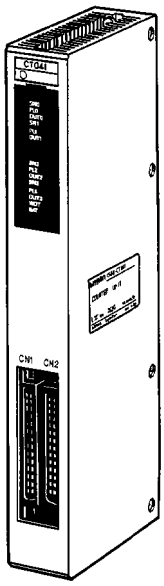
C500-CT041
High-speed Counter Unit

Operation Manual

Revised September 1995



Notice:

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 warnings 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.

OMRON Product References

All OMRON products are capitalized in this manual. The word “Unit” is also capitalized when it refers to an OMRON product, regardless of whether or not it appears in the proper name of the product.

The abbreviation “Ch,” which appears in some displays and on some OMRON products, often means “word” and is abbreviated “Wd” in documentation in this sense.

The abbreviation “PC” means Programmable Controller and is not used as an abbreviation for anything else.

Visual Aids

The following headings appear in the left column of the manual to help you locate different types of information.

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

1, 2, 3... Indicates lists of one sort or another, such as procedures, precautions, etc.

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About this Manual:

This manual describes the installation and operation of the C500-CT041 High-speed Counter Unit and includes the sections described below. This High-speed Counter Unit can be used for high-speed counting and timing operations with the C500, C1000H, and C2000H SYSMAC C-series PCs.

Please read this manual completely and be sure you understand the information provide before attempting to install and/or operation the C500-CT041.

Section 1 Introduction describes the basic features of the C500-CT041 and outlines the type of system in which it can be used.

Section 2 Hardware Components and Switch Settings introduces the names and functions of Counter indicators, switches, and connectors.

Section 3 Wiring and Installation describes methods and precautions for connecting to external I/O devices.

Section 4 Introduction to Operation outlines the basic operating modes.

Section 5 Data Configuration describes the data required for Counter operation and the methods used to transfer data between the Counter and the PC and thus control Counter operation.

Section 6 Preset Timer Modes provides operational details necessary when using one or more of the Counter channels as a preset timer.

Section 7 Preset Counter Modes provides operational details necessary when using one or more of the Counter channels as a preset counter.

Section 8 Measurement Modes provides operation details necessary when using one or more of the Counter channels as a gate ring or sampling counter.

Section 9 Applications Examples outlines three applications examples that include both the basic setup and programming for the Counter.

Section 10 Troubleshooting and Maintenance lists several possible trouble areas that can be used when errors occur in Counter operation and provides inspection items and replacement parts.

The ***Appendices*** provide specifications, a switch setting list, and data allocation charts for the various operating modes.

SECTION 1
Introduction

This section introduces the basic features of the High-speed Counter and describes the basic system configuration.

1−1 Features 2
1−2 System Configuration 2

1–1 Features

The C500-CT041 High-speed Counter Unit is a Special I/O Unit for the C500, C1000H, and C2000H SYSMAC C-series PCs. Incremental encoders can be connected to it, and a pulse input maximum of 20 Kcps can be recognized. The Counter supports a total of six operating modes in three groups.

Preset Timers

Timer mode 1-Turns ON an external output when the preset time elapses.

Timer mode 2-Turns ON an external output while the timer is operating (i.e., during the preset time).

Preset Counters

Counter mode 1-Turns ON an external output when the preset count elapses.

Counter mode 2-Turns ON an external output while the counter is operating (i.e., during the preset count).

Measurements

Gate ring counter mode-Counts pulses while the external gate input is ON.

Sampling counter mode-When the input signal is ON, provides the number of pulses counted since the last time the input signal was ON.

General Features

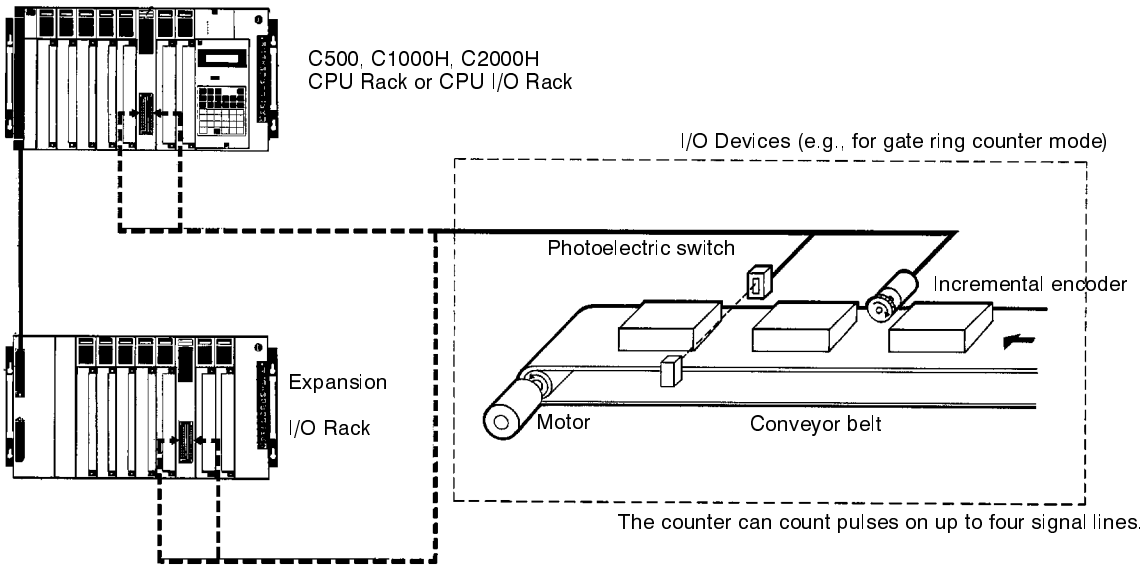
Control signals and pulse signals are required from external inputs. Counting speed is 20 Kcps maximum.

Modes and settings are retained by the battery when the power is OFF, i.e., settings do not need to be re-input unless new settings are necessary when power is applied. Operating modes and settings can be changed while the Counter is ON.

The Counter provides four independent channels that can be set and run individually. READ(88) and WRIT(87) can be used to quickly and efficiently transfer data for any or all of the four channels. Refer to the C1000H/C2000H Operation Manual for details about using READ(88) and WRIT(87).

1–2 System Configuration

The C500-CT041 can be mounted to any slot on a CPU, CPU I/O, or Expansion I/O Rack of a C500, C1000H, or C2000H PC. Do not mount it to a Slave Rack in a Remote I/O System. The C500-CT041 must be connected to a CPU that supports READ(88) and WRIT(87). The Unit is allocated 2 words.



SECTION 2
Hardware Components and Switch Settings

This section introduces the components of the High-speed Counter Unit and provides instructions for setting switches. Details of operation are covered in later sections.

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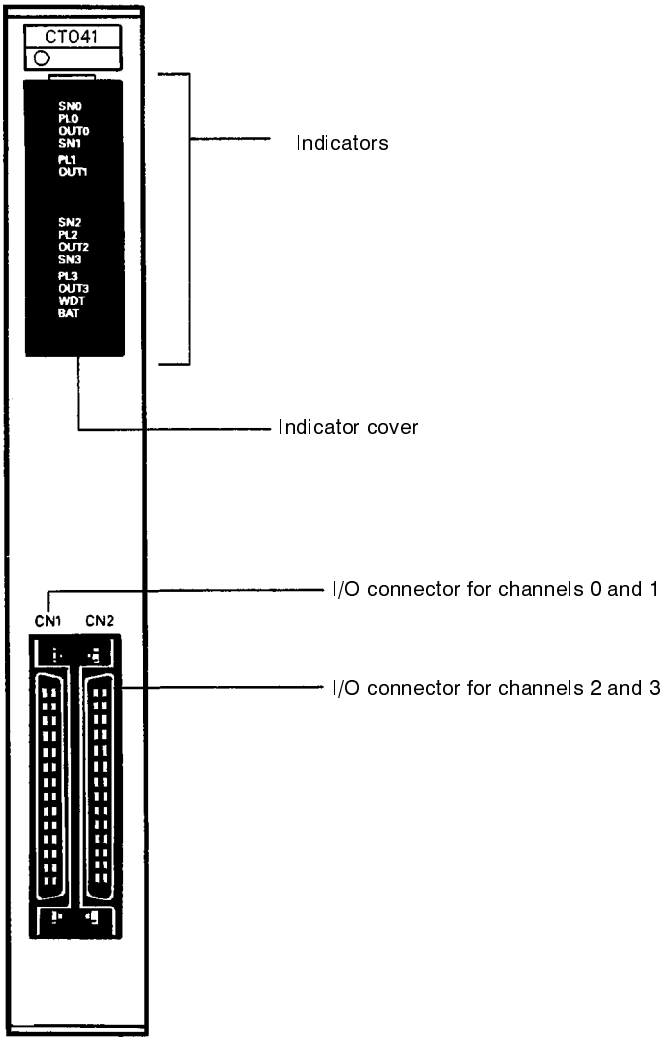
2–1 Counter Components

Front Panel



Front-panel Indicators

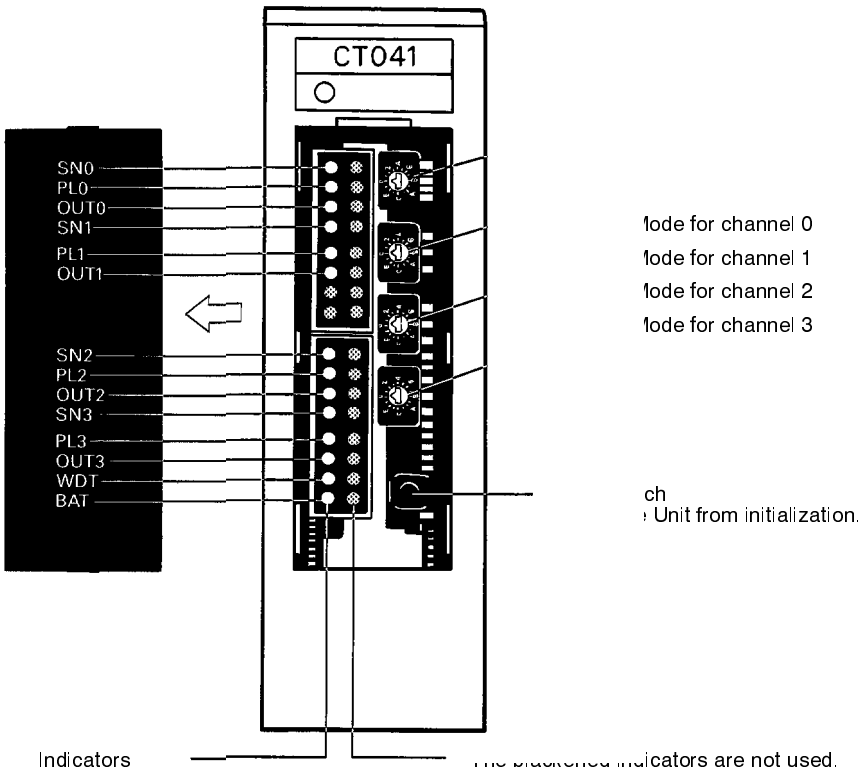
Indicator	Meaning
Sensor input	Lights when the sensor input for the corresponding channel (0 through 3) is ON.
Pulse input	Lights when the pulse input for the corresponding channel (0 through 3) is ON.
External output	Lights when the external output signal for the corresponding word (0 through 3) is ON.
WDT error	Lights to indicate a watchdog timer error.
Battery low	Lights to indicate a battery error.

2–2 Switch Settings

The indicator cover must be removed to change the switch settings. Remove the indicator cover from the front panel with a flat-blade screwdriver and then use the screwdriver to change the settings being careful not to damage the slots on the switches.

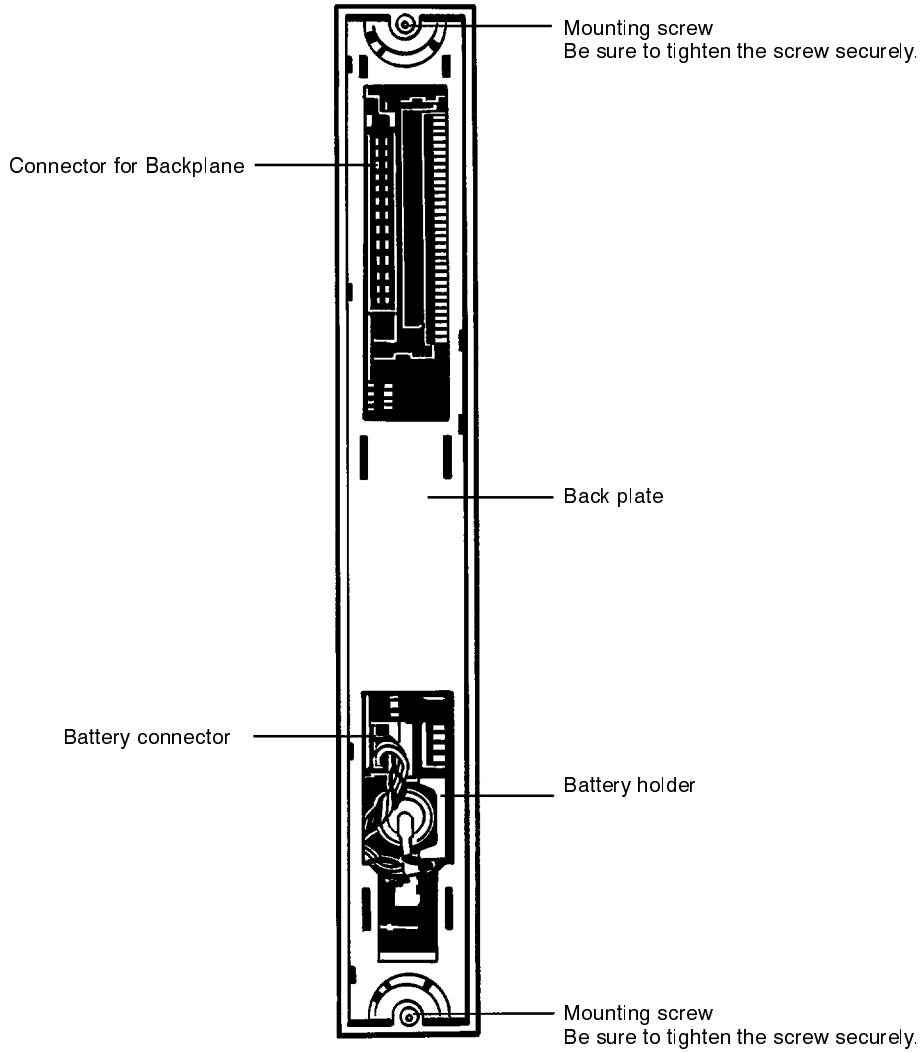
There is a separate mode switch for each Counter channel. Set the operating mode for each Counter channel on these mode switches. If there are any channels that are not going to be used, set them to a setting between 8 and F. Be sure that the switches click properly into place and are not left half-way between settings.

Although the switch settings can be changed at any time, switch status is not read until the Mode Change Bit for each particular channel is changed. Before changing the operating mode, refer to *Section 5 Data Configuration* for details.

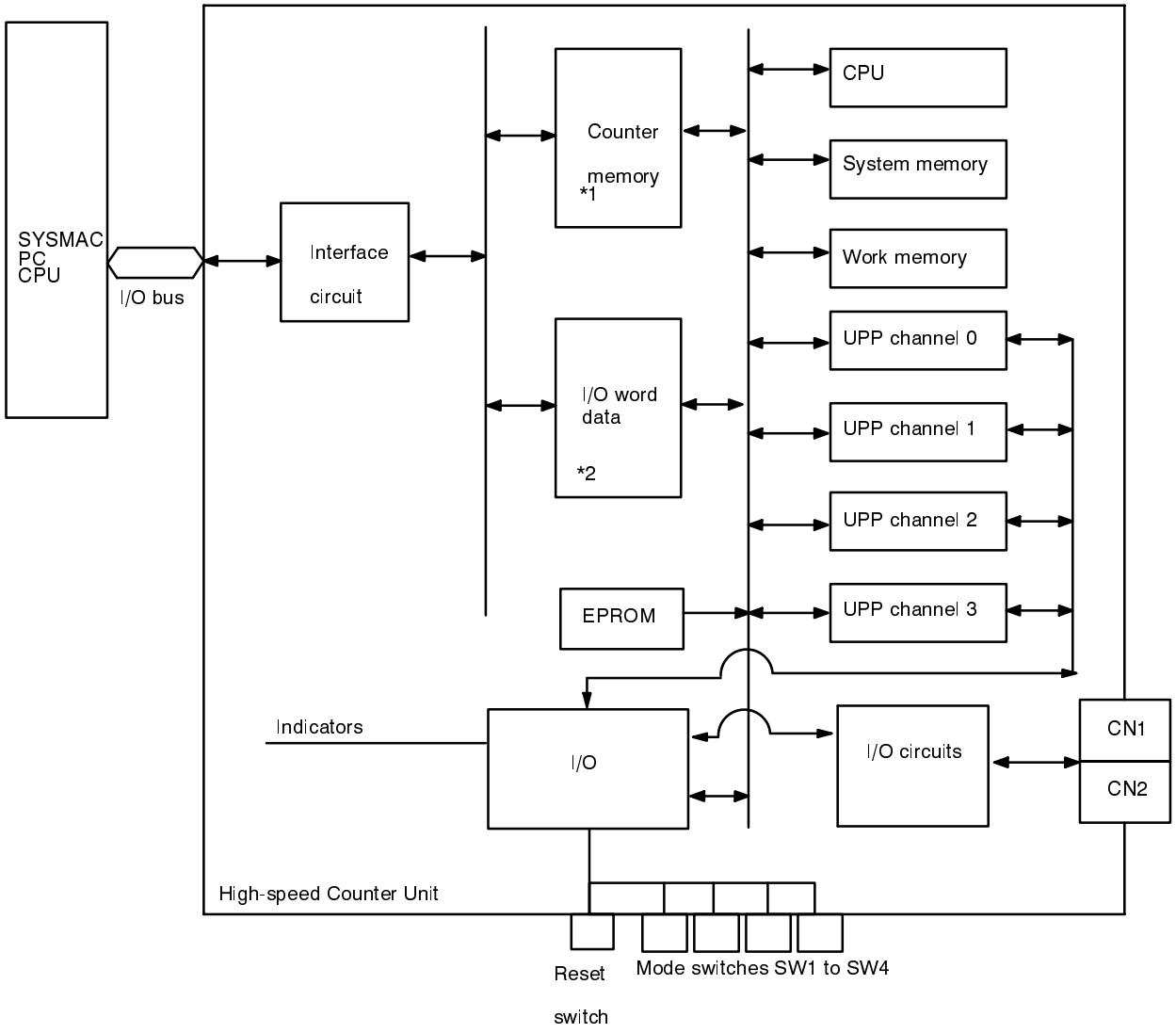


Switch setting	Meaning
0	Sets timer mode 1 using the 20-kHz internal clock.
1	Sets timer mode 1 using the 2-kHz internal clock.
2	Sets timer mode 2 using the 20-kHz internal clock.
3	Sets timer mode 2 using the 2-kHz internal clock.
4	Sets counter mode 1.
5	Sets counter mode 2.
6	Sets gate ring counter mode.
7	Sets sampling counter mode.
8 to F	Sets the counter/timer to unused.

Back Panel


Mounting screw
Be sure to tighten the screw securely.
Connector for Backplane
Back plate
Battery connector
Battery holder
Mounting screw
Be sure to tighten the screw securely.

2–3 Block Diagram



*1: The Counter memory is accessed from the PC using READ(88) and WRIT(87).
*2: I/O word data can be read and manipulated from the PC CPU with LD, OUT, and other instructions.

SECTION 3
Wiring and Installation

This section describes the methods for installing the Counter and wiring the Counter's two external connectors. Counter dimensions are also provided. Technical specifications are found in *Appendix A Specifications*.

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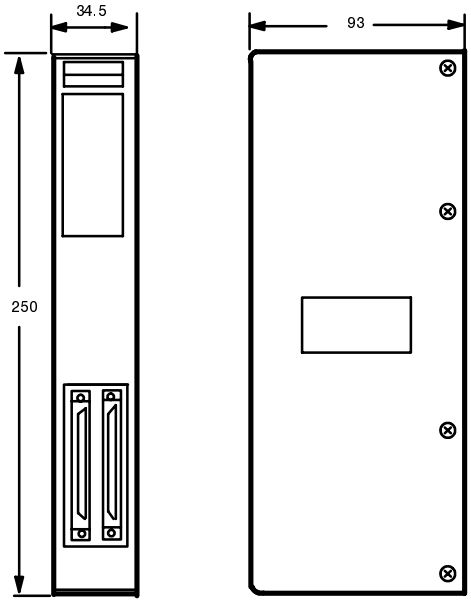
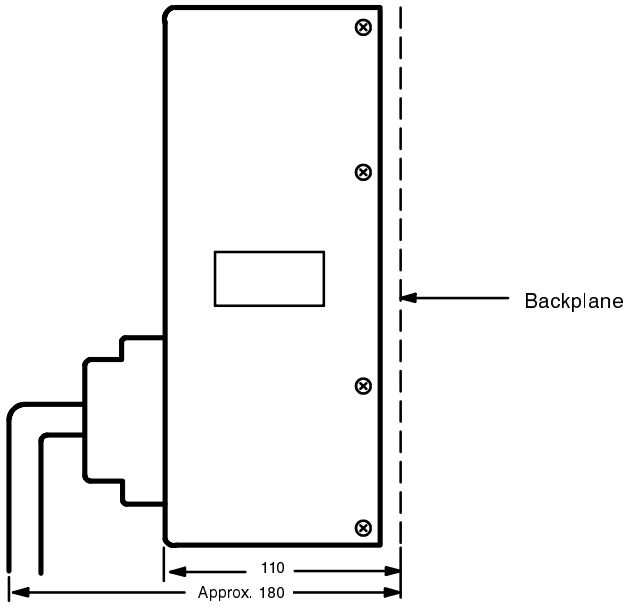
3–1 Mounting Location

The Counter can be mounted to either the CPU, CPU I/O, or Expansion I/O Rack of a C500, C1000H, or C2000H SYSMAC C-series PC. It cannot be mounted to a Slave Rack in a Remote I/O System.

3–2 Dimensions

Counter Dimensions are shown below. Dimensions are in millimeters.





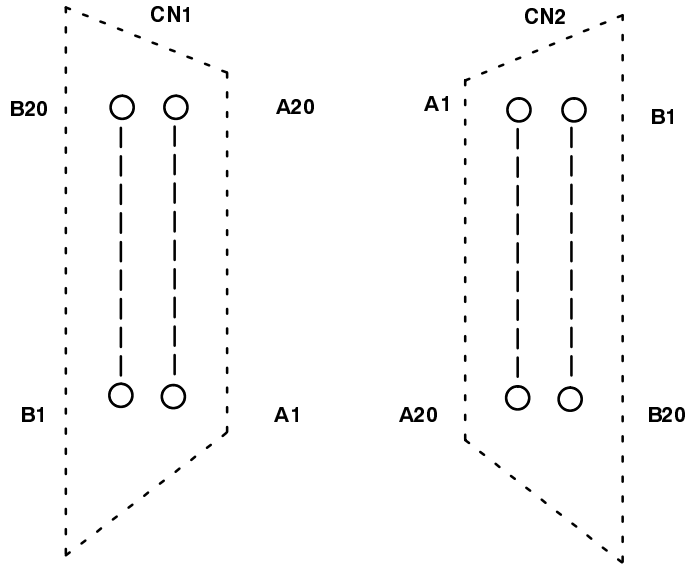
3–3 Connector Pin Allocations

This section provides the pin allocations for the two Counter connectors, the I/O signal names, and the signal applicability for each operating mode.

