Before using the product

Thank you for using our S300 RAPIEnet+ communication option board.

Manual Revision History

Revision History

No.	Date	Version	Changes
1	2024/8/23	1.00	First Issue
2	2025/3/18	1.01	Recommended version for the smart extension function updated

Safety Information

- Always follow safety instructions to prevent accidents and potentially hazardous situations.
- Safety precautions are classified into “WARNING” and “CAUTION,” and their meanings are as follows:

⚠ Warning

Indicates a potentially hazardous situation, which, if not avoided, may cause death or serious injury.

ⓘ Caution

Indicates a potentially hazardous situation, which, if not avoided, may cause minor injury or damage to the product.

- Symbols used in this document and on the product indicate the following.

The ⚠ symbol indicates that there is a risk of danger, so caution is advised.

The ⚠ symbol indicates that there is a risk of electric shock, so caution is advised.

- Keep the operating instructions handy for quick reference.
- Read the operating instructions carefully to fully understand the functions of the S300 series inverters and use them properly.

ⓘ Caution

- **Be careful not to damage the CMOS devices on the option board.**

  Static charge may cause malfunctioning of the product.

- **Turn off the inverter before connecting communication cables.**

  Otherwise, malfunctions or communication errors may occur.

- **Ensure that the inverter body and the S300 RAPIEnet+ communication option board connectors are connected correctly.**

  Otherwise, malfunctions or communication errors may occur.

- **Check the parameter units when configuring the parameter values.**

  Otherwise, a communication error may occur.

Table of Contents

PART 1 Overview

1 Overview

The S300 RAPIEnet+ communication option board connects the LSLV-S300 inverter to the industrial communication networks depending on the user selection.

The RAPIEnet+ mode connects to RAPIEnet corresponding to IEC 61158 Type 21 and IEC 62439 RRP international standards and supports RAPIEnet, EtherNet/IP, and Modbus TCP protocols.

The PROFINET mode connects to the PROFINET network corresponding to IEC 61158 Type 10 international standards and supports connections to the LSE Cloud via Modbus TCP, HTTP, and MQTT.

100 Mbps auto negotiation is used to secure real-time network communication without collisions and allow for controlling and monitoring of the S300 inverter via PLC sequence programs or an arbitrary master module.

With simple network cable wiring, installation times can be reduced and maintenance becomes easier.

(However, when used with XG5000, it is compatible with XGL-EFMxB V8.00 or higher, and some functions will be limited. XGL-EFMxB V9.10 or higher is recommended for full functions.)

** You can download the user manual ("Manual_XGT_FEnet") at https://www.ls-electric.com.

Note

What is RAPIEnet+?
It is a hybrid communication solution that incorporates RAPIEnet, LS ELECTIRC's real-time industrial Ethernet based on international standards for ring control, and a highly versatile Modbus TCP and EtherNet/IP communication technologies. This highly performant and efficient industrial Ethernet by LS ELECTRIC allows for integration of IoT and various future technologies required for automation industry.

2 S300 RAPIEnet+ Communication Option Board Technical Features

2.1 RAPIEnet+

Items	Description	
Communication Protocol	RAPIEnet, EtherNet/IP, Modbus TCP	
Communication speed	100 Mbps	
Communication type	Auto negotiation	
Communication range	100 m (twisted pair)	
Service	Smart Extension	Up to 16 words
Max. number of stations	Varies per PLC CPU type and communication protocol*	
Topology	Line/Ring topology	
Communication range	100 m (twisted pair)	
Recommended cable	UTP, FTP, STP	

* You can set up to 220 for the station number ([OPC1-06] FBus ID), but the maximum number of stations varies per CPU type and communication protocol. Refer to the following table:

By communication protocol CPU type	RAPIEnet Max. number of stations	EtherNet/IP Max. number of stations	Modbus TCP Max. number of stations
XGI-CPUZ	128	64	32
XGI-CPUUN (v2.0 or higher)			
Other CPUs	64	64	32

2.2 PROFINET

Items	Description
Communication Protocol	PROFINET IO CC-A
Communication speed	100 Mbps
Communication type	Full Duplex
Max. number of connectible stations (Varies per PLC specifications)	128 units MRP 48 units
Communication range	100 m (Twisted Pair)
Service	PROFIdrive Class 1
Topology	Line, Tree, Star, RING topology

3 Package components

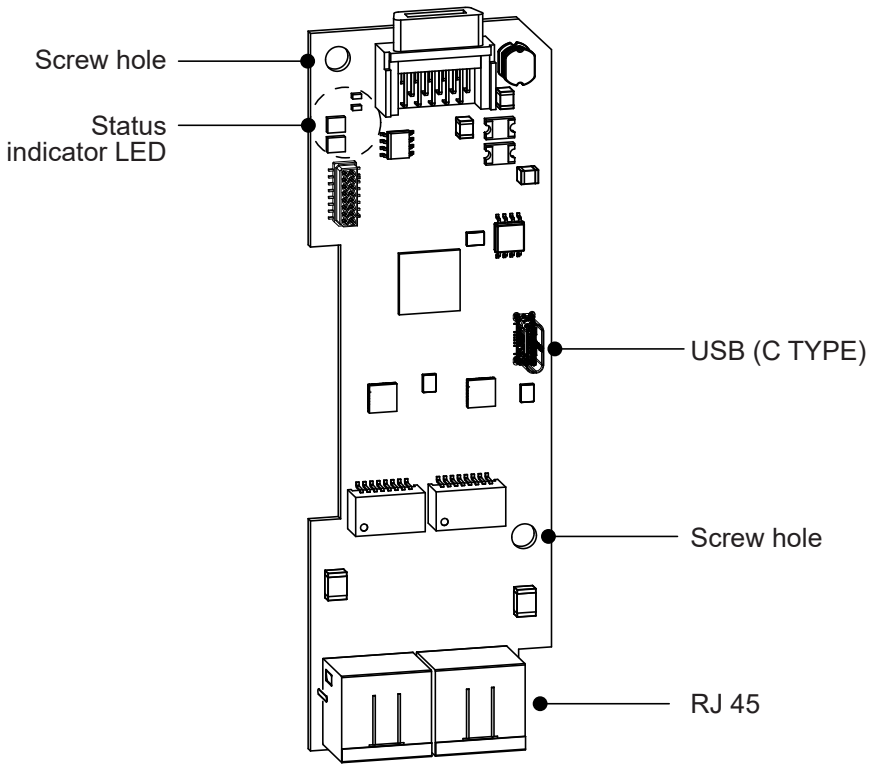
The package includes the S300 RAPIEnet+ communication option board and a quick guide.

4 Model name of the S300 RAPIEnet+ communication option board

Model name: CEPW-S300

5 S300 RAPIEnet+ communication option board layout and installation

5.1 Layout



Name	Description
Screw hole	This is the screw hole for attaching the S300 RAPIEnet+ communication option board to the inverter.
Status indicator LED	This LED indicates the operational status of the S300 RAPIEnet+ communication option board. Refer to “PART2 Chapter 4 LED Indications and troubleshooting” and “PART3 Chapter 1 Information on the PROFINET Mode LED Display” of this manual for details.
USB (C TYPE)	This is the USB port used to update the S300 RAPIEnet+ communication option board's firmware.

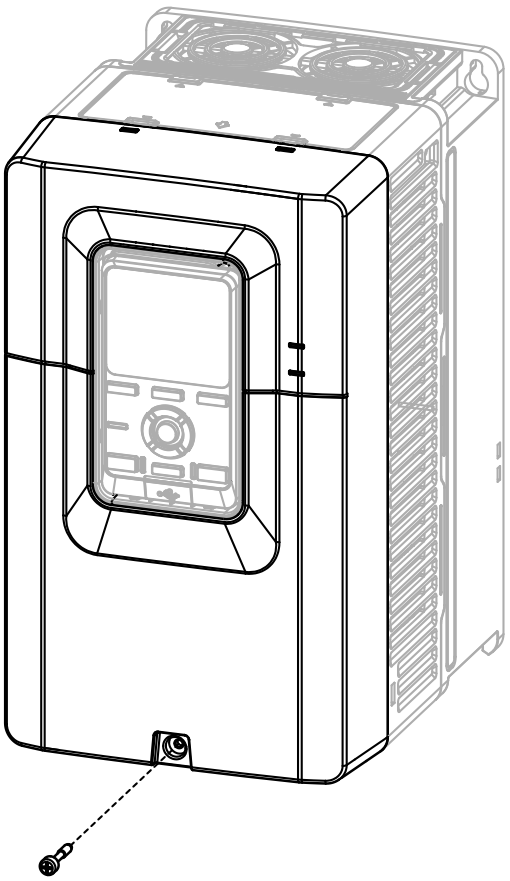
Name	Description
RJ 45	These are the Ethernet ports for industrial Ethernet supported by the S300 RAPIEnet+ communication option board. The ports are arranged from left to right as port 1 and port 2.

5.2 Installation

1 Turn off power to the inverter.

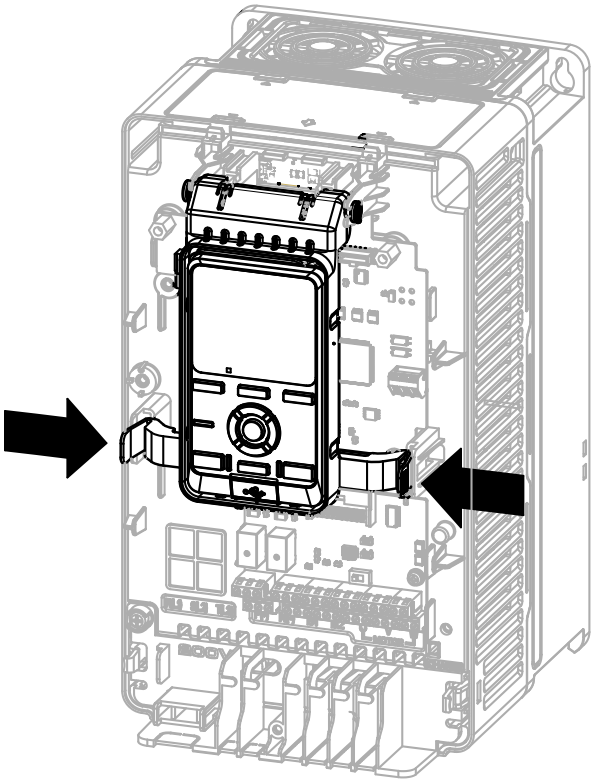
2 Unscrew the fixing bolts on the front cover and disassemble it.

- Disassemble the 400 V products with a capacity of 185-220 kW by unscrewing the fixing bolts on the front terminal cover.

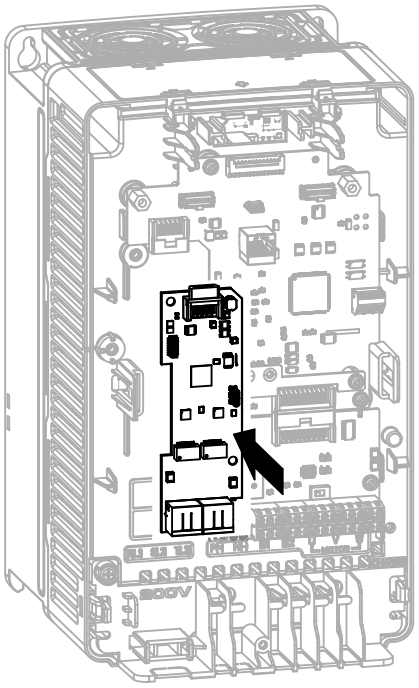


3 Push left and right ends of the Smart Loader Operator mounting bracket in and pull it upwards.

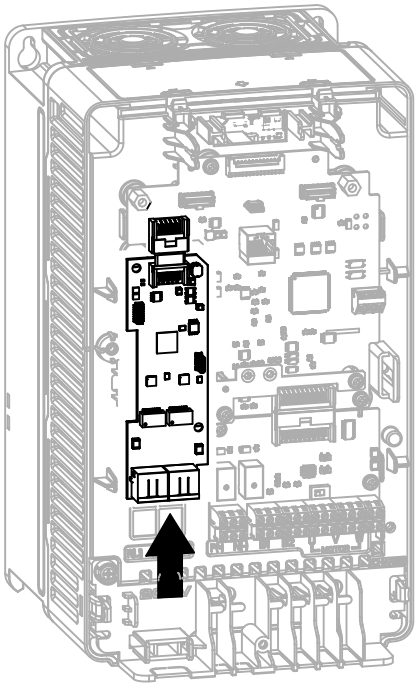
- If the Smart Loader Operator is mounted, remove the RJ45 connector.



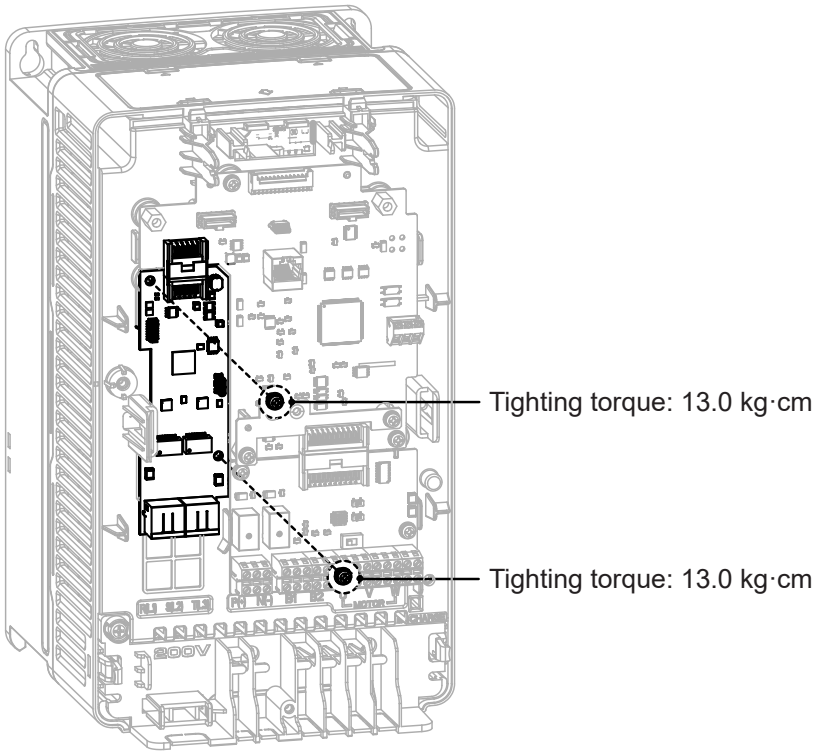
4 Lower the S300 RAPIEnet+ option board toward the bottom of the product.



5 Assemble the S300 RAPIEnet+ communication option board to the connector of the control PCB.



6 Secure the S300 RAPIEnet+ communication option board to the inverter by tightening the two screws (M4) inside the board to the specified torque.



7 Assemble the inverter in the reverse order of disassembly.

⚠ Warning

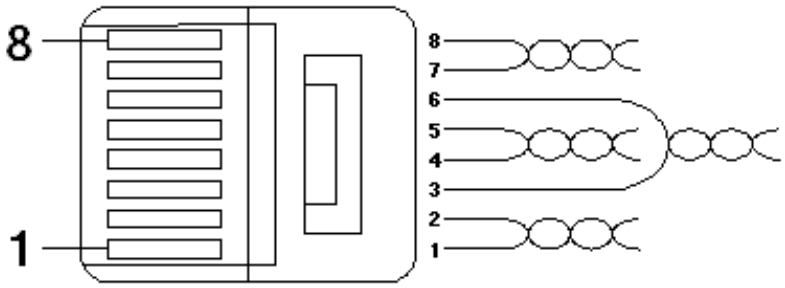
- Do not install or remove the S300 RAPIEnet+ communication option board while the power to the S300 inverter is on.
- Install or remove the S300 RAPIEnet+ communication option board only after the inverter capacitor voltage has completely discharged.
- Ensure that the RJ-45 cable between the inverter body and the S300 RAPIEnet+ communication option board does not come loose.
- The S300 RAPIEnet+ communication option board does not use an FG (Frame Ground).

6 Network connection

6.1 Network connection cable wiring

Pin no.	Signal	Description	Cable color
1	TX+	Data transmission (+)	White/Yellow
2	TX-	Data transmission (-)	Yellow
3	RX+	Data reception (+)	White/Green
4	NONE	Not used	Blue
5	NONE	Not used	White/Blue
6	RX-	Data reception (-)	Green
7	NONE	Not used	White/Brown
8	NONE	Not used	Brown

6.2 Communication cable connector



- The cables connected to pin 1 and pin 2 must be twisted in a pair.
- The cables connected to pin 3 and pin 6 must be twisted in a pair.

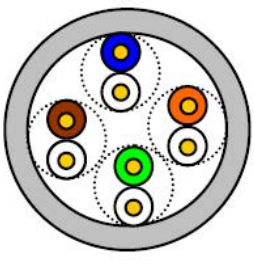
7 Network cable specifications

7.1 Frequency band

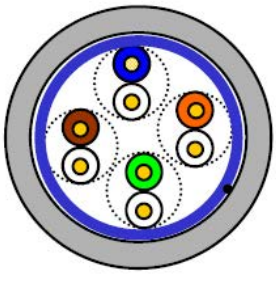
There are five types of UTP cable specifications according to different applications, from category 1 through category 5. Use category 5 for the S300 RAPIEnet+ communication option board.

