Voltage Input Module

M/N 61C542A

Instruction Manual J-3699-2

RELIANCE ELECTRIC

The information in this user's manual is subject to change without notice.

DANGER

ONLY QUALIFIED ELECTRICAL PERSONNEL FAMILIAR WITH THE CONSTRUCTION AND OPERATION OF THIS EQUIPMENT AND THE HAZARDS INVOLVED SHOULD INSTALL, ADJUST, OPERATE, AND/OR SERVICE THIS EQUIPMENT. READ AND UNDERSTAND THIS MANUAL IN ITS ENTIRETY BEFORE PROCEEDING. FAILURE TO OBSERVE THIS PRECAUTION COULD RESULT IN SEVERE BODILY INJURY OR LOSS OF LIFE.

WARNING

INSERTING OR REMOVING THIS MODULE OR ITS CONNECTING CABLES MAY RESULT IN UNEXPECTED MACHINE MOTION. POWER TO THE MACHINE MUST BE TURNED OFF BEFORE INSERTING OR REMOVING THE MODULE OR ITS CONNECTING CABLES. FAILURE TO OBSERVE THESE PRECAUTIONS COULD RESULT IN BODILY INJURY.

CAUTION

THIS MODULE CONTAINS STATIC-SENSITIVE COMPONENTS. CARELESS HANDLING CAN CAUSE SEVERE DAMAGE. DO NOT TOUCH THE CONNECTORS ON THE BACK OF THE MODULE. WHEN NOT IN USE, THE MODULE SHOULD BE STORED IN AN ANTI-STATIC BAG. THE PLASTIC COVER SHOULD NOT BE REMOVED. FAILURE TO OBSERVE THIS PRECAUTION COULD RESULT IN DAMAGE TO OR DESTRUCTION OF THE EQUIPMENT.

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1.0 INTRODUCTION

The products described in this manual are manufactured and/or distributed by Reliance Electric Industrial Company.

The Multibus®-compatible Voltage Analog Input module (M/N 61C542A) allows you to connect up to 16 single-ended or eight differential ±10V input signals to AutoMate®, AutoMax®, and DCS 5000 systems. The voltage input signals may be generated from process control sensors, transmitters, transducers, or drive controllers.

Bipolar operation has an unscaled range of –4095 to 4095 counts. Unipolar operation has an unscaled range of 0 to 4095.

The module converts the input signals into digital values which are then available for application program use. Input circuit calibration is automatic. Parameters such as alarm limits and number of samples are user configurable. Default configuration values are provided at power-up. The module can be used in both local and remote racks.

This manual describes the functions and specifications of the Voltage Input module M/N 61C542A and earlier. The information in this manual is applicable to all versions of the module unless noted otherwise (see Appendix F). This manual also includes installation and troubleshooting procedures, as well as configuration and programming information.

1.1 Related Publications

Related publications that may be of interest:

- J-2611 DCS 5000 PRODUCT SUMMARY
- J-3031 AutoMate 30 HARDWARE INSTRUCTION MANUAL
- J-3063 AutoMate PROGRAMMING EXECUTIVE INSTRUCTION MANUAL
- J-3141 AutoMate 40 HARDWARE INSTRUCTION MANUAL
- J-3150 AutoMate 30/40 SOFTWARE REFERENCE MANUAL
- J-3606 AutoMax REMOTE I/O INSTRUCTION MANUAL
- J-3649 AutoMax CONFIGURATION TASK INSTRUCTION MANUAL
- J-3650 AutoMax PROCESSOR MODULE INSTRUCTION MANUAL
- J-3675 AutoMax ENHANCED BASIC LANGUAGE INSTRUCTION MANUAL
- J-3676 AutoMax CONTROL BLOCK LANGUAGE INSTRUCTION MANUAL
- J-3677 AutoMax LADDER LOGIC LANGUAGE INSTRUCTION MANUAL
- J-3684 AutoMax PROGRAMMING EXECUTIVE V2.0 INSTRUCTION MANUAL
- J-3750 AutoMax PROGRAMMING EXECUTIVE V3.0 INSTRUCTION MANUAL

- IEEE 518 GUIDE FOR THE INSTALLATION OF ELECTRICAL EQUIPMENT TO MINIMIZE ELECTRICAL NOISE INPUTS TO CONTROLLERS FROM EXTERNAL SOURCES

1.2 Related Hardware and Software

The Voltage Input module, M/N 61C542, contains the following:

1. One Voltage Input module

   The following items must be purchased separately:

- Panel mount terminal board and cable assembly, M/N 61C547. One is required per module.

or

- DIN rail mount terminal board and cable assembly, M/N 61C548. One is required per module.

The Voltage Input module can be configured with the hardware (purchased separately) listed in figure 1.1.

Host	Model Number
AutoMate 30, 30E	M/N 45C001, 45C005, 45C007
AutoMate 40X, 40, 40E	M/N 45C409, 45C410, 45C411
DCS 5000	M/N 57C407
AutoMax	M/N 57C430A, 57C431, 57C435
AutoMate Remote I/O Processor	M/N 45C001B
DCS 5000/AutoMax Remote I/O Communication Module	M/N 57C416

Figure 1.1 – Voltage Input Module Hardware Configuration

2.0 MECHANICAL/ELECTRICAL DESCRIPTION

The following is a description of the faceplate LED, field termination connectors, and electrical characteristics of the field connections.

2.1 Mechanical Description

The Voltage Input module is a Multibus-compatible printed circuit board assembly that plugs into the backplane of the DCS 5000/AutoMax or AutoMate rack.

It consists of a printed circuit board, a faceplate, and a protective enclosure. The faceplate contains tabs at the top and bottom to simplify removing the module from the rack. On the back of the module are two edge connectors that attach to the system backplane. Module dimensions are given in Appendix A.

The faceplate of the module contains one 37-pin female D-shell connector socket labeled "CH. 0-15". See figure 2.1.

Analog input signals are brought into the module via a 5-foot multi-conductor cable assembly. The 37-pin male D-shell connector end of the cable attaches to the faceplate connector, while the 37-pin female D-shell connector end of the cable attaches to the male connector on the terminal board assembly (M/N 61C547 or M/N 61C548). Screw-type connectors on the terminal board assembly provide for easy field wiring.

The module faceplate also contains a green LED labeled "OK". This LED is on when the module has passed its power-up diagnostics and is operating properly.

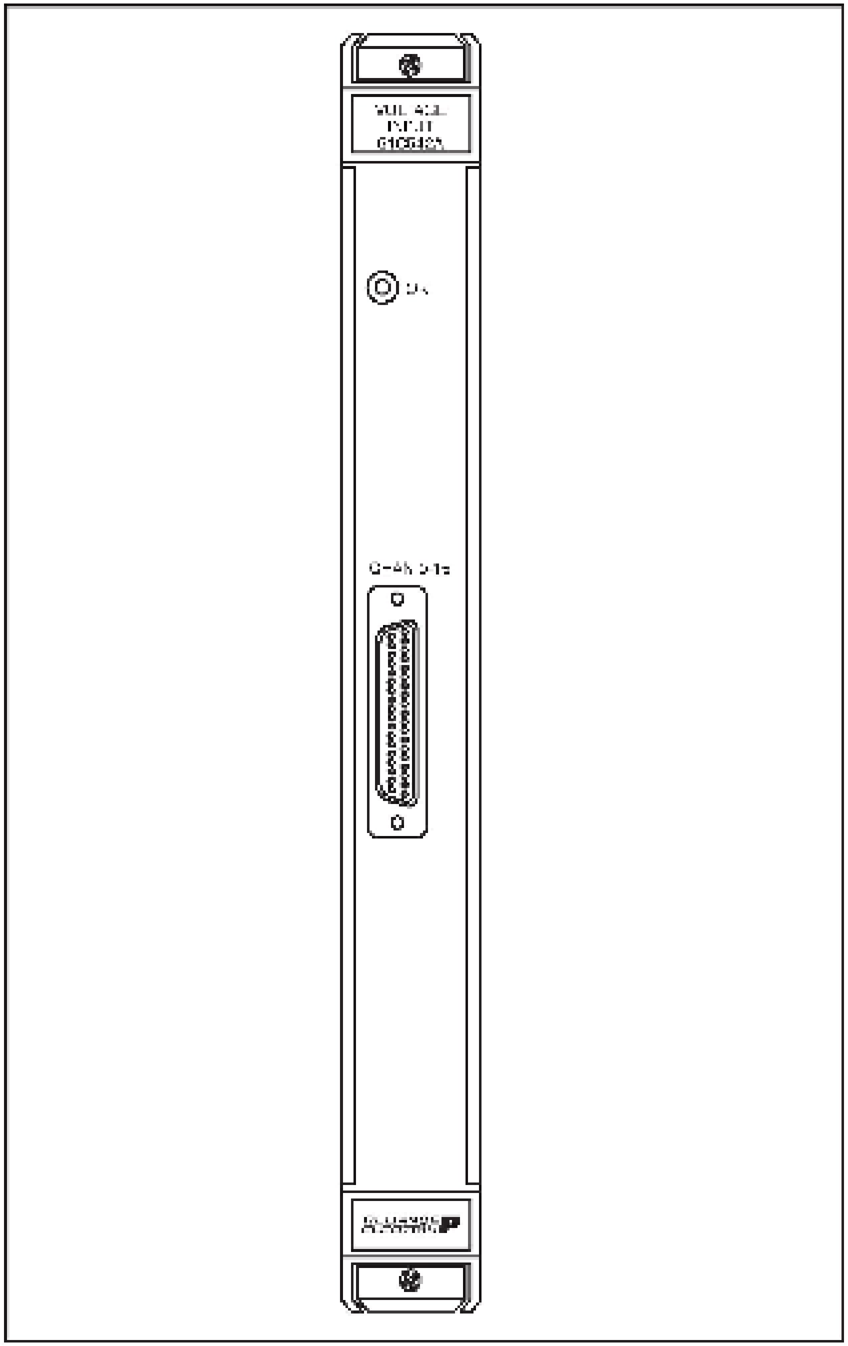

Figure 2.1 - Module Faceplate

2.2 Electrical Description

The module provides analog voltage information to AutoMax and AutoMate systems. The module has sixteen single-ended channels which can alternately be configured as eight differential channels. Single-ended operation versus differential operation is programmable on a per-channel-pair basis via register 31.

Differential channel pairing is hardware-defined as follows: channels 0-1, 2-3 ... 14-15, with the even-number channel being the plus or high input. Each channel is a high-impedance measurement input. No power is supplied from the module for use by the voltage transmitters. See figure 2.2.

Each channel can be configured via register 31 as either bipolar with an input range of +/- 10 volts, or as unipolar with an input range of 0 to 10 volts. All input channels are referenced to the same analog common. All analog inputs must be within the +/- 10 volt range with respect to analog common for proper operation. The analog common has 2500 VAC of isolation from the system common.

Configured channels are sequentially multiplexed to an instrumentation amplifier which drives a thirteen bit (plus sign) A/D converter. Each input line contains a single pole, low-pass filter. The on-board microprocessor also provides line frequency filtering on a per-channel basis. It accomplishes this by converting and averaging together channel input samples over 16.6 ms for a 60 Hz line or 20 ms for a 50 Hz line. In this manner, line frequency noise at the input of the A/D converter is integrated out of the result that is provided to the system. The line frequency filter can be disabled on a per-channel basis to increase the data update rate.

The module contains three voltage references for A/D converter calibration. These voltage references are checked prior to each scan of the configured channels. An out-of-range reference voltage will force a module shutdown. These checks also provide constant updating of the A/D converter's calibration coefficients. No potentiometer adjustments are required to maintain the specified accuracy.

The on-board microprocessor automatically adjusts the input channel's data based on the calibration coefficients. The adjusted input value is then scaled according to the user-selectable values located in registers 24 and 25. The default (unscaled) values in registers 24 and 25 are 4095 and -4095, respectively. The scaled result is then either written to the appropriate channel data register (registers 0 - 15), or it becomes part of the running average specified in register 26. If a running average value is used, the reported output value in the channel data register is the averaged data value.

The module can also be configured to provide a square root extraction value based on a channel's input data value. This provides flow information directly from differential pressure inputs. Note that if you select square root, you must be in unipolar mode.

The module provides high and low limit registers which can be set by the user. Status registers then indicate when the desired high/low values have been exceeded. A broken wire from a transmitter on a configured channel is indicated by an out-of-range status bit in register 20.

All read operations on the module's memory include a parity test. Failure of the parity test results in a module shutdown. Processor modules can read all locations within the module's slot address, but can only write to registers 23 through 31.

The module performs a full complement of power-up diagnostics which must execute successfully before the module enters the run mode. Any diagnostic test failure results in a module shutdown.

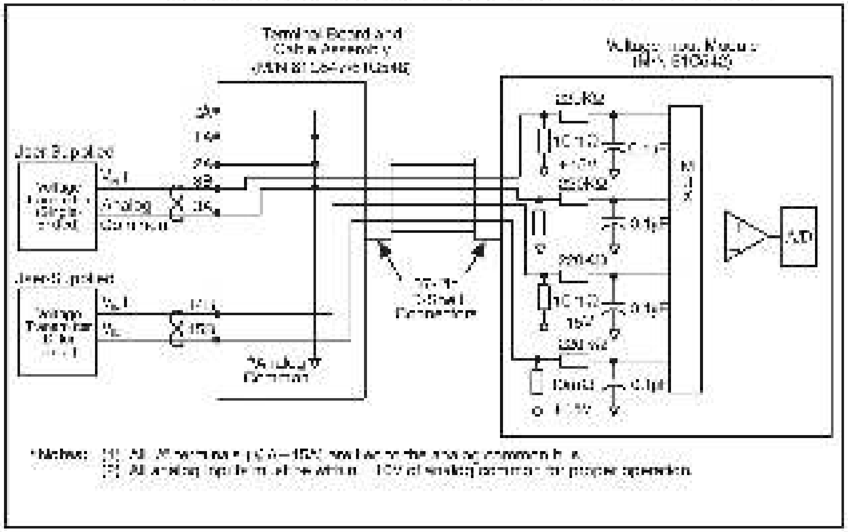

Figure 2.2 - Typical Voltage Input Channel

3.0 INSTALLATION

This section describes how to install and remove the module and its cable assemblies.

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> **DANGER**
>
> **THE USER IS RESPONSIBLE FOR CONFORMING WITH ALL APPLICABLE LOCAL, NATIONAL, AND INTERNATIONAL CODES. WIRING PRACTICES, GROUNDING, DISCONNECTS, AND OVERCURRENT PROTECTION ARE OF PARTICULAR IMPORTANCE. FAILURE TO OBSERVE THIS PRECAUTION COULD RESULT IN SEVERE BODILY INJURY OR LOSS OF LIFE.**

3.1 Wiring

To reduce the possibility of electrical noise interfering with the proper operation of the control system, exercise care when installing the wiring from the system to the external devices. For more detailed recommendations, refer to IEEE 518

3.2 Initial Installation

Use the following procedure to install the module:

Step 1 Turn off power to the system. All power to the rack as well as all power to the wiring leading to the module should be off.

