

SYSMAC
3G2A5-CT001/012
3G2A6-CT001

High-speed Counters

OPERATION MANUAL

OMRON

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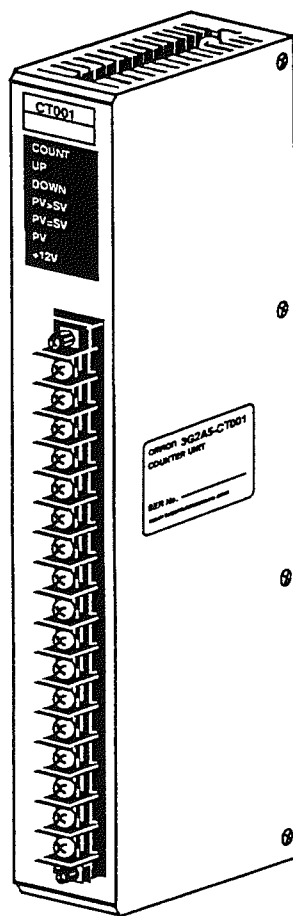
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3G2A5-CT001/CT012 **3G2A6-CT001** **High-speed Counters**

February 1990



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OMRON products are manufactured for use according to proper procedures by a qualified operator and only for the purposes described in this manual.

The following conventions are used to indicate and classify notes of particular interest in this manual. Always heed the information provided with them.

DANGER! Indicates information that, if not heeded, could result in loss of life or serious injury.

Caution Indicates information that, if not heeded, could result in minor injury or damage to the product.

Note Indicates information of particular interest for efficient and convenient operation of the product.

1, 2, 3... Indicates that the following information will be displayed in list format.

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Introduction

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Features

The CT001s are six-digit BCD (Binary Coded Decimal) High-speed Counters compatible with C-Series sensors such as Rotary Encoders. They are capable of counting clock pulses at speeds of up to 50 kHz. Counters can be used for position control or high-speed measurement when connected to various sensors.

The CT012 is a reversible preset Counter for use with pulse output devices such as Rotary Encoders. Although its operation is similar to that of the CT001s, it has several advantages:

- The CT012 can be used with the Intelligent I/O Read/Write Instructions for programming.
- Up to 8 coincidence outputs can be set.
- The Counter value can be changed via presets during operation.
- Two types of input signals can be used: phase differential pulse input and pulse and direction input. Thus, the CT012 is compatible with a wide variety of sensors.
- Three sets of input and output voltages (5, 12, and 24 VDC) can be used.

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About this Manual...

High-speed Counter models 3G2A5-CT001 and 3G2A6-CT001 are Special I/O Units for the C500 and C120 series of Programmable Controllers; High-speed Counter model 3G2A5-CT012 is designed for use with the C1000H and C2000H series of Programmable Controllers. This manual explains the operation and functions of these Counters. Before incorporating a High-speed Counter in your PC system, familiarize yourself with both the Counter and this manual.

This manual is organized as follows:

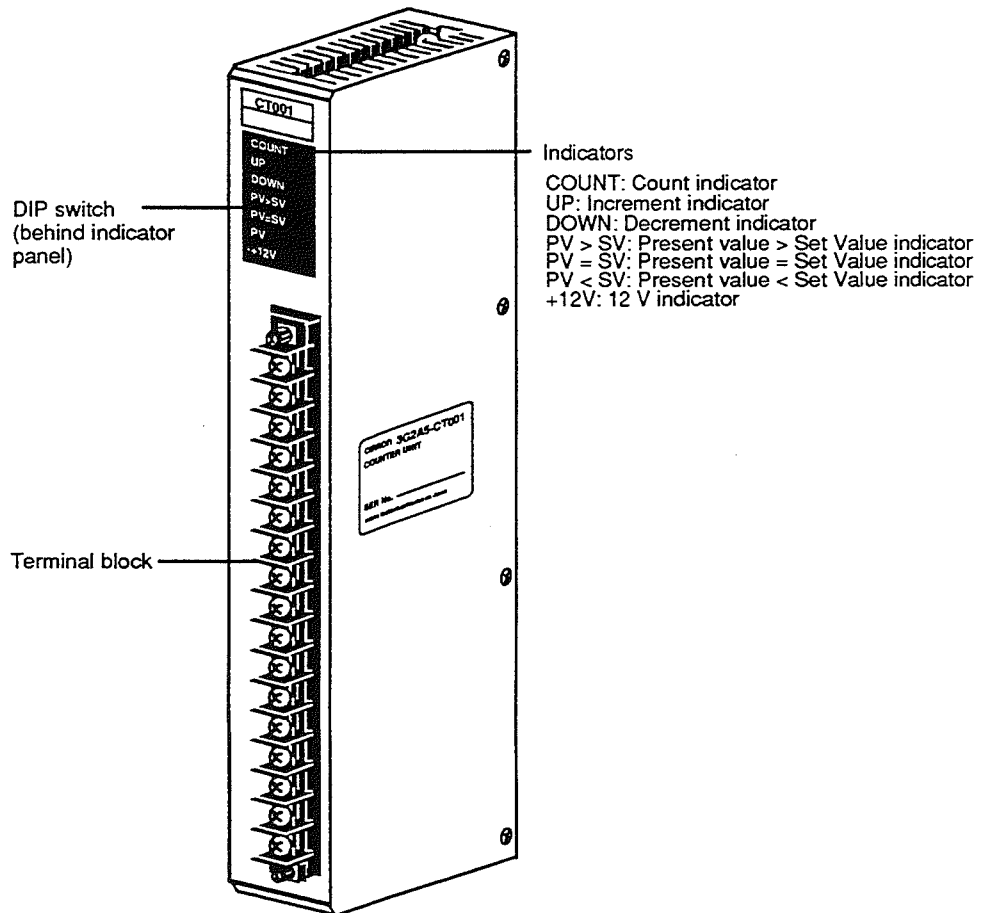
Section 1 introduces the Counters' components and provides information on the DIP switch(es) and wiring.

Section 2 describes the operation of the Counter and operating modes.

Section 3 gives examples of applications and programming.

1-2
Indicators and
Components

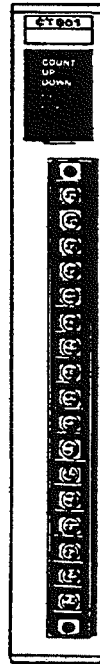
The following figure shows the components of the CT001 High-speed Counters.



Note The CT001s have one DIP switch, located behind the indicator panel. To gain access to the DIP switch, remove the indicator panel with a standard screwdriver.

Front

3G2A5-CT001



3G2A6-CT001



Note Although the 3G2A5-CT001 and 3G2A6-CT001 differ in external appearance, they are operated identically. (The 3G2A6-CT001 is shipped with no external housing; it is designed to be mounted directly in an I/O Unit.) In this manual, these models are referred to collectively as CT001s.

Indicators

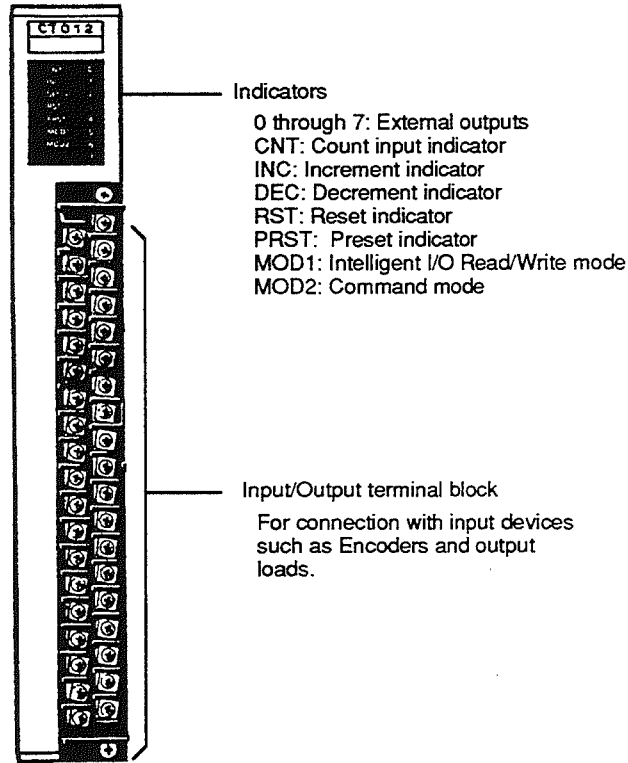
The following table shows the functions of the indicators on the CT001s.

| Indicator | Function |
|-----------|---|
| COUNT | Lit when count input 1 is OFF. Unlit when count input 1 is ON. |
| UP | Lit when Counter is incrementing. |
| DOWN | Lit when Counter is decrementing. |
| PV > SV | Lit when Present Value is greater than Set Value. |
| PV = SV | Lit when Present Value equals Set Value. |
| PV < SV | Lit when Present Value is less than Set Value. |
| 12 V | Lit when 12 V power supply for sensor is normal. |

Note The initials PV and SV stand for Present Value and Set Value, respectively.

The following figure shows the components of a CT012 High-speed Counter.

Front



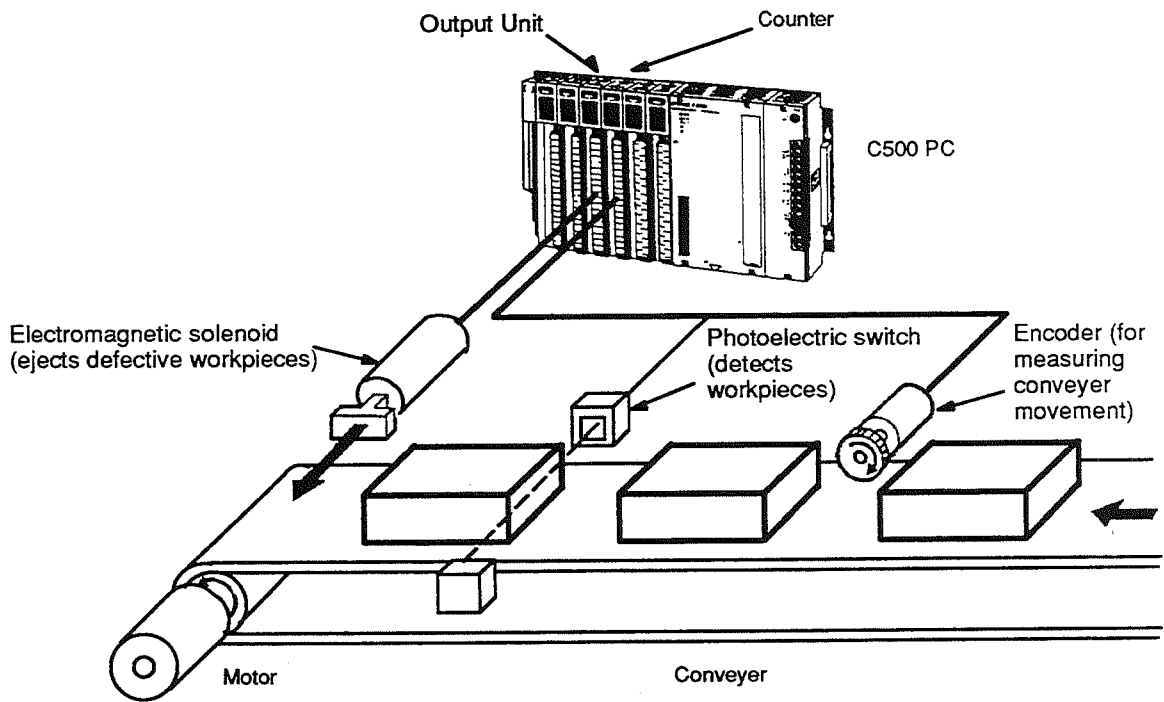
Indicators

The following table shows the functions of the indicators on the CT012.

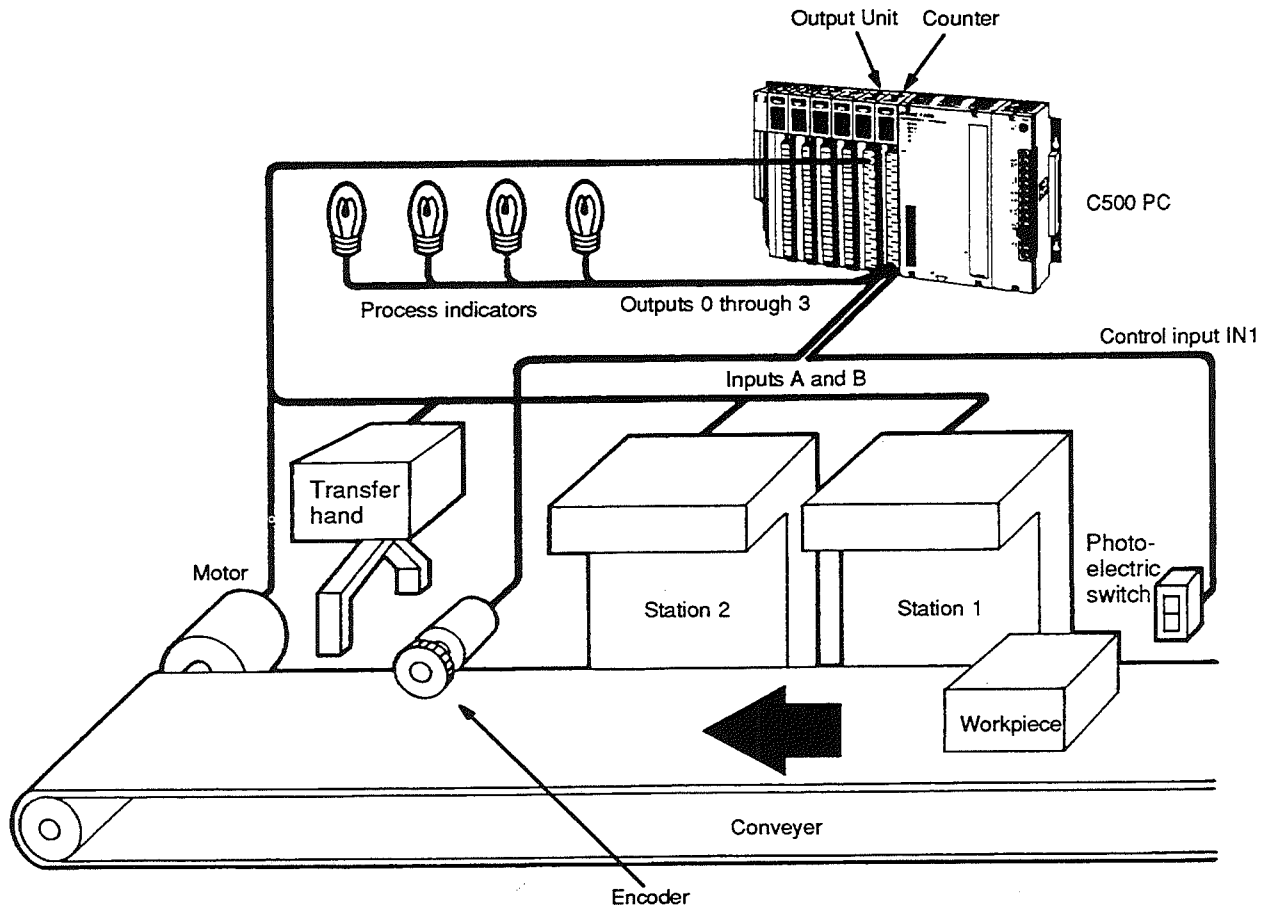
| Indicator | | Function |
|-------------|---------------------------------|---|
| 0 through 7 | External outputs | Lit when their corresponding outputs are turned ON. |
| CNT | Count input | Lit when input A is OFF and unlit when input A is ON. |
| INC | Increment | Lit when Counter is incrementing. |
| DEC | Decrement | Lit when Counter is decrementing. |
| RST | Reset | Lit when Counter is reset. |
| PRST | Preset | Lit when Counter is preset. |
| MOD1 | Intelligent I/O Read/Write mode | Lit when Counter is in Intelligent I/O Read/Write data transfer mode. |
| MOD2 | Command mode | Lit when Counter is in command data transfer mode. |

1-3 System Configurations

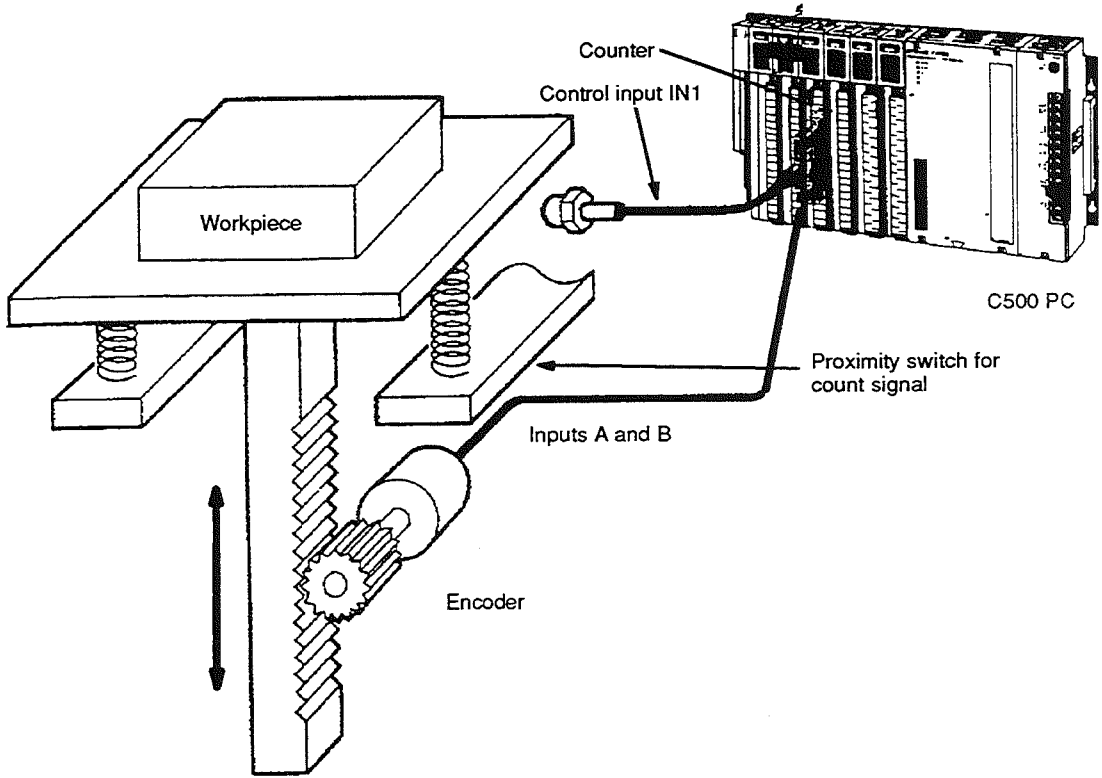
High-speed Counters can perform a variety of functions in the control system. The following system configuration uses a High-speed Counter to determine whether the length of a workpiece is acceptable. The workpieces on the conveyer pass a photoelectric switch, whose output is used to start and stop the counting of pulses from an Encoder. The pulse count is used to determine the length of the workpiece. This length is checked against the standard, and the work is ejected if it is out of the acceptable range.



The next system configuration example shows a Counter detecting the position of a workpiece as it passes on a conveyer. Position is checked by means of the pulse input from the Encoder, and the required operations are performed on the workpiece as it passes the various stations.



This system configuration example shows a Counter being used to measure the mass of a workpiece. Encoder pulses are counted for a fixed period after the workpiece has been placed on a scale. The workpiece is weighed only after all vibration has stopped.



Other examples and the associated programming are discussed in *Section 3 Programming Examples*.

1-4**Precautions**

When mounting or removing a High-speed Counter, first turn OFF the power supplies to both the Counter and the PC.

The High-speed Counter continues to operate even when the operation mode of the PC is changed from RUN or MONITOR to PROGRAM. If input pulses continue to be fed to the Counter and the count value falls within the set range, the corresponding output will turn ON. Thus, once the Counter's coincidence data is set and its outputs are enabled, the outputs will operate regardless of the PC's operation mode.

To adjust the origin and debug a program, first set the coincidence values and enable the outputs while in RUN mode, then switch to PROGRAM mode. However, as a safety precaution, be sure to provide circuitry to shut down equipment, such as motors, that is connected to the outputs.

If an I/O bus error occurs when the Counter is connected to a C1000H or C2000H PC, the PC's RUN operation will stop and all Output Units will turn OFF. The PC will then send a hardware reset signal to all the I/O Units and the Counter will return to the same status as at initial power application. The Counter will not be reset if it is mounted on a Remote I/O Rack.

If an I/O bus error occurs while the Counter is connected to a C500 PC, the Counter will operate as if switched to PROGRAM mode. Therefore, when using a C500 PC, turn OFF the outputs via an external circuit or turn OFF the power to the PC.

All C-series PCs perform a hardware reset during a CPU error.

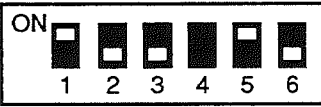
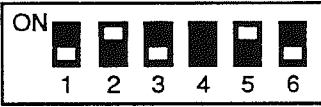



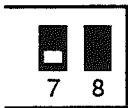
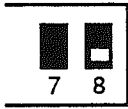
1-5

DIP Switch Settings

Set the Counter's DIP switch(es) before operation. Depending on the Counter model, the DIP switch(es) are used to determine count input mode, response frequency, sensor output, reset/preset mode, reset/preset conditions, and data transfer mode.

