TOSHIBA

UM-TS03***-E032

PROGRAMMABLE CONTROLLER

PROSEC **T3H**

USER'S MANUAL

TOSHIBA CORPORATION

Important Information

Misuse of this equipment can result in property damage or human injury.
Because controlled system applications vary widely, you should satisfy yourself as to the acceptability of this equipment for your intended purpose.
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Safety Precautions

This manual is prepared for users of Toshiba's Programmable Controller T3H.
Read this manual thoroughly before using the T3H. Also, keep this manual and related manuals so that you can read them anytime while the T3H is in operation.

General Information

1. The T3H has been designed and manufactured for use in an industrial environment. However, the T3H is not intended to be used for systems which may endanger human life. Consult Toshiba if you intend to use the T3H for a special application, such as transportation machines, medical apparatus, aviation and space systems, nuclear controls, submarine systems, etc.

2. The T3H has been manufactured under strict quality control. However, to keep safety of overall automated system, fail-safe systems should be considered outside the T3H.

3. In installation, wiring, operation and maintenance of the T3H, it is assumed that the users have general knowledge of industrial electric control systems.
   If this product is handled or operated improperly, electrical shock, fire or damage to this product could result.

4. This manual has been written for users who are familiar with Programmable Controllers and industrial control equipment. Contact Toshiba if you have any questions about this manual.

5. Sample programs and circuits described in this manual are provided for explaining the operations and applications of the T3H. You should test completely if you use them as a part of your application system.

Hazard Classifications

In this manual, the following two hazard classifications are used to explain the safety precautions.

⚠ WARNING — Indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury.

⚠ CAUTION — Indicates a potentially hazardous situation which, if not avoided, may result in minor or moderate injury. It may also be used to alert against unsafe practices.

Even a precaution is classified as CAUTION, it may cause serious results depending on the situation. Observe all the safety precautions described on this manual.

Safety Precautions

Safety Precautions

Installation:

⚠ CAUTION

1. Excess temperature, humidity, vibration, shocks, or dusty and corrosive gas environment can cause electrical shock, fire or malfunction. Install and use the T3H and in the environment described in the T3 User's Manual - Hardware.

2. Improper installation directions or insufficient installation can cause fire or the units to drop. Install the T3H in accordance with the instructions described in the T3 User's Manual - Hardware -.

3. Turn off power before installing or removing any units, modules or terminal blocks. Failure to do so can cause electrical shock or damage to the T3H and related equipment.

4. Entering wire scraps or other foreign debris into to the T3H and related equipment can cause fire or malfunction. Pay attention to prevent entering them into the T3H and related equipment during installation and wiring.

Wiring:

⚠ CAUTION

1. Turn off power before wiring to minimize the risk of electrical shock.

2. Exposed conductive parts of wire can cause electrical shock. Use crimp-style terminals with insulating sheath or insulating tape to cover the conductive parts. Also close the terminal covers securely on the terminal blocks when wiring has been completed.

3. Operation without grounding may cause electrical shock or malfunction. Connect the ground terminal on the T3H to the system ground.

4. Applying excess power voltage to the T3H can cause explosion or fire. Apply power of the specified ratings described in the T3 User's Manual - Hardware.

5. Improper wiring can cause fire, electrical shock or malfunction. Observe local regulations on wiring and grounding.

Safety Precautions

Operation:

⚠ WARNING

1. Configure emergency stop and safety interlocking circuits outside the T3H. Otherwise, malfunction of the T3H can cause injury or serious accidents.

⚠ CAUTION

2. Operate the T3H and the related modules with closing the terminal covers. Keep hands away from terminals while power on, to avoid the risk of electrical shock.

3. When you attempt to perform force outputs, RUN/HALT controls, etc. during operation, carefully check for safety.

4. Turn on power to the T3H before turning on power to the loads. Failure to do so may cause unexpected behavior of the loads.

5. Set operation mode switches of the T3H and I/O modules. Improper switch settings may cause malfunction of the T3H and related equipment.

6. Do not use any modules of the T3H for the purpose other than specified. This can cause electrical shock or injury.

7. Configure the external circuit so that the external power required for output modules and power to the loads are switched on/off simultaneously.
   Also, turn off power to the loads before turning off power to the T3H.

8. Install fuses appropriate to the load current in the external circuits for the relay output modules. Failure to do so can cause fire in case of load over-current.

9. Check for proper connections on wires, connectors and modules. Insufficient contact can cause malfunction or damage to the T3H and related equipment.

10. Turn off power immediately if the T3H is emitting smoke or odor. Operation under such condition can cause fire or electrical shock.
    Also unauthorized repairing will cause fire or serious accidents. Do not attempt to repair. Contact Toshiba for repairing.

Safety Precautions

Maintenance:

⚠ CAUTION

1. Do not charge, disassemble, dispose in a fire nor short-circuit the batteries. It can cause explosion or fire. Observe local regulations for disposal of them.

2. Turn off power before removing or replacing units, terminal blocks or wires. Failure to do so can cause electrical shock or damage to the T3H and related equipment.

3. Replace a blown fuse with a specified one. Failure to do so can cause fire or damage to the T3H.

4. Perform daily checks, periodical checks and cleaning to maintain the system in normal condition and to prevent unnecessary troubles.

5. Check by referring “Troubleshooting” section of the T3 User’s Manual - Hardware, when operating improperly. Contact Toshiba for repairing if the T3H or related equipment is failed. Toshiba will not guarantee proper operation nor safety for unauthorized repairing.

6. The contact reliability of the relays used in the relay output module will reduce if the switching exceeds the specified life. Replace the module if exceeded.

7. Replace the battery every 2 years to maintain the T3H’s program and data normally.

8. Do not modify the T3H and related equipment in hardware nor software. This can cause fire, electrical shock or injury.

9. Pay special attention for safety if you attempt to measure circuit voltage at the T3H’s terminal.

10. Turn off power before replacing modules. Failure to do so can cause electrical shock or damage to the T3H and related equipment.
    If you attempt to replace an I/O module while power on (by using on-line I/O replacement function), carefully check for safety.

Safety Precautions

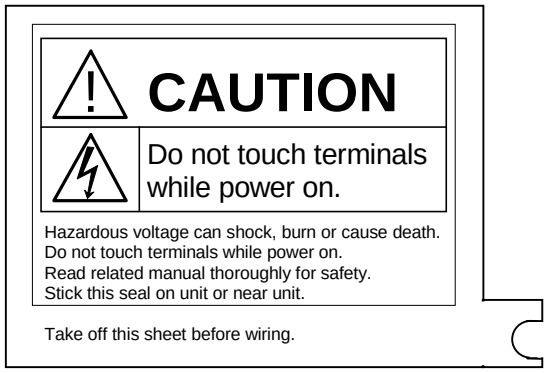
Safety Label

The safety label as shown on the right is attached to the power terminal of the T3H.

Remove the mount paper before wiring.

Peel off the label from the mount paper and stick it near the power terminals where it can be readily seen.

Contact Toshiba if the label is damaged.



About This Manual

About This Manual

The T3H is a high speed and large capacity version of the T3. All the hardware components used for the T3 system, i.e. rack, power supply module, I/O modules, etc., are used with the T3H CPU. Regarding software function, the T3H has all the T3's functions and has some expanded functions.

This manual explains the expanded functions of the T3H and functional differences between the T3H and the T3. Therefore, for your better understanding of the T3H, read the following T3 manuals at first to understand the T3 system, then read this manual.

T3 manuals:

T3 User's Manual – Hardware	UM-TS03∗∗∗-E002
T3 User's Manual – Function	UM-TS03∗∗∗-E003
T-series Instruction Set	UM-TS03∗∗∗-E004
T-series Computer Link Operation Manual	UM-TS03∗∗∗-E008
T3 Analog Input Module (AD368)	UM-TS03∗∗∗-E016
T3 Analog Output Module (DA364/DA374)	UM-TS03∗∗∗-E017
T3 Pulse Input Module (PI312)	UM-TS03∗∗∗-E018
T3 ASCII Module (AS311)	UM-TS03∗∗∗-E020

Terminology

The following is a list of abbreviations and acronyms used in this manual.

µs	microsecond
ASCII	American Standard Code For Information Interchange
AWG	American Wire Gage
BCC	Block Check Code
CPU	Central Processing Unit
EEPROM	Electrically Erasable Programmable Read Only Memory
H	hexadecimal (when it appears in front of an alphanumeric string)
I/O	Input/Output
LED	Light Emitting Diode
LSB	Least Significant Bit
ms	millisecond
MSB	Most Significant Bit
RAM	Random Access Memory
ROM	Read Only Memory
SFC	Sequential Function Chart
Vac	AC voltage
Vdc	DC voltage

Contents

Section 1

T3H Overview

1. T3H Overview

1.1 Introducing the T3H

The T3H is a high performance large scale programmable controller.

Program memory capacity:
The T3H is available in two CPU types, PU325H and PU326H. Each type has the following user program memory capacity.

PU325H: 32 k steps
PU326H: 64 k steps

I/O points:
The T3H can handle up to 76 I/O modules in its local configuration. And the T3H has 512 words of external I/O register (data memory).
If all the I/O modules are discrete I/Os, the T3H can control up to 4864 points.
(64 points × 76 = 4864 points)
If all the I/O modules are analog I/Os, the T3H can control up to 512 channels of analog signals.

High speed processing:
A standard 16-bit micro processor and a special designed language processor are used in the T3H CPU. This dual-processor architecture provides high speed processing.

0.09 μs/contact	0.18 μs/coil
0.54 μs/16-bit transfer	0.90 μs/16-bit addition

Multitasking:
The T3H supports the multitask processing. By using this function, suitable control interval for a target application can be obtained.

1 × internal timer interrupt (interval setting: 1 to 1000 ms, 1 ms units)
8 × I/O interrupts (activated by external events)
1 × main program (core of the user program)
4 × sub-programs (activated from other tasks and executed as back-ground job)

Multiple programming languages:
The T3H supports two types of programming languages, i.e. ladder diagram and SFC (Sequential Function Chart). The ladder diagram is suited for logic control, and the SFC is suited for sequential control. These languages can be used in mixture.

High performance software:
The T3H supports 24 basic ladder instructions and 204 function instructions. Floating points data processing is also available. The T3H can be applied to complex control applications.

Network support:
The T3H can be connected to work-stations/personal-computers through Ethernet. Peer-to-peer communications between two T3H's via Ethernet is also available.
For high-speed control-data linkage, TOSLINE-S20/F10 can be used.

1.2 Differences between T3H and T3

The table below summarizes the differences between the T3H and T3. All other functions supported by the T3 can also be supported by the T3H as same.

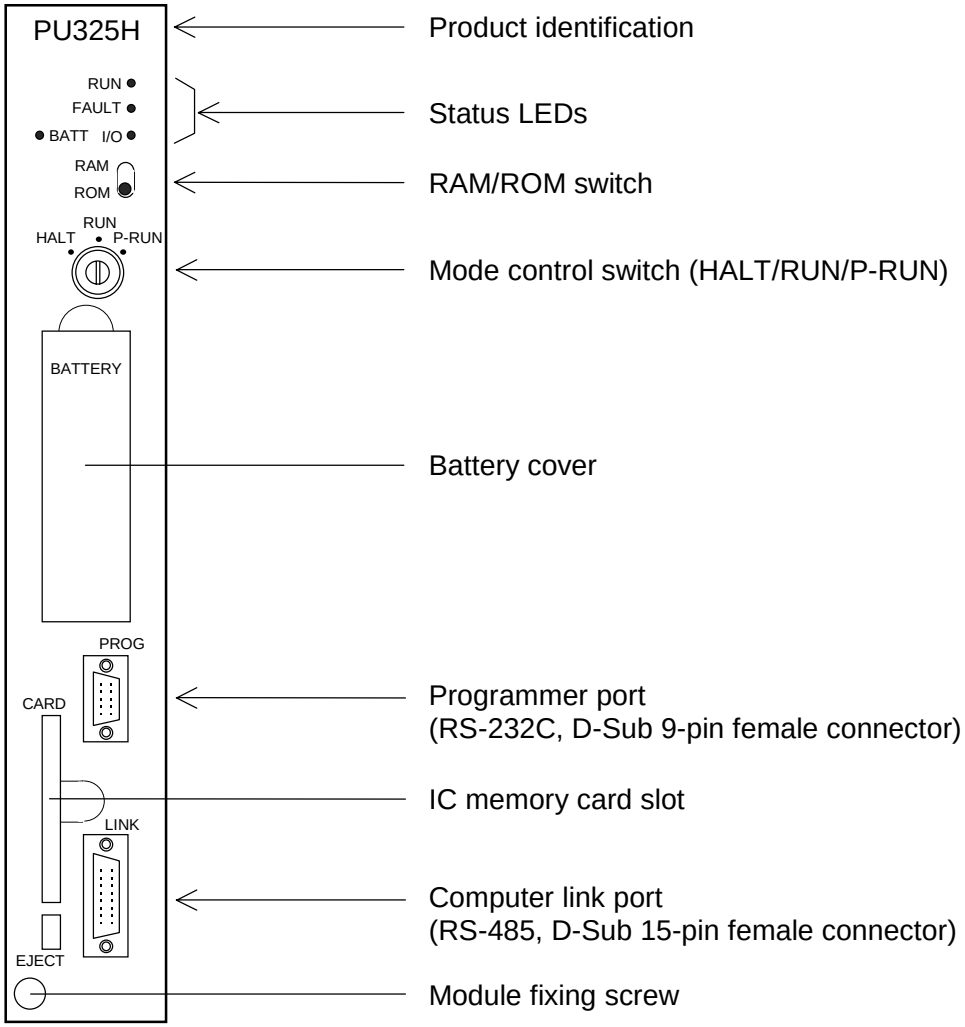
Item		T3H	T3
Program memory capacity		32 k steps (PU325H) 64 k steps (PU326H)	32 k steps (PU315 and PU325)
Built-in EEPROM		Yes (PU325H and PU326H)	No (PU315) Yes (PU325)
Programming instructions		All T3's instructions plus FUN042 D∗/ FUN156 PID3 FUN232 FPID3 FUN239 SEND FUN240 RECV	–
Execution speed (μs)		0.09 / contact 0.18 / coil 0.9 / addition	0.15 / contact 0.3 / coil 1.5 / addition
Max. number of I/O modules supported in local		76 modules (when IF321 is used)	43 modules
System operation	Timer interrupt interval setting	1 to 1000 ms, 1 ms units	2 to 1000 ms, 1 ms units
	Auto-RUN / standby selection	Software setting (system information)	Hardware switch (RAM/ROM switch)
User data	External I/O (X/XW, Y/YW)	8192 points / 512 words	4096 points / 256 words
	Auxiliary register (R/RW)	16000 points / 1000 words	8192 points / 512 words
	Special register (S/SW)	4096 points / 256 words	Same as left
	Timer (T./T)	1000 points (proportion of 0.1s and 0.01s timer is user definable)	512 points (T000 - T063: 0.1s) (T064 - T511: 0.01s)
	Counter (C./C)	512 points	Same as left
	Data register (D)	8192 words	Same as left
	Link register (Z/W) (for TOSLINE-S20)	16000 points / 2048 words (bit access available for leading 1000 words)	8192 points / 1024 words (bit access available for leading 512 words)
	Link register (L/LW) (for TOSLINE-F10)	4096 points / 256 words	Same as left
	File register (F)	32768 words	8192 words
	Index register (I, J, K)	3 words	Same as left
Programming tool		T-PDS	T-PDS and HP911
Networking		Ethernet, TOSLINE-S20, TOSLINE-F10, RS-485 computer link	TOSLINE-S20, TOSLINE-F10, RS-485 computer link

1.3 T3H components

(1) CPU module

Two types of T3H CPU modules are available.

Type	Description
PU325H	EEPROM + RAM (battery backed), User program 32 k steps, Ladder diagram and SFC
PU326H	EEPROM + RAM (battery backed), User program 64 k steps, Ladder diagram and SFC



The external feature of the T3H CPU is the same as the T3 CPU except for the product identification.

