Allen-Bradley

Open-loop Velocity Control Module

(Cat. No. 1746-QV)

User Manual

Important User Information

Because of the variety of uses for the products described in this publication, those responsible for the application and use of this control equipment must satisfy themselves that all necessary steps have been taken to assure that each application and use meets all performance and safety requirements, including any applicable laws, regulations, codes and standards.

The illustrations, charts, sample programs and layout examples shown in this guide are intended solely for purposes of example. Since there are many variables and requirements associated with any particular installation, Allen-Bradley does not assume responsibility or liability (to include intellectual property liability) for actual use based upon the examples shown in this publication.

Allen-Bradley publication SGI-1.1, *Safety Guidelines for the Application, Installation, and Maintenance of Solid-State Control* (available from your local Allen-Bradley office), describes some important differences between solid-state equipment and electromechanical devices that should be taken into consideration when applying products such as those described in this publication.

Throughout this manual we use notes to make you aware of safety considerations:

ATTENTION: Identifies information about practices or circumstances that can lead to personal injury or death, property damage or economic loss.

Attention statements help you to:

- identify a hazard
- avoid the hazard
- recognize the consequences

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

Manual Changes (Series A/D)

Changes to this revision of the manual include these additions:

- Considerations for Selecting the ±15V dc Power Supply (chapter 4)
- Other Design Considerations (chapter 4)
- Testing for Proper System Operation (chapter 5)
- Power Supply Loading Specifications (appendix A)

Notes:

Table of Contents

System Overview

Chapter Objectives

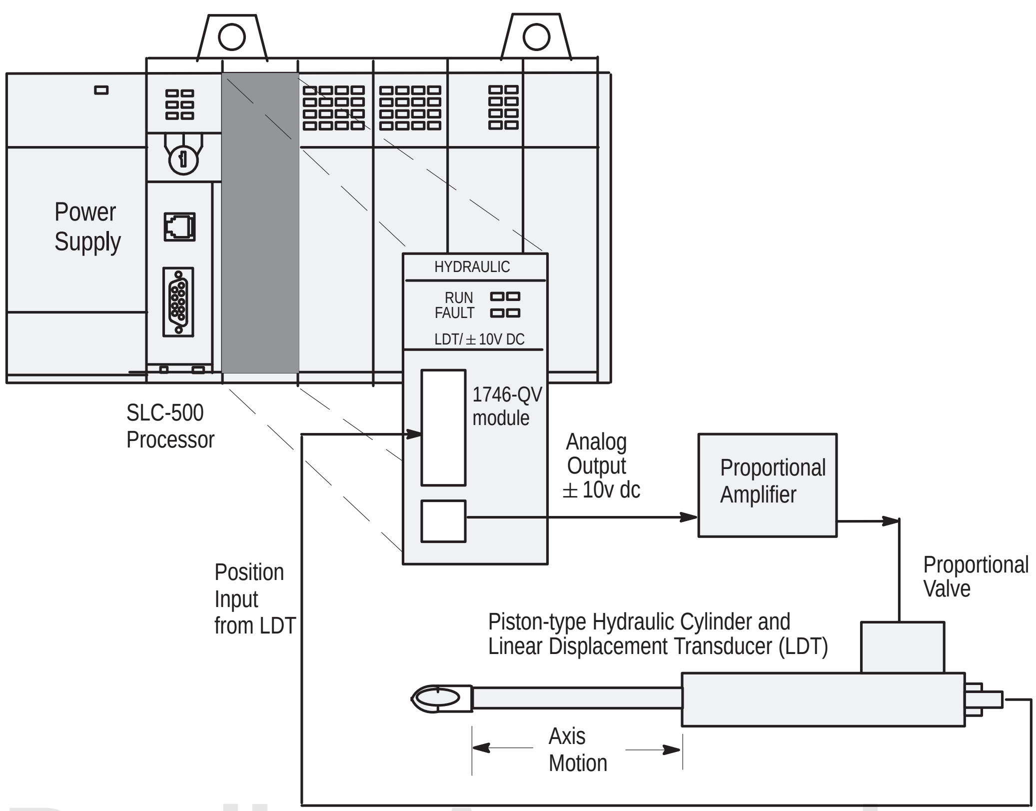
This chapter presents a conceptual overview of how you use the 1746-QV module in an application.

What Is the 1746-QV Module?

The 1746-QV module is part of an SLC-based open-loop control system for controlling the speed and placement of an hydraulic ram. The module accepts an input from a linear displacement transducer (LDT) and motion profiles that you program into the SLC processor, and varies its output in the range of ± 10V dc. The SLC processor sends to the module a pair of extend and retract profiles that define when to accelerate or decelerate hydraulic motion.

What Is an SLC-500 System?

The Allen-Bradley Small Logic Controller (SLC) system is a programmable control system with an SLC processor, I/O chassis containing analog, digital, and/or special-purpose modules, and a power supply. The 1746-QV module interfaces your hydraulic ram and position-monitoring device (LDT) to the ladder sequence in your SLC processor. The system can be illustrated as follows:



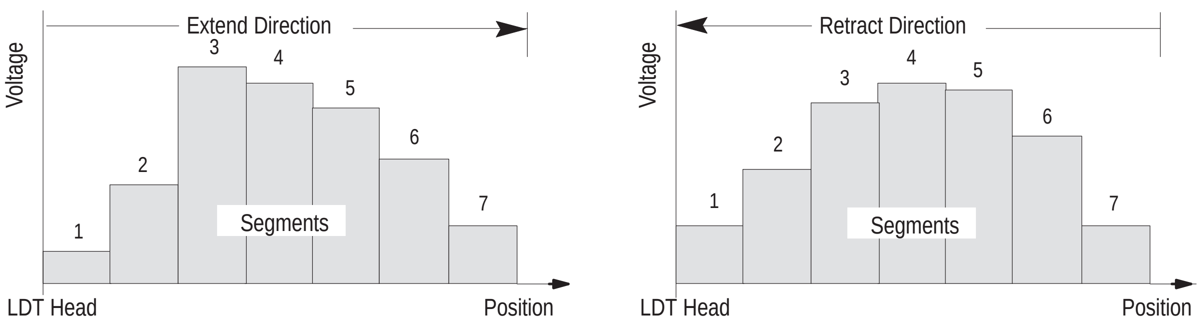
Why Use This System?

Because you can change the speed of the hydraulic ram with extend and retract profiles and store additional profiles (recipes) in data table iNteger (N) files, this control system has these benefits:

- *reduced cycle time* – you can increase ram speed for faster operation
- *reduced or eliminated pressure spikes and water-hammering for smoother operation and less wear and tear on the machine* – you can profile accelerations and decelerations of the hydraulic ram
- *energy savings* – you can match the speed of the hydraulic pump to the force that you need
- *faster new-part change-over* – you can store your setups and minimize mechanical re-adjustments between parts

How Does It Work?

The 1746-QV module executes the extend and retract profiles that you load to control the motion of the hydraulic ram. You can program up to seven different voltages over the length of travel in both the extend and retract directions to control how the ram accelerates or decelerates.



Each position setpoint triggers a corresponding voltage output in the range of –10V to +10V dc that translates into speed. The LDT provides high-speed position updates to the module for consistent and repeatable motion.

What Are Typical Applications?

Use the 1746-QV module in an SLC-based system for low-cost control of:

- hydraulic machinery
- simple (non-CNC) hydraulic presses
- diecasting machinery
- welder placement
- pneumatic actuators for clamping or placement

In addition, the module is designed to support standard proportional amplifiers and retrofit into most existing hydraulic systems.

Quick Start

Use this chapter as an abbreviated procedure for getting the 1746-QV module into operation or as an overview if you need more information.

