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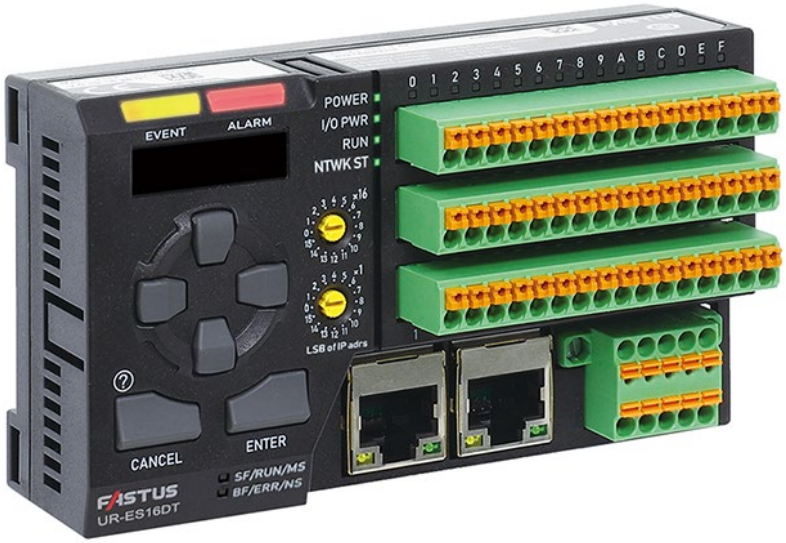
IO-Link Master

UR-MS16DT / UR-ME16DT

UR-ES16DT / UR-EE16DT

User's Manual

(Counter Function Edition)



OPTEX FA CO., LTD.

Introduction

Thank you for purchasing the IO-Link Master UR-MS16DT / UR-ME16DT / UR-ES16DT / UR-EE16DT.

This manual contains information on the counter function for the IO-Link Master UR Series.
Read this manual thoroughly before using the product to ensure correct product use with full understanding of the functions and performance of the product. Also, after you have finished reading this manual, store it safely for future reference.

How to Read this Manual

This document contains information on the IO-Link Master UR Series counter functions.

It does not cover the functions or specifications of the IO-Link Master UR Series, so please refer to the Related Manuals below.

The counter function described in this document is compatible with the following versions of firmware for the IO-Link Master UR Series.

- UR-MS16DT/UR-ME16DT: Firmware version 1.21xx41xx
  (FPGA version: 41)
- UR-ES16DT/UR-EE16DT: Firmware version 1.12xx41xx

■ Related Manuals

Manual number	Manual name	Details
UR-MS_UM-xxx-xxxx	IO-Link Master UR-MS16DT / UR-ME16DT User's Manual	Describes this product's functions and performance as well as operation. Be sure to read these documents.
UR-ES_UM-XXX-XXXX	IO-Link Master UR-ES16DT/-EE16DT User's Manual (Common Edition) (Referred to herein as the “Common Edition.”)	Describes this product's common functions and performance as well as operation. Be sure to read these documents.

Notations Used in this Manual

These are the notations used in this manual.

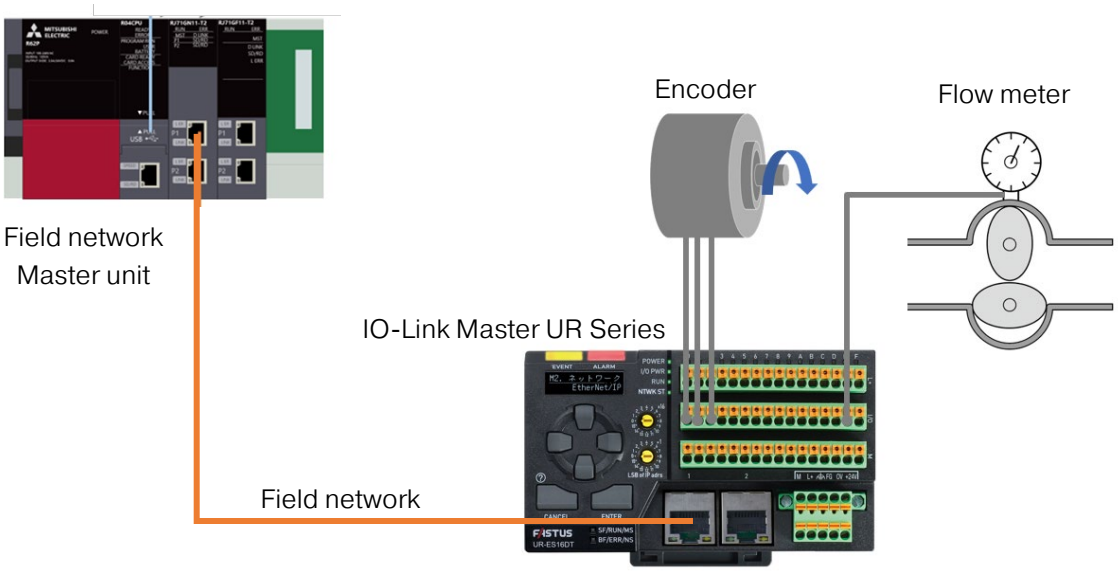
CAUTION
This indicates particularly important points to observe during operation.