> **DANGER**
>
> **THIS EQUIPMENT IS AT LINE VOLTAGE WHEN A-C POWER IS CONNECTED. DISCONNECT AND LOCK OUT ALL UNGROUNDED CONDUCTORS OF THE A-C POWER LINE. FAILURE TO OBSERVE THESE PRECAUTIONS COULD RESULT IN SEVERE BODILY INJURY OR LOSS OF LIFE.**

Step 2 Mount the terminal board assemblies on a flat panel (M/N 61C547) or a DIN rail (M/N 61C548). See figure 3.1.

The terminal boards should be mounted to allow easy access to the screw terminals. Be sure the terminal board assemblies are close enough to the rack so that the cables (M/N 61C547 or M/N 61C548) will reach between them and the Voltage Input module in the rack. The cables are five feet long. See figure 3.2.

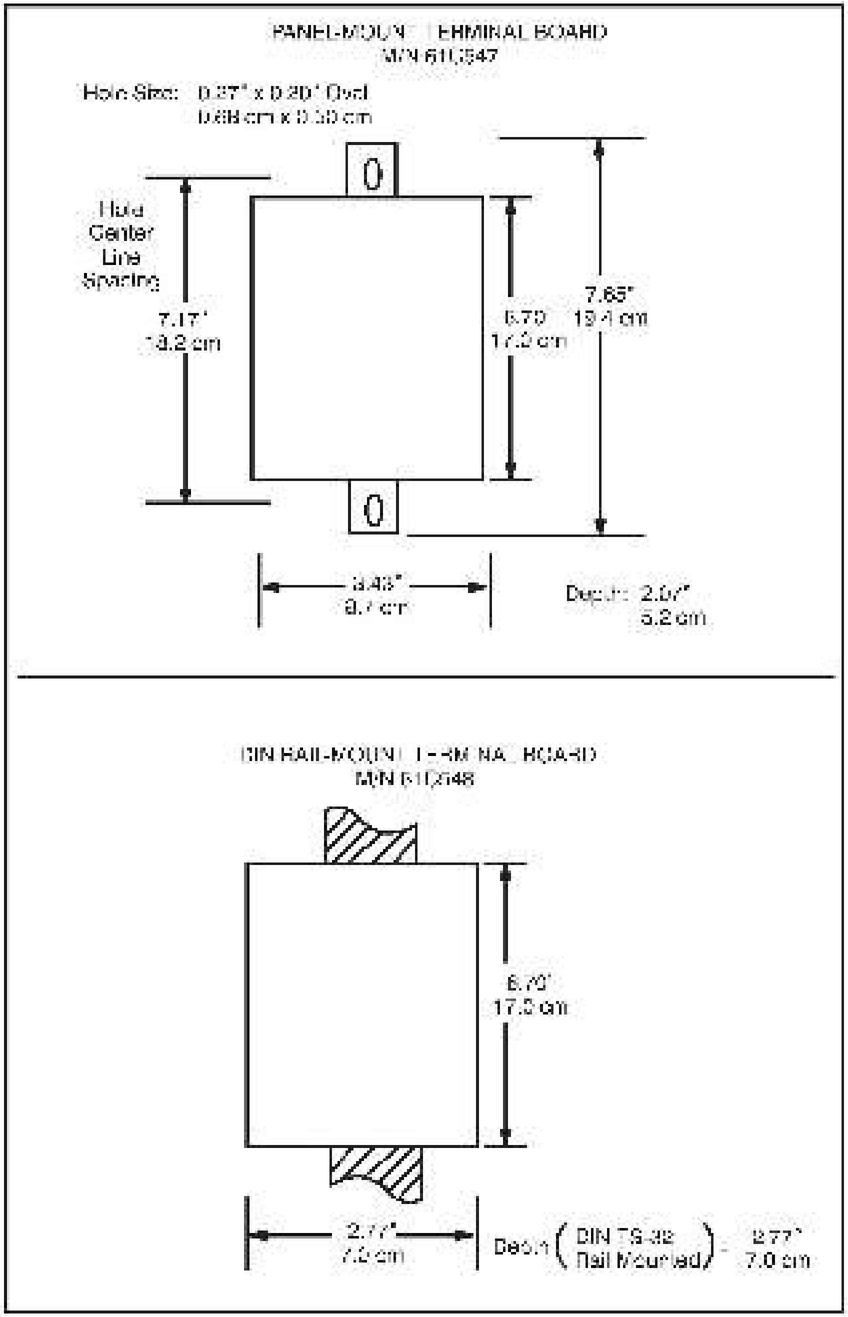


Figure 3.1 - Terminal Board Assembly Mounting Dimensions

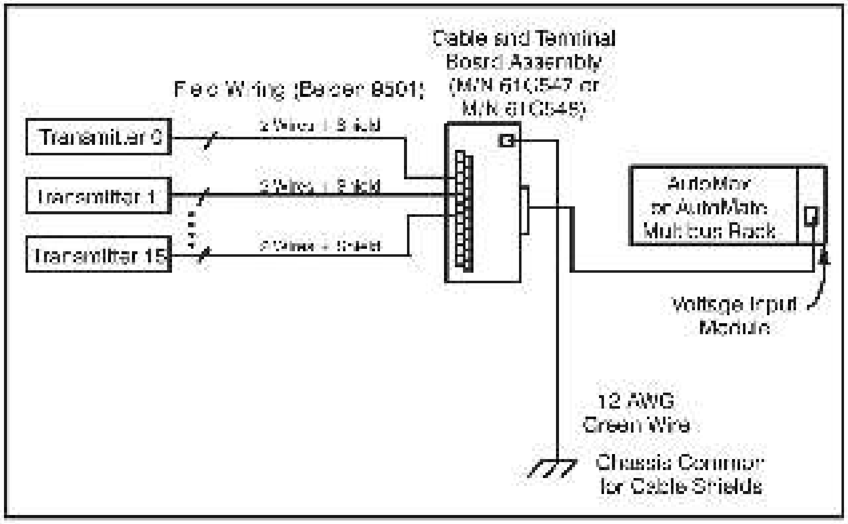


Figure 3.2 - Voltage Input Module Connections

Step 3. Fasten the wires from the transmitters to the screw-type connectors on the terminal board assemblies. Use shielded twisted pair cable, such as Belden 9501 or equivalent. Maximum field wiring length is dependent upon the transmitters. Typical transmitter wiring connections are shown in figure 3.3. Refer to Appendix C for a listing of the terminal board connections. See Appendix G for a listing of module faceplate connections.

Be sure that all of the transmitter field wire connections are tight.

Connect the shields of the twisted-pair wires to the screw-type connectors on the terminal boards that are labeled "S". All "S" terminals are connected to the metal header labeled SHIELD. A lugged 12 AWG green wire connected from the metal header to a chassis ground will shield all of the cables including the cable assembly attached to the module faceplate. See figure 3.2.

The shields must be connected at one end only. Do not connect the shields to the transmitters. Cut the drain wire and remove the foil shielding at the transmitter end. Insulate the shield conductors at the transmitter end with heat shrink tubing or electrical tape.

Step 4. Take the Voltage Input module out of its shipping container. Take it out of its anti-static bag. Be careful not to touch the connectors on the back of the module.

Step 5. Insert the module into the desired slot in the rack. Use a screwdriver to secure the module into the slot.

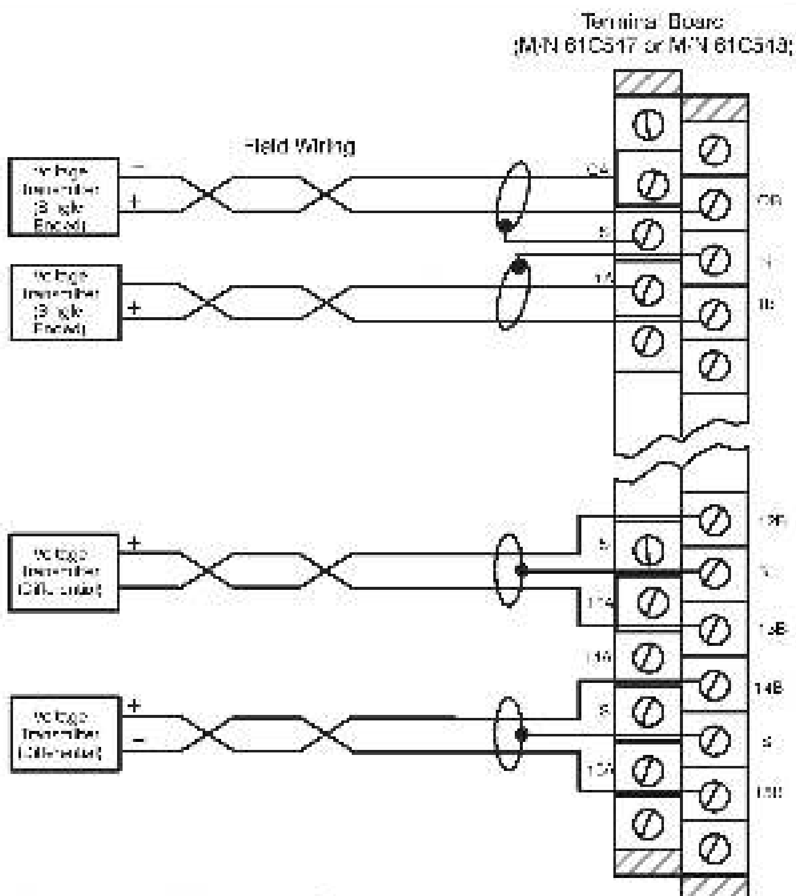
Step 6. Attach the cable between the terminal board assembly and the module. Be sure that the D-shell connectors are oriented properly. Use a screwdriver to secure the D-shell connectors to the terminal board assembly and the module.

Step 7. Turn on power to the system.

Step 8. Connect the programming terminal to the system and run the ReSource Programming Executive Software.

Stop all programs that may be running.

Configure the voltage input channels you are using by following the procedure in section 4.2. You cannot monitor the registers on the module until you have configured the channels. When you are done configuring, read the channels' default values to verify that the installation is correct. Refer to sections 4.1.1 to 4.1.17 for the default values.



Notes: (1) All "A" terminals (0A-15A) are tied to the analog common bus.

(2) All analog inputs must be within ±10V of analog common for proper operation.

Figure 3.3 - Transmitter Wiring Connections

3.3 Module Replacement

Use the following procedure to replace a module:

Step 1 Turn off power to the rack and all external devices.

> **DANGER**
>
> **THIS EQUIPMENT IS AT LINE VOLTAGE WHEN A-C POWER IS CONNECTED. DISCONNECT AND LOCK OUT ALL UNGROUNDED CONDUCTORS OF THE A-C POWER LINE. FAILURE TO OBSERVE THESE PRECAUTIONS COULD RESULT IN SEVERE BODILY INJURY OR LOSS OF LIFE.**

Step 2 Use a screwdriver to loosen the screws holding the D-shell connector to the module. Remove the D-shell connector.

Step 3 Loosen the screws that hold the module in the rack. Remove the module from the rack.

Step 4 Place the module in the anti-static bag that it came in. Do not touch the connectors on the back of the module. Place the module in the cardboard shipping container.

Step 5 Take the new module out of the anti static bag. Do not touch the connectors on the back of the module.

Step 6 Insert the module into the proper slot in the rack. Use a screwdriver to secure the module to the rack.

Step 7 Attach the D-shell connector to the module. Use a screwdriver to secure the connector to the module.

Step 8 Turn on power to the rack and external devices.

Step 9 Connect the programming terminal to the system and run the ReSource Software.

Stop all programs that may be running.

Configure the voltage input channels you are using by following the procedure in section 4.2. You cannot monitor the registers on the module until you have configured the channels. When you are done configuring, read the channels' default values to verify that the installation is correct. Refer to sections 4.1.1 to 4.1.17 for the default values.

4.0 PROGRAMMING

This section describes how the data is organized in the module and provides examples of how the module is accessed by application programs.

For DCS 5000 and AutoMax version 2.1 and earlier, you must assign variable names to registers by writing a configuration task. For AutoMax version 3.0 and later, you define registers using the ReSource™ AutoMax Programming Executive. After these variables are defined, you can generate the configuration file automatically, which eliminates the requirement to write a configuration task for the rack. If you are using AutoMax version 2.1 or earlier, refer to Appendix F for a sample voltage input configuration task. If you are using AutoMax version 3.0 or later, refer to the AutoMax Programming Executive Instruction Manual (J-3750) for more information. Note that AutoMate systems require no special configuration procedure to use the Voltage Input module.

For additional programming information refer to the AutoMate 30/40 Software Instruction Manual (J-3150), the DCS 5000/AutoMax Configuration Task Instruction Manual (J-3649), or the AutoMax Programming Executive Manual (J-3750).

4.1 Register Organization

The Voltage Input module uses 32 registers to store and organize its data. The same registers are used whether the module is in a local rack or a remote rack. See Table 4.1 for a list of the registers. Note that writing to a "read-only" register will result in an I/O error. Table 4.2 contains a list of register default values. When the module is used in a DCS 5000/AutoMax system and a Stop All command is received, the module will be placed in a power up state, which will reset all 32 registers to their default values.

