Non-isolated Analog Output Modules (1756-OF4 and 1756-OF8)

This chapter describes features specific to ControlLogix® non-isolated analog output modules. You can mix current and voltage outputs on 1756-OF4, 1756-OF4K, 1756-OF8, or 1756-OF8K modules. Analog output modules also support the features that are described in Chapter 3.

Choose a Data Format

Data format defines the format of channel data that is 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 configuring custom Module Definition parameters.

You can choose one of these data formats:

- Integer mode
- Floating point

Features Available in Each Data Format

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

For details on input and output data formats, see page 78.

Non-isolated Output Module Features

Ramping/Rate Limiting

Ramping limits the speed that an analog output signal can change. This helps prevent fast transitions in the output from damaging the devices that an output module controls. Ramping is also known as rate limiting.

Types of Ramping

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. **IMPORTANT**: Run mode ramping 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 communication fault occurs.

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

IMPORTANT The ramp rate is rounded down to the nearest available value for:

- Series B 1756-OF4, 1756-OF4K, 1756-OF8, and 1756-OF8K modules (firmware revision 2.012 or earlier)
- Series C 1756-OF4, 1756-OF4K, 1756-OF8, and 1756-OF8K modules (firmware revision 3.011)

See page 86 for how to enable Run mode ramping and set the maximum ramp rate.

Hold for Initialization

Hold for Initialization causes outputs to hold their present state until the value that is 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's 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's 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 84.

Open Wire Detection

This feature detects when current flow isn't present at any channel. The 1756-OF4, 1756-OF4K, 1756-OF8, and 1756-OF8K modules must be configured for 0...20 mA operation to use this feature. At least 0.1 mA of current must be flowing from the output for detection to occur.

When an open wire condition occurs at any channel, a status bit is set for that channel.

For more information on the use of status bits, see page 69.

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 that is 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, if the high clamp that is configured for a module is 8V and the low clamp that is configured is -8V, and the controller sends a value of 9V to the module, the module will only apply 8V to its screw terminals.

IMPORTANT	Clamping is only available in floating point mode. Clamp values are in engineering scaling units and aren't automatically updated when the engineering high and low scaling units are changed. Failure to update the clamp values generates a small output signal that could be misinterpreted as a hardware problem.

To see how to set the clamping limits, see page 88.

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 as notification that the value sent exceeds the clamping limits.

Using the previous example, 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.

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

IMPORTANT Limit alarms are available only in floating point mode.

To see how to enable all alarms, see page 87.

Data Echo

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

Fault and status data is also 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-OF4, 1756-OF4K, 1756-OF8, and 1756-OF8K modules.

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

Available Range	User Count Formula
0...20 mA	y = 3077.9744124443446x-32768 where y = counts; x = mA
+/-10V	y = 3140.5746817972704x-0.5 where y = counts; x = V

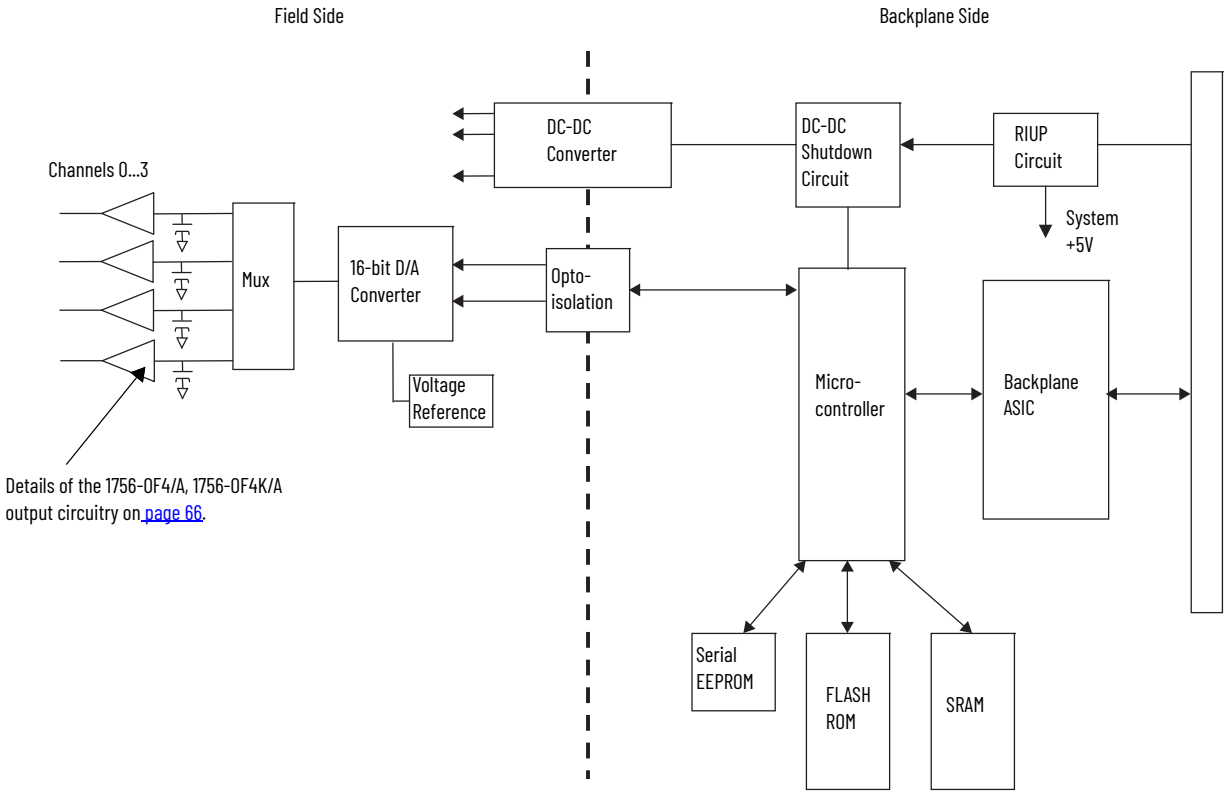
For example, if you have 6 mA in the 0...20 mV range, the user counts = -14300. Counts = 6281 for 2V in the +/-10V range.

