

Compact I/O Analog Output Module



Catalog Number 1769-OF4

User Manual



Important User Information

Solid state equipment has operational characteristics differing from those of electromechanical equipment. Safety Guidelines for the Application, Installation and Maintenance of Solid State Controls (publication [SGI-1.1](#) available from your local Rockwell Automation sales office or online at <http://www.rockwellautomation.com/literature/>) describes some important differences between solid state equipment and hard-wired electromechanical devices. Because of this difference, and also because of the wide variety of uses for solid state equipment, all persons responsible for applying this equipment must satisfy themselves that each intended application of this equipment is acceptable.

In no event will Rockwell Automation, Inc. be responsible or liable for indirect or consequential damages resulting from the use or application of this equipment.

The examples and diagrams in this manual are included solely for illustrative purposes. Because of the many variables and requirements associated with any particular installation, Rockwell Automation, Inc. cannot assume responsibility or liability for actual use based on the examples and diagrams.

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Throughout this manual, when necessary, we use notes to make you aware of safety considerations.

WARNING



Identifies information about practices or circumstances that can cause an explosion in a hazardous environment, which may lead to personal injury or death, property damage, or economic loss.

IMPORTANT

Identifies information that is critical for successful application and understanding of the product.

ATTENTION



Identifies information about practices or circumstances that can lead to personal injury or death, property damage, or economic loss. Attentions help you identify a hazard, avoid a hazard, and recognize the consequence

SHOCK HAZARD



Labels may be on or inside the equipment, for example, a drive or motor, to alert people that dangerous voltage may be present.

BURN HAZARD



Labels may be on or inside the equipment, for example, a drive or motor, to alert people that surfaces may reach dangerous temperatures.

	Preface	
	Introduction	7
	About This Publication	7
	Who Should Use This Publication	7
	Additional Resources.	8
	Chapter 1	
Overview	Introduction	9
	Module Description.	9
	System Overview	11
	Module Operation.	11
	Chapter 2	
Installation and Wiring	Introduction	13
	General Considerations	13
	Hazardous Location Considerations	14
	Preventing Electrostatic Discharge	14
	Removing Power	15
	Reduce Noise	15
	Protect the Circuit Board from Contamination	15
	Assemble the Compact I/O System	16
	Mounting the Module	17
	Minimum Spacing	17
	Mount to a Panel.	18
	Mount to a DIN Rail.	19
	Replace a Single Module Within a System	19
	Grounding the Module	20
	System Wiring Guidelines	21
	Effect of Transducer/Sensor and Cable Length Impedance on Voltage Output Accuracy.	22
	Label the Terminals.	23
	Remove the Finger-safe Terminal Block	23
	Wire the Finger-safe Terminal Block	24
	Wire Size and Terminal Screw Torque	25
	Wire the Modules	25
	Chapter 3	
Module Data, Status, and Channel Configuration	Introduction	29
	Module Addressing	29
	Input Image.	30
	Output Image	30
	Configuration File	30
	Input Data File	31
	General Status Bits (S0...S3).	31
	Over-range (high clamp) Status Bits (O0...O3)	31

Under-range (low clamp) Status Bits (U0...U3)	32
Output Data File	32
Cancel Clamp Alarm Latch Control Bits (CLO0...CLO3 and CHO0...CHO3)	32
Configuration Data File	33
Channel Configuration	34
Enable/Disable Channel (EC)	35
Program Mode (PM)	35
Program Value	35
Fault Mode (FM)	36
Fault Value	36
Program to Fault Enable (PFE)	36
Clamping (limiting)	37
Clamp High and Clamp Low Data Values	37
Output Ramping	38
Type/Range Selection	40
Data Format Selection	40

Chapter 4

**Module Diagnostics and
Troubleshooting**

Introduction	43
Safety Considerations	43
Power Status Indicator	43
Activate Devices When Troubleshooting	44
Stand Clear of the Machine	44
Program Alteration	44
Safety Circuits	44
Power Cycle Diagnostics	45
Channel Diagnostics	45
Output Clamp Detection	45
Non-critical versus Critical Module Errors	45
Module Error Definition Table	46
Module Error Field	46
Extended Error Information Field	46
Error Codes	47
Invalid Output Range Selected	48
Invalid Output Format Selected	48
Invalid Fault Value Selected	49
Invalid Program/Idle Value Selected ⁽¹⁾	49
Invalid Clamp Value Selected	49
Invalid Ramp Rate Selected ⁽¹⁾	49
Module Inhibit Function	50
Contacting Rockwell Automation	50

Specifications	Appendix A	
	Introduction	51
	General Specifications – 1769-OF4.	51
	Output Specifications – 1769-OF4	52
	Certifications – 1769-OF4.	53
	Replacement Parts.	53
Module Addressing and Configuration with MicroLogix 1500 Controller	Appendix B	
	Introduction	55
	Module Input Image	55
	Module Output Image	56
	Module Configuration File.	56
	Configure Analog I/O Modules in a MicroLogix 1500 System	57
Configuration Using the RSLogix 5000 Generic Profile for CompactLogix Controllers	Appendix C	
	Introduction	61
	Add the Module to Your Project	61
	Configure Each I/O Module.	64
Two’s Complement Binary Numbers	Appendix D	
	Positive Decimal Values	65
	Negative Decimal Values.	66
	Glossary	
	Index	

Introduction

Read this preface to familiarize yourself with the rest of the manual.

Topic	Page
About This Publication	7
Who Should Use This Publication	7
Additional Resources	8

About This Publication

This manual is a guide for using the Compact I/O Analog Output Module, catalog number 1769-OF4. It describes the procedures you use to configure, operate, and troubleshoot your module.

For detailed information on related topics like programming your CompactLogix or MicroLogix controller, or DeviceNet adapter, or for information on CompactLogix components, see the list of [Additional Resources on page 8](#).

Who Should Use This Publication

Use this manual if you are responsible for designing, installing, programming, or troubleshooting control systems that use Compact I/O modules.

Additional Resources

These documents contain additional information about control systems that use Compact I/O modules.

Resource	Description
MicroLogix 1500 User Manual, publication 1764-UM001	A user manual containing information on how to install, use, and program your MicroLogix 1500 controller.
DeviceNet Adapter User Manual, publication 1769-UM001	A user manual containing information on how to install and use your 1769-ADN DeviceNet adapter.
CompactLogix System User Manual, publication 1769-UM007	A user manual containing information on how to install, use, and program your 1769-L20 and 1769-L30 CompactLogix controllers.
CompactLogix Controllers User Manual, publication 1769-UM011	A user manual containing information on how to install, use, and program your 1769-L31, 1769-L32C, 1769-L32E, 1769-L35CR, and 1769-L35E CompactLogix controllers.
Compact I/O Selection Guide, publication 1769-SG002	An overview of 1769 Compact I/O modules.
MicroLogix Programmable Controllers Selection Guide, publication 1761-SG001	An overview of the MicroLogix 1500 system, including the 1769 Compact I/O system.
Industrial Automation Wiring and Grounding Guidelines, publication 1770-4.1	In-depth information on grounding and wiring Allen-Bradley programmable controllers.

You can view or download publications at <http://literature.rockwellautomation.com>. To order paper copies of technical documentation, contact your local Rockwell Automation distributor or sales representative.

Overview

Introduction

Topic	Page
Module Description	9
System Overview	11
Module Operation	11

Module Description

The module converts digital data from controllers to provide analog output data. The module provides the following output types and ranges.

Normal and Full Ranges

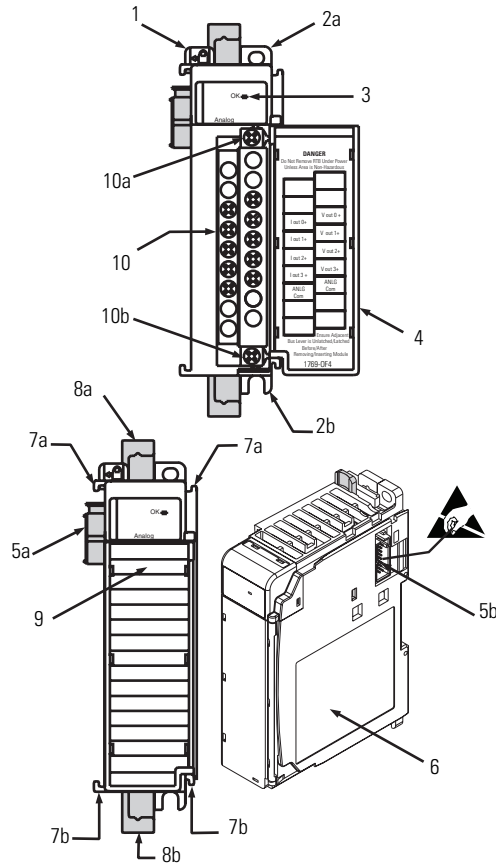
Signal Type	Normal Operating Input Range	Full Module Range
Voltage	$\pm 10\text{V DC}$	$\pm 10.5\text{V DC}$
	$1 \dots 5\text{V DC}$	$0.5 \dots 5.25\text{V DC}$
	$0 \dots 5\text{V DC}$	$-0.5 \dots 5.25\text{V DC}$
	$0 \dots 10\text{V DC}$	$-0.5 \dots 10.5\text{V DC}$
Current	$0 \dots 20\text{ mA}$	$0 \dots 21\text{ mA}$
	$4 \dots 20\text{ mA}$	$3.2 \dots 21\text{ mA}$

The data can be configured as:

- engineering units.
- scaled-for-PID.
- percent range.
- raw/proportional data.

Module configuration is normally done via the controller's programming software. In addition, some controllers support configuration via the user program. In either case, the module configuration is stored in the memory of the controller. Refer to your controller's user manual for more information.

Hardware Features



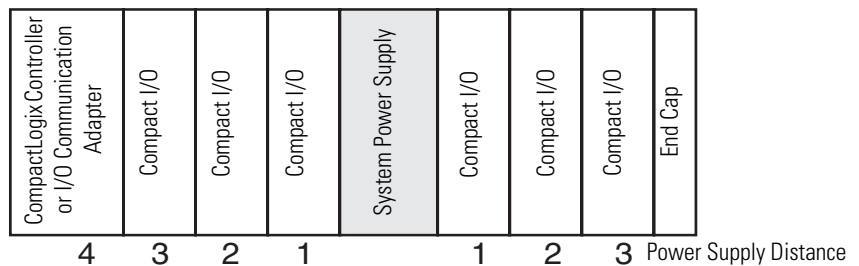
Item	Description
1	Bus lever (with locking function)
2a	Upper-panel mounting tab
2b	Lower-panel mounting tab
3	Module status indicators
4	Module door with terminal identification label
5a	Movable bus connector with female pins
5b	Stationary bus connector with male pins
6	Nameplate label
7a	Upper tongue-and-groove slots
7b	Lower tongue-and-groove slots
8a	Upper DIN-rail latch
8b	Lower DIN-rail latch
9	Write-on label for user identification tags
10	Removable terminal block (RTB) with finger-safe cover
10a	RTB retaining screw
10b	RTB retaining screw

System Overview

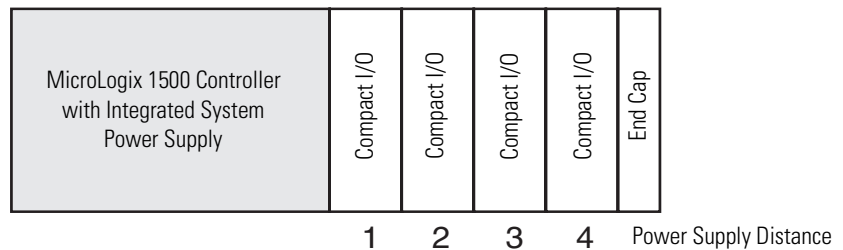
The module communicates to the controller through the bus interface. The module also receives 5 and 24V DC power through the bus interface.

You can install as many analog modules as your power supply can support. However, the modules may not be located more than eight modules away from the system power supply.

Determine Power Supply Distance



or



Module Operation

When you cycle power, the module performs a check of its internal circuits, memory, and basic functions. During this time, the module-status OK indicator remains off. If no faults are found during power-cycle diagnostics, the module-status OK indicator is turned on.

After power-cycle checks are complete, the module waits for valid channel-configuration data. If an invalid configuration is detected, the module generates a configuration error. Once a channel is properly configured and enabled, the module begins its conversion process.

Each time a new output value is sent to the module, it is tested against user-configured high and low output clamps for each output channel. If output values equal to or exceeding either of these clamp levels are detected, the value sent to the module is clamped at that limit by the module, and unique bits are set in the output-channel status word.

The channel status words are described in the [Input Data File on page 31](#).

The controller uses two's complement binary data when communicating with the module. This typically occurs at the end of the program scan or when commanded by the control program. If the controller and the module determine that the bus data transfer was made without error, the input data is used in your control program and the output data is used by the module.

No field calibration is required.

