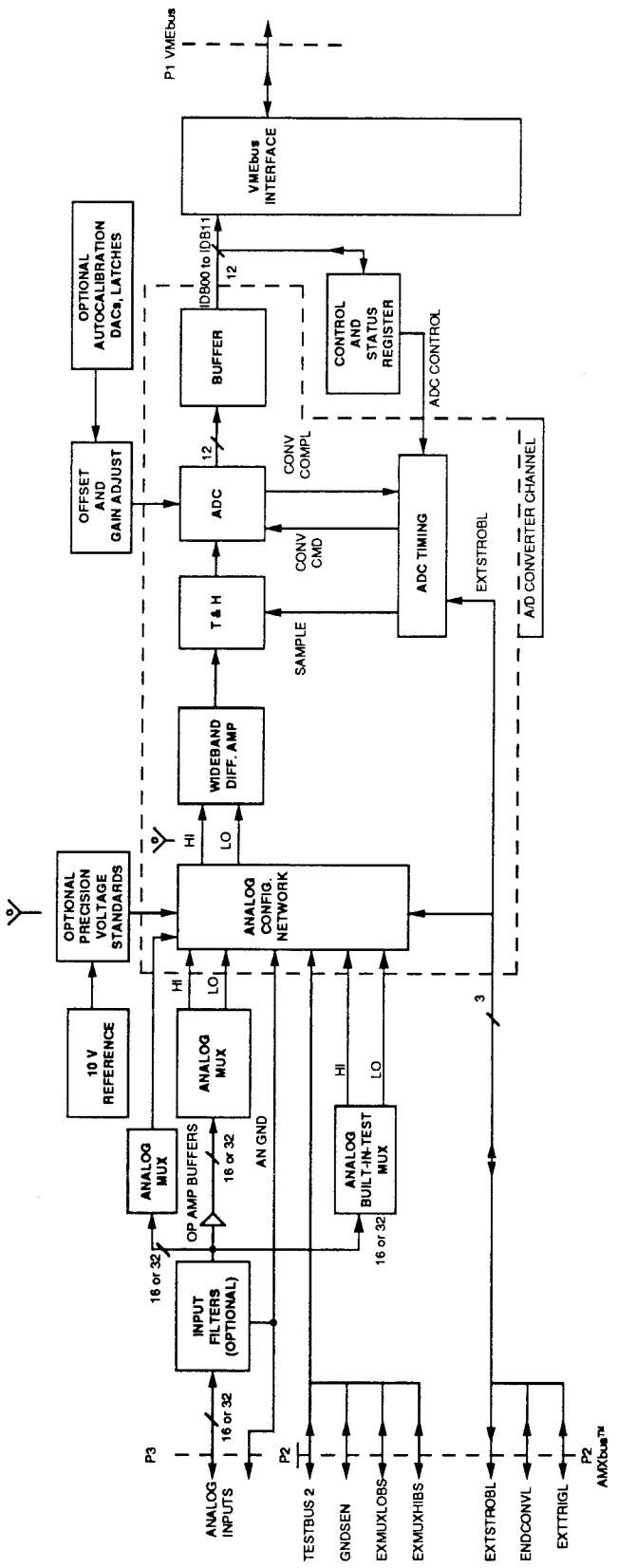
a. VMEbus interface
b. Analog configuration networks
c. Converter channel
d. ADC timing
e. Precision voltage standards and reference
f. Autocalibration DACs
g. Analog multiplexer and input filters
h. Built-in-Test analog Multiplexer
i. Expansion bus (AMXbus™) support
j. Power converter

3.3 VMEbus CONTROL INTERFACE

Four memory-mapped 16-bit registers comprise the communications interface for the VMIVME-3101A. The registers are contiguous, and may be user located on any 8-byte boundary within the short I/O address space of the VMEbus. The board can be user configured to respond to either Short Supervisory or Nonprivileged bus communications, or both.

All VMEbus control signals will be ignored unless the ***board-selection comparator*** detects a match between the on-board selection jumpers shown in Figure 3.3-1, and the address and address-modifier lines from the backplane. The appropriate board response occurs if a valid match is detected, after which the

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M3101A/F3.2-1

Figure 3.2-1. VMIVME-3101A Functional Block Diagram

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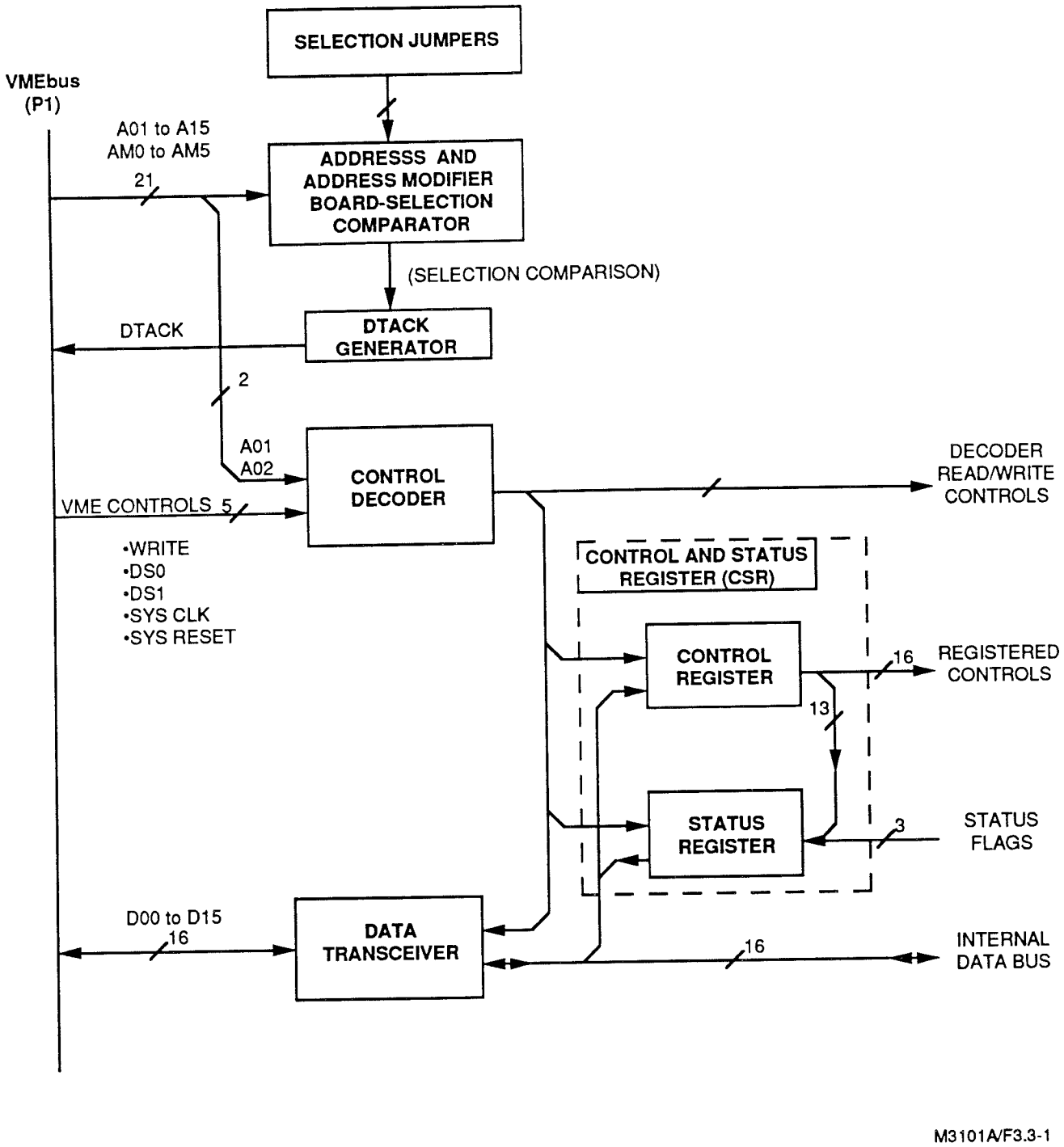


Figure 3.3-1. VMEbus Control Signals and Interface Logic

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open-collector DTACK acknowledgment interface signal is asserted ACTIVE-LOW. Subsequent removal of the CPU-generated command causes the board generated DTACK signal to return to the OFF state.

After board selection has occurred, three groups of VMEbus signals control communications with the board:

a. Data Bus lines D00 through D15
b. Address lines A01, A02
c. Control signals:

    1. WRITE
    2. DS0, DS1
    3. SYS CLK
    4. SYS RESET

Data Bus lines are bi-directional and move data to or from the board through a 16-bit ***data transceiver***, in response to control signals from the ***control decoder***. The data transceiver serves as a buffer for the ***internal data*** bus which interconnects all data devices on the board.

Address lines ***A01*** and ***A02*** map the four communication registers to an eight-byte boundary within the VME address space (Section 4.1). These control signals determine whether data is to be moved to or from the board (***WRITE/READ***), provide the necessary data strobes (***DS0, DS1***), and supply a 16 MHz clock (***SYS CLK***) for use by on-board timers. The ***SYS RESET*** input resets all timers and flags.

Static controls are latched into the ***CONTROL REGISTER***, and are used primarily to establish the operational mode of the board. Status flags, necessary for monitoring and controlling the A/D converter, are read through the ***STATUS REGISTER***. The control and status registers are referred to collectively as the ***Control and Status Register*** (CSR). Most of the CONTROL REGISTER outputs can be monitored directly through the STATUS REGISTER.

3.4 A/D CONVERTER CONTROL AND TIMING

Control commands and status flags associated with controlling the A/D converter are illustrated in Figure 3.4-1, and are described both in the following section, and in Section 4.

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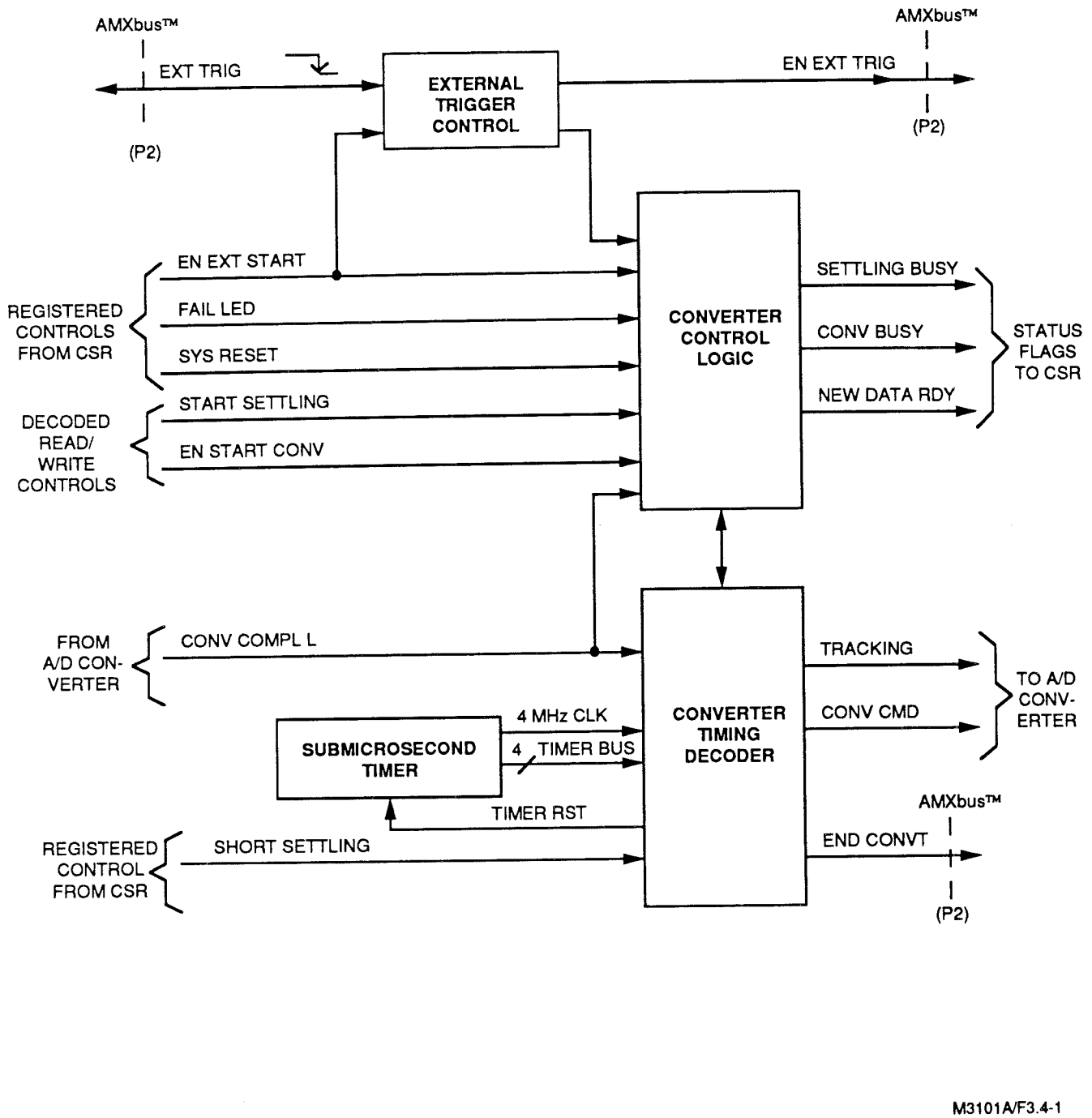


Figure 3.4-1. A/D Converter Timing Logic and Control Signals

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3.4.1 Converter Controls and Status Flags

A ***conversion sequence*** is initiated by writing a "one" to the START SETTLING and EN START CONV controls bits, and is composed of the following consecutive time intervals:

a. Settling delay
b. Tracking interval
c. Analog-to-Digital (A/D) conversion

The ***settling delay*** occurs directly after a state-change has occurred in the analog networks (such as selecting a new input channel), and represents the settling time of the analog networks. After the settling delay has been completed, the Track-and-Hold (T&H) amplifier (Figure 3.2-1) enters the ***tracking*** mode, and the ***tracking interval*** begins. During the tracking interval, the output of the T&H amplifier settles to a value which is equal to its input voltage. The SETTLING BUSY flag is set HIGH at the beginning of the settling delay, and is cleared LOW at the end of the tracking interval. The CONV BUSY flag is set HIGH by the EN START CONV control bit, and remains HIGH until the conversion sequence has been completed.

At the end of the tracking interval, the T&H amplifier enters the ***hold*** mode, in which the output of the amplifier is held at a constant level, and a CONV CMD from the timing decoder causes the ***A/D conversion*** to begin. The A/D conversion digitizes the output of the T&H amplifier as 12 bits in the 16-bit data word, and then terminates the conversion sequence. The CONV COMPL L flag from the A/D converter is HIGH during the conversion, and is LOW otherwise.

Completion of the A/D conversion causes the NEW DATA RDY flag to be set HIGH, indicating that valid data is present in the CONVERTER DATA register (Section 4.1). The action of reading the CONVERTER DATA register resets the NEW DATA RDY and CONV BUSY flags to the LOW ("zero") state.

The END CONVT line to the AMXbus™ goes LOW for 0.25 µs at the end of the tracking interval, and is used to disconnect all driver devices from the AMXbus™.

Setting the EN EXT START control bit HIGH causes the converter control logic to respond to an externally generated EXT TRIG command, by initiating a settling delay. A LOW ("zero") level on the EN EXT TRIG output line indicates that the board is ready to accept an external trigger. A conversion sequence that is initiated by an external trigger will "wait" at the end of the settling delay until an EX START CONV command is received from the VMEbus.

The ***submicrosecond timer*** (Figure 3.4-1) uses the 16 MHz system clock to generate the TRACKING and CONV CMD control signals for the converter,

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and also provides the settling delay. Setting the SHORT SETTLING control bit HIGH provides increased throughput by reducing both the settling delay and the tracking interval.

3.4.2 Throughput (Sample Rate) Factors

Total system throughput (sample rate) F_T can be expressed generally as:

$$F_T = 1 / [N \times (T_1 + T_2 + T_3 + T_4 + T_5)], \qquad (3.4.2\text{-}1)$$

where (all times are expressed in seconds):

F_T = Throughput (samples per second, per channel)
N = Number of channels
T_1 = VMIVME-3101A settling delay = 6.5 µs (default), 4.5 µs (short settling)
T_2 = VMIVME-3101A tracking interval = 1.5 µs
T_3 = VMIVME-3101A A/D conversion time = 3 µs (2.6 µs at 10-bit resolution)
T_4 = Expansion multiplexer acquisition time
T_5 = CPU time invested per channel

For local multiplexer inputs, T_4 is zero. If CPU time is negligible relative to the conversion sequence, then T_5 also is zero, and the expression for local ***maximum*** (N=1) throughput becomes simply:

$$F_T(\text{max}) = 1 / (T_1 + T_2 + T_3) \qquad (3.4.2\text{-}2)$$

For the VMIVME-3101A Board:

T_1 = 6.5 µs (default), 4.5 µs (SHORT SETTLING)
T_2 = 1.5 µs
T_3 = 3 µs

Maximum throughput then (using equation 3.4.2-2), is 90 kHz (90,000 samples per second) for a single local input. Setting the SHORT SETTLING control bit HIGH increases the throughput to 111 kHz. At 10-bit resolution, the throughput increases to 116 kHz.

3.4.3 Interleaved (Pipelined) Operation

By allowing the acquisition settling time of each channel to begin while the conversion (digitizing) of the preceding channel is still in progress, T_3 will be eliminated from Expression 3.4.2-2 for F_T (max). The VMIVME-3101A control logic permits this to take place if the board is operated in the ***interleaved mode***.

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Operating requirements for the interleaved mode are discussed in Section 4.5. By eliminating T_3 , maximum throughput in this mode becomes:

F_T (max) = 125 kHz (default), 166 kHz (SHORT SETTLING)

3.5 PRECISION VOLTAGE STANDARDS

Precision on-board test voltages are derived from a single voltage reference, as shown in Figure 3.5-1. The voltage reference is +10.000 V ±0.001 V, and exhibits a very low temperature-induced drift rate of approximately 1 PPM/deg-C. Nominal values for all on-board reference voltages are listed in Table 4.6.1-1.

Test voltages were selected to produce in-range A/D converter readings, in order to minimize the number of operations required during autocalibration (Section 3.6). Decoded ***cal-test*** control signals select one of three reference voltages through an analog switch. The switched positive reference is buffered and then inverted, to produce a negative reference with the same amplitude as the positive reference. A small fraction of the negative reference is used as a ***live zero***, to provide in-range zero-readings for unipolar ranges.

The positive and negative references, the live zero, and a ***dead zero*** (analog ground) all appear as inputs to the analog configuration network (Figure 3.2-1), and are available for measurement when the board is in the CAL-TEST mode (Table 4.4-1). The live zero is switched into the LOW (inverting) input of the converter channel, and appears therefore, as a ***positive*** voltage to the converter.

3.6 AUTOCALIBRATION

Both the gain and the zero offset of the converter channel can be software calibrated at any time by using the ***autocalibration*** option. This option employs two 12-bit latching Digital-to-Analog Converters (DACs) as shown in Figure 3.6-1. Procedures for applying the autocalibration DACs are described in Section 4.6.2.

3.7 FRONT PANEL (LOCAL) INPUTS

Front panel access to the VMIVME-3101A Board is available as 32 analog input lines at the P3 connector. These inputs can be configured either as 32 individual single-ended channels, as 16 differential pairs, or as a ***combination*** of single-ended and differential inputs. By connecting the analog return in the remote device to the LOCAL GND SEN input (Figure 3.7-1) in the P3 connector, the single-ended lines can be operated as pseudo-differential inputs.

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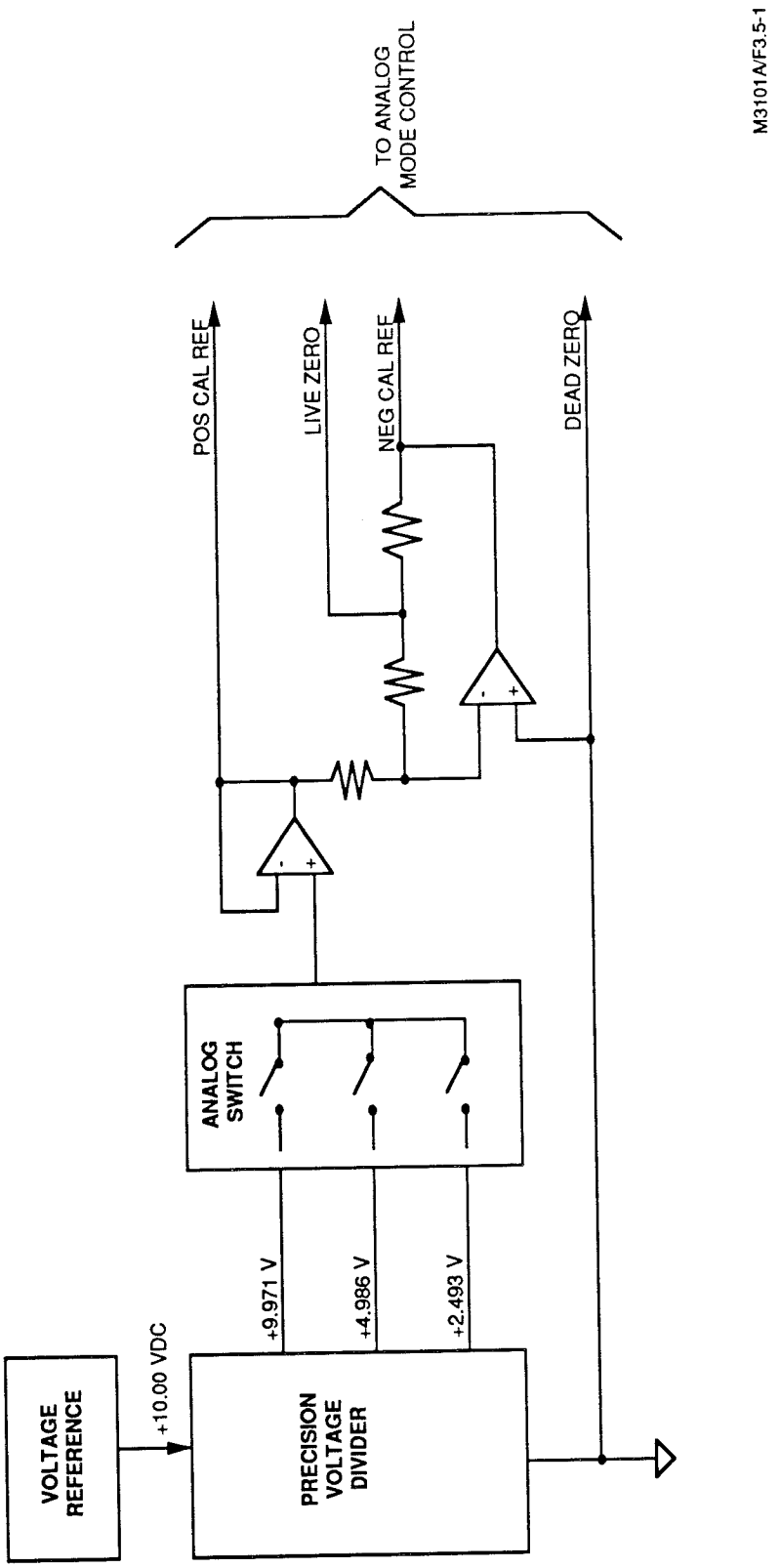