For a table with related values, see Knowledgebase Technote, *ControlLogix 1756-OF4 and 1756-OF8 User Count Conversion to Output Signal*.

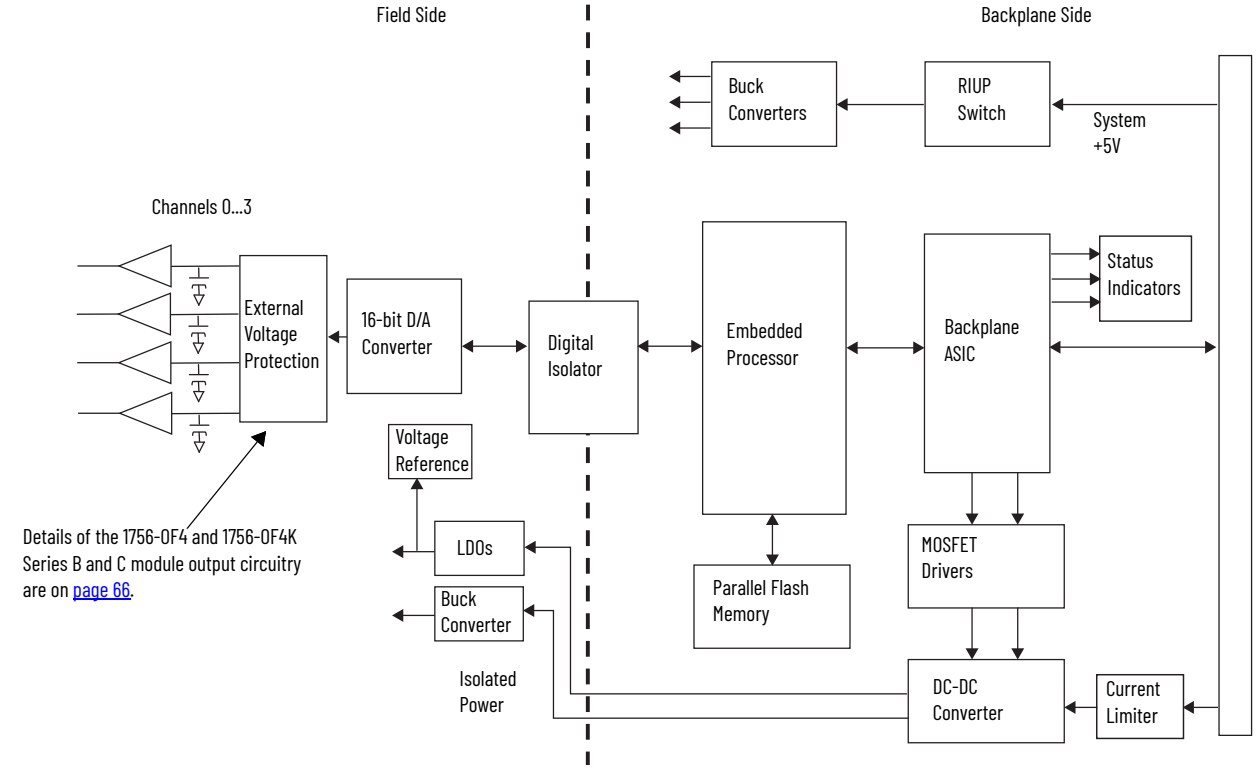
Use Module Block and Output Circuit Diagrams

This section shows the 1756-OF4 and 1756-OF4K series A, B, and C module block diagrams.

