Individual Functions

This section explains the individual functions used in special applications.

◆ Using MODBUS Communications

You can perform serial communications with MEMOCON-series Programmable Controllers (PLCs) or similar devices using the MODBUS protocol.

■MODBUS Communications Configuration

MODBUS communications are configured using 1 master (PLC) and a maximum of 31 slaves. Serial communications between master and slave are normally started by the master, and the slave responds.

The master performs signal communications with one slave at a time. Consequently, you must set the address of each slave beforehand, so the master can perform signal communications using that address. Slaves receiving commands from the master perform the specified function, and send a response to the master.

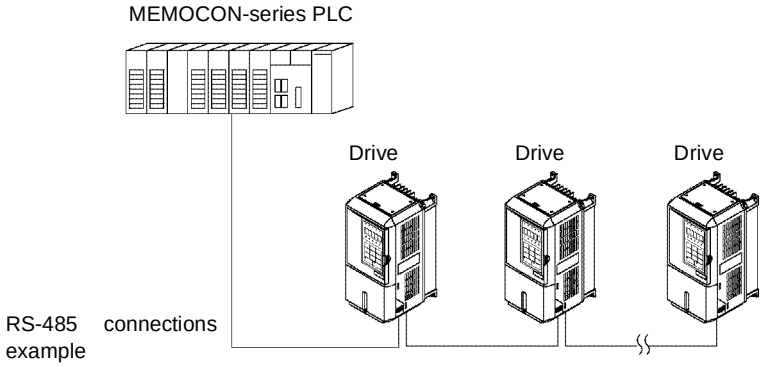


Fig 6.54 Example of Connections between PLC and Drive

■Communications Specifications

The MODBUS communications specifications are shown in the following table.

Item	Specifications
Interface	RS-422, RS-485
Communications Cycle	Asynchronous (Start-stop synchronization)
Communications Parameters	Baud rate: Select from 1,200, 2,400, 4,800, 9,600, and 19,200 bps. Data length: 8 bits fixed Parity: Select from even, odd, or none. Stop bits: 1 bit fixed
Communications Protocol	MODBUS (RTU mode only)
Number of Connectable Units	31 units max. (when using RS-485)

■Communications Connection Terminal

MODBUS communications use the following terminals: S+, S-, R+, and R-. Set the terminating resistance by turning ON pin 1 of switch S1 for the last Drive only, as seen from the PLC.

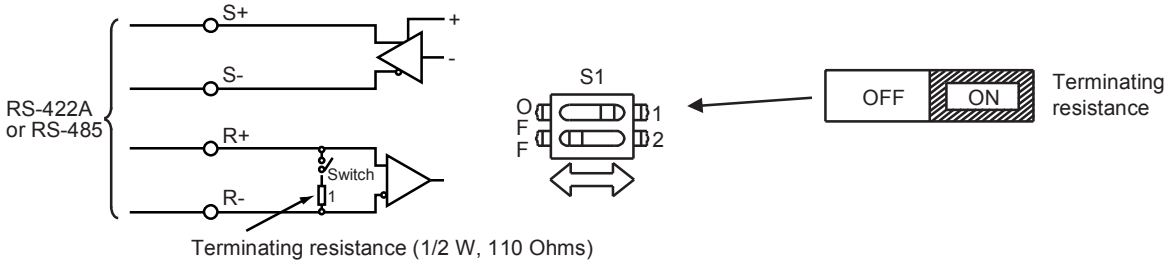
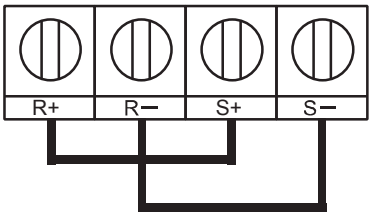


Fig 6.55 Communications Connection Terminal

IMPORTANT

1. Separate the communications cables from the main circuit cables and other wiring and power cables.
2. Use shielded cables for the communications cables, connect the shield cover to the Drive earth terminal, and arrange the terminals so that the other end is not connected to prevent operating errors due to noise.
3. When using RS-485 communications, connect S+ to R+, and S- to R-, on the Drive exterior.



