GE Fanuc Automation

Programmable Control Products

IC697VAL3xx Series Isolated 4- or 8-Channel 12-bit Analog Output Board with Voltage or Current Loop Outputs

User's Manual

GFK-2057 *514-000435-000 B* *May 2002*

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Warning

Warning notices are used in this publication to emphasize that hazardous voltages, currents, temperatures, or other conditions that could cause personal injury exist in this equipment or may be associated with its use.

In situations where inattention could cause either personal injury or damage to equipment, a Warning notice is used.

Caution

Caution notices are used where equipment might be damaged if care is not taken.

Note

Notes merely call attention to information that is especially significant to understanding and operating the equipment.

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Field Control	Motion Mate	Series Five	VuMaster
GEnet	ProLoop	Series One	Workmaster

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Contents

Chapter 1 **Introduction, Description, and Specifications 1-1**
Reference Material and Other GE Fanuc Manuals 1-1
General Description 1-2
Functional Description 1-3
Safety Summary 1-5

Chapter 2 **Configuration and Installation 2-1**
Physical Installation 2-2
Before Applying Power: Checklist 2-3
Operational Configuration 2-4
Calibration 2-14
I/O Cable and Front Connector Configuration 2-17

Chapter 3 **Programming 3-1**
Introduction to Controlling the Analog Output Board 3-2
Board Identification Register (BIR) 3-3
Control/Status Register (CSR) 3-4
Control of Analog Outputs 3-6
Reset Operations 3-8

Chapter 4 **Theory of Operation 4-1**
Internal Functional Organization 4-2
VMEbus Interface 4-3
Channel Control Logic 4-4
Analog Output Channels 4-6
DC/DC Power Converters 4-9

Chapter 5 **Maintenance 5-1**

Chapter 1 Introduction, Description, and Specifications

This manual describes the installation and operation of the IC697VAL304, IC697VAL308, IC697VAL314, IC697VAL318, IC697VAL324, and IC697VAL328 Isolated 8-Channel 12-bit Analog Output Board with Voltage or Current Loop Outputs.

Reference Material and Other GE Fanuc Manuals

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

VITA
VMEbus International Trade Association
7825 East Gelding Dr., No. 104
Scottsdale, AZ 85260
(480) 951-8866
FAX: (480) 951-0720
Internet: www.vita.com

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

Analog I/O Products (Built-in-Test) Configuration Guide (catalog number GFK-2084)	Provides assistance in configuring analog I/O subsystems based on GE Fanuc's analog I/O products, including common designs, which offer a wide variety of solutions.
Connector and I/O Cable Application Guide (catalog number GFK-2085)	Describes I/O connections that can be used with GE Fanuc's VMEbus products. Includes connector compatibility information and examples.

General Description

The Analog Output Board provides eight isolated high quality 12-bit analog output channels on a single 6U form factor VMEbus board. Each channel is electrically isolated from all other channels and from the VMEbus.

Listed below are some features of the Analog Output Board:

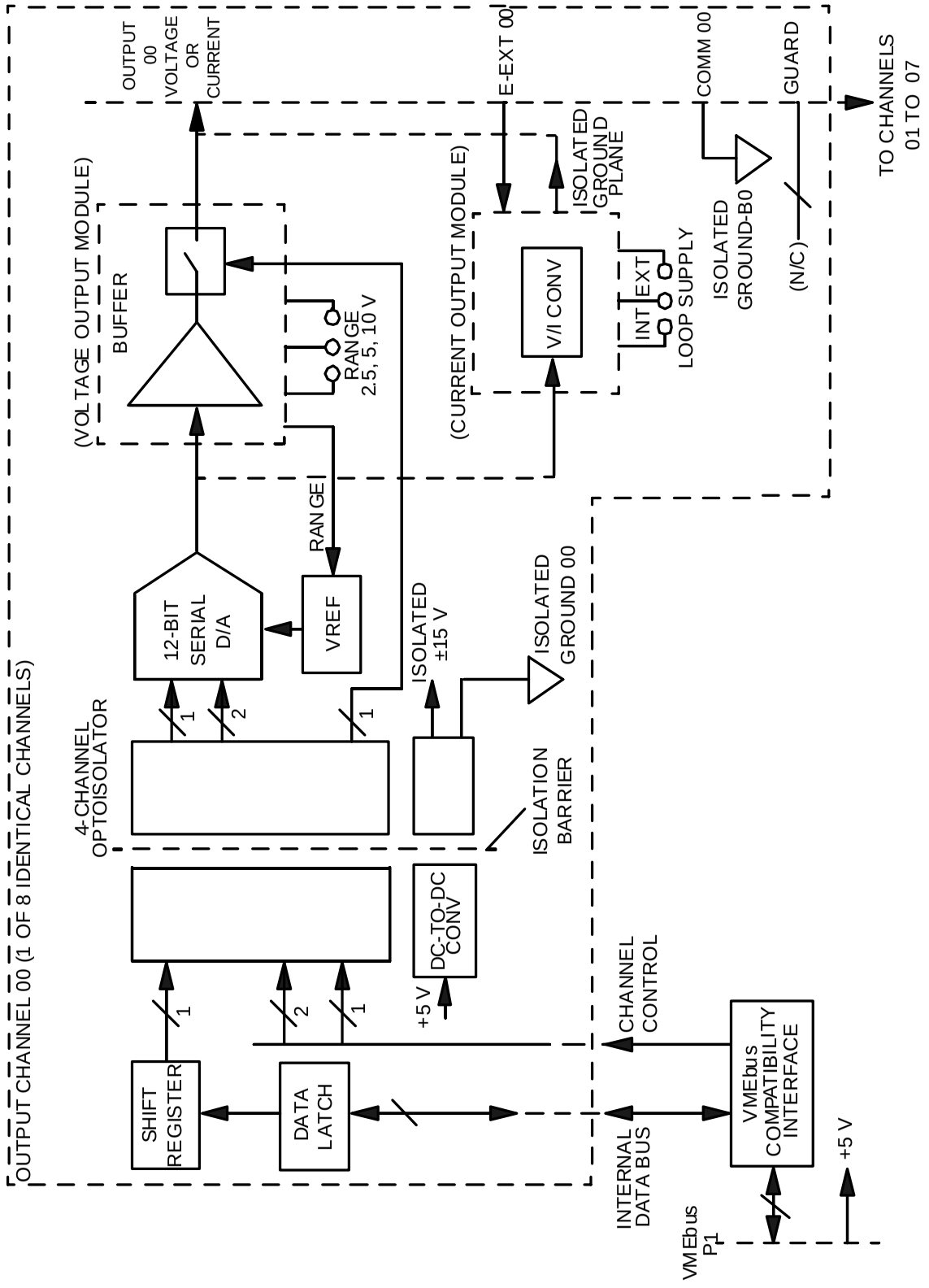
- Eight fully isolated analog outputs
- 1,500 Vpk isolation, channel-to-channel and channel-to-bus
- 12-bit resolution
- Bipolar voltage output ranges selectable as ±2.5, ±5, or ±10 V
- Unipolar voltage output ranges selectable as 0 to 2.5 V, 0 to 5 V, or 0 to 10 V
- 10 mA load capacity for voltage outputs over full ±10 V range
- Available with 4 to 20 mA current loop outputs
- 0.05 percent accuracy for voltage outputs, 0.08 percent for current loop outputs
- Four or eight-channel options
- Optical data coupling provides full galvanic isolation
- Static readback data registers simplify program control
- Front panel access for field connections
- Program-controlled connect/disconnect operation of voltage outputs facilitates system testing

Functional Description

The Analog Output Board internal organization is illustrated in the functional block diagram shown in Figure 1-1 on page 1-4. The board will operate with sustained isolation voltages as high as 1,500 Vpk. Bipolar output voltage ranges are selectable as ±2.5 V, ±5 V, or ±10 V. Unipolar output voltage ranges are selectable as 0 to 2.5 V, 0 to 5 V, or 0 to 10 V, and full 10 mA loading is supported throughout these ranges. Four or 8-channel configurations are available.

Voltage outputs may be disconnected under program control during system testing, and are disconnected automatically during reset. Current-mode outputs support applications that require standard 4 to 20 mA analog current loops. Compliance of the current mode outputs is 9 V if the loop supply originates on the board, or 27 V with an external loop power supply. A front panel LED (Fail) is provided. The LED is illuminated during power up or system reset and can be turned OFF under user software control.

Figure 1-1: Analog Output Board Functional Block Diagram



Safety Summary

The following general safety precautions must be observed during all phases of this operation, service, and repair of this product. Failure to comply with these precautions or with specific warnings elsewhere in this manual violates safety standards of design, manufacture, and intended use of this product. GE Fanuc assumes no liability for the customer's failure to comply with these requirements.