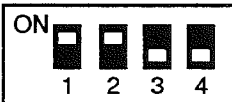



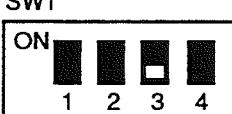





CT001 DIP Switch Settings




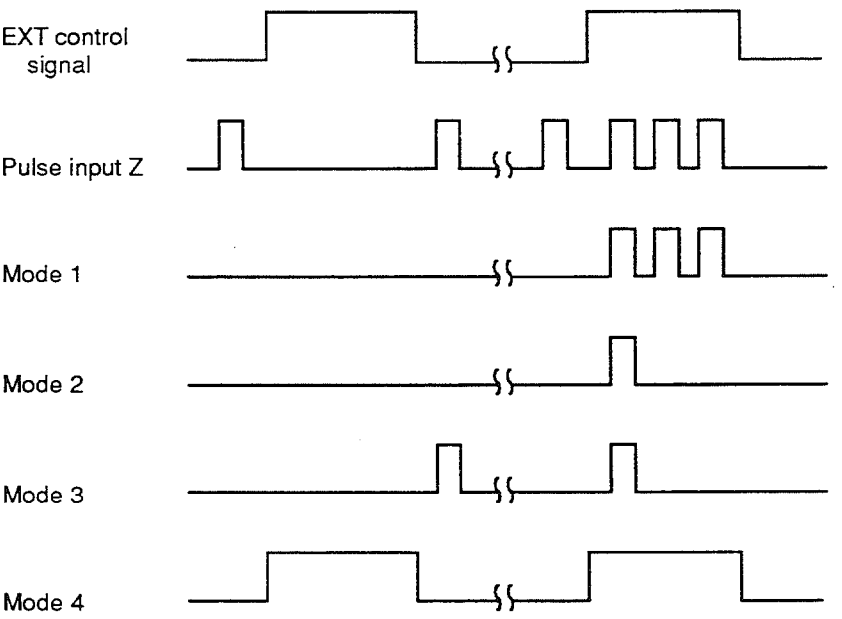
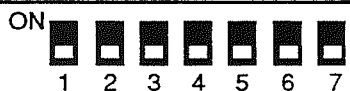

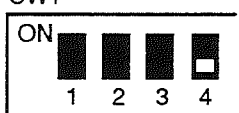
The DIP switch is located behind the indicator panel. To gain access to the DIP switch, remove the indicator panel with a standard screwdriver.

| Pin Settings and Functions | |
|--|--|
| <p>• Count input mode</p> <div style="margin-bottom: 10px;">  </div> <div style="margin-bottom: 10px;">  </div> <div>  </div> | <p>Command input mode 1: In this mode, the Counter counts each leading edge of count input 1. The program specifies increment (UP), or decrement (DOWN). The signal of count input 2 is ignored.</p> <p>Command input mode 2: In this mode, the Counter counts each leading edge of count input 1; count input 2 specifies UP or DOWN operation. The Counter increments when the input level of count input 2 is high, and decrements when count input 2 is low.</p> <p>Phase differential input mode: In this mode, the Counter increments or decrements depending on the phase difference between count inputs 1 and 2. When count input 1 precedes count input 2 by 90° at the leading edge of count input 1, the UP operation is specified at the trailing edge of count input 1. When count input 1 follows count input 2 by 90° at the leading edge of count input 1, the DOWN operation is specified.</p> |
| <p>• Response frequency</p> <div style="margin-bottom: 10px;">  </div> <div>  </div> | <p>Response frequency 30 Hz (with contact input): Use only with command input mode 1; sets response frequency of count input 1 to 30 Hz.</p> <p>Response frequency 50 kHz (with solid state input): Usable with all count input modes; sets response frequency of both count input 1 and count input 2 to 50 kHz.</p> |
| <p>• Sensor output type</p> <div style="margin-bottom: 10px;">  </div> <div>  </div> | <p>Set to OFF when a PNP-type output sensor is connected to input 1; otherwise, set to ON.</p> <p>Set to OFF when a PNP-type output sensor is connected to input 2; otherwise, set to ON.</p> |

Note To ensure correct operation, confirm all settings.

CT012 Dip Switch Settings

| Switches | Pin Settings and Functions |
|--|--|
| | <p>Count input mode SW2</p>  <p>Phase differential input mode: Determines increment/decrement operation according to phase difference between A and B.</p> <p>SW2</p>  <p>Pulse and direction input mode: Determines increment/decrement operation via INC/DEC signal at Encoder input B.</p> |
| <p>SW1</p>  | <p>Response frequency SW1</p>  <p>30 Hz max. (contact input): Use only with pulse and direction input mode. Sets Encoder input A frequency to 30 Hz (max).</p> <p>SW1</p>  <p>50 kHz max. (no-contact mode): Use with either input mode. Sets maximum frequency for both Encoder inputs to 50 kHz (30 kHz for phase differential input mode).</p> |
| <p>SW2</p>  | <p>Counter reset/preset mode (via external control signal(s))</p> <p>SW1</p>  <p>Preset mode: Preset data is '000000' upon initial power application. A preset sets the counter to the preset value sent by the PC.</p> <p>SW1</p>  <p>Reset mode: A reset sets the counter to '000000'.</p> |
| | <p>Counter reset/preset conditions (relationship between EXT and Z phase signals)</p> <p>SW1 SW2</p>  <p>Counter reset/preset mode 1: Counter is reset/preset when EXT and Z phase signals are ON simultaneously (logical AND).</p> <p>SW1 SW2</p>  <p>Counter reset/preset mode 2: Counter is reset/preset when EXT signal and first Z phase pulse are ON simultaneously (logical AND).</p> |

| Switches | Pin Settings and Functions |
|--|---|
| | <p>SW1 SW2</p>  <p>Counter reset/preset mode 3: Counter is reset/preset when EXT signal (latched) and the first Z phase pulse are ON simultaneously (logical AND).</p> <p>SW1 SW2</p>  <p>Counter reset/preset mode 4: Counter is reset/preset via EXT signal only.</p> |
| <p>SW1</p>  |  <p>EXT control signal</p> <p>Pulse input Z</p> <p>Mode 1</p> <p>Mode 2</p> <p>Mode 3</p> <p>Mode 4</p> |
| <p>SW2</p>  | <p>Data transfer mode</p> <p>SW1</p>  <p>Mode 1: Intelligent I/O Read/Write mode Use when Counter is mounted on a PC or Expansion I/O Rack; blocks of data are transferred via Intelligent I/O Read/Write.</p> <p>SW1</p>  <p>Mode 2: Command mode Use only when Counter is mounted on a Remote I/O Rack; commands are transferred via MOV.</p> |

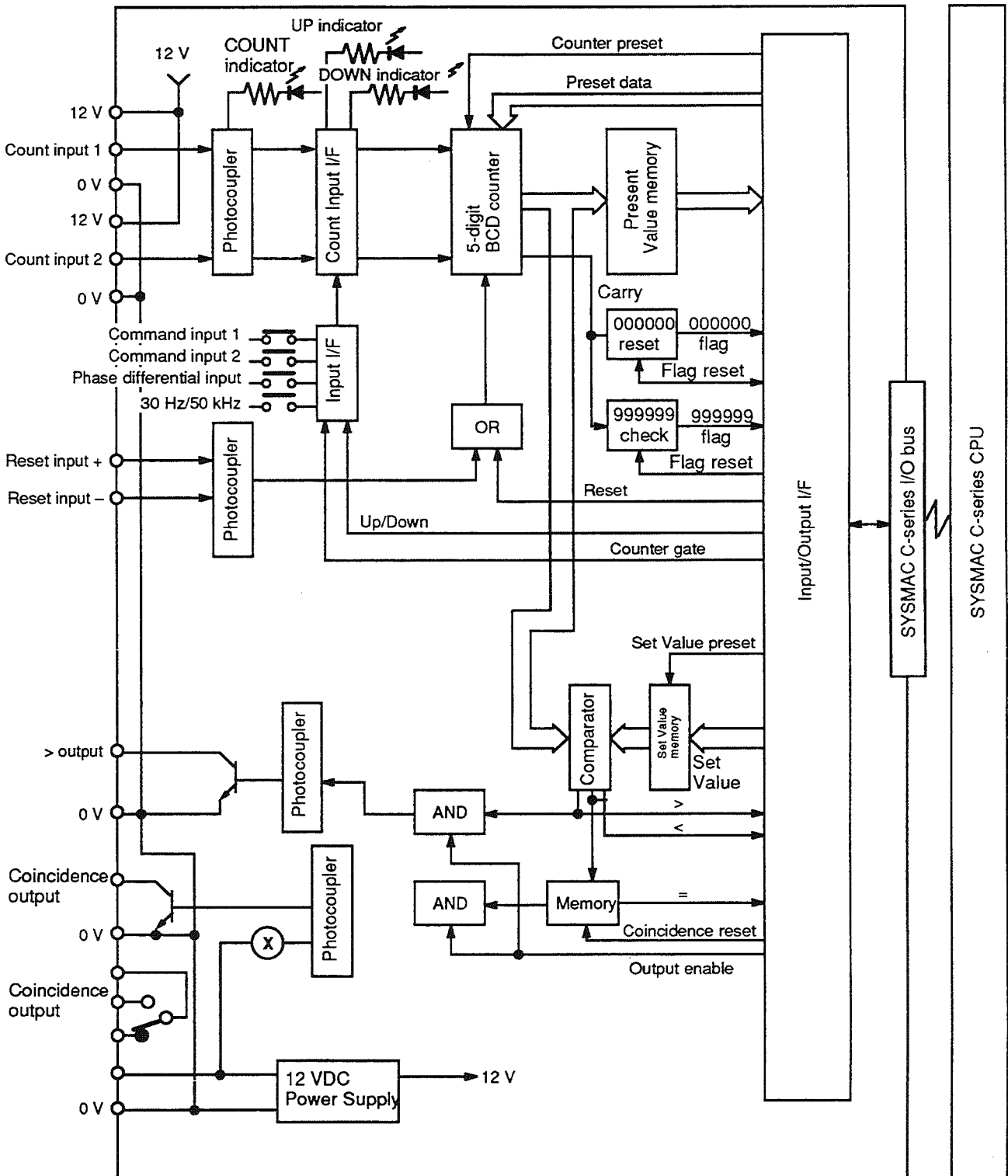
Note To ensure correct operation, confirm all settings.

1-6
Wiring

This section explains how to wire inputs to the Counter's terminal block. For the Counter's signal and power leads, use twisted pair shielded cable. Avoid running signal and power supply leads in the vicinity of other high voltage lines.

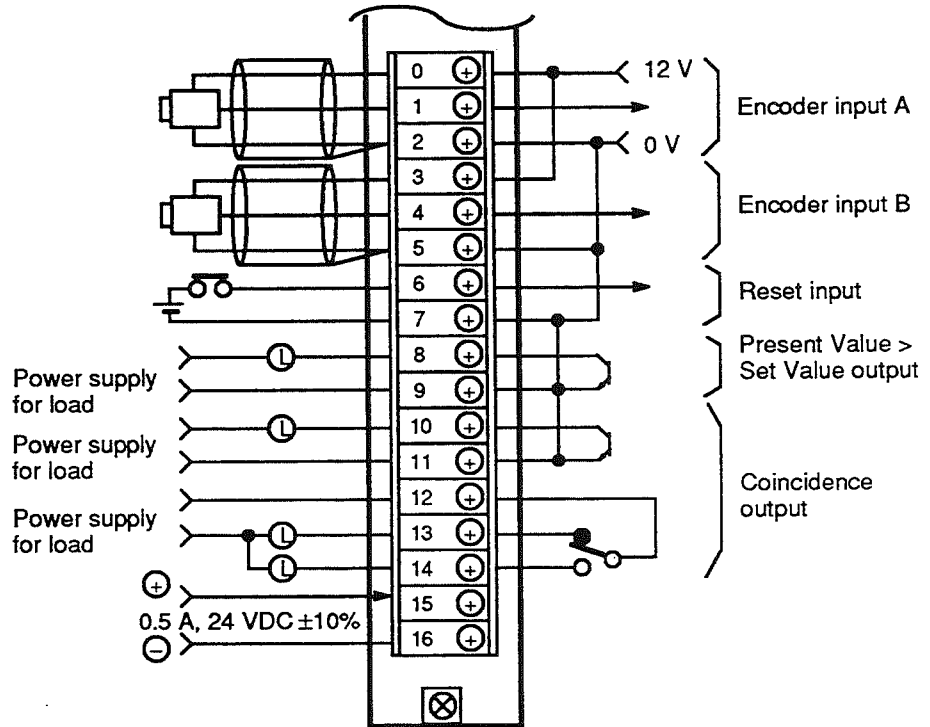
1-6-1 Terminal Blocks

The Counters have a terminal block connector for wiring to devices such as Encoders. The following is a block diagram for the CT001s:

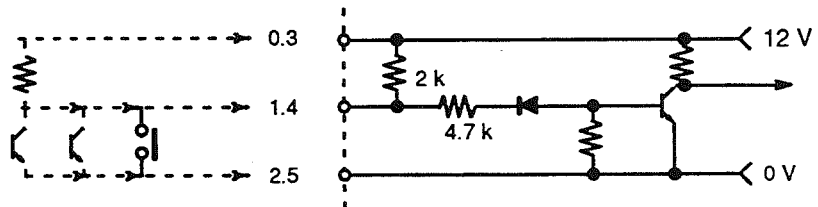


The following diagram shows terminal block allocations for the CT001s.

External connections



Count input signal



Note Because a High-speed Counter operates at a speed of 50,000 counts per second, avoid connecting loads and wiring that may generate noise at the coincidence output terminals.

Terminal block allocations for the CT012 are similar. They are listed in the following table.

| Row A | Pin no. | Row B |
|---|---------|--|
| Encoder input A: 12 VDC | 0 | Encoder input A: 24 VDC |
| Encoder input A: 0 V | 1 | Encoder input A: 5 VDC |
| Encoder input B: 12 VDC | 2 | Encoder input B: 24 VDC |
| Encoder input B: 0 V | 3 | Encoder input B: 5 VDC |
| Pulse input Z: 12 VDC | 4 | Pulse input Z: 24 VDC |
| Pulse input Z: 0 V | 5 | Pulse input Z: 5 VDC |
| External control input 12/24 VDC | 6 | External control input 12/24 VDC |
| External control input 0V | 7 | External control input 5 VDC |
| | 8 | |
| External output 0 | 9 | External outputs 0 through 3, COM: 0 V |
| External output 1 | 10 | External outputs 0 through 3, COM: 0 V |
| External output 2 | 11 | External outputs 0 through 3, COM: 0 V |
| External output 3 | 12 | External outputs 0 through 3, COM: 0 V |
| External outputs 0 through 3 Power Supply: 5 to 24 VDC | 13 | External outputs 0 through 3, COM: 0 V |
| External output 4 | 14 | External outputs 4 through 7, COM: 0 V |
| External output 5 | 15 | External outputs 4 through 7, COM: 0 V |
| External output 6 | 16 | External outputs 4 through 7, COM: 0 V |
| External output 7 | 17 | External outputs 4 through 7, COM: 0 V |
| External outputs 4 through 7 Power Supply: 5 to 24 VDC | 18 | External outputs 4 through 7, COM: 0 V |

Note The power supply terminals to be wired for Encoder inputs A, B, and Pulse input Z differ depending on whether the supply voltage is 5, 12, or 24 VDC. The supply terminals to be wired for the External control input differ depending on whether the supply voltage is 5 or 12/24 VDC. When wiring, be sure that terminal connections are correct.

External outputs 0 through 3 and 4 through 7 are supplied via separate 5 to 24 VDC and COM (0 V) external power supply inputs. These two sets of power supply inputs are not internally connected.

Reversing the 5 to 24 VDC and COM (0V) terminals will cause the internal fuse to blow, disabling the Unit. Never reverse the connections, as this internal fuse is not user-replaceable.

When wiring Encoder inputs A and B, take the following precautions to minimize the effects of electrical noise:

1, 2, 3...

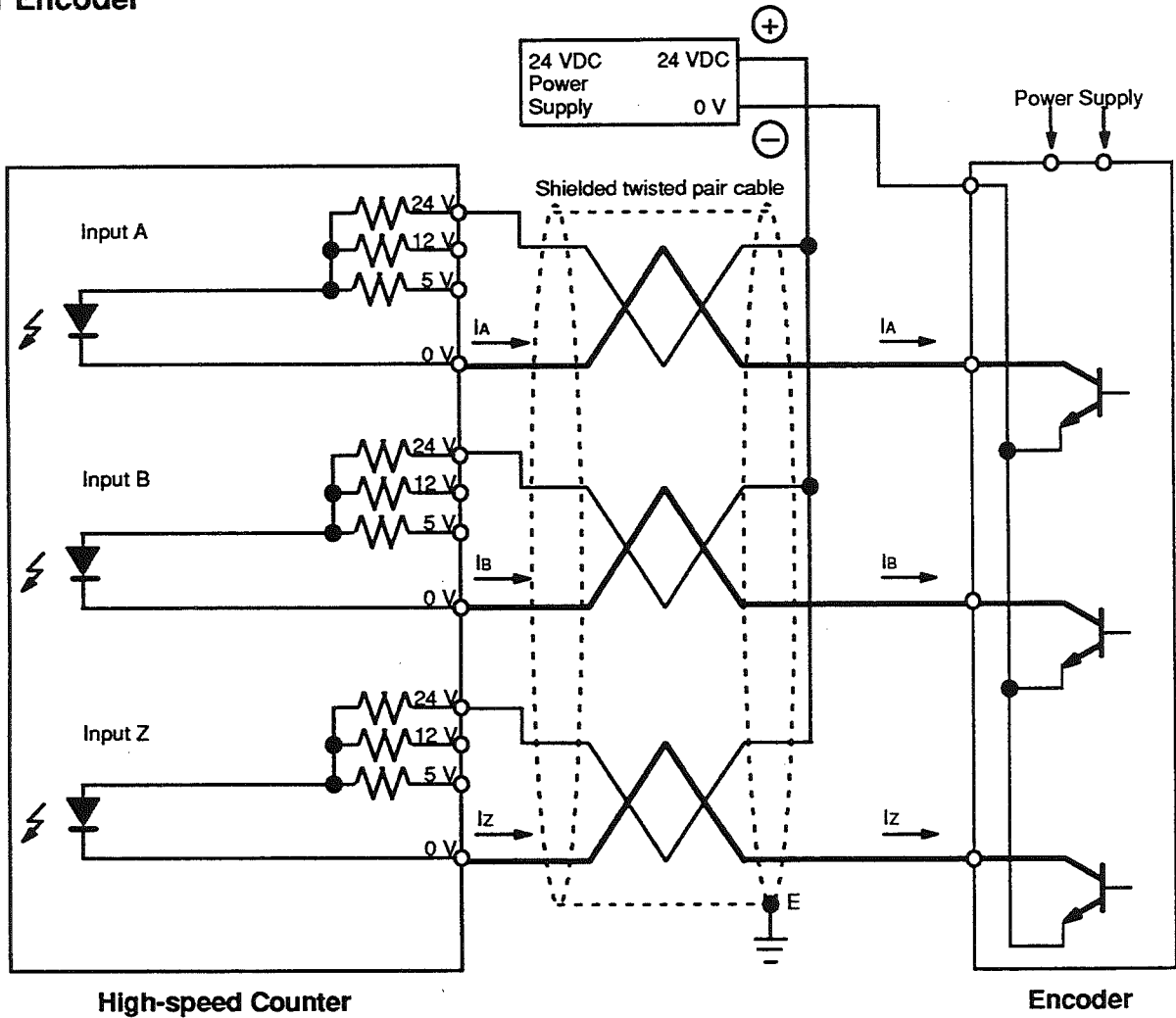
1. Use twisted pair shielded cable for wiring Encoder inputs A and B; connect the shield to ground.
2. Keep the leads of Encoder inputs A and B as short as possible and avoid running them in the vicinity of electrical noise sources such as high voltage power lines.
3. If possible, use a stable power supply, separate from other input/output power supplies, for the Encoder.

1-6-2

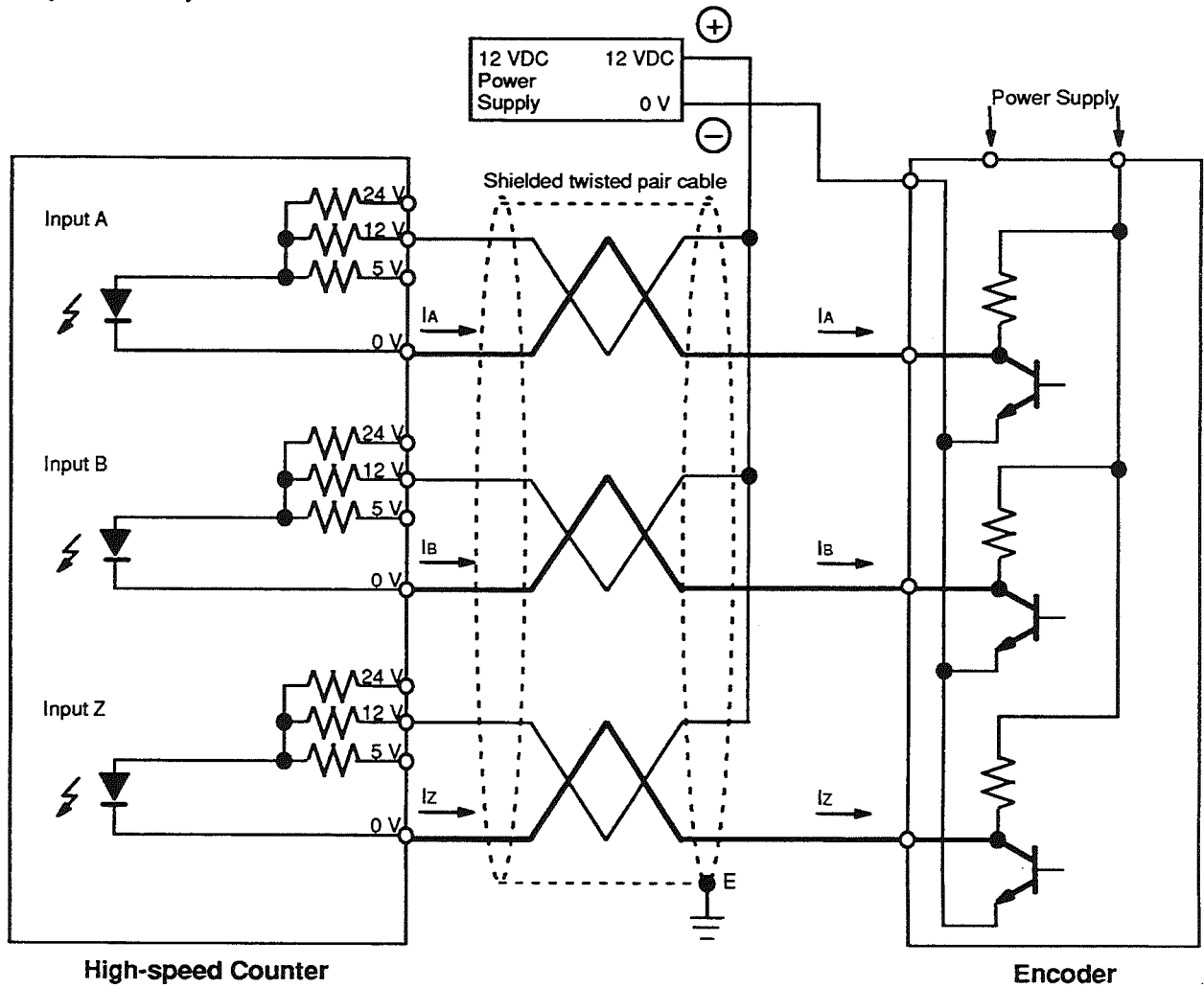
Circuit Wiring Examples

This section illustrates possible wiring examples with Encoders. The following example shows the wiring for an Encoder with A, B, and Z phase outputs.