■Procedure for Communicating with the PLC

Use the following procedure to perform communications with the PLC.

1. Turn OFF the power supply turned and connect the communications cable between the PLC and the Drive.
2. Turn ON the power supply.
3. Set the required communications parameters (H5-01 to H5-07) using the Digital Operator.
4. Turn OFF the power supply, and check that the Digital Operator display has completely disappeared.
5. Turn ON the power supply once again.
6. Perform communications with the PLC.

INFO

Set the timer on the master to monitor response time from the slave. Set the master so that if the slave does not respond to the master within the set time, the same command message will be sent from the master again.

■Related Parameters

Parameter Number	Name / Display	Description	Setting Range	Factory Setting	Change during Operation	Control Methods: V/f	V/f with PG	Open Loop Vector 1	Flux Vector	Open Loop Vector 2
b1-01	Frequency Reference Selection / Reference Source	Selects the frequency reference input source. 0: Operator - Digital preset speed U1-01 or d1-01 to d1-17. 1: Terminals - Analog input terminal A1 (or terminal A2 based on parameter H3-09). 2: Serial Com - Modbus RS-422/ 485 terminals R+, R-, S+, and S-. 3: Option PCB - Option board connected on 2CN. 4: Pulse Input (Terminal RP)	0 to 4	1	No	Q	Q	Q	Q	Q
b1-02	Run Command Selection / Run Source	Selects the run command input source. 0: Operator - RUN and STOP keys on Digital Operator. 1: Terminals - Contact closure on terminals S1 or S2. 2: Serial Com - Modbus RS-422/ 485 terminals R+, R-, S+, and S-. 3: Option PCB - Option board connected on 2CN.	0 to 3	1	No	Q	Q	Q	Q	Q
H5-01	Drive Node Address / Serial Comm Adr	Selects Drive station node number (address) for Modbus terminals R+, R-, S+, S-. The Drive's power must be cycled for the setting to take effect.	0 to 20 *	1F	No	A	A	A	A	A
H5-02	Communication Speed Selection / Serial Baud Rate	Selects the baud rate for Modbus terminals R+, R-, S+ and S-. The Drive's power must be cycled for the setting to take effect. 0: 1200 bps 1: 2400 bps 2: 4800 bps 3: 9600 bps 4: 19200 bps	0 to 4	3	No	A	A	A	A	A
H5-03	Communication Parity Selection / Serial Com Sel	Selects the communication parity for Modbus terminals R+, R-, S+ and S-. The Drive's power must be cycled for the setting to take effect. 0: No Parity 1: Even Parity 2: Odd Parity	0 to 2	0	No	A	A	A	A	A
H5-04	Stopping Method After Communication Error / Serial Fault Sel	Selects the stopping method when a communication timeout fault (CE) is detected. 0: Ramp to Stop 1: Coast to Stop 2: Fast-Stop 3: Alarm Only	0 to 3	3	No	A	A	A	A	A

Parameter Number	Name / Display	Description	Setting Range	Factory Setting	Change during Operation	Control Methods: V/f	V/f with PG	Open Loop Vector 1	Flux Vector	Open Loop Vector 2
H5-05	Communication Fault Detection Selection / Serial Flt Dtct	Enables or disables the communications timeout fault (CE). 0: Disabled - A communication loss will not cause a communication fault. 1: Enabled - If communication is lost for more than 2 seconds, a CE fault will occur.	0 or 1	1	No	A	A	A	A	A
H5-06	Drive Transmit Wait Time / Transmit WaitTIM	Set the delay time from when the Drive receives data to when the Drive sends data.	5 to 65	5ms	No	A	A	A	A	A
H5-07	RTS Control Selection / RTS Control Sel	Enables or disables "request to send" (RTS) control: 0: Disabled - RTS is always on 1: Enabled - RTS turns on only when sending	0 or 1	1	No	A	A	A	A	A

* If H5-01 is set to zero, then the drive will be unable to respond to Modbus communication.

