User Manual

Allen-Bradley

# ControlLogix Analog I/O Modules

Catalog Numbers 1756-IF16, 1756-IF6CIS, 1756-IF6I, 1756-IF8, 1756-IR6I, 1756-IT6I, 1756-IT6I2, 1756-OF4, 1756-OF6CI, 1756-OF6VI, 1756-OF8

# Important User Information

Read this document and the documents listed in the additional resources section about installation, configuration, and operation of this equipment before you install, configure, operate, or maintain this product. Users are required to familiarize themselves with installation and wiring instructions in addition to requirements of all applicable codes, laws, and standards.

Activities including installation, adjustments, putting into service, use, assembly, disassembly, and maintenance are required to be carried out by suitably trained personnel in accordance with applicable code of practice.

If this equipment is used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired.

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

Labels may also be on or inside the equipment to provide specific precautions.

| | |
|---|---|
|  | **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. |
|  | **ARC FLASH HAZARD:** Labels may be on or inside the equipment, for example, a motor control center, to alert people to potential Arc Flash. Arc Flash will cause severe injury or death. Wear proper Personal Protective Equipment (PPE). Follow ALL Regulatory requirements for safe work practices and for Personal Protective Equipment (PPE). |

This manual contains new and updated information. Changes throughout this revision are marked with change bars, as shown to the right of this paragraph.

## New and Updated Information

The table explains the new and updated information in this manual.

| Section | Changes |
|---|---|
| Chapter 3 | • Updated the Electronic Keying section<br>• Updated the Difference Between Integer and Floating Point example |
| Chapter 4 | Added advisory not to exceed the specific isolation voltage when using a separate power source when wiring various modules |
| Chapter 5 | • Added advisory not to exceed the specific isolation voltage when using a separate power source when wiring various modules<br>• Updated diagram labels for wiring the 1756-IF6I Module |
| Chapter 6 | • Updated Fahrenheit temperature conversion range values for Cold-junction Compensation Types and Cold Junction Offset Option<br>• Added advisory not to exceed the specific isolation voltage when using a separate power source when wiring various modules |
| Chapter 7 | Added advisory not to exceed the specific isolation voltage when using a separate power source when wiring various modules |
| Chapter 8 | Added advisory not to exceed the specific isolation voltage when using a separate power source when wiring various modules |

## Notes:

# Isolated Analog Output Modules (1756-OF6CI and 1756-OF6VI)

## Introduction

This chapter describes features specific to ControlLogix isolated analog output modules that provide a high level of noise immunity. The 'C' and 'V' in the respective catalog numbers indicate 'current' and 'voltage'.



The isolated analog output modules also support features described in Chapter 3. See the table for some of these features.

## Choose a Data Format

Data format defines the format of channel data sent from the controller to the module, defines the format of the 'data echo' that the module produces, and determines the features that are available to your application. You choose a data format when you choose a Communication Format.

You can choose one of these data formats:

- Integer mode
- Floating point mode

The table shows features that are available in each format.

**Table 32 - Features Available in Each Data Format**

| Data Format | Features Available | Features Not Available |
|---|---|---|
| Integer mode | Ramp to program value<br>Ramp to fault value<br>Hold for initialization<br>Hold Last State or User Value in fault or program mode | Clamping<br>Ramp in Run mode<br>Rate and Limit alarms<br>Scaling |
| Floating point mode | All features | N/A |

For details on input and output data formats, see page 200 in Chapter 10.

## Isolated Output Module Features

The table lists features that are specific to the isolated analog output modules.

**Table 33 - Isolated Analog Output Module Features**

| Feature | Page |
|---|---|
| Ramping/Rate Limiting | 155 |
| Hold for Initialization | 155 |
| Clamping/Limiting | 156 |
| Clamp/Limit Alarms | 156 |
| Data Echo | 157 |

## Ramping/Rate Limiting

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. Ramping is also known as rate limiting.

The table describes the types of ramping that are possible.

| Ramping type | Description |
|---|---|
| Run mode ramping | This type of ramping occurs when the module is in Run mode and begins operation at the configured maximum ramp rate when the module receives a new output level.<br>**IMPORTANT**: This is only available in floating point mode. |
| Ramp to Program mode | This type of ramping occurs when the present output value changes to the Program value after a Program command is received from the controller. |
| Ramp to Fault mode | This type of ramping occurs when the present output value changes to the Fault value after a communications fault occurs. |

The maximum rate of change in outputs is expressed in engineering units per second and called the maximum ramp rate.

See page 204 for how to enable Run mode ramping and set the maximum ramp rate.

## Hold for Initialization

Hold for Initialization causes outputs to hold present state until the value commanded by the controller matches the value at the output screw terminal within 0.1% of full scale, providing a bumpless transfer.

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

- Initial connection is established after power-up.
- A new connection is established after a communications fault occurs.
- There is a transition to Run mode from Program state.

The InHold bit for a channel indicates that the channel is holding.

To see how to enable the Hold for Initialization bit, see page 202.

## 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 sets the high clamp on a module for 8V and the low clamp for -8V. If a controller sends a value corresponding to 9V to the module, the module only applies 8V to its screw terminals.

Clamping alarms can be disabled or latched on a per channel basis.

| | |
|---|---|
| **IMPORTANT** | Clamping is only available in floating point mode.<br>Clamp values are in engineering scaling units and are not automatically updated when the engineering high and low scaling units are changed. Failure to update the clamp values generates a very small output signal that could be misinterpreted as a hardware problem. |

To see how to set the clamping limits, see page 204.

## 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 to the clamping limit but also sends a status bit to the controller notifying it that the value sent exceeds the clamping limits.

