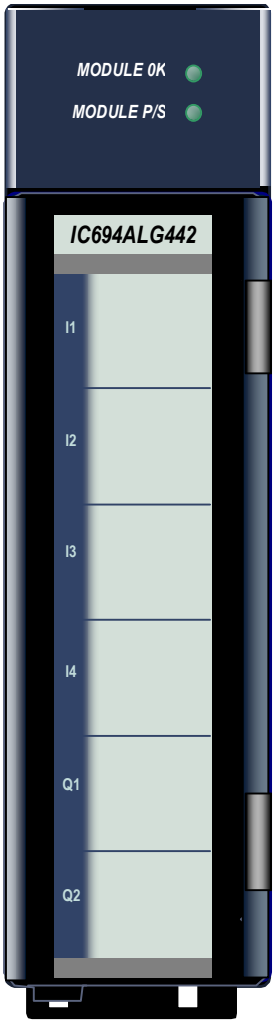
Analog Module, 4 Inputs/2 Outputs, Current/Voltage: IC694ALG442



Analog Current/Voltage Input/Output module, IC694ALG422, provides four differential input channels and two single-ended output channels. Each channel can be configured with the Machine Edition software for one of the following ranges:

- 0 to +10 volts (unipolar), default.
- -10 to +10 volts (bipolar)
- 0 to 20 mA
- 4 to 20 mA

Input channels can also be configured for 4 - 20 mA Enhanced mode.

This module may be installed in any I/O slot in the RX3i system.

Module Features

Outputs can be configured to either Hold Last State if system power is interrupted or to reset to the low end of their range. Outputs can also be configured to operate in ramp mode on command from the application program. In ramp mode, the output channel ramps to a new value over a period of time, rather than taking the new value immediately.

High and low alarm limits can be set for all input channels and an open–wire fault (current output modes) can be reported to the CPU for each output channel.

Isolated +24 VDC Power

This module must receive 24 VDC power from an external source. If the module is located in an RX3i Universal Backplane, the external source can be connected via the TB1 connector on the left side of the backplane or directly on the module's terminal block. If the module is located in an Expansion Backplane, the external source must be connected to the module's terminal block.

LEDs

The **Module OK** LED indicates module status. The **Module P/S** LED indicates whether the external +24 VDC power supply is present and is above a minimum designated level. Both LEDs are powered from the +5 VDC backplane power bus.

LED	Description
Module OK	ON: Module OK and configured Flashing: Module OK but not configured OFF: Module is defective or no +5 VDC backplane power present
Module P/S	ON: User power is present OFF: No user power

Specifications: ALG442

Power Requirements	
External Supply Voltage Range	20 to 30 VDC (24 VDC typical)
Power Supply Rejection Ratio	Current: 5 µA/V (typical), 10 µA/V (maximum) Voltage: 25 mV/V (typical), 50 mV/V (maximum) (measured by varying V_{USER} from 24 VDC to 30 VDC)
Voltage Ripple	10%
Power Consumption	95 mA from internal +5 VDC Supply, 129 mA from external supply
Isolation Field to Backplane (optical) and to frame ground	250 VAC continuous; 1500 VAC for 1 minute
Analog Outputs	2, Single–Ended
Analog Current Output	
Output Current Ranges	0 to 20 mA, 4 to 20 mA
Resolution	at 0 to 20 mA: 0.625 µA (1 LSB = 0.625 A) at 4 to 20 mA: 0.5 µA (1 LSB = 0.5 µA)
Absolute Accuracy[1]	+/-0.1% of full scale @ 25°C (77°F), typical +/-0.25% of full scale @ 25°C (77°F), maximum +/-0.5% of full scale over operating temperature range (maximum)
Maximum Compliance Voltage	V_{USER} –3 V (minimum) to V_{USER} (maximum)
User Load	0 to 850Ω (minimum at V_{USER} = 20 V, maximum 1350Ω at V_{USER} = 30 V)
Output Load Capacitance	2000 pF (maximum)
Output Load Inductance	1 H (maximum)
Analog Voltage Output	
Output Ranges	-10 to +10 V (bipolar), 0 to +10 V (unipolar)
Resolution	at –10 V to +10 V: 0.3125 mV (1 LSB = 0.3125 mV) at 0 to +10 V: 0.3125 mV (1 LSB = 0.3125 mV)
Absolute Accuracy[2]	+/-0.25% of full scale @ 25°C (77°F), typical +/-0.5% of full scale @ 25°C (77°F), maximum +/-1.0% of full scale over operating temperature range (maximum)
Output Loading	5 mA (2 K Ohms minimum resistance)
Output Load Capacitance	1 µF (maximum capacitance)