MODBUS communications can perform the following operations regardless of the settings in b1-01 and b1-02.

- Monitoring operation status from the PLC
- Setting and reading parameters
- Resetting errors
- Inputting multi-function commands

An OR operation is performed between the multi-function commands input from the PLC and commands input from multi-function contact input terminals S3 to S7.

■Message Format

In MODBUS communications, the master sends commands to the slave, and the slave responds. The message format is configured for both sending and receiving as shown below, and the length of data packets is changed by the command (function) contents.

Slave address
Function code
Data
Error check

The space between messages must support the following.

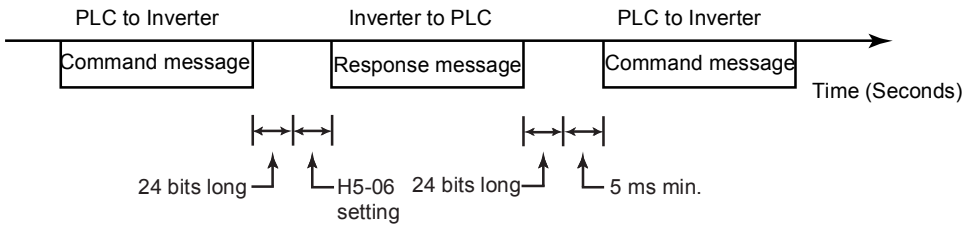


Fig 6.56 Message Spacing

Slave Address

Set the Drive address from 0 to 32. If you set 0, commands from the master will be broadcast (i.e., the Drive will not return responses).

Function Code

The function code specifies commands. There are three function codes, as shown below.

Function Code (Hexadecimal)	Function	Command Message		Response Message	
		Min. (Bytes)	Max. (Bytes)	Min. (Bytes)	Max. (Bytes)
03H	Read storage register contents	8	8	7	37
08H	Loopback test	8	8	8	8
10H	Write multiple storage registers	11	41	8	8

Data

Configure consecutive data by combining the storage register address (test code for a loopback address) and the data the register contains. The data length changes depending on the command details.

Error Check

Errors are detected during communications using CRC-16. Perform calculations using the following method.

1. The factory setting for CRC-16 communications is usually 0, but when using the MODBUS system, set the factory setting to 1 (i.e., set all 16 bits to 1).
2. Calculate CRC-16 using MSB as slave address LSB, and LSB as the MSB of the final data.
3. Also calculate CRC-16 for response messages from the slaves, and compare them to the CRC-16 in the response messages.

■MODBUS Message Example

An example of MODBUS command/response messages is given below.

Reading Storage Register Contents

Read the contents of the storage register only for specified quantities whose addresses are consecutive, starting from a specified address. The contents of the storage register are separated into higher place 8 bits and lower place 8 bits, and comprise the data within response messages in address order.

The following table shows message examples when reading status signals, error details, data link status, and frequency references from the slave 2 Drive.

Command Message

Slave Address		02H
Function Code		03H
Start Address	Higher place	00H
	Lower place	20H
Quantity	Higher place	00H
	Lower place	04H
CRC-16	Higher place	45H
	Lower place	F0H

Response Message (During Normal Operation)

Slave Address		02H
Function Code		03H
Data quantity		08H
Lead storage register	Higher place	00H
	Lower place	65H
Next storage register	Higher place	00H
	Lower place	00H
Next storage register	Higher place	00H
	Lower place	00H
Next storage register	Higher place	01H
	Lower place	F4H
CRC-16	Higher place	AFH
	Lower place	82H

Response Message (During Error)

Slave Address		02H
Function Code		83H
Error code		03H
CRC-16	Higher place	F1H
	Lower place	31H

Loopback Test

The loopback test returns command messages directly as response messages without changing the contents to check the communications between the master and slave. You can set user-defined test code and data values.