Procedure

1.	Load Ladder Logic into Your Computer	Chapter 3

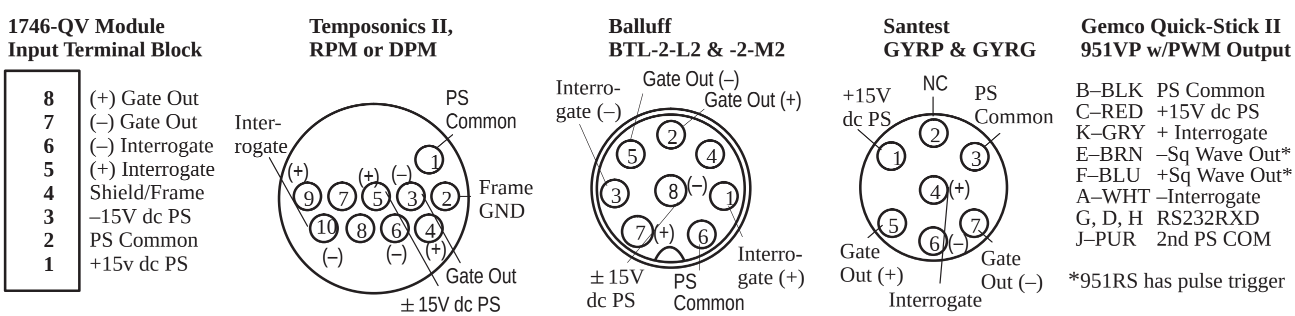
Obtain the ladder program (appendix B) from Rockwell Software Bulletin Board (BBS) or the Internet.
From BBS: (216) 646-ROCK (-7625). If a new user, follow prompts to register. Log in. Look for 1746QV in the Allen-Bradley Products Library. The manual is in Word format. Download it into a hard drive subdirectory and decompress it with PKUNZIP available on BBS. The ladder program, VELMOD, is SLC500 code (65 Kbyte). Download it into a hard drive subdirectory where your programming software looks for files.
From Internet: webpage http://www.ab.com If a new user, click *Join Now* and follow prompts to register. Log in. Search for QV: on homepage, click *Search Our Site*, insert QV in window, and click *search* button. The manual is PDF format and requires Adobe Acrobat viewer. The ladder program is PDF format and must be entered manually.

2.	Set Up Your Software	Chapter 3

Configure the SLC Processor and I/O with your programming software. Enter the following:
a) processor type, b) module I/O-chassis slot, c) module ID (13115), d) G-file size (7 words), and e) G-file configuration values from the ladder program (appendix B).
Modify N files for the profile found in the ladder program (appendix B) to suite your application.

3.	Connect the LDT to the Module's Input Terminal Block	Chapter 4

The following are connections between the 1746-QV module and typical LDTs such as Temposonics, Balluff, Santest, and Gemco.

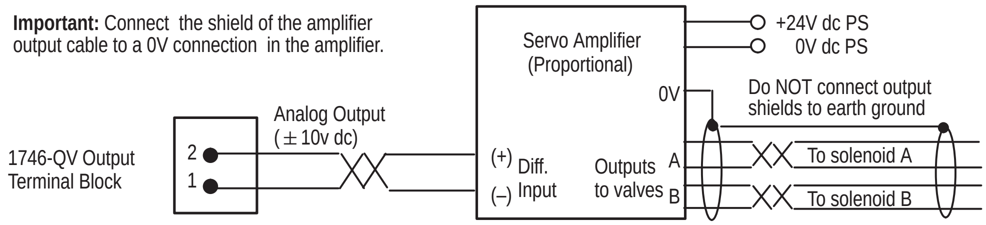


The views are looking at the connector on the LDT head.

1746-QV Input Pin #	Function	Temposonics II RPM or DPM	Balluff BTL-2-L2 & -M2	Santest GYRP/GYRG	Gemco Quick-Stick 951VP/RS
8	(+) Gate Out	4 – Pink	2 – Gray (note 1)	pin 5	F – Blue (note 1)
7	(–) Gate Out	3 – Gray	5 – Green (note 1)	pin 7	E – Brown (note 1)
6	(–) Interrogate	10 – Green	3 – Pink	pin 6	A – White
5	(+) Interrogate	9 – Yellow	1 – Yellow	pin 4	K – Gray
4	Shield/Frame	n/a	n/a	n/a	n/a
3	–15V dc PS	6 – Blue	8 – White	n/a	n/a
2	PS Common	1 – White	6 – Blue	pin 3	B – Black
1	+15V dc PS	5 – Red	7 – Brown	pin 1	C – Red

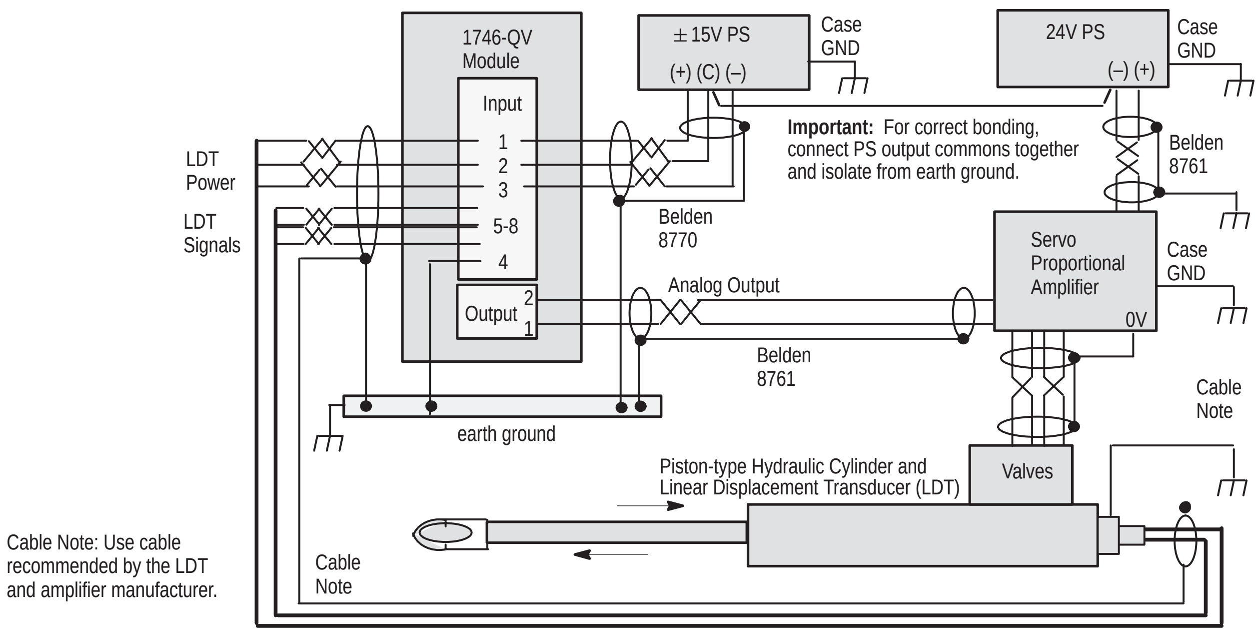
(+) and (–) wires of same function should be a twisted pair within the cable.
Note 1: In the table, we use the term "gate out" for pulse trigger or square wave (Gemco) and start/stop (Balluff -M2) LDT signals.

4.	Connect Module Output Terminals to Output Devices With Correct Bonding	Chapter 4



5.	Minimize Interference from Electrical Noise with Correct Shielding and Grounding	Chapter 4

Important: Connect PS output commons togerther.
Connect the following to earth ground: a) cable shields (except for amplifier outputs) at one end only, b) input terminal 4, c) case grounds of PS and amplifier, e) LDT flange.



6.	Operate the Module for the First time	Chapter 5

After loading profiles with the ladder program (step 1), alternately run the extend profile (O:e.0/0 = 0-to-1), then the retract profile (O:e.0/1 = 0-to-1). Modify the profile to reach the preset reference, and set it.
Important: If motion is reversed: for a ± 10V dc output, change the sign (±) of all extend/retract voltage values; or for a +10V output, energize the other solenoid on the directional valve (with ladder logic).

To do this:	Enter decimal:	at address:
load all profiles	1	N7:40
set preset reference to zero	8	N7:50
clear errors	16	N7:50
read current position	read, only	N7:61
run an extend profile	1	N7:50
run a retract profile	2	N7:50

Setting Up the Software

Chapter Objectives

This chapter helps you do the following:

- Obtain the ladder program electronically
- Configure your SLC processor off-line
- Modify N files in your SLC processor, off-line
- General conventions for profiles
- Profile operation

Obtaining the Ladder Program Electronically from BBS or the Internet

You can obtain ladder logic electronically and download it to your SLC processor conveniently without the worry of data-entry errors.

