

TOSHIBA

UM-TS01***-E033

PROGRAMMABLE CONTROLLER

PROSEC **T1-16S**

USER'S MANUAL
– Communication Function –

TOSHIBA CORPORATION

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Safety Precautions

This manual is prepared for users of Toshiba's Programmable Controller T1-16S. Read this manual thoroughly before using the T1-16S. Also, keep this manual and related manuals so that you can read them anytime while the T1-16S is in operation.

Hazard Classifications

In the manuals related to the T1-16S, 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

 **CAUTION**

- Read the Safety Precautions described in the "T1-16S User's Manual – Basic Hardware and Function –" before using the T1-16S.
- Carefully connect the communication cable. Wrong connection can cause damage to the product.
- Connect the emergency stop input directly to the Inverter when the T1-16S's Inverter connection function is used.

About This Manual

This manual provides all the information you need to wire, set-up and operate the T1-16S's serial communication function.

This manual is divided into two parts as follows.

Part 1 T1-16S Programmer Port Function

The programmer port of the T1-16S can be used to communicate with a master computer, or an operator interface unit using the T-series computer link protocol, as well as to communicate with the T-series programming tool (T-PDS or HP911A). The interface of the programmer port is RS-232C. Part 1 describes the functions of the T1-16S programmer port.

Part 2 T1-16S RS-485 Port Function

The T1-16S enhanced version has a second serial communication port. The interface of this port is RS-485. This RS-485 port and the programmer port can work independently. One of the following four operation modes can be selected for the RS-485 port. Part 2 describes how to use these functions.

- **Computer link mode:** Used to communicate with a master computer, an operator interface unit, etc. to configure SCADA/MMI system, using the T-series computer link protocol. In this mode, the T-series programmer (T-PDS) can also be connected to this RS-485 port for remote programming/monitoring purpose.
- **Data link mode:** Used to configure data link system between two T1-16Ss or between T1-16S and T1-40S/T2E/T2N. This is easy and inexpensive data link system. No special program for this data link is required.
- **Free ASCII mode:** This is an active communication function used to communicate with other serial interface devices, using ASCII characters. By using this mode, the T1-16S can act as a communication master for connecting with bar-code reader, printer, weigh scale, other T-series PLCs, etc.
- **Inverter connection mode:** This is a special communication function to connect with Toshiba's Inverters (Adjustable Speed Drives) VF-A7, VF-G7 or VF-S9. By using this mode, T1-16S can monitor and control the connected Inverters through RS-485 line. No special communication program is required. (just single XFER instruction is used)

For your better understanding of the T1-16S, read the following manual at first to understand the T1-16S system, then read this manual.

T1-16S User's manual – Basic Hardware and Function– UM-TS01*-E031**

Terminology

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

μs	microsecond
ASCII	American Standard Code for Information Interchange
ASD	Adjustable Speed Drive (= Inverter)
bps	bit per second (transmission speed)
CCITT	Consultative Committee in International Telegraphy and Telephony
CPU	Central Processing Unit
EIA	Electronic Industries Association
H	hexadecimal (when it appears in front of an alphanumeric string)
I/O	Input/Output
LED	Light Emitting Diode
MMI	Man Machine Interface
ms	millisecond
RS-232C	An EIA standard for data transmission less than 15 m in length
RS-485	An EIA standard for data transmission less than 1 km in length
SCADA	Supervisory Control And Data Acquisition
Vac	AC voltage
Vdc	DC voltage

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PART 1 T1-16S Programmer Port Function

Section 1
Overview

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- 1.2 System configuration, 8*
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1.1 Computer link function

The T1-16S's programmer port supports the computer link function as well as communication with the programming tool.

The programmer port can accept the T-series computer link commands. By preparing the communication software based on the protocol described in this manual in the master computer (computer, operator interface unit, etc.), the following functions become available by the master computer.

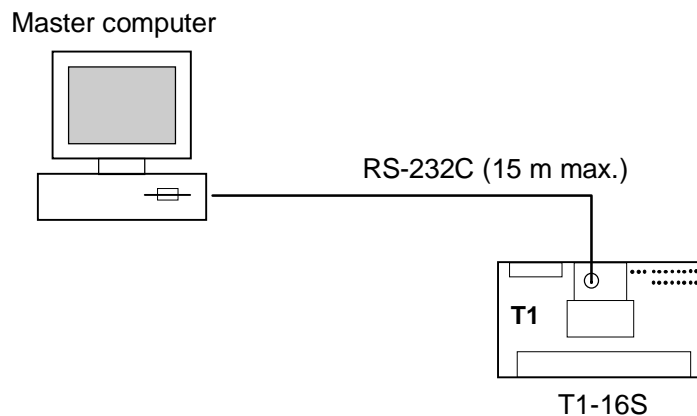
- Reading data (register/device value) from the T1-16S
- Writing data (register/device value) into the T1-16S
- Monitoring the T1-16S's operation status (RUN/HALT/ERROR)
- Reading the error code from the T1-16S
- Reading the clock/calendar data from the T1-16S
- Writing the clock/calendar data into the T1-16S
- Controlling the T1-16S operation mode
- Program up-loading from the T1-16S
- Program down-loading into the T1-16S

Using the computer link function, you can connect a master computer or an operator interface unit with the T1-16S, and can configure a SCADA/MMI system.

1.2 System configuration

The interface of the T1-16S's programmer port is RS-232C. Without using a conversion adapter, the RS-232C serial port of the master computer can be connected to the T1-16S's programmer port directly. (One-to-one configuration)

One-to-one configuration:

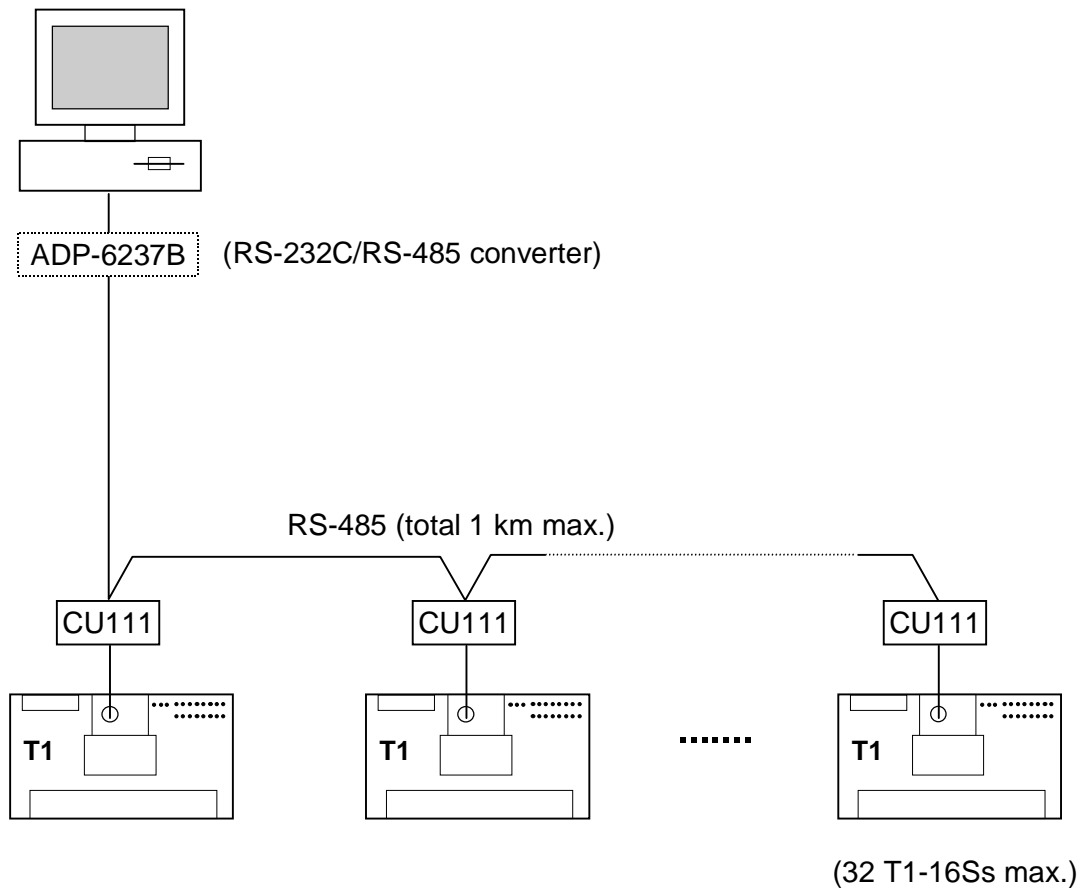


NOTE A 2 m length computer link cable with the programmer port connector is optionally available (type: PT16S). See section 2.2.

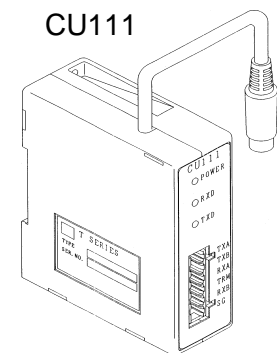
On the other hand, when two or more T1-16S's are connected with a master computer, the multi-drop adapters (CU111) can be used. (One-to-N configuration)

One-to-N configuration:

Master computer



- The CU111 is the RS-232C/RS-485 converter dedicated for the T1-series PLC.
- If the master computer has RS-232C interface but not RS-485, the RS-232C/RS-485 converter (ADP-6237B) can be used.



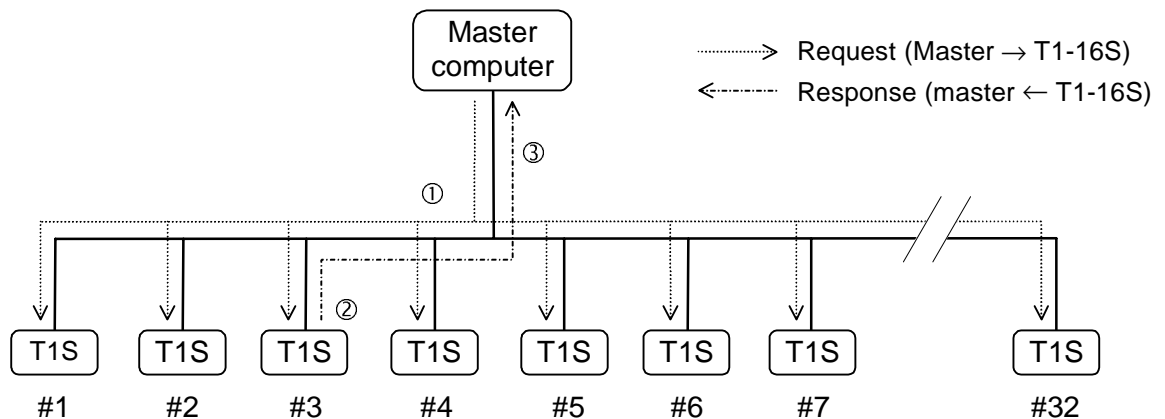
1.3 Communication overview

In the computer link system, the T1-16S waits for receiving a request message issued from the master computer.

When a request message is issued, the T1-16S checks the station number contained in the request message. And when the station number designation matches the T1-16S's station number setting, the T1-16S processes the request and returns the response.

This is why each T1-16S must have a unique station number in the one-to-N configuration. Otherwise, more than one T1-16S may attempt to process the request, resulting in faulty response.

The following figure illustrates the processing sequence executed when a request to station number 3 is issued.



- ① The request message is sent from the master to all the connected T1-16S. (request for station #3 in this example)
- ② The request message is interpreted and processed in the T1-16S which has the same station number as request. (station #3 T1-16S in this example)
- ③ Processing result is returned as response to the master.



NOTE Available station number is 1 to 32. The station number is set in the special register SW36. Refer to sections 4.1.

PART 1 T1-16S Programmer Port Function

Section 2
Specifications

- 2.1 Transmission specifications, 12*
- 2.2 Optional computer link cable, 13*

2.1 Transmission specifications

Item	Specifications
Interface	Conforms to RS-232C (RS-485 when used with CU111)
Transmission distance	15 m max. (RS-232C) 1 km max. (RS-485 by using CU111)
Configuration	One-to-one (RS-232C) One-to-N (RS-485 by using CU111, N is 32 max.)
Station number	1 to 32 (set in T1-16S's memory)
Transmission mode	Half-duplex
Synchronizing	Start-stop system (asynchronous)
Transmission speed	9600 bps (fixed)
Start bit length	1 bit (fixed)
Data bit length	8 bits (fixed)
Parity	Odd or none parity (user setting)
Stop bit length	1 bit (fixed)
Message length	255 bytes max.
Error check	Parity, check-sum
Response delay time	0 - 300 ms (user setting)

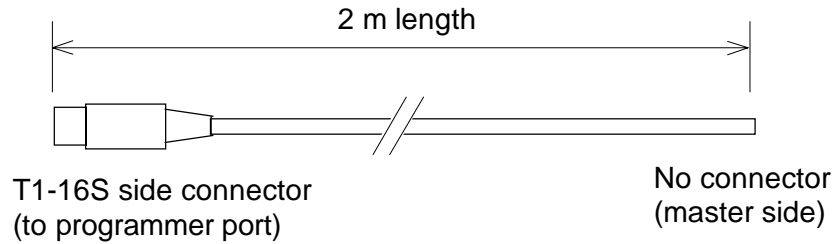
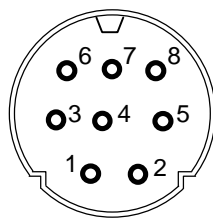


- (1) The station number and parity (odd or none) can be set by user. Transmission speed, start bit, data bit, and stop bit settings are fixed as above. Refer to sections 4.1 and 4.2.
- (2) The response delay time can be set by user. (0 to 300 ms, 10 ms units) Refer to section 4.3.

2.2 Optional computer link cable

The 2 m cable used to connect the T1-16S's programmer port connector with a master computer is optionally available. (Type: PT16S)

T1-16S side connector
(Pin side view)



Pin No.	Signal name	Description	Wire color	Signal direction
1	5 Vdc	–	Brown	–
2	GND	–	Red	–
3	5 Vdc	–	Orange	–
4	RTS (RS)	Request to send	Yellow	T1-16S → Master
5	SG	Signal ground	White	T1-16S ↔ Master
6	TXD (SD)	Transmitted data	Blue	T1-16S → Master
7	CTS (CS)	Clear to send	Purple	T1-16S ← Master
8	RXD (RD)	Received data	Gray	T1-16S ← Master



NOTE Wires of pins 1, 2 and 3 are not used for RS-232C transmission.
Do not connect these wires.

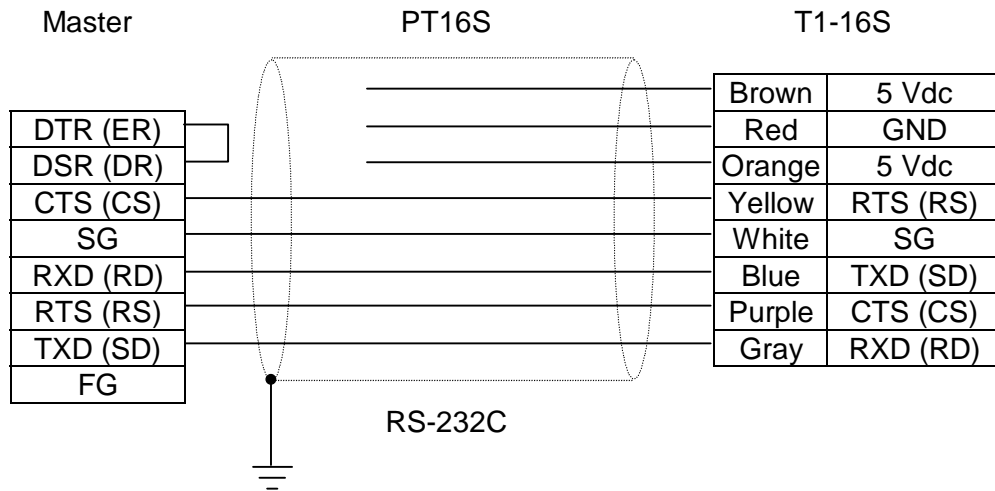
Section 3

Cable Connections

- 3.1 One-to-one configuration, 16*
- 3.2 One-to-N configuration, 18*

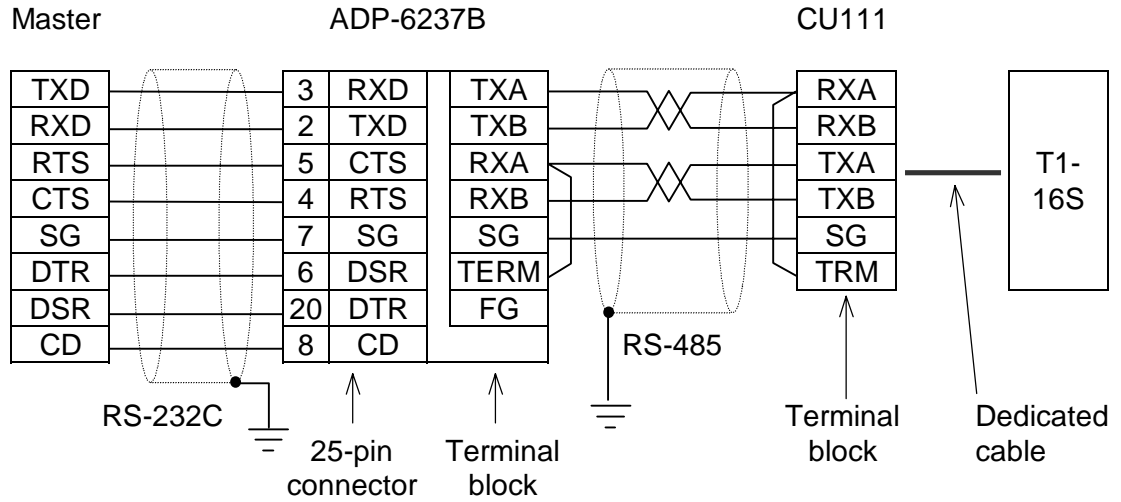
3.1 One-to-one configuration

When one T1-16S is connected to a master computer, the cable connections should be as follows. The optional computer link cable (PT16S) is used for the connection.



- Wires of brown, red and orange should not be connected. These wires should be terminated without connecting each other.
- RTS signal of the T1-16S is always ON.
- The T1-16S can transmit data when CTS signal is ON.

Using the multi-drop adapter CU111, one-to-one connection via RS-485 is also available. In this case, the RS-232C/RS-485 converter ADP-6237B can be used.



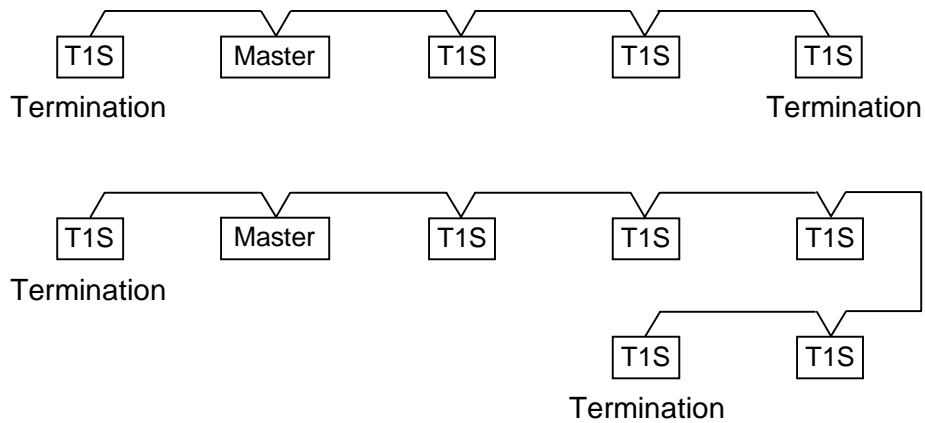
- Short RXA and TERM (TRM) terminals at both the CU111 and the ADP-6237B.
- Use shielded twisted-pair cable for noise immunity. The cable shield should be connected to ground.

3.2 One-to-N configuration

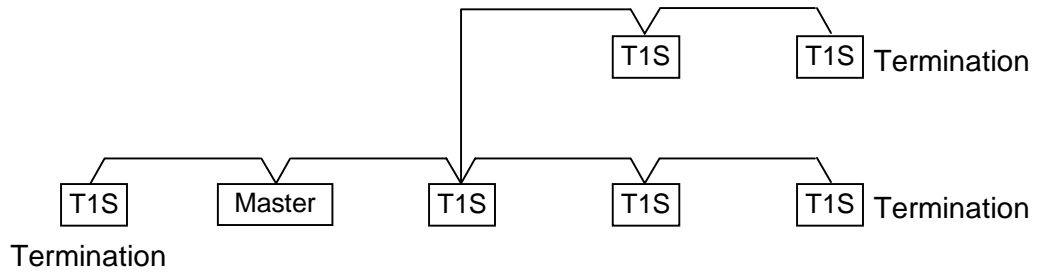
By using the multi-drop adapter CU111, two or more T1-16S's (up to 32) can be connected to a master computer.

In this case, the RS-485 transmission line should be terminated at both ends.

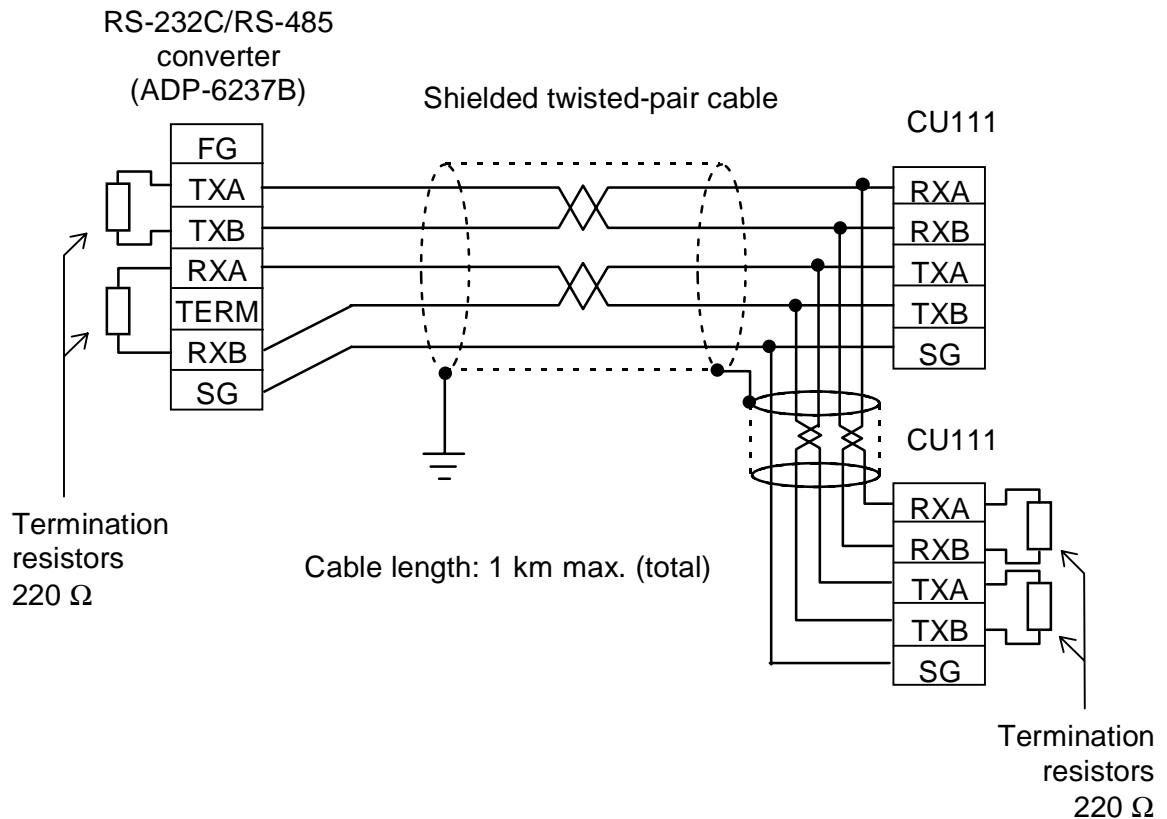
< Available connection >



< Unavailable connection >



Termination resistors (1/2 W - 220 Ω) should be connected between TXA and TXB, and RXA and RXB, at each end of the line (at both termination stations).



- Connect termination resistors (1/2 W - 220 Ω) between TXA and TXB, and RXA and RXB, at each end of the line (at both termination stations).
- Use shielded twisted-pair cable for noise immunity. Connect the cable shield each other, and connect it to ground. (Single point grounding)
- When a terminal block is used to branch off the line, the branch should not exceed 3 m cable length from the terminal block to the CU111 or the master computer.
- For RS-232C side connections, refer to section 3.1.

Section 4

Communication Parameter Settings

- 4.1 Station number setting, 22*
- 4.2 Parity setting, 22*
- 4.3 Response delay time setting, 23*
- 4.4 Peripheral support priority mode, 23*

4.1 Station number setting

The station number is set by writing the data into the special register SW36. The valid station number data is 1 to 32 (decimal).

Turn the T1-16S to HALT mode, and write the station number into SW36. After writing, execute the EEPROM write command. And cycle power off and on again. Then the setting will be effective.

Address	Name	Data range
SW36	PRG port station address	1 to 32 (decimal)



- (1) The default setting of the station number is 1.
- (2) If the data is out of the valid range, the T1-16S works as station 1.



The SW36 setting is saved in the program storage module RM102 (ver. 2 or later). Therefore, when you save the T1-16S program into the RM102 then load it into another T1-16S, the original SW36 setting will be copied. However, in case of the T-PDS, the SW36 setting is not saved in the disk file. Therefore even when you load the T1-16S program by the T-PDS, you must set the SW36 data for the T1-16S manually as mentioned above.

4.2 Parity setting

Parity setting can be selected either odd or none. The even parity is not supported. The default is odd parity. The none parity is normally used for modem connection. The parity is set by writing the data into the special register SW37. The valid data is 1 or 2.

Turn the T1-16S to HALT mode, and write the parity setting (0 = none, 1 = odd) into SW37. After writing, execute the EEPROM write command. And cycle power off and on again. Then the setting will be effective.

Address	Name	Data range
SW37	PRG port parity	0 = none, 1 = odd



- (1) The default setting of the parity is odd.
- (2) If the data is out of the valid range, the T1-16S works as odd parity.



The SW37 setting is saved in the program storage module RM102 (ver. 2 or later). Therefore, when you save the T1-16S program into the RM102 then load it into another T1-16S, the original SW37 setting will be copied. However, in case of the T-PDS, the SW37 setting is not saved in the disk file. Therefore even when you load the T1-16S program by the T-PDS, you must set the SW37 data for the T1-16S manually as mentioned above.

4.3 Response delay time setting

The response time from the programmer port of the T1-16S can be changed. The possible setting is as follows.

Internal processing time + (0 to 300) ms (10 ms units)

This function is useful when a wire-less modem is used.

To set the response delay time, turn the T1-16S to HALT mode, and write the delay time (0 to 30) into SW38. After writing, execute the EEPROM write command. And cycle power off and on again. Then the setting will be effective.

Address	Name	Data range
SW38	PRG port response delay	0 to 30 (decimal) (0 to 30 : 0 to 300 ms)



- (1) The default setting is 0. (Minimum delay)
(2) If the set data is out of the valid range, it is limited by 30 (300 ms).



The SW38 setting is saved in the program storage module RM102 (ver. 2 or later). Therefore, when you save the T1-16S program into the RM102 then load it into another T1-16S, the original SW38 setting will be copied. However, in case of the T-PDS, the SW38 setting is not saved in the disk file. Therefore even when you load the T1-16S program by the T-PDS, you must set the SW38 data for the T1-16S manually as mentioned above.

4.4 Peripheral support priority mode

In the T1-16S, the peripheral support processing (computer link service) is executed at the bottom of each scan with the time limit of 2 ms to minimize the extension of the scan time.

However the T1-16S can work with the peripheral support priority mode. In this mode, the computer link service is executed without a break. By using this mode, the communication response becomes quick although the scan time may be extended at the time.

To select the peripheral support priority mode, set the special relay S158 to ON by user program.

Address	Name	Function
S158	Peripheral support priority mode	When ON, the peripheral support priority mode is selected.

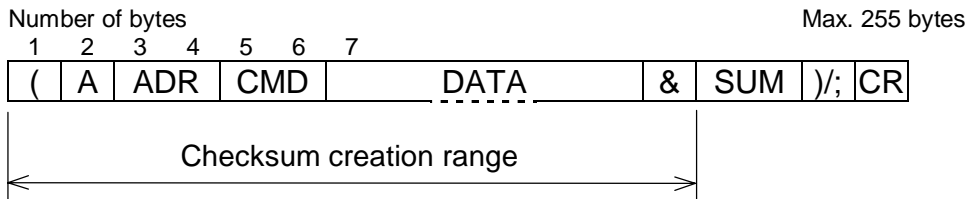
Section 5

Computer Link Protocol

- 5.1 Message format, 26*
- 5.2 Transmission rules, 27*
- 5.3 Checksum creation, 28*
- 5.4 Internal process flow, 29*

5.1 Message format

The T1-16S supports the subset of the T-series PLC computer link commands. The general message format of the T-series PLC computer link is shown below.



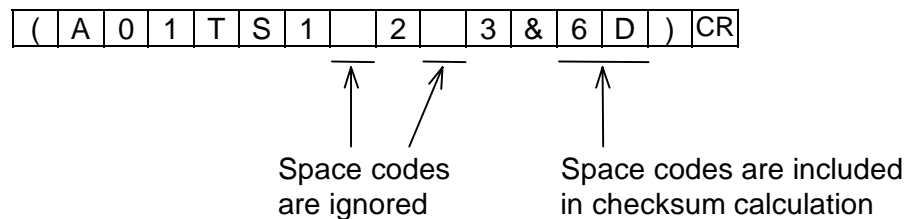
Text contents

- (..... Start code (H28) – 1 byte
- A Format identification code (H41) – 1 byte
- ADR Station number – 2 bytes
 01 (H3031) through 32 (H3332)
- CMD Command – 2 bytes
- DATA ... Data field – depending on the command (max. 244 bytes)
- & Checksum delimiter (H26) – 1 byte
- SUM Checksum – 2 bytes
 ASCII code of the lowest one byte of the sum obtained by adding
 from the start code '(' to the checksum delimiter '&'.
 Refer to section 5.3.
-) End code (H29) – 1 byte
 Normal case
- ; End code (H3B) – 1 byte
 In case of halfway of entire data for BR, RB, BW, and WB commands
- CR Carriage return code (H0D) – 1 byte

5.2 Transmission rules

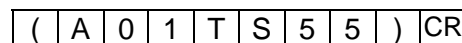
The following transmission rules are applied to the computer link communication.

- (1) The T1-16S is always waiting for a request command issued from the master computer. The T1-16S will not transmit any message without receiving a request.
- (2) 8-bit ASCII is used as transmission code.
- (3) The transmission speed and the frame format are as follows.
 - 9600 bps
 - 1 start bit
 - 8 data bits
 - Odd or none parity (user setting)
 - 1 stop bit
- (4) If some space codes (H20) are included in the request message, they are ignored. However, the space codes are included in checksum calculation.