The following table shows a message example when performing a loopback test with the slave 1 Drive.

Command Message

Slave address		01H
Function code		08H
Test Code	Higher place	00H
	Lower place	00H
Data	Higher place	A5H
	Lower place	37H
CRC-16	Higher place	DAH
	Lower place	8DH

Response Message (During Normal Operation)

Slave address		01H
Function code		08H
Test Code	Higher place	00H
	Lower place	00H
Data	Higher place	A5H
	Lower place	37H
CRC-16	Higher place	DAH
	Lower place	8DH

Response Message (During Error)

Slave address		01H
Function code		89H
Error Code		01H
CRC-16	Higher place	86H
	Lower place	50H

Writing to Multiple Storage Registers

Write the specified data to each specified storage register from the specified addresses. The written data must be in the following order in the command message: Higher place 8 bits, then lower place 8 bits, in storage register address order.

The following table shows an example of a message when forward operation has been set at a frequency reference of 60.0Hz in the slave 1 Drive by the PLC.

Command Message

Slave Address		01H
Function Code		10H
Start Address	Higher place	00H
	Lower place	01H
Quantity	Higher place	00H
	Lower place	02H
No. of data		04H
Lead data	Higher place	00H
	Lower place	01H
Next data	Higher place	02H
	Lower place	58H
CRC-16	Higher place	63H
	Lower place	39H

Response Message (During Normal Operation)

Slave Address		01H
Function Code		10H
Start Address	Higher place	00H
	Lower place	01H
Quantity	Higher place	00H
	Lower place	02H
CRC-16	Higher place	10H
	Lower place	08H

Response Message (During Error)

Slave Address		01H
Function Code		90H
Error code		02H
CRC-16	Higher place	CDH
	Lower place	C1H

INFO

Set the number of data specified using command messages as quantity of specified messages x 2. Handle response messages in the same way.

■Data Tables

The data tables are shown below. The types of data are as follows: Reference data, monitor data, and broadcast data.

Reference Data

The reference data table is shown below. You can both read and write reference data.

Register No.	Contents		
0000H	Not used		
0001H	Frequency reference		
	Bit 0	Run/stop command	1: Run 0: Stop
	Bit 1	Forward/reverse operation	1: Reverse 0: Forward
	Bit 2	External fault	1: Error (EFO)
	Bit 3	Fault reset	1: Reset command
	Bit 4	ComNet	
	Bit 5	ComCtrl	
	Bit 6	Multi-function input command 3	
	Bit 7	Multi-function input command 4	
	Bit 8	Multi-function input command 5	
	Bit 9	Multi-function input command 6	
	Bit A	Multi-function input command 7	
	Bit B	Multi-function input command 8	
	Bit C	Multi-function input command 9	
	Bit D	Multi-function input command 10	
	Bit E	Multi-function input command 11	
	Bit F	Multi-function input command 12	
0002H	Frequency reference (Set units using parameter o1-03)		
0003H	Not used		
0004H	Torque reference		
0005H	Torque compensation		
0006H	PID target value		
0007H	Analog output 1 setting (-11 V/-1540 to 10 V/1540)		
0008H	Analog output 2 setting (-11 V/-1540 to 11 V/1540)		
0009H	Multi-function contact output setting		
	Bit 0	Contact output (terminal M1-M2)	1: ON 0: OFF
	Bit 1	Contact output (terminal M3-M4)	1: ON 0: OFF
	Bit 2	Contact output (terminal M5-M6)	1: ON 0: OFF
	Bit 3	PHC3(Contact P3-C3)	1: ON 0: OFF
	Bit 4	PHC4(Contact P4-C4)	1: ON 0: OFF
	Bit 5	Not used	
	Bit 6	Set error contact (terminal MA-MC) output using bit 7. 1: ON 0: OFF	
	Bit 7	Error contact (terminal MA-MC)	1: ON 0: OFF
	Bits 8 to F	Not used	
000AH to 000EH	Not used		