Installation and Wiring

Introduction

Topic	Page
General Considerations	13
Assemble the Compact I/O System	16
Mounting the Module	17
Replace a Single Module Within a System	19
Grounding the Module	20
System Wiring Guidelines	21
Label the Terminals	23
Remove the Finger-safe Terminal Block	23
Wire the Finger-safe Terminal Block	24
Wire the Modules	25

General Considerations

The Compact I/O system is suitable for use in an industrial environment when installed in accordance with these instructions. Specifically, this equipment is intended for use in clean, dry environments (Pollution degree 2⁽¹⁾) and to circuits not exceeding Over Voltage Category II⁽²⁾ (IEC 60664-1).⁽³⁾

- (1) Pollution Degree 2 is an environment where, normally, only non-conductive pollution occurs except that occasionally a temporary conductivity caused by condensation shall be expected.
- (2) Over Voltage Category II is the load level section of the electrical distribution system. At this level, transient voltages are controlled and do not exceed the impulse voltage capability of the product's insulation.
- (3) Pollution Degree 2 and Over Voltage Category II are International Electrotechnical Commission (IEC) designations.

Hazardous Location Considerations

This equipment is suitable for use in Class I, Division 2, Groups A, B, C, D or nonhazardous locations only. The following attention statement applies to use in hazardous locations.

ATTENTION**EXPLOSION HAZARD**

- Substitution of components may impair suitability for Class I, Division 2.
 - Do not replace components or disconnect equipment unless power has been switched off or the area is known to be nonhazardous.
 - Do not connect or disconnect components unless power has been switched off or the area is known to be nonhazardous.
 - This product must be installed in an enclosure.
 - All wiring must comply with N.E.C. article 501-4(b).
-

Preventing Electrostatic Discharge

ATTENTION

Electrostatic discharge can damage integrated circuits or semiconductors if you touch analog I/O module bus-connector pins or the terminal block on the module. Follow these guidelines when you handle the module:

- Touch a grounded object to discharge static potential.
 - Wear an approved wrist-strap grounding device.
 - Do not touch the bus connector or connector pins.
 - Do not touch circuit components inside the module.
 - Use a static-safe work station, if available.
 - Keep the module in its static-shield box, when it is not in use.
-

Removing Power

ATTENTION

Remove power before removing or inserting this module. When you remove or insert a module with power applied, an electrical arc may occur. An electrical arc can cause personal injury or property damage by:

- sending an erroneous signal to your system's field devices, causing unintended machine motion.
- causing an explosion in a hazardous environment.

Electrical arcing causes excessive wear to contacts on both the module and its mating connector and may lead to premature failure.

Reduce Noise

Most applications require installation in an industrial enclosure to reduce the effects of electrical interference. Analog outputs are highly susceptible to electrical noise. Electrical noise coupled to the analog outputs reduces the performance (accuracy) of the module.

Group your modules to minimize adverse effects from radiated electrical noise and heat. Consider the following conditions when selecting a location for the analog module. Position the module:

- away from sources of electrical noise such as hard-contact switches, relays, and AC motor drives.
- away from modules that generate significant radiated heat, such as the 1769-IA16 module. Refer to the module's heat dissipation specification.

In addition, route shielded, twisted-pair analog wiring away from any high-voltage I/O wiring.

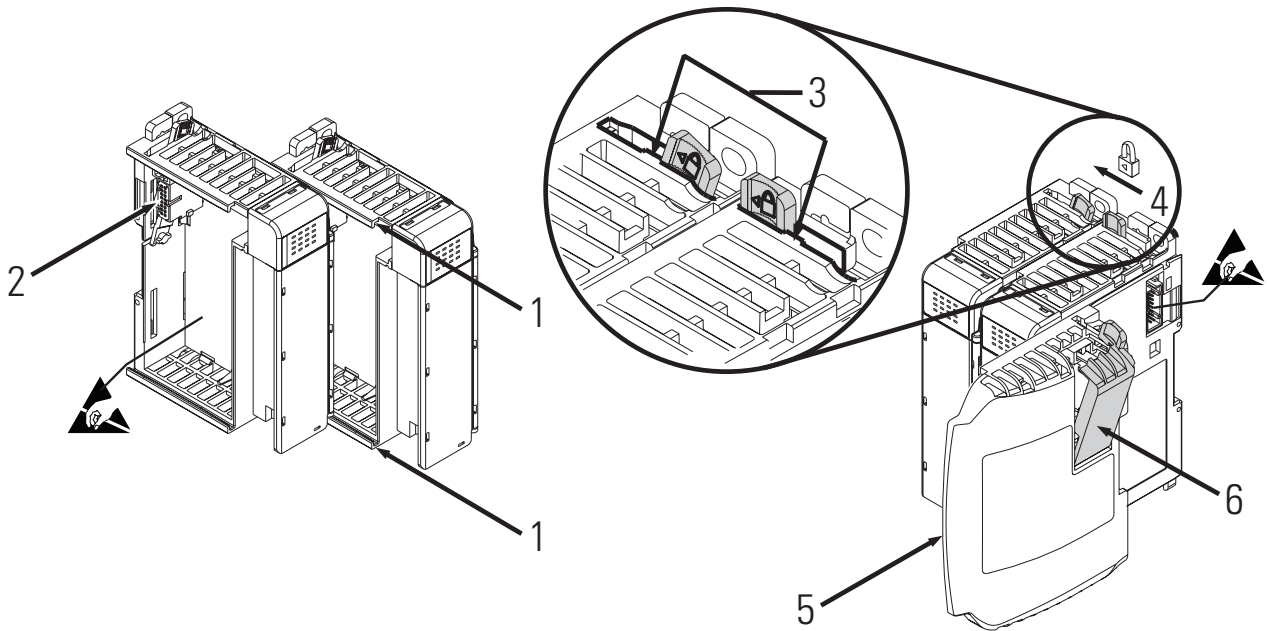
Protect the Circuit Board from Contamination

Protect the board from dirt, oil, moisture, and other airborne contaminants by installing the system in an enclosure suitable for the environment. Keep the interior of the enclosure clean and the enclosure door closed whenever possible.

Assemble the Compact I/O System

The module can be attached to the controller or an adjacent I/O module **before** or **after** mounting.

For mounting instructions, see [Panel Mounting By Using the Dimensional Template on page 18](#), or [Mount to a DIN Rail on page 19](#). To work with a system that is already mounted, see [Replace a Single Module Within a System on page 19](#).



1. Disconnect power.
2. Check that the bus lever of the module to be installed is in the unlocked (fully right) position.
3. Use the upper and lower tongue-and-groove slots (1) to secure the modules together (or to a controller).
4. Move the module back along the tongue-and-groove slots until the bus connectors (2) line up with each other.
5. Use your fingers or a small screwdriver to push the bus lever back slightly to clear the positioning tab (3).

6. To allow communication between the controller and module, move the bus lever fully to the left (4) until it clicks.

Make sure it is locked firmly in place.

ATTENTION


When attaching I/O modules, it is very important that the bus connectors are securely locked together to be sure of proper electrical connection.

7. Attach an end cap terminator (5) to the last module in the system by using the tongue-and-groove slots as before.
8. Lock the end cap bus terminator (6).

IMPORTANT

A 1769-ECR or 1769-ECL right or left end cap must be used to terminate the end of the bus.

Mounting the Module

Modules may be mounted to a panel or to a DIN rail.

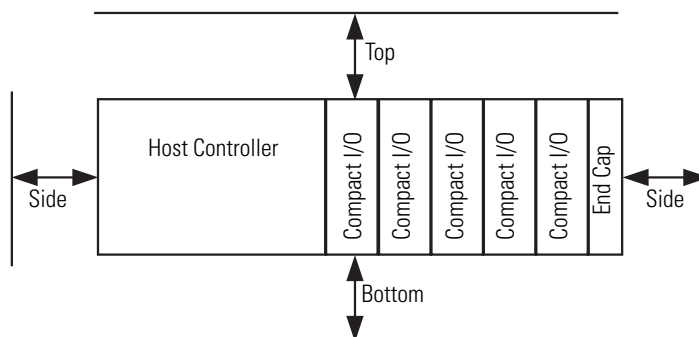
ATTENTION


During panel or DIN rail mounting of all devices, be sure that all debris (that is, metal chips or wire strands) is kept from falling into the module. Debris that falls into the module could cause damage when you cycle power.

Minimum Spacing

Maintain spacing from enclosure walls, wireways, or adjacent equipment. Allow 50 mm (2 in.) of space on all sides for adequate ventilation.

Space Requirements

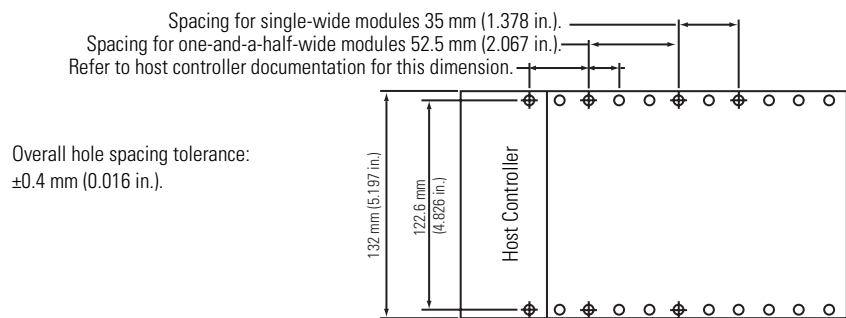


Mount to a Panel

Mount the module to a panel by using two screws per module. Use M4 or #8 panhead screws. Mounting screws are required on every module.

Panel Mounting By Using the Dimensional Template

Locate holes every 17.5 mm (0.689 in.) to allow for a mix of single-wide and one-and-a-half-wide modules (for example, the 1769-OA16 module).



Panel Mounting By Using the Modules as a Template

This procedure lets you use the assembled modules as a template for drilling holes in the panel. If you have sophisticated panel-mounting equipment, you can use the dimensional template provided. Due to module mounting-hole tolerance, it is important to follow these procedures.

1. On a clean work surface, assemble no more than three modules.
2. Using the assembled modules as a template, carefully mark the center of all module-mounting holes on the panel.
3. Return the assembled modules to the clean work surface, including any previously mounted modules.
4. Drill and tap the mounting holes for the recommended M4 or #8 screw.
5. Place the modules back on the panel, and check for proper hole alignment.

6. Attach the modules to the panel by using the mounting screws.

TIP

If mounting more modules, mount only the last one of this group and put the others aside. This reduces remounting time during drilling and tapping of the next group.

7. Repeat steps 1...6 for any remaining modules.

Mount to a DIN Rail

The module can be mounted by using the following DIN rails:

- 35 x 7.5 mm (EN 50 022 - 35 x 7.5)
- 35 x 15 mm (EN 50 022 - 35 x 15)

Before mounting the module on a DIN rail, close the DIN rail latches. Press the DIN-rail mounting area of the module against the DIN rail. The latches will momentarily open and lock into place.

Replace a Single Module Within a System

The module can be replaced while the system is mounted to a panel (or DIN rail). Follow these steps in order.

1. Remove power.

ATTENTION

Remove power before removing or inserting this module. When you remove or insert a module with power applied, an electrical arc may occur. An electrical arc can cause personal injury or property damage by:

- sending an erroneous signal to your system's field devices, causing unintended machine motion.
- causing an explosion in a hazardous environment.

Electrical arcing causes excessive wear to contacts on both the module and its mating connector and may lead to premature failure.

2. On the module to be removed, remove the upper and lower mounting screws from the module or open the DIN latches by using a screwdriver.
3. Move the bus lever to the right to disconnect (unlock) the bus.

4. On the right-side adjacent module, move its bus lever to the right (unlock) to disconnect it from the module to be removed.
5. Gently slide the disconnected module forward.

If you feel excessive resistance, check that the module has been disconnected from the bus, and that both mounting screws have been removed or DIN latches opened.

TIP

It may be necessary to rock the module slightly from front to back to remove it, or, in a panel-mounted system, to loosen the screws of adjacent modules.

6. Before installing the replacement module, be sure that the bus lever on the module to be installed and on the right-side adjacent module are in the unlocked (fully right) position.
7. Slide the replacement module into the open slot.
8. Connect the modules together by locking (fully left) the bus levers on the replacement module and the right-side adjacent module.
9. Replace the mounting screws or snap the module onto the DIN rail.

Grounding the Module

This product is intended to be mounted to a well-grounded mounting surface, such as a metal panel. Additional grounding connections from the module's mounting tabs or DIN rail (if used) are not required unless the mounting surface cannot be grounded. Refer to Industrial Automation Wiring and Grounding Guidelines, publication [1770-4.1](#), for additional information.

System Wiring Guidelines

Consider the following when wiring your system:

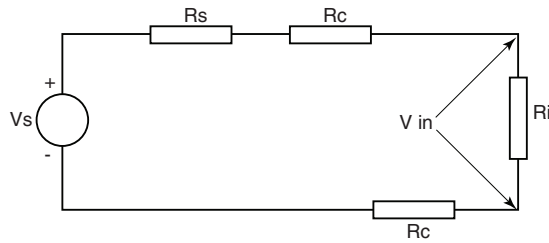
- All module commons (ANLG Com) are connected in the analog module.
- The analog common (ANLG Com) is not connected to earth ground inside the module.
- Channels are not isolated from each other.
- For optimum accuracy, limit overall cable impedance by keeping your cable as short as possible. Locate the I/O system as close to your sensors or actuators as your application will permit.
- Use Belden 8761, or equivalent, shielded wire.
- Under normal conditions, the drain wire and shield junction must be connected to earth ground via a panel or DIN-rail mounting screw at the analog I/O module end.⁽¹⁾
- Keep shield connection to ground as short as possible.
- Voltage outputs (Vout 0+...Vout 3+) of the 1769-OF4 module are referenced to ANLG Com. Load resistance for a voltage output channel must be equal to or greater than 1 k Ω .
- Current outputs (Iout 0+...Iout 3+) of the 1769-OF4 module source current that returns to ANLG Com. Load resistance for a current output channel must remain between 0 and 600 Ω .