Table 1.1 - Register Organization

Register #	Register Name	Accessibility
0	Channel 0 A/D Data	Read Only
1	Channel 1 A/D Data	Read Only
2	Channel 2 A/D Data	Read Only
3	Channel 3 A/D Data	Read Only
4	Channel 4 A/D Data	Read Only
5	Channel 5 A/D Data	Read Only
6	Channel 6 A/D Data	Read Only
7	Channel 7 A/D Data	Read Only
8	Channel 8 A/D Data	Read Only
9	Channel 9 A/D Data	Read Only
10	Channel 10 A/D Data	Read Only
11	Channel 11 A/D Data	Read Only
12	Channel 12 A/D Data	Read Only
13	Channel 13 A/D Data	Read Only
14	Channel 14 A/D Data	Read Only
15	Channel 15 A/D Data	Read Only
16	High High Alarm Status	Read Only
17	High Alarm Status	Read Only
18	Low Alarm Status	Read Only
19	Low Low Alarm Status	Read Only
20	Out of Range Status	Read Only
21	Channel Configuration Status	Read Only
22	Configuration Status	Read Only
23	Channel Number	Read/Write
24	Maximum Scaling Value	Read/Write
25	Minimum Scaling Value	Read/Write
26	Number of Samples	Read/Write
27	High High Alarm	Read/Write
28	High Alarm	Read/Write
29	Low Alarm	Read/Write
30	Low Low Alarm	Read/Write
31	Configuration Command	Read/Write

Table 4.2 - Register Default Values

Register Number and Name	Default Value
0 Channel 0 A/D Data	0
1 Channel 1 A/D Data	0
2 Channel 2 A/D Data	0
3 Channel 3 A/D Data	0
4 Channel 4 A/D Data	0
5 Channel 5 A/D Data	0
6 Channel 6 A/D Data	0
7 Channel 7 A/D Data	0
8 Channel 8 A/D Data	0
9 Channel 9 A/D Data	0
10 Channel 10 A/D Data	0
11 Channel 11 A/D Data	0
12 Channel 12 A/D Data	0
13 Channel 13 A/D Data	0
14 Channel 14 A/D Data	0
15 Channel 15 A/D Data	0
16 High High Alarm Status	0
17 High Alarm Status	0
18 Low Alarm Status	0
19 Low Low Alarm Status	0
20 Out of Range Status	0
21 Channel Configuration Status	0
22 Configuration Status	0
23 Channel Number	0
24 Maximum Scaling Value	+4095
25 Minimum Scaling Value	-4095
26 Number of Samples	1
27 High High Alarm	+4094
28 High Alarm	+4095
29 Low Alarm	−4095
30 Low Low Alarm	−4094
31 Configuration Command	
Bits 1 and 0	Retain old input value
Bits 5 to 2	Reserved
Bit 6	Enable line frequency averaging
Bit 7	Disable square root extraction
Bit 8	Disable differential input
Bit 9	Disable unipolar inputs
Bits 11 to 10	Reserved
Bits 15 to 12	READY command

4.1.1 A/D Data Registers (Registers 0 to 15)

Registers 0 to 15 hold the latest numeric data from configured analog voltage input channels 0 to 15. This data has been filtered (50 or 60 Hz filters) and, if the cycle averaging option has been enabled, averaged together. See figure 4.1. The data is in a 15-bit plus a sign-bit integer format. The data is displayed in engineering units specified by the Maximum Scaling Value (register 24) and Minimum Scaling Value (register 25). Unscaled values will range from –4095 to +4095. If a channel is not configured, its data is held at zero. Note that if a channel is the second channel (odd-number) of a differential pair, its data is held at zero.

Register 0 = A/D Data from Channel 0
Register 1 = A/D Data from Channel 1
Register 2 = A/D Data from Channel 2
.
.
.
Register 14 = A/D Data from Channel 14
Register 15 = A/D Data from Channel 15

Figure 4.1 - A/D Data Register Assignments

4.1.2 High High Alarm Status Register (Register 16)

Register 16 indicates the current status of each configured channel's High High alarm. See figure 4.2. A bit is set in this register whenever a channel's input value exceeds the configured High High alarm limit. The bit is reset when the input value returns to a level below the configured limit.

When two channels are configured as a differential pair, only the bit representing the first channel (even-number) will be updated. The second channel's status bit will remain at zero.

Register 16
Bits 0-15

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H

Bit 0 = Channel 0	Bit 5 = Channel 5	Bit 10 = Channel 10
Bit 1 = Channel 1	Bit 6 = Channel 6	Bit 11 = Channel 11
Bit 2 = Channel 2	Bit 7 = Channel 7	Bit 12 = Channel 12
Bit 3 = Channel 3	Bit 8 = Channel 8	Bit 13 = Channel 13
Bit 4 = Channel 4	Bit 9 = Channel 9	Bit 14 = Channel 14
		Bit 15 = Channel 15

Figure 4.2 - High High Alarm Status Register

4.1.3 High Alarm Status Register (Register 17)

Register 17 indicates the current status of each configured channel's High alarm. See figure 4.3. A bit is set in this register whenever a channel's input value exceeds the configured High alarm limit. The bit is reset when the input value returns to a level below the configured limit.

When two channels are configured as a differential pair, only the bit representing the first channel (even-number) will be updated. The second channel's status bit will remain at zero.

Register 17

Bits 0-15

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R

Bit 0 = Channel 0	Bit 5 = Channel 5	Bit 10 = Channel 10
Bit 1 = Channel 1	Bit 6 = Channel 6	Bit 11 = Channel 11
Bit 2 = Channel 2	Bit 7 = Channel 7	Bit 12 = Channel 12
Bit 3 = Channel 3	Bit 8 = Channel 8	Bit 13 = Channel 13
Bit 4 = Channel 4	Bit 9 = Channel 9	Bit 14 = Channel 14
		Bit 15 = Channel 15

Figure 4.3 - High Alarm Status Register

4.1.4 Low Alarm Status Register (Register 18)

Register 18 indicates the current status of each configured channel's Low alarm. See figure 4.4. A bit is set in this register whenever a channel's input value is less than the configured Low alarm limit. The bit is reset when the input value returns to a level above the configured limit.

When two channels are configured as a differential pair, only the bit representing the first channel (even-number) will be updated. The second channel's status bit will remain at zero.

Register 18

Bits 0-15

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R

Bit 0 = Channel 0	Bit 5 = Channel 5	Bit 10 = Channel 10
Bit 1 = Channel 1	Bit 6 = Channel 6	Bit 11 = Channel 11
Bit 2 = Channel 2	Bit 7 = Channel 7	Bit 12 = Channel 12
Bit 3 = Channel 3	Bit 8 = Channel 8	Bit 13 = Channel 13
Bit 4 = Channel 4	Bit 9 = Channel 9	Bit 14 = Channel 14
		Bit 15 = Channel 15

Figure 4.4 - Low Alarm Status Register

4.1.5 Low Low Alarm Status Register (Register 19)

Register 19 indicates the current status of each configured channel's Low Low alarm. See figure 4.5. A bit is set in this register whenever a channel's input value is less than the configured Low Low alarm limit. The bit is reset when the input value returns to a level above the configured limit.

When two channels are configured as a differential pair, only the bit representing the first channel (even-number) will be updated. The second channel's status bit will remain at zero.

Register 19
Bits 0-15

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R

Bit 0 – Channel 0
Bit 1 – Channel 1
Bit 2 – Channel 2
Bit 3 – Channel 3
Bit 4 – Channel 4
Bit 5 – Channel 5
Bit 6 – Channel 6
Bit 7 – Channel 7
Bit 8 – Channel 8
Bit 9 – Channel 9
Bit 10 – Channel 10
Bit 11 – Channel 11
Bit 12 – Channel 12
Bit 13 – Channel 13
Bit 14 – Channel 14
Bit 15 – Channel 15

Figure 4.5 - Low Low Alarm Status Register

4.1.6 Out of Range Status Register (Register 20)

Register 20 indicates the current status of each configured channel's Out of Range alarm. See figure 4.6. A bit is set in this register whenever a channel's A/D input value is outside of the range of −10.5 volts to 10.5 volts (bipolar inputs) or −0.5 volts to 10.5 volts (unipolar inputs).

The bits in this register are not latched automatically. If you want a bit to be latched the first time a value goes out of range, you must latch it through the application program.

When two channels are configured as a differential pair, only the bit representing the first channel (even-number) will be updated. The second channel's status bit will remain at zero.

If an input is identified as being out of range, the most probable cause is that a wire between the transmitter and the module has either not been properly connected or has been broken.

Register 20
Bits 0-15

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R

Bit 0 – Channel 0
Bit 1 – Channel 1
Bit 2 – Channel 2
Bit 3 – Channel 3
Bit 4 – Channel 4
Bit 5 – Channel 5
Bit 6 – Channel 6
Bit 7 – Channel 7
Bit 8 – Channel 8
Bit 9 – Channel 9
Bit 10 – Channel 10
Bit 11 – Channel 11
Bit 12 – Channel 12
Bit 13 – Channel 13
Bit 14 – Channel 14
Bit 15 – Channel 15

Figure 4.6 - Out of Range Status Register

4.1.7 Channel Configuration Status Register (Register 21)

Register 21 indicates whether or not a channel has been configured. See figure 4.7. A bit is set in this register when a channel receives a correct write configuration command. Note that if two channels are configured as a differential pair, both channel status bits will be set. The bit remains set until it is cleared by a reset configuration command from register 31.

Register 21
Bits 0-15

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R

Bit 0 – Channel 0
Bit 1 – Channel 1
Bit 2 – Channel 2
Bit 3 – Channel 3
Bit 4 – Channel 4
Bit 5 – Channel 5
Bit 6 – Channel 6
Bit 7 – Channel 7
Bit 8 – Channel 8
Bit 9 – Channel 9
Bit 10 – Channel 10
Bit 11 – Channel 11
Bit 12 – Channel 12
Bit 13 – Channel 13
Bit 14 – Channel 14
Bit 15 – Channel 15

Figure 4.7 - Channel Configuration Status Register

4.1.8 Configuration Status Register (Register 22)

Register 22 provides the status of the configuration command issued by register 31. See figure 4.8. Bit 15 is set in this register whenever a channel receives a configuration command. Error bit 14 will be set if an incorrect configuration command is detected.

Register 22
Bits 0-15

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
R	R	–	–	–	–	R	R	R	R	R	R	R	R	R	R

Bit 0 – Channel Number Error
Bit 1 – Illegal Running Average Number Error
Bit 2 – Low Low Alarm Value Is Not the Lowest
Bit 3 – High Alarm Value Is Not Larger Than The Low Alarm Value
Bit 4 – High High Alarm Value Is Not the Highest
Bit 5 – Alarm Value Is Out Of Range Of The Scaling Range
Bit 6 – Illegal Configuration Command
Bit 7 – READY State Not Enabled
Bit 8 – Maximum Scaling Value Must Be At Least 100 Greater Than The Minimum Scaling Value
Bit 9 – Square Root Extraction is Only Valid in the Unipolar Mode
Bits 10 to 13 – Not Used
Bit 14 – Configuration Error
Bit 15 – Configuration is Complete

Figure 4.8 - Configuration Status Register

Bit 15 will remain set after a configuration command is received until bits 12 to 15 of the Configuration Command Register (register 31) are reset to zero. When bits 12 to 15 of register 31 are reset to zero, the Voltage Input module resets bit 15 of register 22, which allows you to enter another configuration command. If you try to enter another configuration command before bit 15 of register 22 is reset, error bits 4 and 14 in register 22 will be set.

4.1.9 Channel Number Register (Register 23)

Register 23 contains the number of the channel to be configured, read, or reset. Channel numbers can range from 0 to 15. A channel number outside of this range will be flagged as an error. If two channels are to be used as differential inputs, register 23 must contain the number of the first channel (even number) of the pair, otherwise a channel number error will result.

4.1.10 Maximum Scaling Value Register (Register 24)

Register 24 defines the upper limit value of the input data. The module uses this value to perform a linear conversion of the input data (in an unscaled range of −4095 to +4095) into engineering units. The value in register 24 must be at least 100 greater than the value in register 25 or a configuration error will result in register 22.

The value in register 24 is a 15-bit plus a sign-bit integer (−32768 to +32767). At system power-up, register 24 is set to a value of 4095. If you want the input value to be in a scaled format, you can change the value in either registers 24 or 25, or both. If you do not change the values in registers 24 and 25, the input value is sent to the appropriate configured channel data register (0 to 15) in an unscaled format.

4.1.11 Minimum Scaling Value Register (Register 25)

Register 25 defines the lower limit value of the input data. The module uses this value to perform a linear conversion of the input data (in an unscaled range of −4095 to +4095) into engineering units. The value in register 25 must be at least 100 less than the value in register 24 or a configuration error will result in register 22. Note that if the channel is to be configured for unipolar operation (0V to 10V range), the value in register 25 may have to be changed to reflect input data in the unscaled range of 0 to 4095.

The value in register 25 is a 15-bit plus a sign-bit integer (−32768 to +32767). At system power-up, register 25 is set to a value of −4095. If you want the input value to be in a scaled format, you can change the value in either registers 24 or 25, or both. If you do not change the values in registers 24 and 25, the input value is sent to the appropriate configured channel data register (0 to 15) in an unscaled format.

4.1.12 Number of Samples Register (Register 26)

Register 26 specifies the number of input data samples that will be averaged together. The module maintains a running average of "x" number of input data samples. The value in the register is a 15-bit signed integer. The default value is one. The maximum allowable value is 60.

If the register contains a value of zero or one, no input data will be averaged together. If the register contains a negative number or a number greater than 60, a configuration error will result in register 22.

As the number of input samples increases, the time span of averaging increases, which results in a less current input value for use in the application program. See figure 4.9 for an equation to determine the amount of time needed to calculate an average input value for registers 0 to 15.

$$\left(\text{\# of configured channels} \times \text{cycle frequency time} + \text{system overhead} \right) \times \text{\# of samples} = \text{time the value in registers 0-15 was averaged over}$$

Where:

# of configured channels that have cycle averaging enabled = 1-16

cycle frequency time = 20 msec for 50 Hz
16.6 msec for 60 Hz

system overhead = 5 msec

# of samples = 1-60

averaged time = time in seconds

Figure 4.9 - Equation for Determining the Input Value Averaging Time

4.1.13 High High Alarm Register (Register 27)

Register 27 defines the High High alarm limit. If a channel's input value exceeds this limit, the channel's corresponding bit in register 16 is set to one. The value in register 27 is a 15-bit plus a sign bit integer. This value must be in engineering units if scaling is used. If scaling is used, this value must be equal to or smaller than the Maximum Scaling Value (register 24) and larger than the Minimum Scaling Value (register 25). Unscaled data can range from −4095 to +4095.

If register 27 does not contain an alarm value greater than or equal to the High alarm value, a configuration error will result in register 22. At power-up, the register is set to a default value of 4091.

4.1.14 High Alarm Register (Register 28)

Register 28 defines the High alarm limit. If a channel's input value exceeds this limit, the channel's corresponding bit in register 17 is set to one. The value in register 28 is a 15-bit plus a sign-bit integer. This value must be in engineering units if scaling is used. If scaling is used, this value must be equal to or smaller than the Maximum Scaling Value (register 24) and larger than the Minimum Scaling Value (register 25). Unscaled data can range from −4095 to +4095.

If register 28 does not contain an alarm value greater than the Low alarm value, a configuration error will result in register 22. At power-up, the register is set to a default value of 4085.

4.1.15 Low Alarm Register (Register 29)

Register 29 defines the Low alarm limit. If a channel's input value is less than this limit, the channel's corresponding bit in register 18 is set to one. The value in register 29 is a 15-bit plus a sign-bit integer. This value must be in engineering units if scaling is used. If scaling is used, this value must be smaller than the Maximum Scaling Value (register 24) and equal to or larger than the Minimum Scaling Value (register 25). Unscaled data can range from −4095 to +4095. Note that if the channel is to be configured for unipolar operation (0V to 10V range), the value in register 29 may have to be changed to reflect input data in the unscaled range of 0 to +4095.

If register 29 does not contain an alarm value less than the High alarm value, a configuration error will result in register 22. At power-up, the register is set to a default value of −4095.

