

**IC693ALG442**

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the %AI and %AQ registers is in a 16-bit 2's complement format. In current modes, an *open-wire fault* is reported to the CPU for each channel. The module can go to a known last state when system power is interrupted. As long as user power is applied to the module, each output will maintain its last value, or reset to the low end of the scale (range), as determined by how you have configured the module.

Each output channel can be configured to operate in ramp mode using ladder logic. In ramp mode, changes in %AQ data cause the corresponding output channel to ramp to the new %AQ value. The ramp output consists of steps taken each millisecond until the final value is reached.

*High and low alarm limits* can be set for all input channels and an *open-wire fault* (current output modes) is reported to the CPU for each output channel. All six analog channels may be updated on every scan, depending on the scan time.

**Table 12-1. Specifications for IC693ALG442**

<b><u>Analog Output Specifications</u></b>	
<b>Number of Output Channels</b>	2, Single-Ended
<b>Update Rate</b>	4 milliseconds (approximate - both channels)
<b><u>Analog Current Output</u></b>	
<b>Output Current Ranges</b>	0 to 20 mA 4 to 20 mA
<b>Resolution</b>	
0 to 20 mA	0.625 $\mu$ A (1 LSB = 0.625 $\mu$ A)
4 to 20 mA	0.5 $\mu$ A (1 LSB = 0.5 $\mu$ A)
<b>Absolute Accuracy<sup>1</sup></b>	
All Current Modes	$\pm 0.1\%$ of full scale @25°C (77°F), typical $\pm 0.25\%$ of full scale @25°C (77°F), (maximum) $\pm 0.5\%$ of full scale over operating temperature range (maximum)
<b>Maximum Compliance Voltage</b>	V <sub>USER</sub> -3V (minimum) to V <sub>USER</sub> (maximum)
<b>User Load</b>	0 to 850 $\Omega$ (minimum) at V <sub>USER</sub> =20V, maximum 1350 $\Omega$ at V <sub>USER</sub> =30V
<b>Output Load Capacitance</b>	2000 pF (maximum)
<b>Output Load Inductance</b>	1 H (maximum)
<b><u>Analog Voltage Output</u></b>	
<b>Output Ranges</b>	-10 to +10V (bipolar) 0 to +10V (unipolar)
<b>Resolution</b>	
-10 to +10V	0.3125 mV (1 LSB = 0.3125 mV)
0 to +10V	0.3125 mV (1 LSB = 0.3125 mV)
<b>Absolute Accuracy<sup>2</sup></b>	
Both Voltage Modes	$\pm 0.25\%$ of full scale @25°C (77°F), typical $\pm 0.5\%$ of full scale @25°C (77°F), (maximum) $\pm 1.0\%$ of full scale over operating temperature range (maximum)
<b>Output Loading</b>	5 mA (2K ohms minimum resistance)
<b>Output Load Capacitance</b>	1 $\mu$ F (maximum capacitance)
<b><u>Analog Input Specifications</u></b>	
<b>Number of Input Channels</b>	4, differential
<b>Update Rate</b>	8 milliseconds (approximate for all 4 channels)
<b><u>Analog Current Input</u></b>	

<b>Input Ranges</b>	0 to 20 mA 4 to 20 mA 4 to 20 mA Enhanced
(Continued from previous page)	(Table continued on next page)
<b>Resolution</b>	
0 to 20 mA	5 $\mu$ A (1 LSB = 5 $\mu$ A)
4 to 20 mA	5 $\mu$ A (1 LSB = 5 $\mu$ A)
4 to 20 mA Enhanced	5 $\mu$ A (1 LSB = 5 $\mu$ A)
<b>Absolute Accuracy<sup>3</sup></b>	
All Current Modes	$\pm 0.25\%$ of full scale @25°C (77°F) $\pm 0.5\%$ of full scale over specified operating temperature range
<b>Linearity</b>	<1 LSB
<b>Common Mode Voltage</b>	200V (maximum)
<b>Common Mode Rejection</b>	>70 db at DC; >70 db at 60 Hz
<b>Cross Channel Rejection</b>	>80 db from DC to 1 kHz
<b>Input Impedance</b>	250 $\Omega$
<b>Input Filter Response</b>	29 Hz
<b>Analog Voltage Input</b>	
<b>Input Ranges</b>	0 to +10V (unipolar) -10 to +10V (bipolar)
<b>Resolution</b>	
0 to +10V	2.5 mV (1 LSB = 2.5 mV)
-10 to +10V	5 mV (1 LSB = 5 mV)
<b>Absolute Accuracy<sup>3</sup></b>	
Both Voltage Ranges	$\pm 0.25\%$ of full scale @25°C (77°F) $\pm 0.5\%$ of full scale over specified operating temperature range
<b>Linearity</b>	<1 LSB
<b>Common Mode Voltage</b>	200V (maximum)
<b>Common Mode Rejection</b>	>70 db at DC; >70 db at 60 Hz
<b>Cross Channel Rejection</b>	>80 db from DC to 1 kHz
<b>Input Impedance</b>	800K $\Omega$ (typical)
<b>Input Filter Response</b>	29 Hz
<b>Power Requirements</b>	
<b>External Supply Voltage Range</b>	20 to 30 VDC (24 VDC typical)
<b>Power Supply Rejection Ratio (PSRR)<sup>4</sup></b>	
Current	5 $\mu$ A/V (typical), 10 $\mu$ A/V (maximum)
Voltage	25 mV/V (typical), 50mV/V (maximum)
<b>Voltage Ripple</b>	10%
<b>Current Consumption</b>	
From Internal +5V Supply	95 mA
From External User Supply	129 mA

<sup>1</sup>In the presence of severe RF interference (IEC 801-3, 10V/m), accuracy may be degraded to  $\pm 1\%$  FS.

<sup>2</sup>In the presence of severe RF interference (IEC 801-3, 10V/m), accuracy may be degraded to  $\pm 4\%$  FS.

<sup>3</sup>In the presence of severe RF interference (IEC 801-3, 10V/m), accuracy may be degraded to  $\pm 2\%$  FS.

<sup>4</sup>PSSR is measured by varying  $V_{USER}$  from 24V to 30V.

Refer to Appendix B for product standards and general specifications.

## IC693ALG442 Input Modes and Current/Voltage Ranges

### Current Operation

In the *4 to 20 mA range*, user data is scaled so that 4 mA corresponds to a count of 0 and 20 mA corresponds to a count of 32000. The other ranges are selected by changing the configuration parameters using the Logicmaster 90-30/20/Micro configurator software or the Hand-Held Programmer. In the *0 to 20 mA range* user data is scaled so that 0 mA corresponds to a count of 0 and 20 mA corresponds to a count of 32000. Full 12-bit resolution is available over the 0 to 20 mA range.

A *4 to 20 mA Enhanced range* can also be selected. When this range is selected, 0 mA corresponds to a count of -8000, 4 mA corresponds to a count of 0 (zero) and 20 mA corresponds to a count of +32000. The Enhanced range uses the same hardware as the 0 to 20 mA range but automatically provides 4 to 20 mA range scaling with the exception that negative digital values are provided to the user for input current levels between 4 mA and 0 mA. This gives you the capability of selecting a low alarm limit that detects when the input current falls from 4 mA to 0 mA, which provides for open-wire fault detection in 4 to 20 mA applications. High and Low alarm limits are available on all ranges. Ranges can be configured on a per channel basis.

User data in the %AI registers is in 16-bit 2's complement format (0 to 20 mA range only). Resolution of the converted signal is 12 bits binary (1 part in 4096) on the 0 to 20 mA range. The placement of the 12 bits from the A/D converter in the %AI data word is shown below.

MSB												LSB			
X	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0	X	X	X

X=not applicable to this discussion.

The relationship between the current input and the data from the A/D converter is show below.

