



# Compact I/O Isolated Analog Modules

Catalog Numbers 1769-IF4I, 1769-OF4CI, 1769-OF4VI



# 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 [SGL-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.



**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.

**IMPORTANT**

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

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**Glossary**

Read this preface to familiarize yourself with the rest of the manual. This preface covers the following topics:

- Who should use this manual
- How to use this manual
- Related publications
- Conventions used in this manual
- Rockwell Automation support

### Who Should Use This Manual

Use this manual if you are responsible for designing, installing, programming, or troubleshooting control systems that use the Allen-Bradley Compact I/O system.

### How to Use This Manual

As much as possible, we organized this manual to explain, in a task-by-task manner, how to install, configure, program, operate and troubleshoot a control system using the 1769 isolated analog I/O modules.

### Manual Contents

For	See
An overview of the analog input and output modules	Chapter 1
Installation and wiring guidelines	Chapter 2
Input module addressing, configuration, and status information	Chapter 3
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Information on module diagnostics and troubleshooting	Chapter 5
Specifications for the input and output modules	Appendix A
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## Related Documentation

The table below provides a listing of publications that contain important information about MicroLogix 1500 systems.

For	Read this document	Document number
A user manual containing information on how to install, use and program your MicroLogix 1500 controller.	MicroLogix 1500 User Manual	1764-UM001
A user manual containing information on how to install, and use your 1769-ADN DeviceNet adapter.	DeviceNet Adapter User Manual	1769-UM001
A user manual containing information on how to install, use and program your 1769-L20 and -L30 CompactLogix controllers.	CompactLogix User Manual	1769-UM007
A user manual containing information on how to install, use and program your 1769-L31, -L32C, -L32E, -L35CR and -L35E CompactLogix controllers.	CompactLogix System User Manual	1769-UM011
An overview of 1769 Compact I/O modules.	Compact I/O Selection Guide	1769-SG002
An overview of the MicroLogix 1500 System, including the 1769 Compact I/O system.	MicroLogix 1500 System Overview	1764-S0001
In-depth information on grounding and wiring Allen-Bradley programmable controllers.	Allen-Bradley Programmable Controller Grounding and Wiring Guidelines	1770-4.1

If you would like a manual, you can:

- download a free electronic version from the internet at [www.literature.rockwellautomation.com](http://www.literature.rockwellautomation.com).
- purchase a printed manual by contacting your local distributor or Rockwell Automation representative.

## Conventions Used in This Manual

The following conventions are used throughout this manual.

- Bulleted lists (like this one) provide information, not procedural steps.
- Numbered lists provide sequential steps or hierarchical information.
- **Bold** type is used for emphasis.



## Overview

This chapter explains how analog data is used, describes the 1769-IF4I isolated analog input module, and describes the 1769-OF4CI and 1769-OF4VI isolated analog output modules. Included is information about:

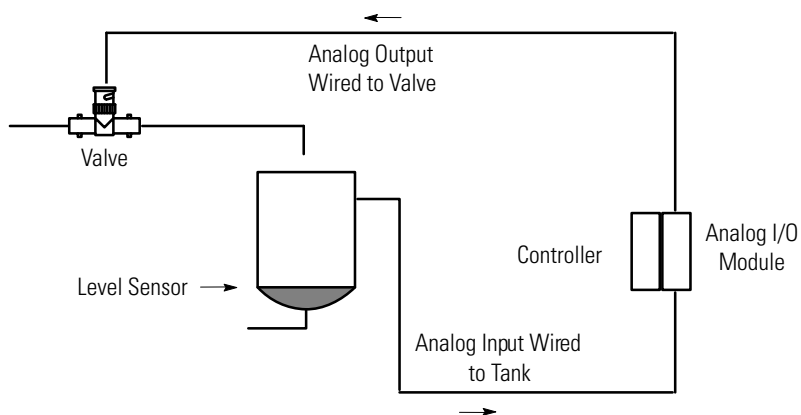
- the use of analog I/O.
- the modules' hardware and diagnostic features.
- an overview of the 1769 analog input system operation.
- an overview of the 1769 analog output system operation.

### How to Use Analog I/O Data

Analog refers to the representation of numerical quantities by the measurement of continuous physical variables. Analog applications are present in many forms. The following application shows a typical use of analog data.

In this application, the controller controls the amount of fluid in a holding tank by adjusting the valve opening. The valve is initially open 100%. As the fluid level in the tank approaches the preset point, the controller modifies the output to close the valve 90%, 80%, and so on, continuously adjusting the valve to maintain the fluid level.

**Figure 1.1 Analog I/O Application Example**



## General Description

The 1769-IF4I isolated analog input module converts and digitally stores analog data for retrieval by controllers, such as the CompactLogix controller or the MicroLogix 1500 controller. The module supports connections from any combination of as many as four voltage or current analog sensors. The 1769-IF4I input module provides four, isolated-differential analog input channels.

The 1769-OF4CI and -OF4VI isolated output modules each provide four, isolated differential analog output channels.

The modules provide the following input/output types/ranges:

**Table 1.1 Normal and Full Ranges**

Normal Operating Input Range	Full Module Range
$\pm 10\text{V dc}$	$\pm 10.5\text{V dc}$
$1 \dots 5\text{V dc}$	$0.5 \dots 5.25\text{V dc}$
$0 \dots 5\text{V dc}$	$-0.5 \dots +5.25\text{V dc}$
$0 \dots 10\text{V dc}$	$-0.5 \dots +10.5\text{V dc}$
$0 \dots 20\text{ mA}$	$0 \dots 21\text{ mA}$
$4 \dots 20\text{ mA}$	$3.2 \dots 21\text{ mA}$

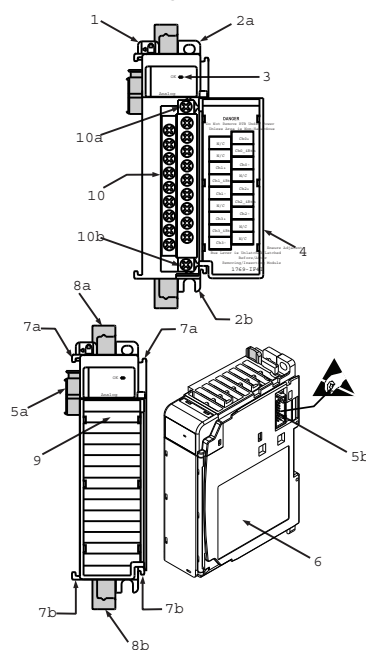
The data can be configured on board each module as:

- engineering Units.
- scaled-for-PID.
- percent.
- raw/proportional data.

## Hardware Features

The modules contain removable terminal blocks. The modules' channels are isolated from each other and are normally wired as differential inputs or outputs. Single-ended applications can be supported by wiring the negative terminal of each channel to the other channel's negative terminals; however, this eliminates the channel-to-channel isolation provided by the modules.

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.

**Figure 1.2 Isolated Analog Modules' Hardware Features****Table 1.2 Isolated Modules' Feature Descriptions**

Item	Description
1	Bus lever (with locking function)
2a	Upper-panel mounting tab
2b	Lower-panel mounting tab
3	Module status LEDs
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 upper retaining screw
10b	RTB lower retaining screw

### General Diagnostic Features

The analog modules contain diagnostic features that can help you identify the source of problems that may occur when cycling power or during normal channel operation.

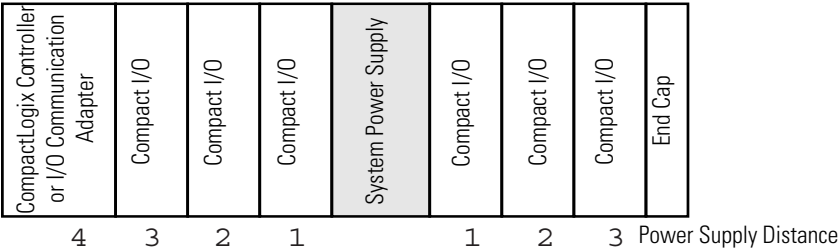
These power cycle and channel diagnostics are explained in chapter 5.

### System Overview

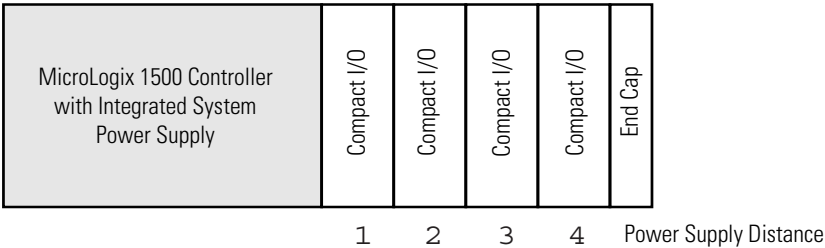
The modules communicate to the controller through the bus interface. The modules also receive 5 and 24V dc power through the bus interface.

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.

Figure 1.3 Determine Power Supply Distance



or



## System 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 LED remains off. If no faults are found during power-cycle diagnostics, the module status OK LED 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, it begins the analog-to-digital or digital-to-analog conversion process.

### *Input Modules*

Each time a channel is read by the input module, that analog data value is tested by the module for an over-range or under-range condition. If any of these conditions are detected, unique bits are set in the channel status word.

The channel status word is described in the 1769-IF4I Input Data File on page 3-3.

The controller reads the two's complement binary converted analog data from the modules. This typically occurs at the end of the program scan or when commanded by the control program. If the controller and the modules determine that the bus data transfer was made without error, the data is used in your control program.

### *Output Modules*

The output modules monitor channels for over-range and under-range conditions and can also clamp the outputs at designated levels (if enabled by the user program). If such conditions are detected, a unique bit is set in the channel status word.

The channel status word is described in the 1769-OF4CI and -OF4VI Output Data File on page 4-3.

The output modules receive two's complement binary values from the bus master. 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 transfer was completed without error, the output module converts the data to an analog output signal.

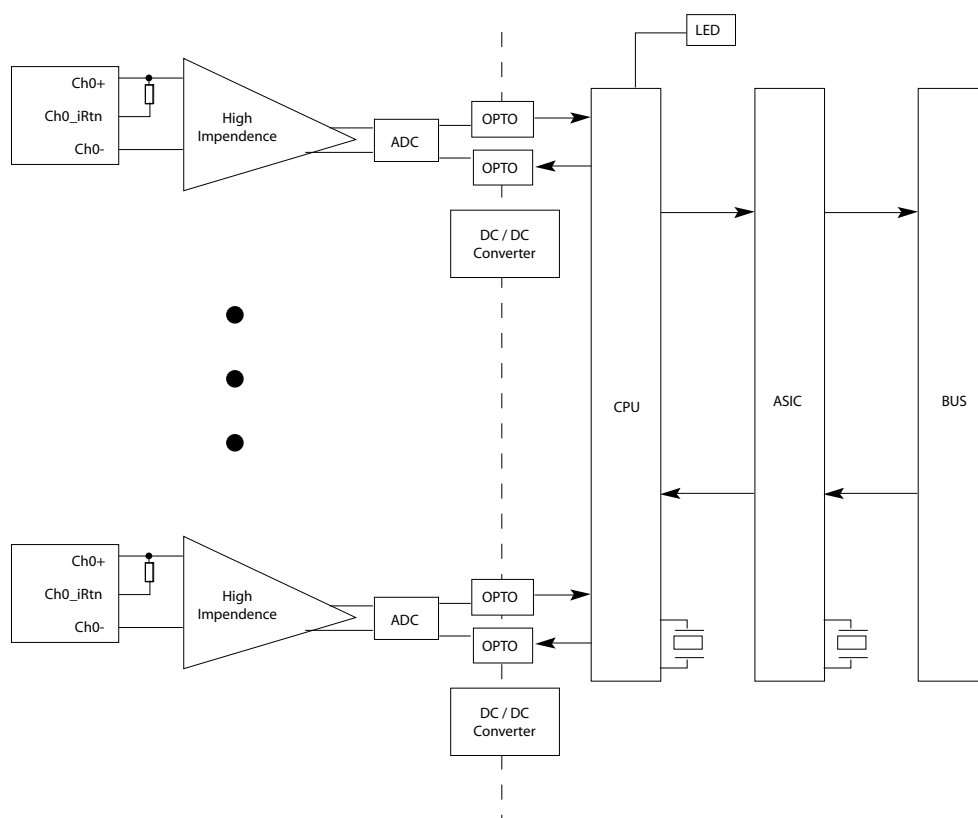
## Module Operation

The following sections describe the input and output modules' block diagrams.

### *Input Module Block Diagram*

The input module's input circuitry consists of four isolated-differential analog inputs each with it's own analog-to-digital (A/D) converter. The A/D converter reads the selected input signal and converts it to a digital value that is presented to the controller.

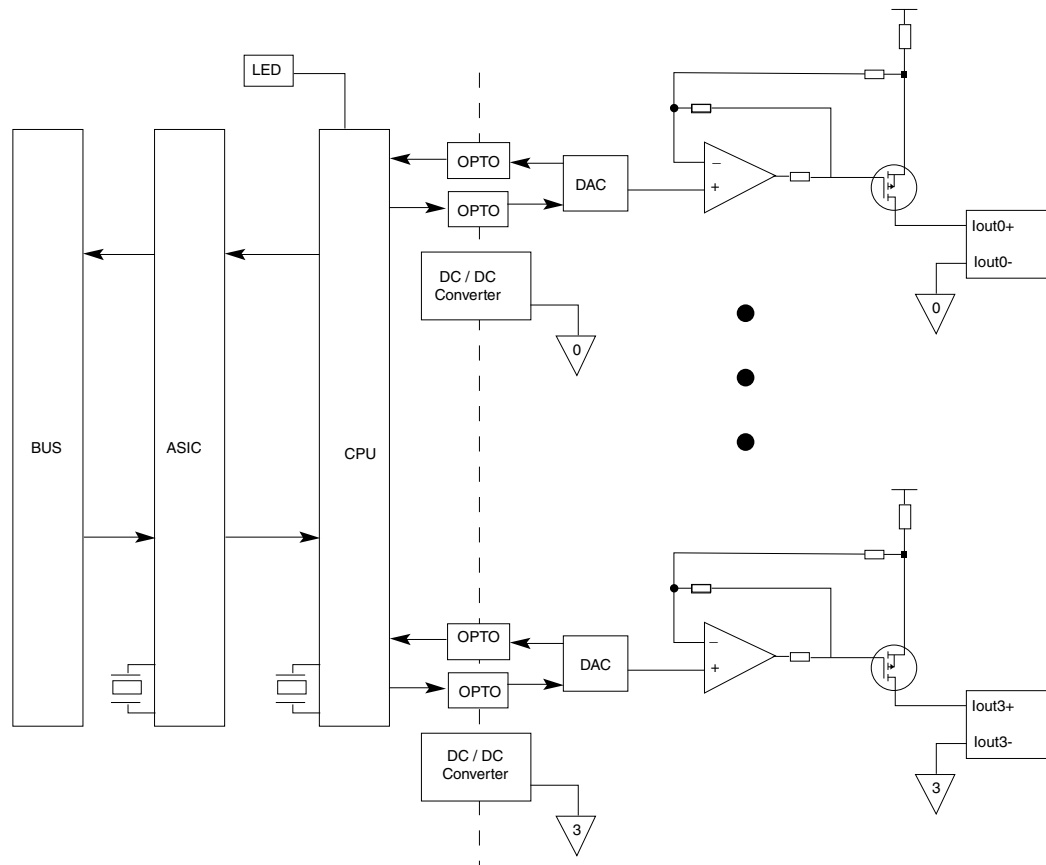
**Figure 1.4 1769-IF4I Block Diagram**



### Output Modules Block Diagram

The output modules use one digital-to-analog (D/A) converter per isolated output channel to convert the digital output data from the controller to an analog output signal.

**Figure 1.5 1769-OF4CI Block Diagram**







## **Installation and Wiring**

This chapter tells you how to:

- determine the power requirements for the modules.
- avoid electrostatic damage.
- install the module.
- wire the module's terminal block.
- wire input devices.
- wire output devices.

### **Compliance to European Union Directives**

This product is approved for installation within the European Union and EEA regions. It has been designed and tested to meet the following directives.

#### **EMC Directive**

The analog modules are tested to meet Council Directive 2004/108/EC Electromagnetic Compatibility (EMC) and the following standards, in whole or in part, documented in a technical construction file:

- EN 61000-6-4  
EMC – Generic Emission Standard, 6-4 - Industrial Environment
- EN 61000-6-2  
EMC – Generic Immunity Standard, Part 6-2 - Industrial Environment

This product is intended for use in an industrial environment.

#### **Low Voltage Directive**

This product is tested to meet Council Directive 2006/95/EC Low Voltage, by applying the safety requirements of EN 61131-2 Programmable Controllers, Part 2 – Equipment Requirements and Tests.

For specific information required by EN61131-2, see the appropriate sections in this publication, as well as the following Allen-Bradley publications:

- Industrial Automation, Wiring and Grounding Guidelines for Noise Immunity, publication 1770-4.1
- Automation Systems Catalog, publication B113

## Power Requirements

The modules receive power through the bus interface from the +5V dc/+24V dc system power supply.

**Table 2.1 Maximum Current Draw**

Module	5V dc	24V dc
1769-IF4I (Series A)	145 mA	125 mA
1769-OF4CI (Series A)	145 mA	140 mA
1769-OF4VI (Series A)	145 mA	75 mA

## 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<sup>(1)</sup>) and to circuits not exceeding Over Voltage Category II<sup>(2)</sup> (IEC 60664-1).<sup>(3)</sup>

<sup>(1)</sup> 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.

<sup>(2)</sup> 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.

<sup>(3)</sup> Pollution Degree 2 and Over Voltage Category II are International Electrotechnical Commission (IEC) designations.

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## Hazardous Location Considerations

This equipment is suitable for use in Class I, Division 2, Groups A, B, C, D or non-hazardous 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 non-hazardous.
  - Do not connect or disconnect components unless power has been switched off or the area is known to be non-hazardous.
  - This product must be installed in an enclosure.
  - All wiring must comply with N.E.C. article 501-4(b).
- 

## Prevent 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 input 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.
  - When it is not in use, keep the module in its static-shield box.
-

## 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.

---

## Reduce Noise

Most applications require installation in an industrial enclosure to reduce the effects of electrical interference. Analog inputs and outputs are highly susceptible to electrical noise. Electrical noise coupled to the analog inputs will reduce 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 which 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 input and output wiring away from any high-voltage I/O wiring.

## Protect the Circuit Board from Contamination

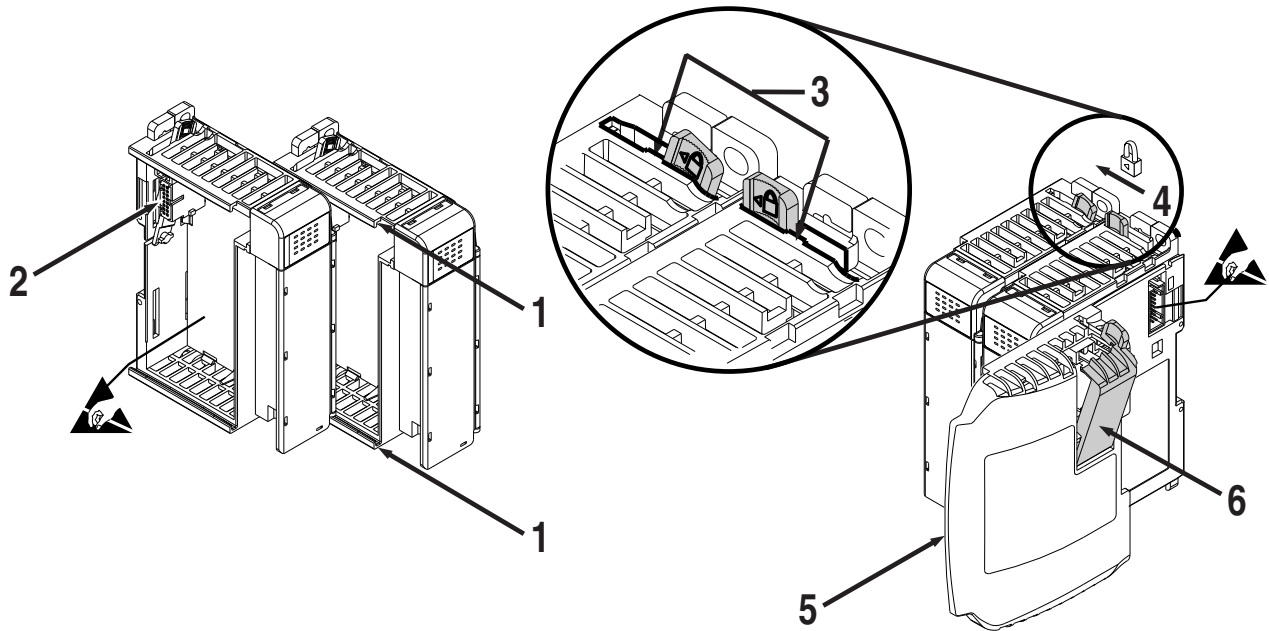
The printed circuit boards of the analog modules must be protected from dirt, oil, moisture, and other airborne contaminants. To protect these boards, the system must be installed in an enclosure suitable for the environment. The interior of the enclosure should be kept clean and the enclosure door should be kept closed whenever possible.

## System Assembly

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

For mounting instructions, see Panel Mounting Using the Dimensional Template on page 2-7, or DIN-rail Mount on page 2-8. To work with a system that is already mounted, see Replace a Single Module Within a System on page 2-8.

**Figure 2.1 Assemble the Compact I/O System**



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. Push the bus lever back slightly to clear the positioning tab (3). Use your fingers or a small screwdriver.

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

## Mount

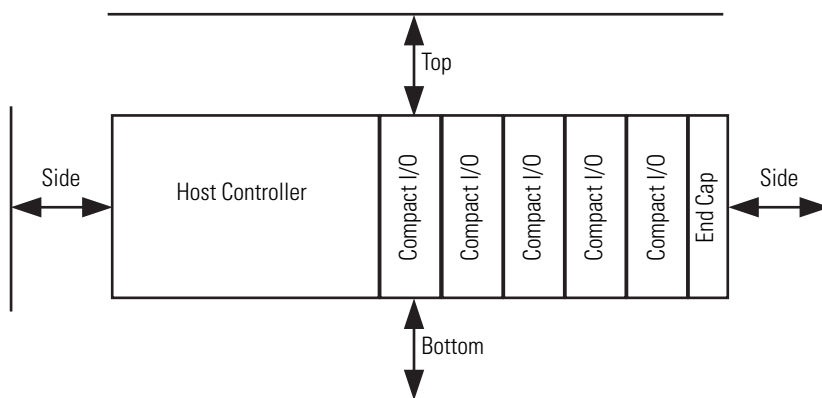
**ATTENTION**

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.

