SIEMENS

SIMATIC 505

High Speed Counter and Encoder Module

User Manual

Order Number: PPX:505–8113–2
Manual Assembly Number: 2586546–0019
Second Edition

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Chapter 1

Overview

1.1 Features

The Series 505™ High Speed Counter (HSC) module (PPX:505-7002) provides two independent high-speed counter channels.

Each channel has the following features.

- Four counter modes:
  - Pulse counter
  - Quadrature counter modes: 1X, 2X, 4X
- A 10 kHz count rate with a minimum pulse width of 25 μs.
- Four inputs:
  - two count inputs
  - reset
  - inhibit
- Two field outputs, each controlled by a separate programmable preset.
- LED indicators display the status of the A and B count inputs, and of Y1 and Y2 outputs.

All inputs may be sinking or sourcing (with external 24 VDC power supply).

The HSC module operates asynchronously from the controller scan. You can program the controller to monitor the HSC and/or to provide high-level control of the HSC's operation. To support these functions, the HSC provides reset, inhibit, output and counter status to the controller and accepts reset and inhibit commands, and preset values from the controller.

⚠ **WARNING**

The HSC module controls its four outputs. If the controller switches from the Run mode to the Program mode, the HSC continues to function as programmed, and outputs may be activated by the HSC. This means that if you switch the controller to Program mode, any devices controlled by the four outputs of the HSC will continue to operate as programmed.

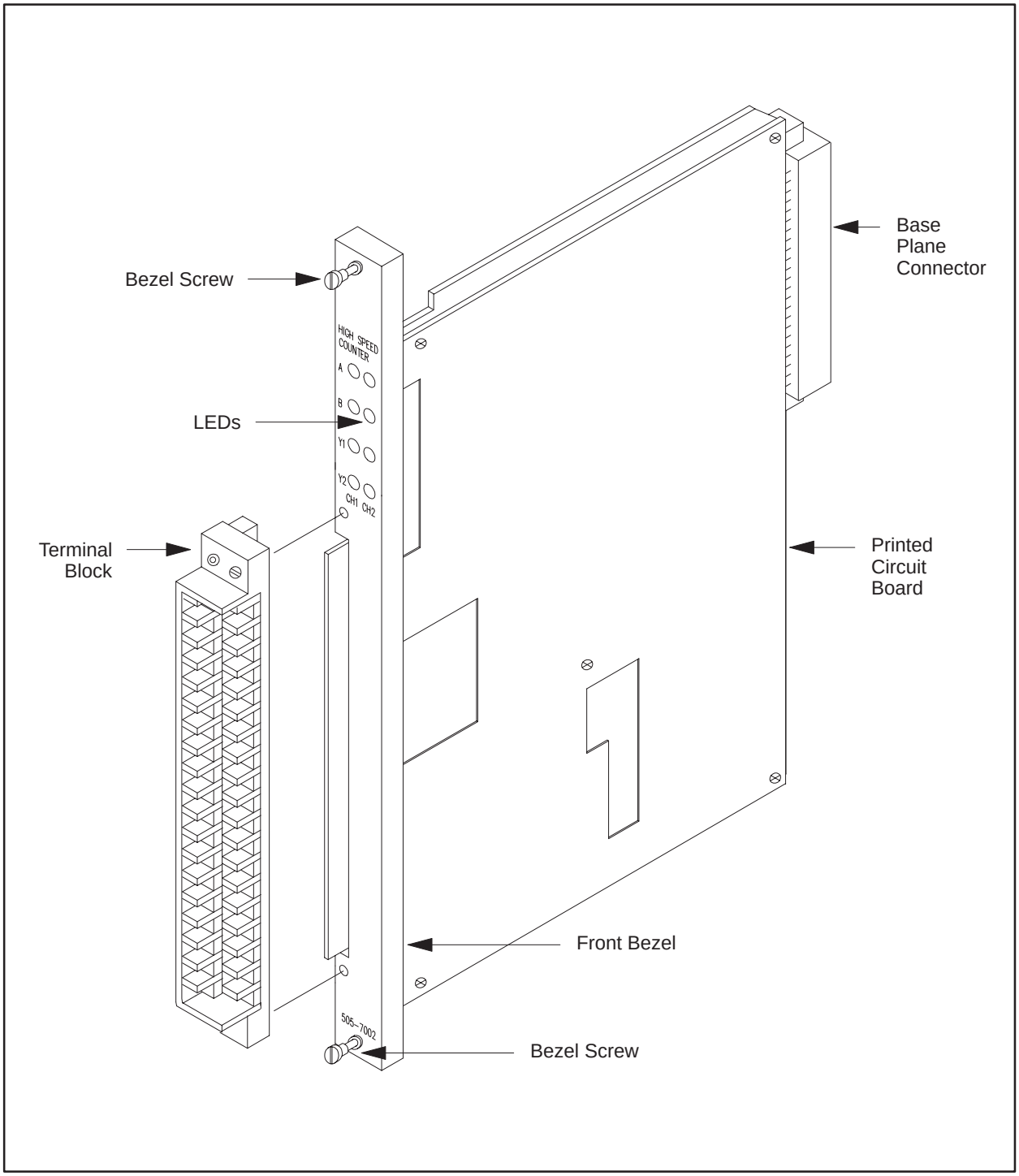


Figure 1-1 High Speed Counter Module

1.2 Inputs

The HSC module has two independent channels. Each channel has four inputs.

- Reset
- Inhibit
- Two counter inputs

Each input may be used as either sinking or sourcing (with external 5–24 VDC power supply). The input signals are connected to the field wiring terminal block on the front bezel.

Counter Inputs Each channel has two counter inputs — Input A and Input B.

Reset Current flow through the reset input sets the channel's counter to zero. The counter will be held at zero until the reset input becomes inactive.

Inhibit Current flow through the inhibit input inhibits the channel from counting. The counter holds at the last value and does not change until the inhibit input becomes inactive.

NOTE: When in the pulse counter mode, if the A or B input is in a different state at the beginning and end of an inhibit signal, the count will change according to the normal counting logic. If both A and B inputs are in different states, the change may be as much as two counts.

NOTE: There are also software reset and inhibit functions. See Section 3.

1.3 Outputs

Each channel has two open collector outputs capable of driving TTL level signals or sinking up to 0.4 Amps of current (at 40°C) from an external 24 VDC source and load.

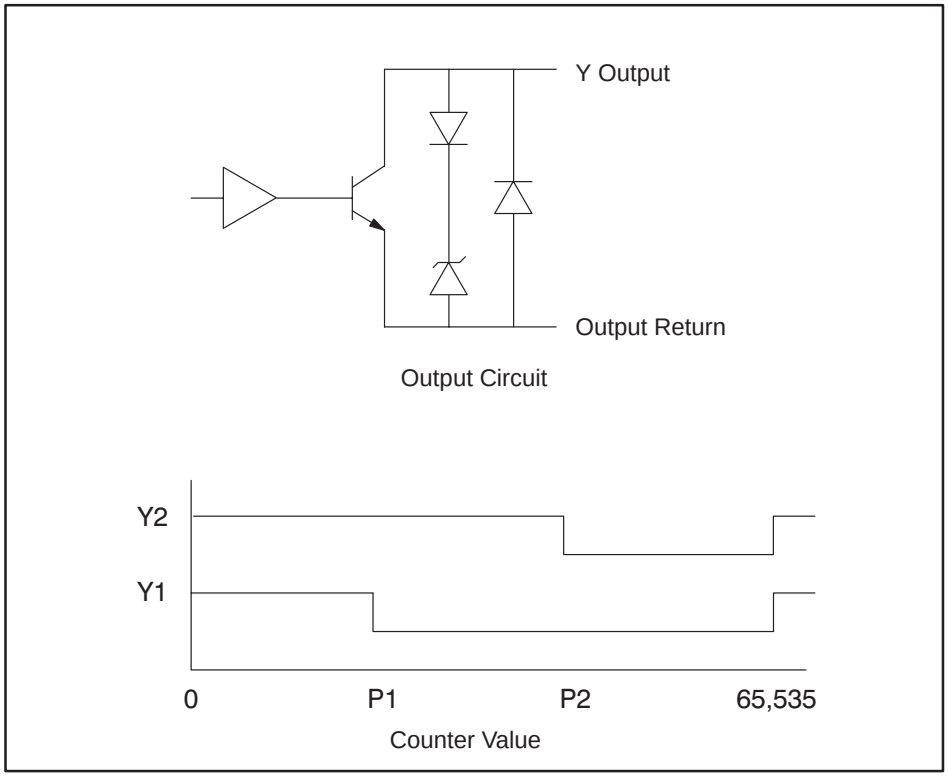


Figure 1-2 Output

The output transistor (Y_1 or Y_2) turns on when the count is greater than or equal to the corresponding preset. Figure 1-2 shows the field output operation. You can invert this operation by setting the appropriate bits in the setup word, WY4. See Section 4.1.

1.4 LED Indicators

Each channel contains four LED indicators which provide a visual indication of the channel's status as shown in Figure 1-3.

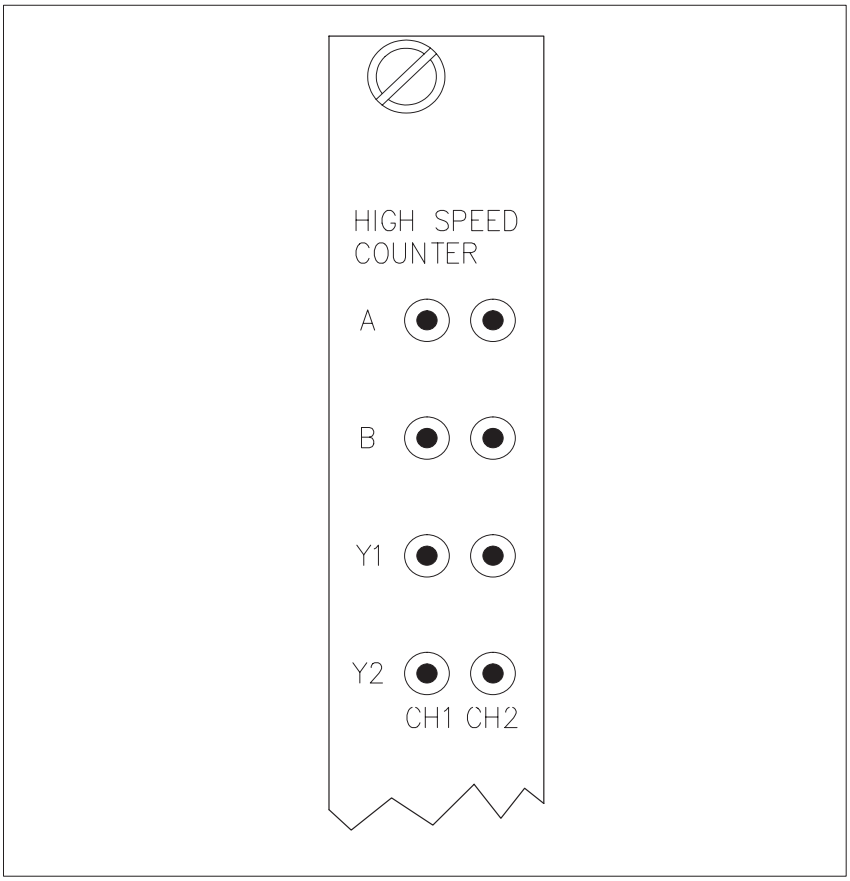


Figure 1-3 High Speed Counter LEDs

A Turns on when there is current flow through the A input.