Connectors 1 (CN1) and 2 (CN2) are essentially the same except that 1) CN2 pin numbers start at the top and CN1 pin numbers start at the bottom and 2) CN1 is used for Counter channels 0 and 1 and CN2 is used for counter channels 2 and 3.

The external connectors for CN1 and CN2 are provided with the Counter. These connectors are Fujitsu FCN-361J040 solder-type connectors.

These two connectors appear as illustrated below when viewed from the front of the Counter. The I/O allocations for the pins are provided following the illustration.



CN1 I/O Connector Pin Allocations

I/O signal	Symbol	Pin		Symbol	I/O Signal
External output power supply input 24 VDC	DC 24V	A20	B20	DC 24V	External output power supply input 24 VDC
		A19	B19		
Channel 1 external output	OUT1	A18	B18	GND COM	External output power supply input 0 VDC
Channel 0 external output	OUT0	A17	B17		
External output power supply input 0 VDC	GND COM	A16	B16		
		A15	B15		
Not used.	NC	A14	B14	NC	Not used.
		A13	B13		
Channel 1 pulse input (–)	PL-1 (–)	A12	B12	PL-1 (+)	Channel 1 pulse input (+)
Channel 1 PCOK input (–)	PC-1 (–)	A11	B11	PC-1 (+)	Channel 1 PCOK input (+)
Channel 1 sensor input* (–)	SN-1 (–)	A10	B10	SN-1 (+)	Channel 1 sensor input* (+)
Channel 1 counter clear input (–)	CC-1 (–)	A9	B9	CC-1 (+)	Channel 1 counter clear input (+)
Not used.	NC	A8	B8	NC	Not used.
		A7	B7		
Channel 0 pulse input (–)	PL-0 (–)	A6	B6	PL-0 (+)	Channel 0 pulse input (+)
Channel 0 PCOK input (–)	PC-0 (–)	A5	B5	PC-0 (+)	Channel 0 PCOK input (+)
Channel 0 sensor input* (–)	SN-0 (–)	A4	B4	SN-0 (+)	Channel 0 sensor input* (+)
Channel 0 counter clear input (–)	CC-0 (–)	A3	B3	CC-0 (+)	Channel 0 counter clear input (+)
Not used.	NC	A2	B2	NC	Not used.
		A1	B1		

***Note:** The sensor input is used for the external gate signal in the gate ring counter operating mode.

CN2 I/O Connector Pin Allocations

I/O signal	Symbol	Pin		Symbol	I/O Signal
Not used.	NC	A1	B1	NC	Not used.
		A2	B2		
Channel 2 counter clear input (–)	CC-2 (–)	A3	B3	CC-2 (+)	Channel 2 counter clear input (+)
Channel 2 sensor input* (–)	SN-2 (–)	A4	B4	SN-2 (+)	Channel 2 sensor input* (+)
Channel 2 PCOK input (–)	PC-2 (–)	A5	B5	PC-2 (+)	Channel 2 PCOK input (+)
Channel 2 pulse input (–)	PL-2 (–)	A6	B6	PL-2 (+)	Channel 2 pulse input (+)
Not used.	NC	A7	B7	NC	Not used.
		A8	B8		
Channel 3 counter clear input (–)	CC-3 (–)	A9	B9	CC-3 (+)	Channel 3 counter clear input (+)
Channel 3 sensor input* (–)	SN-3 (–)	A10	B10	SN-3 (+)	Channel 3 sensor input* (+)
Channel 3 PCOK input (–)	PC-3 (–)	A11	B11	PC-3 (+)	Channel 3 PCOK input (+)
Channel 3 pulse input (–)	PL-3 (–)	A12	B12	PL-3 (+)	Channel 3 pulse input (+)
Not used.	NC	A13	B13	NC	Not used.
		A14	B14		
External output power supply input 0 VDC	GND COM	A15	B15	GND COM	External output power supply input 0 VDC
		A16	B16		
Channel 2 external output	OUT2	A17	B17		
Channel 3 external output	OUT3	A18	B18		
External output power supply input 24 VDC	DC 24V	A19	B19	DC 24V	External output power supply input 24 VDC
		A20	B20		

***Note:** The sensor input is used for the external gate signal in the gate ring counter operating mode.

I/O Signal Usage

The following table shows how I/O signals are used with each operating mode. Actual application of these signals is described later.

Operating mode	Pulse input	PCOK input	Sensor input	Counter clear input	External output
Timer mode	NA	PC OK signal	Sensor signal	Counter clear signal	External output
Counter mode	External pulse	PC OK signal	Sensor signal	Counter clear signal	External output
Gate ring counter mode	External pulse	NA	External gate signal	Counter clear signal	NA
Sampling counter mode	External pulse	NA	Sensor signal	Counter clear signal	NA

3–4 Wiring

3–4–1 Wiring Precautions

Observe the following precautions when wiring the Counter.

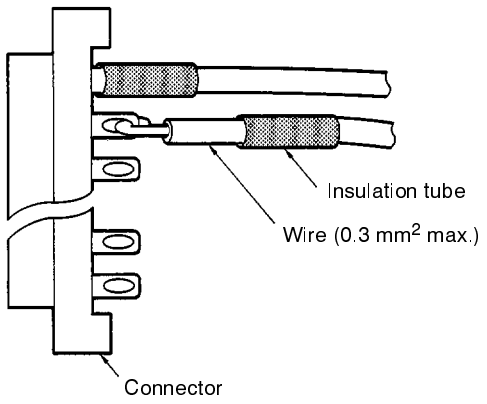
1, 2, 3...

1. Do not reverse the 24-VDC and GND COM (0 V) terminals. If these terminals are reversed, an internal fuse will blow. The internal fuse is not customer serviceable.
2. Use non-contact input devices for input signals to prevent chattering.
3. Use twisted-pair cables for input signal lines and ground the shield to a maximum of 100 W.
4. Keep input signal lines as short as possible and do not run them in parallel with power lines. Excessive line length or power lines can produce noise, making input signals undependable.
5. If possible, use one power supply for input signals and a separate one for output signals.
6. Use a stabilized power supply for input signals.

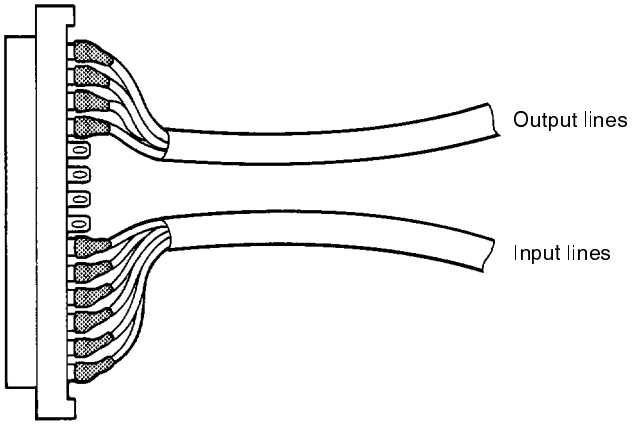
3–4–2 Wiring Methods

The connectors provided with the Counter are designed to be soldered. Use wires that are 0.3 mm^2 or less in cross-sectional area.

When soldering, be sure not to let solder come in contact with the adjacent terminals or wires. After completing solder, cover the terminals and exposed wires with insulation tubes, as shown below.

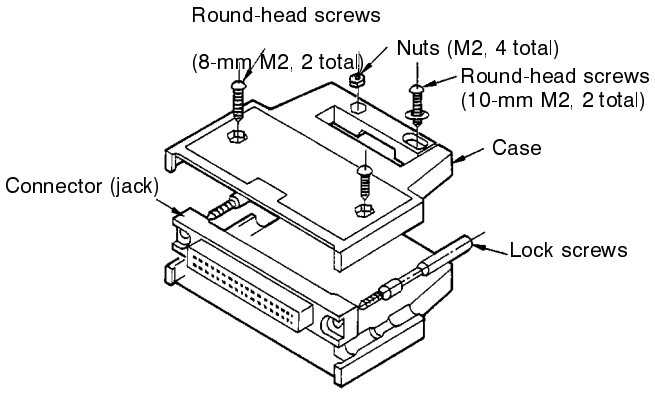


If you bundle lines into cables, always separate input and output lines into separate cables.



3–4–3 Connector Assembly

Assemble the connector as shown below.



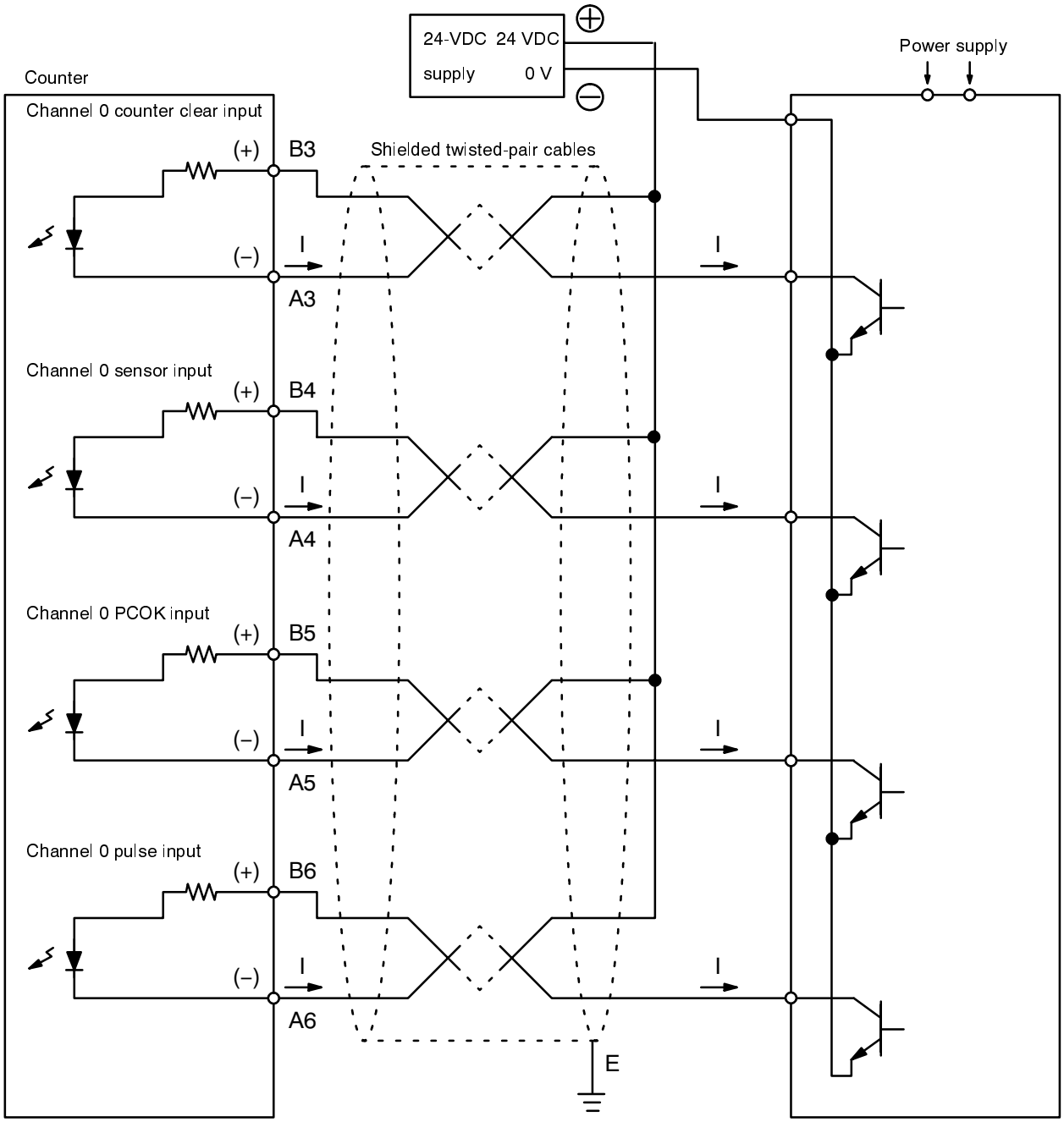
The following Fujitsu connectors can be used. The solder type is provided with the Counter.

1. Solder type: FCN-361J040
2. Wrapping type: FCN-362J040
3. Crimp-connector type FCN-363J040

3–4–4 Input Signal Wiring Examples

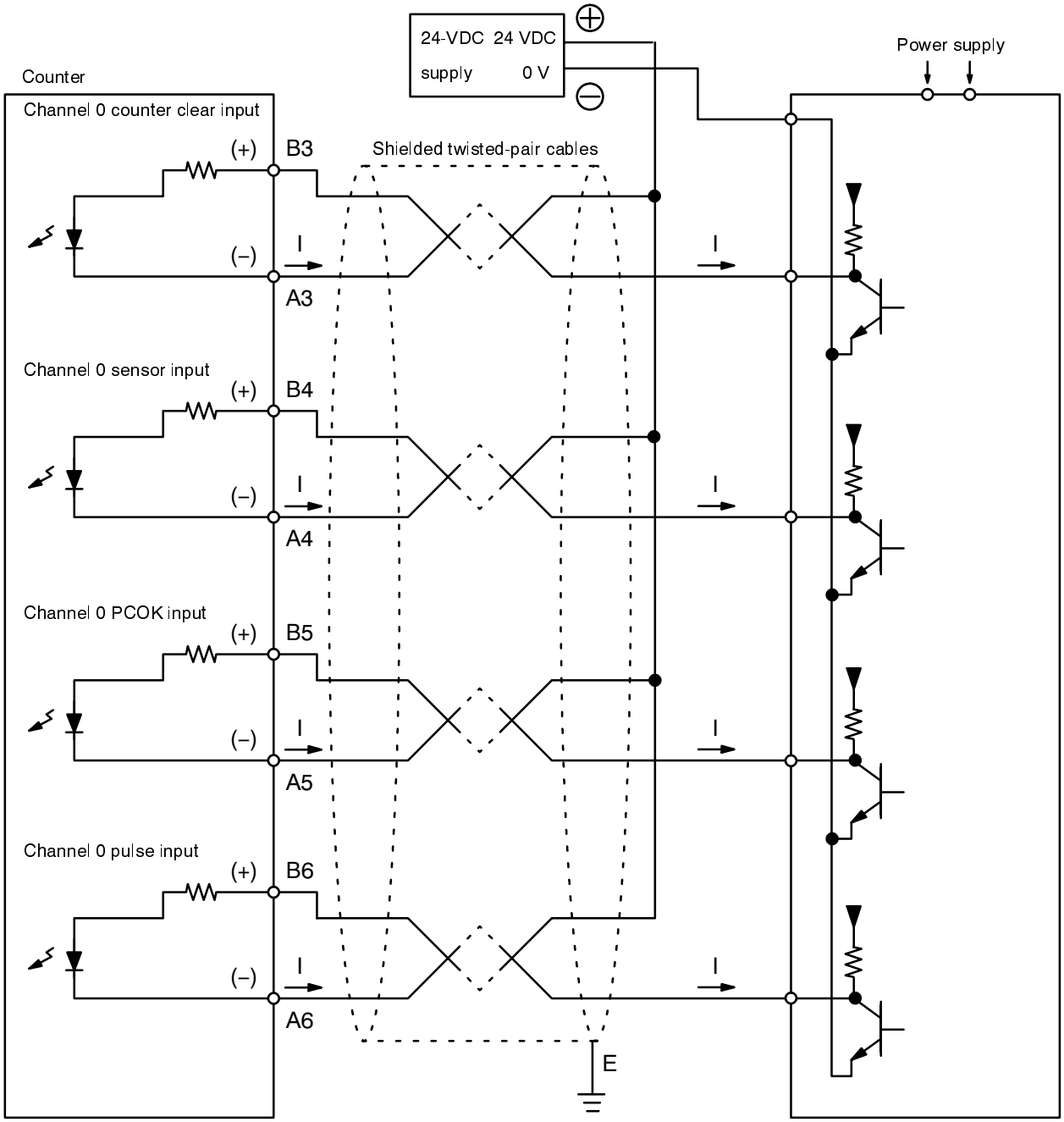
Wiring examples for various non-contact input devices are provided in this section. Non-contact input devices should be used for all input signals to prevent chattering. The following examples are for Counter channel 0.

Example 1: Open-collector Input



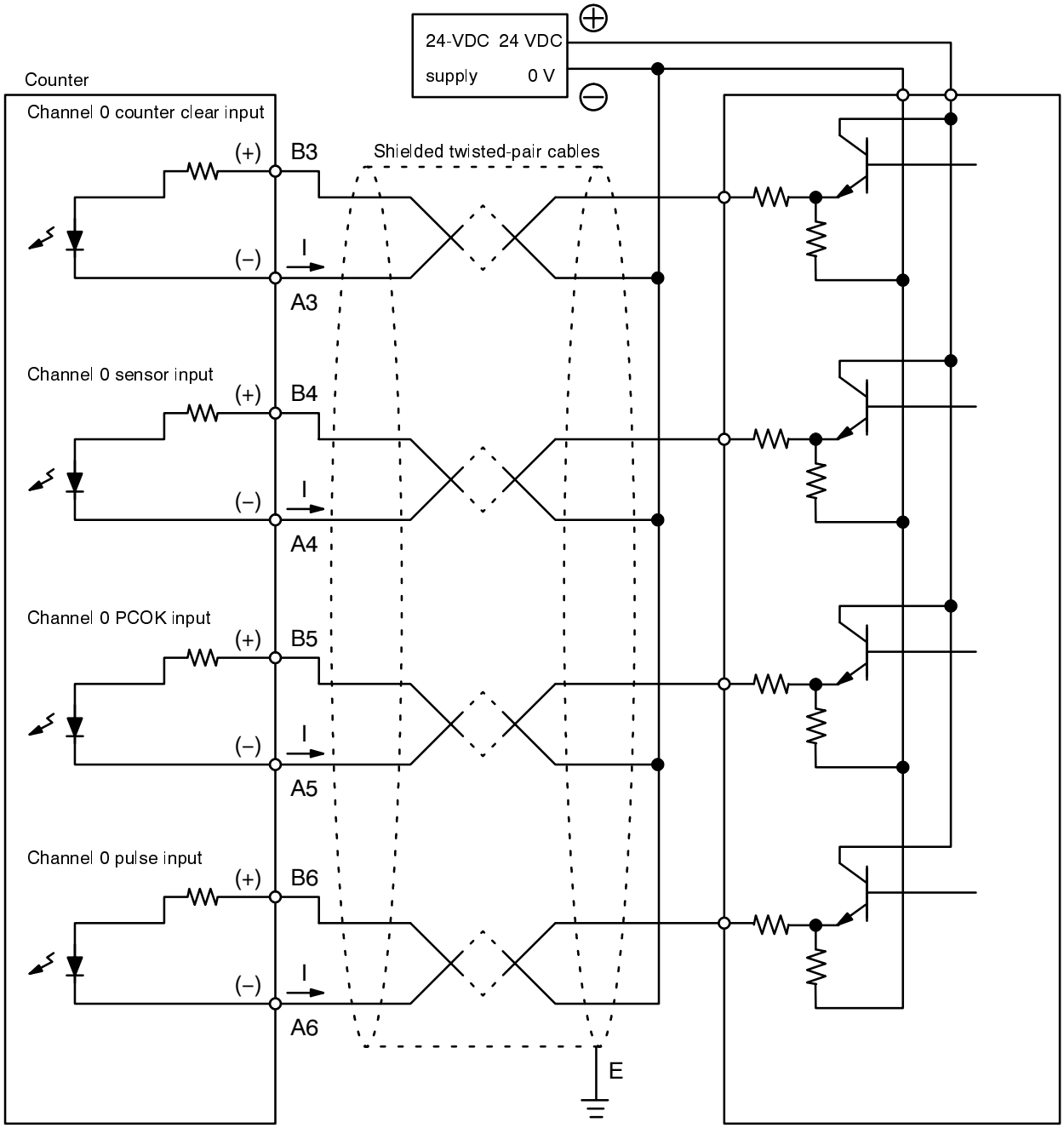
Example 2: Voltage Inputs (Sink Load)

With voltage inputs from current-sinking loads, a Counter input is OFF for high voltage and ON for low voltage.



Example 3: Voltage Inputs (Source Load)

Be sure that the ON voltage is within specifications. Specifications are provided in *Appendix A Specifications*.

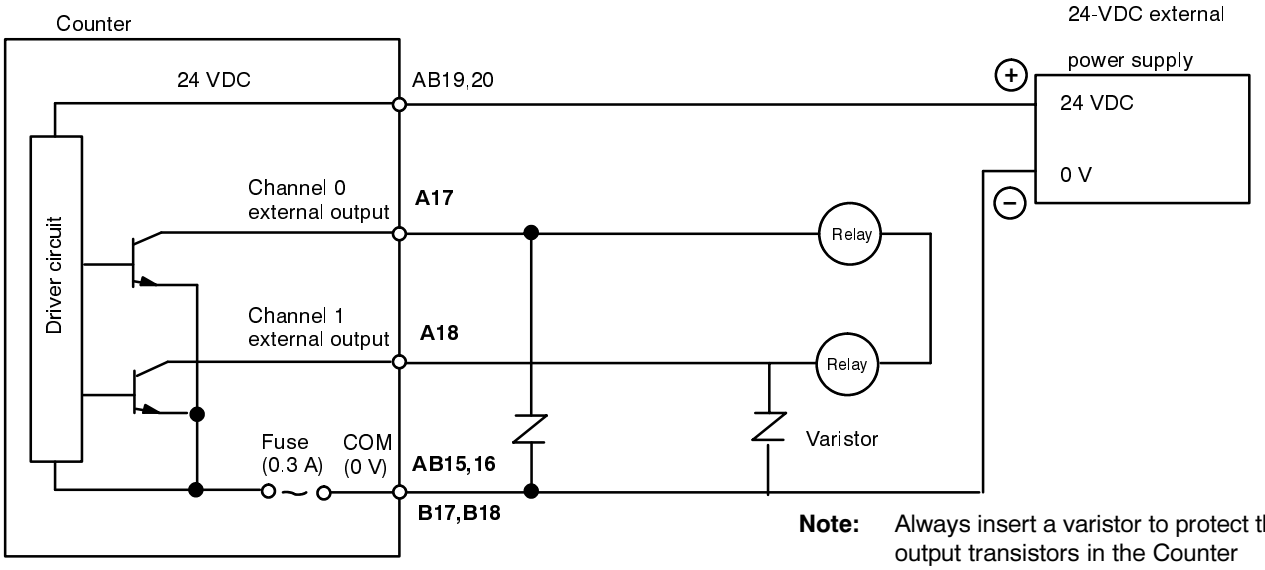


3–4–5 Output Signal Wiring Examples

Wiring examples for various output devices are provided in this section. The following examples are for Counter channels 0 and 1.