Status LEDs:

RUN (green)	Lit	User program is being executed (RUN mode)
	Blink	User program execution is stopped (HOLD mode)
	Not lit	User program execution is stopped (HALT or ERROR mode)
FAULT (red)	Lit	CPU or program error
	Blink	Hardware initialization error
	Not lit	Normal
I/O (red)	Lit	I/O error
	Blink	Hardware initialization error
	Not lit	Normal
BATT (green)	Lit	Battery voltage is normal
	Not lit	Battery voltage is low (battery replacement is required)

RAM/ROM switch:

RAM	User program stored in RAM is used. (Program transfer from EEPROM to RAM is not executed)
ROM	At the beginning of RUN mode, user program stored in EEPROM is transferred to RAM. (It is called Initial load) If an IC memory card which contains user program has been installed, the IC memory card becomes transfer source. (If mode control switch is in P-RUN, the initial load is not executed)

Note) In case of T3, the RAM/ROM switch has the function of auto-RUN/standby selection in addition to the initial load selection.
However, in case of T3H, the RAM/ROM switch only has the function of initial load selection as mentioned above.

Mode control switch:

HALT	User program execution is stopped. (HALT mode) Normally, programming is performed in the HALT mode. T3H operation mode control by programmer is not allowed.
RUN	T3H executes user program cyclically. (RUN mode) It is the normal switch position under operation. Even in the RUN mode, program changes are possible. However, saving into the EEPROM is available only in the HALT mode. T3H operation mode control by programmer is possible.
P-RUN	T3H executes user program cyclically. (RUN mode) User program and the leading 4 k words of D register (D0000 to D4095) are write-protected. T3H operation mode control by programmer is possible.

Note) In case of T3, even in P-RUN, data writing into D0000 to D4095 by instruction is allowed except for some instructions.
However, in case of T3H, data writing into D0000 to D4095 by instruction is inhibited if in P-RUN.

1. T3H Overview

Battery cover:
A battery has been installed inside this cover at the factory shipment. The battery keeps the RAM contents (user program and user data), and supports the clock-calendar operation during power off.
The same battery as the T3's is used.

Programmer port:
The programmer (T-PDS) is connected to the T3H through this port.
The same connection cable as the T3's is used.

Computer link port:
The T3H CPU module has the computer link function as standard. This port is used to connect between T3H and a computer.
The T-series computer link protocol is supported by T3H.

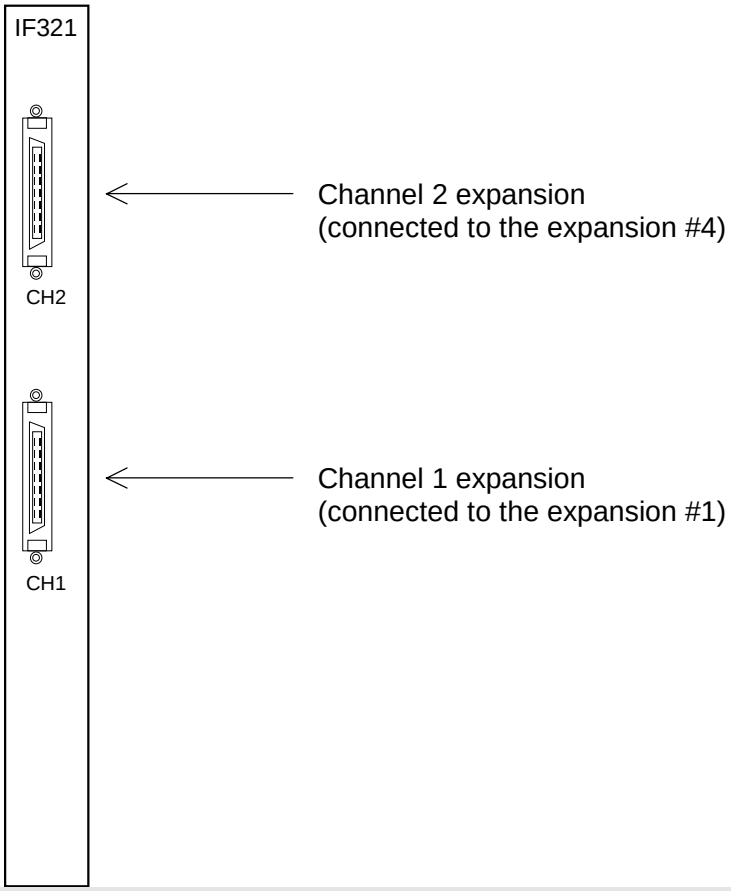
IC memory card slot:
Optional IC memory card (type: ME914) can be used with the T3H.
By using the IC memory card, user program saving/loading or user data expansion is available.

For details of the operation mode and functions, refer to the T3 User's Manual.

(2) Expansion interface module

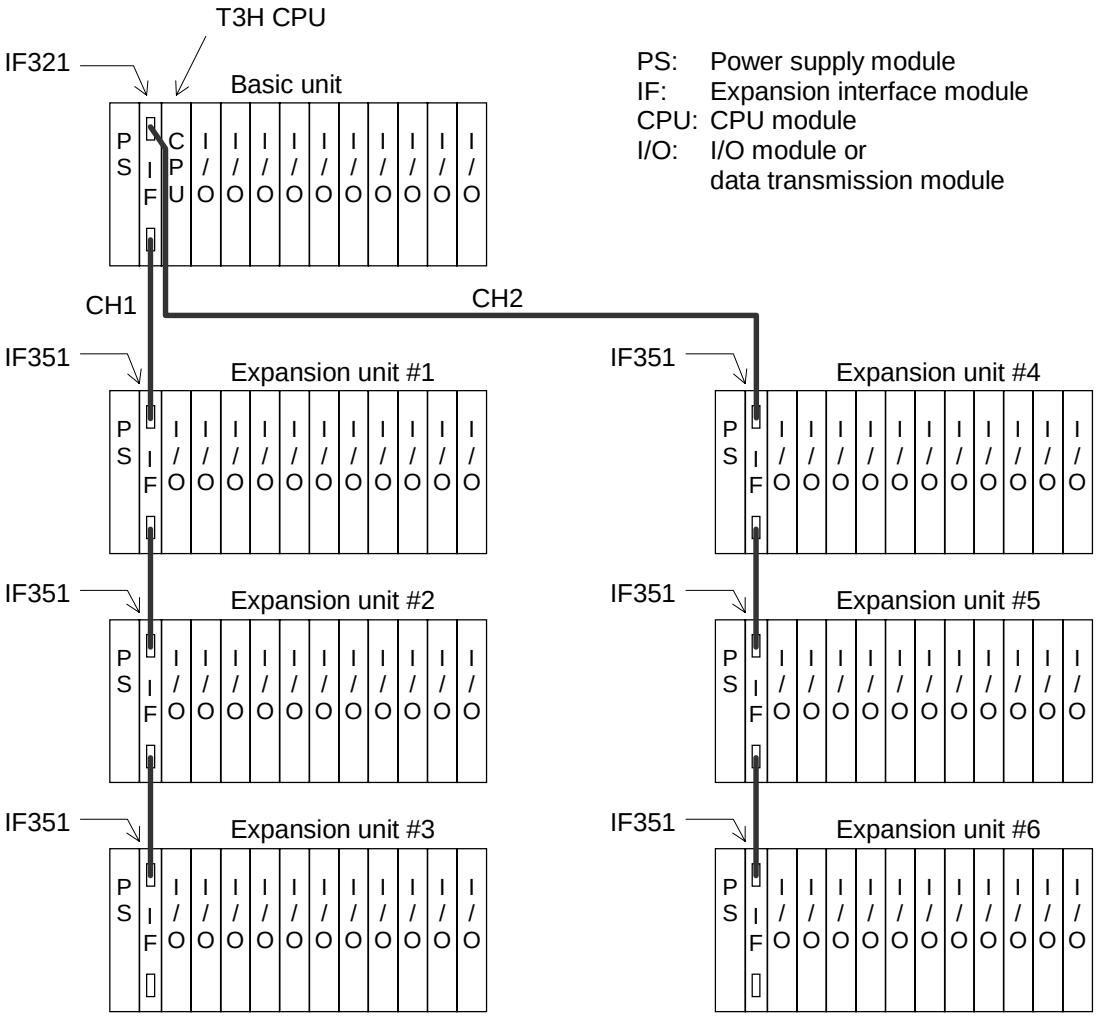
The expansion interface modules for the T3, i.e. IF311, IF351, IF312, IF352 and IF353, are also used with the T3H. When the IF311 or IF312 is used with the T3H, up to three expansion units can be connected, as same as the T3.
On the other hand, the IF321 is a dedicated expansion interface module for the T3H. When the IF321 is used instead of the IF311, up to 6 expansion units can be connected. In the maximum configuration, the T3H can control up to 76 I/O modules.

Type	Description		Remarks
IF321	For basic unit (2 channels)	Standard expansion type. 2 m max. between units, 6 m max. in total cable length for each channel.	Only for T3H
IF311	For basic unit (1 channel)		T3/T3H common
IF351	For expansion unit		
IF312	For basic unit	Long-distance expansion type. 40 m max. in cable length. (one channel only)	
IF352	For middle expansion unit		
IF353	For end expansion unit		



1. T3H Overview

The figure below shows the T3H's maximum expansion configuration.



In this configuration, the T3H can handle up to 76 I/O modules. If 64 points I/O modules are mounted on all the I/O slots (76 slots), the T3H can control up to 4864 points of discrete I/O.

NOTE

The unit configuration using other expansion interface modules are the same as that of T3. Refer to the T3 User's Manual.

(3) Power supply module

The power supply module for the T3 is also used with the T3H. The following two types are available depending on power voltage.

Type	Rated voltage	Frequency
PS361	100 - 120 Vac/200 - 240 Vac (selectable)	50/60 Hz
PS332	24 Vdc	–

NOTE For details, refer to the T3 User's Manual.

(4) Rack

The rack (base board) for the T3 is also used with the T3H. The following four types are available.

Type	Number of slot	Use
BU31A	1 for PS, 1 for IF, 1 for CPU, 10 for I/O's	For basic unit
BU315	1 for PS, 1 for IF, 1 for CPU, 5 for I/O's	
BU35B	1 for PS, 1 for IF, 11 for I/O's	For expansion unit
BU356	1 for PS, 1 for IF, 6 for I/O's	

NOTE For details, refer to the T3 User's Manual.

(5) Expansion cable

The following types of the expansion cables are available.

Type	Cable length	Remarks
CS3R5	0.5 m	For standard expansion. With both-end connectors (50-pin)
CS301	1 m	
CS302	2 m	
CL3R5	0.5 m	For long-distance expansion. With both-end connectors (68-pin)
CL301	1 m	
CL305	5 m	
CL310	10 m	
CL320	20 m	
CL340	40 m	

NOTE For details, refer to the T3 User's Manual.

(6) I/O module

The following types of I/O modules are available.

Type	Description	
DI334	DC input	32 points input (8 points/common), 12 to 24 Vdc, 10 mA/point
DI334H		32 points input (8 points/common), 12 to 24 Vdc, 10 mA/point, high-speed response
DI335		64 points input (8 points/common), 24 Vdc, 5 mA/point (connector type)
DI335H		64 points input (8 points/common), 24 Vdc, 5 mA/point, high-speed response (connector type)
IN354	AC input	32 points input (8 points/common), 100 to 120 Vac, 10 mA/point
IN364		32 points input (8 points/common), 200 to 240 Vac, 10 mA/point
DO333	DC output	16 points output (8 points/common), 12 to 24 Vdc, 2 A/point, 5 A/common
DO334		32 points output (16 points/common), 12 to 24 Vdc, 0.5 A/point, 5 A/common
DO335		64 points output (8 points/common), 5 to 24 Vdc, 0.1 A/point (connector type)
AC363	AC output	16 points output (8 points/common), 100 to 240 Vac, 2 A/point, 5 A/common
AC364		32 points output (16 points/common), 100 to 240 Vac, 0.5 A/point, 3.2 A/common, 5 A/module
RO364	Relay output	32 points output (8 points/common), 240 Vac/24 Vdc, 2 A/point, 5 A/common
RO363S		16 points output (isolated contact), 240 Vac/24 Vdc, 2 A/point
AD368	Analog I/O	8 channels analog input, ±5 V, ±10 V, 0 - 5 V, 0 - 10 V, 1 - 5 V, ±20 mA, 0 - 20 mA, or 4 - 20 mA, 12-bit resolution
DA364		4 channels analog output, ±5 V, ±10 V, 0 - 5 V, 0 - 10 V, or 1 - 5 V, 12-bit resolution
DA374		4 channels analog output, 0 - 20 mA or 4 - 20 mA, 12-bit resolution
PI312	Special I/O	2 channel pulse input, 5/12 V, 50 kHz (max.), 24-bit counter, interrupt function
AS311		Communication interface, 2 port of RS-232C/RS-422, full-duplex, ASCII code, no protocol, 300 / 600 / 1200 / 2400 / 4800 / 9600 / 19200 bps
CD332		Change detect DC input, 8 points input, 12 to 24 Vdc, 10 mA/point, interrupt function

For detailed specifications, refer to the T3 User's Manual.

(7) Data transmission module

The following types of data transmission modules are available.

Type	Description			Remarks
EN311	Ethernet	10BASE5 or 10BASE2, 10 Mbps, computer link, T3H to T3H, and socket service		Only for T3H
SN321	TOSLINE-S20	High-speed control data link, 2 Mbps	Co-axial	T3/T3H common
SN322			Optical	
SN323			Co-axial/optical	
SN325	TOSLINE-S20LP	High-speed control data link, 2 Mbps, 4 k words scan memory, optical loop		Only for T3H
MS311	TOSLINE-F10	Field network, 750 k bps	Master station	T3/T3H common
RS311			Remote station	

NOTE

(1) Maximum number of modules available on one T3H is as follows.
Ethernet: 4
TOSLINE-S20 and S20LP total: 2
TOSLINE-F10: 8

(2) Ethernet module and TOSLINE-S20LP are under development.

(8) Module internal current consumption

The table below shows the internal 5 Vdc current consumption (max. value) of each T3H module. Use this data to check the power capacity.

Type		Internal 5 Vdc consumption
CPU	PU325H	1.5 A
	PU326H	1.5 A
Expansion I/F	IF321	40 mA
	IF311	20 mA
	IF351	20 mA
	IF312	800 mA
	IF352	700 mA
	IF353	700 mA
DC input	DI334	100 mA
	DI334H	100 mA
	DI335	170 mA
	DI335H	170 mA
AC input	IN354	120 mA
	IN364	120 mA
DC output	DO333	320 mA
	DO334	210 mA
	DO335	400 mA

Type		Internal 5 Vdc consumption
AC output	AC363	530 mA
	AC364	800 mA
Relay output	RO364	170 mA
	RO363S	100 mA
Analog input	AD368	450 mA
Analog output	DA364	180 mA
	DA374	180 mA
Pulse input	PI312	800 mA
ASCII	AS311	1.0 A
Change detect	CD332	300 mA
Ethernet	EN311	700 mA
TOSLINE-S20	SN321	800 mA
	SN322	800 mA
	SN323	800 mA
TOSLINE-S20LP	SN325	800 mA
TOSLINE-F10	MS311	600 mA
	RS311	600 mA

1.4 Specifications

Functional specifications

Type			PU325H	PU326H
Control method			Stored program, cyclic scan system	
Scan system			Floating scan or constant scan (10 - 200 ms, 10 ms units)	
I/O update			Batch I/O refresh (direct I/O instruction available)	
Program memory			Main memory: RAM (battery backed) Auxiliary memory: EEPROM (built-in), IC card (option)	
Program capacity			32 k steps	64 k steps
Programming language			Ladder diagram with function block, SFC (sequential function chart)	
Instructions		Ladder	Basic instructions: 24 types, Function instructions: 206 types	
		SFC	Step, transition, sequence selection, simultaneous sequences, jump, etc.	
Execution speed			0.09 μs/contact, 0.18 μs/coil, 0.54 μs/transfer, 0.90 μs/addition	
Multitasking			1 Main program 4 Sub-program 1 Timer interrupt (1 - 1000 ms, 1 ms units) 8 I/O interrupt (task switch 500 μs or less) 256 Subroutine	
I/O capacity			2432 points (using 32 points I/O modules) 4864 points (using 64 points I/O modules) Local I/O space: 8192 points / 512 words (X/XW and Y/YW: batch I/O) (I/IW and O/OW: direct I/O)	
User data	Auxiliary relay		16000 points / 1000 words (R/RW)	
	Special relay		4096 points / 256 words (S/SW)	
	Timer		1000 points (T./T) (proportion of 0.01s and 0.1s timer is user definable)	
	Counter		512 points (C./C)	
	Data register		8192 words (D) (leading 4096 words are stored in EEPROM)	
	Link register		16000 points / 2048 words (Z/W) (for TOSLINE-S20)	
	Link relay		4096 points / 256 words (L/LW) (for TOSLINE-F10)	
	File register		32768 words (F)	
	Index register		3 words (I, J, K)	
	Retentive memory		F register and user defined ranges of RW, T, C, D	
RAS	Self-diagnosis		Power interruption, main/expansion power failure, CPU/RAM/ROM check, I/O response, I/O bus check, I/O registration, I/O parity, battery level, watch dog timer, program check, others	
	Monitoring		Event history record, scan time measurement, others	
	Debugging		On-line trace monitor, force, sampling trace, status latch, single step/N scan execution, break point, others	
RAM data back-up			Lithium battery (type: TBT911∗AS) Recommended replacement: every 2 years	