(1) In environments where high-frequency noise may be present, it may be necessary to directly ground cable shields to earth at the module end and via a 0.01 μ F, 2000V capacitor at the sensor end.

Effect of Transducer/Sensor and Cable Length Impedance on Voltage Output Accuracy

For voltage outputs, the length of the cable used between the load and the module can affect the accuracy of the data provided by the module.

Voltage Output Accuracy



Where:

R_c = DC resistance of the cable (each conductor) depending on cable length

R_s = Source impedance (1 Ω)

R_i = Impedance of the voltage input

V_s = Voltage at the output of 1769-OF4 module

V_{in} = Measured potential at the module input

% A_i = Percent added inaccuracy in a voltage-based system due to source and cable impedance

$$V_{in} = \frac{[R_i \times V_s]}{[R_s + (2 \times R_c) + R_i]}$$

For example, for Belden 8761 two conductor, shielded cable and a 1769-IF4 input module as the load:

R_c = 52.5 Ω /1000 m

R_s = 1 Ω

R_i = 220 K Ω

$$\%A_i = \left(1 - \frac{V_{in}}{V_s}\right) \times 100$$

Effect of Output Impedance and Cable Length on Accuracy

Length of Cable	DC Resistance of the Cable R_c	Accuracy Impact at the Load
50 m (164 ft)	2.625 Ω	0.00284%
100 m (328 ft)	5.25 Ω	0.00523%
200 m (656 ft)	10.50 Ω	0.01%
300 m (984 ft)	15.75 Ω	0.01477%

As output impedance (R_s) and/or resistance (DC) of the cable (R_c) get larger, system accuracy decreases. If you determine that the inaccuracy error is significant, implementing the following equation in the control program can compensate for the added inaccuracy error due to the impedance of the module's voltage outputs and cable.

$$V_s = V_{in} \times \frac{[R_s + (2 \times R_c) + R_i]}{R_i}$$

TIP

For current outputs, source and cable impedance do not impact system accuracy as long as the total resistance of the cable and input impedance of the load remain within the specified maximum limits for the module's current outputs.

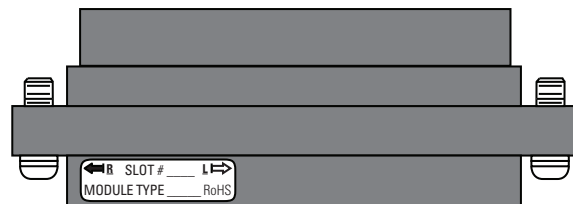
Label the Terminals

A removable, write-on label is provided with the module. Remove the label from the door, mark the identification of each terminal with permanent ink, and slide the label back into the door. Your markings (ID tag) will be visible when the module door is closed.

Remove the Finger-safe Terminal Block

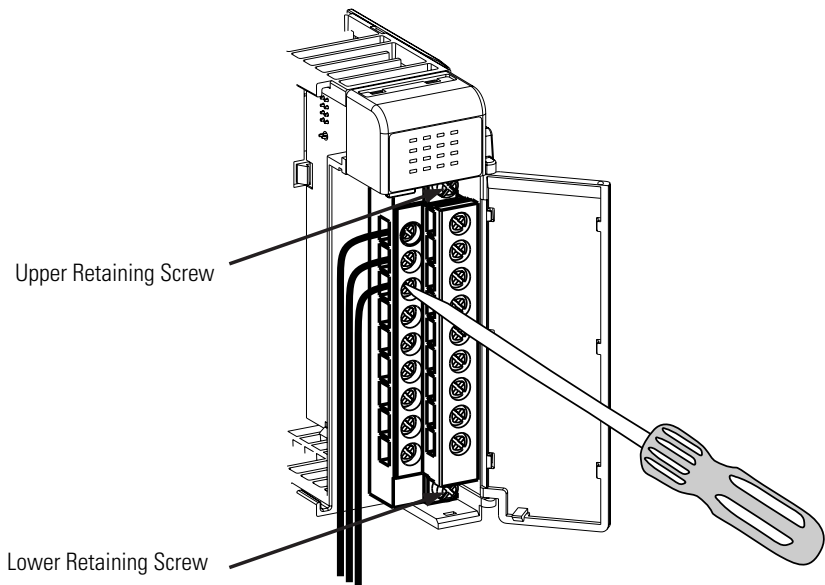
When wiring field devices to the module, it is not necessary to remove the terminal block. If you remove the terminal block, use the write-on label on the side of the terminal block to identify the module slot location and type. RTB position (for one-and-a-half size modules) can be indicated by circling either the R for right side or L for left side.

Finger-safe Terminal Block



To remove the terminal block, loosen the upper and lower retaining screws. The terminal block will back away from the module as you remove the screws. When replacing the terminal block, torque the retaining screws to 0.46 N•m (4.1 lb•in).

Wire the Finger-safe Terminal Block



When wiring the terminal block, keep the finger-safe cover in place.

1. Loosen the terminal screws to be wired.
2. Begin wiring at the bottom of the terminal block and move up.
3. Route the wire under the terminal pressure plate.

You can use the bare wire or a spade lug. The terminals accept a 6.35 mm (0.25 in.) spade lug.

TIP

The terminal screws are non-captive. Therefore, it is possible to use a ring lug (maximum 1/4 in. o.d. with a 0.139 in. minimum i.d. (M3.5)) with the module.

4. Tighten the terminal screw making sure the pressure plate secures the wire.

Recommended torque when tightening terminal screws is 0.68 N•m (6 lb•in).

TIP

If you need to remove the finger-safe cover, insert a screwdriver into one of the square, wiring holes and gently pry the cover off. If you wire the terminal block with the finger-safe cover removed, you will not be able to put it back on the terminal block because the wires will be in the way.

Wire Size and Terminal Screw Torque

Each terminal accepts up to two wires.

Wire Type		Wire Size	Terminal Screw Torque	Retaining Screw Torque
Solid	Cu-90 °C (194 °F)	0.325...2.080 mm ² (22...14 AWG)	0.68 N•m (6 lb•in)	0.46 N•m (4.1 lb•in)
Stranded	Cu-90 °C (194 °F)	0.325...1.310 mm ² (22...16 AWG)	0.68 N•m (6 lb•in)	0.46 N•m (4.1 lb•in)

Wire the Modules

ATTENTION



To prevent shock hazard, care should be taken when wiring the module to analog signal loads. Before wiring any analog module, disconnect power from the system power supply and from any other load to the analog module.

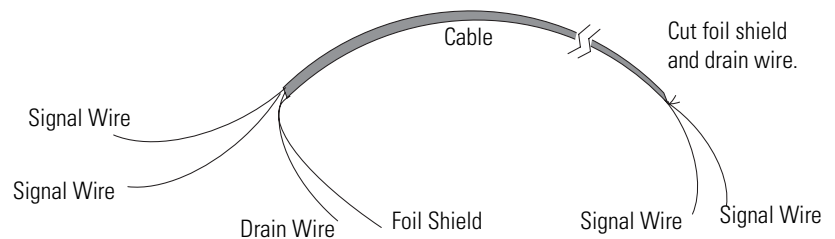
After the analog module is properly installed, follow the wiring procedure below. For proper operation and high immunity to electrical noise, always use Belden 8761 (shielded, twisted-pair) or equivalent wire.

ATTENTION



Never connect a voltage or current source to an analog output channel.

Belden 8761 Wire



To wire your module, follow these steps.

1. At each end of the cable, strip some casing to expose the individual wires.
2. Trim the signal wires to 51 mm (2 in.) lengths.

- Strip about 5 mm (3/16 in.) of insulation away to expose the end of the wire.

ATTENTION



Be careful when stripping wires. Wire fragments that fall into a module could cause damage when you cycle power.

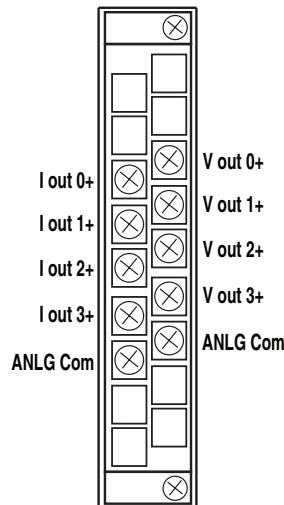
- At one end of the cable, twist the drain wire and foil shield together.

Under normal conditions, this drain wire and shield junction must be connected to earth ground, via a panel or DIN rail mounting screw at the analog I/O module end. Keep the length of the drain wire as short as possible.

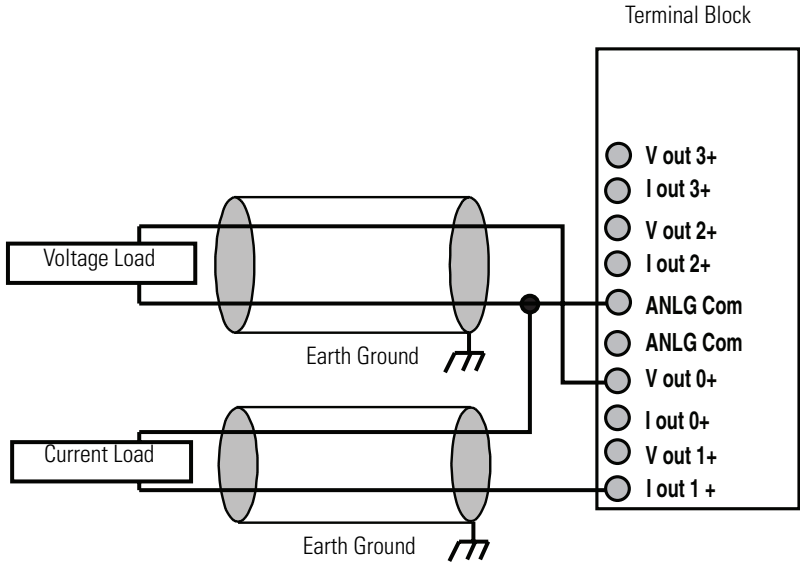
In environments where high frequency noise may be present, it may be necessary to also ground the cable shields to earth via a 0.1 μ F capacitor at the sensor end.

- At the other end of the cable, cut the drain wire and foil shield back to the cable, unless the sensor end of the cable requires the shields to be connected to earth ground via the capacitor described in step 4.
- Connect the signal wires to the terminal block.
- Connect the other end of the cable to the analog output device.
- Repeat steps 1...6 for each channel on the module.

Terminal Layout



Wiring Analog Outputs



ATTENTION



Analog outputs may fluctuate for less than a second when power is applied or removed. This characteristic is common to most analog outputs. While the majority of loads will not recognize this short signal, take preventative measures to make sure that connected equipment is not affected. Failure to take these preventative measures may result in unexpected load reactions.

Notes:

Module Data, Status, and Channel Configuration

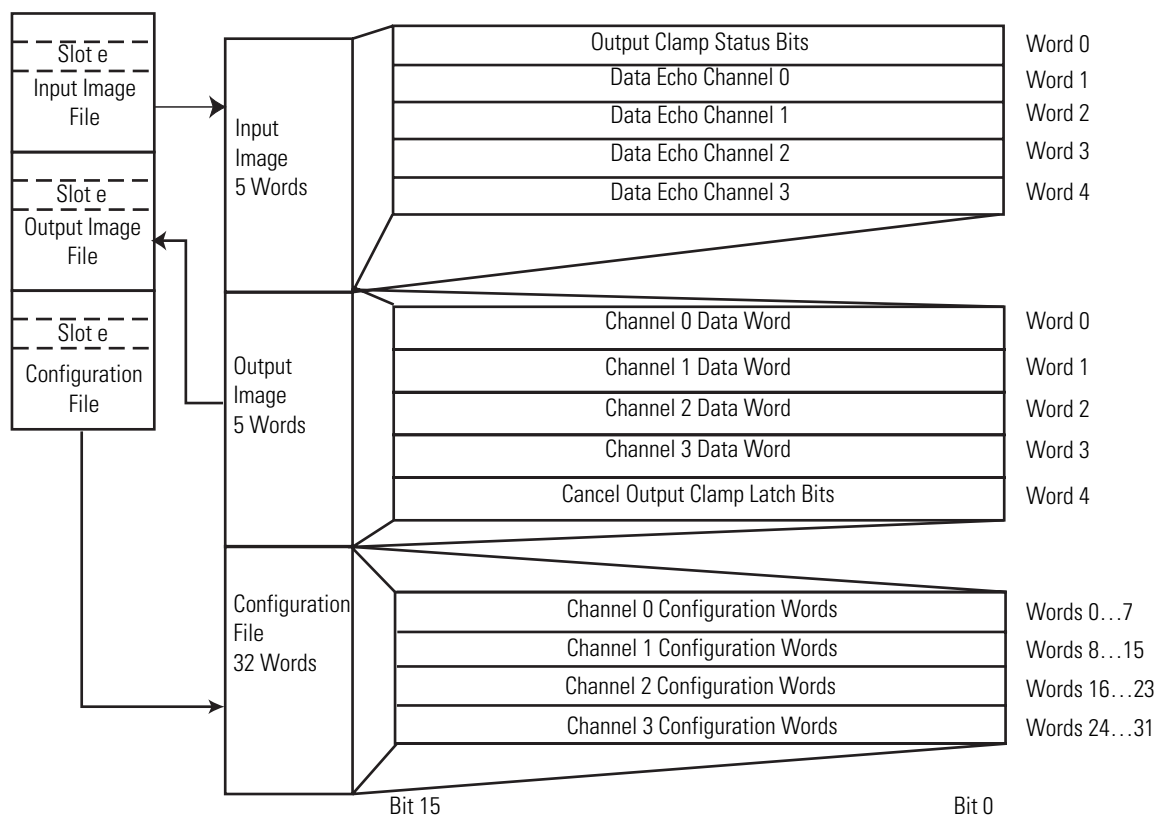
Introduction

Topic	Page
Module Addressing	29
Input Data File	31
Output Data File	32
Configuration Data File	33
Channel Configuration	34

Module Addressing

This memory map shows the output, input, and configuration tables for the module.