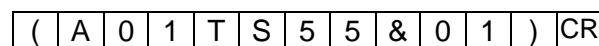


- (5) Checksum can be omitted in the request message issued from the master computer. In the response message issued from the T1-16S, checksum is always added.

Request message



Response message



Response message always includes
the checksum and the delimiter code (&).

- (6) The T1-16S ignores all the data received before the start code '('.
- (7) Message receiving is completed only after the end code ')' and CR have been received. If the end code without CR, or vice versa, is received, it causes transmission error.

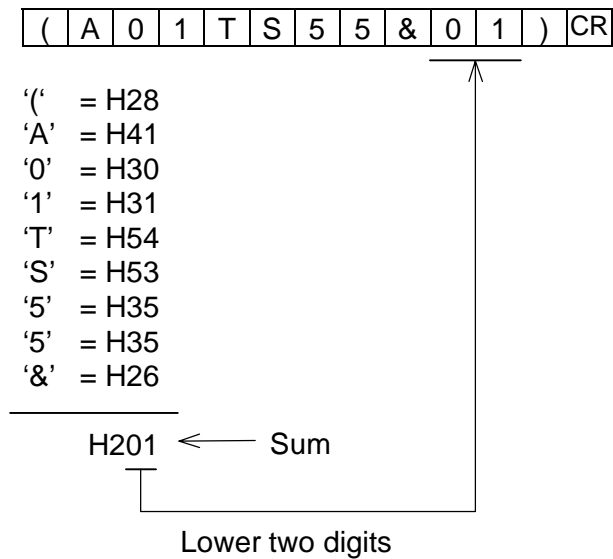


- (1) The T1-16S checks the request message receiving time. If the receiving time from the start code '(' to CR exceeds 3 second, the T1-16S judges as transmission error. In this case, no response will be returned from the T1-16S.
- (2) In the one-to-N configuration, when a T1-16S finishes to send a response message, the T1-16S releases the transmission line in 10 ms (max.). Until the transmission line is released, other T1-16S cannot send any message. Therefore, the master computer should wait to send next request message for at least 10 ms after previous response reception.

5.3 Checksum creation

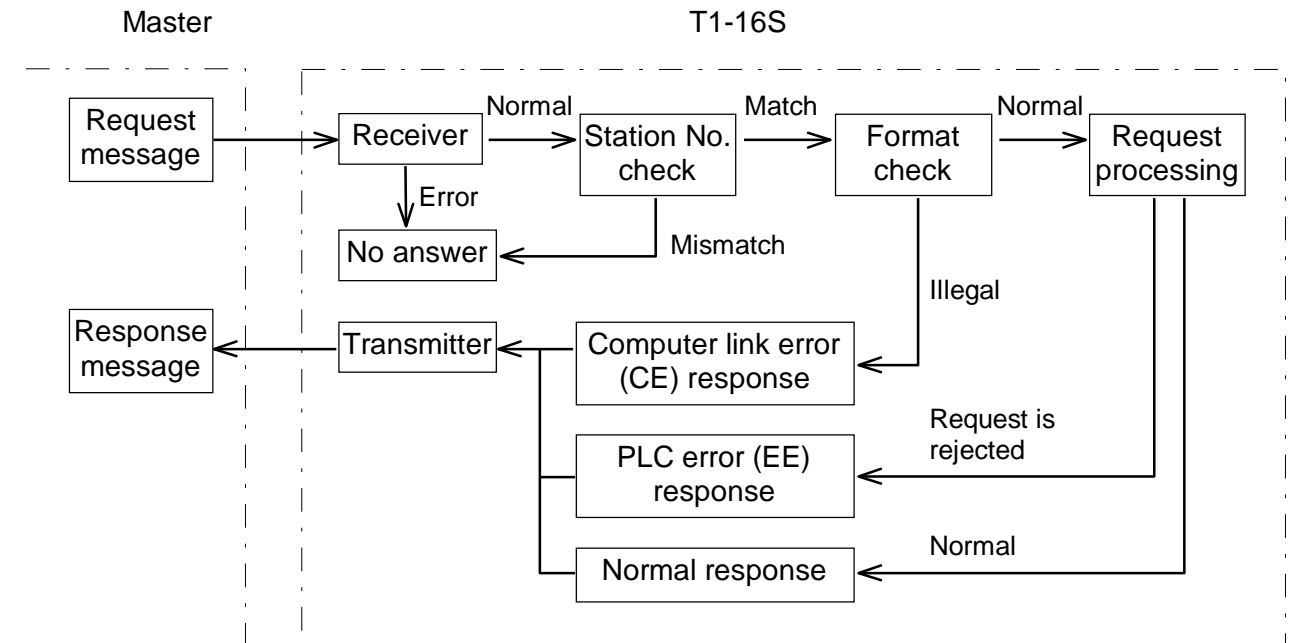
Checksum is a error check code to check validity of the received message. The checksum is the ASCII code of the lower two digits of the sum obtained by adding the hexadecimal data from the start code '(' to the checksum delimiter '&'.

Example:



5.4 Internal process flow

The following diagram illustrates the T1-16S internal process flow for the computer link function.



Section 6

Commands

- 6.1 List of commands, 32*
- 6.2 Computer Link Error Response (CE), 33*
- 6.3 PLC Error Response (EE), 34*
- 6.4 Test (TS), 36*
- 6.5 PLC Status Read (ST), 37*
- 6.6 PLC Error Response (ER), 39*
- 6.7 Data Read (DR), 42*
- 6.8 Data Write (DW), 45*
- 6.9 Clock/calendar Read (RT), 48*
- 6.10 Clock/calendar Write (WT), 49*
- 6.11 System Information 1 Read (SR), 50*
- 6.12 System Information 2 Read (S2), 52*
- 6.13 PLC Control (EC), 54*
- 6.14 System Information Block Read (BR), 56*
- 6.15 Program Block Read (RB), 58*
- 6.16 System Information Block Write (BW), 60*
- 6.17 Program Block Write (WB), 61*

6.1 List of commands

The following computer link commands are available for the T1-16S.

Request command	Function name	Description	Response command	Remarks
–	Computer Link Error Response	Format error was detected in the request message	CE	Response only
–	PLC Error Response	The request command was rejected by T1-16S	EE	Response only
TS	Test	Loop back test -- T1-16S returns the same text	TS	
ST	PLC Status Read	Reads T1-16S operation status	ST	
ER	PLC Error Status Read	Reads error code registered in the T1-16S	ER	
DR	Data Read	Reads registers/devices data from the T1-16S	DR	
DW	Data Write	Writes registers/devices data into the T1-16S	ST	
RT	Clock/calendar Read	Reads clock/calendar data (date & time) from the T1-16S	RT	
WT	Clock/calendar Write	Writes clock/calendar data (date & time) into the T1-16S	ST	
SR	System Information 1 Read	Reads system information 1 from the T1-16S	SR	
S2	System Information 2 Read	Reads system information 2 from the T1-16S	S2	
EC	PLC Control	Changes the T1-16S operation mode	ST	
BR	System Information Block Read	Reads system information from the T1-16S block-by-block	BR	
RB	Program Block Read	Reads program from the T1-16S block-by-block	RB	
BW	System Information Block Write	Writes system information into the T1-16S block-by-block	ST	
WB	Program Block Write	Writes program into the T1-16S block-by-block	ST	



The above commands are subset of the entire T-series computer link commands.

6.2 Computer Link Error Response (CE)

When the T1-16S detects a parity error, checksum error, format error, etc., the T1-16S will respond 'CE' with the error content.

Request message – Any command

Response message

1	2	3	4	5	6	7	8	9	10	11	12	13
(	A	ADR	C	E	Error	&	SUM	)	CR			

↑
Error code as listed below

Error	Error name	Description
01	Command error	Received command is illegal
02	Format error	Received message format is invalid
03	Checksum error	Checksum mismatch is detected

Execution example

Example 1)

Request (A01SS&96)
Response (A01CE01&D9)

Command error (01) ... Illegal command (SS)

Example 2)

Request (A01DRRW,5&90)
Response (A01CE02&DA)

Format error (02) ... Missing the starting register address

6.3 PLC Error Response (EE)

When the T1-16S receives an unacceptable command, the T1-16S will respond 'EE' with the error content.

Request message – Any command

Response message

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
(	A	ADR	E	E	Error code			&	SUM	)	CR			

↑
Error code as listed below

Error code	Error name	Description
0040	I/O bus error	I/O bus error has been detected
0041	I/O mismatch	Registered I/O allocation table and actual I/O configuration are not identical
0042	I/O no answer	No response from I/O module has been received
0043	I/O parity error	I/O bus parity error has been detected
0046	Illegal I/O register	Excess I/O register allocation has been detected
0051	Communication busy	The T1-16S is busy in processing for other peripheral communications
0052	Format error	Received request is invalid (detected by the T1-16S)
0080	No END/IRET error	END or IRET instruction has not been programmed
0081	Pair instruction error	Illegal combination of pair instructions has been programmed
0082	Operand error	Illegal operand has been detected
0083	Invalid program	Program abnormality has been detected
0086	No subroutine entry	Subroutine corresponding to CALL instruction has not been programmed
0087	No RET error	RET (subroutine return) instruction has not been programmed in a subroutine
0088	Subroutine nesting error	Nesting level of subroutines exceeds the limit
0089	Loop nesting error	Nesting of FOR-NEXT loop has been programmed
0098	Invalid function instruction	Function instruction which is not supported by T1-16S has been programmed

Error code	Error name	Description
0106	Password protect	Requested operation is protected by password
0110	Illegal instruction	Illegal instruction has been detected
0111	Register address error	Excess register address range has been programmed
0113	Memory full	Program memory is insufficient for the requested command
0114	Mode mismatch	Received command is invalid in the current T1-16S operation mode
0115	Register address/size error	Specified register range exceeds the limit
0121	Duplicate entry No.	Multiple subroutines which has same subroutine number have been programmed

Execution example

Example)

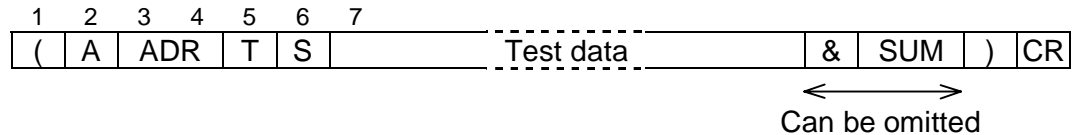
Request (A01DRD4050,32&24)
 Response (A01EE0115&41)

Register address/size error (0115) ... 32 registers starting with D4050 are specified. (Address range over)

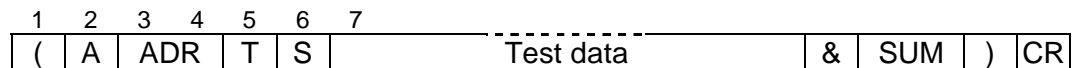
6.4 Test (TS)

This command is used to test the communication between the master computer and the T1-16S. When the T1-16S receives the Test command 'TS', the T1-16S will return the same message to the master.

Request message

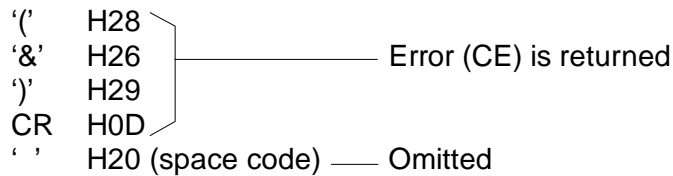


Response message



'CE' or 'EE' is returned if communication error has occurred.

- The maximum size of the Test data field is 244 bytes.
- Any ASCII characters except for the followings can be used.



Execution example

Example 1)

Request (A01TS123456789&74)
 Response (A01TS123456789&74)

Example 2)

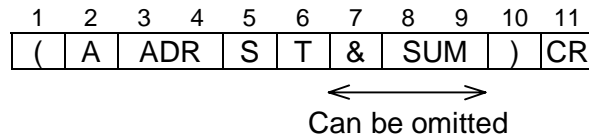
Request (A01TSABC def&AC)
 Response (A01TSABCdef&8C)

Space code (H20) is omitted.

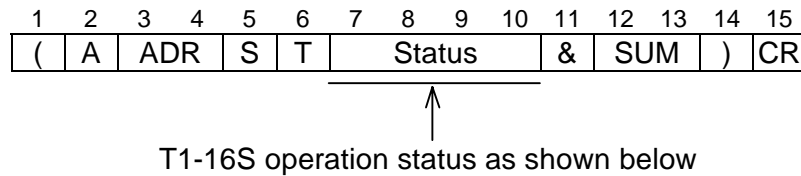
6.5 PLC Status Read (ST)

This command is used to read the T1-16S operation status.

Request message

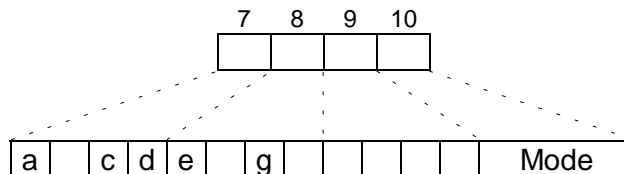


Response message



'CE' or 'EE' is returned if communication error has occurred.

- The Status field shows the T1-16S operation status.



a = 1 : Battery alarm
 c = 1 : TOSLINE-F10 error
 d = 1 : Computer link error
 e = 1 : Constant scan time over
 g = 1 : Under program down-loading

Mode: T1-16S operation mode
 1 = HALT
 2 = RUN
 3 = RUN-F
 4 = HOLD
 6 = ERROR

Other bits are not used. (Reserved)

Execution example

Example 1)

Request (A01ST&97)
 Response (A01ST0001&58)

7	8	9	10
0	0	0	1

T1-16S mode = HALT

Example 2)

Request (A01ST&97)
 Response (A01ST2002&5B)

7	8	9	10
2	0	0	2

T1-16S mode = RUN

TOSLINE-F10 error (c = 1)

Example 3)

Request (A01ST&97)
 Response (A01ST0006&5D)

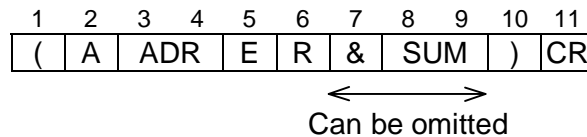
7	8	9	10
0	0	0	6

T1-16S mode = ERROR

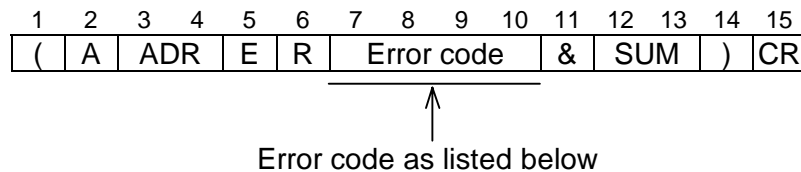
6.6 PLC Error Status Read (ER)

If an error has occurred in the T1-16S, this command can be used to read the error cause.

Request message



Response message



'CE' or 'EE' is returned if communication error has occurred.

- The Error code field shows the most latest error status recorded in the T1-16S's event history table.

Error code	Error name	Description
0000	-	No error recorded
0010	System power on	Power on (no error)
0011	System power off	Power off (no error)
0020	RAM check error	RAM read/write error has been detected
0021	Program BCC error	Program BCC (memory check code) error has been detected
0022	Battery voltage drop	Data invalidity of RAM (back-up area) has been detected
0023	EEPROM BCC error	BCC error of built-in EEPROM has been detected
0026	EEPROM warning	EEPROM write operation has exceeded 100,000 times
0030	System RAM check error	System RAM read/write error has been detected
0031	System ROM BCC error	BCC error of system ROM has been detected

Error code	Error name	Description
0032	Peripheral LSI error	CPU hardware error has been detected
0033	Clock-calendar check error	Invalid clock-calendar data has been detected
0034	Illegal system interrupt	Unregistered interrupt has occurred
0035	WD timer error	Watchdog timer error has occurred
0040	I/O bus error	I/O bus error has been detected
0041	I/O mismatch	Registered I/O allocation table and actual I/O configuration are not identical
0042	I/O no answer	No response from I/O module has been received
0043	I/O parity error	I/O bus parity error has been detected
0046	Illegal I/O register	Excess I/O register allocation has been detected
0064	Scan time over	Scan time has exceeded 200 ms
0080	No END/IRET error	END or IRET instruction has not been programmed
0081	Pair instruction error	Illegal combination of pair instructions has been programmed
0082	Operand error	Illegal operand has been detected
0083	Invalid program	Program abnormality has been detected
0086	No subroutine entry	Subroutine corresponding to CALL instruction has not been programmed
0087	No RET error	RET (subroutine return) instruction has not been in a subroutine
0088	Subroutine nesting error	CALL instruction has been programmed in a subroutine (subroutine nesting)
0089	Loop nesting error	Nesting of FOR-NEXT loop has been programmed
0098	Invalid function instruction	Function instruction which is not supported by T1-16S has been programmed
0110	Illegal instruction	Illegal instruction has been detected
0111	Register address error	Excess register address range has been programmed
0112	Boundary error	Illegal register address is designated by index modification
0121	Duplicate entry No.	Multiple subroutines which has same subroutine number have been programmed

Execution example

Example 1)

Request (A01ST&97)
 Response (A01ST0002&59) – RUN mode

Request (A01ER&87)
 Response (A01ER0010&48)

7	8	9	10
0	0	1	0

 — System power on (normal)

Example 2)

Request (A01ST&97)
 Response (A01ST0006&5D) – ERROR mode

Request (A01ER&87)
 Response (A01ER0064&51)

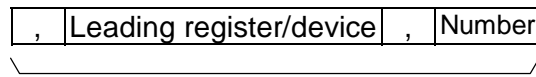
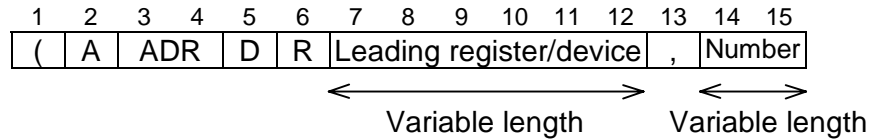
7	8	9	10
0	0	6	4

 — Scan time over

6.7 Data Read (DR)

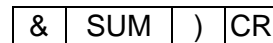
This command is used to read the data of registers and/or devices consecutively. Multiple types of registers/devices can be specified at a time. Total up to 32 registers/devices data can be read.

Request message



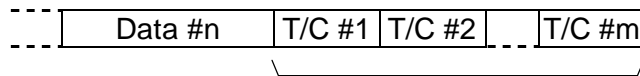
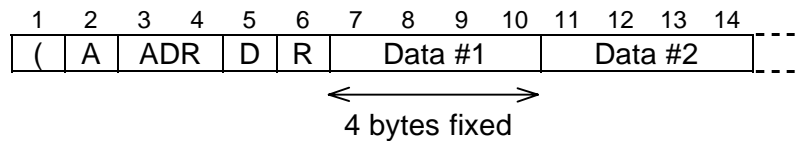
Repeat for multiple types

(255 bytes max.)



Can be omitted

Response message



Added only for Timer/Counter read (see Note)



'CE' or 'EE' is returned if communication error has occurred.

- This command reads the data of specified number of registers/devices starting with specified address.
- Multiple types of registers/devices can be specified at a time.
- Total up to 32 registers/devices data can be specified at a time. However, note that the maximum request message length is limited to 255 bytes.
- Upper 0 can be omitted for the leading register/device address and the number. E.g., R0009 → R9, 05 → 5
- If the number is 1, the number field can be omitted.
- The leading register/device and the number are separated by ',' (comma).
- In the response message, the data are packed in the specified order.
- Each data is expressed in 4 digits hexadecimal format. For a device, '0000' and '0001' represent OFF and ON respectively.



- (1) In case of Timer/Counter register read, the Timer/Counter device data (2 bytes each) corresponding to the Timer/Counter register are added. When the Timer/Counter is time-up/count-up, the device data is '01'. Otherwise, it is '00'.
- (2) The types of register/device which can be specified are as follows.
- Register:
XW, YW, SW, RW, T, C, and D
(Index registers I, J, K cannot be specified)
- Device:
X, Y, S, and R
(Timer/Counter devices T./C. cannot be specified)

Execution example

Example 1)

Request (A01DRRW1,3&BF)
 Response (A01DR1EB922F122A8&2F)

3 registers starting with RW01
 RW01 = H1EB9, RW02 = H22F1, RW03 = H22A8

Example 2)

Request (A01DRRW4&63)
 Response (A01DR004E&5F)

RW04 (Number field omitted)
 RW04 = H004E

Example 3)

Request (A01DRX4,3,D100,2&D0)
 Response (A01DR00010000000102A30508&6B)

X004 to X006 and D0100 and D0101
 X004 = ON, X005 = OFF, X006 = ON, D0100 = H02A3, D0101 = H0508

Example 4)

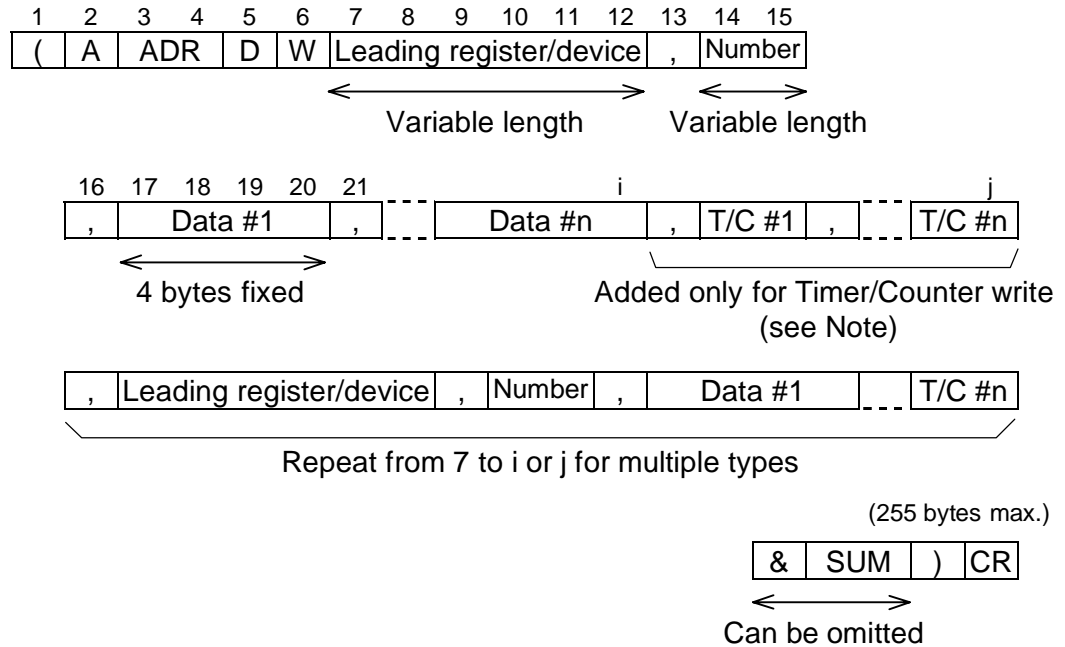
Request (A01DRT0,2,D0,1&65)
 Response (A01DR005B00330100E054&C2)

T000, T001 and D0000
 T000 = H005B, T.000 = ON time-up
 T001 = H0033, T.001 = OFF
 D0000 = HE054

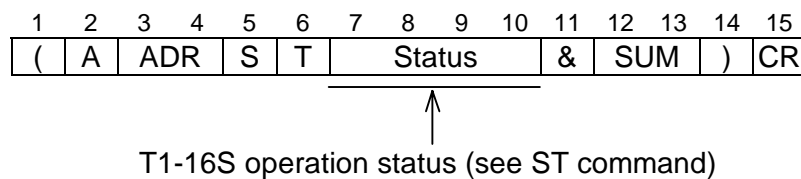
6.8 Data Write (DW)

This command is used to write the data into the T1-16S's registers and/or devices consecutively. Multiple types of registers/devices can be specified at a time. Total up to 32 registers/devices data can be specified.

Request message



Response message



'CE' or 'EE' is returned if communication error has occurred.

- This command writes the data into the specified number of registers/devices starting with specified address.
- Multiple types of registers/devices can be specified at a time.
- Total up to 32 registers/devices data can be specified at a time. However, note that the maximum request message length is limited to 255 bytes.
- Upper 0 can be omitted for the leading register/device address and the number. E.g., R0009 → R9, 05 → 5
- The leading register/device, the number, and each writing data fields are separated by ',' (comma).
- Each data is expressed in 4 digits hexadecimal format. (fixed length)
For a device, '0000' and '0001' represent OFF and ON respectively.



- (1) In case of Timer/Counter register write, the Timer/Counter device data (2 bytes each) corresponding to the Timer/Counter register should be added. If the Timer/Counter device is set to ON, it should be '01'. Otherwise, it should be '00'.
- (2) The types of register/device which can be specified are as follows.
- Register:
XW, YW, SW, RW, T, C, and D
(Index registers I, J, K cannot be specified)
- Device:
X, Y, S, and R
(Timer/Counter devices T./C. cannot be specified)

Execution example

Example 1)

Request (A01DWRW1,3,FFFF,5A5A,0011&0E)
 Response (A01ST0002&59)

Writes HFFFF, H5A5A and H0011 into RW01, RW02, and RW03 respectively

Request (A01DRRW1,3&BF)
 Response (A01DRFFFF5A5A0011&4C)

Read-back confirmation by using DR command

Example 2)

Request (A01DWD100,2,FFFF,EFFF,R20,5,0001,0001,0000,0000,0001&25)
 Response (A01ST0002&59)

Writes HFFFF and HEFFF into D0100 and D0101, and writes ON, ON, OFF, OFF, ON into R020 R021, R022, R023, R024 respectively

Request (A01DRD100,2,R20,5&FA)
 Response (A01DRFFFFEFFF00010001000000000001&78)

Read-back confirmation by using DR command

NOTE

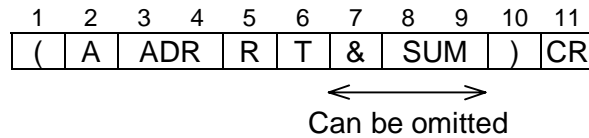


- (1) Upper 0 suppression for Data field is not possible. The Data field must be 4 digits.

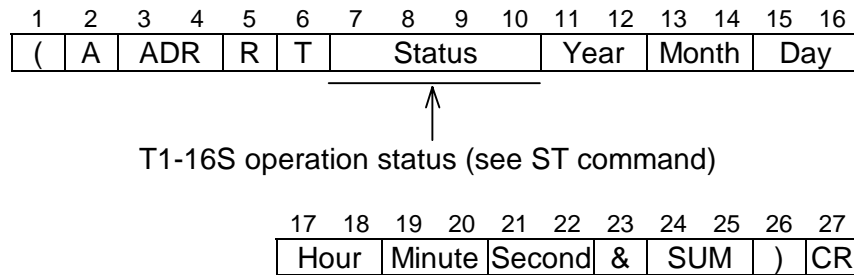
6.9 Clock/calendar Read (RT)

This command is used to read the T1-16S's built-in clock/calendar data.

Request message



Response message



'CE' or 'EE' is returned if communication error has occurred.

- The clock/calendar data are expressed by 2 digits decimal format.

Execution example

Example 1)

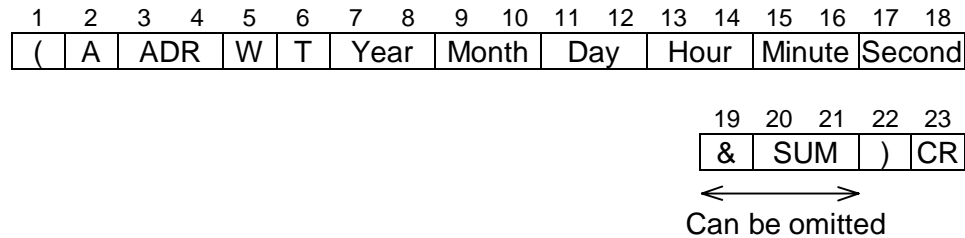
Request (A01RT&96)
 Response (A01RT0002010414115723&B5)

April, 14, 2001 11:57:23
 PLC status = H0002 (RUN)

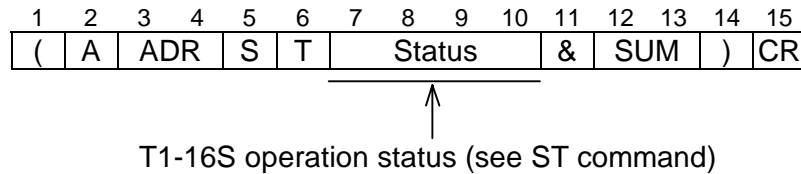
6.10 Clock/calendar Write (WT)

This command is used to set the T1-16S's built-in clock/calendar data.

Request message



Response message



'CE' or 'EE' is returned if communication error has occurred.

- The clock/calendar data are expressed by 2 digits decimal format.

Execution example

Example 1)

Request (A01WT010414120000&E8)

Response (A01ST0002&59)

Normal complete – April, 14, 2001 12:00:00

Example 2)

Request (A01WT010414120080&F0)

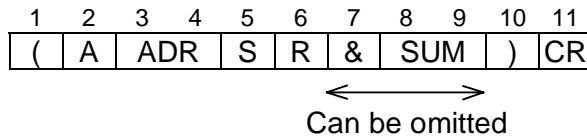
Response (A01EE0052&41)

PLC Error Response (Error 0052: Format error)

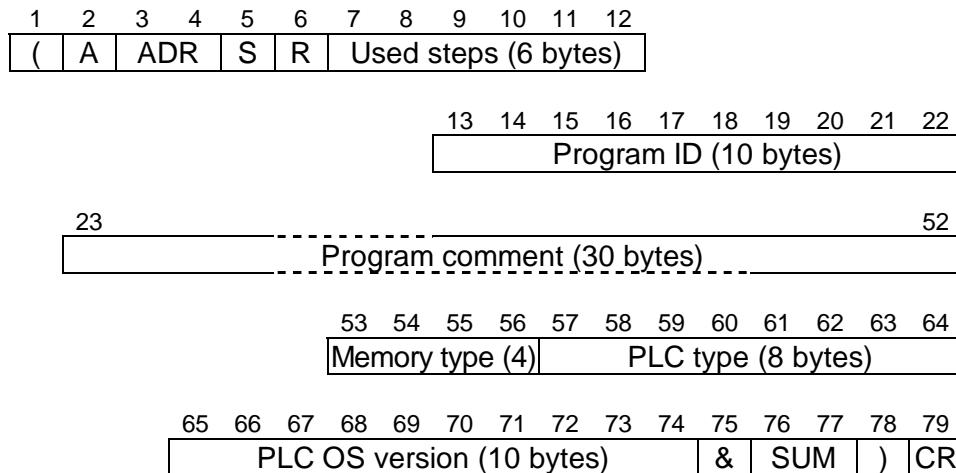
6.11 System Information 1 Read (SR)

This command is used to read the T1-16S's system information (part 1).

Request message

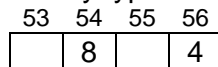


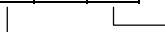

Response message



'CE' or 'EE' is returned if communication error has occurred.

