SIEMENS

SIMATIC TI505

High Speed
Counter Encoder Module

User Manual

Order Number: PPX:505-8127-1
Manual Assembly Number: 2586546-0092
Original Edition

MANUAL PUBLICATION HISTORY

SIMATIC TI505 High Speed Counter Encoder Module (PPX:505–7003) User Manual
Order Manual Number: PPX:505–8127–1

Refer to this history in all correspondence and/or discussion about this manual.

Event	Date	Description
Original Issue	05/94	Original Issue (2802813–0001)

LIST OF EFFECTIVE PAGES

Pages	Description	Pages	Description
Cover/Copyright	Original		
History/Effective Pages	Original		
iii — xiv	Original		
1-1 — 1-23	Original		
2-1 — 2-13	Original		
3-1 — 3-17	Original		
4-1 — 4-5	Original		
5-1 — 5-21	Original		
A-1 — A-8	Original		
B-1 — B-8	Original		
C-1 — C-8	Original		
Index-1 — Index-5	Original		
Registration	Original		

Contents

Chapter 3 Understanding Module Operation

Appendix A Applications

List of Figures

List of Tables

Preface

About this Manual

This manual describes the SIMATIC® TI505™ High Speed Counter Encoder Module. The following major topics are covered:

- Overview of product features.
- Hardware installation and wiring procedures.
- Quick start procedure using the default configuration.
- Basic concepts of operation.
- Configuring optional modes of operation.
- Applications.
- Troubleshooting.
- Product specifications.

Related Manuals

Additional manuals that have relevant information include the following:

- *SIMATIC TI505 Programming Reference Manual* (PPX:505–8104–4 or later)
- *SIMATIC TI505 TISOFT2™ Release 4.3 User Manual* (PPX:TS505–8101–4 or later)
- *SIMATIC TI505 Input/Output User Manual* (PPX:505–8105–x)

Refer to material in these manuals as necessary for additional information about using your TI505 High Speed Counter Encoder module.

NOTE: The listed CPU Software releases may not properly allow the module to update the WX words during an immediate I/O Read cycle. If you use one of the releases listed below, use an immediate I/O Write following the immediate I/O Read to correct a possible conflict:

- SIMATIC® TI545™, Release 2.1.1 and earlier.
- SIMATIC® TI555™, Release 1.1.2 and earlier.

Agency Approvals

Series 505™ products have been developed with consideration of the draft standard of the International Electrotechnical Commission Committee proposed standard (IEC-65A/WG6) for programmable controllers (released as IEC 1131–2, Programmable Controllers Part 2: Equipment Requirements and Tests, First Edition, 1992–09). This module meets the standards of the following regulatory agencies:

- Underwriters Laboratories, Inc.®: UL Listed (Industrial Control Equipment)
- Canadian Standards Association: CSA Certified (Process Control Equipment)
- Factory Mutual Research Corporation: approved for Class I, Div. 2, Groups A, B, C, D Hazardous Locations

Technical Assistance

For technical assistance, contact your Siemens Industrial Automation, Inc. distributor or sales office. If you need assistance in contacting your sales office or distributor in the United States, call 1–800–964–4114.

Conventions

The following conventions are used in this manual:

- Bits are either *set* to their 1 state, or are *cleared* to their 0 state.
- Bit positions within words are referred to by a decimal: WY20.01 refers to bit position .01 in word WY20.
- Text that refers to additional counters or channels, contains the additional counter(s) [5, 6] or channel [2] in brackets.
- Text that refers to signal names is presented in ALL CAPS.
- Shading within a table cell or a jumper position indicates a default setting.

Chapter 1
Product Overview

1.1 Physical Features of the Module

Physical Features

The SIMATIC TI505 High Speed Counter Encoder Module (PPX:505–7003) is a single-wide input/output module that communicates with the PLC when installed in a TI505 system. The physical features of the module are shown in Figure 1-1.

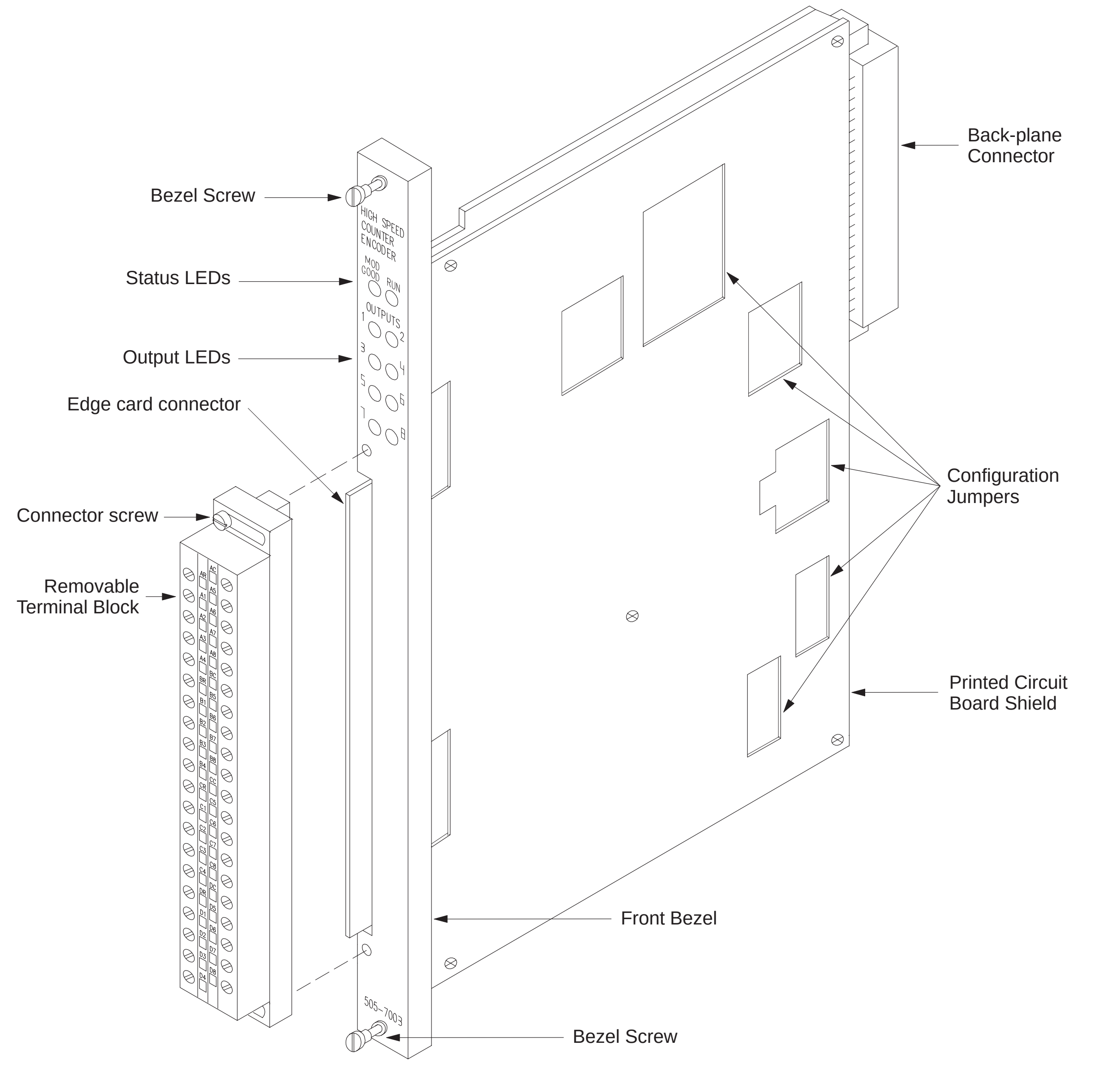


Figure 1-1 Physical Features of the High Speed Counter Encoder Module

LED Indicators

The High Speed Counter Encoder Module (HSCE) provides a total of ten LED indicators on the faceplate. See Figure 1-2.

- Eight red LEDs indicate the on/off status of outputs 1 through 8.
- A red LED labeled MOD GOOD indicates that the module is powered up and has not detected any hardware or software failure.
- A green LED labeled RUN indicates that the module is in Run mode. It flashes when the module is first powered up, before it has been programmed (configured) from the PLC. When the RUN LED is off, the module is not in the Run mode, or has detected a programming or other fault condition. Other flashing patterns indicate fault conditions. (See Table B-1.)

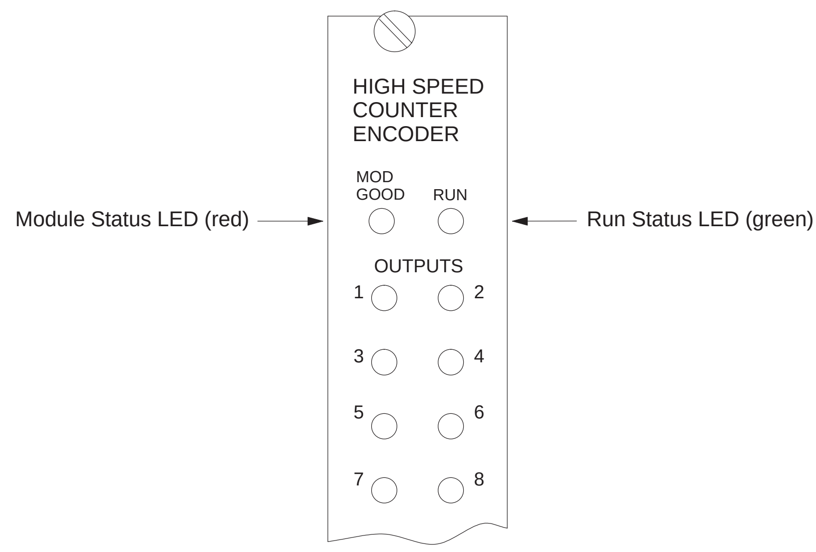


Figure 1-2 LED Indicators

1.2 Functional Features of the Module

Summary of Counters and Outputs

The HSCE module provides a total of six counters and eight outputs, divided into two channels. Each channel contains the following:

- One 24-bit counter: this counter has two pulse inputs, A and B; its primary purpose is to count pulses from an incremental pulse encoder.
- Two 16-bit counters: each counter has a single input, C or D, in each channel; its primary purpose is simple pulse counting, up or down.
- Four discrete outputs: each output is capable of sourcing 24 V to a load, at 200 mA continuous or 500 mA peak output current. The outputs require external, user-supplied 24 VDC power.

The HSCE module operates asynchronously from the PLC. It accumulates pulse inputs and controls outputs according to presets or other conditions you programmed into the module by Relay Ladder Logic (RLL) program.

Features of the 24-Bit Counters

Each 24-bit counter has three control inputs:

- INDEX latches the count value, or reloads the counter preset value. Index can also be configured for a Reset-and-Go operation, which clears the count value before counting continues.
- INHIBIT holds the count value.
- RESET sets the count value to zero.

The 24-bit counters provide the following counting modes:

- Quadrature counting (1X, 2X, or 4X resolution).
- Non-quadrature up/down counting, or direction counting.

Features of the 16-Bit Counters

The 16-bit counters provide the following counting modes:

- Retriggerable one-shot mode.
- Divide-by-N counting mode.
- Square-wave generator mode.
- Triggered strobe mode.
- Binary, Up/Down, Recycle mode.
- Cascaded counting.

Additional Module Features

The HSCE module allows you to connect counters internally for cascaded counting. The module also provides Immediate I/O operation as well as Interrupt I/O capability (using Task 8 to execute interrupt handling routines). To continue the counting operation in case of a loss of power to the I/O base, you can provide back-up power to the module.

NOTE: The listed CPU Software releases may not properly allow the module to update the WX words during an immediate I/O Read cycle. If you use one of the releases listed below, use an immediate I/O Write following the immediate I/O Read to correct a possible conflict:

- *SIMATIC TI545, Release 2.1.1* and earlier.
- *SIMATIC TI555, Release 1.1.2* and earlier.

Functional Diagram

Figure 1-3 presents a functional diagram that summarizes the counters and outputs provided by the HSCE module.

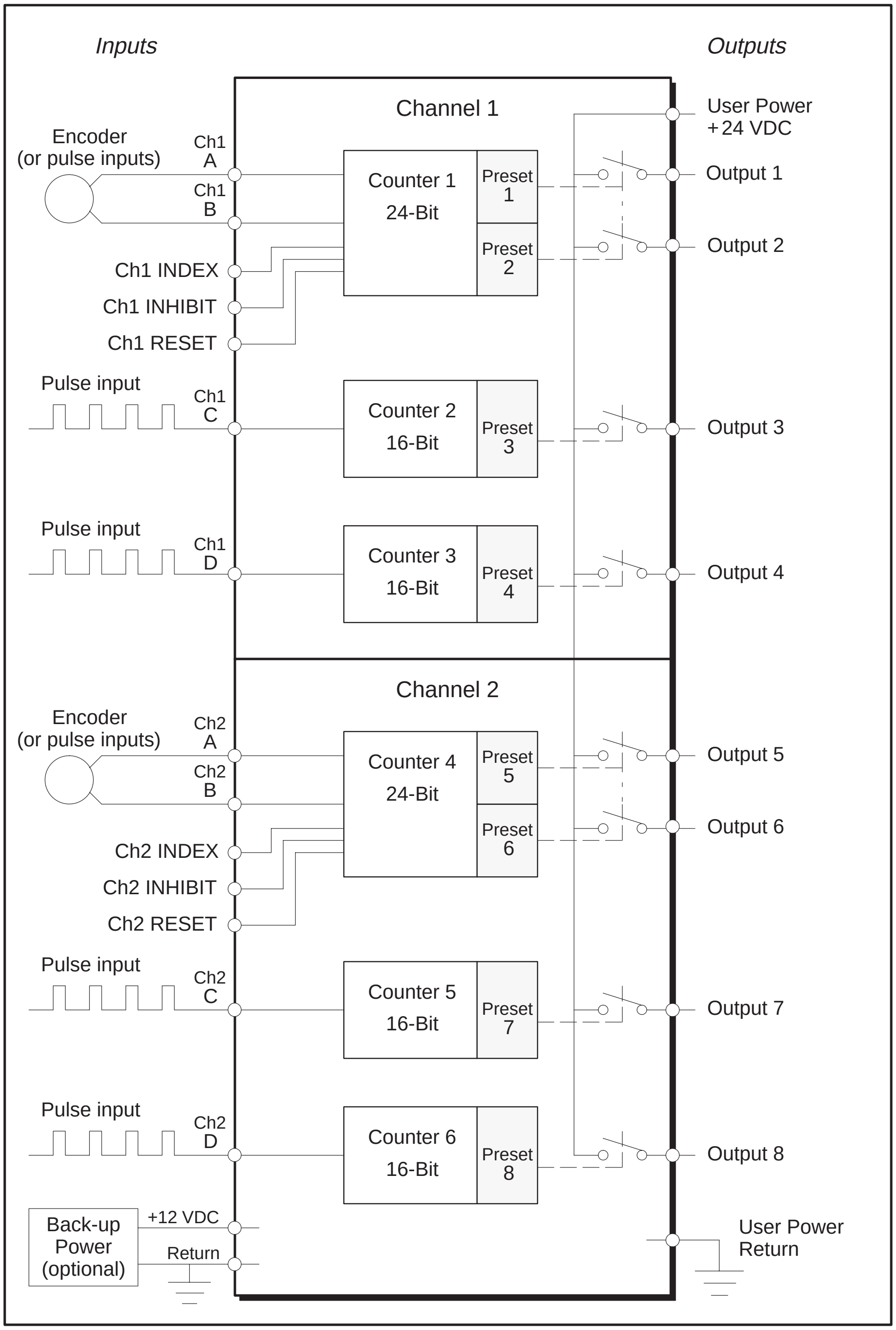


Figure 1-3 High Speed Counter Input/Output Functional Diagram

1.3 Quadrature Modes of Counting

Quadrature Mode Overview

Each 24-bit counter, Counter 1 (Channel 1, inputs A & B) and Counter 4 (Channel 2, inputs A & B) provides Quadrature mode counting. When input A pulses lead input B pulses, the count direction is up. When input B pulses lead input A pulses, the count direction is down. The relationship between input A and input B that determines the count direction applies to 1X, 2X, and 4X Quadrature counting modes, described in this section.

For information on how to configure the module for quadrature counting, refer to Chapter 5.

You select one of the three quadrature modes according to the resolution required by your application and the type of encoder you are using.

1X Quadrature Counting Mode

When set to 1X Quadrature Mode, the module counts the rising or the falling edges of input A pulses, depending on the count direction.

- When input A leads input B, the count direction is up and the count value increments on each rising edge of input A.
- When input B leads input A, the count direction is down and the count value decrements on each falling edge of input A.

Figure 1-4 shows the relationship between inputs A and B, and the count value that results using 1X quadrature mode.

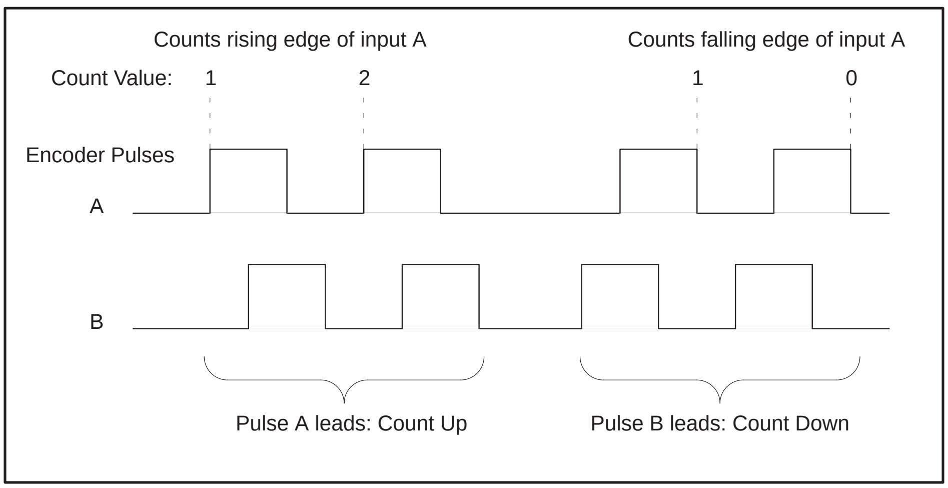


Figure 1-4 1X Quadrature Mode

2X Quadrature Counting Mode

When set to 2X Quadrature Mode, the module counts both edges of input A pulses, in both count directions.

Figure 1-5 shows the relationship between inputs A and B, and the count value that results using 2X quadrature mode.

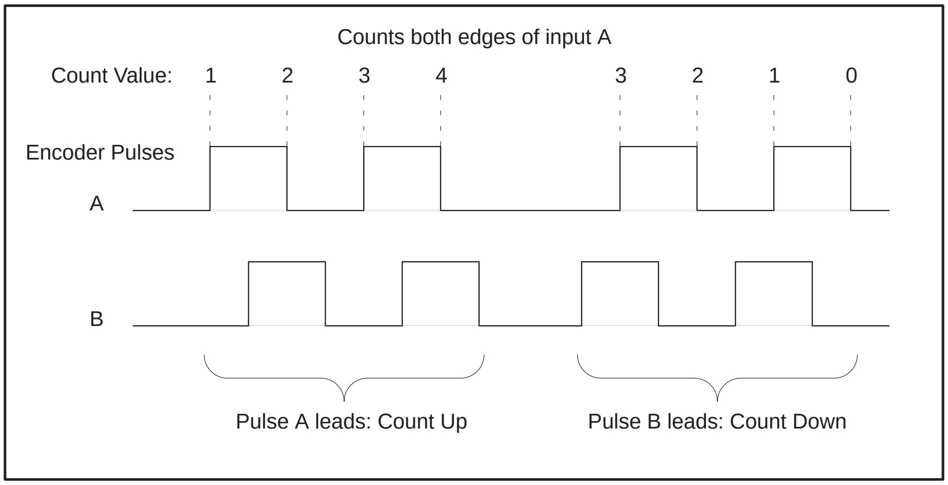


Figure 1-5 2X Quadrature Mode

4X Quadrature Counting Mode

When set to 4X Quadrature Mode, the module counts both edges of both input A pulses and input B pulses, in both count directions.

Figure 1-6 shows the relationship between inputs A and B, and the count value that results using 4X quadrature mode.

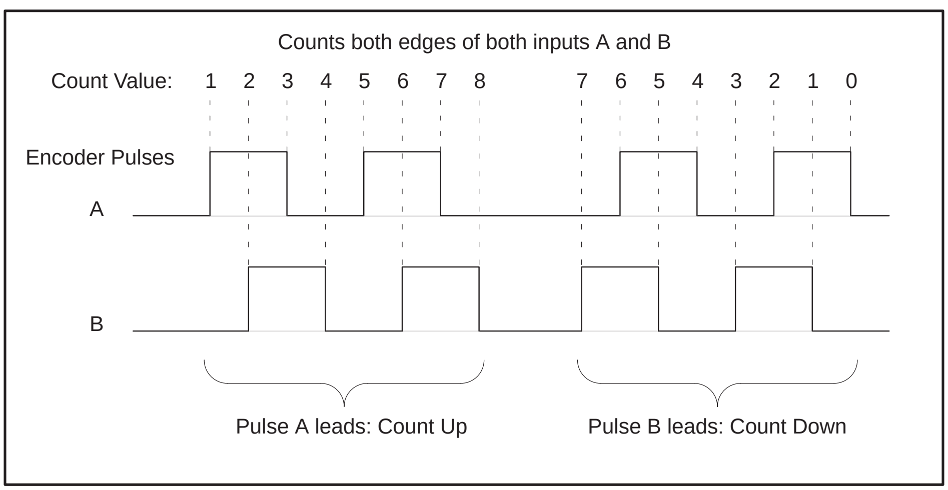


Figure 1-6 4X Quadrature Mode

1.4 Non-Quadrature Modes of Counting

Up/Down Counting Overview

When you select the up/down counting mode, two input pulse signals determine the count value. (Refer to Figure 1-7.)

- With input B high, the count increments on the rising edge of input A.
- With input A high, the count decrements on the rising edge of input B.

For proper counting, the input without the clock must be held high or on; otherwise, the count value that results cannot be defined.

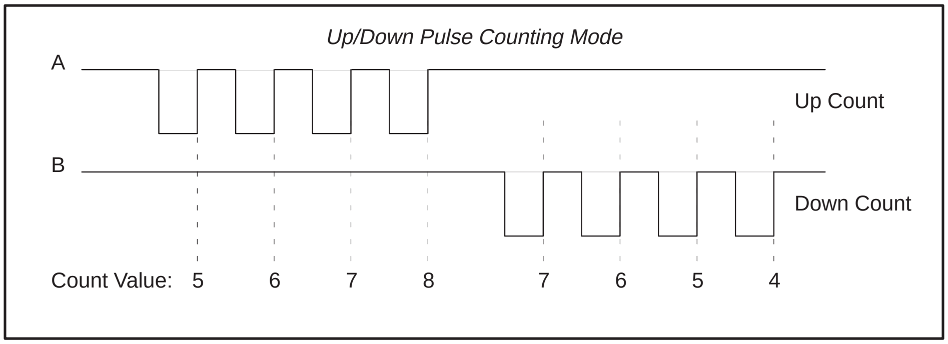


Figure 1-7 Up/Down Counting

Direction Counting Overview

When you select direction counting mode, the input B signal controls the count values of the input A pulse. (Refer to Figure 1-8.)

- With input B low, the count increments on the rising edge of input A.
- With input B high, the count decrements on the rising edge of input A.

For proper counting, input A must be high during the transition of input B; otherwise, the count value that results can not be defined.

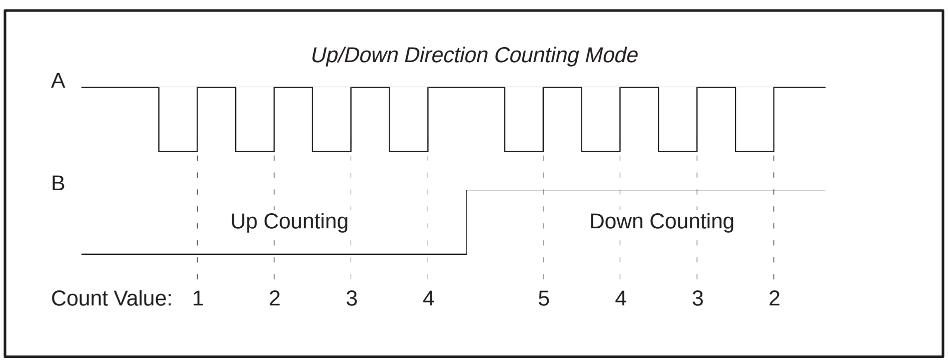


Figure 1-8 Direction Counting

1.5 Counting with the 24-Bit Counters

Binary Counting, Recycle Mode

In binary recycle mode, the counter counts up or down on each input pulse. In the count-up direction, a carry signal is generated when the counter overflows (see note). In the count-down direction, a borrow signal is generated when the count underflows (see note). When the count equals the preset value, the output signal pulses, toggles, or latches, depending on the output option you select.

NOTE: *Overflow:* the count value increments from –1 to 0 in bipolar format, or from 16,777,215 to 0 in unipolar format.
Underflow: the count value decrements from 0 to –1 in bipolar format, or from 0 to 16,777,215 in unipolar format.

Binary Counting, Non-Recycle Mode

In binary non-recycle mode, the counter counts up or down on each input pulse. In the count-up direction, a carry signal is generated when the counter overflows. In the count-down direction, a borrow signal is generated when the count underflows. When a carry or borrow signal occurs, the counter stops.

The counter restarts when you reload the preset value into the counter, or when you reset the counter registers by one of the following conditions:

- An external INDEX pulse when WY21.07, or WY27.07, or both are set).
- A PLC counter reset (WY19.02 or WY19.06).
- Setting the program flag (WY20.01).

Divide-by-N Counting, Recycle Mode

In divide-by-N recycle mode, a preset value is loaded into the counter. The counter counts up or down on each input pulse. In the count-up direction, a carry signal is generated when the counter overflows. In the count-down direction, a borrow signal is generated when the count underflows. In both cases, the carry or borrow signal reloads the counter with the preset value and the count continues. Loading presets loads the new preset value after the next carry or borrow pulse occurs.

Divide-by-N Counting, Non-Recycle Mode

In divide-by-N non-recycle mode, a preset value is loaded into the counter. The counter counts up or down on each input pulse. In the count-up direction, when the counter overflows, it generates a carry signal. In the count-down direction, when the count underflows, it generates a borrow signal. When a carry or borrow signal occurs, the counter stops.