1. In the presence of severe RF interference (IEC 801–3, 10V/m), accuracy may be degraded to +/-1% FS.
2. In the presence of severe RF interference (IEC 801–3, 10V/m), accuracy may be degraded to +/-4% FS.

Continued…

Specifications, continued

Analog Inputs	4, differential
Analog Current Input	
Input Ranges	0 to 20 mA, 4 to 20 mA, 4 to 20 mA Enhanced
Resolution	5 µA (1 LSB = 5µA)
Absolute Accuracy[3]	+/- 0.25% of full scale @25°C (77°F) +/-0.5% of full scale over specified operating temperature range
Linearity	<1 LSB
Common Mode Voltage	200 VDC (maximum)
Common Mode Rejection	>70 dB at DC; >70 dB at 60 Hz
Cross Channel Rejection	>80 dB from DC to 1 kHz
Input Impedance	250 Ω
Input Filter Response	29 Hz
Analog Voltage Input	
Input Ranges	0 to +10 V (unipolar), -10 to +10 V (bipolar)
Resolution	at 0 to +10 V: 2.5 mV (1 LSB = 2.5 mV) at –10 to +10 V: 5 mV (1 LSB = 5 mV)
Absolute Accuracy[3]	+/-0.25% of full scale @25°C (77°F); +/-0.5% of full scale over specified operating temperature range
Linearity	<1 LSB
Common Mode Voltage	200 VDC (maximum)
Common Mode Rejection	>70 dB at DC; >70 dB at 60 Hz
Cross Channel Rejection	>80 dB from DC to 1 kHz
Input Impedance	800 K Ohmş typical)
Input Filter Response	29 Hz

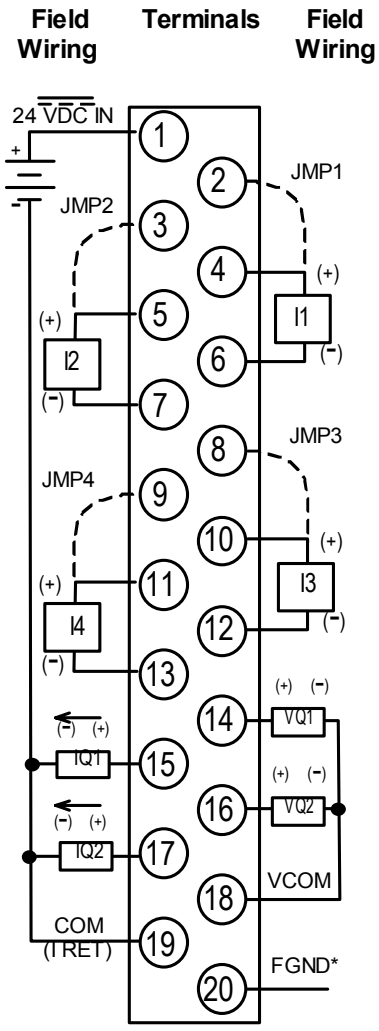
3. In the presence of severe RF interference (IEC 801–3, 10V/m), accuracy may be degraded to +/-2% FS.

Refer to Appendix A for product standards and general specifications. In order to meet the IEC 1000-4-3 levels for RF Susceptibility specified in Appendix A, when this module is present, the system must be mounted in a metal enclosure.

Field Wiring: ALG442

The diagram below shows voltage and current connections for the module. Each channel can be configured independently as a voltage or a current channel, not both simultaneously.