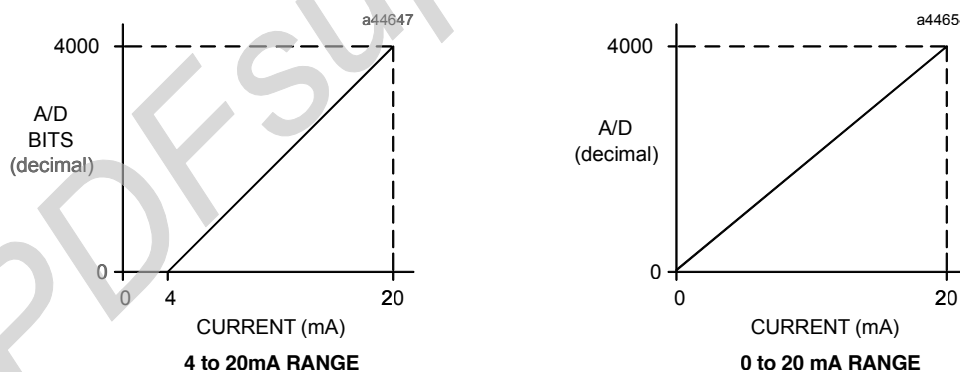


Figure 12-1. A/D Bits vs. Current Input

If the current source is reversed into the input, or is less than the low end of the current range, then the module will output a data word corresponding to the low end of the current range (0000H in %AI). If an input that is out of range is entered (that is, it is greater than 20 mA), the A/D converter will output up to full scale (corresponding to 7FFFH in %AI).

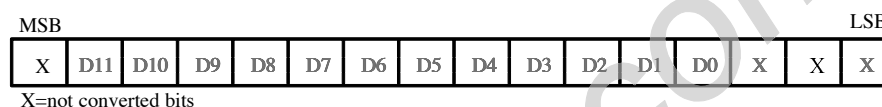
### Voltage Operation

In the *0 to +10 V default range*, user data is scaled so that 0 volts corresponds to a count of 0 and +10 volts corresponds to a count of 32000. The -10 to +10 volt range is selected by changing the

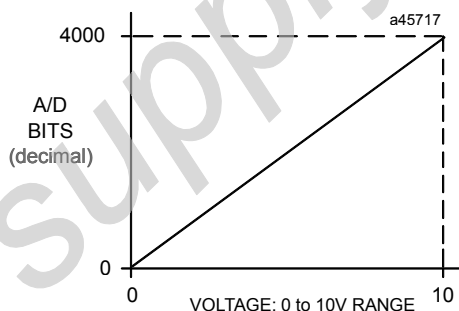
configuration parameters using the Logicmaster 90-30/20/Micro configurator software or the Hand-Held Programmer. In the  $-10$  to  $+10$  volt range user data is scaled so that  $-10$  volts corresponds to a count of  $-32000$  and  $+10$  volts corresponds to a count of  $+32000$ . Full 12-bit resolution is available over either range.

Since converters used in the analog input channels are 12-bit converters, not all of the 16 bits in the data tables contain data required for the conversion. A version of the 12 bits is placed within the 16-bit data word corresponding to the analog point (in the %AI table). The Series 90-30 PLC system handles the integration differently for the various analog modules.

The CPU does not manipulate the data from the input channels before placing it within the word in the %AI data table. The bits in the %AI data table which were not used in the conversion by the input channel are forced to 0 (zero) by the analog input channel. Placement of the 12 data bits from the A/D converter for an analog current input data word for the 16-Channel Analog Voltage Input module in unipolar range is shown below.



Analog values are scaled over the range of the converter. Factory calibration adjusts the analog value per bit (resolution) to a multiple of full scale (that is, 2.5 mV/bit for unipolar; 5 mV/bit for bipolar). This calibration leaves a normal 12-bit converter with 4000 counts (normally  $2^{12} = 4096$  counts). The data is then scaled with the 4000 counts over the analog range. For example, the data to the A/D converter for the Analog Voltage Input is scaled as shown below.



**Figure 12-2. A/D Bits vs. Voltage Input**

## IC693ALG442 Output Modes and Current/Voltage Ranges

### Current Operation

In the 4 to 20 mA range user data is scaled so that 4 mA corresponds to a count of 0 and 20 mA corresponds to a count of 32767. In the 0 to 20 mA range, user data is scaled so that 0 mA corresponds to a count of 0 and 20 mA corresponds to 32000. Note that in the 0 to 20 mA mode, you can enter a value up to 32767 which provides a maximum output of approximately 20.5 mA. Scaling of the current output for both the 4 to 20 mA range and the 0 to 20 mA range is shown below. In current mode the module also provides an open loop fault detect which is reported to the PLC in the %I table.

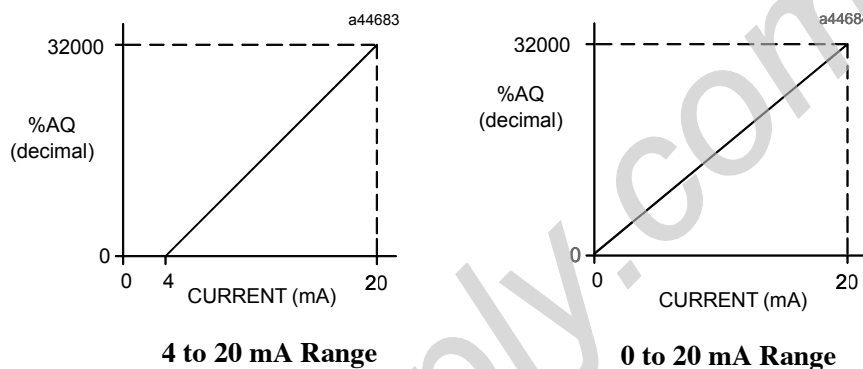


Figure 12-3. Scaling for Current Output

### Voltage Operation

For *Voltage Operation* in the default unipolar mode (0 to +10 volts), user data is scaled so that 0 volts corresponds to a count of 0 and +10 volts corresponds to a count of 32000. In this mode, you can enter up to 32767 for an overrange of approximately 10.24 volts output. In the -10 to +10 volt range user data is scaled so that -10 volts corresponds to a count of -32000 and +10 volts corresponds to a count of +32000. In this range, you can enter -32768 to +32767 for an overrange of approximately -10.24 volts to +10.24 volts.

Scaling of the voltage output for both the 0 to +10 volt range and the -10 to +10 volt range is as shown below.

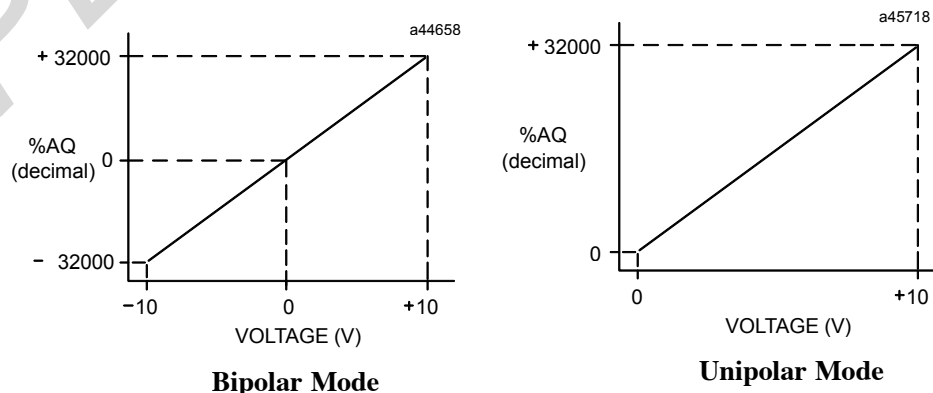


Figure 12-4. Scaling for Voltage Output

## CPU Interface to the IC693ALG442 Analog Combo Module

The Series 90-30 PLC uses the data within the %AI and %AQ data table to record analog values for use by the programmable controller. For detailed information on the CPU interface to analog modules, refer to the “Hardware Description of Analog Module” section at the beginning of this chapter.

## Status Reporting

The Analog Combo module provides status information to the PLC. This status information is updated once each PLC sweep and consists of the following items:

- *health of the module* (all ranges)
- *overload or open wire detect* (current output mode only)
- *alarm low and high status* (input channels)
- *status of the user-supplied power to the module* (all ranges)

## Power Requirements and LEDs

This module requires a maximum of 95 mA from the 5V bus on the PLC backplane for the logic side. The module's analog power *must be supplied* by a single, user supplied +24 VDC power source. This includes current loop output power and voltage output load power. This user supply requires a maximum current of 129 mA.