Example 1: 24 VDC open collector Encoder

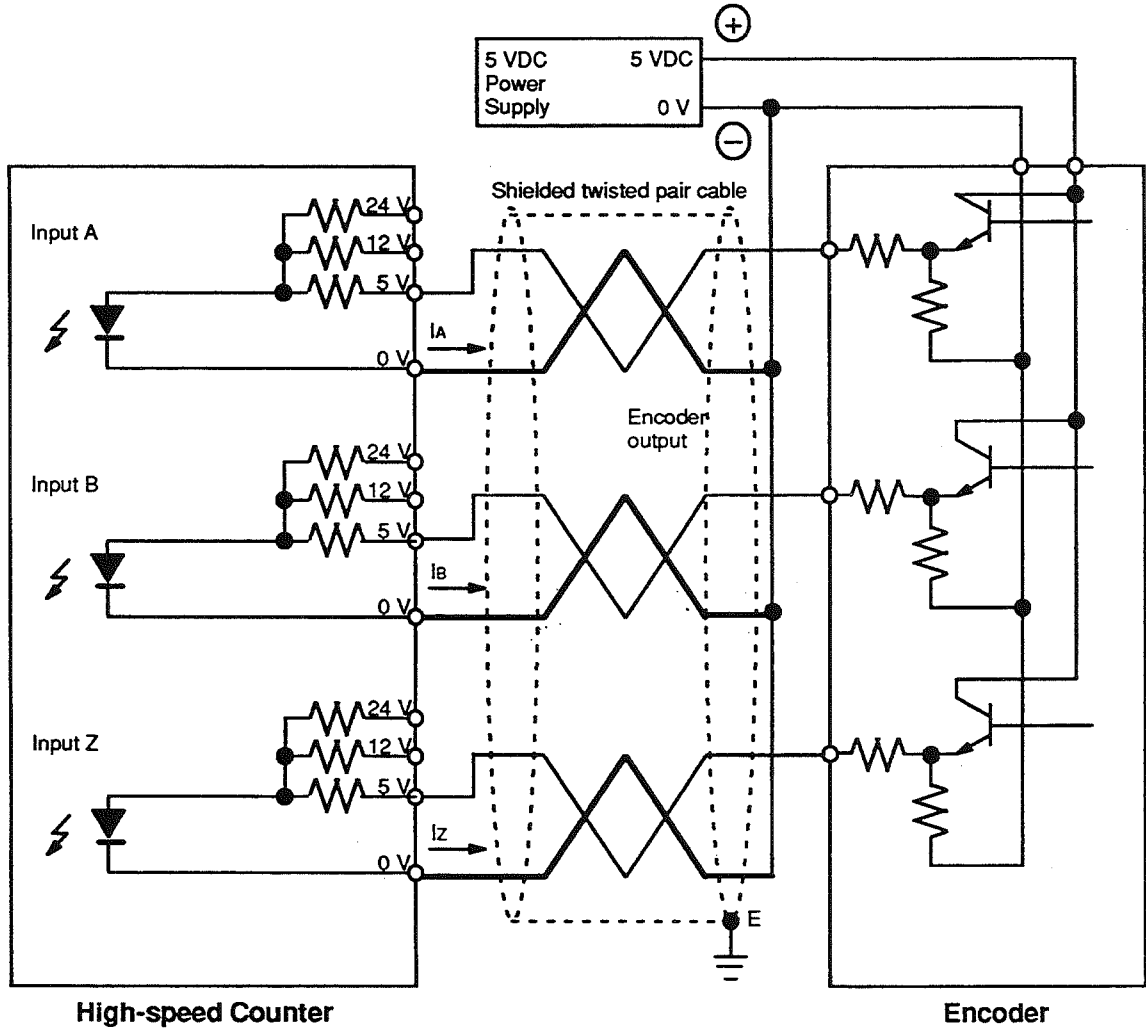


Example 2: 12 VDC voltage output (sink load) Encoder



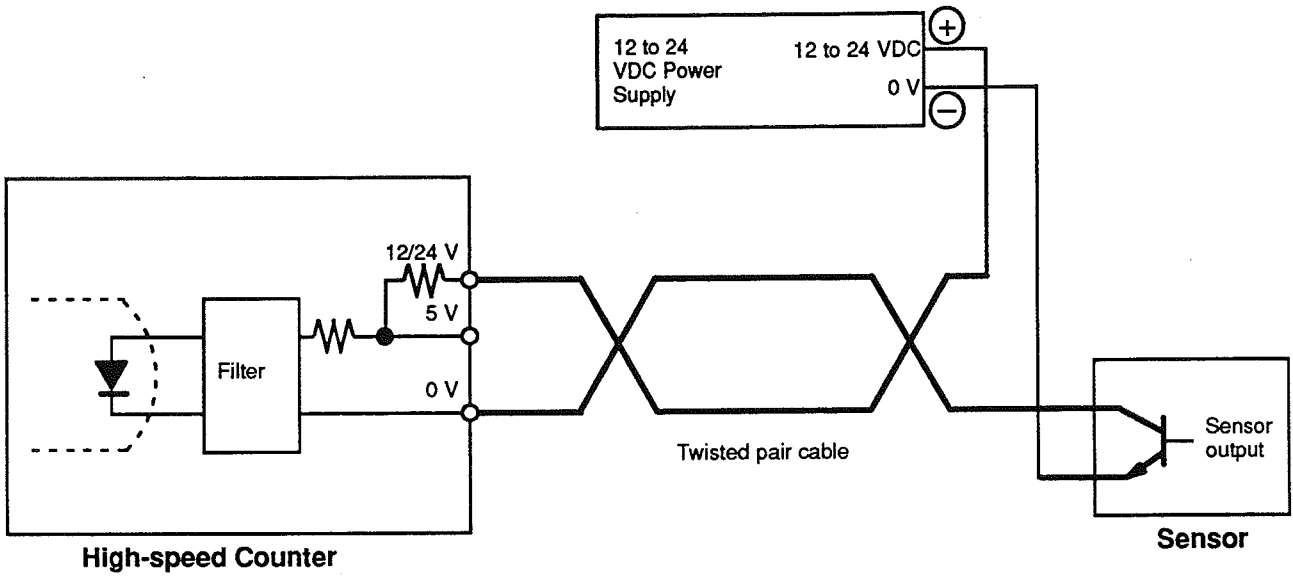
Note High-speed Counter input is OFF when Encoder output is "H" and ON when Encoder output is "L."

Example 3: 5 VDC voltage output (source load) Encoder



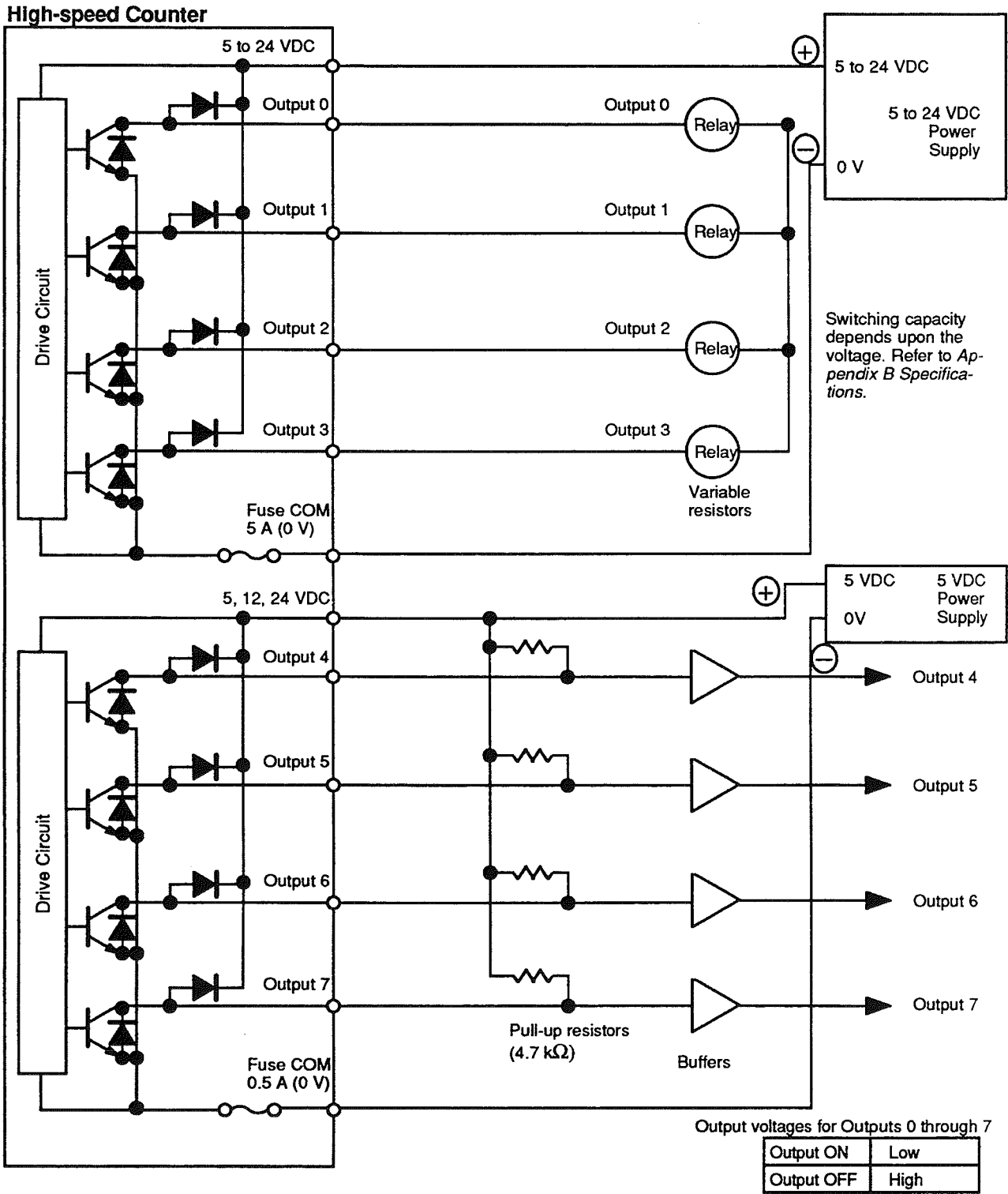
Note Be sure the ON voltage is sufficient.

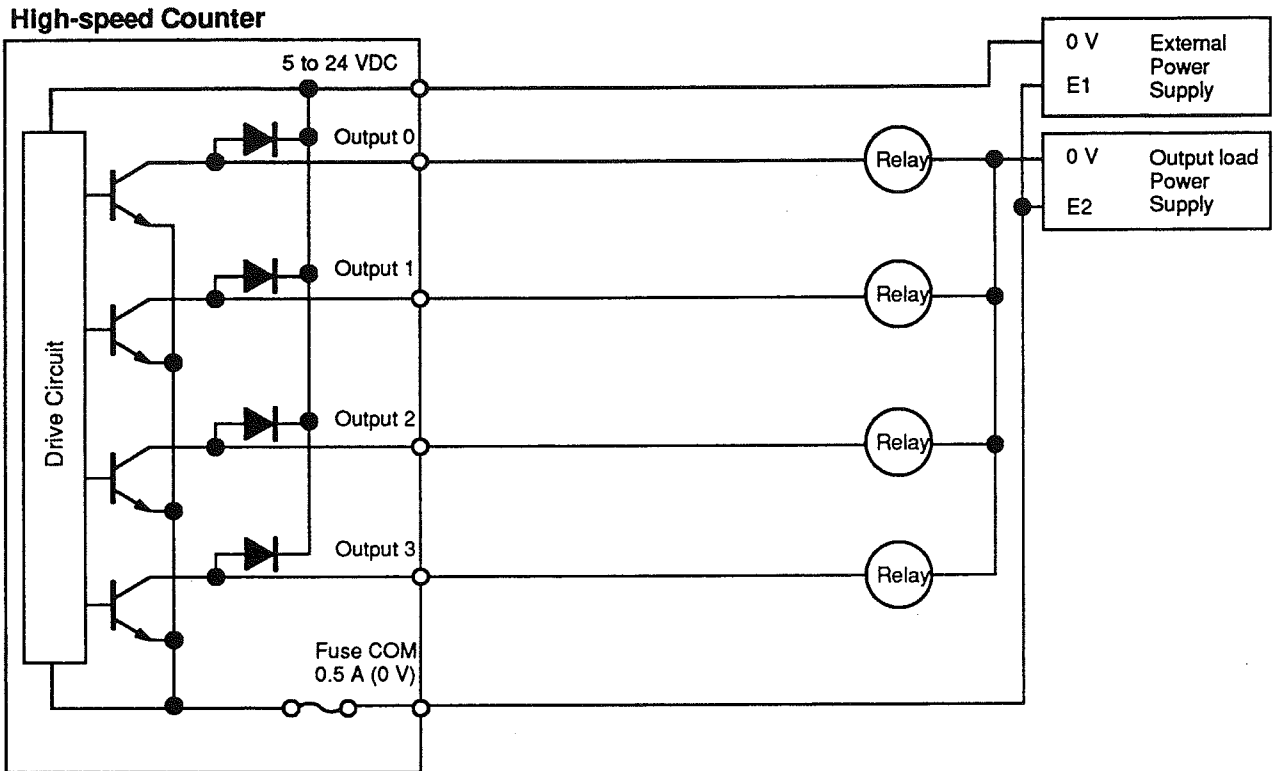
External Control Input Wiring



External Output Wiring

The following diagram shows the wiring when outputs 0 through 3 are connected to relays, and outputs 4 through 7 are connected to TTL devices.





Note Make sure that the external Power Supply voltage is not less than the output load Power Supply voltage; otherwise errors may occur.

SECTION 2

Operation Structures

| | | |
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2-1 Operating Modes

The CT001 and CT012 Counters can be operated in several modes. This section describes these modes as well as the counting speed characteristics of the Counters.

The Counters can be incremented or decremented between 000000 and 999999. Within this range, 500000 through 999999 are treated as negative values. The CT001s have three input modes: command input mode 1, command input mode 2, and phase differential input mode. The CT012 has two input modes: phase differential input mode, and pulse and direction input mode. All input modes include a reset input. Set the DIP switch to select the desired mode.

The Present Value of a CT001 Counter is continually compared to a single Preset Value. The appropriate signal lights to indicate whether the Present Value is greater than, equal to, or less than the Preset Value.

The CT012 Counter compares the Present Value to a maximum of 8 preset coincidence ranges. When the Counter value is within one of these ranges, specified outputs are turned ON. The same output may be specified for one or more overlapping ranges, in which case the output will be turned ON whenever the Counter value is within one or more of the ranges. The ranges specified for the CT012 must be between 000000 and 999999.

The three input modes of the CT001s are explained below.

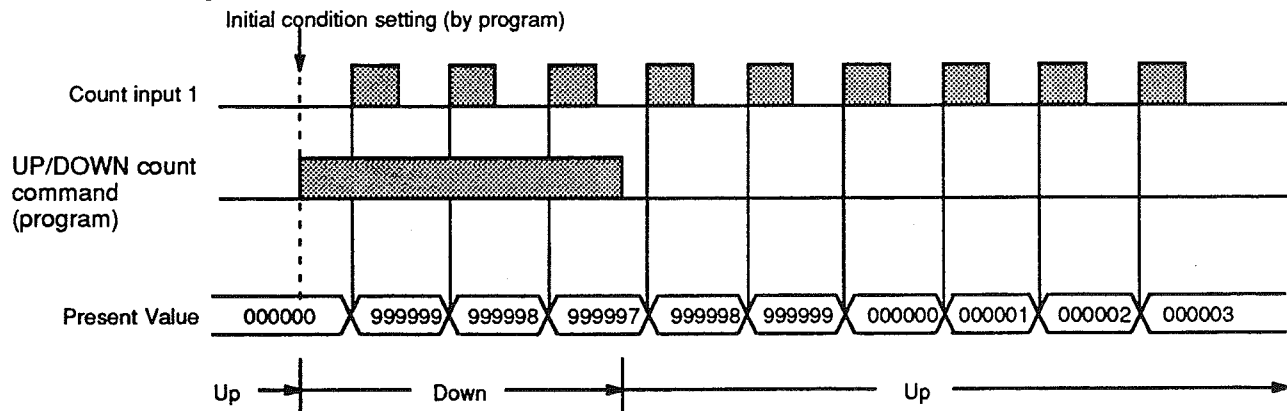
2-1-1 CT001 Operating Modes

Command Input Mode 1

There are two count inputs and a reset input on the terminal block. Count input 1 can be connected to solid-state or contact inputs; count input 2 can be connected only to solid-state inputs. If the control system requires very high counting speeds, note that solid-state inputs can be counted at speeds of up to 50,000 Hz. When input 1 is connected to a contact input this speed is reduced to a maximum of 30 Hz. Set the DIP switch accordingly.

When in command input mode 1, the Counter counts each leading edge of count input 1. The program specifies either UP or DOWN counting. The signal from input 2 is ignored.

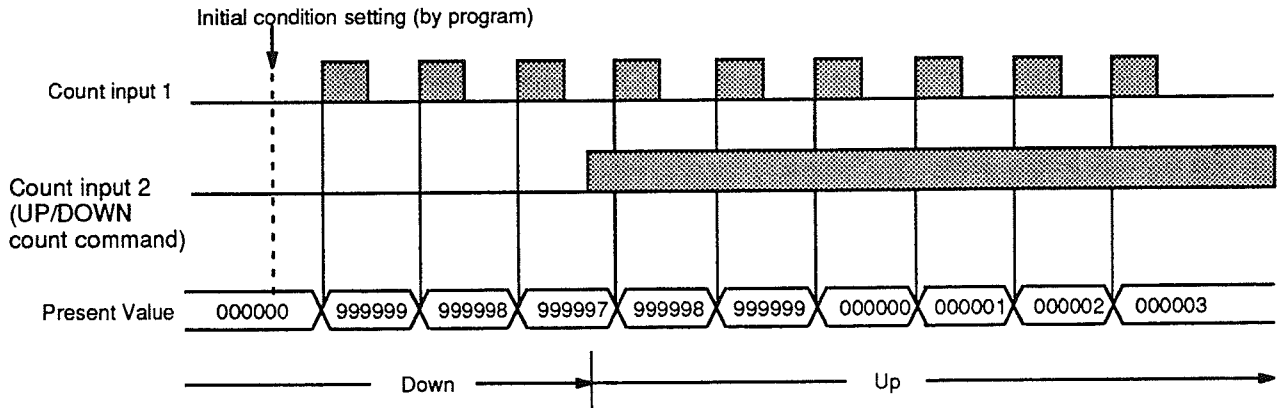
Command input mode 1



Command Input Mode 2

When in command input mode 2, the Counter counts each leading edge of count input 1; count input 2 specifies either UP or DOWN. The count is incremented when count input 2 is ON, and decremented when count input 2 is OFF.

Command input mode 2

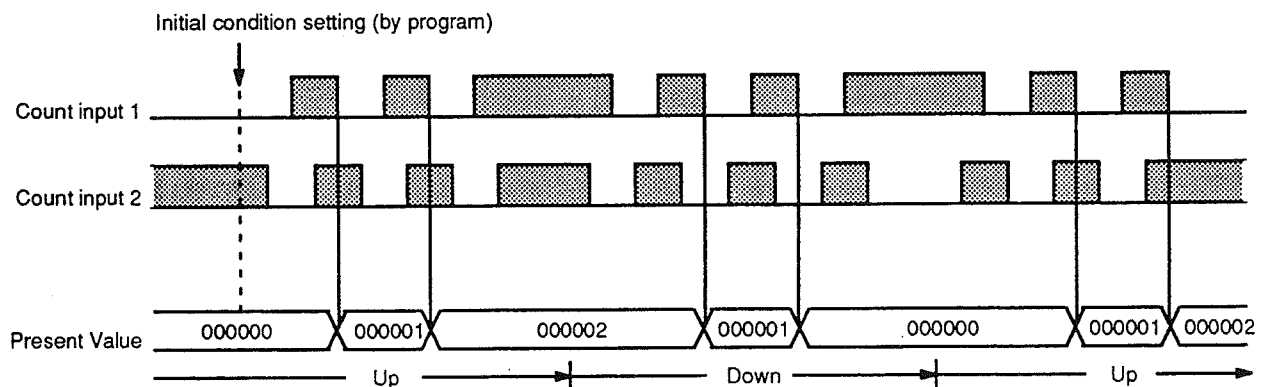


CT001 Phase Differential Input Mode

In this mode, the difference in phase between count inputs 1 and 2 determines whether the count will be incremented or decremented. When the leading edge of count input 1 precedes count input 2 by 90° ($1/4 T$), the UP operation is specified at the trailing edge of count input 1. When count input 1 follows count input 2 by 90° , the DOWN operation is specified at the leading edge of count input 1.

Permissible phase difference error range is $\pm 45^\circ$.

Phase differential input mode



2-1-2

CT012 Operating Modes

The CT012 Counters have two input modes: phase differential input mode and pulse and direction input mode. Use DIP switch 2 on the Counter's back panel to select the mode.

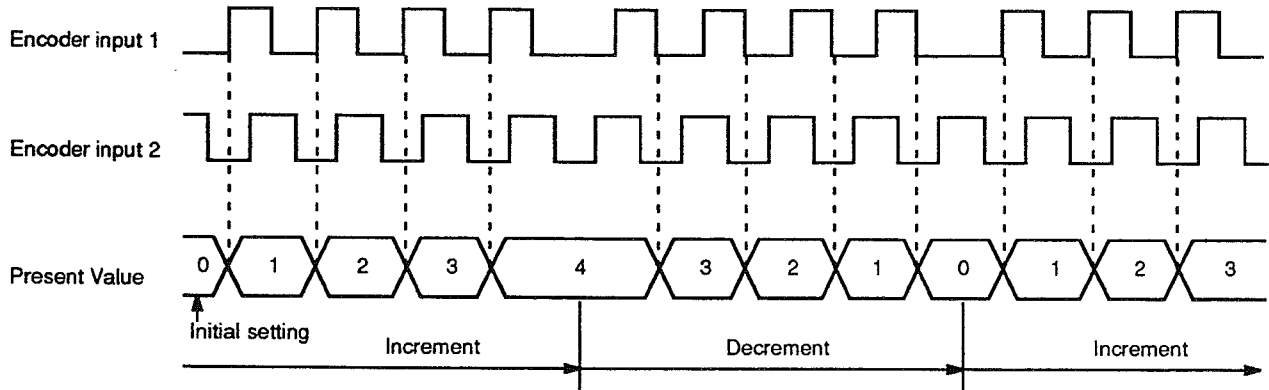
CT012 Phase Differential Input Mode

In this mode, the difference in phase between count inputs 1 and 2 determines whether the count will be incremented or decremented. When the leading edge of count input 1 precedes count input 2 by 90° ($1/4 T$), the UP operation is specified

at the trailing edge of count input 1. When count input follows count input 2 by 90°, the DOWN operation is specified at the leading edge of count input 1.