4.1.16 Low Low Alarm Register (Register 30)

Register 30 defines the Low Low alarm limit. If a channel's input value is less than this limit, the channel's corresponding bit in register 19 is set to one. The value in register 30 is a 15-bit plus a sign-bit integer. This value must be in engineering units if scaling is used. If scaling is used, this value must be smaller than the Maximum Scaling Value (register 24) and equal to or larger than the Minimum Scaling Value (register 25). Unscaled data can range from −4095 to +4095. Note that if the channel is to be configured for unipolar operation (0V to 10V range), the value in register 30 may have to be changed to reflect input data in the unscaled range of 0 to +4095.

If register 30 does not contain an alarm value lower than or equal to the Low alarm value, a configuration error will result in register 22. At power-up, the register is set to a default value of −4094.

4.1.17 Configuration Command Register (Register 31)

Register 31 defines the frequency averaging, the average A-D line frequency, square root extraction, unipolar inputs, differential inputs, and what action should be taken if an input value is out of range. The register also contains the Configuration Command Code. See figure 4.10.

Register 31

Bits 0-15

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
r/w	r/w	r/w	r/w	–	–	r/w	r/w	r/w	r/w	–	–	–	–	r/w	r/w

Bits 1 and 0 – When An Input Value Is Out Of Range, The Voltage Input Module Will:

- 0 0 – Retain Old Input Value
- 0 1 – Force Input Value to Low Low Alarm Value
- 1 0 – Force Input Value to High High Alarm Value
- 1 1 – Retain Old Input Value

Bits 5 to 2 – Reserved

Bit 6 – Cycle Frequency Averaging

- 0 – Enable
- 1 – Disable

Bit 7 – Square Root Extraction

- 0 – Disable
- 1 – Enable

Bit 8 – Differential Input Mode

- 0 = Disabled (single-ended operation)
- 1 = Enabled

Bit 9 – Unipolar Inputs

- 0 = Disabled (Bipolar -10V to 10V inputs)
- 1 = Enabled (Unipolar 0 to 10V inputs)

Bits 11 to 10 – Reserved

Bits 15 to 12 – Configuration Command Code

- 0 0 0 0 – READY State
- 0 0 0 1 – Reset Configuration For This Channel
- 0 0 1 0 – Read Configuration For This Channel
- 0 0 1 1 – Write Configuration For This Channel
- 0 1 0 0 – 50 Hz A-C Line Frequency
- 0 1 0 1 – 60 Hz A-C Line Frequency

Figure 4.10 - Configuration Command Register

When configuring a channel, you must define values for registers 23 through 30 before writing to register 31. Register 31 must be the last register that you write to as you configure each channel.

When you are finished with register 31 for the channel you are configuring, and the module has processed the information, the module will set bit 15 of register 23 equal to one. You must then set bits 12 to 15 of register 31 equal to zero. This places the module in the READY state. The module then resets bit 15 of register 23, which indicates that it is ready to configure another channel via register 31. If you attempt to enter another command before resetting bits 12 to 15 of register 31, a configuration error will result in register 22.

Bits 0 and 1 specify what action should occur when an input value is out of range. The default condition is to retain the old input value from the channel data registers (0 to 15).

Bits 2 to 5 are reserved for future use.

Bit 6 defines whether or not cycle averaging is enabled for the channel specified in register 23. The default condition (0) enables cycle averaging.

Bit 7 defines whether or not square root extraction is enabled for the channel specified in register 23. The default condition (0) disables square root extraction. When square root extraction is enabled, you must be in unipolar mode. The square root function provides flow information directly from a differential pressure input.

If the specified channel has square root extraction enabled and does not use engineering units, the flow information provided is in the range of 0 to +4095. The data returned represents the following ratio:

$$\frac{\text{Data}}{4095} = \frac{\text{Flow}}{\text{Flow (Maximum)}}$$

Set the Maximum Scaling Register (register 24) to 10000 in order to read the flow information in steps of 0.01%:

$$\frac{\text{Data}}{10000} = \frac{\text{Flow}}{\text{Flow (Maximum)}}$$

You can also set register 24 to the maximum flow value. This will allow a direct indication of flow.

Bit 8 defines whether the channel specified in the channel number register (register 23) is a single-ended channel or is the first channel of a differential pair. The default is (0), which represents a single-ended channel. Note that when you are changing between the differential and single-ended modes of operation, you must first reset the channel's configuration.

Bit 9 defines whether the channel specified in the channel number register (register 23) is to be treated as bipolar (-10V to +10V range) or unipolar (0 to +10V range). The default is (0) which represents bipolar.

Bits 10 and 11 are reserved for future use.

Bits 12 to 15, when equal to 0, enable the READY state, which is the default condition. When the module is in the READY state, it is ready to receive a configuration command.

When bits 12 to 15 are set to a binary value of 1, 2, or 3, their operations refer to the channel specified in register 23:

- A binary value of 1 (RESET) resets the channel's configuration by clearing its corresponding channel input register and resetting its corresponding bit in the status registers (registers 16-21). When resetting a differential pair, register 23 must contain the first (even number) channel of the pair, otherwise, a "channel number error" configuration error will result.
- A binary value of 2 (READ) reads the channel's current configuration information in memory and loads it into registers 24 to 30. When reading a differential pair register 23 must contain the first (even number) channel of the pair, otherwise, a "channel number error" configuration error will result.
- A binary value of 3 (WRITE) transfers the channel's configuration information (registers 24 to 30) into the module's memory, configures the channel, and then sets the corresponding bits in the status registers (registers 16-21). If bit 8 is set to 1 (indicating a differential pair), then register 23 must be the first (even number) channel of the pair, otherwise, a "channel number error" configuration error will result.

When bits 12 to 15 are set to a binary value of 4 or 5, they reflect the A-C power line frequency. The default is 60 Hz.

4.2 Analog Input Channel Configuration Procedure

Analog input channel configuration information is stored on board the Voltage Input module. At system power-up, default values are automatically placed in the module's memory. You can change these default values on a channel-by-channel basis. See Figure 4.11 and the steps that follow.

To do this, you need to set bits 12 to 15 of register 31 equal to zero to make sure the Voltage Input module is in the READY state and then place a value in registers 23 through 31 for each analog input channel you wish to configure:

- Channel Number Register (Register 23)
- Maximum Scaling Value (Register 24)
- Minimum Scaling Value (Register 25)
- Number of Samples Register (Register 26)
- High High Alarm Register (Register 27)
- High Alarm Register (Register 28)
- Low Alarm Register (Register 29)
- Low Low Alarm Register (Register 30)
- Configuration Command Register (Register 31)

After you have written values to registers 23 through 30 and written the write Configuration Command Code into register 31, the system automatically transfers the new channel parameters to the appropriate locations in memory. To use these parameters on another unconfigured channel, simply change the channel number and put the write Configuration Command Code into register 31. If you want to configure a channel with the original power up default values, you must first write the read Configuration Command Code to register 31 to restore these values to registers 23 through 30. Note that the channels on the Voltage Input module must be configured from only one application program.

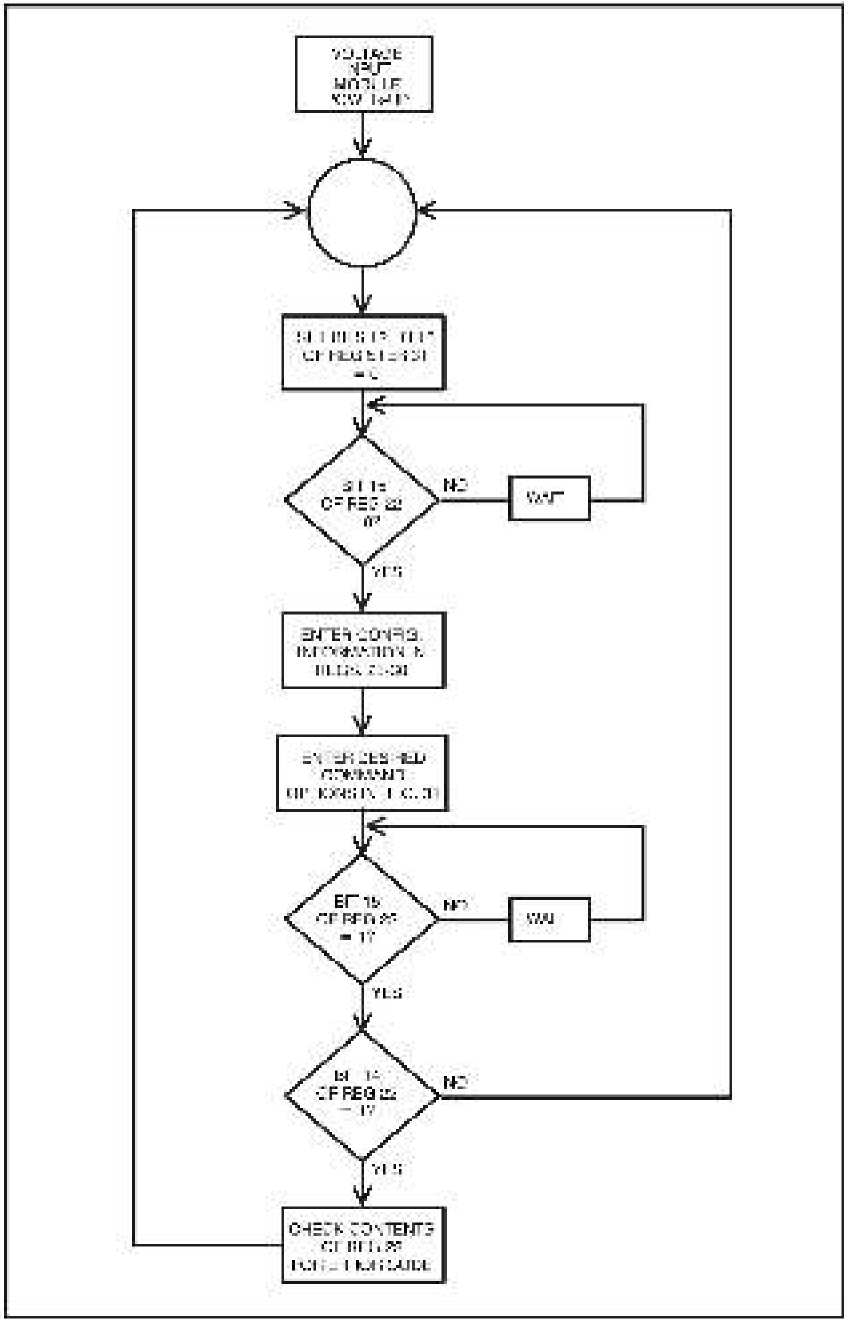


Figure 4.11 - Channel Configuration Flowchart

Use the following procedure to configure a channel.

Step 1. Set bits 12 to 15 of register 31 equal to zero. This resets bit 15 of register 22 and places the module in the READY state. When the READY state is enabled, the module is ready to process a configuration command. Monitor bit 15 until it is equal to zero before continuing with Step 2.

Step 2. Select the channel to be configured by writing the appropriate number to the Channel Number Register (Register 23). This value is a 15-bit plus a sign-bit integer. See section 4.1.9 for more information.

Step 3. Define the channel's Maximum Scaling Value by writing the desired value to the Maximum Scaling Value Register (Register 24). This value is a 15-bit plus a sign-bit integer. See section 4.1.10 for more information.

Step 4. Define the channel's Minimum Scaling Value by writing the desired value to the Minimum Scaling Value Register (Register 25). This value is a 15-bit plus a sign-bit integer. See section 4.1.11 for more information.

Step 5. Define the number of input data samples that are to be averaged together for the input running average value. Write the desired number to the Number of Samples Register (Register 26). This value is a 15-bit plus a sign bit integer. See section 4.1.12 for more information.

Step 6. Define the channel's High High alarm limit by writing the desired value to the High High Alarm Register (Register 27). This alarm value is a 15-bit plus a sign-bit integer. See section 4.1.13 for more information.

Step 7. Define the channel's High alarm limit by writing the desired value to the High Alarm Register (Register 28). This alarm value is a 15-bit plus a sign-bit integer. See section 4.1.14 for more information.

Step 8. Define the channel's Low alarm limit by writing the desired value to the Low Alarm Register (Register 29). This alarm value is a 15-bit plus a sign-bit integer. See section 4.1.15 for more information.

Step 9. Define the channel's Low Low alarm limit by writing the desired value to the Low Low Alarm Register (Register 30). This alarm value is a 15-bit plus a sign-bit integer. See section 4.1.16 for more information.

Step 10. Enter the required information in the Configuration Command Register (Register 31). See section 4.1.17 for more information. Set the Configuration Command Code (bits 12 to 15) equal to three. This code transfers (writes) the channel's parameters into memory.

Step 11. When the module finishes processing the write configuration operation, it will set bit 15 of register 22 equal to one. Monitor bit 15 until it is set to one.

Step 12. Monitor bit 14 of register 22. If this bit is equal to zero the module is ready to configure another channel. To configure another channel repeat the procedure beginning with step 1. If bit 14 is equal to one, check the error code in register 22.

4.3 Monitoring Data and Configuration Register Values

Run the ReSource Programming Executive Software. Use the MONITOR function in DCS 5000/ AutoMax systems or the POINT MONITOR function in AutoMate systems to check the contents of the registers. Note that you need to configure the channels before you can monitor their contents.

Status register values are in hexadecimal format. All other register values are in decimal.

4.4 Sample DCS 5000/AutoMax Voltage Input Application Task

The sample DCS 5000/AutoMax voltage input application task in figure 4.12 is written for a Voltage Input module in slot 2 which is connected to three single-ended, 0-10V transmitters, which are in turn wired into a pressure polymerization process.

One transmitter is used to sense the level of the material in the tank. The second transmitter has its span calibrated for 0 to 3000 psig (gauge pounds-per-square inch) and is used during start-up operation. The third transmitter has its span calibrated for 1940 to 1960 psig and is used for process control.

Channel 0: Material Level

	Process Parameters	Configuration Values
•	Maximum = 20 feet	Reg. 24 = 2000 (Scaled in 0.01 Ft)
•	Minimum = – 1 feet	Reg. 25 = –100
•	High High Alarm = 18 feet	Reg. 27 = 1800
•	High Alarm = 16 feet	Reg. 28 = 1600
•	Low Alarm = 4 feet	Reg. 29 = 400
•	Low Low Alarm = 0 feet	Reg. 30 = 0

Channel 1: Startup Pressure

	Process Parameters	Configuration Values
•	Maximum = 3000 psig	Reg. 24 = 3000 (Scaled directly in psig)
•	Minimum = 0 psig	Reg. 25 = 0
•	High High Alarm = 2500 psig	Reg. 27 = 2500
•	High Alarm = 2000 psig	Reg. 28 = 2000
•	Low Alarm = 500 psig	Reg. 29 = 500
•	Low Low Alarm = 250 psig	Reg. 30 = 250

Channel 2. Operating Pressure

Process Parameters	Configuration Values
• Maximum = 1960 psig	Reg. 24 = 10000 (scaled in 0.01% of span)
• Minimum = 1940 psig	Reg. 25 = 0
• High High Alarm = 1958 psig	Reg. 27 = 9000
• High Alarm = 1955 psig	Reg. 28 = 7500
• Low Alarm = 1945 psig	Reg. 29 = 2500
• Low Low Alarm = 1942 psig	Reg. 30 = 1000

If you are using AutoMax version 2.1 or earlier, you will need to define common (system-wide) variables in a configuration task before writing an application task. The configuration task in Appendix E defines the common variables in the sample task below.