Using the example above, if a module has clamping limits of 8V and -8V but then receives data to apply 9V, only 8V is applied to the screw terminals and the module sends a status bit back to the controller informing it that the 9V value exceeds the module's clamping limits.

| | |
|---|---|
| **IMPORTANT** | Limit alarms are available only in floating point mode. |

To see how to enable all alarms, see page 204.

## Data Echo

Data Echo automatically multicasts channel data values that match the analog value that was sent to the module's screw terminals at that time.

Fault and status data also is sent. This data is sent in the format (floating point or integer) selected at the requested packet interval (RPI).

## User Count Conversion to Output Signal

User counts can be computed in Integer mode for the 1756-OF6CI and 1756-OF6VI modules.

The straight line formulas that can be used to calculate or program a Compute (CPT) instruction are shown in the table.

| Available Range | User Count Formula |
|---|---|
| 0…20 mA | y = 3109.7560975609754x-32768<br>where y = counts; x = mA |
| +/-10V | y = 3115.669867833032x-0.5<br>where y = counts; x = V |

For example, if you have 3.5 mA in the 0...20 mV range, the user counts = -21884. Counts = 6231 for 2 V in the +/-10V range.

For a table with related values, refer to ControlLogix 1756-OF6CI and OF6VI User Count Conversion to Output Signal, Knowledgebase Technical Note IDs 41574 and 41576.

## Use Module Block and Output Circuit Diagrams

This section shows the 1756-OF6CI and 1756-OF6VI modules' block diagrams and output circuit diagrams.

**Figure 41 - 1756-OF6CI Module Block Diagram**

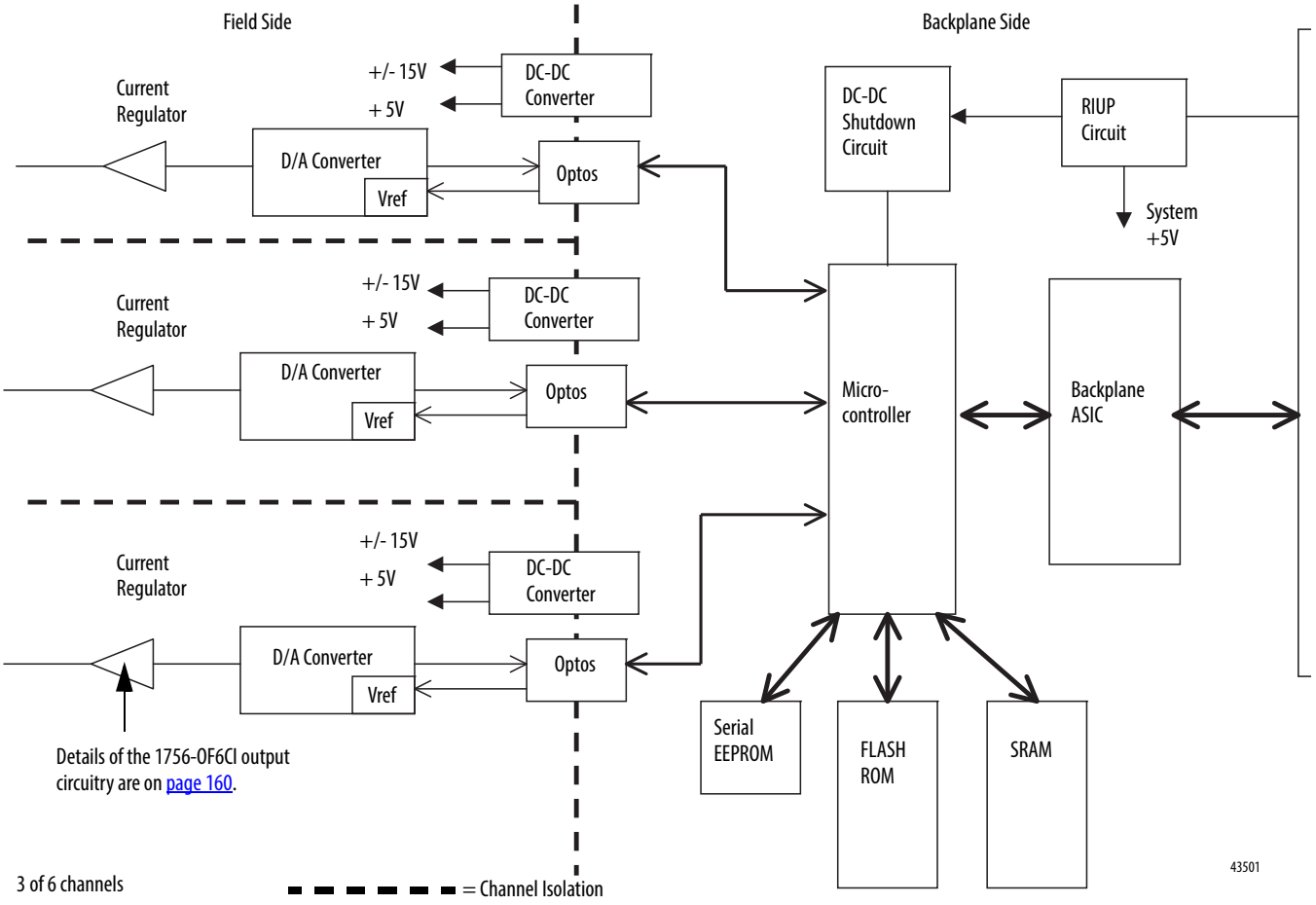
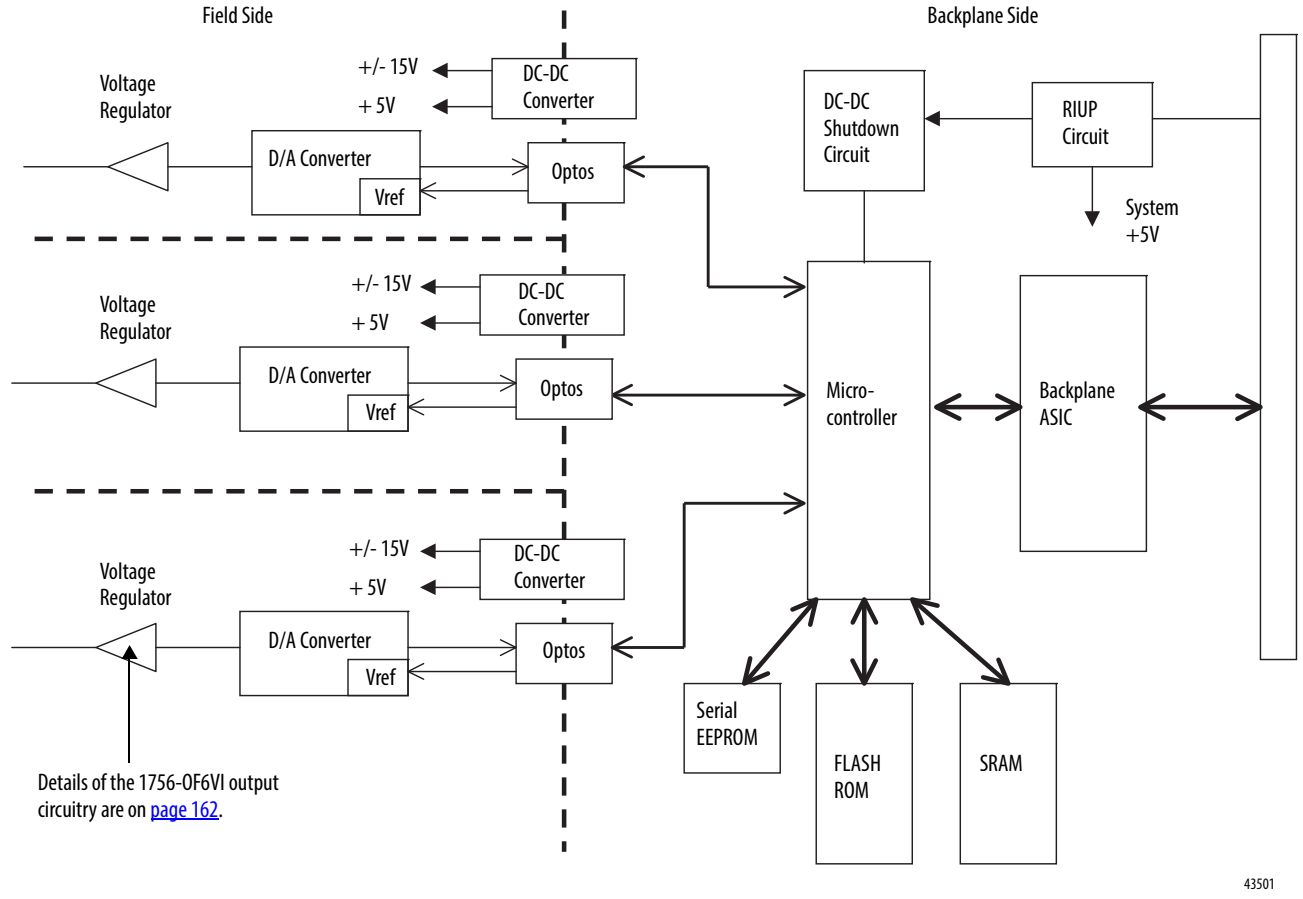