- Used steps: Program steps used in the user program (Decimal format)
- Program ID: Registered name of the user program
- Program comment: Registered comment for the user program
- Memory type: Memory capacity type of the T1-16S



 Data register 4 k words
 Program memory 8 k steps

- PLC type: PLC model name (T1S)
- PLC OS version: T1-16S firmware version number

Execution example

Example 1)

Request	(A01SR&95)		
Response	(A01SR000208SAMPLE	Sample Program 4/14/01	8 4T1S
	Ver. 1.01 &52)		

Used steps = 208 steps

Program ID = SAMPLE

Program comment = Sample Program 4/14/01

Memory type = 8 k steps/4 k words

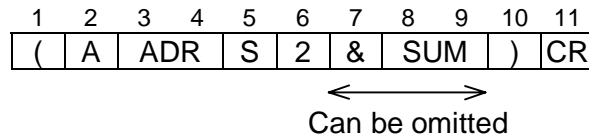
PLC type = T1S

PLC OS version = Ver. 1.01

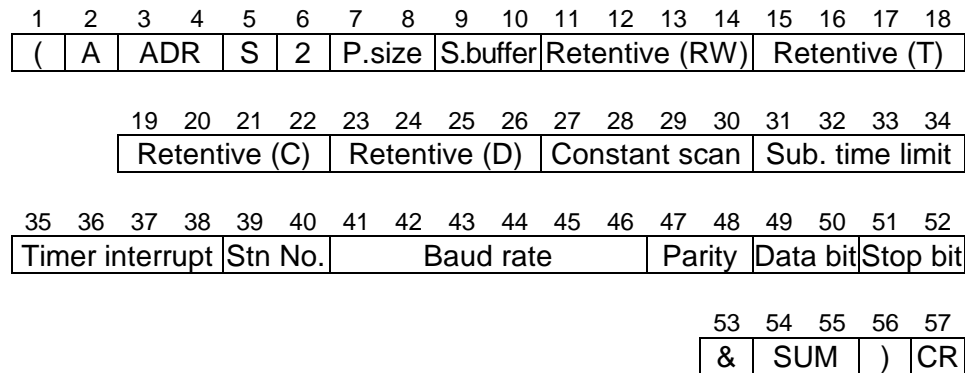
6.12 System Information 2 Read (S2)

This command is used to read the T1-16S's system information (part 2).

Request message



Response message



'CE' or 'EE' is returned if communication error has occurred.

- P. size: Program size setting – “04” (4k steps) or “08” (8k steps) in the T1-16S
- S. buffer: Sampling buffer size setting – “01” (1k words) fixed in the T1-16S
- Retentive: Retentive memory area settings for RW, T, C and D (Decimal)
- Constant scan: Constant scan interval setting (Decimal, in ms units)
 (“0000” if floating scan)
- Sub. time limit: Time limit for subprogram execution (Decimal, in ms units)
 – “0000” fixed in the T1-16S
- Timer interrupt: Timer interrupt interval setting (Decimal, in ms units)
 (“0000” if not used)
- Stn No.: Station number setting for the RS-485 port (Decimal)
- Baud rate: Baud rate setting for the RS-485 port (Decimal)
 (Space code (H20) is inserted into upper 0)
- Parity: Parity setting for the RS-485 port – “00” (none), “01” (odd) or “02” (even)
- Data bit: Data bit length for the RS-485 port – “07” (7 bits) or “08” (8 bits)
- Stop bit: Stop bit length for the RS-485 port – “01” (1 bit) or “02” (2 bits)

Execution example

Example 1)

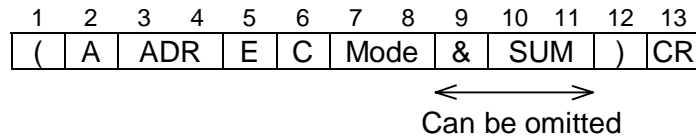
Request (A01S2&75)
Response (A01S20801012700310031051100500000001002 9600000801&B5)

Program size setting = 8 k steps
Sampling buffer size setting = 1 k words (fixed)
Retentive memory area (RW) = RW000 to RW127
Retentive memory area (T) = T000 to T031
Retentive memory area (C) = C000 to C031
Retentive memory area (D) = D0000 to D0511
Constant scan interval = 50 ms
Subprogram execution time limit = 0 ms (fixed)
Timer interrupt interval = 10 ms
Station number = 2
Baud rate = 9600 bps
Parity = None
Data bit length = 8 bits
Stop bit length = 1 bit

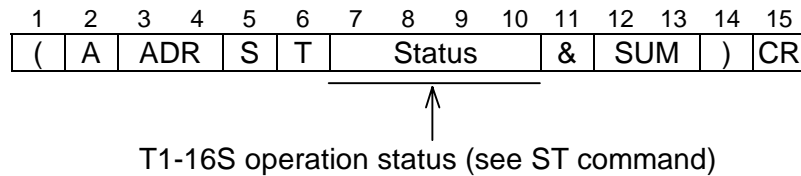
6.13 PLC Control (EC)

This command is used to control the T1-16S operation mode.

Request message



Response message



'CE' or 'EE' is returned if communication error has occurred.

- The Mode field of the request message specifies the T1-16S mode to be changed.
 - 01 ... HALT
 - 02 ... RUN
 - 03 ... RUN-F
 - 04 ... HOLD
 - 06 ... Error reset
 - 07 ... HOLD reset
- The Status in the response message shows the T1-16S mode after changed as per request.
- This command is not valid when the T1-16S's operation mode switch is in HALT. (except Error reset)

Execution example

Example 1)

Request (A01EC02&DA)
 Response (A01ST0002&59)

Changing HALT to RUN – Normal complete

Example 2)

Request (A01EC04&DC)
Response (A01ST0004&5B)

Changing RUN to HOLD – Normal complete

Example 3)

Request (A01EC02&DA)
Response (A01EE0114&4C)

Command RUN during RUN mode – Mode mismatch (0114)

Example 4)

Request (A01ER&87)
Response (A01ER0041&4C)

PLC error status read – I/O mismatch (0041)

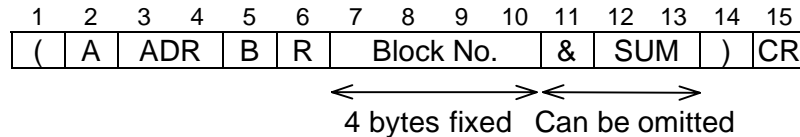
Request (A01EC06&DE)
Response (A01ST0001&58)

Command Error reset – Normal complete

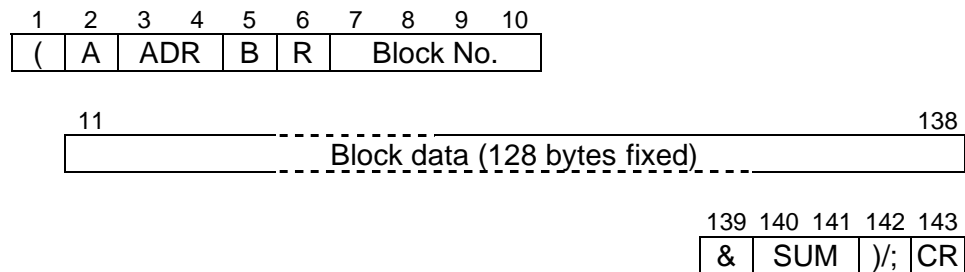
6.14 System Information Block Read (BR)

This command is used to read the system information from the T1-16S block-by-block. The BR command and the RB command are used in combination for program up-loading.

Request message



Response message

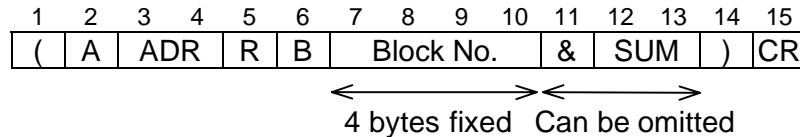
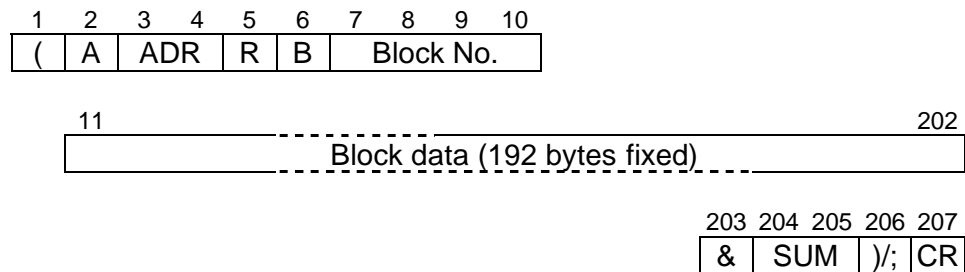


'CE' or 'EE' is returned if communication error has occurred.

- The T1-16S's system information memory contents are read by specifying the block number.
- The size of one block is 128 bytes.
- Block number is 0000 to 0015 (16 blocks). This command should be used from block 0000 through 0015 consecutively.
- The end code “;” (H3B) is returned for block 0000 to 0014 to show a halfway block. And normal end code “)” (H29) is returned for block 0015 to show the final block.

6.15 Program Block Read (RB)

This command is used to read the user program from the T1-16S block-by-block. The BR command and the RB command are used in combination for program uploading.

Request message**Response message**

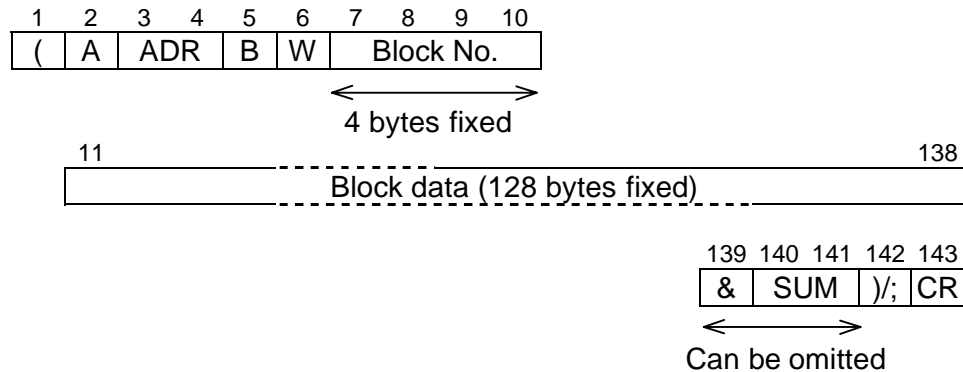
'CE' or 'EE' is returned if communication error has occurred.

- The T1-16S's user program memory contents are read by specifying the block number.
- The size of one block is 192 bytes.
- Block number is 0000 to 1007 (1008 blocks). This command should be started with block 0000 and in order.
- The normal end code ")" (H29) is returned if the block is the final. Otherwise, ";" (H3B) is returned.

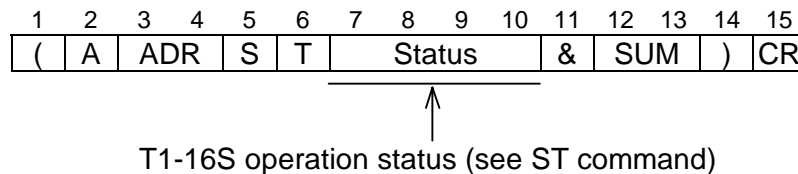
6.16 System Information Block Write (BW)

This command is used to write the system information data obtained by using the BR command into the T1-16S memory block-by-block. The BW command and the WB command are used in combination for program down-loading.

Request message



Response message



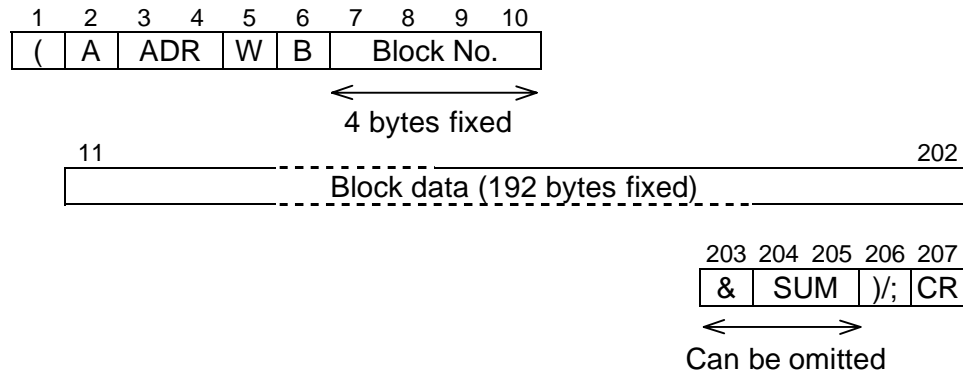
'CE' or 'EE' is returned if communication error has occurred.

- The system information contents are written into the T1-16S memory by specifying the block number.
- The size of one block is 128 bytes.
- Block number is 0000 to 0015 (16 blocks). This command should be used from block 0000 through 0015 consecutively.
- The end code “;” (H3B) must be used for block 0000 to 0014 to show a halfway block. And normal end code “)” (H29) must be used for block 0015 to show the final block.

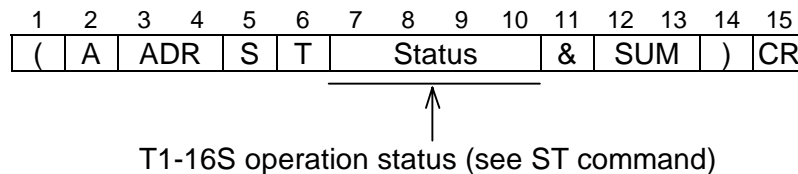
6.17 Program Block Write (WB)

This command is used to write the user program data obtained by using the RB command into the T1-16S memory block-by-block. The BW command and the WB command are used in combination for program down-loading.

Request message



Response message



'CE' or 'EE' is returned if communication error has occurred.

- The user program contents are written into the T1-16S memory by specifying the block number.
- The size of one block is 192 bytes.
- Block number is 0000 to 1007 (1008 blocks). This command should be started with block 0000 and in order.
- The end code “;” (H3B) must be used for halfway blocks. And normal end code “)” (H29) must be used for the final block.

PART 2 T1-16S RS-485 Port Function

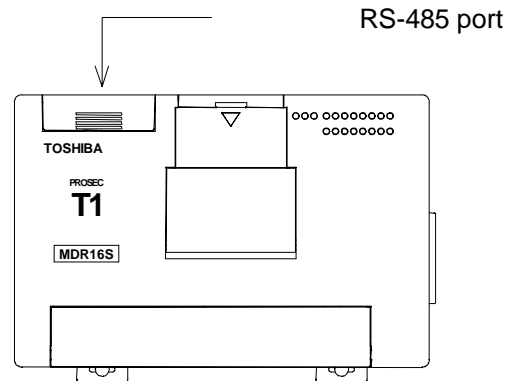
Section 1
Overview

- 1.1 Function overview, 64*
- 1.2 Operation mode selection, 69*

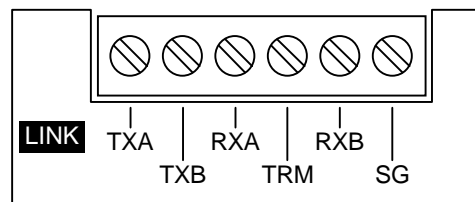
1.1 Function overview

The T1-16S enhanced version has an RS-485 port. This RS-485 port and the programmer port can work independently.

T1-16S enhanced version external feature



Terminal arrangement of the RS-485 port



By using this RS-485 port, one of the following communication functions can be used.

- Communication with a master computer (Computer link mode)
- Data linkage between two T1-16Ss (Data link mode)
- Active communication with serial ASCII devices (Free ASCII mode)
- Monitoring and controlling the Toshiba Inverters (Inverter connection mode)

The operation mode is selected by the data set in SW56. Refer to section 1.2.



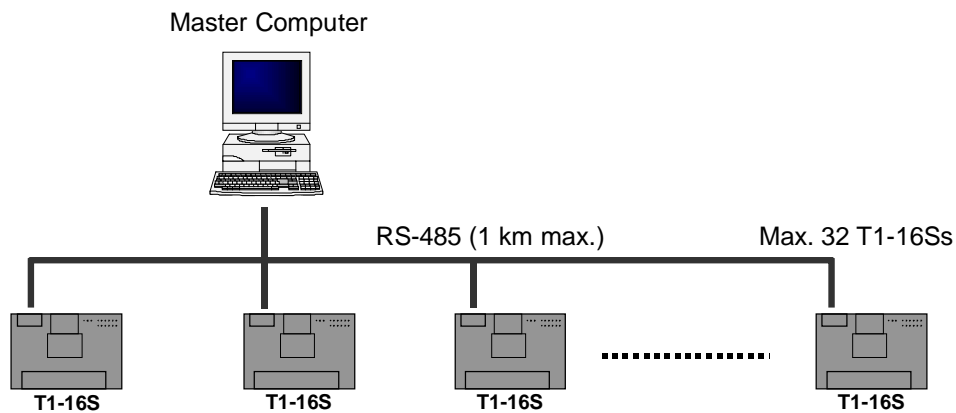
NOTE The standard T1-16S does not have the RS-485 port.

Computer link mode

The computer link mode is used to connect between the T1-16S and a master computer. Up to 32 T1-16Ss can be connected to the master computer on the RS-485 communication line.

By preparing the communication software based on the Toshiba's computer link protocol on the master computer, the following functions become available by the master computer. The computer link protocol is a simple ASCII message communication system.

- Reading data (register/device value) from the T1-16S
- Writing data (register/device value) into the T1-16S
- Monitoring the T1-16S's operation status (RUN/HALT/ERROR)
- Reading the error code from the T1-16S
- Reading the clock/calendar data from the T1-16S
- Writing the clock/calendar data into the T1-16S
- Controlling the T1-16S operation mode (RUN/HALT)
- Program up-loading from the T1-16S
- Program down-loading into the T1-16S



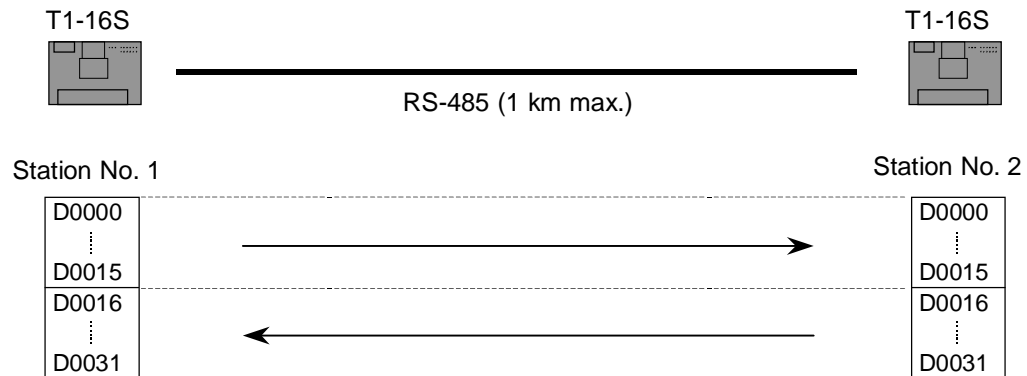
Of course, T-series PLC programming tool (T-PDS) can also be used in this computer link system.

Data link mode

The data link mode is used to connect two T1-16Ss.
 Each 16 words data is automatically exchanged between these two T1-16Ss.
 No user program for this data linkage is required.

For this function, one T1-16S must be set to station number 1, and the other must be set to 2.

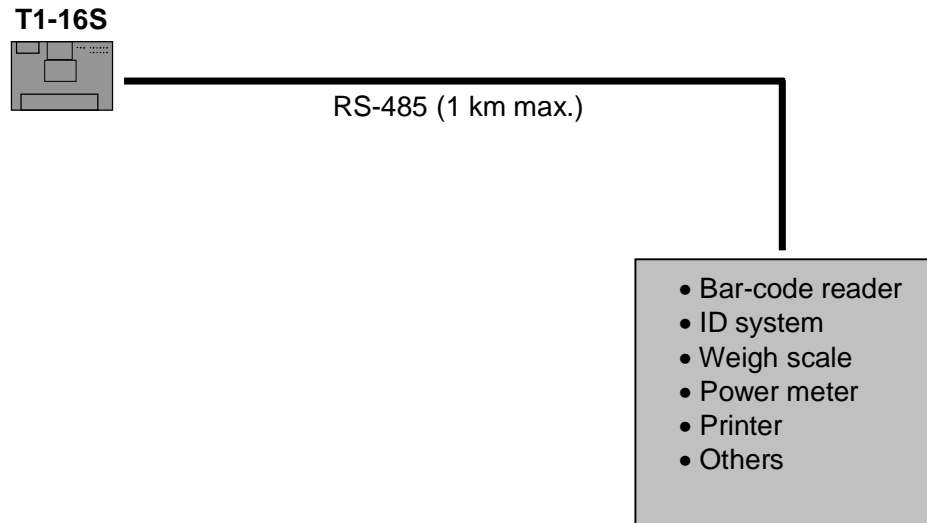
The data registers D0000 to D0031 (32 words) are used for this data linkage.



NOTE By using this function, data linkage between T1-16S and T1-40S/T2E/T2N is also available.

Free ASCII mode

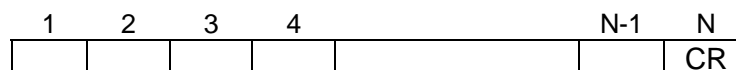
The free ASCII mode is used to connect between the T1-16S and various serial ASCII devices, such as a micro computer, bar code reader, printer, display, etc. By using this mode, the T1-16S can work as a communication master. Therefore, the T1-16S can communicate with other PLCs using the computer link protocol.



In this mode, user defined ASCII messages can be transmitted and/or received through the RS-485 port.

The ASCII message (one set of transmission characters) means a string of ASCII characters which is ended by a specified trailing code. The default setting of the trailing code is CR (carriage return code = H0D).

Applicable message format (default trailing code):



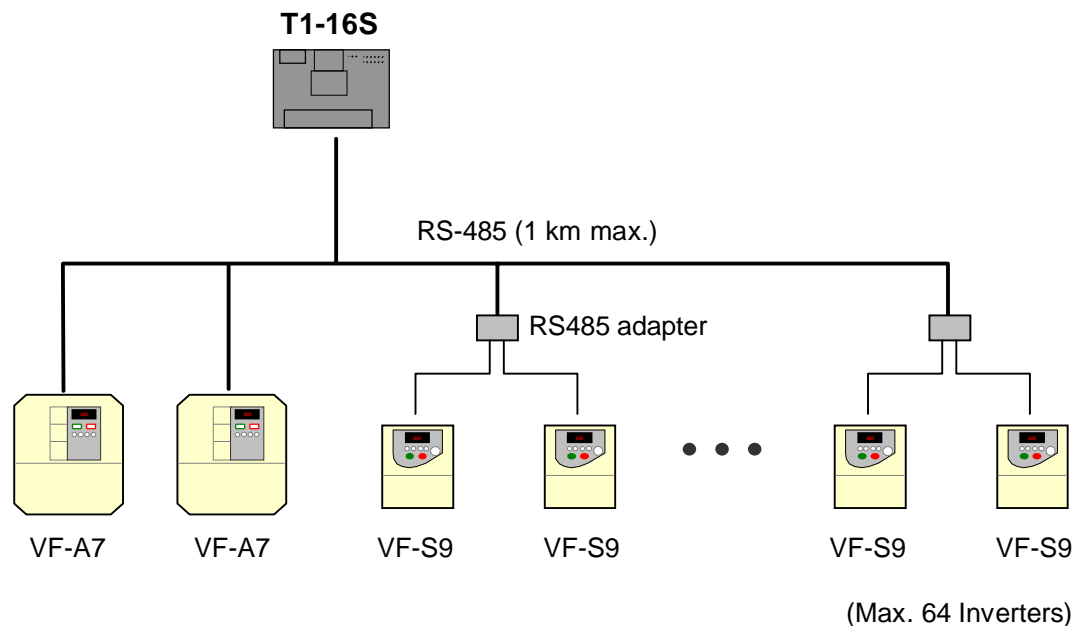
N: message length = 512 bytes max.

In other words, the T1-16S cannot be used for the data communication in which the trailing code may be appeared in the middle of the message (binary transmission) or the message is ended by two or more types of trailing code.

Inverter connection mode

The T1-16S's Inverter connection mode is a special function to monitor/control the Toshiba Inverters (ASDs) VF-A7/G7/S9 through the RS-485 line.
Using this mode, the T1-16S can perform the following functions for the Inverters connected on the RS-485 line without any special communication program.

- Monitoring – Operating frequency and Terminal status
- Control – Run/Stop/Jog, Forward/Reverse, Frequency reference, etc.
- Parameter read/write
- Broadcast command



NOTE This Inverter connection mode is using the standard serial communication function of the Inverters in order to configure monitor/control system inexpensively. For tightly integrated speed and sequence control, Toshiba recommends use of a T2 or T3 PLC with a DeviceNet or with a TOSLINE network module in the PLC and in the Inverters.

1.2 Operation mode selection

The operation mode of the RS-485 port is decided by the data of the special register SW56.

This data is stored in the built-in EEPROM by executing the EEPROM write command. The T1-16S reads this data at power-on initialization, and decides the mode.

To set the mode, turn the T1-16S to HALT mode, and write the mode data (see table below) into SW56 using the programmer. After writing, execute the EEPROM write command. And cycle power off and on again. Then the selected mode will function.

Address	Name	Data range
SW56	RS-485 port operation mode	0 = Computer link mode 1 = Data link mode 2 = Free ASCII mode 3 = Inverter connection mode



If the set data is out of the valid range, the T1-16S regards as the computer link mode.



The SW56 setting is saved in the program storage module RM102 (ver. 2 or later). Therefore, when you save the T1-16S program into the RM102 then load it into another T1-16S, the original SW56 setting will be copied. However, in case of the T-PDS, the SW56 setting is not saved in the disk file. Therefore even when you load the T1-16S program by the T-PDS, you must set the SW56 data for the T1-16S manually as mentioned above.

Section 2

Specifications

- 2.1 Computer link mode, 72*
- 2.2 Data link mode, 72*
- 2.3 Free ASCII mode, 73*
- 2.4 Inverter connection mode, 73*

2.1 Computer link mode

Item	Specification
Interface	Conforms to RS-485 (4-wire system)
Transmission mode	Half-duplex
Synchronizing	Start-stop method (asynchronous)
Transmission speed	300, 600, 1200, 2400, 4800, 9600, 19200 bps
Frame format	Start bit 1 bit (fixed) Data 7 or 8 bits Parity even / odd / no Stop bit 1 or 2 bits
Protocol	T-series computer link protocol (ASCII), T-series programmer protocol (Binary)
Response delay time	0 to 300 ms (user setting)
Configuration	One to N (32 max.)
Transmission distance	1 km max.
Cable connection	Terminal block (fixed)




NOTE Total number of the bits of the frame must be 10 or 11 bits.
For example, when 8 data bits and even parity is selected, the stop bit length must be 1 bit.

2.2 Data link mode

Item	Specifications
Interface	Conforms to RS-485 (4-wire system)
Transmission mode	Half-duplex
Synchronizing	Start-stop method (asynchronous)
Transmission speed	19200 bps
Protocol	Special
Link data capacity	16 words (station No. 1 → station No. 2) 16 words (station No. 2 → station No. 1)
Link data update cycle	Approx. 50 ms + scan times of both stations (synchronized with the T1-16S's program scan)
Configuration	One to one
Transmission distance	1 km max.
Cable connection	Terminal block (fixed)


2.3 Free ASCII mode

Item	Specifications
Interface	Conforms to RS-485 (2-wire or 4-wire system)
Transmission mode	Half-duplex
Synchronizing	Start-stop method (asynchronous)
Transmission speed	300, 600, 1200, 2400, 4800, 9600, 19200 bps
Frame format	Start bit 1 bit (fixed) Data 7 or 8 bits Parity even / odd / no Stop bit 1 or 2 bits
Transmission code	ASCII
Message length	512 bytes max.
Configuration	One to N (32 max.)
Transmission distance	1 km max.
Cable connection	Terminal block (fixed)

 **NOTE** Total number of the bits of the frame must be 10 or 11 bits.
For example, when 8 data bits and even parity is selected, the stop bit length must be 1 bit.

2.4 Inverter connection mode

Item	Specification
Interface	Conforms to RS-485 (4-wire system)
Transmission mode	Half-duplex
Synchronizing	Start-stop method (asynchronous)
Transmission speed	300, 600, 1200, 2400, 4800, 9600, 19200 bps
Frame format	Start bit 1 bit (fixed) Data 8 bits Parity even / odd / no Stop bit 1 or 2 bits
Protocol	Toshiba Inverter VF-A7 binary protocol (16-bit)
Function and command	(1) Data exchange (FA01, FA00, FD00, FE07) (2) Monitor mode (FD00, FE07) (3) Read command mode (user setting) (4) Write command mode (user setting) (5) Broadcast mode (usersetting)
Access delay time	0 to 300 ms (user setting)
Configuration	One to N (64 Inverters max.)
Transmission distance	1 km max.
Cable connection	Terminal block (fixed)

 **NOTE** Total number of the bits of the frame must be 10 or 11 bits.
For example, when parity is added, the stop bit length must be 1 bit.

Section 3

Computer Link Mode

- 3.1 Computer link function, 76*
- 3.2 System configuration, 78*
- 3.3 Setup procedure, 79*
- 3.4 Cable connection, 80*
- 3.5 Mode setting, 82*
- 3.6 Communication parameter setting, 83*
- 3.7 Computer link protocol, 85*

3.1 Computer link function

The computer link mode is used to connect between the T1-16S and a master computer.

By preparing the communication software based on the Toshiba's computer link protocol on the master computer, the following functions become available by the master computer. The computer link protocol is a simple ASCII message communication system.

- Reading data (register/device value) from the T1-16S
- Writing data (register/device value) into the T1-16S
- Monitoring the T1-16S's operation status (RUN/HALT/ERROR)
- Reading the error code from the T1/T1-16S
- Reading the clock/calendar data from the T1-16S
- Writing the clock/calendar data into the T1-16S
- Controlling the T1-16S operation mode (RUN/HALT)
- Program up-loading from the T1-16S
- Program down-loading into the T1-16S

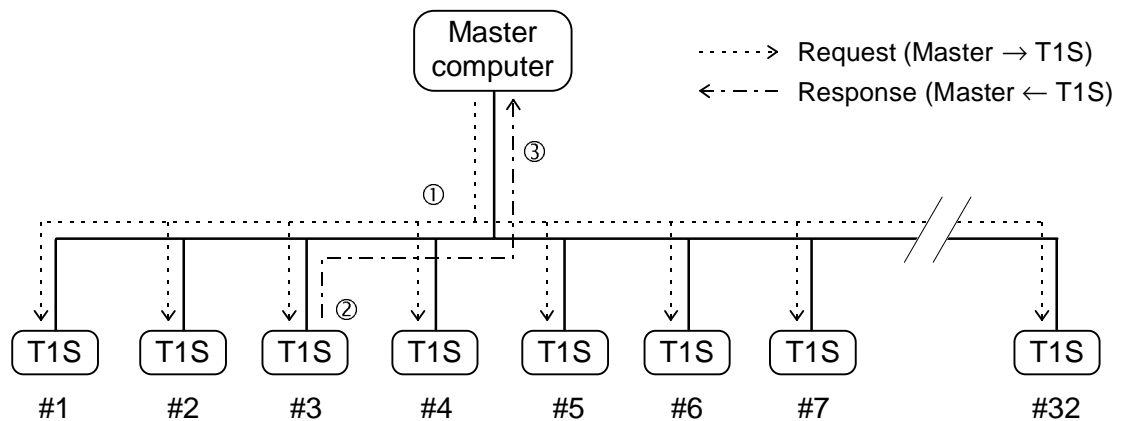
Up to 32 T1-16Ss can be connected to a master computer on the RS-485 communication line. (one-to-N configuration)

In the computer link system, the T1-16S waits for receiving a request message issued from the master computer.