1756-OF4/A, 1756-OF4K/A Module Block Diagram

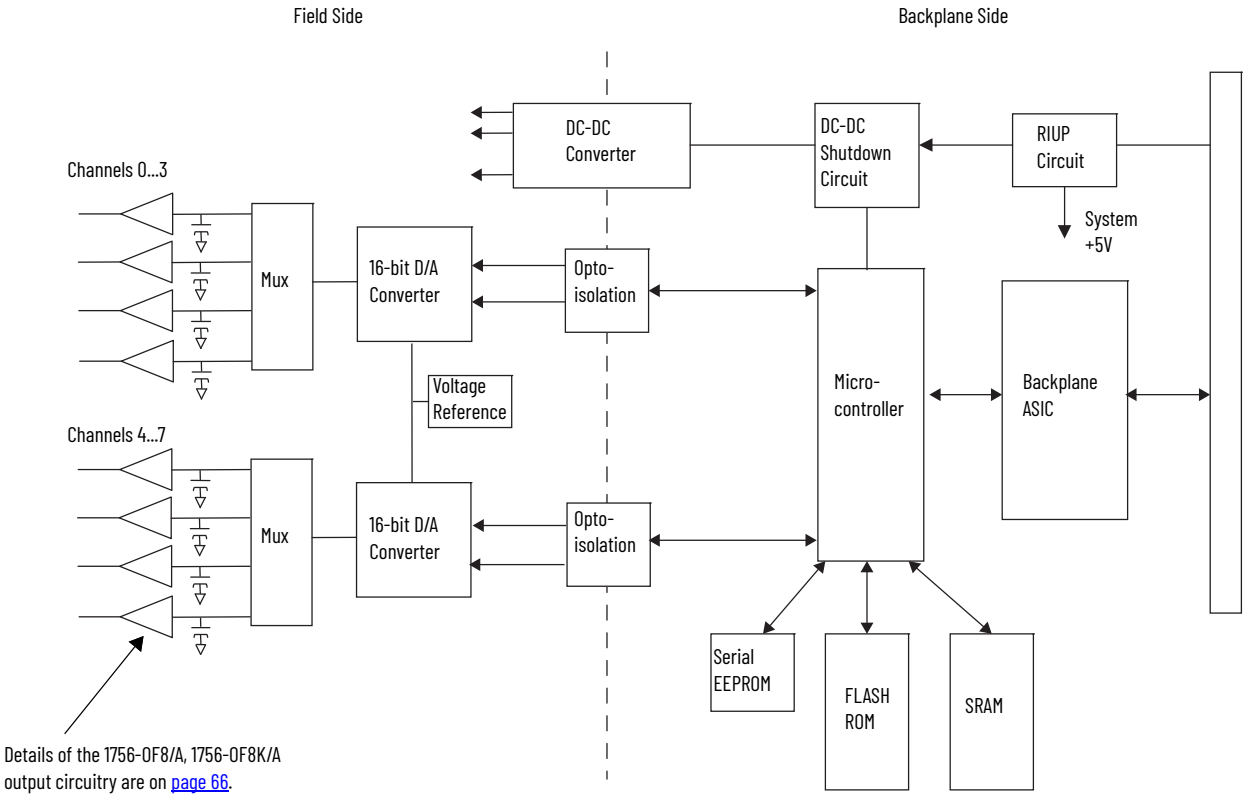


1756-OF4 and 1756-OF4K Series B and C Module Block Diagram



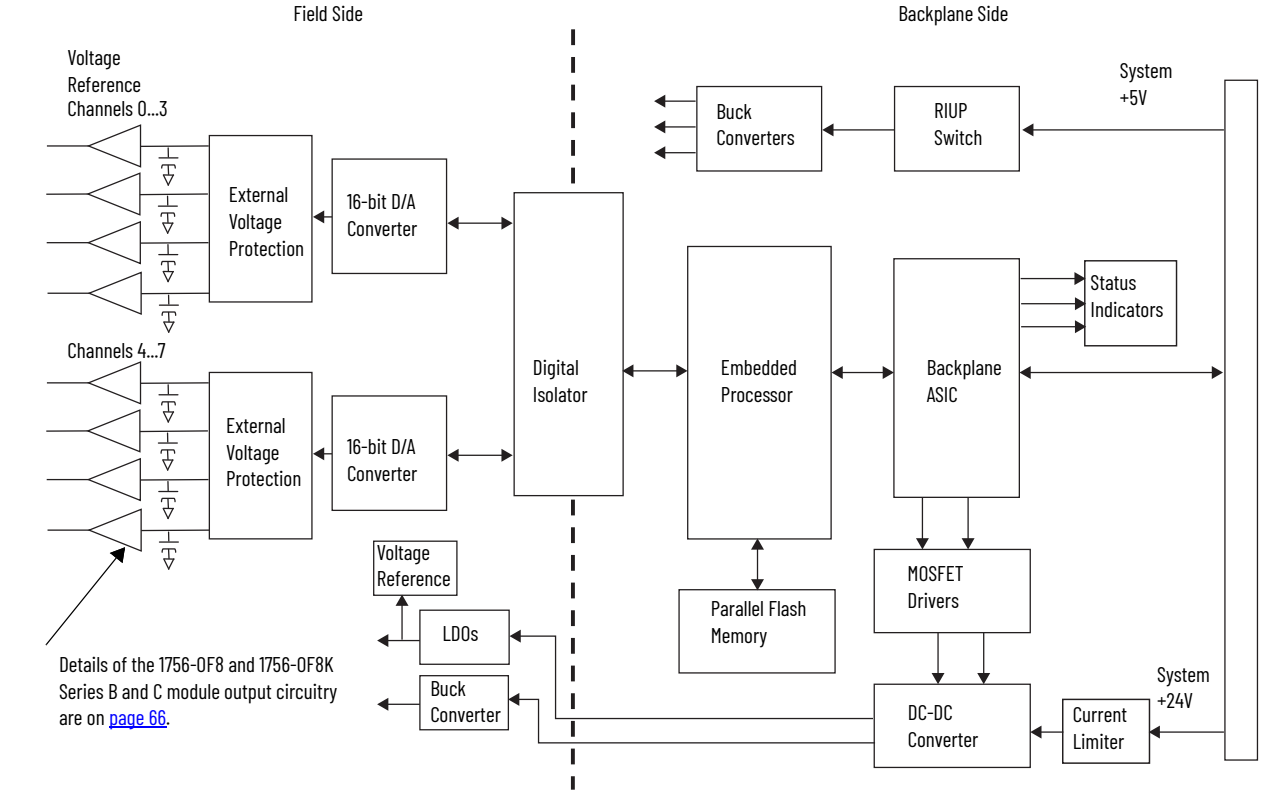
This section shows the 1756-OF8 and 1756-OF8K series A, B, and C module block diagrams.