B Turns on when there is current flow through the B input.

Y1 Turns on when Output 1 is on.

Y2 Turns on when Output 2 is on.

NOTE: If Reset or Inhibit is turned on, the HSC does not count, and the A and B LEDs are frozen.

1.5 Counting Modes

1.5.1 Pulse Counter Mode

Each channel has two inputs, A and B. In the pulse counter mode, counting occurs on the rising or falling edge of the incoming pulses. The relationship of the states of these two inputs determines the direction of the count. See Table 1-1. Typical devices for counting are high-speed static switches or incremental encoders.

Table 1-1 Determining Count in Pulse Counter Mode

Counter Direction	Edge	A Input	B Input
up	”	⎍	high
up	#	low	⎍
down	”	high	⎍
down	#	⎍	low

In the pulse counter mode, the channel senses the edges of the A or the B input to count up or down. See Figure 1-4. To reliably record this transition from low to high, the pulse width must be at least 8 µs.

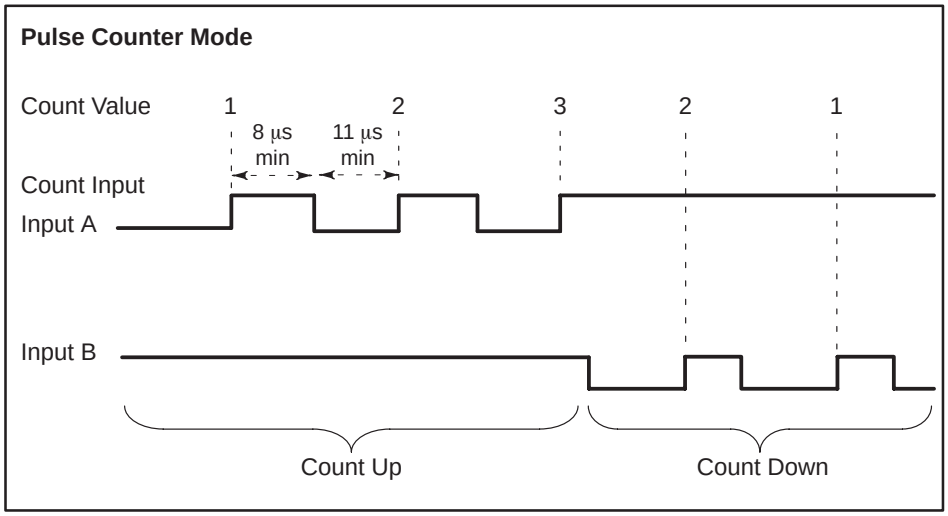


Figure 1-4 Pulse Counter Mode 0

1.5.2 Quadrature Mode Overview

For quadrature mode, each channel counts according to rising and/or falling edges. Typical devices for quadrature inputs are optical encoders. Different quadrature modes are selected based on the resolution required by the application and the encoder used.

1.5.3 1X Quadrature

The module counts on the edges of the A input pulses.

- When input A leads input B, the HSC counts up on each rising edge of input A.
- When input B leads input A, the HSC counts down on the falling edge of input A.

Figure 1-5 illustrates the relationship between inputs A and B and the count value in 1X Quadrature mode.

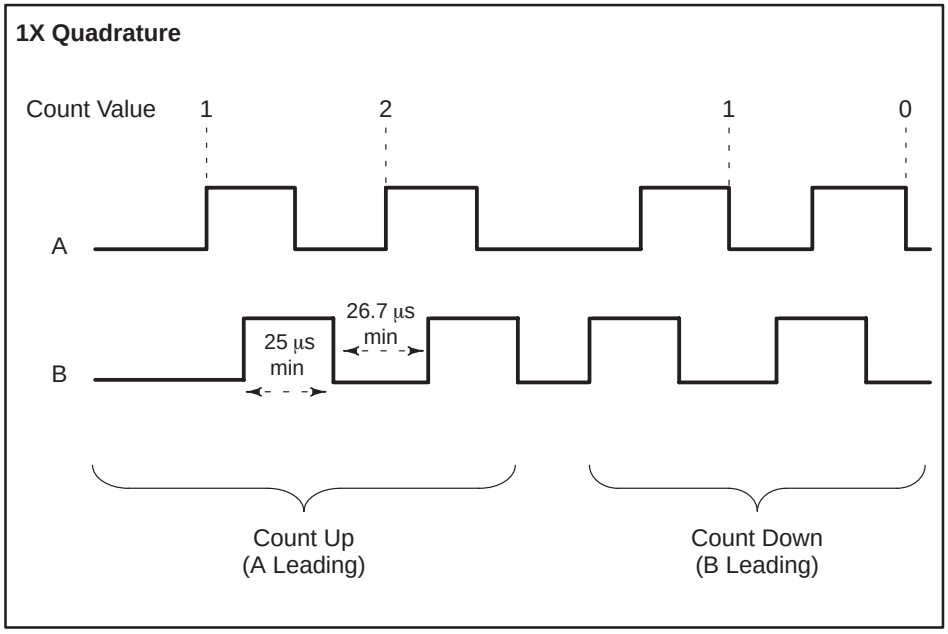


Figure 1-5 1X Quadrature Mode

1.5.4 2X Quadrature

If input A leads input B, the module counts up on both the rising and falling edges of input A. If input B leads input A, the module counts down on the rising and falling edges of input A.

Figure 1-6 illustrates the relationship between inputs A and B and the count value in the 2X quadrature mode.

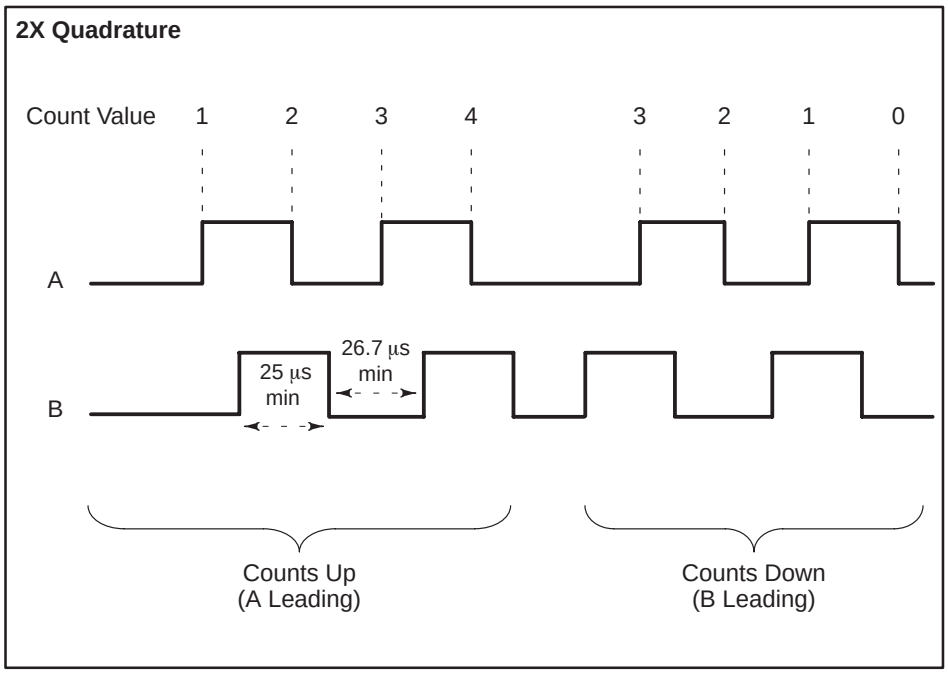


Figure 1-6 2X Quadrature Mode

1.5.5 4X Quadrature

If input A leads input B, the module counts up on rising and falling edges of both input A and input B. If input B leads input A, the module counts down on the rising and falling edges of input A and input B.

Figure 1-7 shows the relationship between inputs A and B and the count value in the 4X quadrature mode.

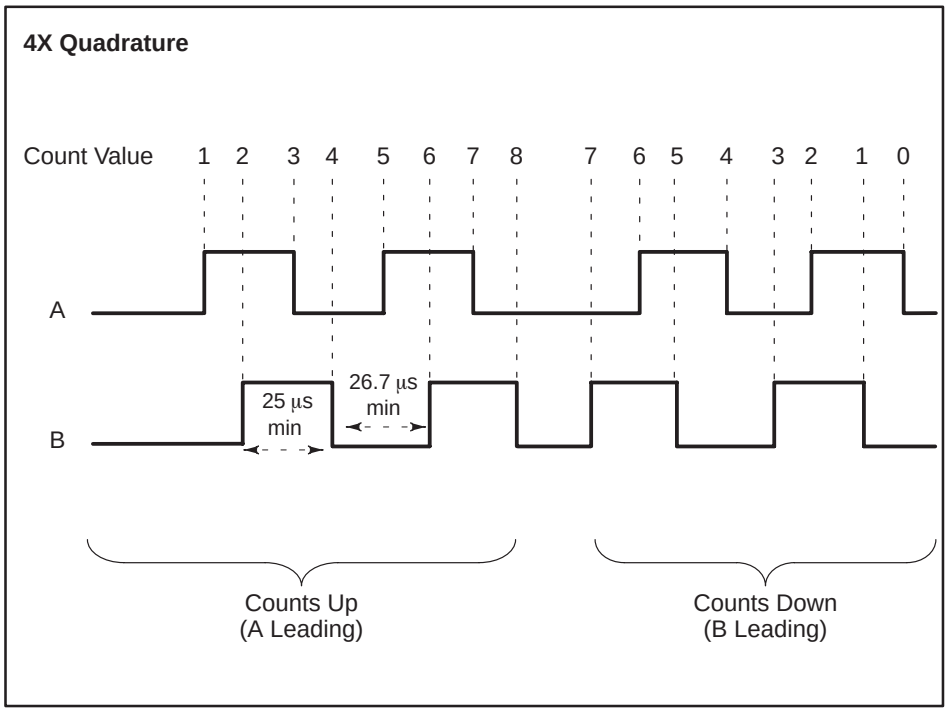


Figure 1-7 4X Quadrature Mode

Chapter 2

Installation

2.1 Before Installing the Module

2.1.1 Visual Inspection

If there is any visible damage to the module, contact your Siemens Industrial Automation, Inc. distributor for replacement.

2.1.2 Additional References

Refer to the manuals listed below for instructions on installing, programming, and troubleshooting your Series 505^{E} controller.