MEMO
This information is useful for operation.

Contents

1 General

Connecting an encoder or flow meter to an IO-Link Master UR Series allows precision measurements of positional information, speed data, flow rate, etc., using the high-speed counter function.

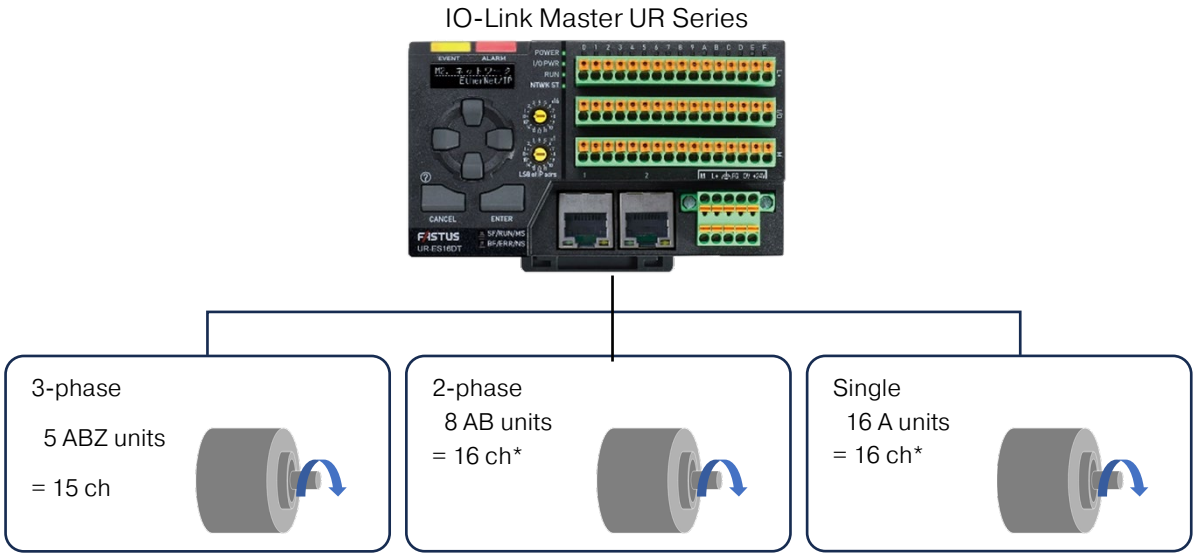


1-1 Types and maximum number of encoders that can be connected

This product can connect to NPN or PNP open collector output or 24 V totem pole output incremental encoders.

3-phase (A, B, Z), 2-phase (A, B), or single (A) encoder types can be connected.

Multiple encoders of different types can be connected as long as there are no more than 16 channels.



* For the following network types, assigning all input information from encoders to the process input data area may result in the upper limit for the process input data area (32 words (64 bytes)) being exceeded.

- CC-Link IE TSN, CC-Link IE Field
- EtherCAT

Accordingly, to connect up to the maximum number of encoders, reduce the process input data area per encoder and manually adjust so that only the necessary input information is acquired. (Refer to “2-3-2 Memory allocation for each encoder type” (page 8))