About the Rockwell Bulletin Board System (BBS)

You can access the Rockwell Software Bulletin Board System (BBS) by modem. Anyone is welcome. The BBS provides utilities, examples, and technical information on Rockwell Software products and on selected Allen-Bradley products.

- new users may:
  – send and receive messages
  – download General Access files
  – upload files for review by technical support specialists
- verified customers may:
  – search for new and existing files
  – download files such as utilities, example programs, tech info
  – access software bulletins
- subscribers to tech bulletins, DataDisc CD-ROM may:
  – download tech bulletins of the Tech Bulletin Subscription series

User accounts are automatically generated online. We use our product data base to verify BBS accounts at your initial log-in, and we adjust your security level according to your support status. Should your registration information change, you can update your account from the "Configure System Defaults" menu.

To Access BBS:

1. Set your modem to no parity, 8 data bits, and 1 stop bit.
2. Dial (216) 646-ROCK (-7625).
3. Follow prompts to log in. New users must create a new account.
4. Look for 1746QV in the Allen-Bradley Products Library. The manual is formatted in Microsoft Word and compressed with PKZIP™. The ladder program, VELMOD, is SLC code.

5. Download ladder program VELMOD (65 Kbyte SLC code) into the subdirectory on your hard drive where your programming software looks for files. With RSLogix: C:\ . . . RSLogix 500 English\Project.
6. Download the ladder program to your SLC processor.
7. Download the manual into a hard drive subdirectory. You must decompress the Word version with PKUNZIP™ available on BBS.

To Access the Internet:

1. Access the Allen-Bradley webpage at: http://www.ab.com
2. To access the member area, you must log in. If you do NOT have an account, click *Join Now* and follow the prompts to register.
3. Search for QV: on homepage, click *Search Our Site*, insert QV into the window, and click *Search* button. The manual is PDF format and requires Adobe Acrobat™ viewer. The ladder program is PDF format and must be entered manually.

Configuring Your SLC Processor, Off-line

This procedure assumes you are using RSLogix500™ Programming Software, version 2.10 or later. For other software, the procedure may vary.

1. Open your 1746-QV project, VELMOD.
2. Configure the type of SLC processor. To do this:
   - **A.** Open the file, Controller Properties.
   - **B.** Select the SLC processor type and click OK.
3. Configure the rack size, module slot, and module ID:
   - **A.** Open the file, I/O Configuration.
   - **B.** Select the rack size.
   - **C.** Highlight the slot number for the module.
   - **D.** From the list of modules, scroll to 1746-QV and double–click. If the module is not listed:
     – Scroll to Other and double-click.
     – Enter the module’s ID (13115) and double-click.
4. Size the “G” file:
   - **A.** Highlight 1746-QV (or 13115 if module was not listed).
   - **B.** Click [Adv Config].
   - **C.** In the dialog box, enter a G-file length of 7.
   - **D.** Press [Edit G Data].

5. Enter values in the G file:

If the module was listed:	If the module was not listed (you entered the ID):
You get the G–file Setup screen. Enter data from the table, below.	You get the following display, shown in decimal radix. Enter a value in each word as shown, next.

G–file display for unlisted module (shown in decimal radix):

Ge:0	2056	0	0	0	0	0	0

Enter a value at each G-file word address and press [ENTER]. Then cursor to the next word address and repeat. For example:

Ge:0	2056	***893***	***730***	***12***	***1200***	***–32768***	***0***

We used values from the ladder logic example (appendix B). You will want to use G-file values that suit your application:

Word:	Function of G-file Word:	Range:	Description of G-file Word or Bit:	Example:
0	Reserved. Do NOT use.	n/a	The processor stores a code for the 1746-QV module.	2056
words 1 & 2 refer to the gradient or transducer calibration value stamped on the name plate on the transducer housing.				
1	LDT calibration: upper 3 digits	800-999 μs/inch	For example: To enter an LDT calibration of 8.9373, use decimal radix and enter 893 in word 1 and 730 in word 2.	*893*
2	LDT calibration: lower 3 digits	000-999 μs/inch		*730*
3	Full-scale length (L) of LDT	$2 \leq L \leq 160$ inch	Enter the length of the LDT (160 inches max).	*12*
4	Full-scale count (C)	$2 \leq C \leq Lx100$	Typically C = L x 100. Position Data (I:e.1) = $\frac{C/(L \times 100)}{\text{LDT Calibration}}$	*1200*
5	Configuration Bits 15 14 13 12-0 Equivalent Value 0 1 0 0 +16,384 1 0 0 0 –32,768 1 1 0 0 –16,384 0 1 1 0 +24,576	bits 0-12	Set to zero.	*–32,768* (bit 15 = 1 for position increases towards LDT head)
		bit 13	0 = output maintained during LDT fault while running profiles and during SLC mode change 1 = output resets for LDT fault and SLC mode change	
		bit 14	Type of LDT: 0 for RPM, 1 for DPM	
		bit 15	0 = position data increases when moving away from LDT head 1 = position increases when moving toward LDT head	
6	Preset Reference	–32,768 to +32,767	Typically zero or home reference value. 32,767 = 327.67 inches.	*0*

Examples of Full-scale Count Values

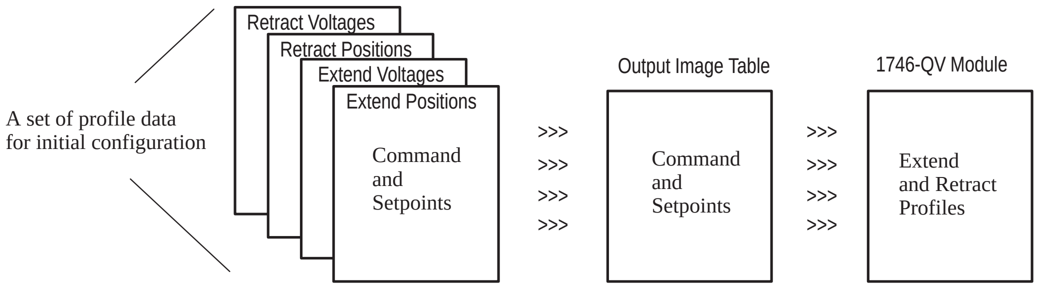
LDT Physical Length	No. of Recirculations	Resolution	Full-scale Length (L)	Full-scale Counts (C)
from 160" to 2"	1	0.01	L (160" to 2")	L x 100
16"	2	0.01	160	8000
16"	4	0.01	160	4000
16"	10	0.001	160	16000

Important: The module checks for invalid data such as out of range values or the setting of reserved bits 0-12. You can clear a data-entry configuration error only by re-entering a corrected value.

6. Save when done.
Click OK. Click OK. Close window.

Modify N Files in Your SLC Processor, Off-line

One N file may contain the initial commands, setpoints, and values for configuring the extend and retract profiles.



The file contains commands and data starting at the these addresses:

- command and position setpoints for extend #N7:0
- command and voltage (velocity) values for extend #N7:10
- command and position setpoints for retract #N7:20
- command and voltage (velocity) values for retract #N7:30

The sample ladder program (appendix B) copies profile data into the output image table from the above locations.

Output Image Table with Profile Data

Word:	Function of Output Image Word:	Bit #:	Description: (For command bits, a 0-to-1 transition enables the command)
0	Command Bits Enable these bits (O:e.0/bit #) with your ladder logic, where e represents the I/O slot number.	0	Set to run an extend profile.
		1	Set to run a retract profile.
		2	Set to disable the profile. This bit over-rides bit 0 or 1.
		3	Set to change the current position data to the value of the preset reference stored in Ge:6.
		4	Set to clear any data-entry errors.
		5	Set to define words 1-7 as programmed position setpoints for extend.
		6	Set to define words 1-7 as programmed voltage values for extend.
		7	Set to define words 1-7 as programmed position setpoints for retract.
		8	Set to define words 1-7 as programmed voltage values for retract.
		9-15	Reserved. Do NOT use.
1-7	Position Setpoint or Voltage Value	n/a	**Important:** Position setpoints are in units of 0.01” (200 = 2.00”) within the range of –327.68” to +327.67”, and voltage values in 5mV units (3005 = 3.005V) within the range of ± 10,000mV.