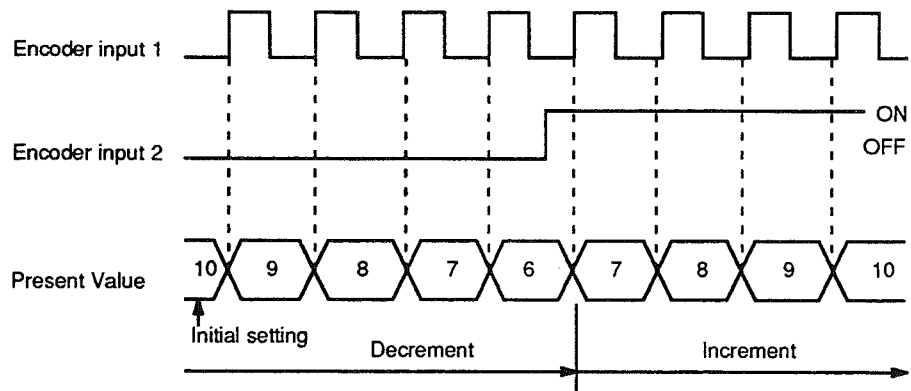
Permissible phase difference error range is $\pm 45^\circ$.

Phase differential input mode



Pulse and Direction Input Mode

The pulse and direction input increments or decrements the Counter according to the ON/OFF status of input 2 at the leading edge of the input 1 signal. The Counter will decrement if input 2 is registering the OFF signal, and increment if input 2 is registering the ON signal.

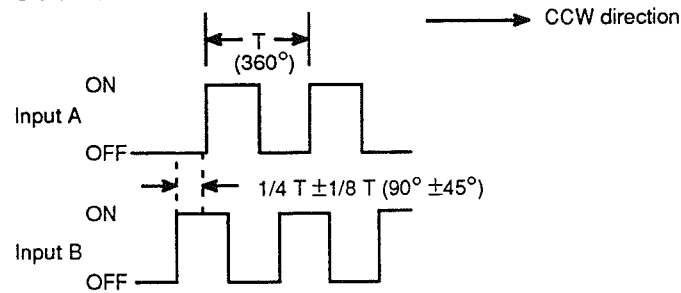


2-2

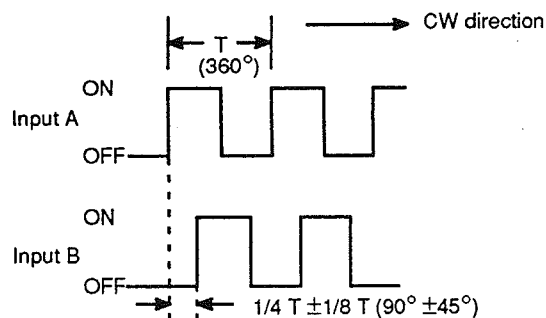
Counting Speeds with Phase Differential Inputs

Both the CT001 and CT012 Counters have a phase differential input mode, in which the phase difference of the inputs determines whether the count will be incremented or decremented. The maximum pulse frequency possible for phase differential inputs is determined by the specifications of the Incremental Encoder connected to the Counter. The following example shows calculations for a CT012 connected to an Incremental Encoder with a resolution of 500 pulses/revolution. Direction of rotation is as viewed from the end of the Encoder shaft.

Counterclockwise Rotation



Clockwise Rotation

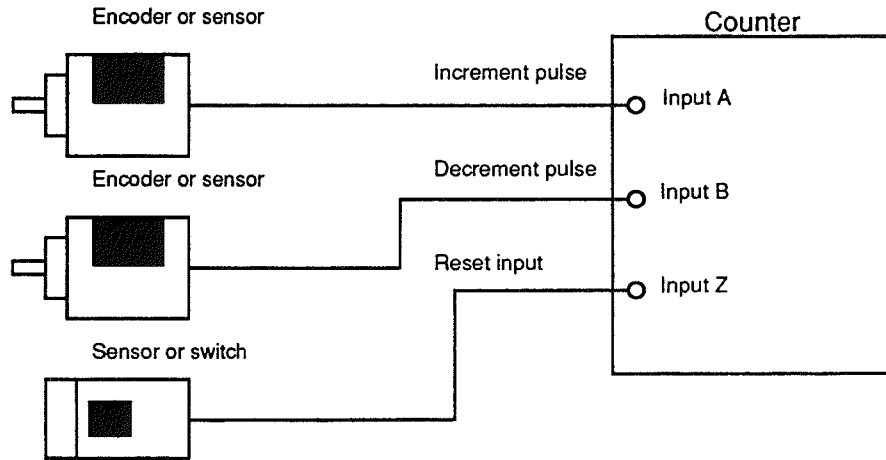


Since the output phase difference is $90^\circ \pm 45^\circ$, the minimum phase difference the Encoder is capable of producing is $90^\circ - 45^\circ = 45^\circ$. Because the CT012 requires a phase difference of at least 3 microseconds, 3 microseconds must be equal to or less than $45^\circ/360^\circ$. The period, T , must therefore be at least 24 microseconds; this represents a maximum frequency ($1/T$) of 41.7 kHz, or approximately 83 rps at the Encoder's resolution of 500 pulses per revolution ($41700 \div 500 = 83.4$). This is the maximum frequency at which this Encoder can be used with the CT012.

Note The minimum pulse width must be considered when using the reset input Z. With the CT012, the pulse width of this input must be 8 microseconds or greater, and the return frequency, allowing for software processing time, must be 10 kHz or less.

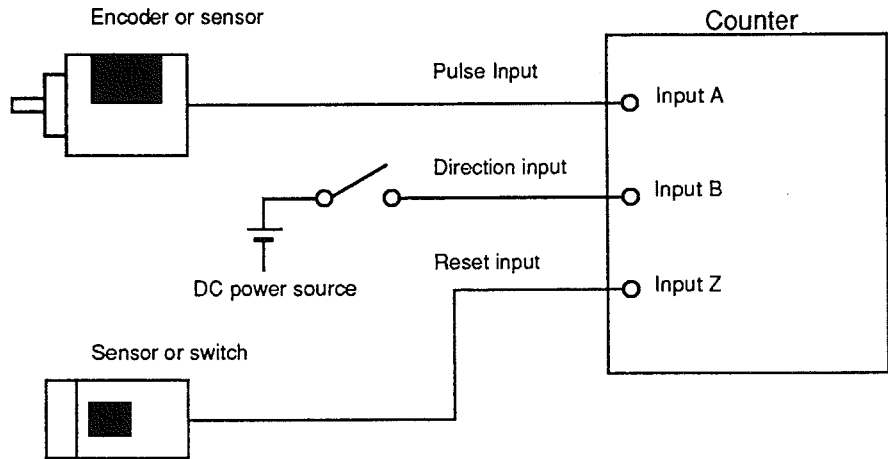
2-3 Up and Down Pulses

With separate up and down pulse inputs (command input mode 2 of the CT001), the Counter value is incremented or decremented on the rising edge of the appropriate input. Here, sensors could replace the Encoders to provide inputs A and B. The Counter can be reset by connecting the reset input Z to a sensor or switch.



2-4 Pulse and Direction

With pulse and direction inputs, the Counter value is incremented or decremented on the leading edge of the pulse input. When the direction input is ON, the Counter value is incremented; when the direction input is OFF, the Counter value is decremented. The direction input should be switched between ON and OFF only when the pulse input is OFF. The Counter can be reset by connecting reset input Z to a sensor or switch.

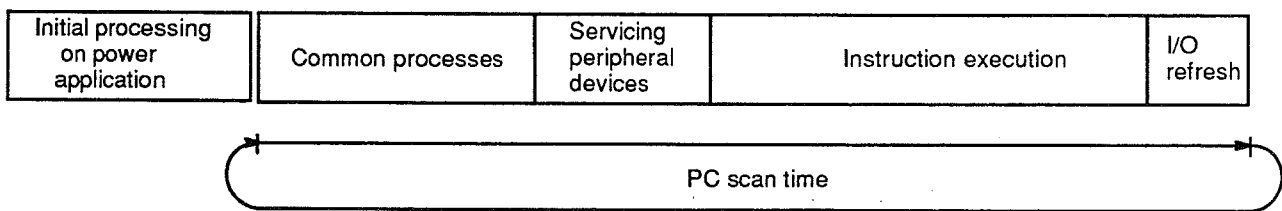


2-5 Data Transfers

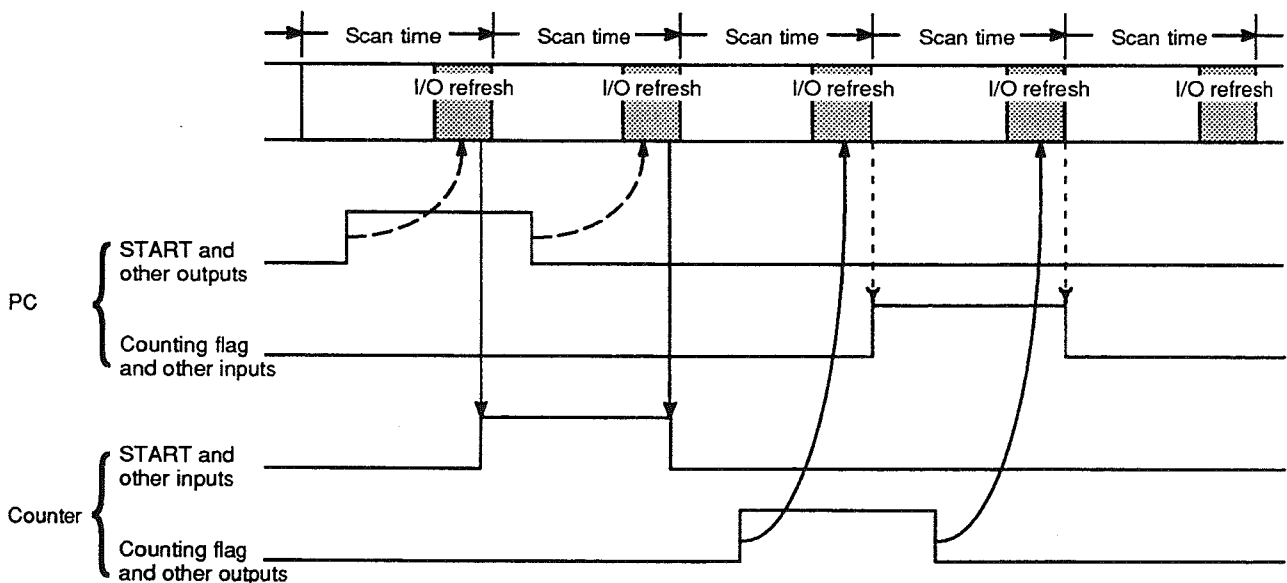
The Present Value of a Counter, and range limit settings of the CT012, can be changed using data transfers from a PC. Data to be transferred must be prepared in the appropriate form in the PC data area. Data transfer specifications are described in *Section 2-5-2 Data Transfer Modes*. This section describes data transfer timing in relation to PC scan time.

2-5-1 Timing of Data Transfers

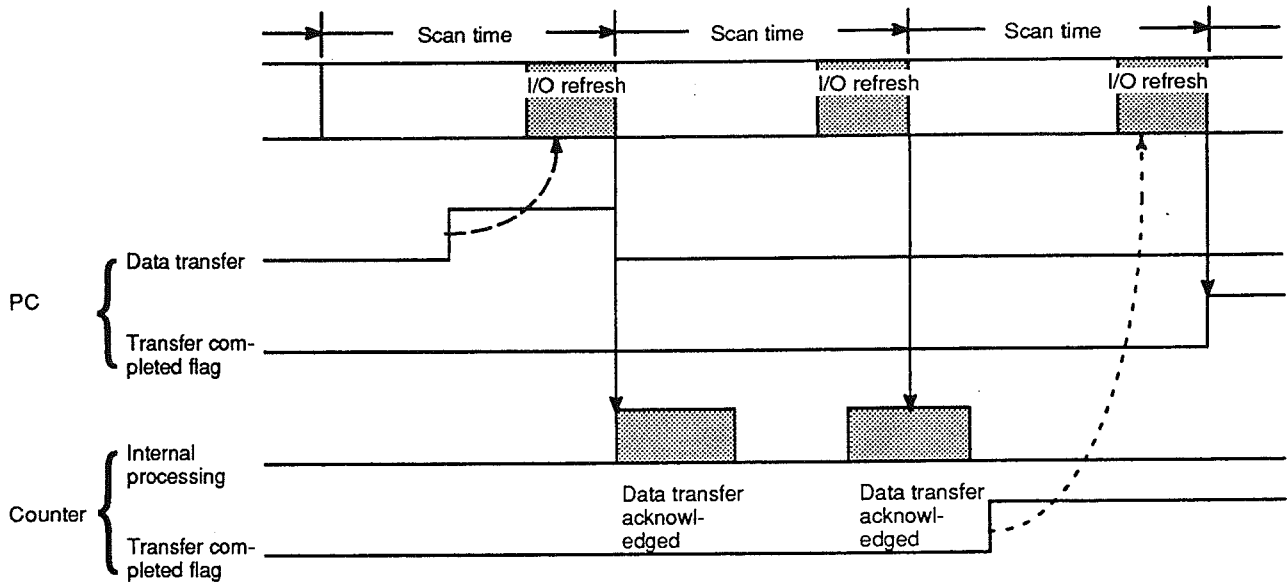
The following diagram shows the timing and relative duration of the operations performed during scan time:



Input and output data is transferred during the PC's I/O refresh cycle. This means that the PC's acknowledgment of Counter's status, and the Counter's acknowledgment of PC commands, are delayed until the next I/O refresh cycle. This is illustrated below.



Data transfer is related to scan time as shown in the following diagram:



2-5-2 Data Transfer Modes

The CT012 has two data transfer modes. Mode 1 is Intelligent I/O Read/Write mode, in which blocks of data are transferred via Intelligent I/O Read/Write. Mode 2 is command mode, in which commands are transferred via MOV. Data transfer can be in either direction between the PC and Counter. Set the DIP switch to select the desired mode. Mode 1 is for use when the Counter is mounted on a PC or Expansion I/O Rack. Mode 2 is for use when the Counter is mounted on a Remote I/O Rack.

Mode 1 of the CT012 is similar to CT001 operation.

The following table shows bit allocations.

CT001 Bit Number Allocations

| | | I/O | | | | | | | |
|-----|----|----------------------|-------------------|-------------------|-------------------|-----------|-------------------|-------------------|-------------------|
| | | OUT | | | IN | | | | |
| | | word n | word n+1 | | word n+2 | | word n+3 | | |
| bit | 0 | Present Value Preset | Preset data 1 | x 10 ² | 000000 reset | | PV data 1 | x 10 ² | |
| | 1 | Set Value Preset | Preset data 2 | | 999999 reset | | PV data 2 | | |
| | 2 | Count Gate | Preset data 4 | | PV > SV | | PV data 4 | | |
| | 3 | Increment/Decrement | Preset data 8 | | PV = SV | | PV data 8 | | |
| | 4 | 000000 Reset | Preset data 1 | x 10 ³ | PV < SV | | PV data 1 | x 10 ³ | |
| | 5 | 999999 Reset | Preset data 2 | | Normally ON | | PV data 2 | | |
| | 6 | Coincidence Reset | Preset data 4 | | Normally ON | | PV data 4 | | |
| | 7 | Output Enable | Preset data 8 | | Normally ON | | PV data 8 | | |
| | 8 | Preset data 1 | x 10 ⁰ | Preset data 1 | x 10 ⁴ | PV data 1 | x 10 ⁰ | PV data 1 | x 10 ⁴ |
| | 9 | Preset data 2 | | Preset data 2 | | PV data 2 | | PV data 2 | |
| | 10 | Preset data 4 | | Preset data 4 | | PV data 4 | | PV data 4 | |
| | 11 | Preset data 8 | | Preset data 8 | | PV data 8 | | PV data 8 | |
| | 12 | Preset data 1 | x 10 ¹ | Preset data 1 | x 10 ⁵ | PV data 1 | x 10 ¹ | PV data 1 | x 10 ⁵ |
| | 13 | Preset data 2 | | Preset data 2 | | PV data 2 | | PV data 2 | |
| | 14 | Preset data 4 | | Preset data 4 | | PV data 4 | | PV data 4 | |
| | 15 | Preset data 8 | | Preset data 8 | | PV data 8 | | PV data 8 | |

Note PV and SV stand for Present Value and Set Value, respectively.

These bits function as shown in the following table.

PC → Counter Unit

| Bit | Function |
|---|---|
| Present Value Preset | Presets the counter to the value specified in the preset data. |
| Set Value Preset | Presets the preset data in the Set Value memory. |
| Count Gate | Controls the Counter's start and stop operations. ON starts the Counter; OFF stops it. |
| Increment/Decrement | In command input mode 1, the Counter's increment and decrement functions receive instructions from the PC program. |
| 000000 Reset | Resets the Counter to 000000 from 999999. |
| 999999 Reset | Resets the Counter to 999999 from 000000. |
| Coincidence Reset | Resets the Counter's Present Value = Set Value signal |
| Output Enable | Enables external output signals. (Coincidence signal and Present Value > Set Value signal). When power source is ON, output is blocked, thus both contact output and transistor output are OFF. |
| Preset data 10 ⁵ through 10 ⁰ | This is preset data for either the Counter (Present Value) or the Set Value memory. The data range is 000000 through 999999. When the power is applied, it is initialized to 000000. |

Counter Unit → PC

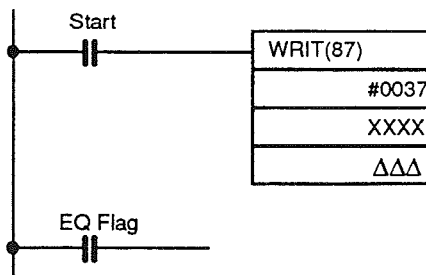
| Bit | Function |
|---------------------------|---|
| 000000 Reset | Using the increment instruction, this turns ON as the Counter's Present Value changes from 999999 to 000000. It is turned OFF by the 000000 reset or by an external reset instruction. |
| 999999 Reset | Using the decrement instruction, this turns ON as the Counter's Present Value changes from 000000 to 999999. It is turned OFF by the 999999 reset or by an external reset instruction. |
| Present Value > Set Value | Turns ON when the Counter's Present Value is greater than the Set Value. |
| Present Value = Set Value | Turns ON when the Counter's Present Value equals the Set Value. It is turned OFF by the coincidence reset or an external reset signal. Although the values still coincide once it is reset, this bit will not turn on again until the next instance of Present Value = Set Value. |
| Present Value < Set Value | This turns on when the Counter's Present Value is smaller than the Set Value. |
| Present Value Data | This is the Counter's Present Value (000000 through 999999). |

Note

1. When power is applied, all bits are OFF.
2. When an external reset is received, UP, DOWN, Present Value = Set Value, and Present Value Data are all reset.
3. When the preset data resets binary data, normal operations are not handled. Preset the BCD data.
4. Present Value preset and Set Value preset require that the coincidence reset be ON.
5. When the Counter is mounted on a Remote I/O Terminal, the ON/OFF signals of the various preset and reset outputs will be delayed at least 20 ms.

CT012 Bit Number Allocations

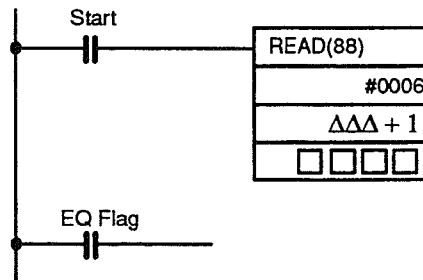
When writing programs to be transferred from the PC to the Counter, use the following format:



In this program, #0037 indicates the number of words to be sent to the Counter Unit. XXXX indicates the first address of PC data that will be sent. $\Delta\Delta\Delta$ indicates the OUT word where the Counter is mounted. The EQ flag will turn ON when the write command has been completed.

Writing data to the Counter does not set the Counter's Present Value unless the proper commands are used. The Present Value of the Counter can be set three ways: Clear, Preset 1, and Preset 2. When an OUT is sent to the appropriate bit, the bit's value is set to 1. Bits are allocated as follows: Input the three digit word where the Counter is mounted, followed by bit 03 (clear), bit 04 (Preset 1), or bit 05 (Preset 2). If a bit is left high, with a 1 value, the Counter will remain in a reset/preset state.

When sending information from the Counter to the PC, the same programming applies.

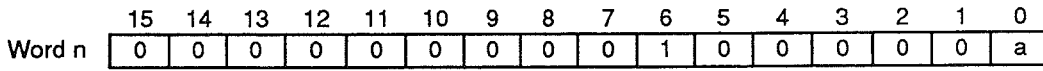


In this program, #0006 indicates the number of words to be read by the PC. $\Delta\Delta\Delta + 1$ indicates that 1 should be added to the word where the Counter is mounted. $\square\square\square\square$ indicates the first location in the PC where data should be sent. The EQ flag turns ON when the READ command has been completed.

In data transfer mode 1, the Counter's status is not updated until an Intelligent I/O Read (READ(88)) has been executed. In order to obtain the most current status, execute READ(88) two consecutive times, and use the data obtained from the second READ(88).

Data transfer mode 2 is command data transfer mode. This mode can be used only when the Counter is mounted on a Remote I/O Rack. As with mode 1, data can be sent to the PC from the Counter, or vice versa. The following six diagrams show word and bit allocation in this mode.