Category 5 network cables support a frequency band up to 100 MHz, with up to 60 MHz channel performance and up to 100 Mbps data transmission speed.

7.2 Twisted pair cable types



UTP



FTP

STP

Category	Description	Usage
UTP (U.UTP)	Unshielded twisted pair cable for high-speed signals	200 MHz max. Voice + Data + Low quality video signals
FTP (S.UTP)	Single insulation for the cable core • Insulation material: AL/Plastic complex foil or copper braid	100 MHz max. Protection against EMI, electrically stable Voice + Data + Low quality video signals
STP (S.STP)	Dual insulation for the cable pair and the cable core • Material for cable pair insulation: AL/Plastic complex foil • Material for core insulation: AL/ Plastic complex foil or copper braid	500 MHz max. Voice + Data + Video signals Replaces 75Ω coaxial cable

8 Inverter communication address

Refer to "Chapter 13 All features lists" of the "S300 Simplified User Manual_Kor" for details.

** Download the document at https://www.ls-electric.com.

9 Smart Loader Operator parameters related to the S300 RAPIEnet+ communication option board

The parameters below display information related to RAPIEnet, EtherNet/IP, PROFINET, and Modbus TCP. The parameters for Protocols R, E, P, and M correspond to RAPIEnet, EtherNet/IP, PROFINET, and Modbus TCP respectively.

To operate the S300 inverter using the S300 RAPIEnet+ communication option board, set the DRV parameter 1st Command Source of the Smart Loader Operator to 6 (Option Comm.).

Also, to provide frequency reference using the S300 RAPIEnet+ communication option board, set the DRV parameter 1st Freq Ref Src to 8 (Option Comm.).

Smart Loader Operator parameters related to the S300 RAPIEnet+ communication option board					
Code No.	**Parameter Name**	**Initial Value**	**Range**	**Description**	**Protocol**
Drive Set-36	Option-1 Type	-	-	This displays the option slot mode where the S300 communication option is configured.	-
DRV-10	1st Command Source	1	0-7	8: Option Comm. will be set.	R/E/M/P
DRV-11	1st Freq Ref Src	0	0-9	8: Option Comm. will be set.	R/E/M/P
OPC1-01	Fbus Option Type	0	0-1	Selects the protocol you want to use. 0: RAPIEnet+ 1: PROFINET	R/E/M/P
OPC1-02	FBus S/W Ver	-	-	Indicates the S/W version of the S300 RAPIEnet+ communication board installed.	R/E/M/P
OPC1-03	FBus H/W Ver	-	-	This displays the version of the S300 RAPIEnet+ communication option board installed in the inverter.	R/E/M/P

Smart Loader Operator parameters related to the S300 RAPIEnet+ communication option board					
Code No.	Parameter Name	Initial Value	Range	Description	Protocol
OPC1-04	FBus Led	-	-	This displays the LED ON/ OFF information of the S300 RAPIEnet+ communication option board.	R/E/M/P
OPC1-06	FBus ID	10	0-220	Sets the station number of the S300 RAPIEnet+ communication option board.	R/E
OPC1-07	FBus IP Addr1	192	0-255	Sets the IP address. * To connect to the network via the RAPIEnet protocol after setting OPC1-54 to "2 (RAPIEnet Enable)," set OPC1-10 to "100 + OPC1-06."	R/E/M/P
OPC1-08	FBus IP Addr2	168	0-255		
OPC1-09	FBus IP Addr3	1	0-255		
OPC1-10	FBus IP Addr4	101	0-255		
OPC1-11	FBus Subnet Mask1	255	0-255	Sets the subnet mask.	R/E/M/P
OPC1-12	FBus Subnet Mask2	255	0-255		
OPC1-13	FBus Subnet Mask3	255	0-255		
OPC1-14	FBus Subnet Mask4	0	0-255		
OPC1-15	FBus Gateway Addr1	192	0-255	Sets the Gateway address.	R/E/M/P
OPC1-16	FBus Gateway Addr2	168	0-255		
OPC1-17	FBus Gateway Addr3	1	0-255		
OPC1-18	FBus Gateway Addr4	10	0-255		
OPC1-21	Profile CSM	0	0-1	0: LSE new mode 1: LSE old mode	P

Smart Loader Operator parameters related to the S300 RAPIEnet+ communication option board					
Code No.	**Parameter Name**	**Initial Value**	**Range**	**Description**	**Protocol**
OPC1-22	Telegram	0	0-4	**Profile CSM 0 LSE new mode** 0: Standard Telegram1 1: Standard Telegram20 2: Vendor Specific Telegram88 3: Vendor Specific Telegram1616 4: Vendor Specific Telegram3232 5: LSE telegram **Profile CSM 1 LSE old mode** 0: Standard Telegram1 1: Vendor Specific Telegram	P
OPC1-26	Password	xxxx	0x0000–0xFFFF	This is the password used to access the built-in web server, and it will automatically change after each reboot, but if the user sets it manually, it will remain fixed.	P
OPC1-27	SSQ Push	0	0-1	Send status data to LS cloud. 0: Disable 1: Enable	
OPC1-28	SSQ Control	0	0-1	Accept control through LS cloud. Displayed if OPC1-27 (SSQ Push) is enabled. 0: Disable 1: Enable	
OPC1-29	Webserver enable	0	0-1	Enable the default webserver 0: Disable 1: Enable	
OPC1-51	OptParameter01	0	0	Set the network communication speed. (fixed to 100 Mbps Auto)	R/E/M
OPC1-52	OptParameter02	1	0-19	CIP Input Instance	R/E

Smart Loader Operator parameters related to the S300 RAPIEnet+ communication option board					
Code No.	Parameter Name	Initial Value	Range	Description	Protocol
OPC1-53	OptParameter03	1	0-19	CIP Output Instance	R/E
OPC1-54	OptParameter04	0	0-2	2: RAPIEnet Enable 0: RAPIEnet Disable	R/E/M
OPC1-98	Para Settings	0	0:Read from Drv Para 1:Read from Opt Para	A value to decide whether to apply OPC 1 group for "Setting – Operator Set - 41.Para Write to Drv" (operated based on the values during "Setting – Operator Set - 40.Para Read from Drv")	R/EM/P
OPC1-99	Comm Update	0	0: NO 1: YES	Update to apply the currently configured communication-related parameters.	R/EM/P

Note

After making changes to parameters OPC1-06 – 54, you must set OPC1-99 (Comm-Update) to "1 (Yes)" to save the changes. (If a parameter change attempt is made and Comm Update OPC1-99 is not executed, the Error LED will blink red at 2-second intervals to alert the user.)

Smart Loader Operator parameters related to the S300 RAPIEnet+ communication option board					
Code No.	Parameter Name	Initial Value	Range	Description	Protocol
OPC2-01	Para Status Num	3	0-16	Automatically set according to the CIP Input Instance.	R/E/P
OPC2-02	Para Status-01	000A	0x0000 -0xFFFF	Set the inverter data address to be read by the client. (Hex.)	R/E/P
OPC2-03	Para Status-02	000E	0x0000 -0xFFFF	Set the inverter data address to be read by the client. (Hex.)	R/E/P
OPC2-04	Para Status-03	000F	0x0000 -0xFFFF	Set the inverter data address to be read by the client. (Hex.)	R/E/P
OPC2-05	Para Status-04	0000	0x0000 -0xFFFF	Set the inverter data address to be read by the client. (Hex.)	R/E/P

Smart Loader Operator parameters related to the S300 RAPIEnet+ communication option board					
Code No.	Parameter Name	Initial Value	Range	Description	Protocol
OPC2-06	Para Status-05	0000	0x0000 -0xFFFF	Set the inverter data address to be read by the client. (Hex.)	R/E/P
OPC2-07	Para Status-06	0000	0x0000 -0xFFFF	Set the inverter data address to be read by the client. (Hex.)	R/E/P
OPC2-08	Para Status-07	0000	0x0000 -0xFFFF	Set the inverter data address to be read by the client. (Hex.)	R/E/P
OPC2-09	Para Status-08	0000	0x0000 -0xFFFF	Set the inverter data address to be read by the client. (Hex.)	R/E/P
OPC2-10	Para Status-09	0000	0x0000 -0xFFFF	Set the inverter data address to be read by the client. (Hex.)	R/E/P
OPC2-11	Para Status-10	0000	0x0000 -0xFFFF	Set the inverter data address to be read by the client. (Hex.)	R/E/P
OPC2-12	Para Status-11	0000	0x0000 -0xFFFF	Set the inverter data address to be read by the client. (Hex.)	R/E/P
OPC2-13	Para Status-12	0000	0x0000 -0xFFFF	Set the inverter data address to be read by the client. (Hex.)	R/E/P
OPC2-14	Para Status-13	0000	0x0000 -0xFFFF	Set the inverter data address to be read by the client. (Hex.)	R/E/P
OPC2-15	Para Status-14	0000	0x0000 -0xFFFF	Set the inverter data address to be read by the client. (Hex.)	R/E/P
OPC2-16	Para Status-15	0000	0x0000 -0xFFFF	Set the inverter data address to be read by the client. (Hex.)	R/E/P
OPC2-17	Para Status-16	0000	0x0000 -0xFFFF	Set the inverter data address to be read by the client. (Hex.)	R/E/P
OPC2-50	Para Ctrl Num	2	0-16	Automatically set according to the CIP Output Instance.	R/E/P
OPC2-51	Para Control-01	0005	0x0000 -0xFFFF	Set the client's command address. (Hex.)	R/E/P
OPC2-52	Para Control-02	0006	0x0000 -0xFFFF	Set the client's command address. (Hex.)	R/E/P

Smart Loader Operator parameters related to the S300 RAPIEnet+ communication option board					
Code No.	Parameter Name	Initial Value	Range	Description	Protocol
OPC2-53	Para Control-03	0000	0x0000 -0xFFFF	Set the client's command address. (Hex.)	R/E/P
OPC2-54	Para Control-04	0000	0x0000 -0xFFFF	Set the client's command address. (Hex.)	R/E/P
OPC2-55	Para Control-05	0000	0x0000 -0xFFFF	Set the client's command address. (Hex.)	R/E/P
OPC2-56	Para Control-06	0000	0x0000 -0xFFFF	Set the client's command address. (Hex.)	R/E/P
OPC2-57	Para Control-07	0000	0x0000 -0xFFFF	Set the client's command address. (Hex.)	R/E/P
OPC2-58	Para Control-08	0000	0x0000 -0xFFFF	Set the client's command address. (Hex.)	R/E/P
OPC2-59	Para Control-09	0000	0x0000 -0xFFFF	Set the client's command address. (Hex.)	R/E/P
OPC2-60	Para Control-10	0000	0x0000 -0xFFFF	Set the client's command address. (Hex.)	R/E/P
OPC2-61	Para Control-11	0000	0x0000 -0xFFFF	Set the client's command address. (Hex.)	R/E/P
OPC2-62	Para Control-12	0000	0x0000 -0xFFFF	Set the client's command address. (Hex.)	R/E/P
OPC2-63	Para Control-13	0000	0x0000 -0xFFFF	Set the client's command address. (Hex.)	R/E/P
OPC2-64	Para Control-14	0000	0x0000 -0xFFFF	Set the client's command address. (Hex.)	R/E/P
OPC2-65	Para Control-15	0000	0x0000 -0xFFFF	Set the client's command address. (Hex.)	R/E/P
OPC2-66	Para Control-16	0000	0x0000 -0xFFFF	Set the client's command address. (Hex.)	R/E/P

Smart Loader Operator parameters related to the S300 RAPIEnet+ communication option board					
Code No.	Parameter Name	Initial Value	Range	Description	Protocol
PRT-21	Lost OptComm Mode	None	00: None 01: CoastStop (FreeRun) 02: Trip Dec Stop 03: Warning 04: Lost Preset	Set the inverter operation for when a Lost Command has occurred due to a loss of communication command with the S300 RAPIEnet+ communication option board. [1]	R/E/M/P
PRT-22	Lost OptComm Time	1.0	0.1 - 120.0	This sets the communication command loss determination time with the S300 RAPIEnet+ communication option board	R/E/M/P
PRT-14	Lost Preset Freq	0.00	0.00 - 60.00	Sets the Lost Preset speed	R/E/M/P

[1] Lost OptComm Mode

Set Value	Functionality
"None"	This maintains the previous status.
"CoastStop (FreeRun)"	A Lost Command Trip occurs, and a free run takes place.
"Trip Dec Stop"	A Lost Command Trip occurs, and the inverter decelerates to stop for the time set for [PRT-01] Trip Dec Time.
"Warning"	A Lost Command Warning occurs, and the inverter operates with the previous operation command and speed reference.
"Lost Preset"	A Lost Command Warning occurs, and the inverter operates with frequency reference set at [PRT-14] Lost Preset Freq.

PART2 RAPIEnet+ Communication Functions

1 Details for RAPIEnet+ and Related Smart Loader Operator Parameters

1.1 Simplified descriptions about parameters for Smart Loader Operator

The following table lists the simplified information of Smart Loader Operator parameters. The detailed information is provided in the parameter group section.

Code No.	Parameter Name	Description
Drive Set-36	Option-1 Type	RAPIEnet+
DRV-10	1st Command Source	Command Source
DRV-11	1st Freq Ref Src	Frequency Settings
OPC1-02	FBus S/W Ver	S300 RAPIEnet+ Communication Option Board S/W Version
OPC1-03	FBus H/W Ver	S300 Ethernet Communication Option Board H/W Version
OPC1-04	FBus Led	S300 RAPIEnet+ Communication Option Board LED Indications
OPC1-06	FBus ID	S300 RAPIEnet+ Communication Option Board Node Number (S300 RAPIEnet+ Communication Option Board ID)
OPC1-07	FBus IP Addr1	Enter the 1st decimal number of the IP address.
OPC1-08	FBus IP Addr2	Enter the 2nd decimal number of the IP address.
OPC1-09	FBus IP Addr3	Enter the 3rd decimal number of the IP address.
OPC1-10	FBus IP Addr4	Enter the 4th decimal number of the IP address.
OPC1-11	FBus Subnet Mask1	Enter the 1st decimal number of the subnet address.
OPC1-12	FBus Subnet Mask2	Enter the 2nd decimal number of the subnet address.

Code No.	Parameter Name	Description
OPC1-13	FBus Subnet Mask3	Enter the 3rd decimal number of the subnet address.
OPC1-14	FBus Subnet Mask4	Enter the 4th decimal number of the subnet address.
OPC1-15	FBus Gateway Addr1	Enter the 1st decimal number of the gateway address.
OPC1-16	FBus Gateway Addr2	Enter the 2nd decimal number of the gateway address.
OPC1-17	FBus Gateway Addr3	Enter the 3rd decimal number of the gateway address.
OPC1-18	FBus Gateway Addr4	Enter the 4th decimal number of the gateway address.
OPC1-51	OptParameter01	Network communication speed (0 fixed, automatically set to 100 Mbps)
OPC1-52	OptParameter02	RAPIEnet: Set Input Parameter Size EtherNet/IP: Set Input Instance
OPC1-53	OptParameter03	RAPIEnet: Set Output Parameter Size EtherNet/IP: Set Output Instance
OPC1-54	OptParameter04	Enable or disable RAPIEnet 2: RAPIEnet Enable 0: RAPIEnet Disable(Default)
OPC1-98	Para Settings	Apply or not apply network parameters using Smart Loader Operator 0: Read from Drv Para 1: Read from Opt Para
OPC1-99	Comm Update	Reflect the network parameter changes.
OPC2-01	Para Status Num	Displays the number of transmitted data
OPC2-02	Para Status-01	Set address 1 for storing the transmitted data.
OPC2-03	Para Status-02	Set address 2 for storing the transmitted data.
OPC2-04	Para Status-03	Set address 3 for storing the transmitted data.
OPC2-05	Para Status-04	Set address 4 for storing the transmitted data.
OPC2-06	Para Status-05	Set address 5 for storing the transmitted data.
OPC2-07	Para Status-06	Set address 6 for storing the transmitted data.
OPC2-08	Para Status-07	Set address 7 for storing the transmitted data.
OPC2-09	Para Status-08	Set address 8 for storing the transmitted data.

Code No.	Parameter Name	Description
OPC2-10	Para Status-09	Set address 9 for storing the transmitted data.
OPC2-11	Para Status-10	Set address 10 for storing the transmitted data.
OPC2-12	Para Status-11	Set address 11 for storing the transmitted data.
OPC2-13	Para Status-12	Set address 12 for storing the transmitted data.
OPC2-14	Para Status-13	Set address 13 for storing the transmitted data.
OPC2-15	Para Status-14	Set address 14 for storing the transmitted data.
OPC2-16	Para Status-15	Set address 15 for storing the transmitted data.
OPC2-17	Para Status-16	Set address 16 for storing the transmitted data.
OPC2-50	Para Ctrl Num	Display the number of received data
OPC2-50	Para Control-01	Set address 1 for storing the received data.
OPC2-50	Para Control-02	Set address 2 for storing the received data.
OPC2-50	Para Control-03	Set address 3 for storing the received data.
OPC2-50	Para Control-04	Set address 4 for storing the received data.
OPC2-50	Para Control-05	Set address 5 for storing the received data.
OPC2-50	Para Control-06	Set address 6 for storing the received data.
OPC2-50	Para Control-07	Set address 7 for storing the received data.
OPC2-50	Para Control-08	Set address 8 for storing the received data.
OPC2-51	Para Control-09	Set address 9 for storing the received data.
OPC2-52	Para Control-10	Set address 10 for storing the received data.
OPC2-53	Para Control-11	Set address 11 for storing the received data.
OPC2-54	Para Control-12	Set address 12 for storing the received data.
OPC2-55	Para Control-13	Set address 13 for storing the received data.
OPC2-56	Para Control-14	Set address 14 for storing the received data.
OPC2-57	Para Control-15	Set address 15 for storing the received data.
OPC2-58	Para Control-16	Set address 16 for storing the received data.
PRT-21	Lost OptComm Mode	Select operation mode for a lost command.
PRT-22	Lost OptComm Time	Set the decision time for a lost command.
PRT-14	Lost Preset Freq	Set the target operation frequency for a command loss.