- *SIMATIC® TI545™ System Manual* (PPX:545–8101)
- *SIMATIC® TI525™/TI535™ Hardware and Installation Manual* (PPX:505–8103)
- *SIMATIC® TI505™ Programming Reference Manual* (PPX:505–8104)

2.1.3 Handling the Module

Many integrated circuit (IC) devices are susceptible to damage by the discharge of static electricity. Follow the suggestions listed below to reduce the probability of damage to these devices when you are handling a controller, a base controller, or any of the I/O modules.

Both the module and the person handling the module should be at the same ground potential. To accomplish this, ensure the following.

- The module is transported in an anti-static container or antistatic material.
- The work area has a conductive pad with a lead connecting it to a common ground.
- You are grounded by making contact with the conductive pad and/or by wearing a grounded wrist strap.

2.1.4 General Wiring Considerations

The count, inhibit, and unfiltered reset inputs are high-speed inputs which may respond to noise present on the lines. To avoid problems, follow these guidelines when installing the HSC module.

- Use the shortest possible wires.
- Avoid placing signal wires parallel to high-energy wires. If the two must meet, cross them at right angles.
- Avoid bending the wire into sharp angles.
- Use wireways for wire routing.
- When using shielded wires, ground them only at the source end for better noise immunity.
- Place wires so that they don't interfere with existing wiring.
- Label the wires.

In some installations when both the HSC and TI505-49XX series of relay modules are used, false counts may be induced when switching high voltage in the relay module, (voltage > 40 Vrms). This is the result of internal arcing of the relay contacts.

If you encounter this problem, place a snubber consisting of a 47 ohm 1/4 watt resistor and a 0.022 μFd capacitor across the relay contact terminals on the terminal block. Snubbers were not included in the relay modules in order to meet the need for lower current leakage in many applications.

NOTE: Snubber components must be UL® component recognized and/or CSA Certified for use across the rated voltage being switched by the relay module.

2.1.5 Hierarchy of Installation

Figure 2-1 provides a simple flowchart of the installation process.

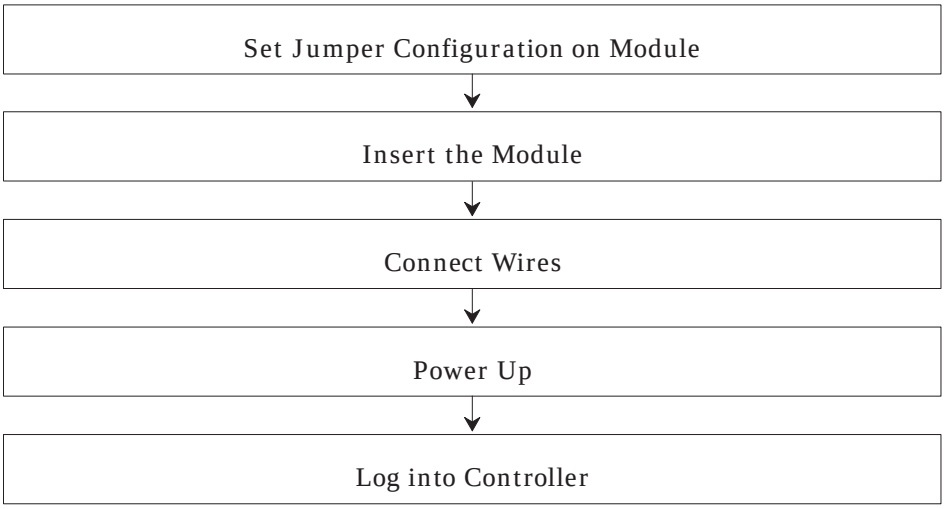


Figure 2-1 Hierarchy of Installation

2.2 Selecting Counter Operation

2.2.1 Selecting Counter Mode

The HSC module has two channels. You can configure each channel to operate in any of four counter modes.

Prior to installing the module into the I/O backplane, configure the module by setting the jumper for each channel. Figure 2-2 shows the location of the jumpers on the printed circuit board. The top set of four pins set the counter mode for Channel 1. The bottom set of four pins set the counter mode for Channel 2. The default setting for the jumpers is 1X Quadrature mode for both channels.

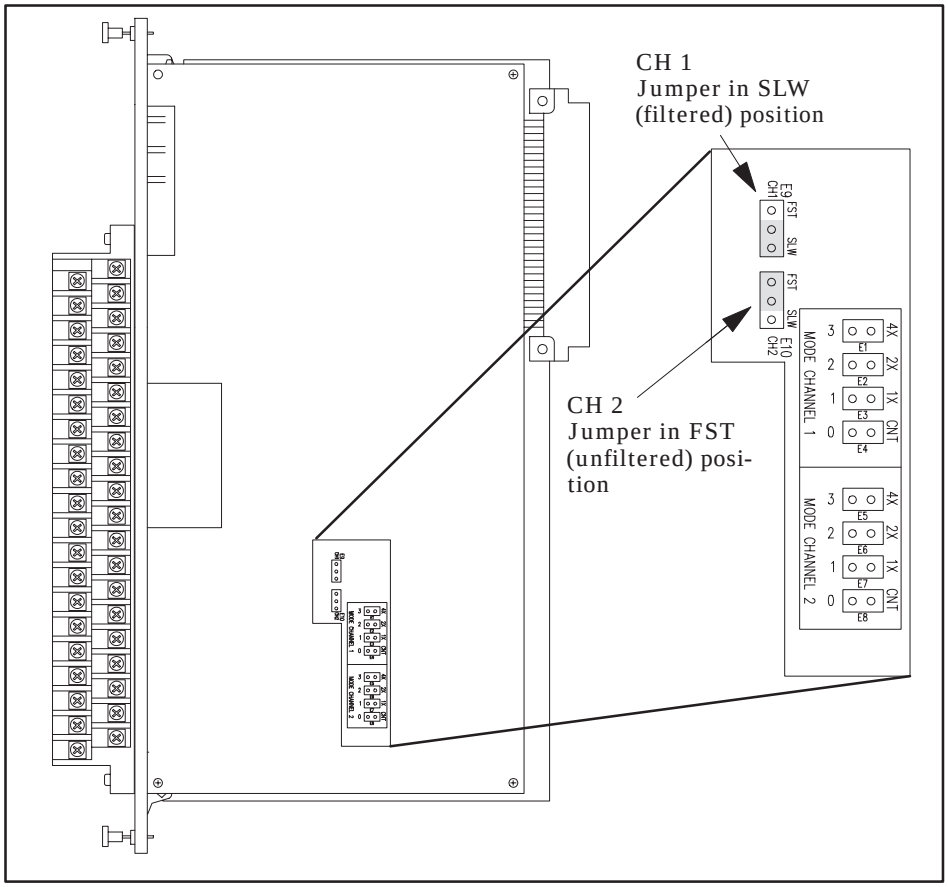


Figure 2-2 Jumper Settings

NOTE: Each channel **must** have one *(and only one)* jumper installed.

2.2.2 Selecting the Reset Filter

Some applications require faster response on the reset input line than the standard 3.75-ms filter allows. For faster response, select the optional 0.95-ms filter. (The 0.9-ms filter is more sensitive to noisy signals, as noted in the Environmental Specifications in Appendix B.)

The reset filter may be selected independently for each input channel by placing the jumper in the **FST** (fast) or **SLW** (slow) position as shown in Figure 2-2.

2.3 Inserting the Module in the I/O Base

The HSC is a single-wide module. Insert it into any available slot on any Series 505 I/O base. Do not touch the printed circuit board while inserting the module. This could cause electrostatic damage to the components on the board. Insert the module as shown in Figure 2-3.

⚠ WARNING

To minimize potential shock, turn off power to the I/O base and any modules installed in the base before inserting or removing a module. Failure to do so may result in potential injury to personnel or damage to equipment.

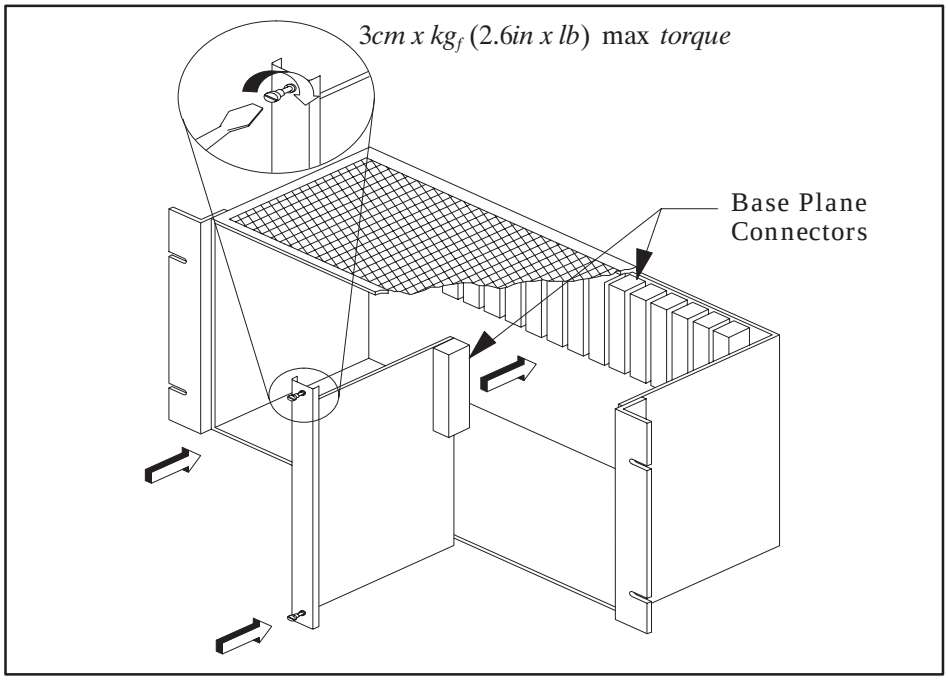


Figure 2-3 Inserting the Module into the I/O Base

2.4 Wiring the Module

2.4.1 Wiring the Terminal Block

Wiring the module consists of wiring the the input and output signals. See Figure 2-4 and Figure 2-5 for general guidelines. All connections are made at the module terminal block. See Figure 2-5. Output returns for Channel 1 and 2 are internally connected.

Use the Terminal Block Worksheet in Appendix B for planning your wiring.

⚠ WARNING

Turn off power to the I/O base and any modules installed in the base before inserting or removing a module. Failure to do so may cause potential injury to personnel or can damage equipment.

2.4.2 Powering Up the Module

After wiring the terminal block for the HSC, restore power to the base.