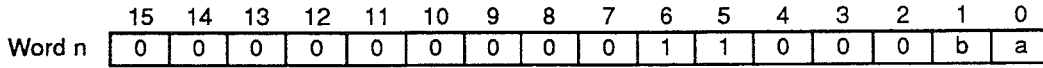
1) Clear Command



- Sets Counter's Present Value to 0.
- Coincidence output status changes accordingly.

| | |
|---|--------------------------------|
| 0 | Outputs disabled |
| 1 | Output enable flags unaffected |

2) Preset Command

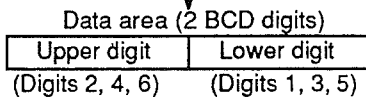
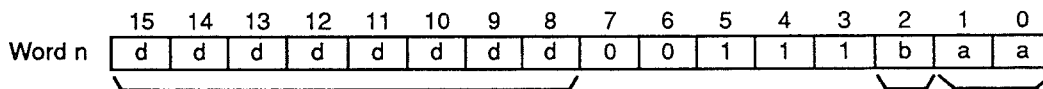


- Sets Counter's Present Value to the value specified via "Preset Data Set".
- Coincidence output status changes accordingly.

| | |
|---|--------------------------------|
| 0 | Outputs disabled |
| 1 | Output enable flags unaffected |

| | |
|---|----------|
| 0 | Preset 1 |
| 1 | Preset 2 |

3) Preset Data Set Command



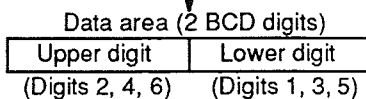
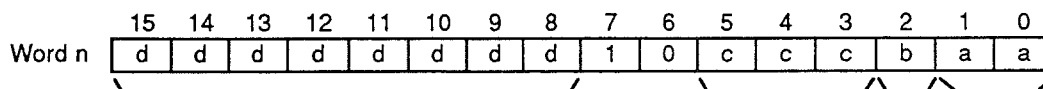
| | |
|----|------------------|
| 00 | Digits 1, 2 data |
| 01 | Digits 3, 4 data |
| 10 | Digits 5, 6 data |
| 11 | Invalid command |

- Sets data* for 2 presets in Counter.
- Output enable flags are not affected.

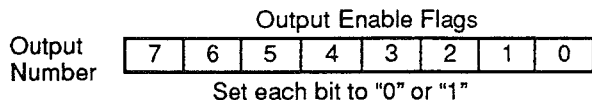
*This data is retained by Counter only while power is being applied.

| | |
|---|----------|
| 0 | Preset 1 |
| 1 | Preset 2 |

4) Coincidence Data Set Command



| | |
|-----|---------------------|
| 00 | Digits 1, 2 data |
| 01 | Digits 3, 4 data |
| 10 | Digits 5, 6 data |
| 11* | Output enable flags |



| | |
|---|----------------|
| 0 | Output disable |
| 1 | Output enable |

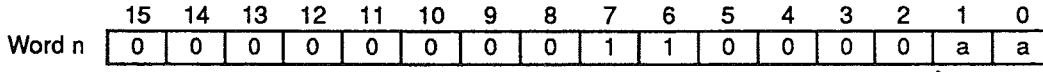
*When bits 0 and 1 are set to "11", set bits 2 through 5 to "0".

| | |
|---|-----------------------------|
| 0 | Coincidence data min. value |
| 1 | Coincidence data max. value |

- Sets coincidence data ranges for coincidence outputs.
- Enables/disables external outputs.

| | |
|---------|---------------------------|
| 000 | Output 0 coincidence data |
| 001 | Output 1 coincidence data |
| through | through |
| 110 | Output 6 coincidence data |
| 111 | Output 7 coincidence data |

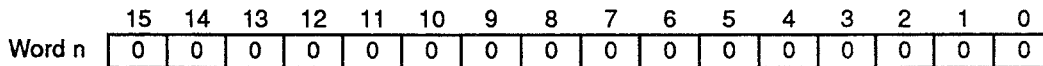
(5) Data Request Command



- When reading Counter's Present Value, reads digits 1 and 2 first.
- Coincidence status is determined by comparison of the Present Value with the coincidence data, regardless of the output enable status.

| | |
|----|-------------------------|
| 00 | Digits 1, 2 data |
| 01 | Digits 3, 4 data |
| 10 | Digits 5, 6 data |
| 11 | Read coincidence status |

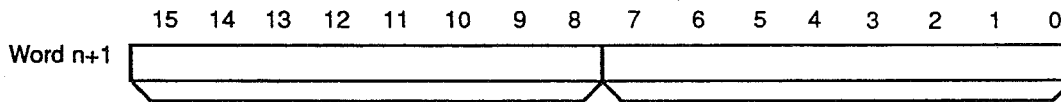
(6) Version Read Command



- Reads the version number of the High-speed Counter's system ROM.

High-speed Counter to PC

The response to the command written to word n appears at word n+1



Response to command written to word n.

Command written to word n. If the command sent disagrees with the data returned, send the command again.

Data Read
(Present Value: 2 BCD digits)

| | |
|------------------|------------------|
| Upper digit | Lower digit |
| (Digits 2, 4, 6) | (Digits 1, 3, 5) |

Data Read
(Coincidence status)

| | | | | | | | | |
|---------------|---|---|---|---|---|---|---|---|
| Output Number | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---------------|---|---|---|---|---|---|---|---|

Bit status

| | |
|---|--|
| 0 | Present Value is outside of coincidence data range |
| 1 | Present Value is within coincidence data range |

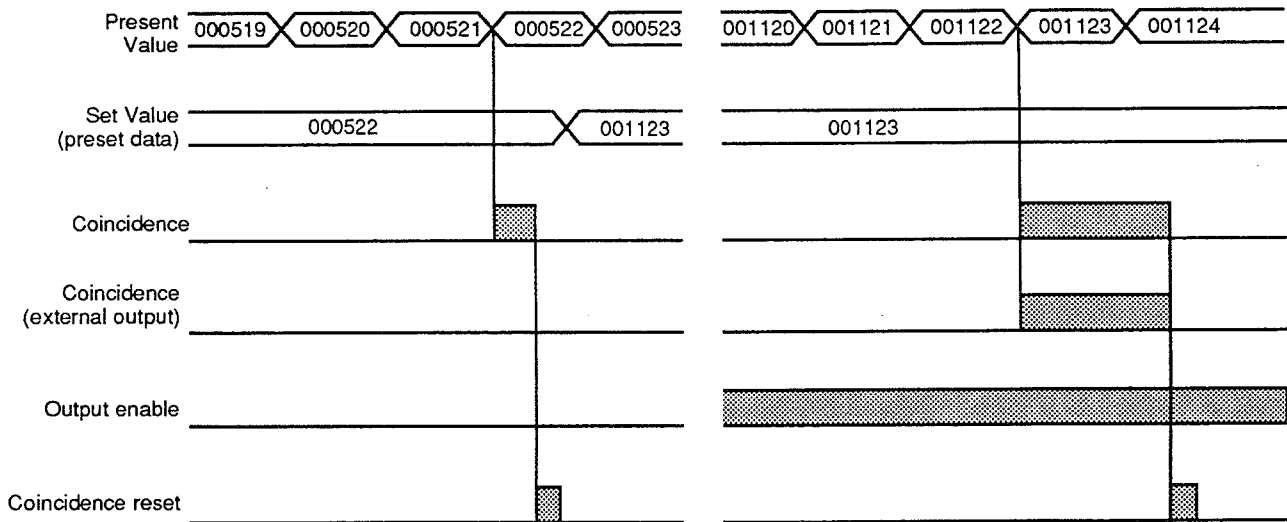
Version Read (2 BCD digits)

| | |
|--|--|
| | |
|--|--|

2-6
Coincidence Signals
CT001 Coincidence
Signals

The coincidence signal turns ON when the Present Value of the Counter coincides with the Set Value. This signal remains ON until the coincidence reset signal or external reset signal is turned ON. The outputs will remain OFF, regardless of coincidence status, if the output enable flags have not been set. Enable the outputs as required via the user program.

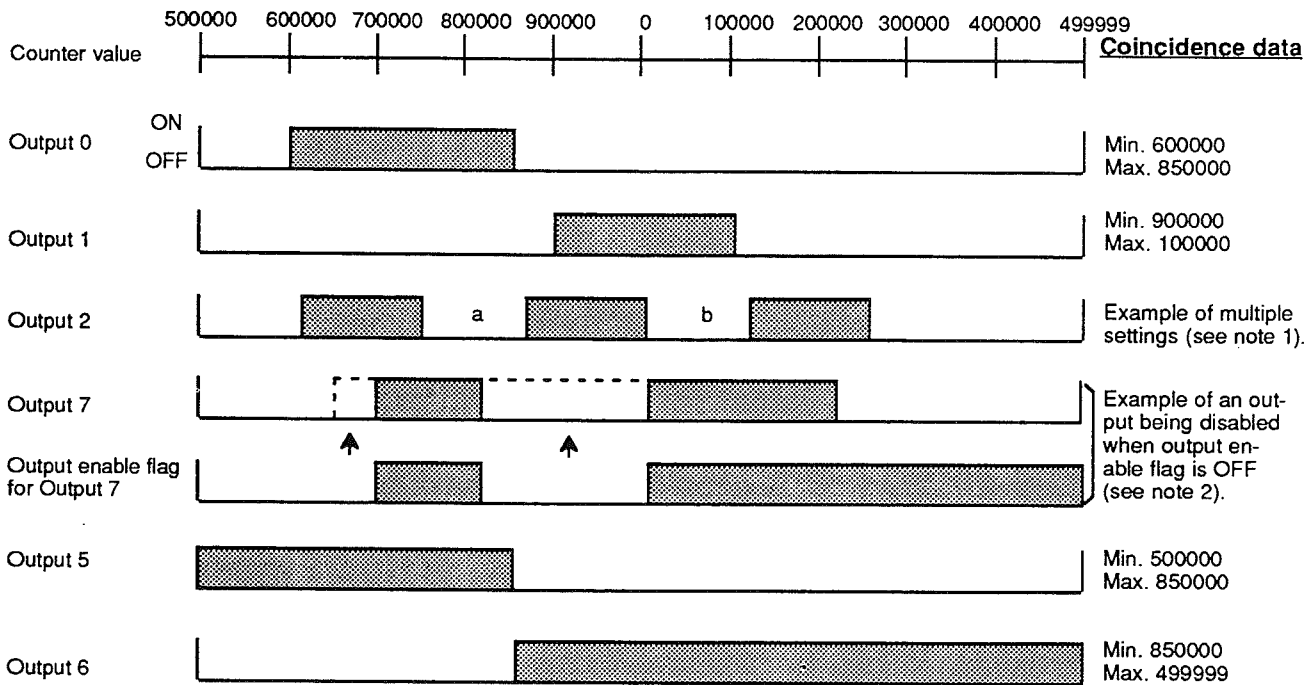
The following diagram shows an example of how coincidence signals operate.



CT012 Coincidence Signals

The CT012 differs from the CT001 in that the CT012 has eight output signals. A PC can be used to set two coincidence values for each of these outputs. The values set from the PC consist of a minimum and maximum value. When the counter value is within this range, the coincidence output will go ON. The outputs will remain OFF, regardless of coincidence status, if the output enable flags have not been set. Enable the outputs as required via the user program.

Example coincidence ranges for outputs are shown in the following diagram.



- Note**
1. Coincidence data is changed during periods 'a' and 'b' via the user program.
 2. All output enable flags (0 through 7) are reset (turned OFF) when power is applied. Enable the outputs as required via the user program.

2-7

Bit Number Allocations

The CT001s can have eight set count values. The CT012 can have eight preset coincidence ranges. These bits are allocated as described below. Assignments are the same regardless of the mode.

CT001 Bit Number Allocations

| | | I/O | | | | | | | |
|-----|----|----------------------|-------------------|-------------------|-------------------|-----------|-------------------|-----------|-------------------|
| | | OUT | | | | IN | | | |
| | | word n | | word n+1 | | word n+2 | | word n+3 | |
| bit | 0 | Present Value Preset | Preset data 1 | x 10 ² | 000000 reset | PV data 1 | x 10 ² | | |
| | 1 | Set Value Preset | Preset data 2 | | 999999 reset | PV data 2 | | | |
| | 2 | Count Gate | Preset data 4 | | PV > SV | PV data 4 | | | |
| | 3 | Increment/Decrement | Preset data 8 | | PV = SV | PV data 8 | | | |
| | 4 | 000000 Reset | Preset data 1 | x 10 ³ | PV < SV | PV data 1 | x 10 ³ | | |
| | 5 | 999999 Reset | Preset data 2 | | Normally ON | PV data 2 | | | |
| | 6 | Coincidence Reset | Preset data 4 | | Normally ON | PV data 4 | | | |
| | 7 | Output Enable | Preset data 8 | | Normally ON | PV data 8 | | | |
| | 8 | Preset data 1 | x 10 ⁰ | Preset data 1 | x 10 ⁴ | PV data 1 | x 10 ⁰ | PV data 1 | x 10 ⁴ |
| | 9 | Preset data 2 | | Preset data 2 | | PV data 2 | | PV data 2 | |
| | 10 | Preset data 4 | | Preset data 4 | | PV data 4 | | PV data 4 | |
| | 11 | Preset data 8 | | Preset data 8 | | PV data 8 | | PV data 8 | |
| | 12 | Preset data 1 | x 10 ¹ | Preset data 1 | x 10 ⁵ | PV data 1 | x 10 ¹ | PV data 1 | x 10 ⁵ |
| | 13 | Preset data 2 | | Preset data 2 | | PV data 2 | | PV data 2 | |
| | 14 | Preset data 4 | | Preset data 4 | | PV data 4 | | PV data 4 | |
| | 15 | Preset data 8 | | Preset data 8 | | PV data 8 | | PV data 8 | |

Note PV and SV stand for Present Value and Set Value, respectively.

CT012 Bit Number Allocations

The CT012 has two data transfer modes: Intelligent I/O Read/Write mode (mode 1) and command mode (mode 2). Mode 1 of the CT012 is similar to CT001 operation. In mode 1, word n and word n+1 bits 0 through 2 are used by the PC and Counter for communication purposes. Using these bits as work bits may cause a malfunction. Use the following table to set the relays.

| | | I/O | | | | | | | | | | | | Intelligent I/O R/W Mode | |
|-----|----|--------------|------------|-----------------|----------------------|--------------|-----------------|------------------|-------------------------------|---------|------------------------|-----------|---------|-----------------------------|-------------|
| | | OUT | | | | | | | | | | | | | |
| | | word n | | | | | | | | | | | | | |
| | | Command Mode | | | | | | | | | | | | | |
| | | Clear | Preset | Preset Data Set | Coincidence Data Set | Data Request | Version Read | | | | | | | | |
| bit | 00 | a | O/P enable | a | O/P enable | a | Digit selection | a | O/P flags/ digit selection | a | Digit/status selection | 0 | Command | (PC Busy) | |
| | 01 | 0 | Command | b | Preset 1/2 | a | Command | a | 0 to 7 selection | 0 | Command | 0 | | (PC WR End) | |
| | 02 | 0 | | 0 | b | Preset 1/2 | | b | | Min/Max | | 0 | | 0 | (PC RD End) |
| | 03 | 0 | | 0 | 1 | c | | Output | | 0 | | 0 | | 0 | Clear |
| | 04 | 0 | | 0 | 1 | c | | 0 to 7 selection | | 0 | | 0 | | 0 | Preset 1 |
| | 05 | 0 | | 1 | 1 | c | | Command | | 0 | | 0 | | 0 | Preset 2 |
| | 06 | 1 | | 1 | 0 | 0 | | Command | | 0 | | 1 | | 0 | |
| | 07 | 0 | | 0 | 0 | 1 | | | | 1 | | 0 | | 0 | |
| | 08 | 0 | | 0 | d | d | | Data Area | | d | | Data Area | | 0 | 0 |
| | 09 | 0 | 0 | d | d | 0 | 0 | | 0 | 0 | | | | | |
| | 10 | 0 | 0 | d | d | 0 | 0 | | 0 | 0 | | | | | |
| | 11 | 0 | 0 | d | d | 0 | 0 | | 0 | 0 | | | | | |
| | 12 | 0 | 0 | d | d | 0 | 0 | | 0 | 0 | | | | | |
| | 13 | 0 | 0 | d | d | 0 | 0 | | 0 | 0 | | | | | |
| | 14 | 0 | 0 | d | d | 0 | 0 | | 0 | 0 | | | | | |
| | 15 | 0 | 0 | d | d | 0 | 0 | | 0 | 0 | | | | | |

| | | I/O | |
|-----|----|--|--------------------------|
| | | IN | |
| | | word n+1 | |
| | | Command mode | Intelligent I/O R/W Mode |
| | | Data Read | |
| bit | 00 | Output enable | (CNT Busy) |
| | 01 | After 2 command has been successfully sent, it reappears here. | (CNT RD End) |
| | 02 | | (CNT WR End) |
| | 03 | | |
| | 04 | Response (Data Requested) | |
| | 05 | | |
| | 06 | | |
| | 07 | | |
| | 08 | | d |
| | 09 | | d |
| | 10 | | d |
| | 11 | | d |
| | 12 | | d |
| | 13 | | d |
| | 14 | | d |
| | 15 | | d |

2-8 DM Coding

The DM area contains parameters that are to be set into the Counter. These parameters include the operating mode and output range limits. The following figures show the DM coding for the CT012 Counter.

Mode 1: Intelligent I/O Read/Write Mode


Data area for Write Instruction (WRIT 87).

Initial setting: Set output enable flags to '0' as counter has not been initialized.

| DM No. | 15 | ← | 00 | Function | | |
|--------|----|---|----|-------------|---------------------|--------|
| 100 | 0 | 0 | | Digits 6, 5 | | |
| 101 | | | | Digits 4, 1 | | |
| 102 | 0 | 0 | | Digits 6, 5 | | |
| 103 | | | | Digits 4, 1 | | |
| 104 | 0 | 0 | 0 | 0 | Output enable flags | |
| 105 | 0 | 0 | | Digits 6, 5 | MIN | DATA 0 |
| 106 | | | | Digits 4, 1 | | |
| 107 | 0 | 0 | | Digits 6, 5 | MAX | DATA 1 |
| 108 | | | | Digits 4, 1 | | |
| 109 | 0 | 0 | | Digits 6, 5 | MIN | DATA 2 |
| 110 | | | | Digits 4, 1 | | |
| 111 | 0 | 0 | | Digits 6, 5 | MAX | DATA 3 |
| 112 | | | | Digits 4, 1 | | |
| 113 | 0 | 0 | | Digits 6, 5 | MIN | DATA 4 |
| 114 | | | | Digits 4, 1 | | |
| 115 | 0 | 0 | | Digits 6, 5 | MAX | DATA 5 |
| 116 | | | | Digits 4, 1 | | |
| 117 | 0 | 0 | | Digits 6, 5 | MIN | DATA 6 |
| 118 | | | | Digits 4, 1 | | |
| 119 | 0 | 0 | | Digits 6, 5 | MAX | DATA 7 |
| 120 | | | | Digits 4, 1 | | |
| 121 | 0 | 0 | | Digits 6, 5 | MIN | DATA 0 |
| 122 | | | | Digits 4, 1 | | |
| 123 | 0 | 0 | | Digits 6, 5 | MAX | DATA 1 |
| 124 | | | | Digits 4, 1 | | |
| 125 | 0 | 0 | | Digits 6, 5 | MIN | DATA 2 |
| 126 | | | | Digits 4, 1 | | |
| 127 | 0 | 0 | | Digits 6, 5 | MAX | DATA 3 |
| 128 | | | | Digits 4, 1 | | |
| 129 | 0 | 0 | | Digits 6, 5 | MIN | DATA 4 |
| 130 | | | | Digits 4, 1 | | |
| 131 | 0 | 0 | | Digits 6, 5 | MAX | DATA 5 |
| 132 | | | | Digits 4, 1 | | |
| 133 | 0 | 0 | | Digits 6, 5 | MIN | DATA 6 |
| 134 | | | | Digits 4, 1 | | |
| 135 | 0 | 0 | | Digits 6, 5 | MAX | DATA 7 |
| 136 | | | | Digits 4, 1 | | |

Output enable data

| DM No. | 15 | ← | 00 | Function | |
|--------|----|---|----|-------------|---------------------|
| 150 | 0 | 0 | | Digits 6, 5 | |
| 151 | | | | Digits 4, 1 | |
| 152 | 0 | 0 | | Digits 6, 5 | |
| 153 | | | | Digits 4, 1 | |
| 154 | 0 | 0 | F | F | Output enable flags |


 Enter appropriate BCD data in the shaded areas.

Data area for Read

| DM No. | 15 | ← | 00 | Function | |
|--------|----|---|--------------------------|--------------------------|----------------------|
| 200 | 0 | 0 | | Digits 6, 5 | |
| 201 | | | | Digits 4, 1 | |
| 202 | 0 | 0 | Δ | Δ | Coincidence |
| 203 | 0 | 0 | | Digits 6, 5 | |
| 204 | | | | Digits 4, 1 | |
| 205 | 0 | 0 | <input type="checkbox"/> | <input type="checkbox"/> | Output enable status |

 : Counter's Present Value (6 BCD digits).

Δ Δ : Result of comparison of coincidence data 0 through 7 and Counter's Present Value (1 = equal)


 : Counter's Preset Value. The Counter will be preset with this value via the appropriate external control signals when the Counter is in the external 'preset' mode.

: Counter's output enable status.