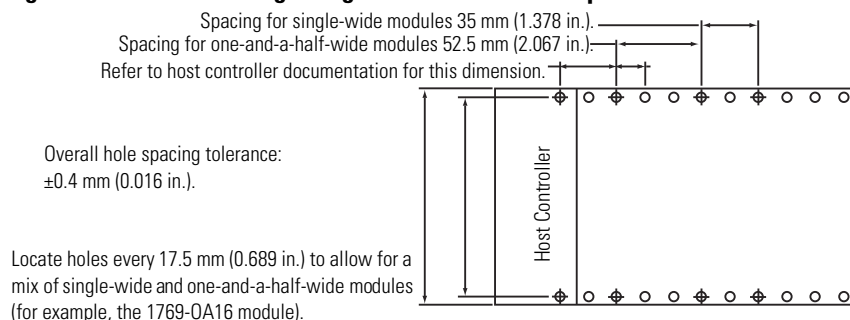
**Figure 2.2 Space Requirements**



## Panel Mount

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

**Figure 2.3 Panel Mounting Using the Dimensional Template**



### *Panel Mounting Procedure Using Modules as a Template*

The following procedure allows you to 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 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 to 6 for any remaining modules.

## DIN-rail Mount

The module can be mounted using the following DIN rails:  
35 x 7.5 mm (EN 50 022 - 35 x 7.5) or 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 using a flat-blade or Phillips 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).

## Field Wiring Connections

Use the following information to properly make field wiring connections.

### Ground

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 Allen-Bradley Industrial Automation Wiring and Grounding Guidelines, publication 1770-4.1, for additional information.

## System Wiring Guidelines

Consider the following when wiring your system.

### *General Guidelines*

- Channels are isolated from each other.
- Do not use the analog module's NC terminals as connection points.
- To ensure 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.
- Keep shield connection to ground as short as possible.
- 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.<sup>(1)</sup>

<sup>(1)</sup> 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 0.1µF capacitor at the sensor end.

### 1769-IF4I Input Module Guidelines

- If multiple power supplies are used with analog inputs, the power supply commons must be kept at potentials that do not result in the module's working voltage rating being exceeded.
- The 1769-IF4I module does not provide loop power for analog inputs. Use power supplies that match the input transmitter specifications.
- Differential analog inputs are more immune to noise than single-ended analog inputs.
- Voltages on Ch+, Ch-, and Ch\_IRtn for a single, isolated channel of the 1769-IF4I module must not exceed the module's maximum overload levels.
- 1769-IF4I channels used as current inputs require a jumper to be placed between a channel's CH\_IRtn and Ch- terminals.

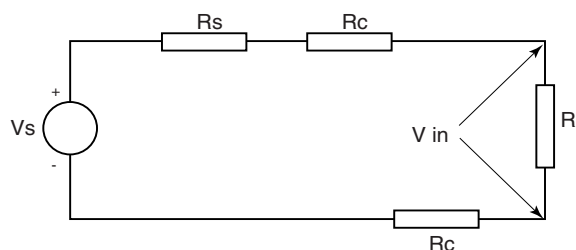
### 1769-OF4CI and -OF4VI Output Modules Guidelines

- Voltage outputs (Vout 0+ to Vout 3+ for 1769-OF4VI) of the output module are referenced to each channel's Vout- terminal (channels are isolated from each other). Load resistance for a voltage output channel must be equal to or greater than 2 k $\Omega$
- Current outputs (Iout 0+ to Iout 3+ for 1769-OF4CI) of the output module source current that returns to each channel's Iout- terminal (channels are isolated from each other). Load resistance for a current output channel must remain between 0 and 500  $\Omega$

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

For voltage inputs, the length of the cable used between the transducer/sensor and the 1769-IF4I module can affect the accuracy of the data provided by the module.

**Figure 2.4 Voltage Input Accuracy**



Where:

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

$R_s$  = Source impedance of analog transducer/sensor input

$R_i$  = Impedance of the voltage input (1 M $\Omega$  for 1769-IF4I)

$V_s$  = Voltage source (voltage at the transducer/sensor input device)

$V_{in}$  = Measured potential at the module input

%Ai = 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:

$R_c$  = 16  $\Omega$ /1000 ft

$R_s$  = 0 (ideal source)

**Table 2.2 Effect of Cable Length on Input Accuracy**

Length of Cable, m (ft)	DC Resistance of the Cable, $R_c$ ( $\Omega$ )	Accuracy Impact at the Input Module
50 (164)	2.625	0.000525%
100 (328)	5.25	0.00105%
200 (656)	10.50	0.0021%
300 (984)	15.75	0.00315%

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

As input source 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 source and cable.

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

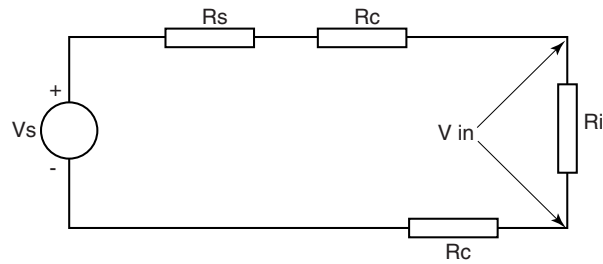
**TIP**

In a current loop system, source and cable impedance do not impact system accuracy.

### Effect of Device and Cable Output Impedance on Output Module Accuracy

The maximum value of the output impedance is shown in the example below, because it creates the largest deviation from an ideal voltage source.

**Figure 2.5 Output Module Accuracy**



Where:

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

$R_s$  = Source impedance (1  $\Omega$  for 1769-OF4VI)

$R_i$  = Impedance of the voltage input (220 k $\Omega$  for 1769-IF4I)

$V_s$  = Voltage at the output of 1769-OF4VI

$V_{in}$  = Measured potential at the module input

%Ai = 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-OF4CI output module:

$R_c$  = 16  $\Omega$ /1000 ft

$R_s$  = 15  $\Omega$

$R_i$  = 220 k $\Omega$

**Table 2.3 Effect of Output Impedance and Cable Length on Accuracy**

Length of Cable (m)	dc Resistance of the Cable $R_c$ ( $\Omega$ )	Accuracy Impact at the Input Module
50	2.625	0.00919%
100	5.25	0.01157%
200	10.50	0.01634%
300	15.75	0.02111%

$$\%Ai = \left(1 - \frac{Vin}{Vs}\right) \times 100$$

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 output module and cable.

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

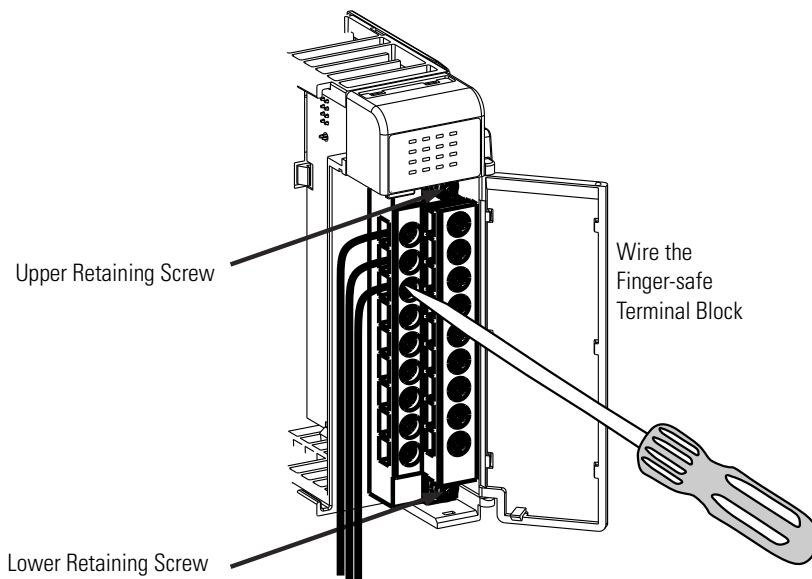
**TIP**

In a current loop system, source and cable impedance do not impact system accuracy.

## 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.

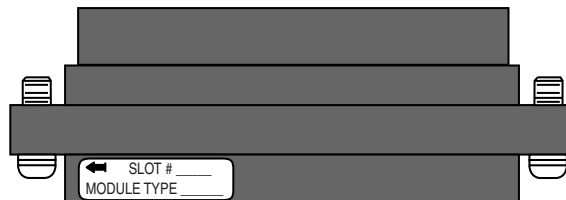
**Figure 2.6 Terminal Labels**



## 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 can be indicated by circling either the R for right side or L for left side.

**Figure 2.7 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 Nm (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 Nm (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.

**Table 2.4 Terminal Wire Considerations**

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

## Wire the Modules

**ATTENTION**

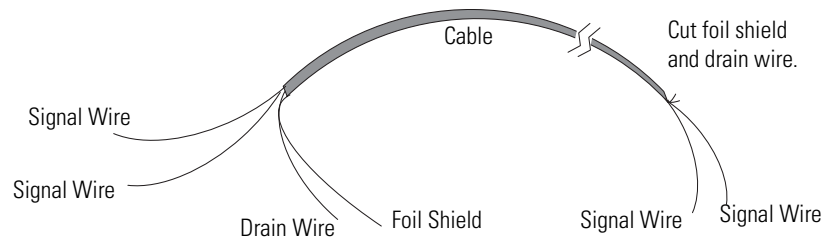
To prevent shock hazard, care should be taken when wiring the module to analog signal sources. Before wiring any analog module, disconnect power from the system power supply and from any other source to the analog module.

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

**ATTENTION**

When wiring an analog input, take care to avoid connecting a voltage source to a channel configured for current input. Improper module operation or damage to the voltage source can occur.

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

**Figure 2.8 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 2-inch 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.

3. 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 ground the cable shields to earth at the module end via a 0.1  $\mu\text{F}$  capacitor at the sensor end for analog inputs and at the load end for analog outputs.

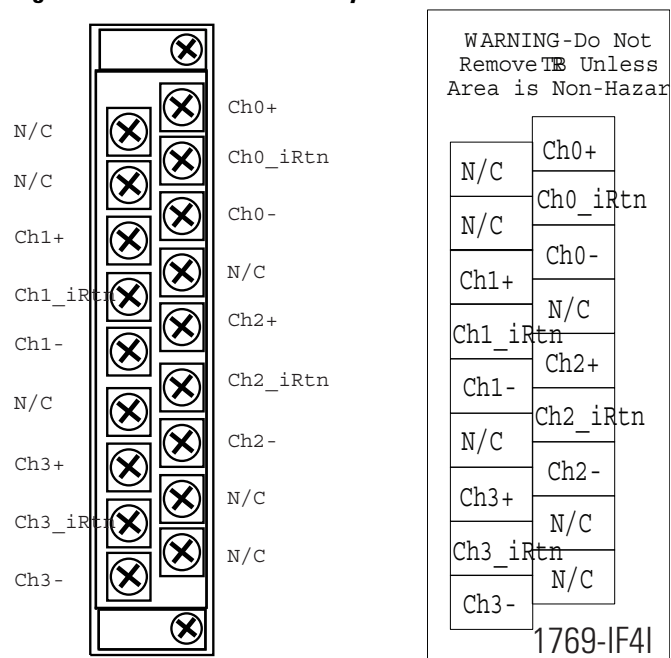
4. At the other end of the cable, cut the drain wire and foil shield back to the cable.
5. Connect the signal wires to the terminal block.

Refer to Analog Input Module Wiring on page 2-19 and Analog Output Modules Wiring on page 2-21.

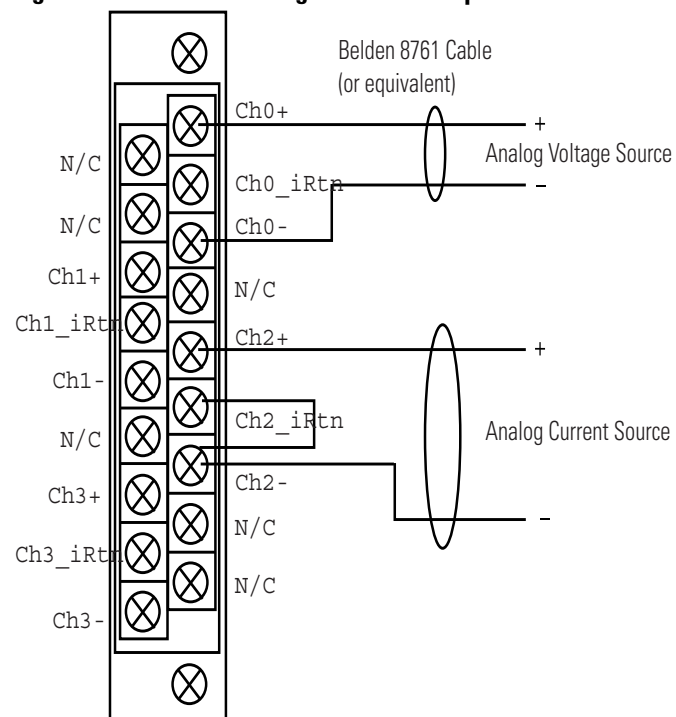
6. Connect the other end of the cable to the analog input or output device.
7. Repeat steps 1 to 5 for each channel on the module.

## Analog Input Module Wiring

**Figure 2.9 1769-IF4I Terminal Layout**

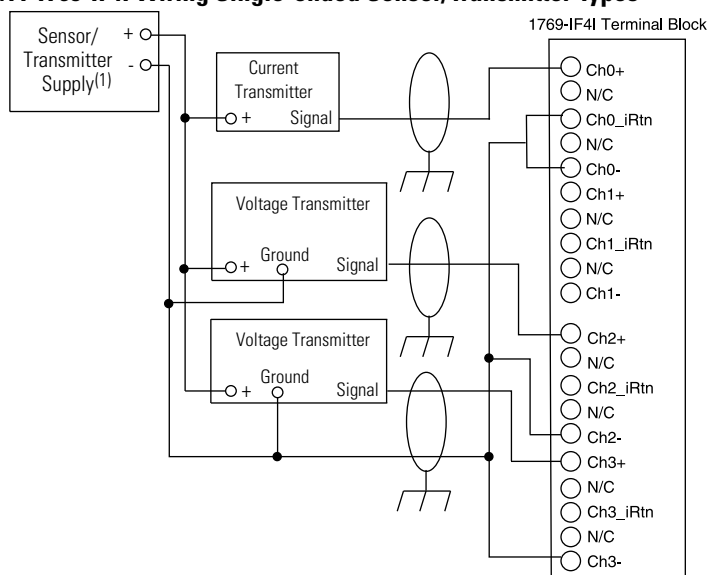
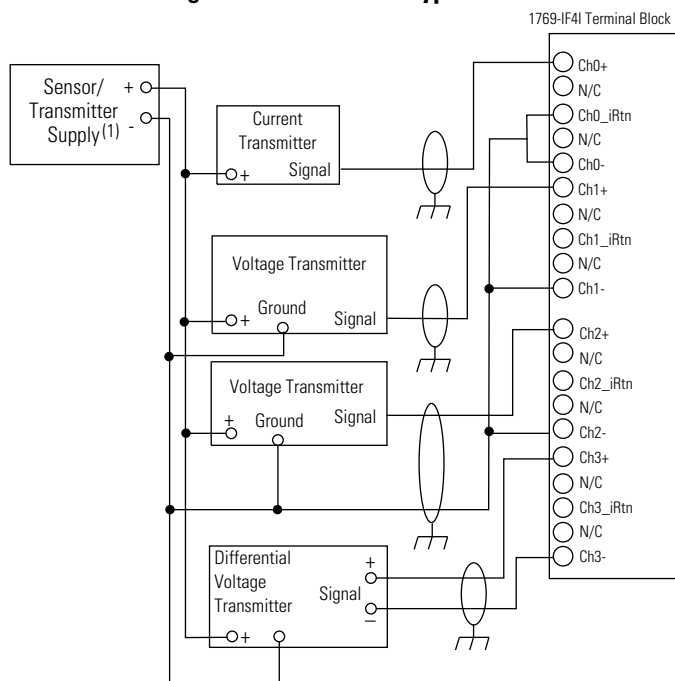


**Figure 2.10 1769-IF4I Wiring Differential Inputs**



### IMPORTANT

1769-IF4I input channels connected to current sources must have a jumper wire placed between Ch#\_iRtn and the Ch#- terminals for that channel.

**Figure 2.11 1769-IF4I Wiring Single-ended Sensor/Transmitter Types****Figure 2.12 1769-IF4I Wiring Mixed Transmitter Types**

(1) The external power supply must be rated Class 2.

### IMPORTANT

1769-IF4I input channels connected to current sources must have a jumper wire placed between Ch#\_iRtn and the Ch#- terminals for that channel.

## Analog Output Modules Wiring

Figure 2.13 1769-OF4CI Terminal Layout

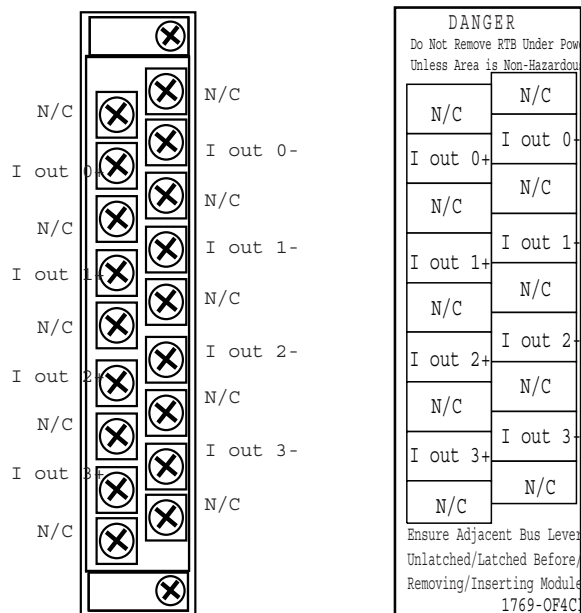


Figure 2.14 1769-OF4CI Wiring Diagram

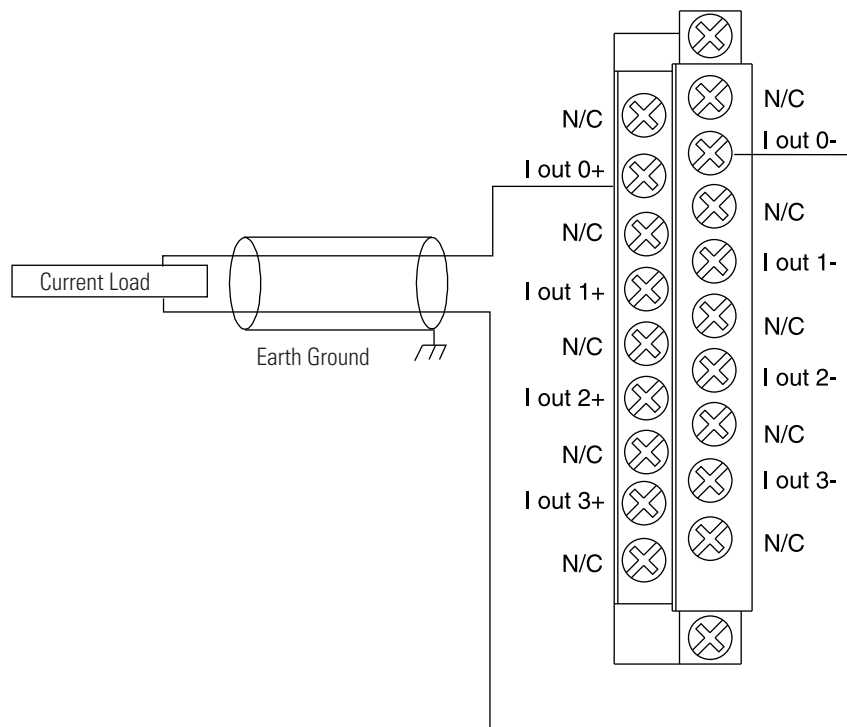


Figure 2.15 1769-OF4VI Terminal Layout

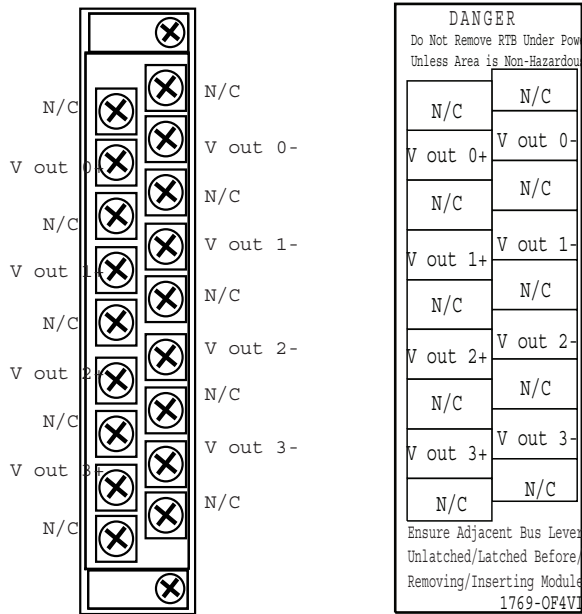
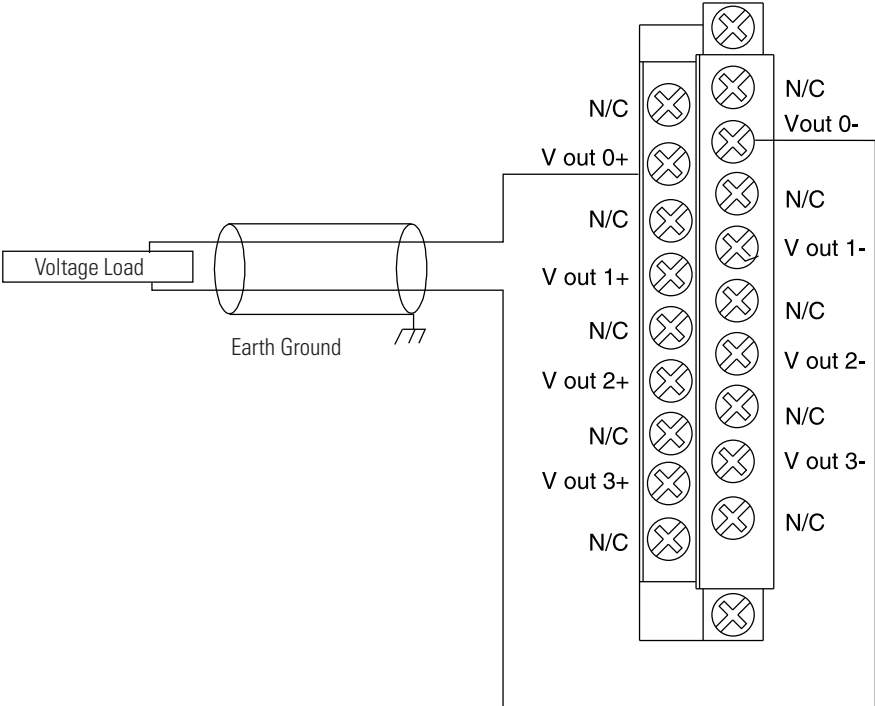