The data monitor mode of your programming software displays the data files shown below (with values from the ladder program).

Important: Modify these values to suit the preset reference chosen for the G file and/or to match the LDT length.

Extend Positions:	N7:0	32	–45	50	200	300	400	425	500	0	0
Extend Velocities:	N7:10	64	3000	3750	4000	4000	4000	4000	4000	0	0
Retract Positions:	N7:20	128	–45	50	200	300	400	425	500	0	0
Retract Velocities:	N7:30	256	5000	6000	6000	3000	1000	50	25	0	0

General Conventions for Profiles

Consider the following when you set up your profiles:

- Extend and retract define the profile with respect to the LDT head: extend is always *away* from the head, retract is always *towards* it
- Position data changes direction depending on how you set configuration bit Ge:0/15 for LDT motion:
  0 = position data increases when moving away from LDT head
  1 = position data increases when moving towards LDT head
- Each position setpoint triggers from the absolute position data (I:e.1) as modified by the preset reference.
- Position setpoints are in units of 0.01”.
  For example, enter 2” as 200.
- If you enter position setpoints in random order, the module places them in ascending order (P1 = lowest and P7 = highest) with their associated voltage value.
- Speed segments are defined increasing from the LDT head, regardless of position data direction.
- Speeds are reported in the input image table words 2-7 (I:e.2-I:e.7) for the *previous* profile (extend speeds reported during the next retract profile and vice versa)
- Voltage values (for speed) are in the range of ± 10,000mV in multiples of 5mV. For example, enter –5.005V as –5005.

Important: Enter voltage values in multiples of 5mV or the module will fault, causing you to correct and re-download the profile.

- Voltage values are cleared when you re-program position setpoints. The profile is cleared when the module loses power or when you change the value of any G-file configuration word.

Important: Your application may require different position setpoints and voltage values. Your profiles must be consistent with the physical parameters of the LDT and G file to guard against damaging hardware.

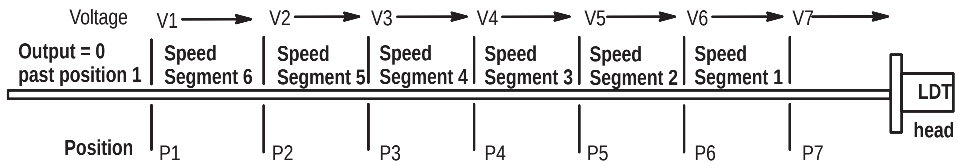
Profile Operation

In general:

- For relatively faster and smoother motion, use two speed segments for acceleration and five speed segments for deceleration.
- Adjust the ramp rate on the proportional amplifier for the smoothest operation. Initially, start with the ramp disabled (fastest ramp rate).
- You may compensate for deadband or valve overlap by specifying a voltage value greater than or equal to the valve’s bias current.

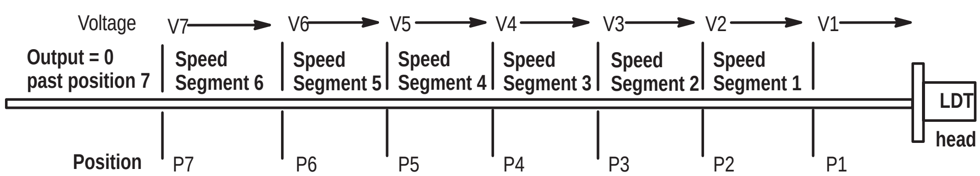
Profile operation depends on how the module reports position data. With the data-direction bit (Ge:0/15), you select whether:
– position data increasing towards the LDT head (Ge:0/15 = 1)
– position data increasing away from the LDT head (Ge:0/15 = 0)

For Position Data Increasing Towards LDT Head (Ge:0/15 = 1)



- Starting with the ram between P7 and the LDT head (open position), running the extend profile results in V7 applied to the output. As the ram passes below P7, V6 is applied to the output, etc.
- If the ram passes below P1, the output is forced to 0V dc, and the profile is disabled. You must load new data to operate the profile.
- Placement operations require two segments. For example, if P2 = 6.07”, V2 = 1.500V, P1 = 0.00” (or a value less than P2), and V1 = –1.500V, then the module will place the ram in the vicinity of P2 (between 6.02 and 6.12). The negative voltage V1 causes motion to reverse or stop. To see this, enter the example values for P2, V2, P1, and V1 in the previous diagram.

Position Data Increases from LDT Head (Ge:0/15 = 0)



- Starting with the ram between P1 and the LDT head (open position), running the extend profile results in V1 applied to the output. As the ram passes P1 towards P2, V2 is applied to the output, etc.
- If the ram passes P7, the output is forced to 0V dc, and the extend profile is disabled. You must load new data to operate the profile.

Setting Up the Hardware

Chapter Objectives

This chapter helps you install the hardware with these tasks:

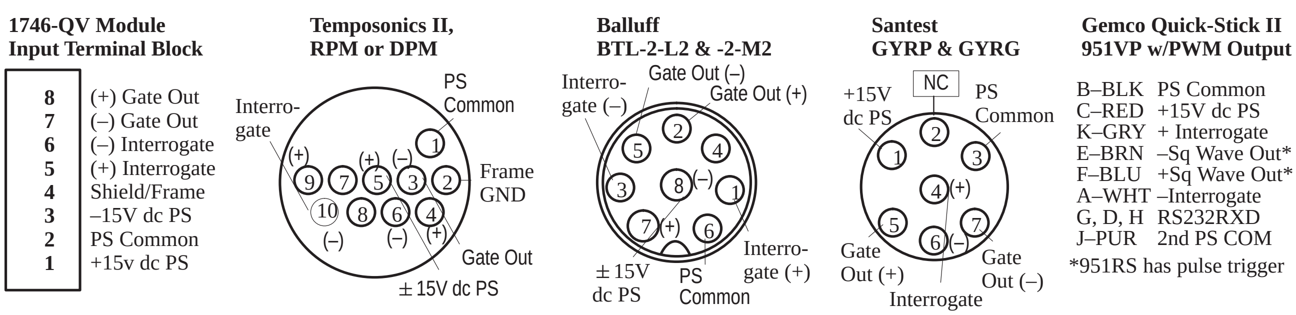
- connect the LDT to module input terminals
- connect module output terminals to output devices
- minimize interference from radiated electrical noise
- considerations for the ± 15V dc power supply
- other design considerations

Connect the LDT to Module Inputs

We assume that you will use one of the following types of LDT:

- Temposonics II: RPM TTS**R**xxxxxx**R,** or DPM TTS**R**xxxxxx**DE**xxx
- Balluff: BTL-2-L2, or BTL-2-M2
- Santest: GYRP, or GYRG
- Gemco Quick-Stick II: 951VP, or 951 RS

We illustrate typical connections between the 1746-QV module and these types of LDTs. (There are other suppliers with compatible LDTs.)



The views are looking at the connector on the LDT head.

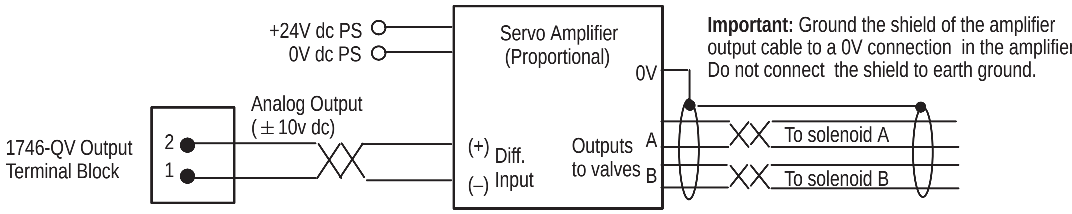
Connect each 1746-QV input pin # to the corresponding LDT pin #.