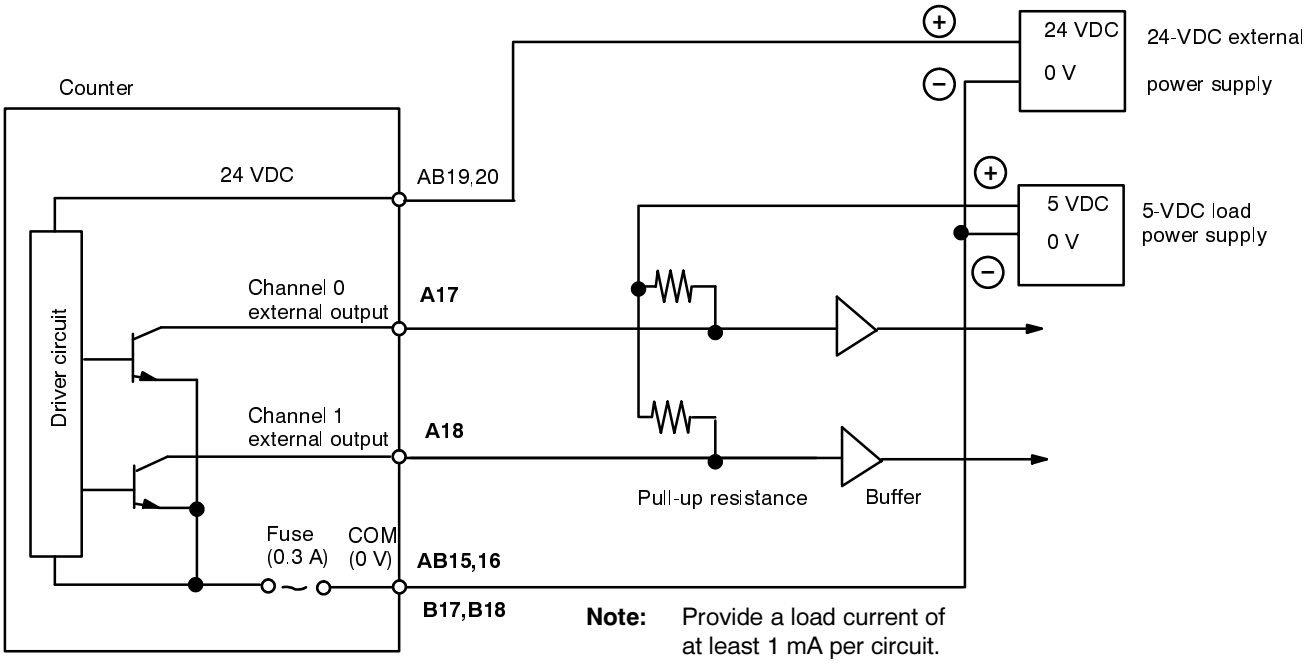
Note Outputs go low for ON signals and high for OFF signals

Example 1: Outputting to Relays



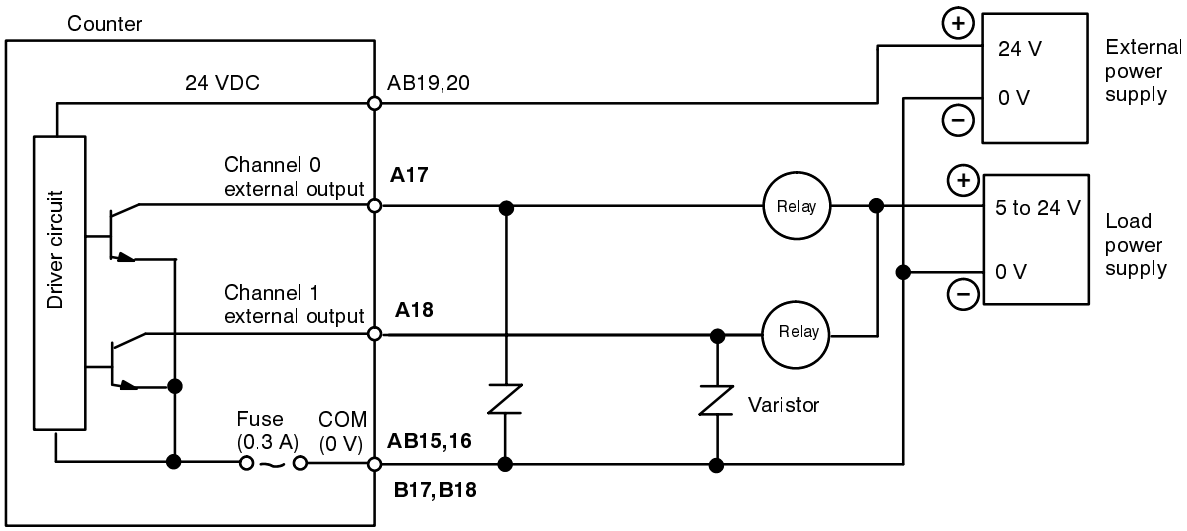
Note: Always insert a varistor to protect the output transistors in the Counter when connecting to inductive loads.

Example 2: Outputting to TTLs



Note: Provide a load current of at least 1 mA per circuit.

Caution Incorrect output signal can result if the voltage of the external power supply is less than that of the load power supply. Always check the voltage levels to confirm that the external power supply voltage is greater than or equal to the load power supply voltage.



SECTION 4
Introduction to Operation

This section describes the six operating modes that can be used for High-speed Counter Unit operation. Details on data configuration and transfer are provided in *Section 5 Data Configuration*. Details on each individual operating mode are provided in *Section 6 Preset Timer Modes*, *Section 7 Preset Counter Modes*, and *Section 8 Gate Ring and Sampling Counter Modes*. Application examples for the operating modes are provided in *Section 9 Application Examples*.

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4–1–5 Counter Mode 2 26
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4–1–7 Sampling Counter Mode 28
4–2 Reset Conditions 28

4–1 Operating Modes

4–1–1 Overview

The Counter offers six basic operating modes that can be set for the four operating channels. Any mode can be set for any channel regardless of the modes set for the rest of the channels. The mode for each channel is set on switches 1 through 4 on the front of the Counter. Each channel is also provided with each of the following: a sensor input, an pulse input, a PCOK input, an external output, an internal clock, and operating parameters, although not all of these are used in every operating mode.

Of the six basic operating modes, each of the preset timer modes can be set for operation either at 2 kHz or 20 kHz, actually making a total of eight modes. In the remainder of this manual, however, the 2-kHz and 20-kHz versions of these modes will be treated together, the only differences being the precision of the timer.

The Counter can count pulses up to 20 kcps. Outputs can be set to a pulse width of between 1 and 999 ms. An output can be disabled by turning OFF the PCOK input.

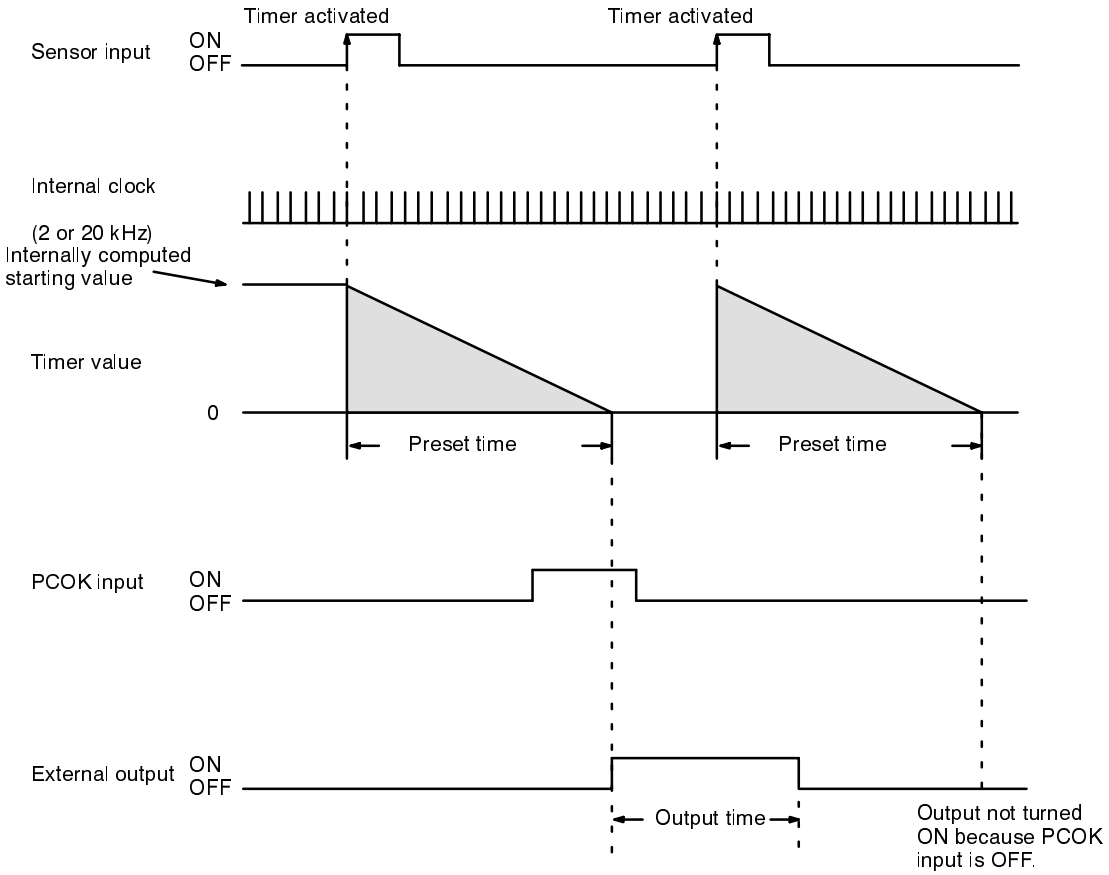
The following table briefly describes the eight modes. These are described in more detail in the following sections.

Application	Mode setting	Operating mode	Description
Preset timer	0	Preset timer mode 1, 20 kHz	When operation is activated by the sensor input going ON, the preset timer is decremented according to the internal clock. When the preset time is timed out, the external output is turned ON for one pulse. The preset timer can be set to a value between 1 and 999 ms.
	1	Preset timer mode 1, 2 kHz	Same as above, but the preset time setting is between 10 and 9,990 ms (i.e., it is numerically set between 1 and 999 in units of 10 ms.)
	2	Preset timer mode 2, 20 kHz	When operation is activated by the sensor input going ON, the external output goes ON and the preset timer is decremented according to the internal clock. When the preset time is timed out, the external output is turned OFF. The preset timer can be set to a value between 1 and 999 ms.
	3	Preset timer mode 2, 2 kHz	Same as above, but the preset time setting is between 10 and 9,990 ms (i.e., it is numerically set between 1 and 999 in units of 10 ms.)
Preset counter	4	Preset counter mode 1	When operation is activated by the sensor input going ON, the preset counter is decremented each time the pulse input goes ON. When the preset count is counted down the external output is turned ON for one pulse. The preset counter can be set to a value between 1 and FFFF in hexadecimal.
	5	Preset counter mode 2	When operation is activated by the sensor input going ON, the external output goes ON and the preset counter is decremented each time the pulse input goes ON. When the preset count is counted down, the external output is turned OFF. The preset counter can be set to a value between 1 and FFFF in hexadecimal.
Measurement	6	Gate ring counter mode	Signals on the pulse input are counted while the external gate input is ON. If the count exceeds FFFF, the count restarts from 0 and an Overflow Flag is turned ON.
	7	Sampling mode	When the sensor input goes ON, the number of pulses counted up to that point is held until cleared. Once cleared, pulses are again counted from 0.

4–1–2 Preset Timer Mode 1

The timing operation is activated when the sensor input goes ON. When the preset value is timed out as a result of decrementing a preset value on signals from an internal clock, the external output is turned ON for a specified duration as long as the PCOK input is ON. If the PCOK input is OFF, no output will be made. The external output can be set to go ON for between 1 and 999 ms.

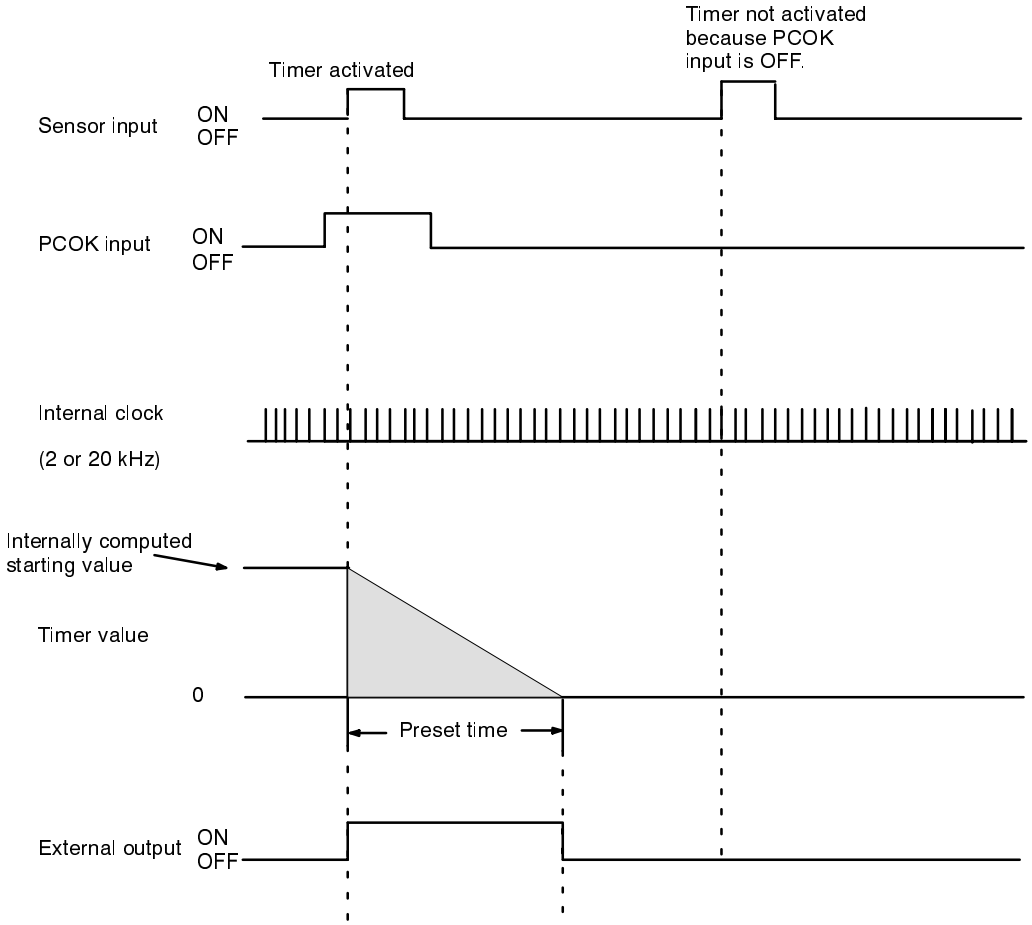
Either a 2-kHz or a 20-kHz internal clock can be used. If the 20-kHz clock is used, the timer can be set to between 1 and 999 ms. If the 2-kHz clock is used, it can be set to between 10 and 9,990 ms (i.e., 0.01 and 9.99 s).



4–1–3 Preset Timer Mode 2

If the PCOK input is ON, the timing operation is activated and the external output goes ON when the sensor input goes ON. When the preset value is timed out as a result of decrementing a preset value on signals from an internal clock, the external output is turned OFF. If the PCOK input is OFF, the timing operation will not start.

Either a 2-kHz or a 20-kHz internal clock can be used. If the 20-kHz clock is used, the timer can be set to between 1 and 999 ms. If the 2-kHz clock is used, it can be set to between 10 and 9,990 ms (i.e., 0.01 and 9.99 s).

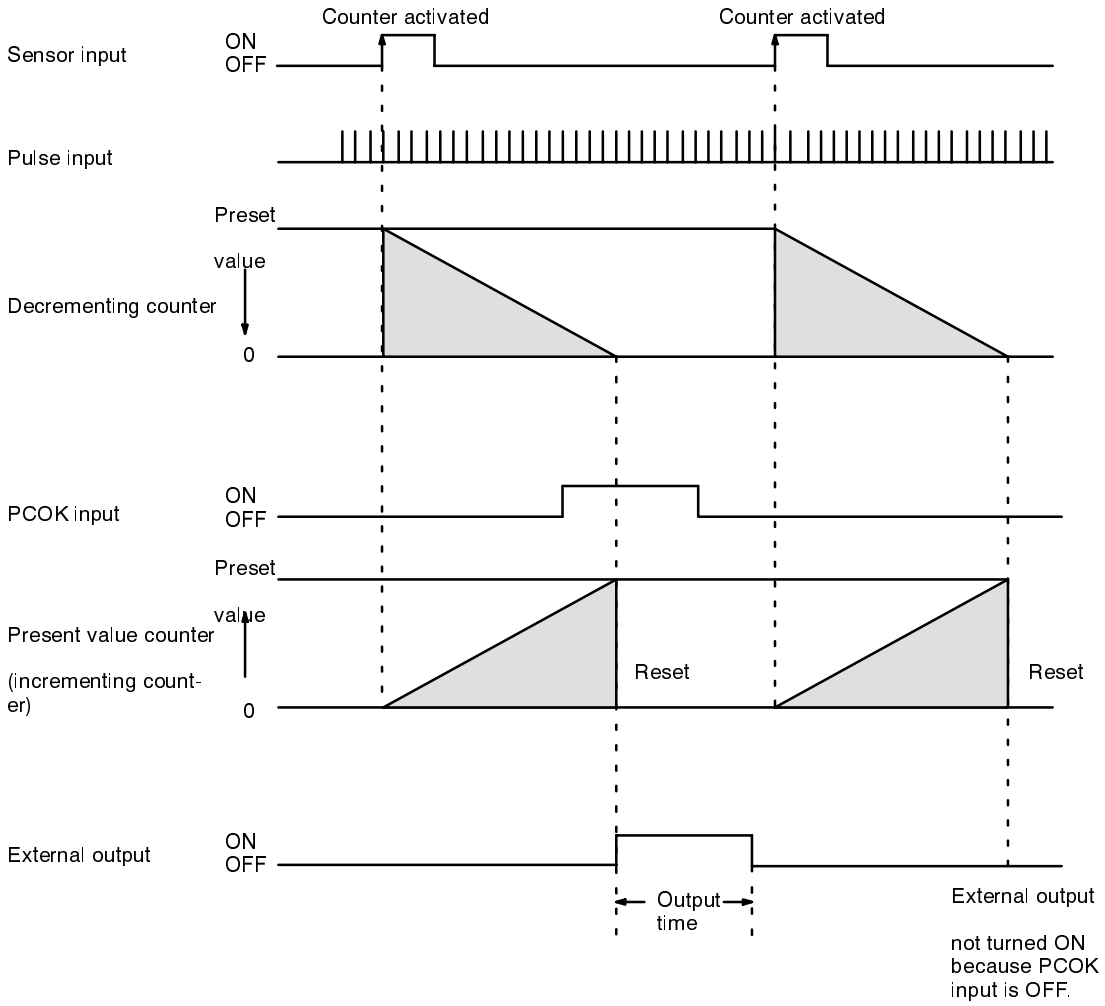


4–1–4 Preset Counter Mode 1

The counting operation is activated when the sensor input goes ON. When the preset value is counted down as a result of decrementing for each pulse input, the external output is turned ON for a specified duration as long as the PCOK input is ON. If the PCOK input is OFF, no output will be made.

When the counting operation is activated, a present value counter is also activated and increments for each pulse input. The present value is counted until it reaches the preset value and then it is reset. The present value can be read from the PC. The present value is not reset when the power supply goes off, but rather is maintained at the current present value (refer to *Section 7 Preset Counter Modes* for details).

The counter can be preset to between 1 and FFFF in hexadecimal. The same present value is used for both the decrementing and the incrementing (present value) counters. The external output can be set to go ON for between 1 and 999 ms.

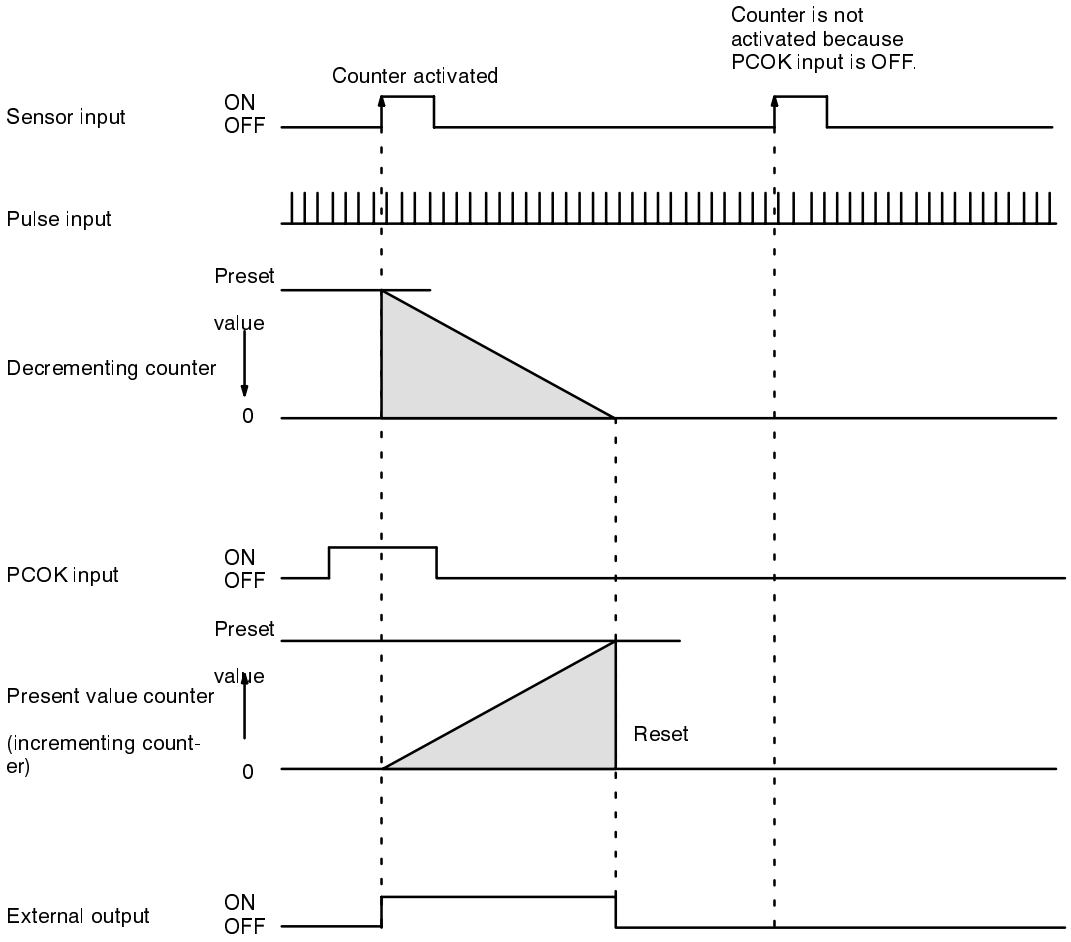


4–1–5 Preset Counter Mode 2

If the PCOK input is ON, the counting operation is activated and the external output is turned ON when the sensor input goes ON. When the preset value is counted down as a result of decrementing for each pulse input, the external output is turned OFF. If the PCOK input is OFF, the counting operation will not start.

When the counting operation is activated, a present value counter is also activated and increments for each pulse input. The present value is counted until it reaches the preset value and then it is reset. The present value can be read from the PC. The present value is not reset when the power supply goes off, but rather is maintained at the current present value (refer to *Section 7 Preset Counter Modes* for details).