If you are using DCS 5000/AutoMax version 3.0 or later, this information will be entered in the configuration form using the Programming Executive software.

```
10    !
20    !
30    !   This task configures three channels:
40    !       Channel 0 monitors the level of a liquid in a tank.
45    !       Channel 1 monitors the startup pressure of a process.
50    !       Channel 2 monitors the operating pressure of a process.
55    !       If any configuration fails, SHUTDOWN@ is set.
60    !
65    !   This task checks for alarms once per second:
70    !       If any channel has an out of range status condition,          &
      !       SHUTDOWN@ is set.
75    !       If any channel has a high or low alarm, WARNING@ is set.
80    !       If any channel has a high-high or low-low alarm,             &
      !       SHUTDOWN@ is set.
90    !
100   !   ------------------------ LOCAL VARIABLES ------------------------
110   !
120   LOCAL CHANNEL%
130   !
200   !   ********************** COMMON VARIABLES **********************
210   !
220   COMMON TANK_LEVEL%                \ Tank level read by the VIM card
230   COMMON START_PROCESS%             \ Pressure read by the VIM card       &
                                        \ during the startup process
240   COMMON OP_PROCESS%                \ Pressure read by the VIM card       &
                                        \ during the operation process
245   !
300   COMMON TANK_HH_ALARM@             \ Tank high-high alarm status
310   COMMON TANK_H_ALARM@              \ Tank high alarm status
320   COMMON TANK_L_ALARM@              \ Tank low alarm status
330   COMMON TANK_LL_ALARM@             \ Tank low-low alarm status
340   !
400   COMMON START_HH_ALARM@            \ High-high alarm status during the   &
                                        \ startup process
410   COMMON START_H_ALARM@             \ High alarm status during the        &
                                        \ startup process
420   COMMON START_L_ALARM@             \ Low alarm status during the         &
                                        \ startup process
430   COMMON START_LL_ALARM@            \ Low-low alarm status during the     &
                                        \ startup process
440   !
500   COMMON OP_HH_ALARM@               \ High-high alarm status during       &
                                        \ the operation process
510   COMMON OP_H_ALARM@                \ High alarm status during the        &
                                        \ operation process
520   COMMON OP_L_ALARM@                \ Low alarm status during the         &
                                        \ operation process
530   COMMON OP_LL_ALARM@               \ Low-low alarm status during the     &
                                        \ operation process
540   !
600   COMMON CNF_CHAN_NUM%              \ Channel number (Register 23)
610   COMMON CNF_MAX%                   \ Maximum scaling value (Register 24)
620   COMMON CNF_MIN%                   \ Minimum scaling value (Register 25)
630   COMMON CNF_AVE_SAMPLES%           \ Number of running average samples (Register 26)
640   COMMON CNF_HH_ALARM%              \ High-high alarm value (Register 27)
650   COMMON CNF_H_ALARM%               \ High alarm value (Register 28)
660   COMMON CNF_L_ALARM%               \ Low alarm value (Register 29)
670   COMMON CNF_LL_ALARM%              \ Low-low alarm value (Register 30)
680   COMMON CNF_COMMAND%               \ Configuration command (Register 31)
690   COMMON CNF_DONE@                  \ Configuration complete (Register 22, bit 15)
700   COMMON CNF_ERROR@                 \ True if configuration error occurs (Register 22, bit 14)
710   COMMON WARNING@                   \ True if any channel has a high or   &
                                        \ low alarm
720   COMMON SHUTDOWN@                  \ True if any channel has a low-low   &
                                        \ or high-high alarm or an out of range &
                                        \ value or configuration error
730   COMMON OUT_OF_RANGE@              \ Not used; if any channel status      &
                                        \ value is out of range
```

Figure 4.12 - Sample DCS 5000/AutoMax Voltage Input Application Task (Continued)

```
990   !
1000  ! ******************** INITIALIZATION ********************
1010  !
1020  !  Configure the first three channels using the data                   &
      !  statements at 9000
1030  !
1100  FOR CHANNEL% = 0 TO 2
1110        ! Reset the configuration register
1120     CNF_COMMAND% = 0000H
1130        ! Wait for the config complete flag to be reset
1140     IF CNF_COMP@ = FALSE THEN GOTO 1180
1150        DELAY 10 TICKS
1160        GOTO 1140
1170        ! Specify the channel to be configured
1180     CNF_CHAN_NUM% = CHANNEL%
1190        ! Specify the max scaling, min scaling, high high, high,         &
              low, low low alarm values
1200     READ CNF_MAX%, CNF_MIN%, CNF_AVE_SAMPLES%, CNF_HH_ALARM%,           &
              CNF_H_ALARM%, CNF_L_ALARM%, CNF_LL_ALARM%
1210      ! Send the MULTI card operation command that specifies               &
          retaining the old value for the out of range mode and              &
          enabling cycle averaging, disabling ... detection, selecting       &
          single ended inputs and enabling ... 
1230     CNF_COMMAND% = 8200H
1240        ! Wait for the config complete flag to be set
1250     IF CNF_COMP@ = TRUE THEN GOTO 1280
1260        DELAY 10 TICKS
1270        GOTO 1250
1280        ! Check for an error configuring the channel
1290     IF CNF_ERROR@ = TRUE THEN SHUTDOWN@ = TRUE
1300  NEXT CHANNEL%
8000  !
8010  !        Max       Min       Run      High      High     Low      Low
8020  !        Scaling   Scaling   Ave      High                        Low
9000  DATA     2000,     -100,     20,      1800,     1600,    400,     0
9010  DATA     3000,     0,        20,      2500,     2000,    500,     250
9020  DATA     10000,    0,        20,      9000,     7500,    2500,    1000
9030  !
9900  !
9910  ! ******************** MAIN LOOP ********************
9920  !
9981  !  If any channels are out of range, then set shutdown flag
9982  !
10000 IF OUT_OF_RANGE% <> 0 THEN SHUTDOWN@ = TRUE
11000 !
11010 !  If tank or startup pressure or dp pressure has a                   &
      !  high or low alarm, set warning flag
11020 !
11030 IF TANK_H_ALARM@ OR START_H_ALARM@ OR DP_H_ALARM@ OR                   &
         TANK_L_ALARM@ OR START_L_ALARM@ OR DP_L_ALARM@ THEN WARNING@ = TRUE
12000 !
12010 !  If tank or startup pressure or dp pressure has a                   &
      !  high high or low low alarm, set the shutdown flag
12020 !
12030 IF TANK_HH_ALARM@ OR START_HH_ALARM@ OR DP_HH_ALARM@ OR                &
         TANK_LL_ALARM@ OR START_LL_ALARM@ OR DP_LL_ALARM@ THEN              &
         SHUTDOWN@ = TRUE
13010 !
13020 !  Wait one second then check again
13030 !
13040 DELAY 1 SECONDS
13050 GOTO 10000
```

Figure 1.12 - Sample DCS 5000/AutoMax Voltage Input Application Task (Continued)

4.5 Sample AutoMate Voltage Input Application Program

The sample AutoMate voltage input application program in figure 4.13 is written for a Voltage Input module in a remote rack that is controlled by an AutoMate 40 processor. If your system uses an AutoMate 30 processor, the addresses you use must be changed accordingly. If the Voltage Input module were in a local rack, LOCIN/LOCOUT commands would replace the REMIN/REMOUT commands. Refer to the A30/A40 Software Reference Manual (J-3150) for additional information.

In the sample AutoMate program, the Voltage Input module is connected to three single-ended, 0-10V transmitters, which are in turn wired into a pressure polymerization process.

One transmitter is used to sense the level of the material in the tank. The second transmitter has its span calibrated for 0 to 3000 psig (gauge pounds-per-square inch) and is used during startup operation. The third transmitter has its span calibrated for 1940 to 1960 psig and is used for process control.

Channel 0: Material Level

Process Parameters	Configuration Values
• Maximum = 20 feet	Reg. 24 = 2000 (Scaled in 0.01 Ft)
• Minimum = −1 feet	Reg. 25 = −100
• High High Alarm = 19 feet	Reg. 27 = 1900
• High Alarm = 16 feet	Reg. 28 = 1600
• Low Alarm = 4 feet	Reg. 29 = 400
• Low Low Alarm = 0 feet	Reg. 30 = 0

Channel 1: Startup Pressure

Process Parameters	Configuration Values
• Maximum = 3000 psig	Reg. 24 = 3000 (Scaled directly in psig)
• Minimum = 0 psig	Reg. 25 = 0
• High High Alarm = 2500 psig	Reg. 27 = 2500
• High Alarm = 2000 psig	Reg. 28 = 2000
• Low Alarm = 500 psig	Reg. 29 = 500
• Low Low Alarm = 250 psig	Reg. 30 = 250

Channel 2: Operating Pressure

Process Parameters	Configuration Values
• Maximum = 1960 psig	Reg. 24 = 10000 (Scaled in 0.01% of span)
• Minimum = 1940 psig	Reg. 25 = 0
• High High Alarm = 1958 psig	Reg. 27 = 9000
• High Alarm = 1955 psig	Reg. 28 = 7500
• Low Alarm = 1945 psig	Reg. 29 = 2500
• Low Low Alarm = 1942 psig	Reg. 30 = 1000

The sample program uses the following memory locations.

Bit 00.00 – Bit to be set by the user when a channel is to be configured.

Bit 1700.00 – Bit used to detect the rising edge of Bit 00.00.

Register 10 – Register contains the coils corresponding to the status of the voltage input High High alarms.

Register 11 – Register contains the coils corresponding to the status of the voltage input High alarms.

Register 12 – Register contains the coils corresponding to the status of the voltage input Low alarms.

Register 13 – Register contains the coils corresponding to the status of the voltage input Low Low alarms.

Register 1600 – Internal coils

Register 160 = Internal coils

Register 1610 – The register's bits are used to indicate the current state of operation.

Bit .00 represents state 0 which writes the READY command to the Voltage Input module and then reads the module's configuration status. If the complete bit of the configuration status register is equal to zero, advance to state 1.

Bit .01 represents state 1 which reads channel configuration data from the AutoMate's memory and writes it out to the Voltage Input module. State 1 then reads the Voltage Input module's configuration status. If the configuration is complete and there are no errors, go to state 2.

Bit .02 represents state 2. This state directs the program to continue with the configuration of the next channel (state 0), provided no errors have been detected.

Bit .16 is set when an error is detected and the configure operation is aborted.

Bit .17 is set when all three of the voltage input channels have been configured.

Register 1611 – Register is loaded by the REMIN instruction which contains the contents of the Configuration Status Register (Register 22).

Register 3000 – Register contains the pointer to the data that is to be written to the Voltage Input module.

Register 3001 – Register contains the voltage input channel number that is being configured.

Register 3002 – Register contains the voltage input channel's Maximum Scaling Value. This value is provided by the data table in the 5000-series registers.

Register 3003 – Register contains the voltage input channel's Minimum Scaling Value. This value is provided by the data table in the 5000-series registers.

Register 3004 – Register contains the voltage input channel's Number of Samples. This value is provided by the data table in the 5000-series registers.

Register 3005 – Register contains the voltage input channel's High High alarm value. This value is provided by the data table in the 5000-series registers.

Register 3006 – Register contains the voltage input channel's High alarm value. This value is provided by the data table in the 5000-series registers.

Register 3007 – Register contains the voltage input channel's Low alarm value. This value is provided by the data table in the 5000-series registers.

Register 3010 – Register contains the voltage input channel's Low Low alarm value. This value is provided by the data table in the 5000-series registers.

Register 3011 – Register contains the voltage input channel's configuration command. This value is provided by the data table in the 5000-series registers.

Registers 3100 to 3137 – Registers contain the data read from the Voltage Input module.

Registers 5000 to 5027 – Registers contain the data used to configure the voltage input channels. Each channel uses eight registers.

	Max. Scale	Min. Scale	Average Samples	High High	High	Low	Low Low	Configure Command
Reg. 5000 –	2000	–100	20	1600	1600	400	0	12800*
Reg. 5010 –	3000	0	20	2500	2000	500	250	12800
Reg. 5020 –	10000	0	20	8000	7500	2500	1000	12800

* 12800 = 3200 Hex

Note that you must use the POINT MONITOR function to enter these values into the 5000-series registers before you begin executing the program.

Register 5200 – Register contains the value (0) for the READY command.