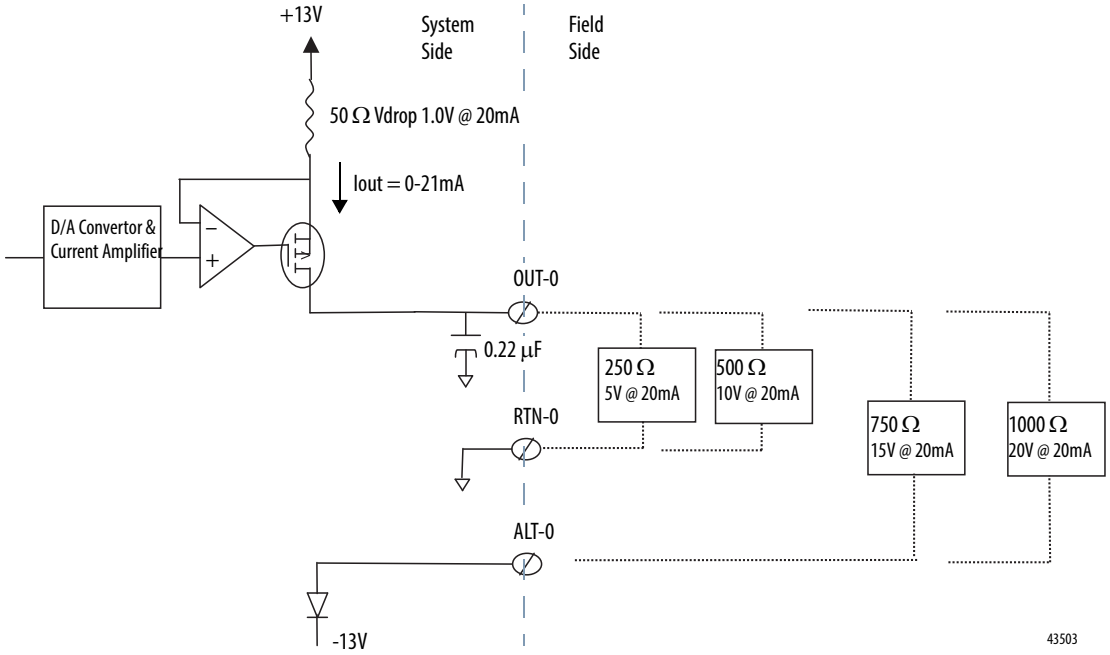
**Figure 42 - 1756-OF6VI Module Block Diagram**



## Field-side Circuit Diagrams

The diagram shows field-side circuitry for the 1756-OF6CI module.