The counter can be preset to between 1 and FFFF in hexadecimal. The same present value is used for both the decrementing and the incrementing (present value) counters.

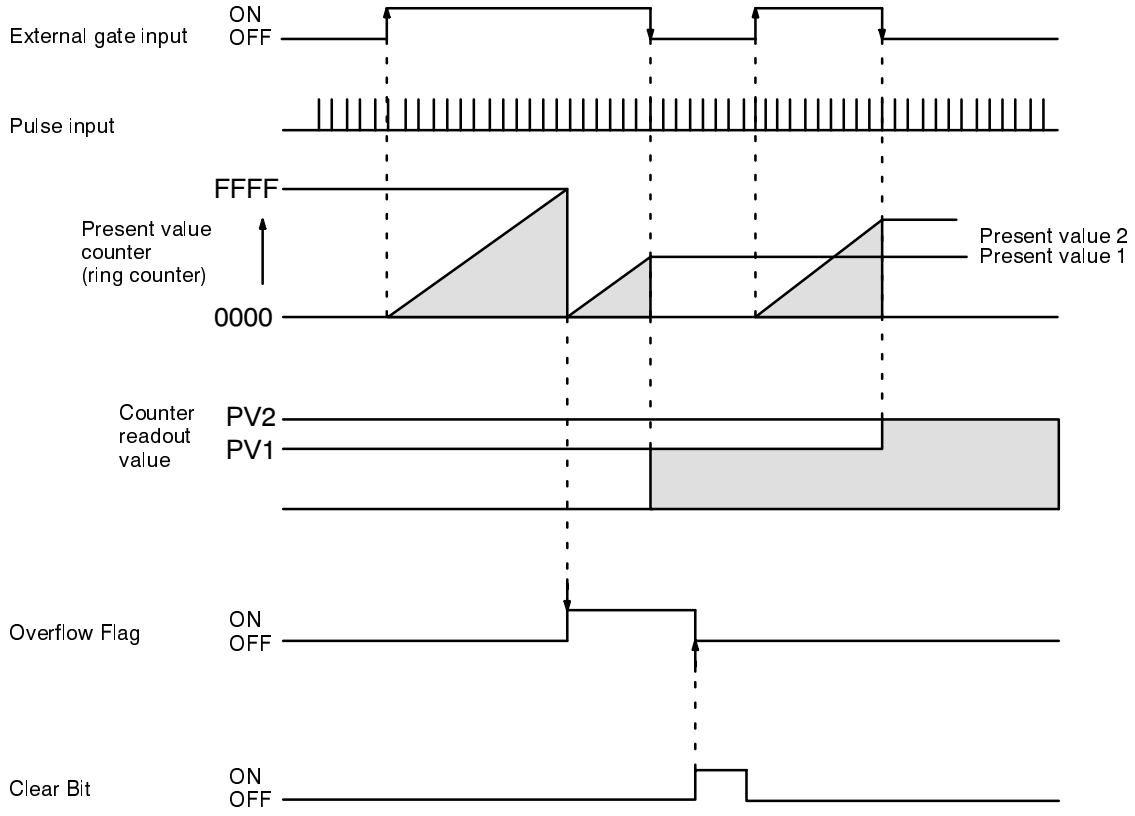


4–1–6 Gate Ring Counter Mode

As long as the the external gate input is ON, the signals on the pulse input are counted between 0 and FFFF hexadecimal. If the count exceeds FFFF, the count restarts from 0 and an Overflow Flag is turned ON. When the external gate input goes OFF, the present value is stored as the counter readout value and then the present value counter is reset to 0. The counter readout value is reset to the final present value each time the external gate input goes OFF.

The Overflow Flag is reset by turning on the Clear Bit from the PC. Each Counter channel is provided with a separate Overflow Flag and Clear Bit.

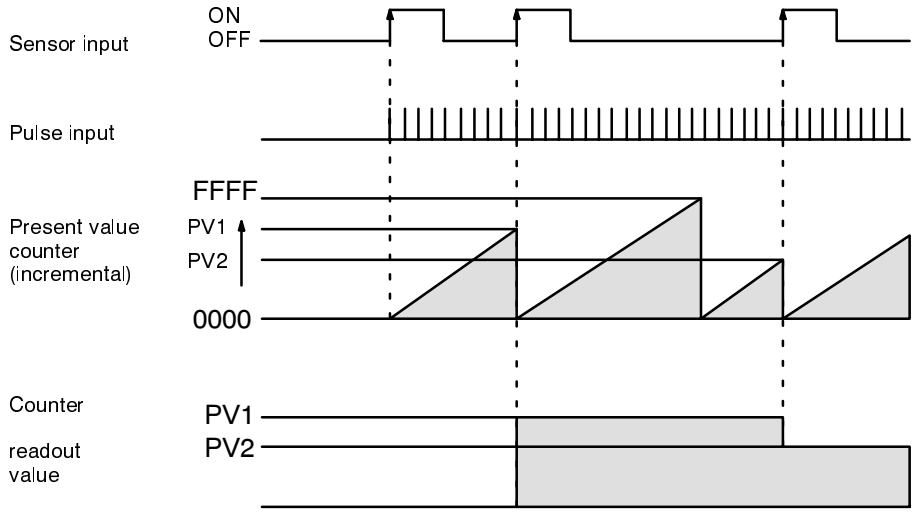
The present value can be read from the PC. The external output and PCOK input are not used in the gate ring counter mode.



4–1–7 Sampling Counter Mode

Signals on the pulse input are continuously counted as long as the Counter is turned ON. When the sensor input goes ON, the present value is stored as the counter readout value and then the present value counter is reset to 0. The counter readout value is reset to the present value each time the sensor input goes ON.

The present value counter counts to FFFF and then restarts immediately from 0. The external output and PCOK input are not used in the sampling counter mode.

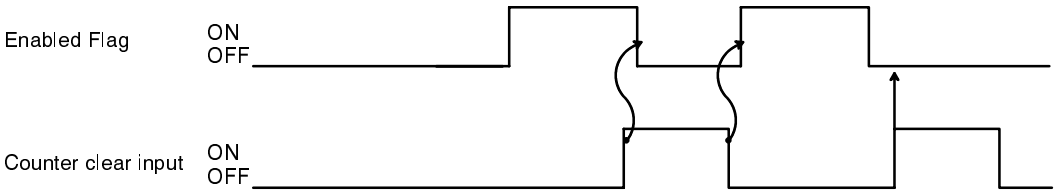


4–2 Reset Conditions

Each Counter channel can be reset by turning on its counter clear input. The clear operation works as follows:

1, 2, 3...

1. When the counter clear input goes ON, the timing/counting operation is stopped and the present value is reset. If the Overflow Flag is ON, it will be turned OFF. If the external output is ON, it will be turned OFF.
2. The counting/timing operation is initialized when the counter clear input goes OFF.
3. The operating mode or set values (including preset values) can be changed while the counter clear input is ON. If they are changed, the new values will be effective when the counter clear input is turned OFF.
4. The Enabled Flag will go OFF whenever the counter clear input is turned ON and will go ON when the counter clear input is turned OFF (unless some an error exists). The Enable Flag can thus be used in programming to check the status of the counter clear input.
5. Counting/timing operation will not be reset when the counter clear input is turned ON if the Enabled Flag is OFF (e.g., if setting errors exist).
6. Turn ON the Mode Change Bit to restart operation after the Enabled Flag turns OFF.
7. The counter clear input must be ON for at least 5 ms to be effective.



SECTION 5
Data Configuration

This section describes the methods used to transfer data and control signals to and from the High-speed Counter Unit, both directly through the IR words allocated to the Unit and indirectly from other memory area words through the I/O READ and WRITE Instructions (READ(88) and WRIT (87)). *Section 6 Preset Timer Modes*, *Section 7 Preset Counter Modes*, and *Section 8 Gate Ring and Sampling Counter Modes* provide more information about data transfer in the various Counter operating modes.

5−1 Overview 30
5−2 Data Allocation 31
5−2−1 I/O Word Allocation (IR n and IR n+1) 31
5−2−2 Allocations for I/O READ and WRITE Instructions 32
5−3 Control Procedures 34
5−4 Data Transfer Programming Examples 36

5–1 Overview

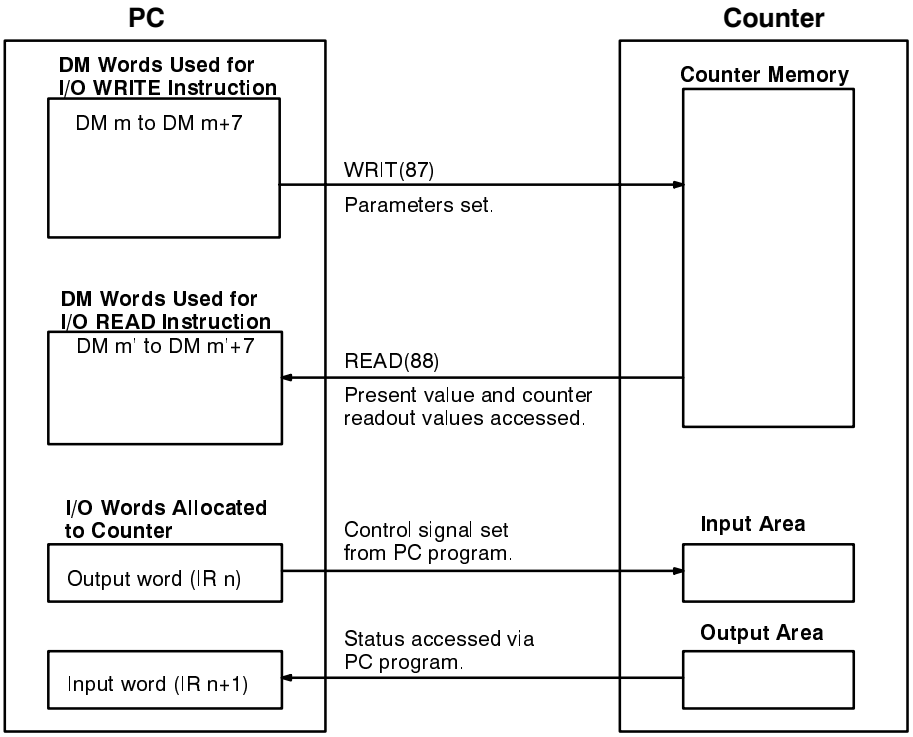
There are two methods to transfer data and control signals between the PC and counter. One is through the IR words allocated to the Counter; the other is through the I/O READ and I/O WRITE instructions.

Bits in the IR words allocated to the Counter are used to control Counter operation and to access Counter status. Because these IR words are refreshed each scan, Counter status can be accessed directly from program simply by reading the contents of the input word (designated here as IR n+1) and the Counter can be controlled directly from the program by manipulating the output word (IR n). Some bits of IR n and IR n+1 are used in relation to overall Counter operation, some are used for specific Counter channels. Details are provided in following sections for each operating mode.

Although various programming instructions can be used to achieve these tasks, the OUTPUT instruction is the most common one used to manipulate output word status and thus control the Counter, and the LOAD and MOVE instructions are the most common ones used to access Counter status from the input word.

The I/O READ instruction (READ(88)) is used read out the present value and/or counter readout value of the timer/counter. The I/O WRITE instruction (WRIT(87)) is used to set the preset values and the output time for the external output. Specific user-specified PC words are used for each Counter channel for the I/O READ and WRITE instructions. The words used in these instructions are specified in the PC program as part of the instruction and can be in any available PC memory area. In this manual DM m through DM m+7 are used for the I/O WRITE instruction and DM m' through DM m'+7 are used for the I/O READ instruction. Refer to your PC's *Operation Manual* for details on I/O word allocation, memory areas, and programming.

The following diagram illustrates data and command signal (control bit) movement between the PC and the Counter.



5–2 Data Allocation

The following subsections provide an overview of data allocations for each operating mode. Details are provided in *Sections 6* through *8*. Allocations include those for both the IR words allocated to the Counter and the words used in the I/O READ and WRITE instructions.

5–2–1 I/O Word Allocation (IR n and IR n+1)

I/O Word Allocation (IR n and IR n+1)

Word	Bit(s)	Name	Function
Output (IR n)	00	(PC busy)	These bits are used for handshaking with READ(88) and WRIT(87). Do not change the status of these bits. If writing to IR n, set these bits to 0.
	01	(PC write complete)	
	02	(PC read complete)	
	03	Not used.	
	04	Clear Bit for channel 0	These bits are used to clear the corresponding Overflow Flags. Turn ON the Clear Bit to clear the Overflow Flag for the same channel. **Note:** Used only in gate ring counter mode.
	05	Clear Bit for channel 1	
	06	Clear Bit for channel 2	
	07	Clear Bit for channel 3	
	08	Mode Change Bit for channel 0	A Mode Change Bit is set to 1 to activate a change in the operating mode. If the Mode Change Bit for any channel is 1, the mode set on the front-panel switches is read.
	09	Mode Change Bit for channel 1	
	10	Mode Change Bit for channel 2	
	11	Mode Change Bit for channel 3	
	12	Parameter Change Bit for channel 0	A Parameter Change Bit is set to 1 to activate a change in a preset value and/or output time. These bits are set to actually initiate changes in the parameters after WRIT(88) has been used to transfer new parameters. **Note:** Not used in gate ring mode or sampling mode.
	13	Parameter Change Bit for channel 1	
	14	Parameter Change Bit for channel 2	
	15	Parameter Change Bit for channel 3	
Input (IR n+1)	00	(Counter busy)	These bits are used for handshaking with READ(88) and WRIT(87).
	01	(Counter read complete)	
	02	(Counter write complete)	
	03	Not used.	
	04	WDT (watchdog timer) Error Flag	The WDT Flag will go ON when an error occurs in the Counter.
	05	Battery Low Flag	The Battery Low Flag will go ON when the battery voltage drops indicating that the battery needs replaced.
	06	Reading Flag	The Reading Flag will be ON whenever any of the Mode Change Bits or Parameter Change Bits is ON (IR n, bits 08 to 15). The Reading Flag will be OFF when all of these bits are OFF.
	07	Not used.	
	08	Enabled Flag for channel 0	An Enable Flag will be ON whenever the Counter can be used. Counter operation will be disabled for any channel whose bit is OFF.
	09	Enabled Flag for channel 1	
	10	Enabled Flag for channel 2	
	11	Enabled Flag for channel 3	
	12	Overflow Flag for channel 0	An Overflow Flag will turn ON when the present value exceeds FFFF in gate ring counter mode. The Overflow Flags can be reset via the Clear Bits (see above). **Note:** Used only in gate ring counter mode.
	13	Overflow Flag for channel 1	
	14	Overflow Flag for channel 2	
	15	Overflow Flag for channel 3	

5–2–2 Allocations for I/O READ and WRITE Instructions

The following tables shows the use of each DM word used for data transfer with READ(88) and WRIT(87) for each operating mode. Details are described in following sections. Remember, DM m and DM m' may be any available words in PC memory and do not necessarily need to be in the DM area.

Mode	DM m (channel 0)	DM m+1 (channel 1)	DM m+2 (channel 2)	DM m+3 (channel 3)	DM m+4 (channel 0)	DM m+5 (channel 1)	DM m+6 (channel 2)	DM m+7 (channel 3)
Preset Timer 1	Preset time				Output time for external output			
Preset Timer 2	Preset time				Not used.			
Preset Counter 1	Preset count				Output time for external output			
Preset Counter 2	Preset count				Not used.			
GateRing Counter	Not used.							
Sampling Counter	Not used.							

Mode	DM m' (channel 0)	DM m'+1 (channel 1)	DM m'+2 (channel 2)	DM m'+3 (channel 3)	DM m'+4 (channel 0)	DM m'+5 (channel 1)	DM m'+6 (channel 2)	DM m'+7 (channel 3)
Preset Timer 1	Not used.							
Preset Timer 2	Not used.							
Preset Counter 1	Present counter value				Not used.			
Preset Counter 2	Present counter value				Not used.			
GateRing Counter	Present count value				Counter readout value (value saved last time external gate input went OFF)			
Sampling Counter	Counter readout value (value saved last time sensor input went ON)				Not used.			

Preset Timer Modes 1 and 2

Words for I/O WRITE Instructions

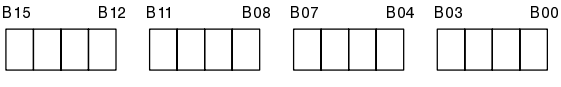
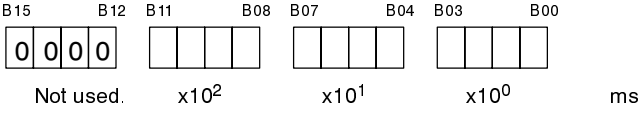
Word	Counter channel	Description
DM m	0	Contain preset times in BCD to be written to the Counter. Used in both modes 1 and 2.
DM m+1	1	B15 B12 B11 B08 B07 B04 B03 B00 0 0 0 0
DM m+2	2	20 kHz Not used. $x10^2$ $x10^1$ $x10^0$ ms 2 kHz Not used. $x10^0$ $x10^{-1}$ $x10^{-2}$ s
DM m+3	3	Preset times can be between 1 and 999 ms for a 20-kHz clock and between 0.01 and 9.99 s for a 2-kHz clock.
DM m+4	0	Contain the output time in BCD for the external output for preset timer mode 1.
DM m+5	1	B15 B12 B11 B08 B07 B04 B03 B00 0 0 0 0
DM m+6	2	Not used. $x10^2$ $x10^1$ $x10^0$ ms
DM m+7	3	Output times can be between 1 and 999 ms.

Words for I/O READ Instructions

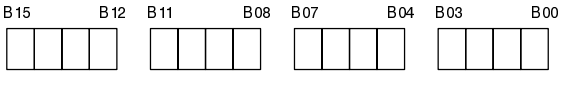
Data readout with the I/O READ instruction is not used for these operating modes. If data is read out, it will not be dependable.

Preset Counter Modes 1 and 2

Words for I/O WRITE Instructions

Word	Counter channel	Description
DM m	0	Contain preset counts in hexadecimal to be written to the Counter in both modes 1 and 2.
DM m+1	1	
DM m+2	2	
DM m+3	3	
DM m+4	0	Contain the output time in BCD for the external output for preset counter mode 1.
DM m+5	1	
DM m+6	2	
DM m+7	3	Output times can be between 1 and 999 ms (–50/+5ms).

Words for I/O READ Instructions

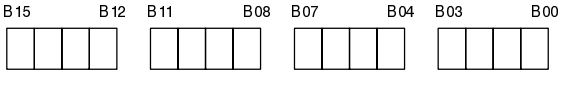
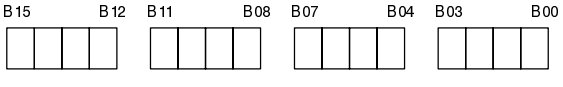
Word	Counter channel	Description
DM m'	0	Used to read out the present value of the counter in preset counter modes 1 and 2. The value read out will be between 0000 and FFFF in hexadecimal. The allocation of specific bits within each word are the same for each Counter channel.
DM m'+1	1	
DM m'+2	2	
DM m'+3	3	

Gate Ring Counter and Sampling Counter Modes

Words for I/O WRITE Instructions

The I/O WRITE instruction is not used for these operating modes.

Words for I/O READ Instructions

Word	Counter channel	Description
DM m'	0	**Gate Ring Counter Mode:** Used to read out the present value. **Sampling Counter Mode:** Used to read out the counter readout value, i.e., the present value stored the last time the sensor input went ON.
DM m'+1	1	
DM m'+2	2	
DM m'+3	3	The value read out will be between 0000 and FFFF in hexadecimal.
DM m'+4	0	**Gate Ring Counter Mode:** Used to read out the counter readout value, i.e., the present value stored the last time the external gate input went OFF.
DM m'+5	1	
DM m'+6	2	
DM m'+7	3	The value read out will be between 0000 and FFFF in hexadecimal.

5–3 Control Procedures

The procedures to set Counter operating parameters and start Counter operations are give below. Procedures are also given for changing the operating mode and for changing parameters. Refer to *8–3 Overflow Flags and Clear Bits* for the procedure to reset the Overflow Flags using the Clear Bits.

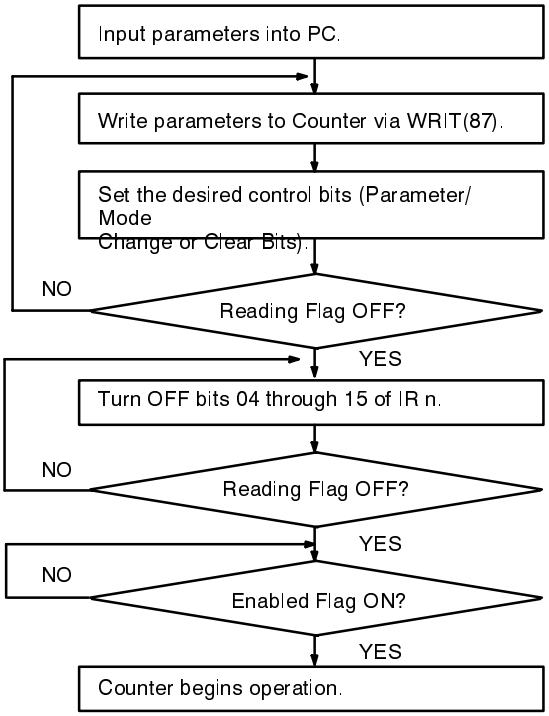
Basic Startup Procedure

The following procedure can be used to initialize Counter operation. The flowchart below the procedure illustrates it.

1, 2, 3...

1. Set the operating mode for each Counter channel on switches SW1 through SW4 on the front panel. If any channel is not going to be used, set it to an OFF position. Refer to *Section 2 Hardware Components and Switch Settings* to set the switches.
2. Write the parameters (preset values, output time, etc.) required for the operating modes being used into PC memory using the program or a Programming Console. Programming Console operations can be found in your PC *Operation Manual*.
3. Use WRIT(87) to write to the Counter any parameter required by the operating modes that are being used.
4. Turn ON the Mode Change Bits for all channels to initialize the operating modes and the parameters. The Change Mode Bits must be used whenever a mode is used for the first time to enable operation. Operation will not be possible if the Parameter Change Bits are used.

   When the Mode Change Bits turn ON, the Counter will turn ON the Reading Flag to indicate that the modes and parameters are being read.
5. Confirm that the Reading Flag went ON to double check Counter operation, turn OFF all control bits in IR n (bits 04 through 15), and then confirm that the Enabled Flag is ON to be sure that settings are okay and that Counter operation is possible. If the Enabled Flag is ON when all of the control bits are turned OFF, the Counter will start operation. The Enabled Flag will be ON as long as the counter clear input is OFF and all operating parameters are set properly.



Changing Operating Modes

The operating modes can be changed at any time by using the Mode Change Bits. The Mode Change Bits are also used to restart operation if the Enabled Flags go ON. Use the following procedure

1, 2, 3...

1. Input the proper parameters into the memory area as required by the new modes.
2. Write the data into the Counter using WRIT(87).
3. Turn ON the Mode Change Bit for the channels being changed. When the Counter detects that any of the Mode Change Bits are ON, it will turn ON the Reading Flag and read in the new modes and parameters.
4. After confirming the the Reading Flag went ON, turn OFF the Mode Change Bits. Operation will not start if any of these bits are ON.