Memory Map



Input Image

The input image file represents data words and status bits.

Word 0 holds the general status bits for each output channel as well as the over-range and under-range output-clamp status bits. To receive valid status information, the output channel must be enabled. Words 1..4 contain the data echo values for the most recent data sent to the output channels.

Output Image

Output words 0..3 contain the digital data to be converted by outputs 0..3 into analog output signals. Word 4 contains the cancel clamp alarm latched status control bits for the high and low output-clamp statuses on each output channel. These bits are used to cancel output-clamp statuses when the clamp statuses are latched.

Configuration File

The configuration file contains information that you use to define the way a specific channel functions.

The manipulation of bits from this file is normally done with programming software (for example, RSLogix 5000, RSLogix 500, or RSNetWorx for DeviceNet software) during initial configuration of the system. In that case, graphical screens provided by the programming software simplify configuration.

Some systems, like the 1769-ADN DeviceNet adapter system, also allow the bits to be altered as part of the control program by using communication rungs. In that case, it is necessary to understand the bit arrangement.

TIP

Not all controllers support program access to the configuration file. Refer to your controller's user manual.

Input Data File

The input data file lets you access analog module read data for use in the control program, via word and bit access. The data table structure is shown in the table below. For each output module, slot x , word 0 contains the output-channel status bits. Words 1...4 in the input data file contain the output channel data echo values. The most significant bit (MSB) is the sign bit, which is in two's complement format. 'Nu' indicates not used with the bit set to zero.

Input Data Array

Word/Bit	15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
Word 0	U3	03	U2	02	U1	01	U0	00	NU	NU	NU	NU	S3	S2	S1	S0
Word 1	SGN	Output Data Loopback/Echo Channel 0														
Word 2	SGN	Output Data Loopback/Echo Channel 1														
Word 3	SGN	Output Data Loopback/Echo Channel 2														
Word 4	SGN	Output Data Loopback/Echo Channel 3														

General Status Bits (S0...S3)

Word 0, bits 0...3 contain the general operational status bits for output channels 0...3. When set (1), these bits indicate an output-clamp range error associated with that channel. The over- and under-range bits are logically ORed to the appropriate general status bit.

Over-range (high clamp) Status Bits (00...03)

Over-range (high clamp) status bits for output channels 0...3 are contained in Word 0, bits 8, 10, 12, and 14. When set (1), these bits indicate an output value sent to the module is greater than or equal to the user-configured high clamp value for the output channel. The module clamps the analog output signal at the high clamp value. These bits are automatically reset (0) by the module when the high clamp condition clears, unless the channel's clamp status bits are latched. The module's output signals always return to normal operation when directed to values allowed by the high clamp and low clamp settings. If the channel's clamp status bits are latched, a set (1) high clamp status bit clears via the corresponding Cancel High Clamp Latch bit in your output data file.

Under-range (low clamp) Status Bits (U0...U3)

Under-range (low clamp) bits for output channels 0...3 are contained in Word 0, bits 9, 11, 13, and 15. When set (1), these bits indicate an output value sent to the module is less than or equal to the user-configured low clamp value for the output channel. The module clamps the analog output signal at the low clamp value. These bits are automatically reset (0) by the module when the low clamp condition clears, unless the channel's clamp status bits are latched. The module's output signals always return to normal operation when directed to values allowed by the high clamp and low clamp settings. If the channel's clamp status bits are latched, a set (1) low clamp status bit clears via the corresponding Cancel Low Clamp Latch bit in your output data file.

Output Data File

The output data file lets you write analog output data and unlatch command data to the module with the control program and bit access. The data table structure is shown in the table below. For each module, slot x, words 0...3 in the output data file contain the digital values of the data to be converted to analog signals by the module outputs. The most significant bit (MSB) is the sign bit, in two's complement format. 'Nu' indicates not used with the bit set to zero.

Word/ Bit	15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
Word 0	SGN	Analog Output Data Channel 0														
Word 1	SGN	Analog Output Data Channel 1														
Word 2	SGN	Analog Output Data Channel 2														
Word 3	SGN	Analog Output Data Channel 3														
Word 4	NU	NU	NU	NU	NU	NU	NU	NU	CLO3	CH 03	CLO2	CH 02	CLO1	CH 01	CLO0	CH 00

Cancel Clamp Alarm Latch Control Bits (CLO0...CLO3 and CH00...CH03)

These bits are written during Run mode to cancel any latched low and high clamp status bits. The status bit is unlatched on a low to high transition (0 to 1) of the unlatch bit if the clamp condition no longer exists. If the clamp condition persists, then the low to high transition of the unlatch bit has no effect. You need to continue to toggle the unlatch bit until verification from the appropriate output-channel status word that the clamp status bit has cleared (0).

Configuration Data File

The configuration file lets you determine how each individual output channel will operate. Parameters such as the output type and data format are set up by using this file. This data file is writable and readable. The default value of the configuration data table is all zeros.

Configuration Data File

Word/Bit	15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00	
Word 0	EC	NU						EHI	ELI	LC	ER	FM	PM	NU	PFE		
Word 1	NU				Format Ch0				NU				Type/Range Sel Ch0				
Word 2	SGN	Fault Value Channel 0															
Word 3	SGN	Program (Idle) Value Channel 0															
Word 4	SGN	Clamp High Data Value Channel 0															
Word 5	SGN	Clamp Low Data Value Channel 0															
Word 6	SGN	Ramp Rate Channel 0															
Word 7	NU																
Word 8	EC	NU						EHI	ELI	LC	ER	FM	PM	NU	PFE		
Word 9	NU				Format Ch1				NU				Type/Range Sel Ch1				
Word 10	SGN	Fault Value Channel 1															
Word 11	SGN	Program (Idle) Value Channel 1															
Word 12	SGN	Clamp High Data Value Channel 1															
Word 13	SGN	Clamp Low Data Value Channel 1															
Word 14	SGN	Ramp Rate Channel 1															
Word 15	NU																
Word 16	EC	NU						EHI	ELI	LC	ER	FM	PM	NU	PFE		
Word 17	NU				Format Ch2				NU				Type/Range Sel Ch2				
Word 18	SGN	Fault Value Channel 2															
Word 19	SGN	Program (Idle) Value Channel 2															
Word 20	SGN	Clamp High Data Value Channel 2															
Word 21	SGN	Clamp Low Data Value Channel 2															
Word 22	SGN	Ramp Rate Channel 2															
Word 23	NU																
Word 24	EC	NU						EHI	ELI	LC	ER	FM	PM	NU	PFE		
Word 25	NU				Format Ch3				NU				Type/Range Sel Ch3				
Word 26	SGN	Fault Value Channel 3															
Word 27	SGN	Program (Idle) Value Channel 3															
Word 28	SGN	Clamp High Data Value Channel 3															
Word 29	SGN	Clamp Low Data Value Channel 3															
Word 30	SGN	Ramp Rate Channel 3															
Word 31	NU																

For information on configuring the module by using MicroLogix 1500 and RSLogix 500 software, see [Appendix B](#); for CompactLogix and RSLogix 5000 software, see [Appendix C](#).

The configuration file can also be modified through the control program, if supported by the controller. The structure and bit settings are shown in [Channel Configuration](#) on the following page.

Channel Configuration

Each channel is independently configured via a group of eight consecutive words in the Configuration Data file. The first two words of the group consist of bit fields, the settings of which determine how the output channel operates. See the tables below and the descriptions that follow for valid configuration settings and their meanings. The default bit status of the configuration file is all zeros.

Bit Definitions for Channel Configuration Words

Define	To choose	Make these bit settings															
		15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
Program to Fault Enable (PFE) ⁽¹⁾	Program Data																1
	Fault Data																0
Program Mode (PM) ⁽¹⁾	User-defined													1			
	Hold Last State													0			
Fault Mode (FM) ⁽¹⁾	User-defined												1				
	Hold Last State												0				
Enable Ramping (ER) ⁽¹⁾	Enable											1					
	Disable											0					
Latch Clamp Status (LC)	Enable										1						
	Disable										0						
Enable Low Clamp Alarm Interrupt (ELI) ⁽²⁾	Enable										1						
	Disable										0						
Enable High Clamp Alarm Interrupt (EHI) ⁽²⁾	Enable									1							
	Disable									0							
Enable Channel (EC)	Enable	1															
	Disable	0															

(1) Alternate output states are not supported by all controllers. Refer to your controller's user manual to determine whether alternate output states and this module function are supported.

(2) Module interrupts are not supported by all controllers. Refer to your controller's user manual to determine whether module interrupts are supported.

Bit Definitions for Type/Range and Data Format Configuration Words

Define	To choose	Make these bit settings															
		15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
Type/Range Select	-10...10V DC													0	0	0	0
	0...5V DC													0	0	0	1
	0...10V DC													0	0	1	0
	4...20 mA													0	0	1	1
	1...5V DC													0	1	0	0
	0...20 mA													0	1	0	1
Data Format Select	Raw/Proportional Counts						0	0	0								
	Engineering Units						0	0	1								
	Scaled for PID						0	1	0								
	Percent Range						0	1	1								

Enable/Disable Channel (EC)

This configuration lets each channel be enabled individually. When a channel is not enabled (EC = 0), the output channel is set to 0V or 0 mA.

Program Mode (PM)

This configuration selection provides individual Program mode selection for the output channels. When this selection is disabled (PM = 0), the module holds the last state. This means that the output remains at the last converted value prior to the condition that caused the control system to enter Program mode.

IMPORTANT

Hold last state is the default condition for the module during a control system Run-to-Program mode change.

If this selection is enabled (PM = 1), and the system enters the Program mode, the module converts the user-specified value from the channel's Program Value word to the appropriate analog output for the range selected.

TIP

Not all controllers support alternate output states and this function. Refer to your controller's user manual for details.

Program Value

Use each output channel's program value word to set the analog values for the outputs to assume when the system enters the Program mode. Valid values are dependent upon the type/range and data format selected for each output channel or the user-defined output clamp values. If the value you enter is outside the full range for the output type/range and data format selected, or outside the limits set by the channel's low and high clamp values, the module generates a configuration error. The default value is 0.

TIP

Not all controllers support alternate output states and this function. Refer to your controller's user manual for details.

Fault Mode (FM)

This configuration selection provides individual Fault mode selection for the output channels. When this selection is disabled (FM = 0), the module holds the last state, meaning that the output remains at the last converted value prior to the condition that caused the control system to enter the Fault mode.

IMPORTANT

Hold last state is the default condition for the module during a control system Run-to-Fault mode change.

If this selection is enabled (FM = 1), and the system enters the Fault mode, the module converts the user-specified value from the channel's Fault Value word to the appropriate analog output for the range selected.

TIP

Not all controllers support alternate output states and this function. Refer to your controller's user manual for details.

Fault Value

Use each output channel's fault value word to set the analog values for the outputs to assume when the system enters the Fault mode. Valid values depend upon the type/range and data format selected for each output channel or the user-defined output clamp values. If the value you enter is outside of the full range for the output type/range and data format selected, or outside of the limits set by the channel's low and high clamp values, the module generates a configuration error. The default value is 0.

TIP

Not all controllers support alternate output states and this function. Refer to your controller's user manual for details.

Program to Fault Enable (PFE)

If a system currently in Program mode faults, this setting determines whether the program or fault value is applied to the output. If the selection is enabled (PFE = 1), the module applies the Fault mode data value. If the selection is disabled (PFE = 0), the module applies the Program mode data value. The default setting is disabled.

TIP

Not all controllers support alternate output states and this function. Refer to your controller's user manual for details.

Clamping (limiting)

Clamping limits the outputs from the module to within a user-configured range when the controller commands an output to a value outside of that range. The module supports a high clamp value and a low clamp value for each output channel. Once clamps are set for a module, any data received from the controller that exceeds those clamp values sets an appropriate over-range and under-range clamp status bit and transitions the output to that limit but not beyond.