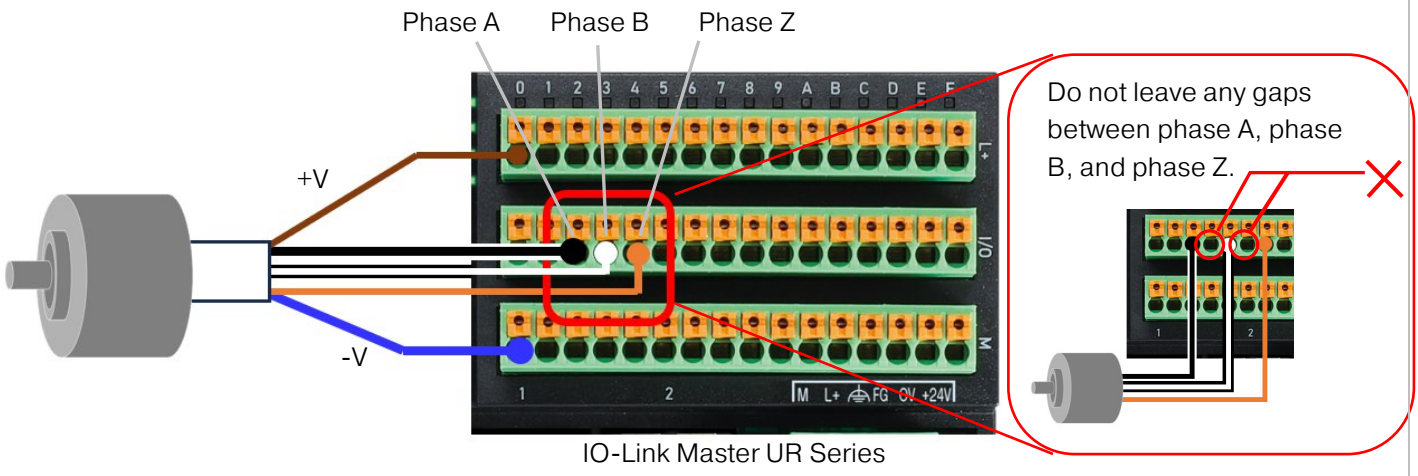
2 Connection Methods

This section describes how to connect encoders to this product.

2-1 Basic connection methods

Connect the signal output cables to phase A, phase B, and phase Z respectively for “pnp Input” or “npn Input” channel.
Connect the power supply cables to one of channels 0 through F, regardless of the encoder output signal cable connections.

Example) When connecting a 3-phase encoder

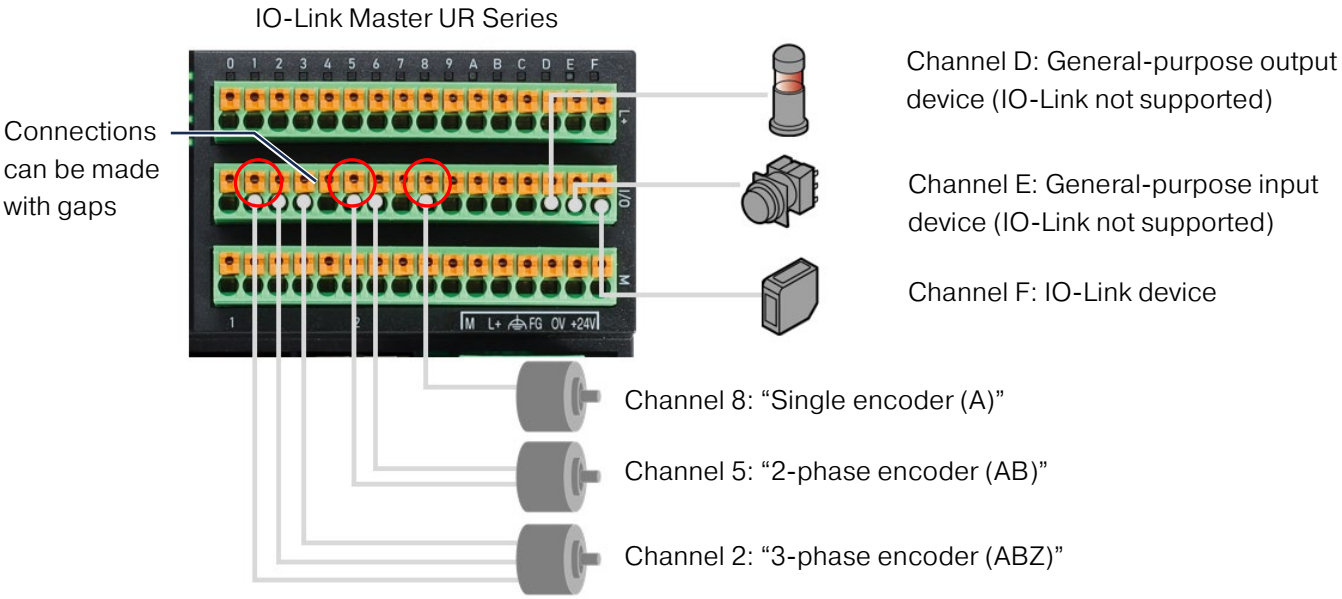


2-2 Connection when connecting multiple encoders

Multiple encoders, IO-Link devices, or general-purpose I/O devices can be connected in combination as long as they are on different channels.