Terminal	Signal	Definition
1	24VIN	User Supplied +24 VDC 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_{out} CH1	Voltage output for channel 1
15	I_{out} CH1	Current output for channel 1
16	V_{out} CH2	Voltage output for channel 2
17	I_{out} 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



* Optional Shield Connection

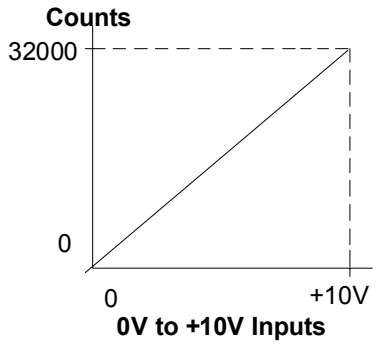
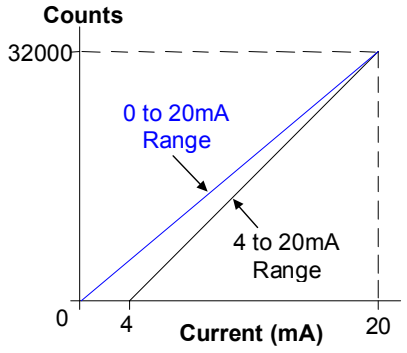
Input Scaling

Resolution per bit depends on the configured input or output range as shown in the table of module specifications. The module scales each current and voltage input to a value in counts for the CPU.

Configured Range	Scaled Counts Values
0 to 10 V (default)	0 to 32767
-10 to 10 V	-32768 to 32767
4 to 20 mA	0 to 32767
0 to 20 mA	0 to 32767
0 to 20 mA Enhanced	-8000 to 32767

In the 0 to +10 V default range, 0 volts corresponds to a count of 0 and +10 volts corresponds to a count of 32000. In the -10 to +10 volt range, -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. In the 4 to 20 mA range, 4 mA corresponds to a count of 0 and 20 mA corresponds to a count of 32000. In the 0 to 20 mA range, 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.

In the 4 to 20 mA Enhanced range, 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 automatically provides 4 to 20 mA range scaling. Negative digital values are provided for input current levels between 4 mA and 0 mA. This creates a low alarm limit that detects when the input current falls from 4 mA to 0 mA, providing open–wire fault detection in 4 to 20 mA applications.

Input Voltage Scaling	*Input Current Scaling*
	

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

Output Scaling

The module scales counts data received from the CPU to a current or voltage value for each output.

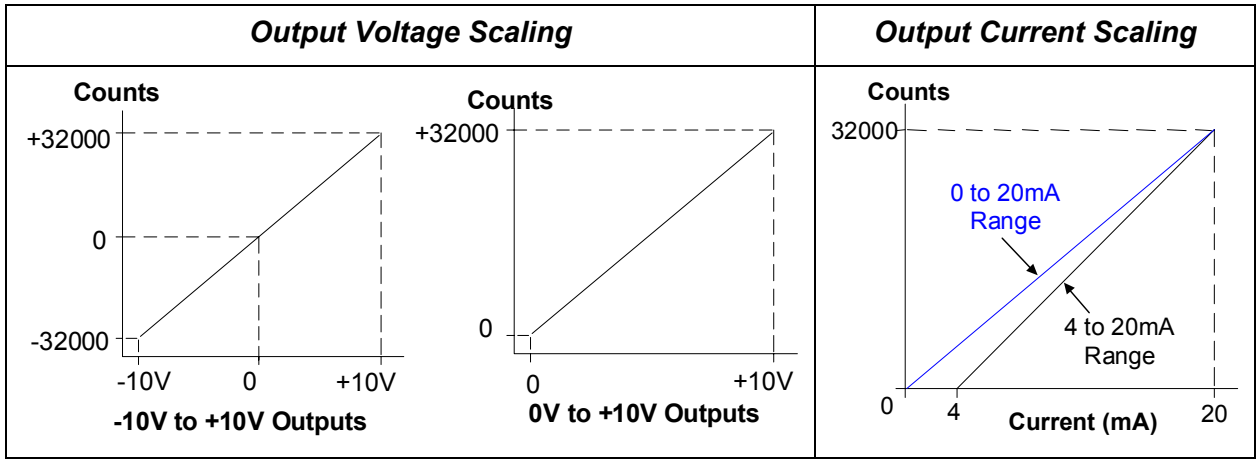
Configured Range	Values Sent By CPU	Values Accepted by Module
0 to 10 V (default)	0 to 32767	0 to 32767
-10 to 10 V	-32768 to 32767	- 32768 to 32767
4 to 20 mA	0 to 32767	0 to 32000
0 to 20 mA	0 to 32767	0 to 32767

For a 0 to 10 V output, the module scales count outputs from 0 to 32000 to output voltages from 0 to +10 volts. The module scales count values from 32001 to 32767 to overrange voltages up to a maximum of approximately 10.24 volts.