Register No.	Contents	
000FH	Reference selection settings	
	Bit 0	Not used
	Bit 1	Use MODBUS 0006H PID target value
	Bits 2 to B	Not used
	C	Broadcast data terminal S5 input 1: Enabled 0: Disabled
	D	Broadcast data terminal S6 input 1: Enabled 0: Disabled
	E	Broadcast data terminal S7 input 1: Enabled 0: Disabled
	F	Broadcast data terminal S8 input 1: Enabled 0: Disabled

Note Write 0 to all unused bits. Also, do not write data to reserved registers.

Monitor Data

The following table shows the monitor data. Monitor data can only be read.

Register No.	Contents	
0020H	Drive status	
	Bit 0	Operation 1: Operating 0: Stopped
	Bit 1	Reverse operation 1: Reverse operation 0: Forward operation
	Bit 2	Drive startup complete 1: Completed 2: Not completed
	Bit 3	Error 1: Error
	Bit 4	Data setting error 1: Error
	Bit 5	Multi-function contact output 1 (terminal M1 - M2) 1: ON 0: OFF
	Bit 6	Multi-function contact output 2 (terminal M3 - M4) 1: ON 0: OFF
	Bit 7	Multi-function contact output 3 (terminal M5 - M6) 1: ON 0: OFF
	Bit 8	Multi-function PHC output 3 (terminal P3 - C3) 1: ON 0: OFF
	Bit 9	Multi-function PHC output 4 (terminal P4 - C4) 1: ON 0: OFF
	Bits A and B	Not used
0021H	Error details	
	Bit 0	Overcurrent (OC) Ground fault (GF)
	Bit 1	Main circuit overvoltage (OV)
	Bit 2	Drive overload (OL2)
	Bit 3	Drive overheat (OH1, OH2)
	Bit 4	Injection brake transistor resistance overheat (rr, rH)
	Bit 5	Fuse blown (PUF)
	Bit 6	PID feedback reference lost (FbL)
	Bit 7	External fault (EF, EFO)
	Bit 8	Hardware error (CPF)
	Bit 9	Motor overload (OL1), overtorque 1 (OL3) detected, or overtorque 2 (OL4) detected
	Bit A	PG broken wire detected (PGO), Overspeed (OS), Speed deviation (DEV)
	Bit B	Main circuit undervoltage (UV) detected
	Bit C	Main circuit undervoltage (UV1), control power supply error (UV2), inrush prevention circuit error (UV3), power loss
	Bit D	SPO output phase open, SPI output phase open
	Bit E	MODBUS communications error (CE)
	Bit F	Operator disconnected (OPR)
0022H	Data link status	
	Bit 0	Writing data
	Bit 1	Not used
	Bit 2	Not used
	Bit 3	Upper and lower limit errors
	Bit 4	Data integrity error
	Bits 5 to F	Not used
0023H	Frequency reference (U1-01)	
0024H	Output frequency (U1-02)	
0025H	Output voltage reference (U1-06)	
0026H	Output current (U1-03)	
0027H	Output power (U1-08)	
0028H	Torque reference (U1-09)	