The counter restarts when you reload the preset value into the counter or you reset the counter registers by one of the following conditions:

- An external INDEX pulse when WY21.07, or WY27.07, or both are set.
- A PLC counter reset (WY19.02 or WY19.06).
- Setting the program flag (WY20.01).

Loading presets loads the new preset value after the next carry or borrow pulse occurs.

1.6 24-Bit Counters Quadrature Mode Outputs

You can select one of four output options, (see Figure 1-9) for the output signal of each 24-bit counter (Counter 1, Output 1; and Counter 4, Output 5).

Outputs in Quadrature Modes

In quadrature counting modes, the internal clocking for the Compare, Carry and Borrow pulses produce a pulse width insufficient to drive the outputs. See Figure 1-9. Compare Toggle and Compare Latch are the only signals that can drive the output circuitry.

Carry Toggle Output

The Carry Toggle output changes state when the count overflows. After a counter reset, the Carry Toggle output is on. Set the output jumper to Compare.

Borrow Toggle Output

The Borrow Toggle output changes state when the count underflows. After a counter reset, the Borrow Toggle output is on. Set the output jumper to Compare Toggle.

In all module counting modes, the PLC can read the Compare Toggle, Carry Toggle and Borrow Toggle flags in Status Word WX17. Table 1-1 and Table 1-2 summarize the active outputs for various counter modes.

Compare Toggle Output

The Compare Toggle jumper selects a signal that changes state on the next count after the count value equals the preset value. This signal appears on Output 1 (Channel 1) or on Output 5 (Channel 2). After counter reset, the output signal is on.

Compare Latch Output

The Compare Latch jumper selects a signal that is active when the count value equals the preset value; the signal remains active until reset by the PLC or by the second preset (Preset 2 or Preset 6). This signal appears on Output 1 (Channel 1) or on Output 5 (Channel 2). After counter reset, the output signal is Off.

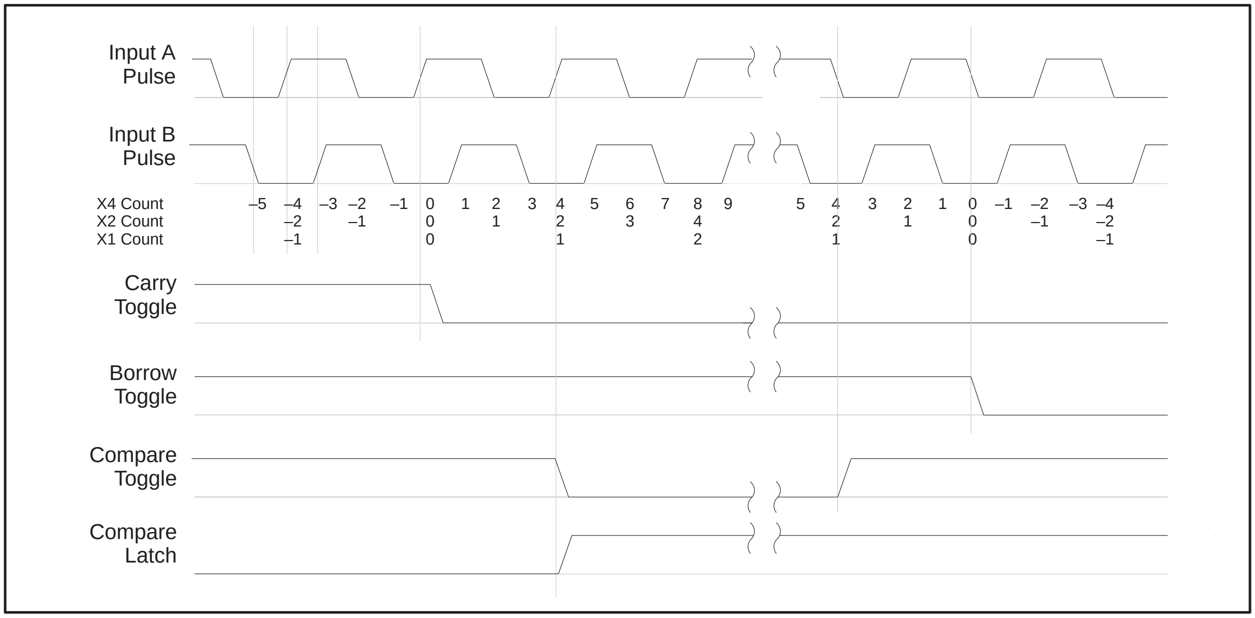


Figure 1-9 24-Bit Quadrature Mode Outputs

1.7 24-Bit Counters Non-Quadrature Mode Outputs

Non-quadrature Modes

In non-quadrature counting modes, the internal clocking for the Compare, Carry and Borrow pulses are one-half of the input clock width.

You can select one of four options for the output signal of each 24-bit counter (Counter 1, Output 1; and Counter 4, Output 5) in Up counting and Down counting modes.

Carry Toggle Output

The Carry Toggle output, in Up counting mode, changes state when the count overflows. See Figure 1-10. After a counter reset, the Carry Toggle output is on. Set the output jumper to Compare.

Borrow Toggle Output

The Borrow Toggle output, in Down counting mode, changes state when the count underflows. See Figure 1-11. After a counter reset, the Borrow Toggle output is on. Set the output jumper to Compare Toggle.

Rollover Output

The Rollover jumper selects a one-half clock pulse signal that is active when the carry or borrow signal is active from the counter. This signal appears on Output 1 (Channel 1) or on Output 5 (Channel 2). After counter reset, the output signal is Off.

Compare Output

The Compare jumper selects a one-half clock pulse that is active when the count value equals the preset value. This pulse appears on Output 1 (Channel 1) or on Output 5 (Channel 2). After counter reset, the output signal is Off.

Compare Toggle Output

The Compare Toggle jumper selects a signal that changes state on the next count after the count value equals the preset value. This signal appears on Output 1 (Channel 1) or on Output 5 (Channel 2). After counter reset, the output signal is on.

Latch Output

The Latch jumper selects a signal that is active when the count value equals the preset value; the signal remains active until reset by the PLC or by the second preset (Preset 2 or Preset 6). This signal appears on Output 1 (Channel 1) or on Output 5 (Channel 2). After counter reset, the output signal is Off.

In all module counting modes, the PLC can read the Compare Toggle, Carry Toggle, and Borrow Toggle flags in Status Word WX17. Table 1-1 and Table 1-2 summarize the active outputs for various counter modes.

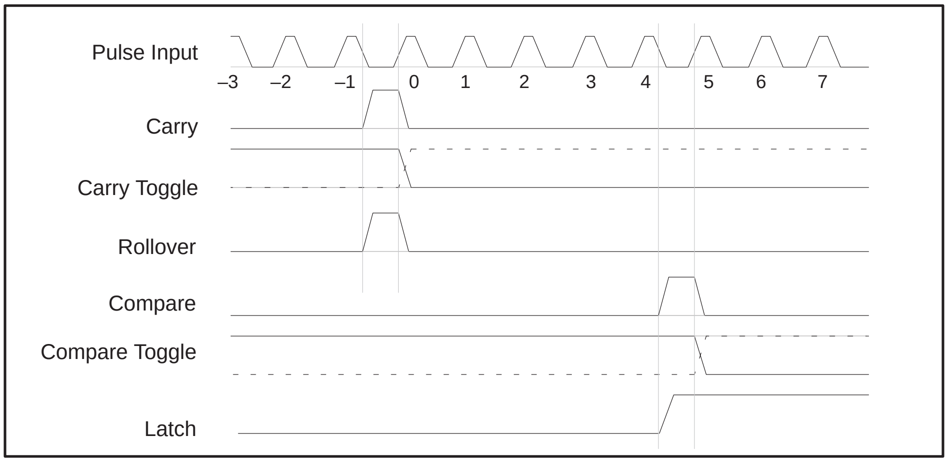


Figure 1-10   24-Bit Counter Output Up Counting

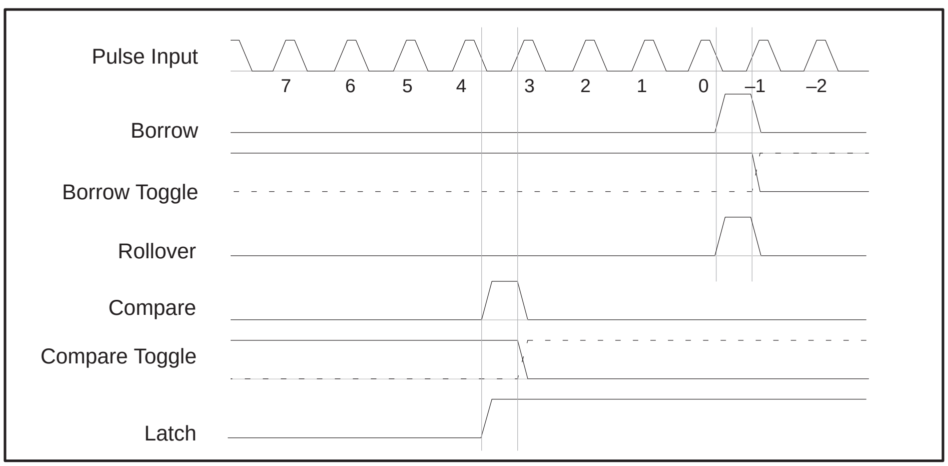


Figure 1-11   24-Bit Counter Output Down Counting

24-Bit Counters Non-Quadrature Mode Outputs (continued)

Outputs in Non-recycle Mode

In non-recycle counting mode, Compare, Carry, and Borrow *pulses* are not generated. Carry *Toggle* and Borrow *Toggle* signals are the cycle completion indicators. At the end of a cycle, additional input count pulses are ignored. One of the following conditions is required to restart the counter:

- An external INDEX pulse (when WY21.07, or WY27.07, or both are set).
- A PLC counter reset (WY19.02 or WY19.06).
- Setting the program flag (WY20.01).

Outputs in Divide-by-N Mode

In Divide-by-N counting mode, Compare, Compare Latch, or Compare Toggle signals are not generated. The counter starts at the preset value and counts to an overflow or underflow, generating a Carry or Borrow.

We recommend that Divide-by-N counting be done in the down count direction only, with the Borrow Toggle signaling the underflow event. In the non-quadrature, recycle counting mode, the Carry and Borrow pulses are externally available, and can be used to cascade to another counter input.

Table 1-1 Binary Counting Outputs

	Recycle Mode		Non-Recycle Mode	
	Quadrature	Non-Quadrature	Quadrature	Non-Quadrature
Compare		Compare	Carry Toggle	Carry Toggle
Compare Toggle	Compare Toggle	Compare Toggle	Borrow Toggle	Borrow Toggle
Compare Latch	Compare Latch	Compare Latch		
Rollover		Carry and Borrow Pulse		

Table 1-2 Divide-by-N Counting Outputs

	Recycle Mode		Non-Recycle Mode	
	Quadrature	Non-Quadrature	Quadrature	Non-Quadrature
Compare	Carry Toggle	Carry Toggle	Carry Toggle	Carry Toggle
Compare Toggle	Borrow Toggle	Borrow Toggle	Borrow Toggle	Borrow Toggle
Compare Latch				
Rollover		Carry and Borrow Pulse		

1.8 Counting with 16-Bit Counters

16–Bit Counter General Description

General information for all 16-bit counter modes is presented in following paragraphs. Figure 1-12 shows that incrementing or decrementing the count value occurs on the rising edge of the input clock signal.

A valid clock is a high-to-low-to-high transition; or from the input viewpoint, the clock input goes from On-to-Off-to-On.

A trigger is an On–to-Off pulse edge. The trigger or gate, followed by a valid clock pulse, sets the timer for proper operation.

A gate pauses the counter on an Off-to-On edge, reloads the preset value, and starts counting on the On-to-Off edge.

When the corresponding Reset Counter flag, WY19.03, .04, .07, or .08 for counter 2, 3, 5, or 6 is set and then cleared; the preset value, read during Program mode or Preset Update (Run mode), is reloaded into the counter.

The external trigger/gate signal and the Reset Counter flag, are Or'd into the count trigger/gate control. Only one signal, the external trigger or the Reset Counter flag, can change state, the other must be 0 (Off).

The 16-bit counter outputs 8, 7, 4, or 3 are OR'ed with the corresponding Force Output On bit WY19.09, .10, .13, or .14. If the corresponding Force Output On bit is 1, the output is forced On and overrides the counter output.

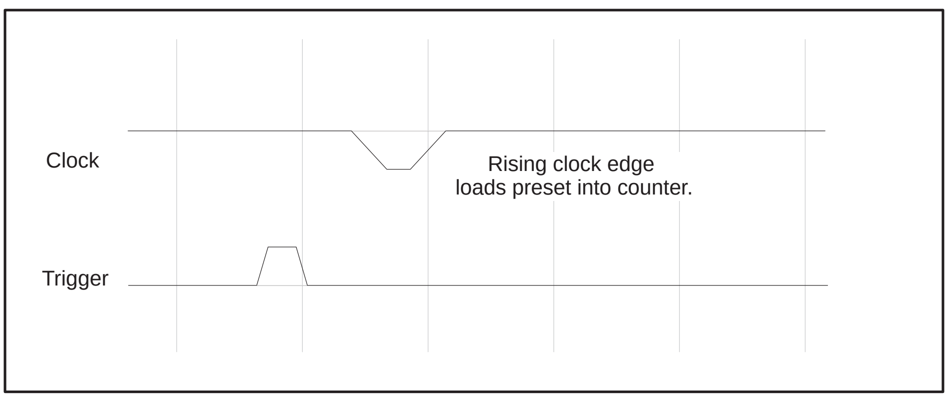


Figure 1-12 Clock and Trigger for 16-Bit Counters

16-Bit Counter Modes

You can select a 16-bit counter mode by setting the appropriate bits in the Setup Word (WY20). Cascade counting requires that a jumper be configured. You can configure the 16-bit counters to count in one of the following modes:

- Retriggerable one-shot.
- Divide-by-N, 16-bit counting.
- Triggered Strobe.
- Square Wave generator.
- Cascade counting.

Appendix A presents applications of the 16-bit counters in cascade mode; and in binary, up/down, recycle mode.

Retriggerable One-Shot

The retriggerable one-shot mode generates an output that is On (high), from the first clock after a trigger, and remains On until the preset number of clocks have been counted down to zero. The output is On for the preset number of clocks.

See Figure 1-13. Twenty is an arbitrary starting count value. The waveforms show that the first clock pulse after the trigger transitions the output On (high), and the counter counts down from the preset value (2). When the counter reaches zero, the output goes Off. The count value continues to decrement, and the output remains Off even through a rollover to the preset value.

If the input clock starts Off (low) after the trigger, the first rising edge decrements the count value without loading the preset value. The next clock, which is a On-to-Off-to-On clock pulse, reloads the preset value.

A trigger is required to repeat the cycle. The output remains Off until the next clock after the next trigger which reloads the preset and starts the count again. The last clock decrements the count to zero and turns the output Off. If a trigger does not occur, the count value continues to decrement, and the output remains Off even through a rollover to the preset value.

A trigger can be either, an external input, or the PLC can set the corresponding Reset Counter flag, WY19.03, .04, .07, .08 for counter [2, 3, 5, or 6]. In this example, the preset value is 2.

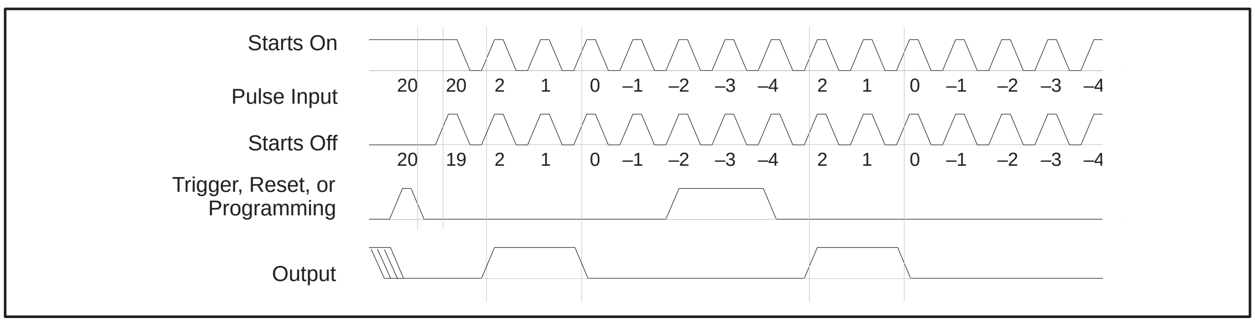


Figure 1-13 Retriggerable One-Shot Mode

Divide-by-N

Divide-by-N counting generates an output that is On for one clock period every count cycle. The length of the count cycle is the preset number of clocks. The counter counts down from the preset value to 1.

The first valid clock pulse, after the gate, loads the preset value (3) and starts decrementing the counter. When the count value is 1, the output turns On. At the next clock the count would be zero, however, the counter automatically reloads the preset and turns the output Off.

You can use a gate signal to stop the counting and reload the preset value. A gate can be an external signal or the PLC can set the Reset Counter flags (WY19.03, .04, .07, .08). When the gate goes On (high), the counter pauses, and the output is turned Off. When the gate turns Off, or the Reset Counter flag is cleared, the preset is loaded into the counter and counting resumes on the next valid clock pulse.

A typical, Divide-by-N counting waveform is presented in Figure 1-14. The waveforms show that the output is initially Off after the gate. The gate input On enables the counter; Off inhibits the counter. When the counter counts the preset value (3) down to 1, the output goes On for one clock period then goes Off. The preset value is reloaded and the cycle continues. If the gate goes Off when the output is Off, the output is set On immediately. In this example, the preset value is 3.

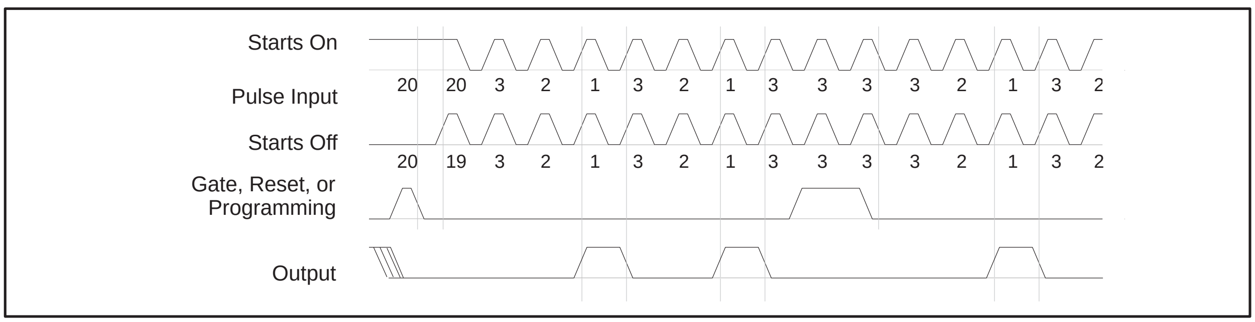


Figure 1-14 Divide-by-N Mode

Triggered Strobe

The triggered strobe mode generates an output that is On for one clock period following the trigger, after the preset number of clocks has been down counted to zero.

The output turns On when the preset number of clocks has been counted to zero, or (preset value +1) clocks after the trigger pulse.

To repeat a cycle, a trigger is required. A trigger can be an external input or the PLC can set the Reset Counter flag, WY19.03, .04, .07, or .08 for the corresponding counter 2, 3, 5, or 6. After the trigger, the next valid clock loads the preset into the counter. The last clock decrements the count to zero and turns the output On. The next clock turns the output Off. If a trigger does not occur, the count value continues to decrement, and the output remains Off even through a rollover to the preset value.

A typical waveform for the Triggered Strobe mode of counting is presented in Figure 1-15. The waveforms show that the output is initially Off after the trigger and clock. The edge of the trigger starts the counter counting down from the preset value. When the counter reaches 0, the output goes On for one clock period then goes Off.

The output remains Off until the edge of the next trigger. In this example, the preset value is 2.

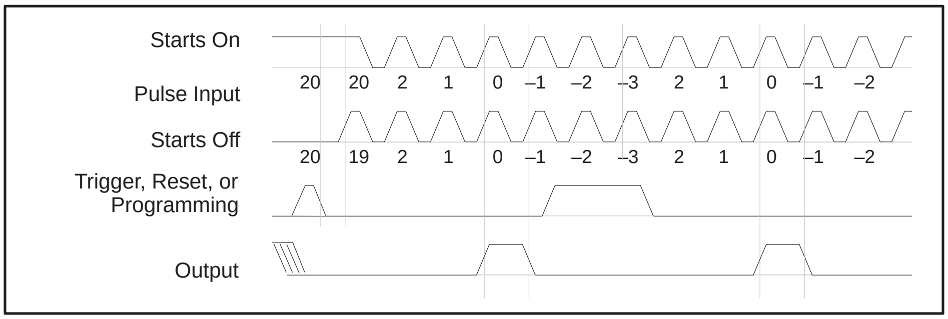


Figure 1-15 Triggered Strobe Mode

Square-Wave Generator Even Preset Value

The square-wave generator generates an active output for one-half of the preset number of clocks. The length of the down count cycle is the preset number of clocks.

For an even preset count, the preset is loaded, the output is Off, and the counter starts decrementing by two after the first clock pulse. The output turns On when the count value is zero. The counter automatically reloads the preset value into the counter and starts decrementing by two again.

The output turns Off when the count value is zero again. The counter automatically reloads the preset value into the counter and starts decrementing by two.

This cycle repeats until an Off Gate control signal pauses the counting. The output is On and Off for (preset value/2) clocks.

This cycle repeats until an high gate control signal pauses the counting. A gate can be an external input or the PLC can set the Reset Counter flags, WY19.03, .04, .07, or .08 corresponding to counter 2, 3, 5, or 6. When the gate is On, the counting pauses and the outputs turn Off. When the gate is released (turns Off) or the Reset Counter flag is cleared, the counter is loaded with the preset value, and counting resumes on the next valid clock.

The square-wave generator waveform, Figure 1-16, shows that for an even initial preset value of four, the output is Off and remains Off until the counter decrements to one-half the initial value. When the counter counts the preset value down (two clocks On and two clocks Off), the output goes On for the other half of the initial count. The gate input Off enables the counter; On inhibits the counter.

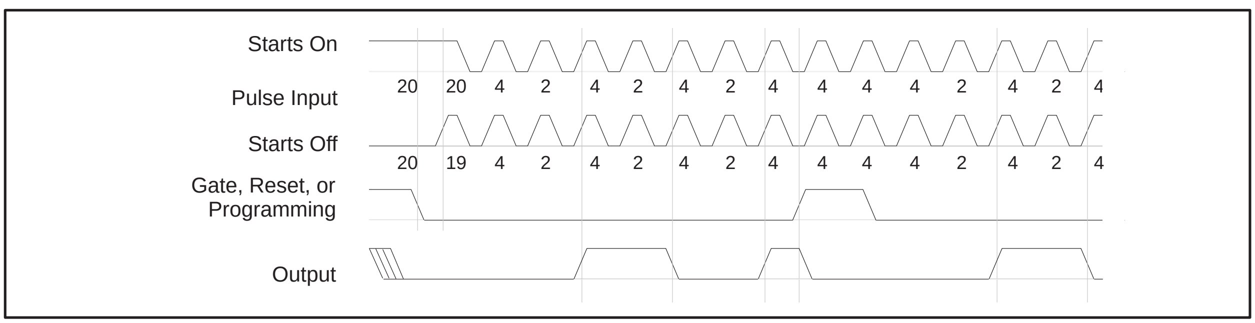


Figure 1-16 Square-Wave Generator (Even Preset Value)

Square Wave Generator Odd Preset Value

For an odd preset value, the preset – 1 value is loaded, and the counter starts decrementing by two after the first clock pulse. The output turns On when the count value is zero and would underflow, however, the counter automatically reloads the preset + 1 value into the counter and starts decrementing by two.

The output turns Off when the count value is zero again. The counter automatically reloads the preset – 1 value into the counter and starts decrementing by two.

This cycle repeats until a high gate control signal pauses the counting. A gate can be an external input or the PLC can set the Reset Counter flags, WY19.03, .04, .07, or .08 corresponding to counters 2, 3, 5, or 6. When the gate goes On, the counting pauses and the outputs turn Off. When the gate is released (turns Off) or the Reset Counter flag is cleared, the counter is loaded with the preset value, and counting resumes on the next valid clock.

The square-wave generator waveform, Figure 1-17, shows that for an odd initial preset value of five, the output is Off and remains Off until the counter decrements to one-half the initial value. When the counter counts the preset value down (three clocks Off and two clocks On), the output goes On for the other half of the initial count. The gate input Off enables the counter; On inhibits the counter.

For an odd initial preset value, the output is On for ((N+1) / 2) counts and Off for ((N–1) / 2) counts. An initial count of five results in the waveform shown in Figure 1-17.

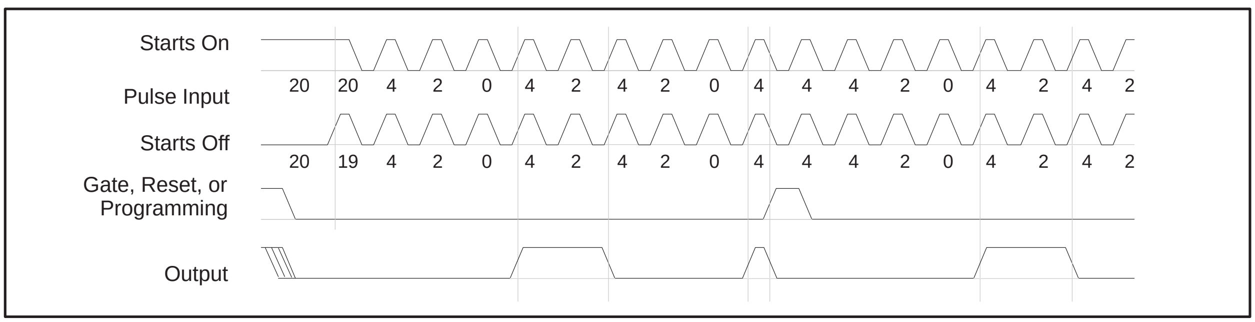


Figure 1-17 Square-Wave Generator (Odd Preset Value)

Chapter 2

Installing the Module

2.1 Overview of Installation

Flow of Tasks

Figure 2-1 shows the flow of tasks to follow when you install this module.