Instruction execution speed

FUN No.	Name	Symbol	Execution time (μs)
	NO contact	┤ ├	0.09
	NC contact	┤/├	0.09
	Transitional contact (rising)	┤↑├	0.36
	Transitional contact (falling)	┤↓├	0.36
	Coil	-( )┤	0.18
	Forced coil	×-( )┤	0.09
	Inverter	┤I├	0.09
	Invert coil	-(I)┤	0.18
	Positive pulse contact	┤P├	0.36
	Negative pulse contact	┤N├	0.36
	Positive pulse coil	-(P)┤	0.36
	Negative pulse coil	-(N)┤	0.36
	Jump control set	JCS	0.09
	Jump control reset	JCR	0.09
	End	END	–
	ON-delay timer	TON	0.18
	OFF-delay timer	TOF	0.18
	Single-shot timer	SS	0.18
	Counter	CNT	0.18
	Master control set	MCS	0.09
	Master control reset	MCR	0.09
18	Data transfer	MOV	0.54
19	Double-word data transfer	DMOV	4.14
20	Invert transfer	NOT	3.6
21	Double-word invert transfer	DNOT	4.32
22	Data exchange	XCHG	6.12
23	Double-word data exchange	DXCH	7.56
24	Table initialization	TINZ	15.5 +0.37n
25	Table transfer	TMOV	24.32 +0.49n
26	Table invert transfer	TNOT	24.44 +0.58n
27	Addition	+	0.9
28	Subtraction	–	0.9
29	Multiplication	*	2.61
30	Division	/	4.59

FUN No.	Name	Symbol	Execution time (μs)
31	Double-word addition	D+	6.1
32	Double-word Subtraction	D–	6.1
33	Double-word Multiplication	D*	6.22
34	Double-word division	D/	9.85
35	Addition with carry	+C	6.29
36	Subtraction with carry	–C	6.29
37	Double-word addition with carry	D+C	7.21
38	Double-word subtraction with carry	D–C	7.21
39	Unsigned multiplication	U*	7.37
40	Unsigned division	U/	7.77
41	Unsigned double/ single division	DIV	8.67
42	Double-word multiplication and division	D*/	61.07
43	Increment	+1	3.23
44	Double-word increment	D+1	4.11
45	Decrement	–1	3.23
46	Double-word decrement	D–1	4.11
48	AND	AND	4.84
49	Double-word AND	DAND	5.92
50	OR	OR	4.84
51	Double-word OR	DOR	5.92
52	Exclusive OR	EOR	4.84
53	Double-word Exclusive OR	DEOR	5.92
54	Not exclusive OR	ENR	4.84
55	Double-word Not exclusive OR	DENR	5.92
57	Table AND	TAND	23.31 +0.72n
58	Table OR	TOR	23.31 +0.72n

Instruction execution speed (continued)

FUN No.	Name	Symbol	Execution time (µs)
59	Table Exclusive OR	TEOR	23.31 +0.72n
60	Table Not exclusive OR	TENR	23.31 +0.72n
64	Bit test	TEST	3.76
65	Double-word bit test	DTST	4.68
66	Bit file bit test	TTST	8.98
68	1 bit shift right	SHR1	4.12
69	1 bit shift left	SHL1	4.68
70	n bit shift right	SHR	4.77 +0.27n
71	n bit shift left	SHL	5.33 +0.27n
72	m bit file n bit shift right	TSHR	(Word) 14.59 -0.08n +0.45m (Bit) 21.3 -0.02n +0.06m
73	m bit file n bit shift left	TSHL	(Word) 14.96 -0.09n +0.45m (Bit) 21.44 -0.04n +0.06m
74	Shift register	SR	16.21 +0.11n
75	Bi-directional shift register	DSR	16.42 +0.14n
76	Device shift	SFT	12.82
78	1 bit rotate right	RTR1	4.31
79	1 bit rotate left	RTL1	4.15
80	n bit rotate right	RTR	5.49 +0.1n
81	n bit rotate left	RTL	5.11 +0.1n
82	m bit file n bit rotate right	TRTR	(Word) 16.23 +0.45n +0.45m (Bit) 23.1 +0.12n +0.06m
83	m bit file n bit rotate left	TRTL	(Word) 16.21 +0.46n +0.45m (Bit) 23.15 +0.12n +0.06m
84	1 bit rotate right with carry	RRC1	4.69
85	1 bit rotate left with carry	RLC1	4.15
86	n bit rotate right with carry	RRC	4.59 +0.81n
87	n bit rotate left with carry	RLC	5.44 +0.72n
88	m bit file n bit rotate right with carry	TRRC	(Word) 16.24 +0.43n +0.45m (Bit) 25.49 +0.12n +0.05m
89	m bit file n bit rotate left with carry	TRLC	(Word) 16.21 +0.46n +0.45m (Bit) 28.55 +0.07n +0.05m
90	Multiplexer	MPX	9.74
91	Demultiplexer	DPX	8.86
92	Table bit transfer	TBM	12.44
93	Bit table transfer	BTM	11.54
95	Bit file compare	TCMP	18.03
96	Greater than	>	3.76
97	Greater than or equal	>=	3.76
98	Equal	=	3.76
99	Not equal	<>	3.76
100	Less than	<	3.76
101	Less than or equal	<=	3.76
102	Double-word greater than	D>	4.84
103	Double-word greater than or equal	D>=	4.48

Instruction execution speed (continued)

FUN No.	Name	Symbol	Execution time (µs)
104	Double-word equal	D=	4.48
105	Double-word not equal	D<>	4.48
106	Double-word less than	D<	4.84
107	Double-word less than or equal	D<=	4.48
108	Unsigned greater than	U>	3.76
109	Unsigned greater than or equal	U>=	3.76
110	Unsigned equal	U=	3.76
111	Unsigned not equal	U<>	3.76
112	Unsigned less than	U<	3.76
113	Unsigned less than or equal	U<=	3.76
114	Device/register set	SET	(Device) 3.6 (Register) 2.32
115	Device/register reset	RST	(Device) 3.6 (Register) 2.52
116	Table bit set	TSET	9.42
117	Table bit reset	TRST	9.62
118	Set carry	SETC	1.26
119	Reset carry	RSTC	1.26
120	Encode	ENC	19.55 +2.91n
121	Decode	DEC	10.68 +2.48n
122	Bit count	BC	10.56
123	Double-word bit count	DBC	18.16
124	Data search	SCH	12.47 +0.9n
125	Push	PUSH	9.99 +0.47n
126	Pop last	POPL	10.9 +0.46n
127	Pop first	POPF	11.46
128	Subroutine call	CALL	9.24
129	Subroutine return	RET	
130	Jump	JUMP	3.24
132	Loop FOR	FOR	6.17
133	Loop NEXT	NEXT	+2.71n

FUN No.	Name	Symbol	Execution time (µs)
134	Master control set n	MCSn	4.9
135	Master control reset n	MCRn	
136	Jump label	LBL	–
137	Subroutine entry	SUBR	0.18
140	Enable interrupt	EI	53.28
141	Disable interrupt	DI	52.88
142	Interrupt return	IRET	–
143	Watch dog timer reset	WDT	62.78
144	Step sequence initialize	STIZ	5.0 +0.02n
145	Step sequence input	STIN	3.22
146	Step sequence output	STOT	5.67 +2.44n
147	Flip-flop	F/F	3.78
148	Timer trigger	TRG	2.89
149	Up/down counter	U/D	2.26
150	Diagnostic display	DIAG	10.98 +0.02n
151	Diagnostic reset	DIAR	6.41 +1.31n
152	Status latch set	STLS	320.48 +12.94n
153	Status latch reset	STLR	47.18
154	Set calendar	CLND	201.98
155	Calendar operation	CLDS	382.48
156	Essential PID	PID3	
158	Drum sequencer	DRUM	16.46 +0.02m
159	Cam sequencer	CAM	9.88 +4.62n
160	Upper limit	UL	5.04
161	Lower limit	LL	5.04
162	Maximum value	MAX	8.89 +0.72n
163	Minimum value	MIN	8.89 +0.81n
164	Average value	AVE	9.79 +1.03n
165	Function generator	FG	10.09 +1.14n
166	Dead band	DB	6.12
167	Square root	RT	80.26
168	Integral	INTG	17.64
169	Ramp function	RAMP	12.24
170	PID	PID	17.78

Instruction execution speed (continued)

FUN No.	Name	Symbol	Execution time (μs)
171	Deviation square PID	PID2	25.28
172	Sine function	SIN	14.94
173	Cosine function	COS	15.44
174	Tangent function	TAN	4.24
175	Arc-sine function	ASIN	4.64
176	Arc-cosine function	ACOS	5.04
177	Arc-tangent function	ATAN	192.28
178	Exponential function	EXP	169.28
179	Logarithm	LOG	217.28
180	Absolute value	ABS	3.76
181	Double-word absolute value	DABS	4.32
182	2's complement	NEG	3.6
183	Double-word 2's complement	DNEG	4.68
184	Double-word conversion	DW	4.12
185	7-segment decode	7SEG	3.76
186	ASCII conversion	ASC	9.29 +0.33n
188	Binary conversion	BIN	13.86
189	Double-word binary conversion	DBIN	32.58
190	BCD conversion	BCD	13.86
191	Double-word BCD conversion	DBCD	13.52
192	BCD addition	B+	25.26
193	BCD subtraction	B–	25.26
194	BCD multiplication	B*	39.66
195	BCD division	B/	34.86
196	Double-word BCD addition	DB+	48.86
197	Double-word BCD subtraction	DB–	46.86
198	Double-word BCD multiplication	DB*	106.88
199	Double-word BCD division	DB/	86.12
200	BCD addition with carry	B+C	25.92
201	BCD subtraction with carry	B–C	26.12
202	Double-word BCD addition with carry	DB+C	47.32

FUN No.	Name	Symbol	Execution time (μs)
203	Double-word BCD subtraction with carry	DB–C	48.12
204	Floating point conversion	FLT	5.03
205	Fixed point conversion	FIX	5.03
206	Floating point absolute value	FABS	4.5
207	Floating point sign inversion	FNEG	4.68
208	Floating point addition	F+	14.44
209	Floating point subtraction	F–	14.82
210	Floating point multiplication	F*	12.08
211	Floating point division	F/	12.06
212	Floating point greater than	F>	7.2
213	Floating point greater than or equal	F>=	7.2
214	Floating point equal	F=	6.31
215	Floating point not equal	F<>	6.31
216	Floating point less than	F<	7.22
217	Floating point less than or equal	F<=	7.18
218	Floating point upper limit	FUL	8.46
219	Floating point lower limit	FLL	8.5
220	Floating point dead band	FDB	20.68
221	Floating point square root	FRT	54.3
222	Floating point PID	FPID	201.98
223	Floating point deviation square PID	FPID2	217.48
224	Floating point sine	FSIN	129.08
225	Floating point cosine	FCOS	148.48

Instruction execution speed (cont'd)

FUN No.	Name	Symbol	Execution time (µs)
226	Floating point tangent	FTAN	259.48
227	Floating point arc-sine	FASIN	213.98
228	Floating point arc-cosine	FACOS	221.98
229	Floating point arc-tangent	FATAN	189.98
230	Floating point exponential	FEXP	141.08
231	Floating point logarithm	FLOG	206.98
232	Floating point essential PID	FPID3	
235	Direct I/O	I/O	*1
236	Expanded data transfer	XFER	*2
237	Special module data read	READ	*3
238	Special module data write	WRITE	*4
239	Network data send	SEND	
240	Network data receive	RECV	
241	SFC initialize	SFIZ	6.95 +0.05n

FUN No.	Name	Execution time (µs)
	SFC initialize	197.48
	SFC initial step	3.15
	SFC step	1.2
	SFC end step	1.26
	SFC macro step	3.96
	SFC wait step	3.81
	SFC alarm step	4.32
	SFC transition	2.24
	SFC end	2.61
	SFC jump	3.21
	SFC macro end	2.61
	SFC label	4.4
	SFC macro entry	1.2
	SFC sequence selection Divergence (I)	2.58
	SFC sequence selection Divergence (II)	2.58
	SFC sequence selection Divergence (III)	2.31
	SFC sequence selection Convergence	0.09
	SFC simultaneous sequences Divergence	0.09
	SFC simultaneous sequences Convergence (I)	2.07
	SFC simultaneous sequences Convergence (II)	3.52

*1 I/O:
6.8+3.05n (Basic unit)
6.45+7.93n (Expansion unit)

*2 XFER:
286.48+4.5n (register → S20 on basic unit)
302.46+9.02n (register → S20 on expansion unit)
394.69+7.49n (S20 on basic unit → register)
417.97+9.51n (S20 on expansion unit → register)
252.44+1.54n (register → EEPROM)
185.88+1.58n (EEPROM → register)
186.75+1.53n (register → IC card)
185.3+1.58n (IC card → register)
179.99+1.09n (register → register)

*3 READ:
261.01+9.97n (Basic unit)
280.62+12.86n (Expansion unit)

*4 WRITE:
252.04+9.93n (Basic unit)
278.57+12.91n (Expansion unit)

NOTE

When index modification, digit designation or direct I/O register (IW/OW) is used for an operand, the additional time is required per one operand as shown below.

Additional time by operand modification (μs)		Operand format		
		Single	Double	Table
Index modification		5.4	6.7	6.7
Digit designation		6.0	10.0	11+3.0(n+1)
Direct I/O	Basic unit	4.3	7.2	3+3.5n
	Expansion unit	8.8	16.2	3+8.0n
Direct I/O with digit designation	Basic unit	14.6	22.3	14+6.26(n+1)
	Expansion unit	23.6	35.8	14+10.76(n+1)

Section 2

Expanded Functions

2. Expanded Functions

2.1 System operation

2.1.1 Auto-RUN / Standby selection

The initial operation mode (HALT or RUN) just after power on is determined by the user-setting status of the Auto-RUN / Standby selection.

When the setting status is;

Auto-RUN: The T3H's initial operation mode is determined by the mode control switch (HALT / RUN / P-RUN). When this switch is in RUN or P-RUN, the T3H moves into RUN mode automatically.

Standby: The T3H stays in HALT mode regardless of the mode control switch (HALT / RUN / P-RUN) after power on. Then the operation mode can be changed manually, i.e. by programmer command or by changing the mode control switch.

The Auto-RUN / Standby selection is included in the system information memory, and the selection is made by using the programmer.

(1) The default setting is Standby.
(2) Different from the T3H, in case of the T3, this selection is made by the hardware switch (RAM/ROM switch).

2.1.2 Timer interrupt interval

In the T3H, the timer interrupt program is available with the interval setting of 1 to 1000 ms in 1 ms increments.
(In case of the T3, it is 2 to 1000 ms in 1 ms increments)

If you use the timer interrupt with 1 ms interval, consider to minimize the execution time of the timer interrupt program. If the interrupt task requires long time, the T3H cannot assign enough time for main program execution. As the result, scan time over error will occur.

In case of the T3H, SFC (Sequential Function Chart) can also be programmed on the interrupt program, as well as Ladder diagram.

2.1.3 Saving the sampling trace condition

The sampling trace function is available on the T3H as well as the T3. In addition to all the sampling trace functions on the T3, the T3H can save the sampling trace condition into the IC memory card. By using this function, the sampling trace data which is collected and saved in the IC memory card on one T3H can be displayed using other T3H via the IC memory card.

This function is used as follows.

T3H which performs sampling (data collection):
- Install the IC memory card in the T3H CPU module.
- Set MMR for the PU slot in the I/O allocation in order to use an IC memory card for sampling data storage.
- Set the special device S0620 to ON.
- Edit the sampling trace condition. The edited condition is also saved into the IC memory card.
- Execute the sampling trace. The sampling data is saved into the IC memory card.
- Remove the IC memory card.

T3H which is used to display the sampling data stored in the IC memory card:
- Install the IC memory card in which the sampling trace data is stored.
- Set MMR for the PU slot in the I/O allocation in order to use an IC memory card for sampling trace function.
- Monitor the sampling trace condition. The condition stored in the IC memory card is displayed.
- Display the sampling trace data. The sampling data stored in the IC memory card is displayed.