Clamp High and Clamp Low Data Values

Clamping is disabled on a per channel basis for each output channel by entering a 0 value in both the clamp high data value and clamp low data value words in the configuration-data file. If either the clamp high data value or clamp low data value words have a non-zero value entered, clamping is enabled for the corresponding output channel. Non-zero clamp data values are considered valid only if they are within the full-range limits set by the type/range and data format selections for the channel. Also, the non-zero clamp data values are valid only if the high clamp data value for an output channel is greater than or equal to the low clamp data value.

Latch Clamp Status (LC)

If the selection is enabled (LC = 1), the module latches any over-range or under-range clamp status bits that are set in the Input Data file. Latched clamp status bits must be reset via the Output Data file. If the selection is disabled (LC = 0), any clamp status bits that are set in the Input Data file are automatically reset when the clamp limits are no longer exceeded by the controller. The default setting is disabled.

Enable Low Clamp Alarm Interrupt and Enable High Clamp Alarm Interrupt (ELI and EHI)

If the selection is enabled (ELI = 1 or EHI = 1), the module generates a module interrupt to the controller when an over-range or under-range clamp status bit is set (1). A separate interrupt can be enabled for each output channel's high clamp status and low clamp status. If the selection is disabled (ELI = 0 or EHI = 0), no module interrupts are generated when output clamp status bits are set. The default setting is disabled.

TIP

Not all controllers support module interrupts and this function. Refer to your controller's user manual for details.

Output Ramping

Ramping limits the speed at which an output signal can change. This prevents vast transitions in the output from damaging the output controls.

Ramp to Fault mode is the only type of ramping supported by the module. This type of ramping occurs when the present output value changes to the fault value after a change in the controller's status to Fault mode has occurred.

Enable Ramping (ER)

If the selection is enabled (ER = 1), the module controls the ramp rate of the output when the system transitions from Run to Fault mode based on the value entered in the channel's ramp-rate configuration word. If the selection is disabled (ER = 0), no ramping control of the output is provided. The default setting is disabled.

TIP

Not all controllers support alternate output states and this function. Refer to your controller's user manual for details.

Ramp Rate

The ramp rate is defined in terms of the selected range/format in units per second. For example, in the 0...20 mA range and percent full scale format, a ramp rate of 1050 is 10% per second (2 mA/s), since 1050 is 10% of the total number of counts in the full scale of the 0...20 mA range when using percent full scale format.

This table describes how the ramp rate is determined for all output types/ranges and output data formats.

Ramp Rates for Output Type/Range and Data Formats

Output Data Format	Output Type/Range	Total Counts in Full Scale	Number of Counts for Every 1% of Ramp Rate	Real Units/Second for Every 1% of Ramp Rate
Proportional Counts	-10...10V DC	65,534 ⁽¹⁾	655	0.21V/s
	0...5V DC			0.058V/s
	0...10V DC			0.11V/s
	1...5V DC			0.048V/s
	0...20 mA			0.21 mA/s
	4...20 mA			0.178 mA/s
Engineering Units	-10...10V DC	21,000	210	0.21V/s
	0...5V DC	5750	58	0.058V/s
	0...10V DC	11,000	110	0.11V/s
	1...5V DC	4750	48	0.048V/s
	0...20 mA	21,000	210	0.21 mA/s
	4...20 mA	17,800	178	0.178 mA/s
Scaled for PID	-10...10V DC	17,203	172	0.21V/s
	0...5V DC	18,840	188	0.058V/s
	0...10V DC	18,021	180	0.11V/s
	1...5V DC	19,455	195	0.048V/s
	0...20 mA	17,202	172	0.21 mA/s
	4...20 mA	18,226	182	0.178 mA
Percent of Full Scale	-10...10V DC	21,000	210	0.21V/s
	0...5V DC	11,500	115	0.058V/s
	0...10V DC	11,000	110	0.11V/s
	1...5V DC	11,875	119	0.048V/s
	0...20 mA	10,500	105	0.21 mA/s
	4...20 mA	11,125	111	0.178 mA/s

(1) Limited to 32,767 by programming software.

If configured, ramping takes place only when the output is commanded to go to a fault state. Ramping does not occur during normal run operation.

The ramp rate values are entered in the Configuration Data file and are accepted as valid only if:

- the number of counts entered for a channel's ramp rate is between a minimum of 1% and a maximum of 100% of the total number of full scale counts for the channel's selected data format.
- the number of counts entered for a channel's ramp rate is equal to zero and ramping is not enabled for that channel.

TIP

Not all controllers support alternate output states and this function. Refer to your controller's user manual for details.

Type/Range Selection

This selection lets you configure each output channel individually and provides the means of designating whether the output is a voltage or current source. The output range for each output channel is also configured by this selection.

Data Format Selection

This selection configures each output channel to accept digital data in any of the following formats:

- Raw/Proportional Data
- Engineering Units
- Scaled-for-PID
- Percent Range

See [Valid Output Data on page 41](#).

Raw/Proportional Data

The value sent by the controller to the output channel is proportional to the selected output and scaled into the maximum data range allowed by the bit resolution of the D/A converter. For example, the data value range for a $\pm 10\text{V}$ DC user input is $-32,767 \dots 32,767$, which covers the full-scale range of $-10.5 \dots 10.5\text{V}$.

Engineering Units

The value sent by the controller to the output channel is the actual current or voltage value for the selected output range. The resolution of the engineering units is 0.001V or 0.001 mA per count.

Scaled-for-PID

The value sent by the controller to the output channel is a signed integer with 0 representing the lower limit of the normal operating range and 16,383 representing the upper limit of the normal operating range. Allen-Bradley controllers, such as the MicroLogix 1500 controller, use this range in their PID equations. The amount over and under the normal operating range (the full-scale range) is also supported.

Percent Range

The value sent by the controller to the output channel is presented as a percentage of the normal operating range selected for that output channel. For example, 0...10V DC equals 0...100%. The resolution of the percent range is 0.01% per count. The amount over and under the normal operating range (the full-scale range) is also supported.

Valid Output Data Word Formats/Ranges

This table shows the valid formats and minimum/maximum data ranges provided by the module.

Valid Output Data

Normal Operating Output Range	Full Range ⁽¹⁾	Raw/Proportional Data	Engineering Units ⁽²⁾	Scaled-for-PID		Percent Range ⁽³⁾		
		Full Range	Full Range	Normal Operating Range	Full Range	Normal Operating Range	Full Range	
-10...10V DC	-10.5...10.5V	-32,767... 32,767	-10,500...10,500	0...16,383	-410...16,793	-10,000... 10,000	-10,500...10,500	
0...5V DC	-0.5...5.25V		-500...5,250		-1638...17,202		-1000...10,500	
0...10V DC	-0.5...10.5V		-500...10,500		-819...17,202		-500...10,500	
1...5V DC	0.5...5.25V		500...5,250		-2048...17,407		0...10,000	-1250...10,625
0...20 mA	0...21 mA		0...21,000		0...17,202		0...10,500	
4...20 mA	3.2...21 mA		3,200...21,000		-819...17,407		-500...10,625	

(1) Includes amounts over and under normal operating range.

(2) 1 count = 0.001V or 0.001 mA.

(3) 1 count = 0.01%.

Notes:

Module Diagnostics and Troubleshooting

Introduction

Topic	Page
Safety Considerations	43
Power Cycle Diagnostics	45
Channel Diagnostics	45
Non-critical versus Critical Module Errors	45
Module Error Definition Table	46
Error Codes	47
Module Inhibit Function	50
Contacting Rockwell Automation	50

Safety Considerations

Safety considerations are an important element of proper troubleshooting procedures. Actively thinking about the safety of yourself and others, as well as the condition of your equipment, is of primary importance.

The following sections describe several safety concerns you should be aware of when troubleshooting your control system.

ATTENTION



Never reach into a machine to actuate a switch because unexpected motion can occur and cause injury.

Remove all electrical power at the main power-disconnect switches before checking electrical connections or inputs/outputs causing machine motion.

Power Status Indicator

When the green status indicator on the analog module is illuminated, it indicates that power is applied to the module and the module is operating without error. A module that has sensed a fault condition or is being held in reset by the system's controller does not illuminate the module's status indicator even though power is still applied.

Activate Devices When Troubleshooting

When troubleshooting, never reach into the machine to actuate a device. Unexpected machine motion could occur.

Stand Clear of the Machine

When troubleshooting any system problem, have all personnel remain clear of the machine. The problem could be intermittent, and sudden unexpected machine motion could occur. Have someone ready to operate an emergency stop switch in case it becomes necessary to shut off power to the machine.

Program Alteration

There are several possible causes of alteration to the user program, including extreme environmental conditions, electromagnetic interference (EMI), improper grounding, improper wiring connections, and unauthorized tampering. If you suspect a program has been altered, check it against a previously saved program on an EEPROM or UVPRM memory module.

Safety Circuits

Circuits installed on the machine for safety reasons, like over-travel limit switches, stop push buttons, and interlocks, should always be hard-wired to the master control relay. These devices must be wired in series so that when any one device opens, the master control relay is de-energized, thereby removing power to the machine. Never alter these circuits to defeat their function. Serious injury or machine damage could result.

Power Cycle Diagnostics

When you cycle power to the module, a series of internal diagnostic tests are performed. These diagnostic tests must be successfully completed or the module status indicator remains off and a module error results and is reported to the controller.

Module Status Indicator	Condition	Corrective Action
On	Proper Operation	No action required.
Off	Module Fault	Cycle power. If condition persists, replace the module. Call your local distributor or Rockwell Automation for assistance.

Channel Diagnostics

When any channel is enabled, the module performs a diagnostic check to see that the channel has been properly configured. In addition, the module checks each channel during every conversion cycle for over-range (high clamp) and under-range (low clamp) conditions.

Output Clamp Detection

Whenever data is sent to an output that meets or exceeds that channel's configured clamp limits, an over-range (high clamp) or under-range (low clamp) error is indicated in the Input Data file.

Non-critical versus Critical Module Errors

Non-critical module errors are typically recoverable. Channel errors (over-range or under-range errors) are non-critical. Non-critical errors are indicated in the module input data table.

Critical module errors are conditions that prevent normal or recoverable operation of the system. When these types of errors occur, the system typically leaves the run or program mode of operation until the error can be dealt with.

Critical module errors are indicated in [Error Codes on page 47](#).

Module Error Definition Table

Module errors are expressed in two fields as four-digit Hex format with the most significant digit as don't care and irrelevant. The two fields are Module Error and Extended Error Information.

Don't Care Bits				Module Error			Extended Error Information								
15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hex Digit 4				Hex Digit 3			Hex Digit 2				Hex Digit 1				

Module Error Field

The purpose of the module error field is to classify module errors into three distinct groups, as described in the table below. The type of error determines what kind of information exists in the extended error information field. Refer to your controller manual for details.

Error Type	Module Error Field Value Bits 11...09 (Bin)	Description
No Errors	000	No error is present. The extended error field holds no additional information.
Hardware Errors	001	General and specific hardware error codes are specified in the extended error information field.
Configuration Errors	010	Module-specific error codes are indicated in the extended error field. These error codes correspond to options that you can change directly. For example, the input range or input filter selection.

Extended Error Information Field

Depending upon the value in the module error field, the extended error information field can contain error codes that are module-specific or common to all 1769 analog modules.

TIP If no errors are present in the module error field, the extended error information field will be set to zero.

Error Codes

Error codes can help troubleshoot your module.

Extended Error Codes for Hardware Errors

Error Type	Hex Equivalent ⁽¹⁾	Module Error Code	Extended Error Information Code	Error Description
		Binary	Binary	
No Error	X000	000	0 0000 0000	No error
General Common Hardware Error	X200	001	0 0000 0000	General hardware error; no additional information
	X201	001	0 0000 0001	Power-up reset state
Hardware-specific Error	X300	001	1 0000 0000	General hardware error
	X301	001	1 0000 0001	Microprocessor hardware error
	X302	001	1 0000 0010	D/A converter communication error

(1) X represents the Don't Care digit. Module hardware error codes are typically presented in their Hex Equivalent by the programming software.

During system configuration, if you set the fields in the configuration file to invalid or unsupported values, the module generates a configuration error and the system controller enters a Fault condition. The invalid configuration data must be corrected and the program downloaded again for the system to enter Run mode. You cannot change module configuration data while the system is in Run mode. Any changes are ignored by the module, which continues to operate with its previous configuration.