Ground the System

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

Do Not Operate in an Explosive Atmosphere

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

Keep Away from Live Circuits

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

Do Not Service or Adjust Alone

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

Do Not Substitute Parts or Modify System

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

Chapter 2 Configuration and Installation

This chapter provides configuration and installation instructions for the Relay Board, and is divided into the following sections:

- Physical Installation
- Before Applying Power: Checklist
- Operational Configuration
- Calibration
- I/O Cable and Front Connector Configuration

Caution

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

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

Physical Installation

Caution

Do not install or remove board while power is applied.

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

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.

- Have the sections pertaining to and programming and theory, chapters 3 and 4, been reviewed and applied to system requirements?
- Review "Operational Configuration" on page 2-4 and Table 2-1 on page 2-5 to verify that all factory-installed jumpers are in place. To change the board address or address modifier response, refer to "Operational Configuration" on page 2-4.
- Have the I/O cables, with the proper mating connectors, been connected to the input/output connectors? Refer to "I/O Cable and Front Connector Configuration" on page 2-16 for connector descriptions
- Calibration has been performed at the factory. If recalibration is required, refer to "Calibration" on page 2-13.

After the checklist above has been completed, the board can be installed in a VMEbus system. This board may be installed in any slot position, except slot-one which is usually reserved for the system controller.

Caution

Do not install or remove this board with power applied.

Operational Configuration

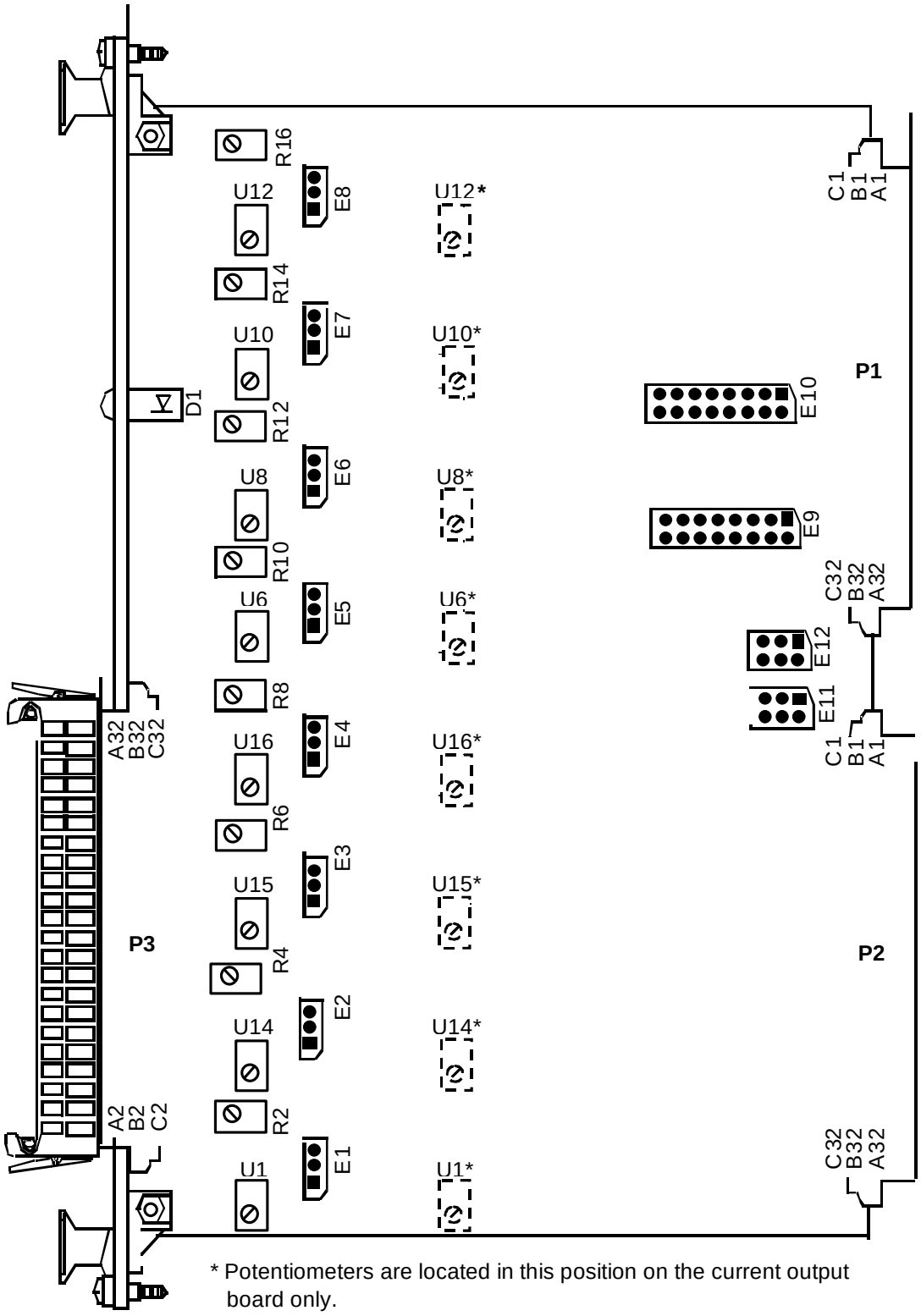
Control of the Analog Output Board address and I/O access mode are determined by field replaceable, onboard jumpers. This section describes the use of these jumpers, and their effects on-board performance. The Analog Output Board jumpers are summarized in Table 2-1 on page 2-5. The locations and functions of all Analog Output Board jumpers are shown in Figure 2-1 on page 2-6. The function of the output range select jumpers are option dependent and will be discussed in detail in “Bipolar Voltage Outputs (Optional)” on page 2-7, “Unipolar Voltage Outputs” on page 2-8, and “Current Loop Output (Optional)” on page 2-9.

Table 2-1: Analog Output Board Jumper Configuration and Functions

Jumper ID	Function	Configurable	Factory Configuration
E11-1, 2	Supervisory Only	Yes	Omitted
E11-3, 4	NonprivilegedOnly	Yes	Installed
E11-5, 6	Short I/O	Yes	Installed
E12-1, 2	Memory Address Bit A5=0	Yes	Installed
E12-3, 4	Memory Address Bit A6=0	Yes	Installed
E12-5, 6	Memory Address Bit A7=0	Yes	Installed
E9-1, 2	Memory Address Bit A8=0	Yes	Installed
E9-3, 4	Memory Address Bit A9=0	Yes	Installed
E9-5, 6	Memory Address Bit A10=0	Yes	Installed
E9-7, 8	Memory Address Bit A11=0	Yes	Installed
E9-9, 10	Memory Address Bit A12=0	Yes	Installed
E9-11, 12	Memory Address Bit A13=0	Yes	Installed
E9-13, 14	Memory Address Bit A14=0	Yes	Installed
E9-15, 16	Memory Address Bit A15=0	Yes	Installed
E10-1, 2	Memory Address Bit A16=0	Yes	Installed
E10-3, 4	Memory Address Bit A17=0	Yes	Installed
E10-5, 6	Memory Address Bit A18=0	Yes	Installed
E10-7, 8	Memory Address Bit A19=0	Yes	Installed
E10-9, 10	Memory Address Bit A20=0	Yes	Installed
E10-11, 12	Memory Address Bit A21=0	Yes	Installed
E10-13, 14	Memory Address Bit A22=0	Yes	Installed
E10-15, 16	Memory Address Bit A23=0	Yes	Installed
E1-1, 2	Channel 0 Output Range Sel	Yes	Installed
E1-2, 3	Channel 0 Output Range Sel	Yes	Omitted
E2-1, 2	Channel 1 Output Range Sel	Yes	Installed
E2-2, 3	Channel 1 Output Range Sel	Yes	Omitted
E3-1, 2	Channel 2 Output Range Sel	Yes	Installed
E3-2, 3	Channel 2 Output Range Sel	Yes	Omitted
E4-1, 2	Channel 3 Output Range Sel	Yes	Installed
E4-2, 3	Channel 3 Output Range Sel	Yes	Omitted
E5-1, 2	Channel 4 Output Range Sel	Yes	*Installed
E5-2, 3	Channel 4 Output Range Sel	Yes	Omitted
E6-1, 2	Channel 5 Output Range Sel	Yes	*Installed
E6-2, 3	Channel 5 Output Range Sel	Yes	Omitted
E7-1, 2	Channel 6 Output Range Sel	Yes	*Installed
E7-2, 3	Channel 6 Output Range Sel	Yes	Omitted
E8-1, 2	Channel 7 Output Range Sel	Yes	*Installed
E8-2, 3	Channel 7 Output Range Sel	Yes	Omitted

* Omitted for 4-Channel Options

Figure 2-1: Location of User-Configurable Jumpers and Potentiometers



* Potentiometers are located in this position on the current output board only.