Figure 3.5-1. VMIVME-3101A Precision Voltage Standards Network

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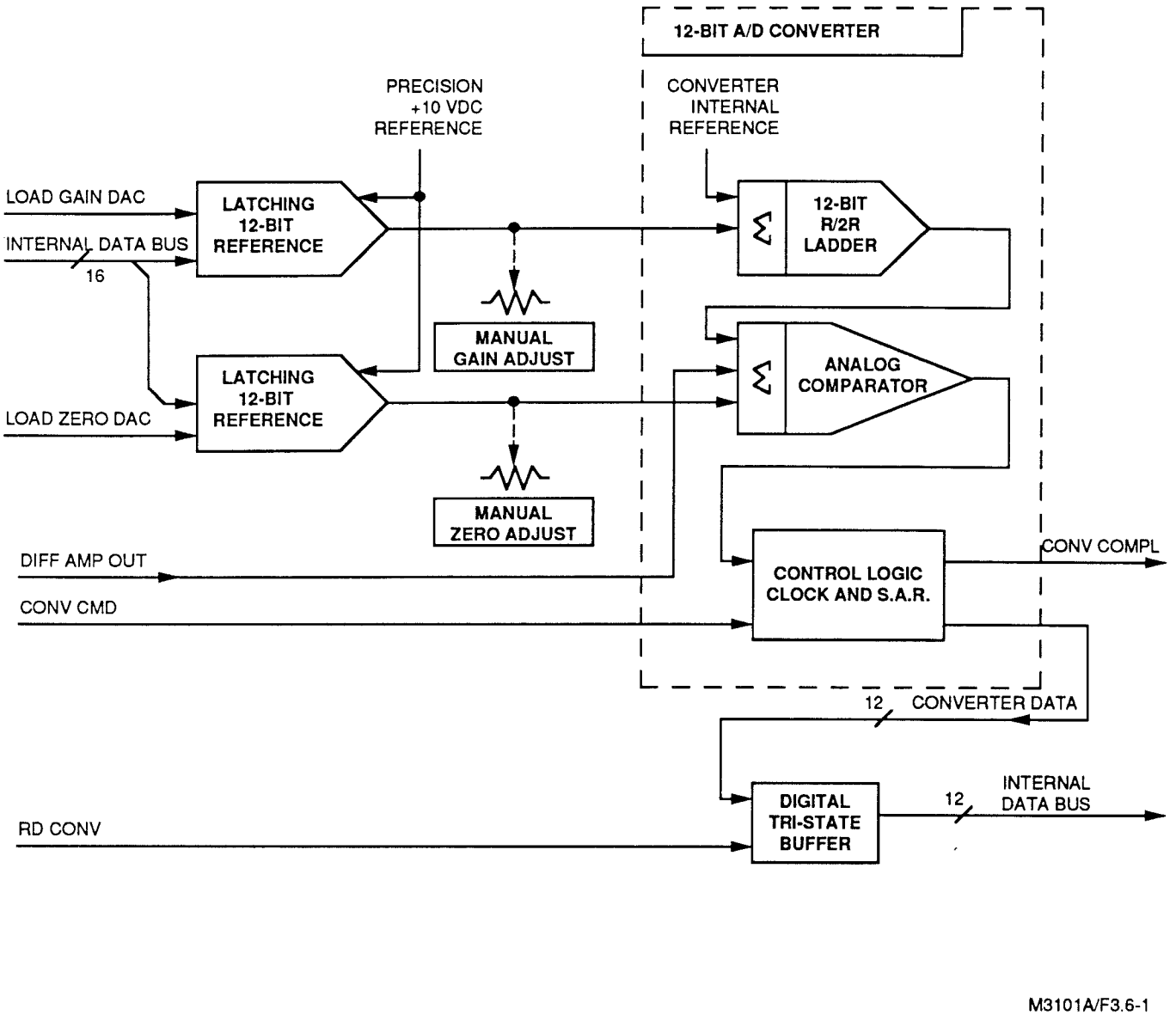


Figure 3.6-1. Converter Channel Autocalibration

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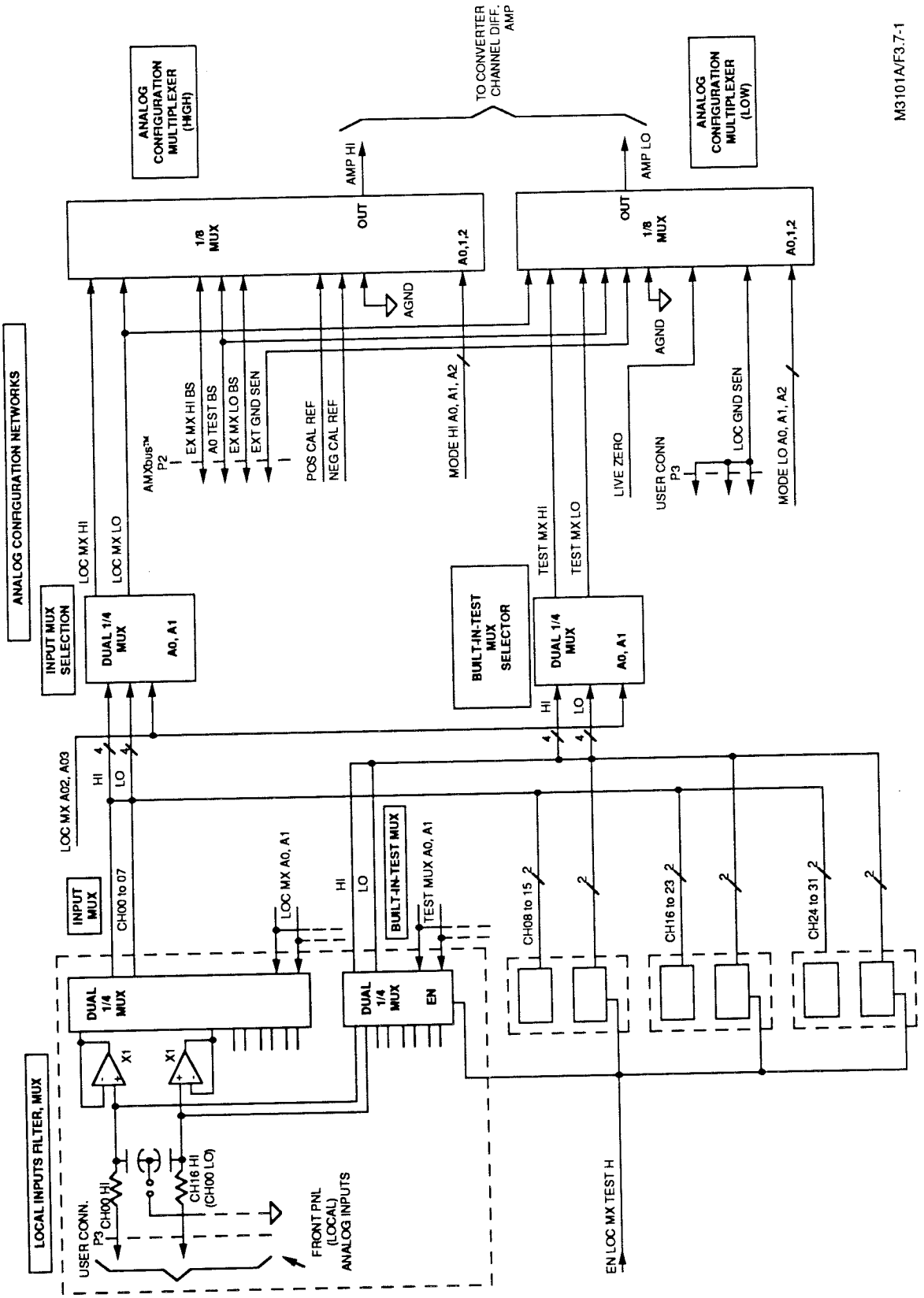


Figure 3.7-1. Analog Inputs and Signal Routing

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3.7.1 Input Filters and Buffer Amplifiers

Optional ***low pass filters*** can be supplied with the front panel inputs (Figure 3.7.1-1). The filters can be jumper-configured to operate either single-ended or differentially. See Document Number 800-103101-000 for input filter specifications.

Each optional low pass filter input is buffered through a unity-gain ***buffer amplifier***, as shown in Figure 3.7-1. Each buffer amplifier introduces a small offset error voltage (less than 0.4 mV), which can be eliminated from measurement data by using the Built-in-Test input multiplexer (Section 3.7.4). These buffer amplifiers are not inserted when ordering a VMIVME-3101A without input filtering.

3.7.2 Input Protection

All VMIVME-3101A front panel input channels are overvoltage protected by current-limiting input resistors. See Document Number 800-103101-000 for Input Overvoltage Specifications.

3.7.3 Analog Multiplexer and Mode Control

After filtering and buffering, each of the 32 front panel inputs is selectable through one of four essentially identical multiplexer sections. Each eight-input multiplexer section contains an 8-channel ***input multiplexer*** and an eight-channel ***Built-in-Test multiplexer***. The input multiplexer inputs are buffered while the Built-in-Test inputs are not buffered. Figure 3.7-1 shows the configuration of a typical section.

All four multiplexer sections are controlled by the same pair of address lines (LOC MX A0, LOC MX A1) from the CONTROL REGISTER (Section 3.3). Selection of one of the four sections occurs in a ***second level of multiplexing***, which is controlled by control bits LOC MX A2 and LOC MX A3. This method of multilevel multiplexing reduces node capacitance, which is a dominant contributor to settling time.

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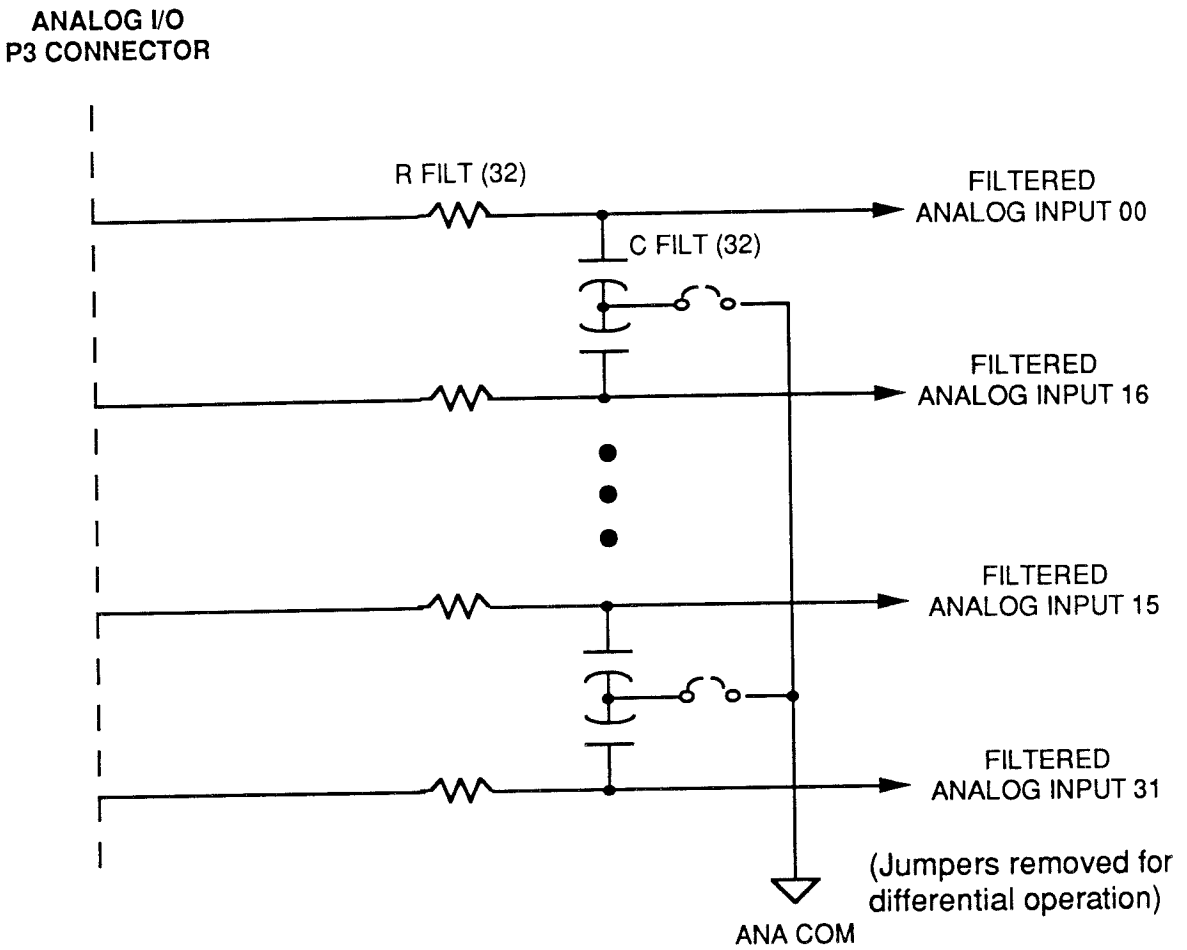


Figure 3.7.1-1. 32-Channel Single-Ended Filtered Analog Inputs

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3.7.4 Built-in-Test Analog Input Multiplexer

Each front panel input is monitored by an unbuffered ***Built-in-Test multiplexer***. The Built-in-Test multiplexer provides a means of testing all inputs, and enables buffer amplifier offsets to be eliminated in software (Section 4.6.3). In the MUX-TEST operational mode (Table 4.4-1), the buffered inputs are measured differentially relative to the self-test inputs.

3.8 AMXbus™ OPERATION

The AMXbus™ is designed to support as many as 16 analog input multiplexer boards with a single A/D converter board, as shown in Figure 3.8-1. AMXbus™ backplanes are available from VMIC in a wide variety of configurations, and support the built-in-test functions associated with the VMIC Analog I/O BITMODULES™.

3.8.1 Multiplexer Expansion

Figures 3.2-1 and 3.8.1-1 show the three dedicated analog bus lines that interconnect multiplexer boards to the A/D converter board. Single-ended and pseudo-differential inputs are supported by the EXMUXHIBUS (Expansion Mux HIGH Bus) and GNDSEN (Ground Sense) lines. The GNDSEN line conveys the multiplexer board analog ground through the AMXbus™ backplane, to minimize the effect of ground offsets throughout the system. The EXMUXHIBUS and EXMUXLOBUS (Expansion Mux LOW Bus) minimize common mode errors by supporting differential inputs from multiplexer boards.

The ENDCONVT (End Convert) signal, generated by the A/D converter board (Figure 3.8.1-1), disconnects all mutiplexer boards from the AMXbus™ at the end of each conversion. This hardware operation ensures that the bus is cleared in preparation for the next input channel.

Figure 3.8.1-1 illustrates an AMXbus™ system configuration which supports 544 single-ended inputs, by using 16 ***VMIVME-3200*** multiplexer boards and one 32-channel ***VMIVME-3101A*** A/D Board. By replacing the 32-channel VMIVME-3200 Boards with 64-channel ***VMIVME-3210*** Boards, the input capacity can be essentially doubled to accept either 1,056 single-ended inputs or 528 differential input pairs. Refer to Section 1 for a list of other VMIC products that are compatible with the VMIVME-3101A board and the AMXbus™.

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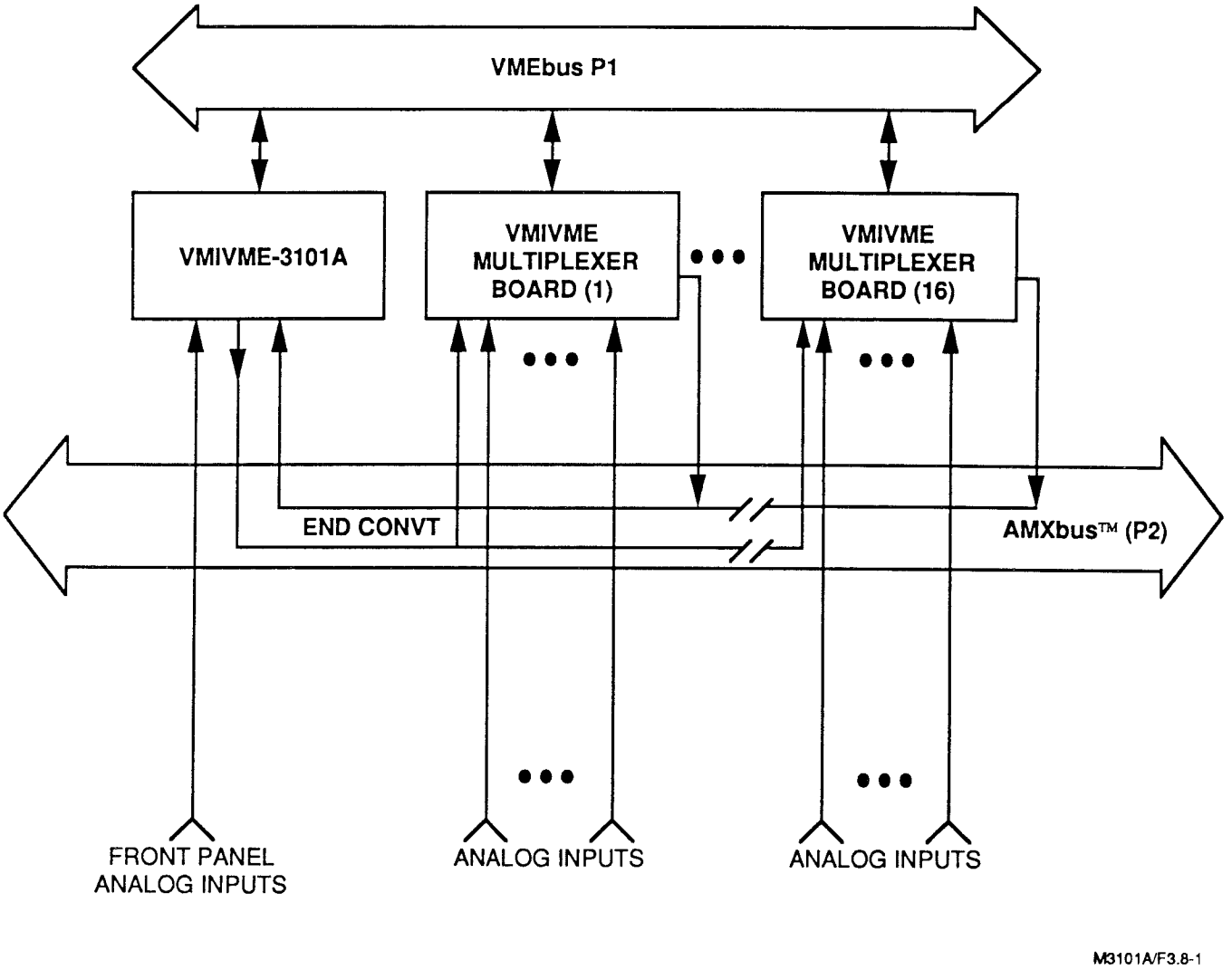


Figure 3.8-1. Typical Configuration with Multiplexer Expansion

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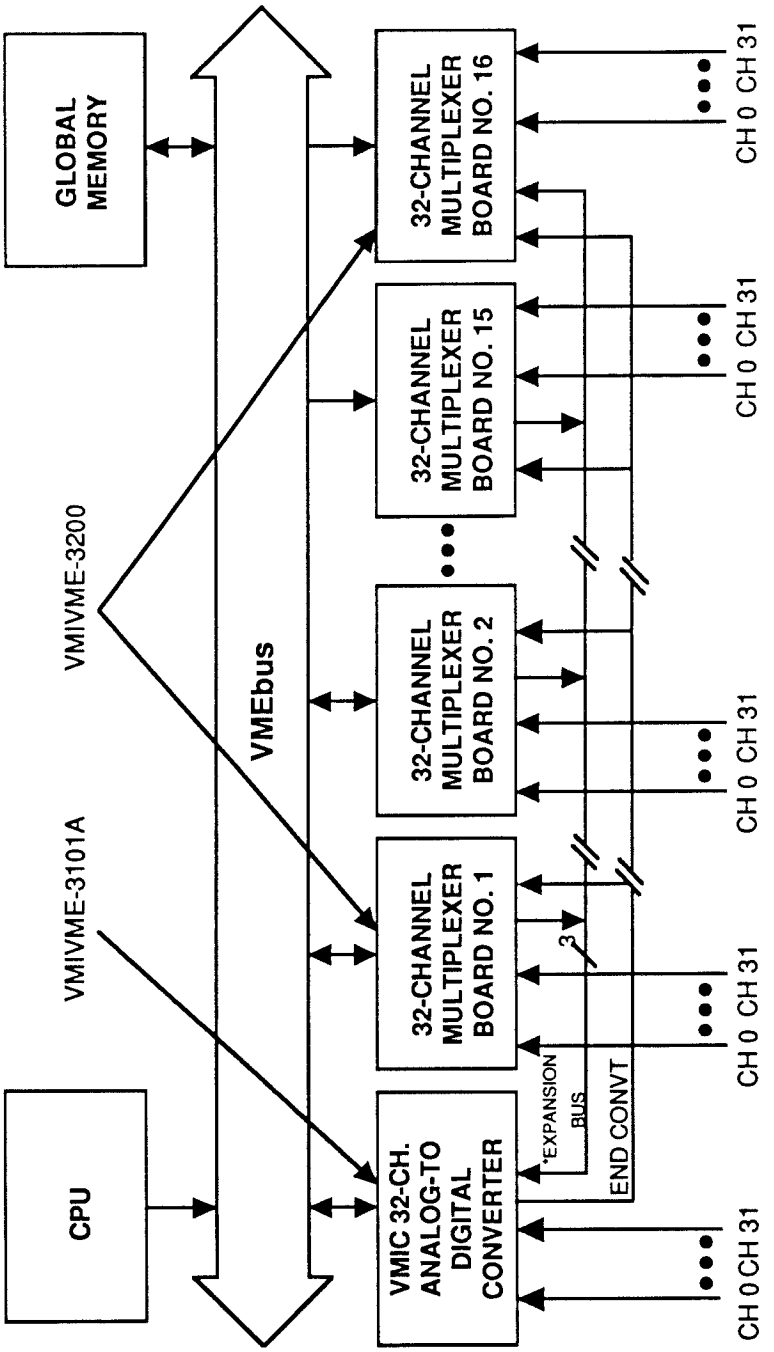


Figure 3.8.1-1. VMIC Multiplexer Expansion Configuration

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In most applications, the following sequence is employed when using multiplexer expansion:

a. The CPU selects a single channel on one of the multiplexer boards. This causes the signal on that channel to be routed through the AMXbus™ to the A/D board expansion inputs.

b. The CPU writes a control word to the A/D converter board, telling that board to configure itself for accepting AMXbus™ inputs, and to begin a conversion.

c. When the conversion has been completed, the END CONVT signal removes the multiplexer board from the AMXbus™, preparing the bus for the next channel, while the CPU stores the A/D converter data in memory.

3.8.2 Testing the VMIVME-32XX and VMIVME-41XX Boards

Figure 3.8.2-1 shows a method by which the VMIVME-3101A (A/D converter) and VMIVME-41XX (DAC output) boards can be used to verify the operation of VMIVME-32XX multiplexer boards. This method uses the AMXbus™ test bus lines (Test Bus 1 and Test Bus 2).

First, the CPU writes a control word to a DAC on the VMIVME-41XX Board, causing the output of the DAC to be routed by Test Bus 1 to the VMIVME-32XX Multiplexer Board. The output of the VMIVME-32XX Board then appears on the Test Bus 2 input of the VMIVME-3101A Converter Board, which digitizes the test signal for examination by the CPU.

By comparing the digitized value with the 12-bit value written originally to the VMIVME-41XX Board, the CPU determines the degree of error, if any, that has been introduced into the system. By routing the VMIVME-41XX DAC output directly to the A/D converter board on Test Bus 2 and commanding a conversion to take place, the CPU can determine whether a detected error has been introduced by the VMIVME-41XX Board or by the VMIVME-32XX Board.

3.8.3 Operation with VMIVME-4500A Boards

This product is designed to support VMIC's 16-channel analog I/O board (VMIVME-4500A). The VMIVME-4500A (AIO) Board is designed with 16 analog output channels and 16 single-ended analog input multiplexer channels. The VMIVME-4500A Board supports off-line and real-time fault detection and isolation. Control logic and output switches are provided to disconnect, via program control, the analog outputs from field connections to support worst-case testing. Logic is also provided to support real-time analog output verification (outputs not disconnected). A functional block diagram of the AIO board is shown in Figure 3.8.3-1.

