USER MANUAL

SPECTRUM CONTROLS

An Allient Company

User's Manual Pub. 0300128-06 Rev. A0

SLC 500™ Isolated Analog Output Module

Catalog Number: 1746sc-INO4i/1746sc-INO4vi

Important Notes

1. Please read all the information in this owner's guide before installing the product.
2. The information in this owner's guide applies to hardware Series A and firmware version 1.00 or later.
3. This guide assumes that the reader has a full working knowledge of the relevant processor.

Notice

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Table of Contents

Preface

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

- Who should use this manual
- What This Manual Covers
- Related documentation
- Technical Support
- Documentation
- Conventions used in this manual

Who Should Use This Manual

Use this guide if you design, install, program, or maintain a control system that uses Allen-Bradley Small Logic Controllers.

You should have a basic understanding of SLC 500 products. You should also understand electronic process control, and the ladder program instructions required to generate the electronic signals that control your application. If you do not, contact your local Allen-Bradley representative for the proper training before using these products.

What This Manual Covers

This guide covers the 1746sc-INO4i and 1746sc-INO4vi isolated analog output modules. It contains the information you need to install, wire, use, and maintain these modules. It also provides diagnostic and troubleshooting help should the need arise.

Related Documentation

The table below provides a listing of publications that contain important information about Allen-Bradley PLC systems.

Refer to this Document	**Allen-Bradley Pub. No.**
SLC 500 System Overview	1747-2.30
Application Considerations for Solid State Controls	SGI-1.1
Allen-Bradley Programmable Controller Grounding and Wiring Guidelines	1770-4.1
Installation & Operation Manual for Modular Hardware Style Programmable Controllers	1747-6.2
Installation & Operation Manual for Fixed Hardware Style Programmable Controllers	1747-NI001
Allen-Bradley Advanced Programming Software (APS) User Manual	1747-6.4

Refer to this Document	Allen-Bradley Pub. No.
Allen-Bradley Advanced Programming Software (APS) Reference Manual	1747-6.11
Getting Started Guide for Advanced Programming Software (APS)	1747-6.3
SLC 500 Software Programmers' Quick Reference	ABT-1747-TSG001 Guide
Allen-Bradley HHT (Hand-Held Terminal) User Manual	1747-NP002
Getting Started Guide for HHT (Hand-Held Terminal)	1747-NM009
Allen-Bradley Publication Index	SD499
Allen-Bradley Industrial Automation Glossary	AG-7.1

Technical Support

For technical support, please contact your local Rockwell Automation TechConnect Office for all Spectrum products. Contact numbers are as follows:

- USA 1-440-646-6900 (US/global, English only
- United Kingdom +44 0 1908 635 230 (EU phone, UK local)
- Australia, China, India, and other East Asia locations: 1-800-722-778 or +61 39757 1502
- Mexico 001-888-365-8677
- Brazil 55-11-5189-9500 (general support)
- Europe +49-211-41553-630 (Germany/general support)

or send an email to support@spectrumcontrols.com

Documentation

If you would like a manual, you can download a free electronic version from the Internet at www.spectrumcontrols.com

Conventions Used in This Manual

The following conventions are used throughout this manual:

- Bulleted lists (like this one) provide information, not procedural steps.
- Lists provide sequential steps or hierarchical information.
- *Italic* type is used for emphasis.
- **Bold** type identifies headings and sub-headings:

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

ATTENTION 	Actions ou situations risquant d'entraîner des blessures pouvant être mortelles, des dégâts matériels ou des pertes financières. Les messages « Attention » vous aident à identifier un danger, à éviter ce danger et en discerner les conséquences.

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

Chapter 1
Module Overview

The 1746sc-INO4i provides four isolated channels of current outputs, while the 1746sc-INO4vi provides four isolated channels of current or voltage outputs (in any combination). In both modules, the voltage and/or current ranges are independently configurable for each channel. These modules also provide new, advanced features to make your control systems more dependable and flexible.

Read this chapter to familiarize yourself further with your isolated analog module (shown above). This chapter covers:

- General features and benefits.
- Detailed specifications.

Section 1.1
General Features And Benefits

Both modules provide 750 VDC channel-to-channel isolation, which means no electrical noise crosstalk between channels, resulting in a high, usable resolution. They provide 750 VDC field-wiring-to-backplane isolation to protect the processor and rack. These modules also feature onboard temperature compensation to maintain their accuracy with fluctuating ambient temperatures, which is important for crowded control cabinets.

These modules provide 16 bits of resolution, user-programmable range settings, continuous temperature compensation (no field calibration), software configuration, programmable output limits, and programmable safe states in case of a fault.

Section 1.2
Detailed Specifications

Table 1-1. Electrical Specifications-Module

Description	Specification
Backplane Current Consumption (maximum)	
1746sc-INO4i	120 mA at 5 VDC 250 mA at 24 VDC
1746sc-INO4vi	120 mA at 5 VDC 250 mA at 24 VDC
Backplane Power Consumption (typical)	0.6 W
Number of Channels	4 (differential, individually isolated)
I/O Chassis Location	Any 1746 I/O module slot except slot 0
A/D Conversion Method	Sigma-Delta
Calibration	Factory calibrated Temperature compensation once a minute
Opto-Electrical Isolation	750 VDC channel-to-channel 750 VDC field wiring-to-backplane
Module ID Code	
1746sc-INO4i	3521
1746sc-INO4vi	3519
Thermal Dissipation	4.5 W maximum

Table 1-2. Electrical Specifications-Outputs

Description	Specification
Output Current Ranges (selectable for each channel)	4 to 20 mA 0 to 20 mA 0 to 21 mA
Output Voltage Ranges–INO4vi only (selectable for each channel)	-10 to +10 VDC 0 to 10 VDC 0 to 5 VDC 1 to 5 VDC
SLC Communication Formats (selectable for each channel)	Scaled engineering units Scaled for PID Proportional counts 1746-INO4 format User-defined scale

Description	Specification
Output Impedance Current Outputs Voltage Outputs—INO4vi only	 Greater than 1 Mohm Less than 1.0 Ohm
Load Range Current Outputs Voltage Outputs—INO4vi only	 0 to 500 Ohm 1 kohm and greater
Max. Current, Voltage Mode-INO4vi only	10 mA
Output Step Response Time	1 ms (0-95% of full scale)
Channel Update Time (maximum)	33.7 ms for all 4 channels in parallel
Output Resolution	16-bit
Current Outputs	366 nA/count
Voltage Outputs-INO4vi only	320 µV/count
Overall Accuracy Current Outputs Voltage Outputs-INO4vi only	 0.08% of full scale at 25 °C typical 0.15% of full scale at 60 °C 0.08% of full scale at 25 °C typical 0.35% of full scale at 60 °C

Table 1-3. Physical Specifications

Description	Specification
LED Indicators	Four green channel status indicators, one for each channel One green module status indicator
Recommended Cable	Belden 8761 (shielded, twisted-pair) or equivalent
Wire Size (maximum)	One 12–24 AWG wire per terminal
Terminal Block	Removable (supplied)

Table 1-4. Environmental Specifications

Description	Specification
Operating Temperature	0 to 60 °C (32 to 140 °F)
Storage Temperature	-40 to 85 °C (-40 to 185 °F)
Relative Humidity	5 to 95% non-condensing Certifications
Certifications	UL/CUL and CE
Hazardous Environment Classifications	Class I Division 2 Groups A, B, C, D

Section 1.3 Regulatory Requirements

Compliance Standards	Industry Standards
UL Safety	UL 61010-2-201 Safety Requirements for Electrical Equipment for Measurement, Control, and Laboratory Use - Part 2-201: Particular Requirements for Control Equipment (NRAQ, NRAQ7) CAN/CSA C22.2 No. 61010-1-12 (Safety Requirements for Electrical Equipment for Measurement, Control, and Laboratory Use – Part 1: General Requirements)
UL Hazardous Locations	ANSI/ISA–12.12.01 Nonincendive Electrical Equipment for Use in Class I, Division 2 Hazardous (Classified) Locations (NRAG) CSA C22.2 No. 213-M1987 - Non-incendive Electrical Equipment for use in Class I Division 2 Hazardous Locations - March 1987 (NRAG7) Temp code T4 or better, Pollution degree 2, gas groups A, B, C, and D
CE EMC Directive	EN 61131-2 Programmable Controllers: Third Edition 2007-02, Clause 8, Zones A&B EN 61000-6-2: Generic Industrial Immunity EN 61000-6-4: Generic Industrial Emissions
UKCA	Electromagnetic Compatibility Regulations 2016 BS EN 61131-2, BS EN 61000-6-4, BS EN 61000-6-2
FCC	27 CFR Part 15, Class A
CMIM	Arrêté ministériel n° 6404-15 du 29 ramadan 1436 (16 juillet 2015) NM EN 61131-2, NM EN 61000-6-4, NM EN 61000-6-2

Chapter 2
Installation and Wiring

This chapter will cover:

- Avoiding electrostatic damage.
- Determining power requirements.
- Setting the DIP switch.
- Selecting a rack slot.
- Inserting your module into the rack.
- Wiring your module.