There are two green LED indicators on the module which provide module and user supply status. The top LED, **OK**, provides module status information, and the bottom LED, **USOK**, indicates whether the user supply is present and is above a minimum designated level. Note that both LEDs are powered from the +5V backplane power bus.

The LEDs have six possible status combinations, which are described below.

LED Status Indications for IC693MDL442			
Combination	LED	Status	Description
1	OK	ON	Module OK and configured
	USOK	ON	User power is present
2	OK	FLASH	Module OK but not configured
	USOK	OFF	No user power
3	OK	FLASH	Module OK but not configured
	USOK	ON	User power is present
4	OK	ON	Module OK and configured
	USOK	OFF	No user power
5	OK	OFF	Module is defective or no +5V backplane power present
	USOK	OFF	User power may or may not be present
6	OK	OFF	Module not OK
	USOK	ON	User power is present

## Location in System

The Analog Combo module is compatible with all Series 90-30 CPU models and may be installed in any I/O slot of any Series 90-30 baseplate.

## References Used and Maximum Modules per System Considerations

The number of IC693ALG442 Analog Combo modules that can be installed in a system depends on the amount of %AQ, %AI, and %I references available. Each module uses 2 %AQ references and 4 %AI references (depending on status configuration) and 8, 16 or 24 %I references (depending on alarm status configuration). The number of these references is dependent on the type of CPU in your system.

Please refer the the “Maximum Number of Analog Modules per System” table in Chapter 8 to determine how many Analog Combo modules can be installed for the various CPU models.



## IC693ALG442 Analog Module Field Wiring Connections

Connections to this module from user devices are made to screw terminals on a removable 20-terminal connector block mounted on the front of the module. The actual terminals used are described in the following table and are shown in the following wiring diagrams.

### Terminal Assignments

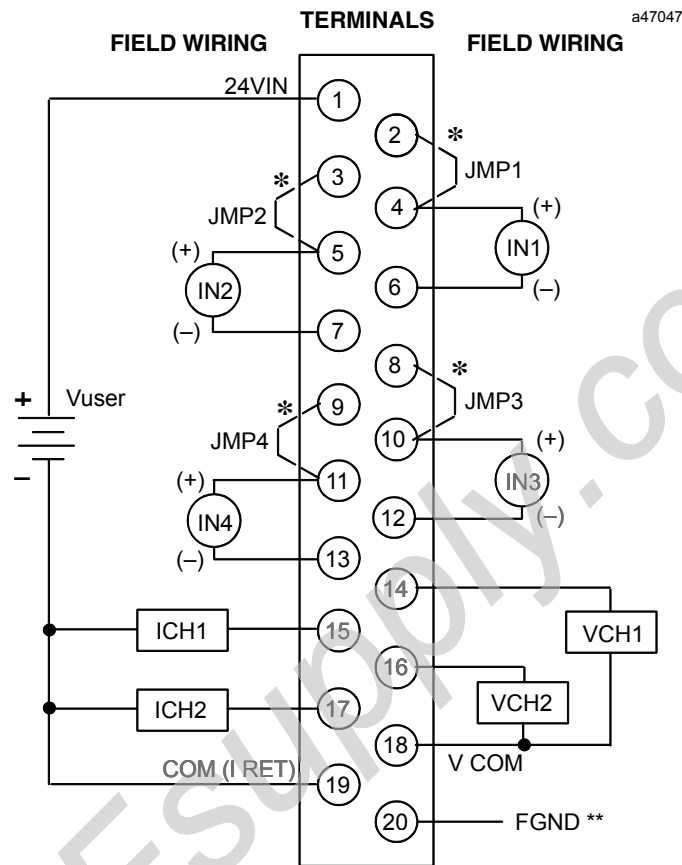
Pin assignments for the 20 terminal I/O connector on the Analog Combo module are as shown in the following table.

**Table 12-2. Terminal Pin Assignments for IC693ALG442**

Pin Number	Signal Name	Signal Definition
1	24VIN	User Supplied +24 Volt Input
2	JMP1	Jumper terminal for connecting 250Ω sense resistor for CH1
3	JMP2	Jumper terminal for connecting 250Ω sense resistor for CH2
4	+CH1	Positive connection for differential analog input channel 1
5	+CH2	Positive connection for differential analog input channel 2
6	–CH1	Negative connection for differential analog input channel 1
7	–CH2	Negative connection for differential analog input channel 2
8	JMP3	Jumper terminal for connecting 250Ω sense resistor for CH3
9	JMP4	Jumper terminal for connecting 250Ω sense resistor for CH4
10	+CH3	Positive connection for differential analog input channel 3
11	+CH4	Positive connection for differential analog input channel 4
12	–CH3	Negative connection for differential analog input channel 3
13	–CH4	Negative connection for differential analog input channel 4
14	V <sub>out</sub> CH1	Voltage output for channel 1
15	I <sub>out</sub> CH1	Current output for channel 1
16	V <sub>out</sub> CH2	Voltage output for channel 2
17	I <sub>out</sub> CH2	Current output for channel 2
18	V COM	Common return for voltage outputs
19	I RET	Common return for User supplied +24 V and current outputs
20	GND	Frame ground connections for cable shields

## IC693ALG442 Analog Combo Module Field Wiring Diagram

The following figure provide information for connecting field wiring to the user terminal board on the Analog Combo module.



\* ADD JMP1 - JMP4 for 250Ω SENSE RESISTOR (CURRENT INPUT MODE ONLY)

\*\* OPTIONAL SHIELD CONNECTION

Figure 12-5. Field Wiring for Analog Combo Module - IC693ALG442

### Notes

1. Each Input channel can be configured independent of other Input channels to operate as a voltage input **or** a current input – *not both simultaneously*.
2. Each Output channel can be configured independent of other Output channels to operate as a voltage output **or** a current output – *not both simultaneously*.
3. Please see Chapter 2 for wiring and shield ground connection information.

## IC693ALG442 Analog Combo Module Block Diagram

The following figure is a block diagram of the Analog Combo module.