Mode 2: Command Mode

| DM No. | 15 | ← | 00 | Function | | |
|--------|----|---|-----|-------------|----------|--------|
| 00 | | | 3 8 | Digits 2, 1 | Preset 1 | |
| 01 | | | 3 9 | Digits 4, 3 | | |
| 02 | | | 3 A | Digits 6, 5 | | |
| 03 | | | 3 C | Digits 2, 1 | Preset 2 | |
| 04 | | | 3 D | Digits 4, 3 | | |
| 05 | | | 3 E | Digits 6, 5 | | |
| 06 | | | 8 0 | Digits 2, 1 | MIN | DATA 0 |
| 07 | | | 8 1 | Digits 4, 3 | | |
| 08 | | | 8 2 | Digits 6, 5 | MAX | |
| 09 | | | 8 4 | Digits 2, 1 | | |
| 10 | | | 8 5 | Digits 4, 3 | | |
| 11 | | | 8 6 | Digits 6, 5 | MIN | DATA 1 |
| 12 | | | 8 8 | Digits 2, 1 | | |
| 13 | | | 8 9 | Digits 4, 3 | | |
| 14 | | | 8 A | Digits 6, 5 | MAX | |
| 15 | | | 8 C | Digits 2, 1 | | |
| 16 | | | 8 D | Digits 4, 3 | | |
| 17 | | | 8 E | Digits 6, 5 | MIN | DATA 2 |
| 18 | | | 9 0 | Digits 2, 1 | | |
| 19 | | | 9 1 | Digits 4, 3 | | |
| 20 | | | 9 2 | Digits 6, 5 | MAX | |
| 21 | | | 9 4 | Digits 2, 1 | | |
| 22 | | | 9 5 | Digits 4, 3 | | |
| 23 | | | 9 6 | Digits 6, 5 | MIN | DATA 3 |
| 24 | | | 9 8 | Digits 2, 1 | | |
| 25 | | | 9 9 | Digits 4, 3 | | |
| 26 | | | 9 A | Digits 6, 5 | MAX | |
| 27 | | | 9 C | Digits 2, 1 | | |
| 28 | | | 9 D | Digits 4, 3 | | |
| 29 | | | 9 E | Digits 6, 5 | MIN | DATA 4 |
| 30 | | | A 0 | Digits 2, 1 | | |
| 31 | | | A 1 | Digits 4, 3 | | |
| 32 | | | A 2 | Digits 6, 5 | MAX | |
| 33 | | | A 4 | Digits 2, 1 | | |
| 34 | | | A 5 | Digits 4, 3 | | |
| 35 | | | A 6 | Digits 6, 5 | MIN | DATA 5 |
| 36 | | | A 8 | Digits 2, 1 | | |
| 37 | | | A 9 | Digits 4, 3 | | |
| 38 | | | A A | Digits 6, 5 | MAX | |
| 39 | | | A C | Digits 2, 1 | | |
| 40 | | | A D | Digits 4, 3 | | |
| 41 | | | A E | Digits 6, 5 | MIN | DATA 6 |
| 42 | | | B 0 | Digits 2, 1 | | |
| 43 | | | B 1 | Digits 4, 3 | | |
| 44 | | | B 2 | Digits 6, 5 | MAX | |
| 45 | | | B 4 | Digits 2, 1 | | |
| 46 | | | B 5 | Digits 4, 3 | | |
| 47 | | | B 6 | Digits 6, 5 | | |

| DM No. | 15 | ← | 00 | Function | | |
|--------|----|---|-----|---------------------|--------------|------|
| 48 | | | B 8 | Digits 2, 1 | MIN | DATA |
| 49 | | | B 9 | Digits 4, 3 | | |
| 50 | | | B A | Digits 6, 5 | MAX | |
| 51 | | | B C | Digits 2, 1 | | |
| 52 | | | B D | Digits 4, 3 | | |
| 53 | | | B E | Digits 6, 5 | MIN | DATA |
| 54 | | | 8 3 | Output enable flags | | |
| 55 | 0 | 0 | 4 0 | Disable o/p | Clear | |
| 56 | 0 | 0 | 4 1 | Flags unaffected | | |
| 57 | 0 | 0 | 6 0 | Disable o/p | Preset 1 | |
| 58 | 0 | 0 | 6 1 | Flags unaffected | | |
| 59 | 0 | 0 | 6 2 | Disable o/p | Preset 2 | |
| 60 | 0 | 0 | 6 3 | Flags unaffected | | |
| 61 | 0 | 0 | C 0 | Digits 2, 1 | Data request | |
| 62 | 0 | 0 | C 1 | Digits 4, 3 | | |
| 63 | 0 | 0 | C 2 | Digits 6, 5 | | |
| 64 | 0 | 0 | C 3 | Status | | |

 Enter appropriate BCD data in the shaded area (except in the case of output enable flags).

| DM No. | 15 | ← | 00 | Function | |
|--------|----|---|-----|--------------------|-----------------------|
| 70 | | | 0 0 | Digits 2, 1 | Counter Present Value |
| 71 | | | 0 0 | Digits 4, 3 | |
| 72 | | | 0 0 | Digits 6, 5 | |
| 73 | | | 0 0 | Coincidence status | |
| 74 | | | | Read Area | |
| 75 | | | | Index Register | |
| 76 | | | | Work Area | |

 = Counter's Present Value and coincidence status.

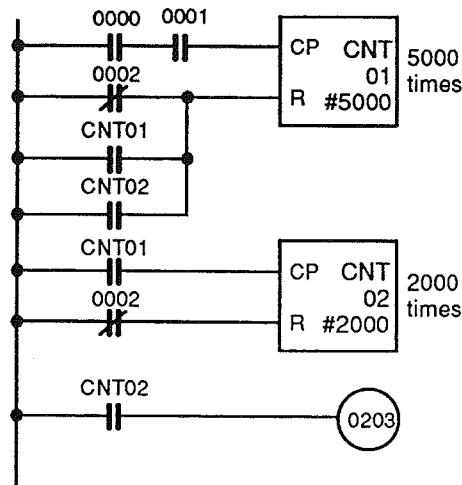
SECTION 3

Programming Examples

| | | |
|-------|--|----|
| 3-1 | Cumulative Counters | 46 |
| 3-2 | Application Examples | 49 |
| 3-3 | Programming Examples for the CT012 | 53 |
| 3-3-1 | Mode 1: Intelligent I/O Read/Write Programming Example | 53 |
| 3-3-2 | Mode 2: Command Mode Programming Example | 56 |

3-1 Cumulative Counters

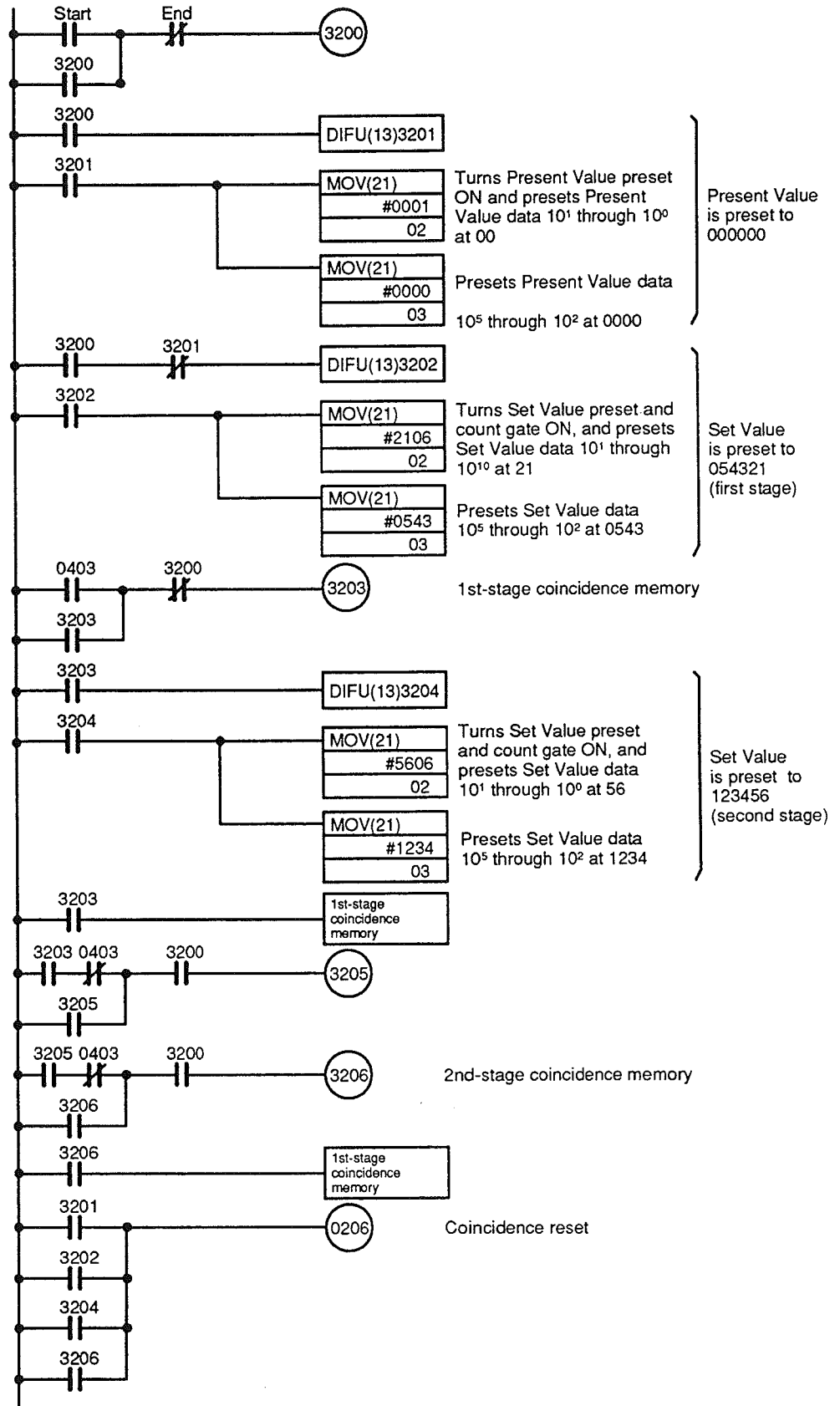
An extended Counter for counting higher than 499,999 can be made by programming Counters in series. The following is an example of a 1,000,000-count Counter.



| Address | Instruction | Data |
|---------|-------------|--------|
| 0000 | LD | 0000 |
| 0001 | AND | 0001 |
| 0002 | LD NOT | 0002 |
| 0003 | OR | CNT 01 |
| 0004 | OR | CNT 02 |
| 0005 | | 01 |
| | | # 5000 |
| 0006 | LD | CNT 01 |
| 0007 | LD NOT | 0002 |
| 0008 | CNT | 02 |
| | | # 2000 |
| 0009 | LD | CNT 02 |
| 0010 | OUT | 0203 |

CT001 Two-stage Preset Counter

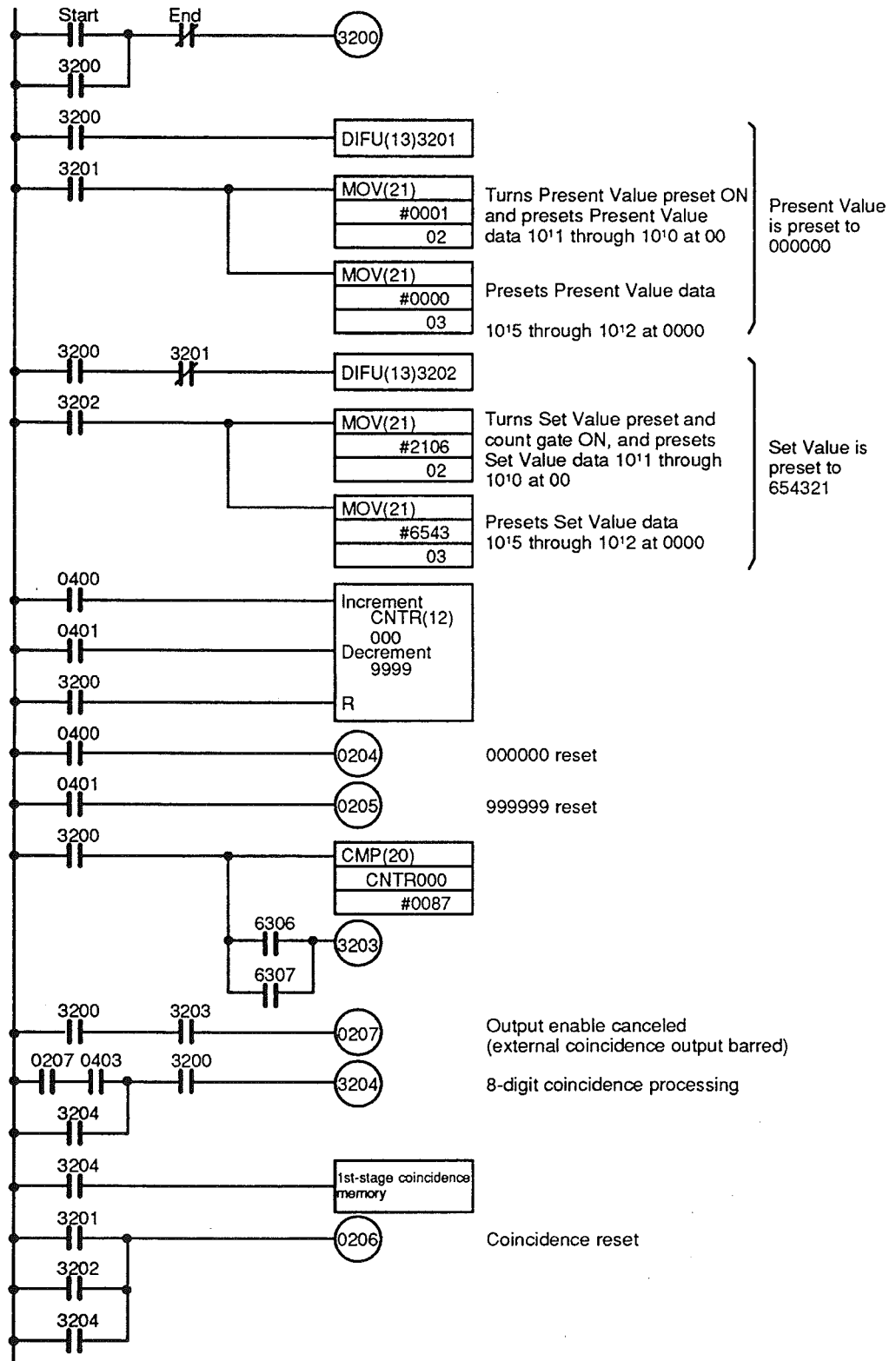
Count values 054321 and 123456 are processed. (The Counter is assigned to words 2 through 5.) Bits 3200 through 3206 are internal bits. This is shown in the following ladder diagram.



Note When performing Present Value preset and Set Value preset, turn coincidence reset ON.

**Multi-digit Preset
Incrementing Counter
(six digits or more)**

Processing is performed with a count value of "87654321." (Counter is assigned words 2 through 5.) This is shown in the following ladder diagram.



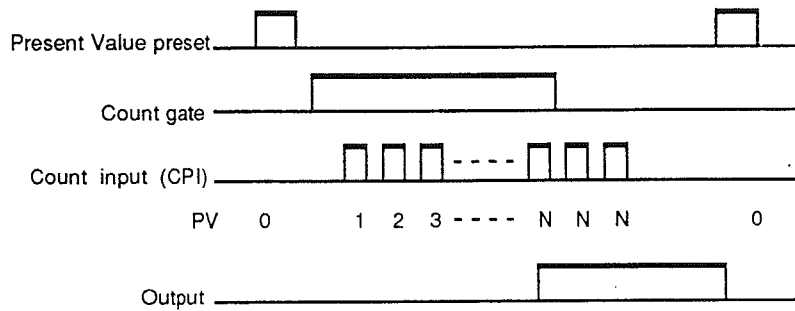
3-2

Application Examples

Example of Four-digit Increment Count

1. Operation

A count is made of pulses from a sensor, such as an Encoder or proximity switch, connected to a CT001. When this matches the value set with a rotary switch, the output goes ON.

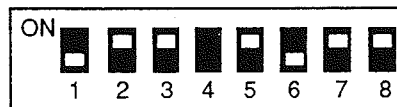


Note PV and SV stand for Present Value and Set Value, respectively.

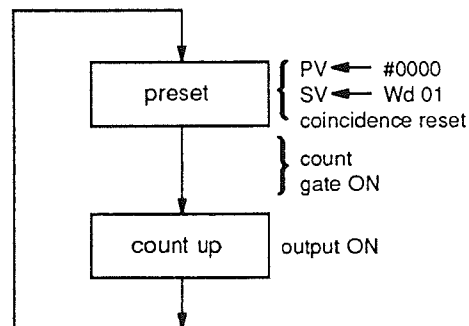
2. Input and output

- Word 00 (control input)
Reset = 0000
- Word 01 (4-digit rotary switch for settings)
- Word 02 (control output)
Output = 0200
- Words 03 through 06 (High-speed Counter)

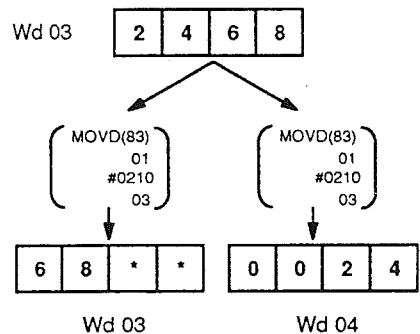
DIP switch



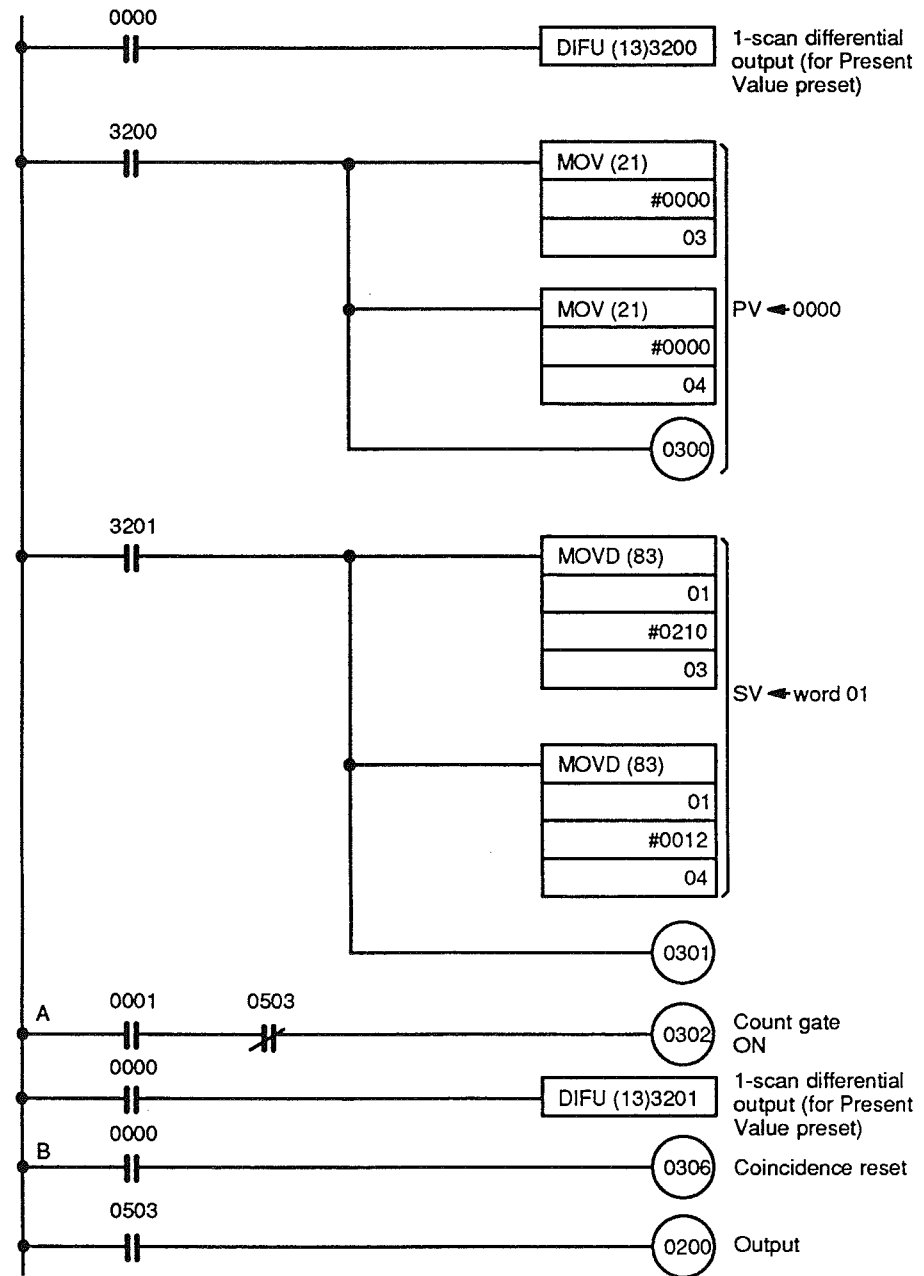
3. Flow



Set Value flow (when SV=2468)



4. Circuits



- Note**
1. Because the I/O refresh occurs at the end of the scan time, the PC can not set both PV and SV within the same scan. Two scans are required, as shown in the above figure.
 2. If the same input (PV and SV setting, count gate, and coincidence reset) is used more than twice, the program will not operate correctly. Consequently, when using signals from the count gate and coincidence reset, the circuits at (A) and (B) above must be added.

CT001 Dual-speed Positioning Counter Example

1. Operation

This is a positioning operation using an Inverter and an Encoder. The goal value N1 is externally set with a rotary switch. A first-stage setting of N2 = (N1 - 80) is made and run at high speed up to N2. Then it is run at low speed from N2 to N1 and stopped at N1.