1.2 DRV group

① [DRV-10] 1st Command Source: Command Source

Select the command source for the S300 inverter. To input an operation command via communication using the S300 RAPIEnet+ communication option board, select 6 (Option Comm.).

② [DRV-11] 1st Freq Ref Src: Frequency reference source

Select the frequency command source for the S300 inverter. Set to “8 (Option Comm.)” to set the S300 RAPIEnet+ communication option board as the frequency command source and provide frequency commands via a network.

1.3 OPC1 and OPC2 Groups

① [OPC1-02] FBus S/W Ver: S300 RAPIEnet+ Communication Option Board S/W Version

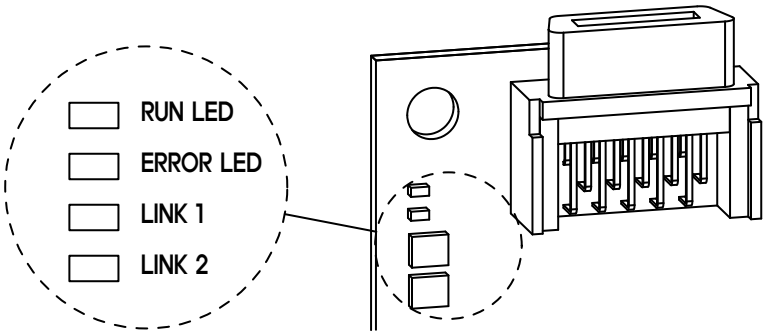
This automatically displays the S/W version of the S300 RAPIEnet+ communication option board currently installed in the S300 inverter.

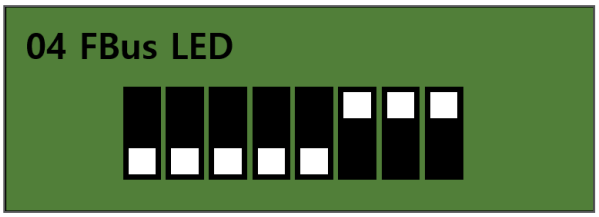
② [OPC1-03] FBus H/W Ver: S300 Ethernet Communication Option Board H/W Version

This automatically displays the version of the S300 RAPIEnet+ communication option board currently installed in the S300 inverter.

③ [OPC1-04] FBus Led: S300 RAPIEnet+ Communication Option Board LED Indications

The LED display section of the S300 RAPIEnet+ communication option board can be checked through the Smart Loader Operator. Refer to "PART2 Chapter 4 LED Indications and troubleshooting" of this document for operations related to the LED display.





Reserved	Reserved	Reserved	Reserved	LINK1	LINK2	ERROR LED	CPU LED
Not used (indicates off)				LED is OFF	LED is ON	LED is ON	LED is ON

④ [OPC1-06] FBus ID: S300 RAPIEnet+ Communication Option Board Node Number (S300 RAPIEnet+ Communication Option Board ID)

This sets the node number of the S300 RAPIEnet+ communication option board. A total of 221 station IDs are available from 0 to 220. (The station ID must be set before you can configure network communication using the RAPIEnet protocol.) Refer to page 2 for the maximum number of station IDs.

When setting the station ID, be careful not to use a station ID that is not already occupied by the PLC system or other network devices.

After making setting changes, you must set [OPC1-99] Comm Update to "1 (Yes)" before the changes can take effect.

⑤ [OPC1-51] OptParameter01: Set the network communication speed. (100 Mbps, Auto Negotiation)

The Communication speed parameter is fixed to 0 by default for 100 Mbps communication speed.

⑥ [OPC1-52] OptParameter02: Transmission data setting

This is used for monitoring the smart extension transmission data of the S300 RAPIEnet+ communication option board. Set the desired values at transmission data addresses [OPC2-02]-[OPC2-17].

You can set "OptParameter02 (smart extension transmission data index)" to between "0" and "19." Refer to the following table for the description of the "OptParameter02" settings.

The "OptParameter02 (smart extension transmission data index)" setting cannot be written while the inverter is operating. Stop inverter operation before making changes to the setting.

This parameter setting is also required for a service via EtherNet/IP protocol.
It specifies the data format of the inverter status to be transmitted to the client (originator) during an I/O communication via a CIP (Common Industrial Protocol). Refer to the Assembly Object section of the EtherNet/IP.

Set value	Input instance value (E)	Data size (R/E)	Number of parameters (R/E)
0	70	4	X
1	71	4	X
2	110	4	X
3	111	4	X
4	141	2	1
5	142	4	2
6	143	6	3
7	144	8	4
8	145	10	5
9	146	12	6
10	147	14	7
11	148	16	8
12	149	18	9
13	150	20	10
14	151	22	11
15	152	24	12
16	153	26	13

Set value	Input instance value (E)	Data size (R/E)	Number of parameters (R/E)
17	154	28	14
18	155	30	15
19	156	32	16

⑦ [OPC1-53] OptParameter03: Reception data setting

This is used for monitoring the smart extension reception data of the S300 RAPIEnet+ communication option board. Set the desired values at reception data addresses [OPC2-51]-[OPC2-66].

You can set "OptParameter03 (smart extension reception data index)" to between "0" and "19." The description of the "OptParameter03" settings are as follows.

The "OptParameter03 (smart extension reception data index)" setting cannot be written while the inverter is operating. Stop inverter operation before making changes to the setting.

This parameter is also required for EtherNet/IP protocol service. It configures the format of the command data transmitted to the inverter by the client (originator) during the I/O communication via the CIP (Common Industrial Protocol). Refer to the Assembly Object section of the EtherNet/IP.

Set value	Output instance value (E)	Data size (R/E)	Number of parameters (R/E)
0	20	4	X
1	21	4	X
2	100	4	X
3	101	4	X
4	121	2	1
5	122	4	2
6	123	6	3
7	124	8	4
8	125	10	5
9	126	12	6
10	127	14	7
11	128	16	8

Set value	Output instance value (E)	Data size (R/E)	Number of parameters (R/E)
12	129	18	9
13	130	20	10
14	131	22	11
15	132	24	12
16	133	26	13
17	134	28	14
18	135	30	15
19	136	32	16

⑧ [OPC1-54] OptParameter04: Enable or disable RAPIEnet

The RAPIEnet feature for the S300 RAPIEnet+ communication option board is “Disabled” by default. This feature is compatible with LSIS products (XGL-EFMxB V9.10 or later) for the RAPIEnet v2 smart extension service. (2: RAPIEnet v2 Enable / 0: RAPIEnet v2 Disable)

** You can download the user manual ("Manual_XGT_FEnet") at https://www.ls-electric.com.

When connecting the S300 RAPIEnet+ communication option board with third-party products, it is recommended to set the parameter to "0," execute Comm Update (OPC1-99), and use it in RAPIEnet Disable state.

⑨ [OPC2-01] Para Status Num: Number of transmission data

You can set [OPC1-52] OptParameter02 to change the amount of transmission data to between 0 and 16. The S300 RAPIEnet+ communication option board can receive up to 16 data items. You can configure the address for a transmission data with parameters [OPC2-02] through [OPC2-17].

⑩ [OPC2-02] Para Status-01 - [OPC2-17] Para Status-16: Transmission data address settings

After setting the number of transmission data with [OPC1-52], enter the matching number of data addresses for the data to transmit to the client (originator) with parameters [OPC2-02] through [OPC2-17].

⑪ [OPC2-50] Para Ctrl Num: Number of reception data

You can set [OPC1-53] OptParameter03 to change the amount of transmission data to between 0 and 16.

The S300 RAPIEnet+ communication option board can receive up to 16 data items. You can configure the address for the received data with parameters [OPC2-51] through [OPC2-66].

⑫ [OPC2-51] Para Control-01 - [OPC2-66] Para Control-16: Reception data address settings

After setting the number of reception data with [OPC2-50], enter the matching number of data addresses for receiving command data from the client (originator) with parameters [OPC2-51] through [OPC2-66].

⑬ [OPC1-98] Para Settings: Apply or not apply network parameters using Smart Loader Operator

Smart Loader Operator offers a feature to read entire parameters from drivers, save them in internal storage, and then write them to the driver when necessary. ("Setting – Operator Set - 40. Para Read from Drv/41. Para Write to Drv")

You can choose whether to overwrite the OPC1 group's parameters that are related to networks via [OPC1-98] Para Settings.

"0: Read from Drv Para" option result in overwriting all parameters.

"1: Read from Opt Para" option result in overwriting all parameters except for the ones from OPC 1. So you can use the existing IPs and station numbers.

However, it is important to know that the settings from [OPC1-98] Para Setting are applied when "Setting – Operator Set - 40. Para Read from Drv" is operated.

⑭ [OPC1-99] Comm Update: Applying the Changed Settings to the S300 RAPIEnet+ Option Board

The option parameters of the OPC1 and OPC2 groups represent the values set in the inverter connected to the S300 RAPIEnet+ communication option board, with the OPC1 group values changed by the Smart Loader Operator not being immediately applied to the S300 RAPIEnet+ communication option board.

The changed settings will be reflected on the S300 RAPIEnet+ communication option board when you set COM-94 (Comm Update) to “1 (Yes).” (Parameters that require communication updates include [OPC1-06] through [OPC1-54])

1.4 PRT group (Lost Command)

① [PRT-21] Lost OptComm Mode: Operation mode for a command loss

You can select the operation mode for the inverter in the event of a network failure or a connection failure between the Smart Loader Operator and the S300 RAPIEnet+ while the inverter is operated via network communication.

② [PRT-22] Lost OptComm Time: Decision time for a command loss

Set the time duration until the operation mode set with PRT-21 will be reflected following a command loss. You can set a value between "0.1" and "120.0 seconds.

③ [PRT-14] Lost Preset Freq: Operation frequency for a command loss

When a lost command occurs, a protective function is activated and the inverter will continue to operate using the frequency set with [PRT-14]. The setting value is from the start frequency to the max frequency [Hz].

④ Lost command conditions by protocol

- RAPIEnet

If data is not received from the RAPIEnet master (XGL-EFMxB V9.10 or higher) within the watchdog setting time, the S300 RAPIEnet+ communication option board enters Lost Command state, and after the time set in [PRT-22] passes, the inverter operates according to the settings in [PRT-21].

Refer to "PART2 Chapter 2 2.2.2 Configuring the master module" for how to set the watchdog timer for the master module.

- EtherNet/IP

If the Implicit Message Connection (Class1 Connection) between the Originator (PLC or Client) and the Target (Inverter) is not established for 1 second, the S300 RAPIEnet+ communication option board will enter the Lost Command state, and after the time set in [PRT-22] passes, the inverter will operate according to the settings in [PRT-21].

- Modbus TCP

If no data is received from the Client for 5 seconds in Modbus TCP, the S300 RAPIEnet+ communication option board will enter the Lost Command state, and after the time set in [PRT-22] passes, the inverter will operate according to the settings in [PRT-21].

2 Services with LS ELECTRIC products

2.1 Summary

This chapter explains about services utilizing the RAPIEnet protocol when the communication board is connected with LS ELECTRIC products. You can choose one of the smart extension (PART2 Chapter 2 2.2) and smart extension interoperability (PART2 Chapter 2 2.3) functions to use the service depending on the versions of the LS ELECTRIC master module XGL-EFMxB, XG5000, and S300 inverter. The S300 RAPIEnet+ communication option board provides somewhat limited functions when using the smart extension feature, so it is recommended to use the smart extension interoperability feature. The following tables lists available features for each version.

Version	Smart extension	Smart extension interoperability
Earlier than XGL-EFMxB V8.00	X	X
XGL-EFMxB V9.10 or later, XG5000 V4.86 or later, S300 V1.02 or later,	O	O

The Smart Loader Operator settings required to utilize the RAPIEnet service are as follows.

The RAPIEnet setting is disabled by default.

S300 RAPIEnet+ communication option board [OPC1-54] OptParameter04	RAPIEnet v2 Availability	EtherNet/IP Availability	Modbus TCP Availability
Setting: "2" RAPIEnet v2 Enable	O	O	O
Setting: "0" RAPIEnet v2 Disable	X	O	O

2.2 Smart extension (LS ELECTRIC master module: XGL-EFMxB V9.10 or later)

The smart extension service is a communication service between automation products that allows for the extension of multiple PLCs and inverters utilizing simple configurations, without the need for complicated parameter settings or programming. The smart extension service also has the EtherNet/IP service integrated within.

The S300 RAPIEnet+ communication option board can be easily used to transmit and receive 8-word I/O data through our master by setting the number of transmission data [OPT2-01], the number of reception data [OPT2-50], the transmission data addresses [OPT2-02]-[OPT2-09], and the reception data addresses [OPT2-51]-[OPT2-58]. Besides, it provides various features, such as, monitoring of diagnostic parameters, RAPIEnet auto scan, and system diagnosis.

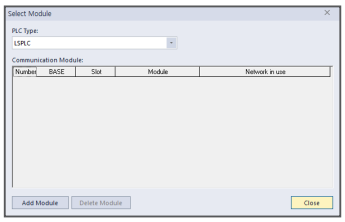
** You can download the user manual ("Manual_XGT_FEnet_V3.00") at https://www.ls-electric.com.

** RAPIEnet protocol is only compatible with LS ELECTRIC's MRS(Multi-port RAPIEnet Switch) and may not provide communication when used with other universal switches (switching hub).

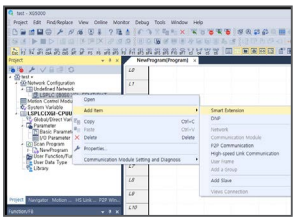
- XOL-ES4T (4 power ports)
- XOL-ES4H (2 power ports and 2 optical ports)

The following figure shows an example of the XG5000 settings screen for an LS ELECTRIC network master module (XGL-EFMxB 9.10 or later).

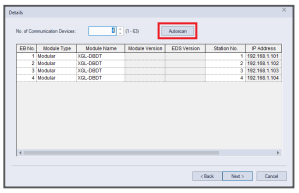
Create project



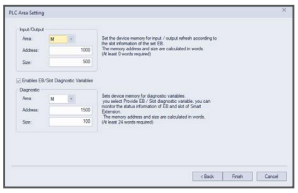
Add master (Fenet) module



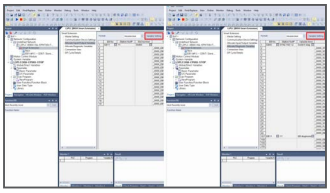
Add smart extension service



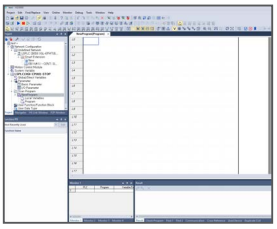
Perform smart extension auto scan



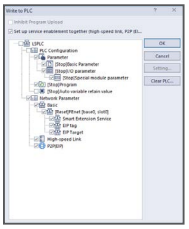
Set smart extension memory area



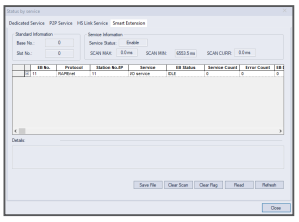
Register input/output and diagnostic variables



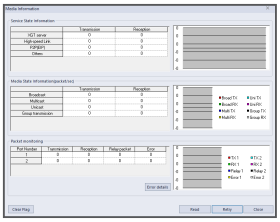
Write PLC program



Write settings data



Check service status



Check communication load information

Note

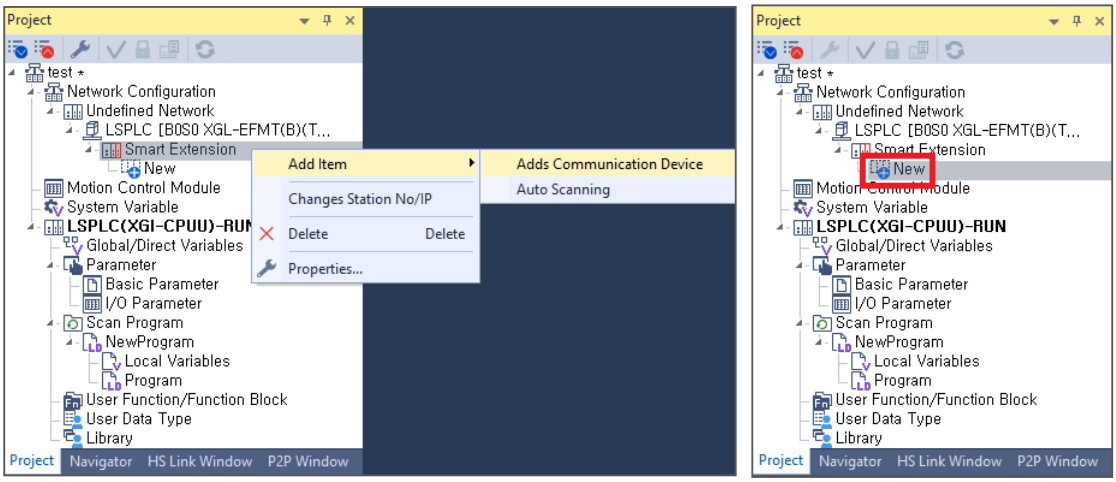
"Smart Extension Memory Area Setting": The S300 RAPIEnet+ communication option board has a fixed allocation of 64-byte (32 word) areas. When configuring the addresses, be careful not to use addresses already occupied by other programs to avoid collisions. Separate warnings are not provided, nor are duplicated addresses prohibited because users may configure a certain area of the addresses to be superimposed for special purposes.