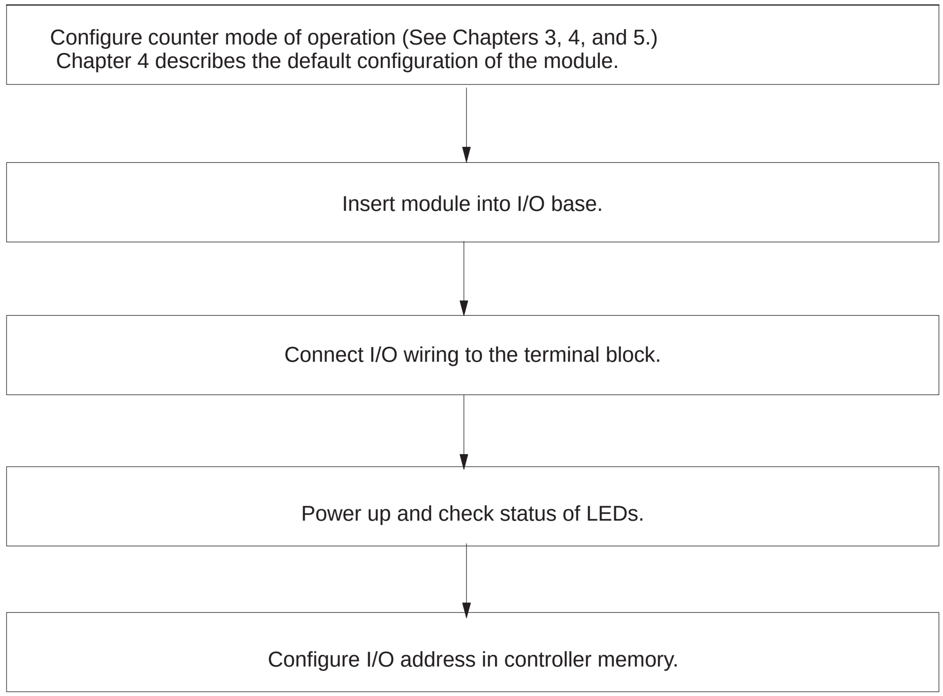


Figure 2-1 Flowchart of Installation

Handling the Module

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

Take the following precautions to help ensure that you and the module are at the same ground potential.

- Transport the module in an anti-static container or in anti-static material.
- Ensure that the work area has a conductive pad with a lead connecting it to a common ground.
- Ground yourself by making contact with the conductive pad and/or by wearing a grounded wrist strap

Visual Inspection

If there is any visible damage to the module, contact your vendor for replacement.

2.2 Inserting the Module into the Base

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

Inserting the Module

The HSCE module is a single-wide module. You can insert it into any available I/O slot on a Series 505 I/O base. To install the module, follow these steps.

1. Disconnect all power to the base and any modules in the base.
2. Position the HSCE module so that the bezel is facing you.
3. Grasp the top and bottom of the module.
4. Carefully push the module into the slot until it mates with the back-plane connector; see Figure 2-2. You will feel a slight increase in resistance as the module connects with the back-plane connector.
5. Tighten the top and bottom bezel screws. Note the minimum torque required for the screws to provide specified electromagnetic shielding.

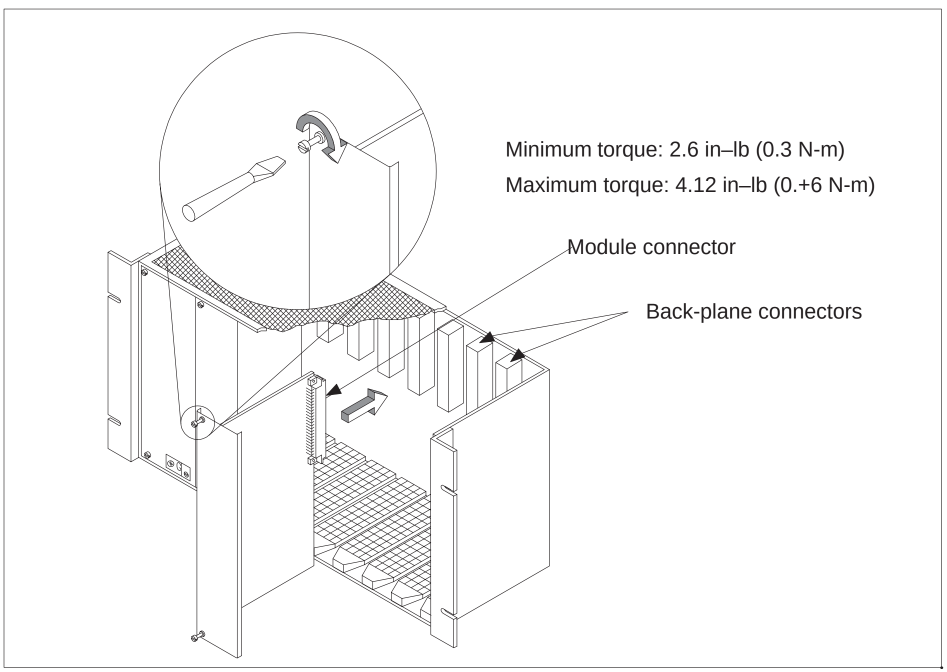


Figure 2-2 Inserting the Module into the I/O Base

2.3 Wiring the Module

I/O Connections

You should wire all of your input and output signals to the HSCE module removable terminal block. Table 2-1 lists the I/O connections together with a cross-reference listing of the terminals in numeric order

Table 2-1 I/O Connections

Terminal Block	Connection	Terminal Block	Connection
AR	Back-up Power RTN	AC	Back-up Power +
A1	Ch1 A–	A5	Ch1 A+
A2	Ch1 B–	A6	Ch1 B+
A3	Ch1 C–	A7	Ch1 C+
A4	Ch1 D–	A8	Ch1 D+
BR	Ch1 INDEX–	BC	Ch1 INDEX+
B1	Ch1 RESET–	B5	Ch1 RESET+
B2	Ch1 INHIBIT–	B6	Ch1 INHIBIT+
B3	Ch2 A–	B7	Ch2 A+
B4	Ch2 B–	B8	Ch2 B+
CR	Ch2 C–	CC	Ch2 C+
C1	Ch2 D–	C5	Ch2 D+
C2	Ch2 INDEX–	C6	Ch2 INDEX+
C3	Ch2 RESET–	C7	Ch2 RESET+
C4	Ch2 INHIBIT–	C8	Ch2 INHIBIT+
DR	RTN	DC	PWR+
D1	Output 2	D5	Output 1
D2	Output 4	D6	Output 3
D3	Output 6	D7	Output 5
D4	Output 8	D8	Output 7

Wiring 24 V User Power

The outputs are driven by external 24 VDC user-supplied power. Figure 2-3 shows the location of the terminals for connecting the 24 V power supply.

Wiring 12 V Back-up Power

The counters can continue counting, in the event of a power loss to the I/O base, if you provide 12 VDC back-up power to the module. Figure 2-3 shows the location of the terminals for connecting the 12 V back-up power.

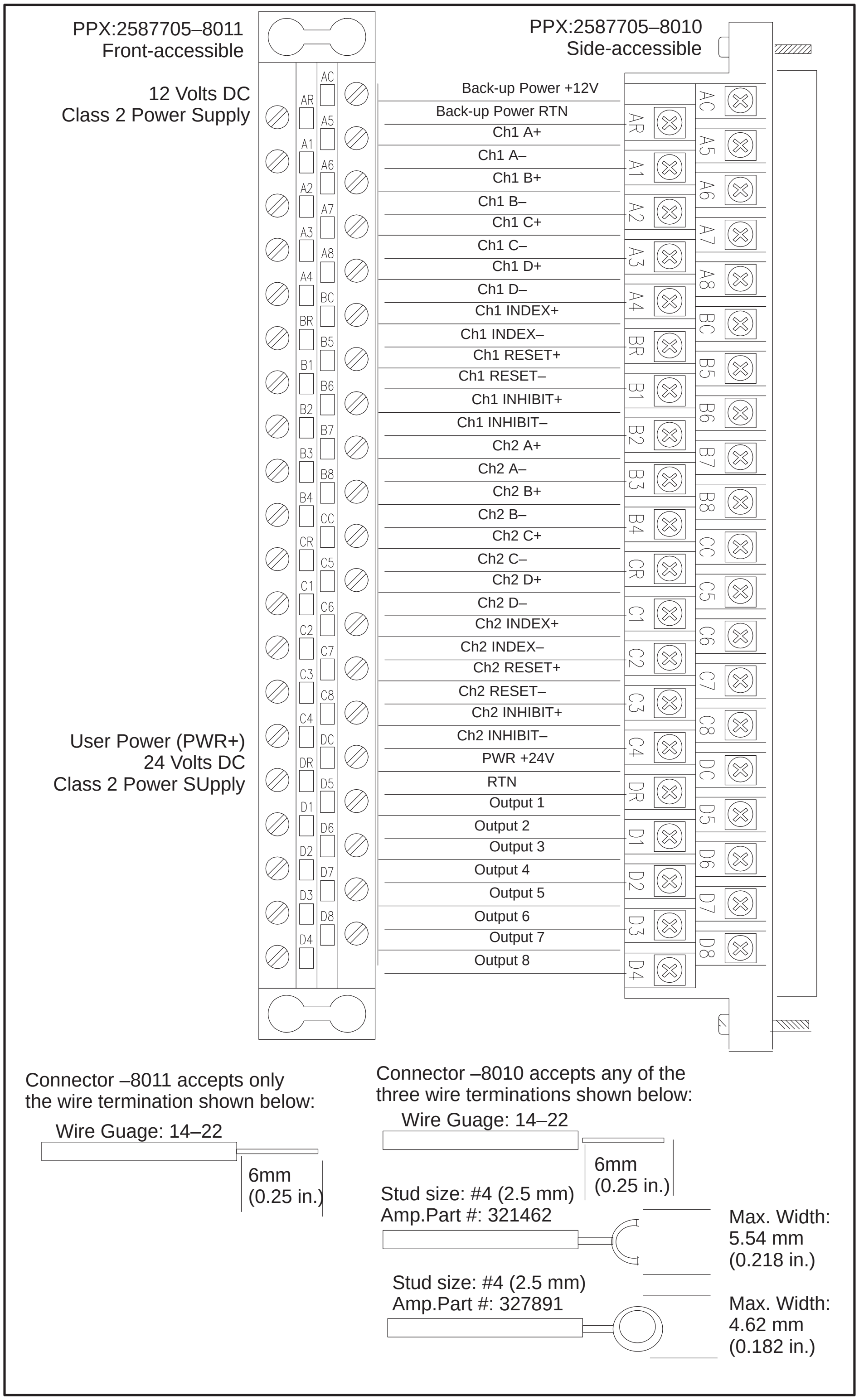


Figure 2-3 Terminal Blocks and I/O Connections

Wiring the Module (continued)

Wiring the Terminal Block

You wire the HSCE module by wiring the user power supply and input and output signals. All connections are made at the terminal block. To wire the terminal block, follow the procedure below.

1. Turn the terminal block, with the screw-heads facing you, until the A series of terminals is at the top and the D series is at the bottom.

2. Start with the D series and loosen the appropriate terminal block screws.

3. Strip back the insulation on the wires about 1/4″ to 3/8″ or 6 mm. Use a 14–22 AWG or a 0.16–3.2 mm^2 metric gauge wire of either stranded or solid type. (If you are using the side-accessible connector, PPX:2587706–8010, a spade or a ring lug may be attached to the end of the wire.)

4. Connect the end of the wire to the loosened terminal block screw and tighten the screw firmly. Once the D series is completed, connect the C series, and continue until the terminal block is completely wired.

NOTE: A stick-on label is provided separately with space available to identify inputs and outputs. Write in the corresponding input or output names and apply the label to the flat side of the terminal block. Appendix B contains worksheets to help you document the input and output labeling.

Wiring Guidelines

Separate the power supply wiring from the signal wiring to avoid introducing noise on the input data lines.

To minimize unwanted noise, follow these wiring guidelines:

- Use the shortest possible wires.
- Avoid placing signal wires parallel to high-energy wires. If the two wires 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 do not interfere with existing wiring.
- Label the wires.

Wiring the Inputs

Input connections to the module can be electronic output drive devices or mechanical switches.

Figure 2-4 shows an example of wiring electronic encoder outputs to the input terminals of the module for a non-inverted signal.

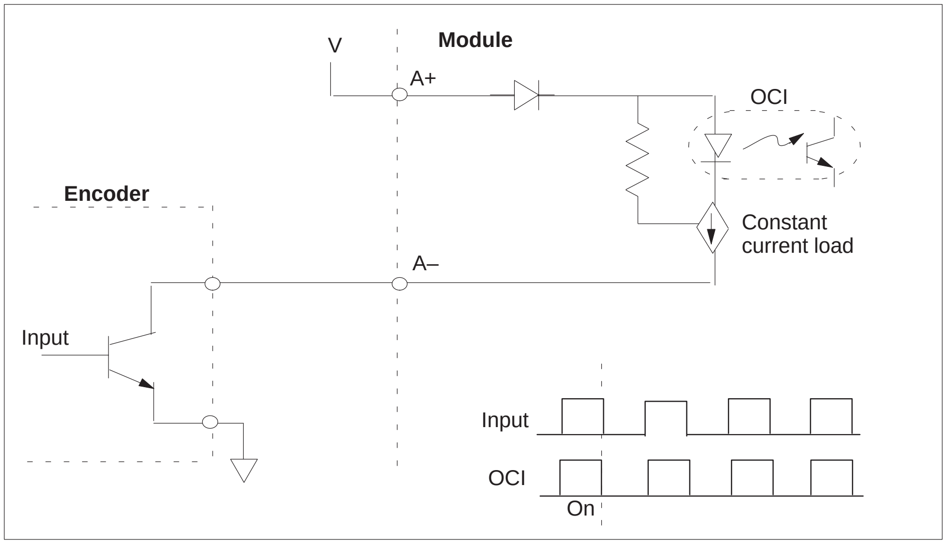


Figure 2-4 Non-Inverted Input Drive

Figure 2-5 shows an example of wiring electronic encoder outputs to the input terminals of the module for an inverted signal.

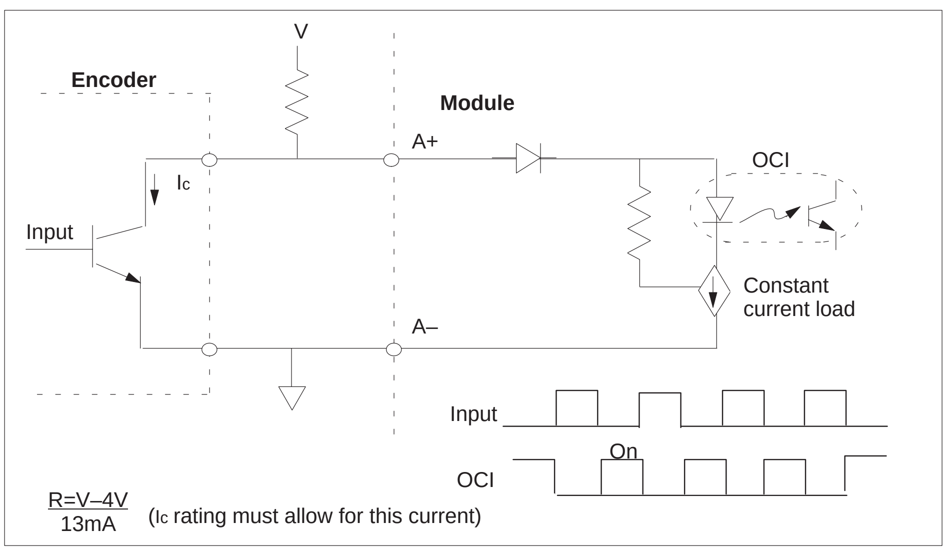


Figure 2-5 Inverted Input Drive

Figure 2-6 shows an example of wiring differential line drive inputs.

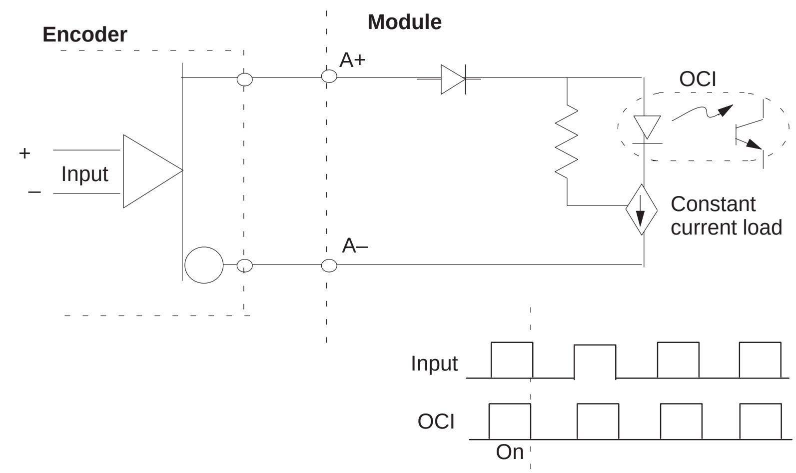


Figure 2-6 Differential Line Drive

Table 2-2 Features of Electronic Drives

Open Collector or Single-Ended	Differential Drives
• 5 to 24 V • Source or sink • Polarity selection • Multiple input drive capability • Can drive long cable lengths	• Normally 5 V • Polarity selection • Voltage and current ratings may not drive input. • Active on and off drive

Figure 2-7 shows an example of wiring mechanical switch inputs. (Note that with mechanical switches, the contacts can “bounce” when switched.)

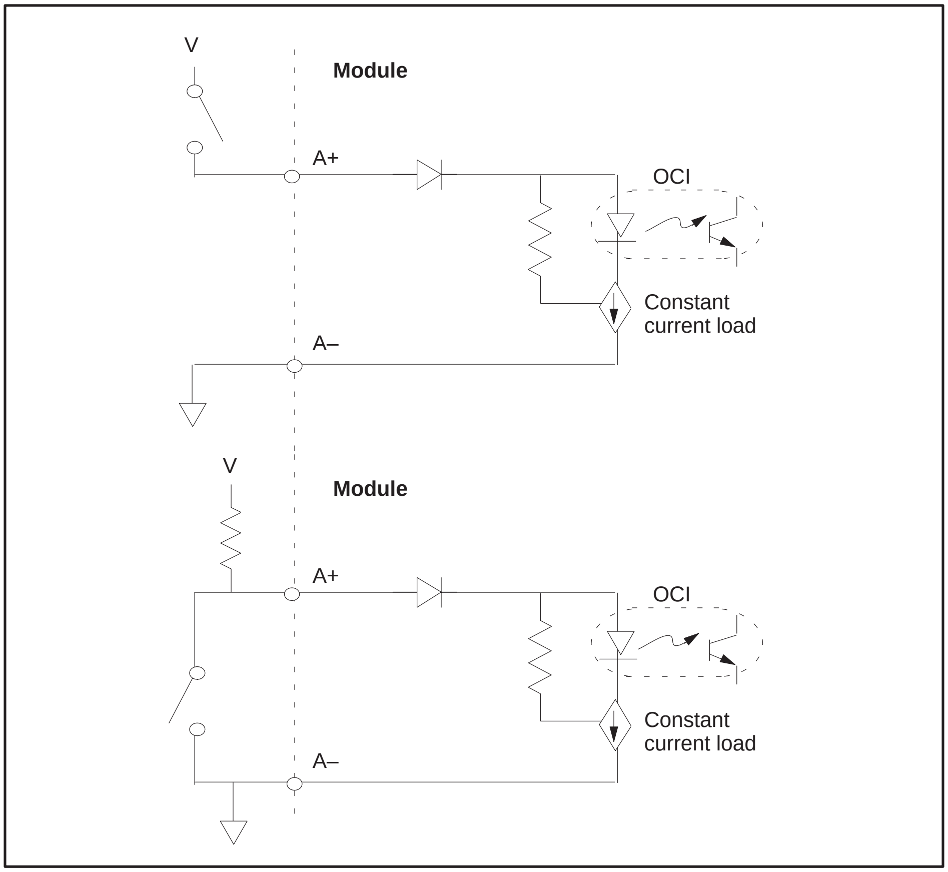


Figure 2-7   Mechanical Switches

Wiring the Outputs

Figure 2-8 shows an example of output wiring.

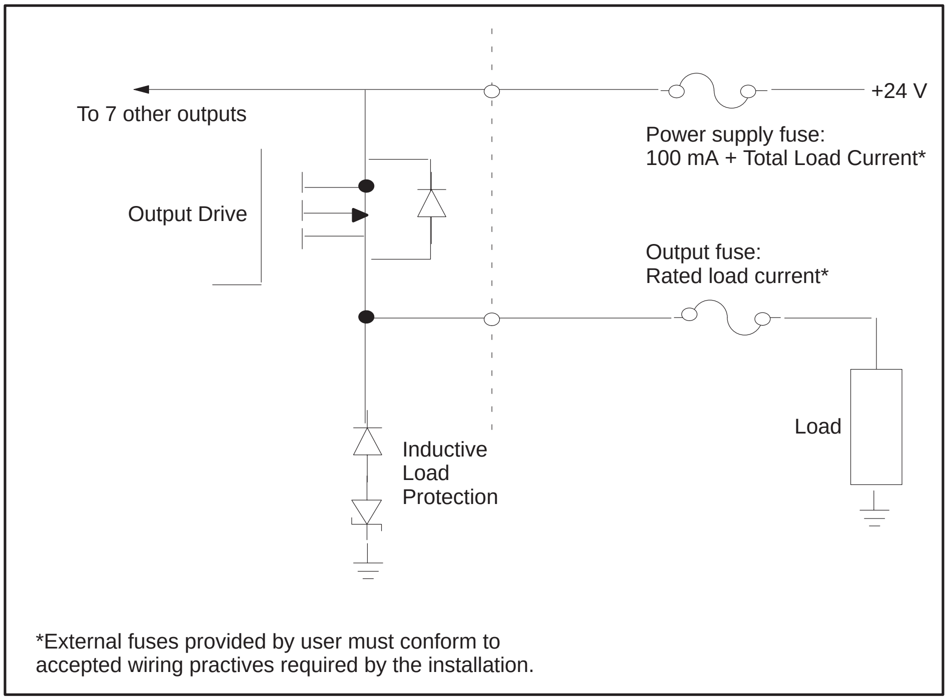


Figure 2-8 Output Wiring

Connecting the Terminal Block

To connect the terminal block to the module, follow these steps. (See Figure 2-9.)

1. Align the terminal block with the edge card connector on the bezel.
2. Press firmly at both ends of the terminal block until it is seated.
3. Tighten the screws at the top and bottom. Do not over-tighten.

Not Available in Electronic Format.

Refer to your hard copy.

Figure 2-9 Connecting the Terminal Block

2.4 Powering Up the Base

Supplying Power to the I/O Base

Refer to the system manual for your controller for information on installing and wiring the power supply for your I/O base. Follow all installation guidelines and safety considerations described in your system manual before powering up the system.

After installing the module, power up the I/O base and observe the status of the LEDs on the front of the module. (Refer to Figure 2-10.)

LED Status after Power-Up

When you power up the base, the module executes a diagnostic check. The power-up diagnostics take less than a second.

The MOD GOOD LED (red) lights to indicate that the module is functional.

The RUN LED (green) blinks; the module has not been programmed. When the Program Module setup bit (WY20.01) is set, the RUN LED stops blinking and is off. When this bit is cleared, either the RUN LED turns on and remains steady, or it blinks in a different pattern to indicate that other fault conditions have been detected. (see Table B-1 in Appendix B).

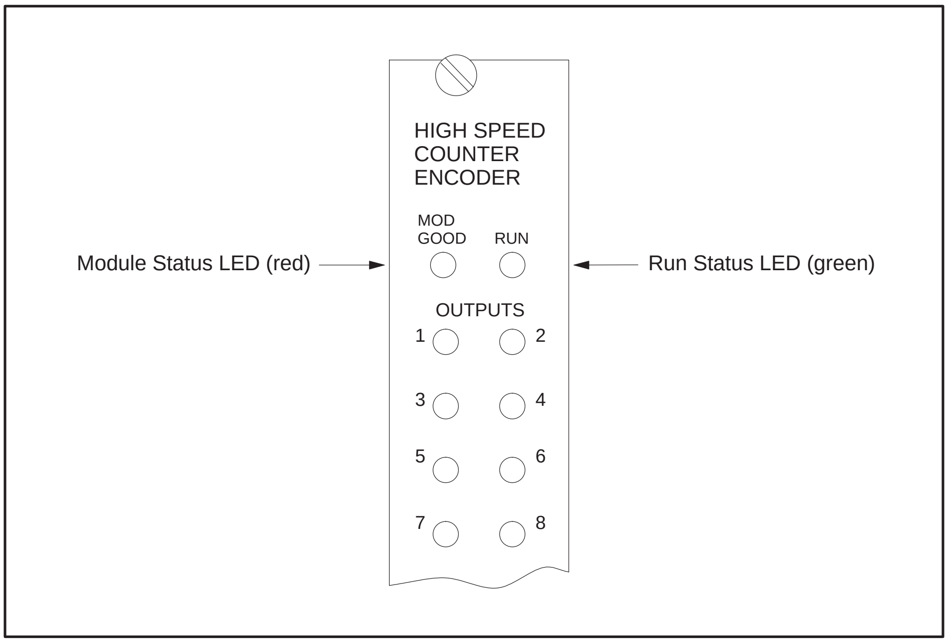


Figure 2-10 LED Indicators

2.5 Configuring I/O Addresses in the Controller

After installing the module in the I/O base, you must assign the I/O starting address in your programmable controller (PLC) memory. (The module is not automatically assigned an I/O address in the controller.)

NOTE: Even though the module may appear to be operating correctly, it does not communicate with the PLC unless it is configured in the I/O map.

To confirm the I/O map and verify controller-to-module communications, connect a PLC programming device (e.g., TISOFT™) to the controller. (For information on configuring the I/O, refer to your *SIMATIC TI505 TISOFT2 User Manual*.) Power up the base and follow these steps:

1. Ensure that the MOD GOOD indicator is on and the error bit is clear.

2. In TISOFT, access the Configure I/O function menu.

3. Select the appropriate channel and base number.

4. Execute the Read Base function.

   The HSCE module appears as 18 WX inputs and 14 WY outputs. In the example shown in Figure 2-11, the module is located in slot 1. It uses 32 I/O address locations.

5. Assign the starting I/O address and write the completed I/O configuration to the controller memory, using the Write PLC functions. In the example for slot 1, the starting address is set for 0001.