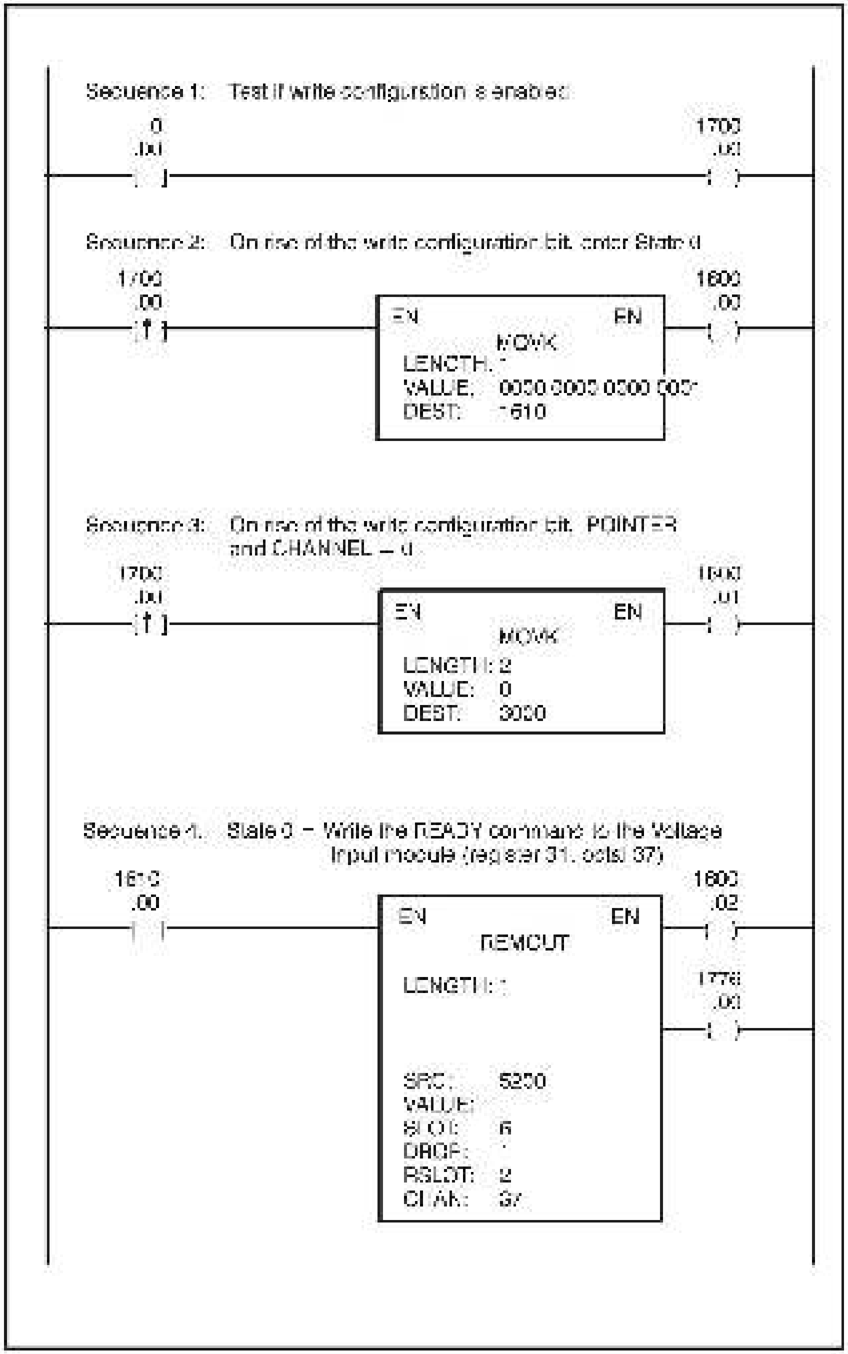


Figure 4.13 - Sample AutoMate Voltage Input Application Program (Continued)

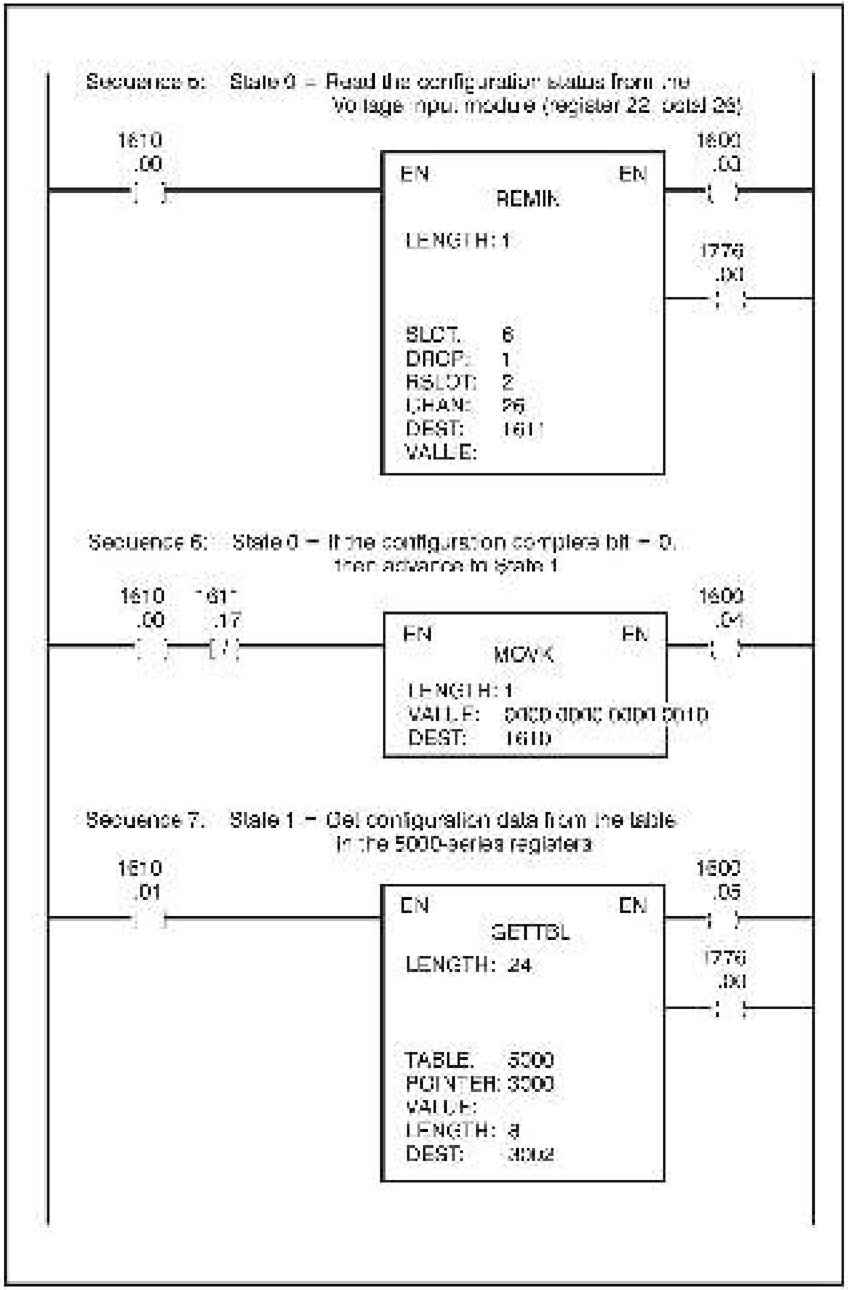


Figure 4.13 - Sample AutoMate Voltage Input Application Program (Continued)

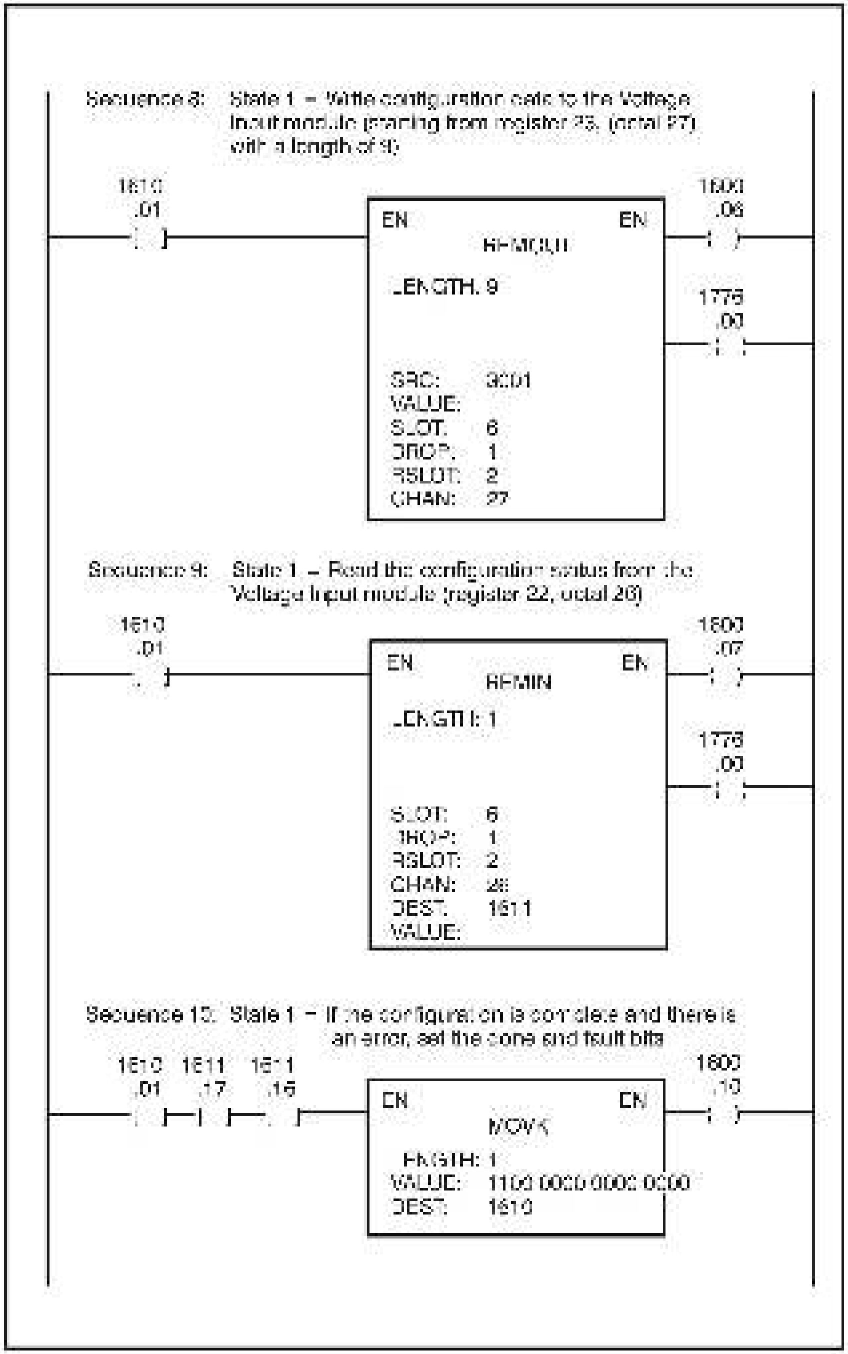


Figure 4.13 - Sample AutoMate Voltage Input Application Program (Continued)

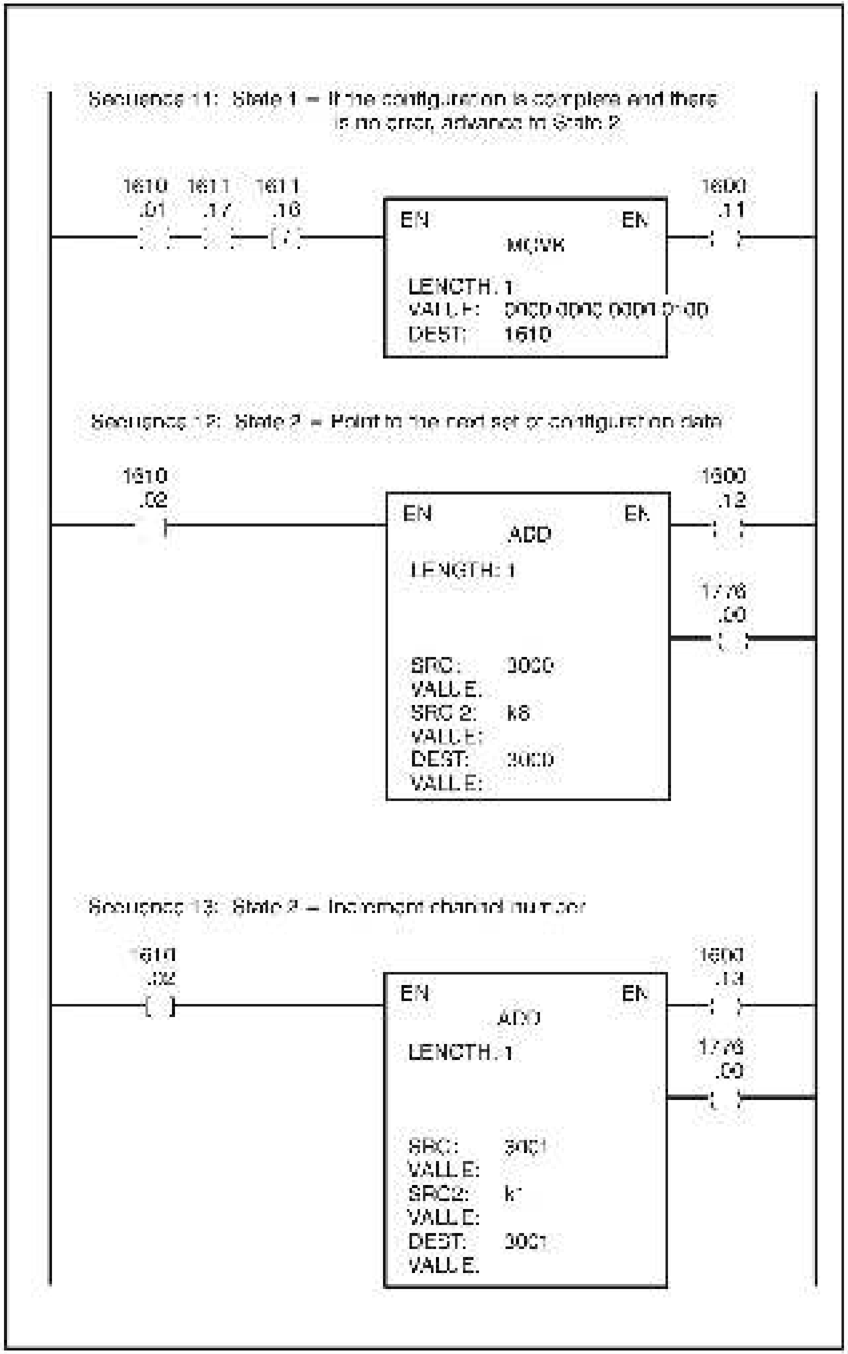


Figure 4.13 - Sample AutoMate Voltage Input Application Program (Continued)

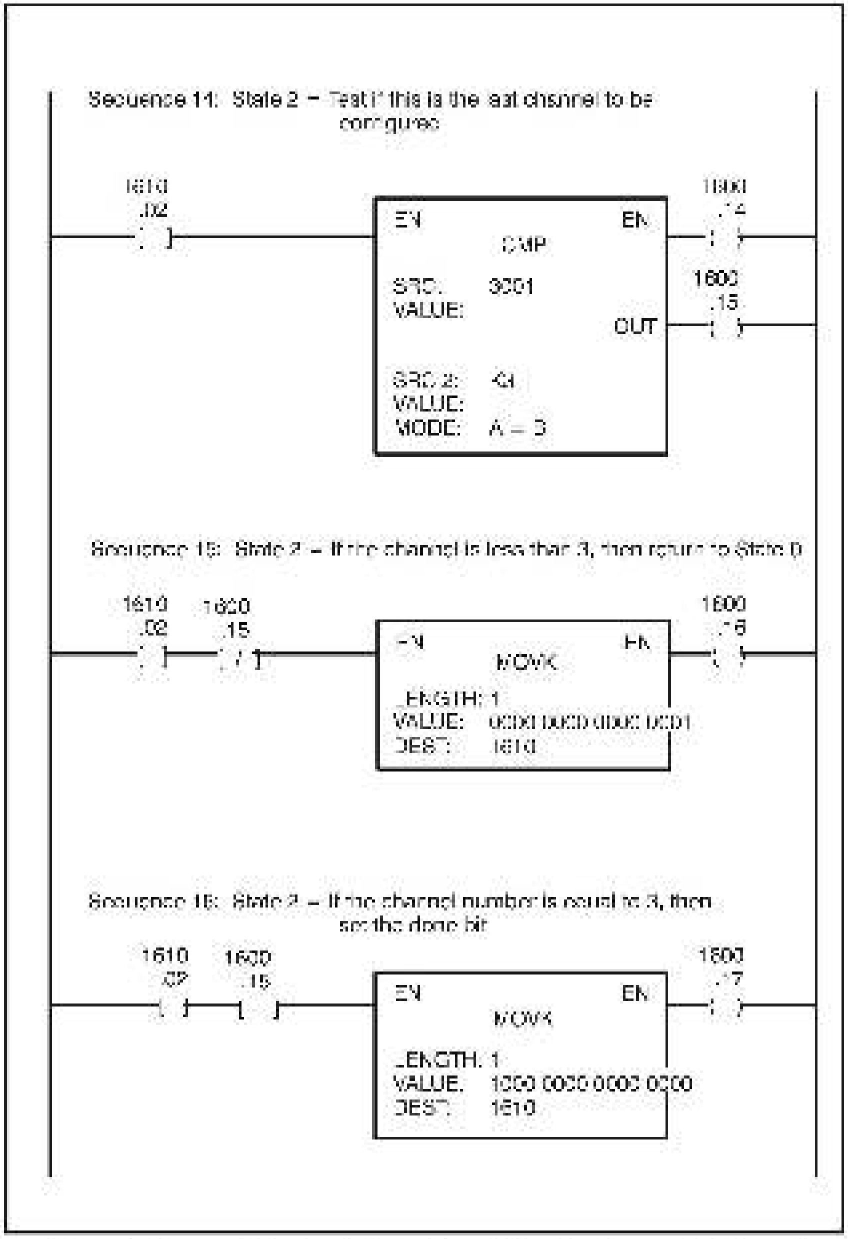


Figure 4.13 - Sample AutoMate Voltage Input Application Program (Continued)