Extended Error Codes for Configuration Errors

Hex Equivalent ⁽¹⁾	Module Error Code	Extended Error Information Code	Error Description
	Binary	Binary	
X400	010	0 0000 0000	General configuration error; reserve bits set to 1
X401	010	0 0000 0001	Invalid output range selected (channel 0)
X402	010	0 0000 0010	Invalid output range selected (channel 1)
X403	010	0 0000 0011	Invalid output range selected (channel 2)
X404	010	0 0000 0100	Invalid output range selected (channel 3)
X405	010	0 0000 0101	Invalid output format selected (channel 0)
X406	010	0 0000 0110	Invalid output format selected (channel 1)
X407	010	0 0000 0111	Invalid output format selected (channel 2)
X408	010	0 0000 1000	Invalid output format selected (channel 3)
X409	010	0 0000 1001	Invalid fault value (channel 0)
X40A	010	0 0000 1010	Invalid fault value (channel 1)
X40B	010	0 0000 1011	Invalid fault value (channel 2)
X40C	010	0 0000 1100	Invalid fault value (channel 3)

Extended Error Codes for Configuration Errors

Hex Equivalent ⁽¹⁾	Module Error Code	Extended Error Information Code	Error Description
	Binary	Binary	
X40D	010	0 0000 1101	Invalid program/idle value (channel 0)
X40E	010	0 0000 1110	Invalid program/idle value (channel 1)
X40F	010	0 0000 1111	Invalid program/idle value (channel 2)
X410	010	0 0001 0000	Invalid program/idle value (channel 3)
X411	010	0 0001 0001	Invalid clamp value (channel 0)
X412	010	0 0001 0010	Invalid clamp value (channel 1)
X413	010	0 0001 0011	Invalid clamp value (channel 2)
X414	010	0 0001 0100	Invalid clamp value (channel 3)
X415	010	0 0001 0101	Invalid ramp rate (channel 0)
X416	010	0 0001 0110	Invalid ramp rate (channel 1)
X417	010	0 0001 0111	Invalid ramp rate (channel 2)
X418	010	0 0001 1000	Invalid ramp rate (channel 3)

(1) X represents the Don't Care digit. Module configuration error codes are typically presented in their Hex Equivalent by the programming software.

Invalid Output Range Selected

These error codes occur when the 4-bit output range code for the indicated channel is not one of the assigned output range codes for the module.

See [Bit Definitions for Type/Range and Data Format Configuration Words on page 34](#) for details on the assigned output range codes for the module.

Invalid Output Format Selected

These error codes occur when the 3-bit output format code for the indicated channel is not one of the assigned output format codes for the module.

See [Bit Definitions for Type/Range and Data Format Configuration Words on page 34](#) for details on the assigned output range codes for the module.

Invalid Fault Value Selected⁽¹⁾

These error codes occur when the value entered is not within the full-range limits of the indicated channel, as determined by the channel's output range/type and format setting, or the value entered is not within the limits set by the indicated channel's output clamp values.

Invalid Program/Idle Value Selected⁽¹⁾

These error codes occur when the value entered is not within the full-range limits of the indicated channel, as determined by the channel's output range/type and format setting, or the value entered is not within the limits set by the indicated channel's output clamp values.

Invalid Clamp Value Selected

These error codes occur when the value entered is not within the full-range limits of the indicated channel, as determined by the channel's output range/type and format setting, or if the low clamp value is greater than the high clamp value.

Invalid Ramp Rate Selected⁽¹⁾

These codes occur when the value entered is less than 1% or more than 100% of the total full-range counts for the indicated channel, as determined by the channel's output range/type and format setting, unless output ramping is disabled for the indicated channel. In that case, the ramp rate may be set to zero without causing a configuration error.

(1) Some controllers do not support alternate output states. Refer to your controller user manual to determine whether alternate output states and these associated functions are supported.

Module Inhibit Function

CompactLogix controllers support the module inhibit function. See your controller manual for details.

Whenever the module is inhibited, it continues to provide information about changes at its inputs to the 1769 Compact Bus Master (for example, a CompactLogix controller).

Contacting Rockwell Automation

If you need to contact Rockwell Automation for assistance, please have the following information available:

- A clear statement of the problem, including a description of what the system is actually doing. Note the state of the status indicators; also note input and output image words for the module.
- List of remedies you have already tried.
- Controller type and firmware number (see the label on the controller.)
- Hardware types in the system, including all I/O modules.
- Fault code, if the controller is faulted.

See the back cover for contact information.

Specifications

Introduction

Topic	Page
General Specifications – 1769-OF4	51
Output Specifications – 1769-OF4	52
Certifications – 1769-OF4	53
Replacement Parts	53

General Specifications – 1769-OF4

Attribute	1769-OF4
Dimensions (HxWxD), approx.	118 x 35 x 87 mm (4.65 x 1.38 x 3.43 in.) Height including mounting tabs is 138 mm (5.43 in.)
Shipping weight (with carton), approx.	280 g (0.61 lb)
Temperature, storage	-40...85 °C (-40...185 °F)
Temperature, operating	0...60 °C (32...140 °F)
Humidity, operating	5...95% noncondensing
Altitude, operating	2000 m (6561 ft)
Vibration, operating	10...500 Hz, 5 g, 0.030 in. peak-to-peak
Shock, operating	30 g, 11 ms panel mounted (20 g, 11 ms DIN rail mounted)
Shock, nonoperating	40 g panel mounted (30 g DIN rail mounted)
Bus current draw, max	120 mA @ 5V DC; 170 mA @ 24V DC
Heat dissipation	2.86 Total Watts (The Watts per point plus the minimum Watts with all points energized.)
Module OK indicator	On: module has power, has passed internal diagnostics, and is communicating over the bus Off: Any of the above is not true
System power supply distance rating	The module may not be more than 8 modules away from the system power supply
Cable, recommended	Belden 8761 (shielded)
ESD immunity (IEC1000-4-2)	4 kV contact, 8 kV air, 4 kV indirect
Radiated immunity (IEC1000-4-3)	10V/m, 80...1000 MHz, 80% amplitude modulation
Fast transient burst (IEC1000-4-4)	2 kV, 5 kHz
Surge immunity (IEC1000-4-5)	1 kV galvanic gun
Conducted immunity (IEC1000-4-6)	10V, 0.15...80 MHz

Attribute	1769-OF4
Vendor I.D. code	1
Product type code	10
Product code	48
Input words	5
Output words	5
Configuration words	32

Output Specifications – 1769-OF4

Attribute	1769-OF4
Analog normal operating ranges ⁽¹⁾	0...20 mA, 4...20 mA, ±10V DC, 0...10V DC, 0...5V DC, 1...5V DC
Full scale analog ranges ⁽¹⁾	0...21 mA, 3.2...21 mA, ±10.5V DC, -0.5...10.5V DC, -0.5...5.25V DC, 0.5...5.25V DC
Number of outputs	4 single-ended, voltage or current
Digital resolution across full range	15 bits plus sign unipolar and bipolar
Conversion rate (all channels) max	Interrupts not enabled: 2.5 ms Interrupts enabled: 3.8 ms
Step response to 63% ⁽²⁾	2.9 ms
Resistive load	Current: 0...600 Ω (includes wire resistance) Voltage: 1 kΩ or greater
Inductive load, max.	0.1 mH (current loads), 1.0 μF (voltage loads)
Field Calibration	None required
Overall Accuracy ⁽³⁾	0.5% full scale at 25 °C (77 °F)

(1) The over- or under-range flag will come on when either the High Clamp or the Low Clamp values are exceeded. When either range flag is set, the module clamps the corresponding channel's output to the High Clamp or the Low Clamp value. Unless latched, the flag automatically resets when directed to a value between the High Clamp and the Low Clamp values. The output channel value always returns to normal operation when directed to a value allowed by the High Clamp and Low Clamp values (even if latching of the Clamp status bits is enabled).

(2) Step response is the period of time between when the D/A converter was instructed to go from minimum to full range until the device is at 63% of full range.

(3) Includes offset, gain, drift, non-linearity, and repeatability error terms.

Certifications – 1769-OF4

Certification	1769-OF4
Agency certification	<ul style="list-style-type: none">• C-UL certified (under CSA C22.2 No. 142)• UL 508 listed• CE compliant for all applicable directives
Hazardous environment class	Class I, Division 2, Hazardous Location, Groups A, B, C, D (UL 1604, C-UL under CSA C22.2 No. 213)
Radiated and conducted emissions	EN50011 Class A

Replacement Parts

The module has these replacement parts:

- Terminal block, catalog number 1769-RTBN10 (one per kit)
- Door, catalog number 1769-RD (two per kit)

Notes:

Module Addressing and Configuration with MicroLogix 1500 Controller

Introduction

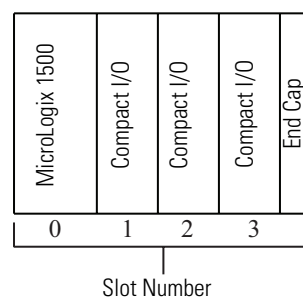
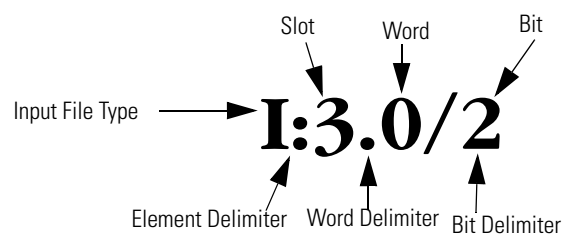
Topic	Page
Module Input Image	55
Module Configuration File	56
Configure Analog I/O Modules in a MicroLogix 1500 System	57

This appendix examines the modules' addressing scheme and describes module configuration using RSLogix 500 software and a MicroLogix 1500 controller.

Module Input Image

The module's input image file represents status bits and data echo words. Input word 0 holds the status bits for the analog output channels. Input words 1...4 hold the data that represents the directed value of the analog outputs for channels 0...3. These data words are valid only when the channel is enabled and there are no errors.

For example, to obtain the general status of channel 2 of the analog module located in slot 3, use address I:3.0/2.

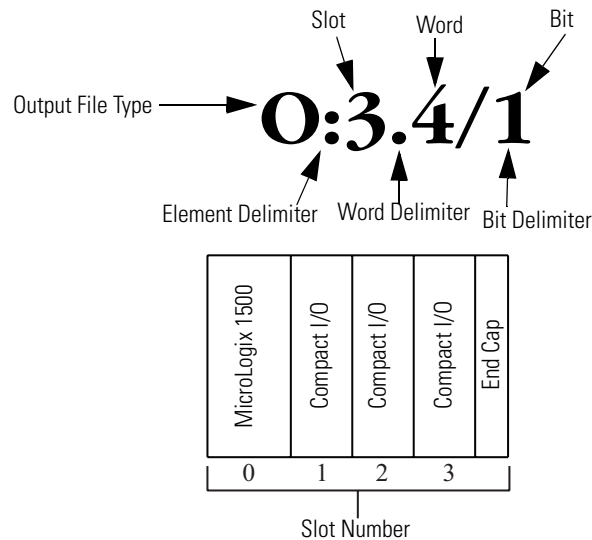


TIP The end cap does not use a slot address.

Module Output Image

The module's output image file represents data words and unlatch control bits. Output words 0...3 are written with output data that represents the analog value commanded to the module's output channels 0...3. These data words only represent the state of the module's outputs when the channel is enabled and there are no errors. Output word 4 is written to control the unlatching of the over-range and under-range status bits.

For example, to control the unlatching of a latched low clamp status bit of channel 0 of the module located in slot 3, use address O:3.4/1.



TIP

The end cap does not use a slot address.

Module Configuration File

The configuration file contains information that you use to define the way a specific channel functions. The configuration file is explained in more detail in [Chapter 3](#).

The configuration file is modified using the programming software configuration screen.

For an example of module configuration using RSLogix 500 software, see [Configure Analog I/O Modules in a MicroLogix 1500 System](#).

TIP

The RSLogix 500 configuration default is to disable each analog input and output channel. For improved analog module performance, disable any **unused** channels.

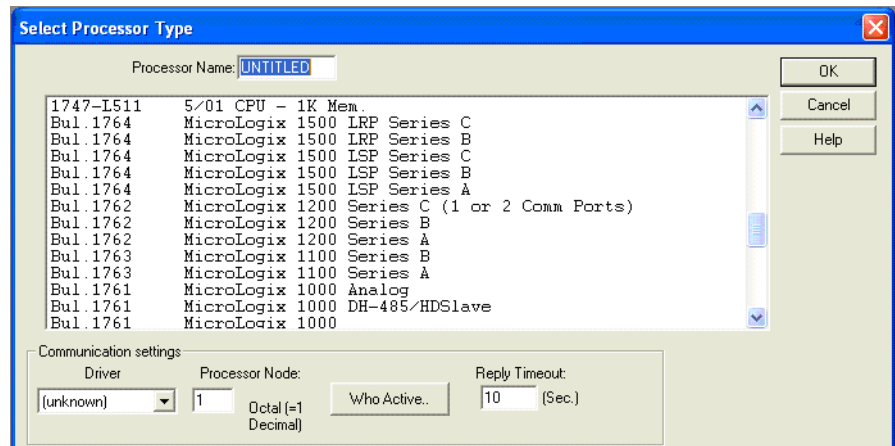
Software Configuration Channel Defaults

Parameter	Default Setting
Enable/Disable Channel	Disabled
Input/Output Range	-10...10V DC
Data Format	Raw/Proportional

Configure Analog I/O Modules in a MicroLogix 1500 System

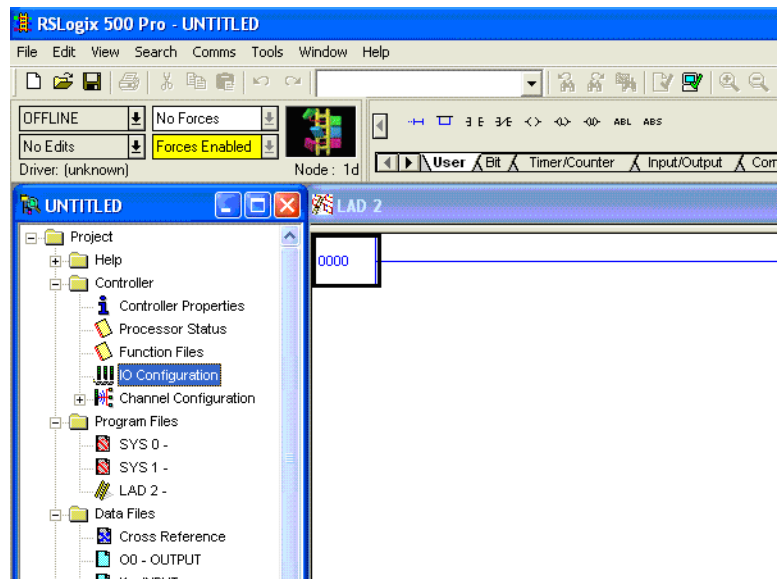
This example takes you through configuring your 1769-OF4 module with RSLogix 500 programming software. This application example assumes your module is installed as expansion I/O in a MicroLogix 1500 system, that RSLinx software is properly configured, and a communication link has been established between the MicroLogix controller and RSLogix 500 software. You must program the 1769-OF4 module by using the Generic Module method.