Bipolar Voltage Outputs (Optional)

Note

The following table applies to IC697VAL304 and IC697VAL308 only.

The Analog Output Board provides Bipolar Voltage Outputs for four or eight channels. The channel can be configured by user-installed jumpers for ±2.5 V, ±5 V, or ±10 V. Table 2-2 below describes the jumper functions for this mode, along with the designators for the adjustment potentiometers (POT) associated with each channel.

Table 2-2: Bipolar Voltage Jumper Functions

Channel*	Output Range Jumper	Voltage	Gain Adj	Zero Adj
0	E1-1,2	±2.5 V	R2	U1 POT
0	E1-2,3	±5 V	R2	U1 POT
0	E1-OPEN	±10 V	R2	U1 POT
1	E2-1,2	±2.5 V	R4	U14 POT
1	E2-2,3	±5 V	R4	U14 POT
1	E2-OPEN	±10 V	R4	U14 POT
2	E3-1,2	±2.5 V	R6	U15 POT
2	E3-2,3	±5 V	R6	U15 POT
2	E3-OPEN	±10 V	R6	U15 POT
3	E4-1,2	±2.5 V	R8	U16 POT
3	E4-2,3	±5 V	R8	U16 POT
3	E4-OPEN	±10 V	R8	U16 POT
4	E5-1,2	±2.5 V	R10	U6 POT
4	E5-2,3	±5 V	R10	U6 POT
4	E5-OPEN	±10 V	R10	U6 POT
5	E6-1,2	±2.5 V	R12	U8 POT
5	E6-2,3	±5 V	R12	U8 POT
5	E6-OPEN	±10 V	R12	U8 POT
6	E7-1,2	±2.5 V	R14	U10 POT
6	E7-2,3	±5.0 V	R14	U10 POT
6	E7-OPEN	±10 V	R14	U10 POT
7	E8-1,2	±2.5 V	R16	U12 POT
7	E8-2,3	±5 V	R16	U12 POT
7	E8-OPEN	±10 V	R16	U12 POT

* Channels 0 through 3, the IC697VAL304 option of the Analog Output Board
Channels 0 through 7, the IC697VAL308 option of the Analog Output Board

Unipolar Voltage Outputs (Optional)

Note

The following table applies to IC697VAL324 and IC697VAL328 only.

The Analog Output Board provides Unipolar Voltage outputs for four or eight channels. The channel can be configured by way of user-installed jumpers for 0 to 2.5 V, 0 to 5 V, or 0 to 10 V. Table 2-3 below describes the jumper functions for this mode, along with the associated gain and zero adjustment designator for each channel.

Table 2-3: Unipolar Voltage Jumper Functions

Channel*	Output Range Jumper	Voltage	Gain Adj	Zero Adj
0	E1-1,2	0 to 2.5 V	R2	U1 POT
0	E1-2,3	0 to 5 V	R2	U1 POT
0	E1-OPEN	0 to 10 V	R2	U1 POT
1	E2-1,2	0 to 2.5 V	R4	U14 POT
1	E2-2,3	0 to 5 V	R4	U14 POT
1	E2-OPEN	0 to 10 V	R4	U14 POT
2	E3-1,2	0 to 2.5 V	R6	U15 POT
2	E3-2,3	0 to 5 V	R6	U15 POT
2	E3-OPEN	0 to 10 V	R6	U15 POT
3	E4-1,2	0 to 2.5 V	R8	U16 POT
3	E4-2,3	0 to 5 V	R8	U16 POT
3	E4-OPEN	0 to 10 V	R8	U16 POT
4	E5-1,2	0 to 2.5 V	R10	U6 POT
4	E5-2,3	0 to 5 V	R10	U6 POT
4	E5-OPEN	0 to 10 V	R10	U6 POT
5	E6-1,2	0 to 2.5 V	R12	U8 POT
5	E6-2,3	0 to 5 V	R12	U8 POT
5	E6-OPEN	0 to 10 V	R12	U8 POT
6	E7-1,2	0 to 2.5 V	R14	U10 POT
6	E7-2,3	0 to 5 V	R14	U10 POT
6	E7-OPEN	0 to 10 V	R14	U10 POT
7	E8-1,2	0 to 2.5 V	R16	U12 POT
7	E8-2,3	0 to 5 V	R16	U12 POT
7	E8-OPEN	0 to 10 V	R16	U12 POT

* Channels 0 Through 3, the IC697VAL324 option of the Analog Output Board
Channels 0 Through 7, the IC697VAL328 option of the Analog Output Board

Current Loop Output (Optional)

Note

The following table applies to IC697VAL314 and IC697VAL318 only.

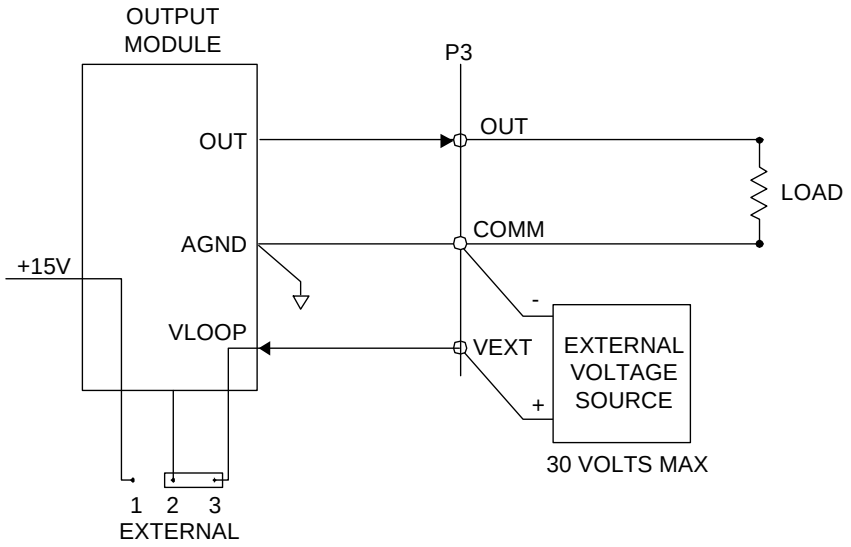
The Analog Output Board provides Current Loop Outputs for four or eight channels. A 15 V loop power supply is provided on the board, or a maximum of 30 V can be supplied with an external loop power supply. A jumper is provided for each channel to configure the internal or external power supply as shown in Table 2-4 below.

Table 2-4: Current Loop Output Jumper Functions

Channel*	Jumper	Loop Supply	Gain Adj	Zero Adj
0	E1-1,2	Internal	R2	U1 POT
0	E1-2,3	External	R2	U1 POT
1	E2-1,2	Internal	R4	U14 POT
1	E2-2,3	External	R4	U14 POT
2	E3-1,2	Internal	R6	U15 POT
2	E3-2,3	External	R6	U15 POT
3	E4-1,2	Internal	R8	U16 POT
3	E4-2,3	External	R8	U16 POT
4	E5-1,2	Internal	R10	U6 POT
4	E5-2,3	External	R10	U6 POT
5	E6-1,2	Internal	R12	U8 POT
5	E6-2,3	External	R12	U8 POT
6	E7-1,2	Internal	R14	U10 POT
6	E7-2,3	External	R14	U10 POT
7	E8-1,2	Internal	R16	U12 POT
7	E8-2,3	External	R16	U12 POT

* Channels 0 Through 3, the IC697VAL314 option of the Analog Output Board
Channels 0 Through 7, the IC697VAL318 option of the Analog Output Board

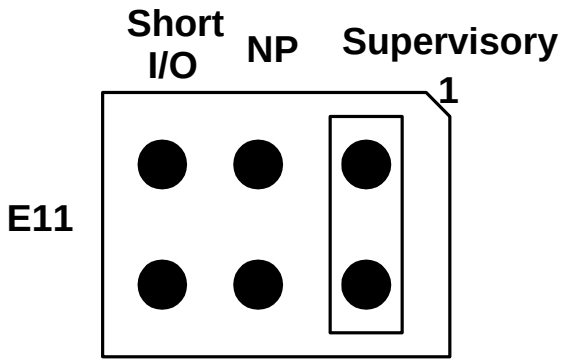
Figure 2-2: Typical External Voltage Connection



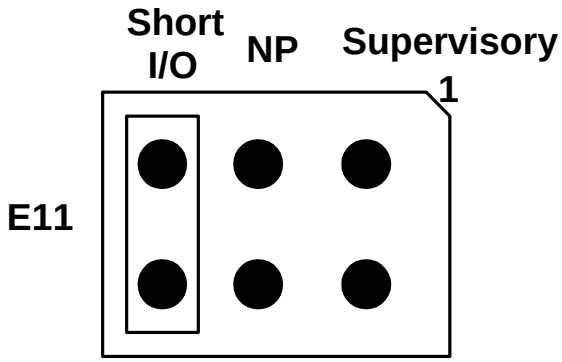
Address Modifiers

The Analog Output Board is factory configured to respond to short nonprivileged access as shown in Figure 2-3 below and Figure 2-4 on page 2-12. The configuration can be changed by installing jumpers at the appropriate locations in the header as shown in Figure 2-3 below and Figure 2-4 on page 2-12.