Connection example)

There is no specific order required when connecting multiple encoders, IO-Link devices, or general-purpose I/O devices. Connect each to an open channel.



2-3 Encoder type and the content of process input data area allocated

2-3-1 Encoder type

The following types of encoders and counter functions can connect to the IO-Link Master UR Series.

Parameter name	Details	Reference
ABZ	Incremental encoders are used for phases A, B, and Z. The count value is cleared when phase Z starts, and the rotation count is added or subtracted. The count increases with both the rising and falling edges of the input pulse. The count is multiplied by four, and the count value will be 16 bits per rotation with 32 bits for the rotation count. (Setting phase Z ON resets the count value, and changes the rotation count by ±1.) The count maximum frequency is 250 kpps (duty ratio 50%).	Page 11
AB	Incremental encoders are used for phases A and B only. The count increases with both the rising and falling edges of the input pulse. The count is multiplied by four, and the count value will be 48 bits per rotation. The count maximum frequency is 250 kpps. (Duty ratio 50%)	Page 11
Single	The count increases with both the rising and falling edges of the input pulse. The count is multiplied by two, and the count value will be 48 bits. (However, this product can only display up to 32 bits.)	Page 11
Frequency*1	The frequency of the monophasic pulses is measured in increments of 1 Hz per second.	Page 13
High response*1	Used when a high speed response is required. The frequency of phase AB and monophasic pulses are measured for each rising cycle of the input. The minimum measurable frequency can be set in the “M22 Lowest frequency” master parameter. Measurement stability depends on the setting. Resolution is in 2.24 µs (446 kHz) increments.	Page 13

*1 Operates in FPGA version 41 and later. UR-MS16DT/-ME16DT will be supported in the near future.

MEMO

The counter value is cleared when the “Reset encoder counter” rises from 0 (OFF) to 1 (ON).

The count value is the value when the cyclic communication data of the field network is updated.

2-3-2 Memory allocation for each encoder type

■ABZ

Occupies 5 words (10 bytes).

Word address (Start number +)	Data type	Details
+0	Counter value (16 bits)	Reset when phase Z starts. For CW direction, the count increases from 0 up to the number of pulses per encoder rotation x 4 -1. For CCW direction, 16-bit data is stored in an extended format, such as 0 to (1 - number of pulses per encoder rotation × 4).
+1	Rotation count (32 bits)*1	The 32-bit counter value that increases or decreases when phase Z starts.
+2		
+3	Frequency*2	Pulse frequency (Hz) is stored.
+4		

*1 If 16 bits is sufficient for the data required for the rotation speed, there is no problem with allocating two words of memory area as the default value for process input data. In such a case, data from the third word onwards will not be input.
*2 UR-MS16DT/-ME16DT will be supported in the near future.

■AB

Occupies 5 words (10 bytes).

Word address (Start number +)	Data type	Details
+0	Counter value (48 bits) *1	A 48-bit up/down counter that counts up in the CW direction and down in the CCW direction. Rotating in the CCW direction from 0 results in a negative value. The count value is multiplied by four per pulse.
+1		
+2		
+3	Frequency*2	Pulse frequency (Hz) is stored.
+4		

*1 If 32 bits is sufficient for the data required for the rotation speed, there is no problem with allocating two words of memory area as the default value for process input data. In such a case, data from the third word onwards will not be input.
*2 UR-MS16DT/-ME16DT will be supported in the near future.

■Single

Occupies 5 words (10 bytes).

Word address (Start number +)	Data type	Details
+0	Counter value (48 bits) *1	A 48-bit up/down counter that counts up in the CW direction and down in the CCW direction. Rotating in the CCW direction from 0 results in a negative value. The count value is multiplied by two per pulse.
+1		
+2		
+3	Frequency*2	Pulse frequency (Hz) is stored.
+4		

*1 If 32 bits is sufficient for the data required for the rotation speed, there is no problem with allocating two words of memory area as the default value for process input data. In such a case, data from the third word onwards will not be input.
*2 UR-MS16DT/-ME16DT will be supported in the near future.