2. Input and Output

Word 00 (control input)

Reset = 0000, start = 0001

Word 01 (Set Value input = 4-digit rotary switch)

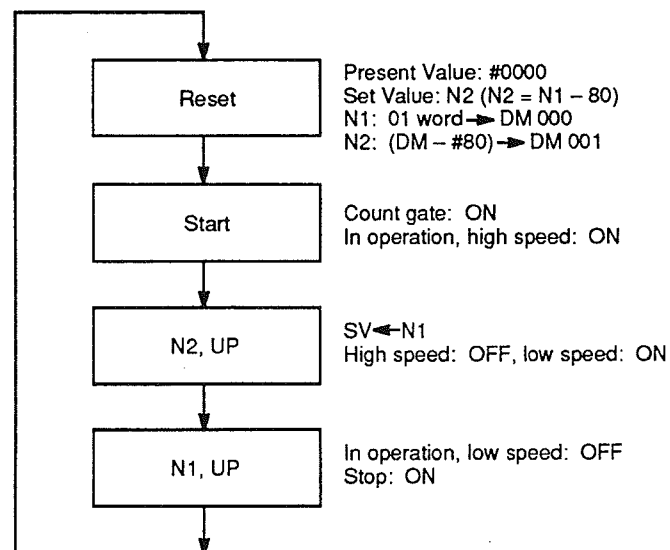
Word 02 (control output)

In operation = 0200, high speed = 0201, low speed = 0202,

stop = 0203

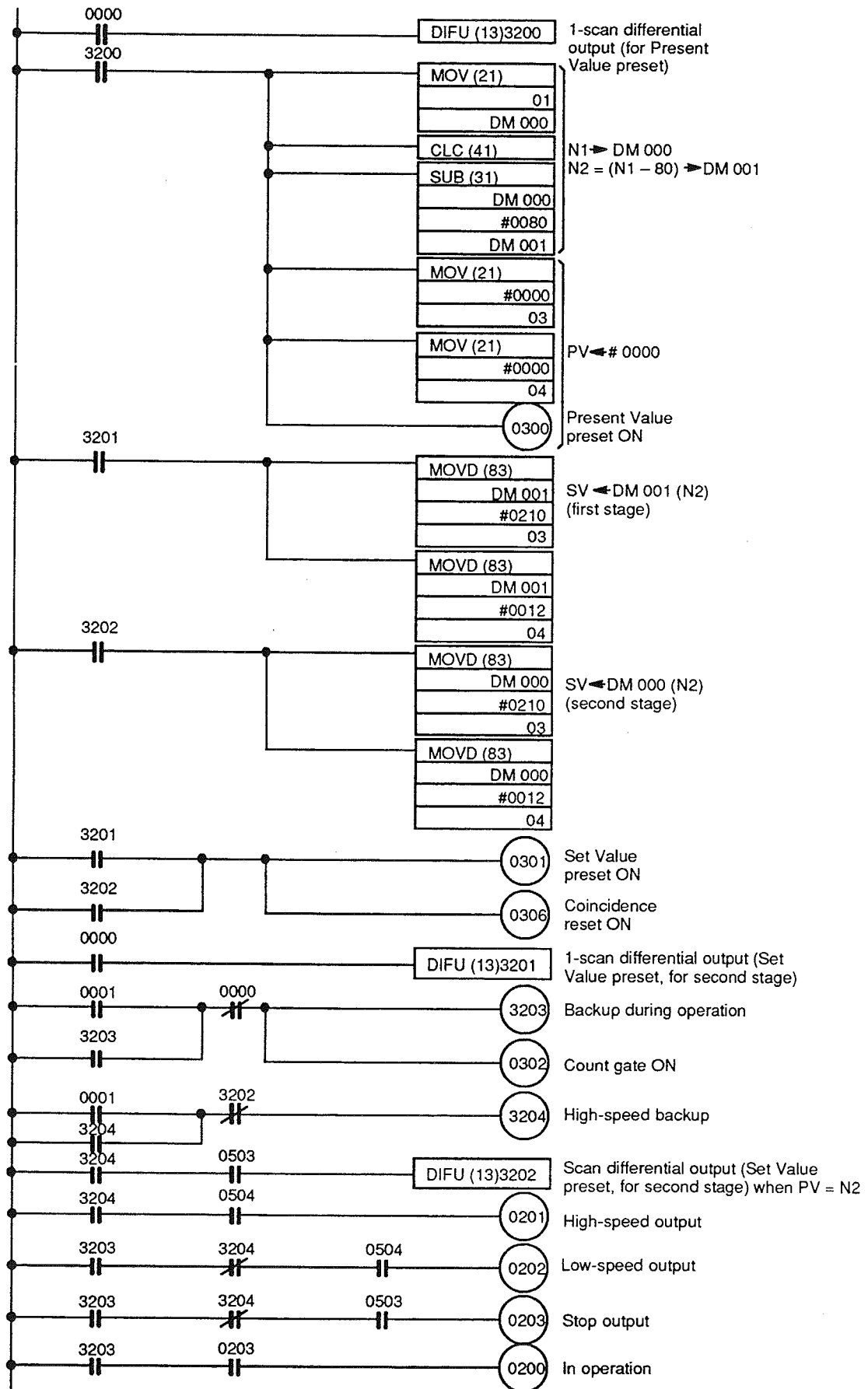
Words 03 through 06 (High-speed Counter)

3. Flow



4. Programming

The required ladder diagram programming is shown in the following diagram.



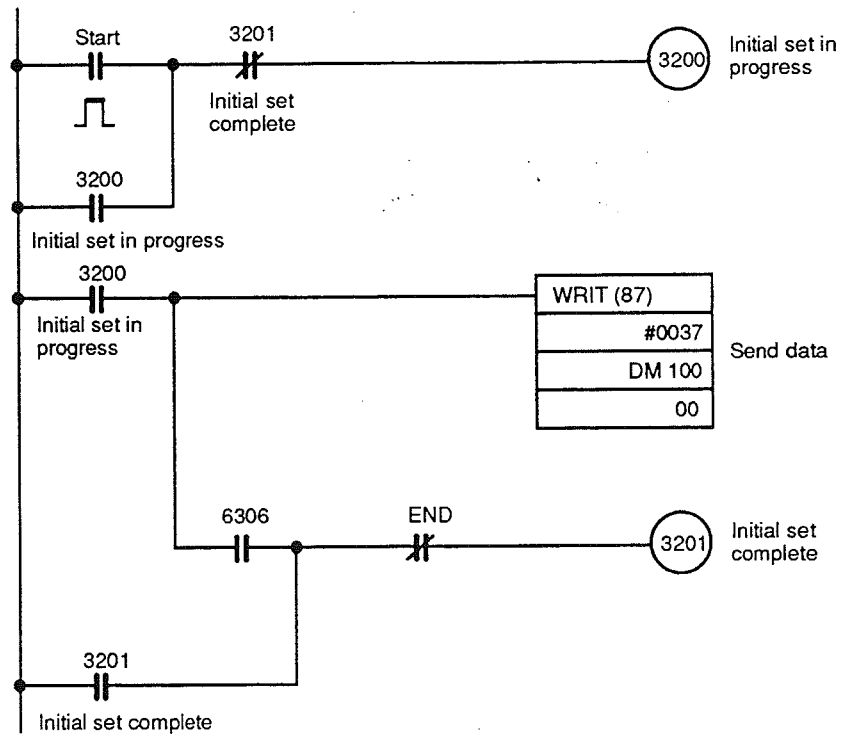
3-3 Programming Examples for the CT012.

The examples in this section show the programming required for each Counter operation. Use the program segments that pertain to the operations your control system requires.

3-3-1 Mode 1: Intelligent I/O Read/Write Programming Example

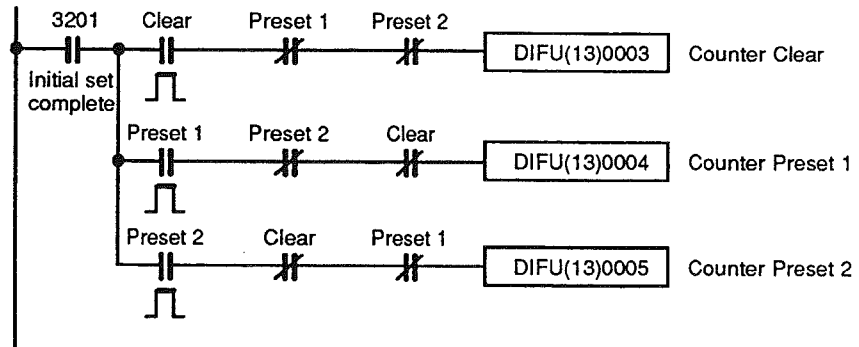
The High-speed Counter occupies words 0 and 1

Set initial data



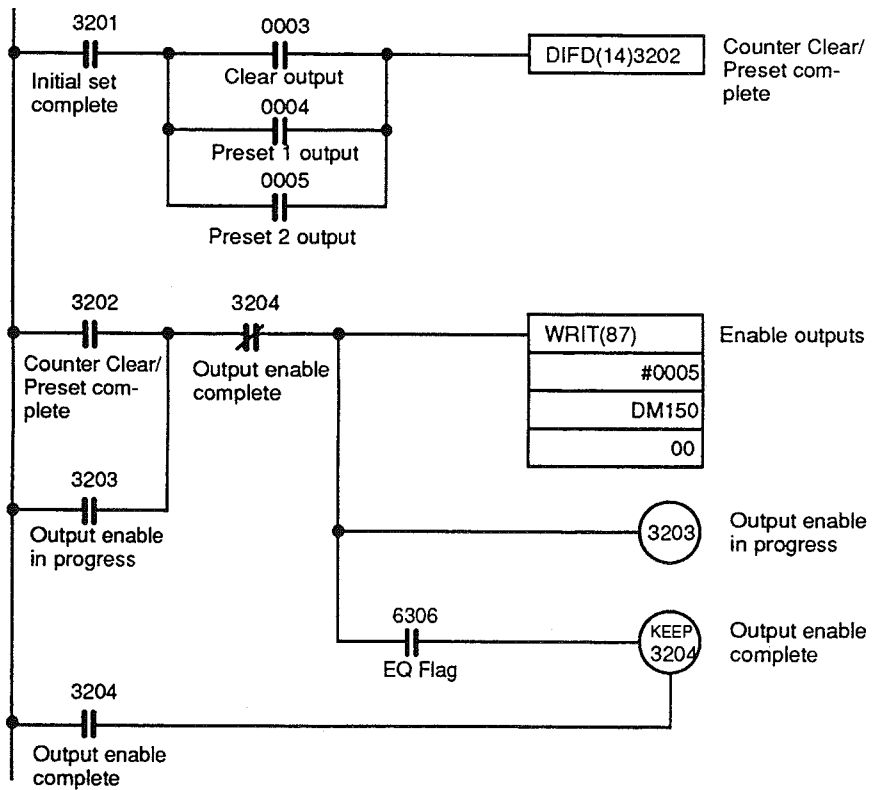
Execution of the above program segment does not set the Counter's Present Value. The coincidence outputs will not operate if the output enable flags are = 0. Set the Present Value as shown in the following diagram.

Set Present Value

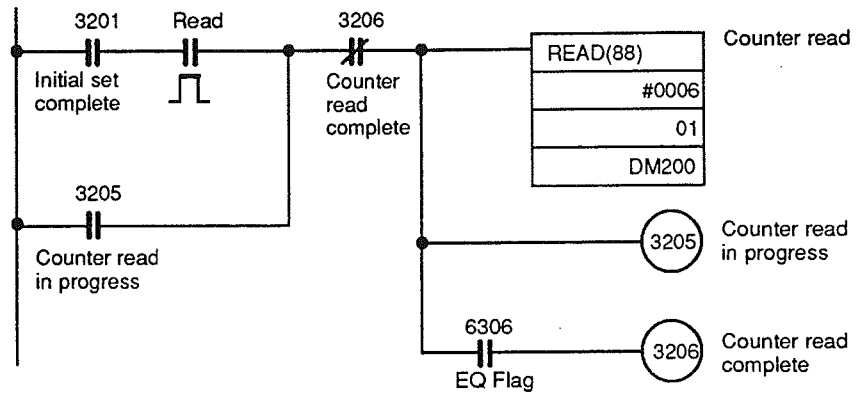


In the preceding diagram, the Counter is Cleared/Preset on the leading edge of the signals and resumes operation on the trailing edge.

Enabling the outputs



Read Counter



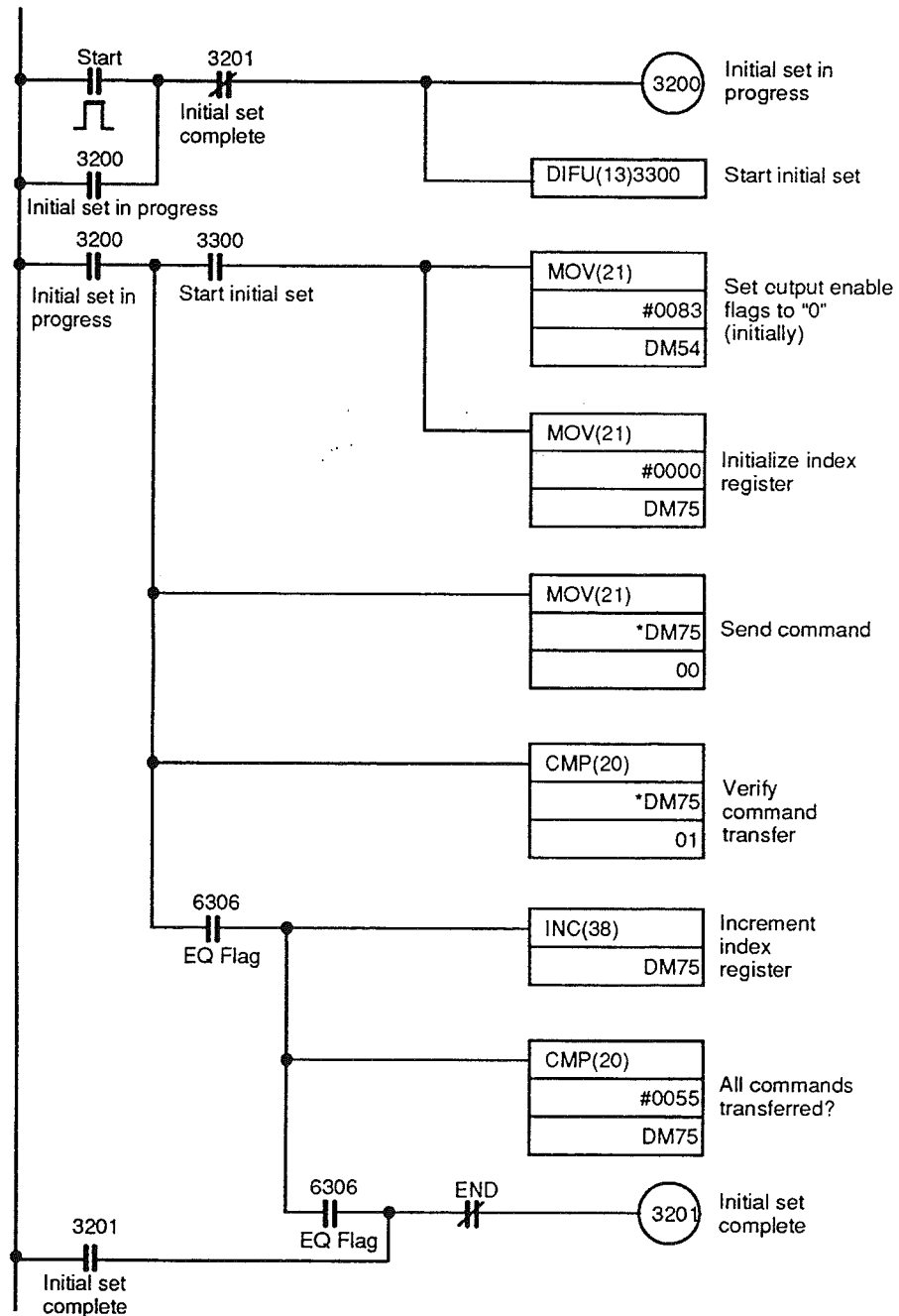
Use the Counter's Present Value, coincidence status etc. as required.

3-3-2

Mode 2: Command Mode Programming Example

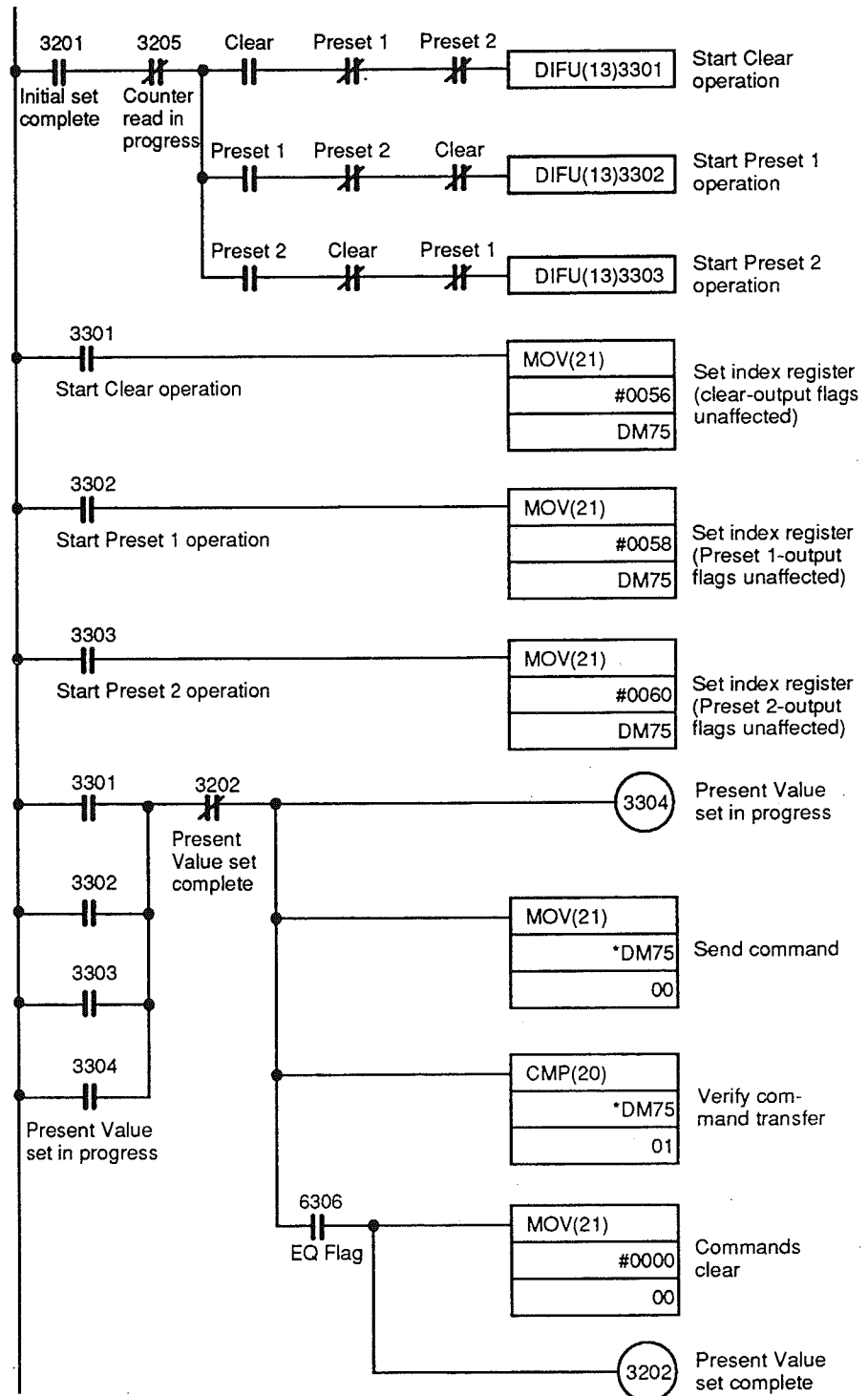
The High-speed Counter occupies words 0 and 1.

Set initial data



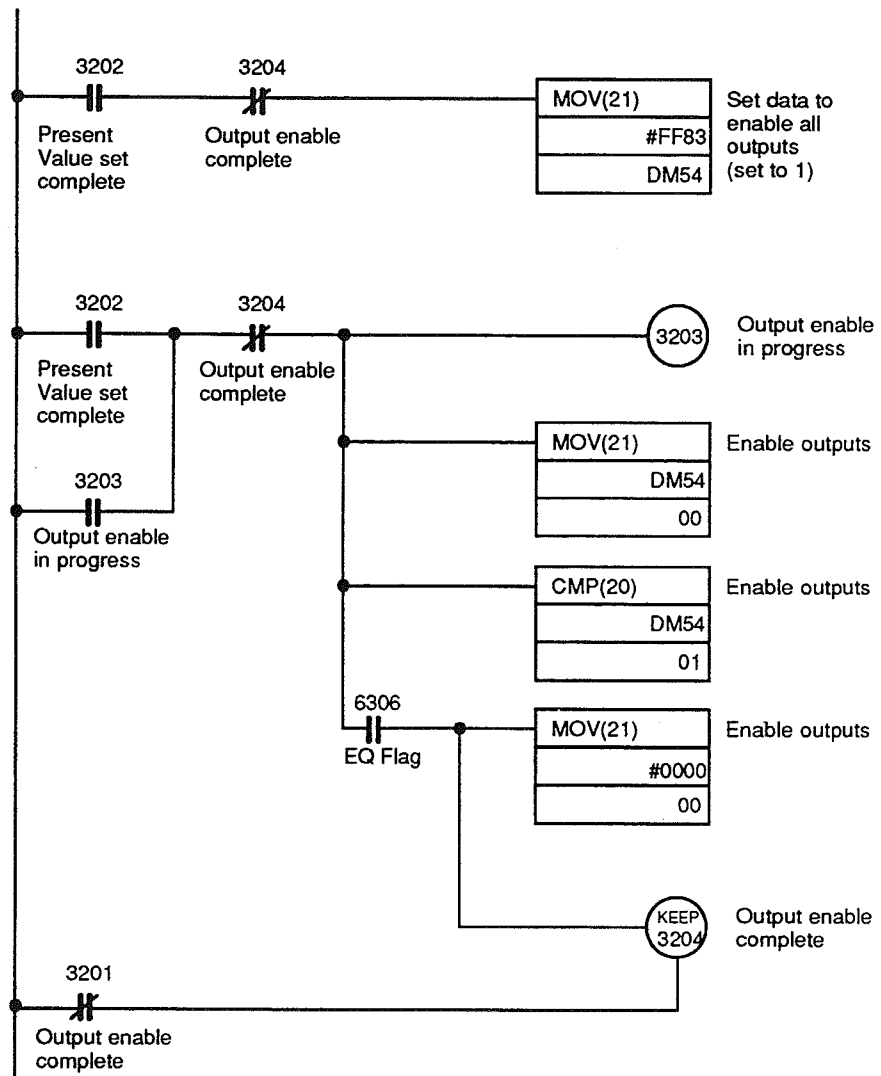
Execution of the preceding program segment does not set the Counter's Present Value. The coincidence outputs will not operate if the output enable flags are = 0. To set the Present Value, run the following program.