1746-QV Input Pin #	Function	Temposonics II RPM or DPM	Balluff BTL-2-L2 & -M2	Santest GYRP/GYRG	Gemco Quick-Stick 951VP/RS
8	(+) Gate Out	4 – Pink	2 – Gray (note 1)	pin 5	F – Blue (note 1)
7	(–) Gate Out	3 – Gray	5 – Green (note 1)	pin 7	E – Brown (note 1)
6	(–) Interrogate	10 – Green	3 – Pink	pin 6	A – White
5	(+) Interrogate	9 – Yellow	1 – Yellow	pin 4	K – Gray
4	Shield/Frame	n/a	n/a	n/a	n/a
3	–15V dc PS	6 – Blue	8 – White	n/a	n/a
2	PS Common	1 – White	6 – Blue	pin 3	B – Black
1	+15V dc PS	5 – Red	7 – Brown	pin 1	C – Red

(+) and (–) wires of the same function should be a twisted pair within the cable.
Note 1: In the table, we use the term “gate out” for pulse trigger or square wave (Gemco) and start/stop (Balluff -M2) LDT signals.

Connect Module Outputs to Output Devices

Module outputs connect to a separate 2-conductor output terminal block located beneath the input terminal block.



Note: Follow manufacturer recommendations for shielding the output cables of the proportional amplifier. Typically, pulse-width modulated outputs radiate electrical noise originating from the +24V dc power supply, so isolate the shields of the amplifier output cable to a 0V dc connection inside the proportional amplifier.

You have a choice of three configurations to match your hydraulics:

- proportional amplifier with ramp and proportional valve
- servo amplifier with ramp and variable-volume pump
- Allen-Bradley 1305 Drive and hydraulic pump

You may use either of the following output voltage ranges:

- 0-10V dc for the Allen-Bradley 1305 Drive or variable-volume pump
- –10 to +10V dc for the proportional amplifier and proportional valve

Minimizing Interference from Radiated Electrical Noise

Important: Signals in this type of control system are very susceptible to radiated electrical noise. The module is designed to set the loss-of-sensor bit I:e.0/8 and the LDT-error bit I:e.0/0 when it detects position values that are lost or corrupted by electrical noise.

Connect module output terminals to output devices with correct bonding:

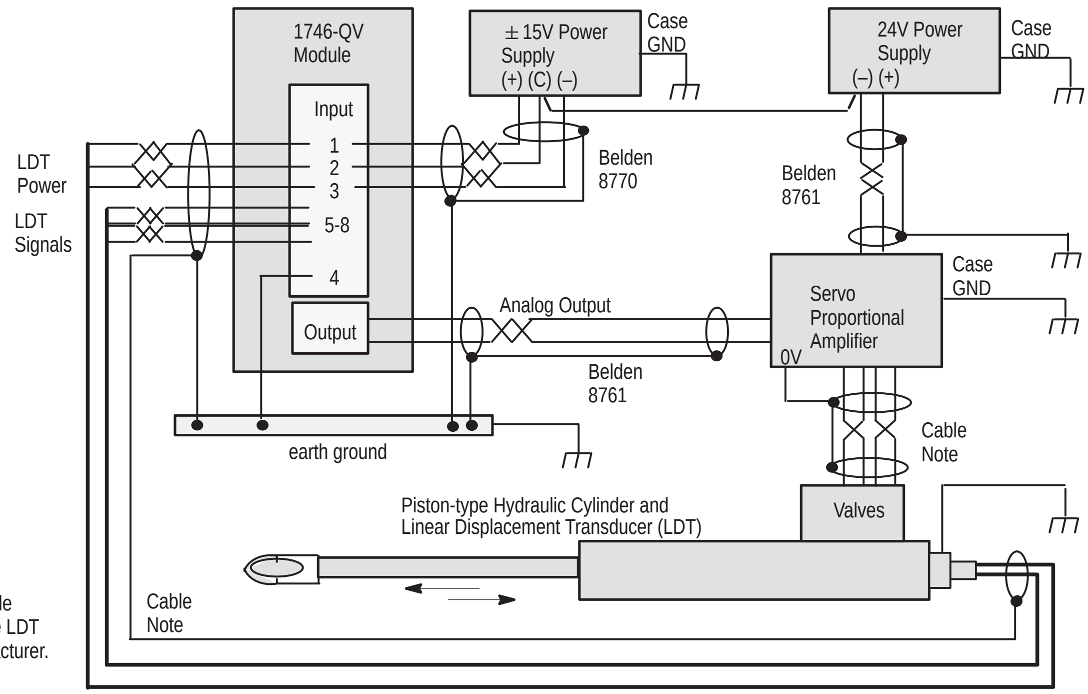
- connect power supply output commons together
- electrically isolate power supply output commons from earth ground
- use bond wires that are equal in size to signal wires

Minimize interference from radiated electrical noise with correct shielding and grounding:

- connect all of the following to earth ground:
  – LDT flange, frame, and machine
  – I/O chassis
  – protective ground
  – AC ground
  – cable shields at one end only, preferably with 3/8” braid wire (for analog output, ±15V dc PS, 24V dc PS, and LDT)
  – terminal 4 of the input terminal block

- run shielded cables only in low-voltage conduit
- place the SLC-500 processor, power supply, and I/O chassis assembly in a suitable enclosure

Typical grounding and shielding for this type of control system:



Cable Note: Use cable recommended by the LDT and amplifier manufacturer.

Considerations for the ± 15V dc Supply

Selection of the ± 15V Power Supply

The positive and negative supply of some ± 15V dc power supplies decay at different rates when ac power is removed. The module's output will be biased, based upon the difference in voltage level between the positive and negative supply. The duration is dependent upon the magnitude of the difference and the decay rate. For these reasons, the ± 15V dc power supply should have or be equipped with:

- proper interlocks with machine operation and e-stop circuits
- an internal voltage-sense relay that drops the ± 15V (without variation in decay rates) upon loss of ac power
- auxiliary relay to indicate proper operation and voltage (such as loss of +15V but not –15 V dc)

Power Supply Loading

The module and LDT load the power supply typically as follows:

Supply	No Transducer No Load	Transducer Only *	LDT + Module: +10V dc @ 10mA	LDT + Module: –10V dc @ 10mA
+15V dc	86mA	128mA	141mA	128mA
–15V dc	14mA	30mA	30mA	40mA
***MTS Temposonics II, model T1SR0U0120R (Other LDTs will have different loading.)**				

Application of the ±15V Power Supply

The module uses the ±15V dc power supply to drive the ±10V dc valve output and to power the LDT. The module detects loss of ±15V dc with its internal LDT diagnostic. The diagnostic concludes loss of ±15V when it detects loss of LDT magnet.

Partial failure of the ±15V dc power supply may cause limited machine operation when the LDT continues to operate properly. Some LDTs will operate with its supply voltage down to 12V. If you monitor the ±15V dc with SLC diagnostics, you can enable a blocking valve to lock the actuator in its last position upon detection of:

- e-stop
- power loss
- low voltage condition of the ±15V dc supply

ATTENTION: If you provide a system e-stop circuit and design the system to manage power to the SLC chassis and ±15V dc supply, in all cases DO NOT connect the e-stop to ac power for power supplies.

Other Design Considerations

ATTENTION: We recommend using reasonable methods to assure that unintended motion does not cause machine damage or create a safety issue with personnel who will operate the machine.
(Chapter 5 covers testing for proper system operation.)

- Use a proportional valve that does not respond to voltage spikes created by power supply operation.
- Shut down the hydraulic system upon loss of ac power and automatically vent pressurized fluid back to the tank.
- Provide ladder programming that interlocks the operation of the power supply with permissives to run the hydraulic pump.
- Connect a high-speed relay between the module and the valve amplifier to drop-out the valve signal upon loss of ac power.