When a request message is issued, the T1-16S checks the station number contained in the request message. And when the station number designation matches the T1-16S's station number setting, the T1-16S processes the request and returns the response.

This is why each T1-16S must have a unique station number in the one-to-N configuration. Otherwise, more than one T1-16Ss may attempt to process the request, resulting in faulty response.

The following figure illustrates the processing sequence when a request to station number 3 is issued.



- ① The request message is sent from the master to all the connected T1-16Ss. (request for station #3 in this example)
- ② The request message is interpreted and processed in the T1-16S which has the same station number as request. (station #3 T1-16S in this example)
- ③ Processing result is returned as response to the master.



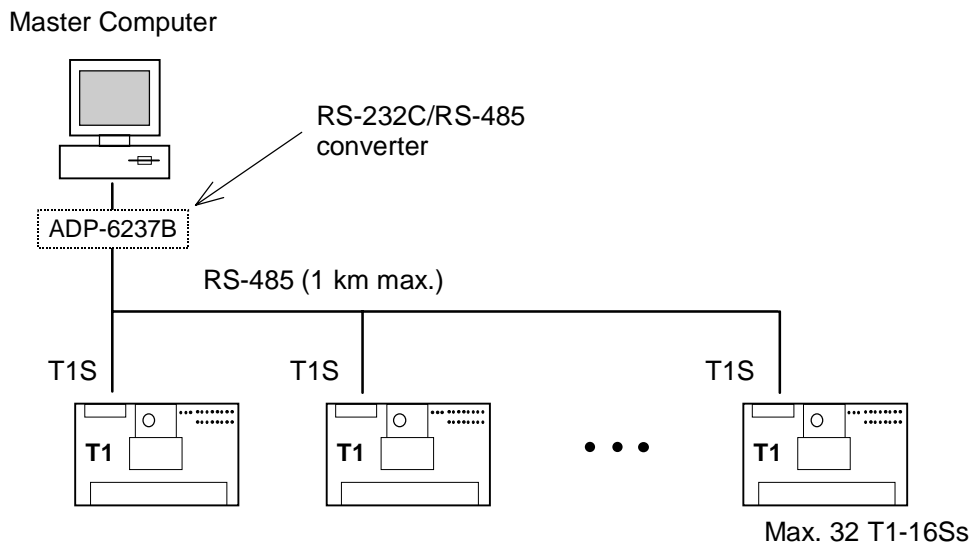
Available station number is 1 to 32. The station number is set in the T1-16S's system information memory.

3.2 System configuration

The following figure shows the system configuration.

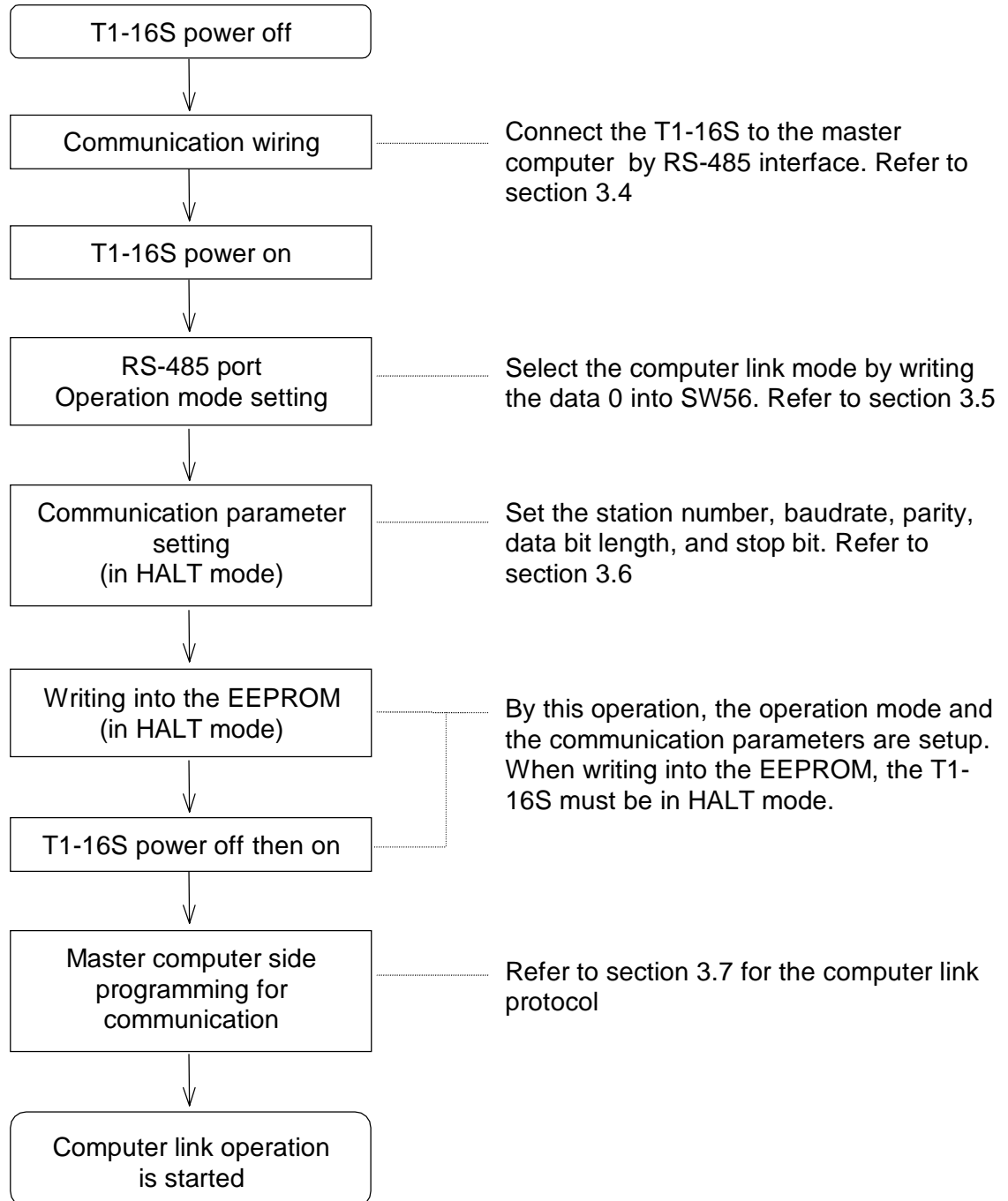
On the RS-485 communication line, up to 32 T1-16Ss can be connected. If the master computer has RS-232C interface only, the RS-232C/RS-485 converter (ADP-6237B) can be used.

One-to-N configuration



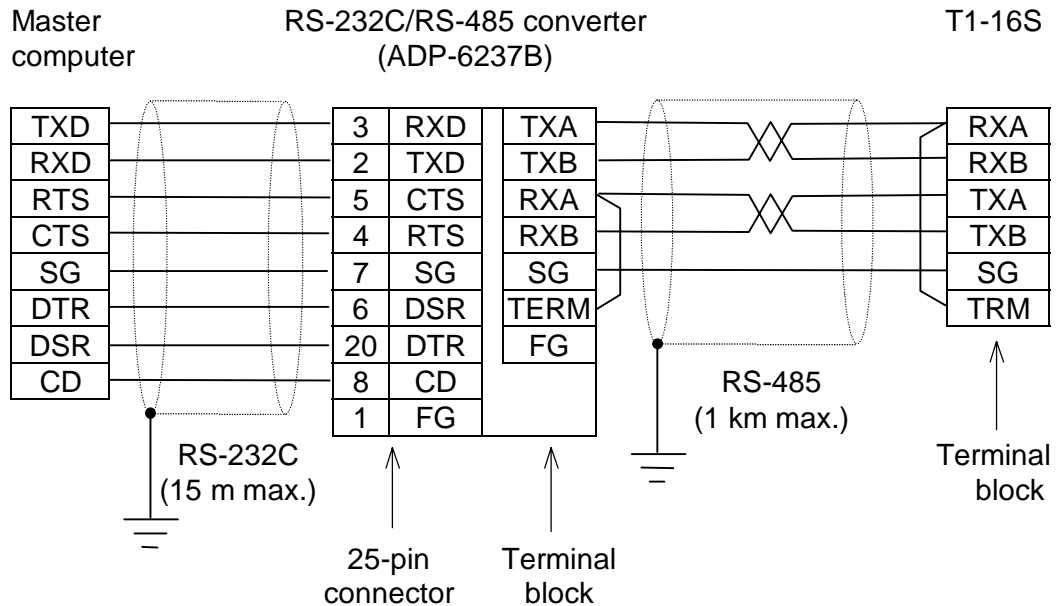
3.3 Setup procedure

The following chart shows the setup procedure of the computer link mode.



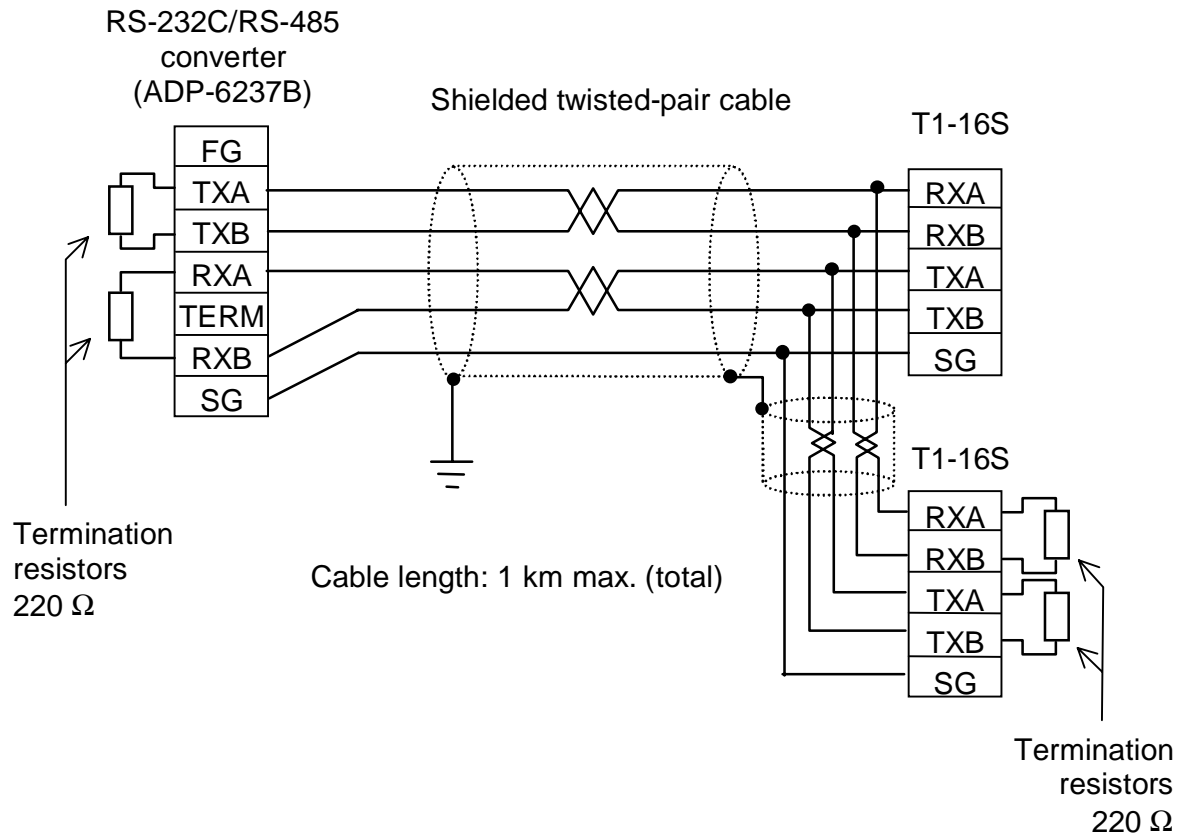
3.4 Cable connection

One to one configuration



- Above figure shows an example of cable connection using the RS-232C/RS-485 converter (ADP-6237B).
- Short between RXA and TRM for termination at the T1-16S.
- Short between RXA and TERM for termination at the ADP-6237B.
- If the master has RS-485 (or RS-422) interface and the T1-16S is connected to the master directly, connect termination resistor 1/2 W - 120 Ω between RXA and RXB at the master end.
- Use shielded twisted-pair cable for data communication suited to RS-485 standard. The cable shield should be connected to ground.

One to N configuration



- Connect termination resistors (1/2 W - 220 Ω) between TXA and TXB, and RXA and RXB, at each end of the line (at both termination stations).
- When a terminal block is used to branch off the line, the branch should not exceed 3 m cable length from the terminal block to the T1-16S or the master computer.
- Use shielded twisted-pair cable for data communication suited to RS-485 standard. Connect the cable shield each other, and connect it to ground. (Single point grounding)

3.5 Mode setting

The operation mode of the RS-485 port is decided by the data of the special register SW56.

This data is stored in the built-in EEPROM by executing the EEPROM write command. The T1-16S reads this data at power-on initialization, and decides the mode.

To select the computer link mode, follow the procedure below.

- (1) Turn the T1-16S to HALT mode
- (2) Write **0** into **SW56** by using the programmer
- (3) Execute the EEPROM write command
- (4) Turn off power
- (5) Turn on power again

Then the T1-16S's RS-485 port functions as the computer link mode.



NOTE The default setting of SW56 is 0. (Computer link mode)



NOTE The SW56 setting is saved in the program storage module RM102 (ver. 2 or later). Therefore, when you save the T1-16S program into the RM102 then load it into another T1-16S, the original SW56 setting will be copied. However, in case of the T-PDS, the SW56 setting is not saved in the disk file. Therefore even when you load the T1-16S program by the T-PDS, you must set the SW56 data for the T1-16S manually as mentioned above.

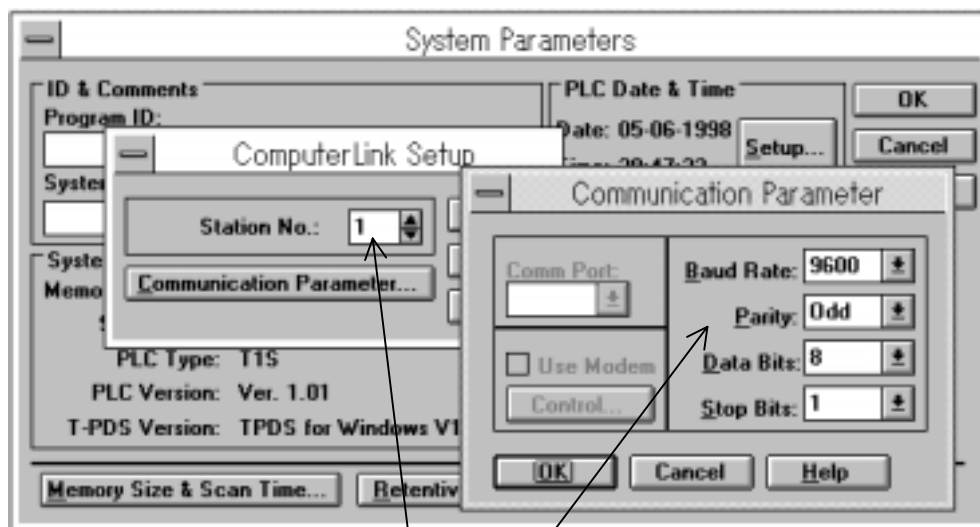
3.6 Communication parameter setting

3.6.1 Transmission parameters

The transmission parameters are set by writing it into the system information memory of the T1-16S.

Turn the T1-16S to HALT mode, then set the communication parameter in the system information.

(T-PDS screen example)



Set station number, baudrate, parity, data bit length, and stop bit.

After the communication parameter setting, write it into the T1-16S's built-in EEPROM before turning off power.



The default settings are as follows.

- Station number = 1
- Baudrate = 9600 bps
- Parity = odd
- Data bits = 8 bits
- Stop bit = 1 bit

3.6.2 Response delay time setting

The response time from the RS-485 port in the computer link mode can be changed. The possible setting is as follows.

Internal processing time + (0 to 300) ms (10 ms units)

This function is useful when a wire-less modem is used.

To set the response delay time, turn the T1-16S to HALT mode, and write the delay time (0 to 30) into SW57. After writing, execute the EEPROM write command. And cycle power off and on again. Then the setting will be effective.

Address	Name	Data range
SW57	RS-485 port response delay	0 to 30 (decimal) (0 to 30 : 0 to 300 ms)



NOTE If the data is out of the valid range, it is limited by 30 (300 ms).



NOTE The SW57 setting is saved in the program storage module RM102 (ver. 2 or later). Therefore, when you save the T1-16S program into the RM102 then load it into another T1-16S, the original SW57 setting will be copied. However, in case of the T-PDS, the SW57 setting is not saved in the disk file. Therefore even when you load the T1-16S program by the T-PDS, you must set the SW57 data for the T1-16S manually as mentioned above.

3.6.3 Communication priority mode

In the T1-16S, the peripheral support processing (computer link service) is executed at the bottom of each scan with the time limit of 2 ms to minimize the extension of scan time.

However the T1-16S can work with the peripheral support priority mode. In this mode, the computer link service is executed without a break. By using this mode, the communication response becomes quick although the scan time is extended at the time.

To select the peripheral support priority mode, set the special relay S158 to ON by user program.

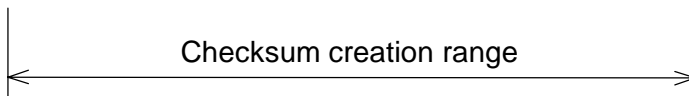
Address	Name	Function
S158	Peripheral support priority mode	When ON, the peripheral support priority mode is selected.



NOTE This mode setting is effective commonly for both programmer port and the RS-485 port.

3.7 Computer link protocol

General message format

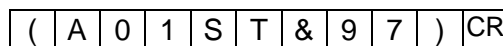


Text contents

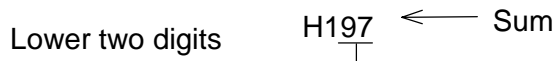
- (..... Start code (H28) – 1 byte
- A Format identification code (H41) – 1 byte
- ADR Station number – 2 bytes
 01 (H3031) through 32 (H3332)
- CMD Command – 2 bytes
- DATA ... Data field – depending on the command (max. 244 bytes)
- & Checksum delimiter (H26) – 1 byte
- SUM Checksum – 2 bytes
 ASCII code of the lowest one byte of the sum obtained by adding
 from the start code '(' to the checksum delimiter '&'.
 See Note below.
-) End code (H29) – 1 byte
- ; End code (H3B) – 1 byte
 in case of halfway of entire data
- CR Carriage return code (H0D) – 1 byte



Checksum creation example:



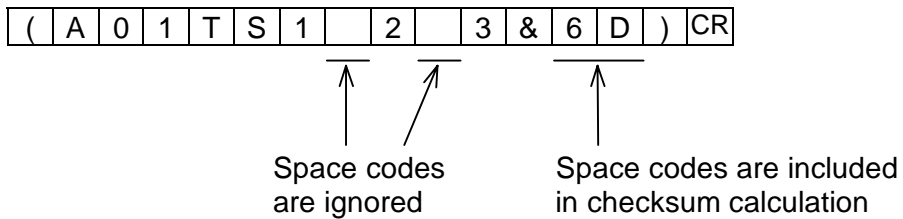
- '(' = H28
- 'A' = H41
- '0' = H30
- '1' = H31
- 'S' = H53
- 'T' = H54
- '&' = H26



Transmission rules

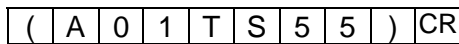
The following transmission rules are applied to the RS-485 computer link communication.

- (1) The T1-16S is always waiting for a request command issued from the master computer. The T1-16S will not transmit any message without receiving a request.
- (2) 7 or 8-bit ASCII is used as transmission code.
- (3) If some space codes (H20) are included in the request message, they are ignored. However, the space codes are included in checksum calculation.

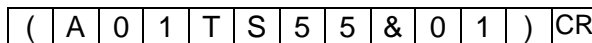


- (4) Checksum can be omitted in the request message issued from the master computer. In the response message issued from the T1/T1-16S, checksum is always added.

Request message



Response message



Response message always includes
the checksum and the delimiter code (&).

- (5) The T1-16S ignores all the data received before the start code '('.
- (6) Message receiving is completed only after the end code ')' and CR have been received. If the end code without CR, or vice versa, is received, it causes transmission error.

- (7) The T1-16S checks the request message receiving time. If the receiving time from the start code '(' to CR exceeds the time limit below, the T1-16S judges as transmission error. In this case, no response will be returned from the T1-16S.

Baudrate	Time limit
300 bps	96 s
600 bps	48 s
1200 bps	24 s
2400 bps	12 s
4800 bps	6 s
9600 bps	3 s
19200 bps	1.5 s

- (8) In the one-to-N configuration, when a T1-16S finishes to send a response message, the T1-16S releases the transmission line in 10 ms (max.). Until the transmission line is released, other T1-16S cannot send any message. Therefore, the master computer should wait to send next request message for at least 10 ms after previous response reception.

List of computer link commands

The following computer link commands are available for the T1-16S.

Request command	Function name	Description	Response command	Remarks
–	Computer Link Error Response	Format error was detected in the request message	CE	Response only
–	PLC Error Response	The request command was rejected by T1/T1-16S	EE	Response only
TS	Test	Loop back test -- T1/T1-16S returns the same text	TS	
ST	PLC Status Read	Reads T1/T1-16S operation status	ST	
ER	PLC Error Status Read	Reads error code registered in the T1/T1-16S	ER	
DR	Data Read	Reads registers/devices data from the T1/T1-16S	DR	
DW	Data Write	Writes registers/devices data into the T1/T1-16S	ST	
RT	Clock/calendar Read	Reads clock/calendar data (date & time) from the T1-16S	RT	
WT	Clock/calendar Write	Writes clock/calendar data (date & time) into the T1-16S	ST	
SR	System Information 1 Read	Reads system information 1 from the T1-16S	SR	
S2	System Information 2 Read	Reads system information 2 from the T1-16S	S2	
EC	PLC Control	Changes the T1-16S operation mode	ST	
BR	System Information Block Read	Reads system information from the T1-16S block-by-block	BR	
RB	Program Block Read	Reads program from the T1-16S block-by-block	RB	
BW	System Information Block Write	Writes system information into the T1-16S block-by-block	ST	
WB	Program Block Write	Writes program into the T1-16S block-by-block	ST	

For details of each command, see Part 1 Section 6 of this manual.

Section 4

Data Link Mode

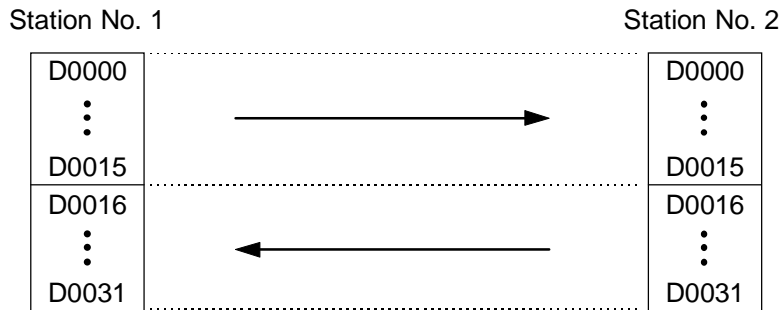
- 4.1 Data link function, 90*
- 4.2 System configuration, 90*
- 4.3 Setup procedure, 91*
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4.1 Data link function

The data link function performs data linkage between two T1-16Ss. No user program for this data linkage is required. By using this function, two stations data linkage system can be configured easily.

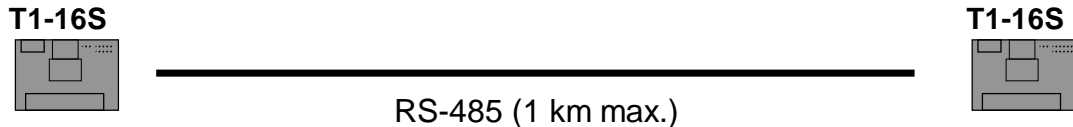
For this function, one T1-16S must be set to the station No. 1, and the other must be set to the station No. 2. The station number is set by writing it into the system information memory of the T1-16S, as same as the computer link setting.

The data registers D0000 to D0031 (32 words) are used for this data linkage. The station No. 1 T1-16S sends the data of D0000 to D0015 to the station No. 2 T1-16S. The station No. 2 T1-16S sends the data of D0016 to D0031 to the station No. 1 T1-16S.

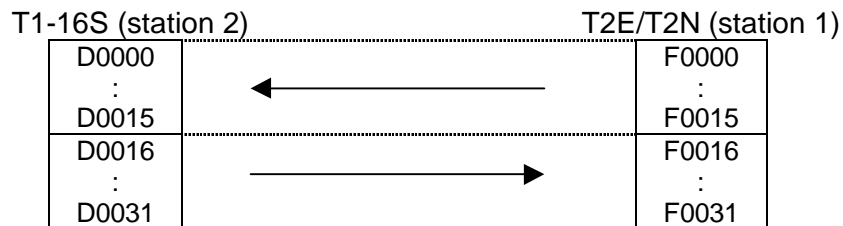


The data update cycle of these 32 words is approx. 50 ms + scan times of both T1-16Ss. The link data update timing is synchronized with T1-16S's program scan.

4.2 System configuration

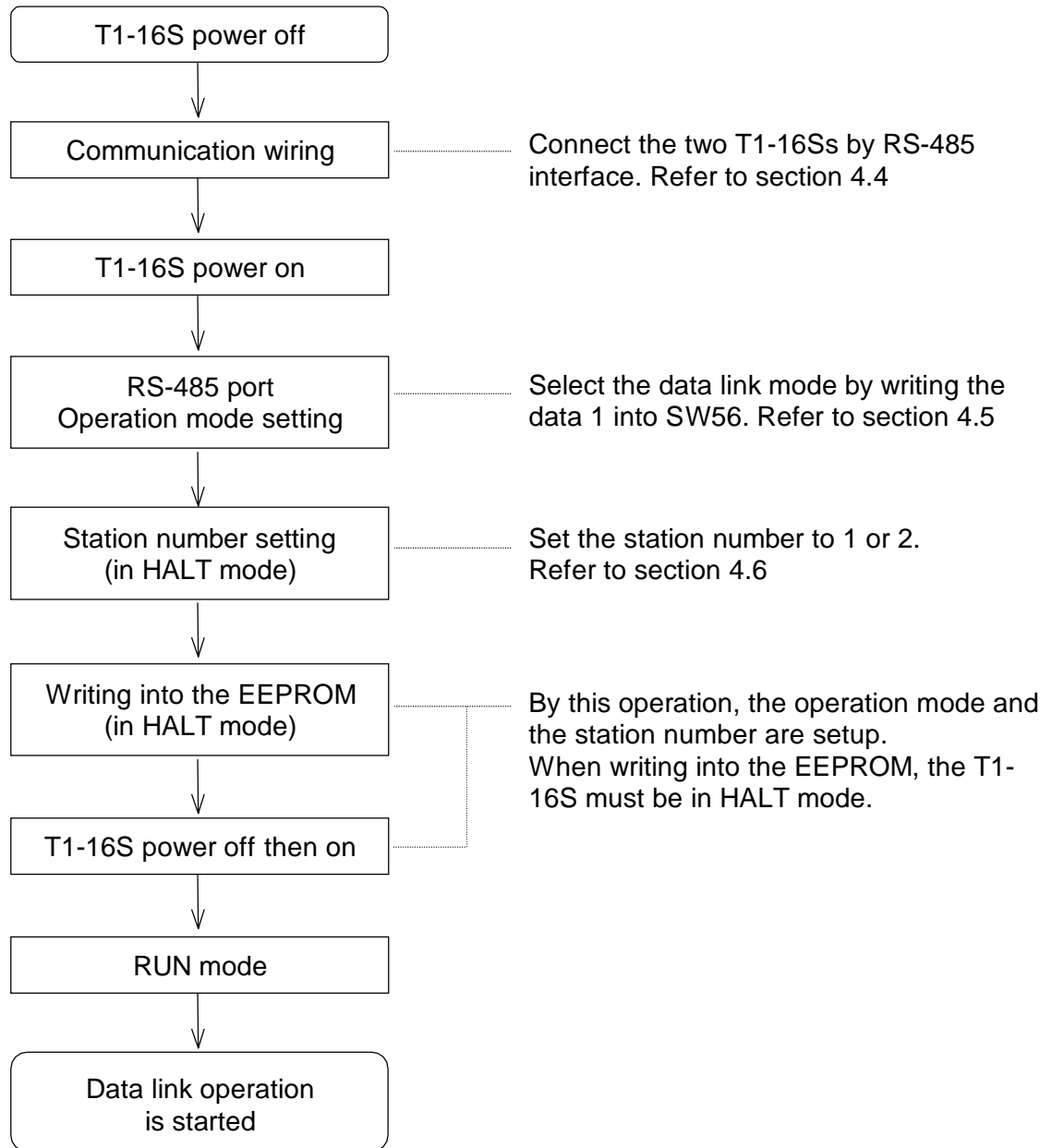


The T1-16S's data link mode is compatible with that of T2E/T2N. Therefore using this data link mode, easy data linkage between T1-16S and T2E or T2N is possible. In this case, the link data assignment is as follows.



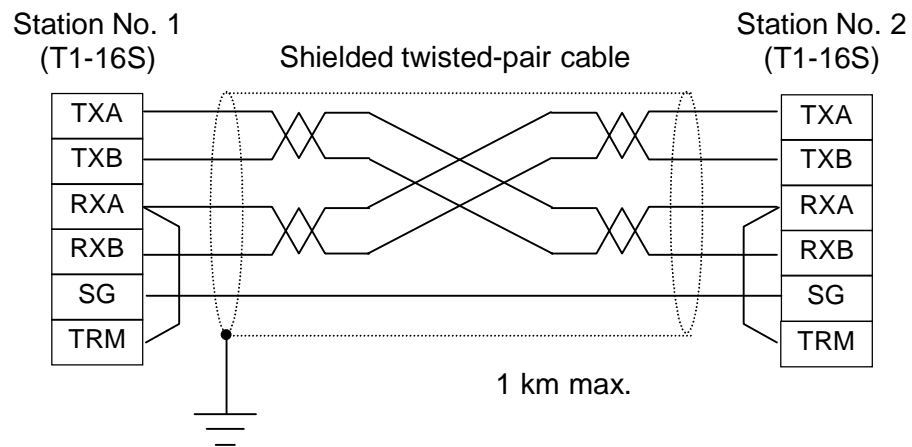
4.3 Setup procedure

The following chart shows the setup procedure of the data link function.



Follow the above procedure for both station No. 1 and station No. 2 T1-16Ss.

4.4 Cable connection



- Short between RXA and TRM for termination at both the T1-16Ss.
- Use shielded twisted-pair cable for data communication suited to RS-485 standard. The cable shield should be connected to ground.