2.2.1 Configuring the XG5000 program for the PLC

To communicate with a PLC System using the S300 RAPIEnet+ communication option board, use XGL-EFMxB (RAPIEnet I/F module). For a smart extension service, the station ID (EB) and the IP address of the smart extension device must be specified first: (e.g., [OPC1-06] FBus ID: "05", [OPC1-10] FBus IP Addr4: "100 + FB US ID (05)" = "105") (This prevents IP address collisions between the communication boards installed to the inverters.) Refer to the user manual provided with the XGL-EFMxB product for detailed instructions.

Also, to configure network communications utilizing a PLC system, installation of the XG5000 program is required. You can download XG5000 program from the LS ELECTRIC website.

** Download the document at https://www.ls-electric.com.

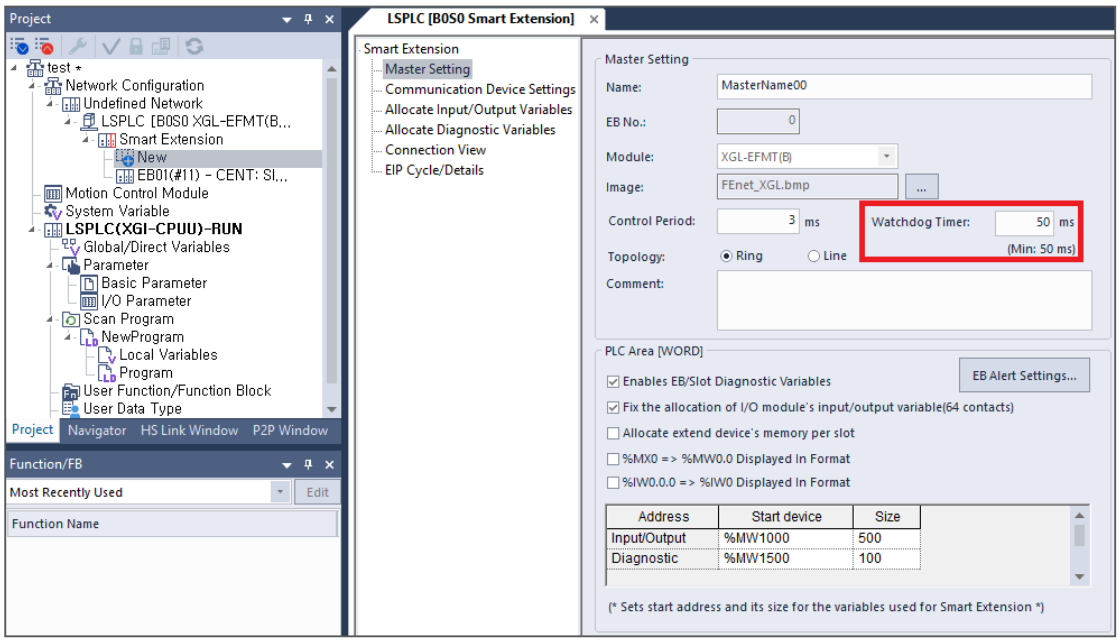


After specifying the connection information in the connection tab of the communication device addition window, select "OK" to add the communication device [CENT] (S300 RAPIEnet+ communication option board) of the smart extension service.

2.2.2 Configuring the master module

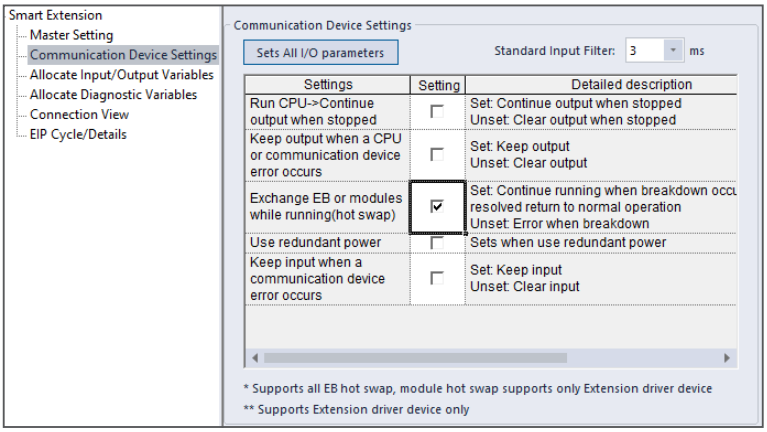
You can configure the "Watchdog timer" for a master module (XGL-EFMxB V9.10 or later). If PRT-21 (Lost OptComm Mode), which is the parameter for Smart Loader Operator, is enabled, the Lost OptComm Time of parameter PRT-22 will be extended by the time set as the watchdog time for the master module. Therefore, the watchdog time must be considered when setting the parameter value of PRT-22 (Lost OptComm Time).

Watchdog timer: The time for the network device (S300 RAPIEnet+ communication option board) to monitor the uninterrupted network connection with the master module.



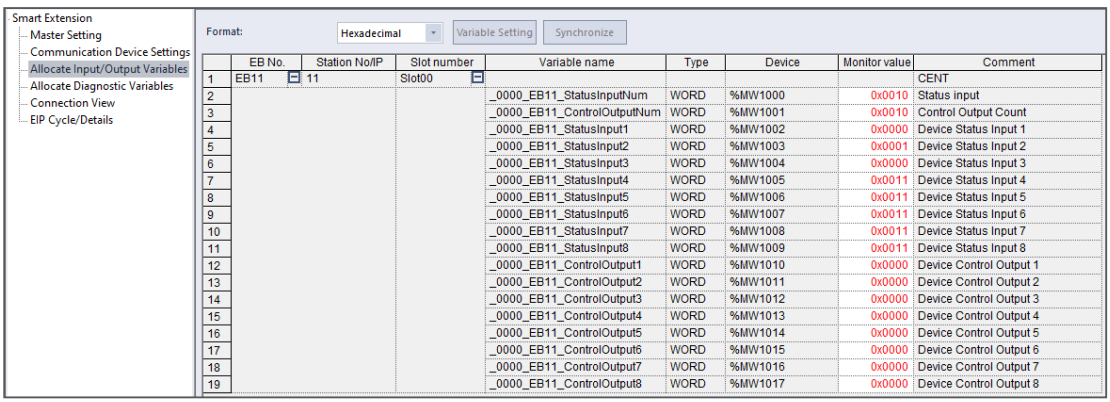
2.2.3 Network device settings

Select the hot swap feature. If the hot swap feature is not selected, losing one station ID (EB) on the network will cause the entire network to stop communicating.



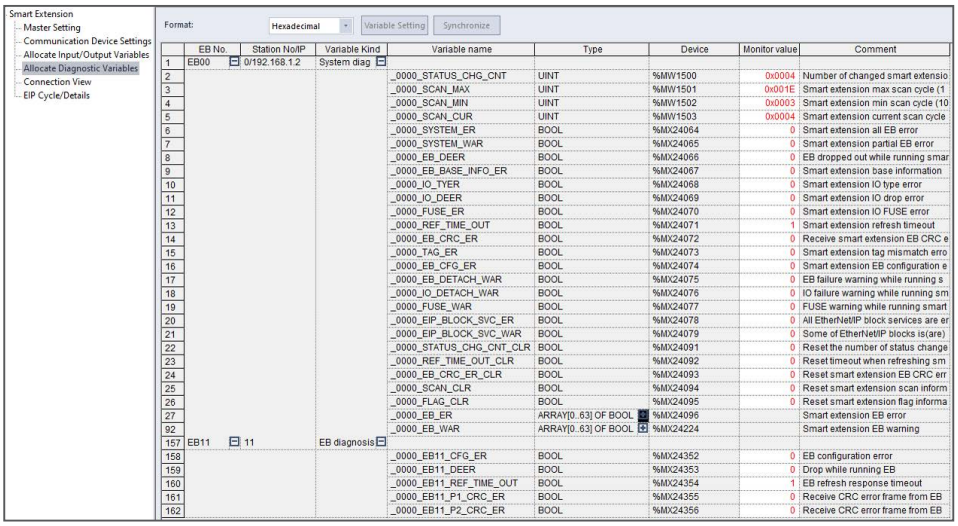
2.2.4 Input/Output parameter settings

The following settings enable an automatic 8-word/8-word communication of input/ output parameters.



	EB No.	Station No/IP	Slot number	Variable name	Type	Device	Monitor value	Comment
1	EB11	11	Slot00					CENT
2				_0000_EB11_StatusInputNum	WORD	%MW1000	0x0010	Status input
3				_0000_EB11_ControlOutputNum	WORD	%MW1001	0x0010	Control Output Count
4				_0000_EB11_StatusInput1	WORD	%MW1002	0x0000	Device Status Input 1
5				_0000_EB11_StatusInput2	WORD	%MW1003	0x0001	Device Status Input 2
6				_0000_EB11_StatusInput3	WORD	%MW1004	0x0000	Device Status Input 3
7				_0000_EB11_StatusInput4	WORD	%MW1005	0x0011	Device Status Input 4
8				_0000_EB11_StatusInput5	WORD	%MW1006	0x0011	Device Status Input 5
9				_0000_EB11_StatusInput6	WORD	%MW1007	0x0011	Device Status Input 6
10				_0000_EB11_StatusInput7	WORD	%MW1008	0x0011	Device Status Input 7
11				_0000_EB11_StatusInput8	WORD	%MW1009	0x0011	Device Status Input 8
12				_0000_EB11_ControlOutput1	WORD	%MW1010	0x0000	Device Control Output 1
13				_0000_EB11_ControlOutput2	WORD	%MW1011	0x0000	Device Control Output 2
14				_0000_EB11_ControlOutput3	WORD	%MW1012	0x0000	Device Control Output 3
15				_0000_EB11_ControlOutput4	WORD	%MW1013	0x0000	Device Control Output 4
16				_0000_EB11_ControlOutput5	WORD	%MW1014	0x0000	Device Control Output 5
17				_0000_EB11_ControlOutput6	WORD	%MW1015	0x0000	Device Control Output 6
18				_0000_EB11_ControlOutput7	WORD	%MW1016	0x0000	Device Control Output 7
19				_0000_EB11_ControlOutput8	WORD	%MW1017	0x0000	Device Control Output 8

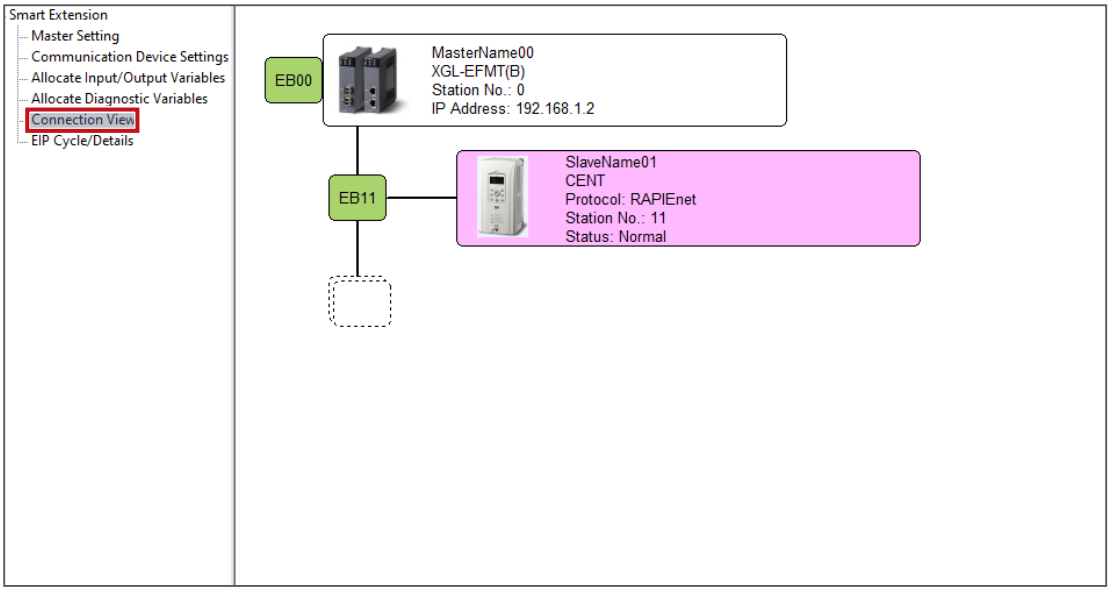
2.2.5 Diagnostic parameter settings



System diagnostics

Diagnose each EB

2.2.6 Network device connections

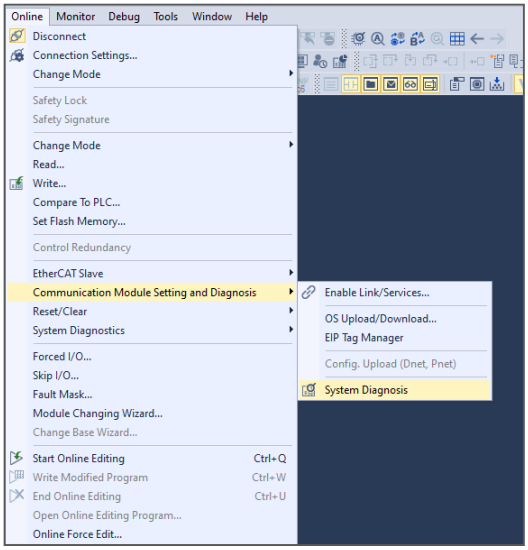


The image above is a reference for connecting the communication device.

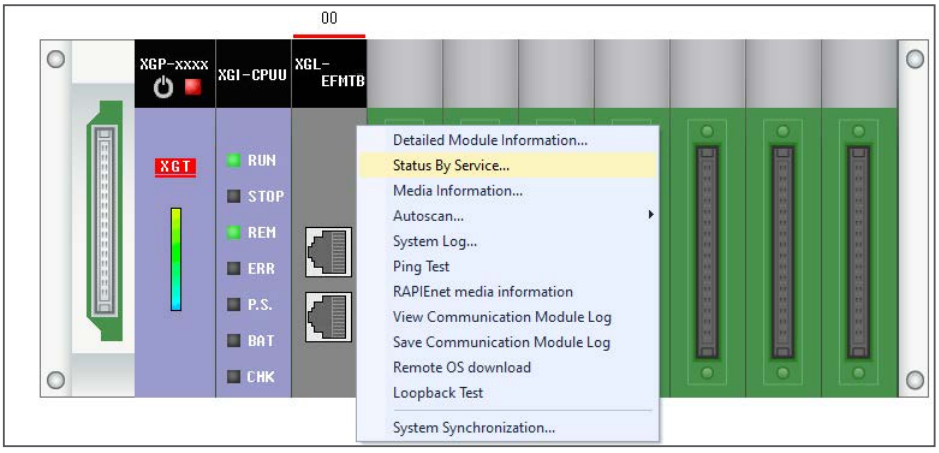
2.2.7 Service status

Service status shows the service operation status of the smart extension service, service counts, and error counts. (Service status can be provided only when the system is online.)

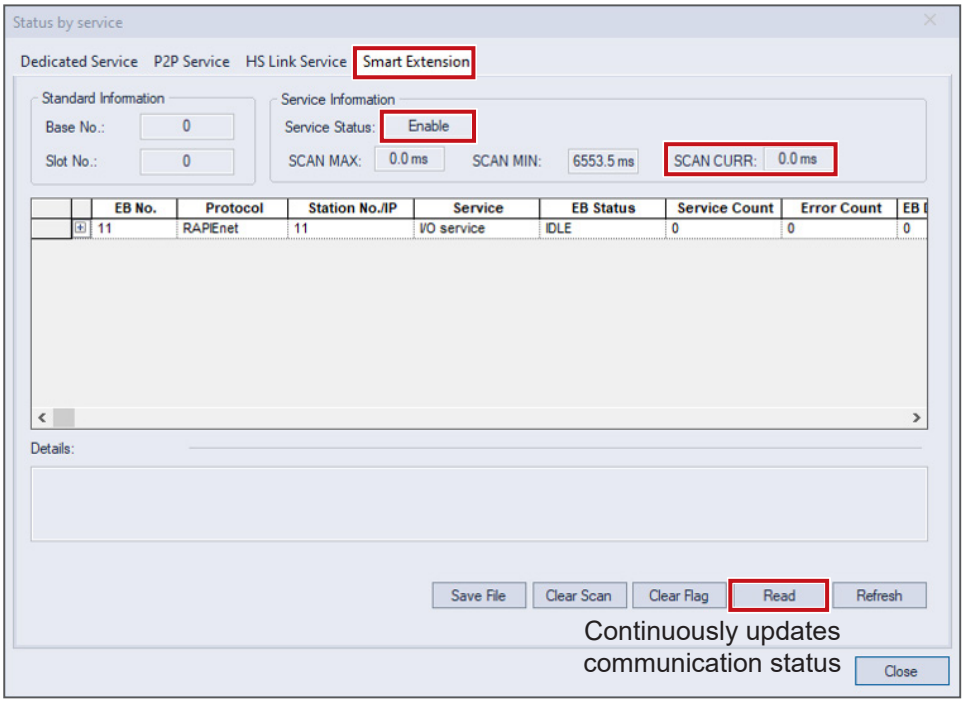
① Click [Online] → [Network module settings and diagnosis] → [System diagnosis].