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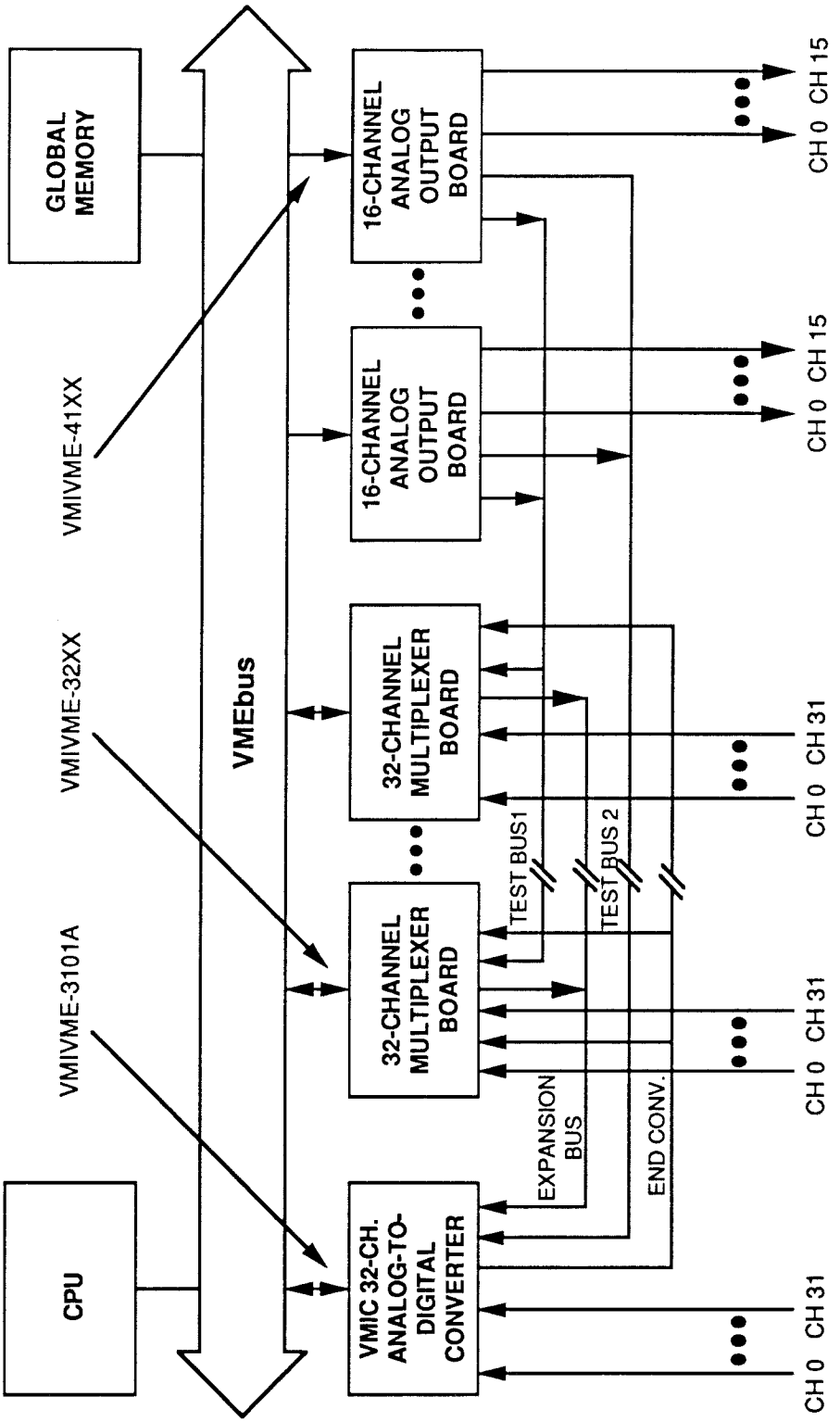


Figure 3.8.2-1. Typical Subsystem Configuration Using VMIC's Built-in-Test Analog I/O Products

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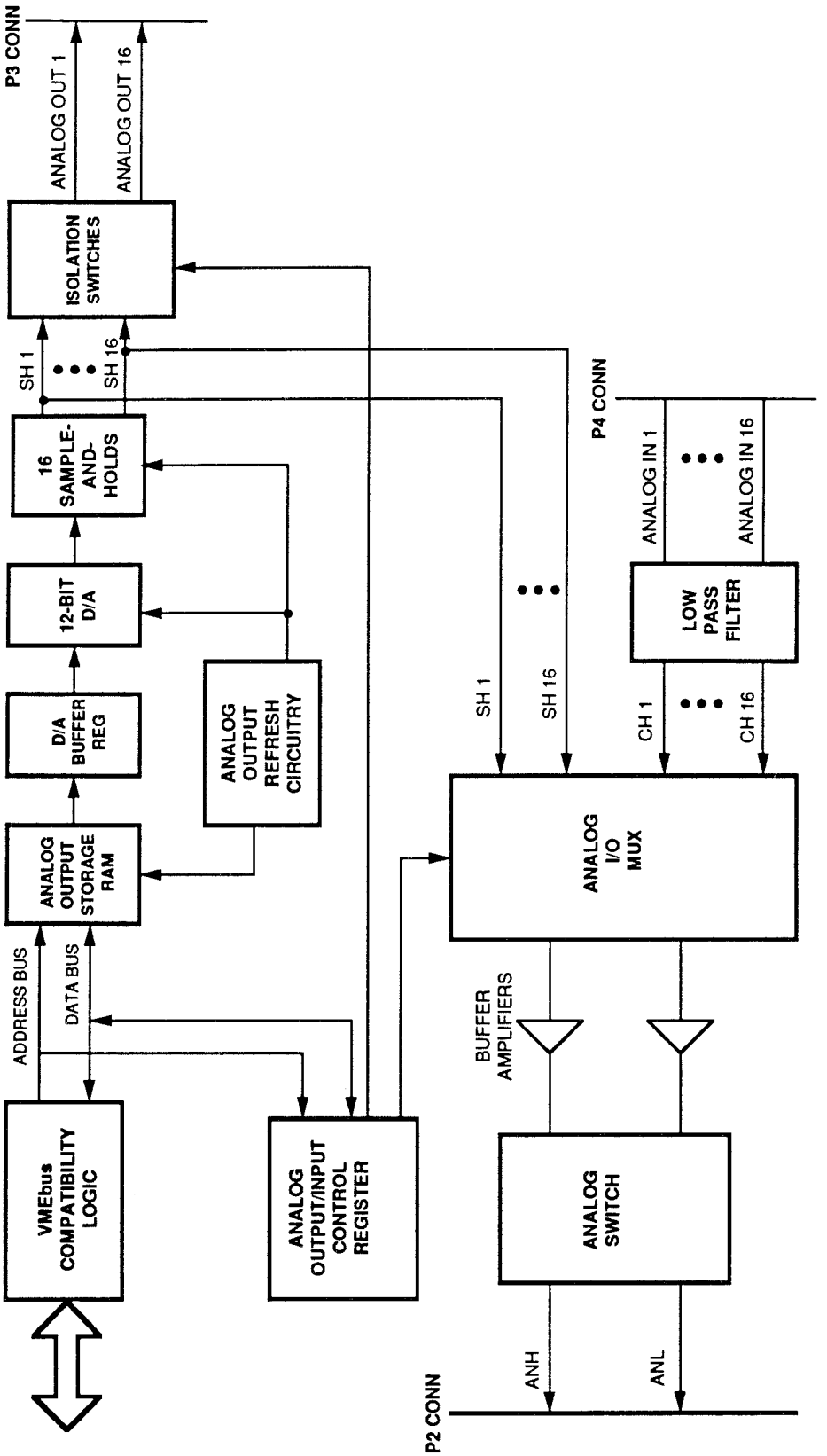


Figure 3.8.3-1. VMIVME-4500A 16-Channel Analog I/O Board Functional Block Diagram

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The VMIVME-3101A Board can be used in a system configuration as shown in Figure 3.8.3-2. Up to 16 AIO (VMIVME-4500A) boards can be connected via the AMXbus™ to one VMIVME-3101A Board. In this configuration, analog multiplexer inputs from the AIO board are selected via program control and routed to the VMIVME-3101A Board for conversion. During real-time operation or off-line testing the analog outputs can be tested by routing a selected analog output to the VMIVME-3101A via the analog input multiplexers and AMXbus™.

3.9 BUILT-IN POWER CONVERTER

Electrical power for the VMIVME-3101A analog network is supplied by the DC-to-DC Converter shown in Figure 3.9-1. The converter converts 5 V logic power into regulated and isolated ±15 VDC power with a load capacity of approximately 190 mA on each 15 V bus.

3.10 P2 CONNECTOR (AMXbus™) I/O SIGNAL DEFINITION

All AMXbus™ signals that are used by the VMIVME-3101A Board can be summarized as follows:

a. **AOTESTBS:** P2 Connector, Pin A9 (Test Bus 2). An analog test bus from the VMIVME-4100 Board; used in conjunction with the VMIVME-3101A A/D Converter Board to verify the outputs of the DAC boards.

b. **EXMUXHIBS:** P2 Connector, Pin A13. The HIGH (noninverted) signal of a differential or pseudo-differential input to the A/D converter board.

c. **EXMUXLOBS:** P2 Connector, Pin A11. The LOW (inverted) signal of a differential pair to the A/D converter board.

d. **GNDSEN:** P2 Connector, Pin A15. The LOW signal of a pseudo-differential pair to the A/D converter board.

e. **EXTTRIG:** P2 Connector, Pin A27 (External Trigger). External Start-Conversion command for the A/D converter board; active on the falling (HIGH to LOW) edge; acknowledged when the ENEXTTRIG (Pin 32) signal is asserted LOW. The trigger signal must be TTL-compatible, and must be valid LOW for a minimum of 100 ns before returning the HIGH state.

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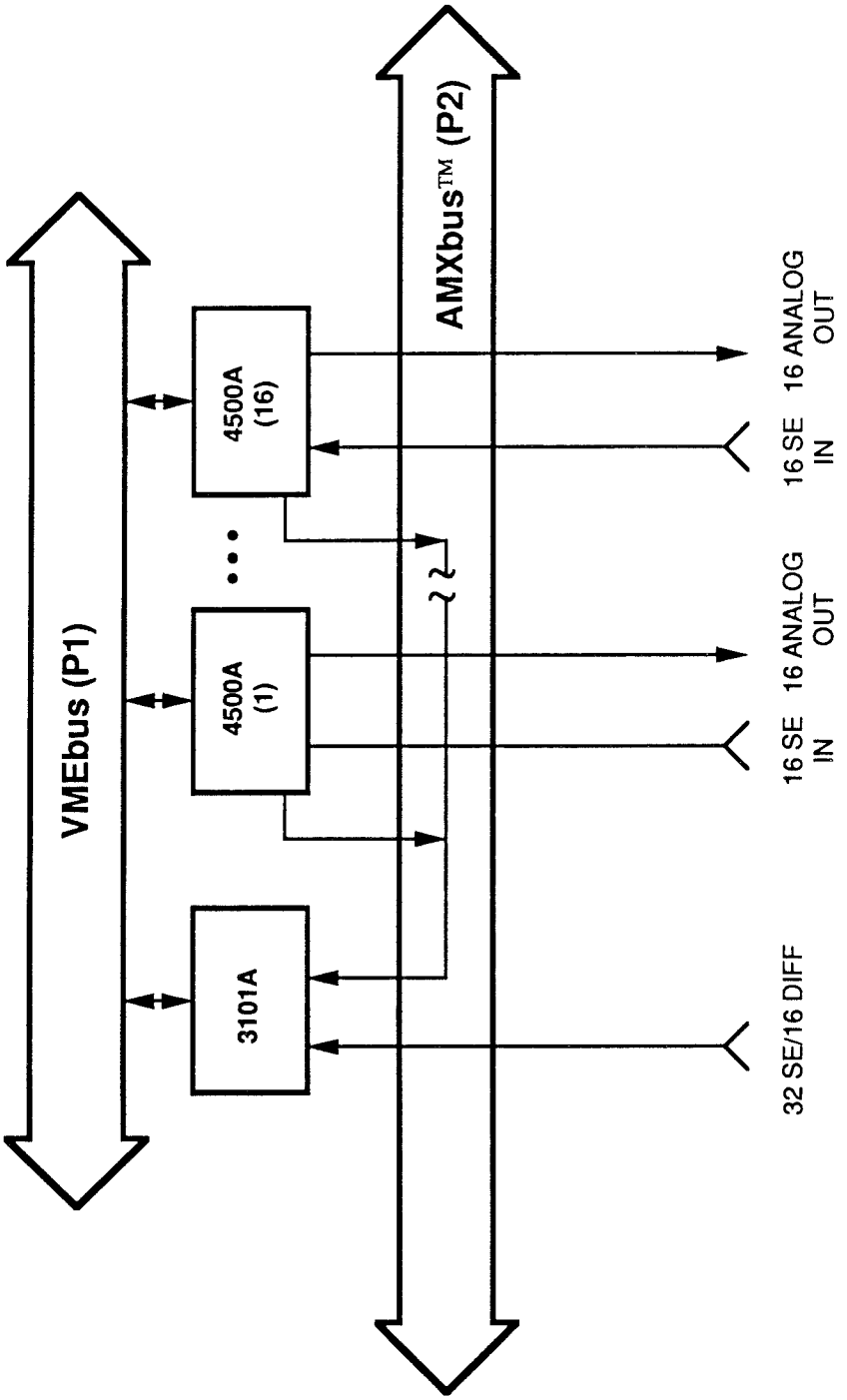


Figure 3.8.3-2. Typical Cost-Effective AIO Subsystem with Built-in-Test

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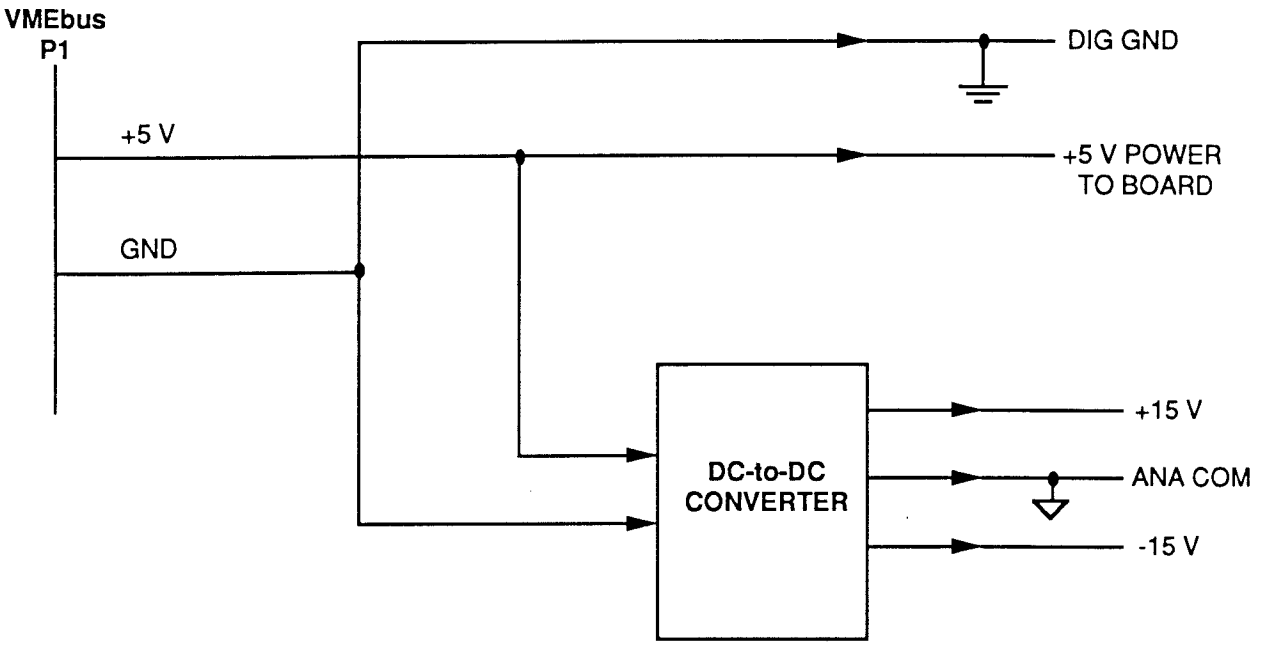


Figure 3.9-1. A/D Converter Board Power

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f. **ENDCONVT:** P2 Connector, Pin A29 (End Convert). A 250 ns LOW TTL pulse which is generated by the A/D converter board at the end of each settling interval, and which is used to clear all multiplexer boards from the AMXbus™.

g. **ENEXTTRIG:** P2 Connector, Pin A31 (Enable External Trigger). Indicates when TTL-LOW, that the A/D converter board is ready to accept an external trigger signal (Pin A27).

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SECTION 4

PROGRAMMING

4.1 INTRODUCTION TO CONTROLLING THE VMIVME-3101A BOARD

Communication with the VMIVME-3101A A/D Board takes place through four contiguous 16-bit register locations which are mapped into the VME short I/O address space. Table 4.1-1 below summarizes the functions of the four registers, which are discussed in detail later in this section.

Table 4.1-1. Communication Register Map

RELATIVE ADDRESS*	REGISTER NAME	ACCESS MODE	REGISTER FUNCTION
0	CONTROL REGISTER	WRITE	Command Flags
0	STATUS REGISTER	READ	Status Flags
2	CONVERTER DATA	READ	A/D Converter Output
4	ZERO DAC	WRITE	AUTOCAL ZERO-Error Correction
6	GAIN DAC	WRITE	AUTOCAL GAIN-Error Correction

M3101A/T4.1-1

4.2 CONTROL AND STATUS REGISTER DESCRIPTION

The two communication registers located at relative address "zero" are referred to collectively as the CONTROL AND STATUS REGISTER and contain all of the flags necessary to control and monitor the following board operations:

a. Front Panel (Local) channel selection
b. AMXbus™ backplane input selection
c. Precision references Built-in-Test
d. Multiplexer input Built-in-Test

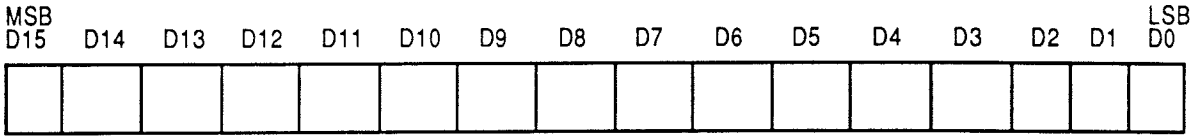
The Control and Status Registers are 16 bits in width, and are described briefly below in Tables 4.2-1 and 4.2-2, respectively. They are discussed in detail in associated programming sections.

*REGISTER ADDRESS is the sum of the RELATIVE ADDRESS and the BOARD ADDRESS.

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Table 4.2-1. Control Register Functions

CONTROL REGISTER DATA FORMAT



CONTROL BIT	NAME	FUNCTION
D0 (2) D1 (2) D2 (2) D3 (2) D4 (2)	LOC MX A0 H (LSB) LOC MX A1 H LOC MX A2 H LOC MX A3 H LOC MX A4 H (MSB)	D0 through D4 select the local (on-board) multiplexer input channel, when Built-in-Test bits D9, D10, and D11, are reset to "zero". D0 through D2 select the on-board precision voltage when D9 is set to "one".
D5 (2)	BOARD RESET	While D5 is HIGH ("one"), the A/D converter timing networks are forced to their "RESET" conditions.
D6	START SETTLING H	When set to a "one", D6 initiates the input settling interval that is required before the A/D conversion can begin.
D7 (2)	EN SING END H	When set to a "one", D7 selects the single-ended analog mode for both the external (AMXbus™) and the local (on-board) multiplexer. If D7 is reset to "zero", the differential mode is selected.
D8 (2)	EN LOC MX H	If D8 is set to a "one", and bits D9 through D11 are "zero", the converter monitors the local (on-board) multiplexer. If D8 is reset to "zero", and bits D9 through D11 are also "zero", the external AMXbus™ signals will be routed to the converter.
D9 (1)(2)	EN STDS TEST H	When D9 is set to a "one", control bits D0 through D2 select one of seven local calibration voltages for conversion. This bit should be reset to "zero" if the board is not equipped with the Precision Voltage Standards option.

M3101A/T4.2-1/1

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Table 4.2-1. Control Register Functions (Concluded)

CONTROL BIT	NAME	FUNCTION
D10 (1)(2)	EN TEST MX H	Built-in-Test of the local multiplexer input is enabled when D10 is set to "one".
D11 (1)(2)	EN AMX BS TEST H	The AMXbus™ A0 test bus is monitored when D11 is HIGH.
D12 (2)	EN EXT TRIG H	When D12 is set to "one", input settling commences each time a falling edge ("one" to "zero" transition) appears at the EXT TRIG L input pin at connector P2.
D13	EN START CONV H	A single A/D conversion is enabled each time a "one" is written to this control bit. This bit will be ignored if the CONVERTER DATA register (Table 4.1-1) contains unread data from the previous sequence. A conversion sequence will not be completed until this command occurs.
D14(2)	Fail LED L	The Fail LED is OFF if this bit is set to "one", and is ON if this bit is reset to "zero".
D15	SHORT SETTLING H	This bit controls the selection of two distinct input settling times. The default ("zero") state selects that settling time which ensures that the full accuracy of the converter is available. Setting D15 to "one" reduces the settling time, in order to accommodate situations in which a slight decrease in accuracy is acceptable in order to increase throughput.

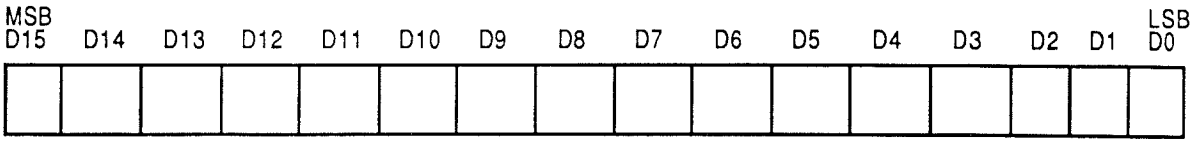
M3101A/T4.2-1/2

NOTES:
1. Control bits D9, D10, and D11 supersede (override) local multiplexer and external bus selections. D9 supersedes D10 and D11; D10 supersedes D11.
2. Control bit is mapped directly into the corresponding status bit in the STATUS REGISTER.

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Table 4.2-2. Status Register Flags

STATUS REGISTER DATA FORMAT



STATUS BIT	NAME	FUNCTION
D0(1)	LOC MX A0 H (LSB)	
D1(1)	LOC MX A1 H	
D2(1)	LOC MX A2 H	
D3(1)	LOC MX A3 H	
D4(1)	LOC MX A4 H (MSB)	
D5(1)	(Board Reset)	
D6	SETTLING BUSY H	When set to a "one", this flag indicates that the input settling sequence is in progress, and that START SETTLING commands will be ignored. The START SETTLING command will be recognized when this flag is LOW ("zero").
D7(1)	EN SING END H	
D8(1)	EN LOC MX H	
D9(1)	EN STDS TEST H	
D10(1)	EN TEST MX H	
D11(1)	EN AMX BS TEST H	
D12(1)	EN EXT TRIG H	

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NOTE: 1. The corresponding CONTROL REGISTER is mapped directly to this flag.

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Table 4.2-2. Status Register Flags (Concluded)

STATUS BIT	NAME	FUNCTION
D13	CONV BUSY H	Writing a "one" to the EN START CMD control bit causes the D13 flag to be set to a "one". This flag will remain set until the next conversion has been completed, and new data is available in the CONVERTER DATA register. (If this flag has not been set, the settling sequence will not run to completion).
D14(1)	Fail LED	
D15	NEW DATA RDY	When set to a "one", this flag indicates that a conversion has been completed, and that data is available in the CONVERTER DATA register. Reading the CONVERTER DATA register clears this flag.

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NOTE: 1. The corresponding CONTROL REGISTER is mapped directly to this flag.

4.3 INITIALIZATION

When SYSTEM RESET is applied to the converter board, the CONTROL REGISTER and all converter flags are cleared to the LOW state ("zero"). The clearing process is sequential, and a delay of at least 50 µs should be allowed before attempting to control the board after a RESET has occurred.

An independent RESET can be generated by first setting, and then immediately clearing, the BOARD RESET control bit in the CONTROL register. Failing to clear this control bit will prevent operation of the amplifier settling/tracking timers.