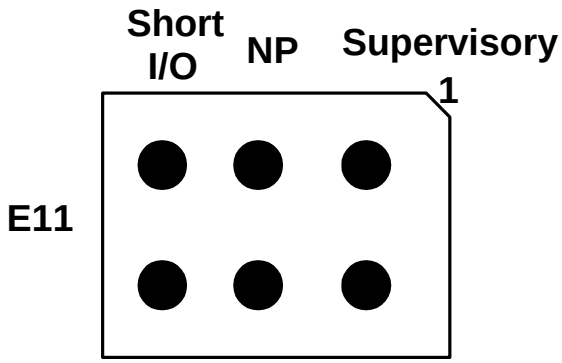
Figure 2-3: Address Modifier Jumper Configurations (a)



Jumper Configuration for Standard Supervisory Access

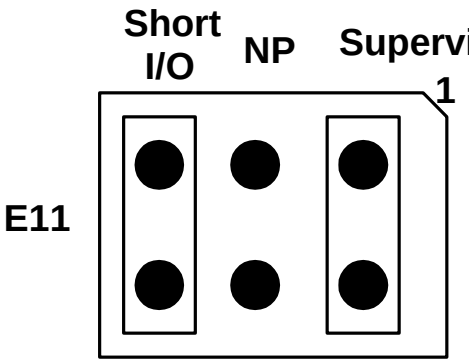


Jumper Configuration for Short Addressing with Supervisory or Nonprivileged Access

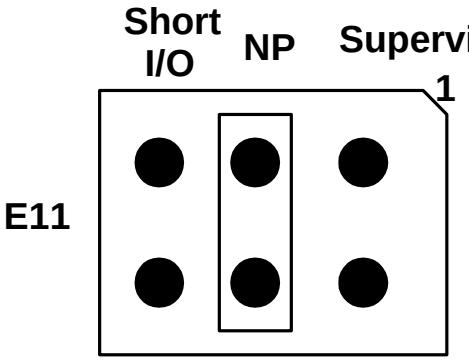


Jumper Configuration for Standard Addressing with Supervisory or Nonprivileged Access

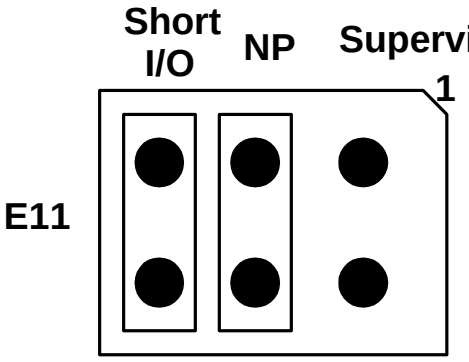
Figure 2-4: Address Modifier Jumper Configurations (b)



Jumper Configuration for Short Supervisory Access



Jumper Configuration for Standard Nonprivileged Access

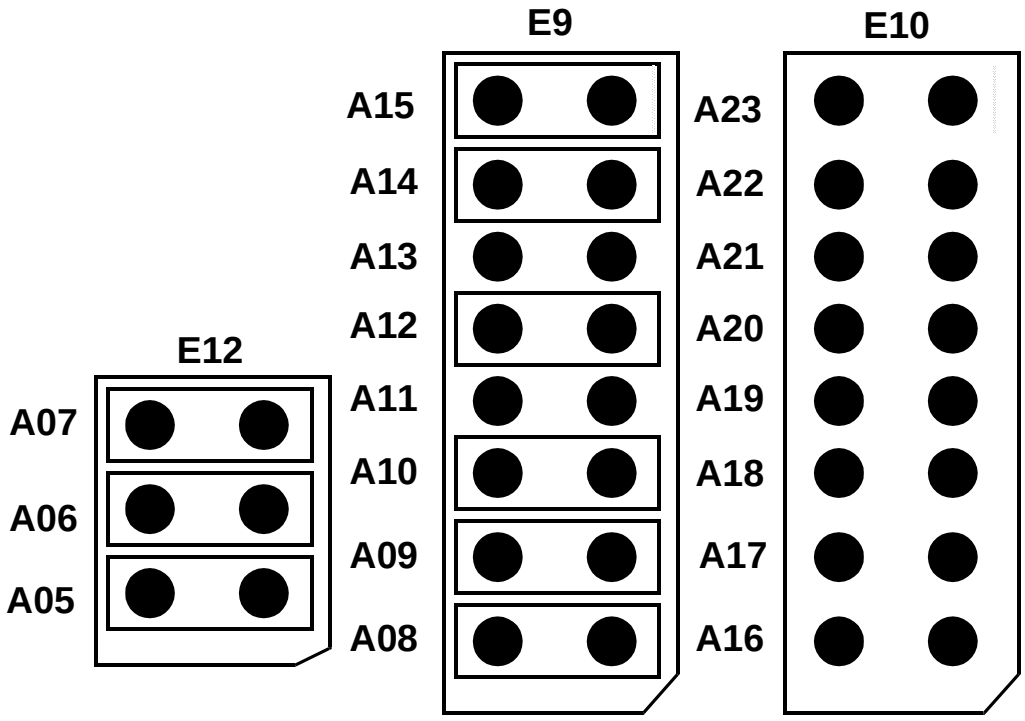


Jumper Configuration for Short Nonprivileged Access

Address Selection

The Analog Output Board is designed with banks of Address Select Jumpers that specify the base address of the board. The Address Selection Jumpers are shown in Figure 2-5 below. The Analog Output Board is factory configured to respond to $0000 short nonprivileged access. An installed jumper causes the board to compare to a low address line, an omitted jumper causes the board to compare to a high address line.

Figure 2-5: Base Address Select Jumpers



The example shown is for a I/O base address of $2800h (Short I/O Access) or FF2800 (Standard I/O Access)

Calibration

Before delivery from the factory, the Analog Output Board is fully calibrated. Should recalibration be required, refer to "Equipment Required" and "Analog Outputs Calibration Procedure" below, "Bipolar Voltage Output Calibration" and "Unipolar Voltage Output Calibration" on page 2-14, and "Current Output Calibration" on page 2-15 and perform the indicated calibration procedures in the order shown. Location of all adjustments are shown in Figure 2-1 on page 2-6. As delivered from the factory, all calibration adjustments are sealed against accidental movement. The seals are easily broken for recalibration, however, all adjustments should be resealed with a suitable fast-curing sealing compound after recalibration has been completed.

Note:

The bipolar and unipolar voltage modules (option dependent) will be calibrated at full scale value for the MINimum range. If the user configures the board for any OTHER range, calibration will be required.

Equipment Required

Digital Mutimeter:	Voltage Measurements: ±10 VDC range; 5 or more digits; ±0.005 percent of reading accuracy; 10W minimum input resistance.
	Current Measurements: 0 -100 mADC range; 5 or more digits; ±0.005 percent of reading accuracy; 100 maximum input resistance.
Chassis:	VMEbus 6U backplane or equivalent, with J1 and J2 connectors, 680x0 series controller, +5 ±0.2 VDC, 8 Amp (reserved current) power supply. One slot allocated for testing the Analog Output Board.
Extender Card:	VMEbus 6U extender card.
Resistors:	250Ω ±5%, 1/4 watt (current outputs only)

Analog Outputs Calibration Procedure

1. Refer to "Operational Configuration" on page 2-4 and configure the Analog Output Board for the output configuration that is required for the application. For calibration of current outputs, configure the outputs for operation with the internal loop supply.
2. Install the Analog Output Board on an extender card in the VMEbus chassis. Make provisions for connecting the DMM to each analog output channel, with the (+) common lead at the output pin (OUT*) and the (-) lead at the common pin (COMM*). The channel output pins are defined in the table in Figure 2-6 on page 2-16.
3. Apply power to the board. Write the value A000 (HEX) to the CSR, this will enable all outputs and extinguish the fail LED (refer to Table 3-1 on page 3-2 for the locations of all registers). All data transfers will be D16.
4. Allow a minimum warm-up interval of ten minutes before proceeding.