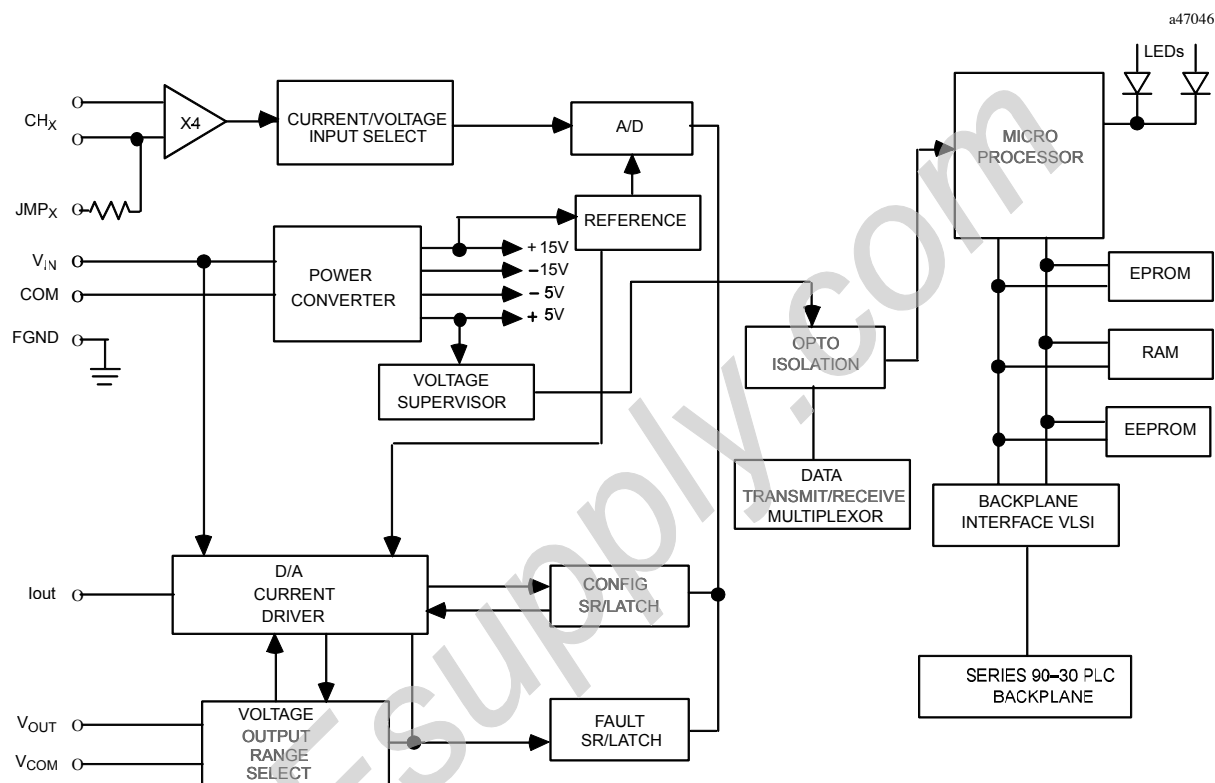


Figure 12-6. Analog Combo Module Block Diagram - IC693ALG442

## Configuring the IC693ALG442 Analog Combo Module

The Analog Combo module can be configured using the Logicmaster, VersaPro, or Control programming software configurator function, or with the GE Fanuc Hand-Held Programmer.

The parameters that can be configured are described in the following table. Configuration procedures using Logicmaster 90-30/20/Micro Programming Software and the Hand-Held Programmer are described in the following pages.

**Table 12-3. Configuration Parameters for IC693ALG442**

Parameter	Description	Values	Defaults	Units
<i>STOP MODE</i>	Output state when module toggled from RUN to STOP mode	HOLD or DEFLOW	HOLD	N/A
<i>%AI ADR</i>	Starting address for the %AI reference type	standard range	%AI0001, or next highest available reference	N/A
<i>%AQ ADR</i>	Starting address for the %AQ reference type.	standard range	%AQ0001, or next highest available reference	N/A
<i>%I ADR</i>	Starting address for the %I reference type	standard range	%I0001, or next highest available reference	N/A
<i>%I SIZE</i>	Number of %I status locations	8, 16, 24	8	bits
<i>RANGE OUTPUT</i>	Type of output range	0,+10 V, -10,+10 V, 4,20 mA, 0, 20mA	0,+10 V	volts (Voltage) mA (Current)
<i>RANGE INPUT</i>	Type of input range	0,+10 V, -10,+10 V, 4,20 mA, 0, 20mA, 4-20 mA Enhanced	0,+10 V	volts (Voltage) mA (Current)
<i>ALARM LO</i>	Low limit alarm value	-32768 to 32759	0	User counts
<i>ALARM HIGH</i>	High limit alarm value	-32767 to 32760	+32000	User counts

For detailed information on configuration of the Analog Combo module, see

- *Configuration Using Logicmaster 90-30/20/Micro Programming Software* beginning on page 3-93.
- *Configuration Using the Hand-Held Programmer* beginning on page 3-104.

## Configuring IC693ALG442 Using Logicmaster Software

This section describes how to configure the IC693ALG442 Analog Combination module using the configurator function in Logicmaster 90-30/20/Micro Programming Software. *Configuration can also be done using VersaPro or Control Programming Software. For details refer to the VersaPro or Control online help.*

To configure an Analog Combo module on the I/O Configuration Rack screen, follow these steps:

1. Move the cursor to the desired rack and slot location. The slot may be either unconfigured or previously configured.
2. Press the **lm30 io** key (**F1**). Your screen will change to one similar to the one shown below.

The screenshot shows the 'I/O Configuration Rack' screen. At the top, there is a header bar with labels: RACK, 1d in, 2d out, 3d mix, 4a in, 5a out, 6a mix, 7other, 8, 9, 10. Below this, the text 'SERIES 90-30 MODULE IN RACK 2 SLOT 3' is displayed. The main area is titled 'SOFTWARE CONFIGURATION' and contains a 'SLOT 3' label and a 'Catalog #' field. At the bottom, there are status indicators: 'C:\LM90\LESSON', 'REPLACE', 'OFFLINE', 'PRG: LESSON', and 'CONFIG VALID'.

3. From this screen, press the **a mix** key (**F6**). Your screen will change to one similar to the one shown below.

The screenshot shows the 'I/O Configuration Rack' screen after pressing the 'a mix' key. The header bar is the same. The main area is titled 'SOFTWARE CONFIGURATION' and contains a 'SLOT 3' label and a 'Catalog #' field. Below this, there is a table with the following data:

CATALOG #	DESCRIPTION	TYPE
1	IC693ALG442	ANALOG CURRENT/VOLTAGE I/O

Below the table, there are instructions: '<< CURSOR TO THE DESIRED CATALOG NUMBER AND PRESS THE ENTER KEY >>' and '<< PRESS PGDN KEY FOR NEXT PAGE, PGUP KEY FOR PREVIOUS PAGE >>'. At the bottom, there are status indicators: 'C:\LM90\LESSON', 'REPLACE', 'OFFLINE', 'PRG: LESSON', and 'CONFIG VALID'.

4. Currently, there is only one selection. (If more than one selection appears, use your **Cursor Movement** (or **Arrow**) keys to move to Catalog # IC693ALG442.) Press **Enter** to accept this selection and to move to the screen shown below.

1	2	3	4	5	6	7	8	9	10	
BACK	1d in	2d out	3d mix	4a in	5a out	6a mix	7other	8	9	10
>										
SERIES 90-30 MODULE IN RACK 2 SLOT 3										
SOFTWARE CONFIGURATION										
SLOT 3	Catalog #: IC693ALG442 ANALOG CURRENT/VOLTAGE I/O									
ALG442										
%AI Ref Adr: %AI0001    %AQ Ref Adr: %AQ001    %I Ref Adr: %I0001 Stop Mode: HOLD    %I Size: 8										
- OUTPUTS -										
Channel 1: 0,+10V										
Channel 2: 0,+10V										
- INPUTS -										
Channel 1: 0,+10V    Alarm Low: +00000    Alarm High: +32000										
Channel 2: 0,+10V    Alarm Low: +00000    Alarm High: +32000										
Channel 3: 0,+10V    Alarm Low: +00000    Alarm High: +32000										
Channel 4: 0,+10V    Alarm Low: +00000    Alarm High: +32000										
OFFLINE										
C: NLM90NLESSON					PRG: LESSON			CONFIG VALID		
REPLACE										

5. All the remaining configuration does not have to be done on this screen. You can move your cursor from field to field by pressing the **Cursor Movement** (or **Arrow**) keys. When you are in the field you want to modify, you can either type in your choice or press the **Tab** key to scroll through the available selections (or **Shift-Tab** to reverse the direction of the scrolling).

### Note

The entry in the **Stop Mode** field (**HOLD** or **DEFLOW** (Default **LOW**)) determines how the outputs will behave when the module is toggled from **RUN** to **STOP** mode. When this value is set to **HOLD** (default), the outputs will retain their last state. When you change this value to **DEFLOW**, the output will go to zero.

## Other Configuration Considerations

The entry in **%I Size** will only accept 8, 16 and 24, and will accept only **%I** addresses. This field denotes the number of bits returned to the user. The only allowable entries for the **%AI Ref Adr** are **%AI** addresses. Similarly, the only allowable entries for the **%AQ Ref Adr** are **%AQ** addresses.

The **Alarm Low** limit for each channel must be less than its corresponding **Alarm High** limit.

The **%AI Ref Adr** field is the reference address for the **%AI** data and points to the start of the locations in the **%AI** memory where the input data to the module begins. Each channel provides 16 bits of analog output data as an integer value from 0 to 32,767 or -32,768 to 32,767, depending on the range type selected.

The **%AQ Ref Adr** field is the reference address for the **%AQ** data and points to the start of the locations in the **%AQ** memory where the output data to the module begins. Each channel provides 16 bits of analog output data as an integer value from 0 to 32,767 or -32,768 to 32,767, depending on the range type selected.