4.4 OPERATIONAL MODES AND CHANNEL SELECTION

Considerable flexibility is provided in the CONTROL REGISTER for controlling the VMIVME-3101A operational modes. For most applications however, a relatively small number of specific modes will suffice. Table 4.4-1 is a summary of the most commonly required operating modes, and lists both the applicable CONTROL REGISTER HEX codes and the required states of the individual control bits. The purpose of each mode is described here briefly:

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Table 4.4-1. Analog Operation Mode Control

	CONTROL INPUTS (1)									
	D11	D10	D9	D8	D7	D4, D3	D2	D1	D0	
ANALOG MODE	EN AMX BS TEST H	EN TEST MX H	EN STDS TEST H	EN LOC MX H	EN SING END H	LOC MX A4 H	LOC MX A2 H	LOC MX A1 H	LOC MX A0 H	CONTROL (3) WORD (HEX)
LOCAL INPUTS, DIFFERENTIAL	0	0	0	1	0	X	A(2)	A(2)	A(2)	2140 (4)
LOCAL, SINGLE-ENDED	0	0	0	1	1	A(2)	A(2)	A(2)	A(2)	21C0 (4)
EXPANSION BUS, DIFFERENTIAL	0	0	0	0	0	X	X	X	X	2040
EXPANSION BUS, SINGLE-ENDED	0	0	0	0	1	X	X	X	X	20C0
ANALOG OUTPUT TEST BUS	1	0	0	X	X	X	X	X	X	2840
CAL TEST, +10 V	X	X	1	X	X	X	0	0	0	2240
CAL TEST, +5 V	X	X	1	X	X	X	0	0	1	2241
CAL TEST, +2.5 V	X	X	1	X	X	X	0	1	0	2242
CAL TEST, DEAD ZERO	X	X	1	X	X	X	0	1	1	2243
CAL TEST, -2.5 V	X	X	1	X	X	X	1	0	0	2244
CAL TEST, -5 V	X	X	1	X	X	X	1	0	1	2245
CAL TEST, -10 V	X	X	1	X	X	X	1	1	0	2246
CAL TEST, LIVE ZERO	X	X	1	X	X	X	1	1	1	2247
MUX-TEST	X	1	0	X	X	A(2)	A(2)	A(2)	A(2)	2440 (4)

NOTES: 1. "One" = HIGH; "zero" = LOW; "X" = Don't Care
2. "A" = Channel Address Bit
3. Includes D6 (START SETTLING) and D13 (EN START CONV)
4. Plus local input channel selection (Table 4.4-2)

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a. LOCAL INPUTS, DIFFERENTIAL: The front panel (local) inputs are routed to the A/D converter as differential pairs. The four least significant control bits are used to select one of the sixteen available input channels.

b. LOCAL INPUTS, SINGLE-ENDED: The front panel (local) inputs are routed to the A/D converter as single-ended or pseudo-differential inputs. The five least significant control bits are used to select one of the 32 available input channels.

c. EXPANSION BUS, DIFFERENTIAL: Input to the A/D converter consists of the differential backplane AMXbus™ EXMUXHIBS and EXMUXLOBS signals (Section 3). The AMXbus™ signals permit expansion of the input multiplexer through the use of VMIC multiplexer boards, such as the VMIVME-3200 Board.

d. CAL-TEST: In this mode, the on-board precision reference voltages are available to the A/D converter. The least significant three control bits select one of the eight available references.

e. ANALOG OUTPUT TEST BUS: The analog backplane bus AMXbus™ analog output test line AOTESTBS is routed to the converter as a single-ended input.

f. MUX-TEST: The input and output of each input multiplexer buffer amplifier is available for measurement as a differential pair. This mode is useful both for multiplexer Built-in-Test, and for generating a table of correction terms which can be used to cancel the effects of the small offset voltage errors (less than 400 µV) that may be introduced by the buffer amplifiers.

Table 4.4-2 lists the CONTROL REGISTER D0-D4 HEX codes for selecting the front panel (local) input channels, in both the differential and single-ended modes.

4.5 CONTROLLING AND READING THE A/D CONVERTER

Two principal methods are available for controlling the A/D converter on the VMIVME-3101A Board. For applications in which conversion speed is not a critical factor, the basic method will provide suitable performance. This is the simpler of the two methods to implement, and will produce a maximum throughput on the order of 90 kHz (90,000 samples per second).

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Table 4.4-2. Local Input Channel Selection

CONTROL REGISTER D0-D4 (D0 = LSB) HEX VALUE	LOCAL CHANNEL SELECTED	
	SINGLE-ENDED	DIFFERENTIAL
00	CH 0	CH 0 HIGH, LOW
01	CH 1	CH 1 HIGH, LOW
02	CH 2	CH 2 HIGH, LOW
03	CH 3	CH 3 HIGH, LOW
04	CH 4	CH 4 HIGH, LOW
05	CH 5	CH 5 HIGH, LOW
06	CH 6	CH 6 HIGH, LOW
07	CH 7	CH 7 HIGH, LOW
08	CH 8	CH 8 HIGH, LOW
09	CH 9	CH 9 HIGH, LOW
0A	CH 10	CH 10 HIGH, LOW
0B	CH 11	CH 11 HIGH, LOW
0C	CH 12	CH 12 HIGH, LOW
0D	CH 13	CH 13 HIGH, LOW
0E	CH 14	CH 14 HIGH, LOW
0F	CH 15	CH 15 HIGH, LOW
10	CH 16	
11	CH 17	
12	CH 18	
13	CH 19	
14	CH 20	
15	CH 21	
16	CH 22	
17	CH 23	
18	CH 24	
19	CH 25	
1A	CH 26	
1B	CH 27	
1C	CH 28	
1D	CH 29	
1E	CH 30	
1F	CH 31	

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If a higher throughput is essential, the interleaved method may be required. The interleaved control approach permits the settling interval of a new channel to begin while a conversion is in progress. This technique eliminates the conversion time interval from the throughput equation (Section 3), and raises the throughput to approximately 125 kHz.

Short-settling conversions may be used in those situations in which a small degradation in accuracy may be tolerated in order to obtain a higher throughput. Setting the SHORT SETTLING control bit decreases all major contributors to settling time, and increases maximum throughput to as high as 166 kHz.

The following controls, flags, and registers are available for use in controlling the A/D converter (controls and flags are described briefly in Tables 4.2-1 and 4.2-2):

CONTROLS (CONTROL REGISTER):

- START SETTLING H D06*
- EN EXT TRIG H D12
- EN START CONV H D13*
- SHORT SETTLING H D15

FLAGS (STATUS REGISTER):

- SETTLING BUSY H D06
- CONV BUSY H D13
- NEW DATA READY . . . . . D15 . .(Set when data is available in the CONVERTER DATA register).

CONVERTER DATA REGISTER (12 ACTIVE BITS):

- 16-bit read-only register

The START SETTLING and EN START CONV controls are essentially strobes, and are effective only at the moment of writing to the CONTROL REGISTER. Although supplied as two separate control bits ~~for flexibility~~, these controls ~~usually~~ are written to the register simultaneously along with the operational mode and channel selections.

Figures 4.5-1 and 4.5-2 illustrate a measurement sequence which uses basic conversion control. The sequence is simplified by the fact that only the NEW DATA READY flag must be monitored in order to determine when each conversion has been completed.

The interleaved control method is presented in Figures 4.5-3 and 4.5-4. A higher throughput is achieved by using a somewhat more complex control sequence. With this method, both the SETTLING BUSY and NEW DATA READY flags are monitored.

*Effective only upon writing ("strobed").

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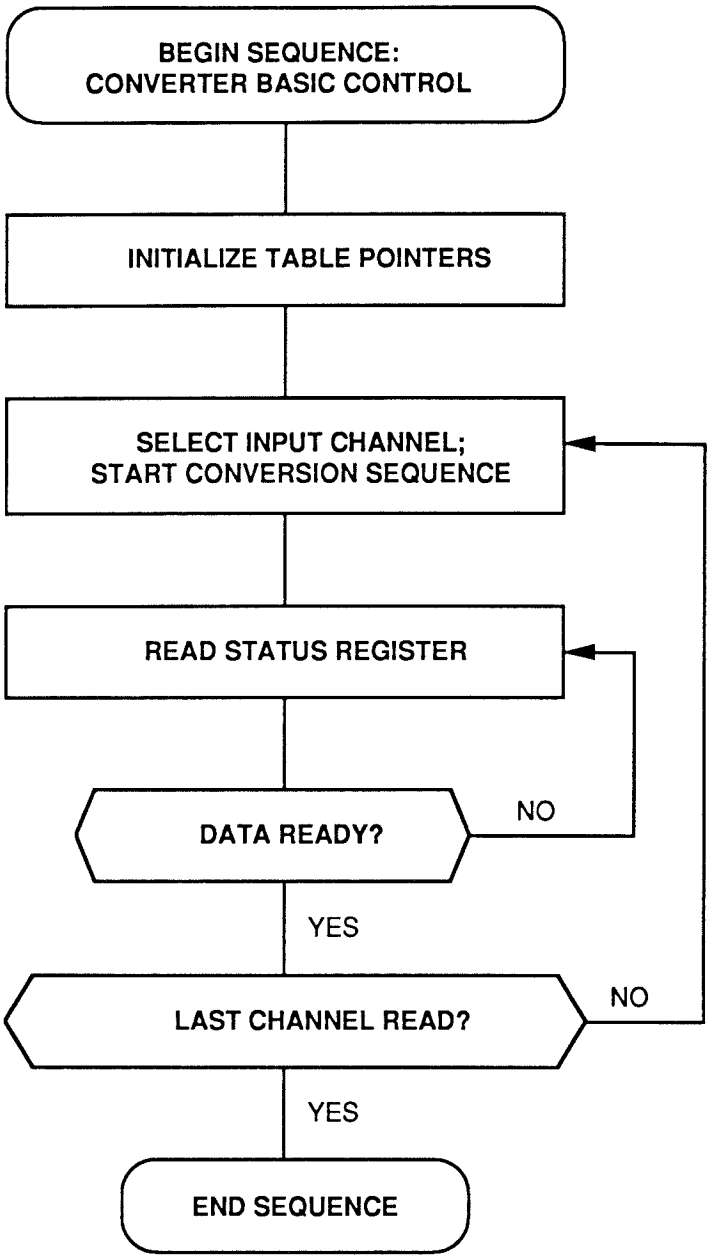


Figure 4.5-1. Program Flowchart - Converter Basic Control Sequence

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```
*****************************************************************
*
*         READAD1:  READ ADC & AVERAGE READINGS FOR NOISE
*         ----------------------------------------------
*         ENTER:    DO.W    HAS CONTROL WORD TO WRITE ADC
*         EXIT :    CF=0:   DO.W HAS THE AVERAGED READING
                            WITH THE UPPER WORD CLEARED..
                    CF=1:   READ ERROR; DO.W HAS STATUS..

READAD1   EQU       *
          MOVEM.L   D1-D4,-(A7)      PRESERVE USER REGISTERS
          CLR.L     D2               USE D2 FOR READ AVERAGE
          MOVE.W    #15,D3           USE D3 FOR AVERAGE COUNT
          MOVE.W    D0,D4            PRESERVE CONTROL WORD...
RDAVG     MOVE.W    D4,D0            RESTORE CONTROL WORD....
          JSR       READAD2          USE READ ADC CONVERTER 2
          BCS.S     AVGERR           READ TIMEOUT ERR IF CF=1
          ADD.L     D0,D2            DO AVG SUM IN D2 REGISTER
          DBF       D3,RDAVG         THIS WILL AVG 16 READINGS
          LSR.L     #4,D2            DIV BY THE READING COUNT
          MOVE.W    D2,D0            RDING AVG TO D0 FOR RET
AVGERR    MOVEM.L   (A7)+,D1-D4      RESTORE USER REGISTERS
          RTS                        RETURN TO CALLING ROUTINE


*****************************************************************
*
*         READAD2:  READ 3101 ADC WITH SETTLING DELAY
*         -------------------------------------------
*         ENTER:      DO.W   HAS CONTROL WORD TO WRITE ADC
*         EXIT :      CF=0:  DO.W HAS READING WITH THE
*                            UPPER WORD CLEARED FOR ADDING.
*                     CF=1:  READ ERROR; DO.W HAS STATUS


READAD2   EQU         *
          MOVEM.L     D1,-(A7)       PRESERVE USER REGISTERS
          BCLR        #13,DO         CLEAR START CONVERT BIT
          MOVE.W      D0,ADC.CR      WRT START SETTLING+CHAN
          MOVE.W      ADELAY,D1      DO AN EXTRA SETTLING DLY
RDDLY     DBF         D1, RDDLY      FILTERS/RESOLUTION/..ETC
          BSET        #13,D0         NOW SET START CONVERT
          JSR         READADC        RD ADC & RET ERR IF CF=1
          MOVEM.L     (A7)+,D1       RESTORE USER REGISTERS
          RTS                        RETURN TO CALLING ROUTINE
```

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Figure 4.5-2. Program Example - Converter Basic Control Sequence (Page 1 of 2)

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```
*****************************************************************
*
*         READADC: READ 3101 ADC CONVERTER ROUTINE
*         ----------------------------------------
*         ENTER:      D0.W HAS CONTROL WORD TO WRITE
*         NOTE :      TIMES OUT ON 65535 STATUS READS
*                     IF NEW DATA READY IS NOT TRUE.
*         EXIT :      CF=0: DO.W HAS READING WITH THE
*                           UPPER WORD CLEARED FOR ADD.
*                     CF=1: READ ERROR; D0.W HAS STATUS.

READADC   EQU         *
          MOVEM.L     D1,-(A7)        PRESERVE USER REGISTERS
          MOVE.W      D0,ADC.CR       WRT CH & START SETTLING
          MOVE.W      #$FFFE,D1       GET ADC READ TIMEOVT VAL
ADSTS     MOVE.W      ADC.SR,D0       GET THE ADC STATUS WORD
          BTST        #15,D0          CHECK NEW DATA READY BIT
          DBNE        D1,ADSTS        LOOP NOT TIMEOUT OR DATA
          ADD.W       #1,D1           TEST TIMEOUT VIA CARRY
          BCS.S       ADERR           EXIT WITH READ IF CF=1
          CLR.L       D0              FOR HI WORD CLR ON RET
          MOVE.W      ADC.DR,D0       GET THE AD CONVERSION
ADERR     MOVEM.L (A7)+,D1            RESTORE USER REGISTERS
          RTS                         RETURN TO CALLING ROUTINE
```

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Figure 4.5-2. Program Example - Converter Basic Control Sequence (Page 2 of 2)

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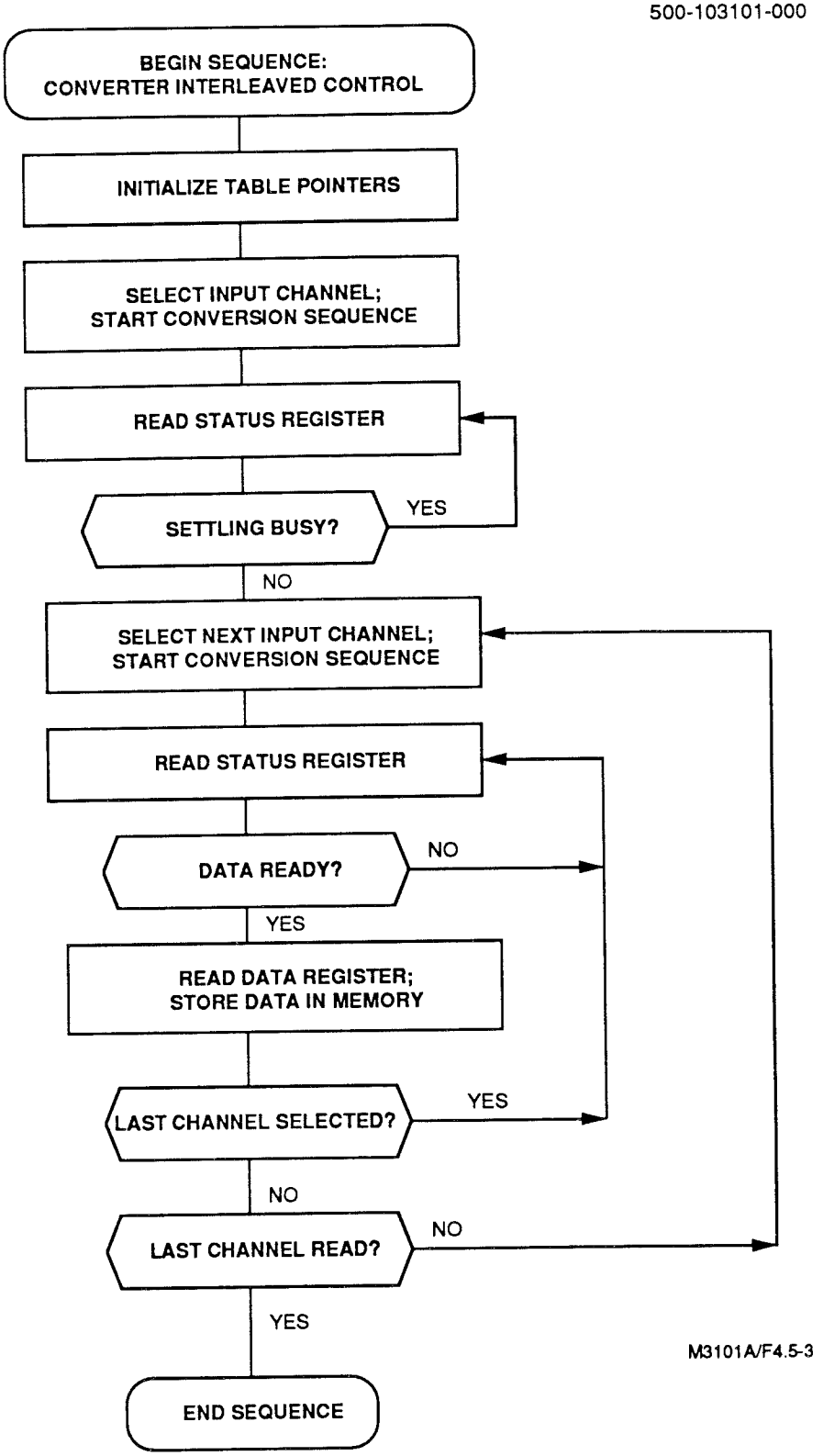


Figure 4.5-3. Program Flowchart - Converter Interleaved Control Sequence

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```
*****************************************************************
*                                                               *
*          TEST SOFTWARE INTERLEAVE MODE....                    *
*                                                               *
*****************************************************************

LOCINT   EQU       *
         DISPLAY   MSG08            SHO WERE DOING INTERLEAVE

*        DO INIT'S FOR INTERLEAVE TESTING

         MOVE.W    #$000A,ALLOW     INIT ERROR ALLOWANCE
         MOVE.W    #$4100,DAC.CR    4116:  IMMED UPDATE MODE
         CLR.W     D2               CLR D2 FOR DAC UPDATE VAR

*        EACH PASS THRU LDNXT SETS A NEW TEST LEVEL...

LDNXT    JSR       LDDACS           LOAD DACS TO VALUE IN D2

*        GET CURRENT SETUPS AND TEST...

         MOVE.W    LMODE,D0         GET LOCAL MODE TO DO
         LEA       CHSTG,A1         GET CHANNEL READING STG

*        NOW WRITE FIRST CTRL WHOLE THEN INTERLEAVE...

         MOVE.W    D0,21            PRESERVE CONTROL WORD
         MOVE.W    D0,ADC.CR        WRT CTRL W/START CONVERT
INTONE   MOVE.W    ADC.SR,D0        GET ADC STATUS WORD
         BTST      #6,D0            CHECK FOR SETTLING BUSY
         BNE.S     INTONE           AND WAIT UNTIL NOT BUSY
         MOVE.W    D1,D0            RESTORE CONTROL WORD
         ADD.W     #1,D0            AND INCREMENT CTRL WORD

*        EACH PASS THRU CHNXT INTERLEAVES ANOTHER CHANNEL

CHNXT    MOVE.W    D0,D1            PRESERVE CONTROL WORD
         JSR       READADC          GO READ A/D CONVERTER
         BCS.S     INTERR           READ INTERLEAVE ERROR
         MOVE.W    D0, (A1)+        PUT READING INTO TABLE
         MOVE.W    D1,D0            RESTORE CONTROL WORD
         ADD.W     #1,D0            INCREMENT CHANNEL ADDR
         CMP.W     LDONE,D0         LAST CHANNEL TO TEST..
         BLT.S     CHNXT            IF LESS THEN CONTINUE
         SUB.W     #1,D0            AND GET LAST ADDRESS
         JSR       READADC          AND GO DO LAST READ
         BCS.S     INTERR           READ INTERLEAVE ERROR
         MOVE.W    D0, (A1)+        PUT READING INTO TABLE
```

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Figure 4.5-4. Program Example - Converter Interleaved Control Sequence (Page 1 of 2)

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```
*         NOW TEST ALL SAVED READING FOR GOOD DATA..

          LEA       CHSTG,A1        POINT TO READINGS
          LEA       CTERMS,A0       AND TO CORRECTION TERMS
          MOVE.W    LMODE,D1        CLR D1 FOR CH COUNTER
CHCHK     MOVE.W    (A1)+,D0        GET READING FROM TABLE
          SUB.W     (A0)+,D0        SUB CORRECTION TERM
          MOVE.W    D0,D3           SAVE READ DATA...
          MOVE.W    D2,D6           GET DATA TO UNUSED REG
          LSR.W     #4,D6           AND ADJUST FOR 12 BIT
          SUB.W     D6,D0           SUB ADJ'D WRT FROM READ
          BPL.S     INTPOS          BRANCH ON POSITIVE ELSE
          NEG.W     DO              ELSE INVERT NEG DATA
INTPOS    SUB.W     ALLOW,D0        SUB TESTER ALLOWANCE
          BGT.S     INTERR          ERROR ON GREATER THAN
          ADD.W     #1,D1           INCREEMNT CNT & CHAN.
          CMP.W     LDONE,D1        TEST D1 TO TERMINATOR
          BLT.S     CHCHK           AND KEEP CHKING RANGES

*         INCREMENT LOAD VAL AND DO NEXT LOAD

          ADD.W     NXTLVL,D2       INCREMENT UPDATE VARIABLE
          BCC       LDNXT           IF NOT CARRY DO NEXT LOAD

*         ELSE SHOW WE PASSED AND GO...

          JSR       PASS            TEST PASSED SUB..
          JMP       MAIN            GO TO MAIN MENU

*         HANDLE INTERLEAVE MODE ERROR...

INTERR    DISPLAY   FAILED          SHOW FAILED
          MOVE.W    D0,D3           GET DATA TO D3
          JSR       BREAKOUT        SHOW WHAT FAILED..
          JMP       MAIN            BACK TO MAIN MENU
```

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Figure 4.5-4. Program Example - Converter Interleaved Control Sequence (Page 2 of 2)

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4.5.1 Reading Converter Output Codes

Figure 4.5.1-1 shows the data format which applies when reading the CONVERTER DATA register. Coding can be straight binary, offset binary, or two's complement, depending upon the configuration of the A/D converter selection jumpers. Table 4.5.1-1 summarizes the converter output codes that are produced at major points within the full scale ranges shown.

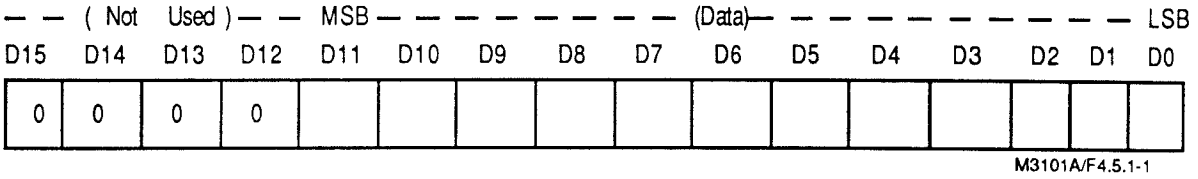


Figure 4.5.1-1. A/D Read-Data Format

For any offset binary converter output code (bipolar range), the associated input voltage is obtained with the expression:

INPUT (Volts) = -EFS + 2 x EFS x [DECIMAL OUTPUT CODE] / 4096,

where EFS is the positive or negative full-scale voltage.

The input voltage for a straight binary code (unipolar range) is:

INPUT (Volts) = EFS x [DECIMAL OUTPUT CODE] / 4096.

4.6 BUILT-IN-TEST ON THE VMIVME-3101A BOARD

Built-in-Test is available in two areas. On-board precision reference voltages are used to verify the integrity of the converter channel, which consists of the analog configuration network, and the A/D converter (ADC) shown previously in the block diagram (Figure 1.2-2). In order to test the input analog multiplexer and the associated buffer amplifiers, the dedicated Built-in-Test multiplexer provides a redundant measurement path from the front panel analog inputs (See "MUX-TEST", Section 4.4).

4.6.1 Precision Reference Voltage

Table 4.6.1-1 lists the on-board precision reference voltages and the associated acceptance ranges of converter readings for various levels of accuracy. Figures 4.6.1-1 and 4.6.1-2 illustrate a calibration testing method which uses the references, and which provides the flags and data necessary to perform autocalibration.