To copy the sampling data stored in the T3H's file register to an IC memory card, set the special device S0620 to ON and display the sampling trace condition. By this operation, the sampling trace condition and the sampling data stored in file register are copied into the IC memory card.

2. Expanded Functions

2.2 Expanded registers

The T3H has the same types of registers as the T3. However, the address ranges of some registers are expanded in the T3H.
This section explains the expanded registers and the notes.

NOTE

For details of functions of each register/device, refer to the T3 User's Manual.

2.2.1 External I/O register

The T3H can handle up to 76 I/O modules. Accordingly, the T3H has 512 words of external I/O register.

Function type	Type code	Address range	Quantity	Expression example
Input register	XW	000 - 511	Total 512 words	XW280
Output register	YW			YW412
Direct input register	IW			IW280
Direct output register	OW			OW412
Input device	X	0000 - 511F	Total 8192 points	X280A
Output device	Y			Y4128
Direct input device	I			I2809
Direct output device	O			O412C

Regarding the I/O allocation, the channel 1 of the IF321 is assigned to Unit 1 to 3, and the channel 2 of the IF321 is assigned to Unit 4 to 6. The XW/YW registers are assigned in the sequence of Unit 0 → 1 → ... → 6.

2.2.2 Auxiliary register

The T3H has 1000 words of auxiliary register.

Function type	Type code	Address range	Quantity	Expression example
Auxiliary register	RW	000 - 999	1000 words	RW725
Auxiliary device	R	000 - 999F	16000 points	R725B

2.2.3 Timer

The T3H has 1000 points of timer.

Function type	Type code	Address range	Quantity	Expression example
Timer register	T	000 - 999	1000 words	T670
Timer device	T.	000 - 999	1000 points	T.670

The proportion of the 0.01 s base and the 0.1 s base timers within this 1000 points can be specified by user. This setting information is stored in the system information.

10 ms Timer Range Setting:
T000 - T [ ] ← User setting (max. 999)

NOTE

T3H internally, the register ranges T000 to T511 and T512 to T999 are handled separately. Therefore, index modification or table designation across these ranges are not allowed.

For example)

```
├─[ T450  TMOV  (100)  D1000 ]-        Not allowed
          ↓
├─[ T450  TMOV  (62)  D1000 ]-         Allowed
└─[ T512  TMOV  (38)  D1062 ]-
```

2.2.4 Link register

The T3H has 2048 words of link register. This link register is prepared for the TOSLINE-S20 (here called S20).

Function type	Type code	Address range	Quantity	Expression example
Link register	W	0000 - 2047	2048 words	W1500
Link device	Z	0000 - 999F	16000 points	Z847E

The link device Z corresponds to a bit in a link register W. The bit access as Z device is available for the leading 1000 words of W register.

2. Expanded Functions

Regarding the network assignment, the W register is divided into 32 blocks.
(64 words per one block)

The S20 has 1024 words of scan memory. In case of the T3H, even if two S20's are used, the scan memory of each S20 can be fully mapped to the W register. Channel 1 S20 is allocated to the blocks 1 to 16, and channel 2 S20 is allocated to the blocks 17 to 32.

The allocation example below shows the case of all the blocks are set as "LINK".

T3H's link register W	Block	Setting		CH1 S20 scan memory	CH2 S20 scan memory
		CH1	CH2		
W0000 - W0063	1	LINK		0000 - 0063	–
W0064 - W0127	2	LINK		0064 - 0127	
W0128 - W0191	3	LINK		0128 - 0191	
W0192 - W0255	4	LINK		0192 - 0255	
W0256 - W0319	5	LINK		0256 - 0319	
W0320 - W0383	6	LINK		0320 - 0383	
W0384 - W0447	7	LINK		0384 - 0447	
W0448 - W0511	8	LINK		0448 - 0511	
W0512 - W0575	9	LINK		0512 - 0575	
W0576 - W0639	10	LINK		0576 - 0639	
W0640 - W0703	11	LINK		0640 - 0703	
W0704 - W0767	12	LINK		0704 - 0767	
W0768 - W0831	13	LINK		0768 - 0831	
W0832 - W0895	14	LINK		0832 - 0895	
W0896 - W0959	15	LINK		0896 - 0959	
W0960 - W1023	16	LINK		0960 - 1023	
W1024 - W1087	17		LINK	–	0000 - 0063
W1088 - W1151	18		LINK		0064 - 0127
W1152 - W1215	19		LINK		0128 - 0191
W1216 - W1279	20		LINK		0192 - 0255
W1280 - W1343	21		LINK		0256 - 0319
W1344 - W1407	22		LINK		0320 - 0383
W1408 - W1471	23		LINK		0384 - 0447
W1472 - W1535	24		LINK		0448 - 0511
W1536 - W1599	25		LINK		0512 - 0575
W1600 - W1663	26		LINK		0576 - 0639
W1664 - W1727	27		LINK		0640 - 0703
W1728 - W1791	28		LINK		0704 - 0767
W1792 - W1855	29		LINK		0768 - 0831
W1856 - W1919	30		LINK		0832 - 0895
W1920 - W1983	31		LINK		0896 - 0959
W1984 - W2047	32		LINK		0960 - 1023

When “GLOBAL” setting is used, the link registers of “GLOBAL” setting block are assigned to both CH1 and CH2 S20’s.

T3H’s link register W	Block	Setting		CH1 S20 scan memory	CH2 S20 scan memory
		CH1	CH2		
⋮	⋮	⋮	⋮	⋮	⋮
W0192 - W0255	4	LINK		0192 - 0255	−
W0256 - W0319	5	GLOBAL		0256 - 0319	0256 - 0319
W0320 - W0383	6	GLOBAL		0320 - 0383	0320 - 0383
W0384 - W0447	7	GLOBAL		0384 - 0447	0384 - 0447
W0448 - W0511	8	GLOBAL		0448 - 0511	0448 - 0511
W0512 - W0575	9	LINK		0512 - 0575	−
⋮	⋮	⋮	⋮	⋮	⋮
W1216 - W1279	20		LINK	−	0192 - 0255
W1280 - W1343	21				−
W1344 - W1407	22				
W1408 - W1471	23				
W1472 - W1535	24				
W1536 - W1599	25		LINK		0512 - 0575
⋮	⋮	⋮	⋮	⋮	⋮

- The blocks 1 - 16 are dedicated to the CH1 S20, and the blocks 17 - 32 are dedicated to the CH2 S20.
  It is not allowed to assign the blocks 1 - 16 to CH2, and blocks 17 - 32 to CH1.

- For the blocks set as “LINK” or “GLOBAL”, the T3H performs data read from S20 (for data receive area) and data write to S20 (for data send area).
  The data transfer direction (read or write) is automatically decided by the T3H according to the S20’s receive/send setting.

- For the blocks set as “GLOBAL”, the data transfer is as follows.
  1) If CH1 is receive and CH2 is send;
     CH1 receive data is read and written into both W register and CH2.
  2) If CH1 is send and CH2 is receive;
     CH2 receive data is read and written into both W register and CH1.
  3) If both CH1 and CH2 are send;
     W register data is written into both CH1 and CH2.
  4) If both CH1 and CH2 are receive;
     The receive data of “GLOBAL” setting channel is read and stored in W register.

NOTE

In case of TOSLINE-S20LP, it has 4096 words of scan memory. The leading 2048 words can be assigned straight to W register. The following 2048 words can be accessed by using XFER instruction.

2.2.5 File register

The T3H has 32768 words of file register in the CPU module.

Function type	Type code	Address range	Quantity	Expression example
File register	F	0000 - 9999 (10000 - 32767)	32768 words	F9000

For the address range F0000 to F9999, normal direct addressing is available as follows.

–[D1000 MOV F9999]–

However, for the addresses F10000 and after, direct addressing is not possible.
To use this address range with an instruction, the index modification must be used.

```
                    I
–[ D1000  MOV  F0000 ]–      If I=30000, D1000 data is transferred to F30000.
```

2.2.6 Special register

The T3H has 256 words of special register as same as the T3. However, within the address range, some functions are added according to function expansion of the T3H.
The table below shows the added functions on the special register. They are not used with the T3.

Special device	Name	Function
S0500	I/O error map #4-0	ON when I/O error detected in unit 4 - slot 0
S0501	I/O error map #4-1	ON when I/O error detected in unit 4 - slot 1
S0502	I/O error map #4-2	ON when I/O error detected in unit 4 - slot 2
S0503	I/O error map #4-3	ON when I/O error detected in unit 4 - slot 3
S0504	I/O error map #4-4	ON when I/O error detected in unit 4 - slot 4
S0505	I/O error map #4-5	ON when I/O error detected in unit 4 - slot 5
S0506	I/O error map #4-6	ON when I/O error detected in unit 4 - slot 6
S0507	I/O error map #4-7	ON when I/O error detected in unit 4 - slot 7
S0508	I/O error map #4-8	ON when I/O error detected in unit 4 - slot 8
S0509	I/O error map #4-9	ON when I/O error detected in unit 4 - slot 9
S050A	I/O error map #4-10	ON when I/O error detected in unit 4 - slot 10
S050B		Reserve (for future use)
S050C		
S050D		
S050E		
S050F		

Special device	Name	Function
S0510	I/O error map #5-0	ON when I/O error detected in unit 5 - slot 0
S0511	I/O error map #5-1	ON when I/O error detected in unit 5 - slot 1
S0512	I/O error map #5-2	ON when I/O error detected in unit 5 - slot 2
S0513	I/O error map #5-3	ON when I/O error detected in unit 5 - slot 3
S0514	I/O error map #5-4	ON when I/O error detected in unit 5 - slot 4
S0515	I/O error map #5-5	ON when I/O error detected in unit 5 - slot 5
S0516	I/O error map #5-6	ON when I/O error detected in unit 5 - slot 6
S0517	I/O error map #5-7	ON when I/O error detected in unit 5 - slot 7
S0518	I/O error map #5-8	ON when I/O error detected in unit 5 - slot 8
S0519	I/O error map #5-9	ON when I/O error detected in unit 5 - slot 9
S051A	I/O error map #5-10	ON when I/O error detected in unit 5 - slot 10
S051B S051C S051D S051E S051F		Reserve (for future use)
S0520	I/O error map #6-0	ON when I/O error detected in unit 6 - slot 0
S0521	I/O error map #6-1	ON when I/O error detected in unit 6 - slot 1
S0522	I/O error map #6-2	ON when I/O error detected in unit 6 - slot 2
S0523	I/O error map #6-3	ON when I/O error detected in unit 6 - slot 3
S0524	I/O error map #6-4	ON when I/O error detected in unit 6 - slot 4
S0525	I/O error map #6-5	ON when I/O error detected in unit 6 - slot 5
S0526	I/O error map #6-6	ON when I/O error detected in unit 6 - slot 6
S0527	I/O error map #6-7	ON when I/O error detected in unit 6 - slot 7
S0528	I/O error map #6-8	ON when I/O error detected in unit 6 - slot 8
S0529	I/O error map #6-9	ON when I/O error detected in unit 6 - slot 9
S052A	I/O error map #6-10	ON when I/O error detected in unit 6 - slot 10
S052B S052C S052D S052E S052F		Reserve (for future use)

Special device	Name	Function
S0620	Sampling trace copy	Used for saving sampling trace data (ON for active)
S0621 ⋮ S062F		Reserve (for future use)

Special register	Name	Function
SW067	Write protect for SEND/RECV	Used for setting write protect against SEND and RECV instructions

Special register	Name		Function
SW192	TOSLINE-S20 scan healthy map	W1024 - W1039	• The corresponding bit is ON when the W register is updated normally. • The lowest address of W register corresponds to bit 0 in the SW register, and in the order.
SW193		W1040 - W1055	
SW194		W1056 - W1071	
SW195		W1072 - W1087	
SW196		W1088 - W1103	
SW197		W1104 - W1119	
SW198		W1120 - W1135	
SW199		W1136 - W1151	
SW200		W1152 - W1167	
SW201		W1168 - W1183	
SW202		W1184 - W1199	
SW203		W1200 - W1215	
SW204		W1216 - W1231	
SW205		W1232 - W1247	
SW206		W1248 - W1263	
SW207		W1264 - W1279	
SW208		W1280 - W1295	
SW209		W1296 - W1311	
SW210		W1312 - W1327	
SW211		W1328 - W1343	
SW212		W1344 - W1359	
SW213		W1360 - W1375	
SW214		W1376 - W1391	
SW215		W1392 - W1407	
SW216		W1408 - W1423	
SW217		W1424 - W1439	
SW218		W1440 - W1455	
SW219		W1456 - W1471	
SW220		W1472 - W1487	
SW221		W1488 - W1503	
SW222		W1504 - W1519	
SW223		W1520 - W1535	

In case of TOSLINE-S20LP, it does not have the scan healthy map. Therefore these SW registers are not effective for the TOSLINE-S20LP.

Special register	Name		Function
SW224	TOSLINE-S20 scan healthy map	W1536 - W1551	• The corresponding bit is ON when the W register is updated normally. • The lowest address of W register corresponds to bit 0 in the SW register, and in the order.
SW225		W1552 - W1567	
SW226		W1568 - W1583	
SW227		W1584 - W1599	
SW228		W1600 - W1615	
SW229		W1616 - W1631	
SW230		W1632 - W1647	
SW231		W1648 - W1663	
SW232		W1664 - W1679	
SW233		W1680 - W1695	
SW234		W1696 - W1711	
SW235		W1712 - W1727	
SW236		W1728 - W1743	
SW237		W1744 - W1759	
SW238		W1760 - W1775	
SW239		W1776 - W1791	
SW240		W1792 - W1807	
SW241		W1808 - W1823	
SW242		W1824 - W1839	
SW243		W1840 - W1855	
SW244		W1856 - W1871	
SW245		W1872 - W1887	
SW246		W1888 - W1903	
SW247		W1904 - W1919	
SW248		W1920 - W1935	
SW249		W1936 - W1951	
SW250		W1952 - W1967	
SW251		W1968 - W1983	
SW252		W1984 - W1999	
SW253		W2000 - W2015	
SW254		W2016 - W2031	
SW255		W2032 - W2047	

In case of TOSLINE-S20LP, it does not have the scan healthy map. Therefore these SW registers are not effective for the TOSLINE-S20LP.

2.3 Network support function

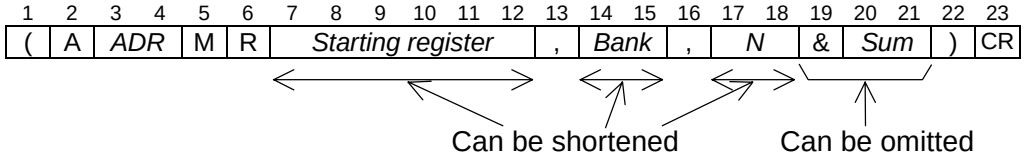
2.3.1 IC memory card data access through computer link

The expanded file register data stored in the IC memory card can be read/written through RS-485 computer link.

There are two types of data storage format for the IC memory card. They are 8 k words per bank and 64 k words per bank. (Refer to XFER instruction)
Note that the computer link command for these formats are slightly different.

Expanded file register data read [MR]

Request message format (Host → T3H):



ADR: Station address ... 01 to 32

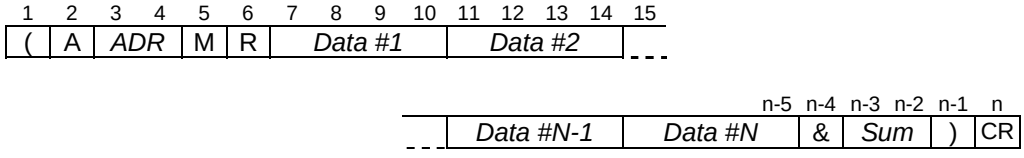
Starting register:
For 8 k words per bank ..... F0000 to F8191 ← Upper case F
For 64 k words per bank ... f0000 to f65535 (bank 1) ← Lower case f
f0000 to f57343 (bank 2)

Bank: For 8 k words per bank ..... 1 to 15
For 64 k words per bank ... 1 to 2

N: Number of registers to be read ... 1 to 61 (61 words max.)