Figure 2.16 1769-OF4VI Wiring Diagram



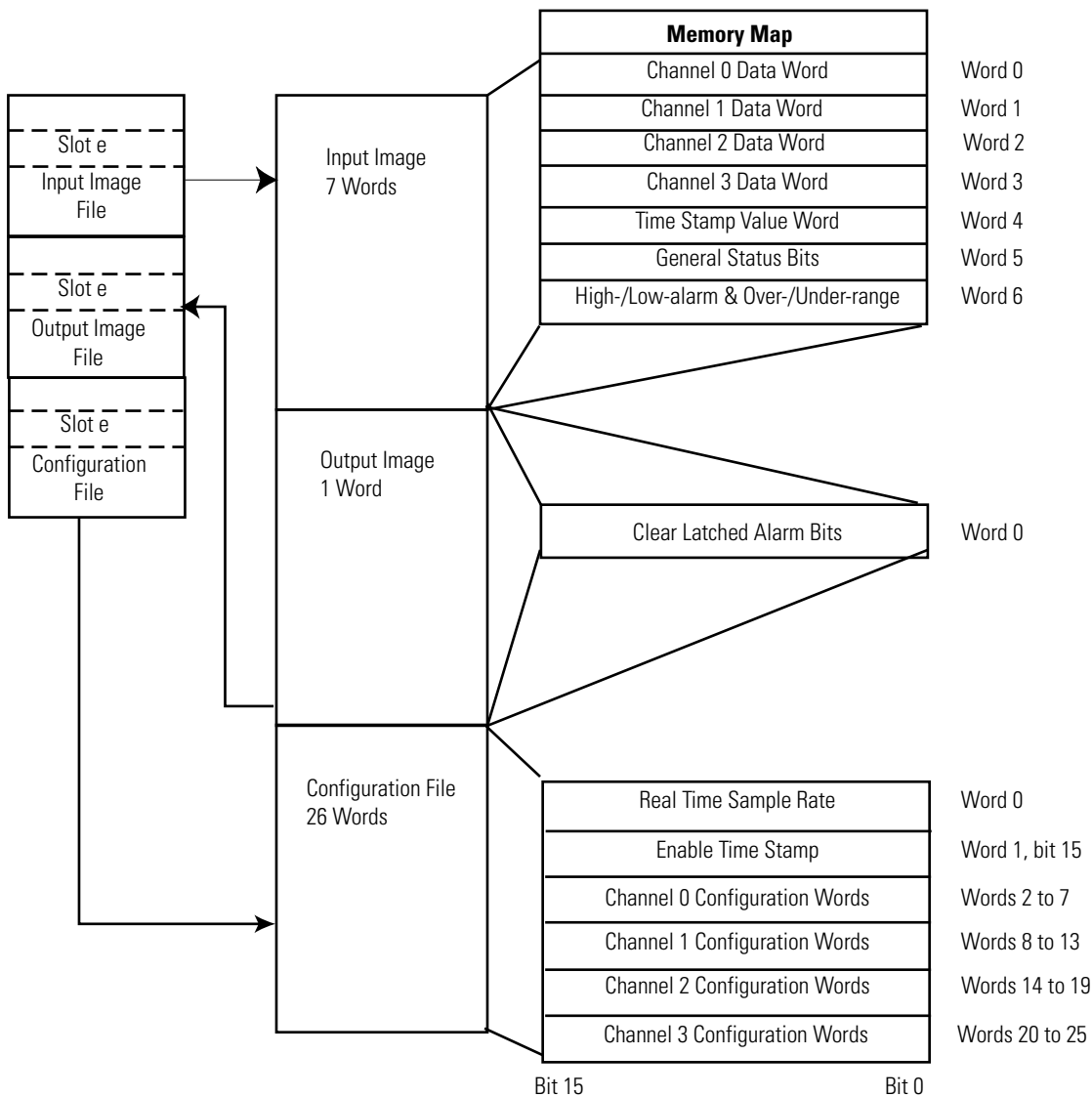
# Module Data, Status, and Channel Configuration for the Input Module

This chapter examines the analog input module’s data table, channel status, and channel configuration word.

## 1769-IF4I Input Module Addressing

The 1769-IF4I memory map shows the output, input, and configuration tables for the 1769-IF4I module.

Figure 3.1 1769-IF4I Memory Map



## 1769-IF4I Input Image

The 1769-IF4I input image file represents data words and status bits. Input words 0 to 3 hold the input data that represents the value of the analog inputs for channels 0 to 3. These data words are valid only when the channel is enabled and there are no errors. Input words 5 and 6 hold the status bits. To receive valid status information, the channel must be enabled.

**TIP**

You can access information in the input image file using the programming software configuration screen.

## 1769-IF4I Output Image

The 1769-IF4I output image file contains the clear alarm control bits for the high- and low-alarm bits on each input channel. These bits are used to clear alarms when alarms are latched.

**TIP**

You can access information in the output image file using the programming software configuration screen.

## 1769-IF4I 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 1769-IF4I Configuration Data File on page 3-6.

**TIP**

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



## 1769-IF4I Input Data File

The input data table lets you access analog input 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 input module, slot x, words 0 to 3 in the input data file contain the analog values of the inputs.

**Table 3.1 1769-IF4I Input Data Table**

Word	Bit Position															
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	SGN	Analog Input Data Channel 0														
1	SGN	Analog Input Data Channel 1														
2	SGN	Analog Input Data Channel 2														
3	SGN	Analog Input Data Channel 3														
4	Nu	Time Stamp Value														
5	Nu	Nu	Nu	Nu	Nu	Nu	Nu	Nu	Nu	Nu	Nu	Nu	S3	S2	S1	S0
6	L3	H3	U3	O3	L2	H2	U2	O2	L1	H1	U1	O1	L0	H0	U0	O0

## 1769-IF4I Input Data Values

Words 0 to 3 contain the converted analog input data from the field device. 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 0.)

### *General Status Bits (S0 to S3)*

Word 5, bits 0 to 3 contain the general operational status bits for input channels 0 to 3. If set (1), these bits indicate an error associated with that channel. The over- and under-range bits and the high- and low-alarm bits for channels 0 to 3 are logically ORed to the appropriate general status bit.

### *Low Alarm Flag Bits (L0 to L3)*

Word 6, bits 3, 7, 11, and 15 contain the low alarm flag bits for input channels 0 to 3. If set (1), these bits indicate the input signal is outside the user-defined range. The module continues to convert analog data to minimum full-range values. The bit is automatically reset (0) when the low alarm condition clears, unless the channel's alarm bits are latched. If the channel's alarm bits are latched, a set (1) low alarm flag bit clears via the corresponding Clear Alarm Latch bit in your output data file.

### *High Alarm Flag Bits (H0 to H3)*

Word 6, bits 2, 6, 10, 14 contain the high alarm flag bits for input channels 0 to 3 and applies to all input types. If set (1), the input signal is outside the user-defined range. The module continues to convert analog data to maximum full-range values. The bit is automatically reset (0) when the high alarm condition clears, unless the channel's alarm bits are latched. If the channel's alarm bits are latched, a set (1) high alarm flag bit clears via the corresponding Clear Alarm Latch bit in your output data file.

### *Over-Range Flag Bits (O0 to O3)*

Over-range bits for channels 0 to 3 are contained in Word 6, bits 0, 4, 8, 12. They apply to all input types. When set (1), this bit indicates input signals beyond the normal operating range. However, the module continues to convert analog data to the maximum full range value. The bit is automatically reset (0) by the module when the over-range condition is cleared and the data value is within the normal operating range.

### *Under-Range Flag Bits (U0 to U3)*

Under-range bits for channels 0 to 3 are contained in Word 6, bits 1, 5, 9, 13. They apply to all input types. When set (1), this bit indicates input signals below the normal operating range. It may also indicate an open circuit condition, when the module is configured for any voltage range or the 4 to 20 mA range. However, the module continues to convert analog data to the minimum full range value. The bit is automatically reset (0) by the module when the under-range condition is cleared and the data value is within the normal operating range.

### *Time Stamp Value (Word 4)*

The 1769-IF4I supports a 15-bit rolling timestamp that is updated during each new update of the analog input values. The timestamp has a 1 ms resolution. The timestamp value is placed in the Input Data file, word 4, for each module input data update (if the timestamp function is enabled). Enable and/or disable this timestamp in word 1, bit 15 of the Configuration Data file.

## 1769-IF4I Output Data File

The output data table lets you access analog output module write data for use in the control program, via word and bit access.

**Table 3.2 1769-IF4I Output Data Table**

Word	Bit Position															
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	Nu <sup>(1)</sup>	Nu	Nu	Nu	Nu	Nu	Nu	Nu	UL3 <sup>(2)</sup>	UH3 <sup>(3)</sup>	UL2	UH2	UL1	UH1	UL0	UH0

<sup>(1)</sup> Nu = Not used. Bit must be set to 0.

<sup>(2)</sup> ULx = Unlatch Low Process Alarm Latch x. This lets you individually cancel each low process alarm latch. Cancel = 1.

<sup>(3)</sup> UHx = Unlatch High Process Alarm Latch x. This lets you individually cancel each high process alarm latch.

These bits are written during run mode to clear any latched low- and high-process alarms. The alarm is unlatched when the unlatch bit is set (1) and the alarm condition no longer exists. If the alarm condition persists, then the unlatch bit has no effect until the alarm condition no longer exists. You need to keep the unlatch bit set until verification from the appropriate input channel status word that the alarm status bit has cleared (0). Then you need to reset (0) the unlatch bit. The module will not latch an alarm condition if a transition from no alarm to alarm occurs while a channel's clear latch bit is set.

## 1769-IF4I Configuration Data File

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

**Table 3.3 1769-IF8 Configuration Data Table**

Word	Bit Position															
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	Real Time Sample Value															
1	ETS	Reserved														
2	EC	Reserved				EA	AL	E <sub>I</sub> <sup>(1)</sup>	Reserved				Inpt Filter Sel ChI0			
3	Reserved					Inpt Dta Fm ChI0			Reserved				Inpt Tp/RngeSel ChI0			
4	S	Process Alarm High Data Value Channel 0														
5	S	Process Alarm Low Data Value Channel 0														
6	S	Alarm Dead Band Value Channel 0														
7	Reserved															
8	EC	Reserved				EA	AL	E <sub>I</sub> <sup>(1)</sup>	Reserved				Inpt Filter Sel ChI1			
9	Reserved					Inpt Dta Fm ChI1			Reserved				Inpt Tp/RngeSel ChI1			
10	S	Process Alarm High Data Value Channel 1														
11	S	Process Alarm Low Data Value Channel 1														
12	S	Alarm Dead Band Value Channel 1														
13	Reserved															
14	EC	Reserved				EA	AL	E <sub>I</sub> <sup>(1)</sup>	Reserved				Input Filter Sel ChI2			
15	Reserved					Inpt Dta Fm ChI2			Reserved				Inpt Tp/RngeSel ChI2			
16	S	Process Alarm High Data Value Channel 2														
17	S	Process Alarm Low Data Value Channel 2														
18	S	Alarm Dead Band Value Channel 2														
19	Reserved															
20	EC	Reserved				EA	AL	E <sub>I</sub> <sup>(1)</sup>	Reserved				Input Filter Sel ChI3			
21	Reserved					Inpt Dta Fm ChI3			Reserved				Inpt Tp/RngeSel ChI3			
22	S	Process Alarm High Data Value Channel 3														
23	S	Process Alarm Low Data Value Channel 3														
24	S	Alarm Dead Band Value Channel 3														
25	Reserved															

<sup>(1)</sup> CompactLogix L43 controllers will be able to support these interrupts.

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

For information on configuring the module using MicroLogix 1500 and RSLogix 500 software, see Appendix B; for CompactLogix and RSLogix 5000 software, see Appendix C; for 1769-ADN DeviceNet adapter and RSNetWorx software, see Appendix D.

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 page 3-7.

## Channel Configuration

Each channel's configuration words consist of bit fields, the settings of which determine how the channel operates. See the table below and the descriptions that follow for valid configuration settings and their meanings. The default bit status of the configuration file is all zeros.

**Table 3.4 Bit Definitions for Channel Configuration Words**

Define	To Select	Make these bit settings													
		15	14	13	12	11	10	9	8	7...4	3	2	1	0	
Input Filter Selection	60 Hz											0	0	0	0
	50 Hz											0	0	0	1
	28.5 Hz											0	0	1	0
	300 Hz											0	0	1	1
	360 Hz											0	1	0	0
Enable Interrupt	Enable <sup>(1)</sup>									1					
	Disable									0					
Enable Process Alarm Latch	Enable								1						
	Disable								0						
Enable Process Alarms	Enable							1							
	Disable							0							
Enable Channel	Enable	1													
	Disable	0													

<sup>(1)</sup> CompactLogix L43 controllers will be able to support these interrupts.

**Table 3.5 Bit Definitions for Input Range and Input Data**

Define	Indicate this	These bit settings								
		15...11	10	9	8	7...4	3	2	1	0
Input 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
Input 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

This configuration selection lets each channel to be individually enabled.

**TIP**

When a channel is not enabled (0), no voltage or current input is provided to the controller by the A/D converter.

## Input Filter Selection

The input filter selection field lets you select the filter frequency for each channel and provides system status of the input filter setting for analog input channels 0 to 3. The filter frequency affects the noise rejection characteristics, as explained below. Select a filter frequency considering acceptable noise and step response time.

### *Noise Rejection*

The 1769-IF4I module uses a digital filter that provides noise rejection for the input signals. The filter is programmable, allowing you to select from five filter frequencies for each channel. A lower frequency (60 Hz versus 300 Hz) can provide better noise rejection but it increases channel update time. Transducer power supply noise, transducer circuit noise, or process variable irregularities may also be sources of normal mode noise.

Common Mode Rejection is better than 60 dB at 50 and 60 Hz, with the 50 and 60 Hz filters selected, respectively. The module performs well in the presence of common mode noise as long as the signals applied to the user plus and minus input terminals do not exceed the working voltage rating of the module. Improper earth ground may be a source of common mode noise.

### *Channel Step Response*

The selected channel filter frequency determines the channel's step response. The step response is the time required for the analog input signal to reach 100% of its expected final value. This means that if an input signal changes faster than the channel step response, a portion of that signal will be attenuated by the channel filter.

### *Module Update Time and Scanning Process*

The module update time is defined as the time required for the module to sample and convert the input signals of all enabled input channels and provide the resulting data values to the controller. For the 1769-IF4I, each input channel is continuously sampled at an independent rate determined by the filter setting selected for each channel. The module's Input Data file is updated on a channel-by-channel basis at a rate corresponding to the sample rate for each enabled channel.

The Filter Frequency and Update Times table shows the channel update times associated with each input channel filter setting. Selecting a filter setting for a channel will set the indicated update time for that channel in the Input Data file.

The Real Time Sampling function can be used to set a pre-determined module update time. When a valid Real Time Sample rate is set by the user, the module will update the Input Data file with the most recently sampled value from each input channel at the interval (module update time) set by the Real Time Sample rate. The Input Data file values are left unchanged between update times, but the input channels continue to be sampled at the fastest rate allowed by each channel's filter setting.

**Table 3.6 Filter Frequency and Update Times**

<b>Filter Frequency</b>	<b>Update Time per Channel</b>	<b>Update Time per Module<sup>(1)</sup></b>
28.5 Hz	108 ms	Not applicable
50 Hz	62 ms	Not applicable
60 Hz	52 ms	Not applicable
300 Hz	12 ms	Not applicable
360 Hz	10 ms	Not applicable

<sup>(1)</sup> If you use real-time sampling, the user-configured sample rate is used as the module update time.

### **Input Type/Range Selection**

This selection along with proper input wiring lets you configure each channel individually for current or voltage ranges and provides the ability to read the configured range selections.

## Input Data Selection Formats

This selection configures channels 0 to 3 to present analog data in any of the following formats.

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

### *Raw/Proportional Data*

The value presented to the controller is proportional to the selected input and scaled into the maximum data range allowed by the bit resolution of the A/D converter and filter selected. The full range for a  $\pm 10\text{V}$  dc user input is -32767 to +32767.

See Valid Input Data on page 3-11.

### *Engineering Units*

The module scales the analog input data to the actual current or voltage values for the selected input range. The resolution of the engineering units is dependent on the range selected and the filter selected.

See Valid Input Data on page 3-11.

### *Scaled-for-PID*

The value presented to the controller is a signed integer with zero representing the lower user range and 16383 representing the upper user range.

Allen-Bradley controllers, such as the MicroLogix 1500, use this range in their PID equations. The amount over and under user range (full scale range -410 to 16793) is also included.

See Valid Input Data on page 3-11.

### *Percent Range*

The input data is presented as a percentage of the user range. For example, 0V to 10V dc equals 0% to 100%.

See Valid Input Data on page 3-11.



### Valid Input Data Word Formats/Ranges

The following table shows the valid formats and min./max. data ranges provided by the module.

**Table 3.7 Valid Input Data**

1769-IF4I Normal Operating Input Range	Full Range (includes amounts over and under normal operating range)	Raw/Pro- portional Data	Engineering Units	Scaled-for-PID		Percent	
		Full Range		Normal Operating Range	Full Range	Normal Operating Range	Full Range
-10...+10V dc	+10.5...-10.5V	-32767... +32767	-10500... +10500	0...16383	-410...16793	-100... +100%	-105.00... 105.00%
0...5V dc	-0.5...5.25V	-32767... +32767	-500...5250		-1638... 17202	0...100%	-10.00... 105.00%
0...10V dc	-0.5...10.5V	-32767... +32767	-500... 10500		-819...17202		-5.00... 105.00%
4...20 mA	3.2...21 mA	-32767... +32767	3200... 21000		-819... +17407		-5.00... +106.25%
1.0...5V dc	0.5...5.25V		500...5250		-2048... 17407		-12.50... +106.25%
0...20 mA	0...21 mA		0...21000		0...17202		0.00... 105.00%

### 1769-IF4I Real Time Sampling

This parameter instructs the module how often to place the most recently scanned data for each enabled input channel into the Input Data file. This feature is applied on a module-wide basis.

During module configuration, you specify a Real Time Sampling (RTS) period by entering a value into Word 0 of the Configuration Data file. This value entered in Word 0 can be in the range of 0 to 5000 and indicates the sampling rate the module will use in 1 ms increments.

If you enter a 0 for the Real Time Sample Rate, the module will place each input channel's most recently scanned data into the Input Data file at as fast a rate as possible, controlled by the filter setting selected for each enabled channel.

The module compares the Real Time Sample Rate value entered in Word 0 of the Configuration Data file with each input channel's calculated update time, again based on the filter setting selected for each enabled channel. If the value entered for the Real Time Sample Rate is smaller than any input channel's calculated update time, the module indicates a configuration error. The longest Real Time Sample Rate supported by the 1769-IF4I is 5s, the maximum value for Word 0 of the Configuration Data file is 5000 decimal.

## **1769-IF4I Time Stamping**

This parameter instructs the module to insert a time stamp value into the Input Data file every time the file is updated.

During module configuration, you enable time stamping using Word 1, bit 15 of the Configuration Data file: Enable Time Stamping (ETS). Setting the ETS bit (1) enables the module's time stamping function. Clearing the ETS bit (0) disables the function. The default condition of the ETS bit is disabled (0).

The 1769-IF4I provides (when enabled) a rolling time stamp value of 0 to +32767 with each count representing 1 ms. When the time stamp count reached +32767, the value is reset to 0 and the value continues to increment one count every ms.

When enabled, the time stamp value in the Input Data file is updated with the current time stamp value each time an input channel data value is updated by the module. In normal sampling mode, each input channel of the 1769-IF4I is sampled and its converted value is placed into the Input Data file at a rate set by the filter setting for the channel.

Since each input channel is sampled independent from the other input channels, the time stamp value is updated each time any channel's value is updated. If Real Time Sampling is used, the values of all enabled input channels are updated in the Input Data file at the same time. In this case, the time stamp value is updated once per Real Time Sample period at the same time the channels' data values are updated.

## 1769-IF4I Process Alarms

Process alarms alert you when the module has exceeded configured high or low limits for **each channel**. You can latch process alarms. Process alarms can generate interrupts. (CompactLogix L43 controllers will be able to support these interrupts.) Process alarms are set at two user configurable alarm trigger points:

- Process Alarm High
- Process Alarm Low

Each input channel's process alarms are controlled by bits in the Configuration Data file. Enable alarms for a channel by setting (1) the EA bit for that channel. Set the AL bit (1) for a channel to enable the alarm latching. Set the EI bit (1) for a channel to enable interrupts on that channel's process alarms.