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Table 4.5.1-1. Converter Output Coding

UNIPOLAR RANGES			STRAIGHT BINARY			
	0 TO +10 V	0 TO +5 V	D15			D0
+FS-1 LSB	+9.9975 V	+4.9988 V	0000	1111	1111	1111
+1/2 FS	+5.0000 V	+2.5000 V	0000	1000	0000	0000
+1 LSB	+0.0024 V	+0.0012 V	0000	0000	0000	0001
BIPOLAR RANGES			**OFFSET BINARY**			
	±10 V	±5 V	D15			D0
+FS-1 LSB	+9.9951 V	+4.9976 V	0000	1111	1111	1111
+1/2 FS	+5.0000 V	+2.5000 V	0000	1100	0000	0000
+1 LSB	+0.0049 V	+0.0024 V	0000	1000	0000	0001
ZERO	0.0000 V	0.0000 V	0000	1000	0000	0000
-FS+1 LSB	-9.9951 V	-4.9976 V	0000	0000	0000	0001
-FS	-10.0000 V	-5.0000 V	0000	0000	0000	0000

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Table 4.6.1-1. Precision Reference Voltage Cal-Test Limits

NOMINAL SELF-TEST STANDARD (VDC)	REFERENCE VOLTAGE (VDC)	FULL SCALE RANGE (VDC)	ACCEPTANCE RANGE (HEX, BINARY) [1] ±0 LSB (NOMINAL)	±2 LSB MAX	±2 LSB MIN	±4 LSB MAX	±4 LSB MIN	±6 LSB MAX	±6 LSB MIN
+10.0	+9.971	0 TO +10 +/-10	0FF4 0FFA	0FF6 0FFC	0FF2 0FF8	0FF8 0FFF	0FF0 0FF6	0FFC 0FFF	0FEC 0FF4
+5.0	+4.986	0 TO +5 [2] +/-5	0FF4 0FFA	0FF6 0FFC	0FF2 0FF8	0FF8 0FFF	0FF0 0FF6	0FFC 0FFF	0FEC 0FF4
+2.5	+2.493	+/-2.5 [2]	0FF4	0FF6	0FF2	0FF8	0FF0	0FFC	0FEC
-2.5	-2.493	+/-2.5 [2]	0006	0008	0004	000A	0002	000C	0000
-5.0	-4.986	+/-5	0006	0008	0004	000A	0002	000C	0000
-10.0	-9.971	+/-10	0006	0008	0004	000A	0002	000C	0000
LIVE ZERO:									
5.0 V STD 10.0 V STD	-0.010 -0.020	0 TO +5 [2] 0 TO +10	0008 0008	000A 000A	0006 0006	000C 000C	0004 0004	000E 000E	0002 0002
DEAD ZERO:	0.000	ALL BIPOLAR RANGES	0800	0802	07FE	0804	07FE	0806	07FA

NOTES: 1. To convert the binary code into two's complement code, invert the most significant bit.
2. See ordering information (Section 2.4). Not available for all options.

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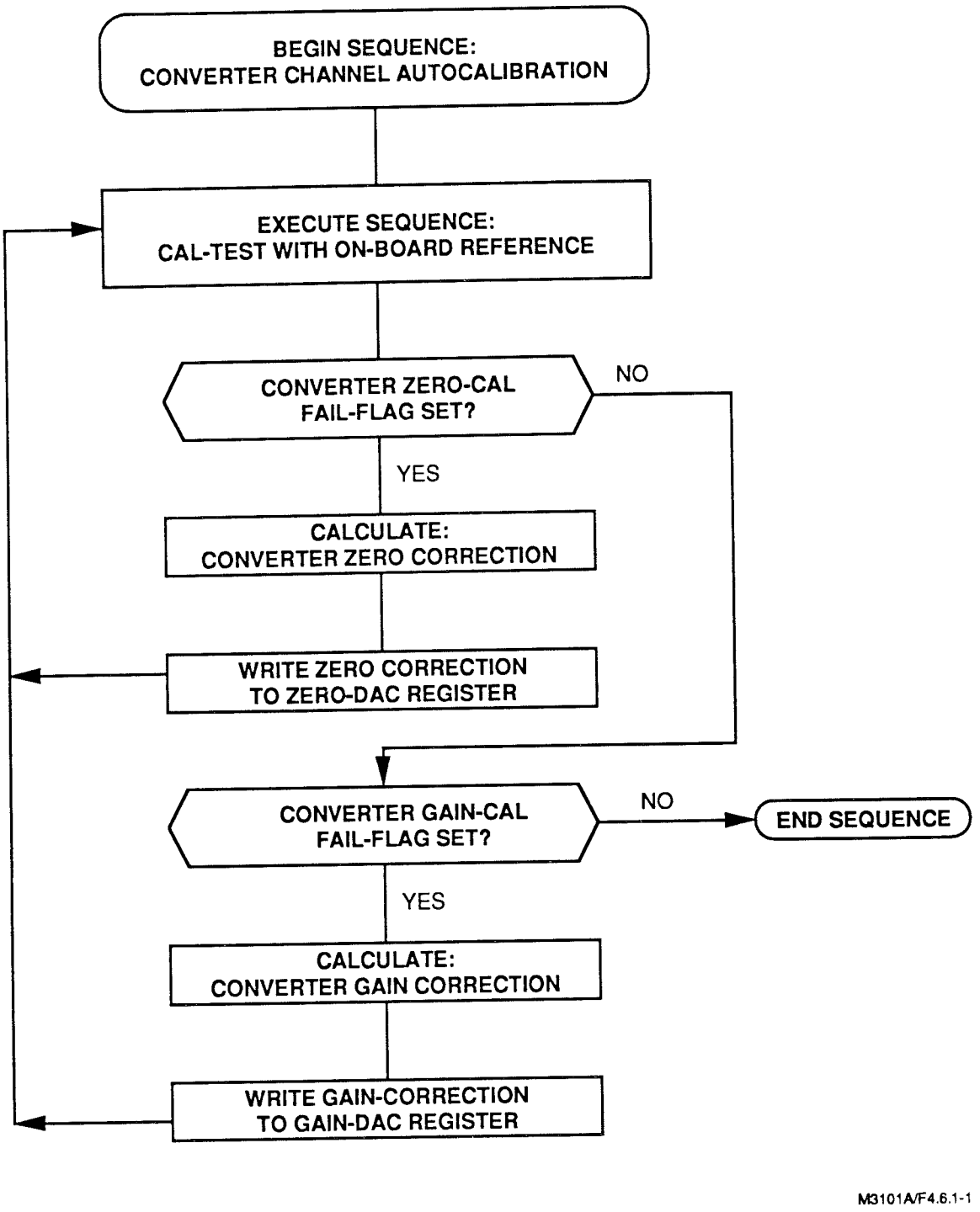


Figure 4.6.1-1. Program Flowchart - Converter Channel Autocalibration

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```
*****************************************************************
*                                                               *
*        AUTOCALIBRATION OF ADC GAIN AND OFFSET                 *
*                                                               *
*****************************************************************

TEST4     EQU       *
          DISPLAY   MSG04            SHOW STARTING AUTOCAL TEST
          MOVE.W    #$2000,ADELAY    INIT ADC READ DELAY

*         (1) GET DEAD ZERO REFERENCE

CALZERO   MOVE.W    #$2243,D0        CONTROL WORD FOR ZERO
          JSR       READAD1          READ ADC W/NOISE AVERAGE
          BCS       ACTERR           READ ERROR ON CARRY FLAG
          CMP.W     #$0800,D0        CHECK FOR CORRECT ZERO
          BGT.S     HIZERO           IF GREATER THAN DO HIZERO
          BLT.S     LOZERO           IF LESS THAN DO LOZERO
          MOVE.W    D0,ZEROCAL       STORE ZERO CAL SET FOR DSP
          JMP       CAL_PFS          THEN GO CAL POS FULL SCALE

*         (2) DO AUTO CAL OFFSET CORRECTIONS

HIZERO    MOVE.W    ZEROSET,D0       MEM IMAGE OF ZERO SETUP
          SUB.W     #$0008,D0        DECREMENTS ERROR TOWARD
          JMP       SETZERO          THE NOMINAL VALUE $0800
LOZERO    MOVE.W    ZEROSET,D0       MEM IMAGE OF ZERO SETUP
          ADD.W     #$0008,D0        INCREMENTS ERROR TOWARD
SETZERO   MOVE.W    D0,ZEROSET       THE NOMINAL VALUE $0800
          MOVE.W    D0,ADC.ZD        WRITE OFFSET CORRECTION
          AND.W     #$FFF,D0         MASK OFF INVALID D'BITS
          CMP.W     #$0,D0           TEST FOR MAX RANGE ERROR
          BEQ.S     ACTERR           ERROR IF Z'DAC MAX'ED OUT
          JMP       CALZERO          CONTINUE AUTOCALIBRATION

*         (3) GET POSITIVE FULL SCALE REFERENCE

CAL_PFS   MOVE.W    #$2240,D0        CONTROL WORD FOR +FS
          JSR       READAD1          READ ADC W/NOISE AVG
          BCS.S     ACTERR           READ ERROR IF CARRY SET
          CMP.W     #$0FFA,D0        CHECK ACCEPTANCE RANGE
          BGT.S     HI_PFS           IF LESS THAN DO HI_PFS
          BLT.S     LO_PFS           IF GREATER THAN DO LO_PFS
          MOVE.W    D0,GAINCAL       STORE GAIN CAL READING
          JMP       AUTOEXIT         JUMP TO AUTO CAL EXIT
```

M3101A/F4.6.1-2/1

Figure 4.6.1-2. Program Example - Converter Channel Autocalibration (Page 1 of 2)

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```
*          (4) DO AUTO CAL GAIN CORRECTIONS...

HI_PFS     MOVE.W     GAINSET,D0        MEM IMAGE OF GAIN SETUP
           ADD.W      #$0008,D0         DECREASE GAIN BY 8 CLICKS
           JMP        SET_PFS           AND FIX UP THE GAIN DAC
LO_PFS     MOVE.W     GAINSET,D0        MEM IMAGE OF GAIN SETTING
           SUB.W      #$0008,D0         INCREASE GAIN BY 8 CLICKS
SET_PFS    MOVE.W     D0,GAINSET        REWRITE MEM IMAGE OF GAIN
           MOVE.W     D0,ADC.GD         WRITE GAIN CORRECTION
           CMP.W      #$0,D0            TEST FOR MAX RANGE ERROR
           BEQ.S      ACTERR            ERROR IF G'DAC MAX'ED OUT
           JMP        CAL_PFS           CONTINUE AUTOCALIBTATION

*          (5) FALL THRU LAST AUTO CAL CHECK

AUTOEXIT   MOVE.W     #$2243,D0         DEAD ZERO REF C'WORD
           JSR        READAD1           AND GET DEAD ZERO REF
           BCS.S      ACTERR            READ ERROR ON CARRY SET
           SUB.W      #$0800,D0         SUBTRACT NOMINAL VALUE
           BPL.S      POS               BRANCH IF POSITIVE ELSE
           NEG.W      D0                GET ABSOLUTE VALUE OF DO
POS        SUB.W      #$1,D0            AND TAKE AWAY ALLOWANCE
           BGT.S      ACTERR            ERROR IF STILL GREATER

*          IF WE MADE IT HERE ... WE PASSED ...

           JSR        PASS              SHOW TEST PASSED &
           JMP        ACBRK             BREAKOUT SET VALUES

*          (7) HANDLE AUTOCAL ERROR

ACTERR     DISPLAY    FAILED            AUTOCAL TEST FAILED
ACBRK      JSR        ACBOR             AUTOCAL ERR BREAKOUT
           JMP        MAIN              BACK TO MAIN MENU
```

M3101A/F4.6.1-2/2

Figure 4.6.1-2. Program Example - Converter Channel Autocalibration (Page 2 of 2)

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The positive full-scale cal-test voltage is the largest available positive reference voltage that falls within the existing full-scale range. The negative full-scale voltage is the most-negative reference that falls within the range ("Dead-Zero" for unipolar ranges). The gain error is obtained as follows:

GAIN FACTOR = POS REFERENCE READING - NEG REFERENCE READING

GAIN ERROR = GAIN FACTOR - (POS FULL SCALE - NEG FULL SCALE)

GAIN ERROR AT A BIPOLAR RANGE OF ±10 V = [GAIN FACTOR - (FFA HEX - 0006 HEX)]

The zero-reference cal-test voltage is "Dead-Zero" for bipolar ranges, and "Live-Zero" for unipolar ranges. Zero error is calculated as:

ZERO ERROR (bipolar ranges) = ZERO READING - 0800 (HEX)
ZERO ERROR (unipolar ranges) = ZERO READING - 0008 (HEX)

4.6.2 Applying Autocalibration

Gain and Zero calibration errors in the converter channel can be corrected by periodically performing the reference voltage cal-test, and then applying the results of the cal-test in the autocalibration sequence described here.

ALLOW 250µS FOR DAC SETTLING TIME.

The principle of autocalibration used by the VMIVME-3101A Board implements two latching 12-bit Digital-to-Analog Converters (DACs). One DAC adjusts the gain of the converter channel; the other DAC adjusts the channel zero-offset. Both DACs accept right-justified 12-bit data in their assigned registers (Table 4.1-1), and are write-only devices. Since the autocalibration algorithm applies incremental corrections to the DAC contents, each DAC must have a corresponding register in CPU memory for data retention. Both DACs should be initialized to 800 (HEX) after a RESET occurs.

To use the autocalibration method illustrated in Figures 4.6.1-1 and 4.6.1-2, gain correction and zero correction can be calculated as:

GAIN CORRECTION = GAIN ERROR ^{X} (-64)

ZERO CORRECTION = ZERO ERROR ^{X} (-64),

where the gain and zero errors are obtained during CAL-TEST (Section 4.6.1).

Each application of the autocalibration sequence will reduce the gain and zero calibration errors by approximately one-half. Multipliers larger than "64" shown will accelerate the procedure, but may cause overcorrection to occur. If the converter produces end-of-scale readings (0000 or 0FFF, HEX) for any of the references used during CAL-TEST, reduce the contents of the GAIN DAC by 40 (HEX) and repeat the CAL-TEST.

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4.6.3 Software Correction of Local Multiplexer Zero Offsets

Zero offset errors which may be present in the local analog multiplexer can be corrected by first performing the Built-in-Test procedure shown in Figures 4.6.3-1 and 4.6.3-2, and then applying the results of the test (correction table) in the input multiplexer zero correction procedure illustrated in Figures 4.6.3-3 and 4.6.3-4.

4.7 ACCESSING THE 32 FRONT PANEL (LOCAL) INPUT CHANNELS

Front panel (local) analog input access is obtained by selecting either the differential or single-ended LOCAL operational mode with the CONTROL REGISTER (Table 4.4-1). Figures 4.5-1 and 4.5-3 illustrate the basic and interleaved methods of controlling the A/D converter for sequential measurements. Refer also to Section 4.4.

4.8 USING THE AMXbus™ EXPANSION CAPABILITIES

The VMIVME-3101A, via VMIC's AMXbus™ (connects to the P2 connector), can access a large number of analog input channels from VMIC's 32XX Series of Analog Input Multiplexer Boards. The A/D Board can process a wide variety of analog input signals that are multiplexed under program control via VMIC's AMXbus™.

The example program shown in Figures 4.8-1 and 4.8-2 selects an analog input from the VMIVME-3200 multiplexer board (Channel 1) and multiplexes the signal to the A/D Board via the AMXbus™ backplane. The signal is then digitized and stored in memory. A flowchart of the example is shown in Figure 4.8-1, and the assembly language program is shown in Figure 4.8-2. The board address of the VMIVME-3200 is FF0002 (HEX).

The A/D Board also will accept and digitize differential signals from the VMIVME-3200 multiplexer board. To select differential inputs, a change in the control register programming is required. The multiplexer Board Control Register requires a control word of 180 (HEX).

4.9 VERIFYING THE VMIVME-41XX DAC OUTPUTS

A dedicated test bus (TEST BUS 2) on the AMXbus™ is designed to connect the VMIVME-41XX multiplexed analog outputs to the A/D Board. The A/D Board can verify each of the DAC channel outputs by converting the multiplexed outputs via Test Bus 2, then comparing the digitized value (12 bits) with the original value written to the DAC Board(s).

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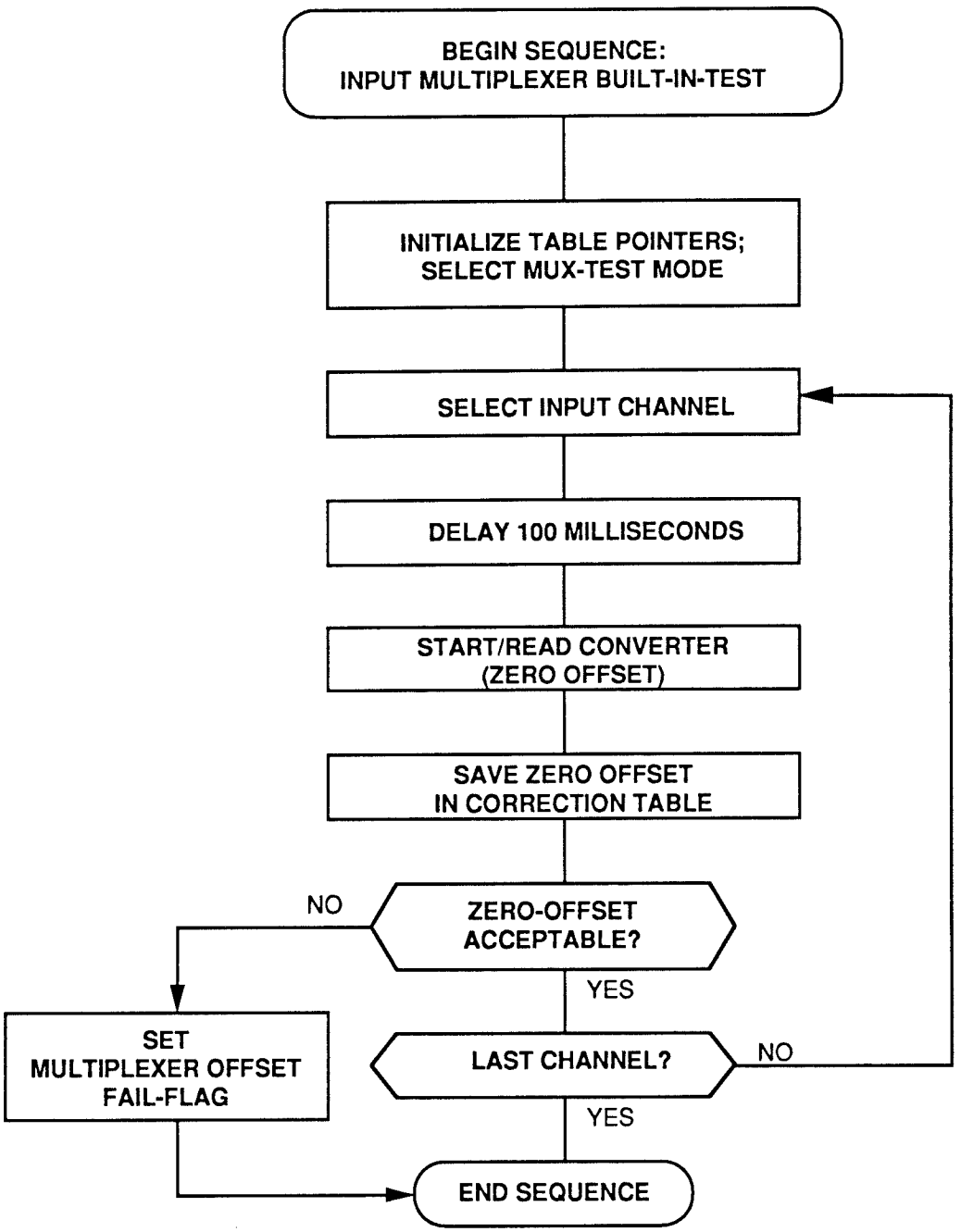


Figure 4.6.3-1. Program Flowchart - Built-in-Test Using the Input Multiplexer

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```
*****************************************************************
*                                                               *
*         MULTIPLEXER TEST MODE TEST                            *
*                                                               *
*         Note: Store correction terms in arrays CTERMS         *
*                                                               *
*****************************************************************


TEST5     EQU *
          DISPLAY   MSG05             DISPLAY MUX TEST START
          MOVE.W    #$3000,ADELAY     INIT ADC READ DELAY
          LEA       CTERMS,A0         POINT A0 TO TERM TABLE
          MOVE.W    #$2440,D0         START AT MUX CHANNEL 0

*         READ (AVERAGE) TEST MUX CHANNELS...

MUXCHK    MOVE.W    D0,D4             PRESERVE CONTROL WORD
          JSR       READAD1           READ MUX CHANNEL OFFSET
          BCS.S     MUXERR            READ ERROR ON CARRY SET
          SUB.W     #$0800,D0         SUBTRACT TRUE ZERO VAL
          MOVE.W    D0,(A0)+          STORE AVG MUX OFFSET
          MOVE.W    D4,D0             RESTORE THE CTRL WORD...
          ADD.W     #1,D0             CTRL WORD + NEXT CHAN ADDR
          CMP.W     #$2460,D0         CHECK FOR LAST CHANNEL ADD
          BLT.S     MUXCHK            IF NOT CONTINUE MUX READS..

*         NOW CHECK ALL THE TERM'S FOR IN RANGE

          LEA       CTERMS,A0         PTR TO CORRECTION TERMS
          MOYE.W    TRMCNT,D1         SET LOOPCOUNTER FOR TERMS
TRMCHK    MOVE.W    (A0)+,D0          GET TABLED CORRECTION TERM
          BPL.S     POSTRM            SKIP FIX IF TERM IS POS
          NEG.W     D0                ELSE INVERT NEG VALUE
POSTRM    CMP.W     #$0002,D0         MAXIMUM ALLOWABLE VALUE
          BGT.S     MUXERR            MUX ERROR IF GREATER THAN
          DBF       D1,TRMCHK         LOOP/CHECK ALL THE TERMS

          JSR       PASS              TEST PASSED SUB...
          JMP       MUXBRK            BREAKOUT ALL C'TERMS

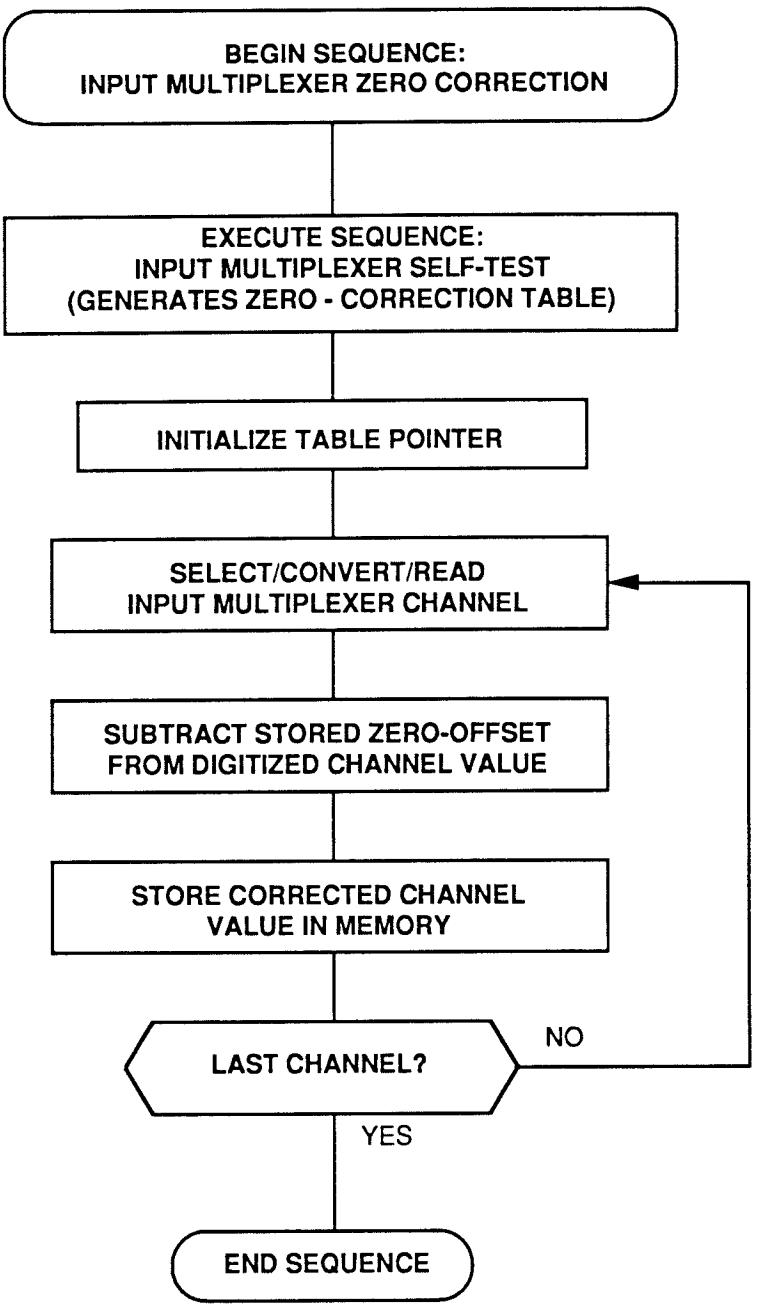
*         SHOW MUX TEST ERROR

MUXERR    DISPLAY   FAILED            SHOW TEST FAILED!
MUXBRK    JSR       MUXBOR            MUX ERROR BREAKOUT
          JMP       MAIN              AND BACK TO MAIN MENU
```

M3101A/F4.6.3-2

Figure 4.6.3-2. Program Example - Built-in-Test Using the Input Multiplexer

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M3101A/F4.6.3-3

Figure 4.6.3-3. Program Flowchart - Input Multiplexer Zero Correction

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```
*****************************************************************
*         LOCAL CHANNEL INTERFACE (P3) TEST                     *
*         ----------------------------------------              *
*         TWO ENTRY POINTS:   1. SINGLE ENDED MODE TEST         *
*                             2. DIFFERENTIAL MODE TEST         *
*                                                               *
*****************************************************************
*
*         ENTER HERE FOR SINGLE ENDED

LOCSE     EQU       *                LOCAL SINGLE ENDED MODE
          DISPLAY   MSG06            SHOW WE'RE DOING S.E.
          MOVE.W    #$2000,ADELAY    INIT ADC READ DELAY
          MOVE.W    #1000,DACDLY     INIT DAC LOAD DELAY
          MOVE.W    #$0006,ALLOW     INIT ERROR ALLOWANCE
          MOVE.W    #$1F,TRMCNT      INIT TRMCNT FOR S.E. MODE
          MOVE.W    #$21C0,LMODE     SET THE LOCAL MODE TO SE
          MOVE.W    #$21E0,LDONE     AND SET THE DONE VARIABLE
          JMP       LOCTST           AND GO DO THE LOCAL TEST

*****************************************************************
*
*         ENTER HERE FOR DIFFERENTIAL

LOCDIFF   EQU       *                LOCAL DIFFERENTIAL MODE
          DISPLAY   MSG07            SHOW WE'RE DOING DIFF.
          MOVE.W    #$2000,ADELAY    INIT ADC READ DELAY
          MOVE.W    #1000,DACDLY     INIT DAC LOAD DELAY
          MOVE.W    #$0004,ALLOW     INIT ERROR ALLOWANCE
          MOVE.W    #$F,TRMCNT       INIT TRMCNT FOR DIFF MODE
          MOVE.W    #$2140,LMODE     SET THE LOCAL MODE TO DIFF
          MOVE.W    #$2150,LDONE     16 DIFFERENTIAL CHANNELS


*****************************************************************
*
*         THIS IS THE MAIN BODY OF LOCAL TEST
*

LOCTST    EQU       *

*         INIT DAC AND DAC REG'S

          MOVE.W    #$4100,DAC.CR    4116 IMMEDIATE UPDATE MODE
          CLR.W     D2               CLR D2 FOR DAC UPDATE VAR

*         EACH PASS THRU NXTLD SETS A NEW TEST LEVEL..

NXTLD     JSR       LDDACS           LOAD DACS TO VAL IN D2
```

M3101A/F4.6.3-4/1

Figure 4.6.3-4. Program Example - Input Multiplexer Zero Correction (Page 1 of 2)

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```
*         DO A SINGULAR CONV. BEFORE LOOPING...