NOTE 	Although your module has a jumper on its printed circuit board, this jumper is for the manufacturer's use only. Your module was calibrated by the manufacturer, so no further calibration is required.

NOTE 	For UL and CUL compliance, power and input/output (I/O) wiring must be in accordance with Class I, Division 2, wiring methods [Article 501-4 (b) of the National Electrical Code, NFPA 70] and in accordance with the authority having jurisdiction. Also, you must observe the warnings shown below. Failure to observe these warnings can cause personal injury.

WARNING 	**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. Touch a grounded object to discharge static potential. • 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 IP54 rated enclosure that requires a tool to open. • All wiring must comply with N.E.C. article 501-4(b).

The following documents contain information that may help you as you install and wire your module:

- *National Electrical Code*, published by the National Fire Protection Association of Boston, MA
- IEEE Standard 518-1977, *Guide for the Installation of Electrical Equipment to Minimize Electrical Noise Inputs to Controllers from External Sources*

- IEEE Standard 142-1982, *Recommended Practices for Grounding of Industrial and Commercial Power Systems*
- *Noise Reduction Techniques in Electronic Systems*, by Henry W. Ott; published by Wiley-Interscience of New York in 1976

Section 2.1 Prevent Electrostatic Discharge

WARNING 	Electrostatic discharge can damage integrated circuits or semiconductors if you touch analog module card bus connector pins or the terminal block on the module. Follow these guidelines when you handle the module: • Touch a grounded object to discharge static potential. • Wear an approved wrist-strap grounding device. • Do not touch the bus connector or connector pins. • Do not touch circuit components inside the module. • If available, use a static-safe workstation. • When it is not in use, keep the module in its static-shield bag.

Section 2.2 Compliance to European Directive

If this product bears the CE marking, it is approved for installation within the European Union and EEA regions. It has been designed and tested to meet the following directives.

Section 2.3 EMC Directive

This product is tested to meet Council Directive 2014/30/EU Electromagnetic Compatibility (EMC) and the following standards, in whole or in part, documented in a technical construction file:

- EN 61000-6-4 Electromagnetic compatibility (EMC)–Part 6-4: Generic standards–Emission standard for industrial environments.
- EN 61000-6-2 Electromagnetic compatibility (EMC)–Part 6-2: Generic standards–Immunity for industrial environments.

UKCA Electromagnetic Compatibility Regulations 2016

- BS EN 61131-2, BS EN 61000-6-4, BS EN 61000-6-2.

This product is intended for use in an industrial environment.

Section 2.4 Low Voltage Directive

This product is tested to meet Council Directive 2014/35/EU Low Voltage, by applying the safety requirements of EN 61010-2-201 Safety Requirements for

Electrical Equipment for Measurement, Control, and Laboratory Use - Part 2-201: Particular Requirements for Control Equipment.

For specific information required by EN 61010-2-201, 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 B111.

This equipment is classified as open equipment and must be installed (mounted) in an enclosure during operation as a means of providing safety protection.

Section 2.5 Power Requirements

The module receives power through the bus interface from the +5 VDC/+24 VDC system power supply. The maximum current drawn by the module is shown in the table below:

Module	5 VDC	24 VDC w/o external supply	24 VDC with external supply
1746sc-INO4i	120 mA	250 mA	0 mA
1746sc-INO4vi	120 mA	250 mA	0 mA

The 1746sc-INO4i and 1746sc-INO4vi output modules can use an external 24 VDC power supply to reduce backplane loading. To use an external 24 VDC power supply, you must set your module's DIP switch as indicated in the following subsection.

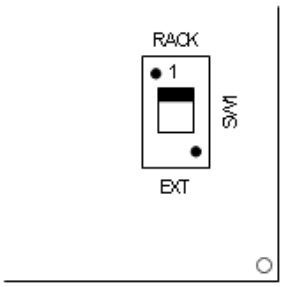
Use the table above to calculate the total load on the system power supply. For more information, see the Allen-Bradley system *Installation and Operation Manual*.

Section 2.6 Setting the DIP Switch

The 1746sc-INO4i and 1746sc-INO4vi output modules have an external 24 VDC power switch, SW1, giving you the option of using an external power supply:

- With the switch in the **RACK** position, the module draws all its power from the backplane of the SLC system.
- With the switch in the **EXT** position, the module draws its 24 VDC power from an external power source; however, the module still draws its 5 VDC from the backplane.

The switch, SW1, is located in the bottom corner of the module's large circuit board.



Section 2.7 Selecting a Rack Slot

Two factors determine where you should install your module in the rack: ambient temperature and electrical noise. When selecting a slot for your module, try to position your module:

- In a rack close to the bottom of the enclosure (where the air is cooler).
- Away from modules that generate significant heat, such as 32-point input/output modules.
- In a slot away from AC or high-voltage DC modules, hard contact switches, relays, and AC motor drives.
- Away from the rack power supply (if using a modular system).

Remember that in a modular system, the processor always occupies the first slot. of the rack.

Section 2.8 Selecting a Location

Most applications require installation in an industrial enclosure to reduce the effects of electrical interference. Analog inputs 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. Refer to the module's heat dissipation specification.

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

Section 2.9 Inserting your Module into the Rack

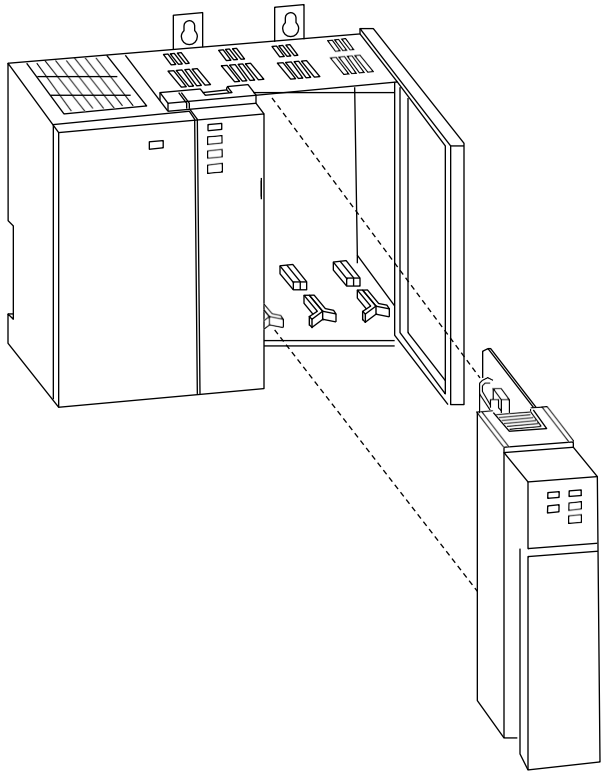
WARNING	POSSIBLE EQUIPMENT OPERATION
	Before installing or removing your module, always disconnect power from the SLC 500 system and from any other source to the module (in other words, do not "hot swap" your module), and disconnect any devices wired to the module. Failure to observe this precaution can cause unintended equipment operation and damage.

When inserting your module into the rack, you do not need to remove the supplied 16-position terminal block from the module. If, however, you do remove the terminal block, apply the supplied write-on label to the terminal block, and use the write-on label to identify your module's location.

To remove the terminal block, unscrew the two retaining screws at the top and bottom of the terminal block, and using a screwdriver or needle-nose pliers, carefully pry the terminal block loose.

To insert your module into the rack, follow these steps:

1. Align the circuit board of your module with the card guides at the top and bottom of the chassis.



2. Slide your module into the chassis until both top and bottom retaining clips are secure. Apply firm even pressure on your module to attach it to

its backplane connector. Never force your module into the slot.

Cover all unused slots with the Card Slot Filler, Allen-Bradley part number 1746-N2.