For a -10 to +10 V output, the module scales count outputs in the range +/-32000 to output voltages from –10 V to +10 V. The module scales count values from -32001 to -32768 and from +32001 to +32767 to overrange voltages up to a maximum of approximately +/-10.24 V.

For a 4 to 20 mA output, the module scales count outputs from 0 to 32000 counts to output currents from 4 to 20 mA. If the CPU sends a value above 32000 counts, the module uses the value 32000 in the D/A converter. No error is returned.

For a 0 to 20 mA output, the module scales count outputs from 0 to 32000 to output currents from 0 to 20 mA. The module scales count values from 32001 to 32767 up to a maximum output current of approximately 20.5 mA.



I/O Data: ALG442

This module uses two %AQ references and four %AI references, depending on configuration. Data in the %AI and %AQ registers is in 16–bit 2's complement format.

MSB LSB

X	11	10	9	8	7	6	5	4	3	2	1	0	X	X	X

The module also uses 8, 16 or 24 %I references for status data, depending on the alarm status configuration. Status data format is shown on the next page.

Input Data

Resolution of the converted signal is 12 bits binary (1 part in 4096). The placement of the 12 bits from the A/D converter in the %AI data word is shown above.

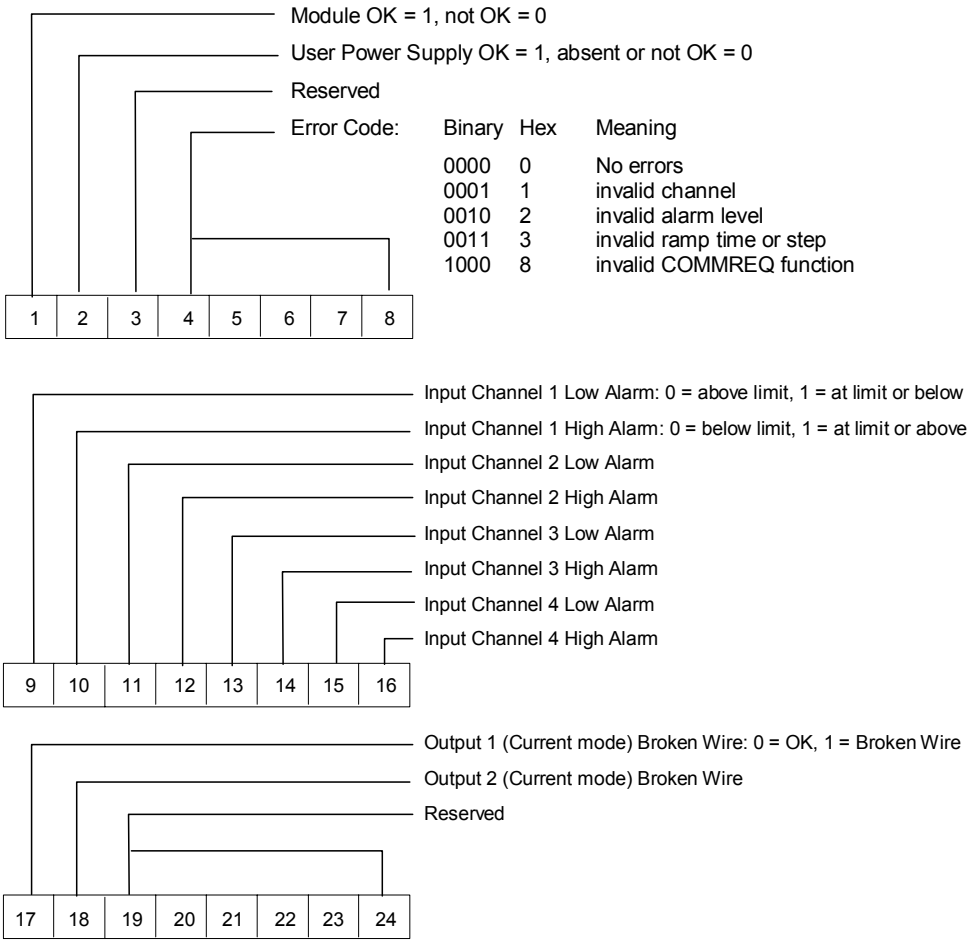
The bits in the %AI data table that were not used are forced to 0 (zero) by the analog input channel.