1756-OF8/A, 1756-OF8K/A Module Block Diagram



Details of the 1756-OF8/A, 1756-OF8K/A output circuitry are on page 66.

1756-OF4 and 1756-OF4K Series B and C Module Block Diagram

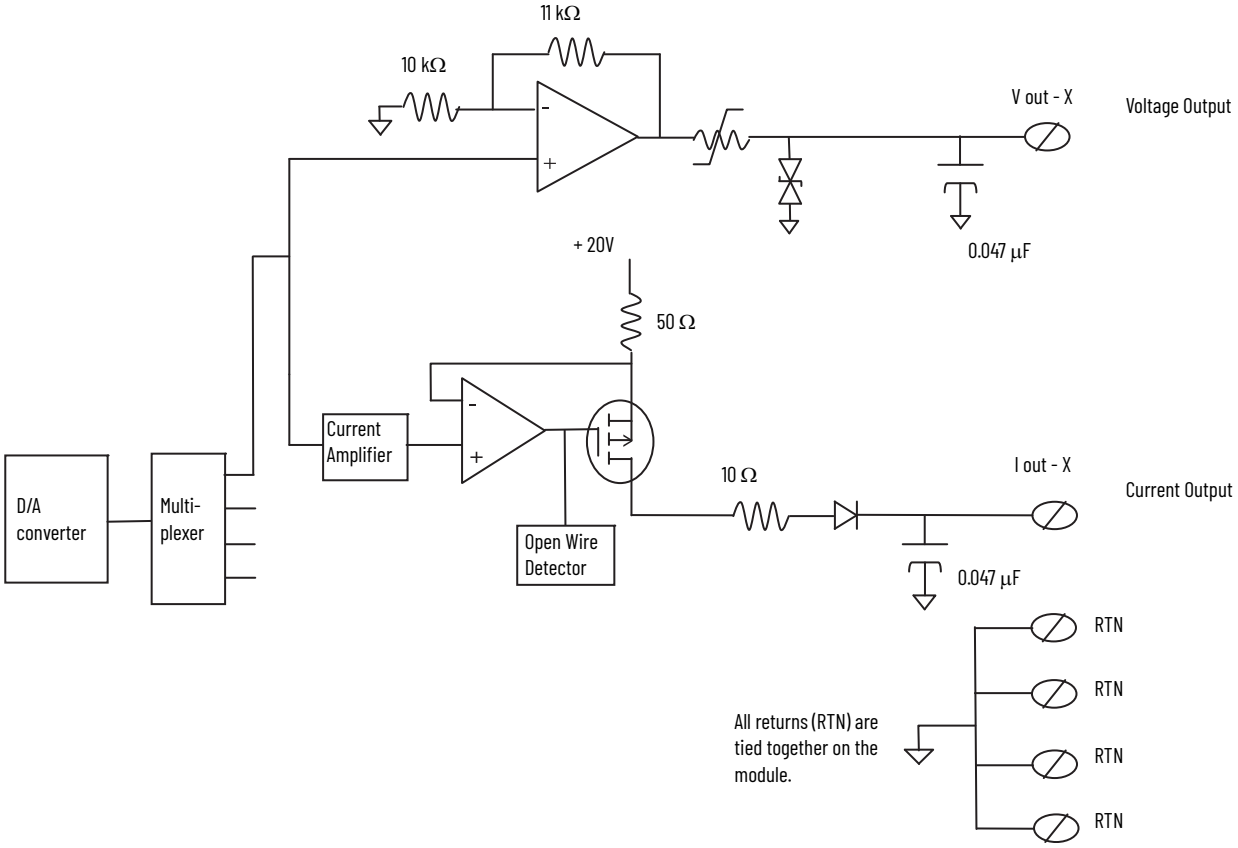


Details of the 1756-OF8 and 1756-OF8K Series B and C module output circuitry are on page 66.