To remove your module, press the retaining clips at the top and bottom of your module and slide it out.

Section 2.10 Wiring Your Module

To wire the terminal block, you need:

- A small, flat-blade screwdriver.
- Belden 8761 (shielded, twisted pair) cable or equivalent.

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

Before wiring the terminal block, take some time to plan your system:

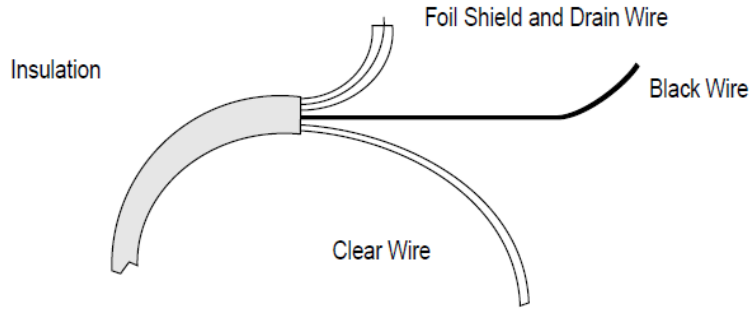
- Ensure that the SLC 500 system is installed in a NEMA-rated enclosure and that the SLC 500 system is properly grounded.
- Ensure that the load resistance for a current output channel is less than 500 Ω.
- Ensure that the load resistance for a voltage output channel is greater than 1 kΩ.
- Route the field wiring away from any other wiring and as far as possible from sources of electrical noise, such as motors, transformers, contactors, and AC devices. Generally, allow at least 6 in. (about 15.2 cm) of separation for every 120 V of power.
- Routing the field wiring in a grounded conduit can reduce electrical noise further.
- If the field wiring must cross AC or power cables, ensure that they cross at right angles.

To wire your module, follow these steps:

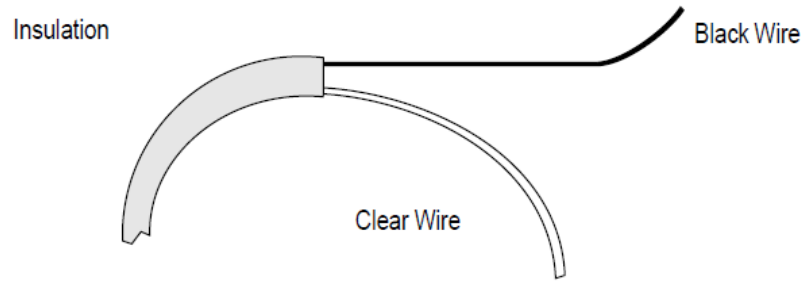
1. Determine the length of cable you need to connect a channel to its field device. Remember to include additional cable to route the drain wire and foil shield to their ground points.
2. At each end of the cable, strip some casing to expose the individual wires.
3. Trim the exposed signal wires to 2 in. lengths. Strip about 3/16 in. (about

5 mm) of insulation away to expose the end of each wire.

4. At one end of the cable, twist the drain wire and foil shield together, bend them away from the cable, and apply shrink wrap.



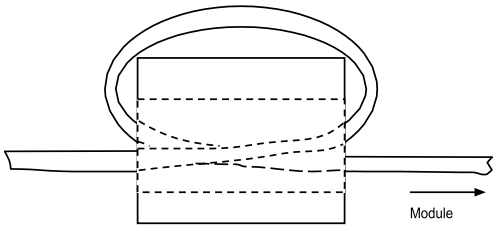
5. At the other end of the cable, cut the drain wire and foil shield back to the cable and apply shrink wrap.



6. Connect the wires to the terminal block and field device as shown in the following figures and table. The recommended maximum torque is 5 in-lb. (0.565 Nm) for all terminal screws.
7. To guard against electrostatic damage and improve chassis grounding, connect one of the shield pins on the terminal block of your module to the chassis itself.

NOTE	**Important:** For CE compliance, Ferrite EMI Suppressors are needed on each channel's terminal block connection. Apply the suppressor close to the module terminal block, as shown below. A Steward Part 28B2024-0A0 or equivalent is recommended. The Steward 28B2024-0A0 has an impedance of 157 Ω at 25 MHz, 256 Ω at 100 MHz, and can accommodate one turn of wire.

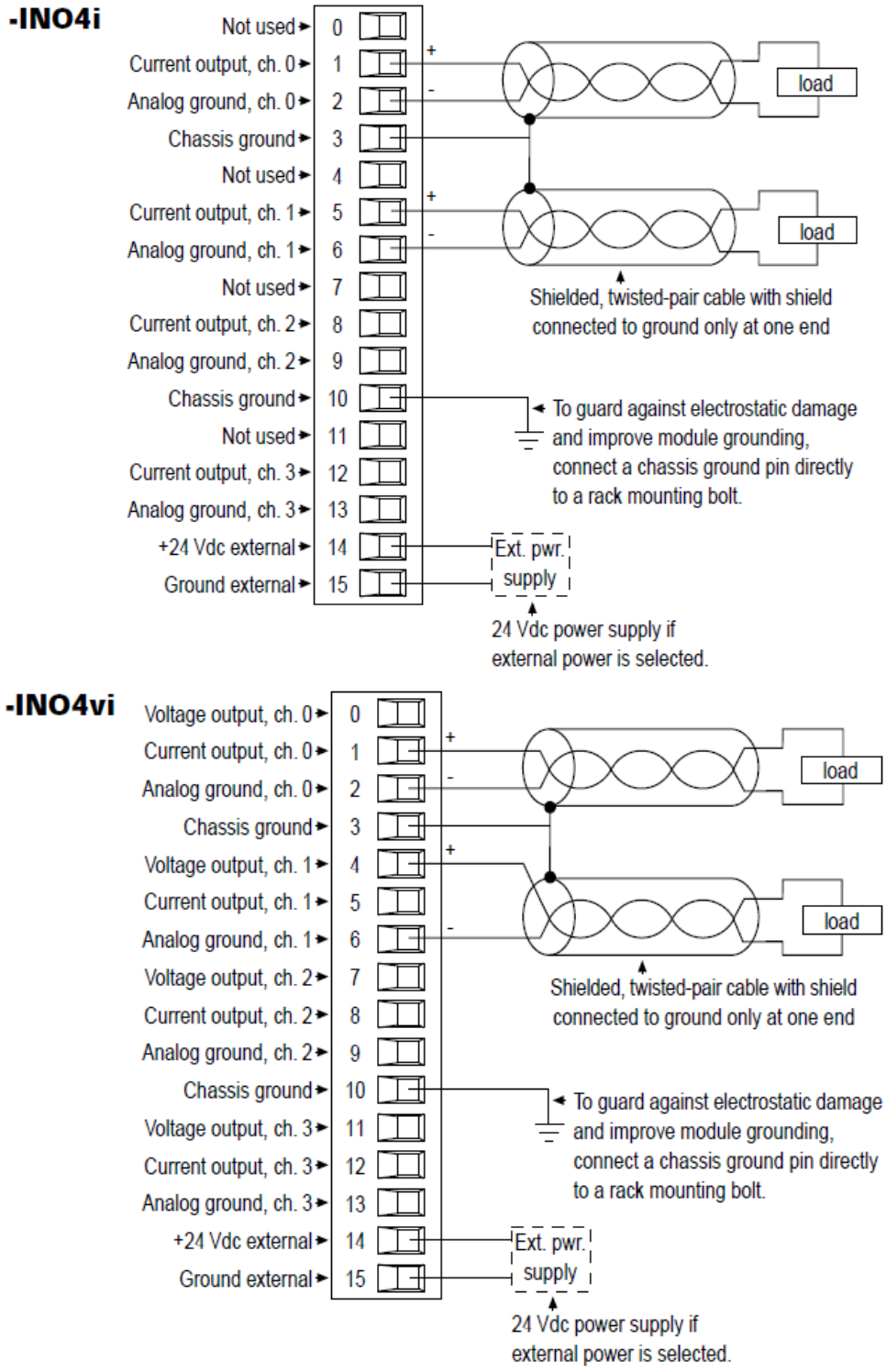
Figure 2-1. Ferrite EMI suppressor for CE compliance



8. Repeat steps 1 through 7 for each channel on your module.

A system may malfunction due to a change in its operating environment. After installing and wiring your module, check system operation. See the Allen-Bradley system *Installation and Operation Manual* for more information.