Output Data

Each output channel is capable of converting 15 to 16 bits (depending on the range selected) of binary data to an analog output.

Status Data: ALG222

Analog Module IC694ALG222 can be configured to return 8, 16, or 32 status bits to the PLC CPU. Content of the status data is shown below.



Error Code

Byte 1 of the status data contains a status/error code for COMMREQs sent to the module. Only the most recent error is reported; an existing error code will be overwritten if another error occurs. The priority of errors is:

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

If multiple errors occur, the one with the highest priority is reported in the error code. The module will not stop standard operation if an error is detected; these error bits are informational only, and can be ignored.

Configuration: ALG442

The following module parameters can be configured using the Machine Edition software:

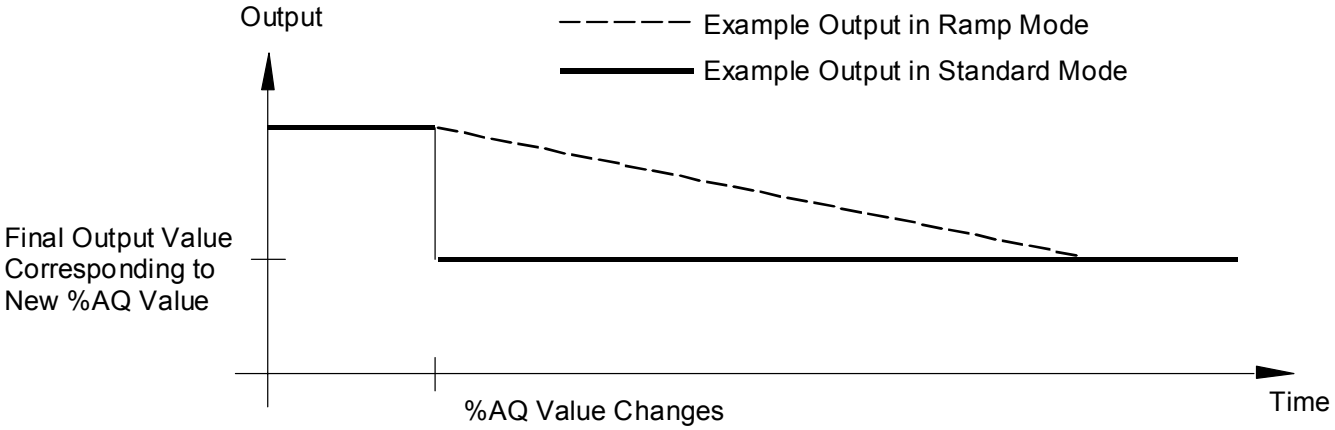
Parameter	Description	Values
Stop Mode	Output state when module goes from Run to Stop mode	Hold or Default Low
Reference Address	Starting %AI address for the module's analog input data	
Reference Address	Starting %AQ address for the module's analog output data	
Reference Address	Starting %I address for the module's status data	
%I Length	Number of %I status bits that will be used for module and channel status data:	8 (module and power status only) 16 (above plus input status) 24 (all above plus output status)
Output Range	Type of output range	0 to +10 V, -10 to +10 V, 4 to 20 mA, 0 to 20 mA
Input Range	Type of input range	0 to +10 V, -10 to +10 V, 4 to 20 mA, 0 to 20 mA, 4 to 20 mA Enhanced
Alarm Low Limit	Low limit alarm value for each input. Must be less than the same channel's high alarm	-32768 to 32759
Alarm High Limit	High limit alarm value for each input	-32767 to 32760

The choice for Stop Mode (Hold or Default Low) determines how outputs operate when the module goes from Run to Stop mode. If the configured Stop Mode is Hold (the default), the module holds outputs at the last state received from the CPU. If the Stop Mode is Default Low, the outputs will go to their low values. In current mode (4-20 mA), outputs go to 4 mA if configured for DEFLOW. In current mode (0-20 mA), outputs go to 0 mA if configured for DEFLOW. In voltage mode (unipolar (0 to +10V) and bipolar (+10V to -10V), outputs go to 0V if configured for DEFLOW.