4.5 Mode setting

The operation mode of the RS-485 port is decided by the data of the special register SW56.

This data is stored in the built-in EEPROM by executing the EEPROM write command. The T1-16S reads this data at power-on initialization, and decides the mode.

To select the data link mode, follow the procedure below.

- (1) Turn the T1-16S to HALT mode
- (2) Write **1** into **SW56** by using the programmer
- (3) Execute the EEPROM write command
- (4) Turn off power
- (5) Turn on power again

Then the T1-16S's RS-485 port functions as the data link mode.



NOTE The default setting of SW56 is 0. (Computer link mode)



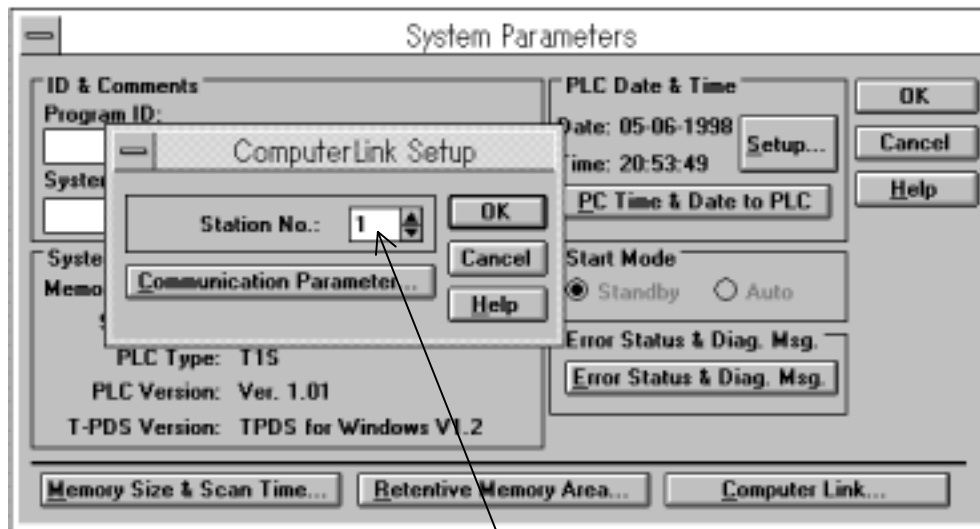
NOTE The SW56 setting is saved in the program storage module RM102 (ver. 2 or later). Therefore, when you save the T1-16S program into the RM102 then load it into another T1-16S, the original SW56 setting will be copied. However, in case of the T-PDS, the SW56 setting is not saved in the disk file. Therefore even when you load the T1-16S program by the T-PDS, you must set the SW56 data for the T1-16S manually as mentioned above.

4.6 Communication parameter setting

To use the data link mode, one T1-16S must be set to the station No. 1, and the other must be set to the station No. 2. The station number is set by writing it into the system information memory of the T1-16S.

Turn the T1-16S to HALT mode, then set the station number (1 or 2) in the system information.

(T-PDS screen example)



Set the station number here.
Other parameters are ignored.

After the station number setting, write it into the T1-16S's built-in EEPROM before turning off power.

4.7 RAS information

To watch the normal data link operation, the following flags are provided. Use these flags in the program to check the validity of received data.

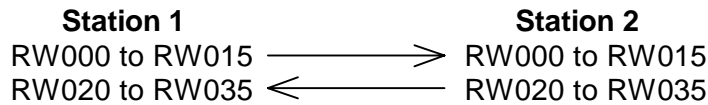
Device	Function
S058D	Indicates the link partner's (T1-16S's) operation mode ON: RUN mode OFF: HALT or ERROR mode
S058E	Indicates the communication status ON: Normal OFF: Communication error



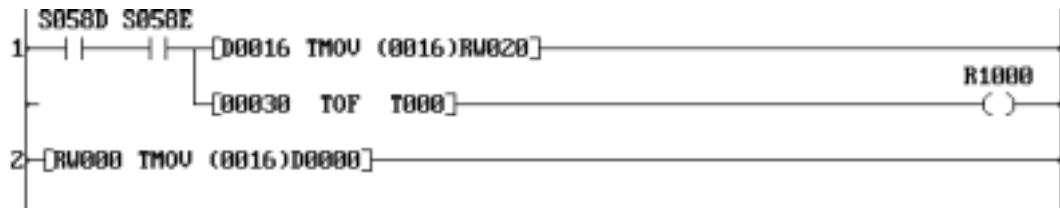
NOTE These flags indicate the most recent status. That is, they are not latched.

4.8 T1-16S sample program

One sample program using the data link mode is shown below.
 In this program, the data link status is checked each other by S058D and S058E.
 16 words data of RW000 to RW015 are sent from station 1 to station 2. And 16
 words data of RW020 to RW035 are sent from station 2 to station 1.



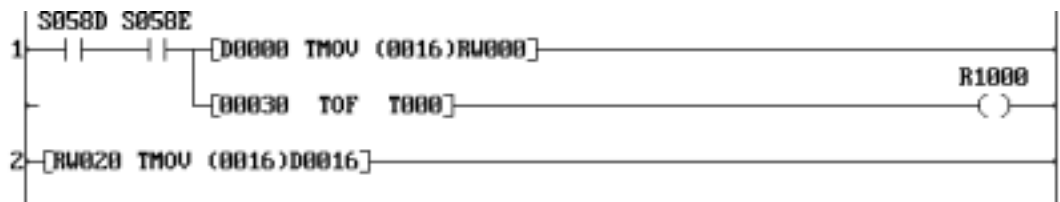
<Station 1 program>



Rung 1: When both S058D and S058E are ON (data link normal), R1000 is set to ON, and the received 16 words data of D0016 to D0031 are transferred to RW020 to RW035.
 If S058D or S058E comes OFF and stays more than 300 ms (data link error), R1000 is reset to OFF.

Rung 2: 16 words data of RW000 to RW015 are transferred to D0000 to D0015. These data are transmitted to the station 2 T1S.

<Station 2 program>



Rung 1: When both S058D and S058E are ON (data link normal), R1000 is set to ON, and the received 16 words data of D0000 to D0015 are transferred to RW000 to RW015.
 If S058D or S058E comes OFF and stays more than 300 ms (data link error), R1000 is reset to OFF.

Rung 2: 16 words data of RW020 to RW035 are transferred to D0016 to D0031. These data are transmitted to the station 1 T1S.

Section 5

Free ASCII Mode

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- 5.2 System configuration, 100*
- 5.3 Setup procedure, 101*
- 5.4 Cable connection, 102*
- 5.5 Mode setting, 105*
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- 5.7 Message format, 107*
- 5.8 Related instructions, 108*
- 5.9 Programming, 113*
- 5.10 T1-16S application example, 119*

5.1 Free ASCII communication function

The free ASCII mode is used to connect between the T1-16S and various serial ASCII devices, such as a micro computer, bar code reader, printer, display, etc. By using this mode, the T1-16S can work as a communication master. Therefore, the T1-16S can communicate with other PLCs using the computer link protocol

In this mode, user defined ASCII messages can be transmitted and/or received through the RS-485 port.

The ASCII message (one set of transmission characters) means a string of ASCII characters which is ended by specified trailing code. The default setting of the trailing code is CR (carriage return code = H0D).

Applicable message format (default trailing code):



N: message length = 512 bytes max.

In other words, the T1-16S cannot be used for the data communication in which the trailing code may be appeared in the middle of the message like binary transmission or the message is ended by two or more types of trailing code.



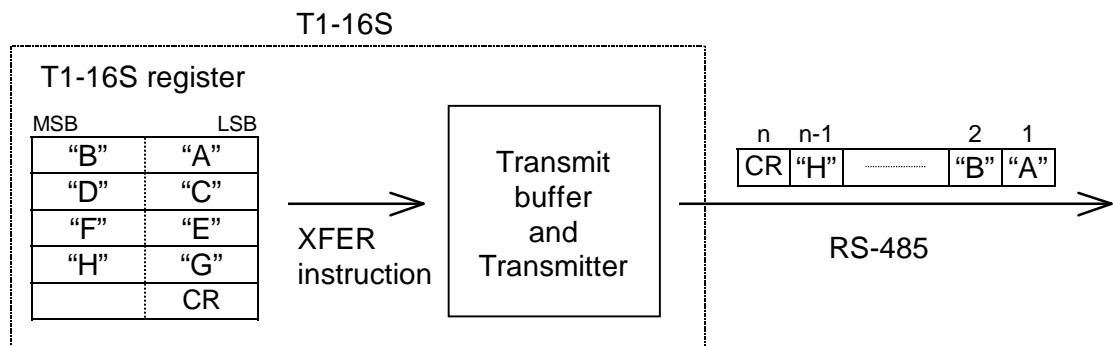
NOTE The Free ASCII mode works as half-duplex communication system. Therefore, simultaneous operation of transmitting and receiving is not possible.

In the free ASCII mode, communication (message transmitting and receiving) is controlled by T1-16S's user program.

The expanded transfer (XFER) instruction is used for transmitting and receiving messages.

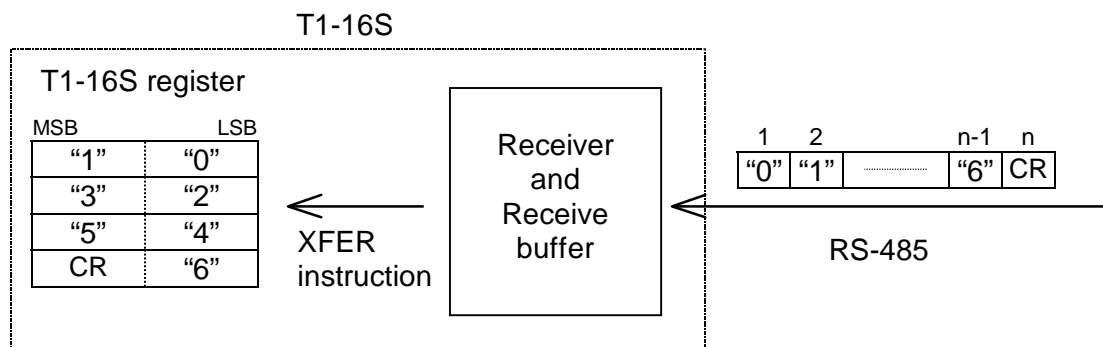
Transmitting:

To transmit, the user prepares the message in the T1-16S registers in the format of ASCII character. The message must be ended by a specified trailing code. Then executes the XFER instruction to start transmission.



Receiving:

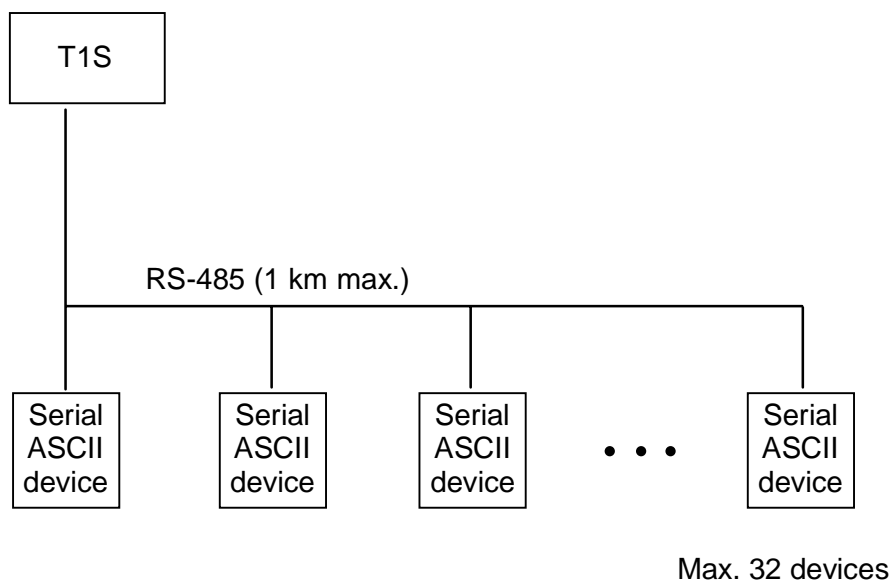
When a message is received, it is stored in the receive buffer. Then, by using the XFER instruction, the message is read and stored in the designated T1-16S registers in the format of ASCII character.



The T1-16S supports the hexadecimal to ASCII conversion (HTOA) instruction and the ASCII to hexadecimal conversion (ATOH) instruction. These instructions are useful to handle ASCII characters. Refer to section 5.8.

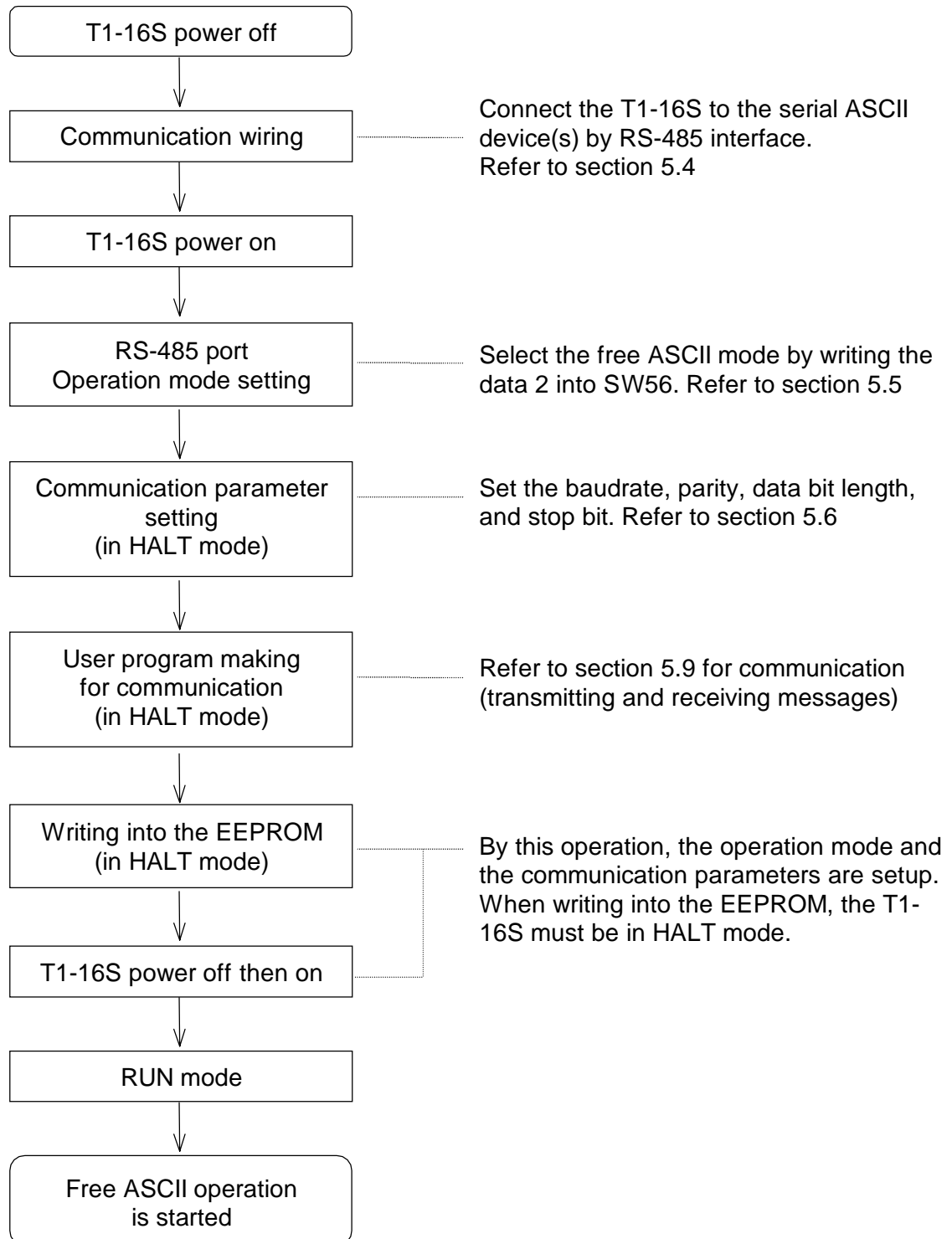
5.2 System configuration

The following figure shows the system configuration.
The T1-16S is connected to the serial ASCII device(s) through RS-485 interface.



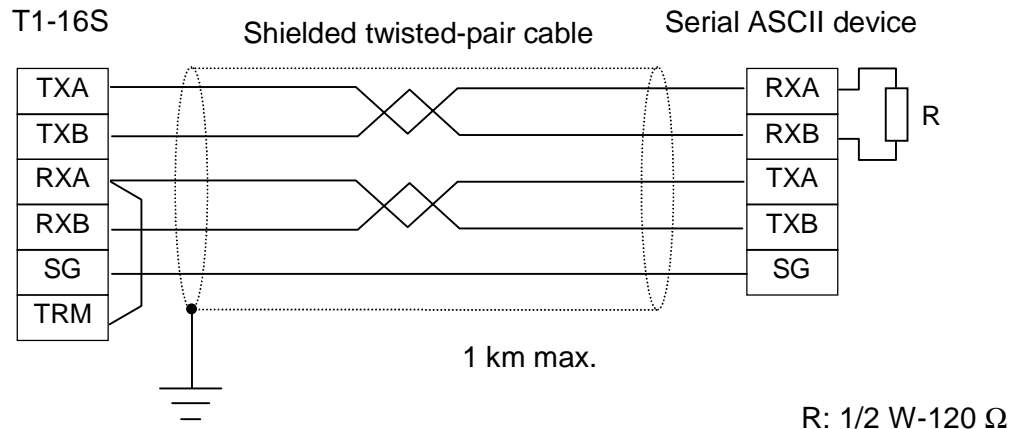
5.3 Setup procedure

The following chart shows the setup procedure of the free ASCII communication function.



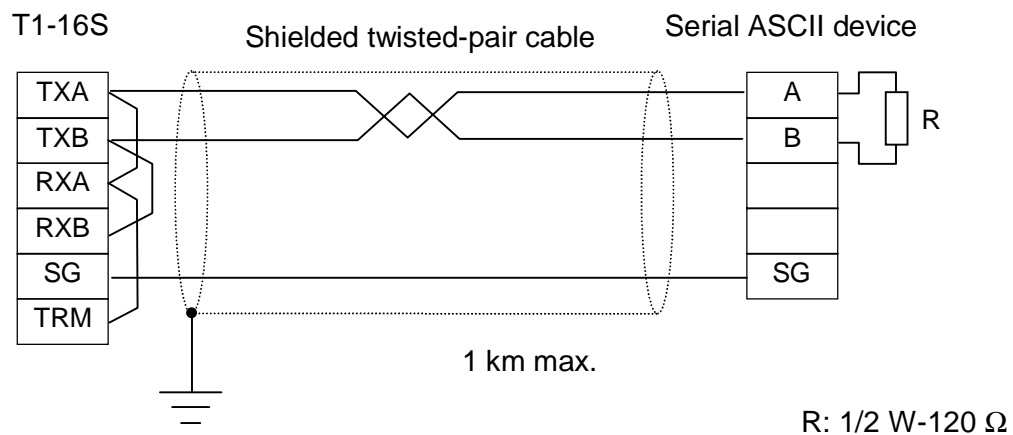
5.4 Cable connection

One to one configuration (4-wire system)



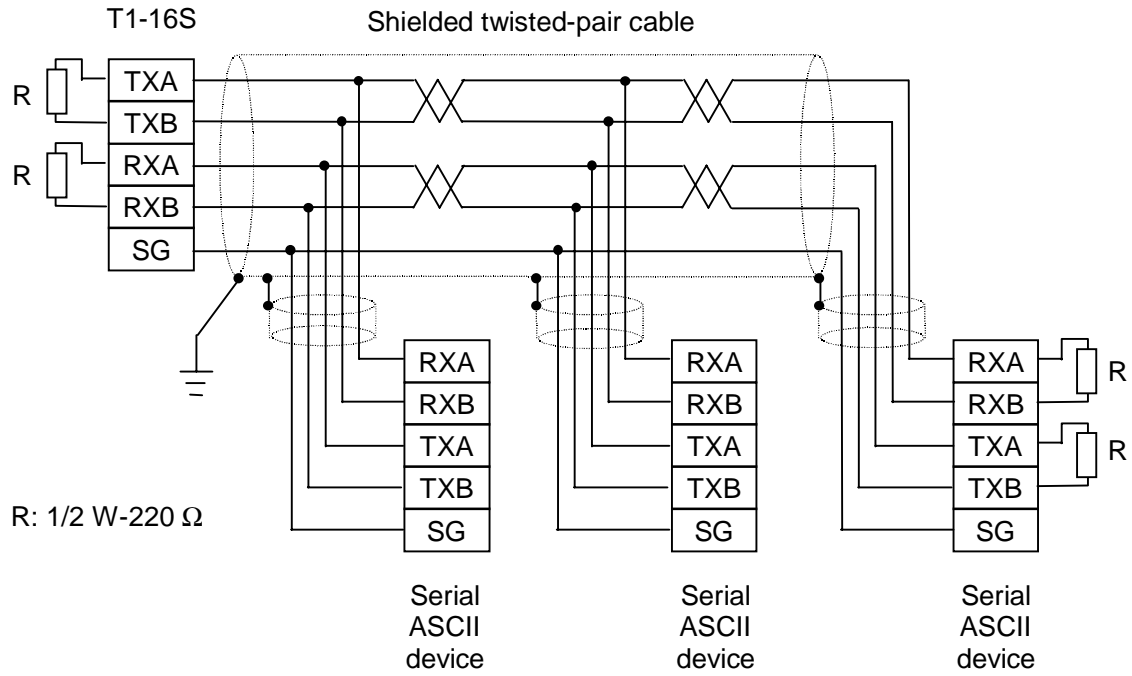
- Maximum cable length is 1 km.
- Short between RXA and TRM for termination at the T1-16S.
- Connect termination resistor 1/2 W - 120 Ω between RXA and RXB at the serial ASCII device.
- Use shielded twisted-pair cable for data communication suited to RS-485 standard. The cable shield should be connected to ground.

One to one configuration (2-wire system)



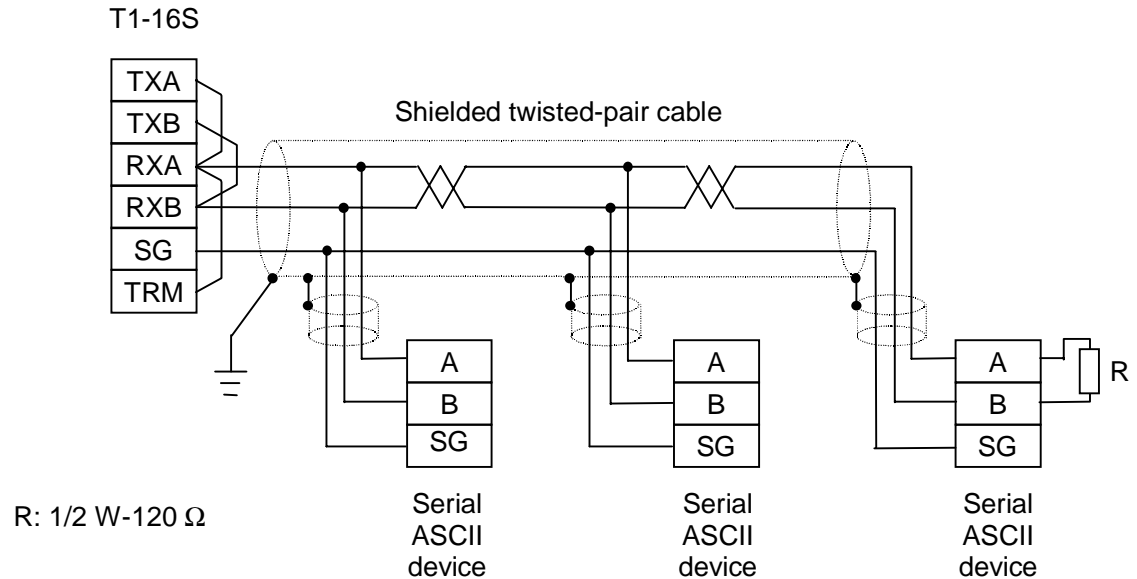
- Maximum cable length is 1 km.
- Short TXA - RXA - TRM, and TXB - RXB at the T1-16S.
- Connect termination resistors 1/2 W - 120 Ω between signal A and signal B at the serial ASCII device.
- Use shielded twisted-pair cable for data communication suited to RS-485 standard. The cable shield should be connected to ground.

One to N configuration (4-wire system)



- Maximum total cable length is 1 km.
- Connect termination resistor 1/2 W - 220 Ω between RXA and RXB, and between TXA and TXB at the both terminal stations.
- The length of the branch line should be less than 3 m.
- Use shielded twisted-pair cable for data communication suited to RS-485 standard. The cable shield should be connected each other and connected to ground.

One to N configuration (2-wire system)



- Maximum total cable length is 1 km.
- Short TXA and RXA, and TXB and RXB at the T1-16S.
- Connect termination resistor 1/2 W - 120 Ω between line A and line B at the both terminal stations.
If the T1-16S is terminal, short RXA and TRM to insert the termination resistor.
- The length of the branch line should be less than 3 m.
- Use shielded twisted-pair cable for data communication suited to RS-485 standard. The cable shield should be connected each other and connected to ground.

5.5 Mode setting

The operation mode of the RS-485 port is decided by the data of the special register SW56.

This data is stored in the built-in EEPROM by executing the EEPROM write command. The T1-16S reads this data at power-on initialization, and decides the mode.

To select the free ASCII mode, follow the procedure below.

- (1) Turn the T1-16S to HALT mode
- (2) Write **2** into **SW56** by using the programmer
- (3) Execute the EEPROM write command
- (4) Turn off power
- (5) Turn on power again

Then the T1-16S's RS-485 port functions as the free ASCII mode.



NOTE The default setting of SW56 is 0. (Computer link mode)



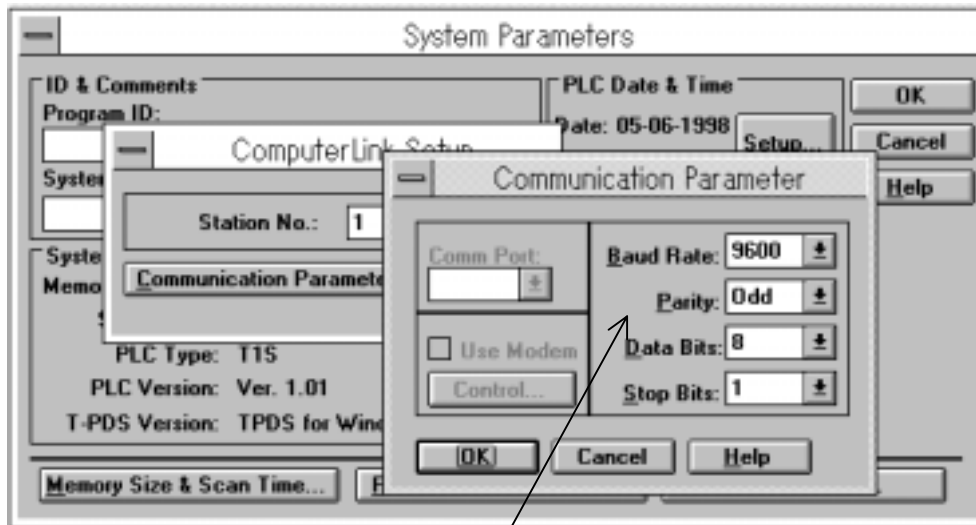
NOTE The SW56 setting is saved in the program storage module RM102 (ver. 2 or later). Therefore, when you save the T1-16S program into the RM102 then load it into another T1-16S, the original SW56 setting will be copied. However, in case of the T-PDS, the SW56 setting is not saved in the disk file. Therefore even when you load the T1-16S program by the T-PDS, you must set the SW56 data for the T1-16S manually as mentioned above.

5.6 Communication parameter setting

The communication parameter is set by writing it into the system information memory of the T1-16S.

Turn the T1-16S to HALT mode, then set the communication parameter in the system information.

(T-PDS screen example)



Set baudrate, parity, data bit length, and stop bit.
Station number is ignored.

After the communication parameter setting, write it into the T1-16S's built-in EEPROM before turning off power.

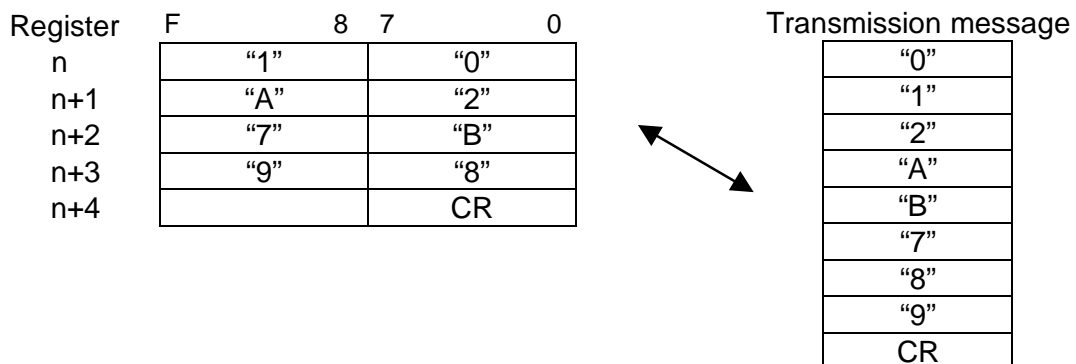
5.7 Message format

The transmission message is composed by ASCII characters and a specified trailing code. The default setting of the trailing code is CR (carriage return code = H0D). Refer to section 5.9.1 for setting the trailing code other than CR. The maximum length of a message is 512 bytes. An example of the message is shown below.

1	2	3	4	5	6	7	8	9
"0"	"1"	"2"	"A"	"B"	"7"	"8"	"9"	CR

In the above figure, "x" means an ASCII character. For example, "0" is H30. The number (1 to 9) shown on each character means the order of transmitting or receiving.

When the above message is received or transmitted, the data arrangements in the T1-16S registers are as follows.



5.8 Related instruction

5.8.1 Expanded data transfer (XFER)

FUN 236	XFER	Expanded data transfer (Free ASCII mode)
---------	------	------------------------------------------

Expression

Input $-[A \text{ XFER } B \rightarrow C]$ - 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*.

When the CPU register (RW or D) is designated as source and the RS-485 port is designated as destination, it operates transmitting.

When the RS-485 port is designated as source and the CPU register (RW or D) is designated as destination, it operates receiving.