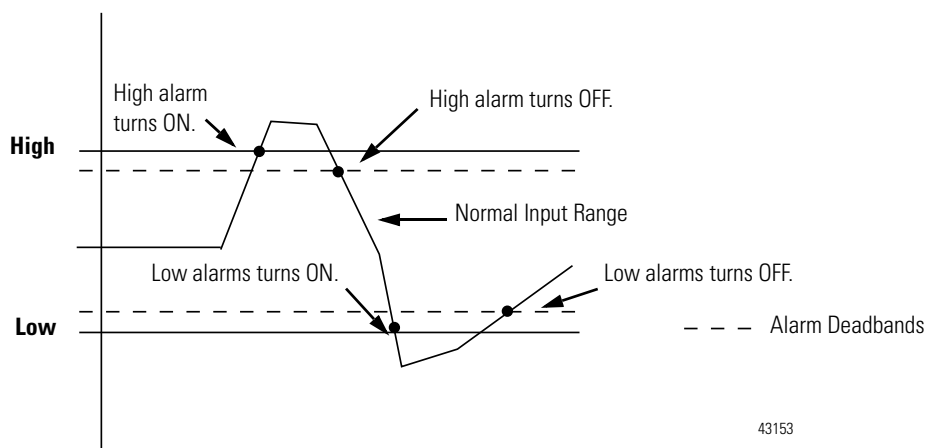
Each channel's process alarm high data value and process alarm low data value are set by entering values in the corresponding words of the Configuration Data file for that channel.

The values entered for a channel's process alarm data values must be within the normal operating data range as set by the input Data Format selected for that channel. If a process alarm data value is entered that is outside the normal operating data range set for a channel, the module indicates a configuration error.

### *Alarm Deadband*

You may configure an **Alarm Deadband** to work with the process alarms. The deadband lets the process alarm status bit to remain set, despite the alarm condition disappearing, as long as the input data remains within the deadband of the process alarm.

Alarm Deadbands on page 3-14 shows input data that sets each of the two alarms at some point during module operation. In this example, latching is disabled; therefore, each alarms turns OFF when the condition that caused it to set ceases to exist.

**Figure 3.2 Alarm Deadbands**

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The value entered for a channel's alarm deadband value must be within the normal operating data range as set by the Input Data Format selected for that channel. If an alarm deadband value is entered that is outside the normal operating data range set for a channel, the module indicates a configuration error.

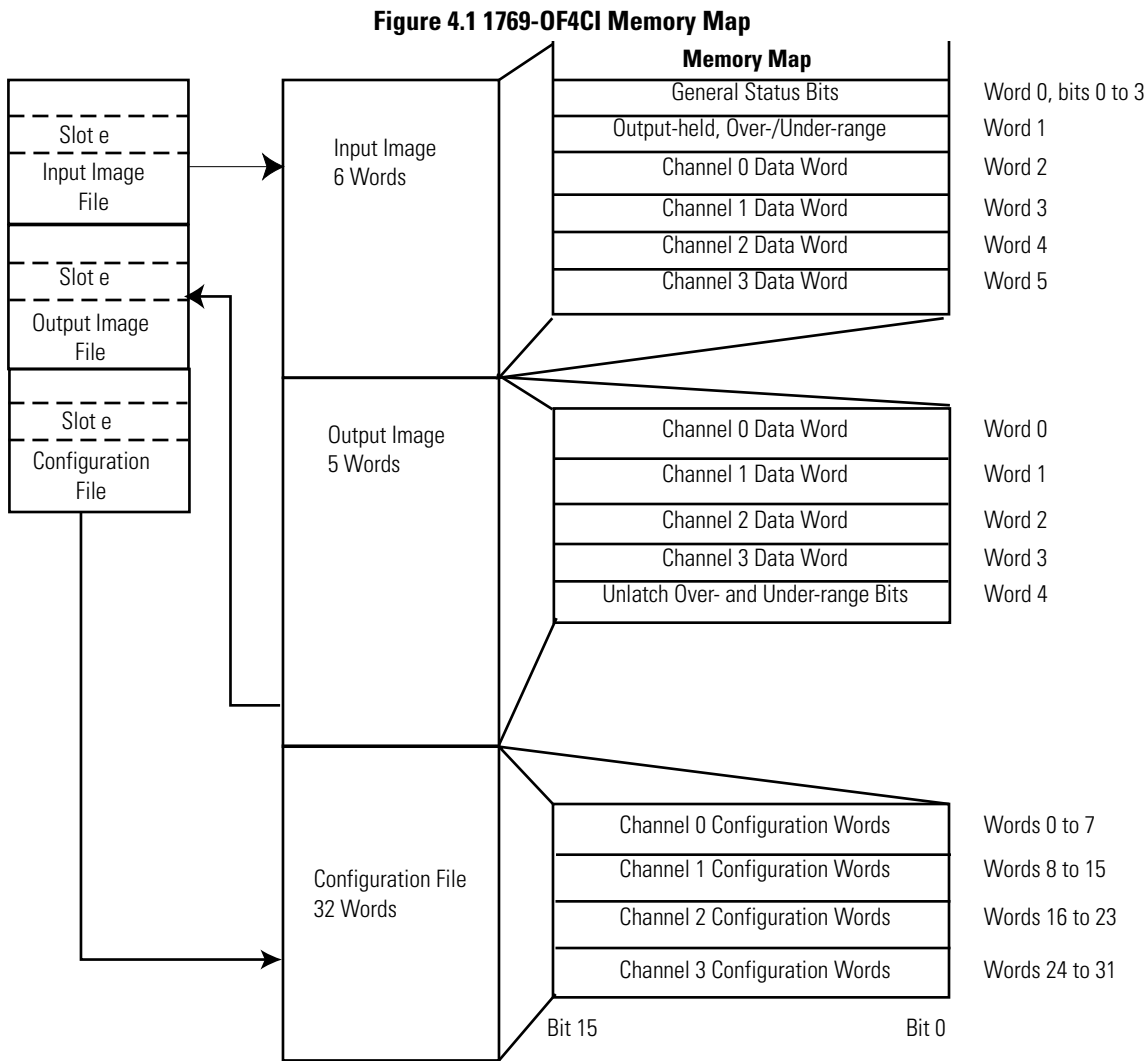
The module also checks for an alarm deadband value that is less than 0 or large enough to exceed one or both of the channel's full range limits. When one of these conditions occurs, the module changes the alarm deadband value that is in violation to one that is allowed. A deadband value less than 0 is set at 0. A deadband value that when added to the process alarm low data value or subtracted from the process alarm high data value results in a value that exceeds the full range limits of the channel is adjusted to the first, smaller value that eliminates this full range violation.

# Module Data, Status, and Channel Configuration for the Output Modules

This chapter examines the analog output module’s output data file, input data file, channel status, and channel configuration words.

## 1769-OF4CI Output Module Memory Map

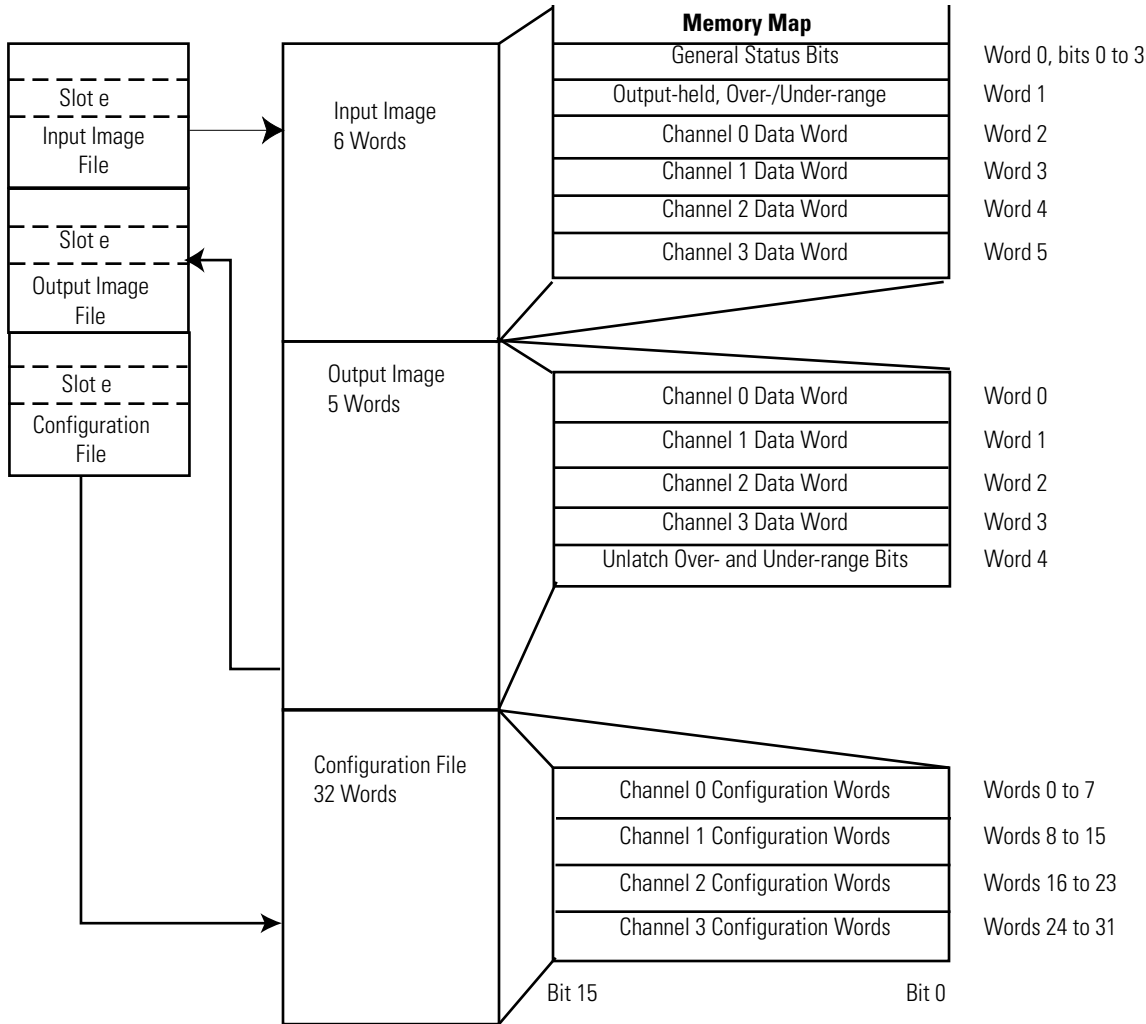
The 1769-OF4CI memory map shows the output, input, and configuration tables for the 1769-OF4CI module.



# 1769-OF4VI Output Module Memory Map

The 1769-OF4VI memory map shows the output, input, and configuration tables for the 1769-OF4VI module.

Figure 4.2 1769-OF4VI Memory Map



## 1769-OF4CI and -OF4VI Output Data File

The structure of the output data file is shown in the table below. Words 0 to 3 contain the commanded analog output data for channels 0 to 3, respectively. The most significant bit is the sign bit. Word 4 contains the control bits for unlatching alarms.

**Table 4.1 1769-OF4CI and -OF4VI Output Data Table**

Word	Bit Position															
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	SGN	Analog Output Data Channel 0														
1	SGN	Analog Output Data Channel 1														
2	SGN	Analog Output Data Channel 2														
3	SGN	Analog Output Data Channel 3														
4									UU3	U03	UU2	U02	UU1	U01	UU0	U00

## Channel Alarm Unlatch

These bits are written during run mode to clear any latched low- and high-clamps and under- and over-range alarms. The alarm is unlatched when the unlatch bit is set (1) and the alarm condition no longer exists. If the alarm condition persists, then the unlatch bit has no effect. You need to keep the unlatch bit set until verification from the appropriate input channel status word says that the alarm status bit has cleared (0). Then you need to reset (0) the unlatch bit. The module will not latch an alarm condition when a transition from a no alarm condition to an alarm condition occurs while a channel's clear latch bit is set.

**Table 4.2 Channel Alarm Unlatch**

Word	Bit Position															
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	Nu <sup>(1)</sup>	Nu	Nu	Nu	Nu	Nu	Nu	Nu	UU3 <sup>(2)</sup>	U03 <sup>(3)</sup>	UU2	U02	UU1	U01	UU0	U00

<sup>(1)</sup> Not used. Bit must be set to 0.

<sup>(2)</sup> Unlatch channel x under-range or low-clamp exceeded alarm.

<sup>(3)</sup> Unlatch channel x over-range or high-clamp exceeded alarm.

## 1769-OF4CI and -OF4VI Input Data File

This data table file provides immediate access to channel diagnostic information and analog output data at the module for use in the control program. To receive valid data, you must enable the channel. The data table structure is described below.

**Table 4.3 1769-OF4CI and -OF4VI Input Data Table**

Word	Bit Position															
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0													S3	S2	S1	S0
1		H3	U3	O3		H2	U2	O2		H1	U1	O1		H0	U0	O0
2	Channel 0 Data Value															
3	Channel 1 Data Value															
4	Channel 2 Data Value															
5	Channel 3 Data Value															

### 1769-OF4CI and -OF4VI Data Values

Words 2 to 5 contain the data echo of the analog data presently commanded by the module for each output.

#### *1769-OF4CI and -OF4VI General Status Bits (S0 to S3)*

Word 0, bits 0 to 3 contain the general status information for output channels 0 to 3. If set (1), these bits indicate an error associated with that channel. The over-range and under-range bits are logically ORed to this position.

#### *1769-OF4CI and -OF4VI Over-Range Flag Bits (O0 to O3)*

Word 1, bits 0, 4, 8, and 12 contain the over-range bits for channels 0 to 3. When set, the over-range bit indicates that the controller is attempting to drive the analog output above its normal operating range or above the channel's High Clamp level (if clamp limits are set for the channel). However, the module continues to convert analog output data to a maximum full range value if clamp levels are not set for the channel.

If alarm latching is not enabled for the channel, the bit is automatically reset (0) by the module when the over-range condition is cleared or the commanded value no longer exceeds the high clamp (the output is commanded to return to within the normal allowed range). The over-range bits apply to all output ranges.

Refer to 1769-OF4CI Valid Output Data Table on page 4-17 and 1769-OF4VI Valid Output Data Table on page 4-18 to view the normal operating and over-range areas.



### *1769-OF4CI and -OF4VI Under-Range Flag Bits (U0 to U3)*

Word 1, bits 1, 5, 9, and 13 contain the under-range bits for channels 0 to 3. When set (1), the under-range bit indicates that the controller is attempting to drive the analog output below its normal operating range or below the channel's Low Clamp level (if clamp limits are set for the channel). However, the module continues to convert analog output data to a minimum full range value if clamp levels are not set for the channel.

If alarm latching is not enabled for the channel, the bit is automatically reset (0) by the module when the under-range condition is cleared or the commanded value no longer exceeds the low clamp (the output is commanded to return to within the normal allowed range). The under-range bits apply to all output ranges.

Refer to 1769-OF4CI Valid Output Data Table on page 4-17 and 1769-OF4VI Valid Output Data Table on page 4-18 to view the normal operating and under-range areas.

### *1769-OF4CI and -OF4VI Output Held Bits (H0 to H3)*

Word 1, bits 2, 6, 10, and 14 contain the output held bits for input channels 0 to 3. When one of these bits is set (1), the corresponding channel is in the hold state. Output data will not change until value commanded by the controller matches the value being held by the module for any held output channel.

When the value commanded for a channel by the controller matches the value being held by the module, the Output Held bit for that channel is cleared (0). The output channel can again be directly controlled by the values commanded in the Output Data file by the controller. The control can determine the output value being held by the module for any channel whose Output Held bit is set (1) by reading words 2 to 5 of the Input Data file.

## 1769-OF4CI and -OF4VI Output Data Loopback/Echo

Words 2 to 5 provide output loopback/data echo through the Input Data file for channels 0 to 3. The value of the data echo is the analog value currently being converted on-board the module by the D/A converter. This ensures that the logic-directed state of the output is true. Otherwise, the state of the output could vary depending on controller mode.

Under normal operating conditions, the data echo value is the same value that is being sent from the controller to the output module. Under abnormal conditions, the values may differ.

---

### EXAMPLE

- During run mode, the control program could direct the module to a value over or under the defined full range. In that case, the module raises the over- or under-range flag and continues to convert and data echo up to the defined full range. However, upon reaching either the maximum upper or lower full range value, the module stops converting and echoes back that maximum upper or lower full range value, not the value being sent from the controller.
  - During program or fault mode with Hold Last State or User-Defined Value selected, the module echoes the hold last value or alternate value you selected. For more information on the hold last and user-defined values, see 1769-OF4CI and -OF4VI Fault Value on page 4-15 and 1769-OF4CI and -OF4VI Program/Idle Value on page 4-16.
  - When one or more of the output channel's Output Held bits are set (1). See 1769-OF4CI and -OF4VI Output Held Bits (H0 to H3) on page 4-5.
-

## 1769-OF4CI and -OF4VI Configuration Data File

The configuration file lets you determine how each individual output channel will operate. Parameters such as the output type/range and data format are set up using this file. The configuration data file is writable and readable. The default value for the configuration data file is all zeros. The structure of the channel configuration file is explained below.

**Table 4.4 1769-OF4CI and -OF4VI Configuration Data File**

Word	Description	Word	Description
0	Channel 0 Configuration Word 0	16	Channel 2 Configuration Word 0
1	Channel 0 Configuration Word 1	17	Channel 2 Configuration Word 1
2	Channel 0 Fault Value Word	18	Channel 2 Fault Value Word
3	Channel 0 Program Idle Mode Word	19	Channel 2 Program Idle Mode Word
4	Channel 0 Low Clamp	20	Channel 2 Low Clamp
5	Channel 0 High Clamp	21	Channel 2 High Clamp
6	Channel 0 Ramp Rate	22	Channel 2 Ramp Rate
7	Channel 0 Spare	23	Channel 2 Spare
8	Channel 1 Configuration Word 0	24	Channel 3 Configuration Word 0
9	Channel 1 Configuration Word 1	25	Channel 3 Configuration Word 1
10	Channel 1 Fault Value Word	26	Channel 3 Fault Value Word
11	Channel 1 Program Idle Mode Word	27	Channel 3 Program Idle Mode Word
12	Channel 1 Low Clamp	28	Channel 3 Low Clamp
13	Channel 1 High Clamp	29	Channel 3 High Clamp
14	Channel 1 Ramp Rate	30	Channel 3 Ramp Rate
15	Channel 1 Spare	31	Channel 3 Spare

**Table 4.5 1769-OF4CI and -OF4VI Configuration Words 0 and 1 Bit Descriptions**

Word/ Bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Word 0	E	Reserved							SIU	SIO	LA	ER	FM	PM	HI	PFE
Word 1	Reserved					Output Data Format Select			Reserved					Output Type/Range		

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

For information on configuring the module using MicroLogix 1500 and RSLogix 500 software, see Appendix B; for CompactLogix and RSLogix 5000 software, see Appendix C; for 1769-ADN DeviceNet adapter and RSNetWorx software, see Appendix D.

The configuration file can also be modified through the control program, if supported by the controller.

The structure and bit settings are shown in 1769-OF4CI and -OF4VI Channel Configuration on page 4-8.

## 1769-OF4CI and -OF4VI Channel Configuration

The first two words of each eight word group in the configuration file allow you to change the parameters of each channel independently. For example, words 8 and 9 correspond to channel 1 while words 24 and 25 correspond to channel 3.

**Table 4.6 1769-OF4CI and -OF4VI Channel Configuration Word 0<sup>(1)</sup>**

Define	Indicate	Bit Settings															
		15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Program (Idle) to Fault Enable	Program (Idle) Mode Data Applied <sup>(2)</sup>																0
	Fault Mode Data Applied <sup>(2)</sup>																1
Hold for Initialization	Disabled															0	
	Enabled															1	
Program (Idle) Mode	Hold Last State <sup>(2)</sup>														0		
	User-Defined Value <sup>(2)</sup>														1		
Fault Mode	Hold Last State <sup>(2)</sup>													0			
	User-Defined Fault Value <sup>(2)</sup>													1			
Enable Ramping	Disabled												0				
	Enabled <sup>(2)</sup>												1				
Enable Clamp/ Alarm Latching	Disabled											0					
	Enabled											1					
Enable High Clamp/ Alarm Interrupt	Disabled										0						
	Enabled <sup>(2)</sup>										1						
Enable Low Clamp/ Alarm Interrupt	Disabled									0							
	Enabled <sup>(2)</sup>									1							
Enable Channel	Disabled	0															
	Enabled	1															

<sup>(1)</sup> Refer to the 1769-OF4CI and -OF4VI Output Channel Configuration Word 1 table.

<sup>(2)</sup> Hold Last State and User Defined Fault functionality is **only** supported when the analog module is used in a DeviceNet application via the 1769-ADN adapter. No local configuration, that is, a MicroLogix or CompactLogix system, supports this functionality. Refer to your controller manual for details.

**Table 4.7 1769-OF4CI and -OF4VI Output Channel Configuration Word 1**

Define	Indicate	Bit Settings															
		15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
1769-OF4CI	Output Range Select														0	0	0
															0	0	1
	Output Data Select						0	0	0								
	Raw/Proportional Counts						0	0	1								
	Engineering Units						0	0	1								
	Scaled for PID						0	1	0								
	Percent Range						0	1	1								
1769-OF4VI	Output Range Select														0	0	0
															0	0	1
															0	1	0
															0	1	1
	Output Data Select						0	0	0								
	Raw/Proportional Counts						0	0	1								
	Engineering Units						0	0	1								
	Scaled for PID						0	1	0								
	Percent Range						0	1	1								

## 1769-OF4CI and -OF4VI Enable/Disable Channel

This configuration selection (bit 15 of Configuration Word 0) allows each channel to be individually enabled.

### TIP

A channel that is not enabled has zero voltage or current at its terminal.

## Clamping/Limiting

Clamping limits the output from the analog module to remain within a range configured by the controller, even when the controller commands an output outside that range. This safety feature sets a high clamp and a low clamp.

Once clamps are determined for a module, any data received from the controller that exceeds those clamps sets an appropriate limit alarm and transitions the output to that limit but not beyond the requested value.

For example, an application may set the high clamp on a 1769-OF4CI module for 15 mA and the low clamp for 5 mA. If a controller sends a value corresponding to 16 mA to the module, the module will only apply 15 mA to its screw terminals.

Clamping is disabled on a per channel basis by entering a 0 value for both the high and low clamps in the Configuration Data file. Interrupts are generated on a high- or low-alarm by setting (1) the SIO bit (for high-clamp or over-range alarm) or setting (1) the SIU bit (for low-clamp or under-range alarm). Alarms caused by exceeding over-/under-range or clamp limits can be latched by setting (1) a channel's LA bit on a per channel basis.

## Clamp/Limit Alarms

This function works directly with clamping. When a module receives a data value from the controller that exceeds clamping limits, it applies signal values at the clamping limit but also sends a status bit to the controller notifying it that the value sent exceeds the clamping limits.