■Frequency/high response

Occupies 2 words (4 bytes).

Word address (Start number +)	Data type	Details
+0	Frequency measurement value	The frequency measured is stored in Hz units. When the frequency measured is less than the value set in “M22 Lowest frequency,” the value measured will be 0. Since the resolution is 2.24 µs, data is coarser at high frequencies. For example, the next frequency after 9920 Hz is 10146 Hz.
+1		

MEMO

Although the data size required to store the frequency is two words, using “M42 Process data words auto allocation” allocates in three words.

2-4 Encoder connection configuration procedure

This section describes the main configuration methods for connecting encoders.

Refer to “3-1 Settings related to counter functions” (page 11) for further information on encoder-related settings.

(1) Configure the output settings for the channel to which the encoder is connected.

In “M10. I/O setting,” set the channel output to “pnp Input” or “npn Input.”

CAUTION

Some incremental encoder models are not equipped with output short-circuit protection.

Before connecting this product, check that the “M10. I/O setting” master parameter for the channel you are connecting is not set to “PNP output” or “NPN output”.

(2) In “M18. Pulse input,” specify the type of encoder (ABZ, AB, single, frequency, high response*1) you are connecting to the channel.

*1: UR-MS16DT/-ME16DT will be supported in the near future.

MEMO

Leave channels to which you are connecting phase B or phase Z to the default “None” setting.

(3) Set the process input data area data size to allocate to the channel to which the encoder will be connected in “M40 Process input data words allocation.”

Refer to “2-3-2 Memory allocation for each encoder type” (page 8) for further information on the data size required for each encoder type.

3 Counter Function Settings

3-1 Settings related to counter functions

The following is a list of settings related to counter functions.

Since some functions may not be available or changed depending on the firmware version, be careful when using past firmware versions.

■Specifications

Firmware version / Specifications	UR-MS16DT/UR-ME16DT: Firmware version 1.21xx40xx or later UR-ES16DT/UR-EE16DT: Firmware version 1.12xx41xx or later	Versions lower than those at left
Counter points	16	1

■Master parameters

Firmware version / Setting Items	UR-MS16DT/UR-ME16DT: Firmware version 1.21xx40xx or later UR-ES16DT/UR-EE16DT: Firmware version 1.12xx41xx or later			Versions lower than those at left
M10. I/O setting	Set I/O modes for each channel. Set the channel to connect to the encoder to “npn Input” or “pnp Input” according to the encoder's output type.			
M11. Input filter time	It also functions as a filter for counter function input. Normally, set it to “None.” Setting to “0.1 ms” or “1 ms” etc., is effective when chattering or noise occurs. (However, this lowers the maximum input frequency.) When setting to any other value than “None,” set all input channels to the same value.			The counter function input filter is fixed at 1.7 µs.
M15. Encoder input (ABZ)	Not displayed. Moved to M18 when writing from a field network. The value is always 0 when reading from a field network.			Set the counter input channel and phase ABZ/phase AB/single/frequency.
M18. Pulse input	Set the encoder type to connect to one of the following for each channel.			Not displayed. Accessing from a field network will result in an error.
	0	None	The counter function is not used.	
	1	ABZ	Incremental encoders are used for phases A, B, and Z. The count value is cleared when phase Z starts, and the rotation count is added or subtracted. The count increases with both the rising and falling edges of the input pulse. (Multiplied by four)	
	2	AB	Incremental encoders are used for phases A and B only. The count increases with both the rising and falling edges of the input pulse. (Multiplied by four)	
	3	Single	The count increases with both the rising and falling edges of the input pulse. (Multiplied by two)	
	4	Frequency	The frequency of the monophasic pulses is measured in increments of 1 Hz per second.	
	5	High response (*1)	The frequency of phase AB and monophasic pulses are measured for each rising cycle of the input. The minimum measurable frequency can be set in the “M22 Lowest frequency” master parameter. Measurement stability depends on the setting. Resolution is in 2.24 µs (446 kHz) increments.	