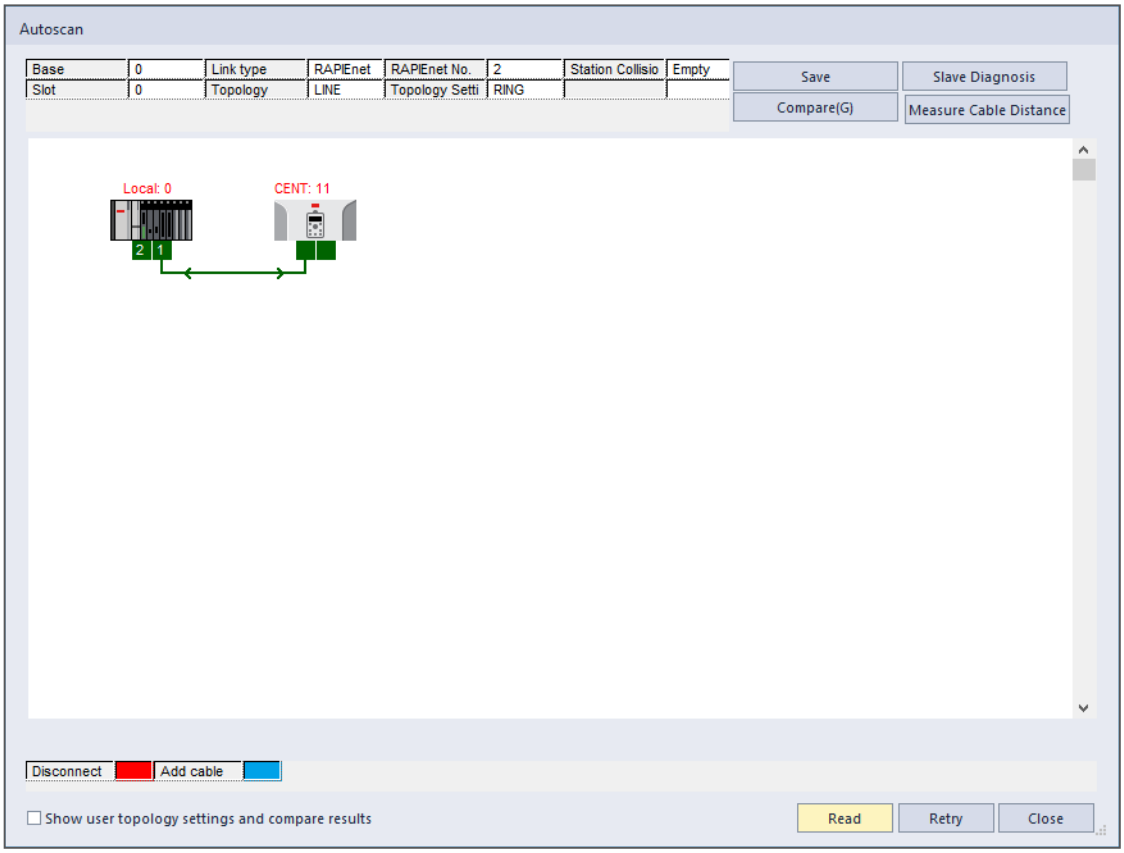
② In the [System diagnosis] window, right-click the master module (XGL-EFMxB) on the figure, then click Service status.



③ Click [Service status] → [Smart extension] tap to view the smart extension service status.



④ **In step ②, you can click the [Auto scan] tap to view the RAPIEnet connection status.**



2.3 Smart extension interoperability (master module XGL-EFMxB v9.10 or later/ XG5000 v4.86 or later/ S300 v1.02 or later)

Configuring LS ELECTRIC modules to a certain version or later enables a more user-friendly features in smart extension services in a certain version combination. The smart extension service is a communication service between automation products that allows for a more intuitive extension of multiple PLCs and inverters than the existing smart extension services by utilizing simple configurations, without the need for complicated parameter settings or programming. The smart extension service also has the previous EtherNet/IP service integrated within. The station ID (EB) and the IP address of the smart extension device must be specified first: (e.g.: [OPC1-06] FBus ID: "05", [OPC1-10] FBus IP Addr4: "100 + FB US ID (05)" = "105") (This prevents IP address collisions between the communication boards installed to the inverters.) Refer to the user manual provided with the XGL-EFMxB product for detailed instructions.

Also, to configure network communications utilizing a PLC system, installation of the XG5000 program is required. You can download XG5000 program from the LS ELECTRIC website.

The major improvements for XG5000 smart extension are as follows:

1 Model information for the drive

2 Input/output parameter settings and batch application

3 Setting up parameters related to Fail safe (related to Lost Command)

4 Diagnosis about the drive

5 Expansion of maximum input/output parameters size (Users can set up to 16 words and was previously fixed to 8 words)

The S300 RAPIEnet+ communication option board can simply transmit and receive 16-word I/O data through the LS ELECTRIC master by setting the transmission data addresses [OPT2-02]-[OPT2-17] and the reception data addresses [OPT2-51]-[OPT2-66]. Other functions include drive model information, drive diagnosis monitoring, fail-safe parameter settings, intuitive in/out parameter settings, batch parameter application for the same type of drive, etc.

Provided that, the changes through XG5000 are reflected if:

1 Write by changing the inverter's parameters in XG5000

2 Reboot the LS ELECTRIC PLC

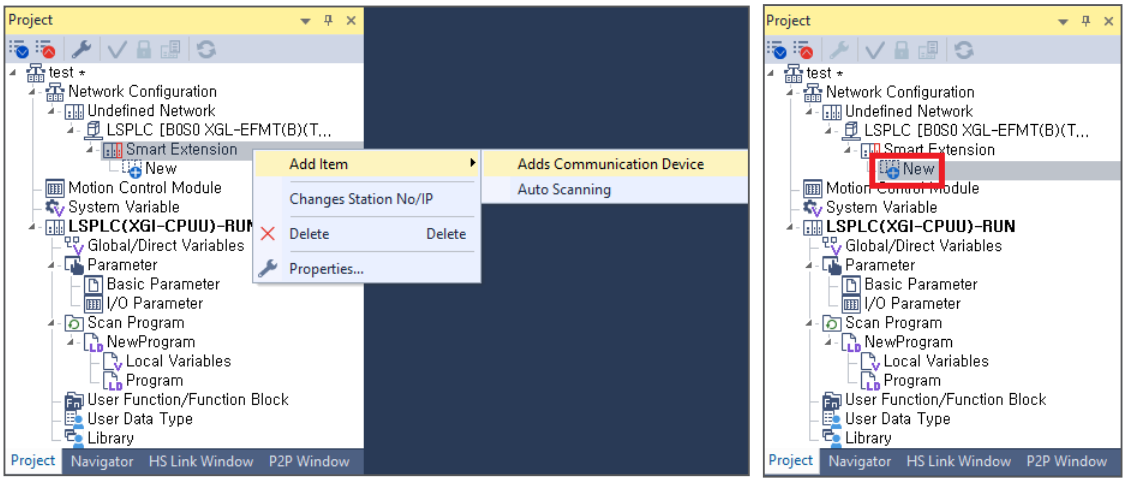
3 Reset the LS ELECTRIC PLC

4 Reboot the inverter body

The above four cases can reflect the S300 RAPIEnet+ communication option board parameter values through our XG5000.

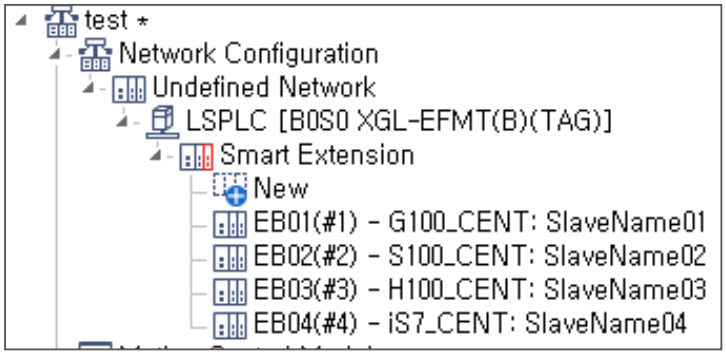
2.3.1 Model information for the drive

** Download the document at https://www.ls-electric.com.



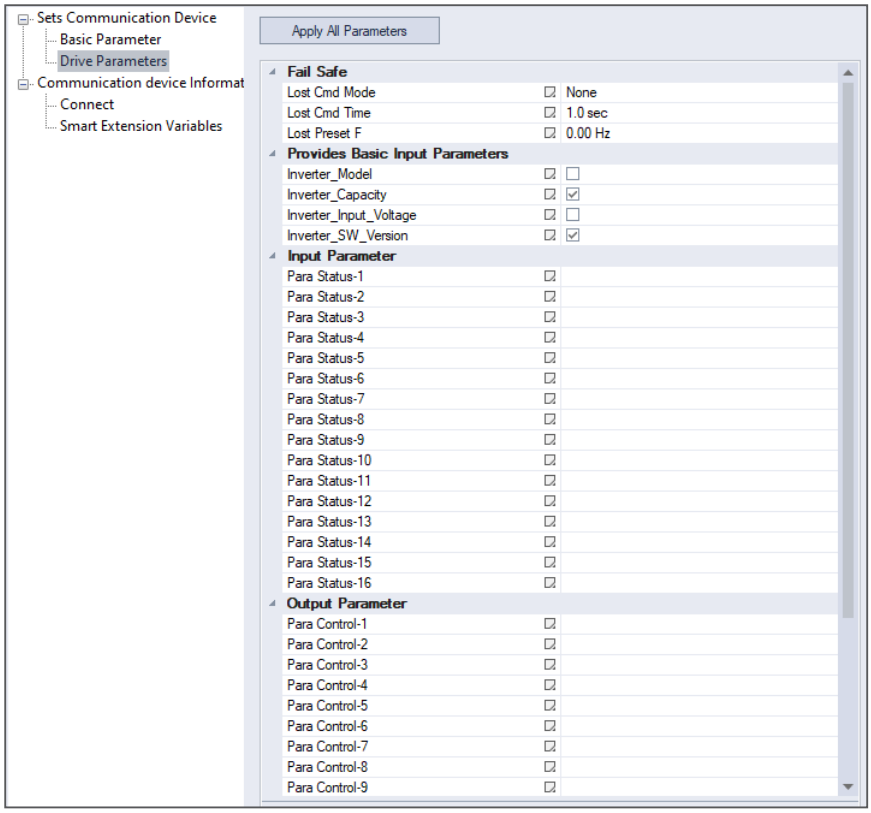
After specifying the connection information in the connection tab of the communication device addition window, select "OK" to add the communication device "S300_CENT" (S300 RAPIEnet+ communication option board) of the smart extension service.

For systems with the interoperability feature, the inverter (drive) model is shown in the "Drive model_CENT" format like below.



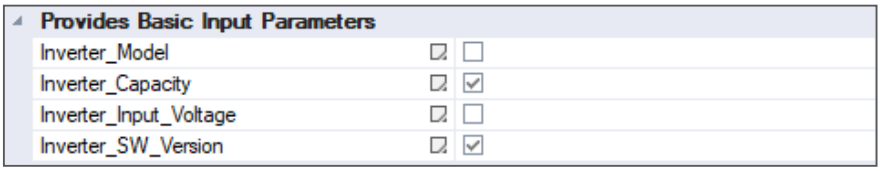
2.3.2 Input/output parameter settings and batch application

An UI showing network device settings and information

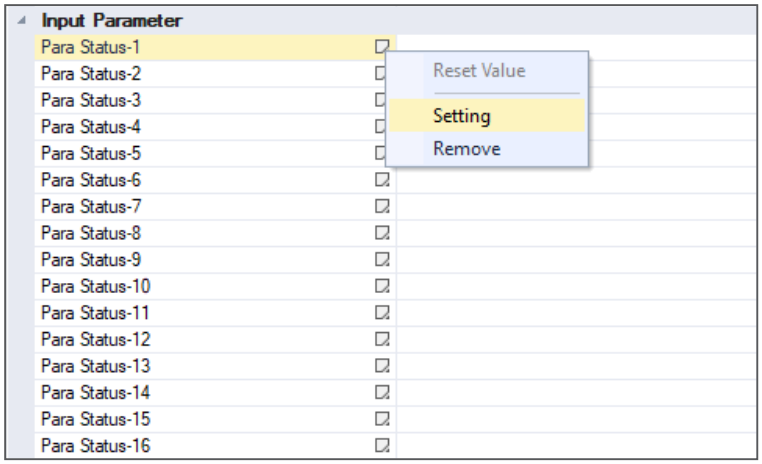


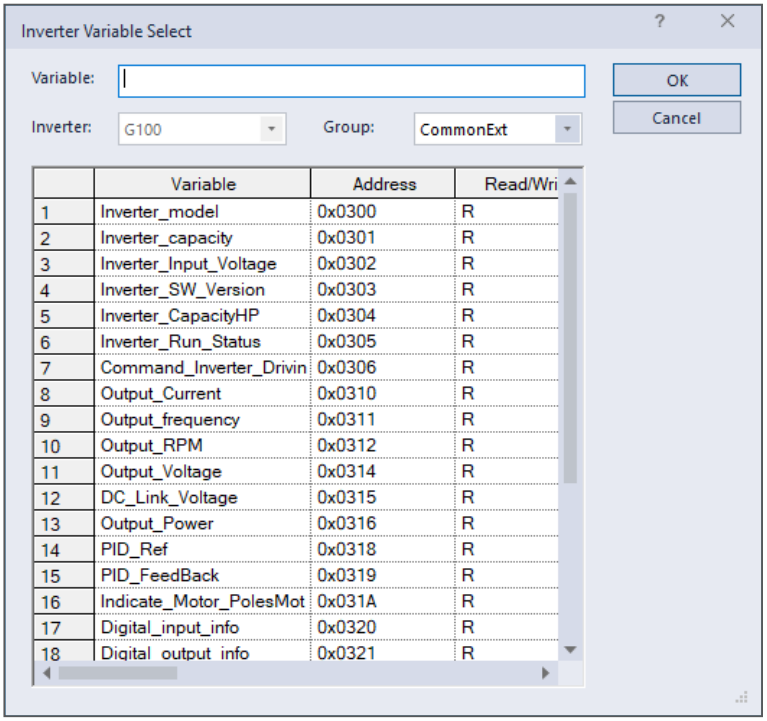
You can enjoy intuitive settings for input/output parameters in XG5000, rather than Smart Loader Operator or Loader. Visit Network device settings → Drive parameter settings.

The storage and SW version for the inverter is ticked by default and you can select up to 4 basic information for drives in input parameters.

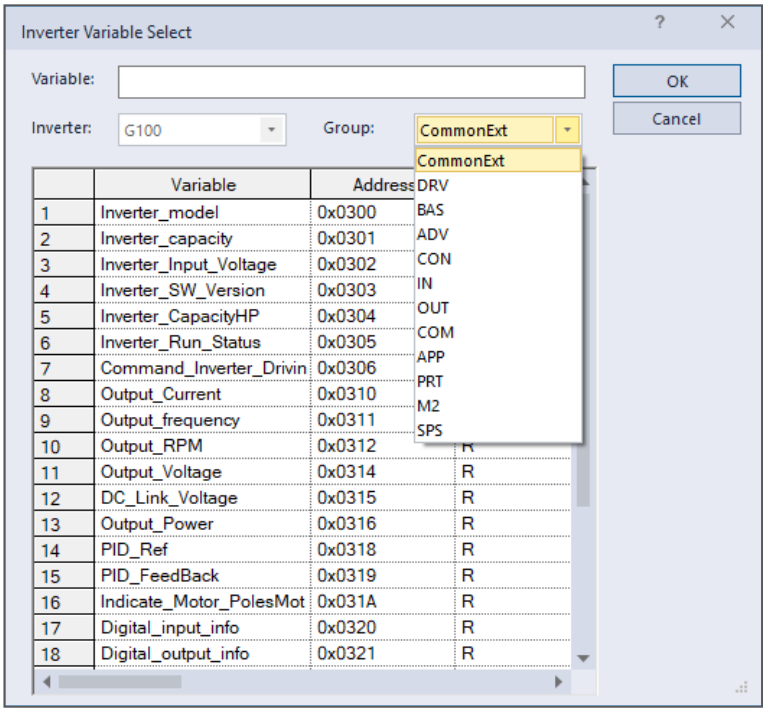


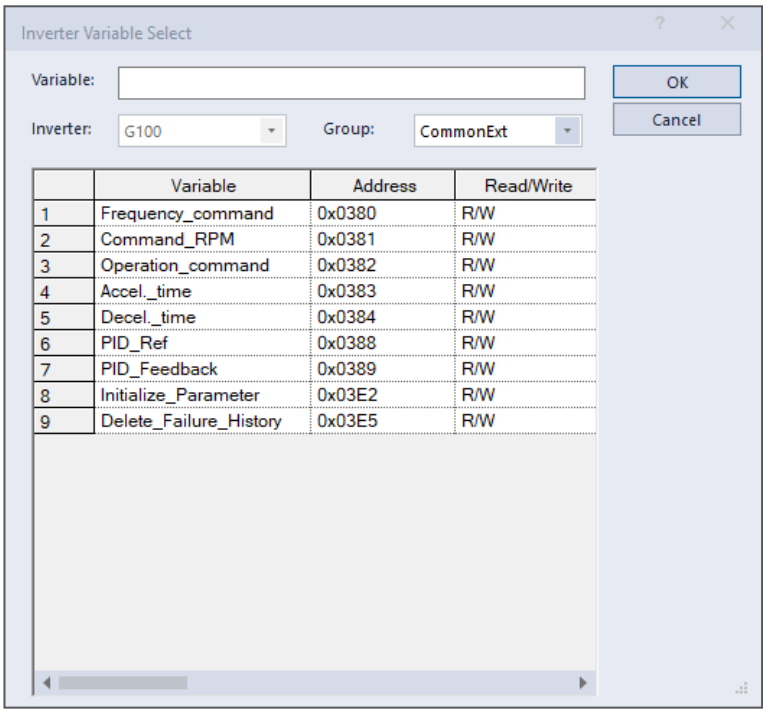
Set the desired input/output parameters through the pop-up window displayed when clicking in the XG5000 UIs. However, you must set at least one input/output parameter, respectively, click "Save project" and write before changes are reflected. Close the drive parameter settings window if more than one window is opened when saving the projects. It is important to remember that no changes are reflected if you simply copy and paste the parameters.