With reference to the example in the Clamping/Limiting section, if a 1769-OF4CI module has clamping limits of 15 mA and 5 mA but then receives data to apply 16 mA, only 15 mA is applied to the screw terminals. The module sends a status bit back to the controller informing it that the 16 mA value exceeds the module's clamping limits.

## Ramping

Ramping limits the speed at which an analog output signal can change. This prevents fast transitions in the output from damaging the devices that an output module controls.

**Table 4.8 Ramping Types**

Ramping Type	Description
Ramp to Fault Mode	This type of ramping occurs when the present output value changes to the Fault Value after a communications fault occurs. This is the only type of ramping for the 1769-OF4CI and -OF4VI modules.

The ramp rate is defined in terms of the selected range/format in units per second. For example, in the 0 to 20 mA range and percent of full scale format, a ramp rate of 1000 is 10%/second (since 1000 is 10% of the total number of counts in the full scale of the 0 to 20 mA range) or a maximum of 2 mA per second.

Table 4.9 and Table 4.10 describes how ramp rate is defined for all output range/types and output data formats.

**Table 4.9 1769-OF4CI Output Range/Types and Output Data Formats**

Output Data Format Output Range/Type	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			
0...20 mA	65534	655	0.2 mA/s
4...20 mA			0.16 mA/s
Engineering Units			
0...20 mA	21000	210	0.2 mA/s
4...20 mA	17800	178	0.16 mA/s
Scaled for PID			
0...20 mA	16383	164	0.2 mA/s
4...20 mA			0.16 mA/s
Percent of Full Scale			
0...20 mA	10000	100	0.2 mA/s
4...20 mA			0.16 mA/s

**Table 4.10 1769-OF4VI Output Range/Types and Output Data Formats**

Output Data Format Output Range/Type	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	65534	655	0.2V/s
0...5V			0.05V/s
0...10V			0.1V/s
1...5V			0.04V/s
Engineering Units			
-10...+10V	21000	210	0.2V/s
0...5V	5750	58	0.05V/s
0...10V	11000	110	0.1V/s
1...5V	4750	48	0.04V/s
Scaled for PID			
-10...+10V	16383	164	0.2V/s
0...5V			0.05V/s
0...10V			0.1V/s
1...5V			0.04V/s
Percent of Full Scale			
-10...+10V	10000	100	0.2V/s
0...5V			0.05V/s
0...10V			0.1V/s
1...5V			0.04V/s

Ramping only takes place, if configured, when the output is being commanded to go to a fault state. Ramping is not done in 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 greater than or equal to a minimum of 1% of the total number of full scale counts for the channel's selected data format.

See Ramping Types on page 4-11 and 1769-OF4CI Output Range/Types and Output Data Formats on page 4-11 for minimum values.

**or**

- the number of counts entered for a channel's ramp rate may be equal to 0 if ramping is not enabled for the channel.



## Hold for Initialization

Hold for Initialization causes outputs to hold present state until the value commanded by the controller matches the value held by the module providing a bumpless transfer.

If Hold for Initialization is selected, outputs hold if any of these three conditions occur.

- Initial connection is established after cycling power
- New connection is established after a communications fault occurs
- Transition to Run mode from Program state

The Output Held bit (see the Input Data file) for a channel indicates that the channel is holding.

## 1769-OF4CI and -OF4VI Fault Mode (FM)

This configuration selection provides individual fault mode selection for the analog channels. When this selection is disabled [the bit is reset (0)], the module **holds** the **last state**, meaning that the analog output remains at the last converted value prior to the condition that caused the control system to enter the program mode.

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**IMPORTANT**

Hold last state is the default condition for the 1769-OF4CI and -OF4VI during a control system run-to-program mode change.

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**TIP**

The MicroLogix 1500 and CompactLogix controllers do not support Hold Last State. This functionality is **only** supported when the analog module is used on the DeviceNet network via the 1769-ADN adapter.

If this selection is enabled [the bit is set (1)] and the system enters the program mode, it commands the module to convert the **user-specified** value from the channel's Fault mode word to the appropriate analog output for the range selected.

**TIP**

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

## 1769-OF4CI and -OF4VI Program/Idle Mode (PM)

This configuration selection provides individual program/idle mode selection for the analog channels. When this selection is disabled [the bit is reset (0)], the module **holds** the **last state**, meaning that the analog output remains at the last converted value prior to the condition that caused the control system to enter the Program mode.

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**IMPORTANT**

Hold last state is the default condition for the 1769-OF4CI and -OF4VI during a control system run-to-program mode change.

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**TIP**

The MicroLogix 1500 and CompactLogix controllers do not support Hold Last State. This functionality is **only** supported when the analog module is used on the DeviceNet network via the 1769-ADN adapter.

If this selection is enabled [the bit is set (1)] and the system enters the program mode, it commands the module to convert the **user-specified** value from the channel's Program/Idle mode word to the appropriate analog output for the range selected.

**TIP**

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

## 1769-OF4CI and -OF4VI Program/Idle to Fault Enable (PFE)

If a system currently in program/idle mode faults, this setting determines whether the program/idle or fault value is applied to the output. If the selection is enabled [the bit is set (1)], the module applies the fault value. If the selection is disabled [the bit is reset (0)], the module applies the program/idle mode data value. The default setting is disabled.

**TIP**

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

## 1769-OF4CI and -OF4VI Fault Value

Using words each channel's Fault Value word, you can specify the values the outputs will assume when the system enters the fault mode. The default value is 0. Valid values are dependent upon the range selected in the range selection field. If the value you entered is outside the normal operating range for the output range selected, the module generates a configuration error.

For example, if you select engineering units for the 0 to 20 mA range and enter a fault value within the normal operating range (0 to 20000), the module will configure and operate correctly. However, if you enter a value outside the normal operating range (for example 21000), the module indicates a configuration error.

### TIP

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

### EXAMPLE

- If the default value, 0000, is used and the range selected is 0 to 20 mA, the module will output 0 mA for all data formats.
- If the raw/proportional or engineering units format is selected and zero is entered as Fault Value in the 4 to 20 mA range (for 1769-OF4CI) or the 1 to 5V range (for 1769-OF4VI), a configuration error results.
- See 1769-OF4CI Valid Output Data Table on page 4-17 and 1769-OF4VI Valid Output Data Table on page 4-18 for more examples.

## 1769-OF4CI and -OF4VI Program/Idle Value

Use each channel's Program/Idle Mode word to set the integer values for the outputs to assume when the system enters the program mode. The values are dependent upon the range selected in the range selection field. If the value you entered is outside the normal operating range for the output range selected, the module generates a configuration error. The default value is 0.

For example, if you select engineering units for the 0 to 20 mA range and enter a program/idle value within the normal operating range (0 to 20000), the module will configure and operate correctly. However, if you enter a value outside the normal operating range (for example 21000), the module indicates a configuration error.

**TIP**

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

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**EXAMPLE**

- If the default value, 0000, is used and the range selected is 0 to 20 mA, the module will output 0 mA for all data formats.
  - If the raw/proportional or engineering units format is selected and zero is entered as Program/Idle mode word in the 4 to 20 mA range (for 1769-OF4CI) or the 1 to 5V range (for 1769-OF4VI), a configuration error results.
  - See 1769-OF4CI Valid Output Data Table on page 4-17 and 1769-OF4VI Valid Output Data Table on page 4-18 for more examples.
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### 1769-OF4CI Valid Output Data Word Formats/Ranges

The following table shows the valid formats and data ranges accepted by the module.

**Table 4.11 1769-OF4CI Valid Output Data Table**

OF4CI Normal Operating Range	Input Value	Example Data		Output Range State	Raw/Proportional Data		Engineering Unit		Scaled-for-PID		Percent Full Range	
					Decimal Range		Decimal Range		Decimal Range		Decimal Range	
		Controller Ordered	OF8C Output		Controller Ordered	OF8C Output and Echo	Controller Ordered	OF8C Output and Echo	Controller Ordered	OF8C Output and Echo	Controller Ordered	OF8C Output and Echo
4... 20 mA	Over 21.0 mA	+22.0 mA	+21.0 mA	Over	N/A	N/A	22000	21000	18431	17407	11250	10625
	21.0 mA	+21.0 mA	+21.0 mA	Over	32767	32767	21000	21000	17407	17407	10625	10625
	4.0 mA to 20.0 mA	+20.0 mA	+20.0 mA	Normal	29085	29085	20000	20000	16383	16383	10000	10000
		+4.0 mA	+4.0 mA	Normal	-29822	-29822	4000	4000	0	0	0	0
	3.2 mA	+3.2 mA	+3.2 mA	Under	-32767	-32767	3200	3200	-819	-819	-500	-500
	Under 3.2 mA	0.0 mA	+3.2 mA	Under	N/A	N/A	0	3200	-4096	-819	-2500	-500
0... 20 mA	Over 21.0 mA	+22.0 mA	+21.0 mA	Over	N/A	N/A	22000	21000	18201	17202	11000	10500
	21.0 mA	21.0 mA	+21.0 mA	Over	32767	32767	21000	21000	17202	17202	10500	10500
	0.0... 20.0 mA	20.0 mA	+20.0 mA	Normal	29646	29646	20000	20000	16383	16383	10000	10000
		0.0 mA	0.0 mA	Normal	-32767	-32767	0	0	0	0	0	0
	Under 0.0 mA	-1.0 mA	0.0 mA	Under	N/A	N/A	-1000	0	-819	0	-500	0

### 1769-OF4VI Valid Output Data Word Formats/Ranges

The following table shows the valid formats and data ranges accepted by the module.

**Table 4.12 1769-OF4VI Valid Output Data Table**

OF4VI Normal Operating Output Range	Input Value	Example Data		Output Range State	Raw/Proportional Data		Engineering Unit		Scaled-for-PID		Percent Full Range	
					Decimal Range		Decimal Range		Decimal Range		Decimal Range	
		Controller Ordered	OF8C Output		Controller Ordered	OF8C Output and Echo	Controller Ordered	OF8C Output and Echo	Controller Ordered	OF8C Output and Echo	Controller Ordered	OF8C Output and Echo
±10V dc	Over 10.5V dc	+11.0V dc	+10.5V dc	Over	N/A	N/A	11000	10500	17202	16793	11000	10500
	+10.5V dc	+10.5V dc	+10.5V dc	Over	32767	32767	10500	10500	16793	16793	10500	10500
	-10... +10V dc	+10.0V dc	+10.0V dc	Normal	31207	31207	10000	10000	16383	16383	10000	10000
		0.0V dc	0.0V dc	Normal	0	0	0	0	8192	8192	0	0
		-10.0V dc	-10.0V dc	Normal	-31207	-31207	-10000	-10000	0	0	-10000	-10000
	-10.5V dc	-10.5V dc	-10.5V dc	Under	-32767	-32767	-10500	-10500	-410	-410	-10500	-10500
	Under -0.5V dc	-11.0V dc	-11.0V dc	Under	N/A	N/A	-11000	-10500	-819	-410	-11000	-10500
0...5V dc	Over 5.25V dc	5.5V dc	+5.25V dc	Over	N/A	N/A	5500	5250	18021	17202	11000	10500
	5.25V dc	5.25V dc	+5.25V dc	Over	32767	32767	5250	5250	17202	17202	10500	10500
	0.0... 5.0V dc	5.0V dc	+5.0V dc	Normal	29918	29918	5000	5000	16383	16383	10000	10000
		0.0V dc	0.0V dc	Normal	-27068	-27068	0	0	0	0	0	0
	-0.5V dc	-0.5V dc	-0.5V dc	Under	-32767	-32767	-500	-500	-1638	-1638	-1000	-1000
	Under -0.5V dc	-1.0V dc	-0.5V dc	Under	N/A	N/A	-1000	-500	-3277	-1638	-2000	-1000

Table 4.12 1769-OF4VI Valid Output Data Table

OF4VI Normal Operating Output Range	Input Value	Example Data		Output Range State	Raw/Proportional Data		Engineering Unit		Scaled-for-PID		Percent Full Range	
					Decimal Range		Decimal Range		Decimal Range		Decimal Range	
		Controller Ordered	OF8C Output		Controller Ordered	OF8C Output and Echo	Controller Ordered	OF8C Output and Echo	Controller Ordered	OF8C Output and Echo	Controller Ordered	OF8C Output and Echo
0...10V dc	Over 10.5V dc	11.0V dc	+10.5V dc	Over	N/A	N/A	11000	10500	18021	17202	11000	10500
	+10.5V dc	+10.5V dc	+10.5V dc	Over	32767	32767	10500	10500	17202	17202	10500	10500
	0.0...10.0V dc	+10.0V dc	+10.0V dc	Normal	29788	29788	10000	10000	16383	16383	10000	10000
		0.0V dc	0.0V dc	Normal	-29788	-29788	0	0	0	0	0	0
	-0.5V dc	-0.5V dc	-0.5V dc	Under	-32767	-32767	-500	-500	-819	-819	-500	-500
	Under -5.0V dc	-1.0V dc	-0.5V dc	Under	N/A	N/A	-1000	-500	-1638	-819	-1000	-500
1.0...5V dc	Over 5.25V dc	+5.5V dc	+5.25V dc	Over	N/A	N/A	5500	5250	18431	17407	11250	10625
	+5.25V dc	+5.25V dc	+5.25V dc	Over	32767	32767	5250	5250	17407	17407	10625	10625
	1.0...5.0V dc	+5.0V dc	+5.0V dc	Normal	29318	29318	5000	5000	16383	16383	10000	10000
		+1.0V dc	+1.0V dc	Normal	-25869	-25869	1000	1000	0	0	0	0
	0.5V dc	+0.5V dc	+0.5V dc	Under	-32767	-32767	500	500	-2048	-2048	-1250	-1250
	Under 0.5V dc	0.0V dc	0.0V dc	Under	N/A	N/A	0	500	-4096	-2048	-2500	-1250

## **Notes:**



## Module Diagnostics and Troubleshooting

This chapter describes troubleshooting the analog input and output modules. This chapter contains information on:

- safety considerations when troubleshooting.
- module versus channel operation.
- the module's diagnostic features.
- critical vs. non-critical errors.
- module condition data.

### 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.

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**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.

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### Indicator Lights

When the green LED on the analog module is illuminated, it indicates that power is applied to the module.

### 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 UVROM 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.

## Module Operation versus Channel Operation

The module performs operations at two levels:

- Module level
- Channel level

Module-level operations include functions such as power-up, configuration, and communication with a bus master, such as a MicroLogix 1500 controller.

Channel-level operations describe channel related functions, such as data conversion and over- or under-range detection.

Internal diagnostics are performed at both levels of operation. When detected, module error conditions are immediately indicated by the module status LED. Both module hardware and channel configuration error conditions are reported to the controller. Channel over-range or under-range conditions are reported in the module's input data table. Module hardware errors are typically reported in the controller's I/O status file. Refer to your controller manual for details.

## 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 LED remains off and a module error results and is reported to the controller.

**Table 5.1 Diagnostics**

Module Status LED	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 an input or output module 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 on every scan for configuration errors, over-range and under-range, open-circuit (input module in 4 to 20 mA current range and all voltage ranges).

### Out-of-range Detection (Input and Output Modules)

For input modules, whenever the data received at the channel word is out of the defined operating range, an over-range or under-range error is indicated in the Input Data file.

For output modules, whenever the controller is driving data over or under the defined operating range, an over-range or under-range error is indicated in the Input Data file.

## Open-circuit Detection (1769-IF4I Module Only)

The module performs an open-circuit test on all enabled channels configured for 4 to 20 mA inputs and for all voltage inputs. Whenever an open-circuit condition occurs, the under-range bit for that channel is set on all channels configured for 4 to 20 mA inputs or the over-range bit for that channel is set on all channels configured for voltage inputs in the Input Data file.

Possible causes of an open circuit include:

- the sensing device may be broken.
- a wire may be loose or cut.
- the sensing device may not be installed on the configured channel.

## Non-critical vs. 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. Non-critical configuration errors are indicated by the extended error code.

See 1769-IF4I Extended Error Codes on page 5-6 and 1769-OF4CI and -OF4VI Extended Error Codes on page 5-8.

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 1769-IF4I Extended Error Codes on page 5-6 and 1769-OF4CI and -OF4VI Extended Error Codes on page 5-8.

## Module Error Definition Table

Analog 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.

**Table 5.2 Module Error Table**

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. These types of module errors are typically reported in the controller's I/O status file. Refer to your controller manual for details.

**Table 5.3 Module Error Types**

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

Check the extended error information field when a non-zero value is present in the module error 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.

### Hardware Errors

General or module-specific hardware errors are indicated by module error code 2.

See 1769-IF4I Extended Error Codes on page 5-6 and 1769-OF4CI and -OF4VI Extended Error Codes on page 5-8.

### Configuration Errors

If you set the fields in the configuration file to invalid or unsupported values, the module ignores the invalid configuration, generates a non-critical error, and keeps operating with the previous configuration.

Each type of analog module has different features and different error codes. See 1769-IF4I Extended Error Codes on page 5-6 and 1769-OF4CI and -OF4VI Extended Error Codes on page 5-8.

## Error Codes

Error codes can help troubleshoot your module.

**Table 5.4 1769-IF4I Extended Error Codes**

Error Type	Hex Equivalent <sup>(1)</sup>	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	0 1000 0000	General hardware error
	X301	001	0 1000 0001	Microprocessor hardware error
	X302	001	1 0000 0010	A/D converter communication error

**Table 5.4 1769-IF4I Extended Error Codes**

Error Type	Hex Equivalent <sup>(1)</sup>	Module Error Code	Extended Error Information Code	Error Description
		Binary	Binary	
1769-IF4I Specific Configuration Error	X400	010	0 0000 0000	General configuration error; no additional information
	X403	010	0 0000 0011	Invalid real time sample rate value
	X404	010	0 0000 0100	Invalid input filter selected (channel 0)
	X405	010	0 0000 0101	Invalid input filter selected (channel 1)
	X406	010	0 0000 0110	Invalid input filter selected (channel 2)
	X407	010	0 0000 0111	Invalid input filter selected (channel 3)
	X408	010	0 0000 1000	Invalid input range selected (channel 0)
	X409	010	0 0000 1001	Invalid input range selected (channel 1)
	X40A	010	0 0000 1010	Invalid input range selected (channel 2)
	X40B	010	0 0000 1011	Invalid input range selected (channel 3)
	X40C	010	0 0000 1100	Invalid input format selected (channel 0)
	X40D	010	0 0000 1101	Invalid input format selected (channel 1)
	X40E	010	0 0000 1110	Invalid input format selected (channel 2)
	X40F	010	0 0000 1111	Invalid input format selected (channel 3)
	X410	010	0 0001 0000	Invalid low alarm data value (channel 0)
	X411	010	0 0001 0001	Invalid low alarm data value (channel 1)
	X412	010	0 0001 0010	Invalid low alarm data value (channel 2)
	X413	010	0 0001 0011	Invalid low alarm data value (channel 3)
	X414	010	0 0001 0100	Invalid high alarm data value (channel 0)
	X415	010	0 0001 0101	Invalid high alarm data value (channel 1)
	X416	010	0 0001 0110	Invalid high alarm data value (channel 2)
	X417	010	0 0001 0111	Invalid high alarm data value (channel 3)
	X418	010	0 0001 1000	Invalid alarm deadband value (channel 0)
	X419	010	0 0001 1001	Invalid alarm deadband value (channel 1)
	X41A	010	0 0001 1010	Invalid alarm deadband value (channel 2)
	X41B	010	0 0001 1011	Invalid alarm deadband value (channel 3)
	X41C	010	0 0001 1100	Alarm not enabled (channel 0)
	X41D	010	0 0001 1101	Alarm not enabled (channel 1)
	X41E	010	0 0001 1110	Alarm not enabled (channel 2)
	X41F	010	0 0001 1111	Alarm not enabled (channel 3)

<sup>(1)</sup> X represents the Don't Care digit.

**Table 5.5 1769-OF4CI and -OF4VI Extended Error Codes**

Error Type	Hex Equivalent <sup>(1)</sup>	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 cycle reset state
	X216	001	0 0001 0110	Microprocessor watchdog error
	X220	001	0 0010 0000	Firmware corrupt (checksum failure)
	X221	001	0 0010 0001	Firmware checksum error in NVRAM (calibration data checksum failure)
Hardware-Specific Error	X300	001	1 0000 0000	General hardware error (ASIC)
1769-OF4CI and -OF4VI Specific Configuration Error	X401	010	0 0000 0001	Invalid input range selected (channel 0)
	X402	010	0 0000 0010	Invalid input range selected (channel 1)
	X403	010	0 0000 0011	Invalid input range selected (channel 2)
	X404	010	0 0000 0100	Invalid input range selected (channel 3)
	X409	010	0 0000 1001	Invalid data format selected (channel 0)
	X40A	010	0 0000 1010	Invalid data format selected (channel 1)
	X40B	010	0 0000 1011	Invalid data format selected (channel 2)
	X40C	010	0 0000 1100	Invalid data format selected (channel 3)
	X411	010	0 0001 0001	Invalid fault value (channel 0)
	X412	010	0 0001 0010	Invalid fault value (channel 1)
	X413	010	0 0001 0011	Invalid fault value (channel 2)
	X414	010	0 0001 0100	Invalid fault value (channel 3)
	X419	010	0 0001 1001	Invalid idle value (channel 0)
	X41A	010	0 0001 1010	Invalid idle value (channel 1)
	X41B	010	0 0001 1011	Invalid idle value (channel 2)
	X41C	010	0 0001 1100	Invalid idle value (channel 3)
	X421	010	0 0010 0001	Invalid clamps (channel 0)
	X422	010	0 0010 0010	Invalid clamps (channel 1)
	X423	010	0 0010 0011	Invalid clamps (channel 2)
	X424	010	0 0010 0100	Invalid clamps (channel 3)
	X429	010	0 0010 1001	Invalid ramp rate (channel 0)
	X42A	010	0 0010 1010	Invalid ramp rate (channel 1)
	X42B	010	0 0010 1011	Invalid ramp rate (channel 2)
	X42C	010	0 0010 1100	Invalid ramp rate (channel 3)



**Table 5.5 1769-OF4CI and -OF4VI Extended Error Codes**

Error Type	Hex Equivalent <sup>(1)</sup>	Module Error Code	Extended Error Information Code	Error Description
		Binary	Binary	
1769-OF4CI and -OF4VI Specific Configuration Error	X431	010	0 0011 0001	Configuration word 0 illegal bits set (channel 0)
	X432	010	0 0011 0010	Configuration word 0 illegal bits set (channel 1)
	X433	010	0 0011 0011	Configuration word 0 illegal bits set (channel 2)
	X434	010	0 0011 0100	Configuration word 0 illegal bits set (channel 3)
	X439	010	0 0011 1001	Configuration word 1 illegal bits set (channel 0)
	X43A	010	0 0011 1010	Configuration word 1 illegal bits set (channel 1)
	X43B	010	0 0011 1011	Configuration word 1 illegal bits set (channel 2)
	X43C	010	0 0011 1100	Configuration word 1 illegal bits set (channel 3)

<sup>(1)</sup> X represents the Don't Care digit.