The Alarm Low and Alarm High parameters can be used to set up limits that cause alarm indications to be passed to the PLC for each channel. Values entered without a sign are assumed to be positive. These configured alarm limits are stored until changed by a new configuration. The configured high and low alarm limits can be changed temporarily by a COMMREQ from the application program as described later in this chapter.

Ramp Mode Operation for ALG442

Outputs on module ALG442 can be set up to operate in Ramp mode. In normal operating mode, a new value entered in an output channel's %AQ reference causes the output to change directly to the new value. In Ramp mode, the output goes to the new value over a period of time. The output channel starts a new ramp (either up or down) each time the value in its %AQ reference changes. The module performs range checking on new output values and automatically adjusts out-of-range values before making the ramp computations.



Use of Ramp mode is set up for either channel or both output channels using a COMMREQ command as explained in this chapter. The ramp slope can be set up in the COMMREQ as:

- a total ramp time from 1 millisecond to 32 seconds, or:
- a sequence of 1 to 32000 1-millisecond steps.

A channel stays in Ramp mode until the module receives a new COMMREQ either changing or canceling the ramp operation, or until power is cycled. The channel will not change modes after a hardware configuration download. Because COMMREQ settings are temporary, it will be lost after a power cycle.

If the module receives a new COMMREQ that changes ramp operation while an output is in the process of ramping, the new ramp settings take effect as follows:

- If Ramp mode is turned off during a ramp, the channel goes directly to the value in its %AQ reference.
- If a channel is set up to ramp over a period of time, but a new COMMREQ is received commanding the channel to instead ramp in a sequence of measured steps, ramp operation changes as soon as the COMMREQ is processed (assuming that the step is valid).
- If a channel is set up to ramp as a sequence of measured steps, but a new COMMREQ is received commanding the channel to instead ramp over a period of time, it immediately starts a new ramp using the present output as the starting output and the present time as the start time.

If the module receives a Ramp command for an invalid channel, step height or ramp time, the module ignores the command and returns an error code in the first byte of its %I status references. The error code can be cleared by a Clear Errors COMMREQ as described in this chapter, or by reconfiguring the module.

Changing Module Operation on Command

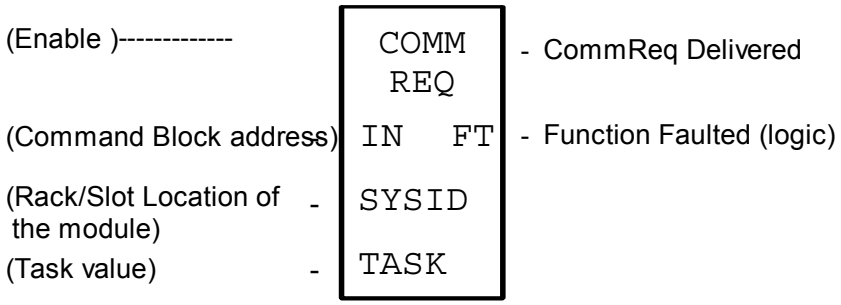
Module ALG442 can respond directly to a specific COMMREQ command from the application program to:

- clear the module's %I error code
- modify the Input alarm limits, and
- put one or both outputs in Ramp mode and set up the ramp characteristics

These changes to module are not retained during loss of power. If the module is power-cycled, new commands must be sent to the module to again modify the configured alarm limits, or to set up Ramp operation for the outputs.

COMMREQ Format

The Communications Request is triggered when the logic program passes power to the COMMREQ Function Block.



When sent to module ALG442, the parameters of the COMMREQ are:

Enable: Control logic for activating the COMMREQ Function Block.