Set Present Value

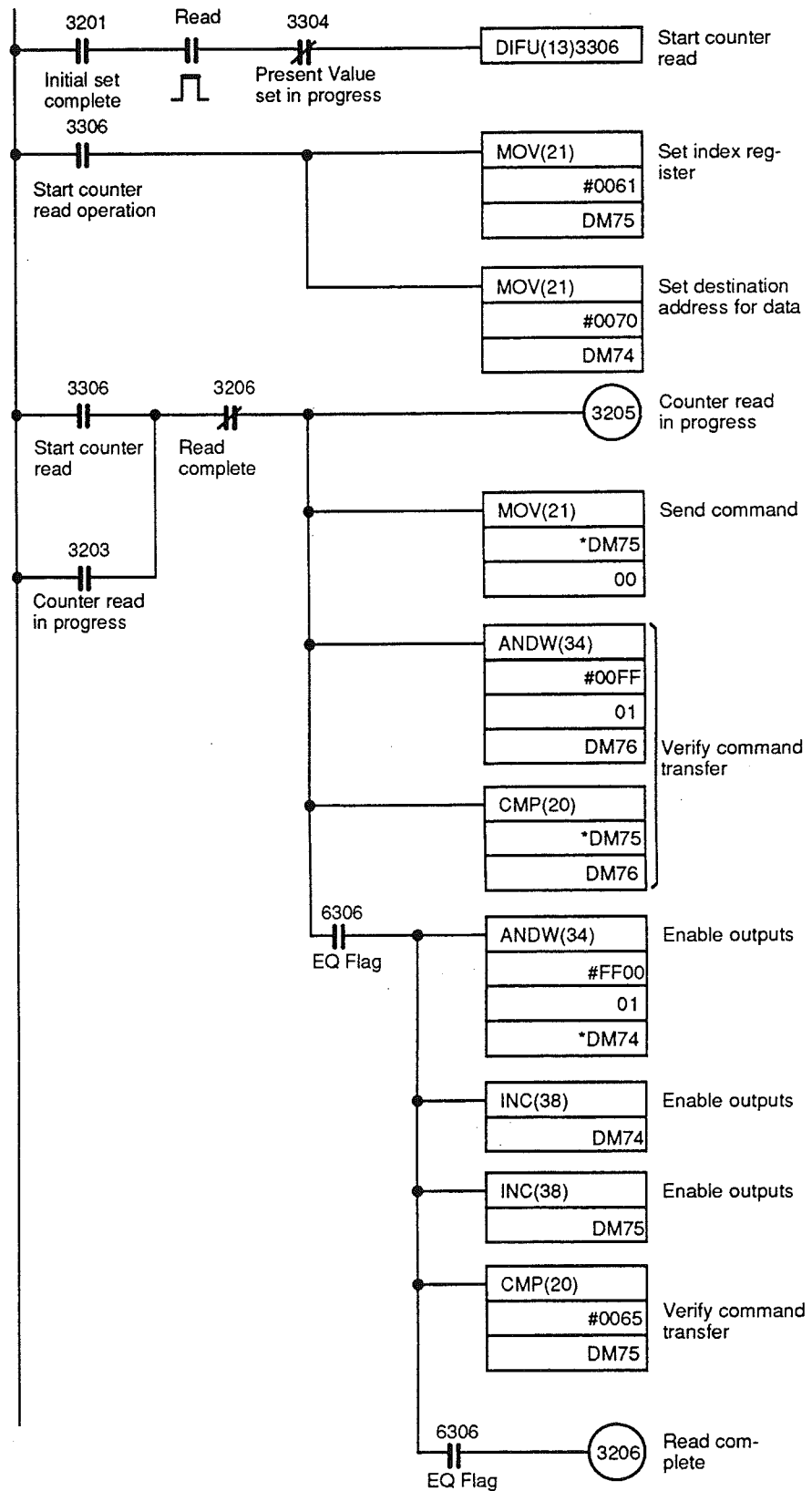


The Counter is Cleared/Preset when the command is sent. Counter operation resumes after the command has been cleared.

Enable outputs



Read Counter



Use the Counter's Present Value, coincidence status etc. as required.

Appendix A

Standard Models

| Name | Description | Model |
|--------------------|------------------------------|-------------|
| High-speed Counter | For C120 | 3G2A6-CT001 |
| | For C500 | 3G2A5-CT001 |
| | For C500 C1000H C2000H | 3G2A5-CT012 |

Appendix B

Specifications

CT001

| | | |
|----------------------------------|---|---|
| Count input | Input signals* | Count input 1 Count input 2 |
| | Voltage levels | H: 6 to 12 V L: 0 to 4 V |
| | Input modes | <ul style="list-style-type: none"> • Command input 1 mode/command input 2 mode: Specifies whether UP/DOWN count command is executed via a program or count input 2. • Phase differential input mode: Specifies execution of UP/DOWN count command according to phase difference between count inputs 1 and 2, as follows: UP: When count input 1 precedes count input 2 by 90°. DOWN: When count input 1 follows count input 2 by 90°. (Input modes are DIP switch-selectable.) |
| | Counting speeds | Solid-state input: 50 kHz max. (30 kHz max. for phase differential input mode) Contact input: 30 Hz max. (Counting speeds are DIP switch-selectable.) |
| Reset input | Voltage levels | H: 6 to 12 V L: 0 to 4 V |
| | ON-response time | 1.5 ms max. |
| | OFF-response time | 2 ms max. |
| Output signals | <ul style="list-style-type: none"> • Output by hardware Coincidence signal: Relay contact output and transistor (open collector) output Present Value > Set Value output signal: transistor (open collector) output | |
| Internal power supply | 300 mA 5 V max. | |
| Terminal for external connection | Terminal block (not removable) | |
| Power supply for sensor | 100 mA 12 VDC ±10% (per point) | |
| Power supply to outside circuit | 500 mA 24 VDC ±10% 500 mA | |
| Dimensions (mm) | 250(H)X34.5(W)X113(D) (CG2A5-CT001) 244(H)X29(W)X110(D) (CG2A6-CT001) | |
| Weight | 700 grams | |

*Count input 1 can be connected to either the solid-state or contact inputs. Count input 2 can be connected to the solid-state input only.

RELAY OUTPUT

| | |
|---------------------------|---|
| Output switching capacity | Relay contact output (G6B) 250 VAC/2A (p.f. = 1) 24 VDC/2A |
| ON-response time | 10 ms max. |
| OFF-response time | 15 ms max. |
| Service life | Electrical: 300 x 10 ³ operations Mechanical: 20 x 10 ⁶ operations |

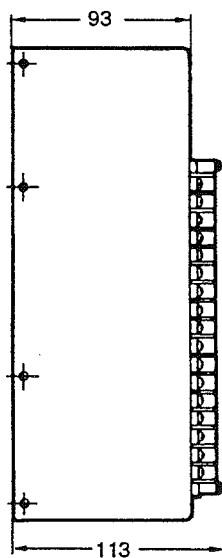
OPEN COLLECTOR TYPE TRANSISTOR OUTPUT

| | |
|-------------------------|---------------|
| Max. switching capacity | 24 VDC/200 mA |
| Leakage current | 500 mA max. |
| Saturation voltage | 1.3 V max. |
| ON-response time | 50 μs max. |
| OFF-response time | 50 μs max. |

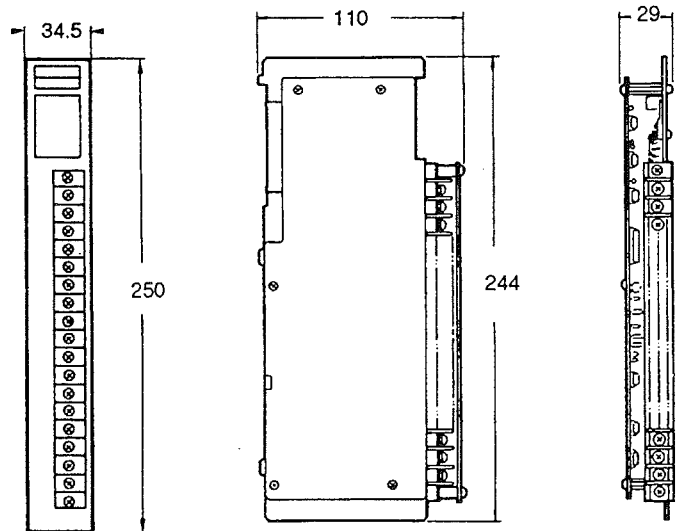
- Note**
1. Insert the High-speed Counter into the upper slot of an I/O Unit when mounting the Counter on a C120 PC.
 2. To mount the Counter on a C120 PC, use a Type 3G2C4-SI025 or 3G2C4-SI026 I/O Unit.

CT001 External Dimensions

3G2A5-CT001



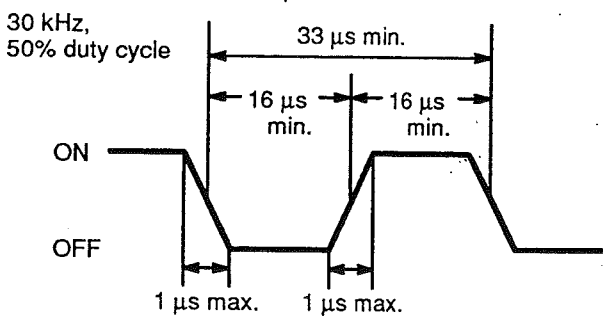
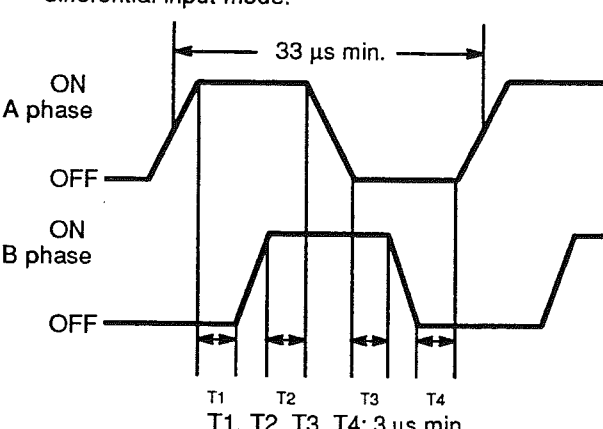
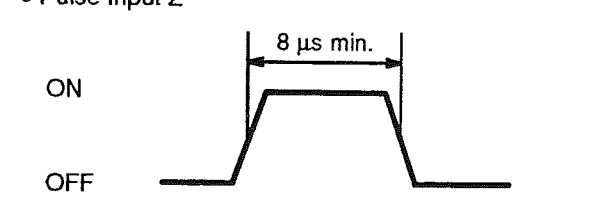
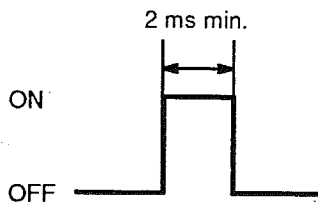
3G2A6-CT001



CT012

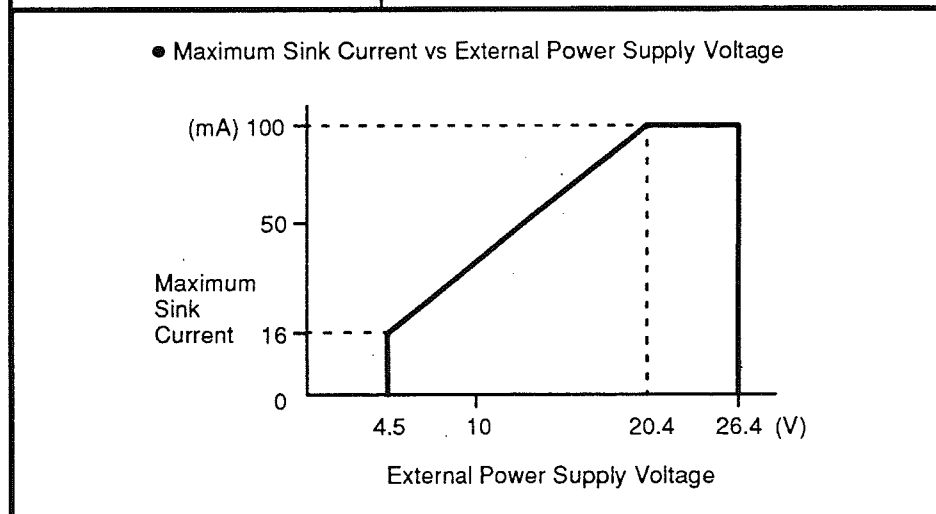
| | | | |
|---|-----------------|---|--|
| No. of axes | | 1 axis/Unit | |
| I/O Points consumed | | 2 words (32 points) | |
| Count inputs | Input signals | Encoder input A Encoder input B | |
| | Signal levels | 5, 12, 24 VDC Voltage determined by terminal block wiring. | |
| | Input modes | Phase differential } Pulse and direction } DIP Switch-selectable | |
| | Input frequency | Non-contact input: 50 kHz max. Contact input: 30 Hz max. (pulse and direction mode) (Frequency is dependent upon encoder specifications. Refer to following page.) | |
| Control inputs | Input signals | Pulse input Z EXT control input (reset/preset): DIP switch-selectable | |
| | Signal levels | 5, 12, 24 VDC (EXT is 5 or 12 to 24 VDC) Voltage determined by terminal block wiring. | |
| | Input modes | Counter's Present Value reset/preset by: Mode 1: concurrent EXT and Z signals. Mode 2: EXT and the first concurrent Z pulse. Mode 3: EXT (latched) and first concurrent Z pulse. Mode 4: EXT signal only. | |
| Coincidence | Flags | No. of points | 8 |
| | | Coincidence range | 0 to 999999 (6 digits, BCD) 500000 to 999999 are treated as negative values. |
| | | Coincidence status | '1' when min. coincidence data ≤ Present Value ≤ max. coincidence data. |
| | Out-puts | Outputs | 8 points: external coincidence outputs 0 through 7 |
| | | Sink current | Open collector outputs, max. 100 mA at 24 VDC (output power supply: 5 to 24 VDC). |
| Data transfer modes (DIP switch-selectable) | | Mode 1: blocks of data transferred via Intelligent I/O Read/Write (use only when mounted on PC or Expansion I/O Rack). Mode 2: commands transferred via MOV (use only when mounted on Remote I/O Rack). | |
| Current consumption | | 550 mA max. 5 VDC (supplied by Backplane) | |
| Dimensions (mm) | | 250(H)×34.5(W)×115(D) (including terminal block) | |
| Weight | | 660 grams (including terminal block) | |

Input Specifications

| Item | Encoder Inputs A, B, Pulse Input Z | | | EXT | |
|----------------------|--|------------------|------------------|--|---------------------|
| | 5 VDC \pm 5% | 12 VDC \pm 10% | 24 VDC \pm 10% | 5 VDC \pm 5% | 12/24 VDC \pm 10% |
| Input Voltage | 5 VDC \pm 5% | 12 VDC \pm 10% | 24 VDC \pm 10% | 5 VDC \pm 5% | 12/24 VDC \pm 10% |
| Input Current | 10 mA (typ.) | 10 mA (typ.) | 10 mA (typ.) | 10 mA (typ.) | 5/10 mA (typ.) |
| ON Voltage | 4.5 V min. | 10.2 min. | 21.6 min. | 4.5 min. | 10.2 V min. |
| OFF Voltage | 1.5 V max. | 3.0 max. | 4.0 max. | 1.5 max. | 3.0 V max. |
| ON/OFF Response Time | 4 μ s max. | | | 2 ms max. | |
| Minimum Pulse Width | <ul style="list-style-type: none"> Encoder Inputs A, B <ul style="list-style-type: none"> Waveforms of Encoder inputs A, B (Phase differential input mode) Input rise/fall times: 1 μs max. 30 kHz, 50% duty cycle  Relationship between A and B phases for phase differential input mode.  Pulse Input Z  | | | <ul style="list-style-type: none">  | |

Output Specifications

| Item | External Outputs 0 to 7 |
|-----------------------|---|
| Maximum Sink Current | 16 mA 4.5 VDC to 100 mA 26.4 VDC (See graph below) Maximum of 400 mA/Common |
| Leakage Current | 0.1 mA max. |
| V _{ce} max. | 0.4 V max. |
| In→Out Response Time | 1 ms max. See Note 1 |
| External Power Supply | 5 to 24 VDC ±10% (Maximum 800 mA at 26.4 V) |

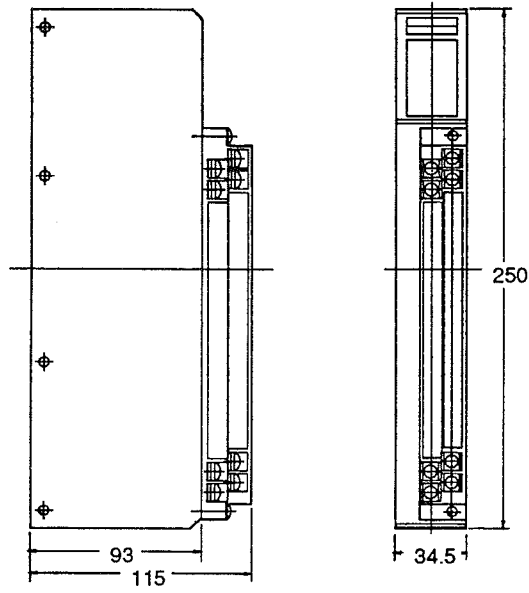


Note In→Out response time is the interval between the arrival of an input pulse that affects the coincidence output status and the point at which the corresponding output(s) are switched ON or OFF. However, the 1 ms maximum may be exceeded if the pulse arrives:

- 1) during the period between completion of data initialization and enabling of the output enable flags when power is applied (mode 1); or
- 2) during an access of the High-speed Counter via the user program to change coincidence data, preset data, etc.

CAUTION If the output current exceeds 0.5 A/common (4 points) the internal fuse will burn out, disabling the Unit. The fuse is not user-replaceable.

CT012 External Dimensions



Glossary

| | |
|--|---|
| Backplane | A base to which Units are mounted to form a Rack. Backplanes provide a series of connectors for these Units along with wiring to connect them to the CPU and Power Supply. Backplanes also provide connectors used to connect them to other Backplanes. In some Systems, different Backplanes are used for different Racks; in other Systems, Racks differ only by the Units mounted to them. |
| backup | A copy of existing data which is valuable if data is accidentally erased. |
| bit | The smallest piece of information that can be represented on a computer. A bit has the value of either zero or one, corresponding to the electrical signals ON and OFF. A bit is one binary digit. |
| central processing unit | A device that is capable of storing a program and data, and executing the set of instructions contained in the program. In a PC System, the central processing unit executes the program, processes I/O signals, communicates with external devices, etc. |
| coincidence signal | A coincidence signal is generated by the Counter when the Present Value of the Counter matches or falls within the range of the Set Value(s). |
| command mode | Mode 2 of the CT012, set via the Unit's DIP switch; available only when the Unit is mounted on a Remote I/O Expansion Rack. |
| CPU | An acronym for central processing unit. |
| data area | An area in the PC's memory that is designed to hold a specific type of data. For example, the LR area is designed to hold common data in a PC Link System. |
| debugging | The process of checking for errors in a program. |
| default condition | The original condition of a function or system. |
| Expansion I/O Backplane | A Backplane used to create an Expansion I/O Rack. |
| Expansion I/O Rack | Part of a Rack PC, an Expansion I/O Rack is connected to a CPU Rack to increase the number of slots available for mounting Units. |
| Expansion I/O Unit | An I/O Unit for a Package-type PC that provides more I/O points to the PC. |
| flag | A bit that is turned ON and OFF automatically by the system in order to provide status information. |
| hexadecimal | A number system used to represent numbers in base 16 with digits 0,1,2...9,A,B...F. |
| High-Speed Counter | A Special I/O Unit. A High Speed Counter Unit counts independently of the PC's scan time. This allows counting of very short, fast signals. |
| Intelligent I/O Read/Write mode | Data transfer mode 1 of the CT012, set via the Counter's DIP switch; available only when the Unit is mounted on a PC or an I/O Expansion Rack. |

Glossary

| | |
|--------------------------------------|---|
| Intelligent I/O Unit | A Unit, such as an ASCII Unit or Ladder Program I/O Unit, that is equipped with its own CPU and can be programmed. |
| I/O Control Unit | A Unit mounted to the CPU Rack in certain PCs to monitor and control I/O points on Expansion I/O Units. |
| I/O devices | The devices which are connected to the terminals on I/O Units, Special I/O Units, or Intelligent I/O Units. I/O devices may be part of the Control System if they function to help control other devices, or they may be part of the controlled system if they interact directly with it. |
| I/O point | The place at which an input signal enters the PC System or an output signal leaves the PC System. In physical terms, an I/O point corresponds to terminals or connector pins on a Unit; in terms of programming, an I/O point corresponds to an I/O bit in the IR area. |
| I/O Unit | The most basic type of Unit mounted to a Backplane. I/O Units include Input Units and Output Units, each of which is available in a range of specifications. I/O Units do not include Special I/O Units, Link Units, etc. |
| Limit Switch | A switch that detects when an object has reached the limit of its movement by actually making contact with the object. Limit Switches are fitted to electric elevators, traveling cranes, etc. to indicate when a certain part of the equipment has traveled to the specified limit. |
| origin | The number set against which the Counter is incremented or decremented. |
| OUT instruction | Outputs the result of a logical operation to a specified bit. |
| PC | An acronym for Programmable Controller. |
| phase difference | The difference between Counter inputs measured in degrees per 360°. For example, if the two inputs send signals to the Counter at exactly opposite intervals, the phase difference between these inputs would be 180°. |
| phase differential input mode | A Counter input mode in which phase difference determines whether the Counter is incremented or decremented. |
| Photoelectric Switch | A switch that uses light to detect the presence of an object. |
| Power Supply | A Unit that mounts to a Backplane in a Rack PC. It provides power at the voltage required by the other Units on the Rack. |
| Programmable Controller | A small, computer-like device that can control peripheral equipment, such as an electric door or quality control devices, based on programming and peripheral input devices. Any process that can be controlled using electrical signals can be controlled by a PC. PCs can be used independently or networked together into a system to control more complex operations. |
| Proximity Switch | A switch that uses magnetic induction to measure the distance of a metallic object from the front of the switch. |

Glossary

| | |
|---------------------------------------|---|
| pulse and direction input mode | A Counter input mode in which the present status of the Counter's input 2 determines whether the Counter value is incremented or decremented when a pulse is received from an input. |
| Rack | An assembly that forms a functional unit in a Rack PC System. A Rack consists of a Backplane and the Units mounted to it. These Units include the Power Supply, CPU, and I/O Units. Racks include CPU Racks, Expansion I/O Racks, and I/O Racks. The CPU Rack is the Rack with the CPU mounted to it. An Expansion I/O Rack is an additional Rack that holds extra I/O Units. An I/O Rack is used in the C2000H Duplex System, because there is no room for any I/O Units on the CPU Rack in this System. |
| Rack PC | A PC that is composed of Units mounted to one or more Racks. This configuration is the most flexible, and most large PCs are Rack PCs. A Rack PC is the opposite of a Package-type PC, which has all of the basic I/O, storage, and control functions built into a single package. |
| Remote I/O Unit | A Unit that extends the distance an Expansion I/O Rack can be from the CPU. |
| scan time | The time it takes the PC to perform internal operations, i.e., reset the watchdog timer, read the program, receive input data, send output data, and execute instructions. Scan time is monitored by the watchdog timer within the PC, and if it takes longer than a certain specified amount of time, an error message may be generated, or the CPU may just stop. Scan times will differ depending on the configuration of the system. |
| sensor | An input device that "senses" a property of the real world and relays it to the Control System. The property can be a measurement of an object, or simply a signal indicating the presence of the object. |
| Special I/O Unit | A dedicated Unit that is designed for a specific purpose. Special I/O Units include Position Control Units, High-Speed Counters, Analog I/O Units, etc. |
| switch | An input device that sends either an ON or OFF signal to the Control System. A switch can be operated either by a person or by the movement of a piece of equipment or material. |
| Unit | In OMRON PC terminology, the word Unit is capitalized to indicate any product sold for a PC System. Though most of the names of these products end with the word Unit, not all do. For example, a Remote Terminal is referred to in a collective sense as a Unit. Context generally makes any limitations of this word clear. |
| word | In digital circuits, a group of bits. Usually a word consists of four, eight, or sixteen bits. In C-series PCs, a word consists of sixteen bits. Words can be used to store data, or they can be used for I/O. |
| work bits | Bits in the IR area that are not being used for input or output. These bits can be used in the program in any way desired. |

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