Sum: Check sum

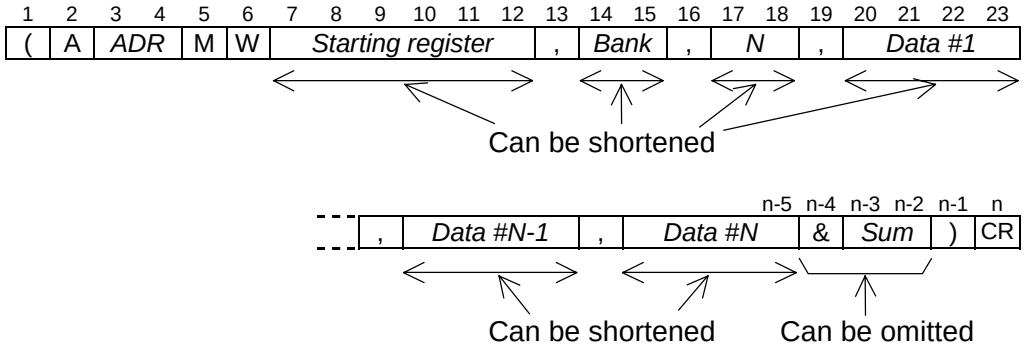
Response message format (T3H → Host):



Data: Data in hexadecimal

Expanded file register data Write [MW]

Request message format (Host → T3H):



ADR: Station address ... 01 to 32

Starting register:
For 8 k words per bank ..... F0000 to F8191 ← Upper case F
For 64 k words per bank ... f0000 to f65535 (bank 1)
f0000 to f57343 (bank 2) ← Lower case f

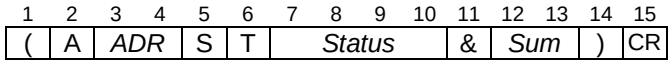
Bank: For 8 k words per bank ..... 1 to 15
For 64 k words per bank ... 1 to 2

N: Number of registers to be written ... 1 to 46 (see Note)

Data: Data in hexadecimal

Sum: Check sum

Response message format (T3H → Host):



Status: T3H operation status

NOTE

(1) The maximum message text length is limited to 255 bytes.

(2) Shortening expression for starting register, bank, number and data (MW only) are available. E.g. F9 for F00009.
When shortening expression is used, the maximum number of MW command can be increased more than 46 words. In this case, it is limited by the maximum message text length (255 bytes).

(3) When an error has occurred, error response CE or EE is returned.
- If designated register or bank is out of the effective range, EE115 (register no./size error) is returned.
- If IC memory card is not installed or MMR setting for PU slot is not made, EE128 (No IC card error) is returned.
- If IC memory card is used for program storage, EE132 (IC card type error) is returned.
- If IC memory card is set as write-protect, EE134 (IC card write-protect error) is returned.

(4) For general information of computer link function, refer to T-series Computer Link Operation Manual.

2.3.2 TOSLINE-S20LP (loop) support

In addition to the standard bus connection type TOSLINE-S20 (here called S20), the optical loop connection type TOSLINE-S20LP (here called S20LP) can be used with the T3H. (SN325: T3H station module of S20LP)
By using the S20LP, high speed control-data linkage is available as same as the S20. Furthermore, peer-to-peer communication between T3H's becomes available via S20LP.

- Up to two S20LP can be installed on a T3H. (S20LP and S20 total)
- The S20LP has 4 k words of scan transmission capacity.
  The leading 2 k words of the scan memory can be assigned to T3H's link register (W). And the following 2 k words can be read/written by using XFER instruction.
- The S20LP does not have the scan healthy map. Therefore, SW128 to SW255 are not used for the S20LP.
- The S20LP has the loop map which indicates loop connection status of each station. This loop map can be read by using READ instruction.
- By using SEND and RECV instructions, any register data of a T3H can be sent to other T3H, and any register data of other T3H can be read into a T3H, via S20LP. (peer-to-peer communication)

(1) The S20LP is under development.
(2) For details of the S20LP, refer to the separate manual for S20LP.

2.3.3 Ethernet support

The Ethernet module (EN311) is available for the T3H. By using the EN311, the T3H can be connected to Ethernet network.
Using the Ethernet module, the T3H supports the following communication functions.

- Computer link function:
  Host computer on the Ethernet can perform data read/write, T3H status read, program up-load/down-load, etc. for the T3H, by using the T-series computer link command.

- Peer-to-peer communication:
  By using SEND and RECV instructions, any register data of a T3H can be sent to other T3H, and any register data of other T3H can be read into a T3H, via Ethernet.

- Socket service:
  Communication between a computer and a T3H user program is available by using SEND and RECV instructions. Maximum 8 ports of socket are available. The protocol can be selected either TCP/IP or UDP/IP for each port.

Up to four EN311's can be installed on a T3H.
To activate the EN311, SEND instruction is required to set parameters (IP address, UDP port number) and to send commands (communication start, etc.)

(1) The Ethernet module (EN311) is under development.
(2) For details of the EN311, refer to the separate manual for EN311.

2.4 Instructions

This section explains the specifications of the following instructions.

Double-word multiplication and division (FUN042 D*/)
Combination instruction of multiplication and division for double-word data.
This instruction is not available on the T3.

Essential PID (FUN156 PID3)
PID (Proportional, Integral, Derivative) control instruction which has the following features.
- Incomplete derivative action expanding stable application range
- Essential digital algorithm succeeding to benefits of analog PID

This instruction is not available on the T3.

Floating point essential PID (FUN232 FPID3)
Essential PID instruction for floating point data.
This instruction is not available on the T3.

Expanded data transfer (FUN236 XFER)
Data transfer instruction between special objects, i.e. expanded file register in IC memory card, data in EEPROM, TOSLINE-S20 scan memory, etc.
Some functions are added to this instruction for the T3H.

Network data send (FUN239 SEND)
Used to peer-to-peer communication via TOSLINE-S20LP or Ethernet. This instruction is also used for Ethernet module (EN311) control.
This instruction is not available on the T3.

Network data receive (FUN240 RECV)
Used to peer-to-peer communication via TOSLINE-S20LP or Ethernet. This instruction is also used for Ethernet module (EN311) control.
This instruction is not available on the T3.

2.4.1 Double-word multiplication and division (D∗/)

FUN 042	D∗/	Double-word multiplication and division

Expression

Input –[*A+1·A* D∗/ *B+1·B* → *C+1·C*]– Output

Function

When the input is ON, the data of *A+1·A* is multiplied by the data of *B+1·B*, and the product is divided by *B+3·B+2*, then the quotient is stored in *C+1·C* and the remainder in *C+3·C+2.*
The data range is -2147483648 to 2147483647. If the result (quotient) is out of the data range, the following limit value is stored.

Positive overflow: quotient = 2147483647, remainder = 0
Negative overflow: quotient = -2147483647, remainder = 0

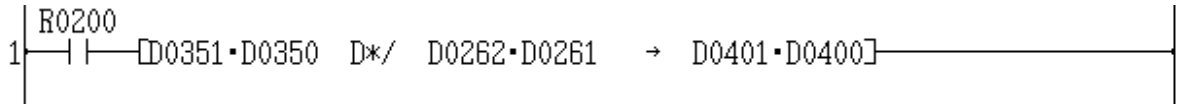
Execution condition

Input	Operation		Output	ERF
OFF	No execution		OFF	–
ON	*B+3·B+2* ≠ 0, no overflow	Normal execution	ON	–
	B+3·B+2 ≠ 0, overflow	Limit	ON	ON
	B+3·B+2 = 0	No execution	OFF	ON

Operand

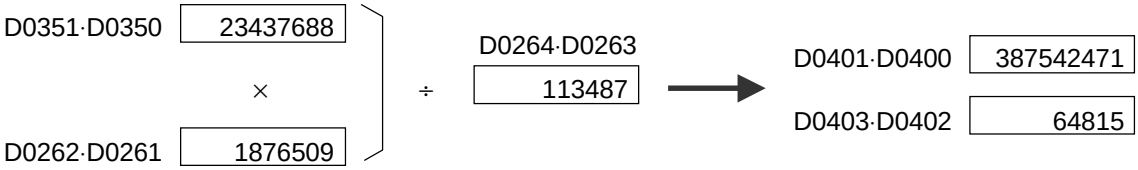
	Name	Device										Register															Con-stant	Index
		X	Y	S	L	R	Z	T.	C.	I	O	XW	YW	SW	LW	RW	W	T	C	D	F	IW	OW	I	J	K		
A	Operation data											√	√	√	√	√	√	√	√	√	√						√	√
B	Multiplier, divisor											√	√	√	√	√	√	√	√	√	√							√
C	Result												√	√	√	√	√	√	√	√	√							√

Example



When R0200 is ON, the double-word data of D0351·D0350 is multiplied by the data of D0262·D0261, and the product is divided by the data of D0264·D0263, then the quotient is stored in D0401·D0400 and the remainder in D0403·D0402.

If the data of D0351·D0350 is 23437688, D0262·D0261 is 1876509, and D0264·D0263 is 113487, the quotient (387542471) is stored in D0401·D0400 and the remainder (64815) is stored in D0403·D0402.



Note

- Edge execution modifier is also available for this instruction.

2.4.2 Essential PID (PID3)

FUN 156	PID3	Essential PID

Expression

Input –[*A* PID3 *B* → *C*]– Output

Function

Performs PID (Proportional, Integral, Derivative) control which is a fundamental method of feed-back control. (Pre-derivative real PID algorithm)
This PID3 instruction has the following features.

- For derivative action, incomplete derivative is used to suppress interference of high-frequency noise and to expand the stable application range,
- Controllability and stability are enhanced in case of limit operation for MV, by using digital PID algorithm succeeding to benefits of analog PID.
- Auto, cascade and manual modes are supported in this instruction.
- Digital filter is available for PV.
- Direct / reverse operation is selectable.

Execution condition

Input	Operation	Output
OFF	Initialization	OFF
ON	Execute PID every setting interval	ON when execution

Operand

	Name	Device										Register															Con-stant	Index
		X	Y	S	L	R	Z	T.	C.	I	O	XW	YW	SW	LW	RW	W	T	C	D	F	IW	OW	I	J	K		
A	Top of input data											√	√	√	√	√	√	√	√	√	√							√
B	Top of parameter											√	√	√	√	√	√	√	√	√	√							√
C	Top of output data												√	√	√	√	√	√	√	√	√							√

Input data

A	Process input value	**PVC**
A+1	A-mode set value	**ASV**
A+2	C-mode set value	**CSV**
A+3	M-mode MV input	**MMV**
A+4	MV tracking input	**TMV**
A+5	Mode setting	**MODE**

A-mode: Auto mode
C-mode: Cascade mode
M-mode: Manual mode

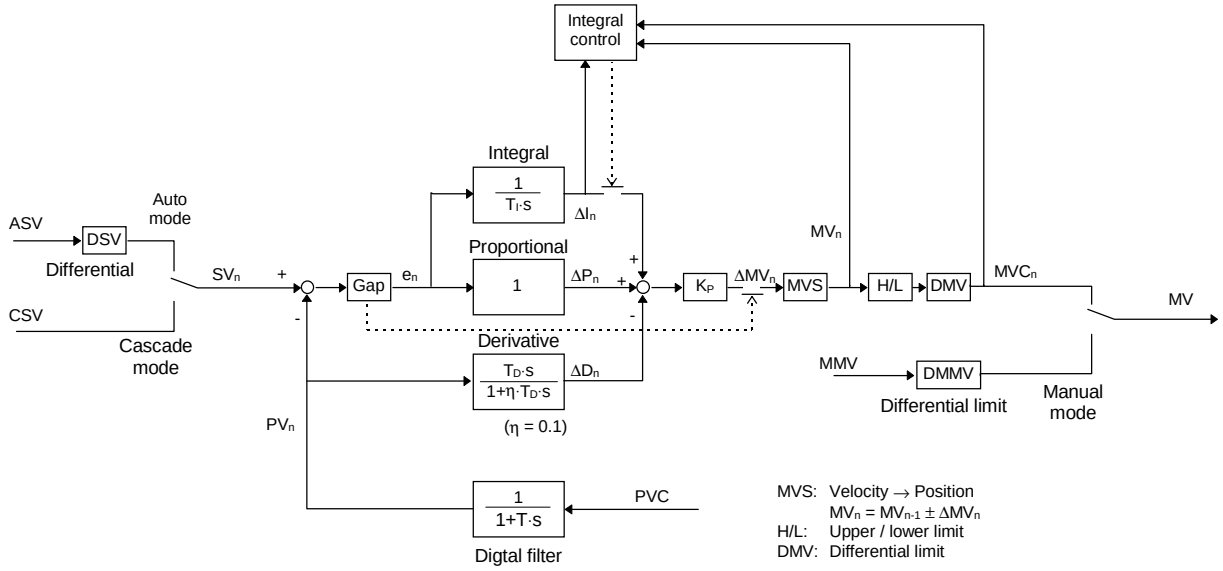
Control parameter

B	Proportional gain	**K_P**
B+1	Integral time	**T_I**
B+2	Derivative time	**T_D**
B+3	Dead-band	**GP**
B+4	A-mode initial SV	**ISV**
B+5	Input filter constant	**FT**
B+6	ASV differential limit	**DSV**
B+7	MMV differential limit	**DMMV**
B+8	Initial status	**STS**
B+9	MV upper limit	**MH**
B+10	MV lower limit	**ML**
B+11	MV differential limit	**DMV**
B+12	Control interval setting	**n**

Output data

C	Manipulation value	**MV**
C+1	Last error	**e_{n-1}**
C+2	Last derivative value	**D_{n-1}**
C+3	Last PV	**PV_{n-1}**
C+4	Last SV	**SV_{n-1}**
C+5	Integral remainder	**Ir**
C+6	Derivative remainder	**Dr**
C+7	Internal MV	**MV_n**
C+8	Internal counter	**C**
C+9	Control interval	**Δt**

Control block diagram



Integral action control:

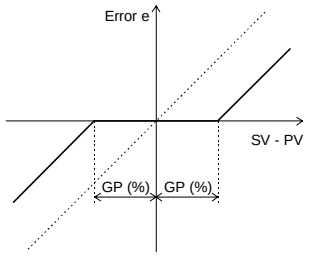
When MV is limited (H/L, DMV) and the integral value has same sign as limit over, integral action is stopped.

Velocity → Position conversion:

In Direct mode, MV increases when PV is increased. → $MV_n = MV_{n-1} - \Delta MV_n$

In Reverse mode, MV decreases when PV is increased. → $MV_n = MV_{n-1} + \Delta MV_n$

Gap (dead-band) operation:



Algorithm

Digital filter:

$$PV_n = (1 - FT) \cdot PVC + FT \cdot PV_{n-1}$$

Here,

$$0.000 \le FT \le 0.999$$

2. Expanded Functions

PID algorithm:

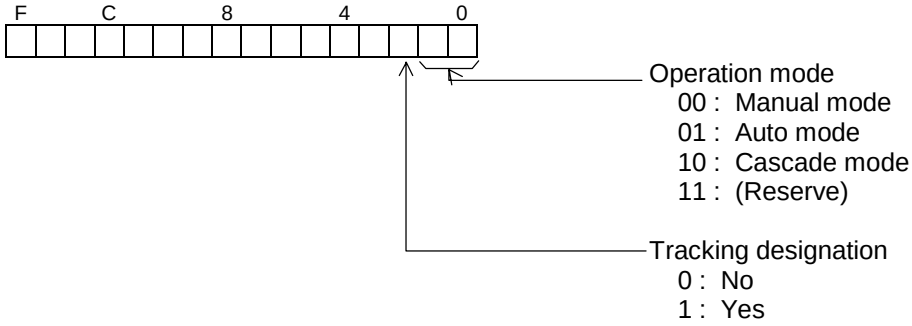
$$\Delta MV_n = K_P \cdot (\Delta P_n + \Delta I_n + \Delta D_n)$$
$$MV_n = MV_{n-1} \pm \Delta MV_n$$

Here,

$$\Delta P_n = e_n - e_{n-1}$$
$$e_n = SV_n - PV_n \quad \text{(If GP} \neq 0\text{, Gap is applied)}$$
$$\Delta I_n = \frac{e_n \cdot \Delta t + Ir}{T_I} \quad \text{(If } T_I = 0,\ \Delta I_n = 0\text{)}$$
$$\Delta D_n = \frac{T_D \cdot (PV_{n-1} - PV_n) - \Delta t \cdot D_{n-1} + Dr}{\Delta t + \eta \cdot T_D}$$
$$D_n = D_{n-1} + \Delta D_n$$
$$\eta = 0.1 \text{ (Fixed)}$$