For detailed information of the data format, see the *CPU Interface to Analog Modules* section at the beginning of this chapter.

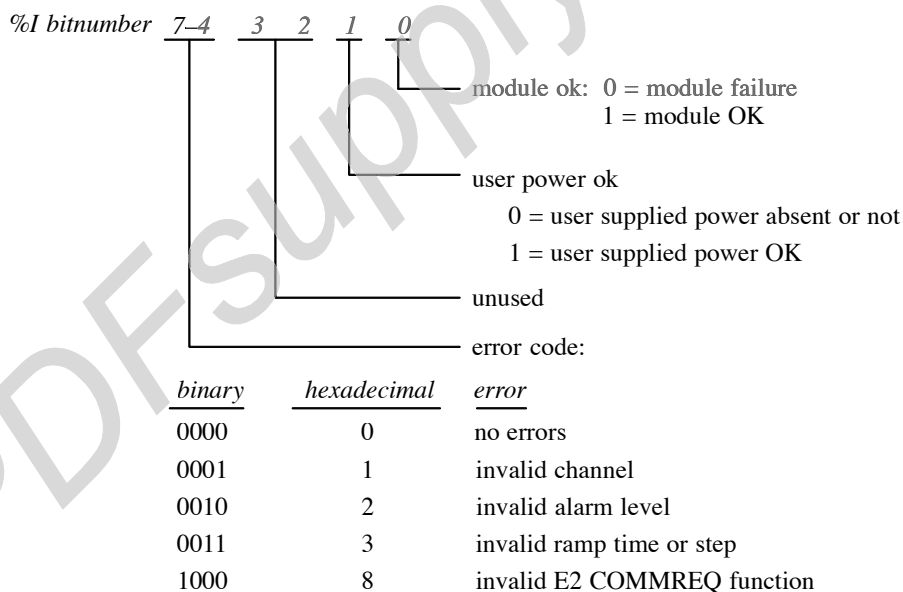
## %I Status Information

The **%I Ref Addr** is the reference address for the %I data and points to the start of the locations in the %I memory (that is, the Input Table) where status information from the module is reported. You can select the number of %I status locations reported to the PLC by editing the value in the **%I Size** field. Allowable values in the %I Size field are 8, 16, and 24 which refer to the number of %I locations reported to the PLC. For %I SIZE values 8 or greater, the data brought back is in the format described in the following tables.

### First eight %I locations - (available for %I SIZE values 8, 16, 24)

%I Locations	Description
%I	Module OK - 0 indicates NOT OK, 1 indicates module OK.
%I+1	User Supply OK - Indicates when user supply is in specified limits; reads a 0 when User supply below specified limit, 1 when User supply OK.
%I+2 & %I+3	Reserved for future modules. Not used in this module.
%I+4 through 7	☞ See definition for these bits below.

☞ %I+4through 7 (upper 4 bits of first %I byte) hold an error code which is defined as follows:



If the you send E2 COMMREQ data that reflects an invalid condition, the module will ignore the COMMREQ command and return an error code in the upper 4 bits of the first %I byte. The module will NOT stop standard operation if an error is detected; these error bits are for the user's information and can be ignored if desired. The error code will remain until you send an E2 COMMREQ to clear the error code or reconfigure the module.

Only the most recent error will be reported; an existing error code will be overwritten if another error occurs. The priorities for errors are:

1. Invalid COMMREQ function (highest priority)
2. Invalid channel.
3. Invalid data (ramp or alarm parameter) (lowest priority).

Thus, if multiple error conditions exist, the one with the highest priority is reported in the error code.

### Second eight locations - (available for %I SIZE values 16, 24)

%I Locations	Description
%I+8	Input Ch #1 ALARM LO - 0 indicates value above limit; 1 below or =
%I+9	Input Ch #1 ALARM HI - 0 indicates value below limit; 1 above or =
%I+10	Input Ch #2 ALARM LO - 0 indicates value above limit; 1 below or =
%I+11	Input Ch #2 ALARM HI - 0 indicates value below limit; 1 above or =
%I+12	Input Ch #3 ALARM LO - 0 indicates value above limit; 1 below or =
%I+13	Input Ch #3 ALARM HI - 0 indicates value below limit; 1 above or =
%I+14	Input Ch #4 ALARM LO - 0 indicates value above limit; 1 below or =
%I+15	Input Ch #4 ALARM HI - 0 indicates value below limit; 1 above or =

### The third eight locations (available for %I SIZE values 24)

%I Locations	Description
%I+16	Output Ch #1 BROKEN WIRE 0 = OK, 1 = Wire Broken (Current modes only)
%I+17	Output Ch #2 BROKEN WIRE 0 = OK, 1 = Wire Broken (Current modes only)
%I+18 through %I+23	Reserved for future modules. Not used in this module

One of four input or output ranges can be selected; two are voltage ranges. The default range is 0 to +10V, where input or output voltage values range from 0 to 10 volts. In input mode they report 0 to 32767 integer values to the CPU and in output mode values between 0 and 32767 are sent to the module. In the -10 to +10V range, values between -32768 to 32767 are sent or received from the CPU over an input voltage range of -10 to +10V.

The two current ranges are 4 to 20 mA, and 0 to 20 mA. In each of the current ranges, values between 0 and 32767 are reported back from the module to sent to the module for the entire range.



### Values Sent From CPU to Module for Output Channels

The following tables show values sent from the CPU to the module for the Output channels.

Range	Module Mode	*Allowed Values	Sent values from CPU
0 to 10 V	Voltage	0 to 32767	0 to 32767
–10 to 10 V	Voltage	– 32768 to 32767	–32768 to 32767
4 to 20 mA	Current	0 to 32000*	0 to 32767
0 to 20 mA	Current	0 to 32767	0 to 32767

\* *Allowed Values* refers to the values that are valid. If a value outside the specified range is sent, the module clips it to the nearest valid value before sending it to the Digital to Analog Converter. No errors are returned.

The following table shows values sent from the module back to the PLC for the Input channels.

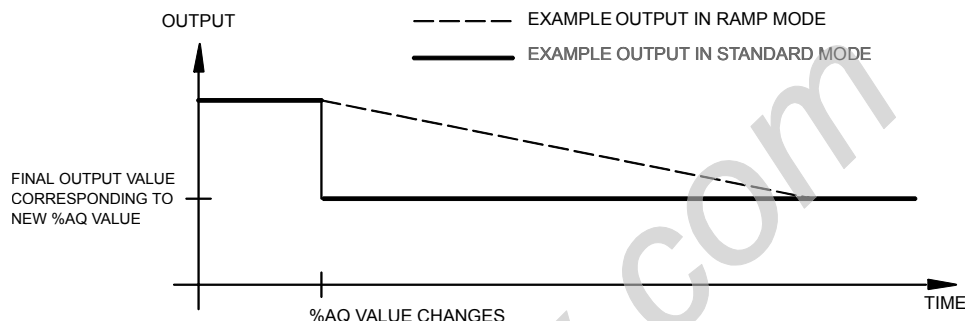
Range	Module Mode	Sent values to CPU
0 to 10 V	Voltage	0 to 32767
–10 to 10 V	Voltage	–32768 to 32767
4 to 20 mA	Current	0 to 32767
0 to 20 mA	Current	0 to 32767
0 to 20 mA Enhanced	Current	–8000 to 32767

The ALARM LO and ALARM HI data fields allow you to enter values that cause *alarm* indications to be passed to the PLC. Each channel has a low limit alarm value (ALARM LO) and a high limit alarm value (ALARM HI). These alarm values cause %I points to be set as indicated in the tables on page 3-95 and 3-96. Values can be entered in all high and low limit fields. Values entered without a sign are assumed to be positive. The allowable values are shown in the following table.