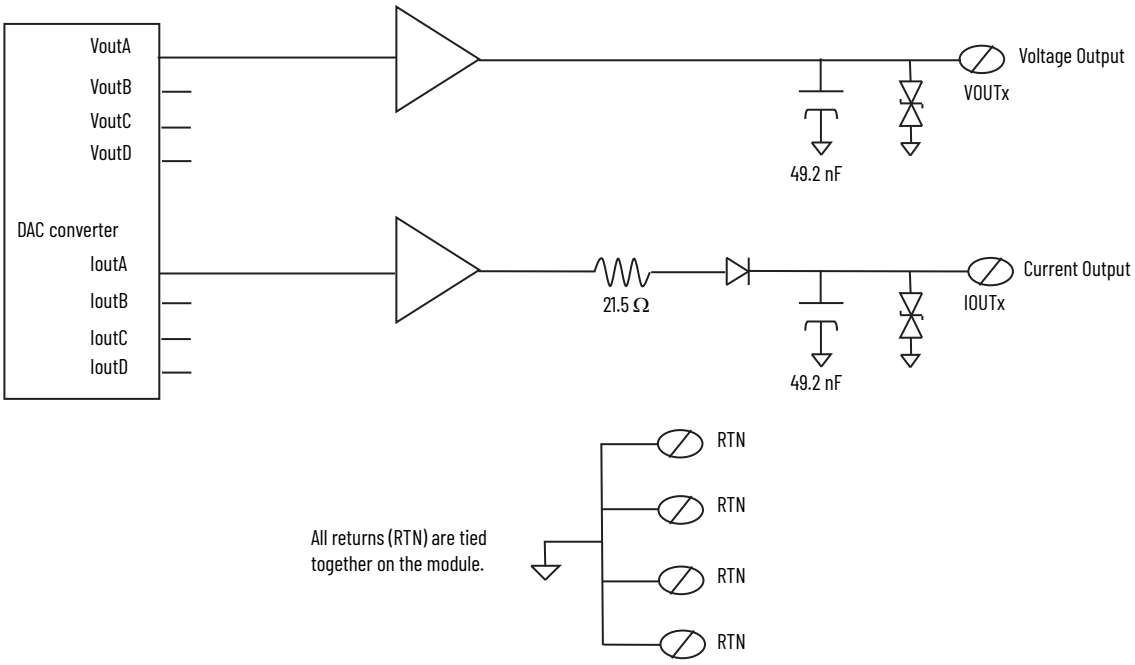
Field-side Circuit Diagrams

This section shows field-side circuitry for the 1756-OF4, 1756-OF4K, 1756-OF8, and 1756-OF8K series A, B, and C modules.

1756-OF4/A, 1756-OF4K/A, 1756-OF8/A, and 1756-OF8K/A Output Circuit



1756-OF4, 1756-OF4K, 1756-OF8, and 1756-OF8K Series B and C Module Output Circuit

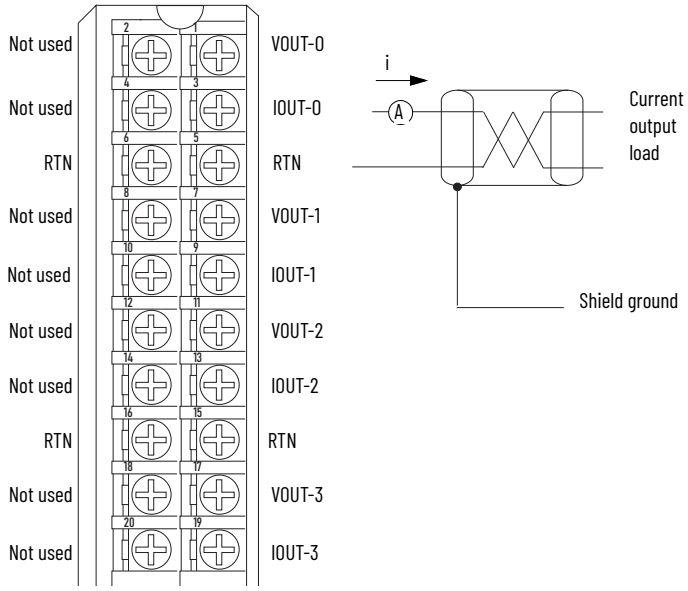


Wire the 1756-OF4 Module

These illustrations show wiring examples for a 1756-OF4 or 1756-OF4K module.

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

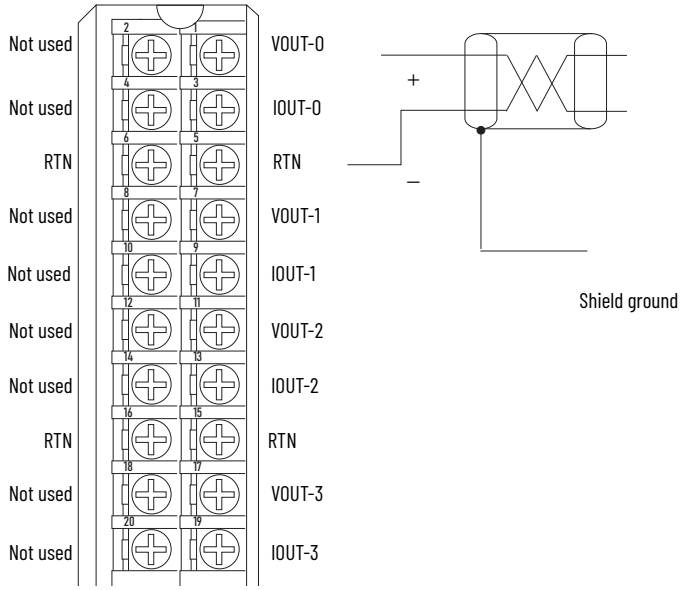
1756-OF4, 1756-OF4K Current Wiring Example



Keep in mind the following:

- Place additional loop devices (that is, strip chart recorders, and so forth) at the A location noted in the wiring example.
- Do not connect more than two wires to any single terminal.
- All terminals marked RTN are connected internally.