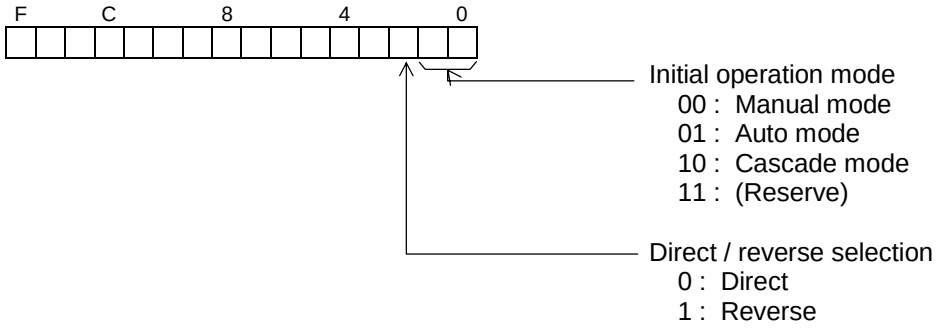
Parameter details

A	Process input value PVC (0.00 to 100.00 %)	Data range: 0 to 10000
A+1	Auto mode set value ASV (0.00 to 100.00 %)	Data range: 0 to 10000
A+2	Cascade mode set value CSV (0.00 to 100.00 %)	Data range: 0 to 10000
A+3	Manual mode MV MMV (-25.00 to 125.00 %)	Data range: -2500 to 12500
A+4	MV tracking input TMV (-25.00 to 125.00 %)	Data range: -2500 to 12500
A+5	Mode setting MODE	



B	Proportional gain K_P (0.00 to 327.67)	Data range: 0 to 32767
B+1	Integral time T_I (0.000 to 32.767 min., stop if T_I = 0)	Data range: 0 to 32767
B+2	Derivative time T_D (0.000 to 32.767 min.)	Data range: 0 to 32767
B+3	Gap (dead-band) GP (0.00 to 10.00 %)	Data range: 0 to 1000
B+4	Auto mode initial set value ISV (0.00 to 100.00 %)	Data range: 0 to 10000
B+5	Input filter constant FT (0.000 to 0.999)	Data range: 0 to 999
B+6	ASV differential limit DSV (0.00 to 100.00 %/Δt)	Data range: 0 to 10000
B+7	MMV differential limit DMMV (0.00 to 100.00 %/Δt)	Data range: 0 to 10000

B+8 Initial status STS



B+9	MV upper limit MH (-25.00 to 125.00 %)	Data range: -2500 to 12500
B+10	MV lower limit ML (-25.00 to 125.00 %)	Data range: -2500 to 12500
B+11	MV differential limit DMV (0.00 to 100.00 %/Δt)	Data range: 0 to 10000
B+12	Control interval setting n (1 to 32767 times)	Data range: 1 to 32767

Executes PID every n scan. Therefore, control interval Δt = n × constant scan interval
(It is treated as n = 1 when n ≤ 0)

C	Manipulation value MV (-25.00 to 125.00 %)	Data range: -2500 to 12500
C+1 to *C+9*	Internal work area	

Operation

1. When the instruction input is OFF:
   Initializes the PID3 instruction.

Operation mode is set as specified by *B+8*.	*A+5* bit 0, 1 ← *B+8* bit 0, 1
Auto mode SV is set as specified by *B+4*.	ASV ← ISV
Manual mode MV is set as current MV.	MMV ← MV
Internal calculation data is initialized.	
MV remains unchanged.	

2. When the instruction input is ON:
   Executes PID calculation every n scan which is specified by *B+12*. The following operation modes are available according to the setting of *A+5*.

- Auto mode
  This is a normal PID control mode with ASV as set value.
  Set value differential limit DSV, manipulation value upper/lower limit MH/ML and differential limit DMV are effective.
  Bump-less changing from auto mode to manual mode is available. (Manual mode manipulation value MMV is over-written by current MV automatically. MMV ← MV)

2. Expanded Functions

- Manual mode
  In this mode, the manipulation value MV can be directly controlled by the input value of MMV.
  MV differential limit for manual mode DMMV is effective. MH/ML and DMV are not effective.
  When mode is changed from manual to auto or cascade, the operation is started from the current MV.

- Cascade mode
  This is a mode for PID cascade connection. PID is executed with CSV as set value.
  Different from the auto mode, set value differential limit is not effective. Manipulation value upper/lower limit MH/ML and differential limit DMV are effective.
  Bump-less changing from cascade mode to manual mode is available. (Manual mode manipulation value MMV is over-written by current MV automatically. MMV ← MV)
  And, bump-less changing from cascade mode to auto mode is available. (Auto mode set value ASV is over-written by current CSV automatically. ASV ← CSV)

- MV tracking
  This function is available in auto and cascade modes. When the tracking designation (*A+5* bit 2) is ON, tracking input TMV is directly output as MV.
  Manipulation value upper/lower limit MH/ML is effective, but differential limit DMV is not effective.
  When the tracking designation is changed to OFF, the operation is started from the current MV.

Note

- PID3 instruction is only usable on the main-program.

- PID3 instruction must be used under the constant scan mode. The constant scan interval can be selected in the range of 10 to 200 ms, 10 ms increments.

- The data handled by the PID3 instruction are % units. Therefore, process input value PVC, manipulation value MV, etc., should be converted to % units (scaling), before and/or after the PID3 instruction. For this purpose, the function generator instruction (FUN165 FG) is convenient.

2.4.3 Floating point essential PID (FPID3)

FUN 232	FPID3	Floating point essential PID

Expression

Input –[*A+1*·*A* FPID3 *B+1*· *B* → *C+1*· *C*]– Output

Function

Performs PID (Proportional, Integral, Derivative) control which is a fundamental method of feed-back control. (Pre-derivative real PID algorithm)
The operation of this FPID3 instruction is the same as the PID3 (FUN156) instruction except for dealing data as floating point data.

Execution condition

Input	Operation	Output
OFF	Initialization	OFF
ON	Execute PID every setting interval	ON when execution

Operand

	Name	Device										Register														Con-stant	Index
		X	Y	S	L	R	Z	T.	C.	I	O	XW	YW	SW	LW	RW	W	T	C	D	F	IW	OW	I	J	K		
A	Top of input data											√	√	√	√	√	√	√	√	√	√							√
B	Top of parameter											√	√	√	√	√	√	√	√	√	√							√
C	Top of output data												√	√	√	√	√	√	√	√	√							√

Input data

A+1·*A*	Process input value	**PVC**
	A-mode set value	**ASV**
	C-mode set value	**CSV**
	M-mode MV input	**MMV**
	MV tracking input	**TMV**
	Mode setting	**MODE**

A-mode: Auto mode
C-mode: Cascade mode
M-mode: Manual mode

Control parameter

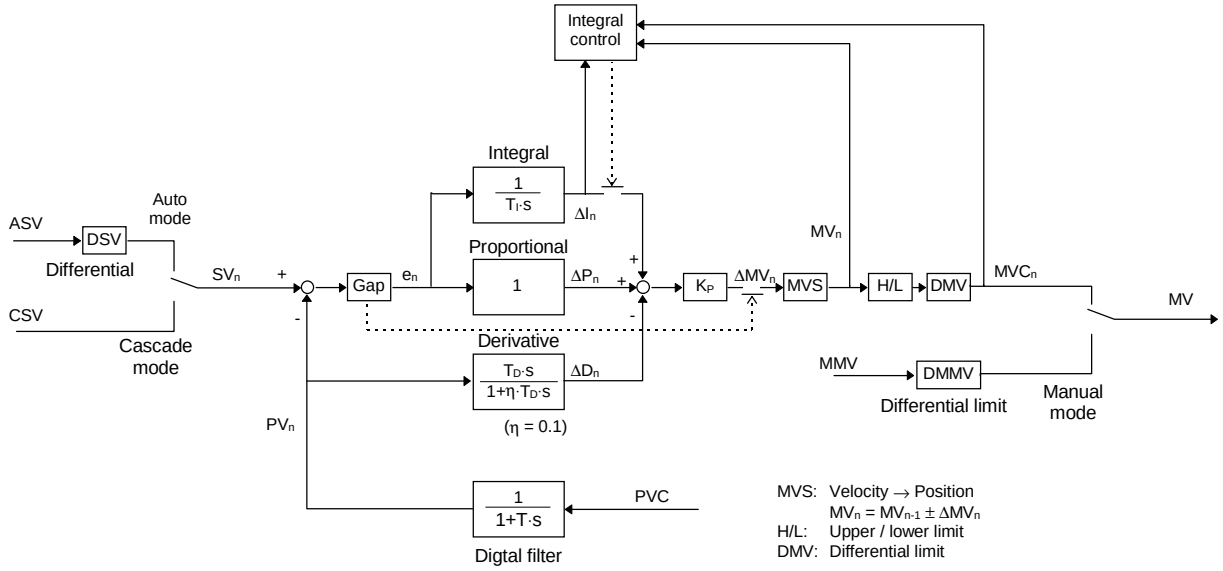
B+1·*B*	Proportional gain	$\mathbf{K_P}$
	Integral time	$\mathbf{T_I}$
	Derivative time	$\mathbf{T_D}$
	Dead-band	**GP**
	A-mode initial SV	**ISV**
	Input filter constant	**FT**
	ASV differential limit	**DSV**
	MMV differential limit	**DMMV**
	Initial status	**STS**
	MV upper limit	**MH**
	MV lower limit	**ML**
	MV differential limit	**DMV**
	Control interval setting	**n**

Output data

C+1·*C*	Manipulation value	**MV**
	Last error	$\mathbf{e_{n-1}}$
	Last derivative value	$\mathbf{D_{n-1}}$
	Last PV	$\mathbf{PV_{n-1}}$
	Last SV	$\mathbf{SV_{n-1}}$
	Integral remainder	**Ir**
	Derivative remainder	**Dr**
	Internal MV	$\mathbf{MV_n}$
	Internal counter	**C**
	Control interval	**Δt**

2. Expanded Functions

Control block diagram



Integral action control:

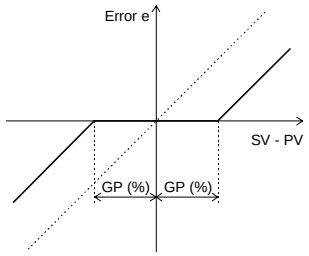
When MV is limited (H/L, DMV) and the integral value has same sign as limit over, integral action is stopped.

Velocity → Position conversion:

In Direct mode, MV increases when PV is increased. → $MV_n = MV_{n-1} - \Delta MV_n$

In Reverse mode, MV decreases when PV is increased. → $MV_n = MV_{n-1} + \Delta MV_n$

Gap (dead-band) operation:



Algorithm

Digital filter:

$$PV_n = (1 - FT) \cdot PVC + FT \cdot PV_{n-1}$$

Here,

$$0 \le FT < 1$$

PID algorithm:

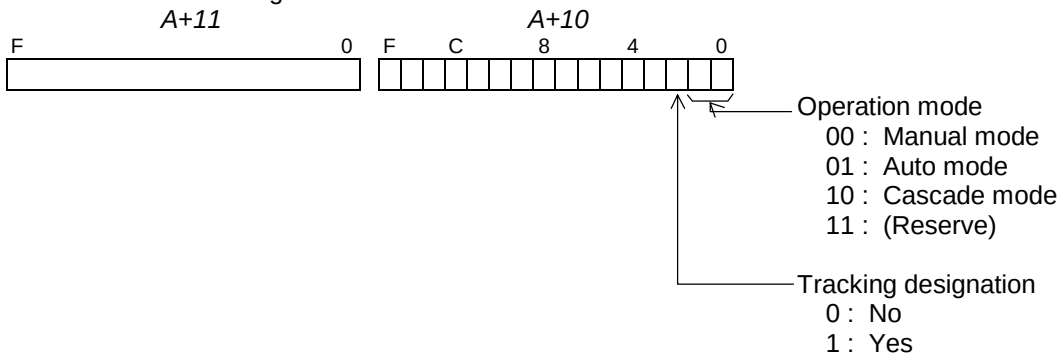
$$\Delta MV_n = K_P \cdot (\Delta P_n + \Delta I_n + \Delta D_n)$$
$$MV_n = MV_{n-1} \pm \Delta MV_n$$

Here,

$$\Delta P_n = e_n - e_{n-1}$$
$$e_n = SV_n - PV_n \quad \text{(If GP} \neq 0\text{, Gap is applied)}$$
$$\Delta I_n = \frac{e_n \cdot \Delta t + Ir}{T_I} \quad \text{(If } T_I = 0,\ \Delta I_n = 0\text{)}$$
$$\Delta D_n = \frac{T_D \cdot (PV_{n-1} - PV_n) - \Delta t \cdot D_{n-1} + Dr}{\Delta t + \eta \cdot T_D}$$
$$D_n = D_{n-1} + \Delta D_n$$
$$\eta = 0.1 \text{ (Fixed)}$$

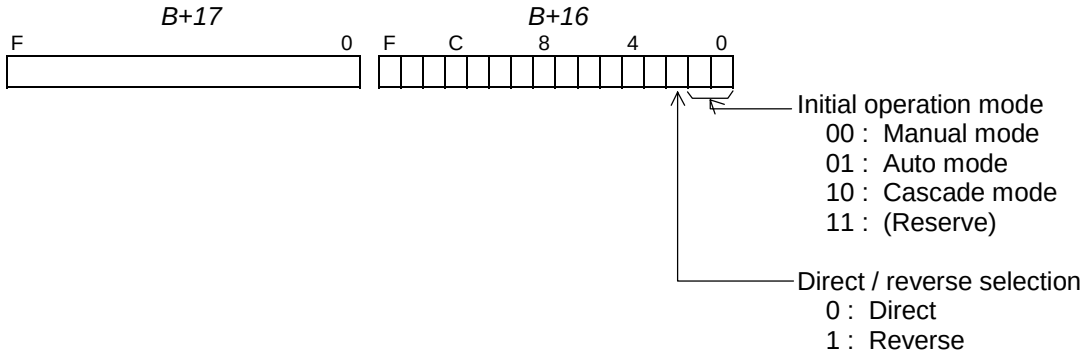
Parameter details

A+1·A	Process input value PVC (0 to 100 %)	Data range: 0.0 to 100.0
A+3·A+2	Auto mode set value ASV (0 to 100 %)	Data range: 0.0 to 100.0
A+5·A+4	Cascade mode set value CSV (0 to 100 %)	Data range: 0.0 to 100.0
A+7·A+6	Manual mode MV MMV (-25 to 125 %)	Data range: -25.0 to 125.0
A+9·A+8	MV tracking input TMV (-25 to 125 %)	Data range: -25.0 to 125.0
A+11·A+10	Mode setting MODE	



B+1·B	Proportional gain KP (0 to 327.67)	Data range: 0.0 to 327.67
B+3·B+2	Integral time TI (0 to 32.767 min., stop if TI = 0)	Data range: 0.0 to 32.767
B+5·B+4	Derivative time TD (0 to 32.767 min.)	Data range: 0.0 to 32.767
B+7·B+6	Gap (dead-band) GP (0 to 10 %)	Data range: 0.0 to 10.0
B+9·B+8	Auto mode initial set value ISV (0 to 100 %)	Data range: 0.0 to 100.0
B+11·B+10	Input filter constant FT (0 to less than 1)	Data range: 0.0 to less than 1.0
B+13·B+12	ASV differential limit DSV (0 to 100 %/Δt)	Data range: 0.0 to 100.0
B+15·B+14	MMV differential limit DMMV (0 to 100 %/Δt)	Data range: 0.0 to 100.0

B+17·B+16 Initial status STS



B+19·B+18	MV upper limit MH (-25 to 125 %)	Data range: -25.0 to 125.0
B+21·B+20	MV lower limit ML (-25 to 125 %)	Data range: -25.0 to 125.0
B+23·B+22	MV differential limit DMV (0 to 100 %/Δt)	Data range: 0.0 to 100.0
B+25·B+24	Control interval setting n (1 to 32767 times)	Data range: 1.0 to 32767.0

Executes PID every n scan. Therefore, control interval Δt = n × constant scan interval
(It is treated as n = 1 when n ≤ 0)

C+1·C	Manipulation value MV (-25 to 125 %)	Data range: -25.0 to 125.0
C+3·C+2 to *C+15·C+14*	Internal work area	

Operation

1. When the instruction input is OFF:
   Initializes the FPID3 instruction.

Operation mode is set as specified by *B+17·B+16*.	*A+10* bit 0, 1 ← *B+16* bit 0, 1
Auto mode SV is set as specified by *B+9·B+8*.	ASV ← ISV
Manual mode MV is set as current MV.	MMV ← MV
Internal calculation data is initialized.	
MV remains unchanged.	

2. When the instruction input is ON:
   Executes PID calculation every n scan which is specified by *B+25·B+24*. The following operation modes are available according to the setting of *A+11·A+10*.