Caution Although the operating mode can be changed during Counter operation, all outputs will be turned OFF and all inputs will be ignored while the Mode Change Bits are ON.

Changing Parameters

Operating parameters can be changed during operation and will be effective as soon as the Counter detects that the Parameter Change Bit is ON. The procedure is given below. Refer to *Section 6 Preset Timer Modes* and *Section 7 Preset Counter Modes* for details on external output operation when operating parameters are changed during operation.

1, 2, 3...

1. Input the new parameters into the memory area as required by the operating modes.
2. Write the data into the Counter using WRIT(87).
3. Turn ON the Parameter Change Bit for the channels being changed. When the Counter detects that any of the Parameter Change Bits are ON, it will turn ON the Reading Flag and read in the parameters. The new parameters will be effective immediately.
4. After confirming the the Reading Flag went ON, turn OFF the Parameter Change Bits.

Caution When setting the operating mode for the first time, always use the Mode Change Bits. The Counter will not operate if only the Parameter Change Bits are used.

Clear Bit Operation

The Clear Bits are used to clear the Overflow Flags in gate ring counter mode. Refer to *8–3 Overflow Flags and Clear Bits* for details.

Restarting Operation

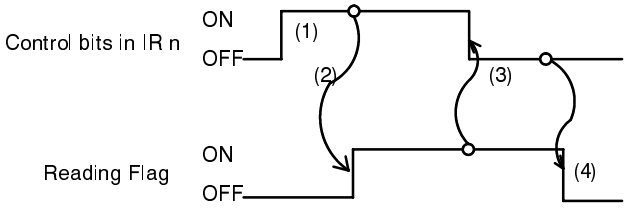
Operation will not restart automatically when the Enabled Flag goes OFF for one or more bits. To restart any channel after its Enabled Flag goes ON, use the Mode Change Bit as described on the previous page.

Flag and Control Bit Timing

The timing of the control bits in IR n (bits 04 though 15) in relation to the Reading Flag (bit 6 of IR n+1) is described and illustrated next. The numbers in the following procedure correspond to those in the illustration.

1, 2, 3...

1. A control bit is turned ON from the PC program.
2. When the Counter detects that a control bit has been turned ON, it turns ON the Reading Flag.
3. Check that the Reading Flag went ON and then turn OFF all control bits.
4. When the Counter detects that all control bits have gone OFF, it will turn OFF the Reading Flag.



Caution The status of the control bits (Clear Bits, Mode Change Bits, and Parameter Change Bits) are not read while the Reading Flag is ON. Write the PC program to manipulate these bits so that they will not interfere with each other.

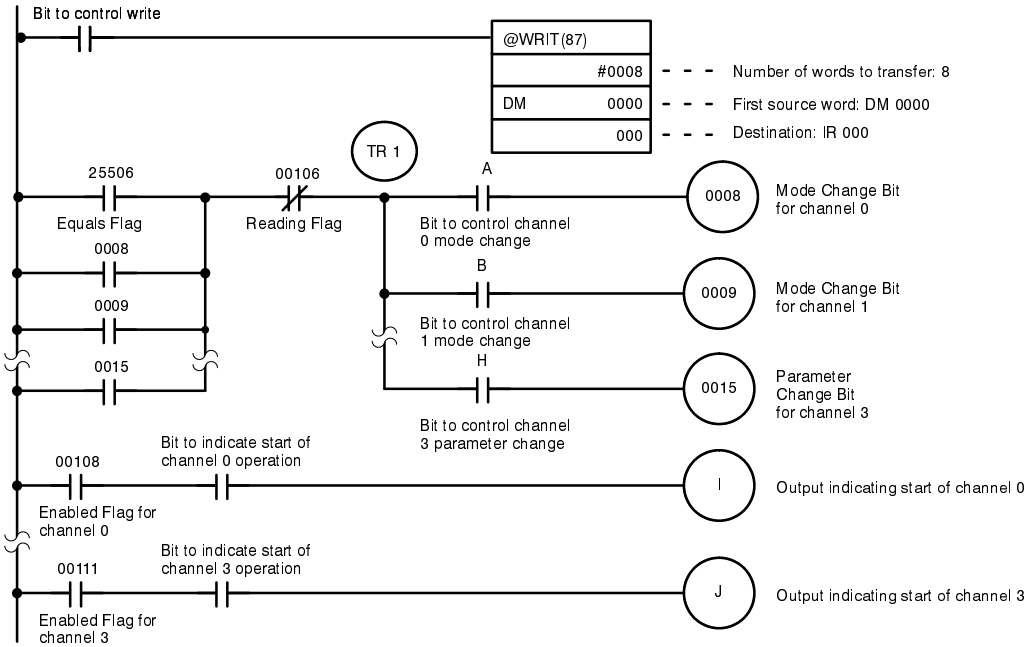
5–4 Data Transfer Programming Examples

Setting Data

The first program example transfers data to the Counter and is for a C1000H PC. The program assumes that the Counter is allocated IR 000 and IR 001. Parts of the program have been left out ( ). Once input, the program works as follows:

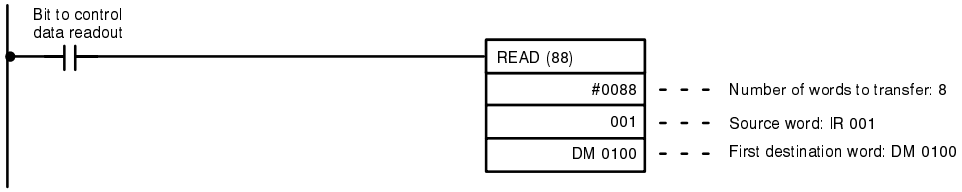
1, 2, 3...

1. Any of the bits A through H are turned on to indicate the modes or parameters to be changed.
2. When the bit to control writing to the Counter is turned ON, the data in DM 0000 through DM 0007 is written into the Counter.
3. When @WRIT(87) is executed, the Equals Flag comes ON and the control bits for the desired actions are activated.
4. When the Reading Flag comes ON, all control bits are reset.
5. When the Enabled Flags come ON, Counter operation is started.



Data Readout

The next program example reads data from the Counter and is for a C1000H PC. The program assumes that the Counter is allocated IR 000 and IR 001. When the bit controlling readout is turned ON, eight words of data is read from the Counter and transferred to DM 0100 through DM 0107.



SECTION 6
Preset Timer Modes

This section provides details on the operation of preset timer modes 1 and 2. Switch settings are provided in *Section 2 Hardware Components and Switch Settings*.

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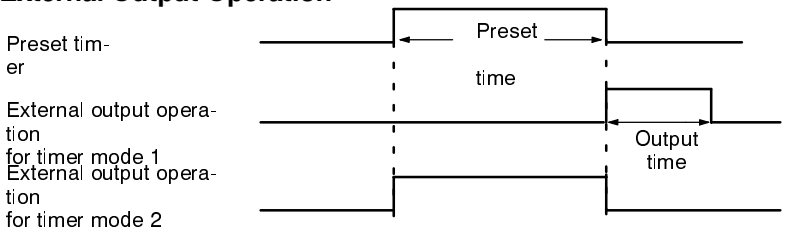
6–1 Signals

The following signals are used with the the preset timer modes.

Signal	Functions	
Internal clock signal	Clock signals are counted to produce timer operations. Either a 2- or 20-kHz clock can be used. The clock frequency is determined by the mode switch setting.	
PCOK input	Used to enable and disable the timer or external output. If the PCOK input is OFF, operation is disabled. This input must be ON for the timer to operate properly.	
Sensor input	Used to activate the timer.	
Counter clear input	Used to initialize the timer.	
External output (see diagram below)	Preset timer mode 1	Turns ON for the specified output time when the preset time has expired.
	Preset timer mode 2	Turns ON when the timer is activated and then turns ON then the preset time has expired.

External Output Operation



6–2 Memory Area Allocations

The following data must be input into a memory area of the PC and then transferred to the Counter using the I/O WRITE instruction (WRIT(87)). All data must be in BCD. If a value not allowed in BCD is input, the Enabled Flag will go OFF and Counter operation will not be possible.

Accuracies for timer and output time values do not include ON/OFF delays.

Data readout with the I/O READ instruction is not used with the preset timer modes. If data is read out, it will not be dependable.

Words for I/O WRITE Instructions

Word	Counter channel	Description
DM m	0	Contain preset times to be written to the Counter. Used in both modes 1 and 2. Set values must be between 00 and 999 in BCD. A setting of 0 is considered to be a setting of 1. The allocation of specific bits within each word are the same for each Counter channel. The actual contents depend on the clock used, as shown below.
DM m+1	1	B15 B12 B11 B08 B07 B04 B03 B00 Set B12 to B15 to 0.
DM m+2	2	20 kHz Not used. $x10^2$ $x10^1$ $x10^0$ ms 2 kHz Not used. $x10^0$ $x10^{-1}$ $x10^{-2}$ s
DM m+3	3	Preset times can thus be between 1 and 999 ms (–50/+5ms) for a 20-kHz clock and between 0.01 and 9.99 s (–500/+5ms) for a 2-kHz clock.
DM m+4	0	Contain the output times for the external outputs for preset timer mode 1. Set values must be between 00 and 999 in BCD. A setting of 0 is considered to be a setting of 1. The allocation of specific bits within each word are the same for each Counter channel.
DM m+5	1	B15 B12 B11 B08 B07 B04 B03 B00 Set B12 to B15 to 0. 0 0 0 0
DM m+6	2	Not used. $x10^2$ $x10^1$ $x10^0$ ms
DM m+7	3	Output times can thus be between 1 and 999 ms (–50/+5ms).

I/O Word Allocation (IR n and IR n+1)

The following IR bits can be used to control Timer operation and access Timer status. Refer to *Section 5 Data Configuration* for details on operation.

Word	Bit(s)	Name	Function
Output (IR n)	00	(PC busy)	These bits are used for handshaking with READ(88) and WRIT(87). Do not change the status of these bits. If writing to IR n, set these bits to 0.
	01	(PC write complete)	
	02	(PC read complete)	
	03 to 07	Not used in this operating mode.	The status of these bits must be 0.
	08	Mode Change Bit for channel 0	A Mode Change Bit is set to 1 to activate a change in the operating mode. If the Mode Change Bit for any channel is 1, the mode set on the front-panel switches is read.
	09	Mode Change Bit for channel 1	
	10	Mode Change Bit for channel 2	
	11	Mode Change Bit for channel 3	
	12	Parameter Change Bit for channel 0	A Parameter Change Bit is set to 1 to activate a change in a preset value and/or output time. These bits are set to actually initiate changes in the parameters after WRIT(88) has been used to transfer new parameters.
	13	Parameter Change Bit for channel 1	
	14	Parameter Change Bit for channel 2	
	15	Parameter Change Bit for channel 3	
Input (IR n+1)	00	(Timer busy)	These bits are used for handshaking with READ(88) and WRIT(87).
	01	(Timer read complete)	
	02	(Timer write complete)	
	03	Not used.	
	04	WDT (watchdog timer) Error Flag	The WDT Flag will go ON when an error occurs in the Counter.
	05	Battery Low Flag	The Battery Low Flag will go ON when the battery voltage drops indicating that the battery needs replaced.
	06	Reading Flag	The Reading Flag will be ON whenever any of the Mode Change Bits or Parameter Change Bits is ON (IR n, bits 08 to 15). The Read Flag will be OFF when all of these bits are OFF.
	07	Not used.	
	08	Enabled Flag for channel 0	An Enable Flag will be ON whenever the Counter can be used. Counter operation will be disabled for any channel whose bit is OFF. If an Enabled Flag is OFF, the external output will be turned OFF and all inputs will be ignored.
	09	Enabled Flag for channel 1	
	10	Enabled Flag for channel 2	
	11	Enabled Flag for channel 3	
	12 to 15	Not used in this operating mode.	

6–3 Changing Operating Modes and Parameters

Both the operating mode and parameters for any channel can be changed before or during operation. Details are provided in *5–3 Control Procedures*.

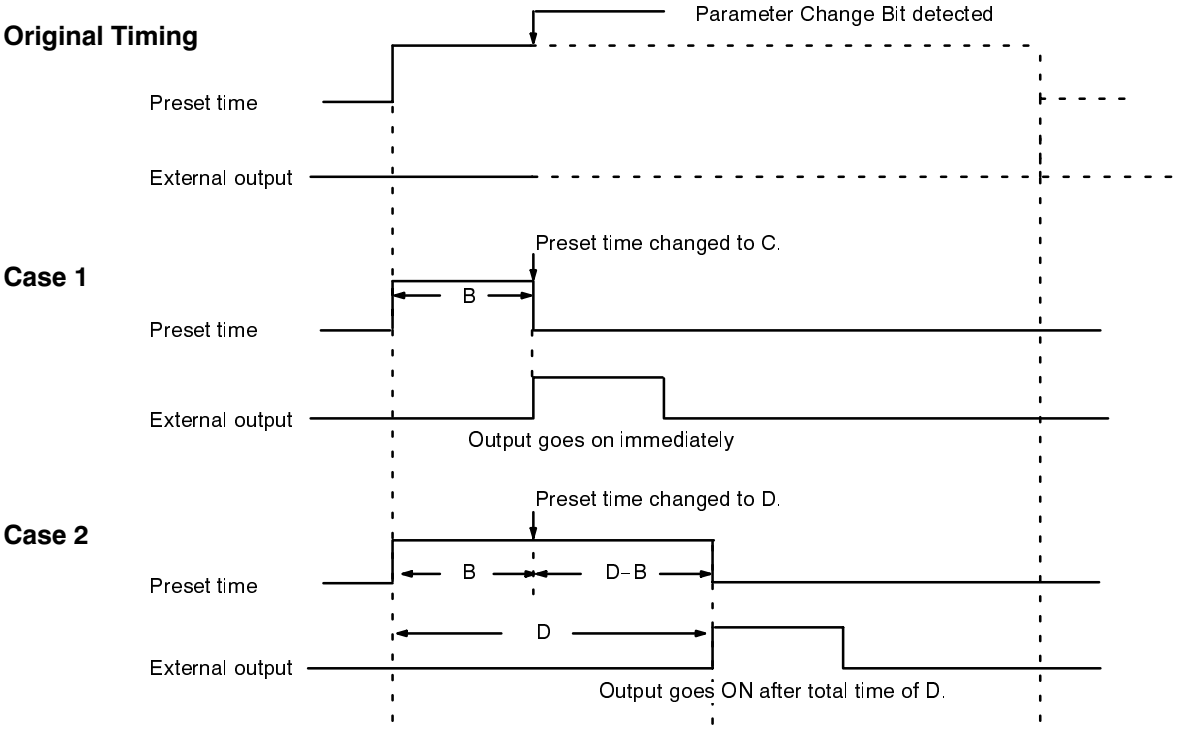
The following timing chart illustrates the operation of the external outputs when the preset values are changed during operation for preset timer mode 1. The following conditions are assumed for this timing chart.

1, 2, 3...

1. The original preset time is A.
2. The time B has elapsed from the beginning of the timing operation before the Parameter Change Bit is detected as ON by the Counter.
3. The preset time is changed to either C (case 1) or D (case 2).
4. A > D > B > C

In other words, case 1 assumes that the preset time is changed to a time less than the time that has expired before the change is made. Case 2 assumes that the present time is changed to a time greater than the time that has expired before the change is made.

As you can see, if the new preset time has already expired when it is changed, the output operates immediately. If the new preset time has not yet expired, the output operates according to the new preset time starting from the point at which the original timing operation started.



The operation of the external output for changes to the preset time in preset timer mode 2 and the operation of the external output for changes in the output time in preset timer mode 1 follow the same logic as shown in this example.

6–4 I/O Signal Timing

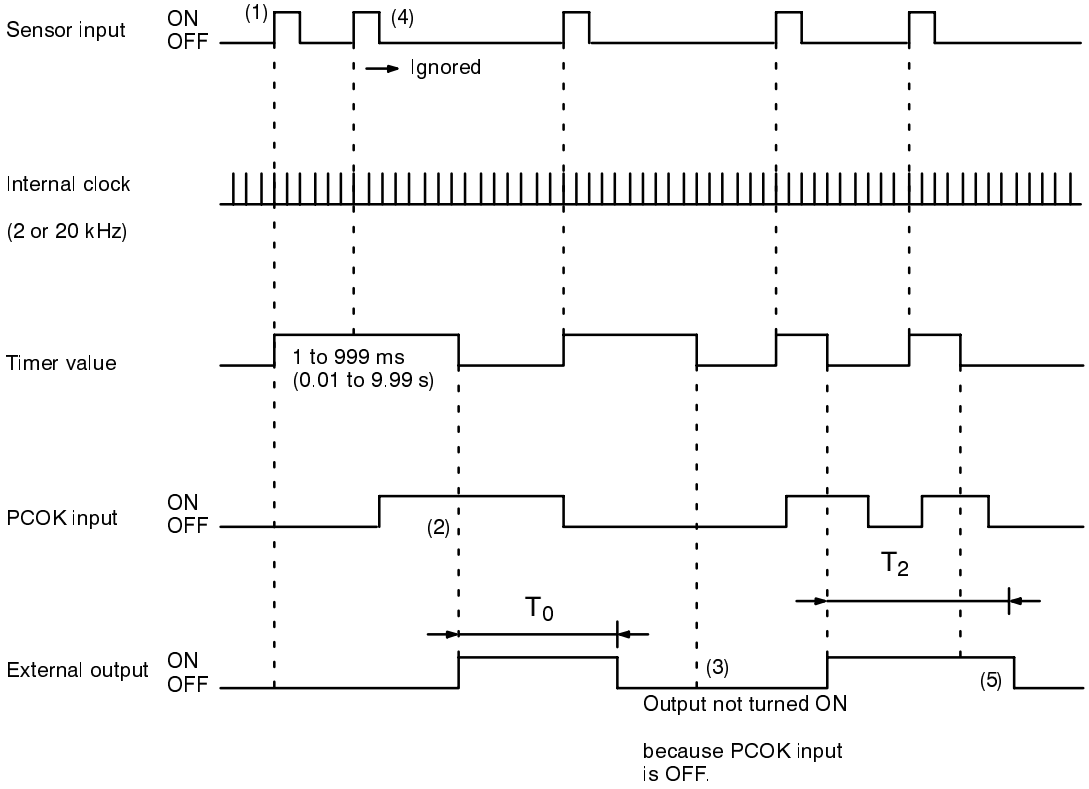
The following timing charts illustrate the relationships between inputs and outputs for preset timer modes 1 and 2.

6–4–1 Preset Timer Mode 1

The numbered sections of the timing chart indicate the following:

1, 2, 3...

1. Timer operation begins when sensor input goes ON.
2. If the PCOK input is ON when the preset time expires, the external output is turned ON for the specified output time T_0.
3. If the PCOK input is OFF when the preset time expired, the external output remains OFF.
4. If the sensor input turns ON when the timer operation is in progress, the signal is ignored.
5. If the timer operation is reactivated and the preset time expires before the output time expires, the external output will not be reactivated, but will turn OFF as normal for the first timer operation.

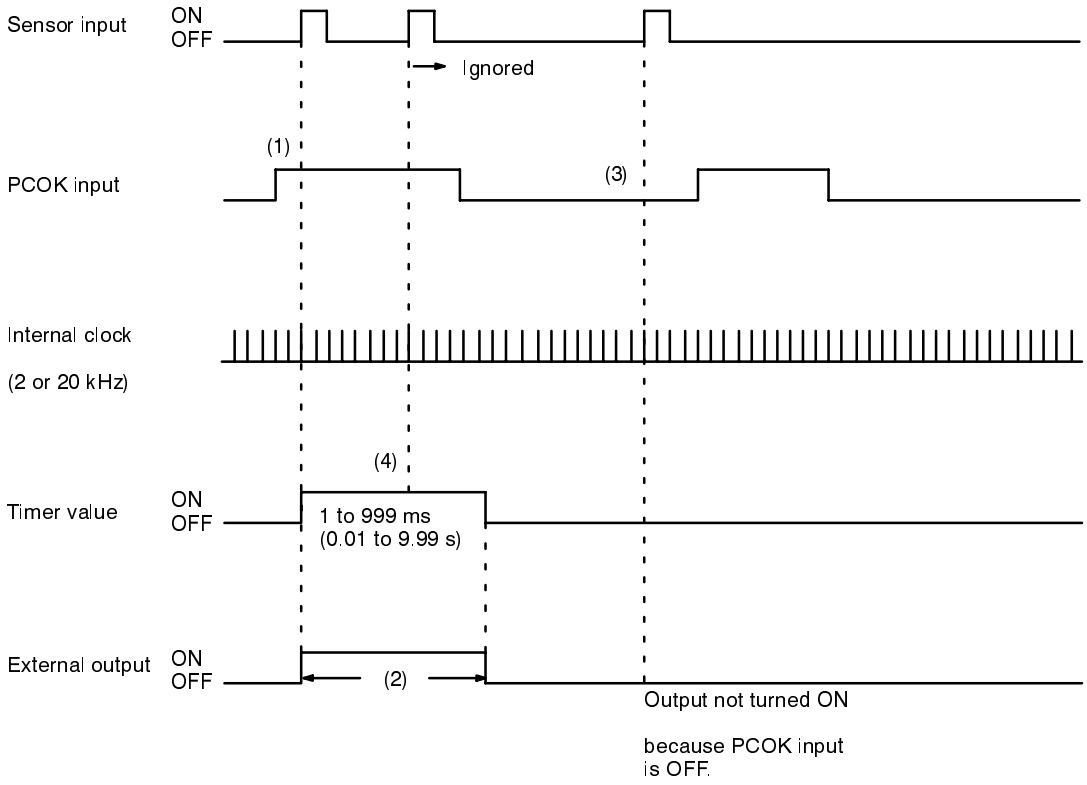


6–4–2 Preset Timer Mode 2

The numbered sections of the timing chart indicate the following:

1, 2, 3...

1. If the PCOK input is ON when the sensor input goes ON, the timer operation is started.
2. The external output turns ON as soon as the timer operation starts and remains ON until the preset time expires.
3. If the PCOK input is OFF when the sensor input goes ON, the sensor input is ignored and the timer operation is not started.
4. If the sensor input turns ON when the timer operation is in progress, the signal is ignored.



SECTION 7
Preset Counter Modes

This section provides details on the operation of preset counter modes 1 and 2. Switch settings are provided in *Section 2 Hardware Components and Switch Settings*.

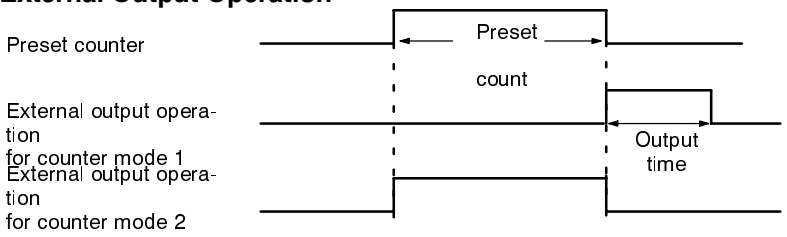
7–1 Signals 46
7–2 Memory Area Allocations 46
7–3 Changing Operating Modes and Parameters 48
7–4 I/O Signal Timing 49
7–4–1 Preset Counter Mode 1 49
7–4–2 Preset Counter Mode 2 50

7–1 Signals

The following signals are used with the the preset counter modes.