Chapter 5

Operating the Module for the First Time

Chapter Objectives

This chapter outlines the steps for operating the module for the first time with an operating hydraulic ram. We cover these steps:

- power-up the system
- test for proper system operation
- troubleshoot possible problems

Power Up the System

Starting with module and LDT power turned off, bring the system on-line for the first time as follows (refer to I/O wiring in chapter 4):

Check Wiring and Grounding

1. Disconnect the LDT connector at the head end.
2. Disconnect both of the module's input and output terminal blocks.
3. Turn ON the power supplies for the LDT and SLC processor, and check the LDT connector and module input terminal block for:
   - pin 1 +15V dc
   - pin 2 PS common
   - pin 3 –15V dc
4. Observe that the module's fault LED (red) is ON.
5. Verify NO continuity between pin 2 (PS commons) and pin 4 (shield/frame) on the module's input terminal block.
6. Verify NO continuity between the LDT cable shield and pin 2 (PS commons) on the module's input terminal block.
7. Verify continuity between pin 2 (PS commons) on the module's input terminal block and the output common on the ±15V dc PS that powers the LDT and module.
8. Verify continuity between pin 2 (PS commons) on the module's input terminal block and the (–) terminal on the +24V dc PS that powers the proportional amplifier.
9. Verify NO continuity between the +24V dc PS (–) connection and earth ground.
10. Verify continuity between the shield of the amplifier output cable and pin 2 (PS commons) on the module's input terminal block.
11. Verify continuity between the cable shield (Belden 8761 or equivalent) on the +24V dc PS and earth ground.

Get Ready to Move the Ram

1. Turn on the +24V dc PS that powers the amplifier.
2. Turn on the hydraulic pump and “null” the ram for no movement.
3. Turn off all power supplies.
4. Connect the LDT cable and input terminal block.
5. Turn on all power supplies.
6. Be sure that you have loaded the extend and retract profiles into the module.
7. Observe module LEDs. The RUN LED (green) should be blinking. If not blinking, refer to troubleshooting covered last in this chapter. Module LEDs indicate the following to assist you with the procedures:

This LED:	Is:	When the Module detects:
RUN (green)	Flashing	output is at 0V dc
	ON	profiles are loaded and output is active
FAULT (red)	OFF	no internal faults
	Flashing	an LDT fault
	ON	an internal fault
For Series A Revision A: During startup, Run LED ON and Fault LED flashing indicate outputs are at 0V dc. During profiles, Fault LED is OFF.		

8. Observe that the output image table word 0 (O:e.0) is zero. If not zero, toggle the value of N7:50 from 0 to 16 to 0. Reload the profiles by entering the value of 1 into N7:40. If profiles do not reload, refer to Troubleshooting on page 5-4.
9. With the output terminal block still *dis*connected, run the extend profile by changing the value in N7:50 to 1. The RUN LED should change to ON. If not, refer to troubleshooting covered last. **Important:** Reset the value in N7:50 to 0.
10. Connect the output terminal block.

Move the Ram

Important: When you set an output bit with your programming terminal, the commanded action takes place immediately.

1. Run the extend profile by momentarily changing the value in N7:50 to 1, and observe the direction of ram movement in N7:61. If the ram moves in the wrong direction:

If using this type of valve and signal:	Then reverse the:
proportional valve with ±10V input	sign (±) of *all voltage* values and load them into the module
hydraulic motor or ac drive with 0-10V input	other solenoid on the directional valve (with ladder logic)

2. After reversing the sign of voltages (if needed), run the extend profile again by changing the value in N7:50 to 1.
   Observe that the direction of ram travel is correct.
   Important: Reset the value in N7:50 to 0.

3. Check the position value reported in the status word, N7:61, as you run the ram to the end of its travel. If the position data is reversed, you may need to change the data-direction bit (Ge:5/15) in the G file off-line as follows:

   - 0 = position increases while moving away from LDT head
   - 1 = position increases while moving toward LDT head

   Important: You must reload profiles for either of these conditions:
   - Changing a value in the G file. (This clears the profiles).
   - When position data exceeds the position setpoint that is farthest from the LDT head, the profile is disabled and you must modify position setpoints and reload the profiles.

4. Verify operation of the retract profile by changing the value in N7:50 to 2. **Important:** Reset the value in N7:50 to 0, afterwards.

Jog the Ram to the Reference Position

The reference position may require that you jog the ram beyond a position defined by the profile in the ladder program (appendix B). You may jog the ram as follows:

1. Observe the current position data (in I:e.1).

2. Modify profile position setpoint(s) to permit the ram to travel to the required reference position using the current position. For example: If position data reads –100, change P1 to –1300 (length of the LDT)

3. **Important:** Reset the value in N7:50 to 0.
   Load the profiles into the module.

4. Run the extend profile by changing the value in N7:50 to 1, and jog the ram to the reference position.

5. At the reference position, the position data, I:e.1, (N7:61) will be an arbitrary value. Set the position data to the value of the preset reference by changing the value in N7:50 to 8 (N7:40 must = 0). Position data will change to preset reference (0 in this example).

6. Verify that N7:61 now reads zero at the reference position.

Important: Once you establish the reference position:
- the module will maintain the preset reference's position data in I:e.1
- all profile position setpoints will be referenced to it
  (until you clear Ge:6 by changing any G-file value or set another reference position. The preset reference is retained during power up.

Test for Proper System Operation

ATTENTION: Test for proper system operation to verify that precautions to guard against unexpected motion perform as intended. (See Power Supply and Design Considerations in chapter 4)

Because of the wide variety of applications for this module, we leave the procedural details to you.

Look for proper system operation as you test for these conditions:

- controlled system startup/shutdown when turning hydraulics on/off
- startup/shutdown of ac to power supplies (± 15V dc, SLC chassis, and 24V dc)
- loss of LDT input
- effect of the last-state-of-output bit (G-file, word 5, bit 13) regarding one or more of the above

Troubleshoot Possible Problems

Using Status Bits for Errors Detected by the Module

The module is designed to detect and indicate status as follows (in the input image table word I:e.0 or N7:60 in the ladder program):

- hardware operational faults
- data entry errors when entering setpoints or setting control bits
- acknowledgement of stored setpoints

Important: To clear error bits, toggle N7:50 from 0 to 16 to 0.

Bit #:	Description: (for error & fault bits 0-8, status of 0 = OK, status of 1 = fault.)
0	The module sets this LDT error bit when it detects a: – broken or mis-wired LDT cable – faulty LDT – incompatible LDT type (DPM or RPM) – missing LDT magnet – loss of ± 15V dc PS
1	Module fault, such as EEPROM error. May turn outputs OFF (fault dependent)
2	The module sets this bit when it detects any of the following invalid command bits or bit combinations in output image table word 0 (O:e.0): – one or more of the reserved bits 9-15 were set – bit 5 or 7 (position) was set concurrently with bit 6 or 8 (voltage) – output enable bit 0 (extend) or 1 (retract) was set before loading valid profiles – both output enable bits 0 (extend) and 1 (retract) were set concurrently – started to run a profile after the module had flagged an LDT error (I:e.0/0)
3	You set one or more of the reserved bits 0-13 in G-file word 5 (Ge:5).
4	You entered an invalid length (word 3) or count (word 4) in the G file.
5	You entered an invalid LDT calibration (words 1 and/or 2) in the G file.
6	You entered position setpoint outside the range –32,768 to +32,767 in O:e.1-O:e.7.
7	You entered a voltage value outside the range of ± 10,000mV in O:e.1-O:e.7.
8	Loss of sensor. The module detected position data (in I:e.1) greater than the LDT length plus the preset reference. Clear this bit by running a profile.
9-11	Reserved. Do NOT use.

Bit #:	Description: (for error & fault bits 0-8, status of 0 = OK, status of 1 = fault.)
12	The module sets this bit after it stores retract position setpoints or voltage values, or when retract profile is active. It remains set until another operation is performed.
13	The module sets this bit after it stores your position setpoints. It resets it after you reset the “program position” bit (O:e.0/5 or O:e.0/7)
14	The module sets this bit after it stores your voltage values. It resets it after you reset the “program voltage” bit (O:e.0/6 or O:e.0/8)
15	The module sets this bit when it detects the profile is active (output is applied).