1. From the File menu, choose New to create a new project.

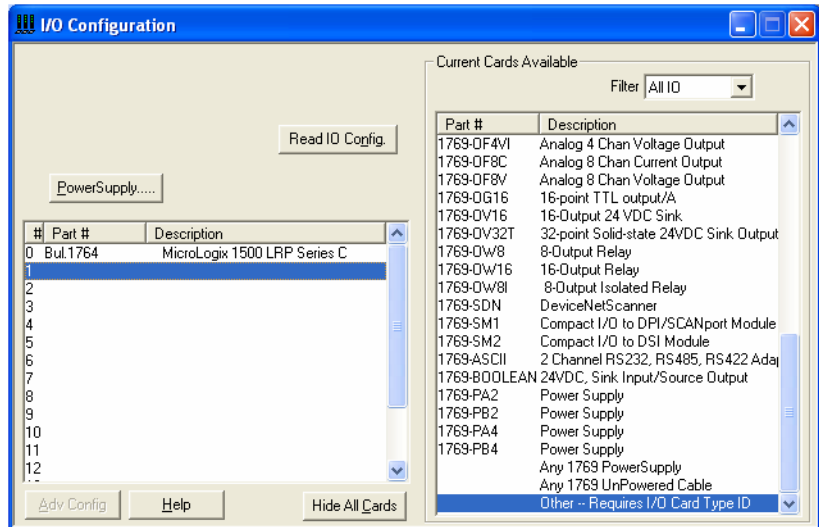


2. Type a name for the project in the Processor Name field.
3. Select your MicroLogix 1500 controller from the list and click OK.

4. Double-click I/O Configuration in the project tree to open the I/O Configuration dialog box.



5. On the I/O Configuration dialog box, select the slot position where you want to add your module.
6. In the Current Cards Available list, double-click Other – Requires I/O Card Type ID to add the module to the project in the indicated slot position.



7. Enter the module identification parameters as shown.

Vendor ID: 1

Product Type: 10

Product Code: 48

Series/Major Rev/Minor Rev: A

Input Words: 5

Output Words: 5

Input Bits: 0

Output Bits: 0

Extra Data Length: 32

Ignore Configuration Error:

OK Cancel

8. Configure the module's channels by double-clicking the newly-added module and then clicking the Generic Extra Data Config tab.
9. Change the Radix to Hex/BCD.

Module #1: OTHER - I/O Module - ID Code = 48

Expansion General Configuration Generic Extra Data Config

Offset

0	8000	0	0	0	0
5	0	0	0	0	0
10	0	0	0	0	0
15	0	0	0	0	0
20	0	0	0	0	0
25	0	0	0	0	0
30	0	0			

Hex/BCD Radix

OK Cancel Apply Help

10. Enter each of the 32 Configuration Data File words (in hexadecimal format) as required.

See [Configuration Data File on page 33](#) for details on setting up the configuration data.

11. When you are finished entering the data, click Apply and then OK.
12. Download the project to the MicroLogix 1500 controller.

Notes:

Configuration Using the RSLogix 5000 Generic Profile for CompactLogix Controllers

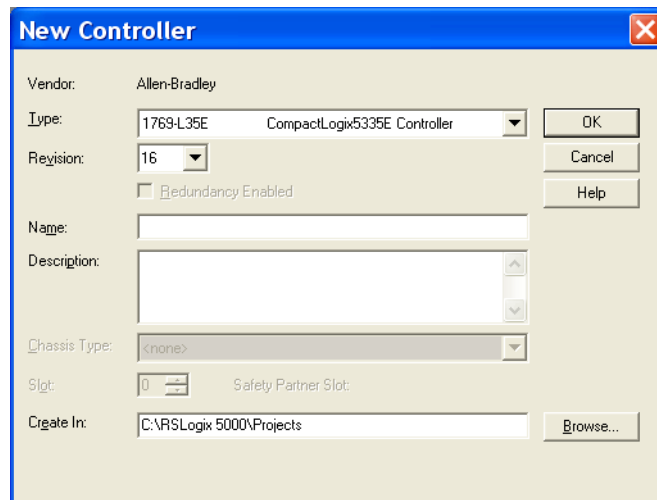
Introduction

Topic	Page
Add the Module to Your Project	61
Configure Each I/O Module	64

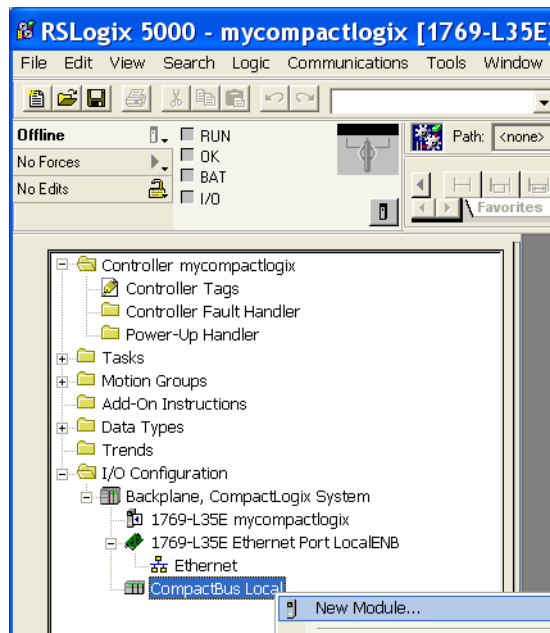
If the Add-on Profile for the 1769-OF4 module is not yet available, follow this procedure to configure your module by using a generic profile.

Add the Module to Your Project

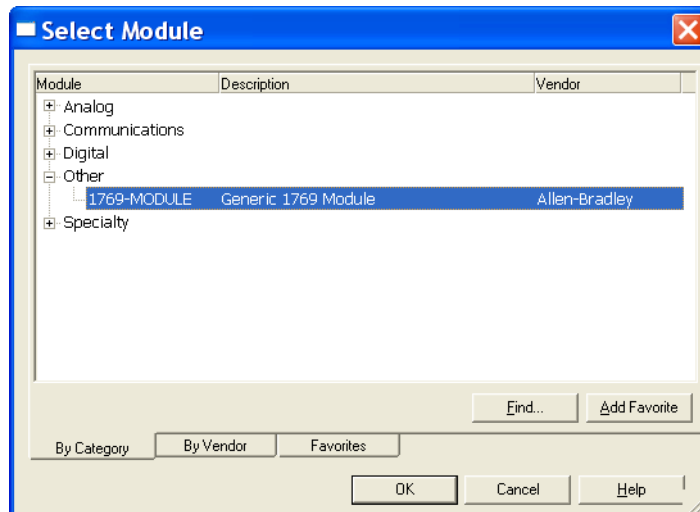
1. Start RSLogix 5000 software.
2. From the File menu, choose New to open an existing project or start a new project.
3. If this is a new project select a CompactLogix controller, type a name for the controller, and click OK.



4. In the controller organizer, right-click CompactBus Local, and choose New Module.

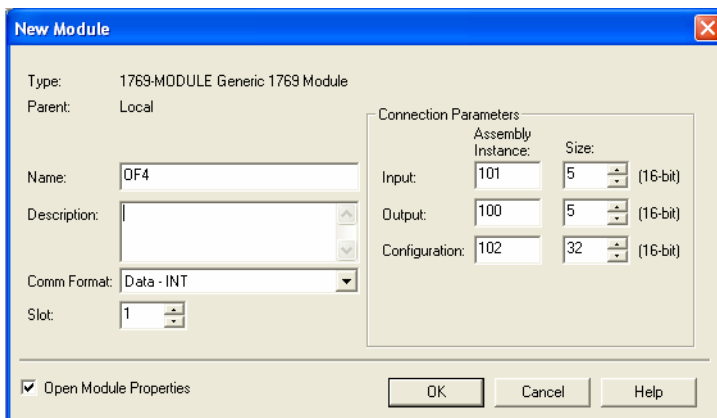


5. Expand the Other group and select the 1769-MODULE Generic Profile.



6. Click OK.

7. Type a Name for the module and an optional Description.



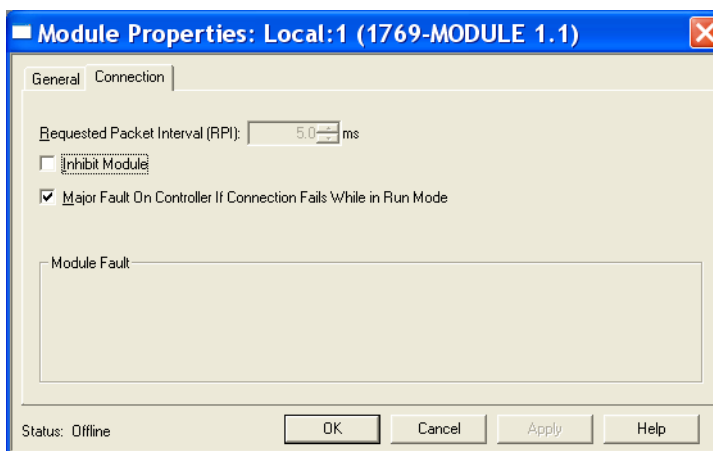
8. Select the slot number.

The slot number begins with the first available slot number, 1, and increments automatically for each subsequent Generic Profile you configure.

9. Enter the Comm Format, Assembly Instance numbers and their associated sizes, as shown above.

10. Click OK.

11. On the Connection tab, you can choose to inhibit the module or configure the module to fault if the connection fails.



TIP

Refer to the Help screens in RSLogix 5000 software, under Connection Tab Overview for a complete explanation of these features.

12. Click OK.

Configure Each I/O Module

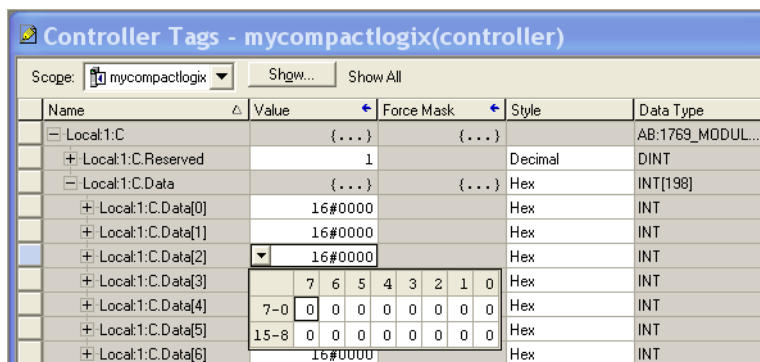
Once you have created Generic Profiles for each analog I/O module in your system, you must then enter configuration information into the Tag database that has been automatically created from the Generic Profile information you entered for each of these modules. This configuration information is downloaded to each module at program download, at going to run, and at power cycle.

Tag addresses are automatically created for configured I/O modules. All local I/O addresses are preceded by the word Local. These addresses have the following format:

- Input Data: Local:s.I
- Output Data: Local:s.O
- Configuration Data: Local:s.C

Where *s* is the slot number assigned the I/O modules in the Generic Profiles.

1. Open the Controller Tag database by double-clicking Controller Tags in the upper portion of the controller organizer.
2. Open the configuration tag for your module by clicking on the plus sign to the left of its configuration tag in the tag database.
3. To configure the input modules in slot 1, click the plus sign left of Local:1.C.
4. Click the plus sign to the left of Local:1.C.Data to reveal the 32 data words where the configuration data may be entered for the module.