Firmware version / Setting Items	UR-MS16DT/UR-ME16DT: Firmware version 1.21xx40xx or later UR-ES16DT/UR-EE16DT: Firmware version 1.12xx41xx or later			Versions lower than those at left
M19. Input inversion	If the counter phase Z input is normally set to ON, invert it with this setting.			Not displayed. Accessing from a field network will result in an error.
	0	No	The input state of the specified channel is directly conveyed internally.	
	1	Inversion	In the same manner, the input state is inverted and conveyed internally.	
M22. Lowest frequency (*1)	If measuring frequencies, select the highest frequency that is closest to the lowest frequency required. The higher the value, the more stable the measurement value. Set the following for each channel.			Not displayed. Accessing from a field network will result in an error.
	0	27.2 Hz	Measured over a cyclic period of 16 pulse input rises. The minimum measurable frequency is 27.2 Hz, but the resolution of frequency measurement is improved, and the measured values are stabilized.	
	1	13.6 Hz	As above, measured over a cyclic period of eight pulse input rises.	
	2	6.8 Hz	As above, measured over a cyclic period of four pulse input rises.	
	3	3.4 Hz	As above, measured over a cyclic period of two pulse input rises.	
	4	1.7 Hz	As above, measured over a cyclic period of one pulse input rises.	
M40. Process input data words allocation	Set the number of words to allocate to the process input data for the devices connected to each channel. Refer to “2-3-2 Memory allocation for each encoder type” (page 8) for further information on the appropriate number of words for each encoder type.			

*1: Operates in FPGA version 41 and later. UR-MS16DT/-ME16DT will be supported in the near future.

■Master parameter number (data for access from PLC)

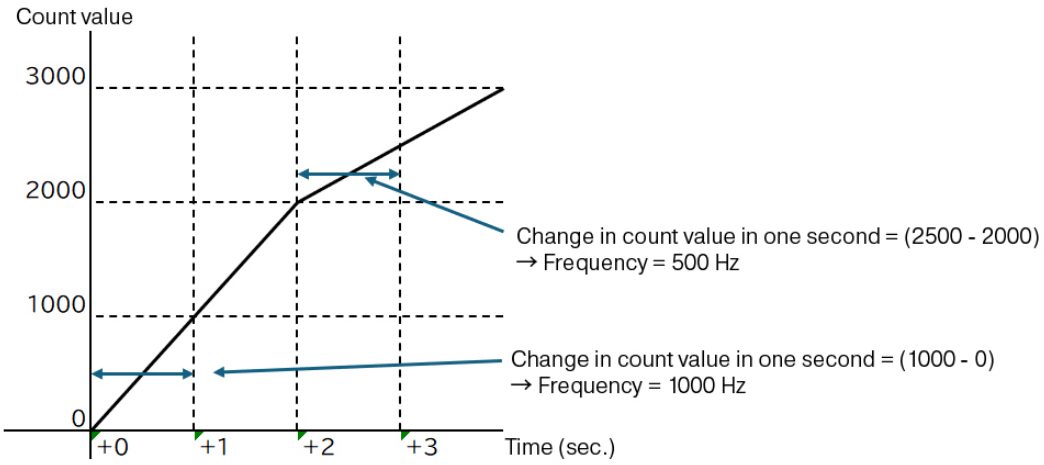
Firmware version / Master parameter number	UR-MS16DT/UR-ME16DT: Firmware version 1.21xx40xx or later UR-ES16DT/UR-EE16DT: Firmware version 1.12xx41xx or later				Versions lower than those at left
115h (For writing only)	Target numbers	0	The count value for all channels is cleared to zero.		The count value is cleared to zero.
		1	A value is written to the count value for channel 0. When phase Z is enabled, the data written is as follows.		
			+0	Count value (16 bits) low-order byte	
			+1	Count value (16 bits) high-order byte	
			+2	Rotation count (32 bits) lowest-order byte	
			+3	Rotation count (32 bits) low-order byte	
			+4	Rotation count (32 bits) high-order byte	
			+5	Rotation count (32 bits) highest-order byte	
			When phase Z is disabled, the data written is as follows.		
			+0	Count value (48 bits) lowest-order byte	
			+1	Count value (48 bits) low-order byte	
			+2	Count value (48 bits) mid low-order byte	
			+3	Count value (48 bits) mid high-order byte	
			+4	Count value (48 bits) high-order byte	
			+5	Count value (48 bits) highest-order byte	
		2 to 16	A value is written to the count value for channels 1 to F. (Same as for channel 1)		

3-2 Frequency measurement principle

3-2-1 “Frequency”

This section describes the measurement principle when the “M18. Pulse input” master parameter is set to “Frequency.”