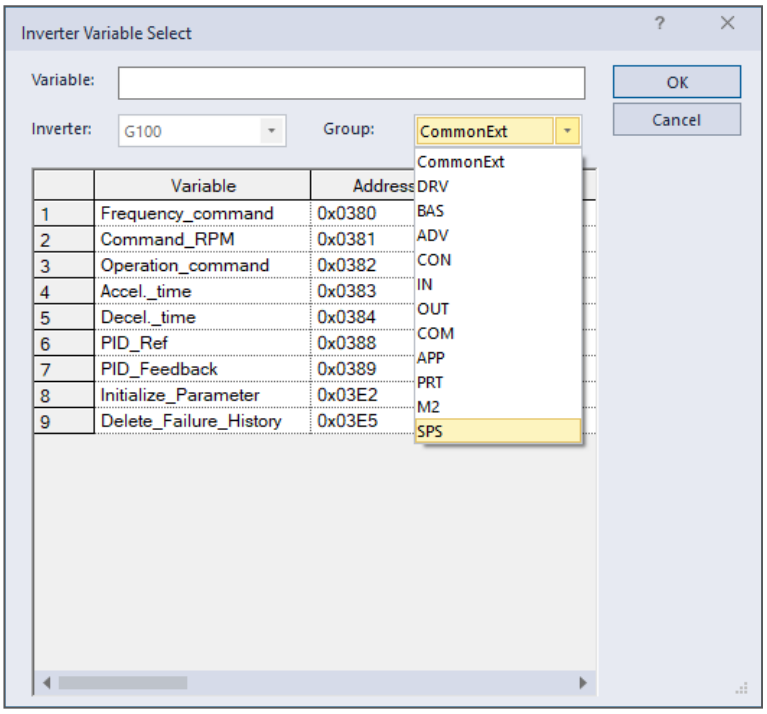




You can intuitively choose the parameters for each group and both input/output parameters in the XG5000 UI using the same method.



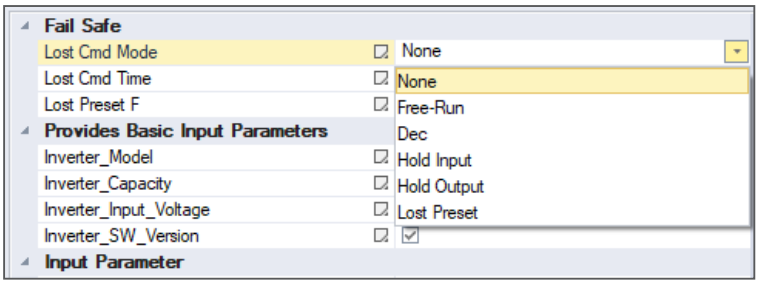




2.3.3 Setting up parameters related to Fail safe (related to Lost Command)

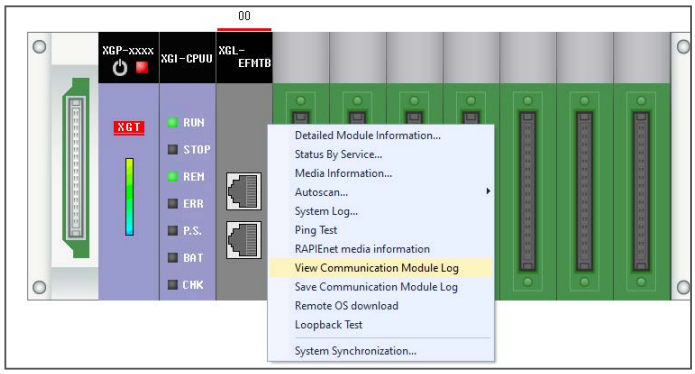
You can set parameters related to Fail safe through XG5000 rather than Smart Loader Operator.

Click ▫ in the XG5000 UI to set.



2.3.4 Diagnosis about the drive

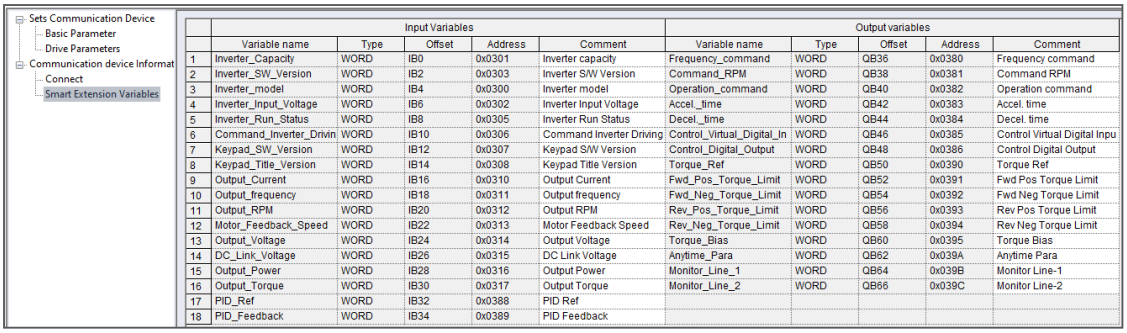
You can check the diagnostic information of the XG5000 smart extension service and the event history under the communication module history view.



2.3.5 Expansion of maximum input/output parameters size (previously fixed at 8 words, now configurable up to 16 words)

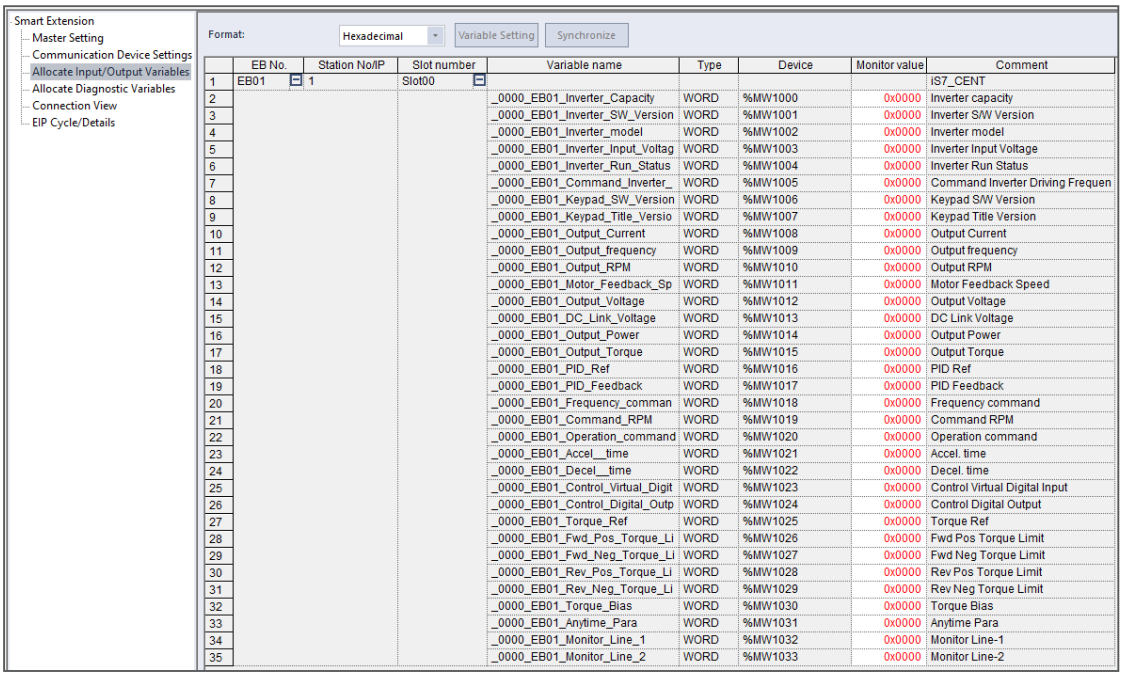
Available through XG5000's diagnosis about (inverter) drives. Available through the communication master module's communication module history function.

As shown below, you can set up to 16-word/16-word for in/out parameters by choosing the values in the intuitive XG5000 UI as in Section 11.3.2.



	Input Variables					Output variables				
	Variable name	Type	Offset	Address	Comment	Variable name	Type	Offset	Address	Comment
1	Inverter_Capacity	WORD	IB0	0x0301	Inverter capacity	Frequency_command	WORD	QB36	0x0380	Frequency command
2	Inverter_SW_Version	WORD	IB2	0x0303	Inverter S/W Version	Command_RPM	WORD	QB38	0x0381	Command RPM
3	Inverter_model	WORD	IB4	0x0300	Inverter model	Operation_command	WORD	QB40	0x0382	Operation command
4	Inverter_Input_Voltage	WORD	IB6	0x0302	Inverter Input Voltage	Accel._time	WORD	QB42	0x0383	Accel. time
5	Inverter_Run_Status	WORD	IB8	0x0305	Inverter Run Status	Decel._time	WORD	QB44	0x0384	Decel. time
6	Command_Inverter_Drivin	WORD	IB10	0x0306	Command Inverter Driving	Control_Virtual_Digital_In	WORD	QB46	0x0385	Control Virtual Digital Inpu
7	Keypad_SW_Version	WORD	IB12	0x0307	Keypad S/W Version	Control_Digital_Output	WORD	QB48	0x0386	Control Digital Output
8	Keypad_Title_Version	WORD	IB14	0x0308	Keypad Title Version	Torque_Ref	WORD	QB50	0x0390	Torque Ref
9	Output_Current	WORD	IB16	0x0310	Output Current	Fwd_Pos_Torque_Limit	WORD	QB52	0x0391	Fwd Pos Torque Limit
10	Output_frequency	WORD	IB18	0x0311	Output frequency	Fwd_Neg_Torque_Limit	WORD	QB54	0x0392	Fwd Neg Torque Limit
11	Output_RPM	WORD	IB20	0x0312	Output RPM	Rev_Pos_Torque_Limit	WORD	QB56	0x0393	Rev Pos Torque Limit
12	Motor_Feedback_Speed	WORD	IB22	0x0313	Motor Feedback Speed	Rev_Neg_Torque_Limit	WORD	QB58	0x0394	Rev Neg Torque Limit
13	Output_Voltage	WORD	IB24	0x0314	Output Voltage	Torque_Bias	WORD	QB60	0x0395	Torque Bias
14	DC_Link_Voltage	WORD	IB26	0x0315	DC Link Voltage	Anytime_Para	WORD	QB62	0x039A	Anytime Para
15	Output_Power	WORD	IB28	0x0316	Output Power	Monitor_Line_1	WORD	QB64	0x039B	Monitor Line-1
16	Output_Torque	WORD	IB30	0x0317	Output Torque	Monitor_Line_2	WORD	QB66	0x039C	Monitor Line-2
17	PID_Ref	WORD	IB32	0x0388	PID Ref					
18	PID_Feedback	WORD	IB34	0x0389	PID Feedback					

Example of 16-word/16-word parameters for input/output



	EB No.	Station No/IP	Slot number	Variable name	Type	Device	Monitor value	Comment
1	EB01	1	Slot00					iS7_CENT
2				_0000_EB01_Inverter_Capacity	WORD	%MW1000	0x0000	Inverter capacity
3				_0000_EB01_Inverter_SW_Version	WORD	%MW1001	0x0000	Inverter S/W Version
4				_0000_EB01_Inverter_model	WORD	%MW1002	0x0000	Inverter model
5				_0000_EB01_Inverter_Input_Voltag	WORD	%MW1003	0x0000	Inverter Input Voltage
6				_0000_EB01_Inverter_Run_Status	WORD	%MW1004	0x0000	Inverter Run Status
7				_0000_EB01_Command_Inverter_	WORD	%MW1005	0x0000	Command Inverter Driving Frequen
8				_0000_EB01_Keypad_SW_Version	WORD	%MW1006	0x0000	Keypad S/W Version
9				_0000_EB01_Keypad_Title_Versio	WORD	%MW1007	0x0000	Keypad Title Version
10				_0000_EB01_Output_Current	WORD	%MW1008	0x0000	Output Current
11				_0000_EB01_Output_frequency	WORD	%MW1009	0x0000	Output frequency
12				_0000_EB01_Output_RPM	WORD	%MW1010	0x0000	Output RPM
13				_0000_EB01_Motor_Feedback_Sp	WORD	%MW1011	0x0000	Motor Feedback Speed
14				_0000_EB01_Output_Voltage	WORD	%MW1012	0x0000	Output Voltage
15				_0000_EB01_DC_Link_Voltage	WORD	%MW1013	0x0000	DC Link Voltage
16				_0000_EB01_Output_Power	WORD	%MW1014	0x0000	Output Power
17				_0000_EB01_Output_Torque	WORD	%MW1015	0x0000	Output Torque
18				_0000_EB01_PID_Ref	WORD	%MW1016	0x0000	PID Ref
19				_0000_EB01_PID_Feedback	WORD	%MW1017	0x0000	PID Feedback
20				_0000_EB01_Frequency_comman	WORD	%MW1018	0x0000	Frequency command
21				_0000_EB01_Command_RPM	WORD	%MW1019	0x0000	Command RPM
22				_0000_EB01_Operation_command	WORD	%MW1020	0x0000	Operation command
23				_0000_EB01_Accel__time	WORD	%MW1021	0x0000	Accel. time
24				_0000_EB01_Decel__time	WORD	%MW1022	0x0000	Decel. time
25				_0000_EB01_Control_Virtual_Digit	WORD	%MW1023	0x0000	Control Virtual Digital Input
26				_0000_EB01_Control_Digital_Outp	WORD	%MW1024	0x0000	Control Digital Output
27				_0000_EB01_Torque_Ref	WORD	%MW1025	0x0000	Torque Ref
28				_0000_EB01_Fwd_Pos_Torque_Li	WORD	%MW1026	0x0000	Fwd Pos Torque Limit
29				_0000_EB01_Fwd_Neg_Torque_Li	WORD	%MW1027	0x0000	Fwd Neg Torque Limit
30				_0000_EB01_Rev_Pos_Torque_Li	WORD	%MW1028	0x0000	Rev Pos Torque Limit
31				_0000_EB01_Rev_Neg_Torque_Li	WORD	%MW1029	0x0000	Rev Neg Torque Limit
32				_0000_EB01_Torque_Bias	WORD	%MW1030	0x0000	Torque Bias
33				_0000_EB01_Anytime_Para	WORD	%MW1031	0x0000	Anytime Para
34				_0000_EB01_Monitor_Line_1	WORD	%MW1032	0x0000	Monitor Line-1
35				_0000_EB01_Monitor_Line_2	WORD	%MW1033	0x0000	Monitor Line-2

A screen showing that all four default parameters are ticked and up to 16 in/out parameters are selected.

3 Services with LS ELECTRIC products or other manufacturer's products

3.1 Summary

This chapter explains the services utilizing EtherNet/IP and Modbus TCP protocols when the communication board is connected with LS ELECTRIC products or another manufacturer's products.