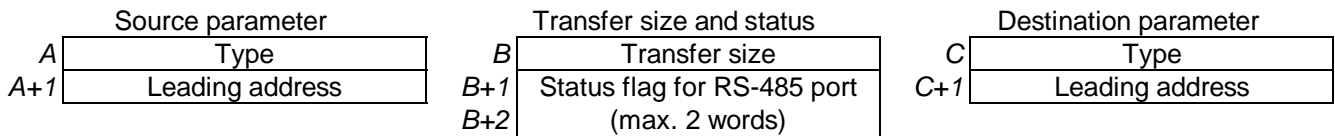
Execution condition

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

Operand

	Name	Device						Register										Constant	Index	
		X	Y	R	S	T	C	XW	YW	RW	SW	T	C	D	I	J	K			
A	Source parameter							√	√	√	√	√	√	√						
B	Transfer size							√	√	√	√	√	√	√						
C	Destination parameter								√	√	√	√	√	√						

Parameters

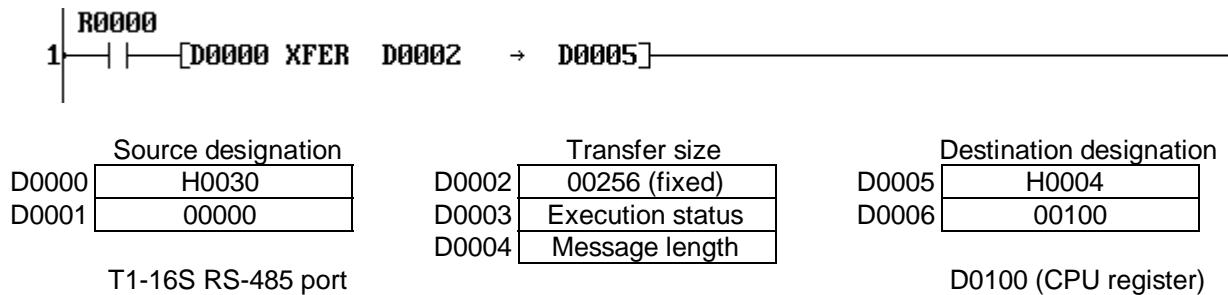


Register type	Type code	Leading address	Transfer size
RW register (RAM)	H0003	0 to 255	1 to 256
D register (RAM)	H0004	0 to 4095	1 to 256
T1-16S RS-485 port	H0030	0 (fixed)	1 to 256

<Receiving>

When the instruction input is ON, one set of message (from start character to the trailing code) which is received by the RS-485 port is read from the receive buffer, and stored in the CPU registers. The transfer size is fixed to 256 words. The execution status and the message length (in bytes) are stored in the status flag.

The instruction input must be kept ON until the receiving operation is complete.

Example

When R0000 is ON, one set of received message is read and stored in D0100 and after.

Execution status: H0000 ... Normal complete
 H0001 ... Communication error (parity error, framing error)
 H0002 ... Message length over (more than 512 bytes)
 H0003 ... Receive buffer over flow
 H0004 ... Receive time-out (from start character to the trailing code) (see table below)
 H0006 ... Multiple execution error

Baudrate	Time-out
300 bps	30 seconds
600 bps	15 seconds
1200 bps	12 seconds
2400 bps	8 seconds
4800 bps	4 seconds
9600 bps	3 seconds
19200 bps	1.5 seconds

Message length: 0 No receive message
 1 to 512 ... Message length in bytes

Note

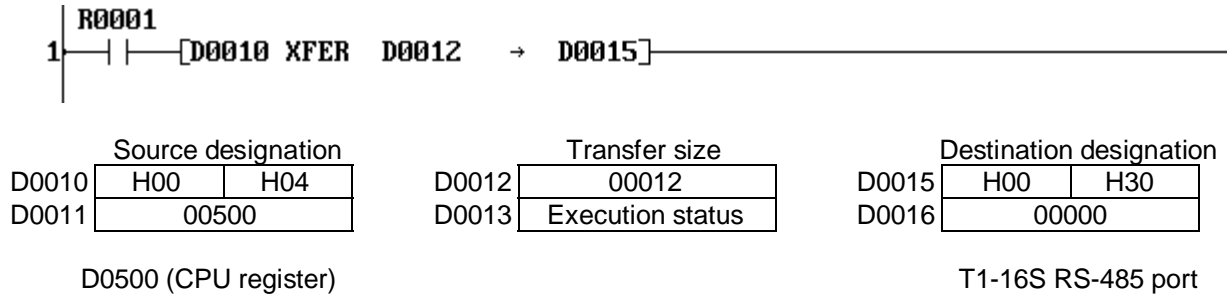
- The XFER instruction is not executed as error in the following cases. In these cases, the instruction error flag (ERF = S051) is set to ON. If the ERF is set to ON once, it remains ON until resetting to OFF by user program.
 - The leading address for the RS-485 port designation is other than 0.
 - Transfer size is other than 256.
 - Mode setting of the RS-485 port is not the free ASCII mode.
 - This instruction is programmed in the sub-program #1.

<Transmitting>

When the instruction input is ON, one set of message which is stored in the source table (from start character to the trailing code) is transmitted through the RS-485 port. The execution status is stored in the status flag.

The instruction input must be kept ON until the transmitting operation is complete.

Example



When R0001 is ON, one set of message (ended by the trailing code) stored in the range of D0500 to D0511 (12 words) is transmitted through the RS-485 port.

- Execution status:
- H0000 ... Normal complete
 - H0001 ... During transmitting the message
 - H0002 ... Communication busy
 - H0003 ... During the reset operation
 - H0004 ... Send time-out (from start character to the trailing code) (see table below)
 - H0005 ... Send message length error (no trailing code in the source table)

Baudrate	Time-out
300 bps	30 seconds
600 bps	15 seconds
1200 bps	12 seconds
2400 bps	8 seconds
4800 bps	4 seconds
9600 bps	3 seconds
19200 bps	1.5 seconds

Note

- The XFER instruction is not executed as error in the following cases. In these cases, the instruction error flag (ERF = S051) is set to ON. If the ERF is set to ON once, it remains ON until resetting to OFF by user program.
 - (1) The leading address for the RS-485 port designation is other than 0.
 - (2) Transfer size is out of the range of 1 to 256.
 - (3) Mode setting of the RS-485 port is not the free ASCII mode.
 - (4) This instruction is programmed in the sub-program #1.

5.8.2 HEX to ASCII conversion (HTOA)

FUN 062	HTOA	Hex to ASCII conversion
---------	------	-------------------------

Expression

Input $-[A \text{ HTOA } (n) B]-$ Output

Function

When the input is ON, the hexadecimal data of n registers starting with A is converted into ASCII characters and stored in B and after. The uppermost digit of source A is stored in lower byte of destination B , and followed in this order. The allowable range of n is 1 to 32.

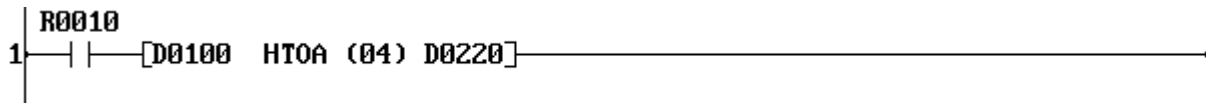
Execution condition

Input	Operation	Output
OFF	No execution	OFF
ON	Execution	ON

Operand

	Name	Device						Register								Constant	Index										
		X	Y	R	S	T	C	XW	YW	RW	SW	T	C	D	I			J	K								
A	Source							√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√		
n	Data size																									1 - 32	
B	Destination								√	√	√	√	√	√	√												

Example



When R010 is ON, 4 words data of D0100 to D0103 are converted into ASCII characters, and stored in 8 words registers starting with D0200.

D0100	F	H0123	0	Converted →	D0220	F	"1" (H31)	8	7	0	"0" (H30)
D0101		H4567			D0221		"3" (H33)				"2" (H32)
D0102		H89AB			D0222		"5" (H35)				"4" (H34)
D0103		HCDEF			D0223		"7" (H37)				"6" (H36)
				D0224		"9" (H39)				"8" (H38)	
				D0225		"B" (H42)				"A" (H41)	
				D0226		"D" (H44)				"C" (H43)	
				D0227		"F" (H46)				"E" (H45)	

Note

- If index register (I, J or K) is used for the operand A , only $n = 1$ is allowed. Otherwise, boundary error will occur.

5.8.3 ASCII to HEX conversion (ATOH)

FUN 063	ATOH	ASCII to Hex conversion
---------	------	-------------------------

Expression

Input $-[A \text{ ATOH}(n) B]-$ Output

Function

When the input is ON, the ASCII characters stored in n registers starting with A is converted into hexadecimal data and stored in B and after. The lower byte of source A is stored as uppermost digit of destination B , and followed in this order. The allowable ASCII character in the source table is "0" (H30) to "9" (H39) and "A" (H41) to "F" (H46). The allowable range of n is 1 to 64.

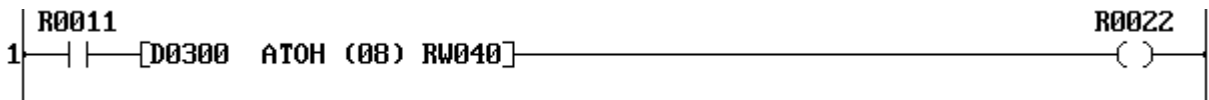
Execution condition

Input	Operation	Output	ERF
OFF	No execution	OFF	-
ON	Normal execution	ON	-
	Conversion data error (no execution)	OFF	Set

Operand

	Name	Device						Register								Constant	Index		
		X	Y	R	S	T	C	XW	YW	RW	SW	T	C	D	I			J	K
A	Source							√	√	√	√	√	√	√	√	√	√	√	
n	Data size																	1 - 64	
B	Destination								√	√	√	√	√	√					

Example



When R011 is ON, the ASCII characters stored in 8 words of D0300 to D0307 are converted into hexadecimal data, and stored in 4 words registers starting with RW040.

	F	8	7	0		F	0
D0300	"1" (H31)			"0" (H30)	Converted →	RW040	H0123
D0301	"3" (H33)			"2" (H32)		RW041	H4567
D0302	"5" (H35)			"4" (H34)		RW042	H89AB
D0303	"7" (H37)			"6" (H36)		RW043	HCDEF
D0304	"9" (H39)			"8" (H38)			
D0305	"B" (H42)			"A" (H41)			
D0306	"D" (H44)			"C" (H43)			
D0307	"F" (H46)			"E" (H45)			

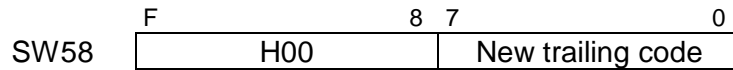
Note

- If index register (I, J or K) is used for the operand A , only $n = 1$ is allowed.
- If n is odd number, lower 2 digits of the last converted data will not be fixed, Use even for n .

5.9 Programming

5.9.1 Changing the trailing code

The default setting of the trailing code is CR (carriage return code = H0D).
The trailing code can be changed by writing the desired code into SW58 at the first scan.



Sample program:



The above program is an example to change the trailing code to H03. The new trailing code H0003 is written into SW58 at the first scan.

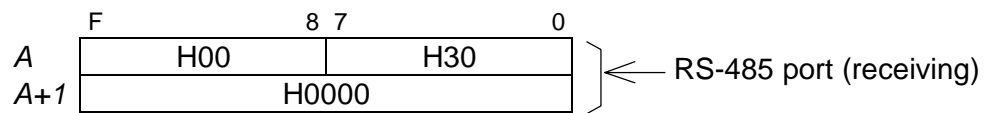
5.9.2 Data receive operation

When a message is received, it is stored in the receive buffer. The receive buffer is a temporarily memory, which has 512 bytes capacity. The expanded transfer (XFER) instruction is used to read the message from the receive buffer and to store it into user registers.

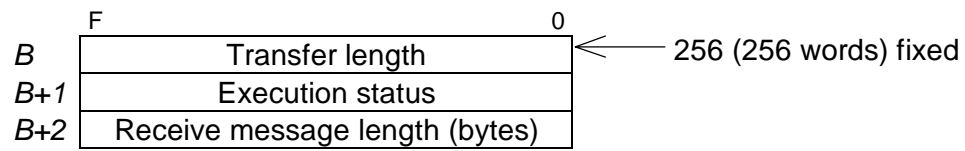
XFER instruction (message receive):

Input —[A XFER B → C]— Output

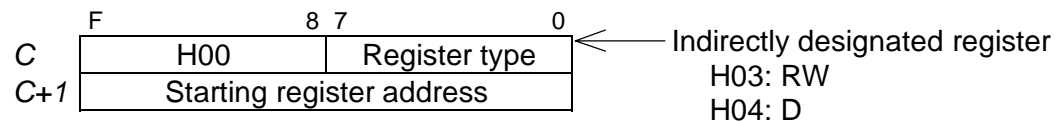
Operand A: Source



Operand B: Parameter



Operand C: Destination register



Operation:

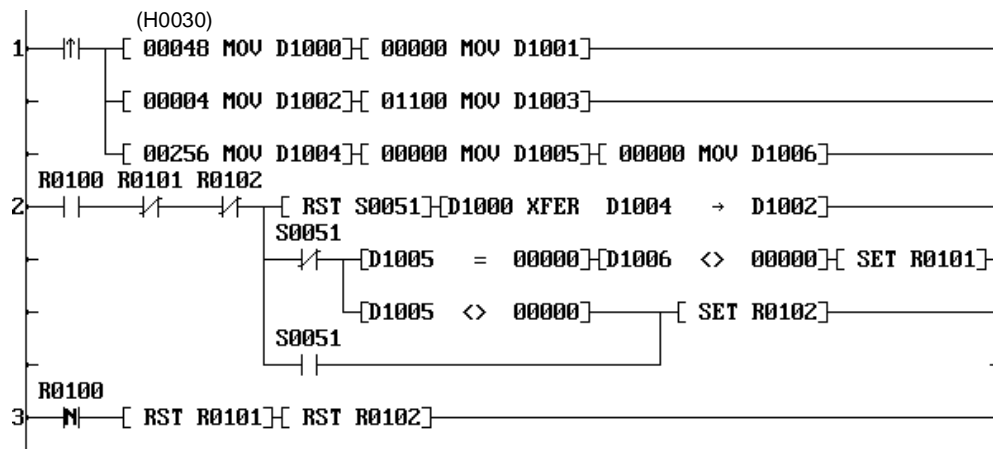
When the input condition of the XFER instruction comes ON, the read operation is started. The execution status is monitored by B+1 as follows.

- B+1 (Execution status):
- H0000 ... Normal complete
 - H0001 ... Communication error (parity error, framing error)
 - H0002 ... Message length over (more than 512 bytes)
 - H0003 ... Receive buffer over flow
 - H0004 ... Receive time-out (see below)
 - H0006 ... Multiple execution error (other receiving routine is under executing)

The receive time-out is detected when the time from the starting character to the trailing code exceeds the following time.

Baudrate	Time-out	Baudrate	Time-out
300 bps	30 s	4800 bps	4 s
600 bps	15 s	9600 bps	3 s
1200 bps	12 s	19200 bps	1.5 s
2400 bps	8 s		

Sample program:



Rung 1: Sets the parameters for the XFER instruction.

The registers of 256 words starting with D1100 are reserved to store the received message.

Rung 2: When R0100 is set to ON, the read operation is started.

If the operation is completed normally, the received message is stored in D1100 and after, and R0101 is set to ON.

If the message could not be received normally by some error, R0102 is set to ON.

Rung 3: When R0100 is reset to OFF, the result status (R0101 and R0102) are reset to OFF.

When using the above sample program as a part of entire application program, set R0100 to ON in the main processing part at first. When a message is received, R0101 (at normal) or R0102 (at error) comes ON. Then reset R0100 and carry out necessary processing for the received message. When the result status shows normal complete (R0101 is ON), the received message has been stored in D1100 and after.

When it becomes ready to receive the next message, set R0100 to ON again.

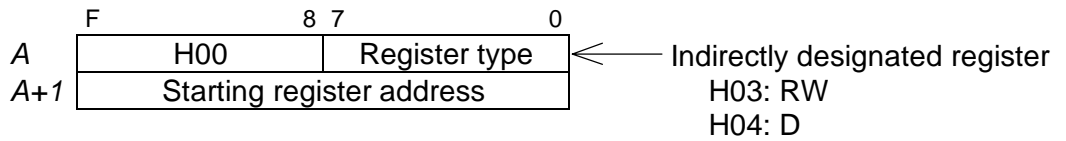
5.9.3 Data send operation

The expanded transfer (XFER) instruction is used to send the message through the RS-485 port.

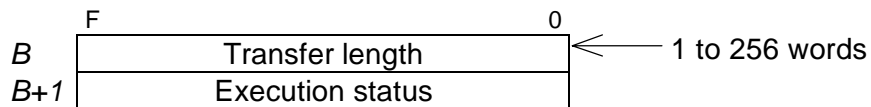
XFER instruction (message send):

Input —[A XFER B → C]— Output

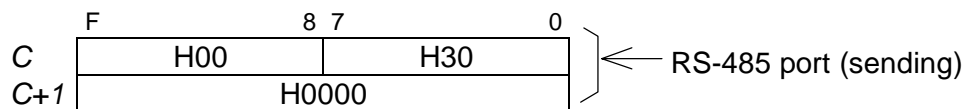
Operand A: Source register



Operand B: Parameter



Operand C: Destination



Operation:

When the input condition of the XFER instruction comes ON, the message prepared in the registers starting with A is transmitted.

The execution status is monitored by B+1 as follows.

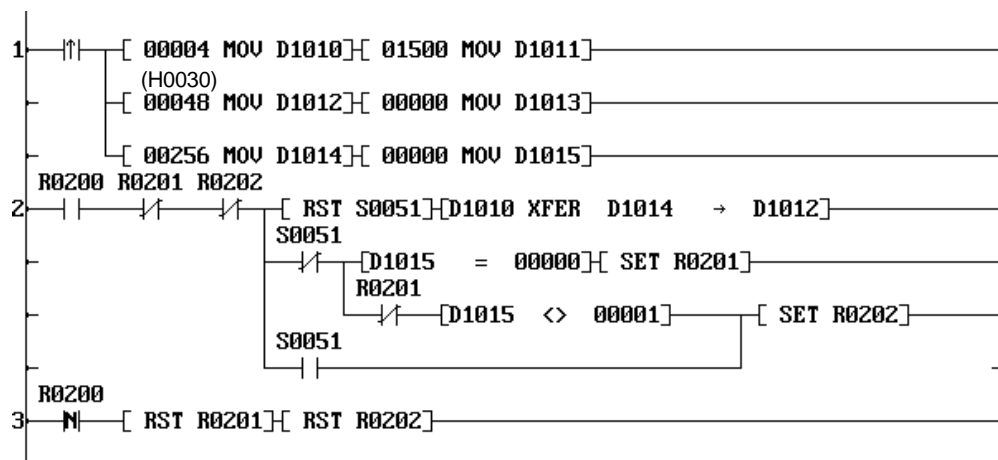
- B+1 (Execution status): H0000 ... Normal complete
- H0001 ... During transmitting the message
- H0002 ... Communication busy (other receiving or transmitting routine is under executing)
- H0003 ... During the reset operation
- H0004 ... Send time-out (see below)
- H0005 ... Send message length error (no trailing code in the source table)

The send time-out is detected when the time from the starting character to the trailing code exceeds the following time.

Baudrate	Time-out
300 bps	30 s
600 bps	15 s
1200 bps	12 s
2400 bps	8 s

Baudrate	Time-out
4800 bps	4 s
9600 bps	3 s
19200 bps	1.5 s

Sample program:



Rung 1: Sets the parameters for the XFER instruction.

The registers of 256 words starting with D1500 are reserved to store the transmitting message.

Rung 2: When R0200 is set to ON, the message stored in the D1500 and after are transmitted.

If the operation is completed normally, R0201 is set to ON.

If some error has occurred during the operation, R0202 is set to ON.

Rung 3: When R0200 is reset to OFF, the result status (R0201 and R0202) are reset to OFF.

When using the above sample program as a part of entire application program, write the transmitting message (including the trailing code) in D1500 and after, and set R0200 to ON in the main processing part. By this operation, message transmitting is started. When the message transmitting is completed, R0201 (at normal) or R0202 (at error) comes ON. Confirm these result status and reset R0200 to OFF.

5.9.4 Reset operation

By setting S58F to ON, resetting the free ASCII mode operation is available. During the reset, the following re-initialization is processed.

- Initializes the RS-485 serial port
- Initializes the transmit and receive buffers, and the error information
- Resets the trailing code based on the data of lower byte of SW58

When the reset operation is completed, S58F is automatically reset to OFF. The free ASCII mode operation should be re-started after confirming S58F is returned to OFF.

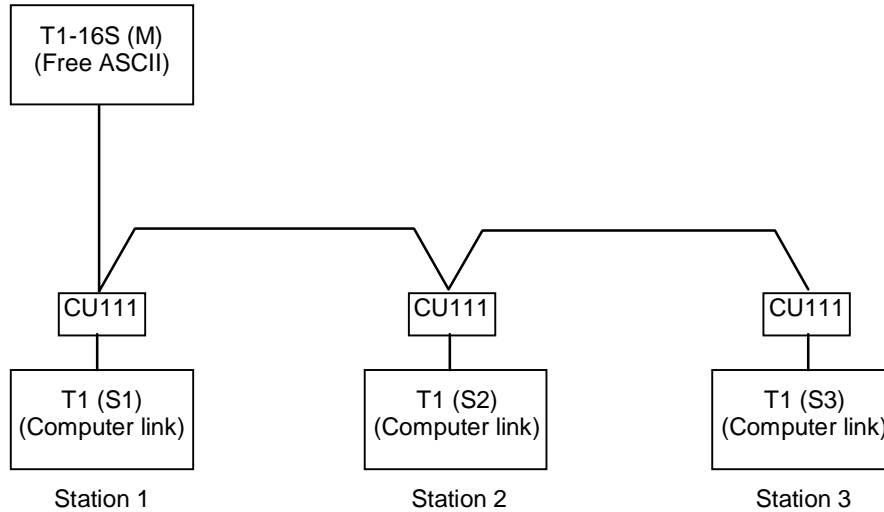


NOTE If S58F is set to ON during a message receiving, the reset operation is started after the message receiving is finished.

5.10 T1-16S application example

Data linkage between T1-16S and three T1s

This is an example of data linkage between the T1-16S and the standard T1s. In this example, T1-16S (M) works as communication master using the free ASCII mode. And other T1s work as slaves using the CU111 (computer link function).



In this configuration, only T1-16S (M) requires the communication program. Other T1s, S1, S2 and S3, do not require any communication program.

In this sample program, the following data link assignment is used.

T1-16S (M)		T1 (S1)		T1 (S2)		T1 (S3)
D0000	← 16 words	D0000				
D0015		D0015				
D0016	→ 16 words	D0016				
D0031		D0031				
D0032	← 16 words			D0000		
D0047				D0015		
D0048				D0016		
D0063	→ 16 words			D0031		
D0064						D0000
D0079						D0015
D0080	← 16 words					D0016
D0095						D0031

(1) Communication port setting

- a) Mode setting of the T1-16S:
Set the mode by writing the following data into SW56.

T1-16S (M) ... Free ASCII mode (SW56 = 2)

- b) Communication parameter setting:
Set all the T1-16S and T1 communication parameters as same. The following settings are recommended.

Baudrate: 9600 bps
Data bits: 8 bits
Parity: Odd
Stop bit: 1 bit

Station number is needed for the slave T1s.

T1 (S1): Station number = 1
T1 (S2): Station number = 2
T1 (S3): Station number = 3

- c) Resetting the T1-16S and T1s:
Execute the EEPROM write command. For the T1-16S, cycle power off and on again to set the free ASCII mode.

(2) Communication protocol used in this sample program

In this sample program, the following computer link commands are used.

ST (status read)
DR (data read)
DW (data write)

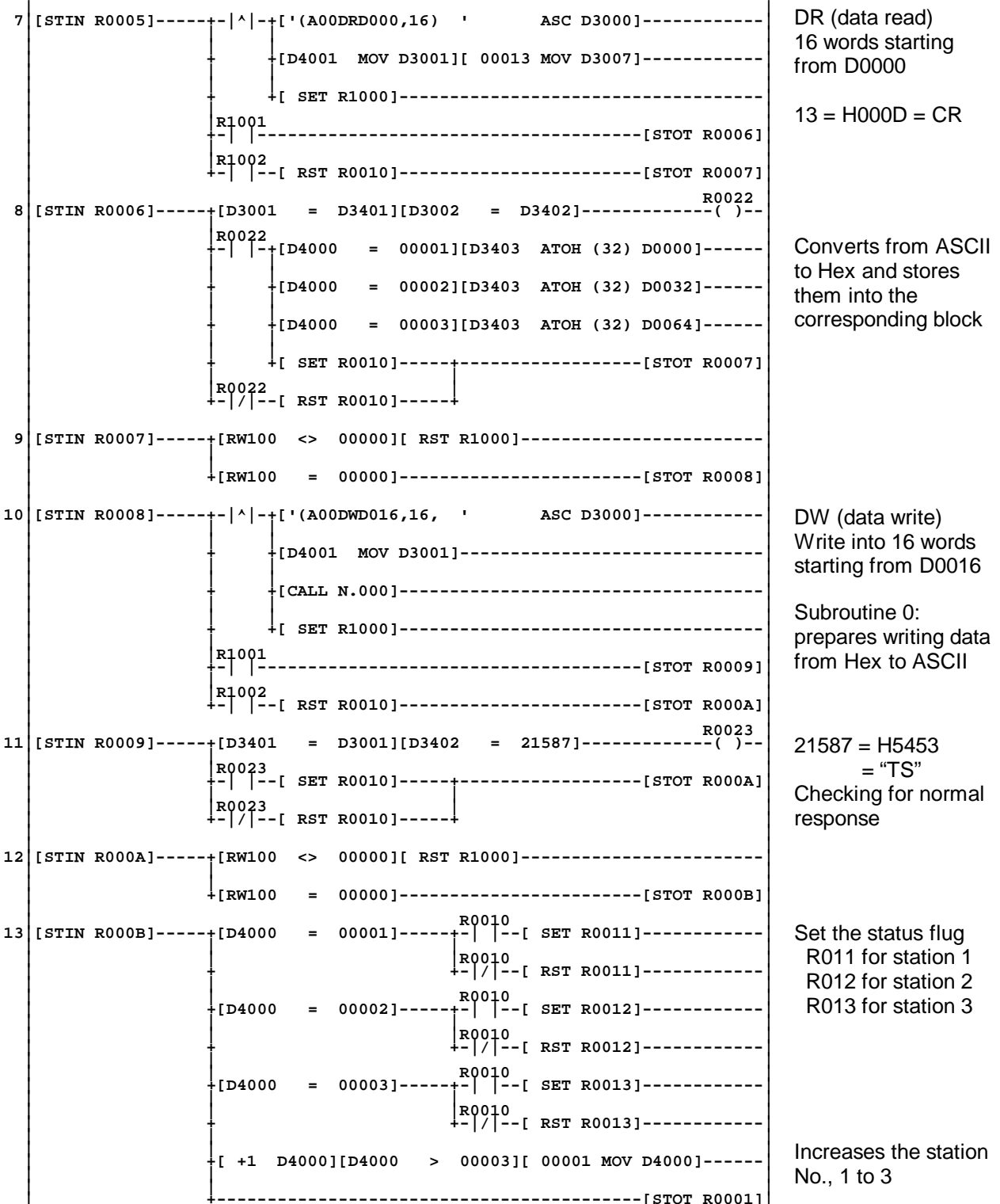
(3) T1-16S sample program

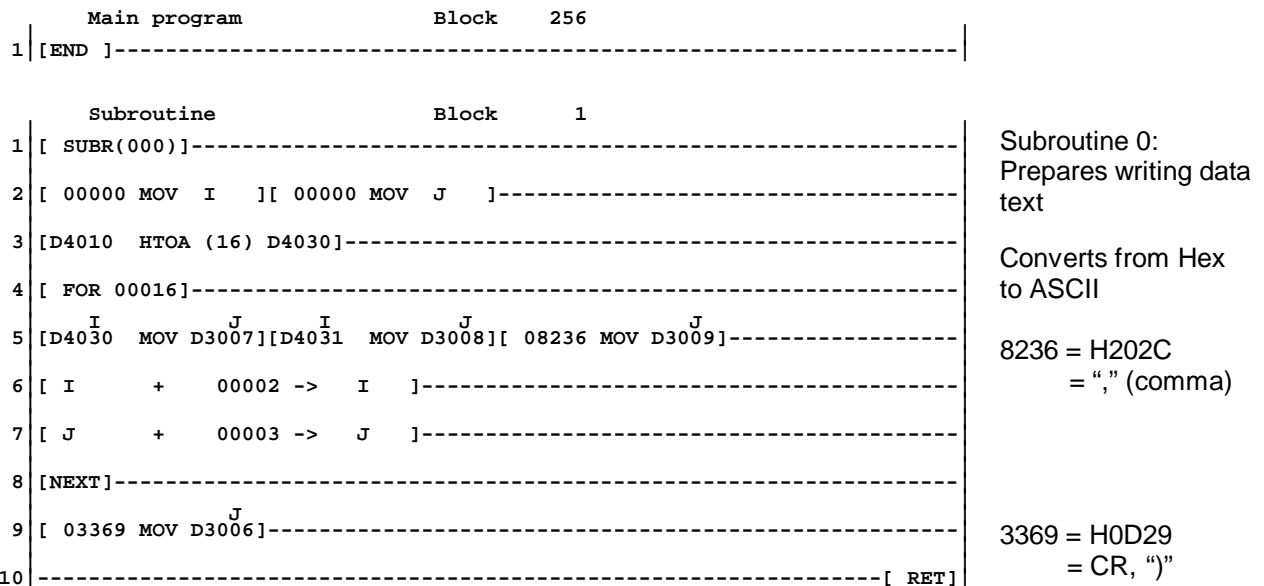
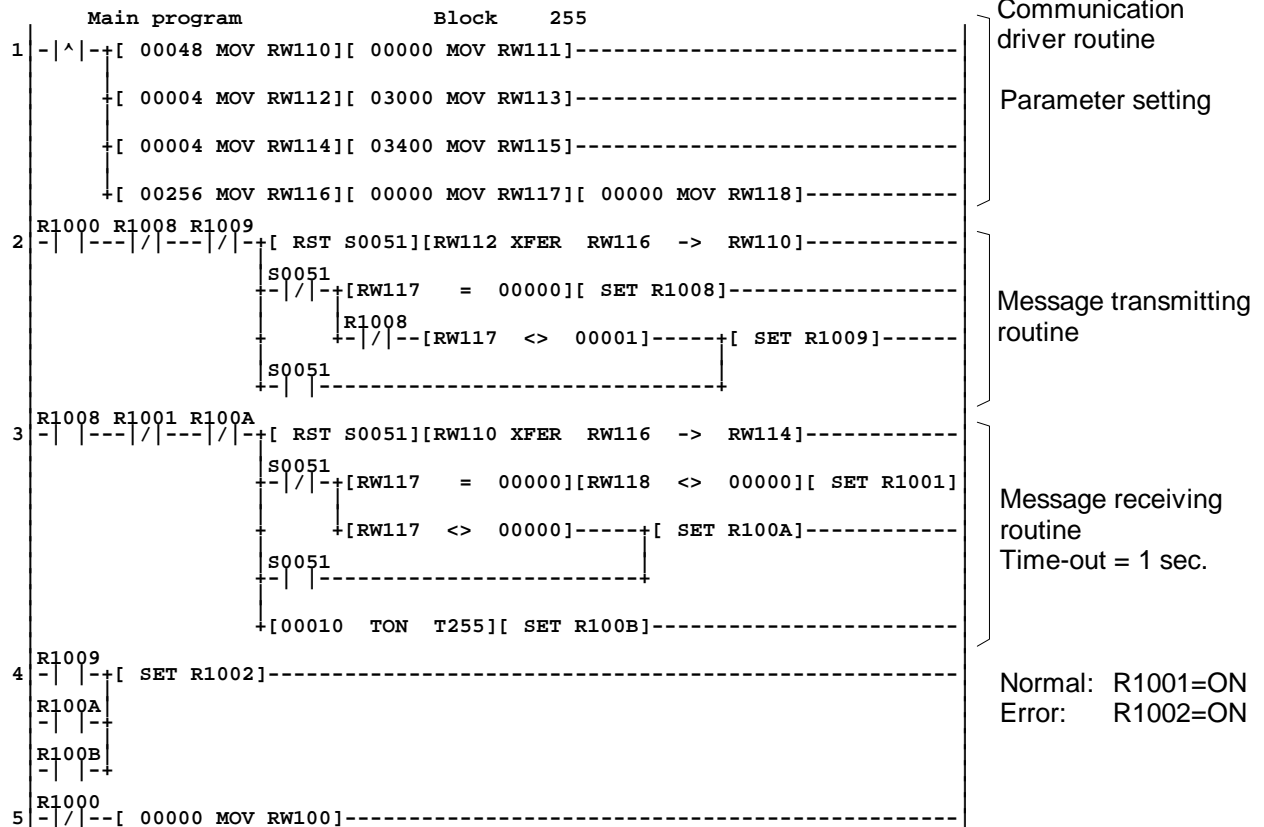
In this sample program, the following devices/registers are assigned.