**Figure 43 - 1756-OF6CI Output Circuit**




## Drive Different Loads with the 1756-0F6CI

The 1756-OF6CI module's output stage provides a constant current that flows through its internal electronics and out through the external output load. Because the output current is constant, the only variable in the current loop is the voltage across the output electronics and the voltage across the load. For a given termination option, the sum of the individual voltage drops around the loop components must add up to the total available voltage (13V for OUT-x/RTN-x termination and 26V for OUT-x / ALT-x).

As seen in the above diagram, a larger external output load drops a larger portion of the available loop voltage, allowing the module to drop less volts across its internal output electronics. This lower drop allows the power dissipation in the module to be lower, minimizing the thermal affect to adjacent modules in the same chassis.

For loads under 550 Ω, the module's +13V internal voltage source can supply voltage for currents up to 21 mA. For loads over 550 Ω, additional compliance voltage is required. In this case, you must use the ALT terminal to provide the additional -13V source.

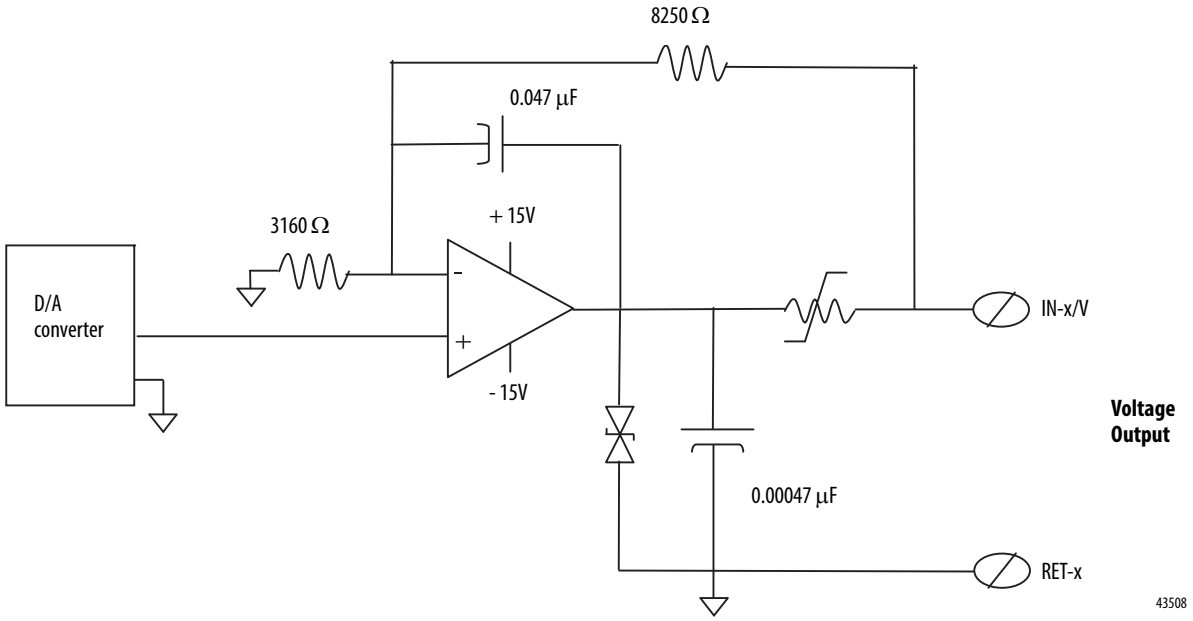
For any size load (that is, 0...1000 Ω), the output channels function if terminated between OUT-x and ALT-x. To improve module reliability and product life, we recommend you:

- Terminate the output channels between the OUT-x and RTN-x terminals for loads of 0...550 Ω
- Terminate the output channels between the OUT-x and ALT-x terminals for loads of 551...1000 Ω

| | |
|---|---|
| **IMPORTANT** | If you are unsure of the load, you can terminate the output channels between OUT-x and ALT-x and the module operates but reliability can be compromised at elevated temperatures.<br>For example, if you terminate the output channels between OUT-x and ALT-x and use a 250 Ω load, the module operates but the lower load results in higher operating temperatures and can affect the module's reliability over time.<br>We recommend you terminate the output channels as described above whenever possible. |

**Figure 44 - 1756-OF6VI Output Circuit**

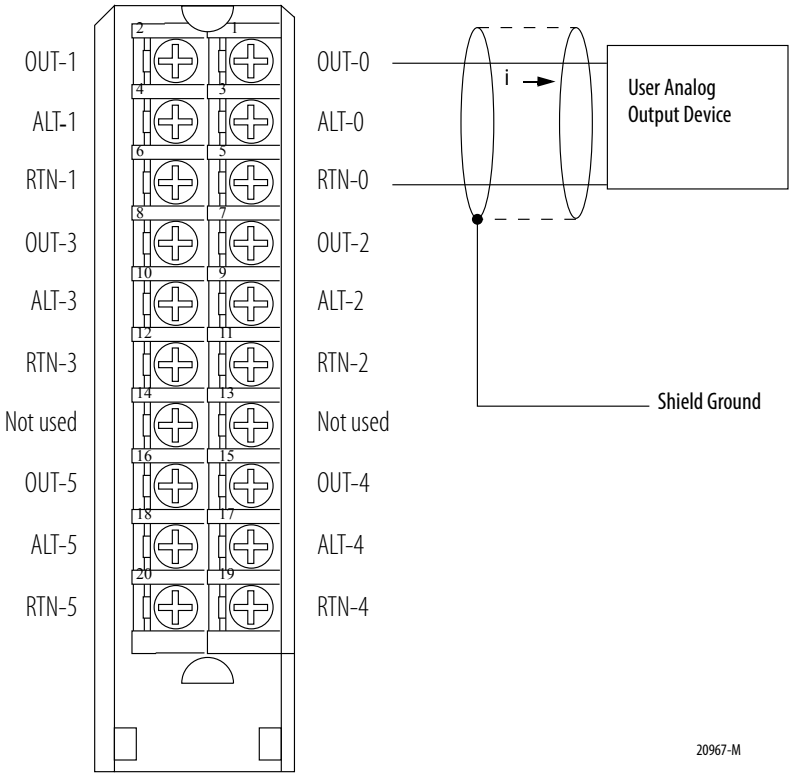
The diagram shows field-side circuitry for the 1756-OF6CI module.