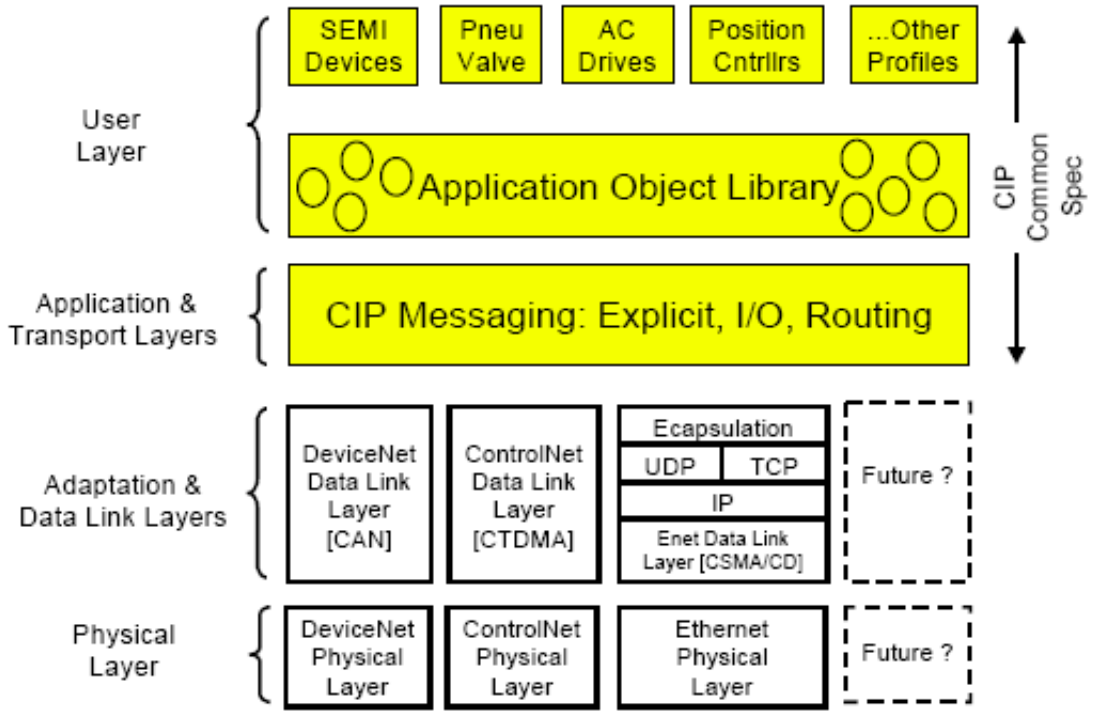
The Smart Loader Operator settings required when not to utilize the RAPIEnet service are as follows.

The RAPIEnet setting is disabled by default.

S300 RAPIEnet+ communication option board OPT1-54 [OptParameter04]	RAPIEnet v2 Availability	EtherNet/IP Availability	Modbus TCP Availability
Setting: "2" RAPIEnet v2 Enable	O	O	O
Setting: "0" RAPIEnet v2 Disable	X	O	O

3.2 EtherNet/IP

3.2.1 Basic protocol structure



EtherNet/IP addresses are protocols using TCP and UDP to introduce common industrial protocol (CIP) set by the ODVA.

- Originator: Devices that make connection requests, which are also called clients.
- PLCs or scanners are examples of originators.
- Target: Devices that respond to connection requests, which are also called servers.
- Inverters are examples of targets.

3.2.2 Implicit message

Implicit messages are also called I/O messages. It refers to the data communicated between the client (originator) and the server (target) at predefined intervals, via input and output instances.

The class 1 connection is used for implicit messages.

① Scope of support

Transport type

Originator→Target: Point to Point
Target→Originator: Multicast

Transport trigger: Cyclic

Configuration connection: 1

Connection tag: Not available

Priority

Originator→Target: Scheduled
Target→Originator: Scheduled

Configuration data: Not available

② Input Instance

Input instances refer to the status data periodically sent from the inverter to PLC or other client devices.

Instance	Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
70	0						Running1 (Fwd)		Faulted
	1								
	2	Speed Actual (Low Byte) – RPM unit							
	3	Speed Actual (High Byte) – RPM unit							
71	0	At Reference	Ref From Net	Ctrl From Net	Ready	Running2 (Rev)	Running1 (Fwd)	Warning	Faulted
	1	Drive State							
	2	Speed Actual (Low Byte) – RPM unit							
	3	Speed Actual (High Byte) – RPM unit							

Instance	Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
110	0						Running1 (Fwd)		Faulted
	1								
	2	Speed Actual (Low Byte) – Hz unit							
	3	Speed Actual (High Byte) – Hz unit							
111	0	At Reference	Ref From Net	Ctrl From Net	Ready	Running2 (Rev)	Running1 (Fwd)	Warning	Faulted
	1	Drive State							
	2	Speed Actual (Low Byte) – Hz unit							
	3	Speed Actual (High Byte) – Hz unit							
141	0	Para Status-01 data (Low Byte)							
	1	Para Status-01 data (High Byte)							
142	0	Para Status-01 data (Low Byte)							
	1	Para Status-01 data (High Byte)							
	2	Para Status-02 data (Low Byte)							
	3	Para Status-02 data (High Byte)							
143	0	Para Status-01 data (Low Byte)							
	1	Para Status-01 data (High Byte)							
	2	Para Status-02 data (Low Byte)							
	3	Para Status-02 data (High Byte)							
	4	Para Status-03 data (Low Byte)							
	5	Para Status-03 data (High Byte)							

Instance	Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
144	0	Para Status-01 data (Low Byte)							
	1	Para Status-01 data (High Byte)							
	2	Para Status-02 data (Low Byte)							
	3	Para Status-02 data (High Byte)							
	4	Para Status-03 data (Low Byte)							
	5	Para Status-03 data (High Byte)							
	6	Para Status-04 data (Low Byte)							
	7	Para Status-04 data (High Byte)							
145	0	Para Status-01 data (Low Byte)							
	1	Para Status-01 data (High Byte)							
	2	Para Status-02 data (Low Byte)							
	3	Para Status-02 data (High Byte)							
	4	Para Status-03 data (Low Byte)							
	5	Para Status-03 data (High Byte)							
	6	Para Status-04 data (Low Byte)							
	7	Para Status-04 data (High Byte)							
	8	Para Status-05 data (Low Byte)							
	9	Para Status-05 data (High Byte)							

Instance	Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
146	0	Para Status-01 data (Low Byte)							
	1	Para Status-01 data (High Byte)							
	2	Para Status-02 data (Low Byte)							
	3	Para Status-02 data (High Byte)							
	4	Para Status-03 data (Low Byte)							
	5	Para Status-03 data (High Byte)							
	6	Para Status-04 data (Low Byte)							
	7	Para Status-04 data (High Byte)							
	8	Para Status-05 data (Low Byte)							
	9	Para Status-05 data (High Byte)							
	10	Para Status-06 data (Low Byte)							
	11	Para Status-06 data (High Byte)							
147	0	Para Status-01 data (Low Byte)							
	1	Para Status-01 data (High Byte)							
	2	Para Status-02 data (Low Byte)							
	3	Para Status-02 data (High Byte)							
	4	Para Status-03 data (Low Byte)							
	5	Para Status-03 data (High Byte)							
	6	Para Status-04 data (Low Byte)							
	7	Para Status-04 data (High Byte)							
	8	Para Status-05 data (Low Byte)							
	9	Para Status-05 data (High Byte)							
	10	Para Status-06 data (Low Byte)							
	11	Para Status-06 data (High Byte)							
	12	Para Status-07 data (Low Byte)							
	13	Para Status-07 data (High Byte)							

Instance	Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
148	0	Para Status-01 data (Low Byte)							
	1	Para Status-01 data (High Byte)							
	2	Para Status-02 data (Low Byte)							
	3	Para Status-02 data (High Byte)							
	4	Para Status-03 data (Low Byte)							
	5	Para Status-03 data (High Byte)							
	6	Para Status-04 data (Low Byte)							
	7	Para Status-04 data (High Byte)							
	8	Para Status-05 data (Low Byte)							
	9	Para Status-05 data (High Byte)							
	10	Para Status-06 data (Low Byte)							
	11	Para Status-06 data (High Byte)							
	12	Para Status-07 data (Low Byte)							
	13	Para Status-07 data (High Byte)							
	14	Para Status-08 data (Low Byte)							
	15	Para Status-08 data (High Byte)							

Instance	Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
149	0	Para Status-01 data (Low Byte)							
	1	Para Status-01 data (High Byte)							
	2	Para Status-02 data (Low Byte)							
	3	Para Status-02 data (High Byte)							
	4	Para Status-03 data (Low Byte)							
	5	Para Status-03 data (High Byte)							
	6	Para Status-04 data (Low Byte)							
	7	Para Status-04 data (High Byte)							
	8	Para Status-05 data (Low Byte)							
	9	Para Status-05 data (High Byte)							
	10	Para Status-06 data (Low Byte)							
	11	Para Status-06 data (High Byte)							
	12	Para Status-07 data (Low Byte)							
	13	Para Status-07 data (High Byte)							
	14	Para Status-08 data (Low Byte)							
	15	Para Status-08 data (High Byte)							
	16	Para Status-09 data (Low Byte)							
	17	Para Status-09 data (High Byte)							

Instance	Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
150	0	Para Status-01 data (Low Byte)							
	1	Para Status-01 data (High Byte)							
	2	Para Status-02 data (Low Byte)							
	3	Para Status-02 data (High Byte)							
	4	Para Status-03 data (Low Byte)							
	5	Para Status-03 data (High Byte)							
	6	Para Status-04 data (Low Byte)							
	7	Para Status-04 data (High Byte)							
	8	Para Status-05 data (Low Byte)							
	9	Para Status-05 data (High Byte)							
	10	Para Status-06 data (Low Byte)							
	11	Para Status-06 data (High Byte)							
	12	Para Status-07 data (Low Byte)							
	13	Para Status-07 data (High Byte)							
	14	Para Status-08 data (Low Byte)							
	15	Para Status-08 data (High Byte)							
	16	Para Status-09 data (Low Byte)							
	17	Para Status-09 data (High Byte)							
	18	Para Status-10 data (Low Byte)							
	19	Para Status-10 data (High Byte)							

Instance	Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
151	0	Para Status-01 data (Low Byte)							
	1	Para Status-01 data (High Byte)							
	2	Para Status-02 data (Low Byte)							
	3	Para Status-02 data (High Byte)							
	4	Para Status-03 data (Low Byte)							
	5	Para Status-03 data (High Byte)							
	6	Para Status-04 data (Low Byte)							
	7	Para Status-04 data (High Byte)							
	8	Para Status-05 data (Low Byte)							
	9	Para Status-05 data (High Byte)							
	10	Para Status-06 data (Low Byte)							
	11	Para Status-06 data (High Byte)							
	12	Para Status-07 data (Low Byte)							
	13	Para Status-07 data (High Byte)							
	14	Para Status-08 data (Low Byte)							
	15	Para Status-08 data (High Byte)							
	16	Para Status-09 data (Low Byte)							
	17	Para Status-09 data (High Byte)							
	18	Para Status-10 data (Low Byte)							
	19	Para Status-10 data (High Byte)							
	20	Para Status-11 data (Low Byte)							
	21	Para Status-11 data (High Byte)							

Instance	Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
152	0	Para Status-01 data (Low Byte)							
	1	Para Status-01 data (High Byte)							
	2	Para Status-02 data (Low Byte)							
	3	Para Status-02 data (High Byte)							
	4	Para Status-03 data (Low Byte)							
	5	Para Status-03 data (High Byte)							
	6	Para Status-04 data (Low Byte)							
	7	Para Status-04 data (High Byte)							
	8	Para Status-05 data (Low Byte)							
	9	Para Status-05 data (High Byte)							
	10	Para Status-06 data (Low Byte)							
	11	Para Status-06 data (High Byte)							
	12	Para Status-07 data (Low Byte)							
	13	Para Status-07 data (High Byte)							
	14	Para Status-08 data (Low Byte)							
	15	Para Status-08 data (High Byte)							
	16	Para Status-09 data (Low Byte)							
	17	Para Status-09 data (High Byte)							
	18	Para Status-10 data (Low Byte)							
	19	Para Status-10 data (High Byte)							
	20	Para Status-11 data (Low Byte)							
	21	Para Status-11 data (High Byte)							
	22	Para Status-12 data (Low Byte)							
	23	Para Status-12 data (High Byte)							

Instance	Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
153	0	Para Status-01 data (Low Byte)							
	1	Para Status-01 data (High Byte)							
	2	Para Status-02 data (Low Byte)							
	3	Para Status-02 data (High Byte)							
	4	Para Status-03 data (Low Byte)							
	5	Para Status-03 data (High Byte)							
	6	Para Status-04 data (Low Byte)							
	7	Para Status-04 data (High Byte)							
	8	Para Status-05 data (Low Byte)							
	9	Para Status-05 data (High Byte)							
	10	Para Status-06 data (Low Byte)							
	11	Para Status-06 data (High Byte)							
	12	Para Status-07 data (Low Byte)							
	13	Para Status-07 data (High Byte)							
	14	Para Status-08 data (Low Byte)							
	15	Para Status-08 data (High Byte)							
	16	Para Status-09 data (Low Byte)							
	17	Para Status-09 data (High Byte)							
	18	Para Status-10 data (Low Byte)							
	19	Para Status-10 data (High Byte)							
	20	Para Status-11 data (Low Byte)							
	21	Para Status-11 data (High Byte)							
	22	Para Status-12 data (Low Byte)							
	23	Para Status-12 data (High Byte)							
	24	Para Status-13 data (Low Byte)							
	25	Para Status-13 data (High Byte)							

Instance	Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
154	0	Para Status-01 data (Low Byte)							
	1	Para Status-01 data (High Byte)							
	2	Para Status-02 data (Low Byte)							
	3	Para Status-02 data (High Byte)							
	4	Para Status-03 data (Low Byte)							
	5	Para Status-03 data (High Byte)							
	6	Para Status-04 data (Low Byte)							
	7	Para Status-04 data (High Byte)							
	8	Para Status-05 data (Low Byte)							
	9	Para Status-05 data (High Byte)							
	10	Para Status-06 data (Low Byte)							
	11	Para Status-06 data (High Byte)							
	12	Para Status-07 data (Low Byte)							
	13	Para Status-07 data (High Byte)							
	14	Para Status-08 data (Low Byte)							
	15	Para Status-08 data (High Byte)							
	16	Para Status-09 data (Low Byte)							
	17	Para Status-09 data (High Byte)							
	18	Para Status-10 data (Low Byte)							
	19	Para Status-10 data (High Byte)							
	20	Para Status-11 data (Low Byte)							
	21	Para Status-11 data (High Byte)							
	22	Para Status-12 data (Low Byte)							
	23	Para Status-12 data (High Byte)							
	24	Para Status-13 data (Low Byte)							
	25	Para Status-13 data (High Byte)							
	26	Para Status-14 data (Low Byte)							
	27	Para Status-14 data (High Byte)							

Instance	Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
155	0	Para Status-01 data (Low Byte)							
	1	Para Status-01 data (High Byte)							
	2	Para Status-02 data (Low Byte)							
	3	Para Status-02 data (High Byte)							
	4	Para Status-03 data (Low Byte)							
	5	Para Status-03 data (High Byte)							
	6	Para Status-04 data (Low Byte)							
	7	Para Status-04 data (High Byte)							
	8	Para Status-05 data (Low Byte)							
	9	Para Status-05 data (High Byte)							
	10	Para Status-06 data (Low Byte)							
	11	Para Status-06 data (High Byte)							
	12	Para Status-07 data (Low Byte)							
	13	Para Status-07 data (High Byte)							
	14	Para Status-08 data (Low Byte)							
	15	Para Status-08 data (High Byte)							
	16	Para Status-09 data (Low Byte)							
	17	Para Status-09 data (High Byte)							
	18	Para Status-10 data (Low Byte)							
	19	Para Status-10 data (High Byte)							
	20	Para Status-11 data (Low Byte)							
	21	Para Status-11 data (High Byte)							
	22	Para Status-12 data (Low Byte)							
	23	Para Status-12 data (High Byte)							
	24	Para Status-13 data (Low Byte)							
	25	Para Status-13 data (High Byte)							
	26	Para Status-14 data (Low Byte)							
	27	Para Status-14 data (High Byte)							
	28	Para Status-15 data (Low Byte)							
	29	Para Status-15 data (High Byte)							

Instance	Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
156	0	Para Status-01 data (Low Byte)							
	1	Para Status-01 data (High Byte)							
	2	Para Status-02 data (Low Byte)							
	3	Para Status-02 data (High Byte)							
	4	Para Status-03 data (Low Byte)							
	5	Para Status-03 data (High Byte)							
	6	Para Status-04 data (Low Byte)							
	7	Para Status-04 data (High Byte)							
	8	Para Status-05 data (Low Byte)							
	9	Para Status-05 data (High Byte)							
	10	Para Status-06 data (Low Byte)							
	11	Para Status-06 data (High Byte)							
	12	Para Status-07 data (Low Byte)							
	13	Para Status-07 data (High Byte)							
	14	Para Status-08 data (Low Byte)							
	15	Para Status-08 data (High Byte)							
	16	Para Status-09 data (Low Byte)							
	17	Para Status-09 data (High Byte)							
	18	Para Status-10 data (Low Byte)							
	19	Para Status-10 data (High Byte)							
	20	Para Status-11 data (Low Byte)							
	21	Para Status-11 data (High Byte)							
	22	Para Status-12 data (Low Byte)							
	23	Para Status-12 data (High Byte)							
	24	Para Status-13 data (Low Byte)							
	25	Para Status-13 data (High Byte)							
	26	Para Status-14 data (Low Byte)							
	27	Para Status-14 data (High Byte)							
	28	Para Status-15 data (Low Byte)							
	29	Para Status-15 data (High Byte)							
	30	Para Status-16 data (Low Byte)							
	31	Para Status-16 data (High Byte)							

The following table explains the data (bytes 0 and 1) for instances 70, 71, 110, and 111.