D0000 - D0095: Link data as shown on the previous page
R0011: Link status for T1 (S1) ... ON when normal
R0012: Link status for T1 (S2) ... ON when normal
R0013: Link status for T1 (S3) ... ON when normal
D3000 - D3255: Reserved area for message transmitting
D3400 - D3655: Reserved area for message receiving
D4000 - D4061: Internal work data
R0000 - R000F: Internal flags for sequence
R0020 - R0022: Internal flags
R1000 - R100F: Control flags for message transmitting/receiving
RW110 - RW118: Parameters for message transmitting/receiving
T255: Response time-out check

T1-16S (M) Program:

	Main program	Block	1	
1	-|^|-[ STIZ (16) R0000]	-----	-----	Step sequence initialize
	|[ 00001 MOV D4000]	-----	-----	Initial station No. =1
2	[STIN R0000]	-----	-----	RS-485 port and flags initialization
	|^|-[ SET S058F]	-----	-----	
	|[RW100 <> 00000][RST R1000]	-----	-----	
	S058F	-----	-----	
	-|/|-[RW100 = 00000]	-----	-----	[STOT R0001]
3	[STIN R0001]	-----	-----	D4001 = station No. in ASCII
	|[D4000 = 00001]	-----	-----	
	|[ 12592 MOV D4001]	-----	-----	
	|[D0016 TMOV (0016)D4010]	-----	-----	
	|[D4000 = 00002]	-----	-----	D4010 - D4025 = writing data (16 w)
	|[ 12848 MOV D4001]	-----	-----	
	|[D0048 TMOV (0016)D4010]	-----	-----	
	|[D4000 = 00003]	-----	-----	
	|[ 13104 MOV D4001]	-----	-----	
	|[D0080 TMOV (0016)D4010]	-----	-----	
	-----	-----	-----	[STOT R0002]
4	[STIN R0002]	-----	-----	ST (status read)
	|^|-[ '(A00ST ASC D3000]	-----	-----	
	|[D4001 MOV D3001][03369 MOV D3003]	-----	-----	3369 = H0D29 = CR, "\r"
	|[ SET R1000]	-----	-----	
	R1001	-----	-----	Normal (R1001=ON)
	-|/|-[ RST R0010]	-----	-----	Communication error (R1002=ON)
	R0020	-----	-----	
5	[STIN R0003]	-----	-----	
	|[D3001 = D3401][D3002 = D3402]	-----	-----	
	R0020 R0021	-----	-----	
	-|/|-[ SET R0010]	-----	-----	Sets R0010 if communication is normal and the PLC is RUN
	R0020	-----	-----	
	-|/|-[ RST R0010]	-----	-----	
	R0021	-----	-----	
	- / -[-----	-----	
6	[STIN R0004]	-----	-----	12800 = H3200 = (RUN)
	|[RW100 <> 00000][RST R1000]	-----	-----	
	|[RW100 = 00000]	-----	-----	[STOT R0005]





Section 6

Inverter Connection Mode

- 6.1 Inverter connection function, 126*
- 6.2 System configuration, 127*
- 6.3 Setup procedure, 128*
- 6.4 Cable connection, 129*
- 6.5 Mode setting, 131*
- 6.6 Communication parameter setting, 132*
- 6.7 Inverter setting, 133*
- 6.8 Related instruction, 134*
- 6.9 Programming, 142*
- 6.10 T1-16S application example, 152*

6.1 Inverter connection function

The Inverter connection mode is provided to communicate with the Toshiba Inverters (ASDs) VF-A7, G7, and/or S9 through the RS-485 line.

By using this mode, the T1-16S can monitor/control the Inverters connected on the RS-485 line without any special communication program.

The maximum number of the Inverters connected to a single T1-16S is 64. Note that the maximum number of the nodes on an RS-485 line is 32. However the RS-485 adapter that is the peripheral device of Toshiba Inverter supports 2 communication ports to Inverters. Therefore more than 32 Inverters can be connected to the T1-16S when using the RS-485 adapters.



NOTE This Inverter connection mode is using the standard serial communication function of the Inverters in order to configure monitor/control system inexpensively. For tightly integrated speed and sequence control, Toshiba recommends use of a T2 or T3 PLC with a DeviceNet or with a TOSLINE network module in the PLC and in the Inverters.

In the Inverter connection mode, the following 5 operation modes are available.

(1) Data exchange mode:

This mode is used to control and monitor the Inverters. The T1-16S cyclically scans all the connected Inverters. The communication commands for Inverters are automatically generated by the T1-16S. This is the basic operation mode of this Inverter connection mode.

The following functions are available for the each Inverter.

- Control: Sends commands (Run, Stop, Jog, etc.) and changes the frequency (Inverter commands FA00 and FA01 are used)
- Monitor: Monitors the operating frequency and the output terminal status (Inverter commands FD00 and FE07 are used)

(2) Monitor mode:

This mode is used to monitor the Inverters. The T1-16S cyclically scans all the connected Inverters. The communication commands for Inverters are automatically generated by the T1-16S. Different from the above Data exchange mode, only monitoring is available in this mode.

The following functions are available for the each Inverter.

- Monitor: Monitors the operating frequency and the output terminal status (Inverter commands FD00 and FE07 are used)

(3) Read command mode:

This mode is provided to read some data or parameters from the specified Inverter. User should specify the Inverter command and the target Inverter number. This mode is used to read the output voltage, current, etc. from the Inverter.

(4) Write command mode:

This mode is provided to write some data or parameters into the specified Inverter. User should specify the Inverter command with the data and the target Inverter number. This mode is used to write some parameters to the Inverter.

(5) Broadcast mode:

This mode is provided to send a command to all the connected Inverters simultaneously. User should specify the Inverter command with the data. This mode is used to send Run, Stop command, etc. to all the Inverters at the same time. In this mode, only the number 0 Inverter will return the response.



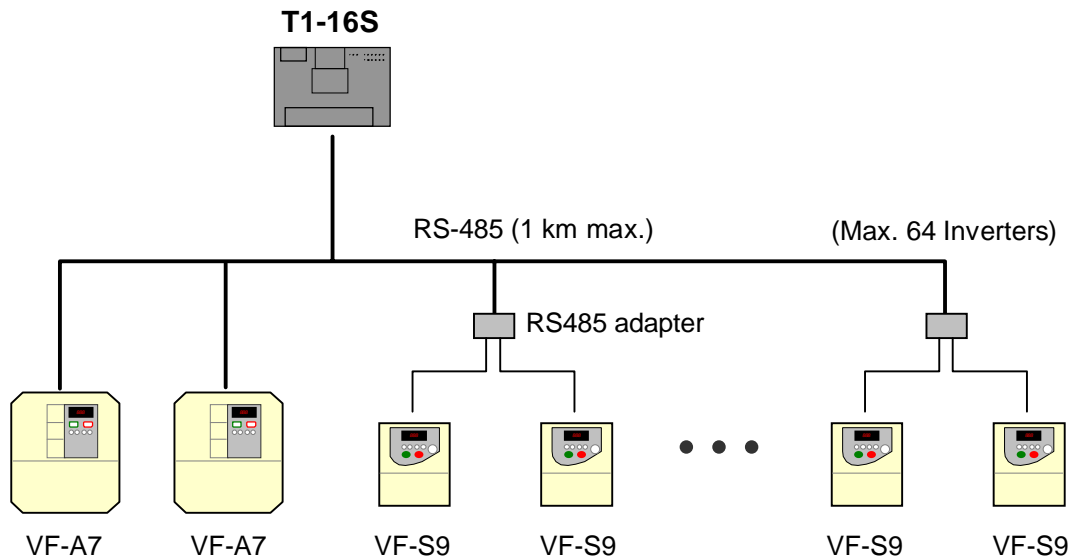
In the Inverter connection mode, the 16-bit binary protocol specified for the VF-A7 is used to communicate with the Inverters.

6.2 System configuration

The following figure shows the system configuration.

In case of the VF-S9, use its serial (logic) port through the RS-485 adapter to connect to the RS-485 line. On the other hand, in case of the VF-A7/G7, use of either its built-in RS-485 port or its serial (logic) port through the RS-485 adapter is possible.

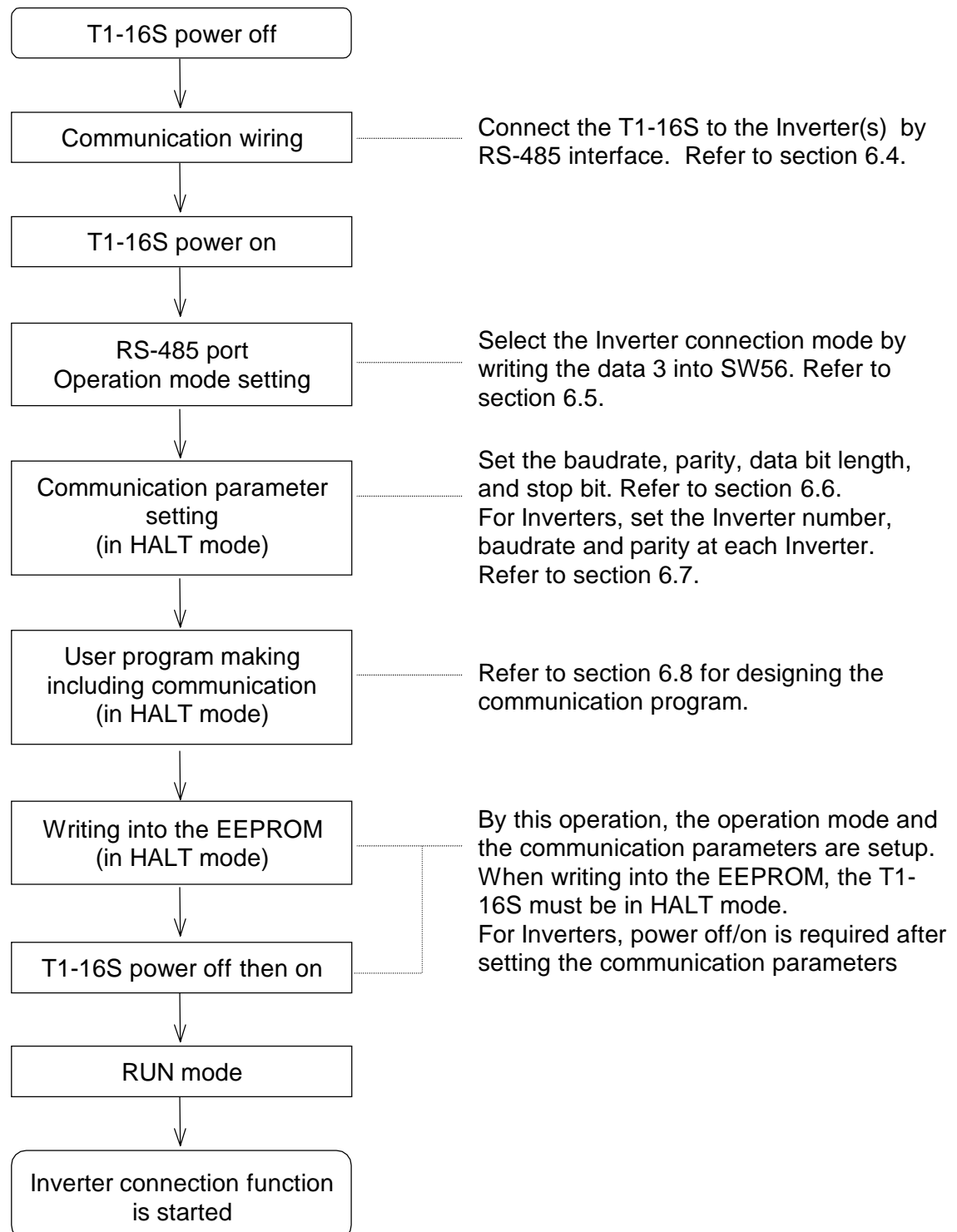
The maximum number of the Inverters connectable to the T1-16S is 64. (Available Inverter number is 0 through 63)



Refer to the Inverter (VF-A7, G7, or S9) manual for details of the RS-485 connection configuration and the RS-485 adapter (Type: RS4001Z).

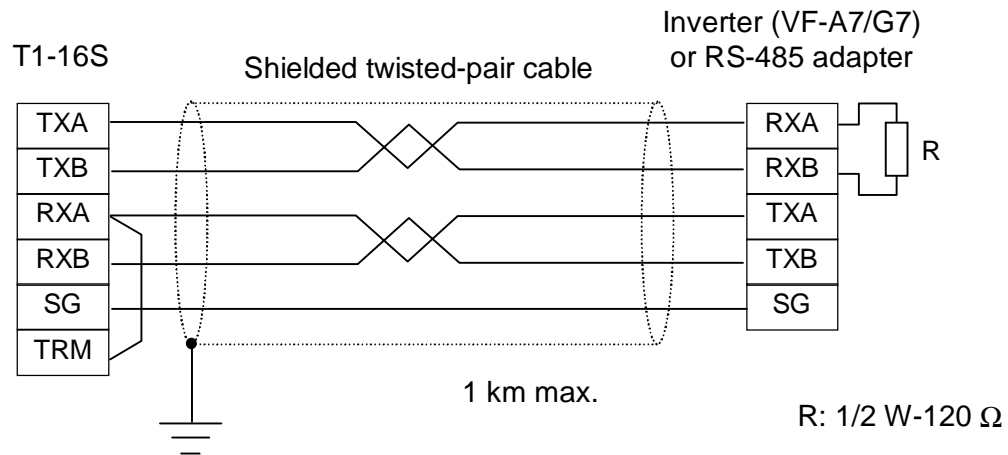
6.3 Setup procedure

The following chart shows the setup procedure of the Inverter connection function.



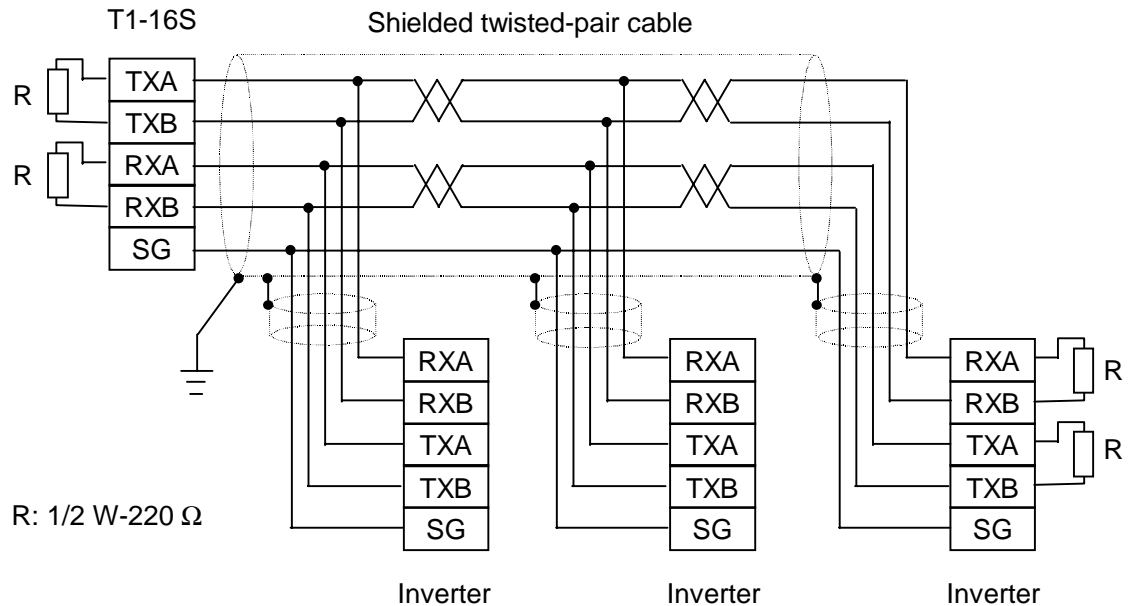
6.4 Cable connection

One to one connection



- Maximum cable length is 1 km.
- Short between RXA and TRM for termination at the T1-16S.
- Connect termination resistor 1/2 W - 120 Ω between RXA and RXB at the Inverter side.
- Use shielded twisted-pair cable for data communication suited to RS-485 standard. The cable shield should be connected to ground.

One to N connection



- Maximum total cable length is 1 km.
- Connect termination resistor 1/2 W - 220 Ω between RXA and RXB, and between TXA and TXB at the both terminal stations.
- The length of the branch line should be less than 3 m.
- Use shielded twisted-pair cable for data communication suited to RS-485 standard. The cable shield should be connected each other and connected to ground.

6.5 Mode setting

The operation mode of the RS-485 port is decided by the data of the special register SW56.

This data is stored in the built-in EEPROM by executing the EEPROM write command. The T1-16S reads this data at power-on initialization, and decides the mode.

To select the Inverter connection mode, follow the procedure below.

- (1) Turn the T1-16S to HALT mode
- (2) Write **3** into **SW56** by using the programmer
- (3) Execute the EEPROM write command
- (4) Turn off power
- (5) Turn on power again

Then the T1-16S's RS-485 port functions as the Inverter connection mode.



NOTE The default setting of SW56 is 0. (Computer link mode)



NOTE The SW56 setting is saved in the program storage module RM102 (ver. 2 or later). Therefore, when you save the T1-16S program into the RM102 then load it into another T1-16S, the original SW56 setting will be copied. However, in case of the T-PDS, the SW56 setting is not saved in the disk file. Therefore even when you load the T1-16S program by the T-PDS, you must set the SW56 data for the T1-16S manually as mentioned above.

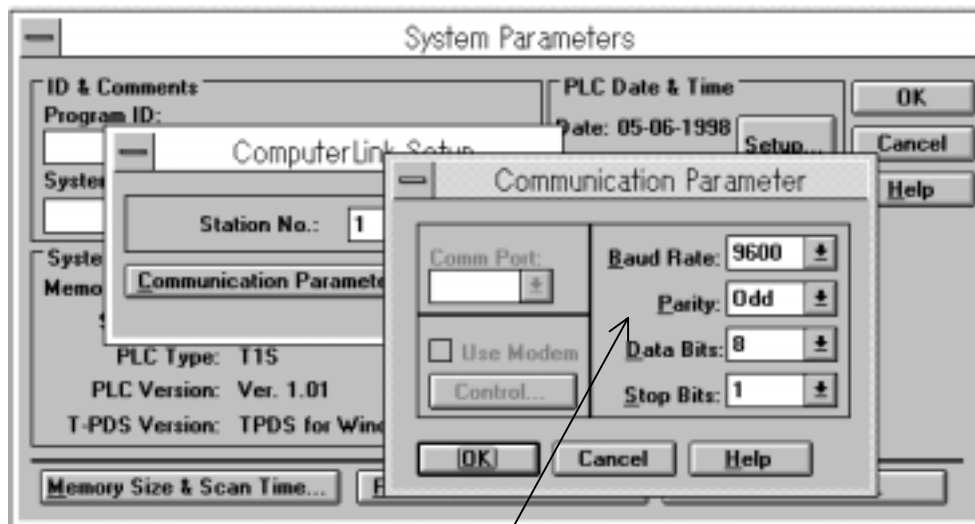
6.6 Communication parameter setting

6.6.1 Transmission parameters

The transmission parameters are set by writing it into the system information memory of the T1-16S.

Turn the T1-16S to HALT mode, then set the communication parameter in the system information.

(T-PDS screen example)



Set baudrate, parity, data bit length, and stop bit to be matched with the Inverter's setting. Station number is ignored.

Baudrate ... 9600 or 19200 bps is recommended.

Data bit length ... It must be 8 bits.

Stop bit ... 1 bit is recommended.

After the communication parameter setting, write it into the T1-16S's built-in EEPROM before turning off power.

6.6.2 Access delay time setting

The access delay time is the interval from receiving #n Inverter response to sending #n+1 Inverter request command.

This access delay time can be changed within the range of 0 to 300 ms.

The shorter the setting, the faster the communication cycle.
Normally 1 (10 ms) setting is recommended.

To set the access delay time, turn the T1-16S to HALT mode, and write the delay time (0 to 30) into SW57. After writing, execute the EEPROM write command. And cycle power off and on again. Then the setting will be effective.

Address	Name	Data range
SW57	Inverter connection mode: Access delay time	0 to 30 (decimal) (0 to 30 : 0 to 300 ms)



NOTE If the data is out of the valid range, it is regarded as 0.



NOTE The SW57 setting is saved in the program storage module RM102 (ver. 2 or later). Therefore, when you save the T1-16S program into the RM102 then load it into another T1-16S, the original SW57 setting will be copied. However, in case of the T-PDS, the SW57 setting is not saved in the disk file. Therefore even when you load the T1-16S program by the T-PDS, you must set the SW57 data for the T1-16S manually as mentioned above.

6.7 Inverter setting

At the each Inverter, set the following communication parameters. For how to set the parameters, refer to your Inverter (VF-A7/G7/S9) serial communication manual.

- Baudrate ... Same as the T1-16S's setting
- RS-485 2-wire or 4-wire ... Set 4-wire system
- Parity ... Same as the T1-16S's setting
- Inverter number ... Set consecutive number starting from 0



NOTE In the Data exchange mode and the Monitor mode (see page 126), the T1-16S scans Inverters from #0 through #n (n: user setting). Therefore, if the Inverter number is skipped, unnecessary access will take place. It results in longer scan cycle.

6.8 Related instruction

6.8.1 Expanded data transfer (XFER)

FUN 236	XFER	Expanded data transfer (Inverter connection mode)
---------	------	---------------------------------------------------

Expression

Input $-[A \text{ XFER } B \rightarrow C]$ - Output

Function

This function is provided to control Toshiba Inverters VF-A7/G7/S9 connected on the RS-485 line. When the RS-485 port operation mode is set to the Inverter mode (SW56 = 3), the T1-16S can perform the following functions for up to 64 Inverters.

- (1) Cyclically scans the Inverters and sends/receives the following data to/from each Inverter.
 - Send to Inverter: Frequency reference write and Operation command write (Run, Stop, Jog, etc.)
 - Receive from Inverter: Operating frequency monitor and Output terminal status monitor
- (2) Cyclically scans the Inverters and receives the following data from each Inverter.
 - Receive from Inverter: Operating frequency monitor and Output terminal status monitor
- (3) Sends a specified Read command to a specified Inverter and stores the response data.
- (4) Sends a specified Write command with the command data to a specified Inverter.
- (5) Sends a specified Write command with the command data to all the connected inverters as broadcast.

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									Constant	Index		
		X	Y	R	S	T	C	XW	YW	RW	SW	T	C	D	I	J			K	
A	Data table							√	√	√	√	√	√	√						
B	Inverter No.							√	√	√	√	√	√	√						
C	RS-485 port								√	√	√	√	√	√						

Parameters

Data table designation		Parameter and status		RS-485 port designation		
A	Register type code	B	Inverter number	C	Fixed to H0030	
A+1	Leading address	B+1	Operation mode	C+1	Fixed to 0	
		B+2	Execution status			
		B+3	Communication error code			
		B+4	Inverter communication status map (each bit shows each Inverter status)			
		B+5				
		B+6				
		B+7				

Data table designation (A, A+1):

Register	Type code (A)	Leading address (A+1)
RW register	H0003	0 to 255
D register	H0004	0 to 4095

Operation mode designation (B+1):

B+1	Operation mode	Description
0	Data exchange mode (Mode 0)	Cyclically scans the connected Inverters (Control & Monitor) (Inverter command: P+FA01&FA00 and R+FD00&FE07)
1	Monitor mode (Mode 1)	Cyclically scans the connected Inverters (Monitor only) (Inverter command: R+FD00&FE07)
2	Read command mode (Mode 2)	Sends a read command to a specified Inverter (Inverter command: R+ User designation)
3	Write command mode (Mode 3)	Sends a write command to a specified Inverter (Inverter command: P+ User designation)
4	Broadcast mode (Mode 4)	Sends a write command to all the connected Inverters as broadcast (Inverter command: P+ User designation)

Inverter number (B):

For the operation mode 0 and 1:

It specifies the maximum Inverter number. For example, if it is 5, the T1-16S scans from #0 through #5 Inverters and repeats. Setting range is 0 to 63.

For the operation mode 2 and 3:

It specifies the target Inverter number for sending commands. Setting range is 0 to 63.

For the operation mode 4:

This setting is ignored. The broadcast address (HFF) is used as Inverter number.

Execution status (B+2):

This register shows the scan count. During normal operation, it increases from 0 to 32767 and repeats. When the following error is detected, the bit-F of this register comes 1.

- RS-485 port busy (communication with Inverter is executing)
- Parameter data error

Communication error code (B+3):

The communication error code responded from the Inverter is shown here. If 2 or more Inverters are error, the smallest Inverter number's error is stored. Refer to Inverter's manual for the error code.

B+3	Meaning
0	No error (Normal) or Response time-out (No answer)
Others	Inverter error response (Refer to Inverter's manual)

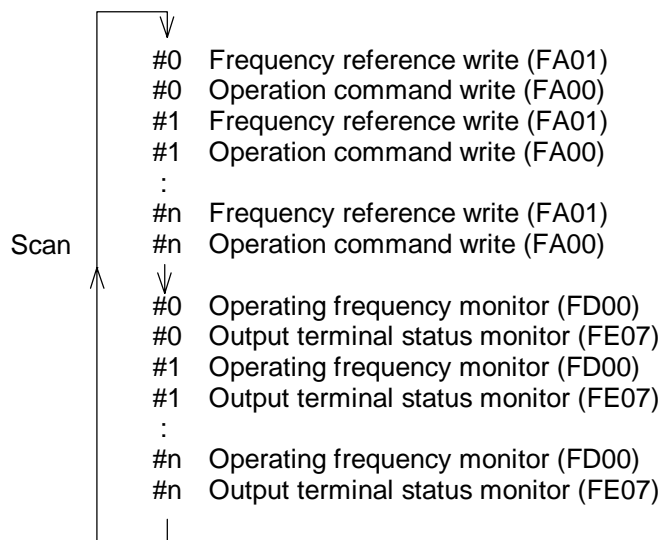
Inverter communication status map (B+4 to B+7):

This table shows the communication status map of each Inverter. (1: Normal / 0: Error or No answer)

	F	E	D	C	B	A	9	8	7	6	5	4	3	2	1	0
B+4	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
B+5	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
B+6	47	46	45	44	43	42	41	40	39	38	37	36	35	34	33	32
B+7	63	62	61	60	59	58	57	56	55	54	53	52	51	50	49	48

< Data exchange mode (Mode 0) >

When the instruction input comes ON with the operand $B+1$ is 0, the Data exchange mode (mode 0) is selected. In this mode, the T1-16S sends the following commands to the Inverters starting from #0 through the Inverter number specified by the operand B , and repeats.



The maximum Inverter number $\#n$ is specified by the operand B .

The scan execution status and the Inverter communication status are stored in the operand $B+2$ to $B+7$.

The command data table is specified by the operand A and $A+1$. If A is 4 and $A+1$ is 1000, the register D1000 is specified as the table leading address.

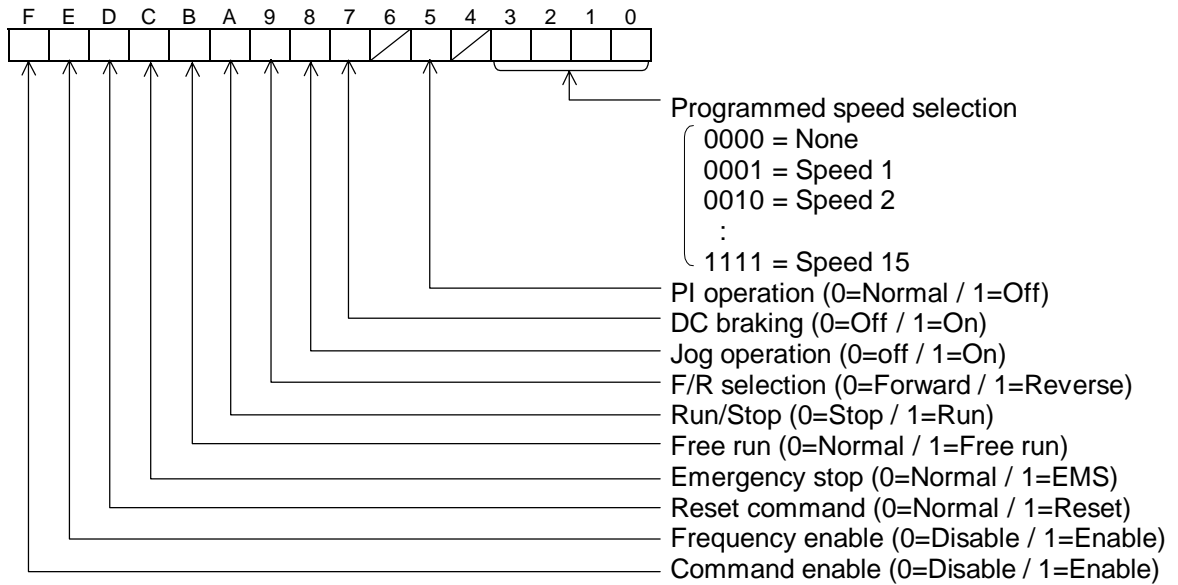
Command data table (if D1000 is specified):

Register	Data contents	Signal direction
D1000	#0 Operating frequency	← Read
D1001	#0 Output terminal status	← Read
D1002	#0 Frequency reference	→ Write
D1003	#0 Operation command	→ Write
D1004	#1 Operating frequency	← Read
D1005	#1 Output terminal status	← Read
D1006	#1 Frequency reference	→ Write
D1007	#1 Operation command	→ Write
⋮	⋮	
D(1000+n*4)	#n Operating frequency	← Read
D(1001+n*4)	#n Output terminal status	← Read
D(1002+n*4)	#n Frequency reference	→ Write
D(1003+n*4)	#n Operation command	→ Write

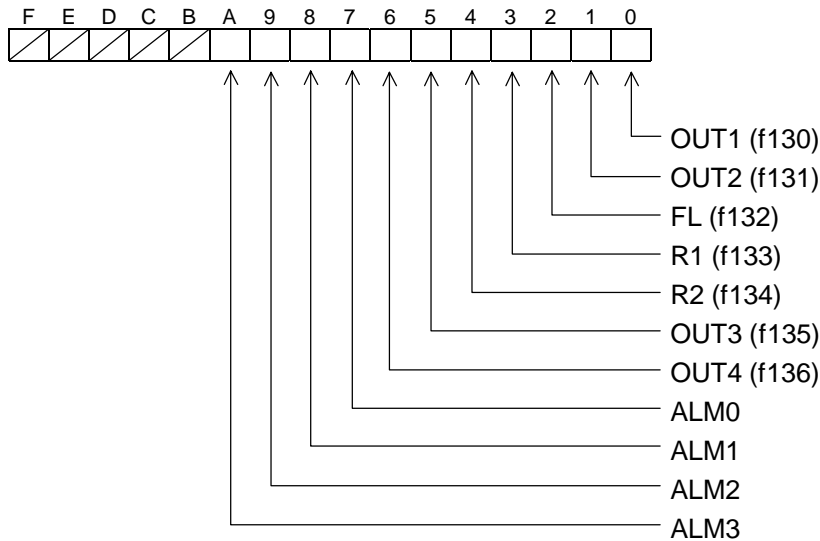
When the instruction input is reset to OFF, the operation is stopped after receiving the response from the Inverter currently communicating.