## Module Inhibit Function

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

Whenever the output modules are inhibited, the modules enter the program mode and the output channel is changed to the state configured for the program mode. Whenever the input modules are inhibited, the modules continue 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 when you call.

- A clear statement of the problem, including a description of what the system is actually doing. Note the LED state; 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

**Notes:**

## Specifications

### General Specifications for 1769-IF4I, -OF4CI, and -OF4VI Modules

**Table A.1 General Specifications**

Specification	Value
Dimensions (HxDxW)	118 mm x 87 mm x 35 mm (4.65 in. x 3.43 in. x 1.38 in.) Height including mounting tabs 138 mm (5.43 in.)
Approximate Shipping Weight (with carton)	300 g (0.65 lb)
Storage Temperature	-40...+85 °C (-40...+185 °F)
Operating Temperature	0...+60 °C (+32...+140 °F)
Operating Humidity	5...95% noncondensing
Operating Altitude	2000 m (6561 ft)
Vibration, Operating	10...500 Hz, 5 g, 0.030 in. peak-to-peak
Vibration, Relay Operation	2 g
Shock, Operating	30 g, 11 ms panel mounted (20 g, 11 ms DIN-rail mounted)
Shock, Relay Operation	7.5 g panel mounted (5 g DIN-rail mounted)
Shock, Nonoperating	40 g panel mounted (30 g DIN-rail mounted)
System Power Supply Distance Rating	8 (The module may not be more than 8 modules away from a system power supply.)
Recommended Cable	Belden 8761 (shielded)
Max Cable Length	1769-IF4I: See Effect of Transducer/Sensor and Cable Length Impedance on Voltage Input Accuracy on page 2-11. 1769-OF4CI and -OF4VI: See Effect of Device and Cable Output Impedance on Output Module Accuracy on page 2-13.
Agency Certification	<ul style="list-style-type: none"> <li>• C-UL certified (under CSA C22.2 No. 142)</li> <li>• UL 508 listed</li> <li>• CE compliant for all applicable directives</li> </ul>
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	CISPR 11 Class A

**Table A.1 General Specifications (cont.)**

<b>Specification</b>	<b>Value</b>
Electrical /EMC:	The module has passed testing at the following levels:
• ESD Immunity (IEC 61000-4-2)	• 4 kV contact, 8 kV air, 4 kV indirect
• Radiated Immunity (IEC 61000-4-3)	• 10V/m, 80...1000 MHz, 80% amplitude modulation
• Fast Transient Burst (IEC 61000-4-4)	• 2 kV, 5 kHz
• Surge Immunity (IEC 61000-4-5)	• 1 kV galvanic gun
• Conducted Immunity (IEC 61000-4-6)	• 10V, 0.15...80 MHz <sup>(1)</sup>

<sup>(1)</sup> Conducted Immunity frequency range may be 150 kHz...30 MHz if the Radiated Immunity frequency range is 30...1000 MHz.

## 1769-IF4I Input Specifications

**Table A.2 1769-IF4I Specifications**

Specification	1769-IF4I
Analog Normal Operating Ranges <sup>(1)</sup>	Voltage: $\pm 10\text{V dc}$ , $0 \dots 10\text{V dc}$ , $0 \dots 5\text{V dc}$ , $1 \dots 5\text{V dc}$ Current: $0 \dots 20\text{ mA}$ , $4 \dots 20\text{ mA}$
Full Scale Analog Ranges <sup>(1)</sup>	Voltage: $\pm 10.5\text{V dc}$ , $0 \dots 10.5\text{V dc}$ , $0 \dots 5.25\text{V dc}$ , $0.5 \dots 5.25\text{V dc}$ Current: $0 \dots 21\text{ mA}$ , $3.2 \dots 21\text{ mA}$
Number of Inputs	4 isolated differential
Bus Current Draw, Max	145 mA at 5V dc 125 mA at 24V dc
Heat Dissipation	3.0 total W (The W per point, plus the min W, with all points energized.)
Converter Type	Delta Sigma
Response Speed per Channel	Input filter and configuration dependent. See Filter Frequency and Update Times on page 3-9.
Resolution, Max <sup>(2)</sup>	16 bits (unipolar) 15 bits plus sign (bipolar)
Rated Working Voltage <sup>(3)</sup>	30V ac/30V dc
Common Mode Rejection	Greater than 60 dB at 50 and 60 Hz with the 10 Hz filter selected, respectively.
Normal Mode Rejection Ratio	-50 dB at 50 and 60 Hz with the 10 Hz filter selected, respectively.
Input Impedance	Voltage Terminal: $1\text{ M}\Omega$ (typical) Current Terminal: $249\ \Omega$
Overall Accuracy <sup>(4)</sup>	Voltage Terminal: $\pm 0.2\%$ full scale at $25\text{ }^{\circ}\text{C}$ Current Terminal: $\pm 0.35\%$ full scale at $25\text{ }^{\circ}\text{C}$

<sup>(1)</sup> The over- or under-range flag will come on when the normal operating range (over/under) is exceeded. The module will continue to convert the analog input up to the maximum full scale range. The flag automatically resets when within the normal operating range.

<sup>(2)</sup> Resolution is dependent upon your filter selection. The maximum resolution is achieved with the 10 Hz filter selected.

<sup>(3)</sup> Rated working voltage is the maximum continuous voltage that can be applied at the input terminal, including the input signal and the value that floats above ground potential (for example, 10V dc input signal and 20V dc potential above ground).

<sup>(4)</sup> Includes offset, gain, non-linearity and repeatability error terms.

**Table A.2 1769-IF4I Specifications (cont.)**

<b>Specification</b>	<b>1769-IF4I</b>
Accuracy Drift with Temperature	Voltage Terminal: $\pm 0.003\%$ per $^{\circ}\text{C}$ Current Terminal: $\pm 0.0045\%$ per $^{\circ}\text{C}$
Calibration	The module performs only initial factory calibration.
Non-linearity (in percent full scale)	$\pm 0.03\%$
Repeatability <sup>(1)</sup>	$\pm 0.03\%$
Module Error over Full Temperature Range 0...+60 $^{\circ}\text{C}$ (+32...+140 $^{\circ}\text{F}$ )	Voltage: $\pm 0.3\%$ Current: $\pm 0.5\%$
Input Channel Configuration	Via configuration software screen or the user program (by writing a unique bit pattern into the module's configuration file). Refer to your controller's user manual to determine if user program configuration is supported.
Module OK LED	On: module has power, has passed internal diagnostics, and is communicating over the bus. Off: Any of the above is not true.
Channel Diagnostics	Over- or under-range by bit reporting, process alarms
Maximum Overload at Input Terminals <sup>(2)</sup>	Voltage Terminal: $\pm 24\text{V}$ dc continuous, 0.1 mA Current Terminal: $\pm 28\text{ mA}$ continuous, $\pm 7.0\text{ V}$ dc
System Power Supply Distance Rating	8 (The module may not be more than 8 modules away from the system power supply.)
Recommended Cable	Belden 8761 (shielded)
Isolation Voltage	30V (continuous), Reinforced Insulation Type, channel to system and channel to channel. Type tested at 710V DC for 60 s
Vendor I.D. Code	1
Product Type Code	10
Product Code	44

<sup>(1)</sup> Repeatability is the ability of the input module to register the same reading in successive measurements for the same input signal.

<sup>(2)</sup> Damage may occur to the input circuit if this value is exceeded.

## 1769-OF4CI Output Specifications

**Table A.3 1769-OF4CI Specifications**

Specification	1769-OF4CI
Analog Normal Operating Ranges <sup>(1)</sup>	0...20 mA, 4...20 mA
Full Scale Analog Ranges <sup>(1)</sup>	0...21 mA, 3.2...21 mA
Number of Outputs	4 isolated differential
Bus Current Draw, Max	145 mA at 5V dc 140 mA at 24V dc
Heat Dissipation	2.68 total W (All points - 21 mA into 250 $\Omega$ - worst case calculated.)
Digital Resolution Across Full Range	16 bits (unipolar) +4...+20 mA: 15.59 bits, 0.323 $\mu$ A/bit 0...+20 mA: 15.91 bits, 0.323 $\mu$ A/bit
Conversion Rate (all channels), Max	110 ms
Step Response to 63% <sup>(2)</sup>	<2.9 ms
Resistive Load on Current Output	0 to 500 $\Omega$ (includes wire resistance)
Max. Inductive Load	0.1 mH
Field Calibration	None required
Overall Accuracy <sup>(3)</sup>	$\pm$ 0.35% full scale at 25 $^{\circ}$ C
Accuracy Drift with Temperature	$\pm$ 0.0058% FS per $^{\circ}$ C
Output Ripple <sup>(4)</sup> Range 0...50 kHz (referred to output range)	$\pm$ 0.05%
Non-linearity (in percent full scale)	$\pm$ 0.05%
Repeatability <sup>(5)</sup> (in percent full scale)	$\pm$ 0.05%
Output Error Over Full Temperature Range 0...60 $^{\circ}$ C (+32...+140 $^{\circ}$ F)	$\pm$ 0.55%

<sup>(1)</sup> The over- or under-range flag will come on when the normal operating range (over/under) is exceeded. The module will continue to convert the analog input up to the maximum full scale range. The flag automatically resets when within the normal operating range unless configured to latch.

<sup>(2)</sup> 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.

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

<sup>(4)</sup> Output ripple is the amount a fixed output varies with time, assuming a constant load and temperature.

<sup>(5)</sup> Repeatability is the ability of the output module to reproduce output readings when the same controller value is applied to it consecutively, under the same conditions and in the same direction.

**Table A.3 1769-OF4CI Specifications**

<b>Specification</b>	<b>1769-OF4CI</b>
Output Impedance	>1 M $\Omega$
Open and Short-circuit Protection	Yes
Max Short-circuit Current	21 mA
Output Overvoltage Protection	Yes
Output Response at System Power Up and Power Down	No power up or power down current glitch
Rated Working Voltage <sup>(1)</sup>	30V ac/30V dc
Output Group to Bus Isolation	500V ac or 710V dc for 1 minute (qualification test) 30V ac/30V dc working voltage
Module OK LED	On: module has power, has passed internal diagnostics, and is communicating over the bus. Off: Any of the above is not true.
Channel Diagnostics	Over- or under-range by bit reporting
System Power Supply Distance Rating	The module may not be more than 8 modules away from the system power supply.
Recommended Cable	Belden 8761 (shielded)
Vendor I.D. Code	1
Product Type Code	10
Product Code	45
Input Words	6
Output Words	5
Configuration Words	32

<sup>(1)</sup> Rated working voltage is the maximum continuous voltage that can be applied at the input terminal, including the input signal and the value that floats above ground potential (for example, 10V dc input signal and 20V dc potential above ground).



## 1769-OF4VI Output Specifications

**Table A.4 1769-OF4VI Specifications**

Specification	1769-OF4VI
Analog Normal Operating Ranges <sup>(1)</sup>	$\pm 10\text{V dc}$ , $0 \dots 10\text{V dc}$ , $0 \dots 5\text{V dc}$ , $1 \dots 5\text{V dc}$
Full Scale Analog Ranges <sup>(1)</sup>	$\pm 10.5\text{V dc}$ , $-0.5 \dots 10.5\text{V dc}$ , $-0.5 \dots 5.25\text{V dc}$ , $0.5 \dots 5.25\text{V dc}$
Number of Outputs	4 isolated differential
Bus Current Draw, Max	145 mA at 5V dc 75 mA at 24V dc
Heat Dissipation	2.0 total W (All points - 10V dc into 2 k - worst case calculated.)
Digital Resolution Across Full Range	16 bits plus sign (bipolar)  $\pm 10\text{V dc}$ : 15.89 bits, 330 $\mu\text{V/bit}$ $0 \dots +5\text{V dc}$ : 13.89 bits, 330 $\mu\text{V/bit}$ $0 \dots +10\text{V dc}$ : 14.89 bits, 330 $\mu\text{V/bit}$ $+1 \dots +5\text{V dc}$ : 13.57 bits, 330 $\mu\text{V/bit}$
Conversion Rate (all channels), Max	120 ms
Step Response to 63% <sup>(2)</sup>	<2.9 ms
Current Load Output, Max	5 mA
Load Range Output	> 2 k $\Omega$ at 10V dc
Capacitive Load, Max	1 $\mu\text{F}$
Field Calibration	None required
Overall Accuracy <sup>(3)</sup>	$\pm 0.5\%$ full scale at 25 °C

<sup>(1)</sup> The over- or under-range flag will come on when the normal operating range (over/under) is exceeded. The module will continue to convert the analog output up to the maximum full scale range. The flag automatically resets when within the normal operating range unless configured to latch.

<sup>(2)</sup> 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.

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

**Table A.4 1769-OF4VI Specifications**

<b>Specification</b>	<b>1769-OF4VI</b>
Accuracy Drift with Temperature	±0.0086% FS per °C
Output Ripple <sup>(1)</sup> Range 0...50 kHz (referred to output range)	±0.05%
Non-linearity (in percent full scale)	±0.05%
Repeatability <sup>(2)</sup> (in percent full scale)	±0.05%
Output Error Over Full Temperature Range 0...60 °C (+32...+140 °F)	±0.8%
Output Impedance	<1 Ω
Open and Short-circuit Protection	Yes
Maximum Short-circuit Current	30 mA
Output Overvoltage Protection	Yes
Output Response at System Power Up and Power Down	Power up: ±1.2V dc spike for less than 0.4 ms Power down: 1.2V dc spike for less than 21 ms
Rated Working Voltage <sup>(3)</sup>	30V ac/30V dc
Output Group to Bus Isolation	500V ac or 710V dc for 1 minute (qualification test) 30V ac/30V dc working voltage
Module OK LED	On: module has power, has passed internal diagnostics, and is communicating over the bus. Off: Any of the above is not true.
Channel Diagnostics	Over- or under-range by bit reporting
System Power Supply Distance Rating	The module may not be more than 8 modules away from the system power supply.
Recommended Cable	Belden 8761 (shielded)
Vendor I.D. Code	1
Product Type Code	10
Product Code	42
Input Words	6
Output Words	5
Configuration Words	32

<sup>(1)</sup> Output ripple is the amount a fixed output varies with time, assuming a constant load and temperature.

<sup>(2)</sup> Repeatability is the ability of the output module to reproduce output readings when the same controller value is applied to it consecutively, under the same conditions and in the same direction.

<sup>(3)</sup> Rated working voltage is the maximum continuous voltage that can be applied at the input terminal, including the input signal and the value that floats above ground potential (for example, 10V dc input signal and 20V dc potential above ground).

# Module Addressing and Configuration with MicroLogix 1500

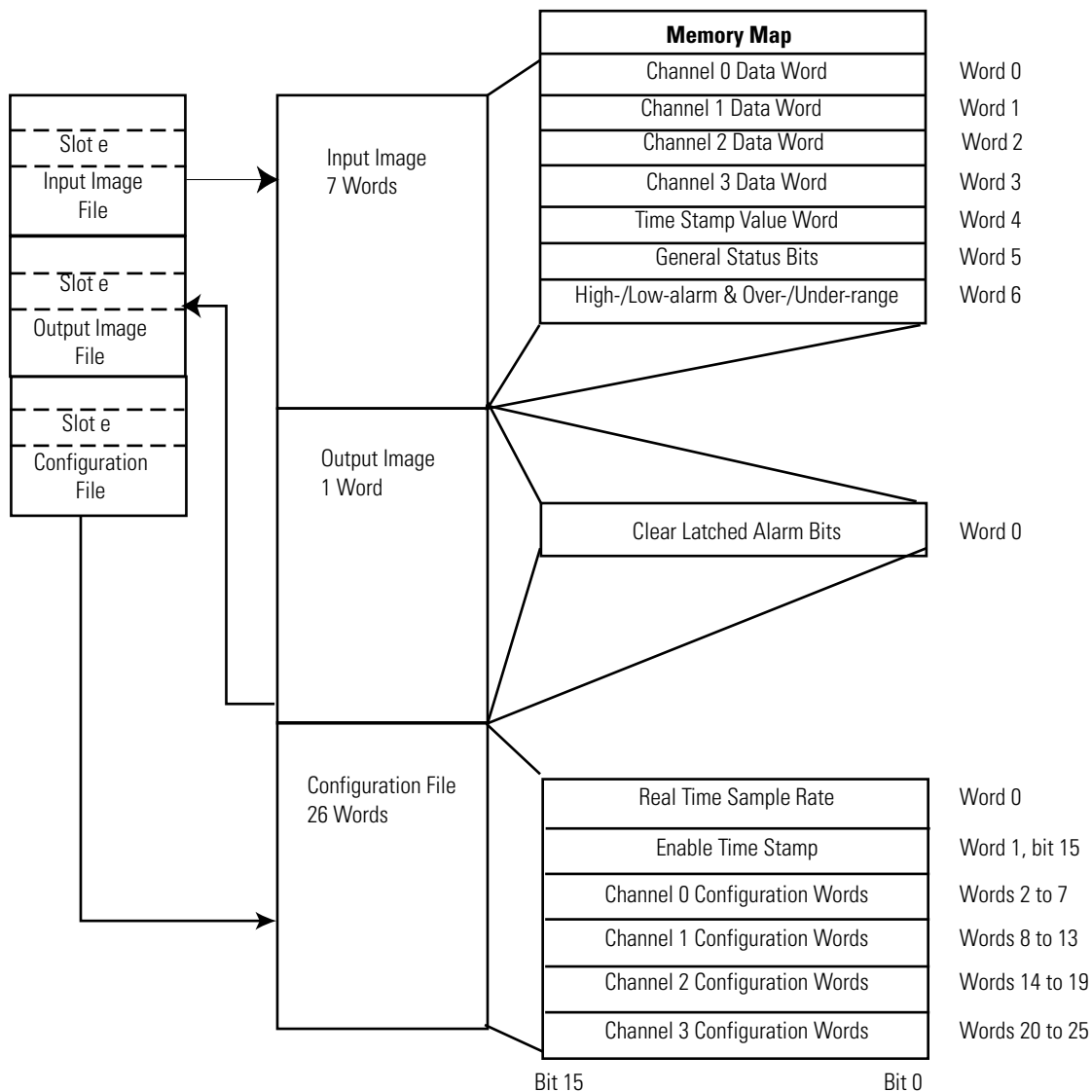
This appendix examines the analog modules' addressing scheme and describes module configuration using RSLogix 500 and MicroLogix 1500 software.

## Input Module Addressing

In the following example, the 1769-IF4I module is used.

Detailed information on the input image table can be found in 1769-IF4I Input Data File on page 3-3.

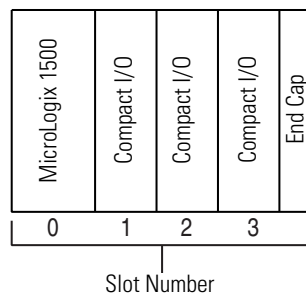
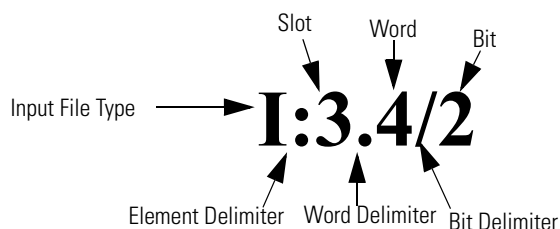
**Figure B.1 1769-IF4I Memory Map**



## Input Module's Input Image

The input modules' input image file represents data words and status bits. Input words 0 to 3 hold the input data that represents the value of the analog inputs for channels 0 to 3. These data words are valid only when the channel is enabled and there are no errors. Input words 4 and 5 hold the status bits. To receive valid status information, the channel must be enabled.

For example, to obtain the general status of channel 2 of the analog module located in slot 3, use address I:3.4/2.



### TIP

The end cap does not use a slot address.

## Input Module's 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 on page B-4.

### TIP

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

**Table B.1 Software Configuration Channel Defaults**

1769-IF4I		1769-OF4CI and -OF4VI	
Parameter	Default Setting	Parameter	Default Setting
Enable/Disable Channel <sup>(1)</sup>	Disabled	Enable/Disable Channel	Disabled
Filter Selection	60 Hz	Output Range Selection	0...20 mA
Input Range	±10V dc	Data Format	Raw/Proportional
Data Format	Raw/Proportional		

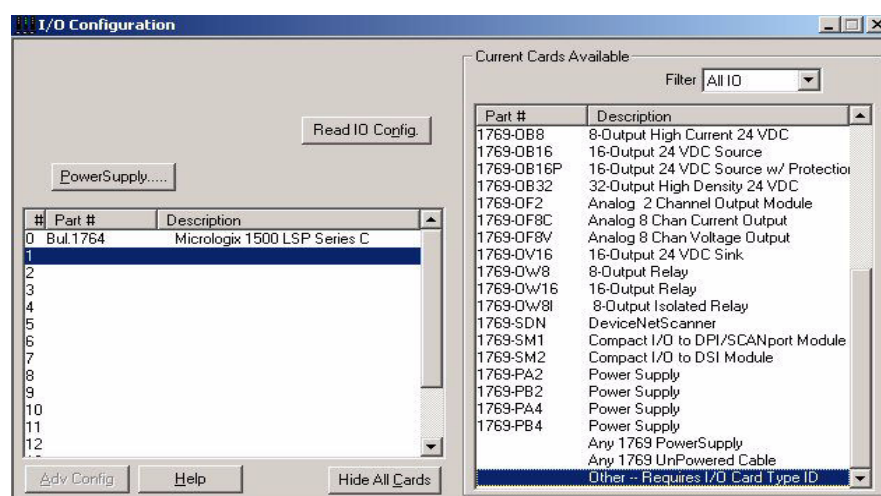
<sup>(1)</sup> The 1769-IF4I, -OF4CI, and -OF4VI modules are disabled by default. You will need to enable the channels.