Frequency is derived by measuring how much the count value for pulse input advances in one second.
The one second cycle is fixed, thus the frequency value is updated once every second.

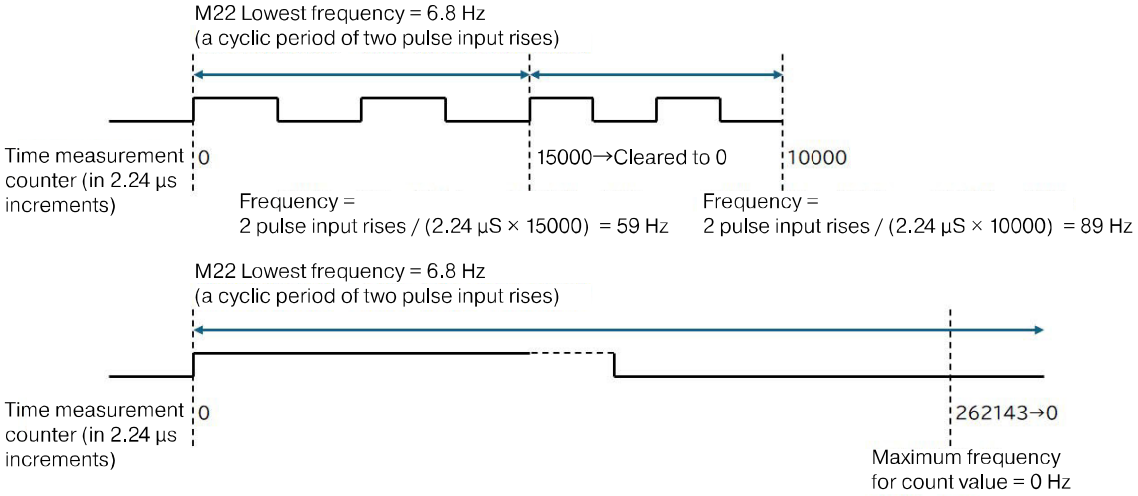


3-2-2 “High response” (UR-MS16DT/-ME16DT will be supported in the near future.)

This section describes the principle for measuring the frequency allocated to the count value process input data when the “M18. Pulse input” master parameter is set to “High response,” or to “ABZ,” “AB,” or “Single.”

The time to count the number of the pulse input rises designated by the value set in the “M22. Lowest frequency” master parameter, with the reciprocal taken as its frequency.

The time measurement resolution is 2.24 µs, and the count value is 0 to 262143.
When the count value reaches the upper limit during time measurement, it is deemed as being below the minimum measurable frequency, and the measurement value will be 0.