5. See the following sections for bipolar voltage outputs, unipolar voltage outputs, or current outputs. The locations of output modules and adjustment potentiometers are illustrated in Figure 2-1 on page 2-6.

Bipolar Voltage Output Calibration

1. Connect the DMM to the channel 00 output pins, with the (+) lead connected to the output pin and the (-) lead connected to the common pin.
2. Write the value $0800 to the channel 00 output data register. Adjust the ZERO potentiometer on the channel 00 output module for a DMM indication that conforms to the MIDSCALE value contained in Table 2-5 below for the assigned output range.
3. Write the value $0FFF to the channel 00 output data register. Adjust the Channel-00 gain potentiometer for a DMM indication that conforms to the POSITIVE FULL SCALE value contained in Table 2-5 below for the assigned output range.
4. Write the value $0000 to the channel 00 output data register. If the DMM indication does not conform to the NEGATIVE FULL SCALE value contained in Table 2-5 below for the assigned output range, repeat steps 2, 3, and 4 until the measurements for all three steps are correct.
5. Repeat steps 1 through 4 for the remaining active output channels.
6. Bipolar calibration is completed. Remove power. Remove all test connections.

Table 2-5: Bipolar Voltage Output Calibration Values

Output Range (VDC)	Output Value (VDC)		
	Midscale	Positive Full Scale	Negative Full Scale
±2.5	0.0000 ±0.0006	+2.4988 ±0.0006	-2.5000 ±0.008
±5	0.0000 ±0.0010	+4.9975 ±0.0010	-5.0000 ±0.011
±10	0.0000 ±0.0002	+9.9951 ±0.0020	-10.0000 ±0.018

Unipolar Voltage Output Calibration

1. Connect the DMM to the channel 00 output pins, with the (+) lead connected to the output pin and the (-) lead connected to the common pin.
2. Write the value $0000 to the channel 00 output data register. Adjust the channel 00 gain potentiometer for a DMM indication that conforms to the ZERO value contained in Table 2-6 on page 2-15 for the assigned output range.
3. Write the value $0FFF to the channel 00 output data register. If the DMM indication does not conform to the POSITIVE FULL SCALE value contained in Table 2-6 on page 2-15 for the assigned output range, repeat steps 2, 3, and 4 until the measurements for all three steps are correct.
4. Repeat steps 1 through 3 for the remaining active output channels.
5. Unipolar calibration is completed. Remove power. Remove all test connections.

Table 2-6: Unipolar Voltage Output Calibration Values

Output Range (VDC)	Output Value (VDC)	
	Zero	Positive Full Scale
0 to +2.5	0.0000 ±0.0006	+2.4988 ±0.0015
0 to +5	0.0000 ±0.0010	+4.9975 ±0.0020
0 to +10	0.0000 ±0.0020	+9.9951 ±0.0040

Current Output Calibration

1. Connect the DMM to the channel 00 output pins (see the table in Figure 2-6 on page 2-16), with the (+) lead connected to the output pin through a series resistance of 250, and the (-) lead connected to the common pin. Leave the external loop supply pins (VEXT) disconnected.
2. Write the value $0000 to the channel 00 output data register. Adjust the ZERO potentiometer on the channel 00 output module for a DMM indication that conforms to the ZERO SCALE value contained in Table 2-7 below for the assigned output range.
3. Write the value $0FFF to the channel 00 output data register. Adjust the channel 00 gain potentiometer for a DMM indication that conforms to the FULL SCALE value contained in Table 2-7 below for the assigned output range.
4. Repeat steps 1 through 4 for the remaining active output channels.
5. Calibration is completed. Remove power, remove all test connections.

Table 2-7: Current Output Calibration Values

Output Range (mADC)	Output Value (mADC)	
	Zero	Positive Full Scale
4 to 20	4.000 ±0.004	+20.000 ±0.008

I/O Cable and Front Connector Configuration

The front input connector (P3) on the Analog Output Board is a standard 41612 DIN form E screw terminal connector. The P3 connector pin layout is shown in Figure 2-6 below. The pin assignments for P3 are also shown below. The connector is supplied with integral latches. To remove the connector, depress both latches simultaneously while gently pulling connector from socket. Install connector by aligning keying and pressing the connector into place.

32-Pin DIN Connector: Connector Specification

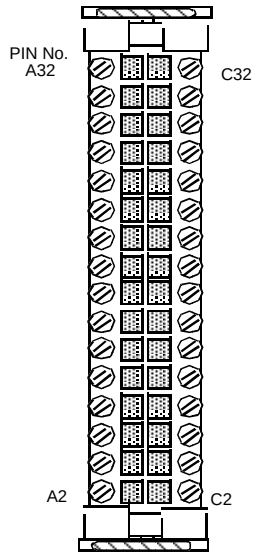
- Wire should be 14-22 AWG
- Insulation stripping length: .315” ±.20”/8mm ±0.5mm
- The binding screw terminals are best suited for a .138” x.20”/3.5mm x 0.5mm common flat-blade screwdriver.
- Recommended screw tightening torque: 5.22 lb./in. /0.6mN
- Contact resistance: ≤10 mΩ

Note

Due to chassis vibration, GE Fanuc recommends periodic checks of screw torque.

Figure 2-6: P3 Connector Pin Layout and P3 Pin Assignments

Front View (Cable Side) of P3 Connector



P3 Pin No.	Signal	P3 Pin No.	Signal
A32	*VEXT 7	C32	N/C
A30	OUT 7	C30	COMM 7
A28	*VEXT 6	C28	N/C
A26	OUT 6	C26	COMM 6
A24	*VEXT 5	C24	N/C
A22	OUT 5	C22	COMM 5
A20	*VEXT 4	C20	N/C
A18	OUT 4	C18	COMM 4
A16	*VEXT 3	C16	N/C
A14	OUT 3	C14	COMM 3
A12	*VEXT 2	C12	N/C
A10	OUT 2	C10	COMM 2
A8	*VEXT 1	C8	N/C
A6	OUT 1	C6	COMM 1
A4	*VEXT 0	C4	N/C
A2	OUT 0	C2	COMM 0

* VEXT pins have no effect on voltage outputs.

Chapter 3 Programming

This chapter contains programming instructions for the Relay Board, and is divided into the following sections:

- Introduction to Controlling the Analog Output Board
- Board Identification Register (BIR)
- Control/Status Register (CSR)
- Control of Analog Outputs
- Reset Operations

Introduction to Controlling the Analog Output Board

Communication with the Analog Output Board is established through control, status, data, and identification registers that are mapped into a 16-word block. On-board configurable address jumpers permit the communication registers to be located in either the A16 short or the A24 standard I/O data space. Access privilege is jumper-selectable as supervisory, nonprivileged, or both. All registers are listed in Table 3-1 below and described throughout this section.

Each of the eight analog outputs is controlled through a dedicated 12-bit Output Data Register (ODR). Data is serialized and transferred to an output D/A converter when the associated ODR receives a data transfer from the bus. All channels operate independently.

All read/write registers are cleared to ZERO by a system reset or power up operation. The reset operation places the board in the following state:

Analog Output Level	Current and voltage outputs are at lowest level.
Analog Output State	All voltage channels are disconnected from the output connectors, no effect on current option.
Data Coding	Offset binary.
Front Panel LED	Illuminated.

Table 3-1: Analog Output Board Register Map

Board Address (Hex)	Register Function	Description	Access	Size
00	Board ID	BIR	Read Only	Byte/Word/Longword
04	Control and Status	CSR	Read/Write	Byte/Word
06	Reserved	...	...	
08	CH 00 Output Data	ODR 00	Read/Write	Word
0A	CH 01 Output Data	ODR 01	Read/Write	Word
0C	CH 02 Output Data	ODR 02	Read/Write	Word
0E	CH 03 Output Data	ODR 03	Read/Write	Word
10	CH 04 Output Data	ODR 04	Read/Write	Word
12	CH 05 Output Data	ODR 05	Read/Write	Word
14	CH 06 Output Data	ODR 06	Read/Write	Word
16	CH 07 Output Data	ODR 07	Read/Write	Word
18 to 1E	Reserved	...	...	

Board Identification Register (BIR)

The Board Identification register contains the board identification code ($46000000) for the Analog Output Board, and occupies the first two words at the board base address.