## Wire the 1756-OF6CI Module

The illustration shows wiring examples for the 1756-OF6CI module.

**Figure 45 - 1756-OF6CI Wiring Example for Loads of 0-550 Ω**

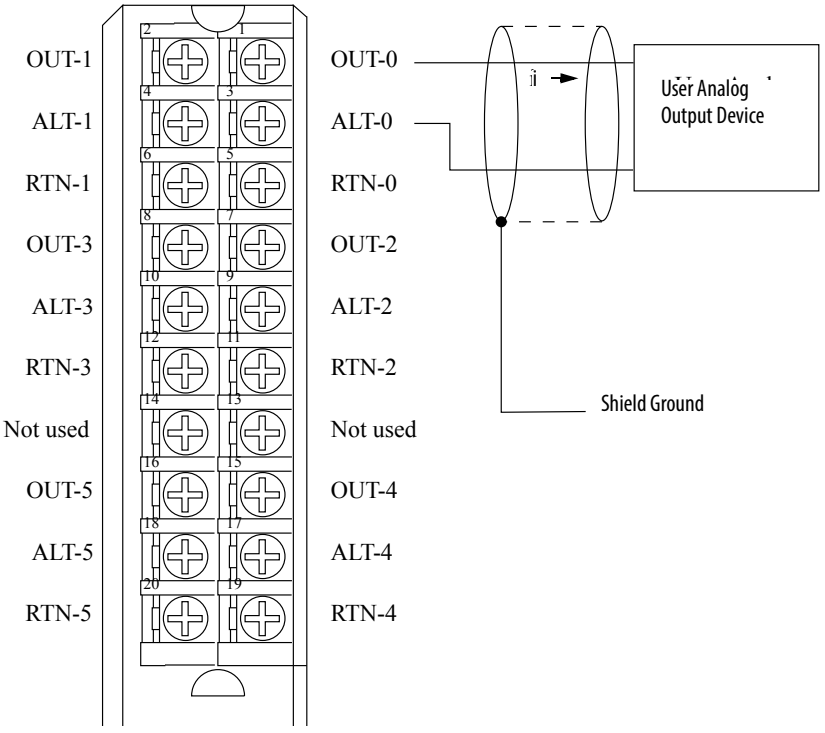



**NOTES**:

1. Place additional devices anywhere in the loop.
2. Do not connect more than two wires to any single terminal.

**ATTENTION**: If you use a separate power source, do not exceed the specific isolation voltage.

**Figure 46 - 1756-OF6CI Wiring Example for Loads of 551-1000Ω**




**NOTES**:

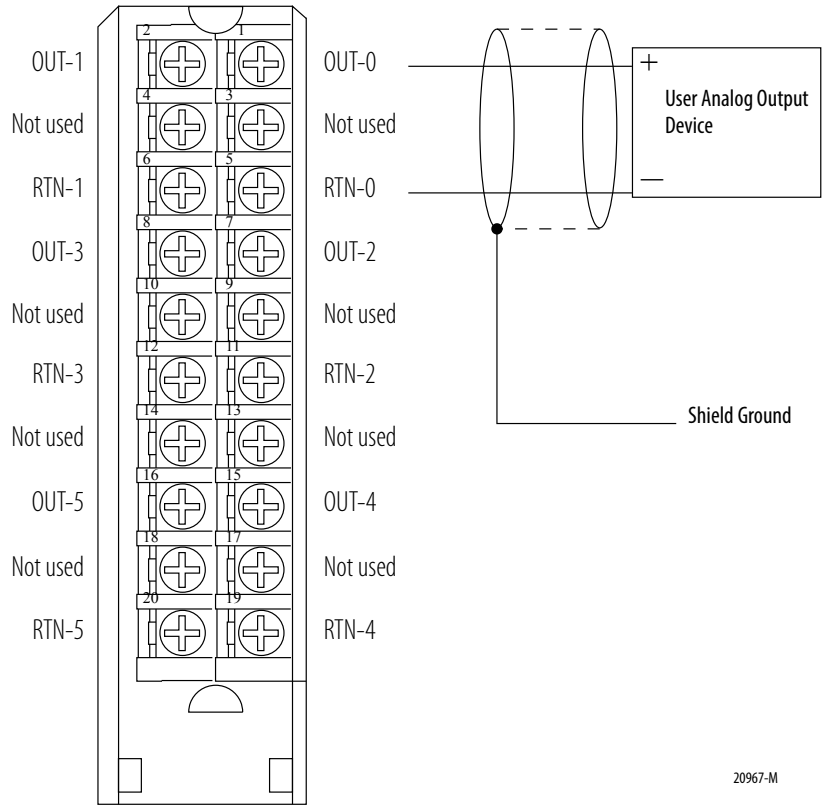
1. Place additional devices anywhere in the loop.
2. Do not connect more than two wires to any single terminal.

**ATTENTION**: If you use a separate power source, do not exceed the specific isolation voltage.

## Wire the 1756-OF6VI Module

The illustration shows wiring examples for the 1756-OF6VI module.