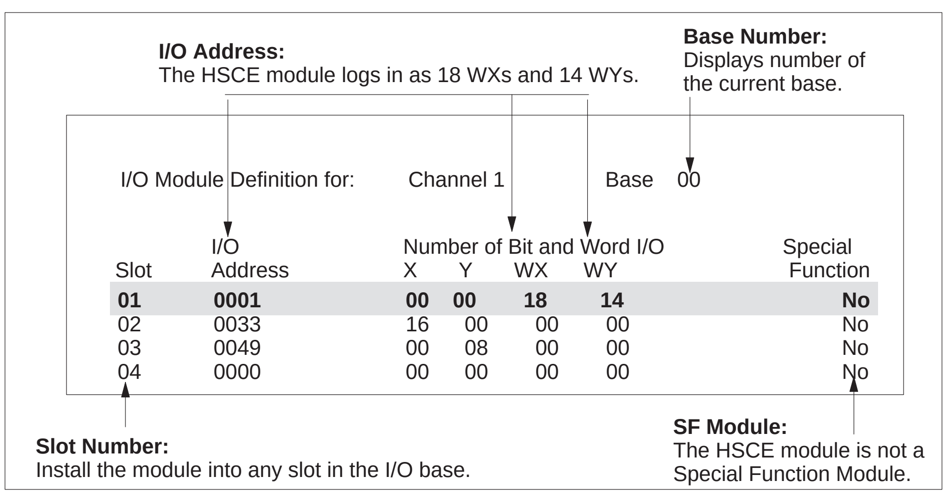


Figure 2-11 Sample I/O Module Definition Chart

Chapter 3

Understanding Module Operation

3.1 Module I/O Map

PLC-to-Module Communications Overview

The HSCE module communicates with the PLC using word inputs and word outputs. The PLC reads current count values, holding registers, and module status bits from word inputs. Word outputs contain user-defined counter configuration setups and preset values.

I/O Word Definitions

Table 3-1 lists the definitions for the word inputs (WX) and the word outputs (WY), relative to a starting address of 1. If you assign a different starting address for your I/O configuration, then all the address numbers are relative to that starting address. For example, if you assign 9 as the starting address, then WX1 through WX18 in the table become WX9 through WX26, and WY19 through WY32 become WY27 through WY40.

Table 3-1 I/O Configuration Table

Word	Description	Counter
WX1	Current count value, high word	Counter 1
WX2	Current count value, low word	Counter 1
WX3	Current count value, word	Counter 2
WX4	Current count value, word	Counter 3
WX5	Current count value, high word	Counter 4
WX6	Current count value, low word	Counter 4
WX7	Current count value, word	Counter 5
WX8	Current count value, word	Counter 6
WX9 WX10 WX11 WX12	Holding Register 1, high word Holding Register 1, low word Holding Register 2, high word Holding Register 2, low word	Counter 1
WX13 WX14 WX15 WX16	Holding Register 3, high word Holding Register 3, low word Holding Register 4, high word Holding Register 4, low word	Counter 4
WX17 WX18	Module STATUS, high word Module STATUS, low word	(See Table 3-6)
WY19 WY20	SETUP Word, high word SETUP Word, low word	(See Table 3-8 and Table 3-9)
WY21 WY22 WY23 WY24	Preset 1, high word Preset 1, low word Preset 2, high word Preset 2, low word	Counter 1
WY25	Preset 3, word	Counter 2
WY26	Preset 4, word	Counter 3
WY27 WY28 WY29 WY30	Preset 5, high word Preset 5, low word Preset 6, high word Preset 6, low word	Counter 4
WY31	Preset 7, word	Counter 5
WY32	Preset 8, word	Counter 6

I/O Words Grouped by Counter

Figure 3-1 shows how the WX and WY words are grouped by counter to help you configure each counter in the HSCE module.

Channel 1

Counter 1 — 24-Bit	
Current Count:	WX1 & WX2
Holding Register #1:	WX9 & WX10
Holding Register #2:	WX11 & WX12
Preset #1:	WY21 & WY22
Preset #2:	WY23 & WY24

Counter 2 — 16-Bit	
Current Count:	WX3
Preset #3:	WY25

Counter 3 — 16-Bit	
Current Count:	WX4
Preset #4:	WY26

Channel 2

Counter 4 — 24-Bit	
Current Count:	WX5 & WX6
Holding Register #3:	WX13 & WX14
Holding Register #4:	WX15 & WX16
Preset #5:	WY27 & WY28
Preset #6:	WY29 & WY30

Counter 5 — 16-Bit	
Current Count:	WX7
Preset #7:	WY31

Counter 6 — 16-Bit	
Current Count:	WX8
Preset #8:	WY32

Figure 3-1 Word Inputs and Word Outputs Grouped by Counter

3.2 Data Formats

Current Count and Holding Register Count Value Formats

The current count value for each 24-bit counter is contained in two word inputs (for example, WX1 and WX2).

- The count range is from 0 to 16,777,215 in unipolar mode.
- The count range is from +8,388,607 to –8,388,608 in bipolar mode.
- Overflow and underflow occur at the 0 value.

Table 3-2 shows the word format for the current count and Holding Register values for the 24-bit counters (Counters 1 and 4).

Table 3-2 24-Bit Count Value Format

Word	MSByte								LSByte							
MSWord	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
LSWord	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16

The count values for Counters 1 and 4 are contained in the following words:

- Counter 1: Count value: WX1 and WX2
- Counter 4: Count value: WX5 and WX6

The Holding Registers for Counters 1 and 4 are the following words:

- Counter 1: Holding Register 1: WX9 and WX10
  Holding Register 2: WX11 and WX12
- Counter 4: Holding Register 3: WX13 and WX14
  Holding Register 4: WX15 and WX16

You can select one of the following two's-complement formats to express the unipolar and bipolar word values:

- 32-bit signed integer format:
  smmmmmmm mmmmmmmm mmmmmmmm mmmmmmmm
- Double 16-bit signed integer format:
  saaaaaaa aaaaaaaa sbbbbbbb bbbbbbbb
  where the numeric value is calculated as:
  ((saaaaaaa aaaaaaaa) *32768 + (sbbbbbbb bbbbbbbb))

24-Bit Preset and Configuration Formats

Each 24-bit counter has two preset values to control two outputs, as listed in Table 3-1 and shown in Figure 3-1. The 24-bit unipolar value for each preset is contained in the lower byte of the most significant word and both bytes of the least significant word, as shown by the shaded areas in Table 3-3. The upper byte of the most significant word is used to configure the counters and outputs.

Table 3-3 24-Bit Preset Value Format

Word	MSByte								LSByte							
MSWord	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
LSWord	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16

16-Bit Count and Preset Value Formats

The current count value for each 16-bit counter is contained in a one word input, (for example, WX3 for Counter 2). The preset value for each 16-bit counter uses a single word output, (for example, WY25 for Counter 2). The format for the count value and preset value is shown in Table 3-4.

Table 3-4 16-Bit Value Format

Word	MSByte								LSByte							
WX/WY	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16

- The count range is from 0 to 65535 (2^{16}) in integer format.
- The count range is from –32768 to +32767 (2^{16}) in signed integer format.
- Overflow and underflow occur at about the 0 value.

The module handles all values and presets as unipolar format. You can choose to handle the values in either integer or signed integer format.

3.3 Reading Module Status

Module Status Words

The PLC reads the module status bits in word inputs WX17 and WX18. The on/off status of the eight outputs, count direction, interrupts, module mode, error conditions, and other indicators are contained in these words, listed in Table 3-6. (Status word format is shown in Table 3-5.)

Table 3-5 Module Status Words

Word	MSByte								LSByte							
WX17	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
WX18	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16

Table 3-6 Bit Definitions for Status Words WX17 and WX18

Word.Bit	Description	
WX17.01	Not used (0)	
WX17.02	Not used (0)	
WX17.03	Ch1, Counters 2 and 3: count up when bit is set, count down when bit is cleared	
WX17.04	Ch1, Counter 1: Quadrature direction; count up when bit is set, count down when bit is cleared*	
WX17.05	Ch1, Counter 1: Sign; set after counter is reset or when it overflows; cleared when it underflows	
WX17.06	Ch1, Counter 1: Compare Toggle; cleared after a counter reset; toggles when count equals preset	
WX17.07	Ch1, Counter 1: Carry Toggle; cleared after a counter reset; toggles when counter overflows	
WX17.08	Ch1, Counter 1: Borrow Toggle; cleared after a counter reset; toggles when counter underflows	
WX17.09	Not used (0)	
WX17.10	Not used (0)	
WX17.11	Ch2, Counters 5 and 6: count up when bit is set, count down when bit is cleared	
WX17.12	Ch2, Counter 4: Quadrature direction; count up when bit is set, count down when bit is cleared*	
WX17.13	Ch2, Counter 4: Sign; set after counter is reset or when it overflows; cleared when it underflows	
WX17.14	Ch2, Counter 4: Compare Toggle; cleared after a counter reset; toggles when count equals preset	
WX17.15	Ch2, Counter 4: Carry Toggle; cleared after a counter reset; toggles when counter overflows	
WX17.16	Ch2, Counter 4: Borrow Toggle; cleared after a counter reset; toggles when counter underflows	
WX18.01	Module in Run mode (Run flag)	
WX18.02	Update Preset values complete	
WX18.03	Error Flag	
WX18.04	User output power failure detected, or voltage below limits for proper operation	
WX18.05	Interrupt function is enabled	
WX18.06	Latched Interrupt is active	
WX18.07	Outputs are disabled	
WX18.08	Counters 1 & 4 count format: double 16-bit signed integer (0) or 32-bit signed integers (1)	
	WX18.01 = 1, 18.06 = 0	**Interrupt Active Mode (WX18.01 = 1 and WX18.06 = 1)**
WX18.09	Output 8 On/Off status	Output 8 has changed state, causing interrupt request to the PLC
WX18.10	Output 7 On/Off status	Output 7 has changed state, causing interrupt request to the PLC
WX18.11	Output 6 On/Off status	Output 6 has changed state, causing interrupt request to the PLC
WX18.12	Output 5 On/Off status	Output 5 has changed state, causing interrupt request to the PLC
WX18.13	Output 4 On/Off status	Output 4 has changed state, causing interrupt request to the PLC
WX18.14	Output 3 On/Off status	Output 3 has changed state, causing interrupt request to the PLC
WX18.15	Output 2 On/Off status	Output 2 has changed state, causing interrupt request to the PLC
WX18.16	Output 1 On/Off status	Output 1 has changed state, causing interrupt request to the PLC

*When counter is in non-quadrature mode, this bit is set.

The following paragraphs provide expanded definitions for status word WX18.

WX18.01, RUN Mode

RUN mode flag is set when the module is in the Run Mode. The flag is cleared in Program Mode or when an error has been detected. When the module is not in the Run Mode, the output drive and Interrupt functions are disabled.

WX18.02, Presets Updated

The presets updated flag indicates that the module has updated the counters with Preset values. Requested when WY20.02 is set. All counters are affected.

WX18.03, Error Detected

The error detected flag indicates an error has been detected. The Current Count and Holding Register WX locations may contain error codes when an error is detected. See Appendix B for the error code listing.

WX18.04, Power Failure Detected

The power failure flag indicates a loss of 24 V user power, or that the voltage is below the limits set for proper operation of the output circuitry.

WX18.05, Interrupt Function Enabled

The interrupt enabled flag indicates that the interrupt function is enabled, and will request an interrupt service, TASK 8, from the PLC when an output changes state. The outputs that can cause an interrupt are set in bits WY19.09 through 16. Refer to the *SIMATIC TI505 Programming Reference Manual* (PPX:505–8104–4 or later) for interrupt information.

WX18.06, Interrupt Request Active

The interrupt request flag indicates that an interrupt request has been generated. The flag is cleared by setting bit WY20.06.

WX18.07, Outputs Disabled

The outputs disabled flag indicates that the output drives are disabled. All of the outputs are off.

WX18.08, Count Format for Counters 1 and 4

The count format flag indicates the format of the Counter 1 and 4 data words. When this bit is cleared, each value is represented as two 16-bit signed integers. When set, each value is represented as a 32-bit signed integer. The format of the presets is not affected.

WX18.09 through WX18.16

With bit WX18.06 clear, each bit .09 through .16 is set when the corresponding Output 1 through 8 is on. A bit is clear when the corresponding output is off.

A counter or the PLC can activate the outputs. Either the counter or the PLC can turn the output on, but both have to be off to turn an output off. Consequently, the PLC cannot force an individual output off, but it can disable all outputs by setting WY20.04 as shown in Table 3-9.

With bit WX18.06 set (Interrupt Active), these bits indicate which output(s) have changed state and generated an interrupt request to the PLC.

3.4 Configuring Program Mode Setup Words

Setup Words: Program Mode

You can use WY19 and WY20 to choose specific counter input or output options in Program Mode, as listed in Table 3-8. (The format is shown in Table 3-7.)

Table 3-7 Module Setup Words

Word	MSByte								LSByte							
WY19	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
WY20	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16

Table 3-8 Bit Definitions for the Program Mode Setup Words

Word.Bit	Description of Bit Functions for PROGRAM Mode	
	At start of Program Mode, all of the counters are inhibited and reset.	
WY19.01	Ch1, Counter 1: Inhibit; counting pauses while set.	
WY19.02	Ch1, Counter 1: Reset Counter; count value is cleared to 0 when set. Reset and Go function.	
WY19.03	Ch1, Counter 2: Reset Counter; count value is cleared to 0 when set. Reset and Go function.	
WY19.04	Ch1, Counter 3: Reset Counter; count value is cleared to 0 when set. Reset and Go function.	
WY19.05	Ch2, Counter 4: Inhibit; counting pauses while set.	
WY19.06	Ch2, Counter 4: Reset Counter; count value is cleared to 0 when set. Reset and Go function.	
WY19.07	Ch2, Counter 5: Reset Counter; count value is cleared to 0 when set. Reset and Go function.	
WY19.08	Ch2, Counter 6: Reset Counter; count value is cleared to 0 when set. Reset and Go function.	
WY19.09	Output 8 interrupt enable bit; Output 8 can trigger an interrupt	
WY19.10	Output 7 interrupt enable bit; Output 7 can trigger an interrupt	
WY19.11	Output 6 interrupt enable bit; Output 6 can trigger an interrupt	
WY19.12	Output 5 interrupt enable bit; Output 5 can trigger an interrupt	
WY19.13	Output 4 interrupt enable bit; Output 4 can trigger an interrupt	
WY19.14	Output 3 interrupt enable bit; Output 3 can trigger an interrupt	
WY19.15	Output 2 interrupt enable bit; Output 2 can trigger an interrupt	
WY19.16	Output 1 interrupt enable bit; Output 1 can trigger an interrupt	
WY20.01	Program module counters	
WY20.02	User 24 V power supply fault fails module	
WY20.03	Read and hold counter values on Reset and power-up	
WY20.04	Counters 1 & 4: double 16-bit (0) or 32-bit (1) signed integer format	
WY20.05	Ch1, 24-bit Counter 1: unipolar (0) or bipolar (1) count format	
WY20.06	Ch2, 24-bit Counter 4: unipolar (0) or bipolar (1) count format	
WY20.07	Channel 1, 16-bit Counters 2 and 3: Down (0) or Up (1) counting	
WY20.08	Channel 2, 16-bit Counters 5 and 6: Down (0) or Up (1) counting	
WY20.09	Channel 1, Counter 2: M_1	
WY20.10	Channel 1, Counter 2: M_2	*16-Bit Counter Mode of Operation:*
WY20.11	Channel 1, Counter 3: M_1	**M_1 M_2 Description**
WY20.12	Channel 1, Counter 3: M_2	0 0 Retriggerable one-shot
WY20.13	Channel 2, Counter 5: M_1	0 1 Divide-by-N
WY20.14	Channel 2, Counter 5: M_2	1 0 Square Wave
WY20.15	Channel 2, Counter 6: M_1	1 1 Triggered Strobe
WY20.16	Channel 2, Counter 6: M_2	

The following paragraphs provide expanded definitions for setup words WY19 and WY20 in Program mode.

Program Mode Definitions

At the start of Program Mode, all counters are inhibited and reset. When programming is complete, WX18.02 is set and WY19.01 through WY19.08 function normally.

Interrupt Enable Bits: WY19.09 through WY19.16

In Program Mode, when you set any Interrupt Enable bit, the corresponding output is programmed as an interrupt source. When that output changes state during RUN mode, an interrupt request to the PLC is generated.

Program Mode Flag Bit: WY20.01

The Program Mode flag is set to start programming the counters. You must set all other preset and programming words before this bit is set. While WY20.01 is set, output drive and Interrupt functions are disabled. Bit WX18.01 is cleared.

User Power Supply Fault Bit: WY20.02

When the user power supply fault bit is set, and the user power supply fails or drops below the minimum voltage for proper operation, the module fails. Bits WX18.04 (power failure detected) and WX18.07 (outputs disabled) are set; bits WX18.09 through WX18.16 are cleared, indicating all outputs are off. The PLC records the module as failed. Restoring power removes the fault. When WY20.2 is cleared and user power is lost, WX18.04 is set; bit WX18.07 is cleared; bits WX18.09 through WX18.16 function normally; the outputs remain operational, and a module failure is not reported

Read Values at Power-Up Bit: WY20.03

During the first module programming request after base power recovers, the counter values are read and placed into the Holding Registers. As long as the programming bit remains set, these values can be read by the PLC.

Data Format Bit: WY20.04

The data format bit selects the data format for Counters 1 and 4: double 16-bit (0) or 32-bit (1) signed integer format.

Select Counter 1 Format Bit: WY20.05

Select Counter 1 bit selects a bipolar count format for Counter 1. Clear this bit to select a unipolar count format for Counter 1.

Select Counter 4 Format Bit: WY20.06

Select Counter 4 bit selects a bipolar count format for Counter 4. Clear this bit to select a unipolar count format for Counter 4.

Up/Down Counting Bit: WY20.07

Set the up/down counting bit to select up-counting for Counters 2 and 3. Clear the bit to select down-counting for Counters 2 and 3.

Up/Down Counting Bit: WY20.08

Set the up/down counting bit to select up-counting for Counters 5 and 6. Clear the bit to select down-counting for Counters 5 and 6.

16-Bit Counter Mode Bits: WY20.09 through WY20.16

Table 3-8 shows that each of the 16-bit counters is programmed by a pattern of two bits: 0 0 for retriggerable one-shot operation, 0 1 for divide-by-N counting, 1 0 for square wave counting, and 1 1 for triggered strobe.

3.5 Configuring Run Mode Setup Words

Setup Words: Run Mode

Table 3-9 shows that you can use WY19 and WY20 to choose specific counter input or output options that are programmable when the module is in Run Mode. These options can be selected only with bit WY20.01 cleared, which puts the module in Run Mode.

Table 3-9 Bit Definitions for the Run Mode Setup Words

Word.Bit	Description of Bit Functions for RUN Mode
WY19.01	Ch1, Counter 1: Inhibit; counting pauses while set.
WY19.02	Ch1, Counter 1: Reset Counter; count value is cleared to 0 when set. Reset and Go function.
WY19.03	Ch1, Counter 2: Reset Counter; count value is cleared to 0 when set. Reset and Go function.
WY19.04	Ch1, Counter 3: Reset Counter; count value is cleared to 0 when set. Reset and Go function.
WY19.05	Ch2, Counter 4: Inhibit; counting pauses while set.
WY19.06	Ch2, Counter 4: Reset Counter; count value is cleared to 0 when set. Reset and Go function.
WY19.07	Ch2, Counter 5: Reset Counter; count value is cleared to 0 when set. Reset and Go function.
WY19.08	Ch2, Counter 6: Reset Counter; count value is cleared to 0 when set. Reset and Go function.
WY19.09	Force Output 8 ON
WY19.10	Force Output 7 ON
WY19.11	Force Output 6 ON
WY19.12	Force Output 5 ON
WY19.13	Force Output 4 ON
WY19.14	Force Output 3 ON
WY19.15	Force Output 2 ON
WY19.16	Force Output 1 ON
WY20.01	Program module counters
WY20.02	Update Preset values
WY20.03	Latch holding registers; prevents Index or Period from updating values in Holding Registers.
WY20.04	Disable outputs
WY20.05	Enable interrupt
WY20.06	Clear interrupt latch
WY20.07	Clear Output 1 latch, set by Preset 1.
WY20.08	Clear Output 5 latch, set by Preset 5.
	Note Used in Run Mode
WY20.09	Reserved (0)
WY20.10	Reserved (0)
WY20.11	Reserved (0)
WY20.12	Reserved (0)
WY20.13	Reserved (0)
WY20.14	Reserved (0)
WY20.15	Reserved (0)
WY20.16	Reserved (0)

The following options can only be selected with bit WY20.01 cleared, which puts the module in Run Mode.

Inhibit Bits: WY19.01 and WY19.05

While the inhibit bit is set, it inhibits (pauses) the counting of Counter 1 and bit WY19.05 inhibits the counting of Counter 4.

Reset Bits: WY19.02 and WY19.06

When set, Reset Counter 1 (WY19.02) and Counter 4 (WY19.06) clears the count value to 0. The reset bit provides the Reset-and-Go function.

Reset Bits: WY19.03, 04 and WY19.07, 08

When set, Reset 16-bit Counters 2 and 3 (WY19.03 and WY19.04) and 16-bit Counters 5 and 6 (WY19.07 and WY19.08) functions as a trigger or gate to the counter.

Force Output Bits: WY19.09 through WY19.16

Table 3-9 shows that setting a bit from WY19.09 through WY19.16 forces the corresponding output on.

Program Mode Flag Bit: WY20.01

Set the PROGRAM mode flag to place the module in Program Mode. After programming the module with the required presets and programming values, clear the Program Mode flag to place the module in RUN Mode. If no fault is found by the module, bit WX18.01 (module in RUN Mode) is set.

Update Preset Values Bit: WY20.02

The update preset values bit reloads all the counters with their preset values. When all counters have been, loaded WX18.02 is set. For Counters 1 and 4, the current count values are not affected. The compare function uses the new preset values. For the divide-by-N mode, the preset is loaded and the counting resumes from the new preset value at the next rollover. For Counters 2, 3, 5 and 6, the count values are loaded with the new preset values, and counting starts on the next clock edges from the preset value.

Latch Holding Registers Bit: WY20.03

Set the latch holding registers bit to halt the INDEX or Period signals from updating the values in the Holding Registers.

Disable Outputs Bit: WY20.04

Set the disable outputs bit to disable all outputs, turning them off.

Enable Interrupt Mode Bit: WY20.05

Set the enable interrupt mode bit to enable the Interrupt function. Outputs that have been enabled in bits WY19.09 through WY19.16 can now cause an interrupt request to be generated. Bit WX18.06 is set to indicate that an interrupt request is active.

Clear Interrupt Bit: WY20.06

Set the clear interrupt bit to clear an interrupt request. Once an interrupt request has been generated, additional changing outputs are OR'ed into WX18.09 through WX18.16. Setting this flag clears bit WX18.06, and bits WX18.09 through WX18.16 resume as output status indicators.

Clear Output Latches Bits: WY20.07 and WY20.08

Set bit WY20.07 to clear Output 1 latch, set by preset 1 (Counter 1).
Set bit WY20.08 to clear Output 5 latch, set by preset 5 (Counter 4).

3.6 Setting Preset Values and Programming Options for Channel 1

Channel 1, 24-Bit Counter 1, Preset 1

The lower byte of WY21 and all of WY22 contain the Preset 1 24-bit integer value. Use the upper byte of WY21 to configure programming values. Together, the preset value and the programming values determine the count method and how Output 1 functions when count and preset are equal, or when the count value overflows or underflows. Table 3-10 (shaded areas) shows the word formats. Table 3-11 lists the programming values of WY21.

Table 3-10 Channel 1, 24-Bit Counter: Preset 1 Value

Word	MSByte								LSByte							
WY21	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
WY22	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16

Table 3-11 Channel 1, 24-Bit Counter: WY21 Programming Bit Values

Bit Position								Description
01	02	03	04	05	06	07	08	**Mode**
0	0	0						Direction counting (count: input A, direction: input B)
0	0	1						
0	1	0						Up/Down counting (count up: input A, count down: input B)
0	1	1						
1	0	0						Quadrature 1X (input A pulses, input B pulses)
1	0	1						Quadrature 2X (input A pulses, input B pulses)
1	1	0						Quadrature 4X (input A pulses, input B pulses)
1	1	1						
01	02	03	04	05	06	07	08	**Counter Mode Setup**
			0	0	0			Binary counting, recycle mode
			0	0	1			Binary counting, non-recycle mode*
			0	1	0			Divide-by-N counting, recycle mode
			0	1	1			Divide-by-N counting, non-recycle mode*
01	02	03	04	05	06	07	08	**Internal Sample Interval**
			1	0	0			1 millisecond sample, (binary, recycle mode)
			1	0	1			10 millisecond sample, (binary, recycle mode)
			1	1	0			100 millisecond sample, (binary, recycle mode)
			1	1	1			1 second sample, (binary, recycle mode)
						0		Index or Period pulse latches counter value
						1		Index or Period pulse loads counter with preset 1 value
							0	Output Compare, Latch, Compare Toggle, (select jumper to match)
							1	Output Rollover, (select jumper to match)

*In this mode, the output is configured as borrow toggle and carry toggle. These outputs are the cycle completion indicator.

Channel 1, 24-Bit Counter 1, Preset 2

The lower byte of WY23 and all of WY24 contain the Preset 2 24-bit integer value. Use the upper byte of WY23 to configure programming values. Together, the preset value and the programming values determine the count method and how Outputs 1 and 2 function when the count and preset are equal, or the count value is less than or greater than the counter preset. All preset values are unipolar in format. The shaded areas of Table 3-12 show the word formats, and Table 3-13 lists the programming values of WY23.

Table 3-12 Channel 1, 24-Bit Counter: Preset 2 Value

Word	MSByte								LSByte							
WY23	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
WY24	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16

Table 3-13 Channel 1, 24-Bit Counter: WY23 Programming Bit Values

Bit Position								Description
01	02	03	04	05	06	07	08	
1								Current count updates on an INDEX or PERIOD
	0	0	0	0	0	0	0	PLC controls Output 2
	1	0	0	0	0	0	0	When Counter 1 value > Preset 2, set Output 2
	0	1	0	0	0	0	0	When Counter 1 value < Preset 2, set Output 2
	0	1	1	0	0	0	0	When Counter 1 value ≥ Preset 1 *and* ≤ Preset 2, set Output 2
	0	0	1	0				When Counter 1 = Preset 2, set Output 2
	0	0	0	1				When Counter 1 = Preset 2, toggle Output 2
					1	0		When Counter 1 = Preset 2, clear Counter 1
					0	1		When Counter 1 = Preset 2, reload Counter 1 with Preset 1
							1	When Counter 1 = Preset 2, clear Output 1 latch

Channel 1, 16-Bit Counter Presets

Table 3-14 and Table 3-15 shows the formats for the preset values (0 – 65535) for Counters 2 and 3.