Two's Complement Binary Numbers

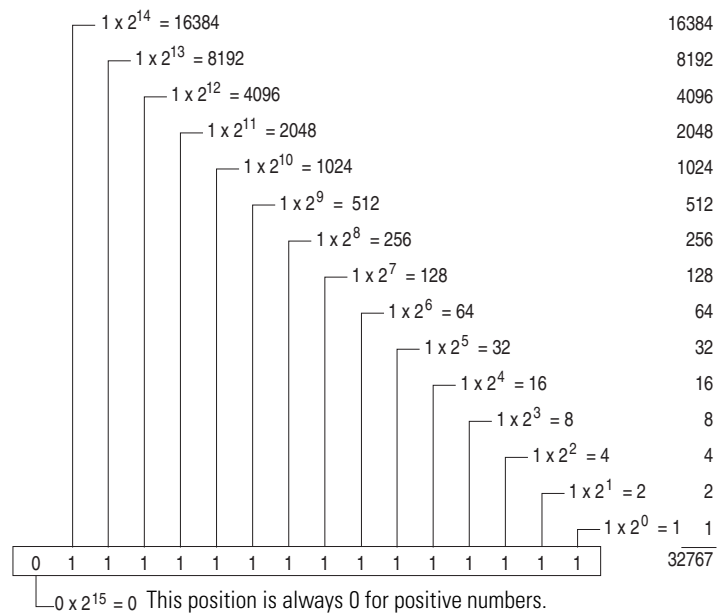
The controller memory stores 16-bit binary numbers. Two's complement binary is used when performing mathematical calculations internal to the controller. Analog input values from the analog modules are returned to the controller in 16-bit two's complement binary format. For positive numbers, the binary notation and two's complement binary notation are identical.

As indicated in the figure on the next page, each position in the number has a decimal value, beginning at the right with 2^0 and ending at the left with 2^{15} . Each position can be 0 or 1 in the controller memory. A 0 indicates a value of 0; a 1 indicates the decimal value of the position. The equivalent decimal value of the binary number is the sum of the position values.

Positive Decimal Values

The far left position is always 0 for positive values. This limits the maximum positive decimal value to 32,767 (all positions are 1 except the far left position).

Positive Decimal Values



EXAMPLE

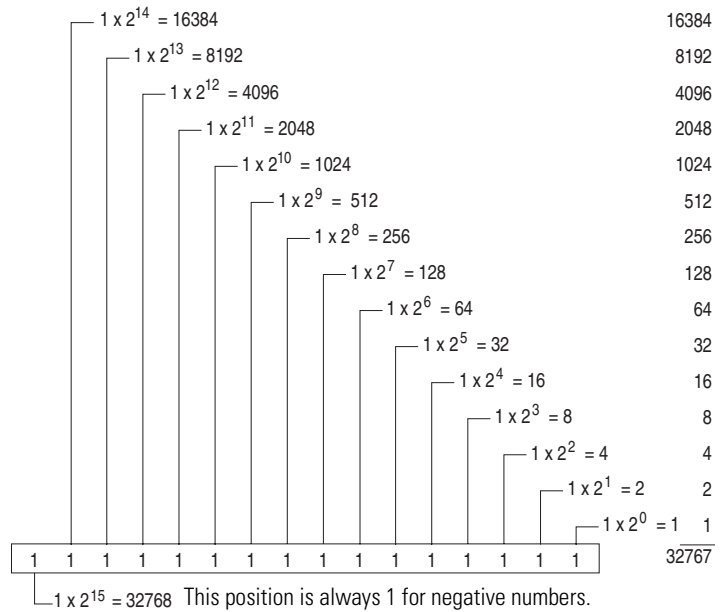
$$0000\ 1001\ 0000\ 1110 = 2^{11} + 2^8 + 2^3 + 2^2 + 2^1 = 2048 + 256 + 8 + 4 + 2 = 2318$$

$$0010\ 0011\ 0010\ 1000 = 2^{13} + 2^9 + 2^8 + 2^5 + 2^3 = 8192 + 512 + 256 + 32 + 8 = 9000$$

Negative Decimal Values

In two's complement notation, the leftmost position is always 1 for negative values. The equivalent decimal value of the binary number is obtained by subtracting the value of the leftmost position, 32,768, from the sum of the values of the other positions. All positions are 1 and the value is $32,767 - 32,768 = -1$.

Negative Decimal Values



EXAMPLE $1111\ 1000\ 0010\ 0011 = (2^{14} + 2^{13} + 2^{12} + 2^{11} + 2^5 + 2^1 + 2^0) - 2^{15} =$
 $(16384 + 8192 + 4096 + 2048 + 32 + 2 + 1) - 32768 =$
 $30755 - 32768 = -13$

The following terms and abbreviations are used throughout this manual. For definitions of terms not listed here refer to the Allen-Bradley Industrial Automation Glossary, publication [AG-7.1](#).

alternate last state – A configuration selection that instructs the module to convert a user-specified value from the channel fault or program/idle word to the output value when the module enters the Fault or Program mode.

attenuation – The reduction in the magnitude of a signal as it passes through a system.

bus connector – A 16-pin male and female connector that provides electrical interconnection between the modules.

channel – Refers to analog output interfaces available on the module's terminal block. Each channel is configured for connection to a variable voltage or current input or output device, and has its own data and diagnostic status words.

configuration word – Contains the channel configuration information needed by the module to configure and operate each channel.

D/A converter – Refers to the digital-to-analog converter inherent to the module. The converter produces an analog DC voltage or current signal whose instantaneous magnitude is proportional to the magnitude of a digital value.

dB – (decibel) A logarithmic measure of the ratio of two signal levels.

data echo – The digital value currently being converted by the D/A converter and shown in words 1...4 of the module's input data file. Under normal operating conditions, the data echo value is the same value that is being sent from the bus master to the output module.

data word – A 16-bit integer that represents the value of the analog output channel. The channel data word is valid only when the channel is enabled and there are no channel errors. When the channel is disabled the channel data word is cleared (0).

differential operation – The difference in voltage between a channel's positive terminal and negative terminal.

full scale – The magnitude of voltage or current over which normal operation is permitted.

full scale error – (gain error) The difference in slope between the actual and ideal analog transfer functions.

full scale range – (FSR) The difference between the maximum and minimum specified analog input values.

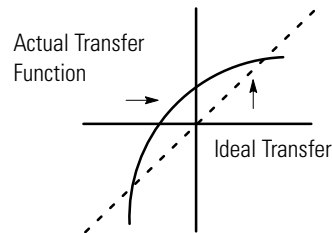
hold last state – A configuration selection that instructs the module to keep the outputs at the last converted value prior to the condition that caused the control system to enter the Fault or Program mode.

input image – The input from the module to the controller. The input image contains the module data words and status bits.

LSB – (Least Significant Bit) The bit that represents the smallest value within a string of bits. For analog modules, 16-bit, two's complement binary codes are used in the I/O image in the card.

For analog inputs, the LSB is defined as the rightmost bit, bit 0, of the 16-bit field. For analog outputs, the three rightmost bits are not significant, and the LSB is defined as the third bit from the right, bit 2, of the 16-bit field.

linearity error – An analog input or output is composed of a series of voltage or current values corresponding to digital codes. For an ideal analog output, the values lie in a straight line spaced by a voltage or current corresponding to 1 LSB. Any deviation of the converted input or actual output from this line is the linearity error of the output. The linearity is expressed in percent of full scale output. See the variation from the straight line due to linearity error (exaggerated) in the example below.



number of significant bits – The power of two that represents the total number of completely different digital codes an analog signal can be converted into or generated from.

module scan time – See [module update time](#).

module update time – The time required for the module to receive, convert, and drive all output data for the enabled output channels.

multiplexer – A switching system that allows several signals to share a common A/D or D/A converter.

normal operating range – Input or output signals are within the configured range.

overall accuracy – The worst-case deviation of the output voltage or current from the ideal over the full output range is the overall accuracy.

Gain error, offset error, and linearity error all contribute to output channel accuracy.

output accuracy – The difference between the actual analog output value and what is expected, when a given digital code is applied to the d/a converter. Expressed as a \pm percent of full scale. The error will include gain, offset and drift elements, and is defined at 25 °C (77 °F), and also over the full operating temperature range, 0...60 °C (0...140 °F).

output image – The output from the controller to the module outputs. The output image contains the digital output data to be converted to analog output signals by the module.

repeatability – The closeness of agreement among repeated measurements of the same variable under the same conditions.

resolution – The smallest detectable change in a measurement, typically expressed in engineering units (for example, 1 mV) or as a number of bits. For example a 12-bit system has 4096 possible output states. It can therefore measure 1 part in 4096.

status word – Contains status information about the channel's current configuration and operational state. You can use this information in your ladder program to determine whether the channel data word is valid.

update time – See [module update time](#).

Notes:

Numerics

1769-ADN
user manual 8

A

abbreviations 67
alternate last state
definition 67
attenuation
definition 67

B

bus connector
definition 67
locking 17
bus interface 11

C

channel
definition 67
diagnostics 45
status indicator 11
clamp high data value word 37
clamp low data value word 37
clamping 37
configuration errors 47
configuration word
definition 67
contacting Rockwell Automation 50

D

D/A converter
definition 67
data echo
definition 67
data word
definition 67
dB
definition 67
decibel. See dB.
definition of terms 67
DeviceNet adapter
user manual publication number 8
differential operation
definition 67
DIN rail mounting 19

E

electrical noise 15
end cap terminator 17
error codes 47
error definitions 46
errors
configuration 47
critical 45
extended error information field 46
hardware 47
module error field 46
non-critical 45
extended error codes 47
extended error information field 46

F

fault condition
at power-up 11
fault mode selection 36
fault value word 36
finger-safe terminal block 24
FSR. See full scale range.
full scale
definition 67
full scale error
definition 67
full scale range
definition 68

G

gain error. See full scale error.
generic profile
configuration example 61
grounding 20

H

hardware errors 47
heat considerations 15
hold last state
definition 68
fault mode 36
program mode 35

I

inhibit function 50
input image
definition 68

installation 13-20
grounding 20
heat and noise considerations 15

L

latch clamp status selection 37
least significant bit. See LSB.
LED. See status indicators.

linearity error
definition 68

LSB
definition 68

M

module error field 46
module inhibit function 50
module interrupt
high clamp alarm 37
low clamp alarm 37
module scan time
definition 68
module update time
definition 68
mounting 17-19
multiplexer
definition 68

N

negative decimal values 66
number of significant bits
definition 68

O

operation
system 11
output data formats
engineering units 41
percent range 41
raw/proportional data 40
scaled for PID 41
valid formats/ranges 41
output image
definition 69
output ramping 38
output range/type selection 40
overall accuracy
definition 69

P

panel mounting 18-19
positive decimal values 65
power-up diagnostics 45
power-up sequence 11
program alteration 44
program mode selection 35
program to fault enable selection 36
program value word 35

R

ramp rate
definition 38
determination 39
Ramp to Fault Mode
definition 38
removing terminal block 23
replacing a module 19
resolution
definition 69
RSLogix 500 software
configuration example 55
RSLogix 5000 software
configuration example 61

S

safety circuits 44
scan time 68
spacing 17
status indicators
status word
definition 69
system operation 11

T

terminal block
removing 23
wiring 24
terminal screw torque 25
troubleshooting
safety considerations 43
two's complement binary numbers 65

W

wire size 25
wiring 13
module 25
routing considerations 15
terminal block 24

Notes:

Notes:

Rockwell Automation Support

Rockwell Automation provides technical information on the Web to assist you in using its products. At <http://www.rockwellautomation.com/support/>, you can find technical manuals, a knowledge base of FAQs, technical and application notes, sample code and links to software service packs, and a MySupport feature that you can customize to make the best use of these tools.

For an additional level of technical phone support for installation, configuration, and troubleshooting, we offer TechConnect support programs. For more information, contact your local distributor or Rockwell Automation representative, or visit <http://www.rockwellautomation.com/support/>.

Installation Assistance

If you experience an anomaly within the first 24 hours of installation, review the information that's contained in this manual. You can contact Customer Support for initial help in getting your product up and running.

United States or Canada	1.440.646.3434
Outside United States or Canada	Use the Worldwide Locator at http://www.rockwellautomation.com/support/americas/phone_en.html , or contact your local Rockwell Automation representative.

New Product Satisfaction Return

Rockwell Automation tests all of its products to ensure that they are fully operational when shipped from the manufacturing facility. However, if your product is not functioning and needs to be returned, follow these procedures.

United States	Contact your distributor. You must provide a Customer Support case number (call the phone number above to obtain one) to your distributor to complete the return process.
Outside United States	Please contact your local Rockwell Automation representative for the return procedure.

Documentation Feedback

Your comments will help us serve your documentation needs better. If you have any suggestions on how to improve this document, complete this form, publication [RA-DU002](#), available at <http://www.rockwellautomation.com/literature/>.

www.rockwellautomation.com

Power, Control and Information Solutions Headquarters

Americas: Rockwell Automation, 1201 South Second Street, Milwaukee, WI 53204 USA, Tel: (1) 414.382.2000, Fax: (1) 414.382.4444

Europe/Middle East/Africa: Rockwell Automation, Vorstlaan/Boulevard du Souverain 36, 1170 Brussels, Belgium, Tel: (32) 2 663 0600, Fax: (32) 2 663 0640

Asia Pacific: Rockwell Automation, Level 14, Core F, Cyberport 3, 100 Cyberport Road, Hong Kong, Tel: (852) 2887 4788, Fax: (852) 2508 1846