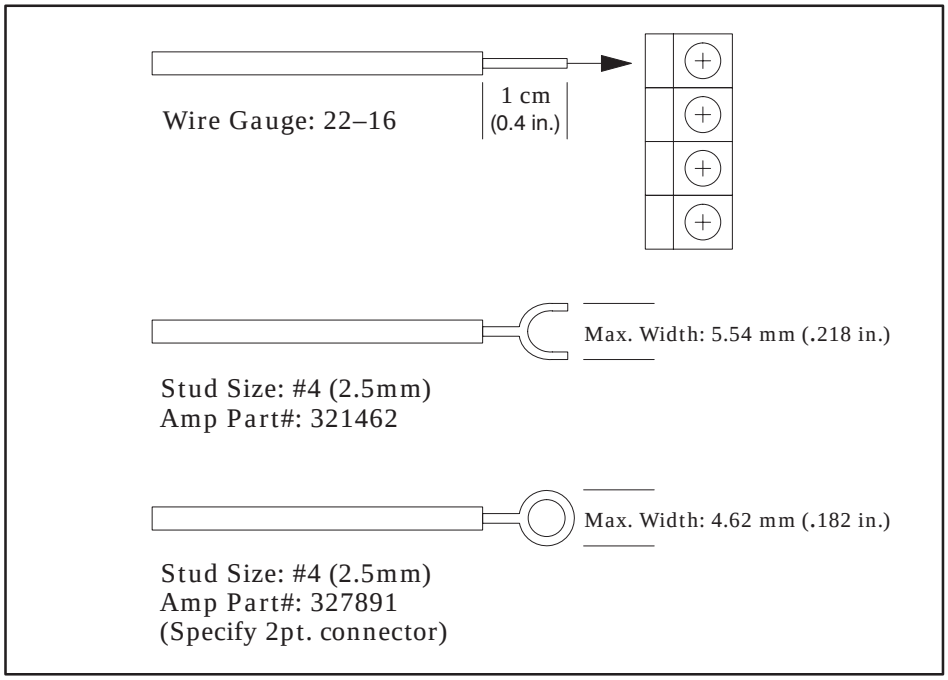


Figure 2-4 Wiring Guidelines

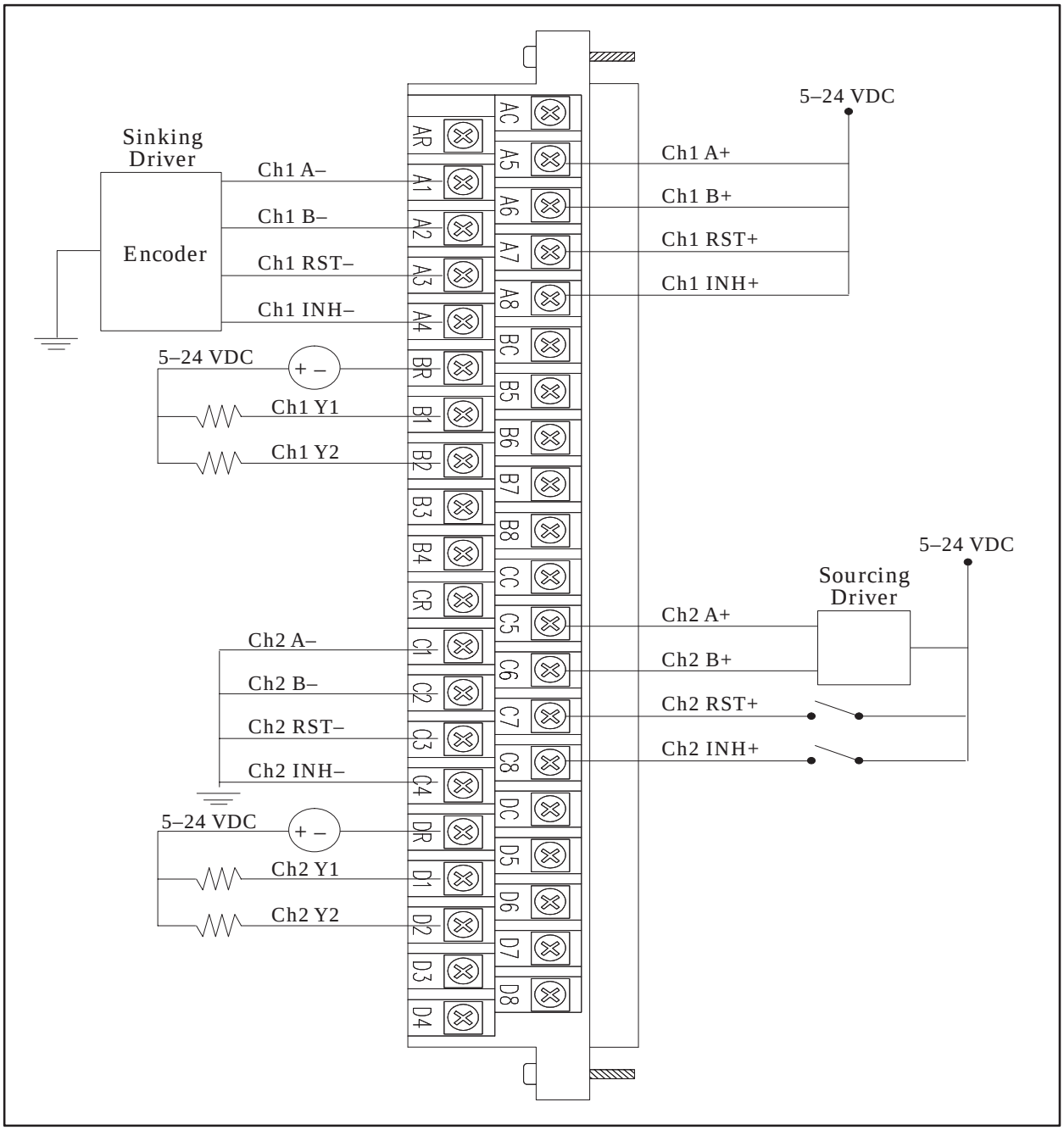


Figure 2-5 Sample Terminal Block Wiring Diagram

2.5 Logging the Module into the Controller

2.5.1 Updating the I/O Configuration Definition

After inserting the module into the base, update the I/O configuration in the controller. The module does *not* automatically onfigure itself. A VPU or other programming device must be connected to the controller to register and verify controller module communication.

2.5.2 Selecting the I/O Configuration

With your VPU or other programming device, select the I/O Configuration option. For example, if you have the module inserted into the first slot of the first I/O base, configure it as displayed in Figure 2-6. Refer to the manual that came with the programming device for instructions.

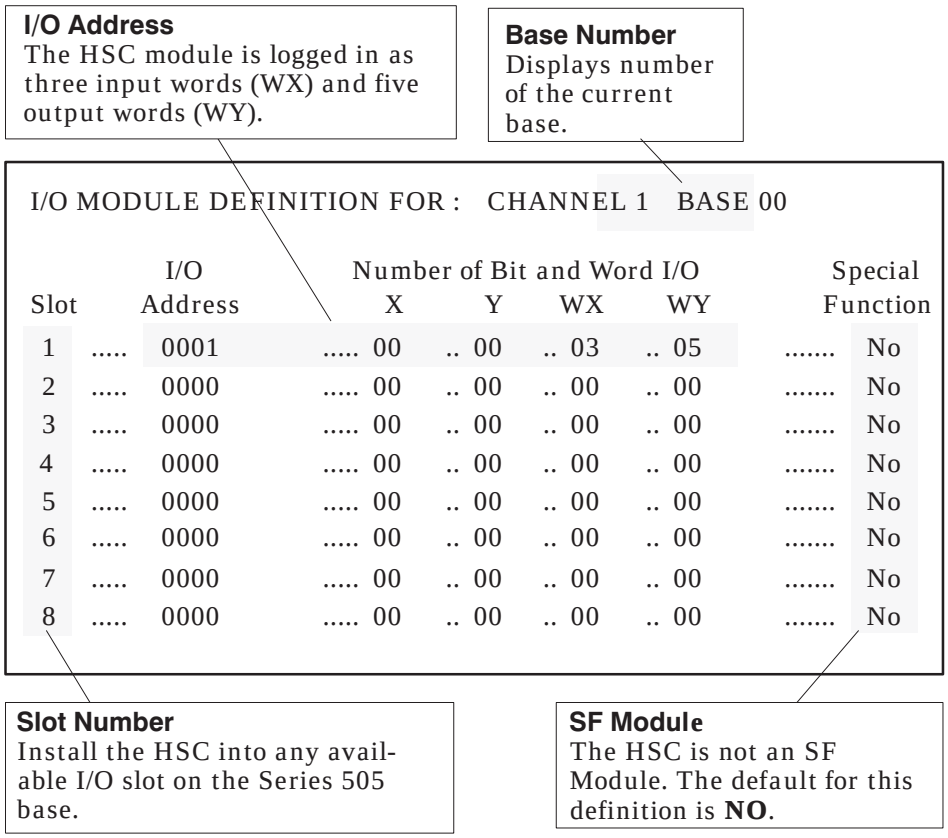


Figure 2-6 Sample I/O Definition Chart

2.5.3 Viewing the I/O Configuration Chart

Use SHOW to view the I/O Configuration Chart. If the HSC is installed in slot 1, for channel 1, base 00, the I/O chart will appear as displayed in Figure 2-7.

I/O CONFIGURATION CHART FOR : CHANNEL 1, BASE 00
I/O POINTS

Slot 1	WX001	WX002	WX003	WY004	WY005	WY006	WY007	WY008
Slot 2	00000	00000	00000	00000	00000	00000	00000	00000
Slot 3	00000	00000	00000	00000	00000	00000	00000	00000
Slot 4	00000	00000	00000	00000	00000	00000	00000	00000
Slot 5	00000	00000	00000	00000	00000	00000	00000	00000
Slot 6	00000	00000	00000	00000	00000	00000	00000	00000

Figure 2-7 I/O Configuration Chart

Chapter 3
Programming

3.1 Controller Input Words

The HSC module is configured as three word inputs (WX) and five word outputs (WY). It occupies eight words of the controller's word image register.

3.1.1 WX1 (Status Word)

Word 1 (WX) is the module's status word. Eight bits provide the status of each of the two channels. Figure 3-1 shows the format of the status word.

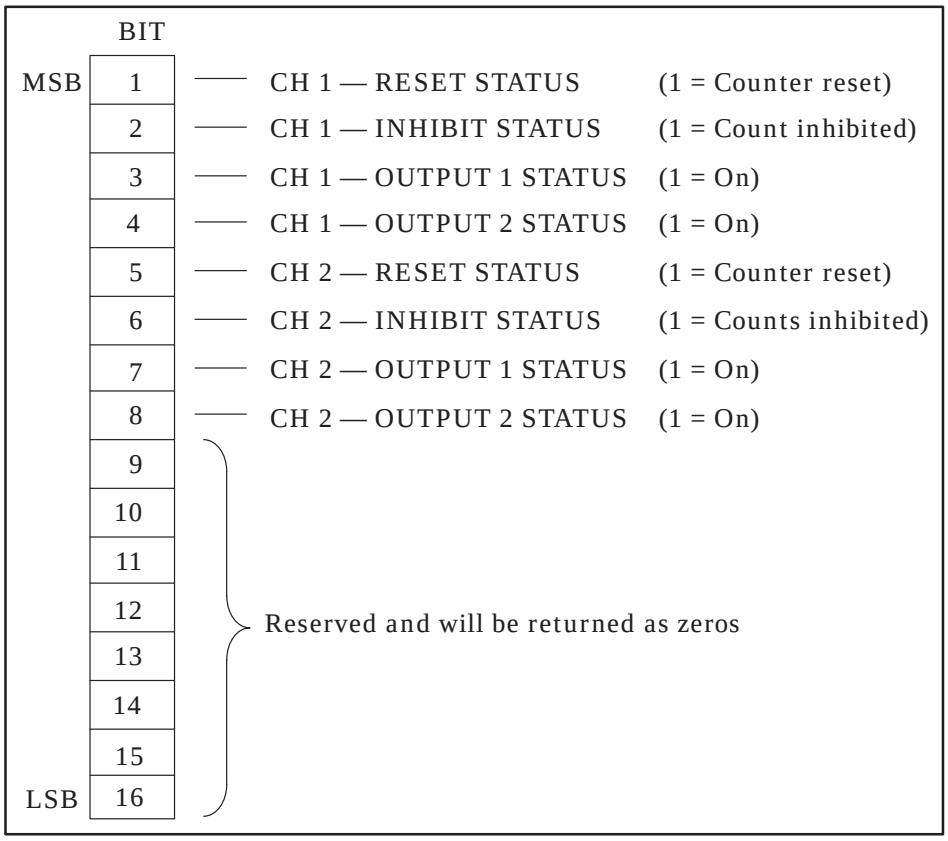


Figure 3-1 Status Word Format

Reset Status. Each channel has a Reset Status bit in the status word. If the channel's RESET field input is active, this bit will be 1; otherwise this bit will be 0.