Table 3-2: Board ID Register Bit Map

Board ID Register (Offset Address $00) Read-only, Byte							
Bit 15	**Bit 14**	**Bit 13**	**Bit 12**	**Bit 11**	**Bit 10**	**Bit 09**	**Bit 08**
0	1	0	0	0	1	1	0

Board ID Register (Offset Address $00) Read-only, Byte							
Bit 07	**Bit 06**	**Bit 05**	**Bit 04**	**Bit 03**	**Bit 02**	**Bit 01**	**Bit 00**
0	0	0	0	0	0	0	0

Control/Status Register (CSR)

Control/Status register functions and the bitmap are summarized in Table 3-3 below. Control register bits are mapped directly to the readback STATUS register at the same location. All CSR bits are cleared to zero (LOW) during a power up or reset operation. The CSR provides control and monitoring of the following board functions:

- Output enabling (voltage outputs)
- Output load cycle status
- Data coding
- Self test LED

Table 3-3: Analog Output Board Control/Status Register (CSR) Bit Map

CSR (Offset Address $04) Read/Write, Byte/Word							
Bit 15	**Bit 14**	**Bit 13**	**Bit 12**	**Bit 11**	**Bit 10**	**Bit 09**	**Bit 08**
LED	Reserved	Output EN	Two's CMPL	Reserved			

CSR (Offset Address $04) Read/Write, Byte/Word							
Bit 07	**Bit 06**	**Bit 05**	**Bit 04**	**Bit 03**	**Bit 02**	**Bit 01**	**Bit 00**
CH 7 Busy	CH 6 Busy	CH 5 Busy	CH 4 Busy	CH 3 Busy	CH 2 Busy	CH 1 Busy	CH 0 Busy

Control/Status Register Bit Definitions

Bit 15: **LED** – The "FAIL LED" is OFF if Bit 15 is set (logical "1"), or is ON if bit is cleared (logical "0"). Default = logical "0".

Bit 14: **Reserved** – This bit is reserved and forced to a logical "0".

Bit 13: **Output Enable** – Output Enable: All outputs are connected to the output connectors if Bit 13 is set to a logical "1," or disconnected if Bit 13 is cleared to a logical zero.

Bit 13 has no effect on current outputs. Default = logical "0."

Note

For current output options, the outputs are placed in a minimal current output state when this bit is cleared to a zero. This bit must be set to a "1" to allow operation. For the default state, reference "Reset Operations" on page 3-8.

Bit 12: **Two's Complement** – Channel data is processed in 12-bit offset binary if Bit 12 is cleared (reset default) or in two's complement format with extended sign if Bit 12 is set a logical "1".

Bits 11 through 08: **Reserved** – This bit is reserved and forced to a logical "0".

Bits 07 through 00: **CH Busy** – The Channel Busy flag is set when the associated channel Output Data Register receives a data transfer from the bus, and remains set for approximately 8 msec while the data word is transferred to the output D/A converter. A channel register should not be updated from the bus while the associated busy flag is set.

Note

LOGIC STATE CONVENTION – To avoid ambiguities in references to logic levels, this document uses the convention that a data bit or control line is "SET" when it is in the "1", or HIGH state, and is "CLEARED" when "0" or LOW STATE.

Control of Analog Outputs

Output Registers and Data Format

The eight independent analog outputs are controlled through output data registers ODR 00 through ODR 07. Readback capability is provided, and both D8 (even/odd) and D16 transfers are supported. It is advisable to update data registers in word format. Data is configured in right-justified 12-bit offset binary format or two's complement format, data format is controlled by CSR Bit 12.

In the offset binary format (reset default), the upper four bits D12 to D15 are ignored during loading and are returned as zero during readback. In two's complement format, data is received and returned in two's complement with the sign extended through the most significant bit, Bit 15 during readback.

Table 3-4: Bipolar Output Offset Binary Format Bit Map

Bipolar Output Data Register Read/Write, Byte/Word							
Bit 15	**Bit 14**	**Bit 13**	**Bit 12**	**Bit 11**	**Bit 10**	**Bit 09**	**Bit 08**
X	X	X	X	D11	D10	D09	D08

Bipolar Output Data Register Read/Write, Byte/Word							
Bit 07	**Bit 06**	**Bit 05**	**Bit 04**	**Bit 03**	**Bit 02**	**Bit 01**	**Bit 00**
D07	D06	D05	D04	D03	D02	D01	D00

Table 3-5: Bipolar Output Data Register Bit Map (Two's Complement)

Bipolar Output Data Register Read/Write, Byte/Word							
Bit 15	**Bit 14**	**Bit 13**	**Bit 12**	**Bit 11**	**Bit 10**	**Bit 09**	**Bit 08**
X	X	X	X	D11	D10	D09	D08

Bipolar Output Data Register Read/Write, Byte/Word							
Bit 07	**Bit 06**	**Bit 05**	**Bit 04**	**Bit 03**	**Bit 02**	**Bit 01**	**Bit 00**
D07	D06	D05	D04	D03	D02	D01	D00

Table 3-6: Data Codes for Some Selected Output Voltages

Offset Binary	Two's Comp	Bipolar Output ±10 V	Unipolar Output 0 - 10 V	Scale Factor
000	800	-10 V	+0 V	- FSR
400	C00	-5 V	+2.5 V	1/4 FSR
800	000	+0 V	+5 V	1/2 FSR
C00	400	+5 V	+7.5 V	3/4 FSR
FFF	7FF	+9.9951 V	+9.9951 V	+ FSR - 1 LSB

Scaling and Enabling

Available output ranges are ±2.5 V, ±5 V, or ±10 V for bipolar voltage outputs, 0 to +2.5 V, 0 to +5 V, or 0 to +10 V for unipolar voltage outputs, and 4 to 20 mA for current outputs. The analog output range is determined independently for each output channel by on-board jumpers which are described in Chapter 2. All voltage outputs are disconnected from the output connectors if Bit 13 in the CSR is cleared, or connected to the output connectors if CSR Bit 13 is set.

If the CSR Bit 12 control bit is cleared, the output data is coded in offset binary. Each output level is scaled linearly from $0000 for negative full scale or lowest output level, to $0FFF for positive full scale, or highest output level.

For two's complement coding (CSR Bit 12 set), the output data is scaled from $F800 for negative full scale to $07FF for positive full scale. Two's complement coding normally is used only for bipolar outputs. Various coding examples are summarized in Table 3-6 above.

Output Load Cycles

Data from an output data register is transferred serially to the output D/A converter during an internal Output Load Cycle. A data transfer to a data register initiates a load cycle for the associated output channel. The load cycle is completed in approximately 8 msec, and proceeds automatically after initiation without further intervention from the VMEbus. The level of the associated analog output channel is updated at the end of the load cycle. For D8 transfers, the load cycle is initiated by an odd-byte transfer.

Each Channel Busy Flag (Bit 00 through Bit 07) is set when the assigned channel output data register receives a data transfer from the bus, and remains set for approximately 8 msec during the ensuing output load cycle. Data transfers to an output register should not take place while the associated busy flag is set. However, any register can be read at any time without affecting board performance. All output channels are controlled independently, and any output data register can be updated without affecting the other seven channels.

Reset Operations

All read/write registers are cleared to ZERO by a system reset operation. The reset operation places the board in the following state:

Analog Output Level	For options "-AB1," current outputs are minimal; For options "-AB0," current outputs are on-line and full-scale voltage outputs are minus full scale.
Analog Output State	All voltage channels are disconnected from the output connectors.
Data Coding	Offset binary.
Front Panel LED	Illuminated.

Chapter 4 Theory of Operation

This chapter describes the internal organization of the Analog Output Board, reviews the general principles of operation, and is divided into the following sections:

- Internal Functional Organization
- VMEbus Interface
- Channel Control Logic
- Analog Output Channels
- DC/DC Power Converters

Internal Functional Organization

Optical data coupling, serial data transfers, and isolated Digital-to-Analog Converters (DACs) are used to produce eight galvanically isolated analog output channels. Each channel contains a serial 12-bit DAC which generates a signal voltage in response to commands from the VMEbus. The DAC voltage then drives an output module which is factory configured for a specific voltage or current output option. Power for each channel is supplied as ±15 VDC by an isolated DC-to-DC converter. A functional block diagram of the Analog Output Board is shown in Figure 1-1 on page 1-4.