## Configure Analog I/O Modules in a MicroLogix 1500 System

This example takes you through configuring your 1769 analog input and output modules with RSLogix 500 programming software. This application example assumes your input and output modules are installed as expansion I/O in a MicroLogix 1500 system, and that RSLogix software is properly configured and a communications link has been established between the MicroLogix controller and RSLogix 500 software.

If you have RSLogix 500, version 6 or earlier, follow this procedure to configure your module.

1. From the list, choose Other:Requires I/O Card Type ID.



2. Enter the appropriate values as listed below.

Vendor ID = 1  
 Product Type = 109  
 Product Code = 66  
 Series/Major Rev/Minor Rev = A  
 Input Words = 108  
 Input Bits = 0  
 Output Words = 108  
 Output Bits = 0  
 Extra Data Length = 31

**"Other" type I/O card**

Vendor ID: 1

Product Type: 109

Product Code: 66

Series/Major Rev/Minor Rev: A

Input Words: 108

Input Bits: 0

Output Words: 108

Output Bits: 0

Extra Data Length: 31

Ignore Configuration Error: ☐

OK Cancel

3. Choose OK.
4. From the Generic Extra Data Config tab, enter your configuration data.

Module #1: OTHER - I/O Module - ID Code = 66

Expansion General Configuration   Generic Extra Data Config

Offset

0	0	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				

Decimal   Radix

OK   Cancel   Apply   Help

## **Notes:**

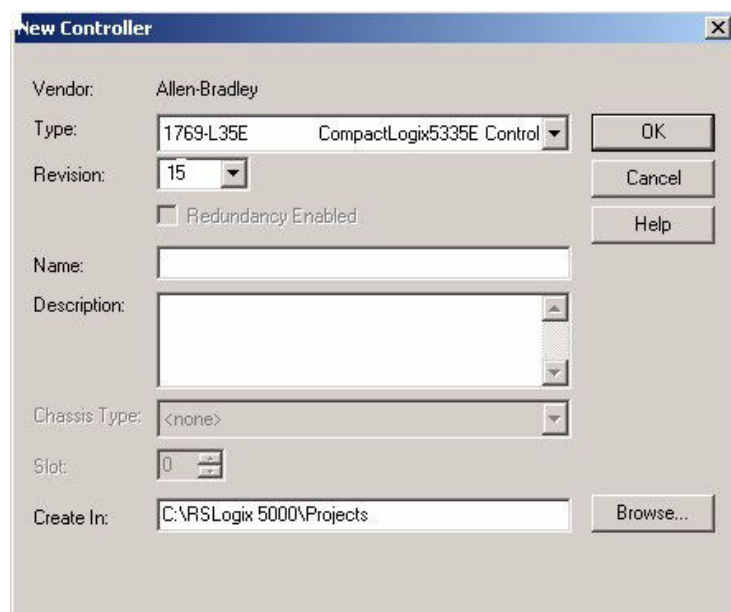


## Configuration Using the RSLogix 5000 Generic Profile for CompactLogix Controllers

To configure a 1769 analog I/O module for a CompactLogix controller in RSLogix 5000 software using the Generic Profile, you must first begin a new project in RSLogix 5000 software.

1. Click on the new project icon or on the FILE pull down menu and select NEW.

The following screen appears.



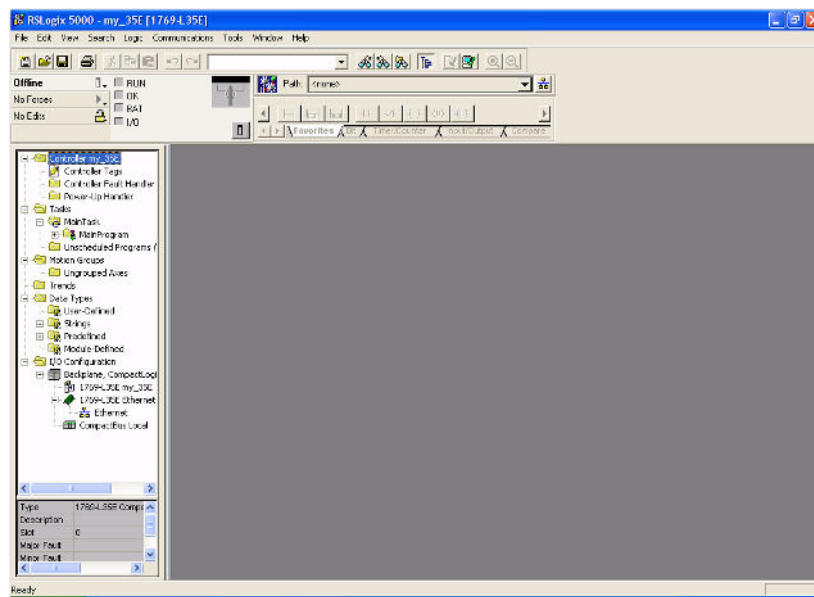
The screenshot shows the 'New Controller' dialog box with the following fields and controls:

- Vendor:** Allen-Bradley
- Type:** 1769-L35E CompactLogix5335E Control
- Revision:** 15
- ☐ Redundancy Enabled
- Name:** (empty text field)
- Description:** (empty text area)
- Chassis Type:** <none>
- Slot:** 0
- Create In:** C:\RSLogix 5000\Projects
- Buttons:** OK, Cancel, Help, and Browse...

2. Choose your controller type and enter a name for your project.

3. Click OK.

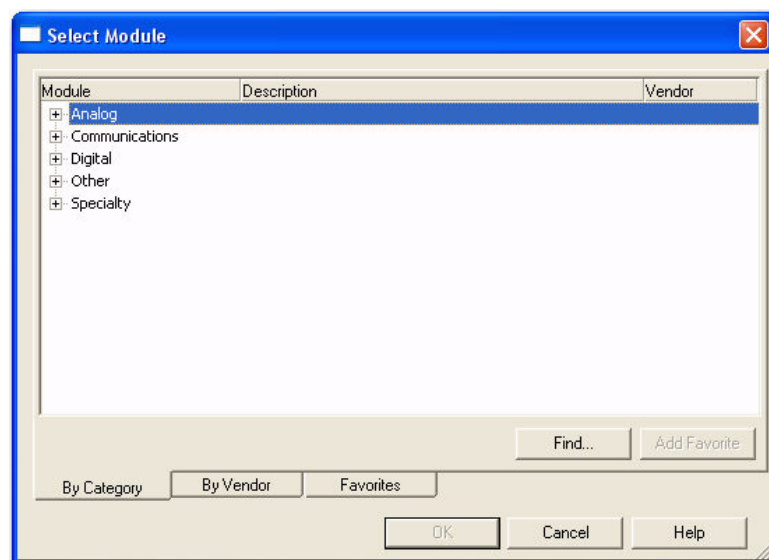
The following main RSLogix 5000 screen appears.



The last entry in the controller organizer on the left of the screen shown above is a line labeled [0] CompactBus Local.

4. Right click on this line, select New Module.

The following screen appears.



This screen narrows your search for I/O modules to configure into your system.

5. Click OK.

The following default Generic Profile screen appears.

The screenshot shows the 'New Module' dialog box. The 'Type' is '1769-MODULE Generic 1769 Module' and the 'Parent' is 'Local'. The 'Name' field is empty. The 'Description' field is empty. The 'Comm Format' is set to 'Input Data - INT'. The 'Slot' is set to '1'. The 'Connection Parameters' section shows 'Input' as '101' with a size of '1 (16-bit)', 'Output' as '104' with a size of '0', and 'Configuration' as '102' with a size of '0 (16-bit)'. The 'Open Module Properties' checkbox is checked. The 'OK', 'Cancel', and 'Help' buttons are at the bottom right.

This is the default Generic Profile screen. The first area to fill in for the Generic Profile screen is the name. This helps to easily identify the module type configured on your local Compact Bus. The Description field is optional and may be used to provide more details concerning this I/O module in your application.

The next parameter to configure is the Comm Format.

6. Click the down arrow for the Comm Format parameter to reveal the choices.

For the 1769-OF4CI and -OF4VI modules, Data – INT is used. Input Data –INT is used for the 1769-IF4I module.

7. 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.

Use the following table for the Comm Format, Assembly Instance and Size values for the 1769-IF4I, -OF4CI, and -OF4VI modules if you have an earlier version of RSLogix 5000 software, version 15.

1769 I/O Modules	Comm Format	Parameter	Assembly Instance	Size (16-bit)
IF4I	Input Data – INT	Input	101	7
		Output	100	1
		Config	102	26
OF4CI and OF4VI	Data – INT	Input	101	6
		Output	100	5
		Config	102	32

- Enter the Comm Format, Assembly Instance numbers and their associated sizes for each analog I/O module type into the Generic Profile.

**New Module**

Type: 1769-MODULE Generic 1769 Module  
Parent: Local

Name: IF4I\_Isolated\_Analog  
Description:   
Comm Format: Data - INT  
Slot: 1

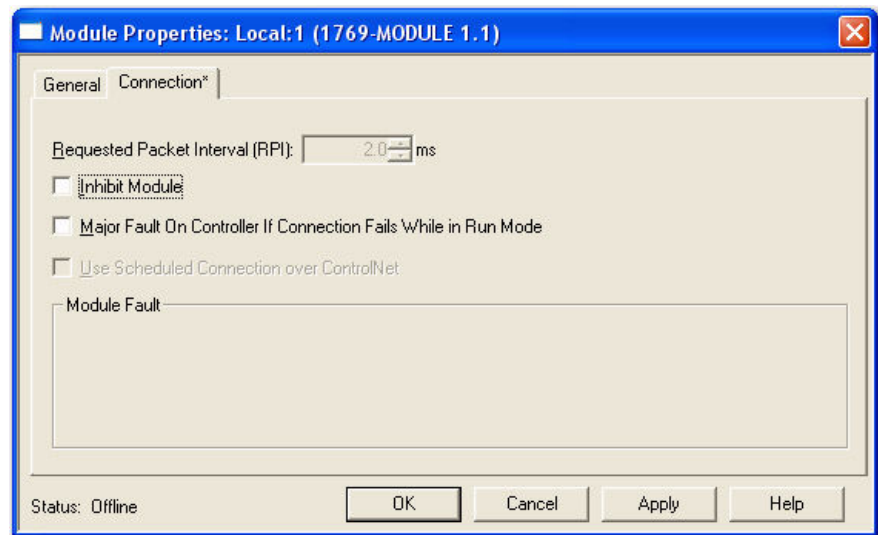
Connection Parameters:

Input:	Assembly Instance: 101	Size: 7 (16-bit)
Output:	Assembly Instance: 100	Size: 1 (16-bit)
Configuration:	Assembly Instance: 102	Size: 26 (16-bit)

☒ Open Module Properties

OK Cancel Help

9. Click OK to complete the configuration of your I/O module.



You may choose to inhibit the module or have the controller fault if the connection to this I/O module fails. The defaults for these two parameters are not to inhibit the module and not to fault the controller should an I/O module connection fail.

**TIP**

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

You may now click Finish to complete the configuration of your analog output module. If you click Next, you will see the Module Information screen, which is only filled in when you are online with your controller. If you clicked Next to get the Module Information screen, click Finish to complete the configuration of your I/O module.

Configure each analog I/O module in this manner.

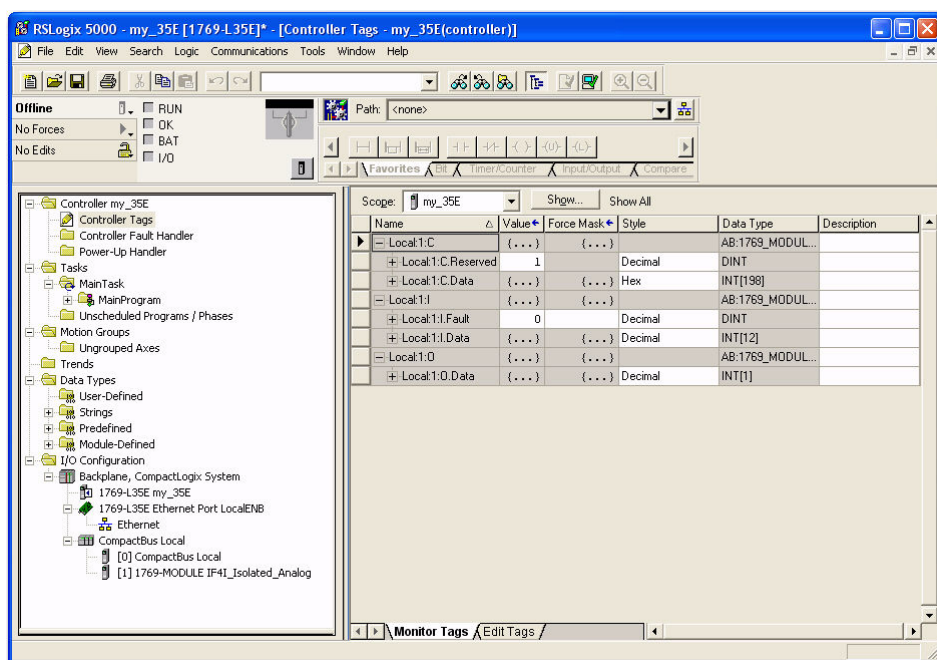
## Configure I/O Modules

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, going to run, and at power cycle.

This section shows how and where to enter configuration data for each analog I/O module, once Generic Profiles have been created for them.

You must first enter the Controller Tag database, by double-clicking Controller Tags in the upper portion of the controller organizer. The example to follow demonstrates entering configuration data for 1769-OF4I module.

For demonstration purposes, Generic Profiles have been created for 1769-IF4I, -OF4CI, and -OF4VI modules. The Controller Tags screen looks like the following:



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.

In order to configure an I/O module, you must open up the configuration tag for that module by clicking on the plus sign to the left of its configuration tag in the tag data base.

## Configure Analog Output Modules

To configure the 1769-OF4CI or -OF4VI module in slot 1, click on the plus sign left of Local:1.C. Configuration data is entered under the Local:1.C.Data tag. Click the plus sign to the left of Local:1.C.Data to reveal the 32 integer data words where configuration data may be entered for the 1769-OF4CI or -OF4VI module.

## Configure Analog Input Modules

To configure the input modules in slot 2, click on the plus sign left of Local:2.C. Click on the plus sign to the left of Local:2.C.Data to reveal the 26 integer data words where the configuration data may be entered for the module. The tag addresses for these 4 words are Local:2.C.Data[0] through Local:2.C.Data[3].

## **Notes:**



## Configure Modules in a Remote DeviceNet System with a 1769-ADN DeviceNet Adapter

### Overview

In this example, the 1769-IF4I and 1769-OF4CI modules are in a remote DeviceNet system controlled by a 1769-ADN DeviceNet adapter. RSNetWorx for DeviceNet software, version 2.23 or later, is used to configure the network and the I/O modules.

The configuration method described here must be done prior to configuring the DeviceNet adapter in the DeviceNet scanner's scanlist. This applies if you are configuring an I/O module offline, then downloading to the adapter, or if you do the configuration online. After the adapter is placed in the scanner's scanlist, you can only configure or re-configure the I/O module using explicit messages or by removing the adapter from the scanner's scanlist, modifying the configuration of the I/O module, and then adding the adapter back into the scanner's scanlist.

For additional information on configuring DeviceNet scanners and adapters, refer to the documentation for those products. The DeviceNet Adapter User Manual, publication 1769-UM001, contains examples on modifying I/O module configurations with explicit messages while the system is running.

---

**IMPORTANT**

You must use a Series B 1769-ADN adapter with the 1769-IF4I, -OF4CI, and -OF4VI modules.

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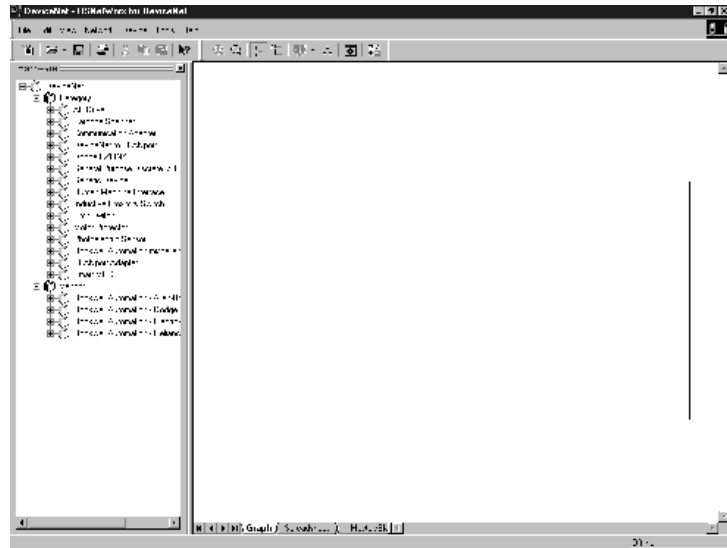
**TIP**

After setting up each slot, be sure to choose Apply.

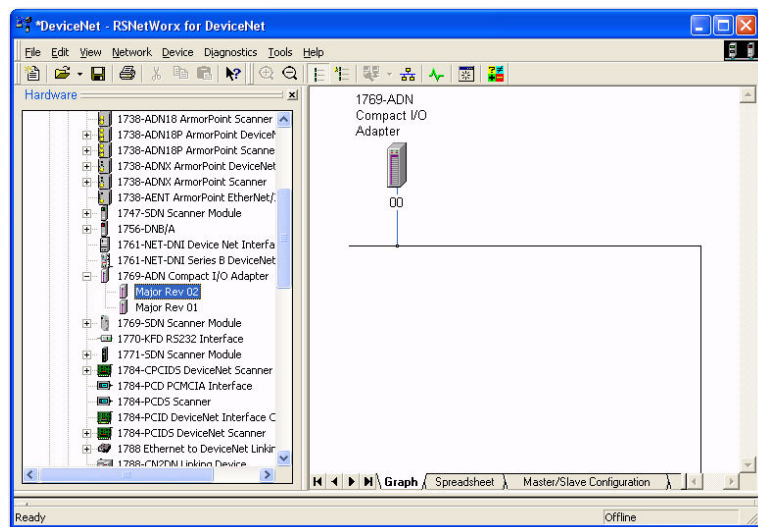
## Add the DeviceNet Adapter to the Scanlist

In this part of the example, the 1769-ADN adapter is added to the DeviceNet scanner's scanlist.

1. Start the RSNetWorx for DeviceNet software.



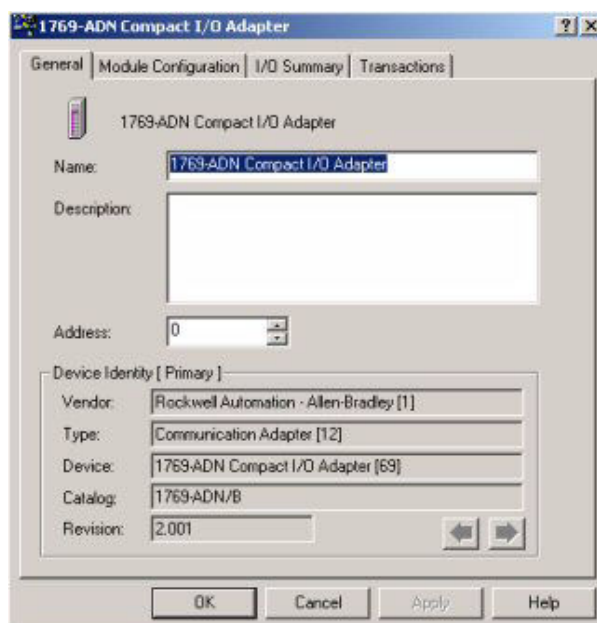
2. In the left column under Category, click the + sign next to Communication Adapters.
3. In the list of products, double-click the 1769-ADN to place it on the network.



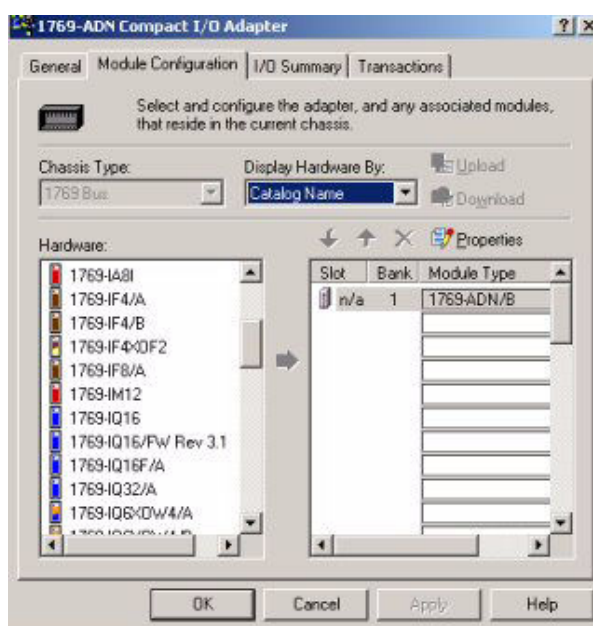
### TIP

If 1769-ADN is not an option, you have an earlier version of RSNetWorx for DeviceNet software.

4. To configure I/O for the adapter, double-click the adapter icon that appears on the network.



5. Click the Module Configuration tab.



### TIP

The I/O Summary tab provides the configured sized and format of the I/O data.

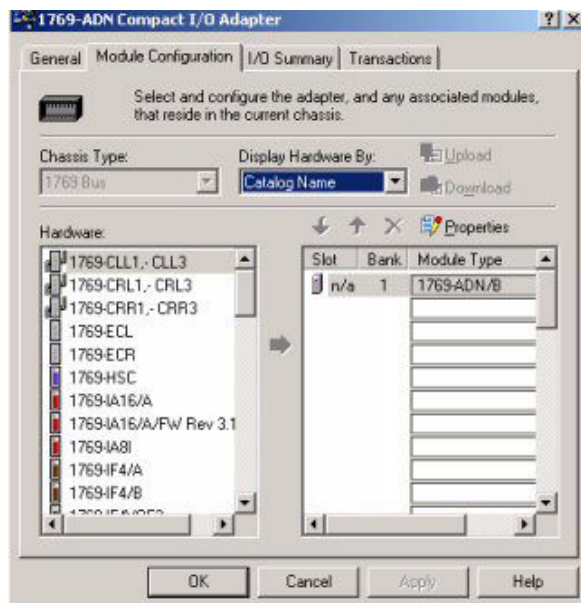
The Transaction tab lets you send services supported by the device. The Clear/Reset Memory transaction returns the module's configuration to the factory defaults, that is, empty. This operation cannot be undone.