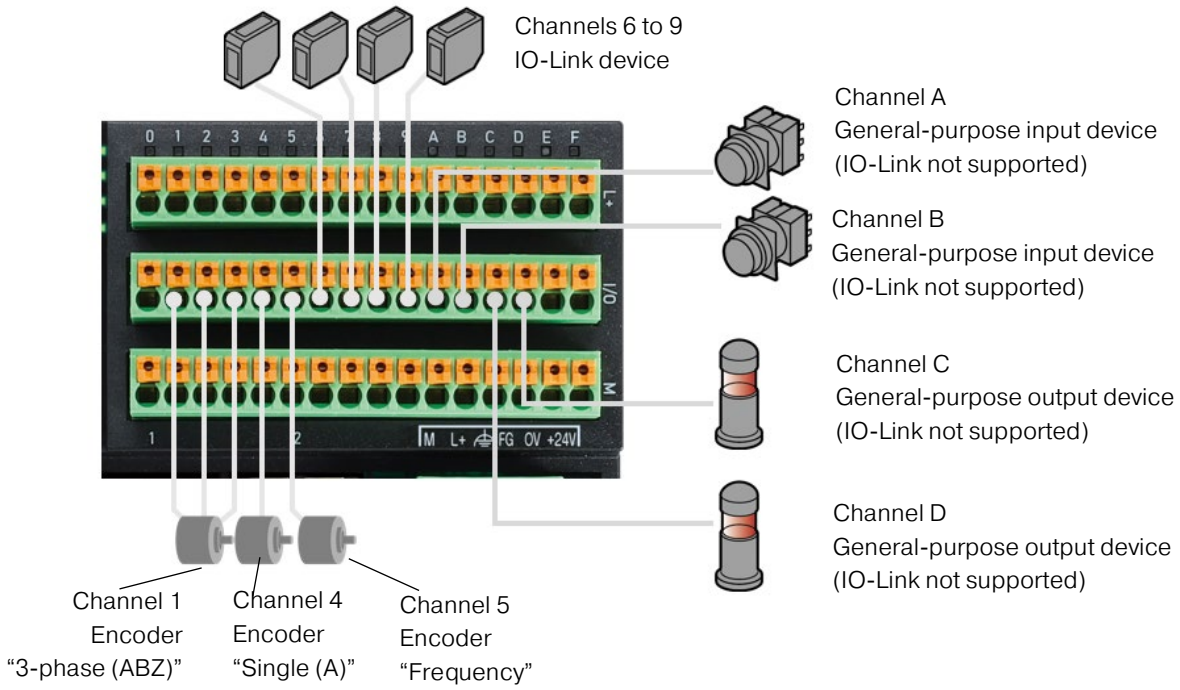
4 Connection Example

This section describes encoder connection settings and process input data area allocation details, using connection to CC-Link IE TSN with UR-MS16DT/UR-ME16DT as an example.

■System configuration

Connect the encoder to channel 1 as “3-phase,” to channel 4 as “Single,” and to channel 5 as “Frequency.”

Connect IO-Link communication devices and general-purpose I/O devices to other channels.



■Master parameter content

Configure the master parameters for each channel as follows.

Setting Items / Channel number	“M10. I/O setting”	“M18. Pulse input”
[Channel 0]	Not used	No
[Channel 1]	npn Input	ABZ
[Channel 2]	npn Input	No
[Channel 3]	npn Input	No
[Channel 4]	npn Input	Single
[Channel 5]	npn Input	Frequency
[Channel 6]	IO-Link	No
[Channel 7]	IO-Link	No
[Channel 8]	IO-Link	No
[Channel 9]	IO-Link	No
[Channel A]	npn Input	No
[Channel B]	npn Input	No
[Channel C]	NPN output	No
[Channel D]	NPN output	No
[Channel E]	Not used	No
[Channel F]	Not used	No

Encoder (3-phase)

...Encoder (single)

...Encoder (frequency)

■Memory area allocation results

In “M40 Process input data words allocation,” allocate process input data areas as follows.

Word address DEC (HEX)	Channel number	Allocation details	
00(00)	Channel 1 Counter settings (ABZ)	Counter value (16 bits)	5 words
01(01)		Rotation count (32 bits)	
02(02)			
03(03)		Frequency measurement value (high response)	
04(04)			
05(05)	Channel 4 Counter settings (single)	Counter value (48 bits)	5 words
06(06)			
07(07)			
08(08)		Frequency measurement value (high response)	
09(09)			
10(0A)	Channel 5 Counter settings (frequency)	Frequency measurement value (frequency)	2 words
11(0B)			
12(0C)	Channel 6 (IO-Link device)		
13(0D)			
14(0E)	Channel 7 (IO-Link device)		
15(0F)			
16(10)	Channel 8 (IO-Link device)		
17(11)			
18(12)	Channel 9 (IO-Link device)		
19(13)			
20(14)	Channel A (General-purpose input device)		
21(15)			
22(16)	Channel B (General-purpose input device)		
23(17)			
24(18)	Channel C (General-purpose output device)		
25(19)			
26(1A)	Channel D (General-purpose output device)		
27(1B)			
28(1C)	Not used		
29(1D)	Not used		
30(1E)	Not used		
31(1F)	Not used		

MEMO

When process input data areas are allocated automatically in “M42 Process data words auto allocation,” process input data areas can be allocated automatically according to the type of encoder connected. However, the data size to store frequencies for “Frequency” and “High response” will be allocated as three words rather than the minimum required two.

5 Revision History

The revision number is listed in the bottom right corner of the back cover of the instruction manual.

UR_COUNTER_UM_XXX_YYYY

(XXX: revision number, YYY: revision date)

Revision number	Revision date	Details
1	January 2025	First edition
2	June 2025	Added notes about UR-MS16DT/-ME16DT.

● Specifications are subject to change without prior notice. Please be aware of this in advance.

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The information in this user's manual is correct as of June 2025.

UR_COUNTER_UM_002_2506