Figure 2-2. Wiring diagrams (showing differential outputs)



Chapter 3
Configuring the 1746sc-INO4I

This chapter covers the following subjects:

- Introduction.
- About Communications.
- About Channel Update Time.
- Configuring Your Module.
- Reading Input Data.
- Getting Technical Assistance.
- Declaration of Conformity.

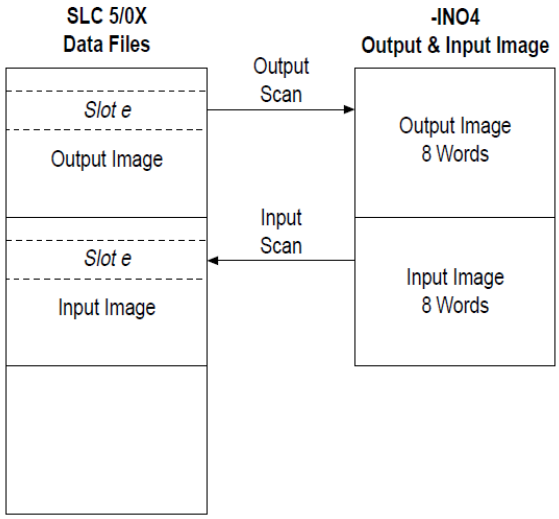
Section 3.1 Introduction

This chapter will describe how your module works, and how to configure the module.

Section 3.2 About Communications

Your processor transfers data to (and receives data from) the processor through an image table residing in the data files of your processor. The processor updates this image table once during each scan of your ladder program. The following figure shows the image table for your output module:

Figure 3-1. Output and Input Scans



Section 3.3
Configuration

3.3.1 Channel Update Time

For an output module, channel update time is the time required for the module to convert the channel data received from the processor to an analog output signal at the terminals.

In general, you can reduce the channel update time by disabling unused channels, as shown in the following table:

Table 3-1. Channel update time (channels already enabled)[1]

	# of channels enabled	Time
Current output	1	24.3 ms (typical)
	2	27.3
	3	30.7
	4	33.7
Voltage output	1	24.3
(-INO4vi only)	2	26.9
	3	30.1
	4	32.7

For the fastest possible channel update time, enable only one channel.

3.3.2 Temperature Calibration Time

About once a minute, if no update is occurring, your module performs a temperature calibration. During this time, your module cannot convert the channel data received from the processor to an analog output signal at the terminals. The temperature calibration takes about 56.2 ms

3.3.3 Output Mode Change Time (-INO4vi only)

Whenever the output mode is changed (usually on module start-up), the power supplied to the isolated channels has to go through a power cycle, affecting all 4 channels. During this time, your module cannot convert channel data from the processor to analog output signals at the terminals. The power cycle takes about 5.2 seconds.

3.3.4 Your Module's Response to Slot Disabling

By writing to the status file in the modular SLC processor, you can disable any chassis slot. Refer to your SLC programming manual for the slot disable/enable procedure.

[1] When the module must enable a disabled channel, add 1.2 ms to the time shown.

WARNING	**UNEXPECTED EQUIPMENT OPERATION** Always understand the implications of disabling a module before using the slot disable feature. Failure to observe this precaution can cause unintended equipment operation

When you disable an output module's slot, the module holds its outputs in their last state. When you re-enable the output module's slot, the data that is in the processor image table is converted to an analog output signal during the next scan. Slot disabling only affects enabled channels.

3.3.5 Entering Your Module's ID Code

Before using your module, you must configure the slot your module is in by entering your module's ID code in APS.

When using APS version 6 or later, simply select your module from the list of modules on the system I/O configuration display to automatically enter the ID code.

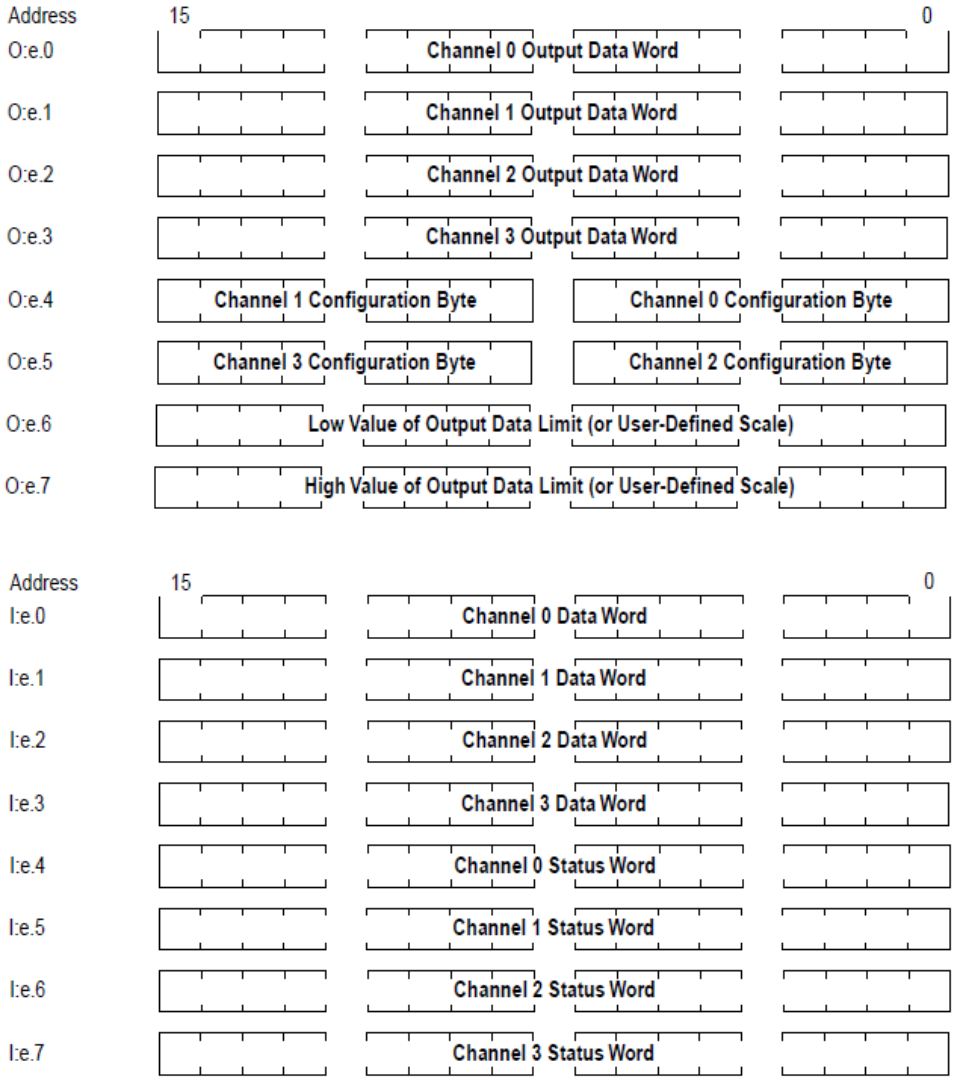
With earlier versions of APS (4 through 5), you must manually enter the ID code. To enter your module's ID code, select "other" from the list of modules on the APS system I/O configuration display, and enter your module's ID code at the prompt. The module ID code for your module is:

Table 3-2. Output Module ID Code

Catalog Number	Module ID Code
1746sc-INO4i	3521
1746sc-INO4vi	3519

No special I/O configuration (SPIO CONFIG) information is required. The module ID code automatically assigns the correct number of input and output words for the processor to access.

Figure 3-2. Output and Input Words



Example – If you want to reconfigure channel 2 on your module, and it is in slot 4 of the SLC chassis, you modify the configuration word at address O:4.5. Alternatively, if you want to obtain the status of channel 2, you check the status word at address I:4.6.

3.3.6 Output Image

The 8-word, output image (defined as the output from the SLC processor to your module) defines how each channel on your module works:

- The **output data words** control output signal levels for each channel.
- The **configuration bytes** replace configuration DIP switches on your module. In your output module, each word configures two channels (one independent byte per channel).
- The **output limit values** define minimum and maximum output data values, if output data limits are properly enabled.
- The **user-defined scale values** define how your module scales output

data values to analog output signals, if the User-Defined Scale data format is selected.

For more information on the user-defined scale and output data limits, see Optional: Setting the Output Data Limits (or User-Defined Scale), later in this chapter.