NOTE: The Reset Command bit (see Setup Word, Section 3.1.3) does not affect the reset status bit.

Inhibit Status. Each channel has an Inhibit Status bit in the status word. If the channel's Inhibit field input is active or if its Inhibit Command bit is 1 (see Setup Word, Section 3.1.3), this bit will be 1 and the counter will not count. Otherwise, this bit will be 0.

Output Status. Each channel has an Output 1 Status and an Output 2 Status bit in the status word. If the corresponding field output is on, the bit will be 1. Otherwise, the bit will be 0.

3.1.2 WX2 and WX3 (Channel Count)

Word 2 (WX2) contains the current value of the Channel 1 count register, and Word 3 (WX3) contains the current value of the Channel 2 count register. These values are unsigned integers between 0 and 65,535 (inclusive).

3.1.3 WY4 (Setup Word)

Word 4 (WY4) is the module setup word. The controller uses eight bits to control the HSC module's operation. See Figure 3-2.

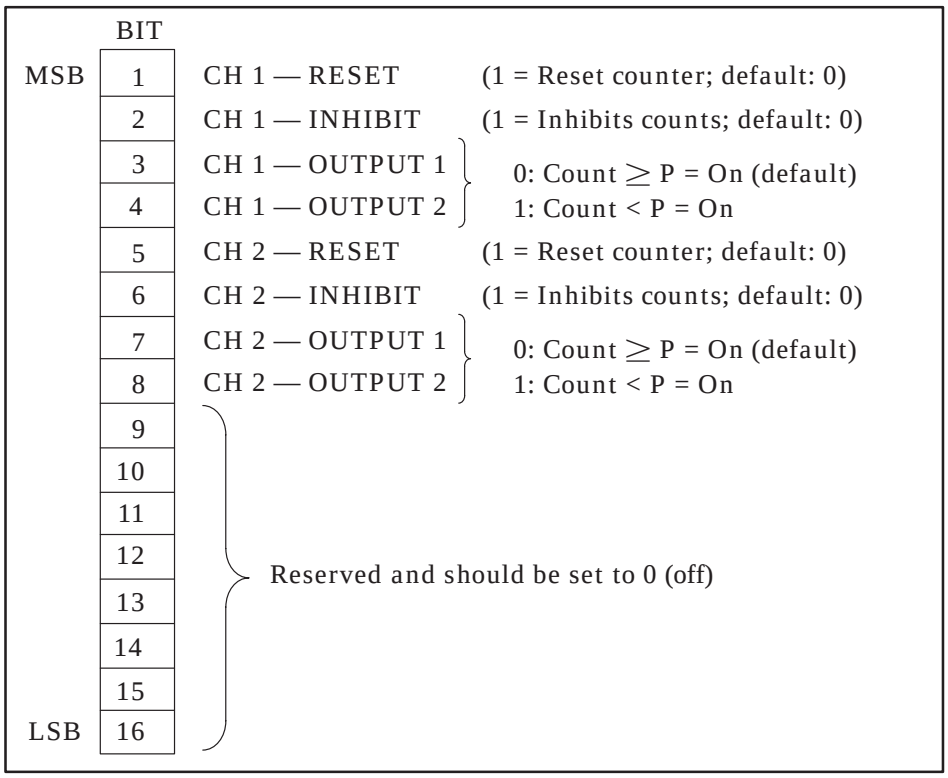


Figure 3-2 Setup Word Format

Reset Command. Both channels have a Reset Command bit. A transition from 0 (off) to 1 (on) of the Reset Command acts as a one-shot (providing a momentary reset of the channel), setting the count to 0. Even though the bit remains 1, counting resumes.

Inhibit Command. Both channels have an Inhibit Command bit. When this bit is set to 1, the channel stops counting.

NOTE: When in the pulse counter mode, if the A or B input is in a different state at the beginning and end of an inhibit signal, the count will change according to the normal counting logic. If both A and B inputs are in different states, the change may be as much as two counts.

Output Level. The output level bit specifies when the outputs for each channel turn on.

- Setting the output level bit to 0 turns the output on when the current count is greater than or equal to the preset. If the current count is less than the preset, the output is off.
- Setting the output level bit to 1 turns the output on when the current count is less than the preset. If the current count is greater than or equal to the preset, the output is off.

3.1.4 WY5 – WY8 (Preset Words)

Words WY5 through WY8 specifies preset values for each channel. You can specify any value between 0 and 65,535.

- WY5 specifies the value for Preset 1, Channel 1.
- WY6 specifies the value for Preset 2, Channel 1.
- WY7 specifies the value for Preset 1, Channel 2.
- WY8 specifies the value for Preset 2, Channel 2.

3.1.5 I/O Update Consideration

In each scan, the controller reads the module WX words before updating the WY words. For example, during a scan when the controller resets the module, the WX word(s) contain counter values existing prior to the reset.

Chapter 4
Troubleshooting

Symptom	Probable Cause	Corrective Action
Input LED is not on and Output LED is not on	No power to board	Re-seat board
		Check for bent pins on board connector
		Check your base power supply
	Problems with input signals, or output being reset or inhibited	Check wiring
		Check encoder or field inputs
		Check Reset and Inhibit bits in Setup word (WY4)
Counts in wrong direction	Connections wrong	Reverse wiring for inputs A and B
	Input wires substantially different lengths	Check that wires are as short as possible, and make wires the same length (if possible)
Incorrect count	Connections wrong	Trace wiring connections
	Input wires substantially different lengths	Check that wires are as short as possible, and make wires the same length (if possible)
	Broken wire	Check continuity
Counts erratically	Wrong quadrature mode or 2 jumpers on same channel	Check jumper position and condition of jumper (metal insert intact)
	Signal wire noise	See wiring considerations (Section 2.1.4)
	Broken wire	Check continuity
Does not count	Count being reset or inhibited	Check Reset and Inhibit signals from field
		Check Reset and Inhibit bits in Setup word (WY4)
	Broken wire	Check continuity
Counts too fast or too slow	Pulse too narrow, or frequency too high	Use slower gear ratio and higher resolution count
		Check quadrature mode
		Check signal wire noise
		Marginal input signal
Controller does not communicate with module	Module not configured in controller I/O configuration table	Configure module
Nonfatal error as a result of the module	Module configured incorrectly in controller	Reconfigure the module
	Module has failed self-diagnostics	Return module for repair

4.1 Checking the Operation of the Module

To check the operation of the module, follow these steps.

NOTE: Module outputs will turn on during this procedure.

---

1. Using a programming device, force all presets to 0.
2. Reset both counters through the reset signals from your application.

   Using the default configuration, the outputs should turn on.
3. Using your programming device, force the presets to any number greater than 0.

   The outputs should turn off.

NOTE: Before resuming normal operation, clear any words that you have forced. Otherwise, these words remain forced during operation and could yield unexpected results.

If you used the setup word to configure the module, then the output follows your configuration.

To check the output operation look at the counter status word (WX1), the outputs correspond to the following bits.

Channel 1, Output 1	bit 3	0 = Output off 1 = Output on
Channel 1, Output 2	bit 4	
Channel 2, Output 1	bit 7	
Channel 2, Output 2	bit 8	

Chapter 5
Applications

5.1 Sprayer Example

5.1.1 Description

A reversible DC motor drives a paint sprayer up and down a vertical assembly. A quadrature encoder on the drive shaft senses the direction and relative position of the sprayer. Channel 1 of the HSC will be used to enable the sprayer during a pre-defined section of travel. (See Figure 5-1.) The encoder resolution is 500 cycles per revolution. One shaft revolution equals 1 inch of sprayer travel. When encoder signal A leads, the direction of travel is up.

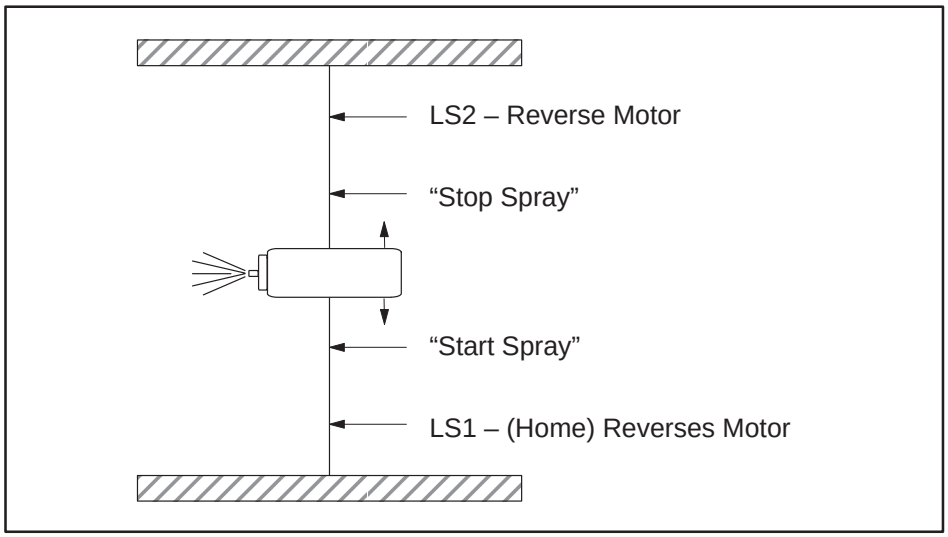


Figure 5-1 Sprayer Application

5.1.2 Solution

Connect encoder signals A and B to inputs A and B of the HSC. See Figure 5–2. Limit switch 1 (sprayer home) drives channel 1 Reset. Channel 1 outputs 1 and 2 are wire ORed and drive the sprayer enable. Select 1X Quadrature mode for channel 1, setup channel 1 output 1 to turn off when count $\geq$ preset, output 2 to turn on when count $<$ preset. Presets 1 and 2 are loaded with the Start Sprayer and Stop Sprayer counts, respectively. The Start Sprayer count = 500 X Distance (inches) from LS1 to Start Sprayer position. The Stop Sprayer count = 500 X Distance (inches) from LS1 to Stop Sprayer position.