1756-OF4, 1756-OF4K Voltage Wiring Example



Keep in mind the following:

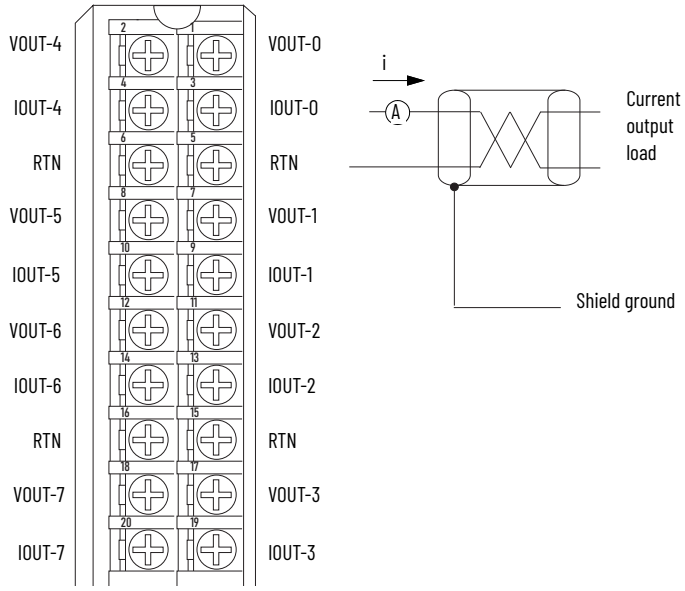
- Do not connect more than two wires to any single terminal.
- All terminals marked RTN are connected internally.

Wire the 1756-OF8 Module

These illustrations show wiring examples for a 1756-OF8 or 1756-OF8K module.

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

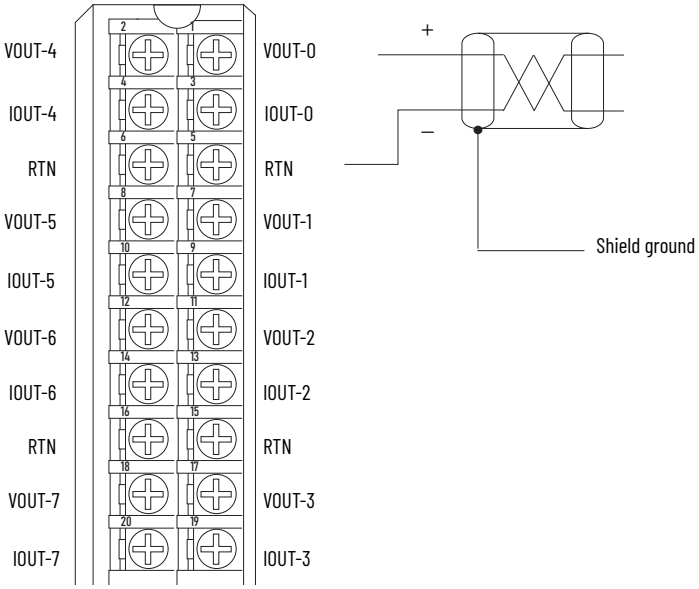
1756-OF8, 1756-OF8K Current Wiring Example



Keep in mind the following:

- Place additional loop devices (that is, strip chart recorders, and so forth) at the A location noted in the wiring example.
- Do not connect more than two wires to any single terminal.
- All terminals marked RTN are connected internally.

1756-OF8, 1756-OF8K Voltage wiring example



Keep in mind the following:

- Do not connect more than two wires to any single terminal.
- All terminals marked RTN are connected internally.

1756-OF4 and 1756-OF8 Module Fault and Status Reporting

The 1756-OF4, 1756-OF4K, 1756-OF8, and 1756-OF8K modules multicast status and fault data to the owner and/or listening controller with its channel data. The fault data is arranged in such a way as to let you choose the level of granularity that is desired for examining fault conditions.