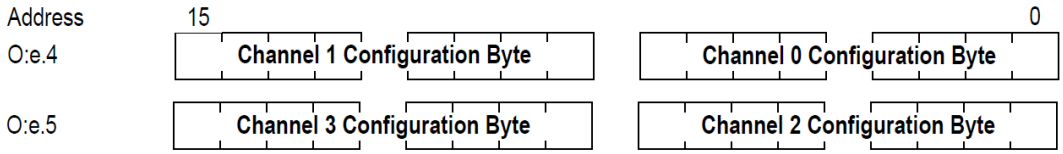
3.3.7 Input Image

The 8-word, input image (defined as the input from your module to the SLC processor) holds the data received by your module and provides the status (configuration and operational state) of each channel.

Important – A data word is valid only when the channel is enabled and there are no channel errors. A status word is valid only when the channel is enabled, and the module has processed all configuration changes.

3.3.8 Configuring Each Output Channel

After installing your module, you must configure each channel by setting big values in each configuration word. Output words 4 and 5 of the output image file (address O:e:4 and O:e:5) configure channels 0 to 1, and 2 to 3, respectively.



A detailed explanation appears in the following table:

Table 3-3. Channel Configuration Word Details, Output Words 4 and 5 (O:e:4 and O:e:5)

To select...	Use these bit settings...															
	For Channel 1 (and 3)								For Channel 0 (and 2)							
Bit:	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Output channel disable								0								0
Output channel enable								1								1
±10 Vdc output range (-INO4vi only)					0	0	0						0	0	0	
1–5 Vdc output range (-INO4vi only)					0	0	1						0	0	1	
0–5 Vdc output range (-INO4vi only)					0	1	0						0	1	0	
0–10 Vdc output range (-INO4vi only)					0	1	1						0	1	1	
0–20 mA output range					1	0	0						1	0	0	
4–20 mA output range					1	0	1						1	0	1	
0–21 mA output range					1	1	0						1	1	0	
Invalid					1	1	1						1	1	1	
Engineering units	0	0	0						0	0	0					
Scaled for PID	0	0	1						0	0	1					
Proportional counts	0	1	0						0	1	0					
1746-NO4 compatible format	0	1	1						0	1	1					
User-defined scale	1	1	0						1	1	0					
Invalid	1	0	0						1	0	0					
Invalid	1	0	1						1	0	1					
Invalid	1	1	1						1	1	1					
Reset output on fault	0								0							
Hold last value on fault	1								1							

3.3.9 Output Channel Enable (configuration bits 0 and 8)

Use this bit to enable or disable a channel. To minimize update times, disable any unused channels.

When you set the channel enable bit to one, the module reads the configuration word. Before accepting any new data as valid, verify that the status word (described in the last subsection of this chapter) reflects the changes you made.

While the channel enable bit is set to zero, the channel data word and status word are also set to zero. When you reset the channel enable bit to one, the channel data word remains set to zero until your module updates the channel status word.

3.3.10 Output Range (configuration bits 1–3 and 9–11)

Use this bit field to configure the channel for the type of output device you have connected to the module.

3.3.11 Data Format (configuration bits 4–6 and 12–14)

Use this bit field to select one of the following formats:

- Engineering units (mV or nA).
- Scaled for PID (works with the SLC PID instruction).
- Proportional counts (two's complement binary).
- 1746-NO4 compatible format (the format used by the 1746-NO4).
- User-defined scale.

These data formats are defined in the following table:

Data Format	Selected Output Range	Data Value (counts) Min.	Max.	Corresponding Signal Min. to Max.
Engineering Units	±10 V	-10250	+10250	-10.25 V - +10.25 V
	0–10 V	-500	+10250	-0.50 V - +10.25 V
	0–5 V	-500	+5500	-0.50 V - +5.50 V
	1–5 V	+500	+5500	+0.50 V - +5.50 V
	0–20 mA	0	+20500	0.0 mA - +20.5 mA
	0–21 mA	0	+21500	0.0 mA - +21.5 mA
	4–20 mA	+3500	+20500	+3.5 mA - +20.5 mA
Scaled for PID	±10 V	0	+16383	-10 V - +10 V
	0–10 V	0	+16383	0 V - +10 V
	0–5 V	0	+16383	0 V - +5 V
	1–5 V	0	+16383	+1 V - +5 V
	0–20 mA	0	+16383	0 mA - +20 mA
	0–21 mA	0	+16383	0 mA - +21 mA
	4–20 mA	0	+16383	+4 mA - +20 mA
Proportional Counts	±10 V	-32768	+32767	-10.25 V - +10.25 V
	0–10 V	-32768	+32767	-0.50 V - +10.25 V
	0–5 V	-32768	+32767	-0.50 V - +5.50 V
	1–5 V	-32768	+32767	+0.50 V - +5.50 V
	0–20 mA	-32768	+32767	0.0 mA - +20.5 mA
	0–21 mA	-32768	+32767	0.0 mA - +21.5 mA
	4–20 mA	-32768	+32767	+3.5 mA - +20.5 mA
1746-NO4-Compatible [2]	±10 V	-32768	+32767	-10 V - +10 V
	0–10 V	0	+32767	0 V - +10 V
	0–5 V	0	+16384	0 V - +5 V
	1–5 V	+3277	+16384	+1 V - +5 V
	0–20 mA	0	+31208	0 mA - +20 mA
	0–21 mA	0	+32767	0 mA - +21 mA
	4–20 mA	+6242	+31208	+4 mA - +20 mA
User-Defined Scale	±10 V			-10.25 V - +10.25 V

[2] Provides direct compatibility with the 1746-NO4 module.

Data Format	Selected Output Range	Data Value (counts) Min. Max.	Corresponding Signal Min. to Max.
	0–10 V 0–5 V 1–5 V 0–20 mA 0–21 mA 4–20 mA	See footnote[3]	-0.50 V - +10.25 V -0.50 V - +5.50 V +0.50 V - +5.50 V 0.0 mA - +20.5 mA 0.0 mA - +21.5 mA +3.5 mA - +20.5 mA

3.3.12 Reset Output Or Hold Last Value On Fault (configuration bits 7 and 15)

Use this bit to select how your module responds to a fault:

- If you set this bit to 1, your module holds the output signal at its last value when it detects a fault.
- If you set this bit to 0, your module resets the output signal to the power-up setting (0 V or 0 mA) when it detects a fault.

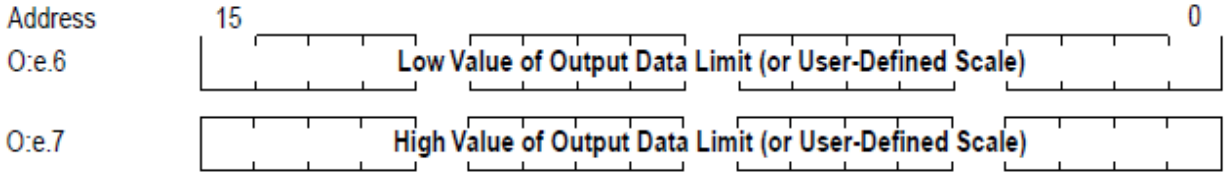
3.3.13 Setting the Output Data Limits (or User-Defined Scale)

Words 6 and 7 of the output image file (addresses O:e.6 and O:e.7) let you define either:

- the low and high values of the output data limits.

  OR

- the low and high values of the user-defined scale, if the User-Defined Scale data format is selected.



If you do not want to use user-defined scaling or output data limiting, set output words 6 and 7 to zero. Setting output words 6 and 7 to zero disables output data limiting and invalidates user-defined scaling.

Because they share the same output words, you cannot use output data limiting with the User-Defined Scale data format.

Important – The values in output words 6 and 7 apply to all four channels. If you want to use user-defined scaling or output data limiting, you must set all four channels to the same data format.

[3] For the user-defined scale, the data in output words 6 and 7 determine the count limits. See the next subsection, Optional: Setting the Output Data Limits (or User-Defined Scale), for information on the User-Defined Scale data format.

3.3.14 Output Data Limits

For added safety, the 1746sc-INO4i and 1746sc-INO4vi output modules let you define limits for the values in the output data words of all four channels. These data limits, in turn, limit the output signals that your module provides. When an output data word exceeds the data limit, the output value is truncated to the limit.

You can use output data limiting to prevent PID loops from exceeding safety limits, to prevent operators from inadvertently setting incorrect values, etc.

To properly enable output data limiting, the low and high output limits (output words 6 and 7, respectively) musts be non-zero and non-equal, and the low limit (output word 6) must be lower than the high limit (output word 7).