- Auto mode
  This is a normal PID control mode with ASV as set value.
  Set value differential limit DSV, manipulation value upper/lower limit MH/ML and differential limit DMV are effective.
  Bump-less changing from auto mode to manual mode is available. (Manual mode manipulation value MMV is over-written by current MV automatically. MMV ← MV)

- Manual mode
  In this mode, the manipulation value MV can be directly controlled by the input value of MMV.
  MV differential limit for manual mode DMMV is effective. MH/ML and DMV are not effective.
  When mode is changed from manual to auto or cascade, the operation is started from the current MV.

- Cascade mode
  This is a mode for PID cascade connection. PID is executed with CSV as set value.
  Different from the auto mode, set value differential limit is not effective. Manipulation value upper/lower limit MH/ML and differential limit DMV are effective.
  Bump-less changing from cascade mode to manual mode is available. (Manual mode manipulation value MMV is over-written by current MV automatically. MMV ← MV)
  And, bump-less changing from cascade mode to auto mode is available. (Auto mode set value ASV is over-written by current CSV automatically. ASV ← CSV)

- MV tracking
  This function is available in auto and cascade modes. When the tracking designation (*A+10* bit 2) is ON, tracking input TMV is directly output as MV.
  Manipulation value upper/lower limit MH/ML is effective, but differential limit DMV is not effective.
  When the tracking designation is changed to OFF, the operation is started from the current MV.

Note

- FPID3 instruction is only usable on the main-program.

- FPID3 instruction must be used under the constant scan mode. The constant scan interval can be selected in the range of 10 to 200 ms, 10 ms increments.

- The data handled by the FPID3 instruction are % units. Therefore, process input value PVC, manipulation value MV, etc., should be converted to % units (scaling), before and/or after the FPID3 instruction.

2.4.4 Expanded data transfer (XFER)

FUN 236	XFER	Expanded data transfer

Expression

Input –[*A* XFER *B* → *C*]– Output

Function

When the input is ON, data block transfer is performed between the source which is indirectly designated by *A* and *A+1* and the destination which is indirectly designated by *C* and *C+1*. The transfer size (number of words) is designated by *B*.
The transfer size is 1 to 256 words. (except for writing into EEPROM)
Data transfer between the following objects are available.

- CPU register ↔ CPU register
- CPU register ↔ Expanded F register (IC memory card)
- CPU register ↔ TOSLINE-S20 or TOSLINE-S20LP (here called S20 or S20LP)
- CPU register ↔ EEPROM (D register)

Execution condition

Input	Operation	Output	ERF
OFF	No execution	OFF	–
ON	Normal execution	ON	–
	When error is occurred (see Note)	ON	Set

Operand

	Name	Device										Register														Con-stant	Index
		X	Y	S	L	R	Z	T.	C.	I	O	X W	Y W	S W	L W	R W	W	T	C	D	F	I W	O W	I	J	K		
A	Source parameter											√	√	√	√	√	√	√	√	√	√							√
B	Transfer size											√	√	√	√	√	√	√	√	√	√							√
C	Destination parameter												√	√	√	√	√	√	√	√	√							√

Source parameter

A	Bank / CH	Type
A+1	Leading address	

Transfer size and status

B	Transfer size
B+1	Status flag
	(Scan healthy map)
B+16	Max. 16 words

Destination parameter

C	Bank / CH	Type
C+1	Leading address	

- Refer to the following table for contents of each designation.
- The status flag is created only when the transfer from S20 to Register.

Transfer parameter table

Transfer object		Bank / CH	TYPE	Leading address	Transfer size	Status flag
CPU register	XW/YW register	0	H00	0 to 511 (T3H) 0 to 255 (T3) 0 to 63 (T2)	1 to 256	None
	W register	0	H01	0 to 2047 (T3H) 0 to 1023 (T3/T2)	1 to 256	None
	LW register	0	H02	0 to 255 (T3H/T3/T2)	1 to 256	None
	RW register	0	H03	0 to 999 (T3H) 0 to 511 (T3) 0 to 127 (T2)	1 to 256	None
	D register	0	H04	0 to 8191 (T3H/T3) 0 to 4095 (T2)	1 to 256	None
	F register	0	H05	0 to 32767 (T3H) 0 to 8191 (T3) 0 to 1023 (T2)	1 to 256	None
Expanded F register (IC memory card) *1		1 to 15	H05	0 to 8191 (T3H/T3/T2)	1 to 256	None
		1 or 2	H06	0 to 65535 (bank 1) (T3H) 0 to 57343 (bank 2) (T3H)	1 to 256	None
S20 scan memory		1 or 2 *2	H10	0 to 1023 (T3H/T3/T2)	1 to 256	Yes *3
S20LP scan memory *4		1 or 2	H10	0 to 4095 (T3H)	1 to 256	None
EEPROM (D register)		0	H20	0 to 8191 (T3H/T3) 0 to 4095 (T2)	Source (read) 1 to 256 Destination (write) 1 to 128 (T3H) 1 to 64 (T3) 1 to 32 (T2)	None

*1) Two format types of the IC memory card is available. They are 8 k words/bank (type: H05) and 64 k words/bank (type: H06). Type H06 is available only in the T3H.

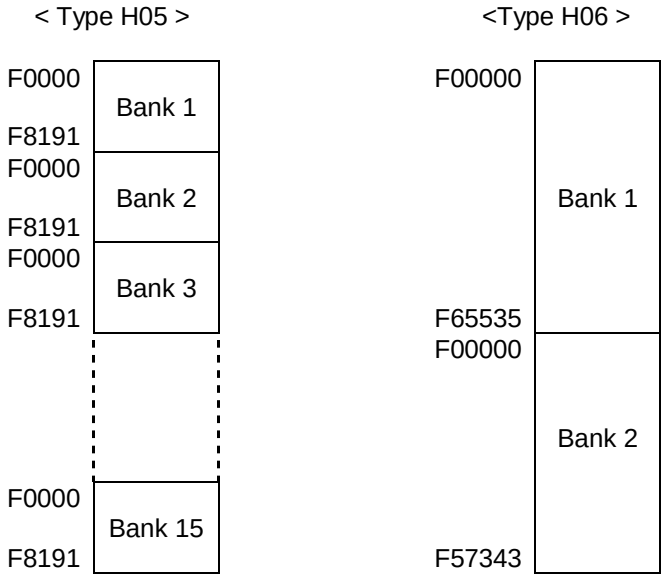
*2) Channel 1 (CH1) only for the T2.

*3) The status flag is created only when S20 is designated as transfer source.

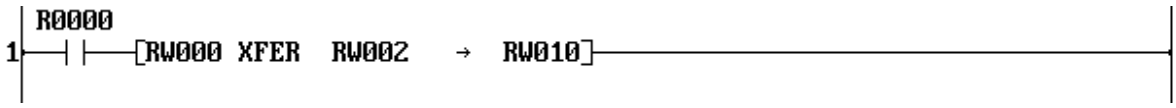
*4) S20LP is available only with the T3H. The S20LP does not have the scan healthy map. Therefore status flag is not created for S20LP.

CPU register ↔ Expanded F register (IC memory card)

Expanded F register configuration:



Example:



Source designation			Transfer size		Destination designation		
RW000	H00	H04	RW002	00045	RW010	H01	H05
RW001	00000				RW011	00000	

D0000 (CPU register) 45 words transfer Bank 1 F0000 (Expanded F register)

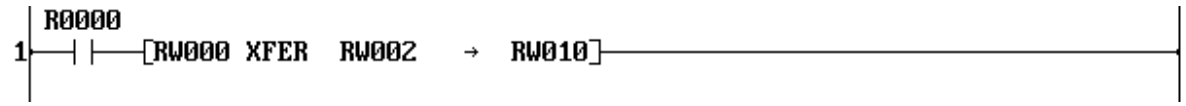
When R0000 is ON, 45 words data starting with D0000 is transferred to Bank 1 F0000 and after in the IC memory card.

Remarks:

- When the IC memory card is used for expanded F register, MMR setting on the PU slot is necessary by I/O allocation.
- In case of the T2, the capacity of F register in CPU is 1024 words. However, the T2 can access 8192 words × 15 banks (= 122880 words) of expanded F register in the IC memory card.
- When type H06 is used in the T3H, the expanded F register can be accessed as F00000 to F65535 (bank 1) and F00000 to F57343 (bank 2).

CPU register ↔ S20/S20LP scan memory

Example:



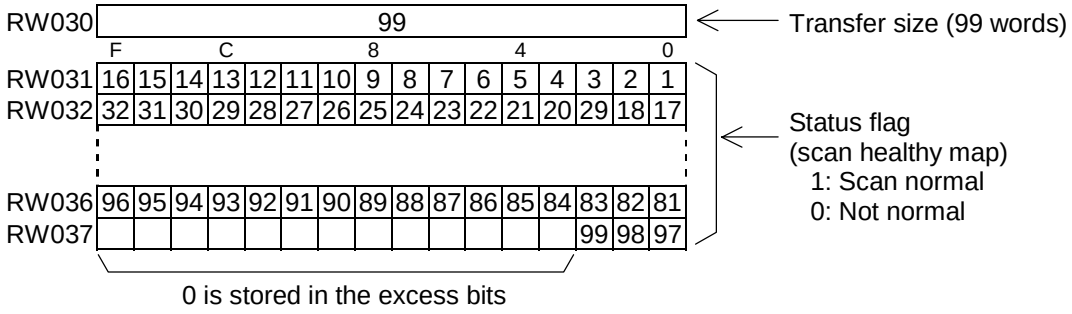
Source designation			Transfer size		Destination designation		
RW000	H00	H01	RW002	00010	RW010	H01	H10
RW001	00000				RW011	00000	

W0000 (CPU register) — 10 words transfer — Channel 1 S20/S20LP scan memory address 00000

When R0000 is ON, 10 words data starting with W0000 is transferred to scan memory address 00000 and after of channel 1 S20/S20LP.

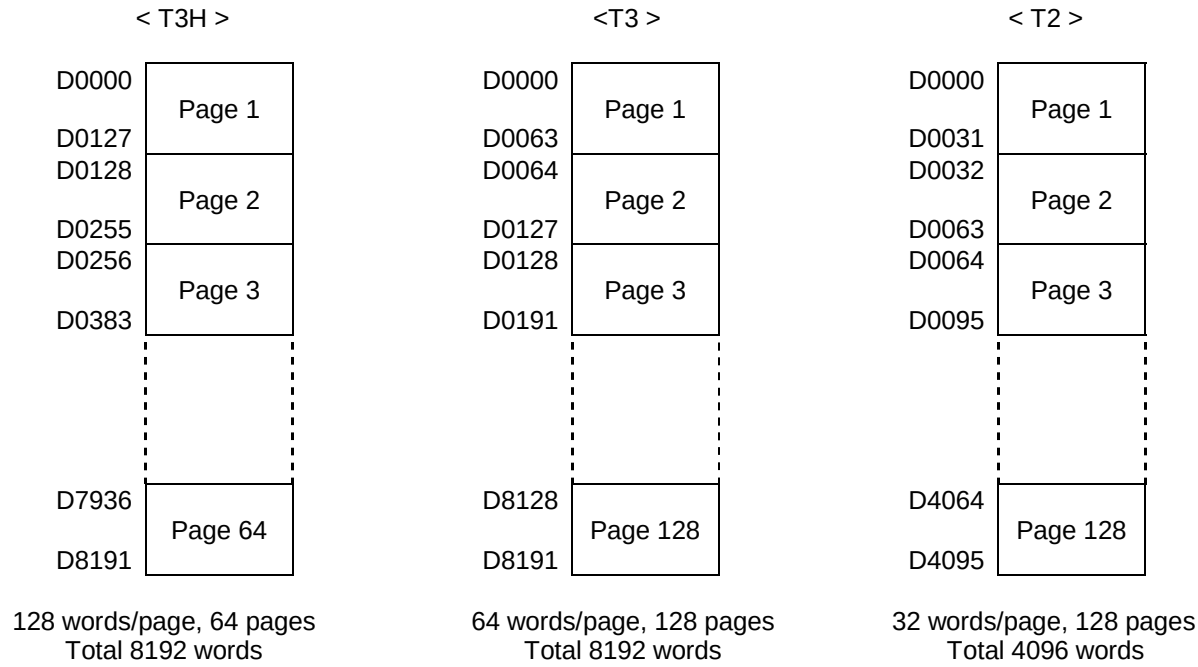
Remarks:

- When writing data into S20/S20LP scan memory, confirm that the address range is S20/S20LP's data send block.
- If S20/S20LP scan memory is accessed only by this XFER instruction, the network assignment, i.e. "LINK" or "GLOBAL" setting, is not necessary.
- When S20 is designated as source, the status flag (scan healthy map) for the read-out data is stored in operand *B+1* and after. (Status flag is not created for S20LP)
  For example, when 99 words data is read from S20 with using RW030 as transfer size designation, RW031 to RW037 (7 words) are used to store the scan healthy map.



CPU register ↔ EEPROM (D register)

EEPROM D register configuration:

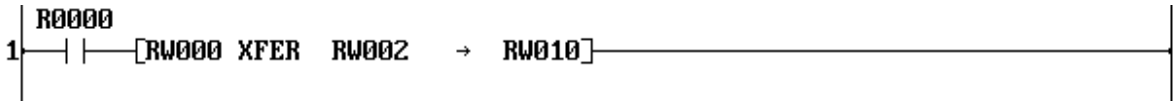


128 words/page, 64 pages
Total 8192 words

64 words/page, 128 pages
Total 8192 words

32 words/page, 128 pages
Total 4096 words

Example:



Source designation		
RW000	H00	H04
RW001	00100	

Transfer size	
RW002	00032

Destination designation		
RW010	H00	H20
RW011	00064	

D0100 (CPU register) — 32 words transfer — D0064 (EEPROM)

When R0000 is ON, 32 words data starting with D0100 is transferred to D0064 and after in the EEPROM. (Data write into EEPROM)

Remarks:

- EEPROM is internally divided by page.
- Writing data into the EEPROM is available within one page at a time.
- For data reading from the EEPROM, there is no need to consider the pages.
- The EEPROM has a life limit for data writing into an address. It is 100,000 times. Pay attention not to exceed the limit. (EEPROM alarm flag = S0007 is not updated by executing this instruction)
- Once data writing into the EEPROM is executed, EEPROM access (read/write) is prohibited for the duration of 10 ms. Therefore, minimum 10 ms interval is necessary for data writing.

Note

- Edge execution modifier is also available for this instruction.
- The XFER instruction is not executed as error in the following cases. (ERF = S0051 is set to ON)

Transfer	Error cause
Between CPU registers	1) When the transfer size is 0 or more than 256. 2) When the source/destination table of transfer is out of the valid range.
CPU register to expanded F register	1) When the transfer size is 0 or more than 256. 2) When the source/destination table of transfer is out of the valid range. 3) When IC memory card is not installed or MMR setting is not made. 4) When the IC memory card is write-protect state. (for data writing) 5) When program is stored in the IC memory card. (detected only T3H)
CPU register to S20/S20LP	1) When the transfer size is 0 or more than 256. 2) When the source/destination table of transfer is out of the valid range. 3) When channel designation is other than 1 or 2. (other than 1 for T2) 4) When S20/S20LP is not installed or not allocated. 5) When status flag area is not sufficient. 6) When an odd address is designated as the leading address in the case of S20/S20LP is set as double-word access. 7) When the transfer size is odd address in the case of S20/S20LP is set as double-word access. 8) When the S20/S20LP module is not normal.
CPU register to EEPROM	1) When the transfer size is 0 or more than 256. 2) When the source/destination table of transfer is out of the valid range. 3) When the data writing address range exceeds page boundary. 4) When this instruction is executed during EEPROM access inhibited (10 ms). 5) When the CPU does not have EEPROM.
Others	1) When source/destination designation is invalid. 2) When an invalid transfer combination is designated. 3) When the index modification is used for an operand and register boundary error is occurred as the result of the index modification. (in this case, the instruction output comes OFF)

2.4.5 Network data send (SEND)

FUN 239	SEND	Network data send

Expression

Input –[*A* SEND *B*]– Output

Function

This instruction sends the designated range of register data to another T3H through the network. (Network: TOSLINE-S20LP or Ethernet)
The transfer source register (self-station) is designated by *A+3* and *A+4*.
The transfer destination register (target-station) is designated by *A+5* and *A+6*.
The transfer size (number of words) is designated by *A+2*. The maximum transfer size is 128 words (S20LP), or 485 words (Ethernet).
The designation method of the target-station is different between S20LP and Ethernet.