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

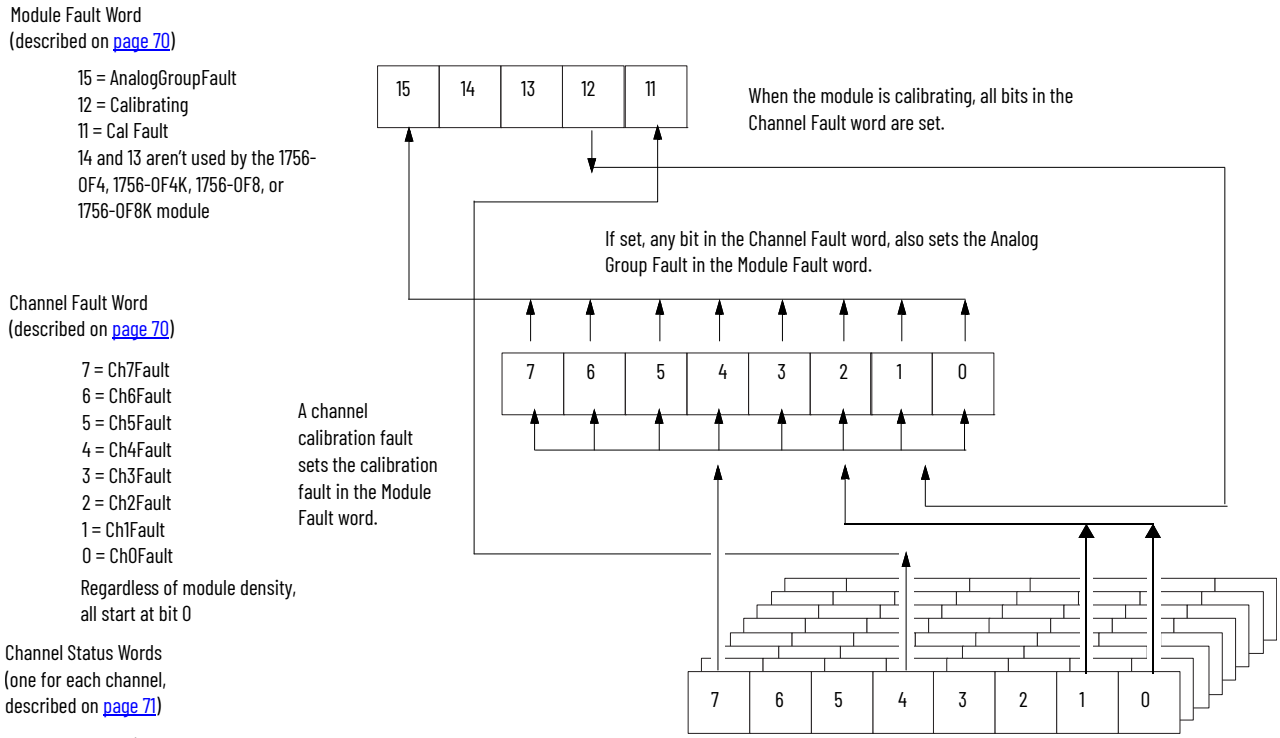
This table lists tags that can be examined in ladder logic when a fault occurs.

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.

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

This illustration provides an overview of the fault reporting process for the 1756-OF4, 1756-OF4K, 1756-OF8, or 1756-OF8K module in floating point mode.



IMPORTANT The 1756-OF4 and 1756-OF4K modules use four Channel Status words and four Channel Fault Word Bits.

The 1756-OF8 and 1756-OF8K modules use eight Channel Status words and eight Channel Fault Word Bits, as seen in this graphic.

1756-OF4, 1756-OF4K, 1756-OF8, 1756-OF8K 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.

This table lists tags that you can further examine in ladder logic to isolate the fault.

Tag	Description
Analog Group Fault	This bit is set when any bits in the Channel Fault word are set. Its tag name is AnalogGroupFault.
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 CalFault.

1756-OF4, 1756-OF4K, 1756-OF8, 1756-OF8K 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 or an Open Wire condition (0...20 mA configuration only). When using the Channel Fault Word, the 1756-OF4 or 1756-OF4K module uses bits 0...3, and the 1756-OF8 or 1756-OF8K module uses bits 0...7. Checking this word for a nonzero condition is a quick way to check for these conditions on a channel.

This table lists the conditions that set **all** Channel Fault word bits in floating point mode.

Condition	Display
A channel is being calibrated	'000F' for all bits on the 1756-OF4 or 1756-OF4K module '00FF' for all bits on the 1756-OF8 or 1756-OF8K module
A communications fault occurred between the module and its owner-controller	'FFFF' for all bits on either module

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

- enable output clamping
- are checking for an open wire condition (0...20 mA configuration only).

1756-OF4, 1756-OF4K, 1756-OF8, 1756-OF8K Channel Status Word Bits – Floating Point Mode

Any of the Channel Status words (four words for 1756-OF4 or 1756-OF4K modules and eight words for 1756-OF8 or 1756-OF8K modules), one for each channel, display a nonzero condition if that particular channel has faulted for the conditions that are listed in the following table. 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.

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

Tag (Status Word)	Bit	Event That Sets This Tag
ChxOpenWire	Bit 7	This bit is set only if the configured Output Range is 0...20 mA, and the circuit becomes open due to a wire falling off or being cut when the output being driven is above 0.1 mA. The bit remains set until the correct wiring is restored.
ChxNotaNumber	Bit 5	This bit is set when the output value that is 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 the full-scale 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's 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's 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's unlatched.

IMPORTANT The 1756-OF4, 1756-OF4K, 1756-OF8, and 1756-OF8K modules do not use **bit 6.**

Fault Reporting in Integer Mode

This illustration provides an overview of the fault reporting process for the 1756-OF4, 1756-OF4K, 1756-OF8, or 1756-OF8K module in integer mode.