Register No.	Contents		
0029H	Not used		
002AH	Not used		
002BH	Sequence input status		
	Bit 0	1: Control circuit terminal S1 ON	
	Bit 1	1: Control circuit terminal S2 ON	
	Bit 2	1: Control circuit terminal S3 ON	
	Bit 3	1: Control circuit terminal S4 ON	
	Bit 4	1: Control circuit terminal S5 ON	
	Bit 5	1: Control circuit terminal S6 ON	
	Bit 6	1: Control circuit terminal S7 ON	
	Bit 7	1: Control circuit terminal S8 ON	
	Bit 8	1: Control circuit terminal S9 ON	
	Bit 9	1: Control circuit terminal S10 ON	
	Bit A	1: Control circuit terminal S11 ON	
	Bit B	1: Control circuit terminal S12 ON	
	Bits C to F	Not used	
002CH	Drive status		
	Bit 0	Operation	1: Operating
	Bit 1	Zero speed	1: Zero speed
	Bit 2	Frequency matching	1: Matched
	Bit 3	User-defined speed matching	1: Matched
	Bit 4	Frequency detection 1	
	Bit 5	Frequency detection 2	
	Bit 6	Drive startup completed	1: Startup completed
	Bit 7	Low voltage detection	1: Detected
	Bit 8	Baseblock	1: Drive output baseblock
	Bit 9	Frequency reference mode	1: Not communications 0: Communications
	Bit A	Run command mode	1: Not communications 0: Communications
	Bit B	Overtorque detection	1: Detected
	Bit C	Frequency reference lost	1: Lost
	Bit D	Retrying error	1: Retrying
	Bit E	Error (including MODBUS communications time-out) 1:Error occurred	
	Bit F	MODBUS communications time-out 1: Timed out	
002DH	Multi-function contact output status		
	Bit 0	Multi-function contact output 1 (terminal M1 - M2) 1: ON 0: OFF	
	Bit 1	Multi-function contact output 2 (terminal M3 - M4) 1: ON 0: OFF	
	Bit 2	Multi-function contact output 3 (terminal M5 - M6) 1: ON 0: OFF	
	Bit 3	Multi-function PHC output 3 (terminal P3 - C3) 1: ON 0: OFF	
	Bit 4	Multi-function PHC output 4 (terminal P4 - C4) 1: ON 0: OFF	
	Bits 5 to F	Not used	
002EH - 0030H	Not used		
0031H	Main circuit DC voltage		
0032H	Torque monitor		
0033H	Output power (U1-08)		
0034H - 0037H	Not used		
0038H	PID feedback quantity (Input equivalent to 100%/Max. output frequency; 10/1%; without sign)		
0039H	PID input quantity (±100%/±Max. output frequency; 10/1%; with sign)		
003AH	PID output quantity (±100%/±Max. output frequency; 10/1%; with sign)		
003BH	CPU software number		
003CH	Flash software number		

Register No.	Contents	
003DH	Communications error details	
	Bit 0	CRC error
	Bit 1	Invalid data length
	Bit 2	Not used
	Bit 3	Parity error
	Bit 4	Overrun error
	Bit 5	Framing error
	Bit 6	Time-out
	Bits 7 to F	Not used
003EH	kVA setting	
003FH	Control method	

Note Communications error details are stored until an fault reset is input (you can also reset while the Unit is operating).

Broadcast Data

The following table shows the broadcast data. You can also write this data.

Register Address	Contents	
0001H	Operation signal	
	Bit 0	Run command 1: Operating 0: Stopped
	Bit 1	Reverse operation command 1: Reverse 0: Forward
	Bits 2 and 3	Not used
	Bit 4	External fault 1: Error (set using H1-01)
	Bit 5	Fault reset 1: Reset command (set using H1-02)
	Bits 6 to B	Not used
	Bit C	Multi-function contact input terminal S5 input
	Bit D	Multi-function contact input terminal S6 input
	Bit E	Multi-function contact input terminal S7 input
	Bit F	Multi-function contact input terminal S8 input
0002H	Frequency reference	30000/100%

Note Bit signals not defined in the broadcast operation signals use local node data signals continuously.

■ENTER Command

When writing parameters to the Drive from the PLC using MODBUS communications, the parameters are temporarily stored in the parameter data area in the Drive. To enable these parameters in the parameter data area, use the ENTER command.

There are two types of ENTER commands: ENTER commands that enable parameter data in RAM, and ENTER commands that write data to EEPROM (non-volatile memory) in the Drive at the same time as enabling data in RAM.