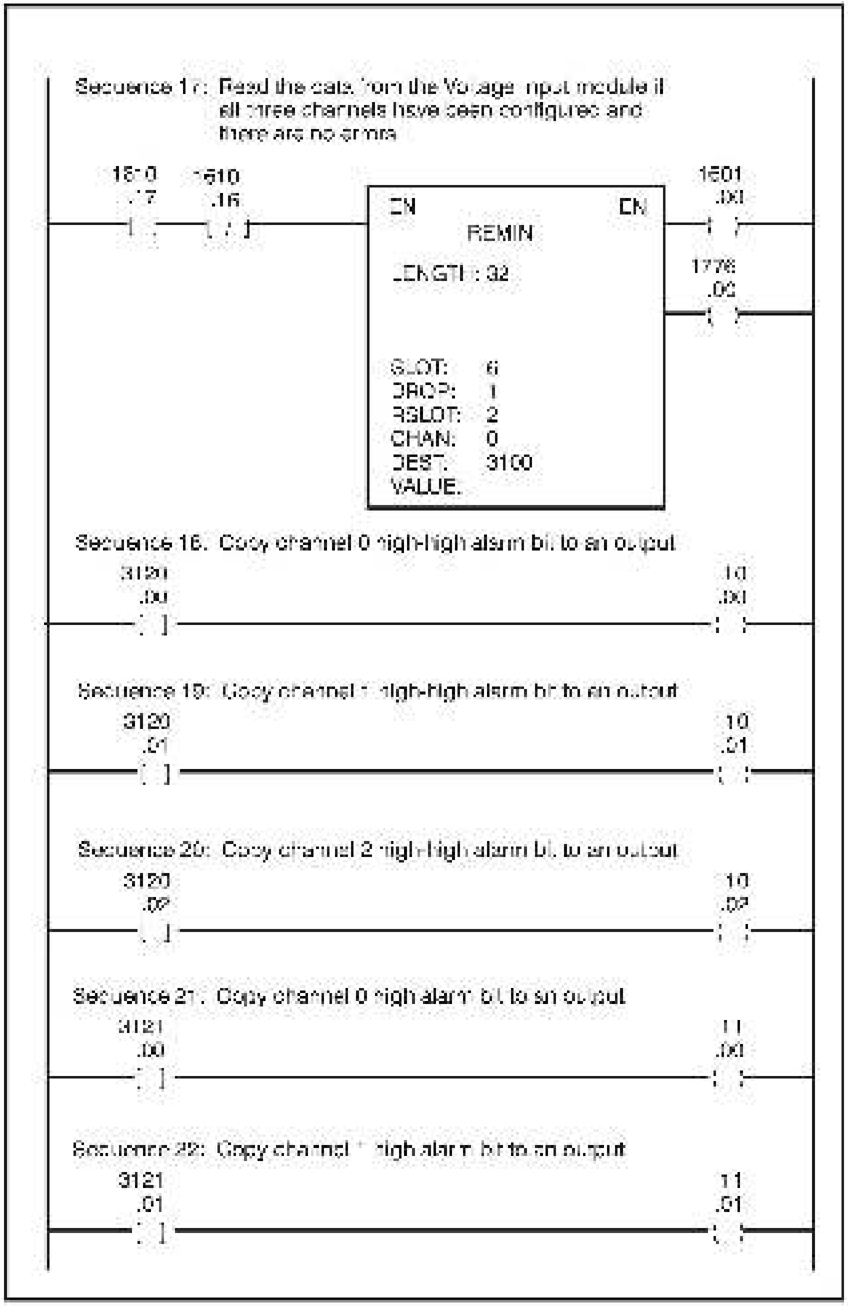


Figure 4.13 - Sample AutoMate Voltage Input Application Program (Continued)

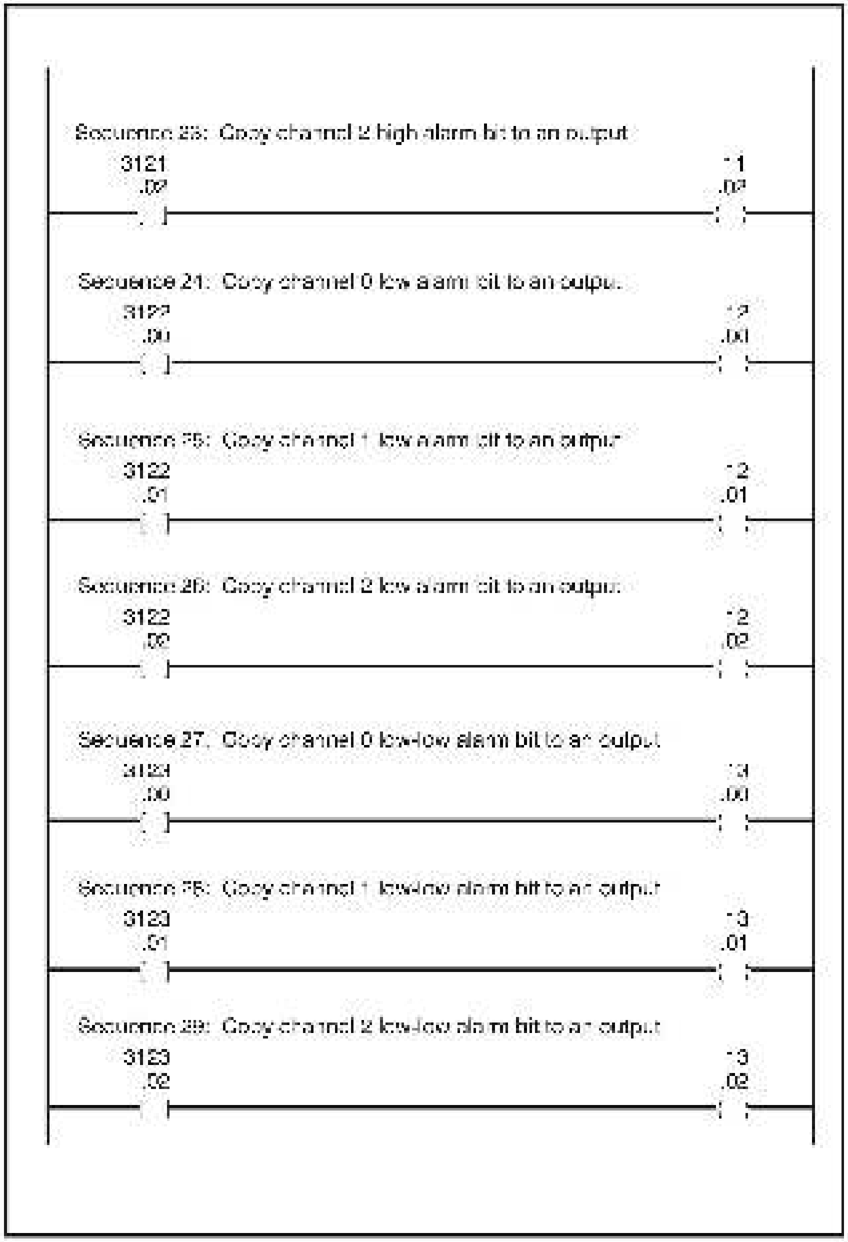


Figure 4.13 - Sample AutoMate Voltage Input Application Program (Continued)

4.6 Restrictions on Use

The channels on a Voltage Input module in an AutoMax/DCS 5000 system are to be configured from only one application task.

Do not configure a channel on the Voltage Input module unless a transmitter or transducer is connected to that channel. If you do, the result will be an out-of-range condition.

If the Voltage Input module is in an AutoMate remote rack, both the master Remote I/O Processor and the slave Remote I/O Processor must be M/N 45C201B or later. If either Processor is of an earlier version, the remote rack will not stay on-line with the master.

You can place up to 15 Voltage Input modules in either a local or remote AutoMate rack when using a 50 Amp AutoMate Power Supply (M/N 45C322). When using a 20 Amp AutoMate Power Supply (M/N 45C321) you are limited to:

- 8 Voltage Input modules in a local rack with an AutoMate 30 Processor
- 5 Voltage Input modules in a local rack with an AutoMate 40 Processor
- 10 Voltage Input modules in a remote rack with a Remote I/O Processor

You can place up to 15 Voltage Input modules in a local AutoMax rack. You can place up to five Voltage Input modules in a remote AutoMax rack due to register transfer limitations. For additional information refer to the AutoMax Remote I/O Communications Manual (J-3606).

Note that when Voltage Input modules are placed in an AutoMax remote rack:

- the power-up default values in registers 23 to 31 are reset to zero. You must individually enter new values into these registers.
- the Read Channel Configuration command (register 31, bits 12 to 15) will not update registers 24 to 31 and therefore cannot be used in a remote installation.

5.0 DIAGNOSTICS AND TROUBLESHOOTING

This section explains how to troubleshoot the module and field connections. If you cannot correct the problem using the instructions below, the module is not user-serviceable. If the procedure calls for a component to be swapped with a replacement part and the problem is not corrected, replace the original component and go on to the next step.

5.1 Incorrect Data

Problem: The data is always on, always off, or different than expected. The possible causes of this are a module in the wrong slot, a programming error, or a malfunctioning module. It is also possible that the transmitter is either not wired or is wired incorrectly. Use the following procedure to isolate the problem:

Step 1 Connect the programming terminal to the system and run the ReSource Programming Executive Software. Determine whether the channel is configured by examining register 21. If it is not, use the procedure in section 4.2 to configure the channel.

Step 2 For DCS 5000/AutoMax systems, verify that the module configuration is correct. Verify that the Voltage Input module is in the correct slot.

Verify that the slot number being referenced agrees with the slot number of the module.

For remote I/O installations, verify that the master slot and remote drop numbers are defined correctly. Verify that register transfer limitations have not been exceeded.

Step 3 Verify that the field wiring is properly connected.

DANGER

THIS EQUIPMENT IS AT LINE VOLTAGE WHEN A-C POWER IS CONNECTED. DISCONNECT AND LOCK OUT ALL UNGROUNDED CONDUCTORS OF THE A-C POWER LINE. FAILURE TO OBSERVE THESE PRECAUTIONS COULD RESULT IN SEVERE BODILY INJURY OR LOSS OF LIFE.

Turn off power to the module.

Confirm that all terminal board connections are tight.

Check the cables for continuity between the faceplate connector and the terminal board assembly.

Turn on power to the module.

Step 4 Check for an input out of range condition.

Monitor register 20. Use the MONITOR function in DCS 5000/AutoMax systems or the POINT MONITOR function in AutoMax systems.

DANGER

THIS EQUIPMENT IS AT LINE VOLTAGE WHEN A-C POWER IS CONNECTED. DISCONNECT AND LOCK OUT ALL UNGROUNDED CONDUCTORS OF THE A-C POWER LINE. FAILURE TO OBSERVE THESE PRECAUTIONS COULD RESULT IN SEVERE BODILY INJURY OR LOSS OF LIFE.

Turn off power to the module.

If an out of range condition exists, check for an open or shorted wire between the terminal board assembly and the transmitter.

Turn on power to the module.

Step 5. Verify that the user application program is correct.

For DCS 5000/AutoMax systems, verify that the application program that references the symbolic names associated with the module has declared those names COMMON in the application tasks.

Verify that the symbolic name in question is being referenced in the application program. This can be done indirectly by monitoring the symbolic name with the MONITOR function in the ReSource Software.

For both DCS 5000/AutoMax and AutoMate systems, verify that the application program is executing fast enough to catch all of the input changes.

Step 6. Verify that the hardware is working correctly.

DANGER

THIS EQUIPMENT IS AT LINE VOLTAGE WHEN A-C POWER IS CONNECTED. DISCONNECT AND LOCK OUT ALL UNGROUNDED CONDUCTORS OF THE A-C POWER LINE. FAILURE TO OBSERVE THESE PRECAUTIONS COULD RESULT IN SEVERE BODILY INJURY OR LOSS OF LIFE.

Verify hardware functionality by systematically swapping out modules in the rack. Make certain power is off before removing any module from the rack. After each swap, if the problem is not corrected, replace the original module before swapping out the next one.

5.2 The "OK" LED is Off

Problem: The "OK" LED on the Voltage Input module faceplate is off. This LED is on when the module passes its power-up diagnostics and is operating properly. The LED is off when the module fails its power-up diagnostics, when a watchdog timeout error occurs, or when the calibration voltage is out of range. If the LED remains off after system power-up, replace the module as described in section 5.3.