Table 3-14 Channel 1, 16-Bit Counter 2: Preset 3 Value

Word	MSByte								LSByte							
WY25	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16

Table 3-15 Channel 1, 16-Bit Counter 3: Preset 4 Value

Word	MSByte								LSByte							
WY26	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16

3.7 Setting Preset Values and Programming Options for Channel 2

Channel 2, 24-Bit Counter 4, Preset 5

The lower byte of WY27 and all of WY28 contain the 24-bit integer Preset 5 value. Use the upper byte of WY27 to configure programming values. Together, the preset value and the programmed values determine the count method and how count Output 5 functions when count and preset are equal, or when the count value overflows or underflows. Table 3-16 shows the word formats, and Table 3-17 lists the programming values of WY27.

Table 3-16 Channel 2, 24-Bit Counter: Preset 5 Value

Word	MSByte								LSByte							
WY27	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
WY28	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16

Table 3-17 Channel 2, 24-Bit Counter: WY27 Programming Bit Values

Bit Position								Description
01	02	03	04	05	06	07	08	**Mode**
0	0	0						Direction counting (count: input A, direction: input B)
0	0	1						
0	1	0						Up/Down counting (count up: input A, count down: input B)
0	1	1						
1	0	0						Quadrature 1X (input A pulses, input B pulses)
1	0	1						Quadrature 2X (input A pulses, input B pulses)
1	1	0						Quadrature 4X (input A pulses, input B pulses)
1	1	1						
01	02	03	04	05	06	07	08	**Counter Mode Setup**
			0	0	0			Binary counting, recycle mode
			0	0	1			Binary counting, non-recycle mode*
			0	1	0			Divide-by-N counting, recycle mode
			0	1	1			Divide-by-N counting, non-recycle mode*
01	02	03	04	05	06	07	08	**Internal Sample Interval**
			1	0	0			1 millisecond sample, (binary, recycle mode)
			1	0	1			10 millisecond sample, (binary, recycle mode)
			1	1	0			100 millisecond sample, (binary, recycle mode)
			1	1	1			1 second sample, (binary, recycle mode)
						0		Index or Period pulse latches counter value
						1		Index or Period pulse loads counter with preset 5 value
							0	Output Compare, Latch, Compare Toggle, (select jumper to match)
							1	Output Rollover, (select jumper to match)

*In this mode, the output is configured as borrow toggle and carry toggle. These outputs are the cycle completion indicator.

Channel 2, 24-Bit Counter 4, Preset 6

The lower byte of WY29 and all of WY30 contain the 24-bit integer Preset 6 value. Use the upper byte of WY29 to configure programming values. Together, the preset value and the programming values determine the count method and how Outputs 5 and 6 function when the count and preset are equal, or when the count value is less than or greater than the counter preset. All preset values are unipolar in format. The shaded areas of Table 3-18 show the word formats, and Table 3-19 lists the programming values of WY29.

Table 3-18 Channel 2, 24-Bit Counter: Preset 6 Value

Word	MSByte								LSByte							
WY29	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
WY30	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16

Table 3-19 Channel 2, 24-Bit Counter: WY29 Programming Bit Values

Bit Position								Description
01	02	03	04	05	06	07	08	
1								Current count updates on an INDEX or PERIOD
	0	0	0	0	0	0	0	PLC controls Output 6
	1	0	0	0	0	0	0	When Counter 4 value > Preset 6, set Output 6
	0	1	0	0	0	0	0	When Counter 4 value < Preset 6, set Output 6
	0	1	1	0	0	0	0	When Counter 4 value ≥ Preset 5 *and* ≤ Preset 6, set Output 6
	0	0	1	0				When Counter 4 = Preset 6, set Output 6
	0	0	0	1				When Counter 4 = Preset 6, toggle Output 6
					1	0		When Counter 4 = Preset 6, clear Counter 4
					0	1		When Counter 4 = Preset 6, reload Counter 4 with Preset 5
							1	When Counter 4 = Preset 6, clear Output 5 latch

Channel 2, 16-Bit Counter Presets

Table 3-20 and Table 3-21 shows the formats for the preset values (0 – 65535) for Counters 5 and 6.

Table 3-20 Channel 2, 16-Bit Counter 5: Preset 7 Value

Word	MSByte								LSByte							
WY31	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16

Table 3-21 Channel 2, 16-Bit Counter 6: Preset 8 Value

Word	MSByte								LSByte							
WY32	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16

Chapter 4

Using the Default Configurations

4.1 Default Hardware Modes

Factory Jumper Settings

This chapter describes the default modes of operation selected by factory installed jumpers. The jumpers are set at the factory to specific defaults. Using these default settings (see Figure 4-1) and a minimal amount of software programming, you can operate your High Speed Counter Encoder module immediately after installing it in the I/O base. If you want to use the optional configurations and counter modes, skip to Chapter 5.

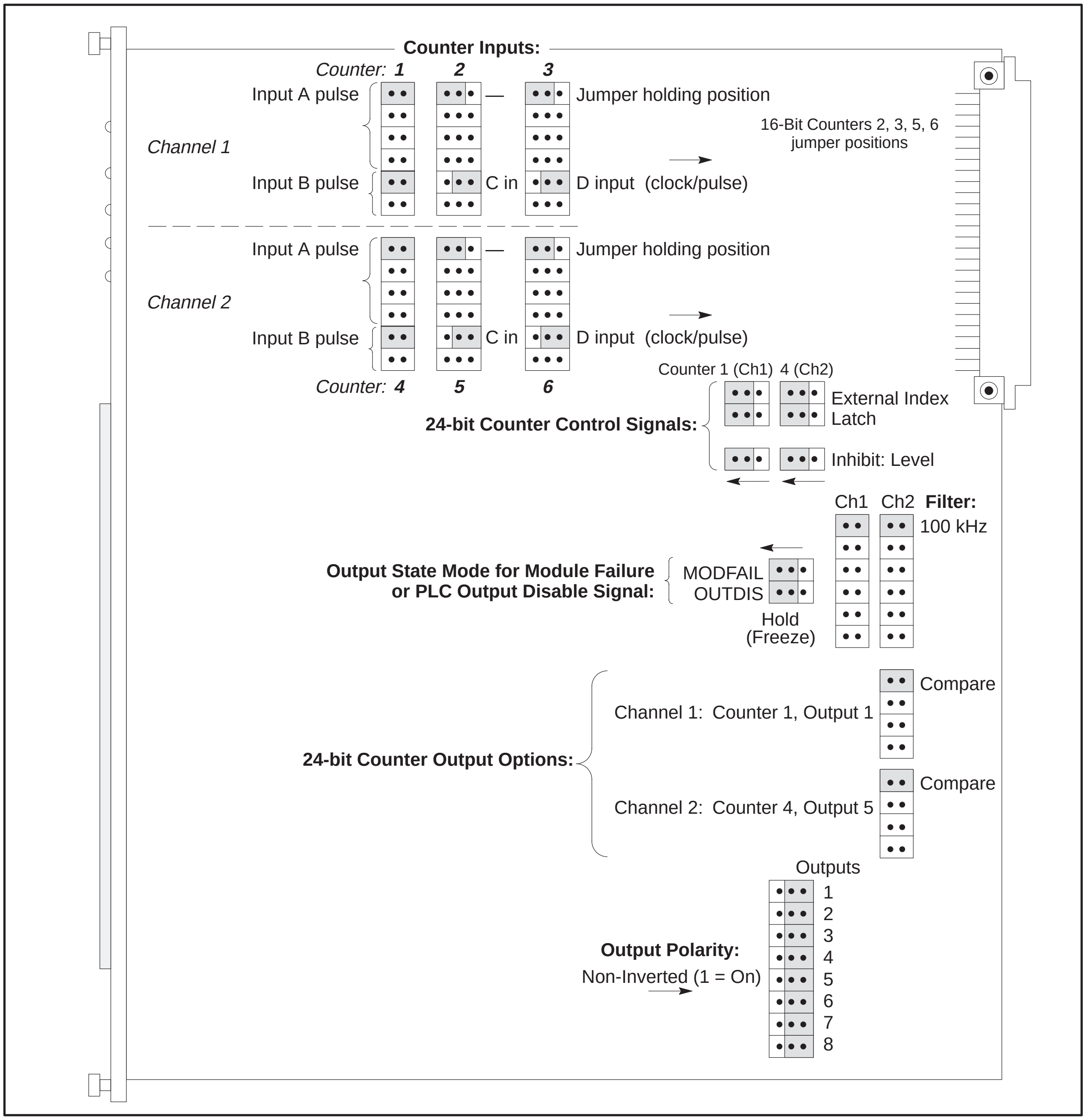


Figure 4-1 Factory Default Jumper Settings

24-Bit Counter Inputs

Figure 4-1 shows that the default inputs for each 24-bit counter (1 and 4) are the A and B input pulse lines. The default jumper settings provide input connections for all counting modes: non-quadrature up/down counting, non-quadrature direction counting, and quadrature mode.

NOTE: To set the counter's mode, you have to set specific bits in the software as described in Chapter 5.

16-Bit Counter Inputs

The external input default clock for each 16-bit counter (2, 3, 5, and 6) follows:

- Channel 1: Counter 2 counts pulses on Ch1 C input
  Counter 3 counts pulses on Ch1 D input
- Channel 2: Counter 5 counts pulses on Ch2 C input
  Counter 6 counts pulses on Ch2 D input

24-Bit Counter Control Signals

The second group of jumpers controls additional signals to the 24-bit counters. The default settings for this group follow:

- An external INDEX signal updates the counter's Holding Register.
- Latch selects external INDEX to load the count value into the Holding Register.
- INHIBIT, in the Level position, a high INHIBIT signal pauses the counter; a low INHIBIT signal resumes the counting action.

Input Signal Filtering

The default input filter setting is 100 kHz. At 100 kHz, the module counts any signal that has a minimum pulse width greater than 4 microseconds. Refer to Figure C-3 for 100 kHz signal duty-cycle specifications.

Module Failure or PLC Output Disable Signal

The MODFAIL and OUTDIS jumpers are set to the Hold (or Freeze) position by default. In this position, if the PLC drives an Output Disable signal (such as in a fatal error condition), or if the module itself generates a Module Failure signal, each output holds its last valid state (either on or off) instead of all outputs being cleared (all off).

24-Bit Counter Outputs 1 and 5

The default setting for Output 1 (from Counter 1) and Output 5 (from Counter 4) is Compare. Compare is active (output goes high) when the count value equals the preset value.

Output Polarity

The default setting for all eight outputs is non-inverted output polarity (1 = on). With Compare and non-inverting jumpers installed, the output signal is active when the count value equals the preset value.

4.2 Default Software Modes

Programming Optional Modes

You program counter modes by setting specific bits in the corresponding WY words. If bits 01 through 08 of the preset word are all zeroes, by default or programming, the module operates in the modes defined in Table 4-1. Programming of optional modes is described in Chapter 5.

Software configurations are not saved in the module. All software programming must be done by the PLC through the WY words.

24-Bit Counter Default Modes

When the bits in the most significant byte of WY21 (for Counter 1) and WY27 (for Counter 4) are all zero (refer to Table 4-1), these counters operate in the following non-quadrature modes:

- Up/Down directional counter: input A pulses are counted, and the state of input B determines the direction of counting.
- 24-bit binary counting, recycle mode.
- INDEX is set to latch the counter value.
- Output is set for Compare (On when count value = preset).

Table 4-1 24-Bit Counter Programming Modes

01	02	03	04	05	06	07	08	**Mode**
0	0	0						Direction counter, (count A, direction B)
			0	0	0			24-bit binary counting, recycle mode
						0		INDEX latches counter value
							0	Output Compare

When the bits in the most significant byte of WY23 (for Counter 1) are zero, the PLC controls Output 2 by setting WY19.15.

When the bits in the most significant byte of WY29 (for Counter 4) are zero, the PLC controls Output 6 by setting WY19.11.

16-Bit Counter Default Mode

When all of the bits in counter setup words WY20.09 through .16 are zero, 16-bit counters 2, 3, 5, and 6 down count in the Retriggerable One-Shot mode. Refer to Section 1.8 for a description of 16-bit counter modes.

4.3 Basic Programming Steps

To program the High Speed Counter Encoder module and place it in Run Mode, perform the following steps:

Writing the Presets

In your RLL program, write the preset values to the words that correspond to the counters you are setting up. A preset value of all zeros is valid. As described in Chapter 3, preset values for each counter are stored in the WY words listed in Table 4-2.

Until the module is programmed, the PLC sees the module as unprogrammed and the green RUN LED blinks fast.

Table 4-2 Word Outputs for Preset Values

Word	Description	Counter
WY21 WY22 WY23 WY24	PRESET 1, high word PRESET 1, low word PRESET 2, high word PRESET 2, low word	Counter 1
WY25 WY26	PRESET 3, word PRESET 4, word	Counter 2 Counter 3
WY27 WY28 WY29 WY30	PRESET 5, high word PRESET 5, low word PRESET 6, high word PRESET 6, low word	Counter 4
WY31 WY32	PRESET 7, word PRESET 8, word	Counter 5 Counter 6

Programming the Module

Set bit WY20.01, shown shaded in Table 4-3. All other bit values in the module Setup Words WY19 and WY20 can be left at zero.

Table 4-3 Setting Bit 1 to Program the Module

Word	MSByte								LSByte							
WY19	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
WY20	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16

When the module detects that WY20.01 is set, it configures the module by reading the programming bits and preset words in locations WY19 through WY32. The green RUN LED goes off.

Setting RUN Mode

Clear bit WY20.01. If no module fault or programming error is detected, the Run flag, WX18.01 becomes set and the module transitions to Run Mode. The green RUN LED comes on steadily.

Chapter 5

Optional Configurations

5.1 Overview

Required Tasks for Setting Up Optional Configurations

Instead of the default configurations, you can set up other counting and connection configurations by changing hardware jumpers and setting software bits in the module setup and preset words.

Default jumpers connect various signals and registers together; however, to function correctly, the module must also be configured in software through the module setup word and the high byte of preset words. Bits in the setup word allow you to set preset values, select counter modes, inhibit certain counters, disable all outputs, or force outputs on. You must write the software configuration words from the PLC to the module to match the desired functions that you selected by jumpers.

⚠ CAUTION

Jumpers must be installed as indicated in the following paragraphs. Not installing a required jumper may cause a signal line to float and produce unpredictable counter operation.

This chapter is organized as follows:

- First, an overview of the configuration tasks is presented.
- Second, those jumpers that affect the basic configuration of the module, and are independent of the software settings, are described.
- Third, jumper configurations for 24-bit counters 1 and 4 input signals are described.
- Fourth, jumper configurations for 24-bit counters 1 and 4 control and output signals are described.
- Fifth, software setup options for 24-bit counters 1 and 4 are described.
- Sixth, jumpers and software configurations for 16-bit counters 2, 3, 5, and 6 are described.
- Seventh, a procedure to load the preset words and place the module in Run mode is presented.

5.2 Configuration Jumpers

An overview of the jumper locations and functions is shown in Figure 5-1. Shaded boxes are the default jumper positions. A jumper configuration work sheet is provided in Appendix B for you to record your jumper settings.

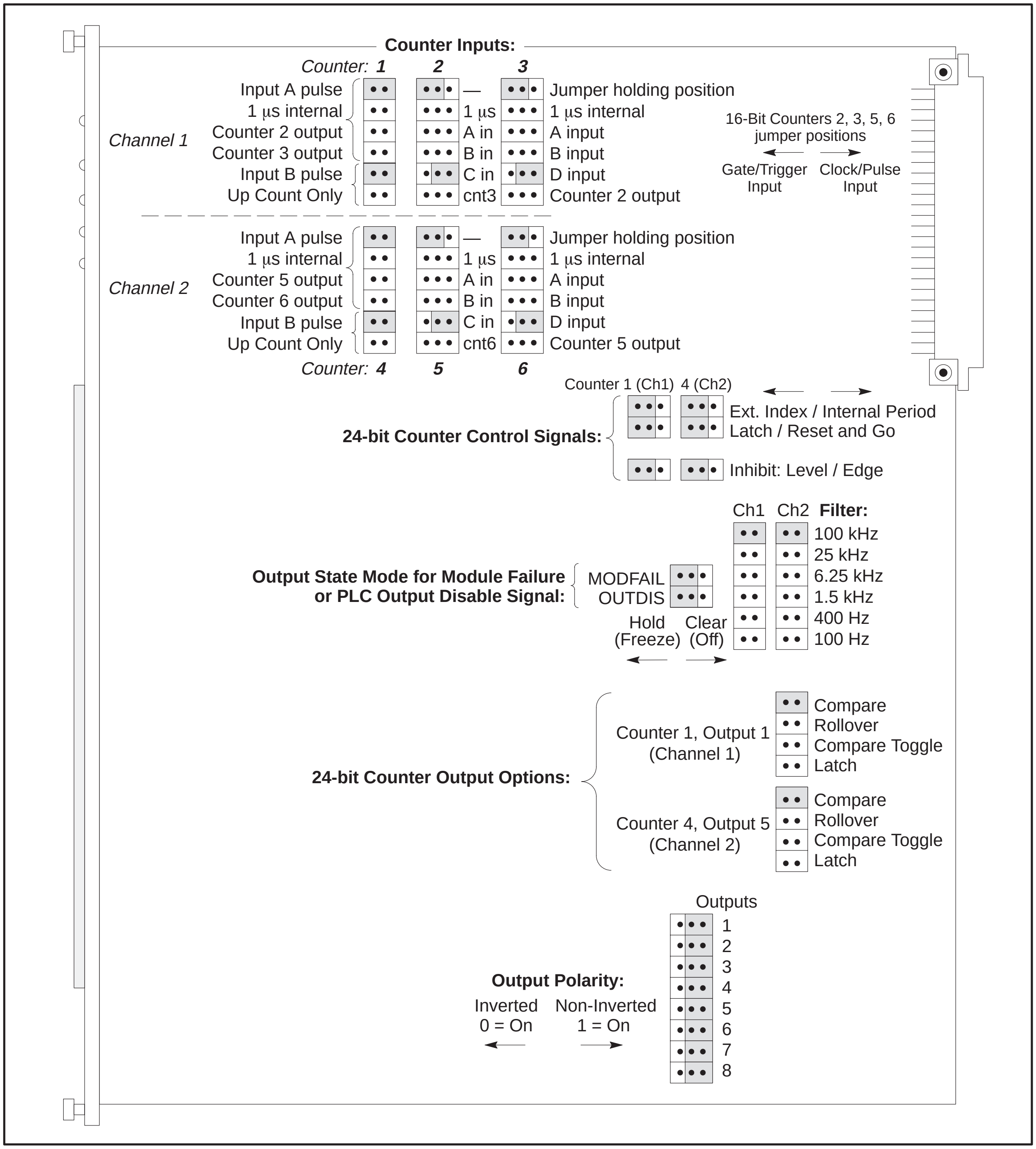


Figure 5-1 Jumper Locations

5.3 Configuration Map

Figure 5-2 presents an overview of the jumper selection and programming tasks necessary to configure the module. Although the tasks are presented serially, you may execute them randomly by choosing those that apply to your application.

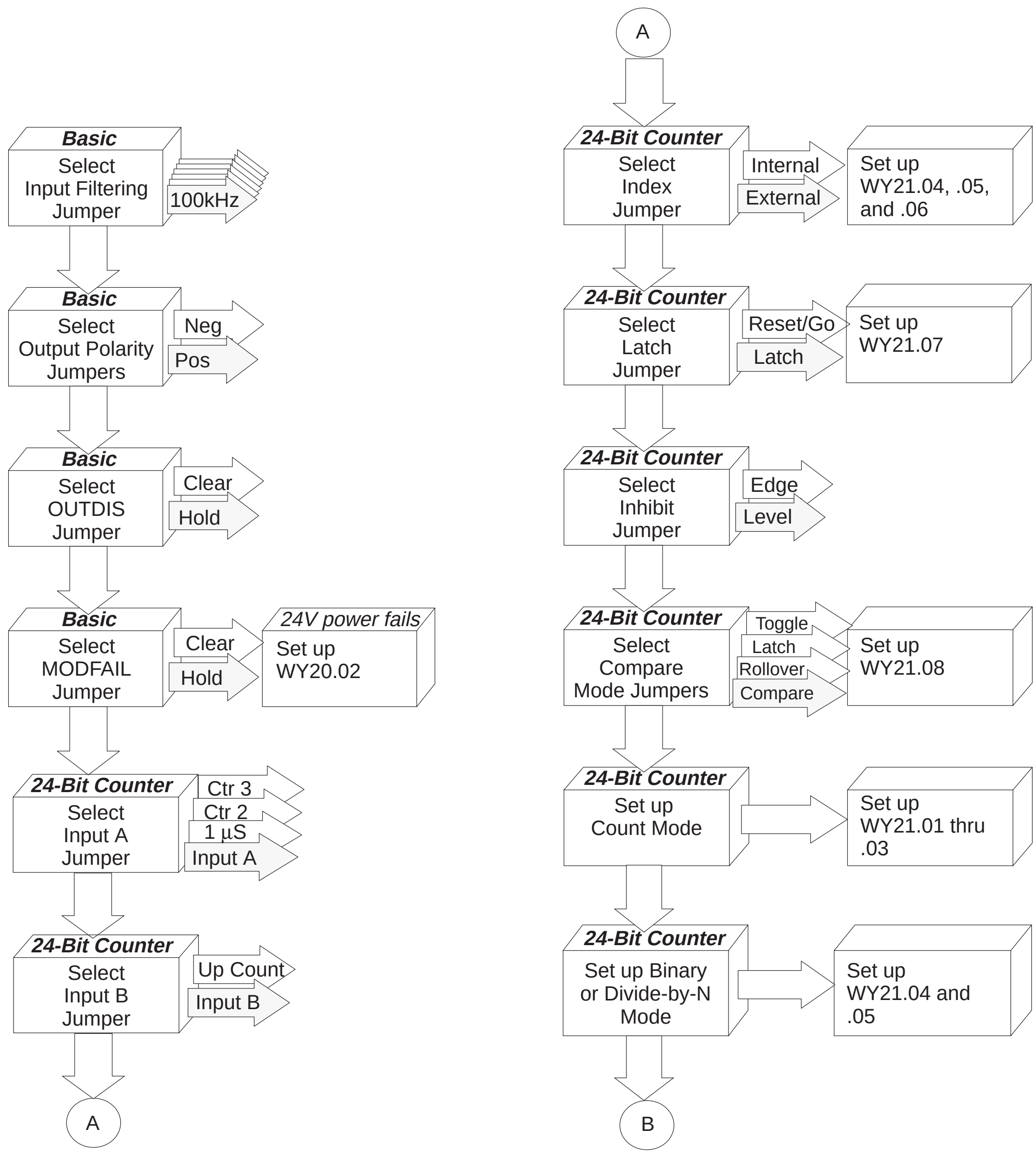


Figure 5-2 Configuration Map

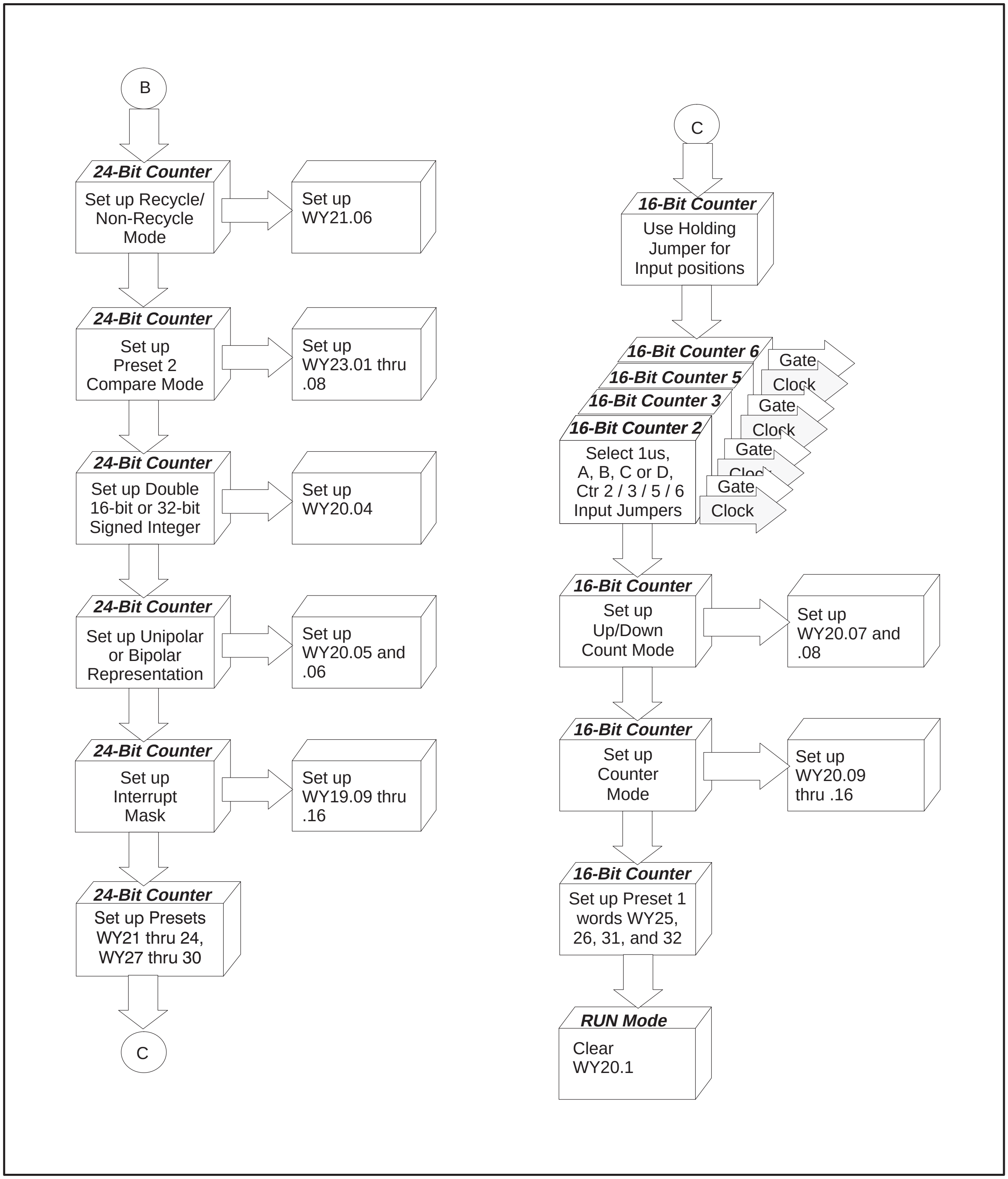


Figure 5-2 Configuration Map (continued)

5.4 Basic Configuration Options

Several jumper options are independent of the options selected by other jumpers or software settings. These basic options include the following:

- Input filtering
- Disabling outputs under Module Failure or PLC Output Disable conditions
- Output polarity

Figure 5-3 shows jumper locations for the basic options. Jumpers are shown in their default positions.