Module Fault Word
(described on page 72)

15 = AnalogGroupFault
12 = Calibrating
11 = Cal Fault
14 and 13 aren't used by the 1756-OF4, 1756-OF4K, 1756-OF8, or 1756-OF8K modules

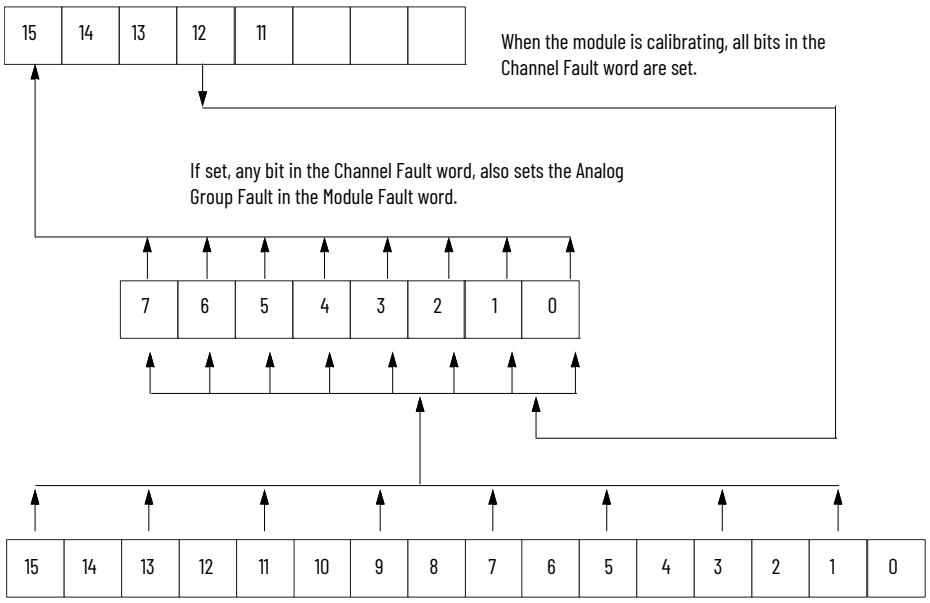
Channel Fault Word
(described on page 73)

7 = Ch7Fault
6 = Ch6fault
5 = Ch5Fault
4 = Ch4Fault
3 = Ch3Fault
2 = Ch2Fault
1 = Ch1Fault
0 = Ch0Fault

4...7 aren't used by the 1756-OF4 or 1756-OF4K modules

Channel Status Word
(described on page 73)

15 = Ch0OpenWire
14 = Ch0InHold
13 = Ch1OpenWire
12 = Ch1InHold
11 = Ch2OpenWire
10 = Ch2InHold
9 = Ch3OpenWire
8 = Ch3InHold
7 = Ch4OpenWire
6 = Ch4InHold
5 = Ch5OpenWire
4 = Ch5InHold
3 = Ch6OpenWire
2 = Ch6InHold
1 = Ch7OpenWire
0 = Ch7InHold



IMPORTANT Channel Status word bits 0...7 not used on 1756-OF4 or 1756-OF4K modules.

1756-OF4, 1756-OF4K, 1756-OF8, 1756-OF8K Module Fault Word Bits – Integer Mode

In integer mode, Module Fault word bits (bits 15...11) operate exactly as described in floating point mode.

This table lists tags that you can further examine in ladder logic to isolate the fault.

Tag	Description
Analog Group Fault	This bit is set when any bits in the Channel Fault word are set. Its tag name is AnalogGroupFault.
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 CalFault.

1756-OF4, 1756-OF4K, 1756-OF8, 1756-OF8K Channel Fault Word Bits – Integer Mode

In integer mode, Channel Fault word bits (bits 7...0) operate exactly as described in floating point mode for calibration and communications faults. During normal operation, these bits are only set for an open wire condition.

This table lists the conditions that set **all** Channel Fault word bits in integer mode.

Condition	Displays
A channel is being calibrated	'000F' for all bits on the 1756-OF4 or 1756-OF4K module '00FF' for all bits on the 1756-OF8 or 1756-OF8K module
A communications fault occurred between the module and its owner-controller	'FFFF' for all bits on either module

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

- enable output clamping.
- are checking for an open wire condition (0...20 mA configuration only).

1756-OF4, 1756-OF4K, 1756-OF8, 1756-OF8K Channel Status Word Bits – Integer Mode

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

- The module only reports the Output in Hold and Open Wire conditions.
- Calibration Fault reporting isn't available in this word, although the Calibration Fault bit in the Module Fault word still activates when that condition exists on any channel.
- There's only one Channel Status word for all four channels on 1756-OF4 or 1756-OF4K module and all eight channels on 1756-OF8 or 1756-OF8K module.

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

Tag (Status word)	Bit	Event that sets this tag
ChxOpenWire	Odd-numbered bits from bit 15 ...bit 1 (that is, bit 15 represents channel 0). For a full listing of the channels these bits represent, see page 72.	The Open Wire bit is set only if the configured Output Range is 0...20 mA, and the circuit becomes open due to a wire falling off or being cut when the output being driven is above 0.1 mA. The bit remains set until the correct wiring is restored.
ChxInHold	Even-numbered bits from bit 14...bit 0 (that is, bit 14 represents channel 0). For a full listing of the channels these bits represent, see page 72.	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 the full-scale current echo value.