Note) Inverter communication command and monitor data format

- The data format for the operating frequency and the frequency reference registers are 0.01 Hz units. For example, if it is 60 Hz, the corresponding register data is 6000.
- The bit assignment of the operation command register is as follows. (VF-A7)



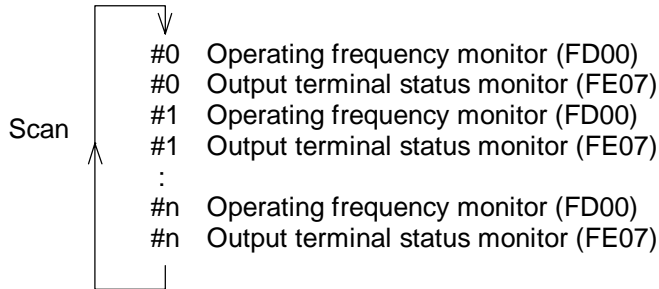
- The bit assignment of the output terminal status register is as follows. (VF-A7)



For the Inverter communication function details, refer to your Inverter's serial communication manual.

< Monitor mode (Mode 1) >

When the instruction input comes ON with the operand $B+1$ is 1, the Monitor mode (mode 1) is selected. In this mode, the T1-16S sends the following Read commands to the Inverters starting from #0 through the Inverter number specified by the operand B , and repeats.



The maximum Inverter number $\#n$ is specified by the operand B .

The scan execution status and the Inverter communication status are stored in the operand $B+2$ to $B+7$.

The monitor data table is specified by the operand A and $A+1$. If A is 3 and $A+1$ is 20, the register RW020 is specified as the table leading address.

Command data table (if RW020 is specified):

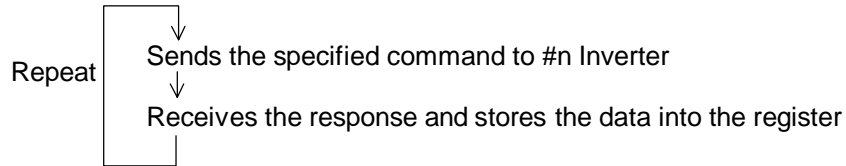
Register	Data contents	Signal direction
RW020	#0 Operating frequency	← Read
RW021	#0 Output terminal status	← Read
RW022	No use	
RW023	No use	
RW024	#1 Operating frequency	← Read
RW025	#1 Output terminal status	← Read
RW026	No use	
RW027	No use	
⋮	⋮	
RW(20+n*4)	#n Operating frequency	← Read
RW(21+n*4)	#n Output terminal status	← Read
RW(22+n*4)	No use	
RW(23+n*4)	No use	

When the instruction input is reset to OFF, the operation is stopped after receiving the response from the Inverter currently communicating.

Note) For the data format, refer to the previous page.

< Read command mode (Mode 2) >

When the instruction input comes ON with the operand $B+1$ is 2, the Read command mode (mode 2) is selected. In this mode, the T1-16S sends the user specified Read command to the Inverter specified by the operand B , and repeats.



The target Inverter number $\#n$ is specified by the operand B .

The scan execution status and the Inverter communication status are stored in the operand $B+2$ to $B+7$.

The command setting register and the response data storing register is indirectly specified by the operand A and $A+1$. If A is 4 and $A+1$ is 3000, the register D3000 is specified as the table leading address.

Data table (if D3000 is specified):

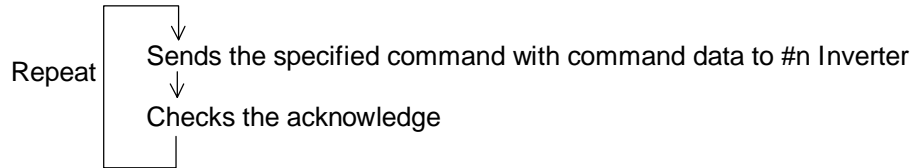
Register	Data contents	Signal direction
D3000	Command code	
D3001	Response data	← Read

When the instruction input is reset to OFF, the operation is stopped after receiving the response from the Inverter.

Note) For the communication command code and the data format, refer to your Inverter 's serial communication manual.

< Write command mode (Mode 3) >

When the instruction input comes ON with the operand $B+1$ is 3, the Write command mode (mode 3) is selected. In this mode, the T1-16S sends the user specified Write command to the Inverter specified by the operand B , and repeats.



The target Inverter number $\#n$ is specified by the operand B .

The scan execution status and the Inverter communication status are stored in the operand $B+2$ to $B+7$.

The command code and the command data setting registers are indirectly specified by the operand A and $A+1$. If A is 4 and $A+1$ is 3010, the register D3010 is specified as the table leading address.

Data table:

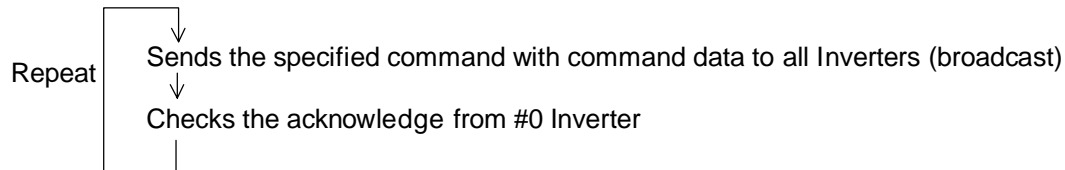
Register	Data contents	Signal direction
D3010	Command code	→ Write
D3011	Command data	

When the instruction input is reset to OFF, the operation is stopped after receiving the response from the Inverter.

Note) For the communication command code and the data format, refer to your Inverter 's serial communication manual.

< Broadcast mode (Mode 4) >

When the instruction input comes ON with the operand $B+1$ is 4, the Broadcast mode (mode 4) is selected. In this mode, the T1-16S sends the user specified Write command to all the Inverters as broadcast. This mode is useful to send Run/Stop command to all the Inverter at the same time.



The Inverter number specified by the operand B is ignored.

The scan execution status and the Inverter communication status are stored in the operand $B+2$ to $B+7$. (only #0 Inverter responds)

The command code and the command data setting registers are indirectly specified by the operand A and $A+1$. If A is 4 and $A+1$ is 3020, the register D3020 is specified as the table leading address.

Data table:

Register	Data contents	Signal direction
D3020	Command code	→ Write
D3021	Command data	

When the instruction input is reset to OFF, the operation is stopped after receiving the response from the Inverter.

Note) For the communication command code and the data format, refer to your Inverter 's serial communication manual.

< Note >

- (1) The XFER instruction is not executed as error in the following cases. In these cases, the instruction error flag (ERF = S051) is set to ON. If the ERF is set to ON once, it remains ON until resetting to OFF by user program.
 - The RS-485 port designation is other than H0030 and 0.
 - The Inverter number designation is other than 0 to 63.
 - Operation mode setting for RS-485 port is other than the Inverter connection mode.
- (2) This XFER instruction must be programmed in the Main program.
- (3) During the instruction input is ON, the data contents in the data table specified by A can be changed. However, parameters specified by B cannot be changed.
- (4) In the Data exchange mode (mode 0) and the Monitor mode (mode 1), the T1-16S scans from #0 to the specified number. Therefore the Inverter number should be consecutive starting with 0. If an Inverter is disconnected from the network, the T1-16S checks its existence periodically. When you turn off power to an Inverter for maintenance purpose and turn on again, it is recommended to reset the instruction input to re-configure the network.

6.9 Programming

6.9.1 Data exchange mode

In the data exchange mode, T1-16S can communicate with multiple (up to 64) Inverters. For each Inverter, T1-16S can send the command (Run, Stop, etc.) and the frequency reference, and can monitor the current operating frequency and the output terminal status.

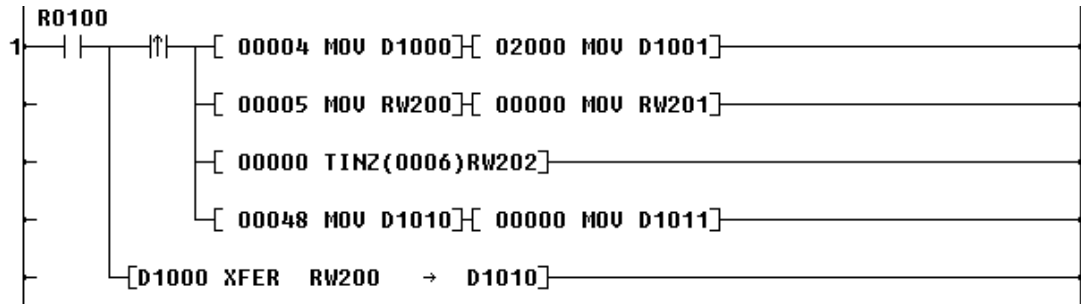
Example:

Following is an example operation using the data exchange mode.

- 6 Inverters are connected. (Inverter number 0 to 5)
- The register table starting with D2000 is used to exchange data.

Register	Data contents	Signal direction
D2000	#0 Operating frequency	← Read
D2001	#0 Output terminal status	← Read
D2002	#0 Frequency reference	→ Write
D2003	#0 Operation command	→ Write
D2004	#1 Operating frequency	← Read
D2005	#1 Output terminal status	← Read
D2006	#1 Frequency reference	→ Write
D2007	#1 Operation command	→ Write
⋮	⋮	
D2020	#5 Operating frequency	← Read
D2021	#5 Output terminal status	← Read
D2022	#5 Frequency reference	→ Write
D2023	#5 Operation command	→ Write

Programming example:



When R0100 comes ON, the parameters for the XFER instruction are set as follows.

Line 1:

Designates the data table. In this example, D2000 is designated as the data table starting address. Because 4 is set to D1000 and 2000 is set to D1001.

Line 2:

Designates the maximum Inverter number and the operation mode.

RW200=5 ... Maximum Inverter number is 5

RW201=0 ... Data exchange mode

Line 3:

Initializes the status registers RW202 to RW207.

Line 4:

These data are fixed for using the Inverter connection function.

D1010=48 (H30) and D1011=0

Data table designation		Parameter & status		RS-485 port	
D1000	4	RW200	5	D1010	H0030 (fixed)
D1001	2000	RW201	0 (mode 0)	D1011	0 (fixed)
		RW202	Execution status		
		RW203	Comm error code		
		RW204	Inverter comms status map		
		RW205			
		RW206			
		RW207			

Then, during R100 is ON, the T1-16S executes the communication with the 6 Inverters cyclically. (Scan)

When the communication with all the 6 Inverters is normal, bit 0 to 5 of RW204 will be ON. (Inverter communication status map)

And the value of RW202 will increase. (Scan count)

The each Inverter's operating status is monitored in the data table (D2000 to D2023).

By setting the required frequency and command data into the corresponding registers in the data table, it will be transmitted to the Inverter automatically.

For example, To operate the #0 Inverter at 30 Hz forward rotation, write the value 3000 in D2002 and HC400 in D2003.

(HC400 = Bits F, E, A are 1, and other bits are 0)

Note) For the data format of the Inverter exchanging data, refer to page 137.

6.9.2 Monitor mode

In the monitor mode, T1-16S can communicate with multiple (up to 64) Inverters. For each Inverter, T1-16S can monitor the current operating frequency and the output terminal status.

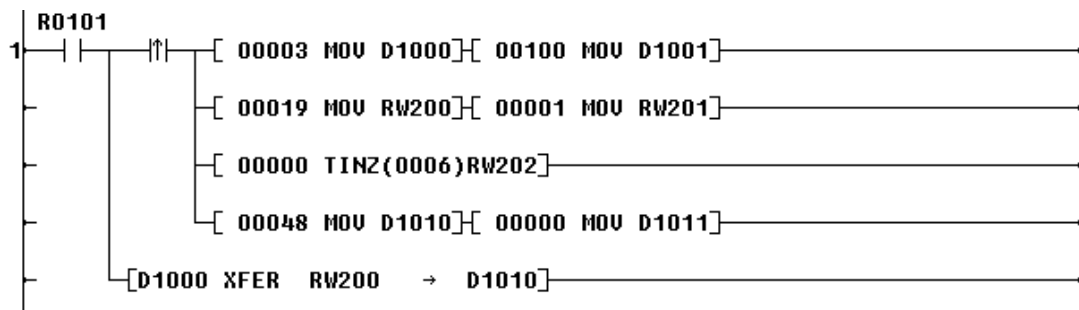
Example:

Following is an example operation using the monitor mode.

- 20 Inverters are connected. (Inverter number 0 to 19)
- The register table starting with RW100 is used to monitor the data.

Register	Data contents	Signal direction
RW100	#0 Operating frequency	← Read
RW101	#0 Output terminal status	← Read
RW102	No use	
RW103	No use	
RW104	#1 Operating frequency	← Read
RW105	#1 Output terminal status	← Read
RW106	No use	
RW107	No use	
⋮	⋮	
RW176	#19 Operating frequency	← Read
RW177	#19 Output terminal status	← Read
RW178	No use	
RW179	No use	

Programming example:



When R0101 comes ON, the parameters for the XFER instruction are set as follows.

Line 1:

Designates the data table. In this example, RW100 is designated as the data table starting address. Because 3 is set to D1000 and 100 is set to D1001.

Line 2:

Designates the maximum Inverter number and the operation mode.

RW200=19 ... Maximum Inverter number is 19

RW201=1 ... Monitor mode

Line 3:

Initializes the status registers RW202 to RW207.

Line 4:

These data are fixed for using the Inverter connection function.

D1010=48 (H30) and D1011=0

Data table designation		Parameter & status		RS-485 port	
D1000	3	RW200	19	D1010	H0030 (fixed)
D1001	100	RW201	1 (mode 1)	D1011	0 (fixed)
		RW202	Execution status		
		RW203	Comm error code		
		RW204	Inverter comms status map		
		RW205			
		RW206			
		RW207			
		RW207			

Then, during R101 is ON, the T1-16S executes the communication with the 20 Inverters cyclically. (Scan)

When the communication with all the 20 Inverters is normal, all bits of RW204 and bit 0 to 3 of RW205 will be ON. (Inverter communication status map)

And the value of RW202 will increase. (Scan count)

The each Inverter's operating status is monitored in the data table (RW100 to RW179). For example, if #1 Inverter is operating with 50 Hz, RW104 data will be 5000.

Note) For the data format of the Inverter monitoring data, refer to page 137.

6.9.3 Read command mode

The read command mode is used to read a specified data from a specified Inverter. User should specify the Inverter communication command code.

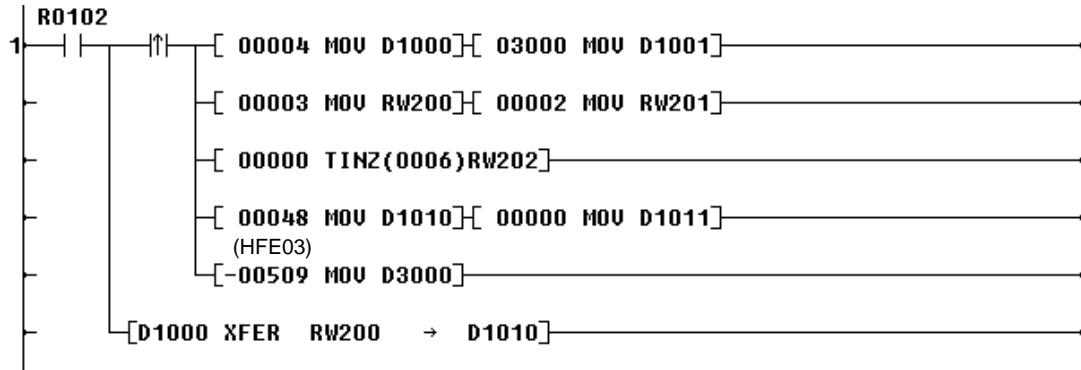
Example:

Following is an example operation using the read command mode.

- Communicates with #3 Inverter.
- Reads the output current. (Inverter communication command code = HFE03)
- D3000 and D3001 are used for communication data table.

Register	Data contents	Signal direction
D3000	Command code (HFE03)	
D3001	Response data	← Read

Programming example:



When R0102 comes ON, the parameters for the XFER instruction are set as follows.

Line 1:

Designates the data table. In this example, D3000 is designated as the data table starting address. Because 4 is set to D1000 and 3000 is set to D1001.

Line 2:

Designates the Inverter number and the operation mode.
 RW200=3 ... Target Inverter number is 3
 RW201=2 ... Read command mode

Line 3:

Initializes the status registers RW202 to RW207.

Line 4:

These data are fixed for using the Inverter connection function.
 D1010=48 (H30) and D1011=0

Line 5:

Inverter communication command designation. The command code HFE03 (-509) is output current monitor.

Data table designation		Parameter & status		RS-485 port	
D1000	4	RW200	3	D1010	H0030 (fixed)
D1001	3000	RW201	2 (mode 2)	D1011	0 (fixed)
		RW202	Execution status		
		RW203	Comm error code		
		RW204	Inverter comms status map		
		RW205			
		RW206			
		RW207			

Then, during R102 is ON, the T1-16S executes the communication with the #3 Inverter for monitoring the output current. The response data is stored in D3001. If the response data is 1915, it means 19.15 %.

When the communication with the #3 Inverter is normal, bit 3 of RW204 will be ON. (Inverter communication status map)

And the value of RW202 will increase. (Scan count)

During R102 is ON, the Inverter communication command code can be changed. In this case, check the scan count RW202 increments to confirm the response.

Note) For the Inverter communication command code and the data format of the response, refer to your Inverter manual.

6.9.4 Write command mode

The write command mode is used to write a specified data/parameter into a specified Inverter. User should specify the Inverter communication command code and the data to be written.

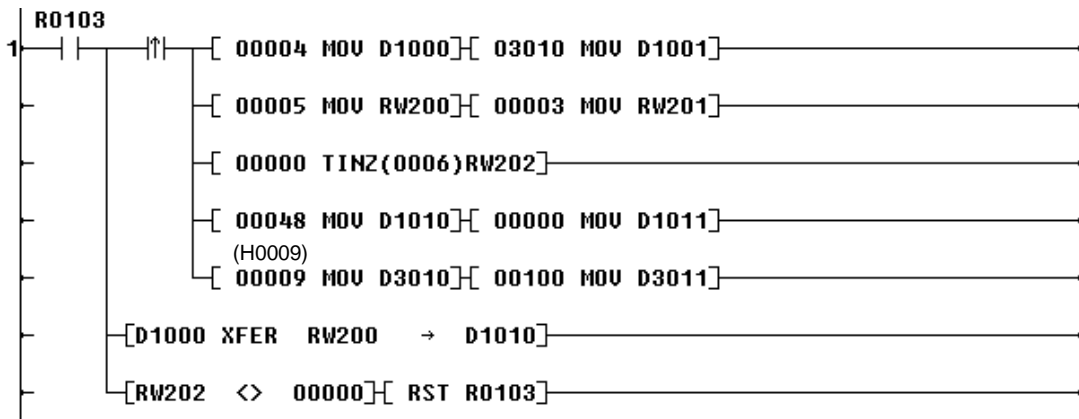
Example:

Following is an example operation using the write command mode.

- Communicates with #5 Inverter.
- Writes the acceleration time parameter (Inverter command code = H0009) with the data 10 seconds (value 100 in 0.1 second units)
- D3010 and D3011 are used for communication data table.

Register	Data contents	Signal direction
D3010	Command code (H0009)	
D3011	Command data (100)	→ Write

Programming example:



When R0103 is set to ON, the parameters for the XFER instruction are set as follows.

Line 1:
Designates the data table. In this example, D3010 is designated as the data table starting address. Because 4 is set to D1000 and 3010 is set to D1001.

Line 2:
Designates the Inverter number and the operation mode.
RW200=5 ... Target Inverter number is 5
RW201=3 ... Write command mode

Line 3:
Initializes the status registers RW202 to RW207.

Line 4:

These data are fixed for using the Inverter connection function.
D1010=48 (H30) and D1011=0

Line 5:

Inverter communication command designation. The command code H0009 is acceleration time parameter. It is changed to 10 seconds.

Data table designation		Parameter & status		RS-485 port	
D1000	4	RW200	5	D1010	H0030 (fixed)
D1001	3010	RW201	3 (mode 3)	D1011	0 (fixed)
		RW202	Execution status		
		RW203	Comm error code		
		RW204	Inverter comms status map		
		RW205			
		RW206			
		RW207			

Then, the T1-16S executes the communication with the #5 Inverter for changing the acceleration time parameter to 10 seconds.

In this sample program, R103 will be reset to OFF automatically when the scan count RW202 is updated.

When the communication with the #5 Inverter is normal, bit 5 of RW204 will be ON. (Inverter communication status map)

Note) For the Inverter communication command code and the data format, refer to your Inverter manual.

6.9.5 Broadcast mode

The broadcast mode is used to send a same command to all the connected Inverters simultaneously. User should specify the Inverter communication command code and the data to be sent.

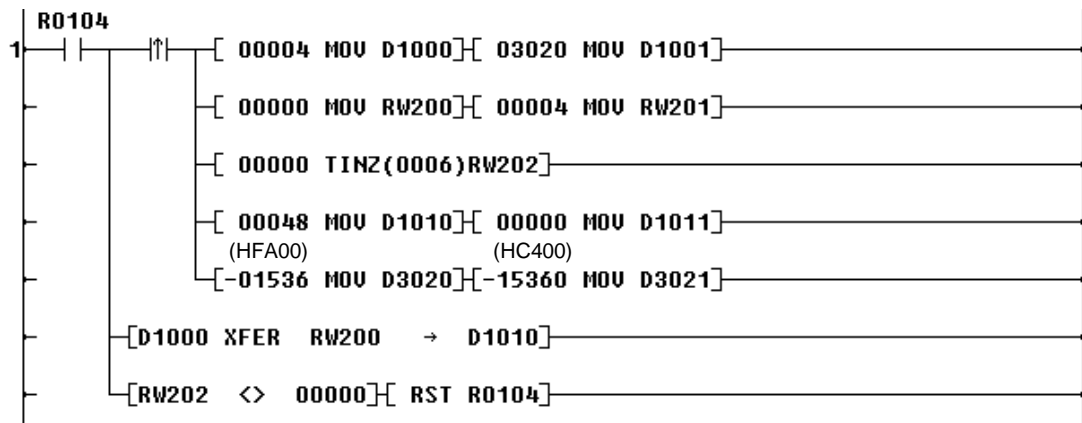
Example:

Following is an example operation using the broadcast mode.

- Sends Run Forward command to all the Inverters.
(Inverter command code = HFA00, command data = HC400)
- D3020 and D3021 are used for communication data table.

Register	Data contents	Signal direction
D3020	Command code (HFA00)	→ Write
D3021	Command data (HC400)	

Programming example:



When R0104 is set to ON, the parameters for the XFER instruction are set as follows.

Line 1:

Designates the data table. In this example, D3020 is designated as the data table starting address. Because 4 is set to D1000 and 3020 is set to D1001.

Line 2:

Designates the Inverter number and the operation mode.
RW200=0 ... For the broadcast mode, any number within 0 to 63
RW201=4 ... Broadcast mode

Line 3:

Initializes the status registers RW202 to RW207.

Line 4:

These data are fixed for using the Inverter connection function.

D1010=48 (H30) and D1011=0

Line 5:

Inverter communication command designation.

D3020=HFA00 ... Operation command (command 1)

D3021=HC400 ... Run forward (bits F, E, and A are ON)

Data table designation		Parameter & status		RS-485 port	
D1000	4	RW200	0	D1010	H0030 (fixed)
D1001	3020	RW201	4 (mode 4)	D1011	0 (fixed)
		RW202	Execution status		
		RW203	Comm error code		
		RW204	Inverter comms status map		
		RW205			
		RW206			
		RW207			

Then, the T1-16S sends the Run forward command to all the connected Inverters in broadcast mode. When every Inverter receives this command, they start operation simultaneously.

In this sample program, R104 will be reset to OFF automatically when the scan count RW202 is updated.

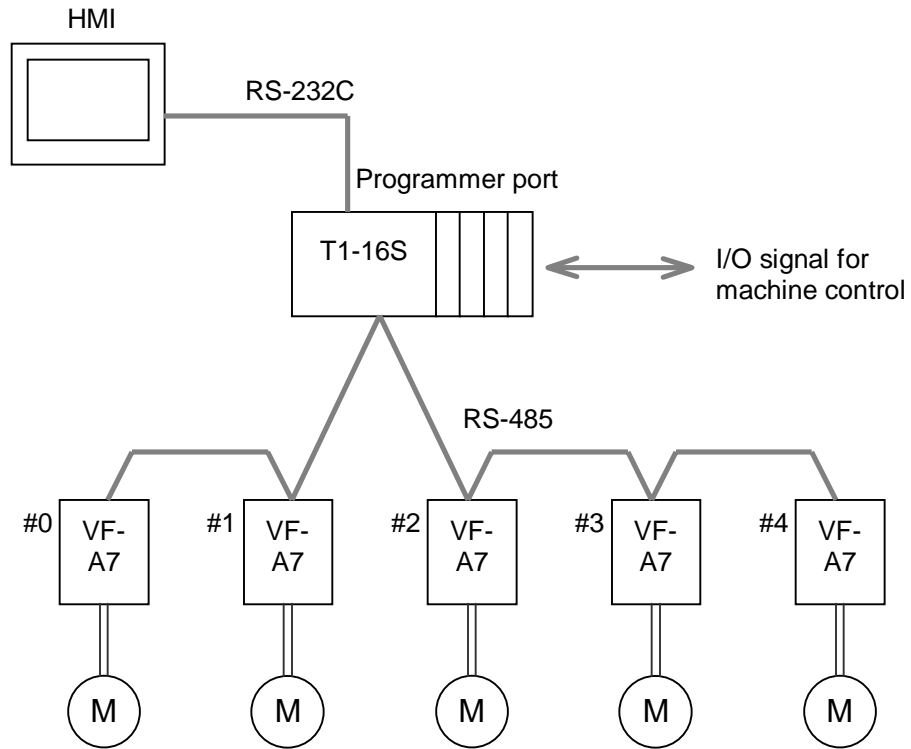
In the broadcast mode, only #0 Inverter returns the response. Therefore only bit 0 of RW204 will be ON when the communication is normal. (Inverter communication status map)

Note) For the Inverter communication command code and the data format, refer to your Inverter manual.

6.10 T1-16S application example

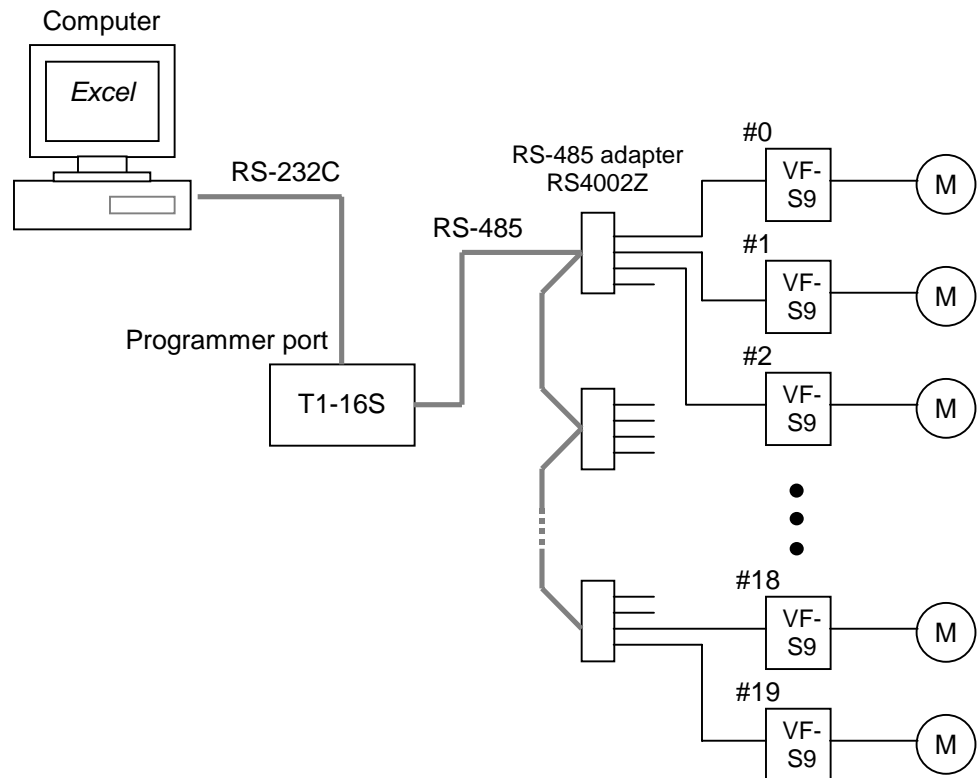
Example 1 (Simple HMI - PLC - Drive system)

System configuration:



Operation:

Five Inverters (VF-A7) are controlled by the T1-16S. The machine operator instructs the each Inverter's operation (start/stop & operation frequency) through the HMI (programmable touch-panel display). The each Inverter's operating frequency can be monitored on the HMI. By assigning the Inverter's alarms into the output terminal signal, this alarm status can also be monitored on the HMI. For this configuration, the T1-16S uses the Data exchange mode. No special program other than single XFER instruction is required in the T1-16S for these Inverters communication control.

Example 2 (Monitoring/controlling system for distributed drives)**System configuration:****Operation:**

This is an application example of multiple drives monitoring and controlling system. In this system, 20 Inverters (VF-S9) are used. The each Inverter operation status can be monitored on the computer. Popular Excel is used to monitor the operation status (Inverter's operating frequency can be displayed on Excel graph as well as on the spreadsheet cell). Toshiba's DDE server software (T-PSV) is used for linking between Excel and the T1-16S data.

From the Excel operation, each Inverter's operating frequency can be changed individually.

For this configuration, the T1-16S uses the Data exchange mode. No special program other than single XFER instruction is required in the T1-16S for these Inverters communication control.

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