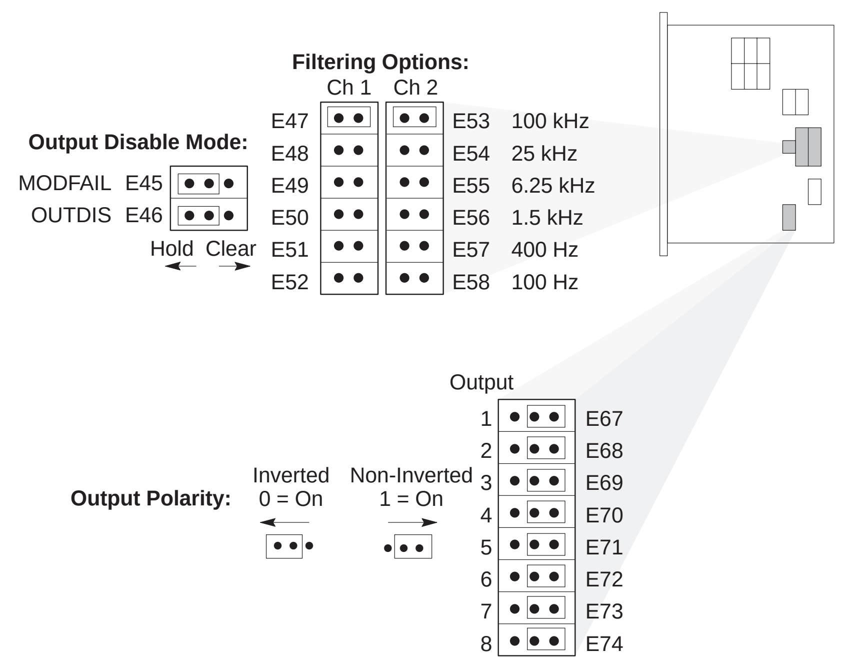


Figure 5-3 Basic Configuration Jumpers

⚠ **CAUTION**

Jumpers must be installed as indicated in the following paragraphs. Not installing a required jumper may cause a signal line to float and produce unpredictable counter operation.

Input Filtering Options

Two jumpers, one for Channel 1 and one for Channel 2, select the minimum input pulse width detected by the counter. By selecting the appropriate filtering jumper, you can prevent narrower input signals or noise from being counted by the counter. Table 5-1 lists the jumper settings for each filtering option. The default setting is shaded in the table. See Figure 5-3 for jumper locations.

Table 5-1 Input Filtering Jumper Options

Channel 1 Jumper	Channel 2 Jumper	Filter Frequency	Minimum
E47	E53	100 kHz	4 microseconds
E48	E54	25 kHz	16 microseconds
E49	E55	6.25 kHz	64 microseconds
E50	E56	1.5 kHz	256 microseconds
E51	E57	400 Hz	1024 microseconds
E52	E58	100 Hz	4096 microseconds

For a more detailed description of the characteristics of input filtering, see Appendix A.

Output Disable Jumpers

Setting both jumpers to the Hold (left) position prevents the MODFAIL or OUTDIS signals from affecting the output drivers. If you install the MODFAIL jumper in the Clear (right) position, an active signal disables (turns off) the eight outputs. If you install the OUTDIS jumper in the Clear (right) position, an active signal disables (turns off) the eight outputs. When the module fails, the output states may continue to change, depending on the counter configuration and input clock.

Output Polarity Jumpers

The polarity of the eight output signals is individually selectable by jumpers. See Figure 5-3.

- Setting a jumper to the right position (non-inverted) causes a 1 output to turn on the output.
- Setting a jumper to the left position (inverted) inverts the output signal so that a 0 turns on the output.

5.5 24-Bit Counter Input Jumper Selection

Figure 5-4 shows the jumpers that select input signals for the 24-bit counter. Table 5-2 defines the input signal names referred to in following paragraphs. After you select the jumpers, you must program the setup words and preset words. Jumpers are shown in their default positions.

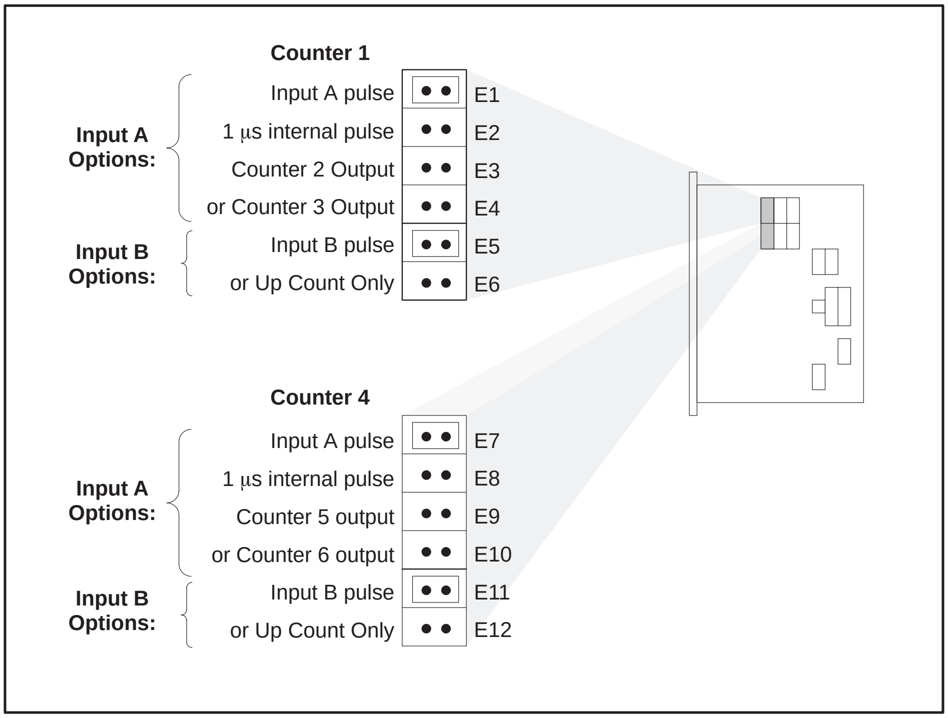


Figure 5-4 24-Bit Counter Input Jumpers

The input signals for each channel are defined in Table 5-2.

Table 5-2 Input Signal Names

Input	Definition
A	Input A: Quadrature, Up Count or Down Count Input
B	Input B: Quadrature, Down Count or Count Direction Input
C	Input C: Pulse Input or Control
D	Input D: Pulse Input or Control
INDEX	Count Control, Edge Triggered (24-bit counter only)
INHIBIT	Count Control, Edge or Level Triggered (24-bit counter only)
RESET	Count Control, Level Triggered (24-bit counter only)

NOTE: Select one of the following four A input jumper positions for both Counter 1 and Counter 4 24-bit counters: (Input A, 1 µs, Counter 2 [5], or Counter 3 [6].

Input A Jumper

The Input A jumper connects the input A terminal to the counter Input A. Input A jumper is the default setting for the 24-bit counter. If you remove the Input A jumper, then Input A can be used by other counters in the module. The function of Input A in 1X, 2X, and 4X Quadrature Modes is described in Section 1.3. The function of Input A, in Non-Quadrature Modes Up/Down counting and Direction counting, is described in Section 1.4.

1 µs Jumper

The Input A jumper can be moved to the 1 µs position to count 1 µsecond periods (up count only) for a period determined by the INDEX Pulse.

Counter 2 [5] or Counter 3 [6] Jumpers

The output of Counter 2 [5] or Counter 3 [6] can be jumpered to the input of Counter 1 [4] for cascaded counting.

NOTE: Select one of the following B input jumpers (Input B, or Up Count Only) for Counter 1 and Counter 4 24-bit counters.

Input B Jumper

The Input B jumper connects the input B terminal to the counter Input B. Input B jumper is the default setting. The function of Input B in 1X, 2X, and 4X Quadrature modes is described in Section 1.3. The function of Input B, in Non-Quadrature modes Up/Down counting and Direction counting, is described in Section 1.4.

Up Count Only Jumper

The Input B jumper can be moved to select Up Count Only. With the jumper in the Up Count Only position, the Input B signal is available to clock or control the remaining Counters 2 [5] or 3 [6].

5.6 Control and Output Jumper Selections

Figure 5-5 shows jumper locations that select signals for the 24-bit counters. After you select the jumpers, you must program the setup words and preset words to enable the selected functions. Jumpers are shown in their default positions.

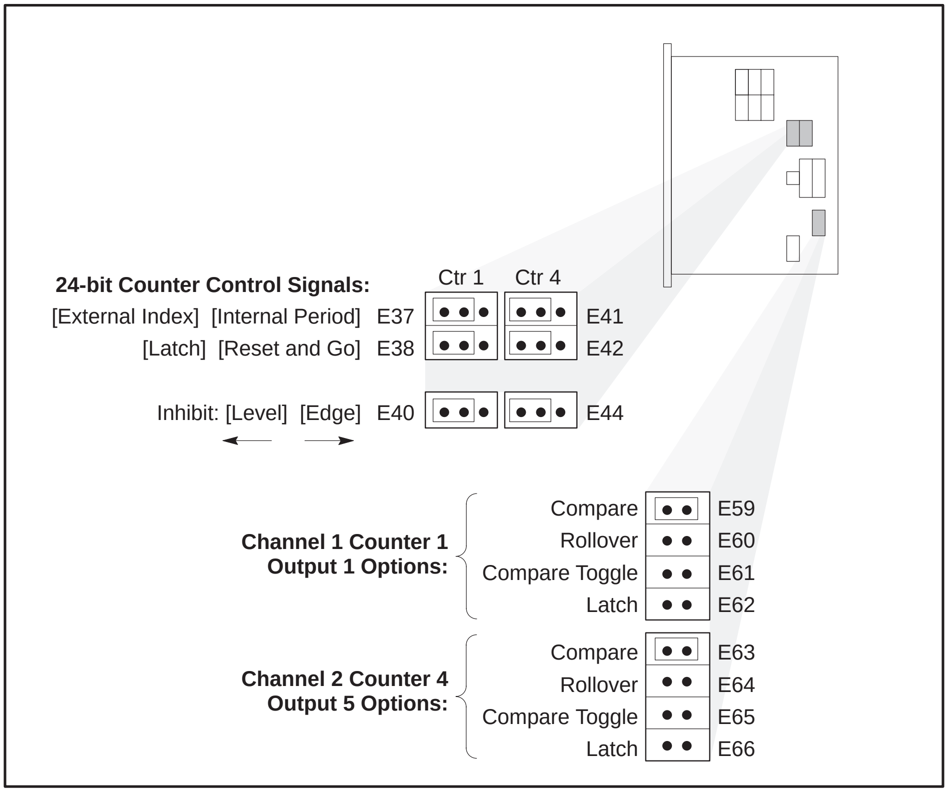


Figure 5-5 Control and Output Jumpers

External Index or Internal Period Jumper

In the External Index (default) position (left), this jumper selects a user-supplied external INDEX pulse to transfer the counter's value to output holding registers 1 and 2, or to reload the preset value into the counter.

In the Internal Period position (right), this jumper selects the internal sampling time, configured by setup word WY21.04 through .06, to transfer the counter's value into output holding registers 1 and 2, or to reload the preset into the counter. The internal sampling time can only be changed in program mode, as explained in Section 5.7.

Latch or Reset-and-Go Jumper

In the Latch (default) position (left), this jumper selects the INDEX signal to load the counter's value into the output holding register. Set WY21.07 [Channel 1] and WY27.07 [Channel 2] to enable the Latch function.

With this jumper in the Reset-and-Go position (right), the INDEX signal loads the counter's value into the output holding register, and then clears the counter to zero. Clear WY21.07 [Channel 1] and WY27.07 [Channel 2] to enable the Reset and Go function.

Inhibit Jumper

With the Inhibit jumper in the Level (default) position (left), a high INHIBIT signal pauses the counter; a low INHIBIT signal resumes the counting.

With the Inhibit jumper in the Edge position (right), the leading edge of an external INHIBIT pulse pauses the counter; later the leading edge of a second external INHIBIT pulse resumes the counting.

NOTE: Select one of the four (Compare, Rollover, Compare Toggle, or Latch) jumper positions for Counter 1 [4].

Compare Jumper

The Compare jumper selects a one-clock-wide pulse that is active when the count equals the preset 2 value [Channel 1] or preset 6 value [Channel 2]. This pulse appears on Output 1 [Channel 1] or on Output 5 [Channel 2]. Compare is the default jumper setting.

Rollover Jumper

The Rollover jumper selects a signal that is active when the carry or borrow signal is active from the counter. This signal appears on Output 1 [Channel 1] or on Output 5 [Channel 2].

Compare Toggle Jumper

The Compare Toggle jumper selects a signal that changes state when the count equals the preset value. This signal appears on Output 1 [Channel 1] or on Output 5 [Channel 2].

Latch Jumper

The Latch jumper selects a signal that is active when the count equals the preset value; the signal remains active until cleared by the PLC, preset 2, or preset 6. This signal appears on Output 1 [Channel 1] or on Output 5 [Channel 2].

5.7 24-Bit Counter Software Setup Options

After you configure the hardware jumpers, select the associated bits in both the preset and setup words to enable the functions. There are four preset words (WY21 through WY24) and two setup words (WY19 and WY20) associated with the 24-bit counter. Refer to Table 5-3 through Table 5-7.

Presets 1 and 2 (WY21 through WY24) for Channel 1 are identical in format with presets 5 and 6 (WY27 through WY30) for Channel 2.

24-Bit Counter Programming Options

Figure 5-6 is a flowchart representing the options available for the 24-bit counter by programming the upper 8 bits of WY21 for Counter 1 or the upper 8 bits of WY27 for Counter 4.

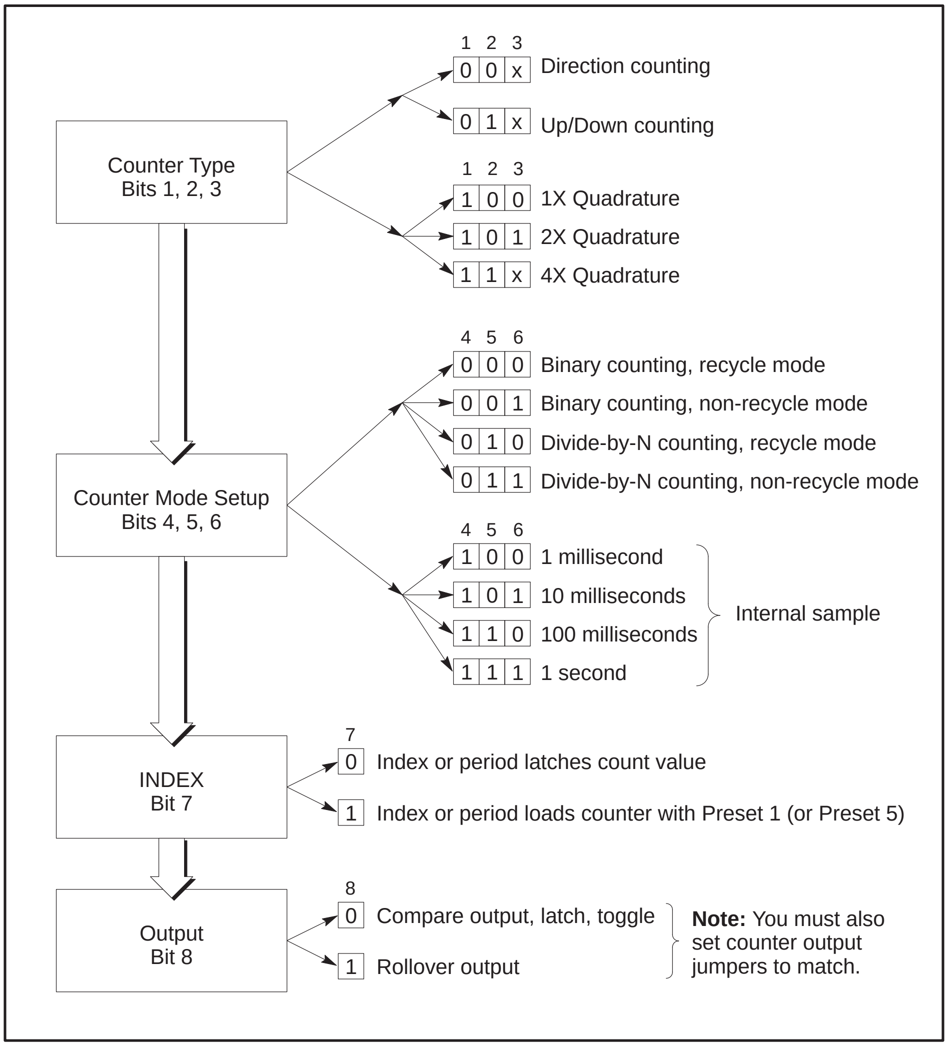


Figure 5-6 Flow of Programming Options for 24-Bit Counter

Table 5-3 Channel 1, 24-Bit Counter: Preset 1 Value

Word	MSByte								LSByte							
WY21	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
WY22	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16

Table 5-4 shows the counting options bit definitions. Shaded areas represent the default modes (all bits are zero).

Table 5-4 Channel 1, 24-Bit Counter: WY21 Programming Bit Values

Bit Position								Description
01	02	03	04	05	06	07	08	**Mode**
0	0	0						Direction counting (count: input A, direction: input B)
0	0	1						
0	1	0						Up/Down counting (count up: input A, count down: input B)
0	1	1						
1	0	0						Quadrature 1X (input A pulses, input B pulses)
1	0	1						Quadrature 2X (input A pulses, input B pulses)
1	1	0						Quadrature 4X (input A pulses, input B pulses)
1	1	1						
01	02	03	04	05	06	07	08	**Counter Mode Setup**
			0	0	0			Binary counting, recycle mode
			0	0	1			Binary counting, non-recycle mode*
			0	1	0			Divide-by-N counting, recycle mode
			0	1	1			Divide-by-N counting, non-recycle mode*
01	02	03	04	05	06	07	08	**Internal Sample Interval**
			1	0	0			1 millisecond sample, (binary, recycle mode)
			1	0	1			10 millisecond sample, (binary, recycle mode)
			1	1	0			100 millisecond sample, (binary, recycle mode)
			1	1	1			1 second sample, (binary, recycle mode)
						0		Index or Period pulse latches counter value
						1		Index or Period pulse loads counter with Preset 1 value
							0	Output Compare, Latch, Compare Toggle, (select jumper to match)
							1	Output Rollover, (select jumper to match)

*In this mode, the output is configured as borrow toggle and carry toggle. These outputs are the cycle completion indicator.

24-Bit Counter Software Setup Options (continued)

Table 5-5 and Table 5-6 show that the MSByte of WY23 programs the preset compare functions of the 24-bit counter. The LSByte of WY23 and all of WY24, shown shaded in the table, contain the 24-bit integer preset 2 value.

Table 5-5 Channel 1, 24-Bit Counter: Preset 2

Word	MSByte								LSByte							
WY23	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
WY24	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16

Table 5-6 Channel 1, 24-Bit Counter: WY23 Programming Bit Values

Bit Position								Description
01	02	03	04	05	06	07	08	
1								Current count updates on an INDEX or PERIOD
	0	0	0	0	0	0	0	PLC controls Output 2
	1	0	0	0	0	0	0	When Counter 1 value > Preset 2, set Output 2
	0	1	0	0	0	0	0	When Counter 1 value < Preset 2, set Output 2
	0	1	1	0	0	0	0	When Counter 1 value ≥ Preset 1 *and* ≤ Preset 2, set Output 2
	0	0	1	0				When Counter 1 = Preset 2, set Output 2
	0	0	0	1				When Counter 1 = Preset 2, toggle Output 2
					1	0		When Counter 1 = Preset 2, clear Counter 1
					0	1		When Counter 1 = Preset 2, reload Counter 1 with Preset 1
							1	When Counter 1 = Preset 2, clear Output 1 latch

Table 5-8 and Table 5-7 show that module setup words WY19 and WY20 program additional functions of the 24-bit counter.

The module setup words have two modes: Run and Program. In Run mode, the definitions in Table 5-7 apply; in Program, the definitions in Table 5-8 apply. During Program mode, the counters are inhibited and the outputs are off. After setting up the module in Program mode, set the module to Run mode as described in Section 5.10.

Table 5-7 Bit Definitions for the Run Mode Setup Words

Word.Bit	Description of Bit Functions for RUN Mode
WY19.01	Ch1, Counter 1: Inhibit; counting pauses while set.
WY19.02	Ch1, Counter 1: Reset Counter; count value is cleared to 0 when set. Reset and Go function.
WY19.05	Ch2, Counter 4: Inhibit; counting pauses while set.
WY19.06	Ch2, Counter 4: Reset Counter; count value is cleared to 0 when set. Reset and Go function.
WY20.01	Program module counters
WY20.02	Update PRESET values
WY20.03	Latch holding registers; prevents Index or Period from updating values in Holding Registers.
WY20.04	Disable outputs
WY20.05	Enable interrupt
WY20.06	Clear interrupt latch
WY20.07	Clear Output 1 latch, set by Preset 1.
WY20.08	Clear Output 5 latch, set by Preset 5.

Table 5-8 Bit Definitions for the Program Mode Setup Words

Word.Bit	Description of Bit Functions for PROGRAM Mode
WY20.01	Program module counters
WY20.02	User 24 V power supply fault fails module
WY20.03	Read and hold counter values on Reset and power-up
WY20.04	Counters 1 & 4: double 16-bit (0) or 32-bit (1) signed integer format
WY20.05	Ch1, 24-bit Counter 1: unipolar (0) or bipolar (1) count format
WY20.06	Ch2, 24-bit Counter 4: unipolar (0) or bipolar (1) count format

5.8 16-Bit Counter Options

Five two-position jumpers enable you to select a clock input and control signal for each 16-bit counter. See Figure 5-7. Jumpers are shown in their default positions.

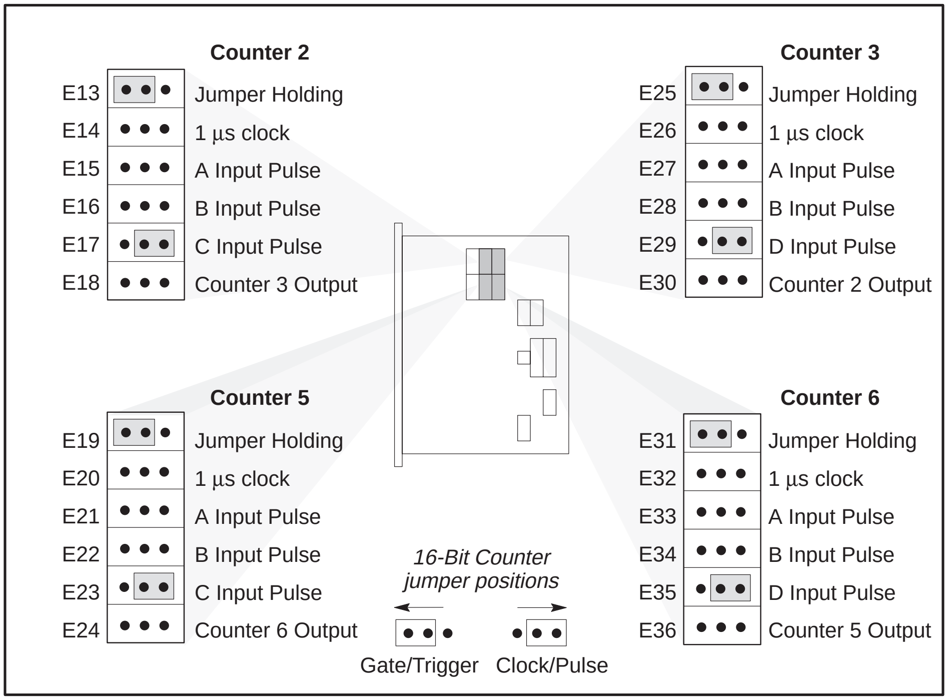


Figure 5-7 16-Bit Counter Jumpers

After you select the jumpers, you must program the setup words and preset words to enable the selected functions.

NOTE: Select two input jumpers from the following list. Select one jumper to clock the counter and one jumper (or none) to gate the counter.

Holding Position

The holding position simply stores the jumper until needed.

1 µs Jumper

The 1 µs jumper selects a 1 µs internal signal to clock the counter; the gate position is not applicable for this jumper.

Input A Jumper

Input A jumper connects this signal to clock or gate/trigger the 16-bit counter.

Input B Jumper

Input B jumper connects this signal to clock or gate/trigger the 16-bit counter.

C/D Input Jumper

The C (for counters 2 and 5) or D (for counters 3 and 6) Input jumper allows you to select this input to clock or gate the counter. Clock is the default position.

Counter 3/2/6/5 Output Jumper

You can jumper the output from counter 3 into counter 2 to either clock or gate the counter.

You can jumper the output from counter 2 into counter 3 to either clock or gate the counter.

You can jumper the output from counter 6 into counter 5 to either clock or gate the counter.

You can jumper the output from counter 5 into counter 6 to either clock or gate the counter.

5.9 16-Bit Counter Software Setup Options

After you configure the hardware jumpers, select the associated bits in the setup words to enable the functions and select the mode. There are two setup words and two preset words associated with the 16-bit counters. In the interest of simplicity, only the parts of these words pertinent to the 16-bit counter are shown. Bits that are in the 1 state set the function; bits that are 0 reset the function.

The module setup words have two modes: Run and Program. In Program Mode, the definitions in Table 5-10 apply; in Run mode, Table 5-11 applies. During Program mode, the counters are inhibited and the outputs are off.

After setting up the module in Program Mode, set the module to Run Mode as described in Section 5.10.