Appendix A

Technical Specifications

Ambient Conditions

- Storage Temperature: −40 to 85°C
  −40 to 185°F
- Operating Temperature: 0 to 60°C
  32 to 140°F
- Humidity: 5 to 95% non condensing

Dimensions:

- Height: 11.75 inches (29.8 cm)
- Width: 1.25 inches (3.2 cm)
- Depth: 7.375 inches (18.7 cm)
- Weight: 2 pounds (0.9 kg)

System Power Requirements From the Backplane

- +5 volts: 1.5 A
- +12 volts: 30 mA

Maximum Module Power Dissipation

- 7.5 Watts

Recommended Field Wiring Cable

- Belden 8501 or Equivalent
- Maximum Recommended Field Wiring Length is Dependent upon the Transmitters

Terminal Board and Cable Assemblies

- M/N 61C547: Panel Mount
- M/N 61C548: DIN-Rail Mount

Input Channels

- Number of Input Channels: 16 single-ended/8 differential; software
  configurable on a per-channel pair basis
- Commons: one analog common shared by all 16 voltage input
  channels
- Isolation: 2500V from analog common to digital ground
  2500V rms for 1 minute

Appendix A

(Continued)

Input Circuit

- Input Voltage Range: −10V to +10V
- Resolution: 1.46mV per count (any configuration)
  (−10V to +10V = −4095 to +4095 unscaled)
  (0V to +10V = 0 to +4095 unscaled)
- Accuracy: 0.2% across the operating temperature range
- Input Filter: first order lowpass, 7 Hz breakpoint
- Input Impedance: 10M ohms typical at 0 Hz
- Out of Range Threshold Voltages:
  Below −10.5V or Above +10.5V (bipolar)
  Below −0.5V or Above +10.5V (unipolar)

Noise Rejection

- Line Frequency Filter (Software Selectable): 60 Hz (default) or 50 Hz
- Averaging Filter (Software Selectable): 1 (default) to 60 samples per average
- Common Mode Rejection: −60dB min (averaging filter = 1 and line filter enabled)
- Normal Mode Rejection: −40dB min (averaging filter = 1 and line filter enabled)

Input Channel Update Times (All times are in milli-seconds)

(Differential Input Mode)

	Number of Configured Channels	Unscaled Data	Scaled Data	Square Root of Scaled Data	Running Average of Square Root of Scaled Data
60 Hz Line Freq. Filter Enabled	One	18.5	18.6	18.8	18.9
	Each Added	17.7	17.8	18	18.1
	Eight	142	145	144	145
Line Freq. Filters Disabled	One	2.2	2.3	2.5	2.6
	Each Added	1.2	1.5	1.6	1.6
	Eight	10.6	11.4	13	13.8
50 Hz Line Freq. Filter Enabled	One	22	22.1	22.3	22.4
	Each Added	21	21.1	21.3	21.4
	Eight	168	169	171	171

Appendix A

(Continued)

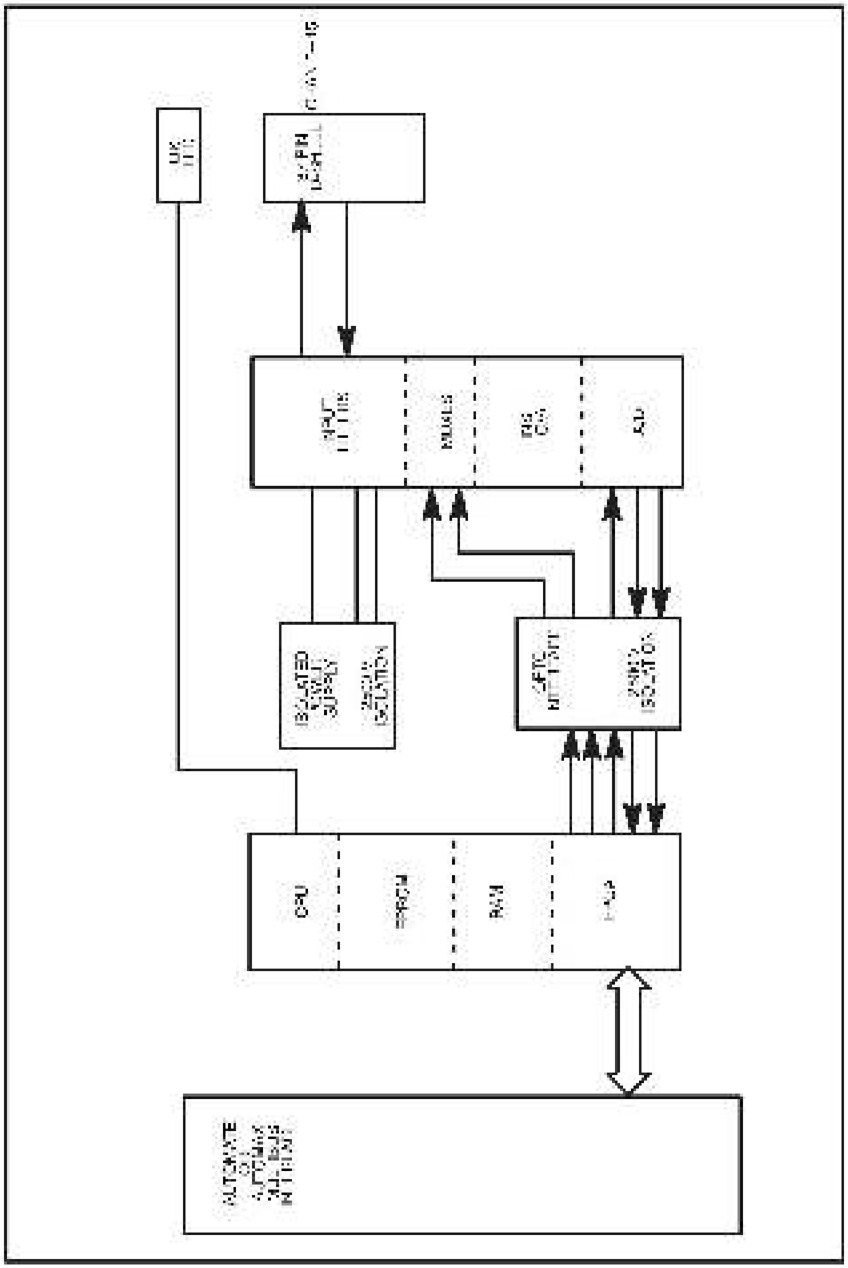
Input Channel Update Times (All times are in milli-seconds)

(Single-Ended Input Mode)

	Number of Configured Channels	Unscaled Data	Scaled Data	Square Root of Scaled Data	Running Average of Square Root of Scaled Data
60 Hz. Line Freq. Filter Enabled	One	18.5	18.6	16.8	18.9
	Each Added	17.7	17.8	18	18.1
	Sixteen	283	285	288	290
Line Freq. Filters Disabled	One	2.2	2.3	2.5	2.6
	Each Added	1.1	1.2	1.4	1.5
	Sixteen	18.7	20.3	23.5	25.1
50 Hz. Line Freq. Filter Enabled	One	22	22.1	22.3	22.4
	Each Added	21	21.1	21.3	21.4
	Sixteen	336	338	341	343

Appendix B

Module Block Diagram



Appendix C

Field Connections

Terminal Block Label	Voltage Input Function
0A 0B S	Voltage Circuit 0: Analog Common Voltage Circuit 0: ±10V Input Voltage Circuit 0: Cable Shield
S 1A 1B	Voltage Circuit 1: Cable Shield Voltage Circuit 1: Analog Common Voltage Circuit 1: ±10V Input
2A 2B S	Voltage Circuit 2: Analog Common Voltage Circuit 2: ±10V Input Voltage Circuit 2: Cable Shield
S 3A 3B	Voltage Circuit 3: Cable Shield Voltage Circuit 3: Analog Common Voltage Circuit 3: ±10V Input
4A 4B S	Voltage Circuit 4: Analog Common Voltage Circuit 4: ±10V Input Voltage Circuit 4: Cable Shield
S 5A 5B	Voltage Circuit 5: Cable Shield Voltage Circuit 5: Analog Common Voltage Circuit 5: ±10V Input
6A 6B S	Voltage Circuit 6: Analog Common Voltage Circuit 6: ±10V Input Voltage Circuit 6: Cable Shield
S 7A 7B	Voltage Circuit 7: Cable Shield Voltage Circuit 7: Analog Common Voltage Circuit 7: ±10V Input
8A 8B S	Voltage Circuit 8: Analog Common Voltage Circuit 8: ±10V Input Voltage Circuit 8: Cable Shield
S 9A 9B	Voltage Circuit 9: Cable Shield Voltage Circuit 9: Analog Common Voltage Circuit 9: ±10V Input
10A 10B S	Voltage Circuit 10: Analog Common Voltage Circuit 10: ±10V Input Voltage Circuit 10: Cable Shield
S 11A 11B	Voltage Circuit 11: Cable Shield Voltage Circuit 11: Analog Common Voltage Circuit 11: ±10V Input

Appendix C
(Continued)

Terminal Block Label	Voltage Input Function
12A 12B S	Voltage Circuit 12: Analog Common Voltage Circuit 12: ±10V Input Voltage Circuit 12: Cable Shield
S 13A 13B	Voltage Circuit 13: Cable Shield Voltage Circuit 13: Analog Common Voltage Circuit 13: ±10V Input
14A 14B S	Voltage Circuit 14: Analog Common Voltage Circuit 14: ±10V Input Voltage Circuit 14: Cable Shield
S 15A 15B	Voltage Circuit 15: Cable Shield Voltage Circuit 15: Analog Common Voltage Circuit 15: ±10V Input

Appendix D

Related Components

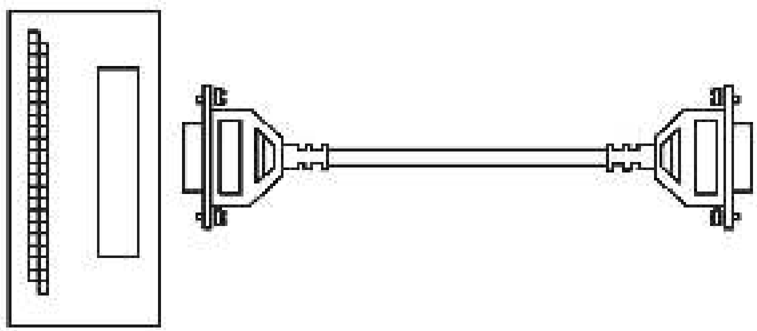
M/N 61C547 Panel Mount Terminal Board and Cable Assembly

The panel mount terminal board assembly provides terminals on a flat panel mounting surface for connecting the field wires coming from the transmitters. Also included is a cable to connect the terminals to the Voltage Input module. The cable is five feet long. One assembly is required per module.

M/N 61C548 DIN Rail Mount Terminal Board and Cable Assembly

The DIN rail terminal board assembly provides terminals on a DIN rail mounting surface for connecting the field wires coming from the transmitters. Also included is a cable to connect the terminals to the Voltage Input module. The cable is five feet long. One assembly is required per module.

M/N 61C547 Terminal Board and Cable Assembly
(M/N 61C548 is similar. Refer to Figure 3.1.)



Appendix E

Configuration Task

The following configuration task is intended as a guide to help you in defining your system-wide −10V to +10V transmitter variables when using DCS 5000 and AutoMax version 2.1 and earlier. This task defines the common variables used in the sample application task in section 4.4.

```
10   ! VIM Sample Configuration Task
20   !
30   !
100  TASK VIM[ TYPE=BASIC, PRIORITY=7, SLOT=0, CRITICAL=FALSE ]
110  !
220  IODEF TANK_LEVEL%[SLOT=2, REGISTER=0 ]
230  IODEF START_PROCESS%[SLOT=2, REGISTER=1 ]
240  IODEF OP_PROCESS%[ SLOT=2, REGISTER=2 ]
245  !
300  IODEF TANK_HH_ALARM@[ SLOT=2, REGISTER=16, BIT=0 ]
310  IODEF TANK_H_ALARM@[ SLOT=2, REGISTER=17, BIT=0 ]
320  IODEF TANK_L_ALARM@[ SLOT=2, REGISTER=18, BIT=0 ]
330  IODEF TANK_LL_ALARM@[ SLOT=2, REGISTER=19, BIT=0 ]
340  !
400  IODEF START_HH_ALARM@[ SLOT=2, REGISTER=16, BIT=1 ]
410  IODEF START_H_ALARM@[SLOT=2, REGISTER=17, BIT=1 ]
420  IODEF START_L_ALARM@[ SLOT=2, REGISTER=18, BIT=1 ]
430  IODEF START_LL_ALARM@[ SLOT=2, REGISTER=19, BIT=1 ]
440  !
500  IODEF OP_HH_ALARM@[ SLOT=2, REGISTER=16, BIT=2 ]
510  IODEF OP_H_ALARM@[SLOT=2, REGISTER=17, BIT=2 ]
520  IODEF OP_L_ALARM@[ SLOT=2, REGISTER=18, BIT=2 ]
530  IODEF OP_LL_ALARM@[ SLOT=2, REGISTER=19, BIT=2 ]
540  !
600  IODEF CNF_MAX%[SLOT=2, REGISTER=24 ]
610  IODEF CNF_MIN%[ SLOT=2, REGISTER=25 ]
615  IODEF CNF_AVE_SAMPLE%[SLOT=2, REGISTER=26]
620  IODEF CNF_HH_ALARM%[SLOT=2, REGISTER=27 ]
630  IODEF CNF_H_ALARM%[SLOT=2, REGISTER=28 ]
640  IODEF CNF_L_ALARM%[SLOT=2, REGISTER=29 ]
650  IODEF CNF_LL_ALARM%[ SLOT=2, REGISTER=30 ]
660  IODEF CNF_COMMAND%[SLOT=2, REGISTER=31 ]
670  IODEF CNF_COMP@[SLOT=2, REGISTER=22, BIT=15 ]
680  IODEF CNF_ERROR@[ SLOT=2, REGISTER=22, BIT=14 ]
690  IODEF CNF_CHAN_NUM%[ SLOT=2, REGISTER=23 ]
700  IODEF OUT_OF_RANGE%[ SLOT=2, REGISTER=20 ]
900  !
910  MEMDEF WARNING@
920  MEMDEF SHUTDOWN@
```

Appendix F

Compatibility with Earlier Versions

Version 61C542 modules are similar in operation to 61C542A modules except for the input channel update times listed below.

Input Channel Update Times (All times are in milli-seconds)

	Number of Configured Channels	Unscaled Data	Scaled Data	Square Root of Scaled Data
60 Hz Line Freq. Filter Enabled	One	24.5	25.5	27.5
	Each Added	19.5	20.5	22.5
	Sixteen	317	333	365
Line Freq. Filters Disabled	One	7.5	6	10
	Each Added	2.5	3	5
	Sixteen	45	53	85
50 Hz Line Freq. Filter Enabled	One	28.5	29.5	31.5
	Each Added	23.5	21.5	26.5
	Sixteen	381	397	429

Appendix G

Module Faceplate Connections

Module Faceplate Connector Pin #	Function
1	Channel 14
2	Channel 15
3	Isolated Common*
4	Channel 12
5	Channel 13
6	Channel 10
7	Channel 11
8	Channel 8
9	Channel 9
10	Isolated Common*
11	Channel 6
12	Channel 7
13	Channel 4
14	Channel 5
15	Channel 2
16	Channel 3
17	Isolated Common*
18	Channel 0
19	Channel 1
20 to 37	Isolated Common*
* All commons are internally connected	

For additional information
1 Allen-Bradley Drive
Mayfield Heights, Ohio 44124 USA
Tel: (800) 241-2886 or (440) 646-3599
http://www.reliance.com/automax

www.rockwellautomation.com

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