          MOVE.W    LMODE,D0          GET THE LOCAL MODE
          JSR       READAD2           AND DO A CONVERSION
          BCS.S     LOCERR1           READ ERROR IF CARRY SET

*         NOW CHECK THE INPUT LEVELS VIA ADC

          MOVE.W    LMODE,D0          GET LOCAL MODE TO D0
          LEA       CTERMS,A0         POINT TO CORRECT'N TERMS

*         EACH PASS THRU NXTCH TESTS AN ADC CHANNEL

NXTCH     MOVE.W    D0,D1             SAVE CTRL WRD AND CH..
          JSR       READAD1           READ THE AD CONVERTER
          BCS.S     LOCERR1           READ ERR IF CARRY SET
          MOVE.W    D0,D3             SAVE READING IN D3
          JSR       CHECK0            TEST WRITTEN TO READ
          BGT.S     LOCERR2           ERROR IF GREATER THAN
          MOVE.W    D1,D0             RESTORE CNTRL WRD & CH
          ADD.W     #1,DO             INCREMENT CHANNEL ADDR
          CMP.W     LDONE,D0          ARE WE PAST THE LAST CH?
          BLT.S     NXTCH             IF LESS THAN DO NXT CHAN..
          ADD.W     NXTLVL,D2         INCREMENT DAC UPDATE VALUE
          BCC.S     NXTLD             IF NOT CARRY REPEAT CH TEST
          JSR       PASS              TEST PASSED SUB..
          JMP       MAIN              BACK TO MAIN MENU

*         HANDLE LOCAL CHANNEL ERRORS...

LOCERR1   DISPLAY   FAILED            SHOW TESTS FAILED
          DISPLAY   ERR03             READ ADC ERROR
          JMP       MAIN              BACK TO MAIN MENU
LOCERR2   DISPLAY   FAILED            SHOW FAILED
          JSR       BREAKOUT          SHOW WHAT FAILED...
          JMP       MAIN              GOTO MAIN MENU
```

M3101A/F4.6.3-4/2

Figure 4.6.3-4. Program Example - Input Multiplexer Zero Correction (Page 2 of 2)

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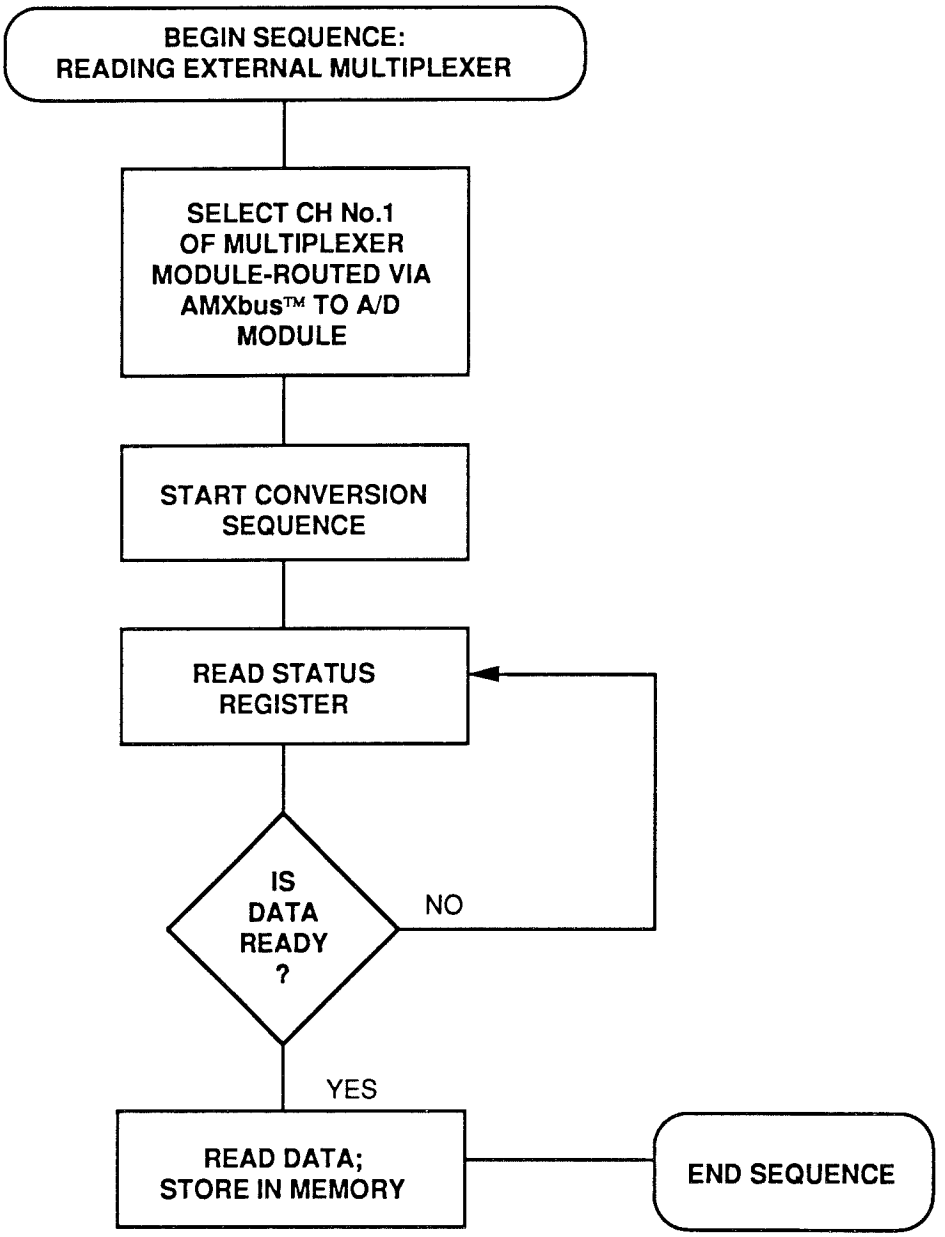


Figure 4.8-1. Program Flowchart - Reading External Multiplexer Inputs

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```
*****************************************************************
*                                                               *
*        AMXbus™ BACKPLANE (P2) TESTS                           *
*        ----------------------------------------               *
*        TWO ENTRY POINTS:  1. EXMUXBUS SINGLE ENDED            *
*                           2. EXMUXBUS DIFFERENTIAL            *
*                                                               *
*****************************************************************

*        EXMXBS SINGLE ENDED MODE ENTRY

EXMXSE   EQU        *
         DISPLAY    MSG09            SHOW TESTING EXMXBS S.E.
         MOVE.W     #$20C0,D1        3101 READING THRU EXMXBS
         MOVE.W     #$60,D4          USE D4 TO CARRY TEST MODE
         BRA.S      EXMXBS           DO EXTERNAL MUX BUS TEST

*        EXMXBS DIFFERENTIAL MODE ENTRY

EXDIFF   EQU1       *
         DISPLAY    MSG10            SHOW TESTING EXMXBS DIFF.
         MOVE.W     #$2040,D1        3101 DIFFERENTIAL MODE ADC
         MOVE.W     #$60,D4          USE D4 T0 CARRY TEST MODE

*        DO INIT'S AND INITIAL READ BEFORE TEST LOOP

EXMXBS   EQU        *
         MOVE.W     #$2000,ADELAY    INIT ADC READ DELAY
         MOVE.W     #1000,DACDLY     INIT DAC LOAD DELAY
         MOVE.W     #$000A,ALLOW     INIT ERROR ALLOWANCE
         MOVE.W     #$5C00,DAC.CR    WRITE 4116 CONTROL WORD
         CLR.W      D2               CLR D2 FOR DAC UPDATE VAR

*        DO AN INITIAL READ BEFORE LOOPING

         MOVE.W     D4,MUX.CR        SET UP THE MULTIPLEXER..
         MOVE.W     D1,D0            GET CONTROL WORD FOR 3101
         JSR        READAD2          AND GO DO AN INITIAL READ
         BCS.S      EXERR1           USE READ ERROR HANDLER
```

M3101A/F4.8-2/1

Figure 4.8-2. Program Example - Reading External Multiplexer Inputs (Page 1 of 2)

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```
*         EACH PASS THRU NXTMUX SETS A NEW TEST LEVEL..

NXTMUX    MOVE.W    D4,MUX.CR        SET UP THE MULTIPLEXER
          JSR       LDDACS           USE LDDACS FOR LOAD DLY
          MOVE.W    D1,D0            RESTORE CONTROL WORD
          JSR       READAD2          WRITE CTRL, READ CONV'N
          BCS.S     EXERR1           READ ERROR IF CARRY SET
          MOVE.W    D0,D3            SAVE READ DATA IN D3
          JSR       CHECK1           TEST WRITTEN TO READ
          BGT.S     EXERR2           ERROR IF STILL GREATER
          ADD.W     NXTLVL,D2        INCREMENT DAC VALUE
          BCC.S     NXTMUX           CONTINUE UNTIL CARRY
          JSR       PASS             TEST PASSED SUB
          JMP       MAIN             AND GOTO MAIN MENU.

*         HANDLE EXMUXBS ERROR..

EXERR1    DISPLAY   FAILED           READ ERROR HANDLER
          DISPLAY   ERR03            SHOW READ ERROR MSG
          JMP       MAIN             AND GOTO MAIN MENU
EXERR2    DISPLAY FAILED             TOLERANCE ERROR HANDLER
          JSR       BREAKOUT         AND BREAKOUT READINGS
          JMP       MAIN             GOTO MAIN MENU
```

M3101A/F4.8-2/2

Figure 4.8-2. Program Example - Reading External Multiplexer Inputs (Page 2 of 2)

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The reader should refer to the programming requirements of the selected VMIVME-41XX Analog Output Board for a thorough understanding of programming requirements. This example utilizes the VMIVME-4100 Board whose base board address was selected at FF0060 (HEX). The program example ramps the analog output from its minimum value 000 (HEX) to its maximum value FFF (HEX) by incrementing one LSB each time through the test loop. Channels 1 through 16 are multiplexed, one at a time, to the A/D Board via the AMXbus™. The analog value is digitized and compared to the original value written to the analog output channel. A flowchart of the programming sequence is shown in Figure 4.9-1, and the assembly language listing is shown in Figure 4.9-2.

4.10 USING THE VMIVME-4100 BOARD TO VERIFY THE VMIVME-3200

A dedicated test bus (TEST BUS 1) on the AMXbus™ supports multiplexed analog outputs from the VMIVME-4100 to the VMIVME-3200. This analog output can be routed through all 32 channels of the multiplexing logic on the VMIVME-3200 Board. This signal is then multiplexed via the AMXbus™ to the A/D Board for conversion. This design concept uses any channel of any VMIVME-4100 Board as a dynamic source for testing VMIVME-3200 multiplexer boards. Prior to testing the VMIVME-3200, the user executes diagnostics on the VMIVME-3101A ADC for verification, followed by diagnostics on the VMIVME-4100 Boards. Upon successful completion of diagnostics on these boards, the user executes diagnostics on all VMIVME-3200 Boards in the system. The program shown in Figure 4.8-2 uses only Channel 1 of the VMIVME-4100 and increments from -10 to +10 V signals (or 000 (HEX) to FFF (HEX) one count at a time through each multiplexer channel. The programming sequence is shown in Figure 4.8-1.

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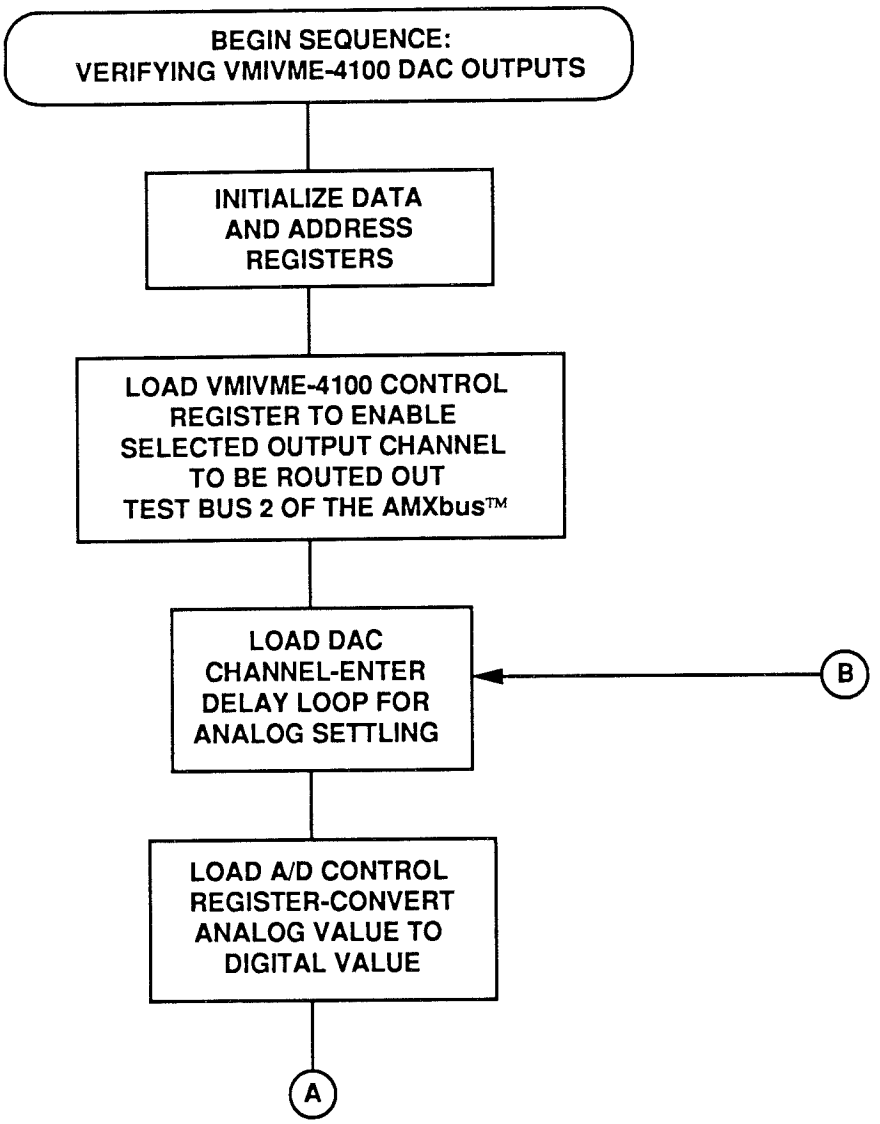


Figure 4.9-1. Program Flowchart - Verifying the VMIVME-4100 DAC Outputs (Page 1 of 2)

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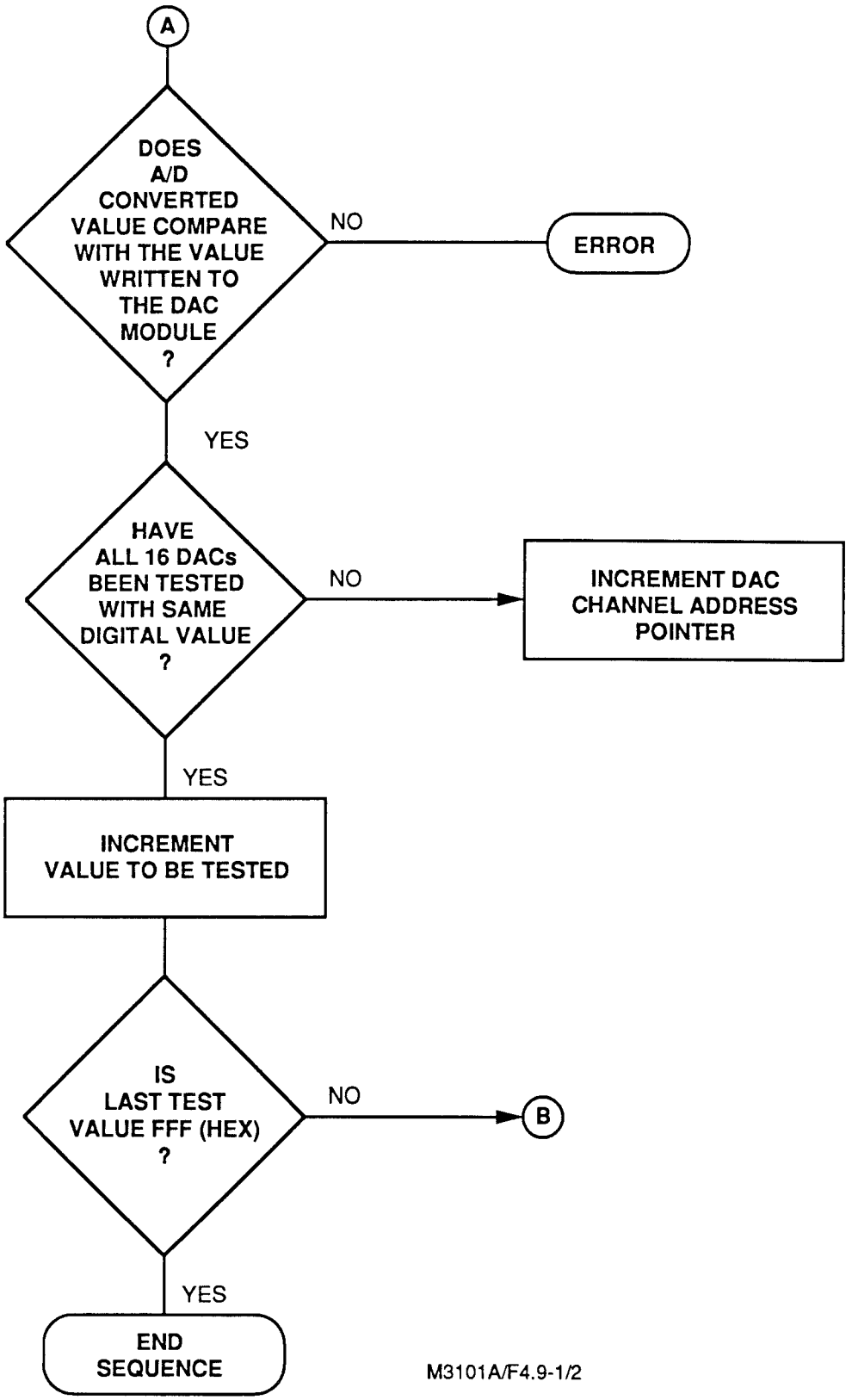


Figure 4.9-1. Program Flowchart - Verifying the VMIVME-4100 DAC Outputs (Page 2 of 2)

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```
*****************************************************************
*                                                               *
*       AOTESTBS TEST FOR ADC:                                  *
*                                                               *
*****************************************************************

TSTBS2   EQU       *
         DISPLAY   MSG11           SHOW AOTESTBS TESTING

*        DO INIT'S FOR AOTESTBS TESTING....

         MOVE.W    #$2000,ADELAY   INIT READ DELAY VAR
         MOVE.W    #1000,DACDLY    INIT DAC LOAD DELAY
         MOVE.W    #$000A,ALLOW    INIT ERROR ALLOWANCE
         MOVE.W    #$6C00,DAC.CR   CONTROL WORD FOR DAC'S
         MOVE.W    #$2840,D1       CONTROL WORD FOR 3101
         CLR.W     D2              CLR D2 DAC UPDATE VAR

*        DO AN INITIAL AOTESTBS READING

         MOVE.W    D1,D0           GET 3101 CONTROL WORD
         JSR       READAD2         DO THE INITIAL READ
         BCS.S     TB2ERR1         READ ERROR IF CARRY SET

*        EACH PASS THRU NXTBS2 SET A NEW TEST LEVEL..

NXTBS2   JSR       LDDACS          LOAD UP THE DA CHANNELS
         MOVE.W    D1,D0           CTRL WORD FOR 3101 INPUT
         JSR       READAD1         WRT CTRL WORD READ CONV
         BCS.S     TB2ERR1         READ ERROR IF CARRY SET
         JSR       CHECR1          TEST WRITTEN TO READ
         BGT.S     TB2ERR2         ERROR IF GREATER THAN
         ADD.W     NXTLVL,D2       INCREMENT DAC VARIABLE
         BCC.S     NXTBS2          CONTINUE ON CARRY NOT SET
         JSR       PASS            TEST PASSED SUB...
         JMP       MAIN            AND GO TO MAIN MENU.

*        HANDLE AOTESTBS ERROR..

TB2ERR1  DISPLAY   FAILED          SHOW ROUTINE FAILED
         DISPLAY   ERR03           SHOW READ ERROR
         JMP       MAIN            & GOTO MAIN MENU
TB2ERR2  DISPLAY   FAILED          SHOW TEST FAILED
         JSR       BREAKOUT        BREAKOUT ERR DATA
         JMP       MAIN            & GOTO MAIN MENU
```

M3101A/F4.9-2

Figure 4.9-2. Program Example - Verifying the VMIVME-4100 DAC Outputs

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SECTION 5

CONFIGURATION AND INSTALLATION

5.1 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. UNUSED BOARDS SHOULD BE STORED IN THE SAME PROTECTIVE BOXES IN WHICH THEY WERE SHIPPED. WHEN THE BOARD IS TO BE LAID ON A BENCH FOR CONFIGURING, ETC., IT IS SUGGESTED THAT CONDUCTIVE MATERIAL BE INSERTED UNDER THE BOARD TO PROVIDE A CONDUCTIVE SHUNT.

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 disposition of the damaged item(s).

5.2 PHYSICAL INSTALLATION

CAUTION

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.

5.3 BEFORE APPLYING POWER: CHECKLIST

Before installing the board in a VMEbus system, check the following items to ensure that the board is ready for the intended application.

a. Have the sections pertaining to theory and programming, Sections 3 and 4, been reviewed and applied to system requirements?