Channel 1, 16-Bit Counter Presets

Table 5-9 shows the format of the preset words for Counters 2, 3, 5, and 6. Table 5-10 and Table 5-11 present the bit definitions for the setup words.

Table 5-9 16-Bit Counter Presets 3, 4, 7, and 8 (WY25, 26, 31, and 32)

Word	MSByte								LSByte							
WY25, 26, 31, 32	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16

Table 5-10 Bit Definitions for the Program Mode Setup Words

Word.Bit	Description of Bit Functions for PROGRAM Mode	
WY19.01 through WY19.08	At start of Program Mode, all of the counters are inhibited and reset.	
WY20.07 WY20.08	Channel 1, 16-bit Counters 2 and 3: Down (0) or Up (1) counting Channel 2, 16-bit Counters 5 and 6: Down (0) or Up (1) counting	
WY20.09 WY20.10 WY20.11 WY20.12 WY20.13 WY20.14 WY20.15 WY20.16	Channel 1, Counter 2: M_1 Channel 1, Counter 2: M_2 Channel 1, Counter 3: M_1 Channel 1, Counter 3: M_2 Channel 2, Counter 5: M_1 Channel 2, Counter 5: M_2 Channel 2, Counter 6: M_1 Channel 2, Counter 6: M_2	16-Bit Counter Mode of Operation: **M_1 M_2 Description** 0 0 Retriggerable one-shot 0 1 Divide-by-N 1 0 Square Wave 1 1 Triggered Strobe

Figure 5-8 is a graphic representation of how to set the bit patterns to configure the counting mode for each of the 16-bit counters.

Counter	2		3		5		6		
WY20	09	10	11	12	13	14	15	16	
	M_1	M_2	M_1	M_2	M_1	M_2	M_1	M_2	**16-Bit Counter Mode:**
	0	0	0	0	0	0	0	0	Retriggerable one-shot
	0	1	0	1	0	1	0	1	Divide-by-N
	1	0	1	0	1	0	1	0	Square Wave
	1	1	1	1	1	1	1	1	Triggered Strobe

Figure 5-8 16-Bit Counter Mode Setup

NOTE: Chapter 1, Section 1.8 describes the Retriggerable One-shot, Divide-by-N, Square Wave, and Triggered Strobe counter modes in detail.

Table 5-11 Bit Definitions for the Run Mode Setup Words

Word.Bit	Description of Bit Functions for RUN Mode
WY19.03	Ch1, Counter 2: Reset Counter; count value is cleared to 0 when set. Reset and Go function.
WY19.04	Ch1, Counter 3: Reset Counter; count value is cleared to 0 when set. Reset and Go function.
WY19.07	Ch2, Counter 5: Reset Counter; count value is cleared to 0 when set. Reset and Go function.
WY19.08	Ch2, Counter 6: Reset Counter; count value is cleared to 0 when set. Reset and Go function.

5.10 Basic Programming Steps

To program the High Speed Counter module and place it in Run Mode, perform the procedure at the beginning of each paragraph heading. Additional paragraphs provide descriptions of status bits and other actions that occur as you program the module.

NOTE: At power-up, the module runs an internal software diagnostic. When the diagnostic successfully completes, the red MOD GOOD LED is turned on. To signal that the module has not been programmed, the green RUN LED blinks fast, and bits WX18.03 (Error Flag) and WX18.07 (Outputs Disabled) are set.

You can write the counter preset values to the module in two ways:

- Forcing the output word values.
- Writing constants or memory locations in RLL.

Because forcing output word values must be done after every power cycle, use of RLL programming automates this task, and also updates all of the I/O words during the same I/O scan.

If you choose to force all of the preset words, do it **before** setting WY20.01 (Program Mode).

Writing the Presets to the Counters

In your RLL program, write the preset values to the words that correspond to the counters you are setting up. A preset value of all zeros is valid. As described in Chapter 3, preset values for each counter are stored in the WY words listed in Table 5-12.

Table 5-12 Word Outputs for Preset Values

Word	Description	Counter
WY21 WY22 WY23 WY24	PRESET 1, high word PRESET 1, low word PRESET 2, high word PRESET 2, low word	Counter 1
WY25 WY26	PRESET 3, word PRESET 4, word	Counter 2 Counter 3
WY27 WY28 WY29 WY30	PRESET 5, high word PRESET 5, low word PRESET 6, high word PRESET 6, low word	Counter 4
WY31 WY32	PRESET 7, word PRESET 8, word	Counter 5 Counter 6

Setting the Program Bit

To program the HSCE module, set bit WY20.01 (see shaded bit in Table 5-13). Set bit WY20.01 by writing the programming values to WY19 and WY20 word locations. After you set the program bit (WY20.01), the RUN indicator is off.

Table 5-13 Setting Bit 1 to Program the Module

WY20	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16

	RUN Mode Definitions	PROGRAM Mode Definitions
WY20.01	Program module counters	Program module counters

When the module detects that WY20.01 is set, it configures the module by reading all of the programming bits and the preset words in locations WY19 through WY32. When configuration is complete, the error flag, WX18.03 is cleared, and WX18.02 (Update Preset Values Complete) is set.

Other status bits, WX17.03 through WX17.16, WX18.04 (Output Power Failure Detected), and WX18.08 (Counter Format), are set or cleared to reflect module status.

While still in Program Mode, WX18.01 (RUN Flag) is cleared, the six current count values report count values, the outputs (WX18.09 through WX18.16) are disabled, and WX18.05, (Interrupt) is disabled.

If bit WY20.03 (Hold counter values on reset and power-up) was set, then the counter values remaining are loaded into the Holding Registers.

Clearing the Program Bit

Clear bit WY20.01 by writing the run-time values to WY19 and WY20 word locations. If no fault exists, WX18.01 (RUN Flag) is set and the module is ready to run. WX18.02 (Update Preset Values) and WX18.03 (Error Flag) are cleared. The RUN LED is on.

If WY20.02 was cleared when programmed, WX18.04 reports the status of the 24 volt power, or else the module sets the Module Fail flag to the PLC. Restoring the power returns the module to RUN mode. If WY20.05 (Enable Interrupt) is set, then WX18.05 (Interrupt Enabled) is set.

With WY20.04 (Disable Outputs) cleared, WX18.07 (Outputs Are Disable) is cleared and WX18.09 through WX19.16 (Outputs 1 – 8 On/Off) report the output on/off status.

With WY20.05 and WX18.06 (Latched Interrupt Active) set, WX18.09 through WX19.16 report the output that generated an Interrupt Request.

The Holding Registers are cleared, and update when an external INDEX or internal PERIOD signal occurs, and WY20.03 (Hold Counter Values) is cleared.

Appendix A
Applications

A.1 Using Counters 1 and 4

In the following counting modes, the 24-bit counter counts up or down on each input pulse received as long as INHIBIT and RESET are low.

Using Gated Counting

In gated counting, the current count words are continuously updated by the module and read by the PLC on each scan. The count value can be reset by the external RESET pulse, the PLC reset signal, or a count roll over.

If the Inhibit jumper is set to [Level], the INHIBIT signal pauses the counter when high, and resumes the counting when low.

If the Inhibit jumper is set to [Edge], the leading edge of the INHIBIT signal pauses the counter, and the leading edge of a second INHIBIT signal resumes the counting.

Using Sampled Cumulative Counting

The cumulative count is continuously sent to the current count register where it is read by the PLC. The count value can be reset by the external RESET pulse, the PLC reset signal, or a count roll over.

The Index jumper is set to [Latch]. An external INDEX signal loads the count value into Holding Register 1. At the next INDEX signal, the new count value is loaded into Holding Register 1, and the previous value is pushed into Register 2. The count value continues to accumulate.

Using Period Measurement Counting

Period measurement counting measures actual time between the rising edge of two external INDEX pulses. The 24-bit counter counts internal 1 µs pulses for an externally specified duration.

The INDEX input signal is configured in the [Reset-and-Go] mode, resetting the counter after each INDEX signal. The number of 1-µs periods is loaded into Holding Register 1. At the next INDEX signal, the new count value is loaded into Holding Register 1, and the previous value is pushed into Register 2. This mode functions in the same way as Sampled Cumulative counting, except that the counter resets at each INDEX signal.

NOTE: When you use the Reset-and-Go function of the module, an occasional count of zero is read. This is a conflict between the INDEX or PERIOD control signal and the module’s microcontroller attempting to read the counter registers. To eliminate this reading of the counter reset value, set WY23.01 (Counter 1) and WY29.01 (Counter 4).

With the bits set, the current count value is updated only when the INDEX or PERIOD pulse is detected. The previous value of the current count register is pushed into Holding Register 1. Holding register 1’s value is pushed into Holding Register 2. In this mode there are effectively three holding registers.

Using Time Sampled Rate Counting

In time sampled rate counting, the counter counts the number of input pulses during a given period. You select the sample period (1 ms, 10 ms, 100 ms, or 1 second) by setting the appropriate bits in the preset word and by setting the control jumpers to [Internal Period] and [Reset-and-go].

The counter is reset at the start of the sample period, and the value is loaded into Holding Register 1 at the end of the sample period. At the next INDEX signal, the new count value is loaded into Holding Register 1, and the previous value is pushed into Register 2.

Using Frequency Counting

Frequency counting mode provides a counts-per-second value. You select the sample period of 1 second by setting the appropriate bits in the Preset word and by setting the control signal jumpers to [Internal Period] and [Reset-and-go].

The counter is reset at the start of the sample period, and the value is loaded into Holding Register 1 at the end of the sample period. At the next INDEX signal, the new count value is loaded into Holding Register 1, and the previous value is pushed into Register 2.

A.2 Using Counters 2, 3, 5, and 6

Using Binary Up or Down Counting

The 16-bit counters can be configured as binary counters. The count value wraps about the count value of zero and continues counting in the upward or downward direction. You select the count direction in bit WY20.07 for counters 2 and 3, or WY20.08 for counters 5 and 6.

Configure the counter as follows:

- Count Format: Up counting.
- Internal Trigger/Gate: Reset Flags WY19.03, .04, .07, and .08.
- External Trigger/Gate: Input jumpered to the counter trigger input.
- Initial Output: Off

In applications that require simple counting, where the count is equal to the number of clock pulses since a reset or trigger, the following description will help you configure the module.

During each internal module scan period, the current count value is read from each of the counter registers and written to the respective WX3, WX4, WX7 and WX8 word locations. The count loads the preset value on the first valid clock. The count is incremented or decremented on each subsequent clock pulse. For simple counting, bits WY20.07 and .08 set the incrementing count (Up Count) format.

Using Retriggerable One-Shot Mode

Configure the counter for Retriggerable one-shot mode as follows:

- Preset: 1

The Retriggerable one-shot mode sets the output On at the first valid clock pulse and presets the count value to one. The count value equals the number of pulses since a reset or trigger. The clock increments the count value until counter rollover at zero. At rollover, the output turns Off (high) and remains Off. Counting continues. Setting the Reset Counter flag, WY19.03, .04, .07, or .08 for the corresponding counter 2, 3, 5, or 6, or an external trigger, repeats the count cycle. The counting does not stop while the trigger is active.

Using Divide-by-N Mode

Configure the counter for Divide-by-N mode as follows:

- Preset: 0

Divide-by-N counting sets the count value to zero on the first valid clock pulse. The clock increments the count value until it is 65535. At that time the output turns On and remains On for one clock period. The preset (0) is loaded into the counter, counting continues, and the output pulses each cycle. Setting the Reset Counter flag, WY19.03, .04, .07, or .08 for the corresponding counter 2, 3, 5, or 6, pauses the counter; clearing the Reset Counter flag reloads the preset value (0). In this mode, the count value is one less than the number of clocks since a reset or gate.

Using Triggered Strobe Mode

Configure the counter for Triggered Strobe mode as follows:

- Preset: 1

Triggered Strobe sets the count value to one on the first valid clock pulse. The count value equals the number of pulses since a reset or trigger. The outputs remain Off. The clock increments the count value until counter rollover at zero. At rollover, the output turns On and remains On for one clock period (at the count of zero). The counting continues, but the output is no longer active. Setting the Reset Counter flag, WY19.03, .04, .07, or .08 for the corresponding counter 2, 3, 5, or 6, or an external trigger, repeats the count cycle. The counting does not stop while the trigger is active.

A.3 Cascade Counting Applications

32-Bit Cascade Counting

The 32-bit cascade counting mode cascades the output of one channel's 16-bit counter (3 or 6), in Divide-by-N mode, into the clock input of the other 16-bit counter (2 or 5) of the same channel.

When both channel counters, 2 *and* 3 or 5 *and* 6, are configured in Up Counting, Divide-by-N mode, the module assumes 32-bit cascaded counting has been configured and converts the count value by adding 1. This configuration sets the 32-bit data word order as MSWord, followed by the LSWord to be read by the PLC.

Counter Configuration:

- Channel Count Format: Up Counting.
- Count Range: Unsigned Integer, 0 to 65535.
- Counter Preset Value: 0.
- Counter Mode: Divide-by-N.
- Internal Gate (Channel 1): Reset Flags, WY19.03 and .04
- Internal Gate (Channel 2): Reset Flags, WY19.07 and .08
- External Gate: Not allowed for proper operation.
- Initial Output: Off.

The counter counts in recycle mode. When the count value rolls over from 65535 to 0, the rollover signal clocks the input of the second 16-bit counter.

The output of each 16-bit counter is the OR'd output [8, 7, 4, or 3] and the corresponding Force Output On bit (WY19.09, .10, .13, or .14). If the corresponding Force Output On bit is 1, the output is forced On and overrides the counter output.

The first valid clock sets the 32-bit count value to 0:1. The counter increments the LSWord until the count value reaches 65535. The output turns On and remains On for one clock period, incrementing the second 16-bit counter. The first 16-bit counter is loaded with the preset value 0, and counting continues. The count value is 1:0. The output of the first counter pulses every 65536 clocks.

Setting the Reset Counter flag, WY19.03, .04, .07, or .08 for the corresponding counter 2, 3, 5, or 6, pauses the 16-bit counters counter; clearing the Reset Counter flag reloads the preset values. The maximum count value is 65535:65535 (2^{32} –1 or 4,294,967,295) which increments to 0:0.

A.4 Prescale Counting Applications

16-Bit Prescale 16-Bit Counting

The 16-bit prescale 16-bit counting mode cascades the output of one 16-bit counter, in Divide-by-N mode, into the same channel's other 16-bit counter. This counting mode functions the same as 32-bit cascade counting described in Section A.3, Cascade Counting Operations; the difference is in the LSWord count fomat and Preset value.

Counter 2 or 5 Configuration (MSWord):

• Channel Count Format:	Up Counting.
• Count Range:	Unsigned Integer, 0 to 65535.
• Counter Preset Value:	0.
• Counter Mode:	Divide-by-N.
• Internal Gate:	Reset Flags, WY19.03, .07.
• External Gate:	Not allowed for proper operation.

Counter 3 or 6 Configuration (LSWord):

• Channel Count Format:	Down Counting.
• Counter Preset Value:	Unsigned Integer, 0 to 65535 prescale value to divide clock pulses
• Counter Mode:	Divide-by-N.
• Internal Gate:	Reset Flags, WY19.04, .08.
• External Gate:	Not allowed for proper operation.

By using the repetitive nature of Divide-by-N mode, the output of Counter 3 or 6 pulses the rollover signal at the count of 1. The rollover signal is defined in Chapter 1. The output of each 16-bit counter is the OR'd output [8, 7, 4, or 3] and the corresponding Force Output On bit (WY19.09, .10, .13, or .14). If the corresponding Force Output On bit is 1, the output is forced On and overrides the counter output.

On the first valid clock, the count values are that Counter 2 equals 0 and Counter 3 equals the value of Preset 4. The clock decrements Counter 3 until the count reaches a count of 0:1. At this time the rollover output turns On, and remains On for one clock incrementing Counter 2. The preset value is loaded into Counter 3 and counting continues. Counter 3's output pulses every preset 4 number of clocks. Setting the Clock Reset flags, WY19.03, .04 pauses the 16-bit counters and reloads the preset values when the flags are cleared.

16-Bit Prescale 24-Bit Counting

The 16-bit prescale 24-bit counting mode cascades the output of one 16-bit counter, in Divide-by-N mode, into the A input of the same channel's 24-bit counter. The B input jumper is set for Up Count Only.

By using the repetitive nature of Divide-by-N mode, the output of the 16-bit counter pulses the rollover signal, at every count of 1, into clock input A of the 24-bit counter. The output of the 16-bit counter is not controlled by the Force Output On bit (WY19.09, .10, .13, or .14).

16-Bit Counter (2, 3, 5, or 6) Configuration:

- Channel Count Format: Down Counting.
- Counter Preset Value: Unsigned Integer, 0 to 65535 prescale value to divide clock pulses
- Counter Mode: Divide-by-N.
- Internal Gate: Reset Flags, WY19.03, .04, .07, .08.
- External Gate: Use the RESET or INHIBIT signal.

24-Bit Counter (1 or 4) Configuration:

- Preset: Per application.
- Internal Inhibit: Reset Flags, WY19.01, .05.
- Internal Reset: Reset Flags, WY19.02, .06.
- Initial Output: Off.

After programming, the 24-bit counter value is zero. On the first valid clock pulse, the 16-bit counter is set to the preset value. The clock decrements the count until the count value reaches 1. During the next clock pulse the output turns On generating a carry into the 24-bit counter. The 16-bit preset is loaded, and counting continues with each clock. The carry is generated every preset number of clocks. Setting the 16-bit Reset flag pauses the counting. Clearing the flag reloads the preset value after the first valid clock.

Appendix B
Troubleshooting

B.1 LED Status and Error Code Descriptions

Table B-1 presents the status indications of the module's LEDs.

Table B-1 LED Indicator Status Chart

MOD GOOD (Red)	RUN (Green)	Description
Off	Off or On	No base power, or fatal error exists
On	On	Normal run condition
On	Off	Module not in Run mode
On	Fast blink	Module not programmed
Off	Slow double blink	User power supply fault detected
Off	Slow single blink	Module fault: hardware or software error detected; power cycle module to attempt recovery.

Table B-2 lists the error codes reported to the PLC using the WX words. These error codes overwrite the values in words WX1 through WX16. If Error bit (WX18.03) is clear and Run bit (WX18.01) is set, then there are no error codes in the I/O words.

Table B-2 Error Codes in I/O Words

Integer	Hex Code	Error Bit (WX18.03)	Run Bit (WX18.01)	Description
32767	7FFF	0 or 1	0	Module failed
32766	7FFE	0 or 1	0	Module in Programming Mode
32765	7FFD	1	0	Error in programming
32764	7FFC	1	0	Module not programmed
32763	7FFB	1	0 or 1	Module software failed
32762	7FFA	–	–	Factory test mode
32761	7FF9	–	–	Reserved for future use
32760	7FF8	–	–	Reserved for future use
32759	7FF7	–	–	Reserved for future use
32758	7FF6	–	–	Reserved for future use
32757	7FF5	–	–	Reserved for future use
32756	7FF4	–	–	Reserved for future use
32755	7FF3	–	–	Reserved for future use
32754	7FF2	–	–	Reserved for future use
32753	7FF1	0 or 1	0	Output power failed
32752	7FF0	–	–	Reserved for future use
0	0000			Default (no data); module overwrites with valid count data

B.2 Troubleshooting

Table B-3 presents basic troubleshooting suggestions for the module.

Table B-3 Troubleshooting Suggestions

Symptom	Probable Cause	Corrective Action
No LEDs on	No power to board	Re-seat board Check for bent pins on board connector Check your base power supply; user power supply
	Module has failed self-diagnostics	Return module for repair
No Output LEDs on	Outputs disabled or no 24 V power supply	Check wiring Check output disable Check bits in Setup word and error bits in Status
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
	Wrong quadrature mode	Check Quadrature Mode
Counts erratically	Wrong quadrature mode	Check jumper position and condition of jumper (metal insert intact); also check Setup and Preset words.
	Signal wire noise	See Wiring the Module, Section 2.3 Check input filter selection
	Broken wire	Check continuity
	Pulse too narrow, or frequency too high	Change input frequency filter jumper Change encoder
	Wrong filter selection	Check signal wire noise Marginal input signal
	Mechanical input switch may have bounce	Debounce input switch
Does not count	Count being reset or inhibited	Check Reset and Inhibit signals from field Check Reset and Inhibit bits in Setup word
	Broken wire	Check continuity
Controller does not communicate with module	Module not configured in controller I/O configuration table	Configure module
	Module failed	Check User Power or Setup Word bit WY20.02

B.3 Terminal Block Worksheets

Terminal block worksheets are provided in Figure B-2 and Figure B-4 for you to record the wiring for this module.