Troubleshooting Table

If you observe this condition:	Try this solution:	Refer to this part of the manual:
Sensor signal (N7:61) has wrong sign (±).	1. Change direction bit (Ge:5/15) and re–download.	a) Enter values in G file, page 3-3. b) Move the Ram, step 3, page 5-3.
	2. Calibrate the sensor at opposite end of cylinder.	Re-do Jog Ram to Reference, pg 5-3.
After download, sensor values do not match values in N7:61 before download.	After axis calibration (preset ref = set, and N7:50 = 8), you must upload and save SLC data files in the PC.	none
Module rejects pre-set reference when N7:50 is toggled from 0 to 8 to 0.	1. Pre-set Ref in G file must be within profile range.	Enter values in G file, page 3-3.
	2. N7:40 must = 0 when setting N7:50 = 8.	Re-do Jog Ram to Reference, pg 5-3.
Profiles will not load into the module.	1. Each profile setpoint must be within sensor's range.	Verify full-scale count in Ge:4, page 3-3.
	2. Clear any errors by toggling N7:50 (0 to 16 to 0)	Prior to step 8 in Get Ready to Move Ram.
	3. N7:40 must = 0 when setting pre-set reference with N7:50 = 8.	Jog Ram to Reference, step 5, pg 5-3.
Unable to initiate extend/retract profiles.	Write ladder rung for extend profile, another for retract. Each must include appropriate permissives to enable a MOV instruction with Source (1 = extend, 2 = retract) and Destination = N7:50.	none

Conditions That Control Module Outputs

The module is designed to control its outputs as follows:

The module is designed to:	When these conditions are satisfied:
apply profile voltages to the output	*all* of the following: – valid extend and retract profiles are stored in the module – the “stop profile” bit (O:e.0/2) is reset. – a “run profile” bit (O:e.0/0 or O:e.0/1) is set
retain its outputs in last state	any of the following: – loss of backplane power (± 15V dc PS remains applied) – loss of sensor (LDT) – SLC mode change or LDT fault (G:e:0/13 = 0)
turn OFF its outputs	any of the following: – LDT position exceeded the setpoint farthest from LDT head – loss of ± 15V dc PS – the “disable output” bit (O:e.0/2) is set – SLC mode change or LDT fault (G:e:0/13 = 1)

Notes:

Module Specifications

This appendix lists the specifications for the 1746-QV Open-loop Velocity Control Module.

Electrical Specifications

Power Requirements	215 mA at 5V dc (from backplane) 400 mA at +15V dc and 295 mA at –15V dc (from independent PS, typical but LDT dependent)
I/O Chassis Location	Any I/O-chassis slot except slot 0
Isolation	1500V ac optical isolation between LDT input and backplane
LDT Inputs	± Interrogate ± Gate ± 15V dc PS PS Common Shield/Frame
Compatible LDT Input Devices	Linear Displacement Transducer such as: Balluff BTL-2-L2 or -M2 Gemco Quick-Stick II Santest GYRP or GYRG Temposonics II with DPM or RPM
Module Range and Resolution	160 inches ± 0.01 inch
Analog Output	0-10V dc @ 250 mA or –10 to +10V dc @ 250 mA
Accuracy of Voltage Output	Within ± 1% of its programmed value
Module Update Time	2 ms

Physical Specifications

LED Indicators	Run (green):	ON Flashing	Profile running, Output active Output at 0V dc
	Fault (red):	OFF Flashing ON	Module OK LDT fault Module fault
Module ID Code	13115		
Maximum Wire Size	Two 18 AWG wires per terminal on terminal block		

Environmental Specifications

Operating Temperature	0°C to 60°C (32°F to 140°F)
Storage Temperature	–40°C to +85°C (–40°F to +185°F)
Relative Humidity	5% to 95% (without condensation)
Agency Certification (when marked on product or package)	CE marked for all applicable directives

Notes:

Ladder Program

The following data define extend and retract profiles for the sample program:

Extend position setpoints #N7:0

Extend voltage values #N7:10

Retract position setpoints #N7:20

Retract voltage values #N7:30

This ladder program loads profiles into the module through the output image table. (The 1746-QV module is in slot 1 for this example.)

```
Rung 2.0                                                              Program Profile  |
|   S:1                                                                     N7:40      |
|---] [-------------------------------------------------------------------(L)--------+
|      15                                                                    0        |
|
Rung 2:1                                                                              |
|  Set to   |Extend   |Positions |Voltages                                            |
|  program  |profile  |stored    |stored                                              |
|  profile  |complete                                         Extend Position Setpts. |
|                                                                                     |
|  N7:40       N7:8      I:1.0      I:1.0                      +COP---------------+ |
|---] [---------]/[-------]/[--------]/[------------------+COPY FILE          +-|
|      0            0         13         14                    |Source      #N7:0| |
|                                                              |Dest       #O:1.0| |
|                                                              |Length          8| |
|                                                              +------------------+ |
Rung 2:2
|  Set to   |Extend   |Positions |Voltages                                            |
|  program  |profile  |stored    |stored                                              |
|  profile  |complete                                         Extend Velocity Setpts. |
|                                                                                     |
|  N7:40       N7:8      I:1.0      I:1.0                      +COP---------------+ |
|---] [---------]/[-------] [--------]/[------------------+COPY FILE          +-|
|      0            0         13         14                    |Source     #N7:10| |
|                                                              |Dest       #O:1.0| |
|                                                              |Length          8| |
|                                                              +------------------+ |
Rung 2:3
|  Set to   |Extend   |Run/store |Positions |Voltages              Extend           |
|  program  |profile  |retract   |stored    |stored                profile          |
|  profile  |complete                                              complete         |
|                                                                                     |
|  N7:40       N7:8      I:1.0      I:1.0    I:1.0                    N7:8           |
|---] [---------]/[-------]/[--------]/[------] [----------------+----(L)----+-|
|      0            0         12         13       14                |     0     | |
|                                                                    | Program   | |
|                                                                    | extend    | |
|                                                                    | voltages  | |
|                                                                    |   O:1.0   | |
|                                                                    +----(U)----+ |
|                                                                          6        |
Rung 2:4
|  Set to   |Extend   |Positions |Voltages                                            |
|  program  |profile  |stored    |stored                                              |
|  profile  |complete                                         Retract Position Setpts.|
|                                                                                     |
|  N7:40       N7:8      I:1.0      I:1.0                      +COP---------------+ |
|---] [---------] [-------]/[--------]/[------------------+COPY FILE          +-|
|      0            0         13         14                    |Source     #N7:20| |
|                                                              |Dest       #O:1.0| |
|                                                              |Length          8| |
|                                                              +------------------+ |
```

```
Rung 2:5
|  Set to   |Extend   |Run/store |Positions |Voltages                              |
|  program  |profile  |retract   |stored    |stored                                |
|  profile  |complete                                  Retract Velocity Setpts.|
|                                                                              |
|  N7:40       N7:8      I:1.0      I:1.0    I:1.0          +COP------------+ |
|---] [---------] [-------] [--------] [------]/[------------+COPY FILE      +-|
|      0            0         12         13       14        |Source   #N7:30| |
|                                                           |Dest     #O:1.0| |
|                                                           |Length        8| |
|                                                           +---------------+ |
Rung 2:6
|  Set to   |Extend   |Run/store |Positions |Voltages              Retract      |
|  program  |profile  |retract   |stored    |stored                profile      |
|  profile  |complete                                              complete     |
|                                                                              |
|  N7:40       N7:8      I:1.0      I:1.0    I:1.0                   N7:8      |
|---] [---------] [-------] [--------]/[------] [----------------+----(L)----+-|
|      0            0         12         13       14            |       1    | |
|                                                               | Program    | |
|                                                               | retract    | |
|                                                               | voltages   | |
|                                                               |   O:1.0    | |
|                                                               +----(U)----+ |
|                                                                       8     |
Rung 2:7
|  Set to   |Extend   |Retract                                   Loading      |
|  program  |profile  |profile                                   profiles     |
|  profile  |complete |complete                                  complete     |
|                                                                              |
|  N7:40       N7:8      N7:8                                       N7:40     |
|---] [---------] [-------] [-----------------------------------+----(U)----+-|
|      0           0         1                                  |       0    | |
|                                                               | Extend     | |
|                                                               | Profile    | |
|                                                               | Complete   | |
|                                                               |   N7:8     | |
|                                                               +----(U)----+ |
|                                                               |      0     | |
|                                                               | Retract    | |
|                                                               | Profile    | |
|                                                               | Complete   | |
|                                                               |   N7:8     | |
|                                                               +----(U)----+ |
Rung 2:8                                                                1
|  Set to                                                                      |
|  program                                                                     |
|  profile                                                                     |
|                                                                              |
|  N7:40                                              +COP---------------+   |
|---]/[-----------------------------------------------+-+COPY FILE         +-+-|
|      0                                             | |Source      #I:1.0| | |
|                                                    | |Dest        #N7:60| | |
|                                                    | |Length           8| | |
|                                                    | +------------------+ | |
|                                                    |                      | |
|                                                    | +MOV---------------+ | |
|                                                    +-+MOVE FILE         +-+ |
|                                                      |Source      N7:50 |   |
|                                                      |                0 |   |
|                                                      |Dest        O:1.0 |   |
|                                                      |                0 |   |
|                                                      +------------------+   |
Rung 2:9
|----------------------------------+END+-------------------------------------+
```