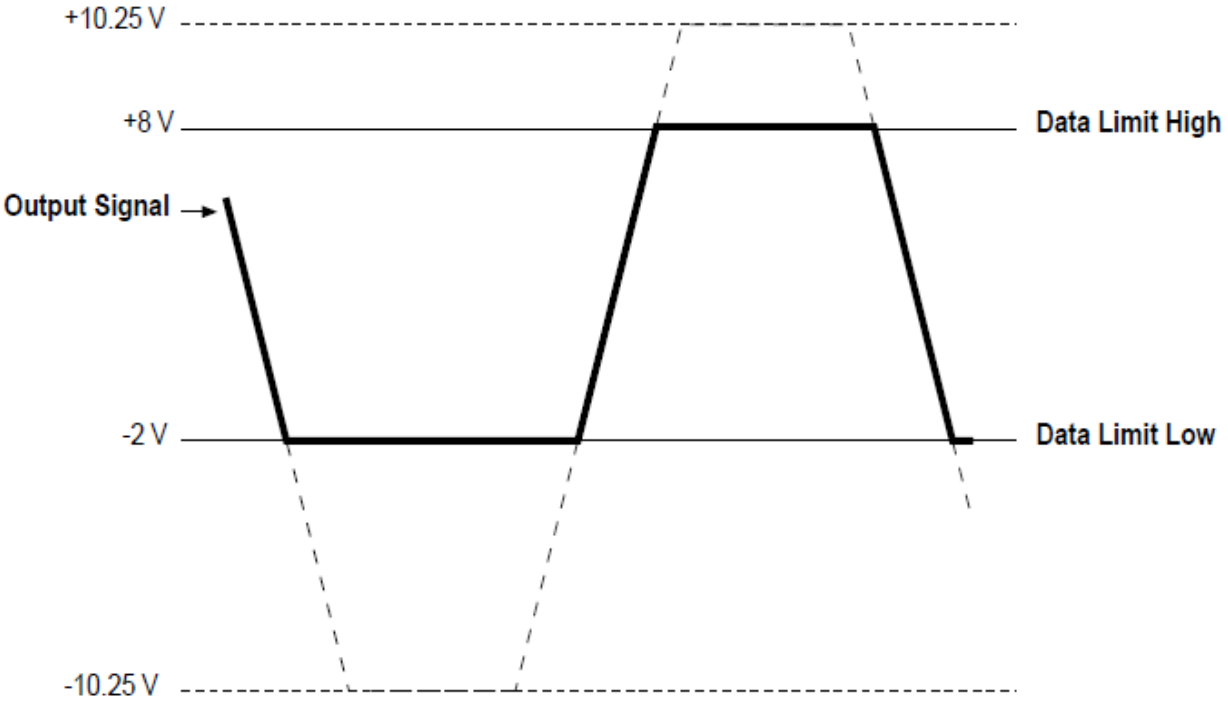
Example – Suppose you have four valves with a ±10 V operating range, and you want to use the Engineering Units data format. For this application, you would use the following bit settings for the channel configuration bytes (output words 4 and 5):

Address	15															0
O:e.4	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1
O:e.5	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1

Suppose, also, that you would like to set the output limits to -2 V and +8 V. After entering the above bit settings for output words 4 and 5, you would enter the following for output words 6 and 7:

Address	15															0
O:e.6	1	1	1	1	1	0	0	0	0	0	1	1	0	0	0	0
O:e.7	0	0	0	1	1	1	1	1	0	1	0	0	0	0	0	0

Your module will now limit the output signal as shown below.



Note that whenever the requested output data values meet or attempt to exceed the output data limits, your module sets bits 10 or 11 in the channel status word to indicate a limit error. Note also that words 0 through 3 of the input image file (addresses I:e.0 through I:e.3) reflect the requested output data values and are not truncated.

3.3.15 User-Defined Scale

For special applications, the 1746sc-INO4i and 1746sc-INO4vi output modules let you define a custom data format. This "user-defined scale" is very similar to the "proportional counts" data format—except that instead of converting the output data to an output signal using a previously defined scale (-32,768 to 32,767), your module converts the output data using a scale defined by the values in output words 6 (low limit of scale) and 7 (high limit of scale).

The high limit value must be greater than the low limit value for proper operation. Also, the difference between the low and high values should be greater than 1024 counts. If the difference between the low and high values is less than 1024 counts, unexpected results can occur (especially at the extreme ends of the range).

You select the data format for each channel using that channel's configuration bits, described in the previous subsection, Configuring Each Output Channel.

The following equations show you how to convert user-defined scale units (or any type of units) to engineering units, and vice versa:

$S = \{(U - U_{low}) \times (\Delta S) \div (\Delta U)\} + S_{low}$

$D = \{(S - S_{low}) \times (\Delta U) \div (\Delta S)\} + U_{low}$

where S = signal value (in engineering units, such as psi)

S_{low} = low limit of signal value

S_{high} = high limit of signal value

$\Delta S = S_{high} - S_{low}$

D = data value (user-defined scale)

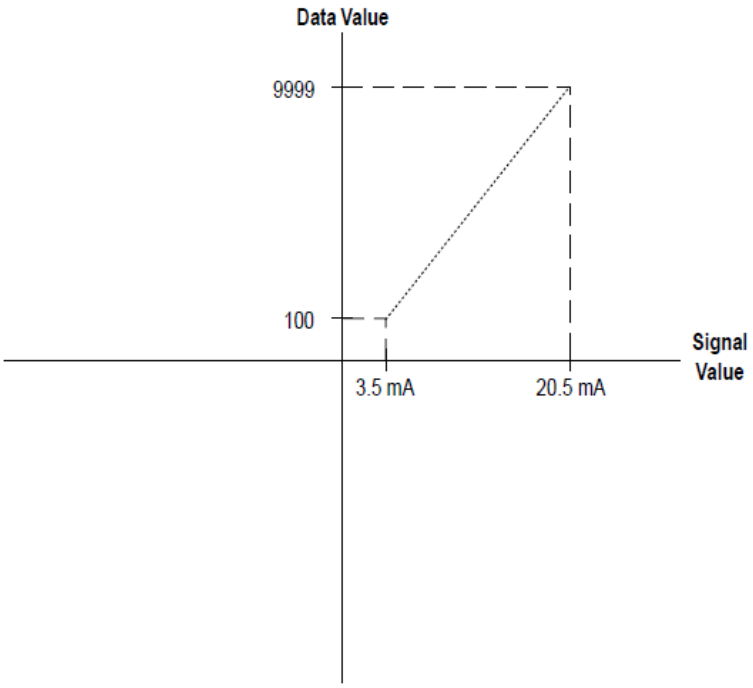
U_{low} = low value of user-defined scale

U_{high} = high value of user-defined scale

$\Delta U = U_{high} - U_{low}$

Example – Suppose you have a valve with a 4–20 mA range, and you want your scale to go from 100 to 9999 counts. For a 4–20 mA output with user-defined scaling, your module sets the signal limits to 3.5 mA and 20.5 mA. After entering 100 and 9999 into output words 6 and 7, respectively, the relationship between data value (counts) and output signal would be as follows

Figure 3-3. Example Relationship Between Output Signal and Channel Data



In the preceding example:

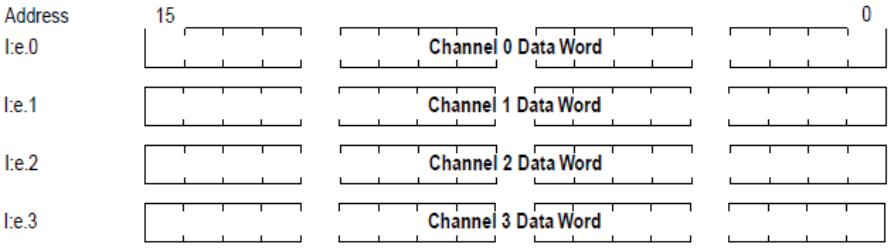
S_{low} = 3.5 U_{low} = 100

S_{high} = 20.5 U_{high} = 9999

ΔS = 17 ΔU = 9899

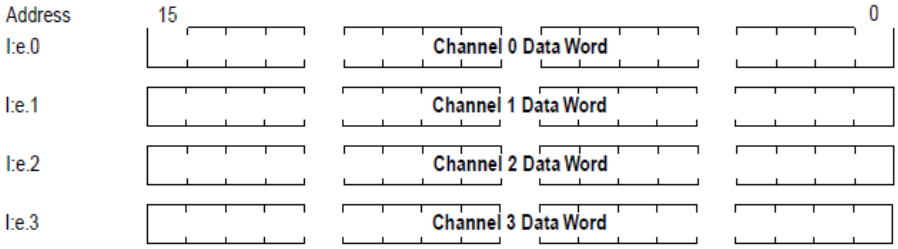
3.3.16 Controlling Each Output Channel's Signal