Signal	Functions	
PCOK input	Used to enable and disable the counter or external output. If the PCOK input is OFF, operation is disabled. This input must be ON for the counter to operate properly.	
Sensor input	Used to activate the counter.	
Counter clear input	Used to initialize the counter.	
External pulse input	Counted in counter operation	
External output (see diagram below)	Preset counter mode 1	Turns ON for the specified output time when the preset count has expired.
	Preset counter mode 2	Turns ON when the counter is activated and then turns OFF when the preset count has expired.

External Output Operation

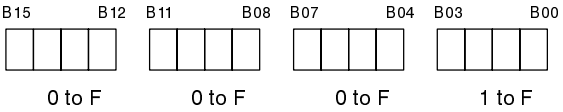
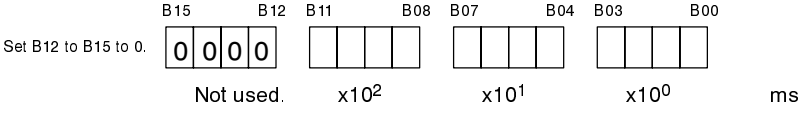


7–2 Memory Area Allocations

Words for I/O WRITE Instructions

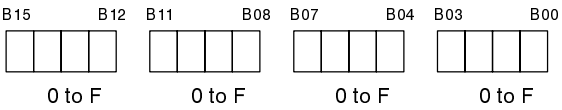
The following data must be input into a memory area of the PC and then transferred to the Counter using the I/O WRITE instruction (WRIT(87)). The output time is required only for preset counter mode 1. The preset count value is input in hexadecimal; the output time for the external output in BCD. If a value not allowed in BCD is input for the output time, the Enabled Flag will go OFF and Counter operation will not be possible.

Accuracy for the output time does not include ON/OFF delays.

Word	Counter channel	Description
DM m	0	Contain preset counts to be written to the Counter. Used in both modes 1 and 2. Set values must be between 0000 and FFFF in hexadecimal. A setting of 0 is considered to be a setting of 1. The allocation of specific bits within each word are the same for each Counter channel.
DM m+1	1	
DM m+2	2	
DM m+3	3	
DM m+4	0	Contain the output times for the external outputs for preset counter mode 1. Set values must be between 000 and 999 in BCD. A setting of 0 is considered to be a setting of 1. The allocation of specific bits within each word are the same for each Counter channel.
DM m+5	1	
DM m+6	2	
DM m+7	3	Output times can thus be between 1 and 999 ms (–50/+5ms).

Words for I/O READ Instructions

The following data is read into the PC using the I/O READ instruction (READ(88)). The present value is updated in the Counter every 10 ms. If the power supply is interrupted, the last present value is maintained in memory.

Word	Channel	Description
DM m'	0	Used to read out the present value of the counter in preset counter modes 1 and 2. The value read out will be between 0000 and FFFF in hexadecimal. The allocation of specific bits within each word are the same for each Counter channel. 
DM m'+1	1	
DM m'+2	2	
DM m'+3	3	

I/O Word Allocation (IR n and IR n+1)

The following IR bits are used to control Counter operation and access Counter status. Refer to *Section 5 Data Configuration* for operational details.

Word	Bit(s)	Name	Function
Output (IR n)	00	(PC busy)	These bits are used for handshaking with READ(88) and WRIT(87). Do not change the status of these bits. If writing to IR n, set these bits to 0.
	01	(PC write complete)	
	02	(PC read complete)	
	03 to 07	Not used in this operating mode.	The status of these bits must be 0.
	08	Mode Change Bit for channel 0	A Mode Change Bit is set to 1 to activate a change in the operating mode. If the Mode Change Bit for any channel is 1, the mode set on the front-panel switches is read.
	09	Mode Change Bit for channel 1	
	10	Mode Change Bit for channel 2	
	11	Mode Change Bit for channel 3	
	12	Parameter Change Bit for channel 0	A Parameter Change Bit is set to 1 to activate a change in a preset value and/or output time. These bits are set to actually initiate changes in the parameters after WRIT(88) has been used to transfer new parameters.
	13	Parameter Change Bit for channel 1	
	14	Parameter Change Bit for channel 2	
	15	Parameter Change Bit for channel 3	
Input (IR n+1)	00	(Counter busy)	These bits are used for handshaking with READ(88) and WRIT(87).
	01	(Counter read complete)	
	02	(Counter write complete)	
	03	Not used.	
	04	WDT (watchdog timer) Error Flag	The WDT Flag will go ON when an error occurs in the Counter.
	05	Battery Low Flag	The Battery Low Flag will go ON when the battery voltage drops indicating that the battery needs replaced.
	06	Reading Flag	The Reading Flag will be ON whenever any of the Mode Change Bits or Parameter Change Bits is ON (IR n, bits 08 to 15). The Read Flag will be OFF when all of these bits are OFF.
	07	Not used.	
	08	Enabled Flag for channel 0	An Enable Flag will be ON whenever the Counter can be used. Counter operation will be disabled for any channel whose bit is OFF. If an Enabled Flag is OFF, the external output will be turned OFF and all inputs will be ignored.
	09	Enabled Flag for channel 1	
	10	Enabled Flag for channel 2	
	11	Enabled Flag for channel 3	
	12 to 15	Not used in this operating mode.	

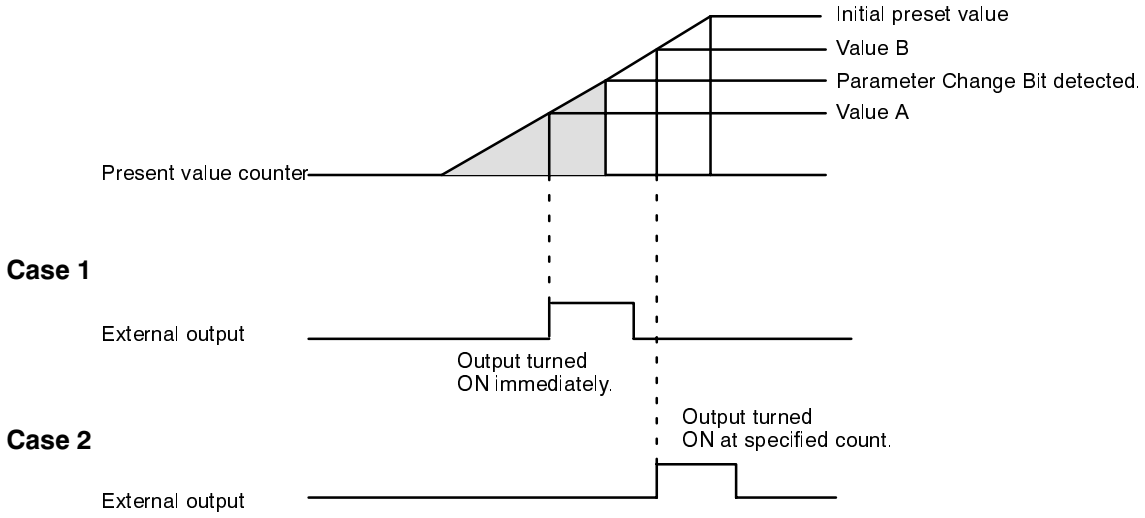
7–3 Changing Operating Modes and Parameters

Both the operating mode and parameters for any channel can be changed before or during operation. Details are provided in *5–3 Control Procedures*.

When a new preset value is written to the Counter and the Parameter Change Bit is turned ON, the Counter will begin operating with the new value as soon as the ON status of the Parameter Change Bit is detected. This is illustrated in the following timing chart for preset counter mode 1.

1, 2, 3...

1. The counter operation is started with an initial preset value.
2. If the preset value is changed to a count below the present value (e.g., to value A in the timing chart), the external output will turn ON immediately as shown (case 1).
3. If the preset value is changed to a count above the present value (e.g., to value B in the timing chart), the external output will turn ON when the present value counter reaches the new preset value (case 2).



The operation of the external output for changes to the preset count in preset counter mode 2 follow the same logic as shown in this example. The operation of the external output for changes in the output time in preset counter mode 1 work just like those for preset timer mode 1 (see *6–3 Changing Operating Modes and Parameters* for details).

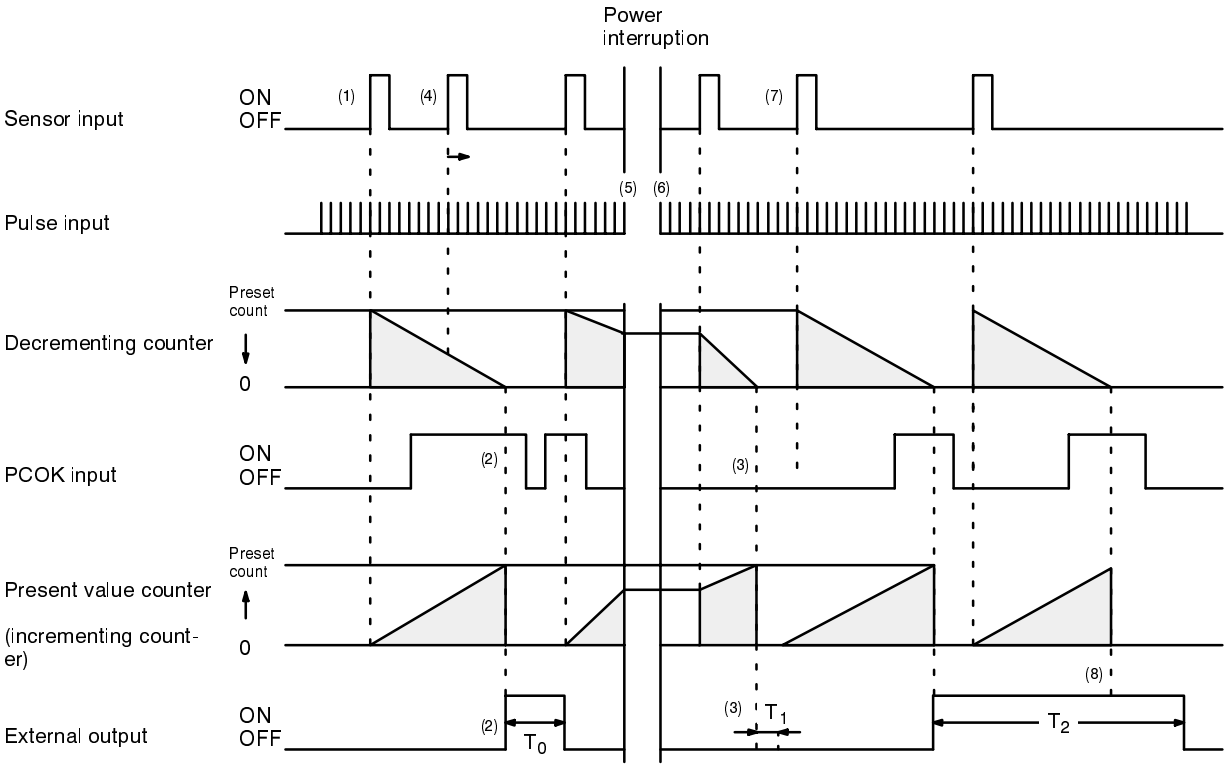
7–4 I/O Signal Timing

The following timing charts illustrate the relationships between inputs and outputs for preset counter modes 1 and 2.

7–4–1 Preset Counter Mode 1

The numbered sections of the timing chart indicate the following:

1, 2, 3... 1. Counter operation begins when sensor input goes ON.
2. If the PCOK input is ON when the preset count expires, the external output is turned ON for the specified output time T_0.
3. If the PCOK input is OFF when the preset count expired, the external output remains OFF.
4. If the sensor input turns ON when the counter operation is in progress, the signal is ignored.
5. If power is interrupted during operation, the present value is stored.
6. When power comes back on, the present value is restored.
7. The Counter continues operation when the sensor input turns ON.
8. If the counter operation is reactivated and the preset count expires before the output time expires, the external output will not be reactivated, but will turn OFF as normal for the first counter operation.

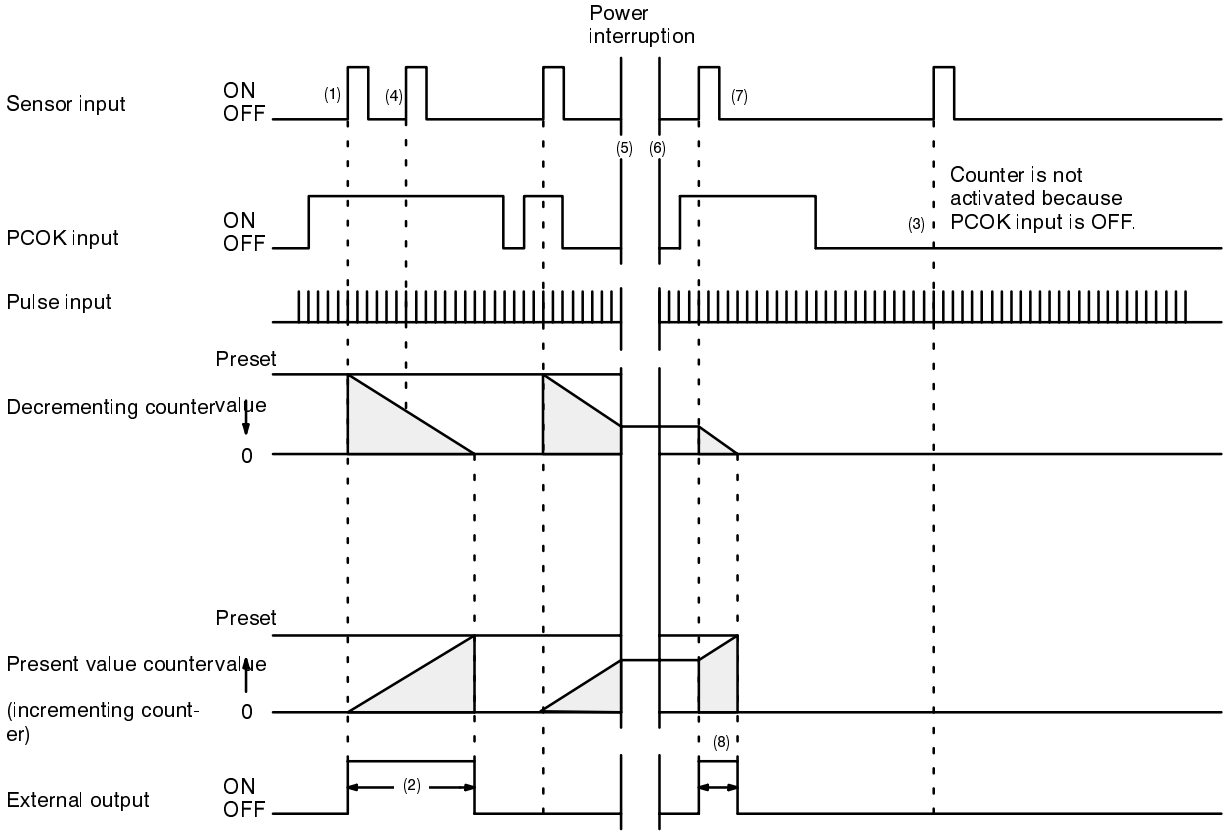


7–4–2 Preset Counter Mode 2

The numbered sections of the timing chart indicate the following:

1, 2, 3...

1. If the PCOK input is ON when the sensor input goes ON, the counter operation is started.
2. The external output turns ON as soon as the counter operation starts and remains ON until the preset time expires.
3. If the PCOK input is OFF when the sensor input goes ON, the sensor input is ignored and the counter operation is not started.
4. If the sensor input turns ON when the counter operation is in progress, the signal is ignored.
5. If power is interrupted during operation, the present value is stored.
6. When power comes back on, the present value is restored.
7. The Counter continues operation when the sensor input turns ON, assuming that the PCOK input is ON.
8. The external output will be ON whenever the counter operation is activated.



SECTION 8
Measurement Modes

This section provides details on the operation of the gate ring counter and sampling modes. Switch settings are provided in *Section 2 Hardware Components and Switch Settings.*

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8−2 Memory Area Allocations 52
8−3 Overflow Flags and Clear Bits 54
8−4 Changing Operating Modes 54
8−5 I/O Signal Timing 55
8−5−1 Gate Ring Counter Mode 55
8−5−2 Sampling Counter Mode 56

8–1 Signals

The following signals are used with the the preset counter modes.

Signal	Functions
Sensor input*	Used to activate the sampling counter.
External gate input*	Used to activate the gate ring counter.
Counter clear input	Used to initialize the counter.
External pulse input	Counted in counter operation

*Physically, the sensor input and the external gate input are the same.

8–2 Memory Area Allocations

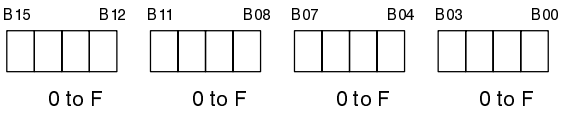
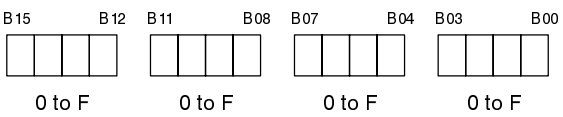
No data needs to be transferred to the Counter and the I/O WRITE instruction is not used for these operating modes.

Words for I/O READ Instructions

The following data is read into the PC using the I/O READ instruction (READ(88)). Both the counter readout value and the present value are read out in gate ring counter mode. Only the counter readout value is read out in sampling mode; the present value is not accessible. The present value is updated in the Counter every 10 ms.

If the power supply is interrupted, the last present value and the last counter readout value are maintained in memory.

If the power present value reaches FFFF for any channel, the Overflow Flag for that channel will turn ON and the counter will automatically restart counting from 0.

<table>
<tr><th>Word</th><th>Counter channel</th><th>Description</th></tr>
<tr><td>DM m’</td><td>0</td><td>Gate Ring Counter Mode: Used to read out the present value.
Sampling Counter Mode: Used to read out the counter readout value, i.e., the present value stored the last time the sensor input went ON.
The value read out will be between 0000 and FFFF in hexadecimal. The allocation of specific bits within each word are the same for each Counter channel.</td></tr>
<tr><td>DM m’+1</td><td>1</td><td rowspan="3"> 
</td></tr>
<tr><td>DM m’+2</td><td>2</td></tr>
<tr><td>DM m’+3</td><td>3</td></tr>
<tr><td>DM m’+4</td><td>0</td><td>Gate Ring Counter Mode: Used to read out the counter readout value, i.e., the present value stored the last time the external gate input went OFF.
The value read out will be between 0000 and FFFF in hexadecimal. The allocation of specific bits within each word are the same for each Counter channel.</td></tr>
<tr><td>DM m’+5</td><td>1</td><td rowspan="3"> 
</td></tr>
<tr><td>DM m’+6</td><td>2</td></tr>
<tr><td>DM m’+7</td><td>3</td></tr>
</table>

I/O Word Allocation (IR n and IR n+1)

The following IR bits are used to control Counter operation and access Counter status. Refer to *Section 5 Data Configuration* for operational details.

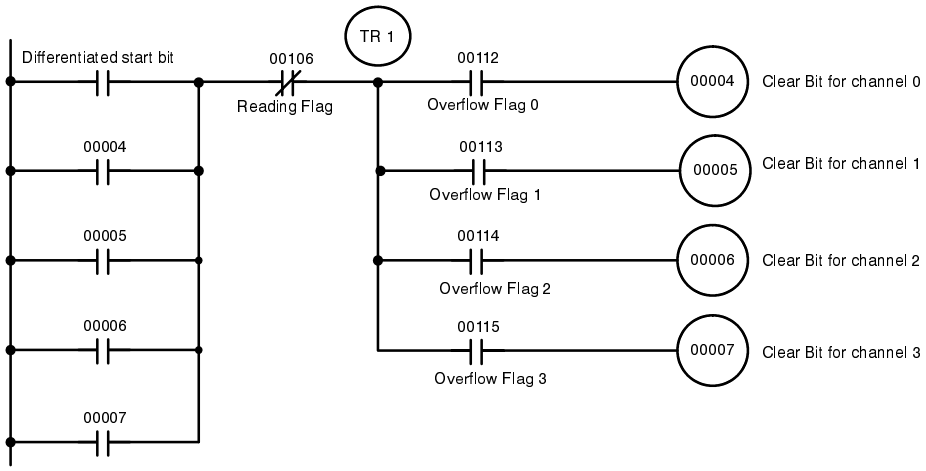
Word	Bit(s)	Name	Function
Output (IR n)	00	(PC busy)	These bits are used for handshaking with READ(88) and WRIT(87). Do not change the status of these bits. If writing to IR n, set these bits to 0.
	01	(PC write complete)	
	02	(PC read complete)	
	03	Not used.	
	04	Clear Bit for channel 0	These bits are used to clear the corresponding Overflow Flags. Turn ON the Clear Bit to clear the Overflow Flag for the same channel. **Note:** These bits are not used in sampling counter mode.
	05	Clear Bit for channel 1	
	06	Clear Bit for channel 2	
	07	Clear Bit for channel 3	
	08	Mode Change Bit for channel 0	A Mode Change Bit is set to 1 to activate a change in the operating mode. If the Mode Change Bit for any channel is 1, the mode set on the front-panel switches is read.
	09	Mode Change Bit for channel 1	
	10	Mode Change Bit for channel 2	
	11	Mode Change Bit for channel 3	
	12 to 15	Not used in these modes.	Leave these bits set to 0.
Input (IR n+1)	00	(Counter busy)	These bits are used for handshaking with READ(88) and WRIT(87).
	01	(Counter read complete)	
	02	(Counter write complete)	
	03	Not used.	
	04	WDT (watchdog timer) Error Flag	The WDT Flag will go ON when an error occurs in the Counter.
	05	Battery Low Flag	The Battery Low Flag will go ON when the battery voltage drops indicating that the battery needs replaced.
	06	Reading Flag	The Reading Flag will be ON whenever any of the Mode Change Bits or Parameter Change Bits is ON (IR n, bits 08 to 15). The Read Flag will be OFF when all of these bits are OFF.
	07	Not used.	
	08	Enabled Flag for channel 0	An Enable Flag will be ON whenever the Counter can be used. Counter operation will be disabled for any channel whose bit is OFF.
	09	Enabled Flag for channel 1	
	10	Enabled Flag for channel 2	
	11	Enabled Flag for channel 3	
	12	Overflow Flag for channel 0	An Overflow Flag will turn ON when the present value exceeds FFFF in gate ring counter mode. The Overflow Flags can be reset via the Clear Bits (see above). **Note:** These bits are not used in sampling counter mode.
	13	Overflow Flag for channel 1	
	14	Overflow Flag for channel 2	
	15	Overflow Flag for channel 3	

8–3 Overflow Flags and Clear Bits

When the present value counter exceeds FFFF for a channel in the gate ring counter mode, the Overflow Flag for that channel will turn ON. These flags can be cleared using the Clear Bits in IR n, bits 04 to 07 (bits IR 00004 through IR 00007 in the example below).

To reset the Overflow Flag in gate ring counter mode, turn ON the Clear Bit for the channel to be reset. When the Counter detects that any of the Clear Bits are ON, it will turn ON the Reading Flag until all of the Clear Bits are OFF.

The following programming example shows how to use the Clear Bits to turn OFF the Overflow Flags. The program is written for a C1000H PC and assumes that the Counter is allocated IR 000 and IR 001.



8–4 Changing Operating Modes

The operating mode for any channel can be changed before or during operation. Details are provided in *5–3 Control Procedures*.