RANGE	Possible limit values
0 to 20 mA	0...32760
4 to 20 mA	0...32760
4 to 20 mA Enhanced	–8000...32760
0 to 10V	0...32760
–10 to +10V	–32768...32760

## IC693ALG442 Ramp Mode Operation

The ramp mode operation represents a separate mode of the module's outputs. When an output channel is not in ramp mode, new values entered in the corresponding %AQ reference cause the output to step to the commanded values as shown in Figure 3-52. When an output channel is in ramp mode, new values entered in the corresponding %AQ reference cause the output to ramp to the given values using ramp variables which have been assigned to the channel using ladder logic. The ramp is composed of output steps taken every 1 millisecond.



**Figure 12-7. Output Behavior in Ramp Mode and in Standard Mode**

The default mode of both outputs is *standard mode*. Ramp mode and ramp variables are set using an E2 COMMREQ in ladder logic as described below. The mode of each output channel is set independent of the mode of the other channel. When an output is in ramp mode, two lower-level modes can be used to specify the ramp slope: **time mode**, in which the user provides the total ramp time in milliseconds, and **step mode**, in which the user provides the step in %AQ counts that will be taken every 1 millisecond.

### Setting the Ramp Mode

An E2 COMMREQ is used to change the ramp mode of an output channel. This is the same COMMREQ that is used to change the input alarm limits of the module and clear the %I error code. When the module receives the COMMREQ, the first word, or *command* word, is checked to determine whether the ramp settings or alarm limits are being changed or whether the %I error code is being cleared.

When step mode is specified, the second COMMREQ data word contains the ramp step in %AQ counts. Valid step values range from 1 to 32000. The direction of the ramp is determined when the value of the corresponding %AQ reference changes. Once the ramp mode and step have been set, changing the corresponding %AQ value causes the output to ramp to the new value.

When time mode is specified, the second COMMREQ data word contains the total time in milliseconds it will take for the output to ramp from the present output value to the final output value. The present and final values are specified by the old and new values of the corresponding %AQ reference. Valid ramp time values range from 1 to 32000, which correspond to ramp times of 1 millisecond to 32 seconds. Once the ramp mode and time have been set, changing the corresponding %AQ value causes the output to ramp to the new value.

If an E2 COMMREQ is issued to the module to change the ramp settings while the indicated output is in the process of ramping, the new ramp settings will take effect as follows:

- If the ramp mode is turned off during a ramp, the output will step completely to the final value (indicated by the corresponding %AQ reference).
- If step mode is turned on during a ramp, the new step is used as soon as the COMMREQ is processed (assuming that the step is valid).
- If time mode is turned on during a ramp, the module will immediately begin a new ramp using the present output as the starting output and the present time as the start time.

In all cases, changing the value of the corresponding %AQ reference will cause the output to begin a new ramp from the present output value.

## Error Handling

If the module receives E2 COMMREQ data that indicates an invalid channel or a step height or ramp time that is out of range, the module will ignore the COMMREQ and return an error code in the first byte of %I data assigned to the module. The error code will be cleared when a Clear Errors E2 COMMREQ is sent to the module or when the module is reconfigured. Range checking of %AQ values received by the module is performed before the values are used in ramp computations. %AQ data which is out of range is clipped to the nearest valid value by the module.

## E2 COMMREQ for IC693ALG442

The E2 COMMREQ allows you to modify the input alarm limits, set the output ramp mode and parameters, and clear the %I error code. The E2 COMMREQ uses the standard COMMREQ format. See Chapter 4 of the *Series 90-30/20/Micro PLC CPU Instruction Set Reference Manual*, GFK-0467, and Chapter 8 of the *Hand-Held Programmer for Series 9030/90-20/Micro Programmable Controllers User's Manual*, GFK-0402, for more information on the COMMREQ.

### E2 COMMREQ Command Block

The E2 COMMREQ command block consists of 10 words as shown in Table 3-25. Example E2 COMMREQ data in hexadecimal format is included in the table for clarity.

**Table 12-4. E2 COMMREQ Command Block Definitions**

Address	Data Description	Example Data
Start Address	Always 0004 for this module	0004
+1	Not used	0000
+2	COMMREQ status data type	0008 (%R)
+3	COMMREQ status address (zero-based)	0000 (%R0001)
+4	Not used	0000
+5	Not used	0000
+6	Command type (E2 → message ID for 6 byte data command to ALG442) and command parameter (1 → write)	E201
+7	Byte length of data sent to ALG442	0006
+8	Data type	0008 (%R)
+9	Data address (zero based)	0064 (%R0101)

The decimal and hexadecimal values which specify COMMREQ data types are shown in Table 3-26. The data format and command word description for the E2 COMMREQ are shown in Table 3-27. The first word holds the command word, the second word holds data for changing alarm or ramp parameters and the third word is unused. The %R addresses correspond to the example command block data in Table 3-25.

**Table 12-5. COMMREQ Data Types**

For This Data Type	Enter This Number	
	Decimal	Hexadecimal
%I Discrete Input	28	1C
%Q Discrete Output	30	1E
%R Register	8	08
%AI Analog Input	10	0A
%AQ Analog Output	12	0C

Table 12-6. E2 COMMREQ Data and Command Word Formats

E2 COMMREQ Data			Channel Convention *
word 1	%R0101	command word	0 = channel 1
word 2	%R0102	alarm or ramp data	1 = channel 2
word 3	%R0103	unused	2 = channel 3
			3 = channel 4

Command Word	Description
000x	Change low alarm of channel x using absolute mode; word 2 holds the new alarm value.
001x	Change high alarm of channel x using absolute mode; word 2 holds the new alarm value.
002x	Change low alarm of channel x using relative mode; word 2 holds the change of the alarm value.
003x	Change high alarm of channel x using relative mode; word 2 holds the change of the alarm value.
004x	Channel x ramp mode off; places channel in standard mode.
005x	Channel x ramp step mode on; word 2 holds the step taken each millisecond.
006x	Channel x ramp time mode on; word 2 holds the total ramp time.
00C0	Clear %I error code; word 2 is ignored.

\* 1 through 4 are valid channels for changing alarm levels.

1 and 2 are valid channels for setting ramp modes.

You can change the high and low alarm limits for any of the four input channels. Two modes are available to modify the alarm data: **absolute** mode and **relative** mode.

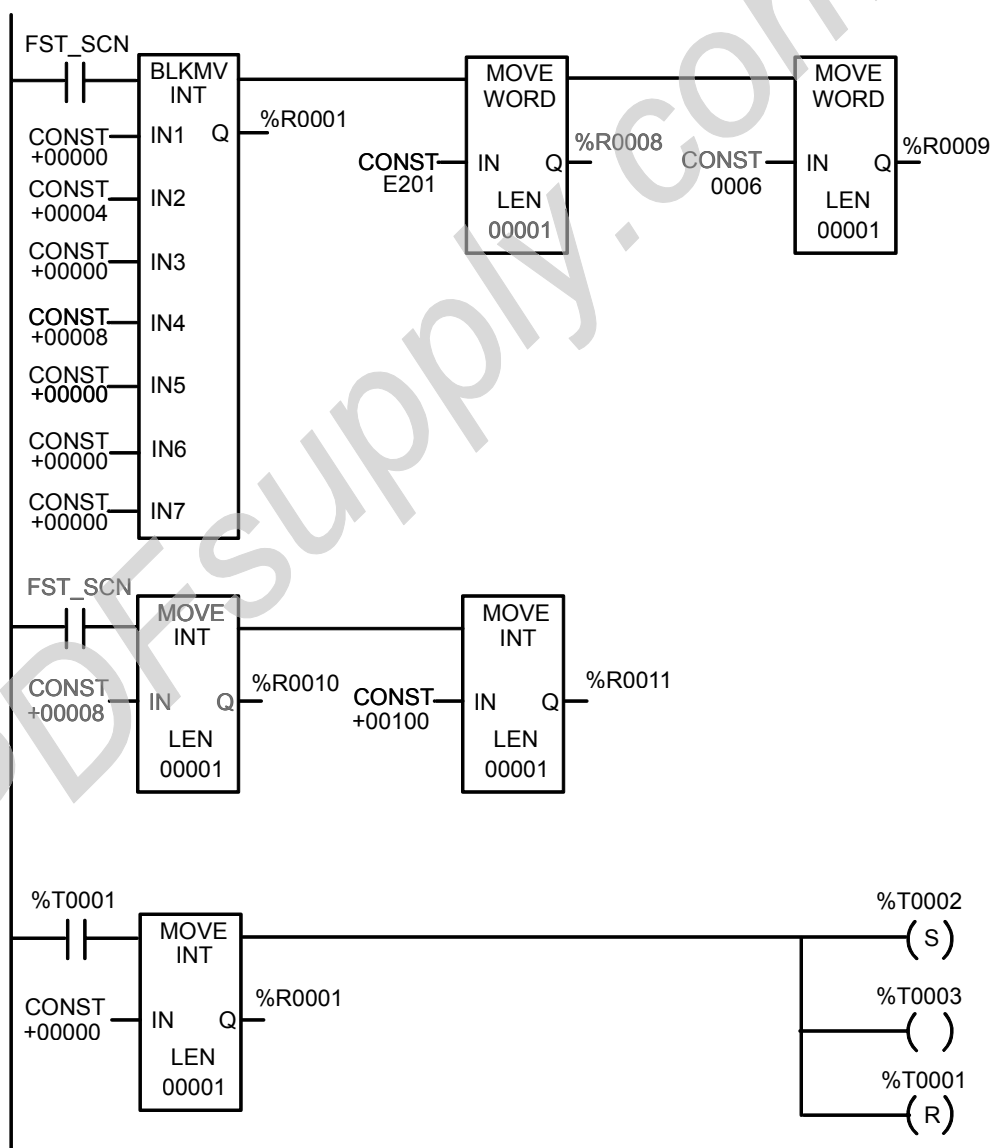
- When using **absolute mode**, the alarm data sent by the COMMREQ specifies the actual new alarm value.
- When using **relative mode**, the alarm data specifies the positive or negative change in the alarm value that is added to the present value.