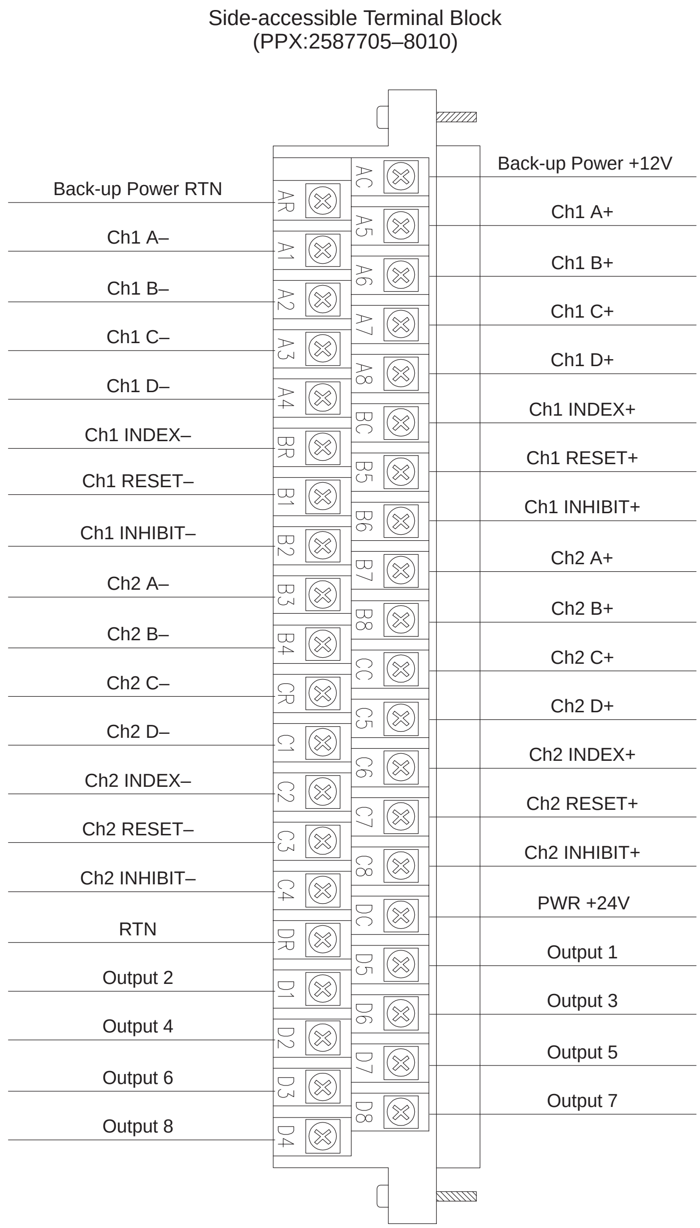


Figure B-1 Typical Side-Accessible Terminal Block

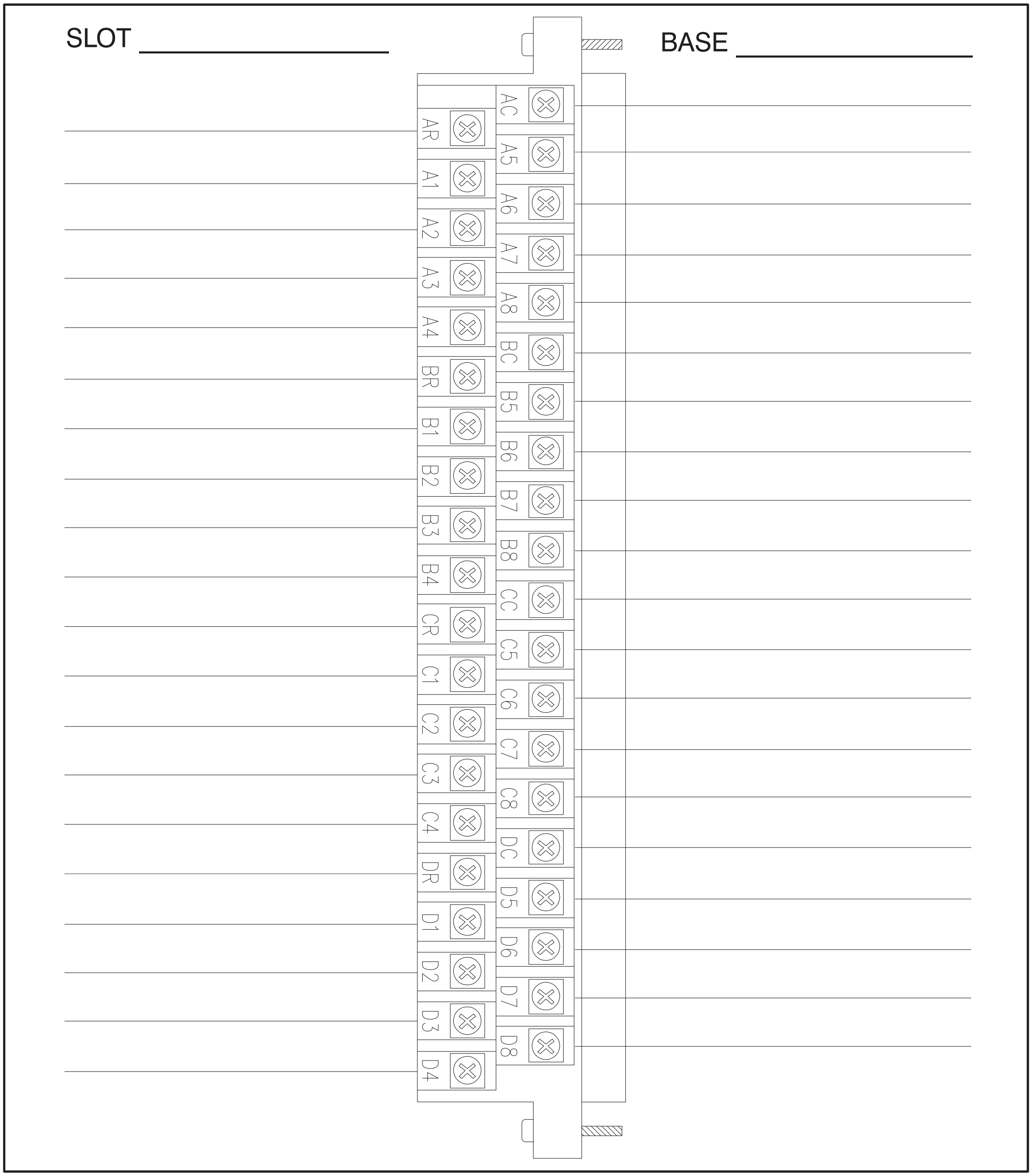


Figure B-2 Terminal Block Worksheet

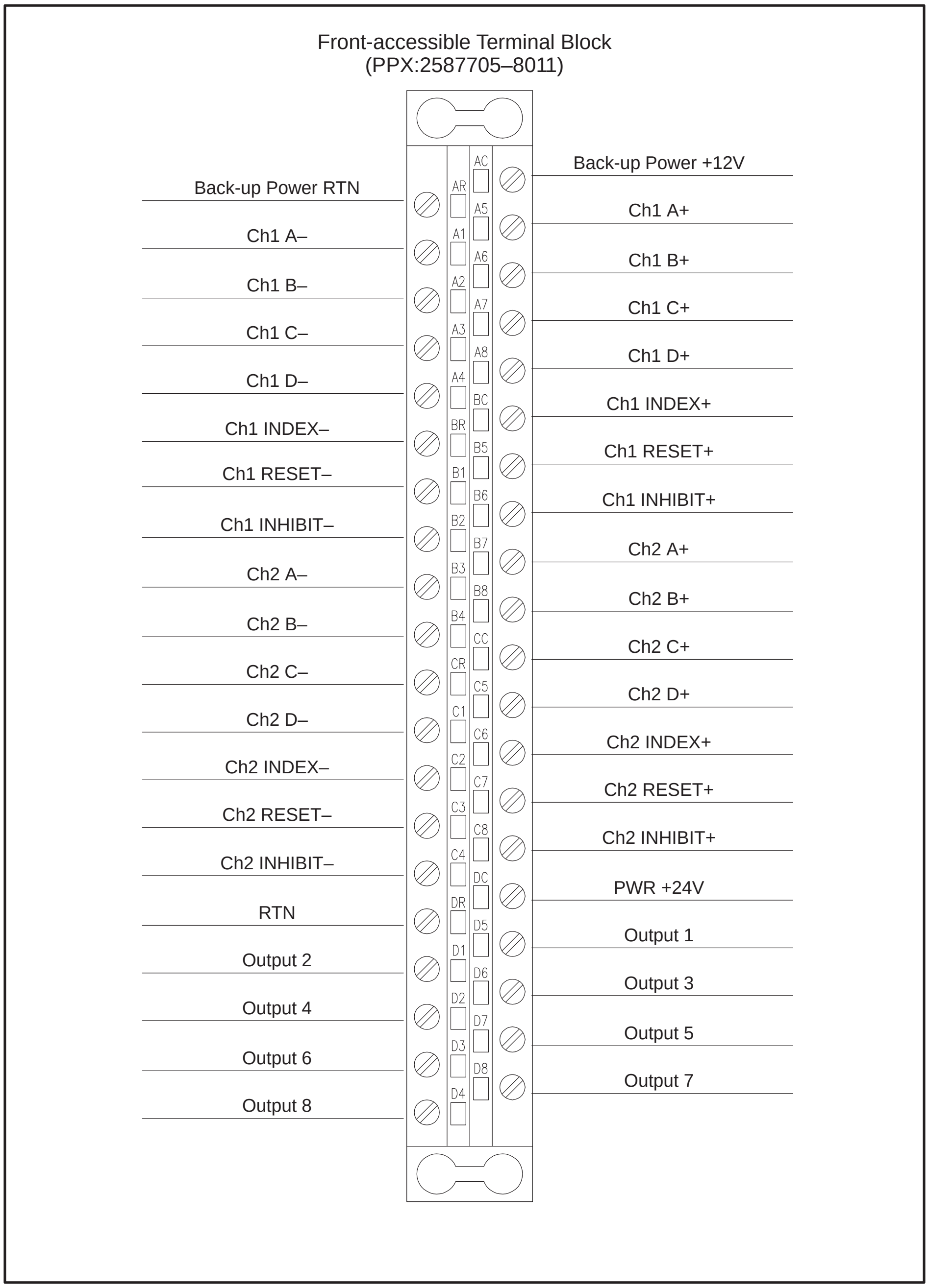


Figure B-3 Typical Front-Accessible Terminal Block

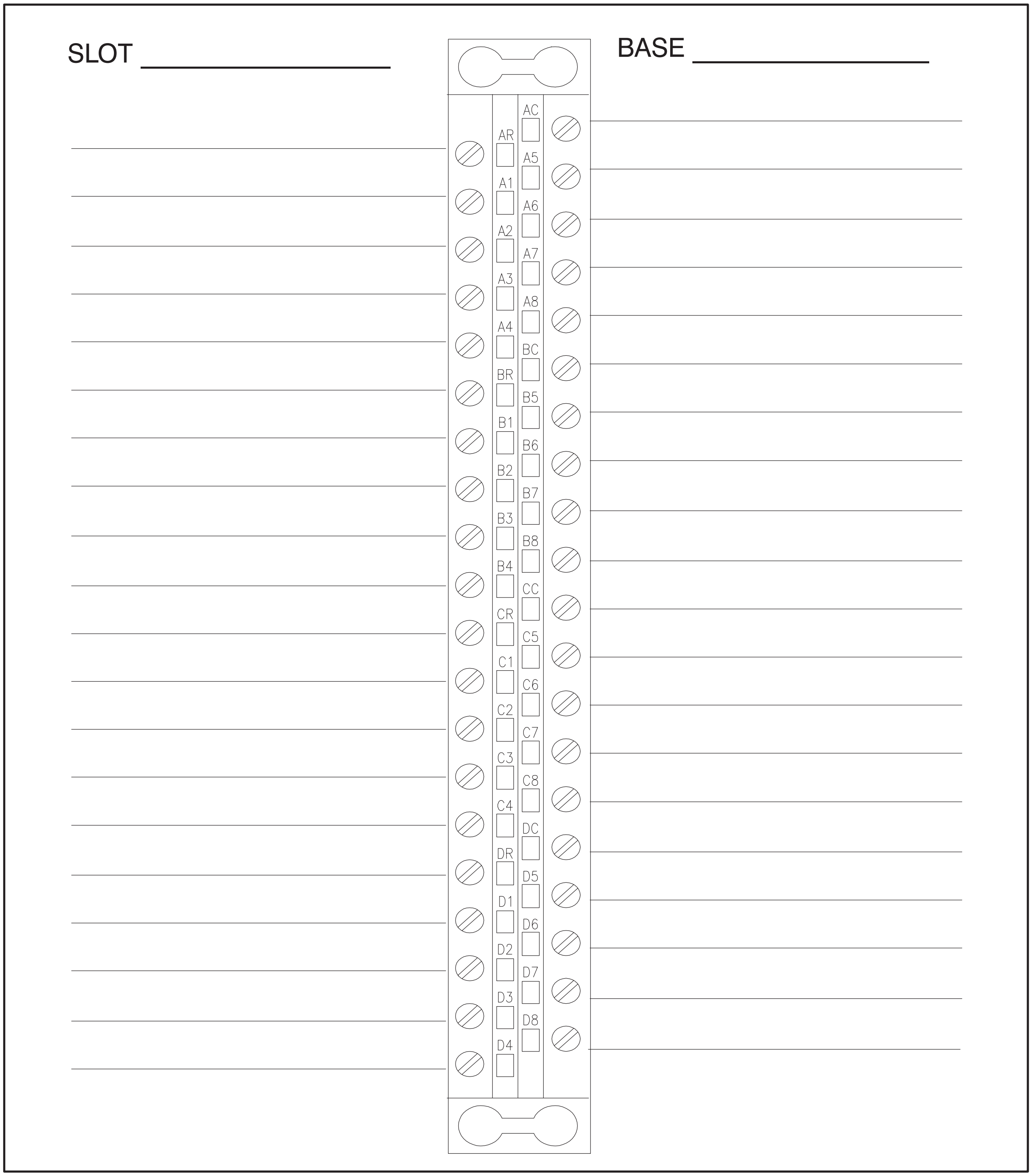


Figure B-4 Terminal Block Worksheet

Figure B-5 provides a jumper configuration worksheet for you to record the jumper configurations that you select.

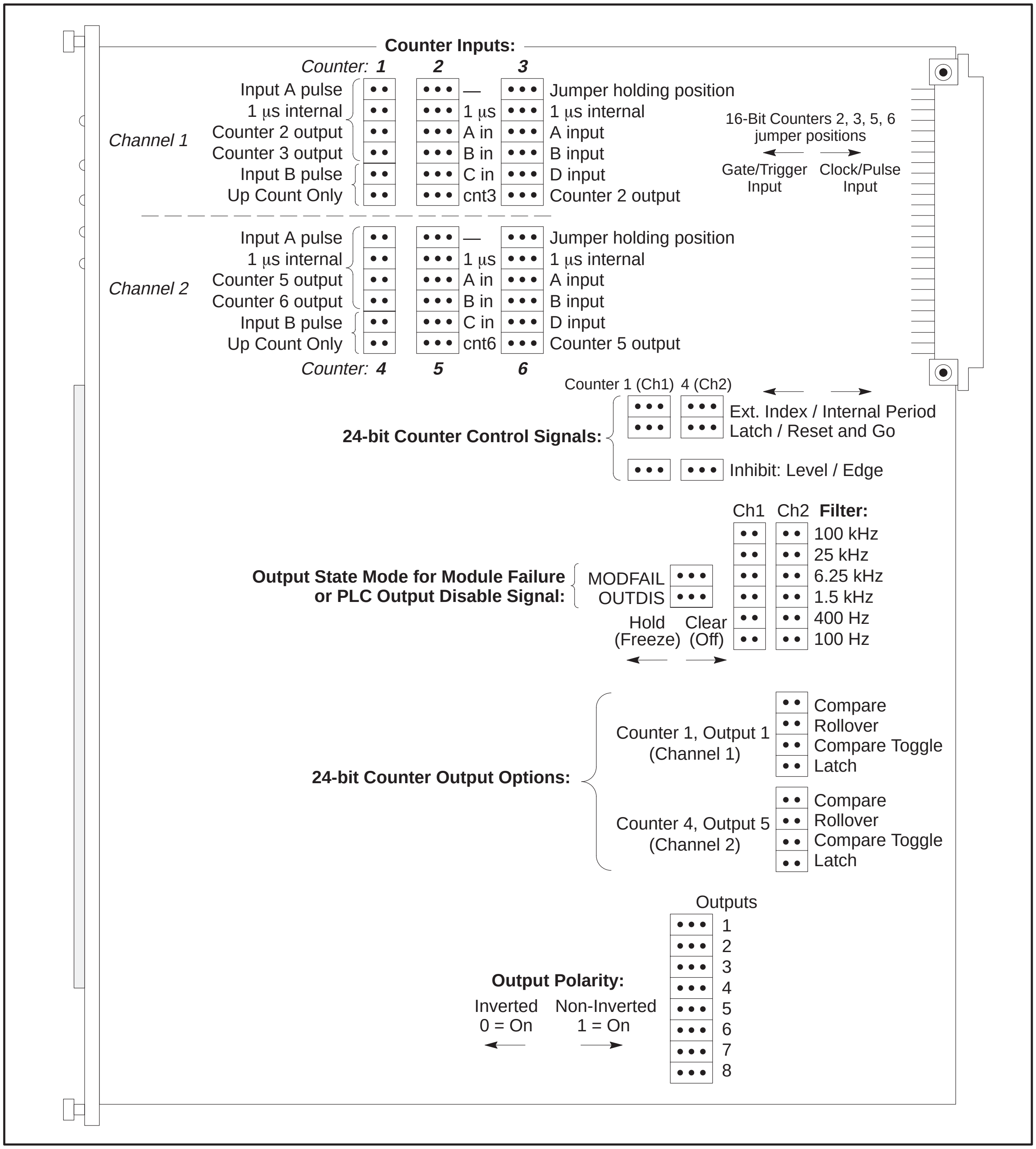


Figure B-5 Jumper Configuration Worksheet

Appendix C
Specifications

C.1 Environmental Specifications

Table C-1 Physical and Environmental Specifications

Minimum torque for bezel screws and connector screws	2.6 in-lb (0.3 N-m)
Maximum torque for bezel screws and connector screws	5.2 in-lb (0.6 N-m)
Input signal wiring	Shielded, twisted pair cable (12–26 AWG or 0.16–3.2 mm^2, stranded or solid)
Spade lug for use with connector 2587705–8010	Amp part number 321462
Ring lug for use with connector 2587705–8010	Amp part number 327891
Module power required from base	2.0 W at 5 VDC
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% non-condensing
Pollution degree	2, IEC 664, 664 A
Vibration	Sinusoidal IEC 68-2-6, Test Fc 0.15 mm peak-to-peak, 10–57 Hz; 1.0 g, 57–150 Hz Random IEC 68-2-34, Test Fdc, equivalent to NAVMAT P–9492 0.04 g^2/Hz, 80–350 Hz 3 dB/octave rolloff 80–20 Hz, 350–2000 Hz
Impact Shock	IEC 68-2-27; Test Ea
Electrostatic discharge	IEC 801, Part 2, Level 4, (15kV)
Noise immunity, conducted on Series 505 power supply and user power supply	IEC 801, Part 4, Level 3 IEC255–4 Appendix E EEC 4517/79 Com(78) 766 Final Part 4 MIL STD 461B CS01, CS02 and CS06
Noise immunity, radiated	IEC 801, Part 3, Level 3, MIL STD 461B RS01, and RS02
Isolation, inputs to controller inputs to inputs inputs to outputs all outputs to controller back-up power to controller, inputs, and outputs	 1500 Vrms 1500 Vrms 1500 Vrms 1500 Vrms 1500 Vrms
Isolation, output to output	No isolation: common power supply and return
Corrosion protection	All parts of corrosion-resistant material, plated, or painted as corrosion protection

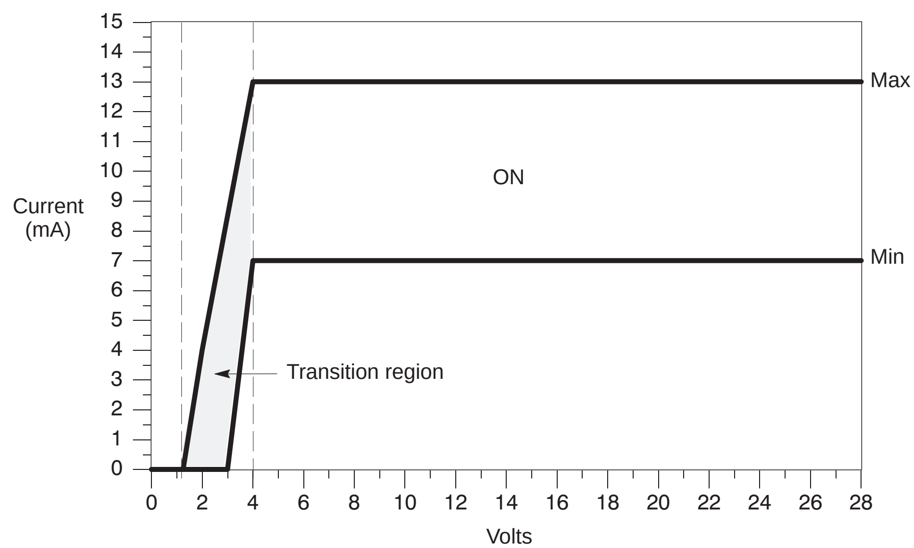
C.2 Input Specifications

Input Voltage and Current Specifications

The HSCE Module responds to input signals according to the specifications listed in Table C-2 and shown in Figure C-1.

Table C-2 Input Voltage and Current Specifications

On Voltage	4 to 28 VDC maximum
On Current	7 to 13 mA
Off Voltage	Less than 1.25 VDC
Off Current	Less than 100 µA



Note: In the transition region from 1.25 to 4 volts, the response of the module cannot be determined. The inputs may be on or off. For the fastest and most reliable counting, the input signal rise and fall times should be as short as possible.

Figure C-1 Input Specifications

Input Specifications (continued)

Input Filter Characteristics

The input filter eliminates glitches or noise in the incoming signal from being counted. The input signal must have a high and low pulse width greater than the specified filter period values listed below for proper operation. Figure C-2 shows an example of a filtered signal.

100 kHz filter:	4	microseconds minimum required to count high or low input
25 kHz filter:	16	microseconds
6.25 kHz filter:	64	microseconds
1.5 kHz filter:	256	microseconds
400 Hz filter:	1024	microseconds
100 Hz filter:	4096	microseconds

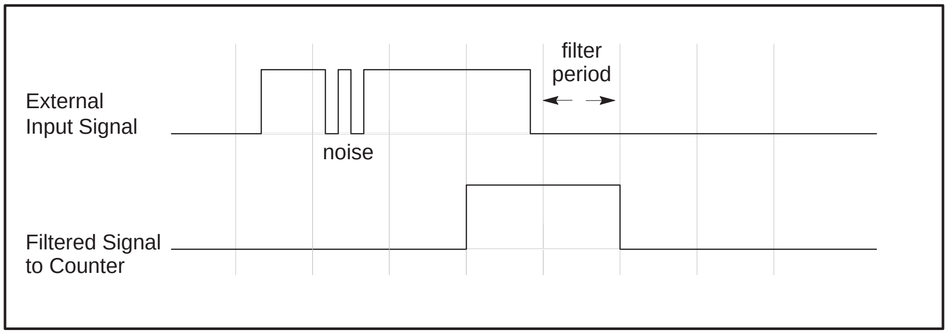


Figure C-2 Filtering Noise from Input Signal

Continuous wave-forms of a frequency higher than the specified filter have a rejection equal to or greater than 20 dB per decade above the cutoff frequency.

Due to the input circuit delays, the minimum input high and low pulse widths at the 100 kHz filter setting are shown in Figure C-3.

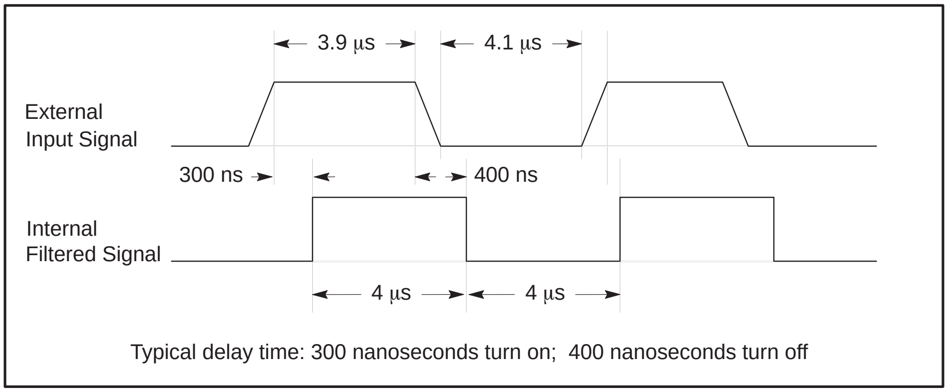


Figure C-3 Minimum High and Low Pulse Widths for 100 kHz Signal

Minimum Pulse Width for Quadrature Mode

The input filter has a clock that synchronizes the input pulse train. The clock periods for each filter are listed below.

Filter Frequency	1/2 Filter Period
100 kHz filter:	2 microseconds
25 kHz filter:	8 microseconds
6.25 kHz filter:	32 microseconds
1.5 kHz filter:	128 microseconds
400 Hz filter:	512 microseconds
100 Hz filter:	2048 microseconds

To properly register the counting edges, the edges must be separated by at least these times. This is demonstrated in Figure C-4 with a 100 kHz Quadrature signal.

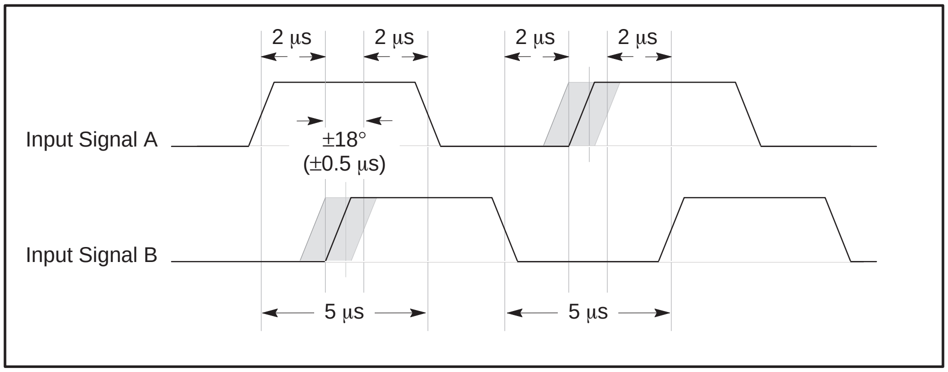


Figure C-4 Pulse Width Requirements for Quadrature Filtering at 100 kHz

The period of a 100 kHz signal is 10 microseconds (µs). A 90 degree phase shift between two 100 kHz signals is 2.5 µs, edge to edge. The filter period is 2 µs. Therefore, the signals can be ±0.5 µs off of a 90 degree phase shift, and still count properly.

To calculate phase shift, use the following formula:

$$\pm\left[\frac{\text{Signal Pulse Width}}{4} - \text{1/2 filter period}\right] \times \left[\frac{\text{360 degrees}}{\text{Signal Pulse Width}}\right]$$

In the example above, the phase shift is calculated as follows:

$$\pm\left[\frac{10\ \mu s}{4} - 2\ \mu s\right] \times \left[\frac{360\ \text{degrees}}{10\ \mu s}\right]$$

$$\pm 0.5\ \mu s \times 36^\circ/\mu s = \pm 18\ \text{degrees}$$

Therefore, an offset of 0.5 µs produces a phase shift of ±18 degrees.

If the edges are not separated by the time required for the filter period, then the counting may be off. This type of error can be determined by inputting both an up-count and down-count Quadrature pulse train at the rated frequency. One direction may be correct, while the other direction counts an incorrect number of pulses. If neither count is what you expect, electrical noise or a configuration error may exist.

C.3 Output Specifications

Output Voltage and Current Specifications

The HSCE Module output circuits meet the specifications listed in Table C-3.

Table C-3 Output Specifications

User Voltage	28.8 VDC maximum
Voltage Drop (power supply to output terminal)	1.4 volts maximum at 500 mA
Leakage Current (Off state)	Less than 10 microamps
Output Current ratings (all outputs operational)	Continuous: 200 mA per output Peak: 500 mA per output, for less than 1/3 of the period of the output pulse, or 1 second, whichever is less (see Figure C-5).
Output Continuous Current (adjacent channel outputs)	200 mA per output OR, one output at 500 mA, with remaining channel outputs off or having a load of less than 20 mA.

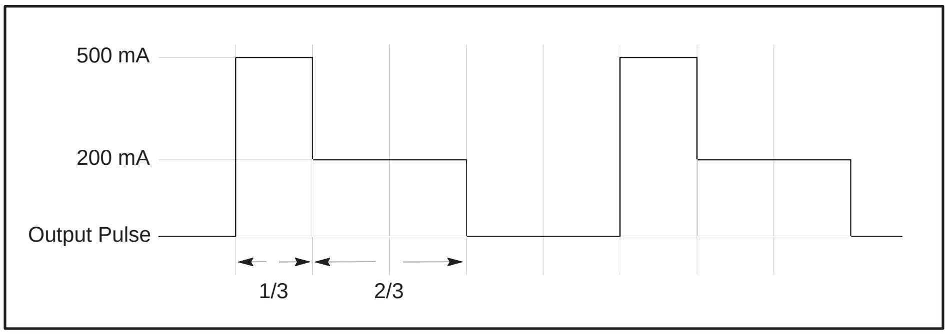


Figure C-5 Peak vs. Continuous Current Output

Output Power Supply Specifications

The Output Power Supply must be rated at 24 V ± 20 per cent at 100 milliamperes plus total output load current. The supply must be a Class 2 power supply.

Output Specifications (continued)

Module Response Times

The module software cycle time is less than 1 millisecond. The typical response times of input to output signals are listed in Table C-4.

Table C-4 Module Response Times

Counter 1 to output 1	Less than 10 microseconds
Counter 1, Preset 2 to output 1	Less than 1 millisecond
Counter 1, Preset 2 to output 2	Less than 1 millisecond
Counter 2 to output 3	Less than 10 microseconds
Counter 3 to output 4	Less than 10 microseconds
Counter 4 to output 5	Less than 10 microseconds
Counter 4, Preset 6 to output 5	Less than 1 millisecond
Counter 4, Preset 6 to output 6	Less than 1 millisecond
Counter 5 to output 7	Less than 10 microseconds
Counter 6 to output 8	Less than 10 microseconds

Backup Power Supply Specifications

The Backup Power Supply must be rated at 12 V ±20 per cent at 200 milliamperes maximum. The supply must be a Class 2 power supply.

Index

Customer Registration

We would like to know what you think about our user manuals so that we can serve you better. How would you rate the quality of our manuals?

	Excellent	Good	Fair	Poor
Accuracy	_______	_______	_______	_______
Organization	_______	_______	_______	_______
Clarity	_______	_______	_______	_______
Completeness	_______	_______	_______	_______
Overall design	_______	_______	_______	_______
Size	_______	_______	_______	_______
Index	_______	_______	_______	_______

Would you be interested in giving us more detailed comments about our manuals?

☐ **Yes!** Please send me a questionnaire.

☐ **No.** Thanks anyway.

Your Name: ____________________________________

Title: ____________________________________

Telephone Number: (_____)______________________________

Company Name: ____________________________________

Company Address: ____________________________________

____

____

Manual Name: SIMATIC TI505 High Speed Counter Encoder User Manual **Edition:** Original
Manual Assembly Number: 2586546–0092 **Date:** 05/94
Order Number: PPX:505–8127–1

FOLD

NO POSTAGE
NECESSARY
IF MAILED
IN THE
UNITED STATES

BUSINESS REPLY MAIL

FIRST CLASS PERMIT NO.3 JOHNSON CITY, TN

POSTAGE WILL BE PAID BY ADDRESSEE

ATTN: Technical Communications M/S 3519
SIEMENS INDUSTRIAL AUTOMATION INC.
3000 BILL GARLAND RD
P O BOX 1255
JOHNSON CITY TN 37605–1255

FOLD