8–5 I/O Signal Timing

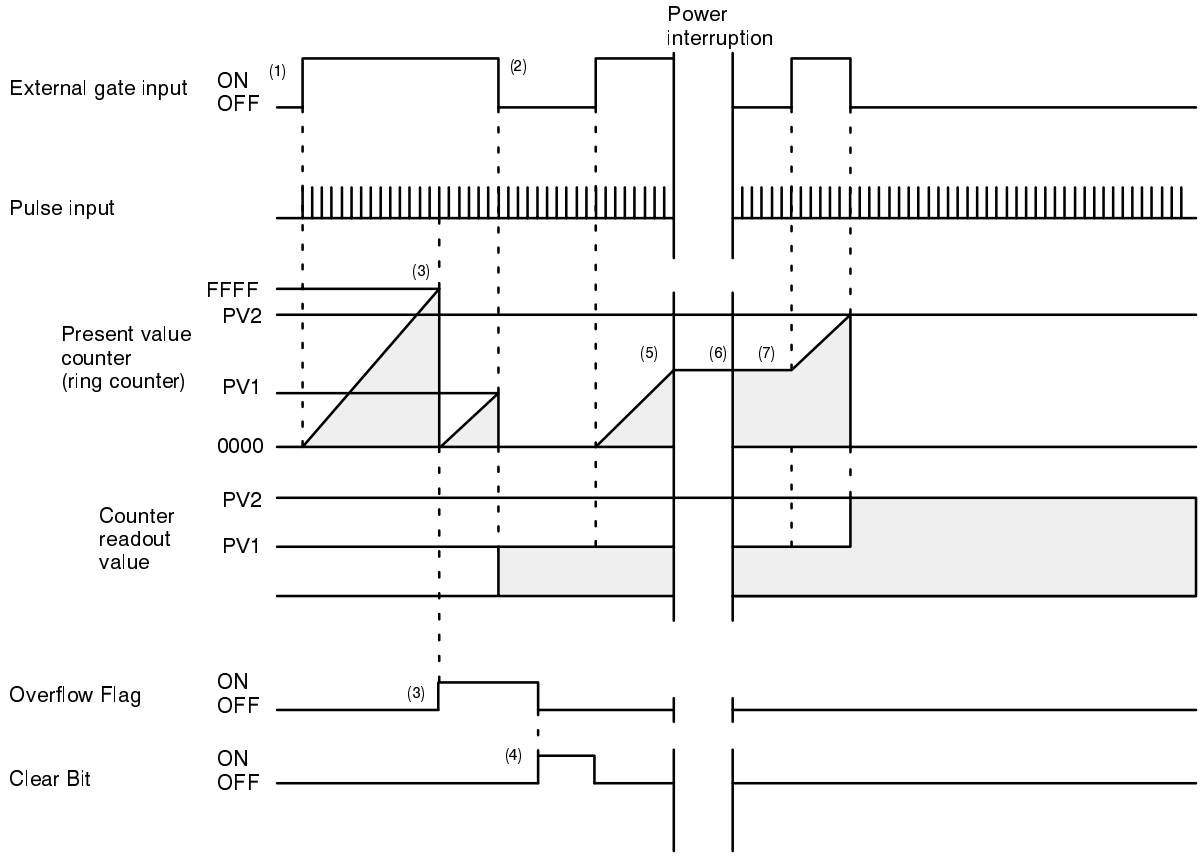
The following timing charts illustrate the relationships between inputs and outputs for the gate ring counter and sampling counter modes.

8–5–1 Gate Ring Counter Mode

The numbered sections of the timing chart indicate the following:

1, 2, 3...

1. Counter operation begins when external gate input goes ON.
2. When the external gate input goes OFF, the present value is stored as the counter readout value and the present value counter is reset.
3. If the present value exceeds FFFF, the Overflow Flag will turn ON and the present value counter immediately starts counting again from 0.
4. The Overflow Flag is turned OFF when the corresponding Clear Bit is turned ON by the PC.
5. If power is interrupted during operation, the present value and counter readout value are stored.
6. When power comes back on, the present value and counter readout value are restored.
7. The Counter continues operation when the gate input turns ON.

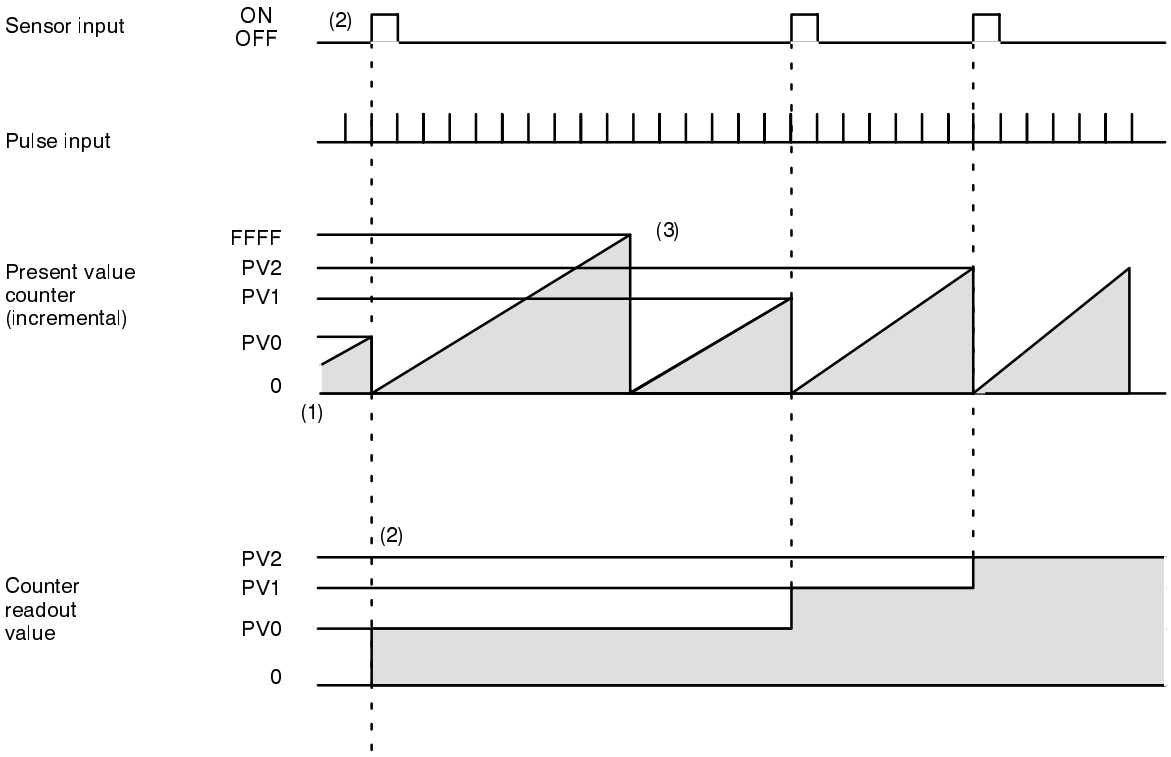


8–5–2 Sampling Counter Mode

The numbered sections of the timing chart indicate the following:

1, 2, 3...

1. The counter continuously counts pulses.
2. When the sensor input comes ON, the present value of the counter is stored as the counter readout value.
3. When the present value exceeds FFFF, the present value counter immediately starts counting again from 0.



Note The sampling counter mode does not activate the Overflow Flags and does not support the external output. The present value cannot be accessed from the PC.

SECTION 9
Applications Examples

This section provides examples of system setups, PC processing, Counter settings, and operation for most of the Counter operating modes. Only details of the applications are provided. Refer to earlier sections of this manual for operational details for the Counter

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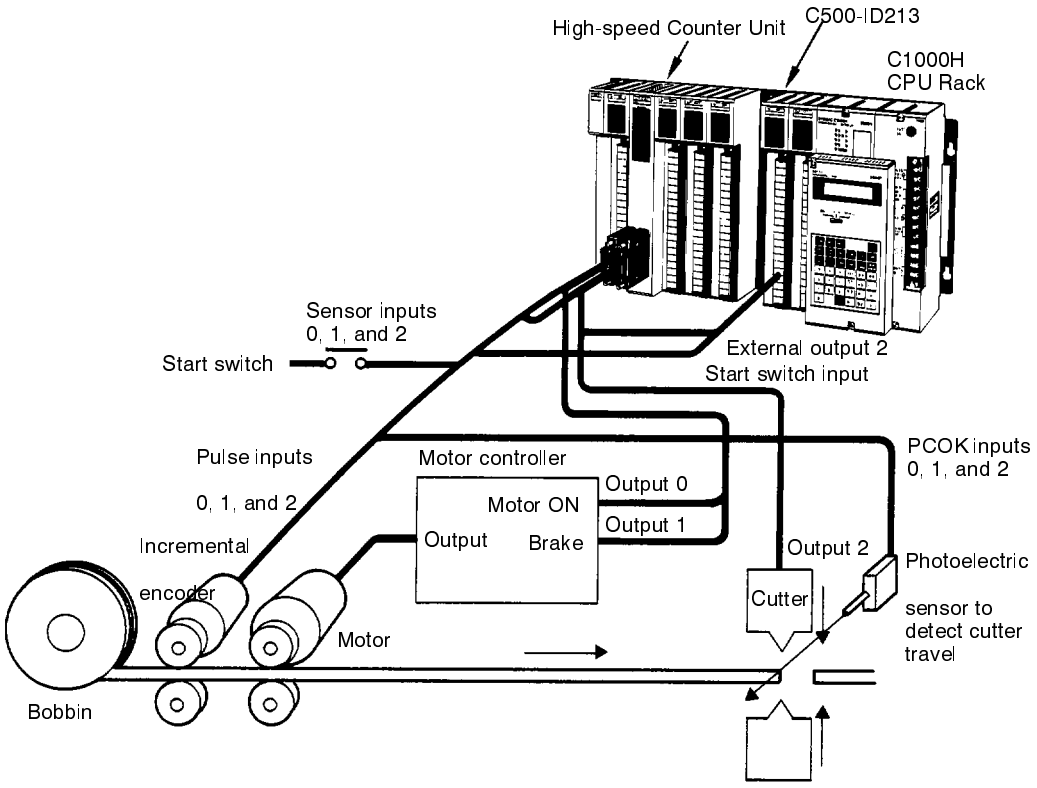
9–1 Preset Counter Modes 1 and 2

This example shows how one High-speed Counter Unit can be used to provide two counters in present counter mode 2 and one counter in preset counter mode 1 to feed, measure, and cut wire.

9–1–1 System Setup

A C1000H CPU Rack equipped with a High-speed Counter Unit allocated IR 000 and IR 001 and a 3G2A5-ID213 DC Input Unit allocated IR 005 are set up as shown below.



9–1–2 Wiring

The following wiring is required.

1, 2, 3...

1. The start switch is wired to sensor inputs 0, 1, and 2 and to the terminals for bit 09 on the DC Input Unit.
2. The output from the incremental encoder is wired to external pulse inputs 0, 1, and 2.
3. The photoelectric switch detecting cutter travel is wired to PCOK inputs 0, 1, and 2.
4. External output 0 is wired to the motor's ON terminal; external output 1 is wired to the motor's brake; and external output 2 is wired to activate the cutter. External output 2 is also wired to the terminals for bit 10 on the DC Input Unit.

9–1–3 Mode Settings

The mode switches are set as follows:

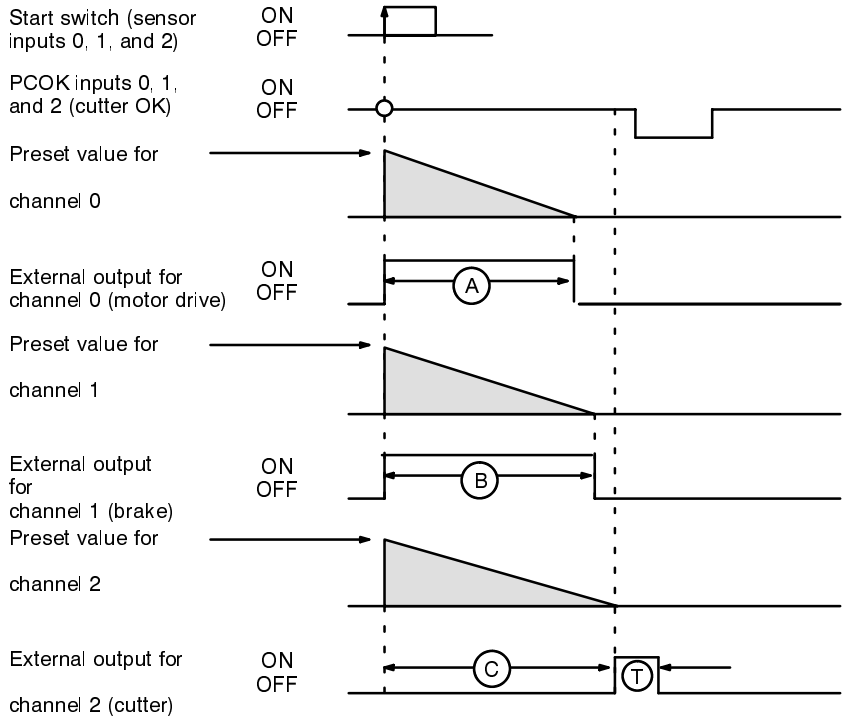
Switch	Channel	Physical setting	Operating mode
SW1	0	5	Preset counter mode 2
SW2	1	5	Preset counter mode 2
SW3	2	4	Preset counter mode 1
SW4	3	Any value 8 to F	Disabled

9–1–4 Operation

The various input and outputs used in this setup are shown in the following timing chart. The operation works as follows:

1, 2, 3... 1. When the start switch is pressed, sensor inputs 0, 1, and 2 turn ON and, if the cutter travel sensor (PCOK inputs 0, 1, and 2) is OFF, the motor and counters are started and the brake is turned OFF. If the cutter travel sensor is ON, operation is not begun and the brake remains ON.
2. The motor is turned OFF before the target position to allow for inertia.
3. The brake is turned ON just before the target position.
4. When the target position is reached, the cutter is activated.

The preset counts A, B, and C plus the output time T must be input into the PC and written to the Counter (see *9–1–5 Data Preparations*).



9–1–5 Data Preparations

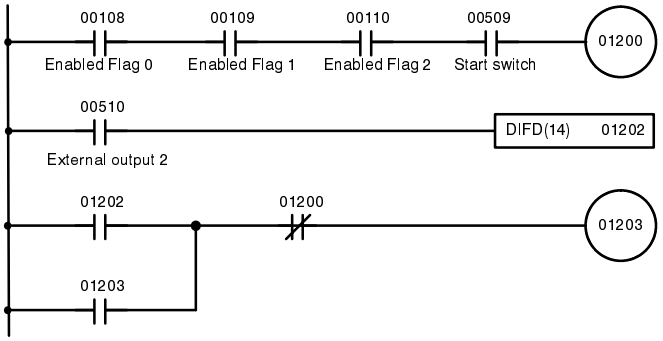
The following data must be input into the PC in advance using a Programming Console, writing from within the program, etc.

Word	Contents	Form	Setting	Application
DM 0000	9900	Hexadecimal	9900 counts	A (length of motor drive)
DM 0001	9950	Hexadecimal	9950 counts	B (length for turning OFF brake)
DM 0002	A000	Hexadecimal	A000 counts	C (length until cutter is activated)
DM 0006	0500	BCD	500 ms	T (time period for cutter activation)

9–1–6 Programming

The following program section is used to control operation. The first output, IR 01200, turns ON when operation has started as indicated by IR 00509, which is controlled indirectly by the start switch through the DC Input Unit.

The last output, IR 01203 turns ON to provide an external signal that the cutting operation has been completed. This bit is controlled by IR 01200 from the first instruction line (indicating that the operation has started) and by IR 01202, which is controlled by IR 00510. IR 00410 is controlled indirectly by the Counter's external output 2, which also activates the cutter.

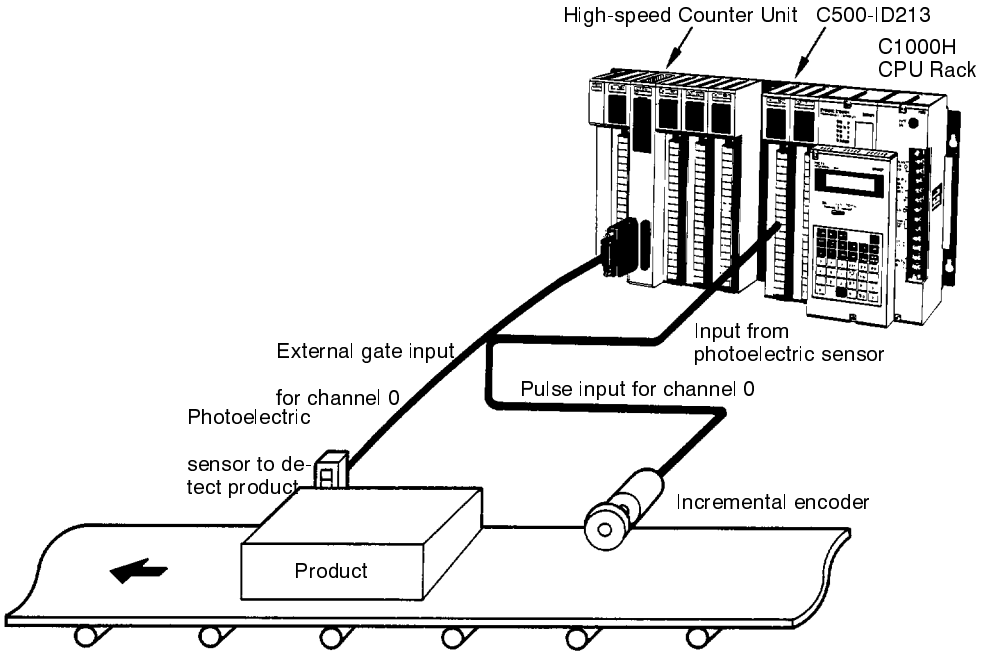


9–2 Gate Ring Counter Mode

This example shows how one High-speed Counter Unit can be used to measure the lengths of products passing by on a conveyor belt using the gate ring counter mode.

9–2–1 System Setup

A C1000H CPU Rack equipped with a High-speed Counter Unit allocated IR 000 and IR 001 and a 3G2A5-ID213 DC Input Unit allocated IR 005 are set up as shown below.



9–2–2 Wiring

The following wiring is required.

1, 2, 3... 1. The output from the incremental encoder is wired to the external pulse input 0.
2. The photoelectric sensor detecting the product is wired to the external gate input and to the terminals for bit 10 on the DC Input Unit.

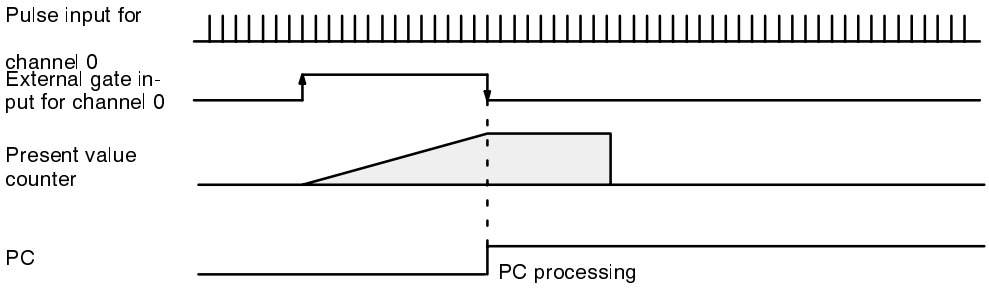
9–2–3 Mode Settings

The mode switches are set as follows:

Switch	Channel	Physical setting	Operating mode
SW1	0	6	Gate ring counter mode
SW2	1	Any value 8 to F	Disabled
SW3	2	Any value 8 to F	Disabled
SW4	3	Any value 8 to F	Disabled

9–2–4 Operation

While the photoelectric sensor detects the product, the pulses input from the incremental encoder are counted. When the photoelectric sensor goes OFF, the gate input to the Counter goes OFF and the counter readout value transferred to the PC is processed to determine if the dimension is with specifications.



9–2–5 Data Preparations

Although it is not necessary to write data to the Counter, the following words are set aside to read out the counter values.

Word	Contents	Form	Setting	Application
DM 0096	Anything	NA	NA	When READ(88) is used to access the counter readout value for channel 0, five words must be accessed. The first four words are not used, but cannot be used for anything else.
DM 0097				
DM 0098				
DM 0099				
DM 0100	Counter readout	Hexadecimal	NA	Used to hold the counter readout value.

The following words are used to hold the comparison values and subtraction results used to determine if the product length is within the desired limits. The upper and lower limits would need to be input in advance.

Word	Form	Contents
DM 0010	Hexadecimal	Lower limit
DM 0011	Hexadecimal	Upper limit
DM 0012	Hexadecimal	Subtraction results

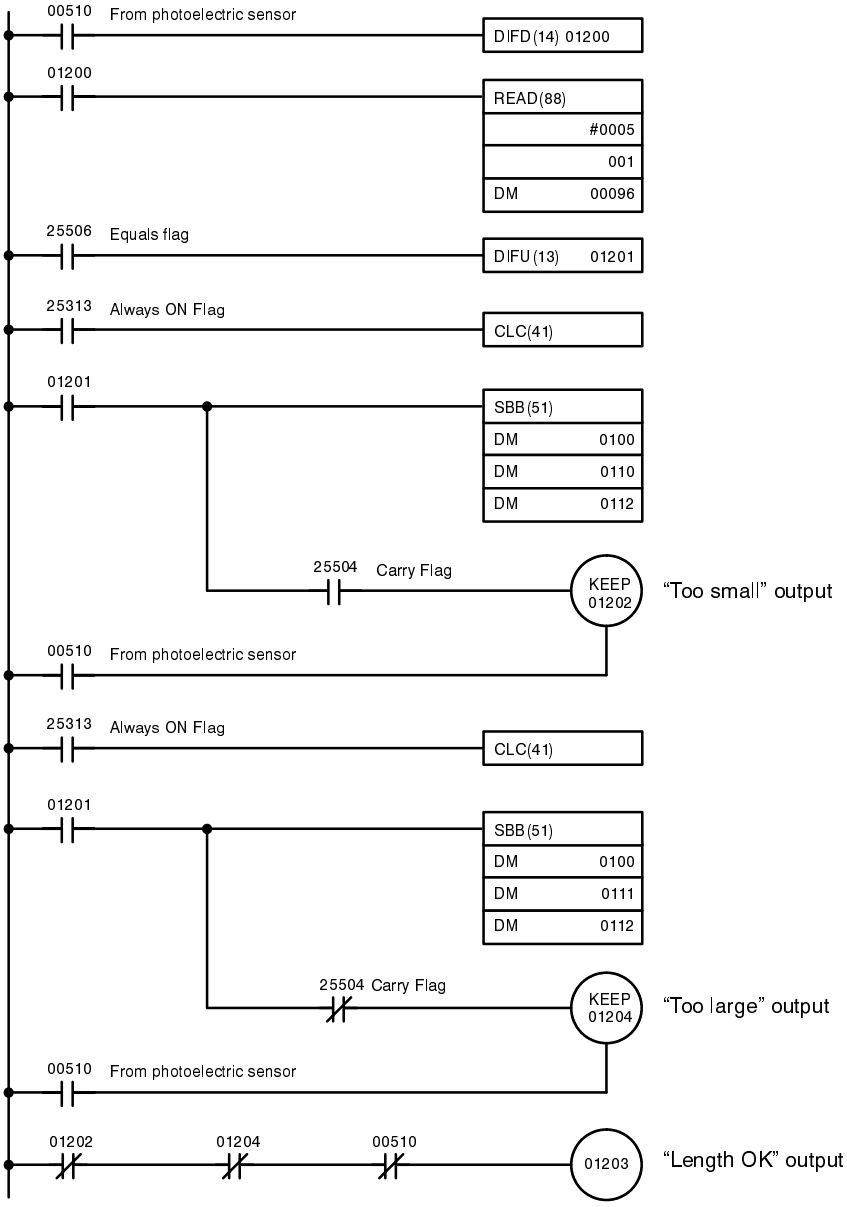
9–2–6 Programming

The following program section is used to control operation. The first line is used to activate READ(88) once each time the photoelectric sensor turns OFF. If the read is successful, IR 01201 will activate the comparison process.