Output words 0 through 3 determine the output signal levels for channels 0 through 3, respectively. The output signal level depends on the output range and data format selected:



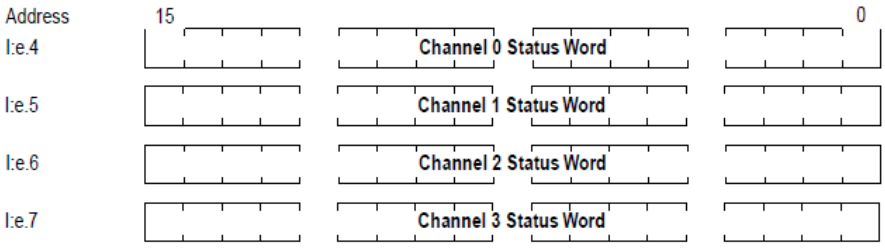
3.3.17 Monitoring Each Output Channel

The requested output data values are reflected in words 0 through 3 of the input image file (addresses I:e.0 through I:e.3). Whenever a channel is disabled, its data word is reset to zero.



3.3.18 Checking Each Output Channel's Configuration Status

Words 4 through 7 of the input image file (addresses I:e.4 through I:e.7) reflect the configuration and status of each channel. Use the data provided in these status words to determine if the configuration data for any channel is valid.



Whenever a channel is disabled, its status word is set to zero.

A detailed explanation appears in Table 3-4.

Channel status word details, Input Words 4 through 7 (I:e.4 through I:e.7 are defined in the following table:

Table 3-4 Channel Status Word Details, Input Words 4 through 7 (I:e.4 through I:e.7)

These bit settings in the status word																Indicate this
Bit:	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	
																0	Output channel disabled
																1	Output channel enabled
													0	0	1		1–5 Vdc output range
													0	1	0		0–5 Vdc output range
													0	1	1		0–10 Vdc output range
													1	0	0		0–20 mA output range
													1	0	1		4–20 mA output range
													1	1	0		0–21 mA output range
									0	0	0						Engineering units
									0	0	1						Scaled for PID
									0	1	0						Proportional counts
									0	1	1						1746-NO4 format
									1	1	0						User-defined scale
									0								Reset output on fault
									1								Hold last value on fault
								0									No output data limiting
								1									Output data limiting
							0										No error
							1										Operating temperature error
						0											No error
						1											Over-limit error
					0												No error
					1												Under-limit error
				0													No error
				1													Over-range error
			0														No error
			1														Under-range error
		0															No error
		1															Non-fatal channel error
	0																No error
	1																Fatal channel error

The first 8 status bits reflect the settings in the channel configuration word. The remaining status bits flag the various errors that the module can detect.

3.3.19 Output Data Limiting Enabled (status bit 8)

This bit is set to one whenever output data limiting is properly enabled. To properly enable output data limiting, the low and high output limits (output

words 6 and 7, respectively) musts be non-zero and non-equal, and the low limit (output word 6) must be lower than the high limit (output word 7). See Optional: Setting The Output Data Limits (or User-Defined Scale), earlier in this chapter, for more information.

3.3.20 Operating Temperature Error (status bit 9)

This bit is set to one whenever the operating temperature exceeds the specified range (0 to 60 ˚C). This bit is reset to zero when the operating temperature returns to the specified range.

3.3.21 Over-Limit Error (status bit 10)

This bit is set to one whenever the output data meets or attempts to exceed the output data limit in output word 7, if output data limiting is properly enabled. This bit is reset to zero when the output data falls below the output data limit in output word 7.

3.3.22 Under-Limit Error (status bit 11)

This bit is set to one whenever the output data meets or attempts to exceed the output data limit in output word 6, if output data limiting is properly enabled. This bit is reset to zero when the output data rises above the output data limit in output word 6.

3.3.23 Over-Range Error (status bit 12)

This bit is set to one whenever the output data meets, or attempts to exceed, the maximum count limit defined by the data format and output range selected (see Table 3-4). This bit is reset to zero when the output data falls below the maximum count limit.

3.3.24 Under-Range Error (status bit 13)

This bit is set to one whenever the output data meets or attempts to exceed the minimum count limit defined by the data format and output range selected (see Table 3-4). This bit is reset to zero when the output data rises above the minimum count limit.

3.3.25 Non-Fatal Channel Error (status bit 14)

This bit is set to one whenever your module detects a recoverable channel error, such as an invalid configuration word or an operating temperature error (see above), or while the SLC 500 processor is resetting. This bit is reset to zero when the error no longer exists.

3.3.26 Fatal Channel Error (status bit 15)

This bit is set to one whenever your module detects a “non-recoverable” channel error, such as a software power-up failure due to corrupt hardware or malfunctioning software. You may be able to recover from this type of error by resetting the SLC 500 processor or cycling power to your module.

Chapter 4
Testing Your Module

Read this chapter to prevent potential problems. This chapter covers:

- Inspecting your module.
- Disconnecting prime movers.
- Powering up.
- Interpreting the LED indicators.
- Interpreting I/O error codes.
- Troubleshooting.

Before testing your module, test your SLC 500 system using the procedures described in your Allen-Bradley system Installation & Operation Manual.

Important — If your module appears to be functioning, but the terminals aren't providing an output signal, the 24 VDC power source (backplane or external) may not be providing enough current (250 mA).

Section 4.1 Inspecting Your Module

You can prevent many potential problems by simply inspecting your analog module:

1. Ensure that the external 24 VDC power switch (SW1, located in the bottom corner of the module's large circuit board) is set properly:
   - With the switch in the **RACK** position, the module draws all its power from the backplane of the SLC system.
   - With the switch in the **EXT** position, the module draws its 24 VDC power from an external power source; however, the module still draws its 5 VDC power from the backplane.
2. Ensure that all wire connections are correct and secure, and that no wires are missing or broken. Refer to Chapter 1, Module Overview, for more information.
3. Ensure that the shield for the cable used to wire your module is properly grounded.
4. Ensure that the removable terminal block on your module is secure.

Section 4.2 Disconnecting Prime Movers

Before testing your module, ensure that machine motion will not occur:

- Disconnect motor wires at the motor starter or the motor itself. This lets you test the operation of the starter coil, verifying that the output circuit is wired correctly and functioning.

- Disconnect solenoids by disengaging the solenoid valves, leaving the coils connected.

If you cannot disconnect a device in the preferred way, open the output circuit as close as possible to the motion-causing device.

Example – If you have a relay coil that in turn energizes a motor starter, and you cannot disconnect the motor wires, open the circuit at a point between the motor starter and the relay contact.

WARNING	**UNEXPECTED EQUIPMENT MOTION**
	During all testing, always disconnect all devices that, when energized, might cause machine motion. Failure to observe this precaution can cause equipment damage or personal injury.

Section 4.3
Powering Up

When you apply power to the system, your module's status LED should illuminate, indicating that your module is receiving power and has completed its onboard self-test. If the LED does not illuminate after several seconds, your module is not functional. Discontinue testing until you can get the LED to illuminate.

The most probable reasons for the LED not illuminating are:

- The SLC 500 system is not receiving power from its power supply.
- The rest of the SLC 500 system is not receiving power.
- The rack slot where your module is located is defective.
- Your module is defective.

Section 4.4
Interpreting the LED Indicators

Your output module has 5 LEDs: 4 channel status LEDs (numbered 0–3 for channels 0–3, respectively) and 1 module status LED.