This instruction is also used for other functions of the Ethernet module. Refer to the Ethernet module (EN311) manual for detailed functions used for the EN311.

Execution condition

Input	Operation	Output	ERF
OFF	No execution	OFF	–
ON	During execution	OFF	–
	Normal complete	ON	–
	When error is occurred (see Note)	ON	Set

Operand

	Name	Device										Register															Con-stant	Index
		X	Y	S	L	R	Z	T.	C.	I	O	X W	Y W	S W	L W	R W	W	T	C	D	F	I W	O W	I	J	K		
A	Transfer parameter											√	√	√	√	√	√	√	√	√	√							√
B	Status												√	√	√	√	√	√	√	√	√							√

< In case of S20LP >

	F C B 8 7 0		
A	MID	CH	Target station No.
A+1	0 (fixed)		
A+2	Transfer size		
A+3	Register type (self-station)		
A+4	Leading address (self-station)		
A+5	Register type (target-station)		
A+6	Leading address (target-station)		
A+7	Response time limit		

< In case of Ethernet >

	F C B 8 7 0		
A	MID	CH	0 (fixed)
A+1	Request command		
A+2	Transfer size		
A+3	Register type (self-station)		
A+4	Leading address (self-station)		
A+5	Register type (target-station)		
A+6	Leading address (target-station)		
A+7	Response time limit		
A+8	Target-station IP address		
A+9			
A+10	Target-station UDP port No.		

Note) Parameters for the Ethernet varies depending on the request command. Above figure shows the parameters for the register read/write command (H0021). Refer to the EN311 manual.

	F	E	D	C	B	8	7	0
B	Abn	Busy	Status		0		TermSTS	
B+1	Transmission error information (if TermSTS is H0B)							

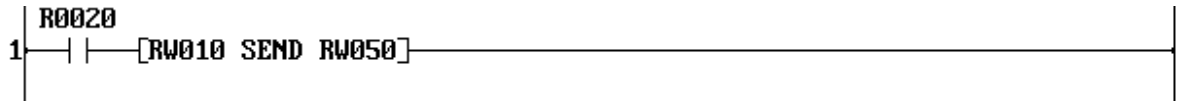
Inside the parameter:

Transfer parameter	S20LP	Ethernet
MID (network type)	2	3
CH (channel of self-station)	1 or 2 (max. two S20LP's on T3H)	1 to 4 (max. four EN311's on T3H)
Target station No.	1 to 64	0 (fixed)
Request command	0 (fixed)	H0021: Register read/write (for other commands, refer to EN311 manual)
Transfer size (number of words)	1 to 128 (max. 84 words for T or C register) (designation across T511 and T512 is not allowed)	1 to 485 (max. 323 words for T or C register) (designation across T511 and T512 is not allowed)
Register type	H0000: XW/YW register H0001: W register H0002: LW register H0003: RW register H0004: D register H0005: F register (CPU) H∗∗05: Expanded F register (IC card, 8k words/bank, ∗∗ is bank No. 01 - 0F) H∗∗06: Expanded F register (IC card, 64k words/bank, ∗∗ is bank No. 01 - 02) H0007: T register H0008: C register H0009: SW register	
Leading address	Designates the leading register address to be transferred	
Response time limit	Specifies the time limit of the response from target-station. (0.1 s units) When the bit F is set to ON, the following default value is used. S20LP ..... 4.1 s Ethernet ... 30 s	
Target-station IP address	N/A	Designates the IP address of the target-station
Target-station UDP port No.	N/A	Designates the UDP port No. of the target-station

Inside the parameter (cont'd):

Status	S20LP	Ethernet
Abn	0: Normal complete 1: Error complete	
Busy	0: Initial state 1: Transmission port busy	
Status	0: Initial state 1: While send requesting 2: While waiting response 3: Complete	
TermSTS	H00: Normal complete H01: Register designation error H02: Response time-out H03: Parameter error H04: Register write protect H05: (Reserve) H06: Module error (send time-out) H07: No send channel H08: Invalid station No. H09: Transfer size error H0A: Boundary error H0B: Transmission error H0C: I/O no answer error H0D: IC card designation error H0E: (Reserve) H0F: (Reserve)	(Bit 7 indicates the error is occurred whether self-station or target-station. 0: Self-station 1: Target-station)
Transmission error information	When TermSTS is H0B, the error information is stored. (0 for other cases) For detailed information, refer to the S20LP or EN311 manual.	

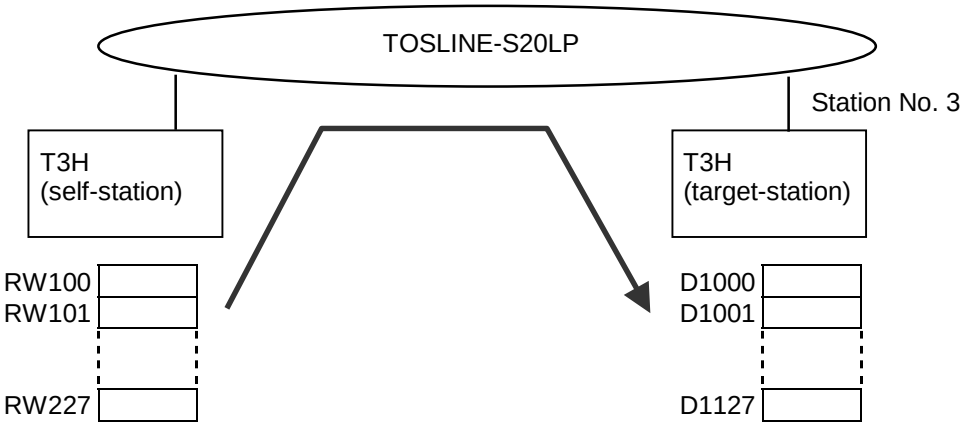
Example



RW010	2	1	3	S20LP, channel 1, target station No. is 3
RW011	0			
RW012	128			Transfer size: 128 words
RW013	3			Self-station RW register
RW014	100			Leading address: RW100
RW015	4			Target-station D register
RW016	1000			Leading address: D1000
RW017	10			Response time limit: 1 second

Send requesting

RW050	0	0	1	0	0	
RW051	0					



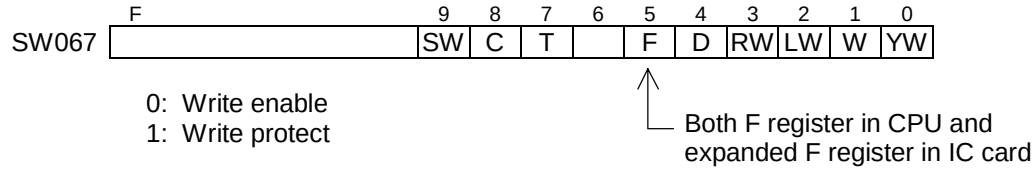
When R0020 is ON, 128 words data starting with RW100 is transferred to D1000 and after of the T3H on which station No. 3 S20LP is installed.
When the operation is completed, the status is set in RW050 and instruction output comes ON.

Note

- Keep the input ON until the output comes ON.

- This instruction becomes error complete in the following cases. (ERF = S0051 is set to ON)
  (1) Target station No. is invalid. (for S20LP)
  (2) Invalid register designation. (In case of T and C registers, T → T and C → C is only possible)
  (3) Source/destination register address range is out of valid range.
  (4) Destination register is write-protected.
  (5) Response time-out is occurred.
  (6) If expanded F register is designated;
  - when MMR setting is not made.
  - when IC card is not installed.
  - when IC card is used to store program.
  - when IC card is write-protected. (for destination)

- By using SW067, register write-protect is available against SEND instruction of other T3H.



- Resetting the status register (operand *B*) is necessary at the first scan.

- When using the TOSLINE-S20LP or Ethernet module (EN311), read the manual for these network modules.

2.4.6 Network data receive (RECV)

FUN 240	RECV	Network data receive

Expression

Input –[*A* RECV *B*]– Output

Function

This instruction reads the designated range of register data from another T3H through the network. (Network: TOSLINE-S20LP or Ethernet)
The transfer source register (target-station) is designated by *A+5* and *A+6*.
The transfer destination register (self-station) is designated by *A+3* and *A+4*.
The transfer size (number of words) is designated by *A+2*. The maximum transfer size is 128 words (S20LP), or 485 words (Ethernet).
The designation method of the target-station is different between S20LP and Ethernet.

This instruction is also used for other functions of the Ethernet module. Refer to the Ethernet module (EN311) manual for detailed functions used for the EN311.

Execution condition

Input	Operation	Output	ERF
OFF	No execution	OFF	–
ON	During execution	OFF	–
	Normal complete	ON	–
	When error is occurred (see Note)	ON	Set

Operand

	Name	Device										Register															Con-stant	Index
		X	Y	S	L	R	Z	T.	C.	I	O	X W	Y W	S W	L W	R W	W	T	C	D	F	I W	O W	I	J	K		
A	Transfer parameter											√	√	√	√	√	√	√	√	√	√							√
B	Status												√	√	√	√	√	√	√	√	√							√

< In case of S20LP >

	F C B 8 7 0		
A	MID	CH	Target station No.
A+1	0 (fixed)		
A+2	Transfer size		
A+3	Register type (self-station)		
A+4	Leading address (self-station)		
A+5	Register type (target-station)		
A+6	Leading address (target-station)		
A+7	Response time limit		

< In case of Ethernet >

	F C B 8 7 0		
A	MID	CH	0 (fixed)
A+1	Request command		
A+2	Transfer size		
A+3	Register type (self-station)		
A+4	Leading address (self-station)		
A+5	Register type (target-station)		
A+6	Leading address (target-station)		
A+7	Response time limit		
A+8	Target-station IP address		
A+9			
A+10	Target-station UDP port No.		

Note) Parameters for the Ethernet varies depending on the request command. Above figure shows the parameters for the register read/write command (H0021). Refer to the EN311 manual.

	F	E	D	C	B	8	7	0
B	Abn	Busy	Status		0		TermSTS	
B+1	Transmission error information (if TermSTS is H0B)							

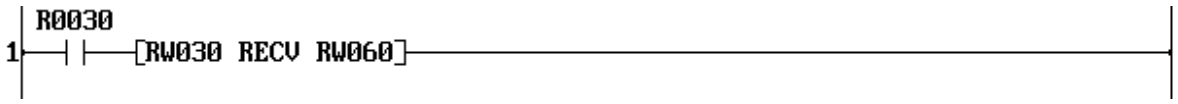
Inside the parameter:

Transfer parameter	S20LP	Ethernet
MID (network type)	2	3
CH (channel of self-station)	1 or 2 (max. two S20LP's on T3H)	1 to 4 (max. four EN311's on T3H)
Target station No.	1 to 64	0 (fixed)
Request command	0 (fixed)	H0021: Register read/write (for other commands, refer to EN311 manual)
Transfer size (number of words)	1 to 128 (max. 84 words for T or C register) (designation across T511 and T512 is not allowed)	1 to 485 (max. 323 words for T or C register) (designation across T511 and T512 is not allowed)
Register type	H0000: XW/YW register H0001: W register H0002: LW register H0003: RW register H0004: D register H0005: F register (CPU) H∗∗05: Expanded F register (IC card, 8k words/bank, ∗∗ is bank No. 01 - 0F) H∗∗06: Expanded F register (IC card, 64k words/bank, ∗∗ is bank No. 01 - 02) H0007: T register H0008: C register H0009: SW register	
Leading address	Designates the leading register address to be transferred	
Response time limit	Specifies the time limit of the response from target-station. (0.1 s units) When the bit F is set to ON, the following default value is used. S20LP ..... 4.1 s Ethernet ... 30 s	
Target-station IP address	N/A	Designates the IP address of the target-station
Target-station UDP port No.	N/A	Designates the UDP port No. of the target-station

Inside the parameter (cont'd):

Status	S20LP	Ethernet
Abn	0: Normal complete 1: Error complete	
Busy	0: Initial state 1: Transmission port busy	
Status	0: Initial state 1: While send requesting 2: While waiting response 3: Complete	
TermSTS	H00: Normal complete H01: Register designation error H02: Response time-out H03: Parameter error H04: Register write protect H05: (Reserve) H06: Module error (send time-out) H07: No send channel H08: Invalid station No. H09: Transfer size error H0A: Boundary error H0B: Transmission error H0C: I/O no answer error H0D: IC card designation error H0E: (Reserve) H0F: (Reserve) (Bit 7 indicates the error is occurred whether self-station or target-station. 0: Self-station 1: Target-station)	
Transmission error information	When TermSTS is H0B, the error information is stored. (0 for other cases) For detailed information, refer to the S20LP or EN311 manual.	

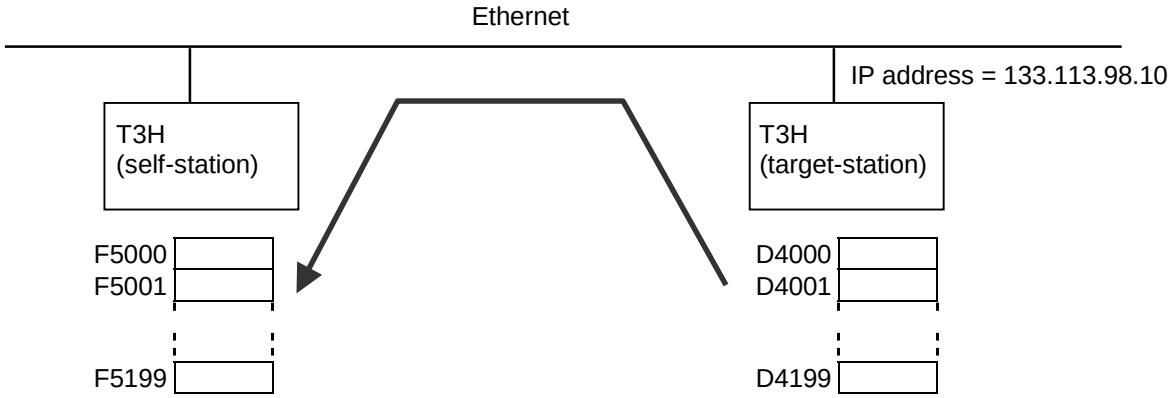
Example



RW030	3	1	0	Ethernet, channel 1
RW031	33 (H21)			Request command H21: Register read/write
RW032	200			Transfer size: 200 words
RW033	5			Self-station F register
RW034	5000			Leading address: F5000
RW035	4			Target-station D register
RW036	4000			Leading address: D4000
RW037	50			Response time limit: 5 second
RW038	H71		H85	Target-station IP address:
RW039	H0A		H62	133.113.98.10 = H85.H71.H62.H0A
RW040	1024			Target-station UDP port No.: 1024

Send requesting

RW060	0	0	1	0	0	
RW061	0					



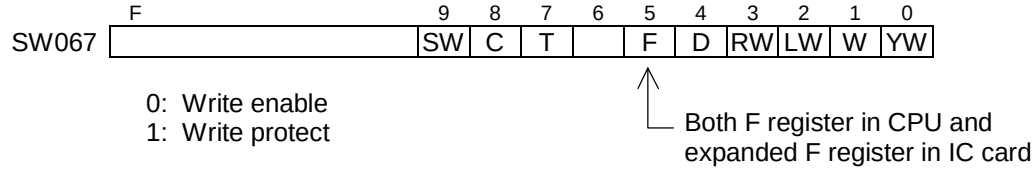
When R0030 is ON, 200 words data starting with D4000 of the T3H on which EN311 (IP address = 133.113.98.10) is installed, is read and stored in F5000 and after.
When the operation is completed, the status is set in RW060 and instruction output comes ON.

Note

- Keep the input ON until the output comes ON.

- This instruction becomes error complete in the following cases. (ERF = S0051 is set to ON)
  (1) Target station No. is invalid. (for S20LP)
  (2) Invalid register designation. (In case of T and C registers, T → T and C → C is only possible)
  (3) Source/destination register address range is out of valid range.
  (4) Destination register is write-protected.
  (5) Response time-out is occurred.
  (6) If expanded F register is designated;
  - when MMR setting is not made.
  - when IC card is not installed.
  - when IC card is used to store program.
  - when IC card is write-protected. (for destination)

- By using SW067, self-station's register write-protect is available.



- Resetting the status register (operand *B*) is necessary at the first scan.

- When using the TOSLINE-S20LP or Ethernet module (EN311), read the manual for these network modules.

TOSHIBA

TOSHIBA CORPORATION
Industrial Equipment Department
1-1, Shibaura 1-chome, Minato-ku
Tokyo 105-8001, JAPAN
Tel: 03-3457-4900 Fax: 03-5444-9268