The first subtraction (SBB(51)) compares the counter readout value with the lower limit. If the subtraction results in a carry, IR 01202 will be turned ON to indicate that the length was too small. IR 01202 will be reset the next time the photoelectric sensor goes ON.

The second subtraction compares the counter readout value with the upper limit. If the subtraction results in a carry, IR 01204 will be turned ON to indicate that the length was too large. IR 01204 will be reset the next time the photoelectric sensor goes ON.

If neither IR 01202 nor IR 01204 have been turned ON and the photoelectric sensor is OFF, IR 01203 will be turned ON to indicate that the length was within specifications.

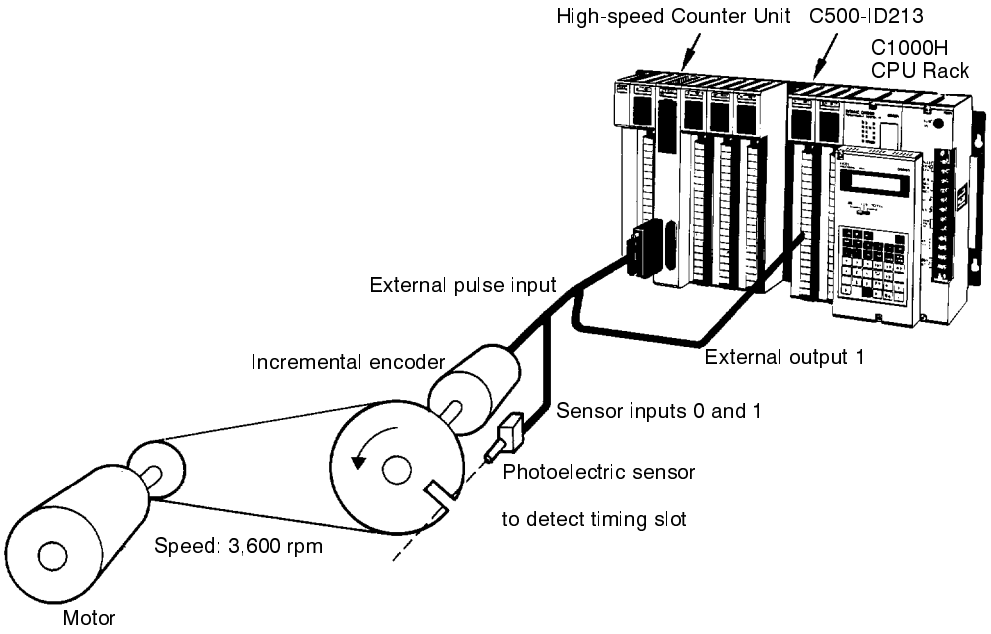


9–3 Sampling Counter Mode and Preset Timer Mode 2

This example shows how one High-speed Counter Unit can be used to measure the pulse resolution of an incremental encoder using one channel in the sampling counter mode and another in the preset timer mode.

9–3–1 System Setup

A C1000H CPU Rack equipped with a High-speed Counter Unit allocated IR 000 and IR 001 and a 3G2A5-ID213 DC Input Unit allocated IR 005 are set up as shown below.



9–3–2 Wiring

The following wiring is required.

1, 2, 3...

1. The output from the incremental encoder is wired to the external pulse input 0.
2. The photoelectric sensor detecting the slot is wired to sensor inputs 0 and 1.
3. The PCOK inputs 0 and 1 are wired so that they remain ON.
4. Output 1 is wired to the terminals for bit 10 on the DC Input Unit.

9–3–3 Mode Settings

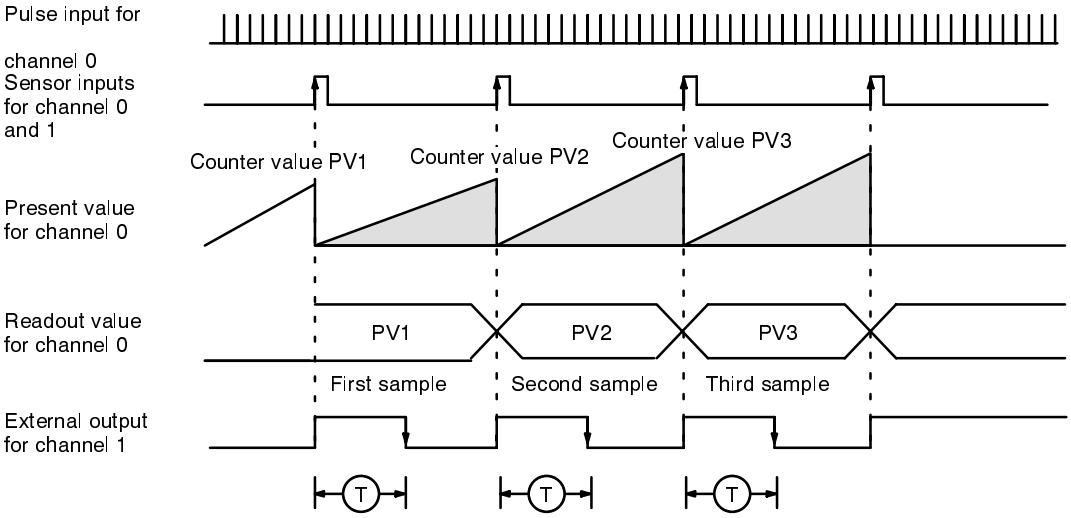
The mode switches are set as follows:

Switch	Channel	Physical setting	Operating mode
SW1	0	7	Sampling counter mode
SW2	1	2	Preset timer mode 2 at 20 kHz
SW3	2	Any value 8 to F	Disabled
SW4	3	Any value 8 to F	Disabled

9–3–4 Operation

When the photoelectric sensor detects the slot, both a sampling counter (channel 0) and a preset timer in mode 2 (channel 1) are started. When the preset time expires, the output from the timer (external output 1) is used to activate reading of the number of pulses from the incremental encoder.

The preset time T for channel 1 must be input into the PC and written to the Counter (see *9–3–5 Data Preparations*).



9–3–5 Data Preparations

The following data must be input into the PC in advance using a Programming Console, writing from within the program, etc.

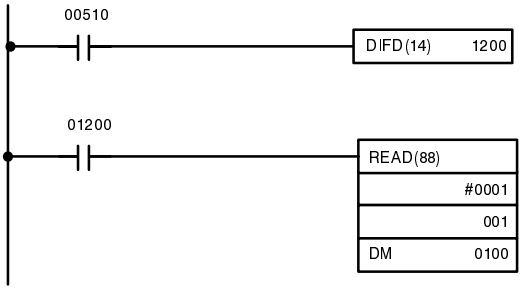
Word	Contents	Form	Setting	Application
DM 0000	0000	NA	NA	Not used; designated for writing with DM 0001
DM 0001	0050	BCD	50 ms	Preset timer for channel 1

The following word is used to hold the counter readout value from channel 0

Word	Form	Contents
DM 0100	Hexadecimal	Counter readout value from channel 0, i.e., the number of pulses counted while the timer in channel 1 was timing out.

9–3–6 Programming

The following program section is used to read out the counter value each time IR 00510 turns ON. IR 00510 is controlled indirectly by the Counter's external output 1 through the DC Input Unit



SECTION 10
Troubleshooting and Maintenance

This section provide information for troubleshoot Counter error and other information related to long-term trouble-free Counter application

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10–1 Error Indicators

There are two error indicators on the front panel that can be used for troubleshooting. If either of these indicators lights, proceed as described in the following table.

Indicator	Cause of error	Corrective measure
WDT error indicator: WDT	The watchdog timer has detected an error in Counter operation.	Press the reset switch to reset the Counter.
Battery low indicator: BAT	The battery supply voltage has dropped because the battery is exhausted or the connector is loose.	Check to be sure the battery is properly connected. If the battery connection is okay, replace the battery with a new one.

10–2 Error Flags

There are four types of error flags available in the word output from the Counter to the PC that can be used for troubleshooting. If any of these flags turn ON, proceed as described in the following table. The last flags (Overflow Flags) are not necessarily indications of an error, but an indication that the counter has exceeded FFFF and restarted from 0. Refer to *Section 5 Data Configuration* for details.

Flag	Cause of error	Corrective measure
WDT Error Flag	The watchdog timer has detected an error in Counter operation.	Press the reset switch to reset the Counter.
Battery Error Flag	The battery supply voltage has dropped because the battery is exhausted or the connector is loose.	Check to be sure the battery is properly connected. If the battery connection is okay, replace the battery with a new one.
Enabled Flags (one for each channel)	Counting/timing operations cannot be started because of incorrect parameters or because the counter clear input is ON.	Check the mode settings and parameters and correct them if necessary. Be sure that operating modes have been initialized with the Mode Change Bits. Check the status of the counter clear input.
Overflow Flags (one for each channel)	The present count has exceeded FFFF in the gate ring counter mode.	Take the appropriate programming action for you application and reset the flag using the Clear Bits.

10–3 Inspections

The following should be periodically checked.

Inspection	Item	Criteria
Ambient conditions	Ambient operating temperature	Must be between 0% and 55%C.
	Ambient operating humidity	Must be between 35% and 85% with no condensation.
	Dust and other debris	Counter must be free of dust and debris.
Installation	Mounting to Rack	Must be mounted firmly to Rack.
	Cable connections	Cables must be connected firmly and screws tight.
	Connecting cables	Must be no malformation or external damage.

10–4 Replacement Parts

Always keep a spare High-speed Counter Unit on hand for immediate replacement if required. The only replacement part required within the Counter is a battery.

The battery is provided as a set, model number 3G2A9-BAT08. The battery will last approximately 5 years at 25%C, less at higher temperatures. The battery must be replaced within a week after the battery low indicator on the front panel of the Counter first lights.

DANGER! Never short the positive and negative terminals; never attempt to recharge or dismantle the battery; and never place the battery into a fire or furnace. The battery may explode, rupture, or leak resulting in serious injury.

10–5 Handling Precautions

Abide by the following precautions when handling the Counter.

1, 2, 3...

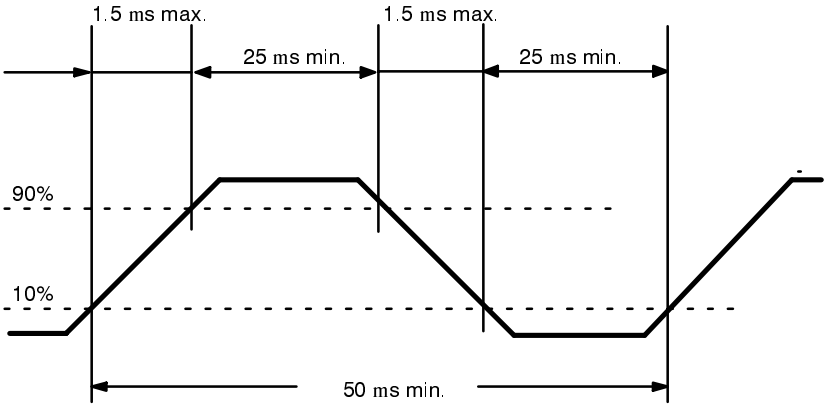
1. Always turn OFF the power supply before replace the Counter.
2. After replacing the Counter, check the new Counter to be sure it is operating normally.
3. When returning a Counter for repairs, attach a detailed description of the application in which it was used and the errors that occurred.

Appendix A
Specifications

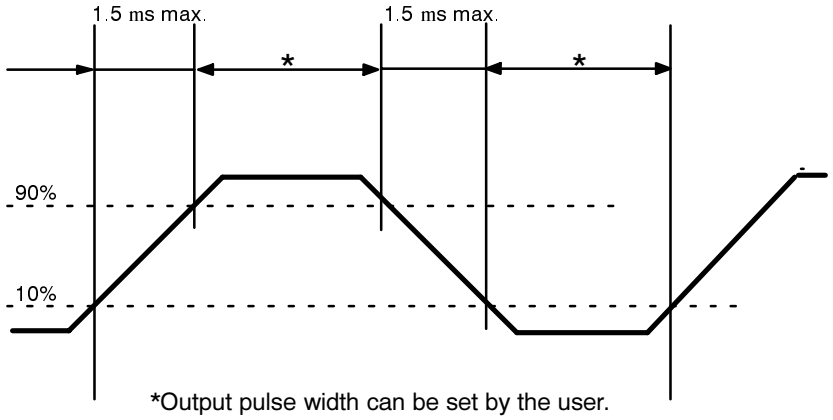
General Specifications

Item		Specification
No. of operating channels		4 channels maximum (each channel individually operable)
Operating modes		The following six modes are available for each of the four counter channels: Preset timer mode 1, preset timer mode 2, preset counter mode 1, preset counter mode 2, gate ring counter mode, and sampling counter mode Any or all of the operating modes can be used in the same Counter Unit.
External inputs	Input signals	The following inputs are used: pulse inputs: PL 0 to PL 3, sensor inputs: SN 0 to SN 3, PCOK inputs PC 0 to PC 3, counter clear input:s CC 0 to CC 3. Each input number corresponds to a channel, i.e., each channel has one of each input.
	Signal level	24 VDC
External outputs	Output signals	External outputs: OUT 0 to 3 Each output number corresponds to a channel, i.e., each channel has one output.
	Switching capacity	5 to 24 VDC (open collector output)
Internal current consumption		1.0 A at 5 VDC maximum (supplied from Backplane)
External power supply		30 mA at 24 VDC +10% maximum (for each of 2 circuits)
Dimensions (mm)		250 x 34.5 x 93 mm (HxWxD)
Weight		800 g maximum (without connectors)
Battery life		5 years at 25%C (Battery life is shortened at higher temperatures.)

Input Specifications

Inputs	Input signals: sensor inputs, pulse inputs, PCOK inputs, counter clear inputs
Input voltage	24 VDC +10%
Input current	8 mA typical (7.0 to 10 mA) per input
Minimum ON voltage	21.6 VDC
Maximum OFF voltage	4.0 VDC
Minimum response pulse (maximum response frequency: 20 KHz)	Input rise/fall time of sensor inputs, pulse inputs, PCOK inputs: 1.5 ms maximum  Counter clear input signal ON level must be maintained for at least 5 ms.

Output Specifications

Output	External output signal
Maximum switching capacity	100 mA/24.0 VDC + 10% 200 mA maximum/common (300-mA fuse in each of 2 circuits)
Minimum switching capacity	1 mA at 5 VDC
Output	Open collector
Leakage current	0.1 mA maximum
Residual voltage	0.4 V maximum
ON/OFF delay	Counter processing time + 15 ms (with a load current of 1 mA minimum)
External power supply	24 VDC +10% (30 mA maximum at 26.4 VDC) for each of 2 circuits
Output pulse	1-mA minimum load current Output rise/fall time 15 ms maximum  *Output pulse width can be set by the user.
Signal level	All output levels are active low.

Appendix B
Switch Settings and Memory Area Allocations

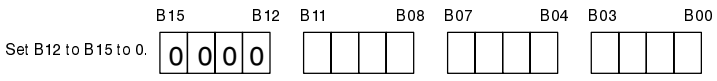
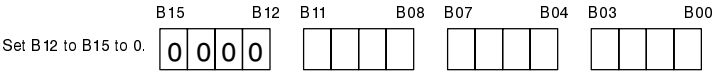
Switch Settings

Switch setting	Meaning
0	Sets timer mode 1 using the 20-kHz internal clock.
1	Sets timer mode 1 using the 2-kHz internal clock.
2	Sets timer mode 2 using the 20-kHz internal clock.
3	Sets timer mode 2 using the 2-kHz internal clock.
4	Sets counter mode 1.
5	Sets counter mode 2.
6	Sets gate ring counter mode.
7	Sets sampling counter mode.
8 to F	Sets the counter/timer to unused.

Memory Area Allocations

Preset Timer Modes 1 and 2

Words for I/O WRITE Instructions

Word	Channel	Description
DM m	0	Preset times. Used in both modes 1 and 2. Must be between 001 and 999 in BCD.
DM m+1	1	
DM m+2	2	20 kHz Not used. $x10^2$ $x10^1$ $x10^0$ ms
DM m+3	3	2 kHz Not used. $x10^0$ $x10^{-1}$ $x10^{-2}$ s
DM m+4	0	Output times for external outputs for preset timer mode 1. Must be between 001 and 999 in BCD.
DM m+5	1	
DM m+6	2	Not used. $x10^2$ $x10^1$ $x10^0$ ms
DM m+7	3	

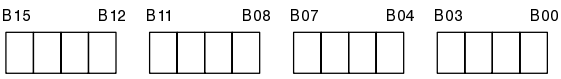
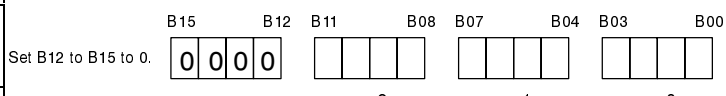
I/O Word Allocation (IR n and IR n+1)

Word	Bit(s)	Name
Output (IR n)	00	(PC busy)
	01	(PC write complete)
	02	(PC read complete)
	03 to 07	Not used in this operating mode.
	08	Mode Change Bit for channel 0
	09	Mode Change Bit for channel 1
	10	Mode Change Bit for channel 2
	11	Mode Change Bit for channel 3
	12	Parameter Change Bit for channel 0
	13	Parameter Change Bit for channel 1
	14	Parameter Change Bit for channel 2
	15	Parameter Change Bit for channel 3

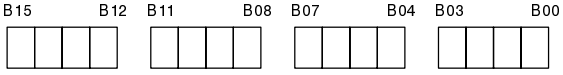
Word	Bit(s)	Name
Input (IR n+1)	00	(Timer busy)
	01	(Timer read complete)
	02	(Timer write complete)
	03	Not used.
	04	WDT (watchdog timer) Error Flag
	05	Battery Low Flag
	06	Reading Flag
	07	Not used.
	08	Enabled Flag for channel 0
	09	Enabled Flag for channel 1
	10	Enabled Flag for channel 2
	11	Enabled Flag for channel 3
	12 to 15	Not used in this operating mode.

Preset Counter Modes 1 and 2

Words for I/O WRITE Instructions

Word	Channel	Description
DM m	0	Preset counts. Used in both modes 1 and 2. Must be between 0001 and FFFF in hexadecimal.
DM m+1	1	
DM m+2	2	
DM m+3	3	
DM m+4	0	Output times for the external outputs for preset counter mode 1. Must be between 001 and 999 in BCD.
DM m+5	1	
DM m+6	2	
DM m+7	3	

Words for I/O READ Instructions

Word	Channel	Description
DM m'	0	Present value in preset counter modes 1 and 2. Will be between 0000 and FFFF in hexadecimal.
DM m'+1	1	
DM m'+2	2	
DM m'+3	3	

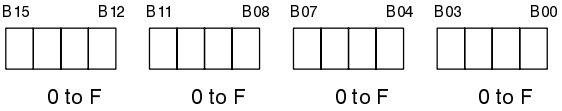
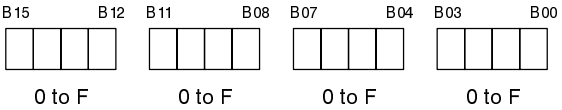
I/O Word Allocation (IR n and IR n+1)

Word	Bit(s)	Name
Output (IR n)	00	(PC busy)
	01	(PC write complete)
	02	(PC read complete)
	03 to 07	Not used in this operating mode.
	08	Mode Change Bit for channel 0
	09	Mode Change Bit for channel 1
	10	Mode Change Bit for channel 2
	11	Mode Change Bit for channel 3
	12	Parameter Change Bit for channel 0
	13	Parameter Change Bit for channel 1
	14	Parameter Change Bit for channel 2
	15	Parameter Change Bit for channel 3

Word	Bit(s)	Name
Input (IR n+1)	00	(Counter busy)
	01	(Counter read complete)
	02	(Counter write complete)
	03	Not used.
	04	WDT (watchdog timer) Error Flag
	05	Battery Low Flag
	06	Reading Flag
	07	Not used.
	08	Enabled Flag for channel 0
	09	Enabled Flag for channel 1
	10	Enabled Flag for channel 2
	11	Enabled Flag for channel 3
	12 to 15	Not used in this operating mode.

Gate Ring Counter and Sampling Counter Modes

Words for I/O READ Instructions

Word	Channel	Description
DM m'	0	**Gate Ring Counter Mode:** Present value. **Sampling Counter Mode:** Counter readout value Will be between 0000 and FFFF in hexadecimal.
DM m'+1	1	
DM m'+2	2	
DM m'+3	3	
DM m'+4	0	**Gate Ring Counter Mode:** Counter readout value. Will be between 0000 and FFFF in hexadecimal.
DM m'+5	1	
DM m'+6	2	
DM m'+7	3	

I/O Word Allocation (IR n and IR n+1)

Word	Bit(s)	Name
Output (IR n)	00	(PC busy)
	01	(PC write complete)
	02	(PC read complete)
	03	Not used.
	04	Clear Bit for channel 0
	05	Clear Bit for channel 1
	06	Clear Bit for channel 2
	07	Clear Bit for channel 3
	08	Mode Change Bit for channel 0
	09	Mode Change Bit for channel 1
	10	Mode Change Bit for channel 2
	11	Mode Change Bit for channel 3
	12 to 15	Not used in these modes.

Word	Bit(s)	Name
Input (IR n+1)	00	(Counter busy)
	01	(Counter read complete)
	02	(Counter write complete)
	03	Not used.
	04	WDT (watchdog timer) Error Flag
	05	Battery Low Flag
	06	Reading Flag
	07	Not used.
	08	Enabled Flag for channel 0
	09	Enabled Flag for channel 1
	10	Enabled Flag for channel 2
	11	Enabled Flag for channel 3
	12	Overflow Flag for channel 0
	13	Overflow Flag for channel 1
	14	Overflow Flag for channel 2
	15	Overflow Flag for channel 3

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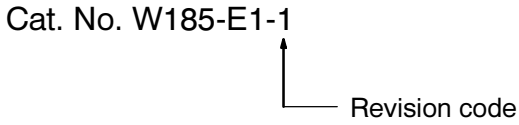
Revision History

A manual revision code appears as a suffix to the catalog number on the front cover of the manual.



The following table outlines the changes made to the manual during each revision. Page numbers refer to the previous version.

Revision code	Date	Revised content
1	September 1991	Original production
1A	September 1995	**Pages 23, 24:** The 2-kHz internal clock and 20-kHz internal clock have been switched.