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b. Review Section 5.4.1 and Figures 5.3-1 and 5.3-2 to verify that all factory installed jumpers are in place. _____

1. To change board address or address modifier response, refer to Section 5.4.2.
2. To modify the analog input voltage range, refer to Section 5.4.3.
3. To select two's complement or binary coding, refer to Section 5.4.4.
4. To select differential or single-ended input filters, refer to Section 5.4.5.

c. Has the I/O cable, with the proper mating connector, been connected to the Analog Input connector? _____

d. Calibration has been performed at the factory. If recalibration may be required, refer to Section 5.5. _____

After the checklist above has been completed, the A/D converter board can be installed in a VMEbus system (**DO NOT** install or remove the board with power applied). This board may be installed in any slot position, except slot-one which is usually reserved for the master processing unit.

```
**********
*  CAUTION  *
**********
```

DO NOT INSTALL OR REMOVE THE BOARD WITH POWER APPLIED TO THE SYSTEM.

5.4 OPERATIONAL CONFIGURATION

Control of the VMIVME-3101A operational configuration is determined by on-board jumpers. Most of these jumpers are implemented with removable shorting plugs, and can be rearranged in the field to conform to individual user requirements. Certain jumpers which are associated with specific options however, are wirewrapped at the factory and should not be removed or altered.

This section discusses both categories of configuration jumpers, and describes their effects on board performance. Figure 5.3-1 shows the locations of all VMIVME-3101A jumpers. Table 5.4-1 lists the functions of all VMIVME-3101A jumpers.

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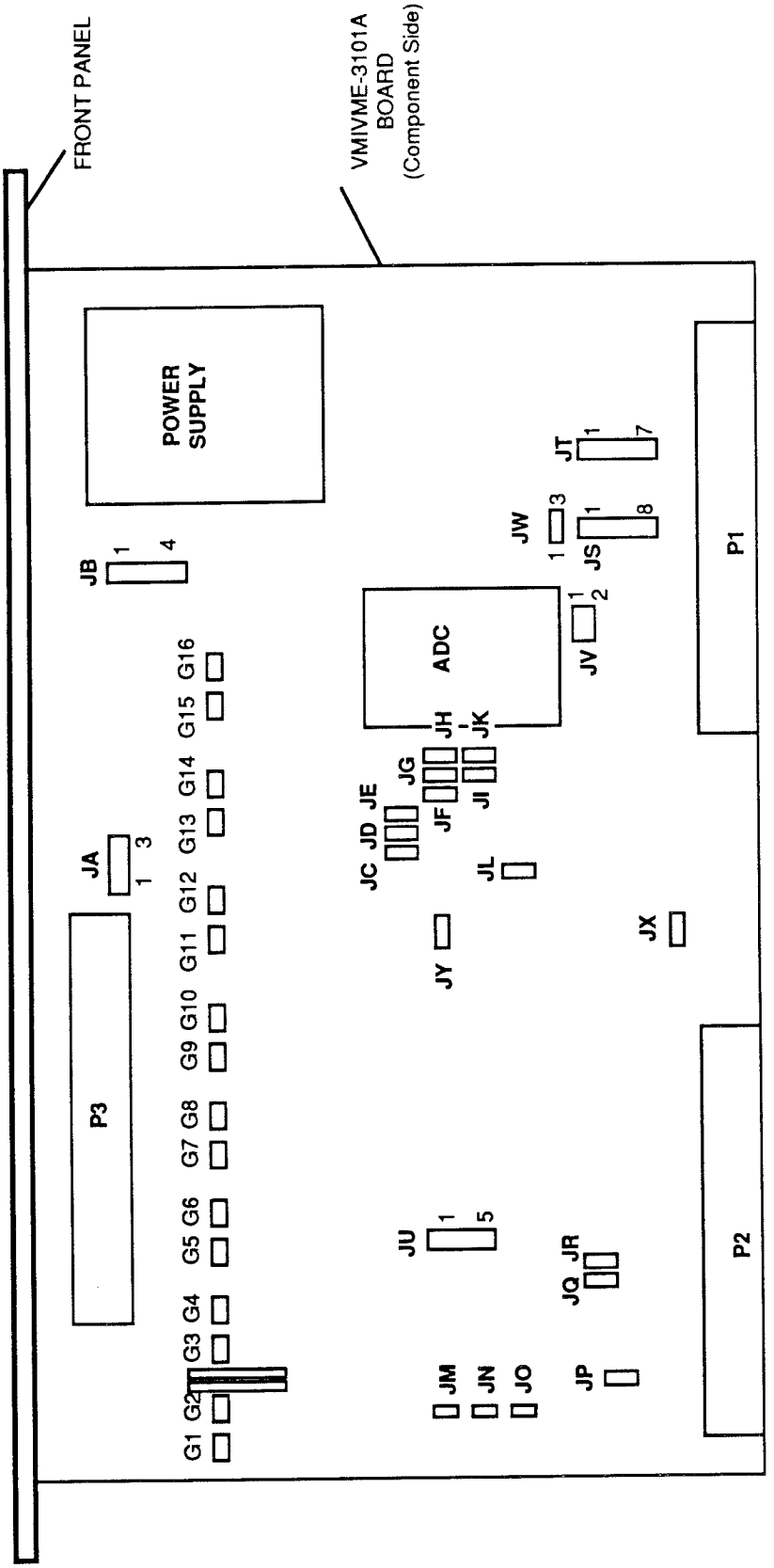


Figure 5.3-1. Jumper Locations

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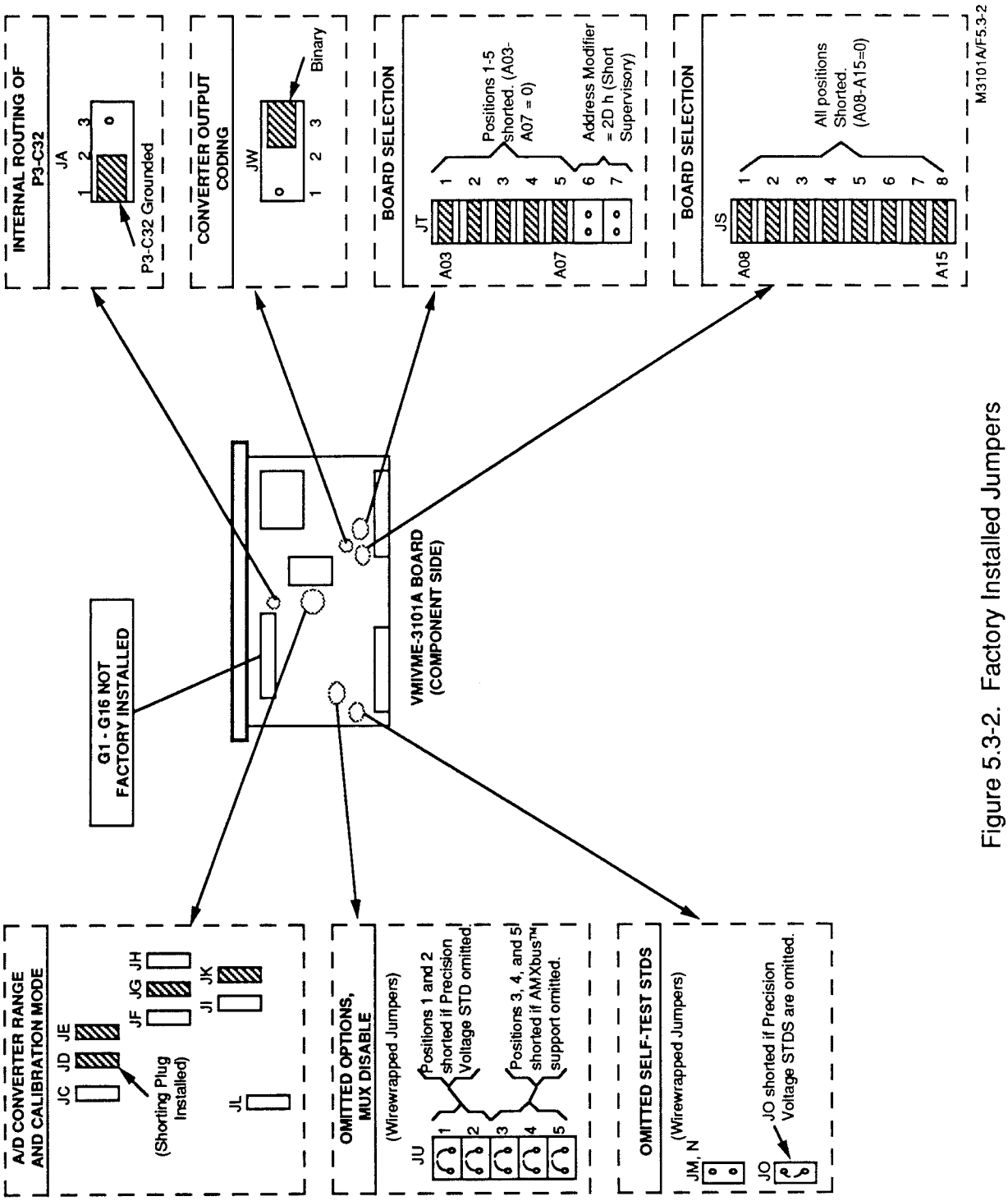


Figure 5.3-2. Factory Installed Jumpers

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Table 5.4-1. Programmable Jumper Functions

JUMPER IDENTIFICATION	FUNCTION (INSTALLED)	ALTERABLE	FACTORY CONFIGURATION
JA-1 to JA-2	Pin C32 of I/O connector P3 is connected to Local Ground Sensors	YES	INSTALLED
JA-2 to JA-3	Pin C32 of P3 is connected to the Precision Voltage STANDARDS network	YES	- - -
JB-1	(Reserved)	NO	- - - (Omitted)
JB-4	Forces the Precision Voltage STDS voltage to 10 V.	YES	- - -
JB-3	Forces the Precision Voltage STDS voltage to 5 V.	YES	- - -
JB-2	Forces the Precision Voltage STDS voltage to 2.5 V.	YES	- - -
JC	Selects AUTO-ZERO adjustment.	YES	(5)
JD	Selects MANUAL GAIN adjustment.	YES	(1)
JE	Selects MANUAL ZERO adjustment.	YES	(1)
JF	Voltage configuration (6)	YES	- - -
JG	Voltage configuration (6)	YES	INSTALLED
JH	Voltage configuration (6)	YES	INSTALLED
JI	Voltage configuration (6)	YES	- - -
JK	Voltage configuration (6)	YES	INSTALLED
JL	Selects AUTO-GAIN adjustment.	YES	(5)
JM, JN	Disable Built-in-Test MUX (Both required).	NO	(2)
JO	Disable LIVE ZERO.	NO	(3)
JP	Disable LOCAL GND SENSE.	YES	- - -
JQ, JR	Enable AMXbus™ filter (Both required).	YES	- - -
JS, JT	Select board address and I/O access mode.	YES	ADDRESS 000 HEX SHORT SPVSR I/O
JU-1, 2	Disable Precision Voltage STDS (Both required).	NO	(3)
JU-3, 4, 5	Disable AMXbus™ inputs.	NO	(4)
JV-1	Select 11-bit conversion resolution.	YES	- - -
JV-2	Select 10-bit conversion resolution.	YES	- - -
JW-1 to JW-2	Selects two's complement converter coding.	YES	- - -
JW-2 to JW-3	Selects binary conversion coding.	YES	INSTALLED
JX-1 to JX-2	Autocalibration	NO	(7)
JX-2 to JX-3	Autocalibration	NO	(8)
G1-G16	Selects filter mode: Install for single-ended operation. Omit for differential operation.	YES	- - -
JY	Gain response	NO	(8)

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NOTES:
1. Installed if Autocalibration option is omitted.
2. (Reserved) Omitted in factory configuration.
3. Installed if Precision Voltage STANDARDS option is omitted.
4. Installed if AMXbus™ SUPPORT option is omitted.
5. Installed if Autocalibration option is selected.
6. See Table 5.4.3-1 for voltage configurations.
7. Installed if U33 is a DATEL 811.
8. Installed if U33 is a DDC 404.

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5.4.1 Factory Installed Jumpers

Each VMIVME-3101A Board is configured at the factory with a specific jumper arrangement. Figure 5.3-2 and Table 5.4-1 show the factory configuration, and indicates which jumpers are user-alterable and which are not.

Modification of "nonalterable" jumpers may cause unpredictable or erratic operation of the VMIVME-3101A Board. For this reason, jumpers which Table 5.4-1 indicates are not alterable are installed as wirewrapped jumpers.

The factory configuration establishes the following functional baseline for the VMIVME-3101A Board and ensures that all essential jumpers are installed. Figure 5.3-2 shows the locations of all factory installed jumpers.

a. Board Short I/O Address is set at 0000 HEX

b. I/O Access Mode is Short Supervisory

c. The A/D converter is configured for the ±10 V range

d. A/D conversion coding is Offset Binary

e. Front Panel (P3) input filters are differential

f. Manual GAIN/ZERO calibration is selected if the Autocalibration option is omitted

g. Pin C32 of the front panel I/O connector (P3) is connected to the external P3 return

5.4.2 Board Address and Address Modifier Selection

Jumper headers JS and JT permit the VMIVME-3101A Board to be located on any 8-byte boundary within the short I/O address space available from the VMEbus (see Sections 3.4 and 4.1). The short I/O address space consists of all address between XXXX0000 HEX and XXXXFFFF HEX. XXXX is CPU dependent. Two lines are used for decoding on-board functions (Section 4.1). The VMIVME-3101A Board location is defined by 13 lines, address bits A03 through A15.

JS and JT are programmed by installing shorting plugs at all "zero" or LOW address bit positions, and by omitting the shorting plugs at the "one" or HIGH positions. Address bits A03 through A07 are located on header JT, and bits A08 through A15 appear on JS (see Figure 5.3-2). Address bit A03 has a weight of eight-byte locations.

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As an example, the following jumper arrangement shown in Table 5.4.2-1 would produce a board address of XXXX8F08 HEX:

Table 5.4.2-1. Board Address XXXX8F08 HEX Selection

JT			JS		
POSITION	ADDRESS BIT	STATE *	POSITION	ADDRESS BIT	STATE *
1	A03	OPEN	1	A08	OPEN
2	A04	SHORTED	2	A09	OPEN
3	A05	SHORTED	3	A10	OPEN
4	A06	SHORTED	4	A11	OPEN
5	A07	SHORTED	5	A12	SHORTED
			6	A13	SHORTED
* SHORTED = "zero" OPEN = "one"			7	A14	SHORTED
			8	A15	OPEN

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I/O access mode is programmed by selecting address modifier AM2 at positions 6 and 7 of JT. Table 5.4.2-2 shows how the VMIVME-3101A can be programmed for short supervisory access (AM = 2D HEX), or short nonprivileged access (AM = 29 HEX), or both of these access modes simultaneously.

Table 5.4.2-2. I/O Access Mode Selection

JT JUMPER POSITION		I/O ACCESS MODE
6	7	
OPEN	OPEN	SHORT SUPERVISORY
SHORTED	OPEN	SHORT NONPRIVILEGED
OPEN	SHORTED	SHORT SUPERVISORY OR NONPRIVILEGED

M3101A/T5.4.2-2

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5.4.3 Analog Input Voltage Range Selection

As it is indicated in the Electrical Specifications (Document Number 800-103101-000), either three or five voltage ranges are available for the VMIVME-3101A Board. Jumpers JF through JK control the ranges and are identified in Table 5.4.3-1. The board is factory configured for ±10 V range.

Table 5.4.3-1. Voltage Range Configuration

	JF	JG	JH	JI	JK
±10 V	OFF	ON	OFF	OFF	ON
±5 V	ON	OFF	OFF	OFF	ON
±2.5 V(1)	ON	OFF	ON	OFF	ON
0 to +5 V(1)	ON	OFF	ON	ON	OFF
0 to +10 V	ON	OFF	OFF	ON	OFF

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(1) Not available on 3 voltage range option. Refer to Table 2.4-1 for ordering information.

5.4.4 Converter Output Coding

Jumper header JW (see Table 5.4-1) controls the conversion output coding format. For two's complement coding, install a shorting plug between pins 1 and 2 on JW. For binary coding, install the shorting plug between pins 2 and 3. (Binary coding will be straight-binary for unipolar ranges, and offset-binary for bipolar ranges).

5.4.5 Differential/Single-Ended Input Mode Selection

INPUT FILTERS. If the VMIVME-3101A Board is equipped with the input filter option, jumpers G1 through G16 ("grounding jumpers"), located near the I/O connector P3 (see Figure 5.3-1), can be used to configure the analog inputs as either differential pairs or single-ended inputs. Unless ordered otherwise, the board is delivered without the grounding jumpers, thereby configuring all inputs as differential pairs.

To convert any input pair into two individual single-ended inputs, simply install a shorting plug at the associated grounding jumper location. The number in the grounding jumper designation corresponds to the next lower differential channel pair-number, as they are listed in Table 5.4.5-1. For example, to convert differential channel "04" pair (P3 pins A9 and C9) to single-ended inputs, install a shorting plug at grounding jumper "G6".

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Table 5.4.5-1. P3 Connector (Front Panel Inputs) Signal Assignments

SINGLE-ENDED INPUTS			DIFFERENTIAL INPUTS	
PIN NO.	ROW-A SIGNAL	ROW-C SIGNAL	ROW-A SIGNAL	ROW-C SIGNAL
1	CH 00	CH 16	CH 00 HIGH	CH 00 LOW
2	GND SEN	GND SEN	GND SEN	GND SEN
3	CH 01	CH 17	CH 01 HIGH	CH 01 LOW
4	GND SEN	GND SEN	GND SEN	GND SEN
5	CH 02	CH 18	CH 02 HIGH	CH 02 LOW
6	GND SEN	GND SEN	GND SEN	GND SEN
7	CH 03	CH 19	CH 03 HIGH	CH 03 LOW
8	GND SEN	GND SEN	GND SEN	GND SEN
9	CH 05	CH 20	CH 04 HIGH	CH 04 LOW
10	GND SEN	GND SEN	GND SEN	GND SEN
11	CH 04	CH 21	CH 05 HIGH	CH 05 LOW
12	GND SEN	GND SEN	GND SEN	GND SEN
13	CH 06	CH 22	CH 06 HIGH	CH 06 LOW
14	GND SEN	GND SEN	GND SEN	GND SEN
15	CH 07	CH 23	CH 07 HIGH	CH 07 LOW
16	GND SEN	GND SEN	GND SEN	GND SEN
17	CH 08	CH 24	CH 08 HIGH	CH 08 LOW
18	GND SEN	GND SEN	GND SEN	GND SEN
19	CH 09	CH 25	CH 09 HIGH	CH 09 LOW
20	GND SEN	GND SEN	GND SEN	GND SEN
21	CH 10	CH 26	CH 10 HIGH	CH 10 LOW
22	GND SEN	GND SEN	GND SEN	GND SEN
23	CH 11	CH 27	CH 11 HIGH	CH 11 LOW
24	GND SEN	GND SEN	GND SEN	GND SEN
25	CH 12	CH 28	CH 12 HIGH	CH 12 LOW
26	GND SEN	GND SEN	GND SEN	GND SEN
27	CH 13	CH 29	CH 13 HIGH	CH 13 LOW
28	GND SEN	GND SEN	GND SEN	GND SEN
29	CH 14	CH 30	CH 14 HIGH	CH 14 LOW
30	GND SEN	GND SEN	GND SEN	GND SEN
31	CH 15	CH 31	CH 15 HIGH	CH 15 LOW
32	GND SEN	*	GND SEN	*

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*Jumper-selectable as either GND SEN or EXT CAL REF.

→ LD < /MTH/FILE.O

→ TFST3101. 0XF8FF0000

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PSEUDO-DIFFERENTIAL INPUT MODE. When a shorting plug is installed at jumper JP, all single-ended input voltages will be measured in reference to the VMIVME-3101A internal signal return. To reference all single-ended inputs to the remote ground-sense line, omit or remove the JP jumper, jumper JA pin 1 to pin 2, and connect the remote ground-sense line(s) to any or all of the GND SEN pins listed in Table 5.4.5-1.

```
*****************
*    CAUTION    *
*****************
```

ANY UNUSED INPUT ON THE P3 CONNECTOR MUST BE CONNECTED TO ANY OTHER USER INPUT OR SIGNAL RETURN ON THE P3 CONNECTOR. (SEE TABLE 5.4.5-1 FOR P3 PINOUT DESCRIPTION); FLOATING INPUTS ON THE P3 CONNECTOR MAY CAUSE ERRATIC OPERATION.

5.5 CALIBRATION

Before delivery from the factory, the VMIVME-3101A Board is fully calibrated to ±10 V operation and conforms to all applicable specifications listed in Document Number 800-103101-000. Should recalibration be required, refer to the appropriate following sections for the correct procedures to use. The locations of all adjustments and test points are shown in Figure 5.5-1.

As delivered from the factory, all calibration adjustments are sealed against accidental movement. The seals are easily broken for recalibration however, and the adjustments should be resealed afterward with a suitable, fast-curing sealing compound.

```
*****************
*    CAUTION    *
*****************
```

DO NOT INSTALL OR REMOVE THE BOARD WITH POWER APPLIED TO THE SYSTEM.

If the AUTOCALIBRATION option is installed on the board, calibration of the A/D converter can be performed by a VMEbus processor while the board is operating within a system (see Section 4.6). If this option is not present, or is not implemented by the VMEbus system software, then calibration must be carried out manually.

If the board is equipped with the PRECISION VOLTAGE STANDARDS or AUTOCALIBRATION option, begin the calibration with Section 5.5.1. If these options are not present, skip Section 5.5.1 and proceed to either Section 5.5.2 or Section 5.5.3.

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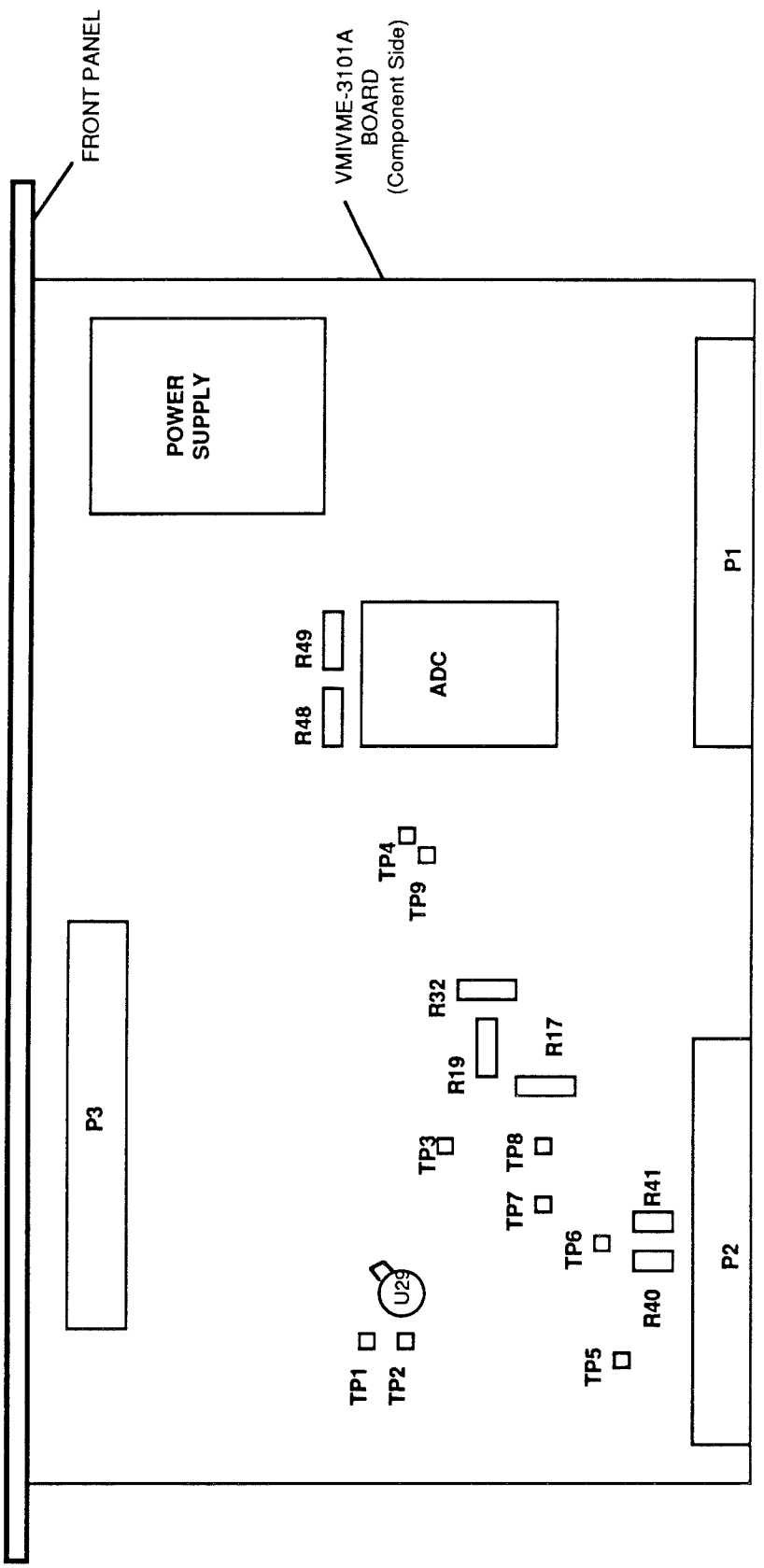


Figure 5.5-1. Testing and Adjustment Locations

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The procedure outlined in Section 5.5.2 descibes manual calibration of the VMIVME-3101A Board, using the on-board PRECISION VOLTAGE STANDARDS option. If the board is not equipped with this option, Section 5.5.3 descibes the manual calibration procedure, using an external voltage source.