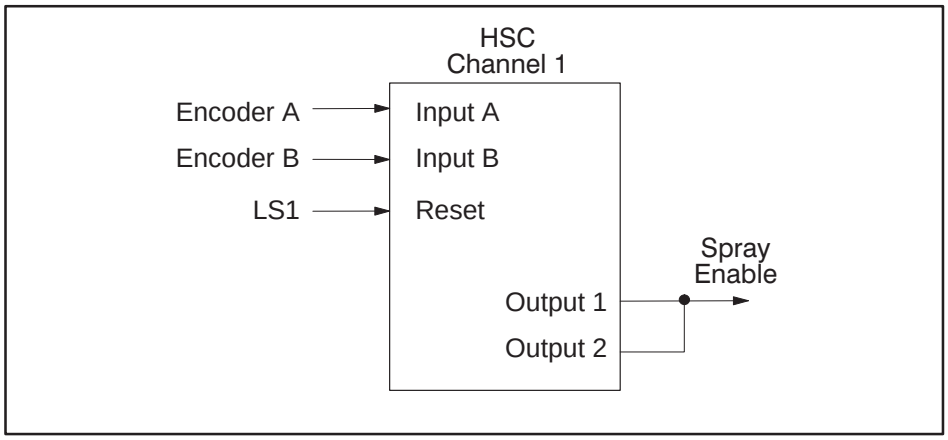


Figure 5-2 HSC Connections

As the sprayer moves up and down, the channel 1 outputs and the sprayer enable signal levels produce the waveform shown in Figure 5-3.

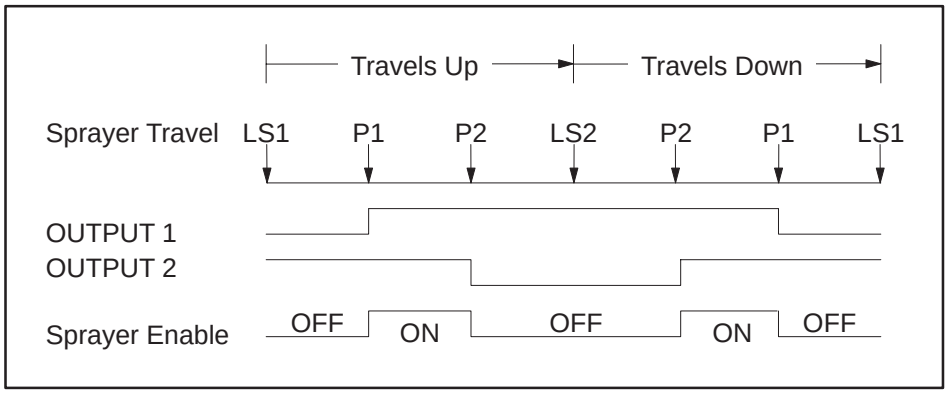


Figure 5-3 Waveform Pattern

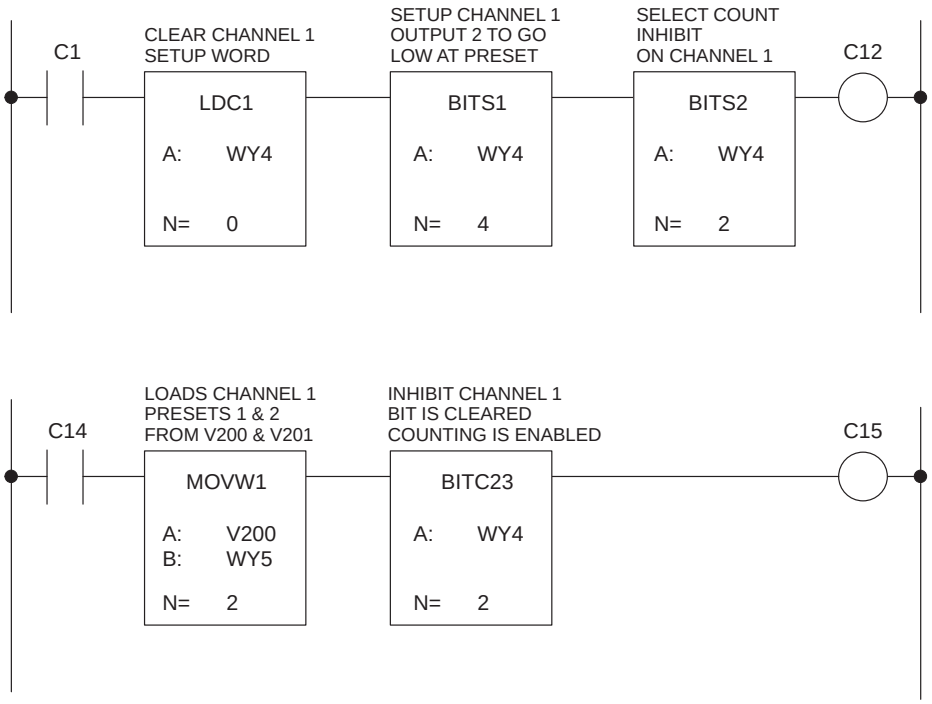


Figure 5-4 Ladder Logic for Sprayer Example

5.2 Flow Rate Example

5.2.1 Description

A flow meter outputs 200 pulses per gallon. The program requires calculation of flow rate in gallons per minute (GPM).

5.2.2 Solution

Configure the HSC as WX9–WX11, WY12–WY16. Attach channel 1 to the flow meter. The HSC accumulates flow meter pulses for the duration of a 1-second fast timer. In the controller, accumulated pulses are scaled to GPM by the following calculation (using the controller memory locations).

Equation: GPM = Pulses per Sec * 60 / 200
Program Locations: (V23,V24) = (WX10) * (V20) / (V19)

Following each calculation, reset the HSC, restart the Timer, and perform a new calculation 1 second later.

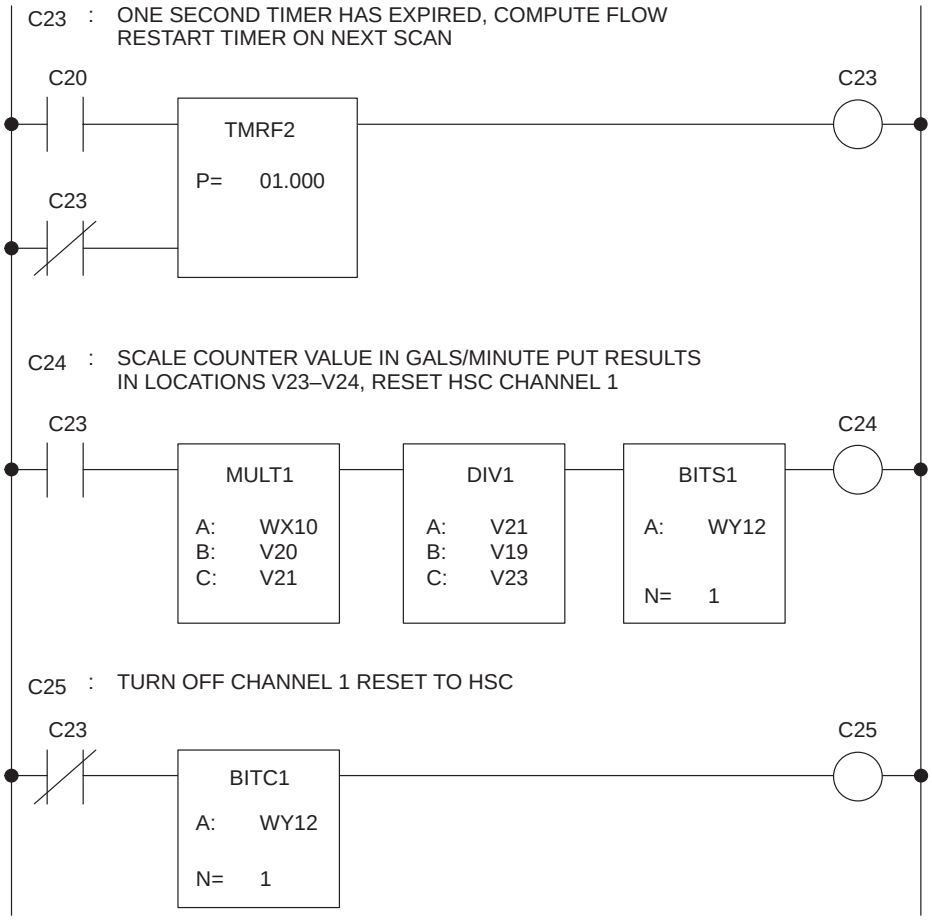


Figure 5-5 Ladder Logic for Flow Rate Example

5.3 Tank Filling Example

5.3.1 Description

The HSC module measures the volume of liquid and control the filling valve. (See Figure 5-6.) A flow meter, generating 200 pulses per gallon, is connected to the HSC channel 2, input A. Output 2 controls the filling valve. In this example, the HSC operates in the pulse counter mode.

5.3.2 Solution

A count of 100,000 pulses is required to fill the tank to 500 gallons. As this would overflow the HSC, the following RLL is used to count 10 sets of 10,000 pulses before closing the filling valve. In this program, output 1 is used to indicate 10,000 pulses. Since the HSC runs asynchronous to the PLC, the program accumulates overcounts for each loop and adjusts the final loop to reach the exact count. The program utilizes the fact that the HSC WX's are read before the WY's are written in an I/O cycle.