IN: The location of the Command Block. The Command Block contains the parameters of the COMMREQ request. It can be located at any valid address within a word-oriented memory area (%R, %AI, %AQ, %P, %L, or %W) in the PACSystems PLC.

SYSID: A hexadecimal word value that gives the rack (high byte) and slot (low byte) location of the analog module.

TASK: Task must be set to zero.

FT Output: The FT output is set if the PLC CPU is unable to deliver the COMMREQ to the module. When the FT output is set, the module is unable to return a COMMREQ status word to the PLC logic application.

COMMREQ Command Block

The format of the COMMREQ for module ALG442 is shown below. For more information about using COMMREQs, check the online help and the *PACSystems Reference Manual*.

Word Offset	*Value*	*Description*
Word 1	Must be 0004	Length of the command block
Word 2	0000	Not used
Word 3	(See below)	Memory type of COMMREQ Status Word
Word 4	0-based.	Offset of COMMREQ Status Word
Word 5	0	Reserved
Word 6	0	Reserved
Word 7	E201H (-7679 decimal)	COMMREQ command number
Word 8	0006	Byte length of Command Data (see below)
Word 9	(See below)	Memory type in the CPU for the Command Data
Word 10	0-based	Memory offset for the Command data

Memory Types and Offsets

The COMMREQ Command Block specifies a memory type and location to receive status information about the execution of the command (word 3), and for the command data (word 9). The memory types are listed in the table below. ***For word 4 and word 10, the address offset is a zero-based number.*** For example, the offset for %R100 is 99 decimal.

Type	Value (Decimal)	Value (Hex.)	Description
%R	8	08H	Register memory (word mode)
%AI	10	0AH	Analog input memory (word mode)
%AQ	12	0CH	Analog output memory (word mode)
%I	16 70	10H 46H	Discrete input memory (byte mode) Discrete input memory (bit mode)
%Q	18 72	12H 48H	Discrete output memory (byte mode) Discrete output memory (bit mode)
%T	20 74	14H 4AH	Discrete temporary memory (byte mode) Discrete temporary memory (bit mode)
%M	22 76	16H 4CH	Discrete momentary internal memory (byte mode) Discrete momentary internal memory (bit mode)
%G	56 86	38H 56H	Discrete global data table (byte mode) Discrete global data table (bit mode)
%W	196	C4H	Word memory (word mode; limited to %W1-%W65536)

COMMREQ Command Data Format

In the COMMREQ Command Block (above) words 9 and 10 assign a CPU memory location for six bytes of command data. The program logic can use these bytes to set the parameters of the COMMREQ. This module does not use the last command data word.

word 1 command word
word 2 alarm or ramp data
word 3 Unused for module ALG442

Command to be Performed	*Word 1 Contains*	*Word 2 Contains*
Change the specified input's low alarm limit to the value in word 2.	0000 (Input 1) 0001 (Input 2) 0002 (Input 3) 0003 (Input 4)	New low alarm limit for the input
Change the specified input's high alarm limit to the value in word 2.	0010 (Input 1) 0011 (Input 2) 0012 (Input 3) 0013 (Input 4)	New high alarm limit for the input
Change the specified input's low alarm limit by the increment in word 2.	0020 (Input 1) 0021 (Input 2) 0022 (Input 3) 0023 (Input 4)	Increment to change the input's configured low alarm limit. Increment can be + or -.
Change the specified input's high alarm limit by the increment in word 2.	0030 (Input 1) 0031 (Input 2) 0032 (Input 3) 0033 (Input 4)	Increment to change the input's high alarm limit. Increment can be + or -.
Turn off Ramp operation for the specified output channel and put it in normal mode.	0040 (Output 1) 0041 (Output 2)	--
Put the specified output channel in Ramp step mode. Step increment in word 2.	0050 (Output 1) 0051 (Output 2)	Step (1 to 32000 counts) to be taken each millisecond.
Put the specified output channel in Ramp time mode. Ramp total time in word 2.	0060 (Output 1) 0061 (Output 2)	Time in milliseconds: 1 to 32000 (1 ms to 32 seconds)
Clear the module's %I error code	00C0	--

If the requested command is not valid (for example, if the changed alarm limit would be out of range) the module ignores the COMMREQ command and returns an error code in the module's %I status data. The module does NOT stop operating; these error bits are informational only and can be ignored. The error code remains in the %I status bits until cleared by another COMMREQ (command 00C0, see directly above), or until the module is reconfigured.