**Figure 47 - 1756-OF6VI Wiring example**




**NOTES**:

1. Place additional devices anywhere in the loop.
2. Do not connect more than two wires to any single terminal.

**ATTENTION**: If you use a separate power source, do not exceed the specific isolation voltage.

## 1756-OF6CI and 1756-OF6VI Module Fault and Status Reporting

The 1756-OF6CI and 1756-OF6VI modules multicast status and fault data to the owner-listening controller with their channel data. The fault data is arranged in such a manner as to let you choose the level of granularity for examining fault conditions.

Three levels of tags work together to provide increasing degree of detail as to the specific cause of faults on the module.

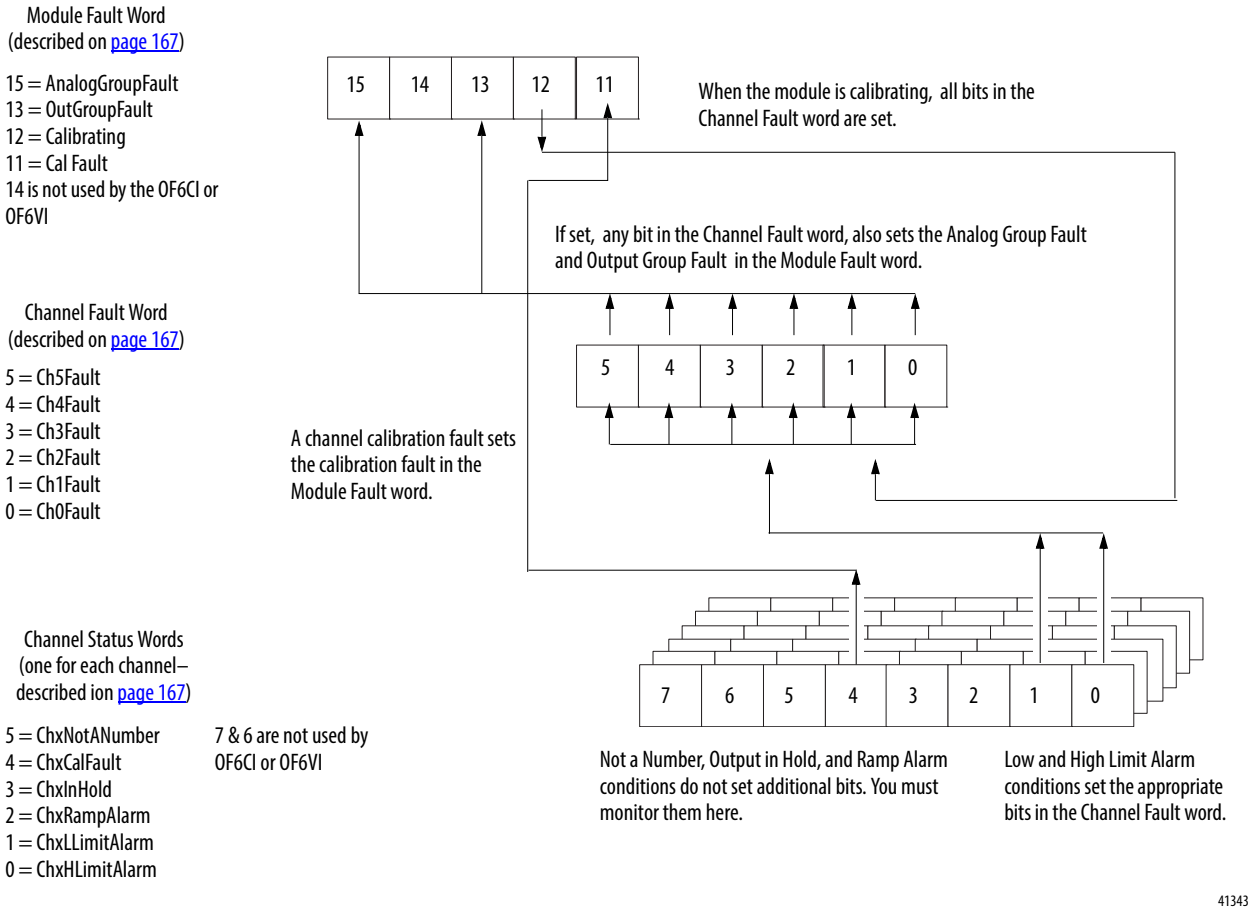
The table lists tags that can be examined in ladder logic to indicate when a fault occurs.

| Tag | Description |
|---|---|
| Module Fault Word | This word provides fault summary reporting. Its tag name is ModuleFaults. |
| Channel Fault Word | This word provides underrange, overrange and communications fault reporting. Its tag name is ChannelFaults. |
| Channel Status Words | This word provides individual channel underrange and overrange fault reporting for process alarms, rate alarms and calibration faults. Its tag name is ChxStatus. |

**IMPORTANT** Differences exist between floating point and integer modes as they relate to module fault reporting. These differences are explained in the following two sections.

# Fault Reporting in Floating Point Mode

The illustration offers an overview of the fault reporting process in floating point mode.



## Module Fault Word Bits – Floating Point Mode

Bits in this word provide the highest level of fault detection. A nonzero condition in this word reveals that a fault exists on the module. You can examine further down to isolate the fault.

The table lists tags that are found in the Module Fault Word:

| Tag | Description |
|---|---|
| Analog Group Fault | This bit is set when any bits in the Channel Fault word are set. Its tag name is AnalogGroupFault. |
| Output Group Fault | This bit is set when any bits in the Channel Fault word are set. Its tag name is OutputGroupFault. |
| Calibrating | This bit is set when any channel is being calibrated. When this bit is set, all bits in the Channel Fault word are set. Its tag name is Calibrating. |
| Calibration Fault | This bit is set when any of the individual Channel Calibration Fault bits are set. Its tag name is CalibrationFault. |

## Channel Fault Word Bits – Floating Point Mode

During normal module operation, Channel Fault word bits are set if any of the respective channels has a High or Low Limit Alarm. Checking this word for a nonzero condition is a quick way to check for High or Low Limit Alarm condition on a channel.