The following table shows the ENTER command data. ENTER command data can only be written.

The ENTER command is enabled by writing 0 to register number 0900H or 0910H.

Register No.	Contents
0900H	Write parameter data to EEPROM
0910H	Parameter data is not written to EEPROM, but refreshed in RAM only.

INFO

The maximum number of times you can write to EEPROM using the Drive is 100 thousand. Do not frequently execute ENTER commands (0900H) written to EEPROM.
The ENTER command registers are write-only. Consequently, if reading these registers, the register address will become invalid (Error code: 02H).

■Error Codes

The following table shows MODBUS communications error codes.

Error Code	Contents
01H	Function code error A function code other than 03H, 08H, or 10H has been set by the PLC.
02H	Invalid register number error • The register address you are attempting to access is not recorded anywhere. • With broadcast sending, a start address other than 0000H, 0001H, or 0002H has been set.
03H	Invalid quantity error • The number of data packets being read or written is outside the range 1 to 16. • In write mode, the number of data packets in the message is not No. of packets x 2.
21H	Data setting error • A simple upper limit or lower limit error has occurred in the control data or when writing parameters. • When writing parameters, the parameter setting is invalid.
22H	Write mode error • Attempting to write parameters from the PLC during operation. • Attempting to write via ENTER commands from the PLC during operation. • Attempting to write parameters other than A1-00 to A1-05, E1-03, or 02-04 when warning alarm CPF03 (defective EEPROM) has occurred. • Attempting to write read-only data.
23H	Writing during main circuit undervoltage (UV) error • Writing parameters from the PLC during UV (main circuit undervoltage) alarm. • Writing via ENTER commands from the PLC during UV (main circuit undervoltage) alarm.
24H	Writing error during parameter processing Attempting to write parameters from the PLC while processing parameters in the Drive.

■Slave Not Responding

In the following cases, the slave will ignore the write function. If the slave address specified in the command message is 0, all slaves execute the write function, but do not return response messages to the master.

- When a communications error (overrun, framing, parity, or CRC-16) is detected in the command message.
- When the slave address in the command message and the slave address in the Drive do not agree.
- When the data that configures the message and the data time length exceeds 24 bits.
- When the command message data length is invalid.

Application Precautions

Set a timer in the master to monitor response time from the slaves. Make the setting so that if no response is sent to the master from the slave within the set time, the same command message is sent again from the master.

■Self-Diagnosis

The Drive has a built-in function for self-diagnosing the operations of serial communications interface circuits. This function is called the self-diagnosis function. The self-diagnosis function connects the communications parts of the send and receive terminals, receives the data sent by the Drive, and checks if communications are being performed normally.

Perform the self-diagnosis function using the following procedure.

1. Turn ON the power supply to the Drive, and set 67 (communications test mode) in parameter H1-05 (Terminal S7 Function Selection).
2. Turn OFF the power supply to the Drive.
3. Perform wiring according to the following diagram while the power supply is turned OFF.
4. Turn ON the terminating resistance. (Turn ON pin 1 on DIP switch 1.)
5. Turn ON the power supply to the Drive again.

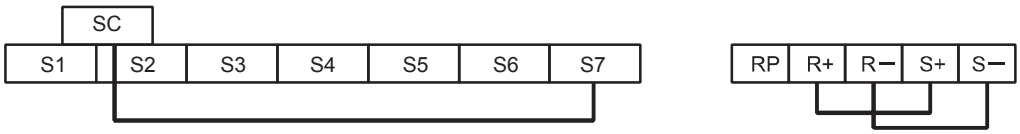


Fig 6.57 Details of Communications Terminals

"Pass" will be displayed if self-diagnosis is completed without an error occurring.

If an error occurs, a CE (MODBUS communications error) alarm will be displayed on the Digital Operator, the error contact output will be turned ON, and the Drive operation ready signal will be turned OFF.