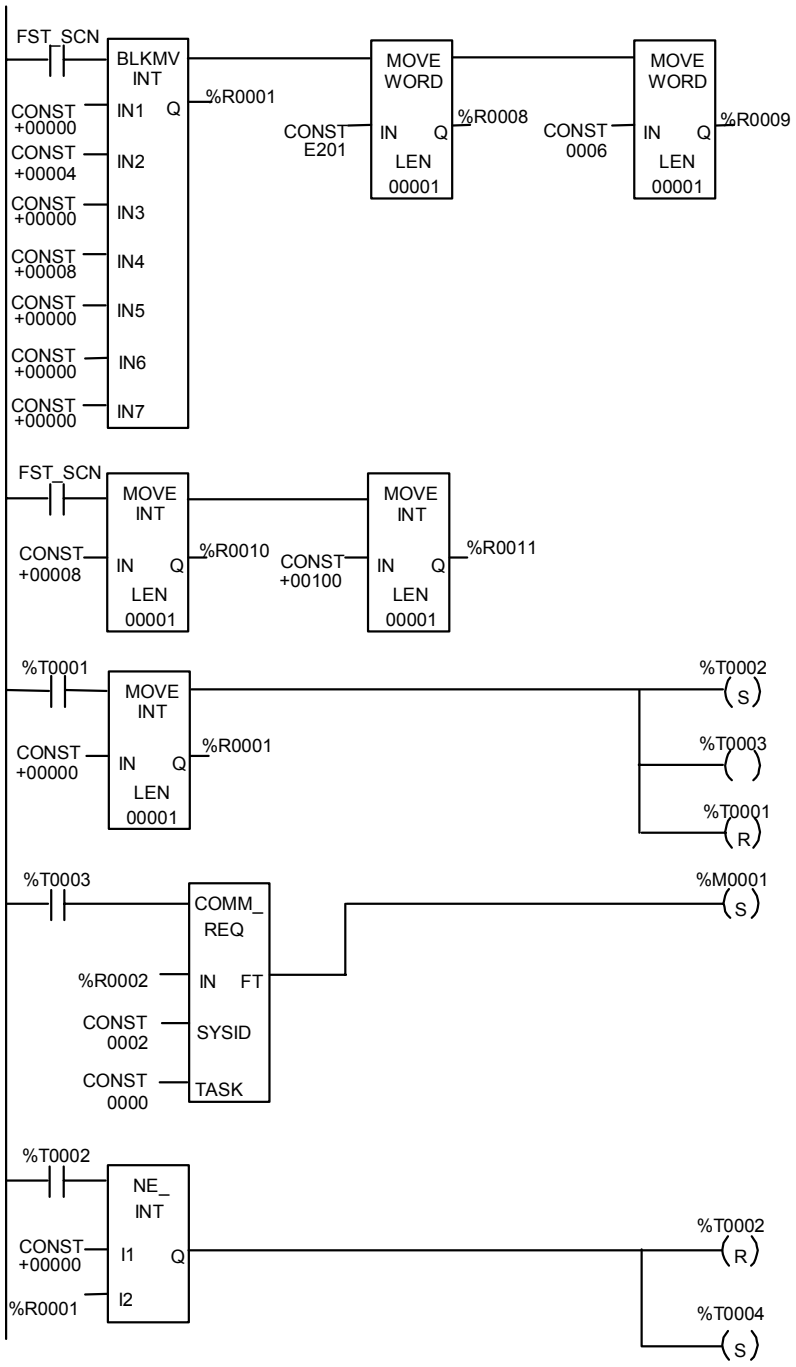
COMMREQ Example

This example shows setting up COMMREQ data and issuing the COMMREQ to an Analog Mixed module.

The application program should verify the completion of the COMMREQ in progress before initiating another, so the module does not receive COMMREQs faster than it can process them. One way to do that 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 indicates that the COMMREQ has completed.

In this example, the COMMREQ command block starts at %R0002 and is initialized on the first scan. The 6 bytes of COMMREQ data sent to the module must have been 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.