Several V memory locations are used in the program, their initial values are:

V200	=	10,000	=	channel 2, preset 1
V201	=	30,000	=	channel 2, preset 2 initial value
V100	=	0		(overcounts will be accumulated here)

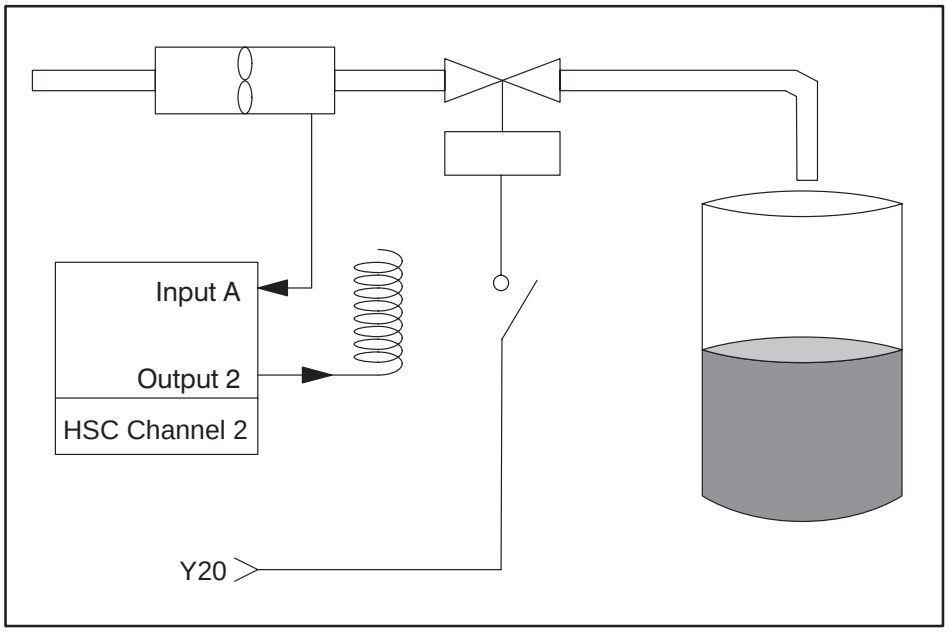


Figure 5-6 Tank Filling Application

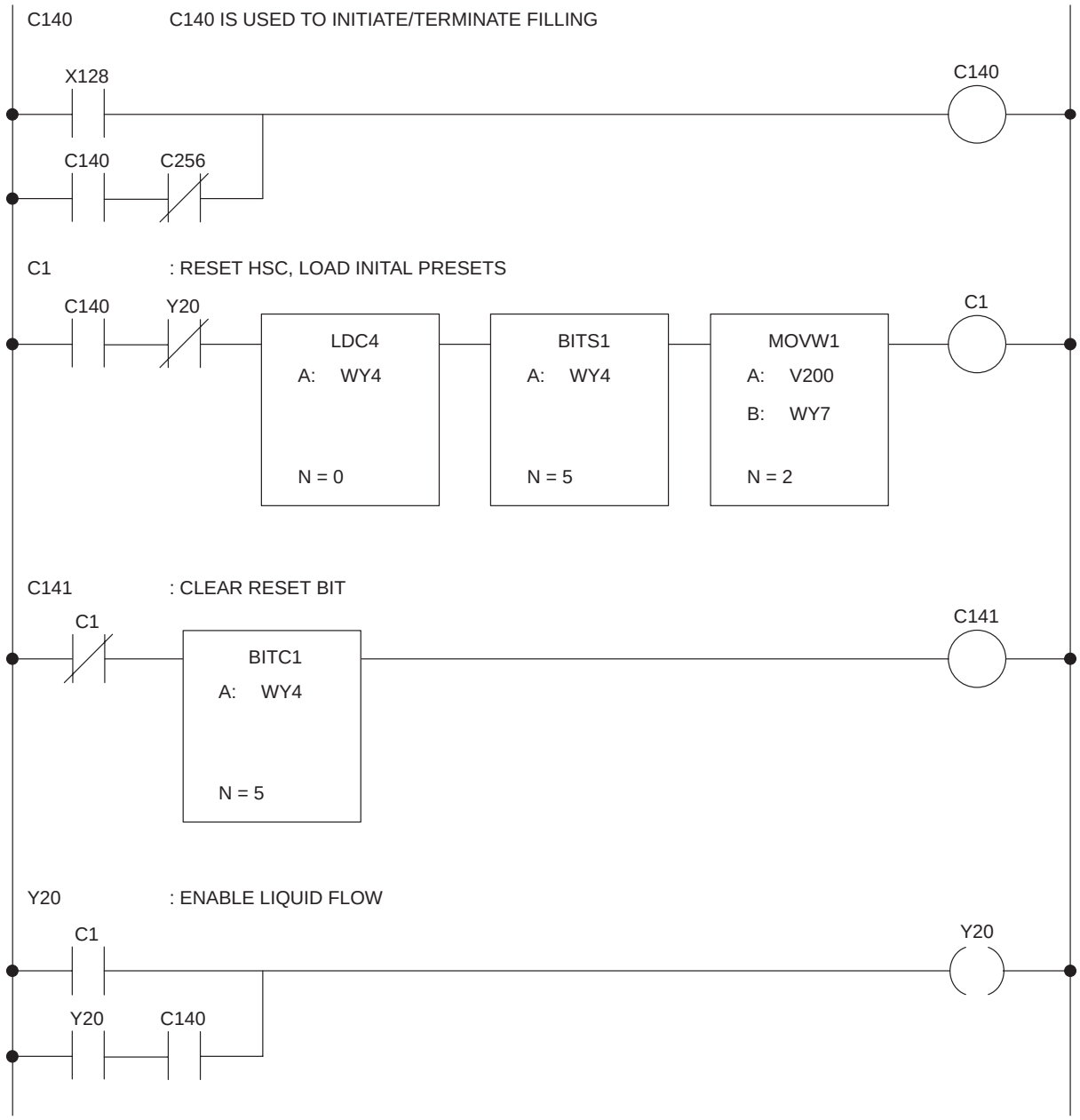


Figure 5-7 Ladder Logic for Tank Filling Example

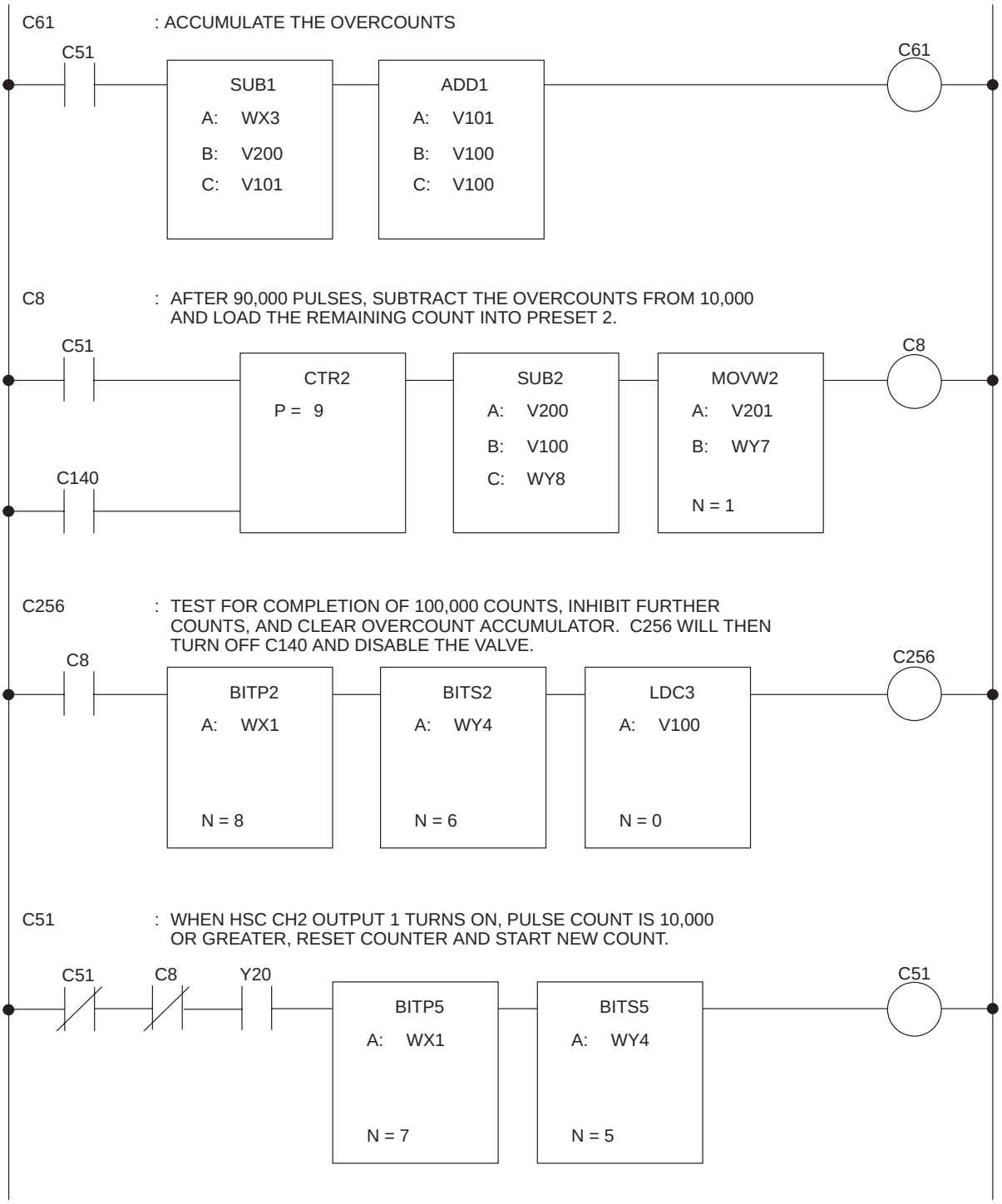
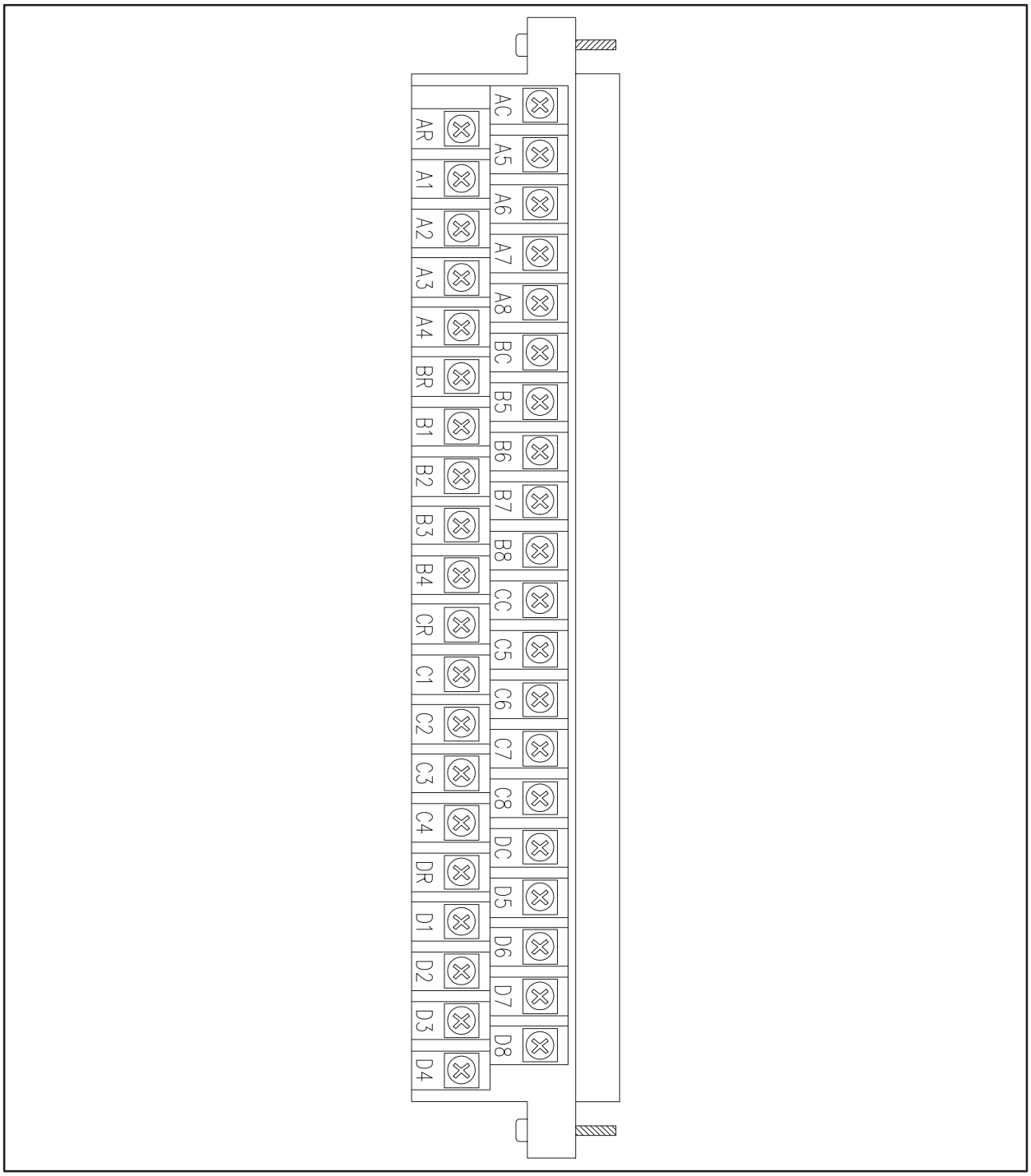