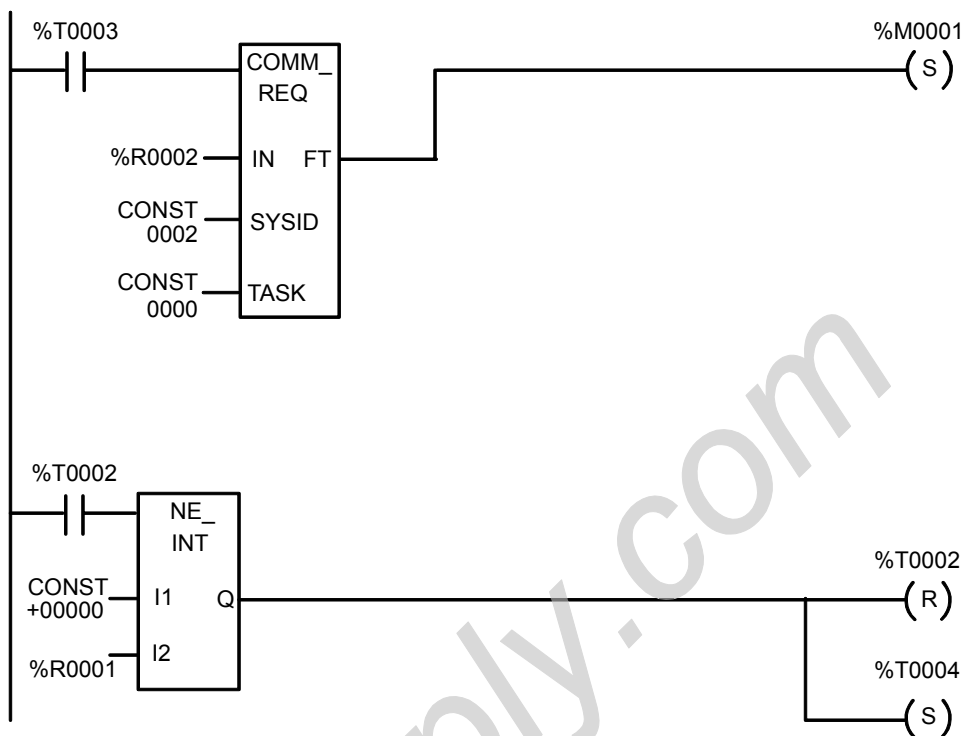
The module verifies that the new alarm limit requested is not out of range and does not violate the condition HIGH>LOW. If an invalid request is made to change an alarm value, the corresponding error code will be returned in the upper four bits of the first byte of %I references assigned to the module.

## E2 COMMREQ Example

The following ladder logic provides an example of setting up E2 COMMREQ data and issuing the COMMREQ. As with all COMMREQs, it is recommended that the ladder verify the completion of the E2 COMMREQ in progress before initiating another. This ensures that the module does not receive COMMREQs faster than it can process them. One way to do this is to zero the contents of the COMMREQ status (%R0001 in this example) as the COMMREQ is enabled. Since the status returned for a completed COMMREQ is never zero, a non-zero status word will then indicate that the COMMREQ has completed.

In this example, the COMMREQ command block begins at %R0002 and is initialized on the first scan. It is assumed that the 6 bytes of COMMREQ data sent to the module are moved into %R0101–%R0103 before the COMMREQ is enabled. The module is located in rack 0, slot 2 so the SYSID input to the COMMREQ is 0002. Setting %T0001 moves zero into the COMMREQ status word, enables %T0003 for one sweep to initiate the COMMREQ, and sets %T0002 to begin checking the status word. When a non-zero status word is detected, %T0002 is reset to discontinue checking and %T0004 is set to indicate that the module is ready for the next COMMREQ. Reference %M0001 is set if a COMMREQ fault occurs.





## Configuring IC693ALG442 with Hand-Held Programmer

You can also configure the Analog Current/Voltage 4-Channel Input/2-Channel Output module using the Series 90-30 Hand-Held Programmer. In addition to the information in this section, refer to Chapter 6 of the *Hand-Held Programmer for Series 90-30/20/Micro Programmable Controllers User's Manual*, GFK-0402F, or later version, for more information on configuration of Intelligent I/O modules.

### Module Present

If a module is physically present in a system, it can be added to the system's configuration by reading the module into the configuration file. For example, assume that an 4-Channel Input/2-Channel Output Analog Current/Voltage module is installed in slot 3 of a Model 311 PLC system. It can be added to the configuration with the following sequence. Use the ↑ and ↓ arrow cursor keys or the # key to display the selected slot.

Initial Display

```
R0:03  EMPTY  <S
```

To add the IC693ALG442 module to the configuration, press the **READ/VERIFY, ENT** key sequence. The following screen will be displayed:

```
R0:03  AIO  2.00<S
I24:I  _
```

### Selecting %I Reference

At this point the starting %I reference address for the status data returned from the module must be entered. Notice that the length of the status field (24) is displayed as the first two digits following the first **I** on the second line of the display.

### Note

This field cannot be changed with the Hand-Held Programmer. However, it can be changed using the Logicmaster 90-30/20/Micro software configurator function. The Hand-Held Programmer will always reflect the currently active length of the status field.

Pressing the **ENT** key will allow the PLC to select the starting address of the status data. You can select a specific starting address by pressing the key sequence for the desired address and pressing the **ENT** key. For example, to specify the starting address as I17, press the key sequence **1, 7, ENT**.




### Note

The configured reference addresses will not be displayed until all three reference types (%I, %AI and %AQ) have been assigned starting addresses. Once this is done, the configured addresses can be viewed by scrolling backward using the  $\square$  key.

You can press the **CLR** key at any time to abort the configuration you have just selected and return the slot to EMPTY.

After selecting the starting %I address and pressing the **ENT** key, the following screen is displayed.



```
R0:03 AIO 2.00<S
AI04:AI _
```

### Selecting %AI Reference

This screen allows you to select the starting address for the %AI reference by specifying the starting reference in the %AI field. Note that the number of references (04) is displayed as the first two digits following the first AI on the second line of the display.

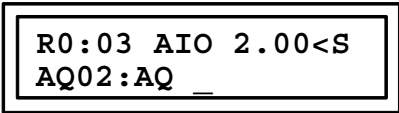
You can select the next available address or enter a specific address. Pressing the **ENT** key will allow the PLC to select the starting address. You can select a specific starting address by pressing the key sequence for the desired address and pressing the **ENT** key. For example, to specify the starting address as %AI35 press the key sequence 3, 5, **ENT**.