The table lists the conditions that set **all** Channel Fault word bits:

| This condition sets all Channel Fault word bits | And causes the module to display the following in the Channel Fault word bits |
|---|---|
| A channel is being calibrated | '003F' for all bits |
| A communications fault occurred between the module and its owner-controller | 'FFFF' for all bits |

Set your logic to monitor the Channel Fault bit for a particular output, if you either:

- set the high and low limit alarms outside your operating range.
- disable output limiting.

## Channel Status Word Bits – Floating Point Mode

Any of the six Channel Status words, one for each channel, displays a nonzero condition if that particular channel has faulted for the conditions listed below. Some of these bits set bits in other Fault words.

When the High or Low Limit Alarm bits (bits 1 and 0) in any of the words are set, the appropriate bit is set in the Channel Fault word.

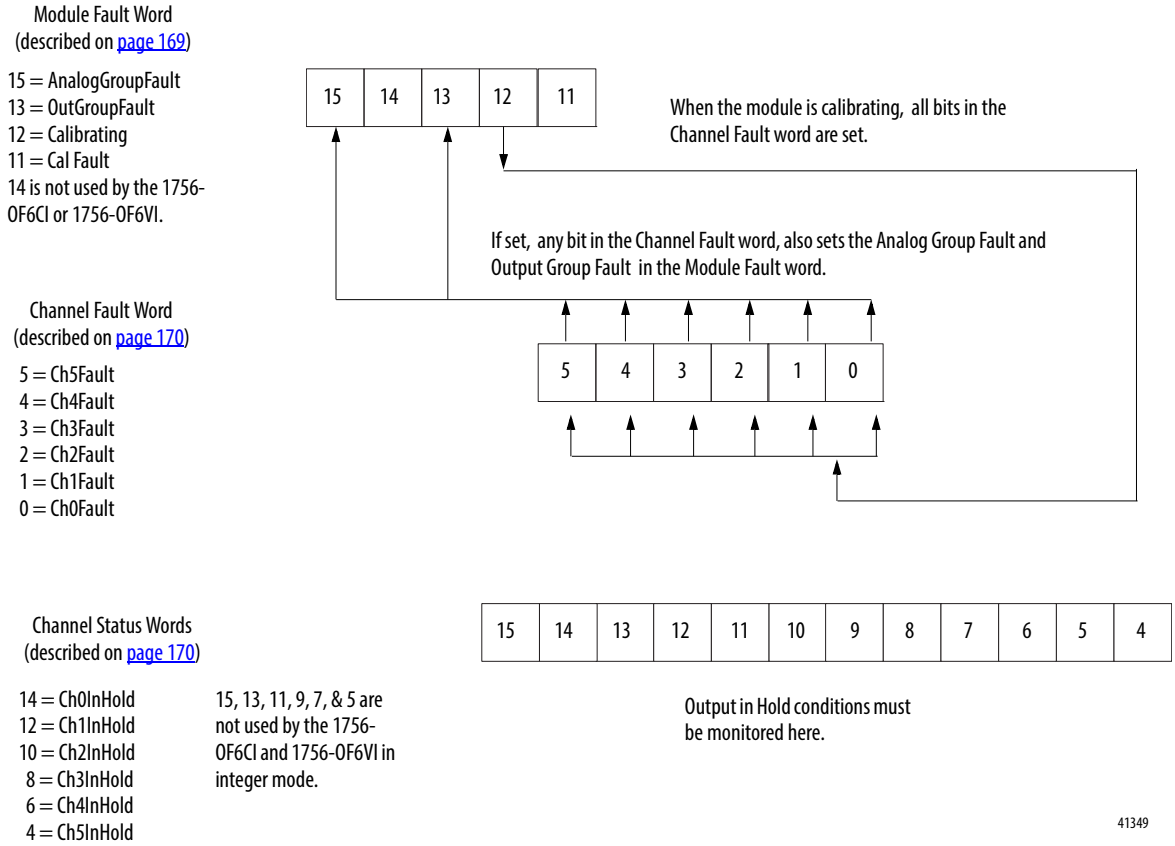
When the Calibration Fault bit (bit 4) is set in any of the words, the Calibration Fault bit (bit 11) is set in the Module Fault word. The table lists the conditions that set each of the word bits.

| Tag (Status word) | Bit | Event that sets this tag |
|---|---|---|
| ChxNotaNumber | Bit 5 | This bit is set when the output value received from the controller is NotaNumber (the IEEE NAN value). The output channel holds its last state. |
| ChxCalFault | Bit 4 | This bit is set when an error occurred when calibrating. This bit also sets the appropriate bit in the Channel Fault word. |
| ChxInHold | BIt 3 | This bit is set when the output channel is currently holding. The bit resets when the requested Run mode output value is within 0.1% of full-scale of the current echo value. |
| ChxRampAlarm | Bit 2 | This bit is set when the output channel's requested rate of change would exceed the configured maximum ramp rate requested parameter. It remains set until the output reaches its target value and ramping stops. If the bit is latched, it remains set until it is unlatched. |
| ChxLLimitAlarm | Bit 1 | This bit is set when the requested output value is beneath the configured low limit value. It remains set until the requested output is above the low limit. If the bit is latched, it remains set until it is unlatched. |
| ChxHLimitAlarm | Bit 0 | This bit is set when the requested output value is above the configured high limit value. It remains set until the requested output is below the high limit. If the bit is latched, it remains set until it is unlatched. |

**IMPORTANT** The 1756-OF6CI and 1756-OF6VI modules do not use bits 6 or 7 in this mode.

# Fault Reporting in Integer Mode

The illustration offers an overview of the fault reporting process in integer mode.