Figure 5-7 Ladder Logic for Tank Filling Example (continued)

Appendix A

Terminal Block Worksheet



Appendix B

Specifications

B.1 Environmental Specifications

Table B-1 Environmental Specifications

Operating Temperature	0° to 60°C (32° to 140°F)
Storage Temperature	–40° to 70°C (–40° to 158°F)
Relative Humidity	5% to 95% noncondensing
Pollution Degree	2, IEC 664, 664A
Vibration	
Sinusoidal	IEC 68–2–6, Test Fc; 0.15 mm, peak-to-peak, 10-57 Hz; 1.0 g 57-150 Hz
Random	NAVMAT P–9492 or IEC 68–2–34, Test Fdc with 0.04 g^2/Hz, 80–350 Hz, and 3 dB/octave rolloff, 80–20 Hz and 350–2000 Hz at 10 min/axis
Impact Shock	IEC 68–2–27, Test Ea; Half Sine, 15 g, 11 ms
Electrostatic Discharge[2]	IEC 801, Part 2, Level 4 (15 kV)[1]
Electrical Noise Immunity	
Conducted[2]	IEC 801, Part 4, Level 3 MIL STD 461B, Part 4; CS01, CS02, CS06[1] IEC 255–4, Appendix E[1] EEC 4517/79 Com(78) 766 Final, Part 4 IEEE 472, 2.5 kV
Radiated	IEC 801, Part 3, Level 3 MIL STD 461B, Part 4; RS01, RS02
Corrosion Protection	All parts are of corrosion resistant material or are plated or painted as corrosion protection.
Agency Approvals	UL® Listed, CSA Certified

[1]The unfilltered reset input may be susceptible to these types of EMI.
[2]The module responds to noise signals at its count or inhibit inputs that are within its passband.

B.2 Electrical Specifications

Table B-2 Electrical Specifications

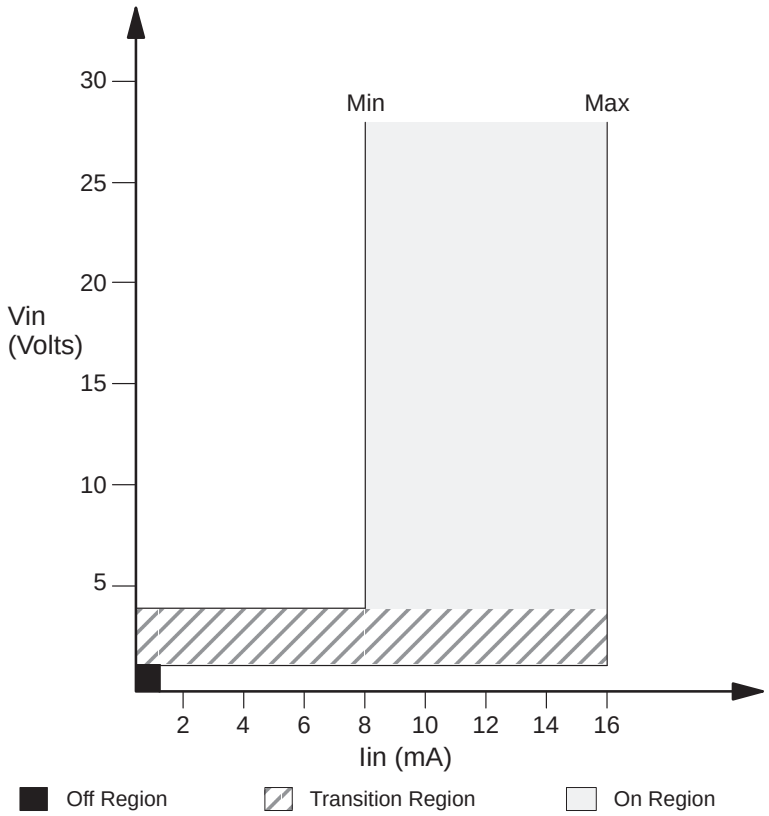
Count Inputs

Frequency (maximum)

Duty Cycle	**Count Mode Freq.**	**Quadrature Mode Freq.** (w/ 15° max. phase error)
10%	10 Khz	4 Khz
20%	25 Khz	8 Khz
25%	30 Khz	10 Khz
30%	35 Khz	12 Khz
40%	50 Khz	15 Khz
50%	45 Khz	15 Khz
60%	35 Khz	15 Khz

On voltage: 4 to 28 VDC, Class 2 supply
Current on: 8 to 16 mA
Off voltage: –1.5 to 1.5 VDC
Current off: 0 to 1 mA

Volt–Ampere Curve for Count Inputs

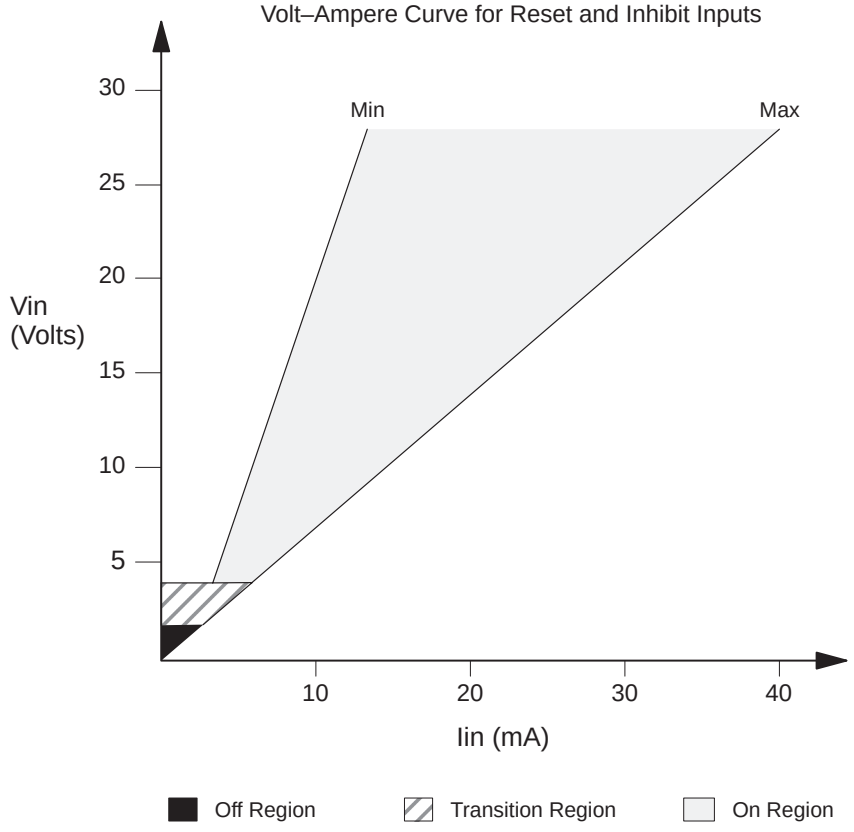


NOTE: Count inputs are constant current type inputs.

Reset and Inhibit Inputs:

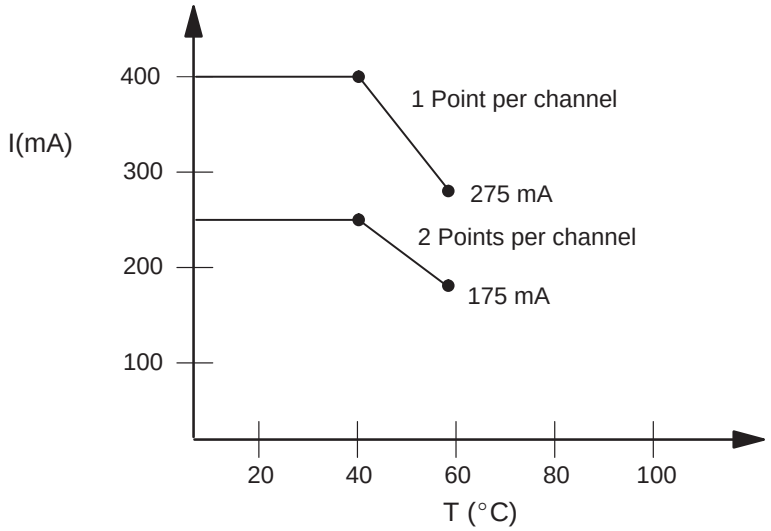
On voltage:	to 28 VDC, Class 2 supply	
Current on:	2 to 40 mA	
Off voltage:	–1.5 to 1.5 VDC	
Current off:	0 to 0.75 mA	
Reset delay time:	unfiltered	950 μs on 950 μs off
	filtered	3.75 ms on 5.00 ms off
Inhibit delay time:	200 μs on 200 μs off	

Volt–Ampere Curve for Reset and Inhibit Inputs



Outputs

User voltage: . . . . . 28 VDC max.
Voltage drop: . . . . . 1.8 VDC max. @ 400 mA
1.0 VDC max. @ 25 mA
Leakage current: . . . . . 500 μA max.
Peak current: . . . . . 500 mA for 1 ms
Output current:



Isolation:

User-side to P/C-side . . . . . 1500 V rms

Channel 1 to 2 (inputs) . . . . . 1500 V rms

Channel 1 to 2 (outputs) . . . . . 0 V rms

Inputs to outputs . . . . . 1500 V rms

Power Required from Base: . . . . . 2.5 W

Response Time . . . . . 1.1 ms
(Input pulse to output action)

B.3 Additional Compliances

In addition, the system complies with applicable requirements of Verband Deutscher Elektrotechniker (VDE) 0160: Electrical Equipment

Series 505 products have been developed with consideration of the draft standard for programmable controllers as described in the proposed standard of the International Electrotechnical Commission Committee (IEC–65A/WG6, Part 2).

Information concerning product reliability and compliance to the IEC or other standards can be provided upon request. Contact your Siemens Industrial Automation, Inc. distributor for additional information.

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