Figure 4-1. LED Block

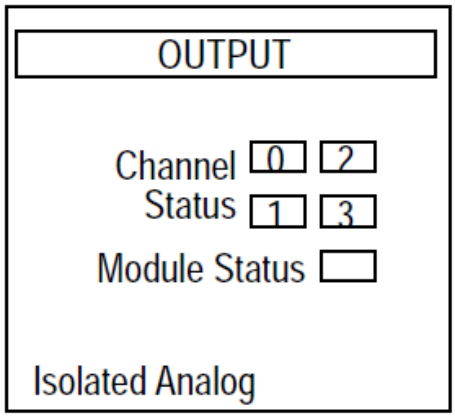


Table 4-1 LED Definition

Use the following table to interpret LED indications:

If the module status LED is…	And the channel status LED is…	Then...
On	On	The channel is enabled.
	Blinking	One of the following channel errors occurred: • Circuit open (4–20 mA outputs only) • Signal is near or beyond end of range • Channel configured incorrectly Refer to Troubleshooting.
	Off	Either your module is powering up or the channel is disabled.
Off	Off	Either the power is off, the module is powering up, or a module fault occurred. Cycle power. If the condition persists, call your local distributor or Spectrum Controls for assistance.

Section 4.5 Interpreting I/O Error Codes

I/O error codes appear in word S:6 of the SLC processor status file. The first two digits of the error code identify the slot (in hexadecimal) with the error. The last two digits identify the I/O error code (in hexadecimal).

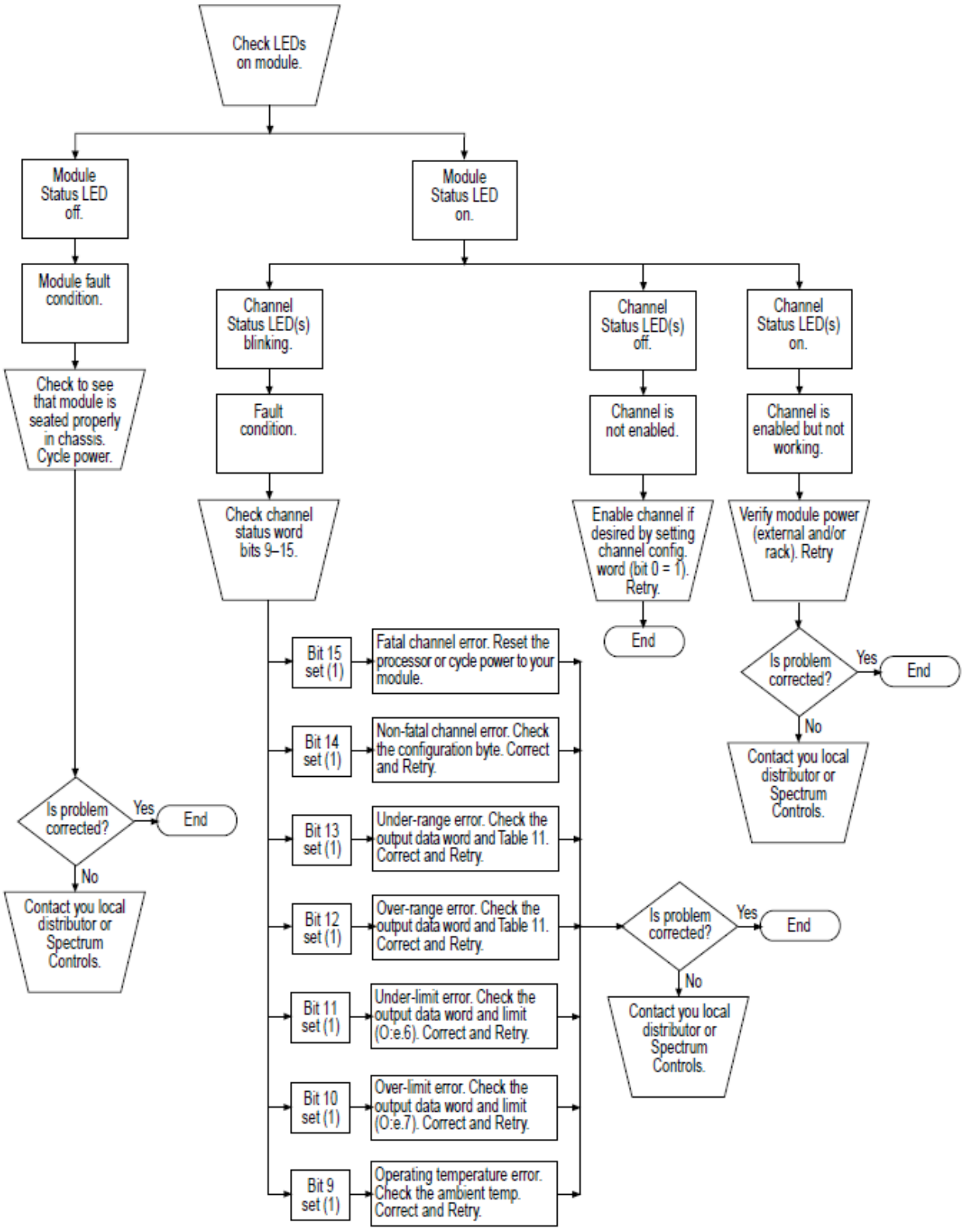
The error codes that apply to your module include (in hexadecimal):

- 50–5E
- 71 (watchdog error)
- 90–94

For a description of the error codes, refer to the *Allen-Bradley Advanced Programming Software (APS) Reference Manual*, Allen-Bradley publication 1746-6.11.

Section 4.6
Troubleshooting

Figure 4-2. Problem Resolution Flowchart



Chapter 5
Maintaining your Module and Ensuring Safety

Read this chapter to familiarize yourself with:

- Preventive maintenance
- Safety considerations

The National Fire Protection Association (NFPA) recommends maintenance procedures for electrical equipment. Refer to article 70B of the NFPA for general safety-related work practices.

Section 5.1
Preventive Maintenance

The printed circuit boards of your module must be protected from dirt, oil, moisture, and other airborne contaminants. To protect these boards, install the SLC 500 system in an enclosure suitable for its operating environment. Keep the interior of the enclosure clean, and whenever possible, keep the enclosure door closed. Also, regularly inspect the terminal connections for tightness. Loose connections may cause a malfunctioning of the SLC system or damage to the components.

WARNING 	**POSSIBILITY OF LOOSE CONNECTIONS.** Before inspecting connections, always ensure that incoming power is off. Failure to observe this precaution may cause personal injury and damage to equipment.

Section 5.2
Safety Considerations

Safety is always the most important consideration. Actively think about the safety of yourself and others, as well as the condition of your equipment. The following are some things to consider:

Indicator Lights – When the module status LED on your module is illuminated, your module is receiving power.

Activating Devices When Troubleshooting – Never reach into a machine to activate a device; the machine may move unexpectedly. Use a wooden stick.

Standing Clear Of Machinery – When troubleshooting a problem with any SLC 500 system, have all personnel remain clear of machinery. The problem may be intermittent, and the machine may move unexpectedly. Have someone ready to operate an emergency stop switch.

WARNING	**POSSIBLE EQUIPMENT OPERATION**
	Never reach into a machine to actuate a switch. Also, remove all electrical power at the main power disconnect switches before checking electrical connections or inputs/ outputs causing machine motion. Failure to observe these precautions can cause personal injury or equipment damage.

Safety Circuits – Circuits installed on machinery for safety reasons (like over-travel limit switches, stop push-buttons, and interlocks) should always be hard-wired to the master control relay. These circuits should also be wired in series so that when any one circuit opens, the master control relay is de-energized, thereby removing power. Never modify these circuits to defeat their function. Serious injury or equipment damage may result.

Refer to your system's Installation & Operation Manual for more information

Section 5.3 Getting Technical Assistance

Note that your module contains electrostatic components that are susceptible to damage from electrostatic discharge (ESD). An electrostatic charge can accumulate on the surface of ordinary wrapping or cushioning material. **In the unlikely event that the module should need to be returned to Spectrum Controls Inc., please ensure that the unit is enclosed in approved ESD packaging (such as static-shielding/metallized bag or black conductive container).** Spectrum Controls, Inc. reserves the right to void the warranty on any unit that is improperly packaged for shipment.

RMA (Return Merchandise Authorization) form required for all product returns.

For further information or assistance, please contact your local distributor, or call the Spectrum Controls Technical Support at +1 (425) 746-9481:

For Rockwell Automation Compatible I/O Products:

- USA 1-440-646-6900 (US/global, English only
- United Kingdom +44 0 1908 635 230 (EU phone, UK local)
- Australia, China, India, and other East Asia locations: 1-800-722-778 or +61 39757 1502
- Mexico 001-888-365-8677
- Brazil 55-11-5189-9500 (general support)
- Europe +49-211-41553-630 (Germany/general support)

or send an email to support@spectrumcontrols.com

Section 5.4 Declaration of Conformity

Available upon request

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