5.5.1 Precision Voltage Standards Calibration

The VMIVME-3101A precision voltage standards are highly stable and should rarely, if ever, require recalibration. Drift rates are approximately 1 to 2 PPM per year and 1 to 2 PPM per degree centigrade.

Should recalibration of the on-board standards be desired however, carry out the following procedure:

a. Install the VMIVME-3101A Board on an extender board in a VMEbus backplane. If a VMEbus backplane is not available at the calibration facility, apply regulated 5 VDC power to the VMEbus I/O connector P1 as follows:

+5 VDC:	P1 pins A32, B32, C32
5 V RETURN:	P1 pins A9, C9, A11, A15, A17, A19

b. Allow a minimum warm-up interval of 10 minutes after power has been applied, before proceeding with calibration.

c. Using a 0.0015 percent 6-digit digital voltmeter (DVM), perform the adjustments listed in Table 5.5.1-1a, starting with the +10 V reference, and proceeding through the remaining adjustments in the sequence shown. For each adjustment:

   1. Install a shorting plug at the indicated "JB" jumper position. (Install only one shorting plug at a time in the JB header.)

   2. Connect the POSITIVE test lead of the DVM to the indicated test point, and the NEGATIVE test lead to TP8.

   3. Adjust the indicated potentiometer until the DVM displays a voltage within the "Acceptance Range". (Refer to Figure 5.5-1 for test point and potentiometer locations.)

5.5.2 Manual Range Calibration with On-Board Voltage Source

Use the following procedure to manually calibrate the converter voltage range, if the board is equipped with the PRECISION VOLTAGE STANDARDS option.

a. Verify that the on-board precision voltage standard voltages are adjusted correctly, as described in Section 5.5.1.

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Table 5.5.1-1. Manual Calibration Adjustments with On-Board Voltage Source

a. SELF-TEST STANDARDS:

CALIBRATION FUNCTION	ADJUSTMENT POTENTIOMETER	ACCEPTANCE RANGE(1)		"JB" JUMPER POSTION	TEST POINT
		MAX	MIN		
+10 V REF.	R50	+9.9723 VDC	+9.9697 VDC	4	TP7
+5 V REF.	R19	+4.9866 VDC	+4.9854 VDC	3	TP7
+2.5 V REF.	R17	+2.4935 VDC	+2.4925 VDC	2	TP7
LIVE ZERO	R40	-0.0045 VDC	-0.0055 VDC	2	TP6
-10 V REF.	R41	-9.9685 VDC	-9.9735 VDC	4	TP5

b. UNIPOLAR A/D CONVERTER:

CALIBRATION FUNCTION	ADJUSTMENT POTENTIOMETER	ACCEPTANCE RANGE(1)		CONTROL WORD, HEX(2)
		MAX	MIN	
LIVE ZERO	R48	0009	0007	2247
GAIN (0 to +10 V Range)	R49	0FF5	0FF3	2240
(0 to +5 V Range)	R49	0FF5	0FF3	2241

c. BIPOLAR A/D CONVERTER:

CALIBRATION FUNCTION	ADJUSTMENT POTENTIOMETER	ACCEPTANCE RANGE(1)		CONTROL WORD, HEX		
		MAX	MIN	POS FULL-SCALE	NEG FULL-SCALE	ZERO
GAIN						
(±10 V Range)	R49	0FF5 (3)	0FF3 (3)	2240	2246	
(±5 V Range)	R49	0FF5 (3)	0FF3 (3)	2241	2245	
(±2.5 V Range)	R49	0FF5 (3)	0FF3 (3)	2242	2244	
DEAD ZERO	R48	0801	07FF			2243

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NOTES:
1. Connect the digital voltmeter POSITIVE lead to the indicated test point and the NEGATIVE lead to TP8.
2. Write the indicated control word to the CONTROL REGISTER at board address 0000 HEX (see Section 4.1).
3. Subtract the negative full-scale reading from the positive full-scale reading. Adjust R48 if either reading is 0000 or 0FFF HEX.

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b. Apply power to the board, and allow 10 minutes for warm-up before proceeding.

c. Through the VMEbus write the first control word indicated in Table 5.5.1-1 to the VMIVME-3101A Control Register at board address 0000 HEX. If the board is configured for unipolar measurements, use Table 5.5.1-1b; if configured for bipolar measurements, use Table 5.5.1-1c.

d. Perform an A/D conversion, as described in Section 4-5; then read the converter (Section 4.5.1).

e. Adjust the potentiometer indicated in Table 5.5.1-1; then repeat Step d, above. Several repetitions of Steps d and e may be necessary to obtain the required converter reading. (Refer to Figure 5.5-1 for test point and potentiometer locations.)

f. Write the next control word to the Control Register, and repeat Steps d and e above.

g. Repeat Step f until all adjustments indicated in the pertinent section of Table 5.5.1-1 have been completed.

h. Seal all potentiometers. Calibration is completed.

5.5.3 Manual Calibration with External Voltage Source

Use the following procedure to calibrate the converter voltage range if the board IS NOT equipped with the SELF-TEST STANDARD option:

a. Remove cable connections from I/O connector P3.

b. Connect a precision voltage source between pins A1 (POS) and A2 (NEG) on P3. (The voltage source should have an accuracy of ±0.01 percent of reading, ±0.000 V, and an adjustment range of 0 to 9.999 V in 0.0001 V steps.)

c. Apply power to the board. Allow 10 minutes for warm up.

d. Adjust the voltage source to the first INPUT VOLTAGE as indicated in Table 5.5.3-1. If the board is configured for unipolar measurements use Table 5.5.3-1a; if configured for bipolar measurements use Table 5.5.3-1b. (Reverse the voltage source test leads, if necessary to obtain a negative input voltage.)

e. Write the control word "21C0 HEX" to the Control Register at board-address 0000.

f. Perform an A/D conversion, as described in Section 4-5; then read the converter (Section 4.5.1).

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Table 5.5.3-1. Manual Calibration Adjustments with External Voltage Source

a. UNIPOLAR A/D CONVERTER:

CALIBRATION FUNCTION	ADJUSTMENT POTENTIOMETER	ACCEPTANCE RANGE (1)		INPUT VOLTAGE (VDC)
		MAX	MIN	
LIVE ZERO				
(0 to +10 V Range)	R48	0009	0007	+0.020 ±0.0010
(0 to +5 V Range)	R48	0009	0007	+0.010 ±0.0005
GAIN (0 to +10 V Range)	R49	0FF5	0FF3	+9.971 ±0.0010
(0 to +5 V Range)	R49	0FF5	0FF3	+4.986 ±0.0005

b. BIPOLAR A/D CONVERTER:

CALIBRATION FUNCTION	ADJUSTMENT POTENTIOMETER	ACCEPTANCE RANGE (1)		INPUT VOLTAGE (VDC)		
		MAX HEX	MIN HEX	POS FULL-SCALE	NEG FULL-SCALE	Zero
GAIN (±10 V Range)	R49	0FF5 (1)	0FF3 (1)	+9.971 ±0.0010	-9.971 ±0.0010	
(±5 V Range)	R49	0FF5 (1)	0FF3 (1)	+4.986 ±0.0005	-4.986 ±0.0005	
(±2.5 V Range)	R49	0FF5 (1)	0FF3 (1)	+2.493 ±0.0003	-2.493 ±0.0003	
DEAD ZERO	R48	0801	07FF			±0.0003

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NOTES: 1. Subtract the negative full-scale reading from the positive full-scale reading. Adjust R48 if either reading is 000 or 0FFF HEX.

g. Adjust the potentiometer indicated in Table 5.5.3-1; then repeat Step f, above. Several repetitions of Steps f and g may be necessary to obtain the required converter reading. (Refer to Figure 5.5-1 for test point and potentiometer locations.)

h. Repeat Steps e, f, and g until all adjustments indicated in the pertinent section of Table 5.5.3-1 have been completed.

i. Seal all potentiometers. Calibration is completed.

5.6 CONNECTOR DESCRIPTIONS

Two connectors, P1 and P2, connect the VMIVME-3101A Board to the VMEbus backplane. The connectors are 96-pin DIN type. The primary connector, P1, contains the address data and control lines and all additional signals necessary to control data transfer and other bus functions. The P2 user I/O pins are used by the AMXbus™ for controlling external multiplexer expansion boards and for testing VMIC's analog output boards. The P2 connector pin and signal assignments are shown in Figure 5.6-1 and Table 5.6-1.

The AMXbus™ backplane is used when the user requires an off-board multiplexer expansion unit (VMIC 32XX Series) or when the built-in-test is desired using the VMIVME-41XX Series analog output board(s). The AMXbus™ is a low-noise backplane, available in 5, 9, 14, or 19 slots.

The P3 connector is a Panduit 64-pin male connector, type 120-964-033A. The matching Panduit connector for the input cable is a female connector, type 120-964-435E. This connector supports the 32 single-ended or 16 differential analog inputs each with an associated analog ground pin. For P3 connector pin and signal assignments, refer to Figure 5.6-2 and Table 5.4.5-1. The board may be ordered in a 16 single-ended/8 differential channel option. In this configuration the 16 single-ended channels supported are Channels 0 through 7 and Channels 16 through 23, as shown in Table 5.4.5-1.

All even-numbered pins in the P3 connector, except the C32 pin, are connected to the LOCAL GND SEN trace on the VMIVME-3101A Board ("GND SEN" in Table 5.5.3-1). The GND SEN pins should be connected to analog ground in the remote device, in order to minimize the effect of differences in ground potentials throughout the system. If the GND SEN pins are left open, the VMIVME-3101A internal analog ground will be used as the return for all single-ended measurements.

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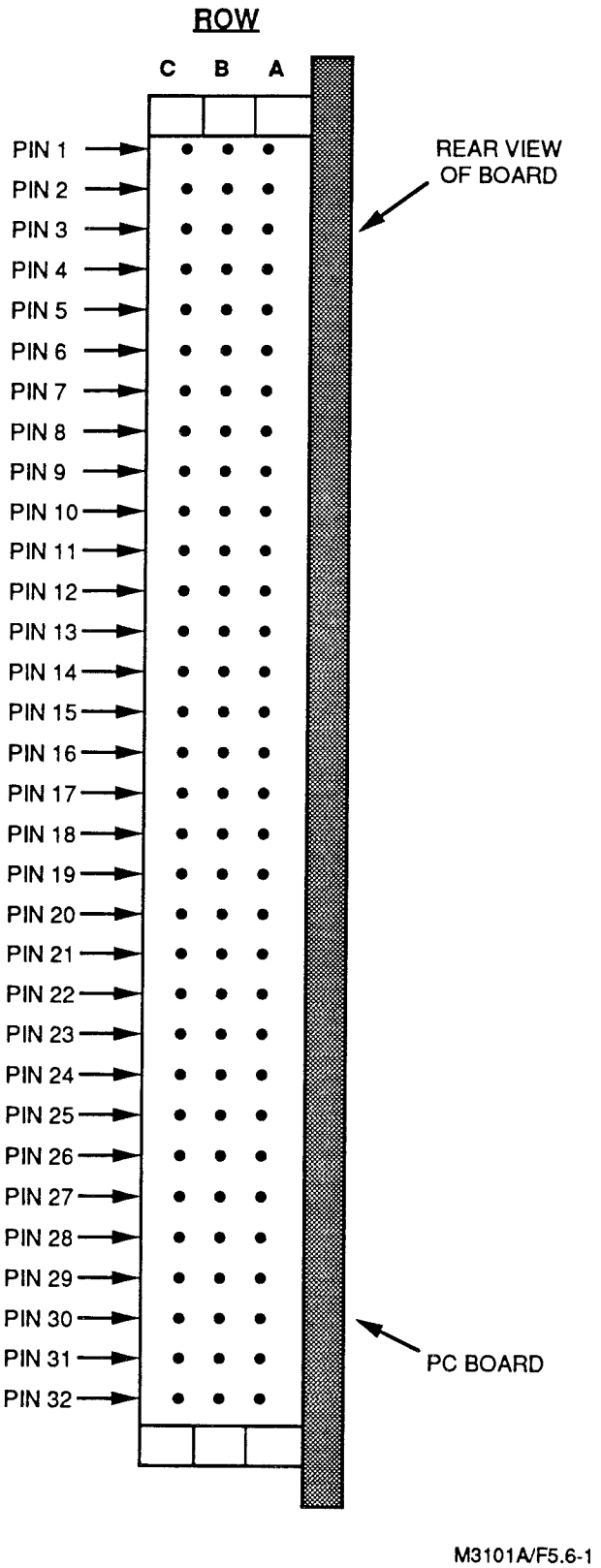


Figure 5.6-1. P2 Connector Pin Configuration

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Table 5.6-1. P2 Connector (AMXbus™) Signal Assignments

	ROW A	ROW B
PIN NUMBER	SIGNAL MNENOMIC	SIGNAL MNENOMIC
1		+5 V
2		GND
3		
4		
5		
6		
7		
8		
9	AOTESTBS	
10		
11	EXMUXLOBS	
12	ANACOM	GND ~~+5 V~~
13	EXMUXHIBS	+5V ~~GND~~
14	ANA COM	
15	GND SEN	
16	ANA COM	
17		
18		
19		
20	ANA COM	
21		
22		GND
23		
24		
25		
26	GND	
27	EXTTRIGL	
28	GND	
29	ENDCONVTL	
30	GND	
31	ENEXTTRIG	GND
32	GND	+5 V

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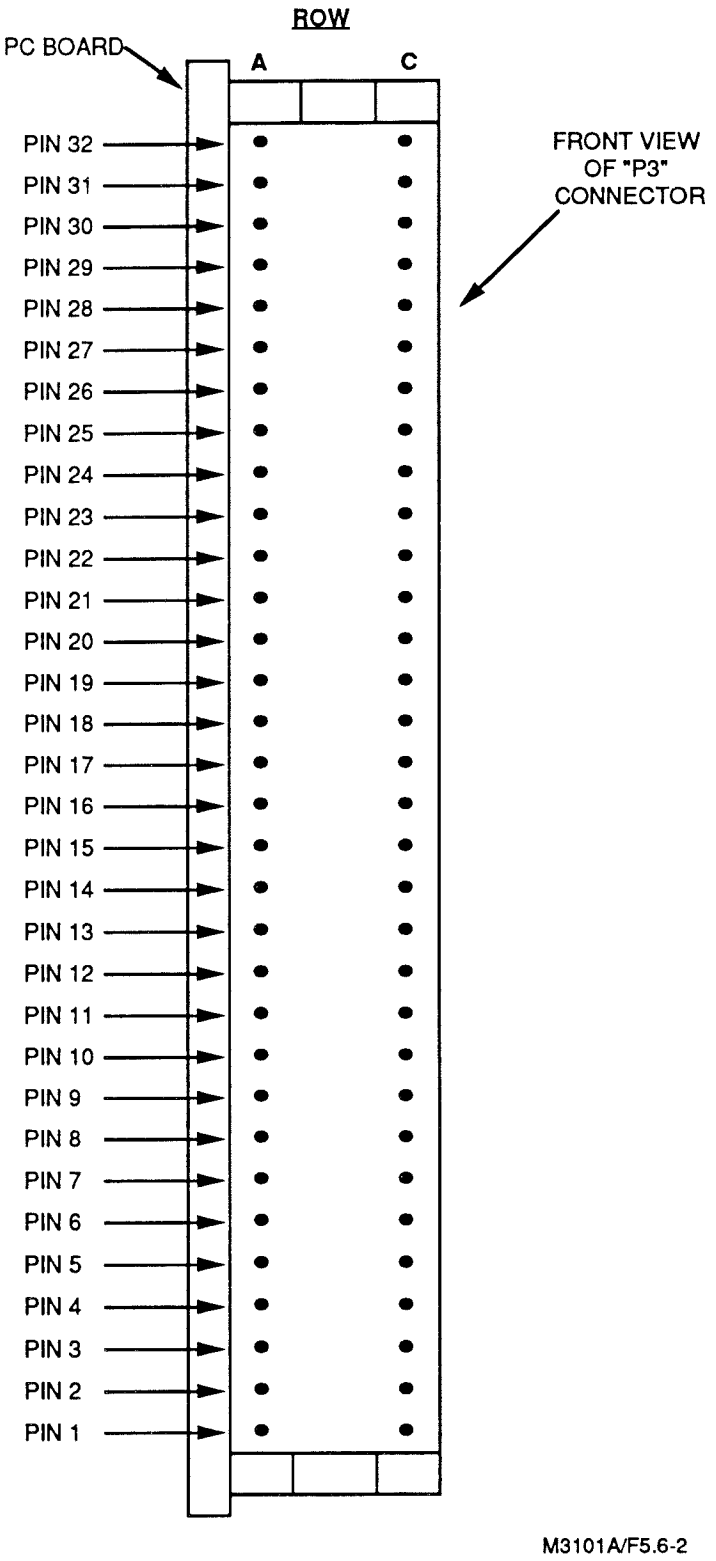


Figure 5.6-2. P3 Connector Pin Configuration

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Active (odd-numbered) P3 connector pins are arranged such that, in a flat-ribbon cable, the two wires in each differential input pair will be adjacent to each other, and each pair will be separated from adjacent pairs by a GND SEN wire.

Pin C32 in the P3 connector is jumper-selectable as either GND SEN or EXT CAL REF. If the EXT CAL REF jumper is installed on the board, then pin C32 is connected to the precision internal POSITIVE CAL REFERENCE signal through a current-limiting resistor, and can be used for system-level self-test by routing the signal back through one or more of the inputs.

A Connector and I/O Cable Applications Guide (VMIC Document No. 825-000000-006) is available from VMIC that provides additional information concerning field connections, the use of round cables, and a thorough explanation of compatible connectors and cabling techniques.

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SECTION 6

MAINTENANCE AND WARRANTY

6.1 MAINTENANCE

This section of the technical manual provides information relative to the care and maintenance of VMIC's products. Should the products malfunction, the user should verify the following:

a. Software
b. System configuration
c. Electrical connections
d. Jumper or configuration options
e. Boards fully inserted into their proper connector location
f. Connector pins are clean and free from contamination
g. No components of adjacent boards are disturbed when inserting or removing the board from the VMEbus card cage
h. Quality of cables and I/O connections

User level repairs are not recommended. Contact VMIC for a Return Authorization Number.

6.2 MAINTENANCE PRINTS

The appendix(ices) to this manual contain(s) drawings and diagrams for reference purposes.

6.3 WARRANTY

VMIC's Standard Products are warranted to be free from defects in material and workmanship for a period of two years (24 months) from the date of shipment. In discharge of this warranty, VMIC, at its option, agrees to either repair or replace, at VMIC's facility and at VMIC's discretion, any part, component, subassembly accessory, or any hardware, software, or system product, which under proper and normal use proves defective in material and workmanship.

The customer shall provide notice to VMIC of each such defect within a reasonable time after the customer's discovery of such defect.

In order to return the defective product(s) or part(s) at VMIC's expense, the customer must contact VMIC's Customer Service Department to obtain a Call Ticket Number. The defective product(s) or part(s) must also be properly boxed

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and weighed. After a VMIC Call Ticket Number and Return Authorization Number has been obtained, the defective product(s) or part(s) may be returned (transportation collect for surface UPS) to VMIC. Any replaced or repaired product(s) or part(s) will be shipped back to the customer's at the expense of VMIC (also UPS surface).

The customer should be aware that the above process can sometimes take up to eight (8) days for the shipment to reach VMIC. The customer has the option to ship the defective product(s) or part(s) at the customer's own expense if the customer cannot afford this possible delay.

There shall be no warranty or liability on any VMIC product(s) or part(s) that is (are) damaged or subjected to accident(s), perils of nature, negligence, overtemperature, overvoltage, misapplication of electrical power, insertion or removal of boards from backplanes and/or I/O connectors with power applied by the customer(s), appointee(s), or any other person(s) without the expressed approval of VMIC.

Final determination of warranty eligibility shall be made by VMIC, and if a warranty claim is considered invalid for any reason, the customer will be charged for services performed and expenses incurred by VMIC in repair, handling and shipping the returned product or part. Determination as to whether the item is within warranty, coverage shall not be unreasonably withheld.

The warranty period of the replacement or repaired product(s) or part(s) shall terminate with the termination of the warranty period with respect to the original product(s) or part(s) for all replacement parts supplied or repairs made during the original warranty period.

THE FOREGOING WARRANTY AND REMEDY ARE EXCLUSIVE AND VMIC SHALL HAVE NO OTHER OR ADDITIONAL LIABILITY TO BUYER OR TO ANYONE CLAIMING UNDER BUYER (THIRD PARTY) UNDER ANY OTHER AGREEMENT OR WARRANTY, EXPRESS OR IMPLIED EITHER IN FACT OR BY OPERATION OF THE LAW, INCLUDING ANY IMPLIED WARRANTY OF MERCHANTABILITY OR FITNESS, STATUTORY, OR OTHERWISE. VMIC SHALL HAVE NO LIABILITY FOR SPECIAL OR CONSEQUENTIAL DAMAGES OF ANY KIND OR FROM ANY CAUSE ARISING OUT OF THE INSTALLATION OR USE OF ANY PRODUCT FURNISHED HEREUNDER.

6.4 OUT-OF-WARRANTY REPAIR POLICY

The following sections describe VMIC's policy on repairs and warranties on repaired products.

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6.4.1 Repair Category

VMIC's repair policy of standard products is divided into two categories, depending on the item to be repaired. These categories are:

a. Product Exchange
b. Fixed Price Repair

Category 1 (product exchange) represents the fastest turn around of the two categories. In this case, the customer sends the malfunctioning product to VMIC. VMIC will return an operational product to the customer within 72 hours of receipt provided VMIC has the product in stock. Customers should contact VMIC prior to returning products for repair to determine stocking status.

Category 2 (Fixed Price Repair) applies to products returned to VMIC for repair and subsequent return to the customer.

Return authorizations are required on all product repairs, and all purchase orders should refer to VMIC's Return Authorization Number which is assigned by VMIC's Customer Service Department.

6.4.2 Repair Pricing

Product exchange is fifty percent (50%) of the current list price. Fixed price repairs are performed at twenty-five percent (25%) of the current list price. Repair prices are not discountable.

(Repair prices are subject to change without notice).

6.4.3 Payment

Payment is due upon delivery or at VMIC's option, net thirty (30) days from the date of delivery. Payment should be made to:

VME Microsystems International Corporation
12090 South Memorial Parkway
Huntsville, Alabama 35803-3308
Attention: Accounts Receivable

VMIC allows a one (1) percent discount for payment made within ten (10) days of invoice date or a two (2) percent discount on payment made prior to shipment of order. This payment discount, however, does not apply to freight.

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6.4.4 Shipping Charges

Shipping charges are the customer's responsibility, with the exception of warranty repairs, whereby VMIC will pay the return to customer shipping charges.

6.4.5 Shipping Instructions

The type of packaging used to ship the product depends on whether the product is shipped singly, in a chassis, or packaged with other boards. The shipper should carefully pack the product(s), using the same precautions listed in the "unpacking procedures". The user should utilize the same (or equivalent) protective packaging container for re-shipment as provided by VMIC. Approved ESD procedures are recommended when handling VMIC's products.

6.4.6 Warranty on Repairs

Products repaired by VMIC are warranted against defects in workmanship and material for a period of ninety (90) days from date of shipment to the customer for all products that were repaired out of warranty. See Standard Conditions of Sale for products repaired within the warranty.

6.4.7 Exclusions

Repair rates may not apply to products which have received unusual physical or electrical damage. In such cases, VMIC will provide an estimated price for product repair or replacement. The customer may then choose to have the product repaired at the estimated price, returned unrepaired at no charge, or replaced at VMIC's current list price.

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