## Configure the 1769-IF4I Input Module Example

The 1769-ADN adapter appears in slot 0. Your I/O modules, power supplies, end caps, and interconnect cables must be entered in the proper order, following the 1769 I/O rules contained in the DeviceNet Adapter User Manual, publication 1769-UM001. To simplify this example, we placed the 1769-IF4I in slot 1 to show how it is configured.

1. To place the input module into slot 1, click Module Configuration.

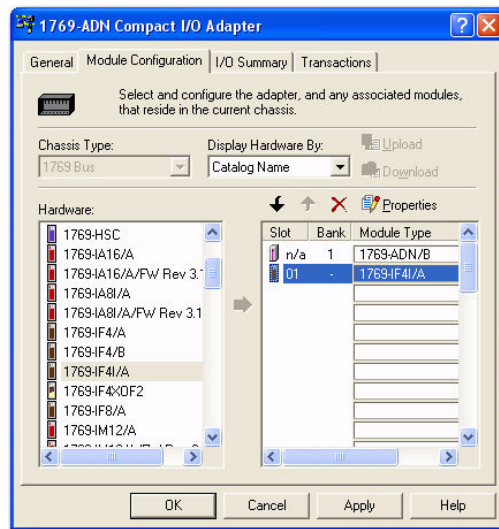
A list of all possible 1769 products appears.



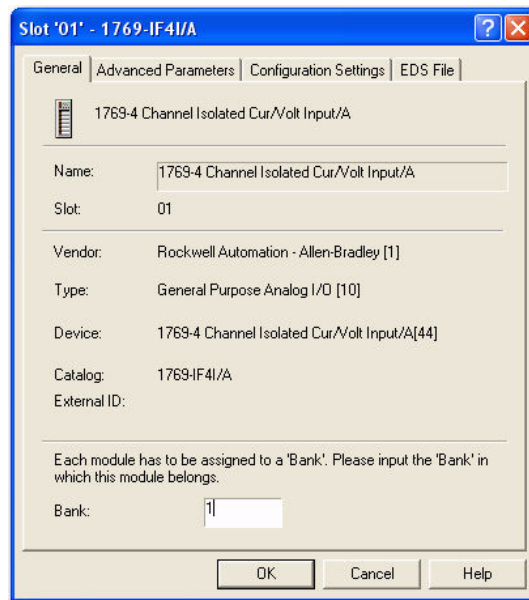
2. Select the 1769-IF4I module from the Hardware tree on the left and click the arrow to move it to the right.

Slot 1 appears to the right of the 1769-IF4I module.

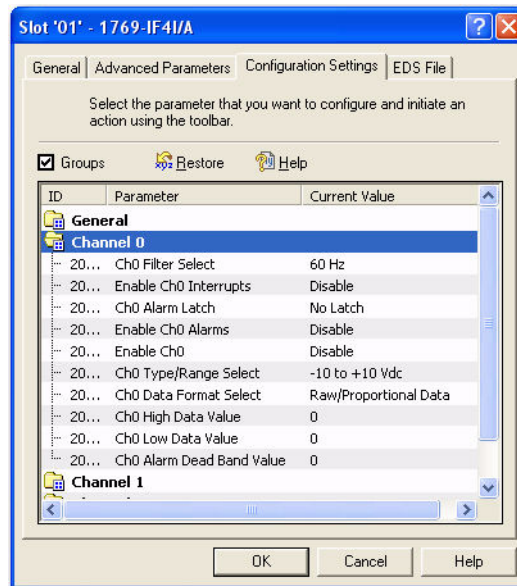
3. Double-click on 1769-IF4I.



4. Under the General tab, select the appropriate bank.  
Bank 1 was selected in this example.



- Under the Configuration Settings tab, you can select the parameter that you want to configure and initiate an action using the toolbar.



By default, the 1769-IF4I module contains six input words and no output words.

- Click the Data Description button to see what the six input words represent.

The first four words are the actual analog input data, while the last two words contain status and over- and under-range bits for the four channels.

- Click OK or Cancel to exit this screen and return to the Configuration screen.
- If your application requires only four data words and not the status information, click the Set for I/O only button

The input size changes to four words. The revision number for the 1769-IF4I module is two. With this setting, you may leave the electronic keying to Exact Match. It is not recommended to disable keying, but if you are not sure of the exact revision of your module, selecting Compatible Module allows your system to operate, while still requiring a 1769-IF4I module in slot 1.

The 1769-IF4I module allows external 24V dc power. The external power connection allows you to draw 24V dc power for the module from your external source, should your 1769 power supply not provide enough 24V dc power for your particular set of 1769 I/O modules.

If you are using external 24V dc power for your 1769-IF4I module, you must click the white box to the left of Using External +24v Power Source, so that a check mark appears in the box. Do not click on the box if you are not using external 24V dc power.

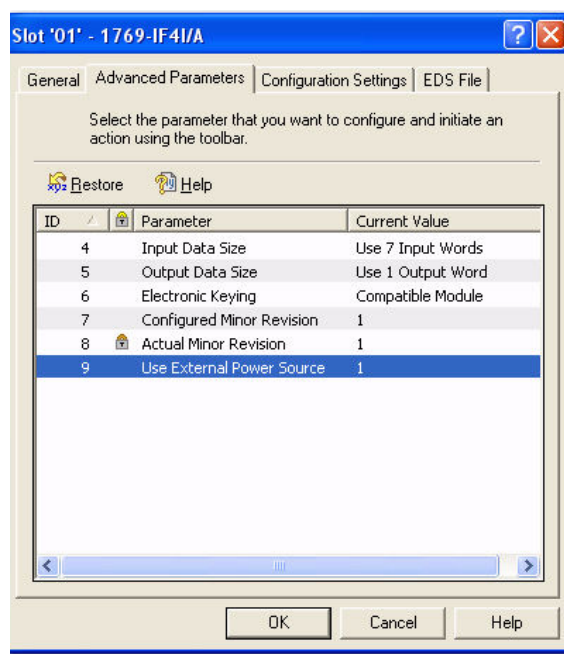
Each of the four analog input channels are disabled by default. To enable a channel, click its Enable box, so that a check mark appears in it. Then, choose your Filter frequency, Input Range, and Data Format for each channel.

See chapter 4 of this manual for a complete description of each of these configuration categories.

## 1769-IF4I External Power Example

In this example, channels 0 through 4 are used and external power is being supplied from an external 24V dc power source. In addition, channels 0 and 1 are driven by 4 to 20 mA transducers, while channels 2 and 3 are driven by devices generating 0 to 10V dc analog signals.

Throughput is not a concern for this application. However, noise immunity is. Therefore, the filter frequency for maximum noise immunity, 50 Hz, has been chosen. The analog input on channel 0 is used as the PV (input) value for a PID loop. Therefore, the Data Format for this channel is Scaled-for-PID. Channels 1 through 3 are not being used with a PID loop and have been configured for the Raw/Proportional Data Format for maximum resolution.

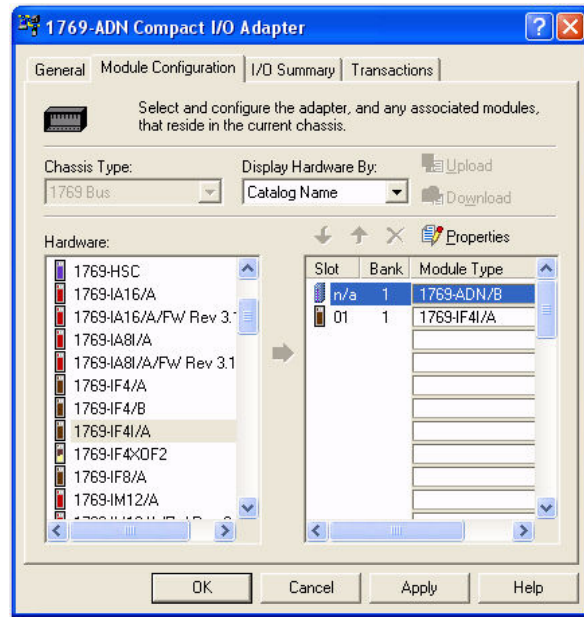


Click OK, and your configuration for the 1769-IF4I analog input module is complete.

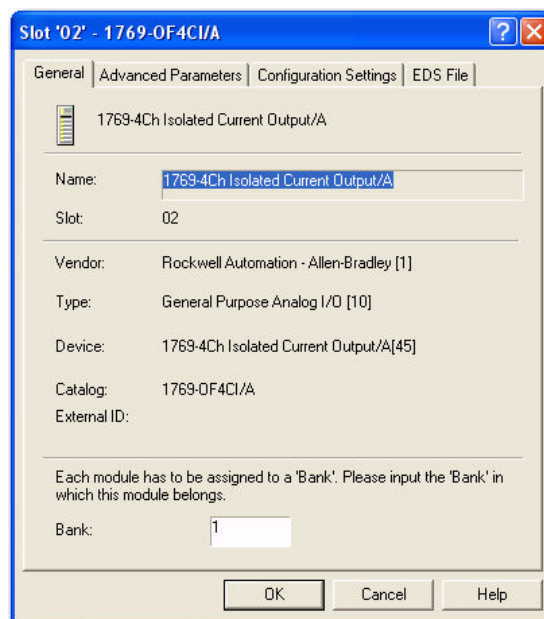


## Configure the 1769-OF4CI Output Module Example

After leaving the 1769-IF4I configuration screen, the I/O Bank 1 screen for the 1769-ADN adapter should look like the following:



1. Click on the pull-down arrow next to the empty slot and this time choose the 1769-OF4CI module.
2. Click on the Slot 2 button that appears to the right of the 1769-OF4CI module.



By default, the 1769-OF4CI module contains eleven input words and nine output words.

3. Click on the Configuration Settings button to see what the eleven input and nine output words represent.

The eleven input words contain channel diagnostic data for the eight channels. The nine output words contain the actual analog output data for the eight channels along with one additional word containing the control bits for unlatching alarms.

4. Click OK or Cancel to exit this screen and return to the Configuration screen.
5. Select No Input Data under Input Data Size if your application requires only the data words and not the status information.

The Input Size changes to 0, while the Output Size remains at nine words. The Revision number for 1769-OF4CI module is two. With this, you may leave the Electronic Keying to Exact Match. It is not recommended to disable keying, but if you are unsure of the exact revision of your module, selecting Compatible Module allows your system to operate, while still requiring a 1769-OF4CI module in slot 2.

## **1769-OF4CI External Power Example**

The 1769-OF4CI module allows external 24V dc power. The external power connection allows you to draw 24V dc power for the module from your external source, should your 1769 power supply not provide enough 24V dc power for your particular set of 1769 I/O modules.

If you are using external 24V dc power for your 1769-OF4CI module, you must click the white box to the left of Using External +24v Power Source, so that a check mark appears in the box. Do not click on the box if you are not using external 24V dc power.

## 1769-OF4CI Output Channels Example

Each of the two analog output channels are disabled by default. To enable a channel, click its Enable box so that a check mark appears in it. Then, choose your Output Range, Data Format, and the state or your outputs should the controlling controller be placed into the program mode, fault, or lose communications.

Program State and Fault State each have two options:

- Hold Last State

Hold last state will hold the analog output at the last value received before the controller was placed in program mode or before it faulted.

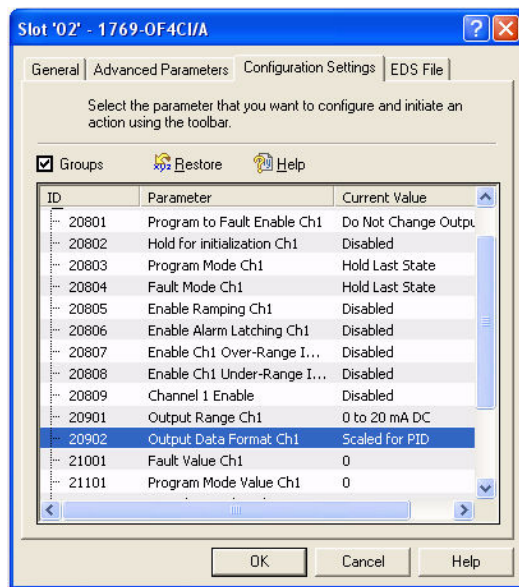
- User-defined State

When selecting user-defined state, you must specify a value for the analog output to revert to should the controller be placed in program mode or fault. The values used for user-defined state must be valid values determined by the selected Data Format and Output Range. If communications fail, you may also choose whether your Program State or Fault State options take place for each channel.

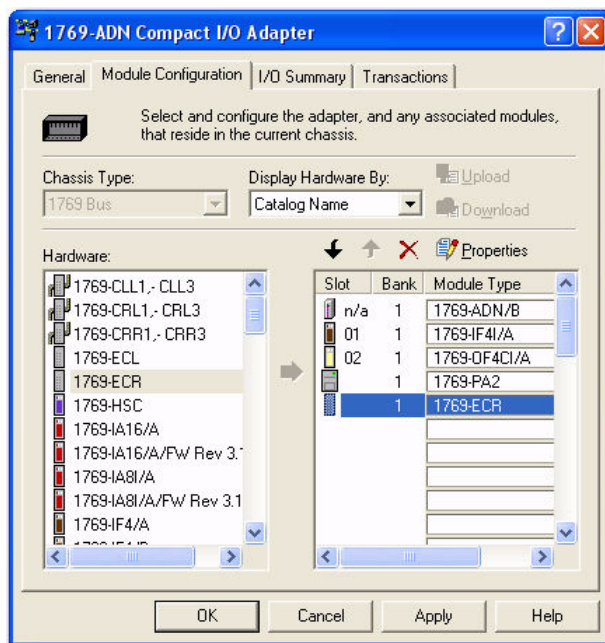
In this example, channels 0 and 1 are enabled and configured for 4 to 20 mA Output Ranges. The Data Format for channel 0 is Scaled-for-PID, because it is the CV (output) value from your PID instruction. Hold last state was chosen for all possible conditions other than Run mode for channel 0.

Channel 1 is also enabled and configured for 4 to 20 mA Output Range. Raw/Proportional Data Format was chosen for maximum resolution. In addition, a requirement of the system is that this analog output must always be at 4 mA if the system is not in control of it.

Therefore, a value of 6241 (decimal) must be used in the event the controlling controller is placed into Program/Fault mode, faults, or loses communications. The decimal number 6241 represents 4 mA, when using the Raw/Proportional Data Format.



Click OK, and your configuration for the 1769-OF4CI analog output module is complete.



### IMPORTANT

Be sure to add appropriate power supplies and end caps.

## Two's Complement Binary Numbers

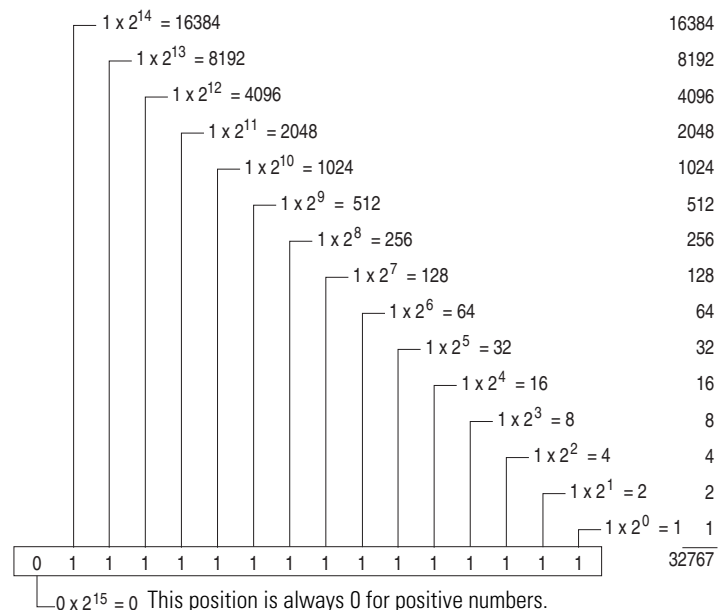
The controller memory stores 16-bit binary numbers. Two's complement binary is used when performing mathematical calculations internal to the controller. Analog input values from the analog modules are returned to the controller in 16-bit two's complement binary format. For positive numbers, the binary 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 32767 (all positions are 1 except the far left position).

**Figure E.1 Positive Decimal Values**



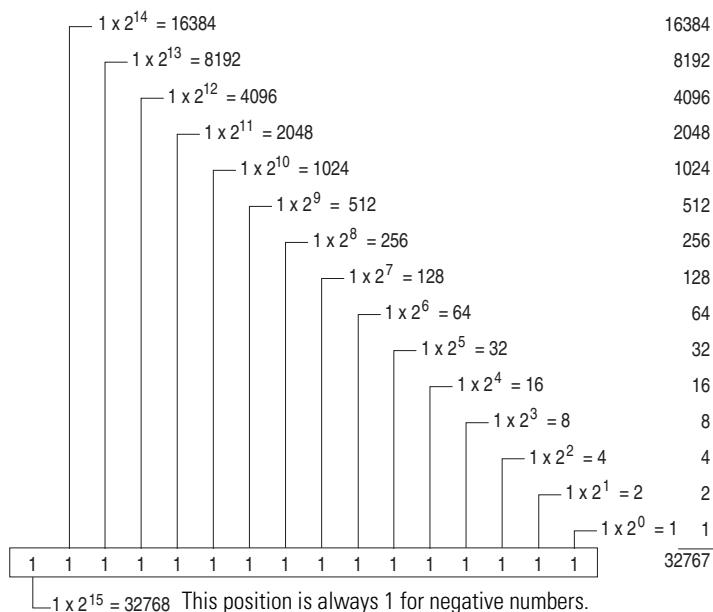
**EXAMPLE** 0000 1001 0000 1110 =  $2^{11} + 2^8 + 2^3 + 2^2 + 2^1 =$   
 2048 + 256 + 8 + 4 + 2 = 2318

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 far left position is always 1 for negative values. The equivalent decimal value of the binary number is obtained by subtracting the value of the far left position, 32768, from the sum of the values of the other positions. In Figure E.2 all positions are 1 and the value is  $32767 - 32768 = -1$ .

**Figure E.2 Negative Decimal Values**



### EXAMPLE

$$\begin{aligned}
 1111\ 1000\ 0010\ 0011 &= (2^{14} + 2^{13} + 2^{12} + 2^{11} + 2^5 + 2^1 + 2^0) - 2^{15} = \\
 &= (16384 + 8192 + 4096 + 2048 + 32 + 2 + 1) - 32768 = \\
 &= 30755 - 32768 = -2013
 \end{aligned}$$

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.

**A/D converter**— Refers to the analog to digital converter inherent to the module. The converter produces a digital value whose magnitude is proportional to the magnitude of an analog input signal.

**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.

**analog input module** — A module that contains circuits that convert analog voltage or current input signals to digital values that can be manipulated by the controller.

**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 input or 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.

**channel update time** — The time required for the module to sample and convert the input signals of one enabled input channel and update the channel data word.

**common mode rejection** — For analog inputs, the maximum level to which a common mode input voltage appears in the numerical value read by the controller, expressed in dB.

**common mode rejection ratio** — The ratio of a device's differential voltage gain to common mode voltage gain. Expressed in dB, CMRR is a comparative measure of a device's ability to reject interference caused by a voltage common to its input terminals relative to ground.  $CMRR = 20 \log_{10} (V_1/V_2)$

**common mode voltage** — For analog inputs, the voltage difference between the negative terminal and analog common during normal differential operation.

**common mode voltage range** — For analog inputs, the largest voltage difference allowed between either the positive or negative terminal and analog common during normal differential operation.

**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 output 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 analog value currently being converted by the D/A converter and shown in words 2 and 3 of the output 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 input or 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.

**digital filter** – A low-pass filter incorporated into the A/D converter. The digital filter provides very steep roll-off above its cut-off frequency, which provides high frequency noise rejection.

**filter** – A device that passes a signal or range of signals and eliminates all others.

**filter frequency** – (-3 dB frequency) The user-selectable frequency.

**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.

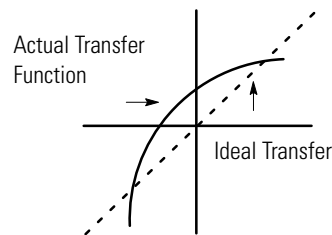
**input image** – The input from the module to the controller. The input image contains the module data words and status bits.



**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 input or 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 input or output. The linearity is expressed in percent of full scale input or 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** – same as module update time

**module update time** – For input modules, the time required for the module to sample and convert the input signals of all enabled input channels and make the resulting data values available to the controller. For output modules, the time required for the module to receive the digital code from the controller, convert it to the analog output signal, and send it to the output channel.

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

**normal mode rejection** – (differential mode rejection) A logarithmic measure, in dB, of a device's ability to reject noise signals between or among circuit signal conductors.

**normal operating range** – Input or output signals are within the configured range. See page 1-2 for a list of input and output types/ranges.

**overall accuracy** – The worst-case deviation of the output voltage or current from the ideal over the full output range is the overall accuracy. For inputs, the worst-case deviation of the digital representation of the input signal from the

ideal over the full input range is the overall accuracy. this is expressed in percent of full scale.

Gain error, offset error, and linearity error all contribute to input and 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, and also over the full operating temperature range (0 to 60°C).

**output image** – The output from the controller to the output module. The output image contains the analog output data.

**analog output module** – An I/O module that contains circuits that output an analog dc voltage or current signal proportional to a digital value transferred to the module from the controller.

**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.

**step response time** – For inputs, this is the time required for the channel data word signal to reach a specified percentage of its expected final value, given a large step change in the input signal.

**update time** – See module update time.

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# 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 a problem within the first 24 hours of installation, review the information that is 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 <a href="#">Worldwide Locator</a> at <a href="http://www.rockwellautomation.com/support/americas/phone_en.html">http://www.rockwellautomation.com/support/americas/phone_en.html</a> , 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.

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