## Module Fault Word Bits – Integer Mode

In integer mode, Module Fault word bits (bits 15...11) operate exactly as described in floating point mode. The table lists tags that are found in the Module Fault Word.

| Tag | Description |
|---|---|
| Analog Group Fault | This bit is set when any bits in the Channel Fault word are set. Its tag name is AnalogGroupFault. |
| Output Group Fault | This bit is set when any bits in the Channel Fault word are set. Its tag name is OutputGroupFault. |
| Calibrating | This bit is set when any channel is being calibrated. When this bit is set, all bits in the Channel Fault word are set. Its tag name is Calibrating. |
| Calibration Fault | This bit is set when any of the individual Channel Calibration Fault bits are set. Its tag name is CalibrationFault. |

## Channel Fault Word Bits – Integer Mode

In integer mode, Channel Fault word bits (bits 5...0) operate exactly as described in floating point mode for calibration and communications faults. The table lists the conditions that set all Channel Fault word bits.

| This condition sets all Channel Fault word bits | And causes the module to display the following in the Channel Fault word bits |
|---|---|
| A channel is being calibrated | '003F' for all bits |
| A communications fault occurred between the module and its owner-controller | 'FFFF' for all bits |

Set your logic to monitor the Channel Fault bit for a particular output, if you either:

- set the high and low limit alarms outside your operating range
- disable output limiting.

## Channel Status Word Bits in Integer Mode

The Channel Status word has the following differences when used in integer mode.

- Only the Output in Hold condition is reported by the module.
- Calibration Fault reporting is not available in this word, although the Calibration Fault bit in the Module Fault word still activates when that condition exists on any channel.
- There is only one Channel Status word for all six channels.

The table lists the conditions that set each of the word bits.

| Tag (Status word) | Bit | Event that sets this tag |
|---|---|---|
| ChxInHold | Even-numbered bits from bit 14…bit 0 (that is, bit 14 represents channel 0).<br>For a full listing of the channels these bits represent, see page 169. | The Output In Hold bit is set when the output channel is currently holding. The bit resets when the requested Run mode output value is within 0.1% of full-scale of the current echo value. |

**IMPORTANT** The 1756-OF6CI and 1756-OF6VI modules do not use bits 15, 13, 11, 9, 7 or 5 in this mode.

**analog interface module (AIFM)**

Modules connect to pre-wired cables to provide the output terminal blocks for the analog I/O module. These modules can be mounted on a DIN rail.

**broadcast**

Data transmissions to all addresses or functions.

**communication format**

Format that defines the type of information transferred between an I/O module and its owner-controller. This format also defines the tags created for each I/O module.

**compatible match**

An electronic keying protection mode that requires that the physical module and the module configured in the software to match according to vendor and catalog number. In this case, the minor revision of the module must be greater than or equal to that of the configured slot.

**connection**

The communication mechanism from the controller to another module in the control system.

**coordinated system time (CST)**

Timer value that is kept synchronized for all modules within a single ControlBus chassis.

**direct connection**

An I/O connection where the controller establishes an individual connection with I/O modules.

**disable keying**

An electronic keying protection mode that requires no attributes of the physical module and the module configured in the software to match.

**download**

The process of transferring the contents of a project on the workstation into the controller.

**electronic keying**

A feature where modules can be requested to perform an electronic check to make sure that the physical module is consistent with what was configured by the software.

**exact match**

An electronic keying protection mode that requires the physical module and the module configured in the software to match according to vendor, catalog number, major revision and minor revision.

**field side**

Interface between user field wiring and I/O module.

**inhibit**

A ControlLogix process that lets you configure an I/O module but prevent it from communicating with the owner-controller. In this case, the controller behaves as if the I/O module does not exist at all.

**interface module (IFM)**

A module that uses pre-wired cable to connect wiring to an I/O module.

**listen-only connection**

An I/O connection where another controller owns/provides the configuration and data for the module.

**major revision**

A module revision that is updated any time there is a functional change to the module.

**minor revision**

A module revision that is updated any time there is a change to the module that does not affect its function or interface.

**multicast**

Data transmissions that reach a specific group of one or more destinations.

**multiple owners**

A configuration set-up where multiple owner-controllers use exactly the same configuration information to simultaneously own an input module.

**network update time (NUT)**

The smallest repetitive time interval in which the data can be sent on a ControlNet network. The NUT ranges from 2 ms to 100 ms.

**owner-controller**

The controller that creates and stores the primary configuration and communication connection to a module.

**Program mode**

In this mode the following events occur:

- Controller program is not executing.
- Inputs are still actively producing data.
- Outputs are not actively controlled and go to their configured Program mode.

**rack connection**

An I/O connection where the 1756-CNB module collects digital I/O words into a rack image to conserve ControlNet connections and bandwidth.

**rack optimization**

A communication format in which the 1756-CNB module collects all digital I/O words in the remote chassis and sends them to controller as a single rack image.

**remote connection**

An I/O connection where the controller establishes an individual connection with I/O modules in a remote chassis.

**removal and insertion under power (RIUP)**

ControlLogix feature that allows a user to install or remove a module or RTB while power is applied.

**removable terminal block (RTB)**

Field wiring connector for I/O modules.

**requested packet interval (RPI)**

The maximum amount of time between broadcasts of I/O data.

**Run mode**

In this mode, the following events occur:

- Controller program is executing
- Inputs are actively producing data
- Outputs are actively controlled

**service**

A system feature that is performed on user demand, such as fuse reset or diagnostic latch reset.

**system side**

Backplane side of the interface to the I/O module.

**tag**

A named area of the controller's memory where data is stored.

**timestamping**

A ControlLogix process that stamps a change in input data with a relative time reference of when that change occurred.

## Numerics



## A



## C

## M



## N



## O



## P



## R

## S



## T



## U



## W