The Analog Output Board consists of the following functional elements, all of which are described in the following sections:

- VMEbus interface
- Channel control logic
- Isolated analog outputs
- DC/DC power converters

VMEbus Interface

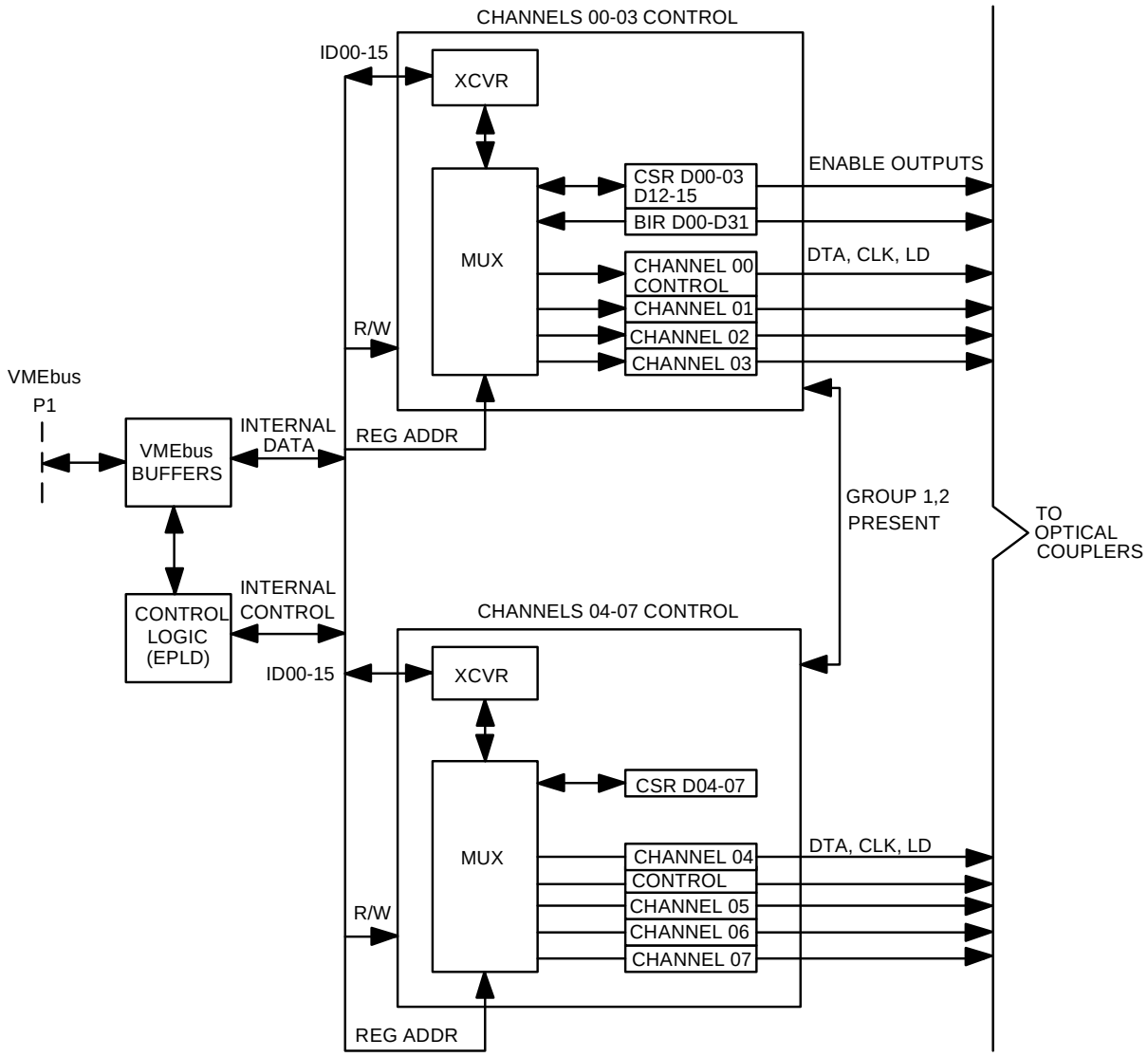
Communications with the VMEbus is controlled with a single Electrically Programmable Logic Device (EPLD), as shown in Figure 4-1 on page 4-4. Data and control registers are distributed among two channel-control EPLD's. The control-logic EPLD responds to data transfer requests from the VMEbus, and directs the flow of data between the bus and the internal data and control registers. Data Transfer Acknowledge (DTACK*) is generated when a transfer from the bus has been completed, or when data is ready to be transferred to the bus. Transfers proceed normally if address pipelining is present, but the board will respond only to the first address in the pipeline sequence. The VMEbus interface logic will not respond to transfer requests in which the BERR*, DTACK*, LWORD*, or IACK* control line is asserted.

Channel Control Logic

Control of data transfer to the output DAC is partitioned into two identical 4-channel groups, with a single EPLD assigned to each group. This method of partitioning permits the board to be populated with only those devices required to support the 4- or 8-channel optional configuration.

As shown in Figure 4-1 below, the EPLD which controls channels 00 through 03 also contains the Board Identification Register (BIR) and part of the Control/Status register (CSR). This EPLD detects the presence of one or both of the channel-control EPLD, and adjusts the distribution of the CSR accordingly.

Figure 4-1: VMEbus Interface and Control



Each channel-control EPLD contains four data registers which receive the channel data words from the VMEbus, and provides an independent data serializer for each channel. Figure 4-2 on page 4-7 illustrates the movement of data within a single control channel. A data transfer to any 16-bit channel data register from the bus initiates the serializing process which moves the data to the serial output D/A converter. Data in each register is right-justified with 12 significant bits.

Only the 12 significant data bits in each channel are serialized for transfer to the associated D/A converter. The four digital signals required to produce the transfer are shown in Figure 4-3 on page 4-8. The board selection (BDSEL L) initiates the transfer sequence. The CLOCK line provides the primary timing, and clocks the information present on the DATA line into the serial D/A converter, MSB first through LSB last. The output of the converter does not change during the serial transfer. When the serial transfer has been completed, the LOAD signal performs a parallel transfer of data to an output latch in the converter, and the output voltage responds to the new data.

Analog Output Channels

Isolation

Each output channel is isolated from the VMEbus and from all other channels by an isolated DC/DC converter and by four optical couplers. The DC/DC converter provides isolated ±15 VDC power for the channel, and the optical couplers isolate the digital control signals IDTA, ICLK, ILD, and IENA from EPLD signals DATA, CLOCK, LOAD, and ENAOUT (Figure 4-4 on page 4-9). Power for the optical couplers is supplied as +5 VDC, and is series regulated from the isolated +15 V rail.

Digital-to-Analog Conversion

A serial Digital-to-Analog Converter (DAC) receives the 12-bit data word from the channel control EPLD, and produces an output voltage range that is jumper controlled from 0 to 10 V. The D/A buffer converts this range into the output ranges specified in the output ordering option. Channel span is adjusted in the feedback loop of the D/A buffer.

The voltage reference level is selected as +2.5 V, +5 V, or +10 V by the output module. A current output module automatically selects a +10 V reference. A voltage output module passes the state of the module control jumpers directly to the reference, and permits any of the three voltages to be selected.