### Note

The configured reference addresses will not be shown until all three reference types (%I, %AI and %AQ) have been assigned starting addresses. Once this is done, the configured addresses can be viewed by scrolling backward using the  $\square$  key.

You can press the **CLR** key while entering the starting address to clear the address field and enter a different address.

After selecting the starting %AI address and pressing the **ENT** key, the following screen is displayed:



```
R0:03 AIO 2.00<S
AQ02:AQ _
```

## Selecting %AQ Reference

This screen allows you to select the starting address for the %AQ reference by specifying the starting reference in the %AQ field. Note that the number of references (**02**) is displayed as the first two digits following the first **AQ** on the second line of the display.

You can select the next available address or enter a specific address. Pressing the **ENT** key will allow the PLC to select the starting address. You can select a specific starting address by pressing the key sequence for the desired address and pressing the **ENT** key. For example, to specify the starting address as %AQ35 press the key sequence **3, 5, ENT**. The following screen will be displayed:

```
R0:03 AIO 2.00<S
AQ02:AQ035-0036
```

Once the %AQ starting address has been assigned, the **□** key can be used to view the configured %I and %AI reference addresses. For example, if %I17 and %AI35 are used as starting addresses then the following screen will be displayed after pressing the key sequence **□, □**:

```
R0:03 AIO 2.00<S
I24:I0017-0040
```

Scrolling forward from this screen using the **□** key causes the following screen to be displayed:

```
R0:03 AIO 2.00<S
AI04:AI0035-0038
```

## Removing Module From Configuration

The module can be removed from the current rack configuration at any time during the configuration process by pressing the **DEL, ENT** key sequence. The following screen will be displayed:

```
R0:03 EMPTY <S
```

If the **CLR** key is pressed after the **DEL** key (instead of the **ENT** key), the delete operation will be aborted.

## Selecting Module Stop Mode

The STOP mode of the module, either HOLD or DEFAULT LOW (DEFLOW), can be displayed and modified using the following procedure. From the %AQ reference screen, press the  $\square$  key to scroll to the next screen:

```
R0:03 AIO 2.00 <S
HLS/DEF:HOLD
```

The default STOP mode is HOLD, which indicates that each output will hold its last state when the PLC is placed in STOP mode. You can toggle between the HOLD and DEFLOW modes by pressing the  $\pm$  key. Pressing this key once causes the following screen to be displayed:

```
R0:03 AIO 2.00 <S
HLS/DEF:DEF LOW
```

In DEFLOW mode, each output will become zero when the PLC is placed in STOP mode. When the desired mode is displayed, it is accepted by pressing the ENT key. To return to the previous screen, press the  $\square$  key.

## Selecting Output Channel Ranges

The range for each of the output and input channels can be displayed and selected or changed as described below. There are two current and two voltage ranges that can be selected for each output channel. From the STOP mode screen, pressing  $\square$  causes the following screen to be displayed:

```
R0:03 AIO 2.00<S
CH 1-AQ:0,10 V
```

You can toggle through the ranges for each channel by pressing the  $\pm$  key. Each range will be displayed as shown below.

```
R0:03 AIO 2.00<S
CH 1-AQ:-10,+10
```

```
R0:03 AIO 2.00<S
CH 1-AQ:4,20 MA
```

```

R0:03 AIO 2.00<S
CH 1-AQ:0,20 MA

```

When the desired range is displayed, it is accepted by pressing the **ENT** key. To return to the previous screen, press the **◀** key. To view the range display for the next channel, press the **▶** key. If the **◀** key is pressed, the following screen will be displayed:

```

R0:03 AIO 2.00<S
CH 2-AQ:0,10 V

```

Edit the range for this channel as you did for the first channel. To view the range display for the first *input* channel, press the **◀** key.

## Selecting Input Channel Ranges

There are three current and two voltage ranges that can be selected for each input channel. The following screen is displayed for the first input channel:

```

R0:03 AIO 2.00<S
CH 1-AI:0,10 V

```

You can toggle through the ranges for each input channel by pressing the **±** key. Each range will be displayed as shown below.

```

R0:03 AIO 2.00<S
CH 1-AI:-10,+10

```

```

R0:03 AIO 2.00<S
CH 1-AI:4,20 MA

```

```

R0:03 AIO 2.00<S
CH 1-AI:0,20 MA

```

```

R0:03 AIO 2.00<S
CH 1-AI:4-20 MA+

```

When the desired range for the module is displayed, it is accepted by pressing the **ENT** key. To return to the previous screen press the **◀** key.

## Selecting Low and High Alarm limits

The low and high alarm limit screens for each channel are displayed immediately following the channel range screen. The following screen is displayed if the  $\square$  key is pressed from the range screen for input channel 1:

```
R0:03 AIO 2.00<S
CH 1 LO:      0
```

This display contains the entry field for the *low alarm limit* for this channel. You can enter positive or negative values using the numeric keys (0 through 9) and the  $\pm$  key. Press the **ENT** key to accept the value you have entered. When an alarm value that is not in the allowed range (–32768 to 32760) is entered, a DATA ERR message will be displayed as shown in the following example:

```
R0:03 DATA ERR<S
CH 1 LO:–33000_
```

The bad data must be corrected before the HHP will allow you to move to another screen. When a valid low alarm has been entered, press the  $\square$  key to move to the high alarm limit screen for this channel. The following screen will be displayed:

```
R0:03 AIO 2.00<S
CH 1 HI: 32000
```

This screen contains the entry field for the *high alarm limit* for this channel. You can enter positive or negative values using the numeric keys (0 through 9) and the  $\pm$  key. To view the range screen for the next input channel, press the  $\square$  key. The following screen will be displayed:

```
R0:03 AIO 2.00<S
CH 2–AI:0,10 V
```

Edit the ranges and alarm limits for this channel and subsequent channels as you did for the first channel.

## Freeze Mode

If an alarm value in the allowed range (–32768 to 32760) is entered that results in an invalid condition, such as a low alarm limit greater than an upper alarm limit or a negative alarm for a channel in a unipolar range, the module will enter *freeze* mode. In this mode, you will not be allowed to move beyond the present channel parameters (range, low alarm limit and high alarm limit) until the invalid condition is corrected or removed. Freeze mode is indicated on the HHP screen by an asterisk (\*) after the slot number. For example, if a low alarm limit of –1000 is entered for input channel 1 in the 0,10V range the following screen will be displayed:

```
R0:03*AIO 2.00<S
CH 1 LO: -1000
```

If you press either the ☐ key or the ☐ key to change slots, the following message will be displayed:

```
SAVE CHANGES? <S
<ENT>=Y <CLR>=N
```

If you *do not* want to save the changes to the CPU, press the **CLR** key. The following message will be displayed:

```
DISCARD CHGS? <S
<ENT>=Y <CLR>=N
```

If you *do not* want to discard the changes you have made, press the **CLR** key. This will return you to the last parameter that was being modified with all changes intact.

If you *do* want to discard the changes you have made, press the **ENT** key. The Hand-Held Programmer will then return you to the last parameter that was being modified with the data reset to its previous value.

If you want to save the data to the CPU from the SAVE CHANGES? screen shown above, press the **ENT** key. If the module is in freeze mode, the Hand-Held Programmer will return with a CFG ERR message on the screen as follows:

```
R0:03*CFG ERR <S
CH 1 LO: -1000
```

If all data is valid, the HHP display will move to an adjacent slot when either the ☐ key or ☐ key is pressed.

## Saved Configurations

Configurations that contain Analog Combo modules can be saved to an EEPROM or MEM card and read from that device into the CPU at a later time. MEM cards and EEPROMs containing these configurations can be read into any Release 4 or later Series 90-30 CPU (cannot be read into a Series 90-20 CPU). Refer to Chapter 2 of the *Hand-Held Programmer for Series 90-30/20/Micro Programmable Controllers User's Manual* for detailed information on the Save and Restore operations.