	Address	Data (radix = DECIMAL)									
Extend Positions	#N7:0	32	–45	50	200	300	400	425	500	0	0
Extend Voltages	#N7:10	64	3000	3750	4000	4000	4000	4000	4000	0	0
Retract Positions	#N7:20	128	–45	50	200	300	400	425	500	0	0
Retract Voltages	#N7:30	256	5000	6000	6000	3000	1000	50	25	0	0

G-file for Module Configuration	G1:0	2056	890	640	12	1200	–32,768	0
		SLC Code for QV Module	LDT Calibration		Length	Counts	Config Word 5 bit 15=1 (position increases toward LDT head)	Preset Reference

SLC Processor Files

You use the following files when programming the SLC processor for an application with the 1746-QV module:

- input image table to indicate status
- G file to configure the module for its LDT
- output image table for commands and loading profiles

Input Image Table

Word 0 (I:e.0 or N7:60 in the ladder program) reports status such as hardware faults, your data-entry errors, and acknowledgement of profile data stored in the module. Word 1 reports position data. Words 2-7 report speeds of the previous profile.

Word #:	Bit #:	Description: (for error & fault bits 0-8, status of 0 = OK, status of 1 = fault.)
0	0	The module sets this LDT error bit when it detects a: – broken or mis-wired LDT cable – faulty LDT – incompatible LDT type (DPM or RPM) – missing LDT magnet – loss of ±15V dc PS
	1	Module fault, such as EEPROM error. May turn outputs OFF (fault dependent)
	2	The module sets this bit when it detects any of the following invalid command bits or bit combinations in output image table word 0 (O:e.0): – one or more of the reserved bits 9-15 were set – bit 5 or 7 (position) was set concurrently with bit 6 or 8 (voltage) – output enable bit 0 (extend) or 1 (retract) was set before loading valid profiles – both output enable bits 0 (extend) and 1 (retract) were set concurrently – started to run a profile after the module had flagged an LDT error (I:e.0/0)
	3	You set one or more of the reserved bits 0-13 in G-file word 5 (Ge:5).
	4	You entered an invalid length (word 3) or count (word 4) in the G file.
	5	You entered an invalid LDT calibration (words 1 and/or 2) in the G file.
	6	You entered a position setpoint outside the range of –32,768 to +32,767 in O:e.1-O:e.7.
	7	You entered a voltage value outside the range of ±10,000mV in O:e.1-O:e.7.
	8	Loss of sensor. The module detected position data (in I:e.1) greater than the LDT length plus the preset reference. Clear this bit by running a profile.
	9-11	Reserved. Do NOT use.
	12	The module sets this bit after it stores the retract position setpoints or voltage values, or when the retract profile is active. It remains set until another operation is performed.
	13	The module sets this bit after it stores your position setpoints. It resets it after you reset the “program position” bit (O:e.0/5 or O:e.0/7)
	14	The module sets this bit after it stores your voltage values. It resets it after you reset the “program voltage” bit (O:e.0/6 or O:e.0/8)
	15	The module sets this bit when it detects the profile is active (output is applied).
1	n/a	Position data
2-7	n/a	Speed segments 1-6, respectively. The module computes the speed of each segment and reports them in the subsequent profile (reports extend speeds during the next retract profile, etc.)

G File

Use this file (Ge:0) to configure the module for use with the LDT. Example values are those from the sample ladder logic (appendix B).

<table>
<tr><th>Word:</th><th>Function of G-file Word:</th><th>Range:</th><th>Description of G-file Word or Bit:</th><th>Example:</th></tr>
<tr><td>0</td><td>Reserved. Do NOT use.</td><td>n/a</td><td>The processor stores a code for the 1746-QV module.</td><td>2056</td></tr>
<tr><td colspan="5">words 1 & 2 refer to the gradient or transducer calibration value stamped on the name plate on the transducer housing.</td></tr>
<tr><td>1</td><td>LDT calibration: upper 3 digits</td><td>800-999 µs/inch</td><td rowspan="2">For example: To enter an LDT calibration of 8.9373,
use decimal radix and enter 893 in word 1 and 730 in word 2.</td><td>893</td></tr>
<tr><td>2</td><td>LDT calibration: lower 3 digits</td><td>000-999 µs/inch</td><td>730</td></tr>
<tr><td>3</td><td>Full-scale length (L) of LDT</td><td>2 ≤ L ≤ 160 inch</td><td>Enter the length of the LDT (160 inches max).</td><td>12</td></tr>
<tr><td>4</td><td>Full-scale count (C)</td><td>2 ≤ C ≤ Lx100</td><td>Typically C = L x 100.
Position Data (I:e.1) = $\frac{C/(L \times 100)}{\text{LDT Calibration}}$</td><td>1200</td></tr>
<tr><td rowspan="4">5</td><td rowspan="4">Configuration Bits
15 14 13 12-0 Equivalent Value
0 1 0 0 +16,384
1 0 0 0 –32,768
1 1 0 0 –16,384
0 1 1 0 +24,576</td><td>bits 0-12</td><td>Set to zero.</td><td rowspan="4">–32,768
(bit 15 = 1 for position increases towards LDT head)</td></tr>
<tr><td>bit 13</td><td>0 = output maintained during LDT fault or SLC mode change
1 = output resets for LDT fault or SLC mode change</td></tr>
<tr><td>bit 14</td><td>Type of LDT: 0 for RPM, 1 for DPM</td></tr>
<tr><td>bit 15</td><td>0 = position data increases when moving away from LDT head
1 = position increases when moving toward LDT head</td></tr>
<tr><td>6</td><td>Preset Reference</td><td>–32,768 to +32,767</td><td>Typically zero or home reference value. 32,767 = 327.67 inches.</td><td>0</td></tr>
</table>

Examples of Full-scale Count Values

LDT Physical Length	No. of Recirculations	Resolution	Full-scale Length (L)	Full-scale Counts (C)
from 160” to 2”	1	0.01	L (160” to 2”)	L x 100
16”	2	0.01	160	8000
16”	4	0.01	160	4000
16”	10	0.001	160	16000

Output Image Table

The ladder program loads commands and profile data into the module through the output image table, O:e.0–O:e.7.

Word:	Function of Output Image Word:	Bit #:	Description: (For command bits, a 0-to-1 transition enables the command)
0	Command Bits Enable these bits with your ladder logic.	0	Set to run an extend profile.
		1	Set to run a retract profile.
		2	Set to disable the profile. This bit over-rides bit 0 or 1.
		3	Set to change current position data to the value of preset reference in Ge:6.
		4	Set to clear any data-entry errors.
		5	Set to define words 1-7 as programmed position setpoints for extend.
		6	Set to define words 1-7 as programmed voltage values for extend.
		7	Set to define words 1-7 as programmed position setpoints for retract.
		8	Set to define words 1-7 as programmed voltage values for retract.
		9-15	Reserved. Do NOT use.
1-7	Position 1-7 Setpoint or Voltage (i.e. word 2 = position 2, etc.)	n/a	**Important:** Enter position setpoints in units of 0.01” (200 = 2.00”) within the range of –327.68 to +327.67”, and voltage values in 5mV units (3005 = 3.005V) within the range of ± 10,000mV.

Q

R

S

T, U, V

W, X, Y, Z

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