Figure 4-2: Analog Output Board Channel Control

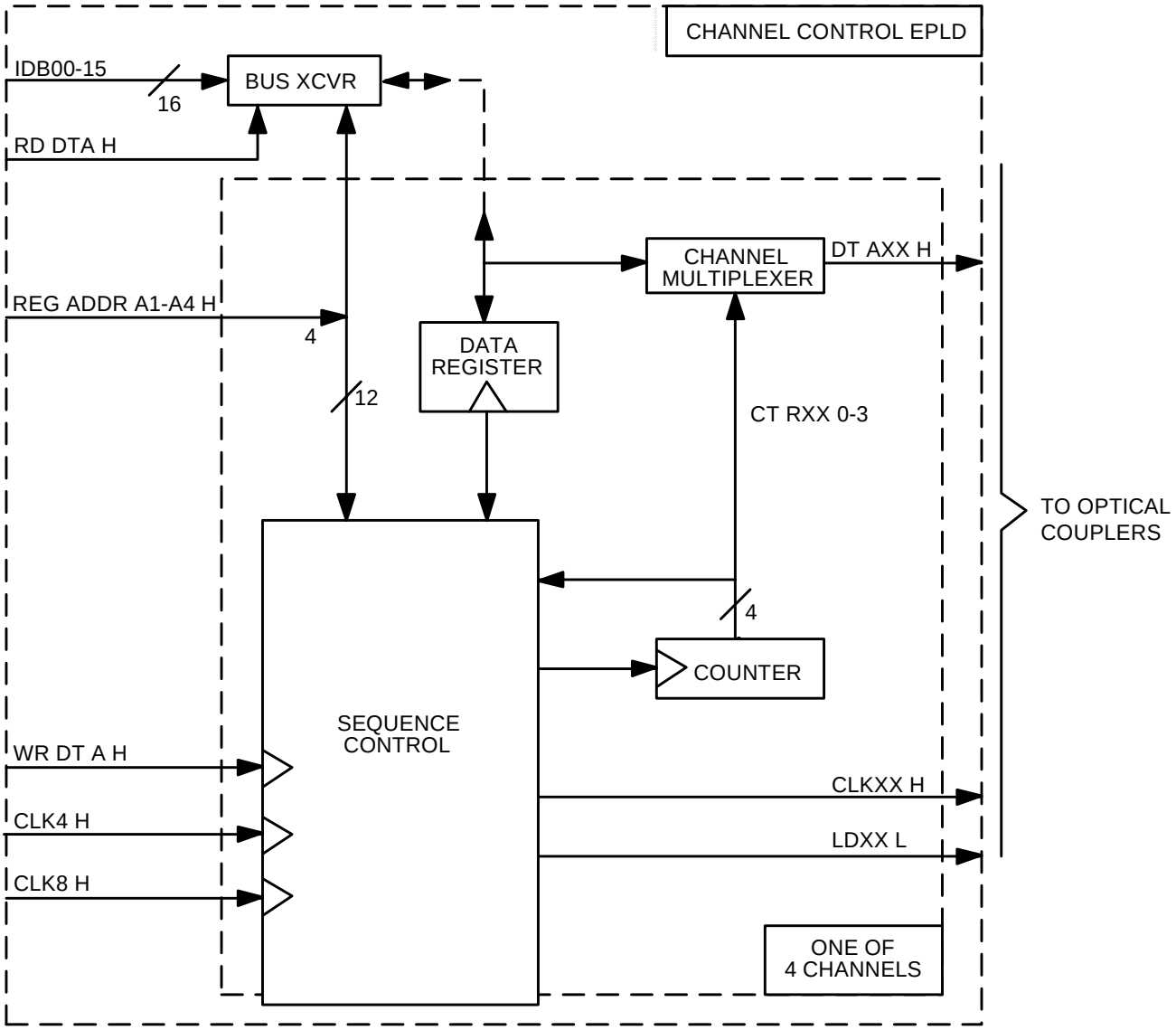
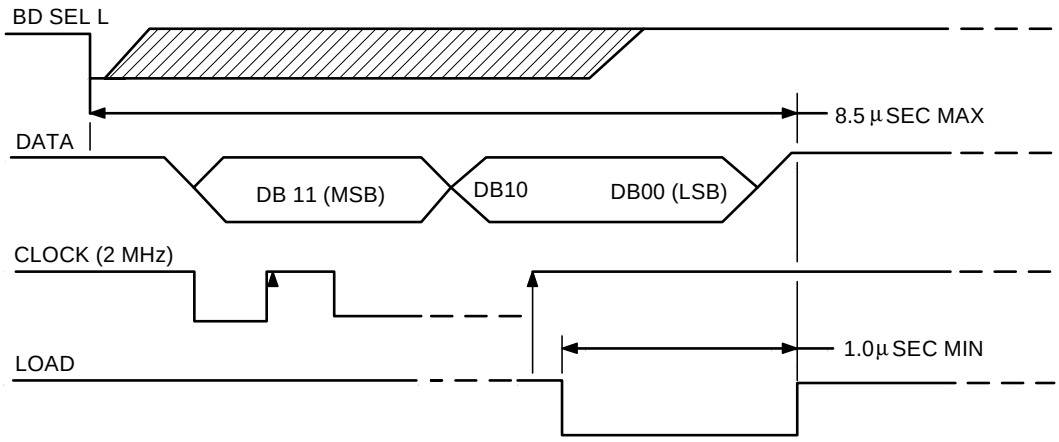


Figure 4-3: Analog Output Board Output Timing (Typical Channel)



Voltage and Current Outputs

All outputs are factory-configured for either unipolar voltage, bipolar voltage, or constant current. Each module contains an offset potentiometer to permit adjustment of the channel offset error to zero.

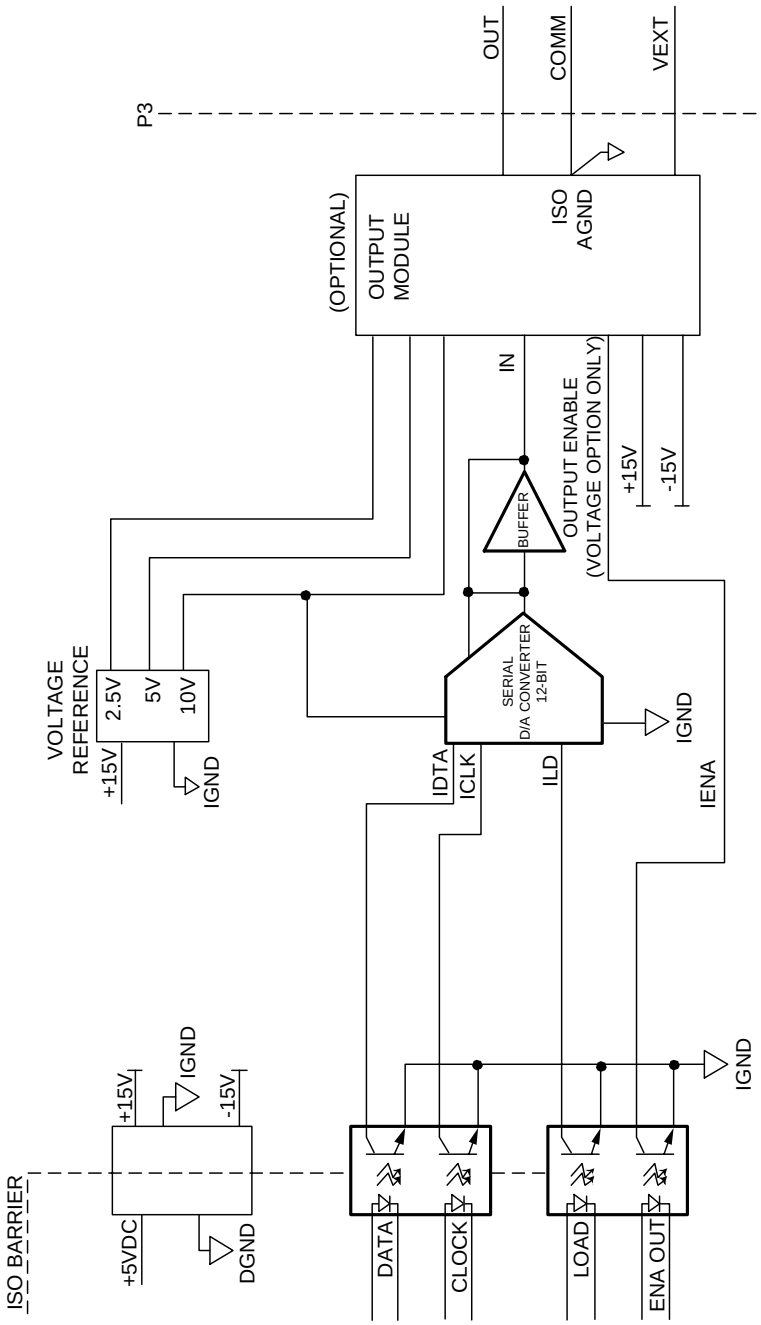
A voltage output module consists of a unity gain buffer and an output switch. The buffer provides the output drive capability necessary to support 10 mA loads over the maximum output range of ±10 V. The switch provides the on-line/off-line field disconnect feature, and is controlled by the Output Enable (OUTPUT EN) bit in the Control/Status Register (CSR). The output switch is located in the feedback loop of the buffer, and consequently does not contribute significantly to the final output impedance of 0.5Ω. The jumpers connected to the voltage module permit selection of any of the three available reference voltages.

The current output module contains a voltage-to-current converter and a pass transistor. The module is factory-jumpered to provide the specified output current range with a voltage range from the D/A converter of 0 to +10 V. The pass transistor boosts the current output capability to the maximum level necessary to support the specified output current range. The jumpers which are connected to the module are used to select the source of loop power either as the internal isolated +15 V rail, or as an external supply which can provide a loop voltage up to +30 V.

DC/DC Power Converters

Each channel contains a single DC/DC converter (Figure 4-4 below) which derives isolated ±15 VDC power from the VMEbus +5 VDC power bus, and is packaged in a 24-pin dual-in-line module. The isolated ±15 VDC outputs from the converter supply all power required for the isolated section of each channel, including the optical isolators, the DAC, and the output module.

Figure 4-4: Isolated Output Channel



Chapter 5 Maintenance

This chapter provides information relative to the care and maintenance of the Analog Output Board product.

If the product malfunctions, verify the following:

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

User level repairs are not recommended. Contact GE Fanuc for a Return Material Authorization (RMA) Number. **This RMA Number must be obtained prior to any return.**