Name	Description	Related attribute	
		Class	Attr. ID
Faulted	Inverter Error	0x29	10
Warning	Not supported	0x29	11
Running1	Motor is running Forward	0x29	7
Running2	Motor is running Reverse	0x29	8
Ready	Motor is ready to running	0x29	9
Ctrl From Net	Run/Stop control	0x29	15
Ref From Net	Speed control	0x2A	29
At Reference	Reached reference Speed	0x2A	3
Drive State	Current Motor State	0x29	6
Actual speed	Reference speed	0x2A	7

③ Output Instance

Out instances refer to the status data periodically sent from the inverter to PLC or other client devices.

Instance	Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
20	0						Fault reset		Run Fwd
	1								
	2	Speed Reference (Low Byte) – RPM unit							
	3	Speed Reference (High Byte) – RPM unit							
21	0		NetRef	NetCtrl			Fault reset	Run Rev	Run Fwd
	1								
	2	Speed Reference (Low Byte) – RPM unit							
	3	Speed Reference (High Byte) – RPM unit							

Instance	Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
100	0						Fault reset		Run Fwd
	1								
	2	Speed Reference (Low Byte) – Hz unit							
	3	Speed Reference (High Byte) – Hz unit							
101	0		NetRef	NetCtrl			Fault reset	Run Rev	Run Fwd
	1								
	2	Speed Reference (Low Byte) – Hz unit							
	3	Speed Reference (High Byte) – Hz unit							
121	0	Para Control-01 data (Low Byte)							
	1	Para Control-01 data (High Byte)							
122	0	Para Control-01 data (Low Byte)							
	1	Para Control-01 data (High Byte)							
	2	Para Control-02 data (Low Byte)							
	3	Para Control-02 data (High Byte)							
123	0	Para Control-01 data (Low Byte)							
	1	Para Control-01 data (High Byte)							
	2	Para Control-02 data (Low Byte)							
	3	Para Control-02 data (High Byte)							
	4	Para Control-03 data (Low Byte)							
	5	Para Control-03 data (High Byte)							
124	0	Para Control-01 data (Low Byte)							
	1	Para Control-01 data (High Byte)							
	2	Para Control-02 data (Low Byte)							
	3	Para Control-02 data (High Byte)							
	4	Para Control-03 data (Low Byte)							
	5	Para Control-03 data (High Byte)							
	6	Para Control-04 data (Low Byte)							
	7	Para Control-04 data (High Byte)							

Instance	Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
125	0	Para Control-01 data (Low Byte)							
	1	Para Control-01 data (High Byte)							
	2	Para Control-02 data (Low Byte)							
	3	Para Control-02 data (High Byte)							
	4	Para Control-03 data (Low Byte)							
	5	Para Control-03 data (High Byte)							
	6	Para Control-04 data (Low Byte)							
	7	Para Control-04 data (High Byte)							
	8	Para Control-05 data (Low Byte)							
	9	Para Control-05 data (High Byte)							
126	0	Para Control-01 data (Low Byte)							
	1	Para Control-01 data (High Byte)							
	2	Para Control-02 data (Low Byte)							
	3	Para Control-02 data (High Byte)							
	4	Para Control-03 data (Low Byte)							
	5	Para Control-03 data (High Byte)							
	6	Para Control-04 data (Low Byte)							
	7	Para Control-04 data (High Byte)							
	8	Para Control-05 data (Low Byte)							
	9	Para Control-05 data (High Byte)							
	10	Para Control-06 data (Low Byte)							
	11	Para Control-06 data (High Byte)							

Instance	Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
127	0	Para Control-01 data (Low Byte)							
	1	Para Control-01 data (High Byte)							
	2	Para Control-02 data (Low Byte)							
	3	Para Control-02 data (High Byte)							
	4	Para Control-03 data (Low Byte)							
	5	Para Control-03 data (High Byte)							
	6	Para Control-04 data (Low Byte)							
	7	Para Control-04 data (High Byte)							
	8	Para Control-05 data (Low Byte)							
	9	Para Control-05 data (High Byte)							
	10	Para Control-06 data (Low Byte)							
	11	Para Control-06 data (High Byte)							
	12	Para Control-07 data (Low Byte)							
	13	Para Control-07 data (High Byte)							

Instance	Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
128	0	Para Control-01 data (Low Byte)							
	1	Para Control-01 data (High Byte)							
	2	Para Control-02 data (Low Byte)							
	3	Para Control-02 data (High Byte)							
	4	Para Control-03 data (Low Byte)							
	5	Para Control-03 data (High Byte)							
	6	Para Control-04 data (Low Byte)							
	7	Para Control-04 data (High Byte)							
	8	Para Control-05 data (Low Byte)							
	9	Para Control-05 data (High Byte)							
	10	Para Control-06 data (Low Byte)							
	11	Para Control-06 data (High Byte)							
	12	Para Control-07 data (Low Byte)							
	13	Para Control-07 data (High Byte)							
	14	Para Control-08 data (Low Byte)							
	15	Para Control-08 data (High Byte)							

Instance	Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
129	0	Para Control-01 data (Low Byte)							
	1	Para Control-01 data (High Byte)							
	2	Para Control-02 data (Low Byte)							
	3	Para Control-02 data (High Byte)							
	4	Para Control-03 data (Low Byte)							
	5	Para Control-03 data (High Byte)							
	6	Para Control-04 data (Low Byte)							
	7	Para Control-04 data (High Byte)							
	8	Para Control-05 data (Low Byte)							
	9	Para Control-05 data (High Byte)							
	10	Para Control-06 data (Low Byte)							
	11	Para Control-06 data (High Byte)							
	12	Para Control-07 data (Low Byte)							
	13	Para Control-07 data (High Byte)							
	14	Para Control-08 data (Low Byte)							
	15	Para Control-08 data (High Byte)							
	16	Para Control-09 data (Low Byte)							
	17	Para Control-09 data (High Byte)							

Instance	Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
130	0	Para Control-01 data (Low Byte)							
	1	Para Control-01 data (High Byte)							
	2	Para Control-02 data (Low Byte)							
	3	Para Control-02 data (High Byte)							
	4	Para Control-03 data (Low Byte)							
	5	Para Control-03 data (High Byte)							
	6	Para Control-04 data (Low Byte)							
	7	Para Control-04 data (High Byte)							
	8	Para Control-05 data (Low Byte)							
	9	Para Control-05 data (High Byte)							
	10	Para Control-06 data (Low Byte)							
	11	Para Control-06 data (High Byte)							
	12	Para Control-07 data (Low Byte)							
	13	Para Control-07 data (High Byte)							
	14	Para Control-08 data (Low Byte)							
	15	Para Control-08 data (High Byte)							
	16	Para Control-09 data (Low Byte)							
	17	Para Control-09 data (High Byte)							
	18	Para Control-10 data (Low Byte)							
	19	Para Control-10 data (High Byte)							

Instance	Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
131	0	Para Control-01 data (Low Byte)							
	1	Para Control-01 data (High Byte)							
	2	Para Control-02 data (Low Byte)							
	3	Para Control-02 data (High Byte)							
	4	Para Control-03 data (Low Byte)							
	5	Para Control-03 data (High Byte)							
	6	Para Control-04 data (Low Byte)							
	7	Para Control-04 data (High Byte)							
	8	Para Control-05 data (Low Byte)							
	9	Para Control-05 data (High Byte)							
	10	Para Control-06 data (Low Byte)							
	11	Para Control-06 data (High Byte)							
	12	Para Control-07 data (Low Byte)							
	13	Para Control-07 data (High Byte)							
	14	Para Control-08 data (Low Byte)							
	15	Para Control-08 data (High Byte)							
	16	Para Control-09 data (Low Byte)							
	17	Para Control-09 data (High Byte)							
	18	Para Control-10 data (Low Byte)							
	19	Para Control-10 data (High Byte)							
	20	Para Control-11 data (Low Byte)							
	21	Para Control-11 data (High Byte)							

Instance	Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
132	0	Para Control-01 data (Low Byte)							
	1	Para Control-01 data (High Byte)							
	2	Para Control-02 data (Low Byte)							
	3	Para Control-02 data (High Byte)							
	4	Para Control-03 data (Low Byte)							
	5	Para Control-03 data (High Byte)							
	6	Para Control-04 data (Low Byte)							
	7	Para Control-04 data (High Byte)							
	8	Para Control-05 data (Low Byte)							
	9	Para Control-05 data (High Byte)							
	10	Para Control-06 data (Low Byte)							
	11	Para Control-06 data (High Byte)							
	12	Para Control-07 data (Low Byte)							
	13	Para Control-07 data (High Byte)							
	14	Para Control-08 data (Low Byte)							
	15	Para Control-08 data (High Byte)							
	16	Para Control-09 data (Low Byte)							
	17	Para Control-09 data (High Byte)							
	18	Para Control-10 data (Low Byte)							
	19	Para Control-10 data (High Byte)							
	20	Para Control-11 data (Low Byte)							
	21	Para Control-11 data (High Byte)							
	22	Para Control-12 data (Low Byte)							
	23	Para Control-12 data (High Byte)							

Instance	Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
133	0	Para Control-01 data (Low Byte)							
	1	Para Control-01 data (High Byte)							
	2	Para Control-02 data (Low Byte)							
	3	Para Control-02 data (High Byte)							
	4	Para Control-03 data (Low Byte)							
	5	Para Control-03 data (High Byte)							
	6	Para Control-04 data (Low Byte)							
	7	Para Control-04 data (High Byte)							
	8	Para Control-05 data (Low Byte)							
	9	Para Control-05 data (High Byte)							
	10	Para Control-06 data (Low Byte)							
	11	Para Control-06 data (High Byte)							
	12	Para Control-07 data (Low Byte)							
	13	Para Control-07 data (High Byte)							
	14	Para Control-08 data (Low Byte)							
	15	Para Control-08 data (High Byte)							
	16	Para Control-09 data (Low Byte)							
	17	Para Control-09 data (High Byte)							
	18	Para Control-10 data (Low Byte)							
	19	Para Control-10 data (High Byte)							
	20	Para Control-11 data (Low Byte)							
	21	Para Control-11 data (High Byte)							
	22	Para Control-12 data (Low Byte)							
	23	Para Control-12 data (High Byte)							
	24	Para Control-13 data (Low Byte)							
	25	Para Control-13 data (High Byte)							

Instance	Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
134	0	Para Control-01 data (Low Byte)							
	1	Para Control-01 data (High Byte)							
	2	Para Control-02 data (Low Byte)							
	3	Para Control-02 data (High Byte)							
	4	Para Control-03 data (Low Byte)							
	5	Para Control-03 data (High Byte)							
	6	Para Control-04 data (Low Byte)							
	7	Para Control-04 data (High Byte)							
	8	Para Control-05 data (Low Byte)							
	9	Para Control-05 data (High Byte)							
	10	Para Control-06 data (Low Byte)							
	11	Para Control-06 data (High Byte)							
	12	Para Control-07 data (Low Byte)							
	13	Para Control-07 data (High Byte)							
	14	Para Control-08 data (Low Byte)							
	15	Para Control-08 data (High Byte)							
	16	Para Control-09 data (Low Byte)							
	17	Para Control-09 data (High Byte)							
	18	Para Control-10 data (Low Byte)							
	19	Para Control-10 data (High Byte)							
	20	Para Control-11 data (Low Byte)							
	21	Para Control-11 data (High Byte)							
	22	Para Control-12 data (Low Byte)							
	23	Para Control-12 data (High Byte)							
	24	Para Control-13 data (Low Byte)							
	25	Para Control-13 data (High Byte)							
	26	Para Control-14 data (Low Byte)							
	27	Para Control-14 data (High Byte)							

Instance	Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
135	0	Para Control-01 data (Low Byte)							
	1	Para Control-01 data (High Byte)							
	2	Para Control-02 data (Low Byte)							
	3	Para Control-02 data (High Byte)							
	4	Para Control-03 data (Low Byte)							
	5	Para Control-03 data (High Byte)							
	6	Para Control-04 data (Low Byte)							
	7	Para Control-04 data (High Byte)							
	8	Para Control-05 data (Low Byte)							
	9	Para Control-05 data (High Byte)							
	10	Para Control-06 data (Low Byte)							
	11	Para Control-06 data (High Byte)							
	12	Para Control-07 data (Low Byte)							
	13	Para Control-07 data (High Byte)							
	14	Para Control-08 data (Low Byte)							
	15	Para Control-08 data (High Byte)							
	16	Para Control-09 data (Low Byte)							
	17	Para Control-09 data (High Byte)							
	18	Para Control-10 data (Low Byte)							
	19	Para Control-10 data (High Byte)							
	20	Para Control-11 data (Low Byte)							
	21	Para Control-11 data (High Byte)							
	22	Para Control-12 data (Low Byte)							
	23	Para Control-12 data (High Byte)							
	24	Para Control-13 data (Low Byte)							
	25	Para Control-13 data (High Byte)							
	26	Para Control-14 data (Low Byte)							
	27	Para Control-14 data (High Byte)							
	28	Para Control-15 data (Low Byte)							
	29	Para Control-15 data (High Byte)							

Instance	Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
136	0	Para Control-01 data (Low Byte)							
	1	Para Control-01 data (High Byte)							
	2	Para Control-02 data (Low Byte)							
	3	Para Control-02 data (High Byte)							
	4	Para Control-03 data (Low Byte)							
	5	Para Control-03 data (High Byte)							
	6	Para Control-04 data (Low Byte)							
	7	Para Control-04 data (High Byte)							
	8	Para Control-05 data (Low Byte)							
	9	Para Control-05 data (High Byte)							
	10	Para Control-06 data (Low Byte)							
	11	Para Control-06 data (High Byte)							
	12	Para Control-07 data (Low Byte)							
	13	Para Control-07 data (High Byte)							
	14	Para Control-08 data (Low Byte)							
	15	Para Control-08 data (High Byte)							
	16	Para Control-09 data (Low Byte)							
	17	Para Control-09 data (High Byte)							
	18	Para Control-10 data (Low Byte)							
	19	Para Control-10 data (High Byte)							
	20	Para Control-11 data (Low Byte)							
	21	Para Control-11 data (High Byte)							
	22	Para Control-12 data (Low Byte)							
	23	Para Control-12 data (High Byte)							
	24	Para Control-13 data (Low Byte)							
	25	Para Control-13 data (High Byte)							
	26	Para Control-14 data (Low Byte)							
	27	Para Control-14 data (High Byte)							
	28	Para Control-15 data (Low Byte)							
	29	Para Control-15 data (High Byte)							
	30	Para Control-16 data (Low Byte)							
	31	Para Control-16 data (High Byte)							

The following table explains the data (bits for byte 0) for instances 20, 21, 100, and 101.

Name	Description	Related Attribute	
		Class	Attr. ID
Run Fwd [1]	Forward Run Command	0x29	3
Run Rev [1]	Reverse Run Command	0x29	4
Fault reset [1]	Fault Reset Command	0x29	12
NetRef [2]	Not used	0x2A	4
NetCtrl [2]	Not used	0x29	5
Speed Reference	Reference speed	0x2A	8

3.2.3 Explicit messages

Explicit messages refer to non-periodic data communications used for reading or writing attribute values of an inverter or an EtherNet/IP.

Using the UCMM communication, data exchange is made without connecting the originator and the target, and periodic data exchange use of a Class 3 connection are available.

3.2.4 Supported objects

① Identity Object (Class 0x01, Instance 1)

Attribute

Attribute ID	Access	Attribute Name	Data Length	Attribute Value
1	Get	Vendor ID	Word	259
2	Get	Device Type (inverter)	Word	2
3	Get	Product Code	Word	7200 [3]

1 Refer to the Drive Run and Fault sections in the "Control Supervisor Object (Class 0x29)".
2 Reference speed and Run/Stop control can be set only on the LCD control panel. Network control instances 21 and 101 (NetRef, NetCtrl) are not available.
3 Product Code 7200 refers to the LS ELECTRIC S300 inverter.

Attribute ID	Access	Attribute Name	Data Length	Attribute Value
4	Get	Revision High Byte - Major Revision Low Byte - Minor Revision	Word	0x0101 [4]
5	Get	Status	Word	[5]
6	Get	Serial Number	Double Words	[6]
7	Get	Product Name	9 Bytes	S300_CENT

[4] The high byte stands for a major revision number, and the low byte stands for a minor revision number. For example, 0x0102 indicates version 1.02.
This revised version is separate from the Smart Loader Operator [OPC1-02] FBus S/W Ver.

[5] Definition of each Status Bit

Bit	Description
0	0: Device is not connected to the master 1: Device is connected to the master
1	Reserved
2	Configured (fixed as "1" because LS ELECTRIC EtherNet/IP is supported)
3	Reserved
4	0: Unknown 2: Faulty IO connection 3: IO connection has not been made 5: Major fault 6: IO connection has been made
5	
6	
7	
8	Minor recoverable fault (Inverter is in warning status)
9	Minor unrecoverable fault (N/A)
10	Major recoverable fault (inverter H/W trip occurred)
11	Major unrecoverable fault (inverter non-H/W trip occurred)

[6] Serial number uses the last 4 digits of the MAC ID.
e.g., The serial number is 0x29000022 when the MAC ID is "00:0B:29:00:00:22".

Service

Service Code	Definition	Support for class	Support for instance
0x0E	Get Attribute Single	No	Yes
0x05	Reset	No	Yes
0x01	Get Attribute All	No	Yes

② Motor Data Object (Class 0x28, Instance 1)

Attribute

Attribute ID	Access	Attribute Name	Range	Definition
3	Get	Motor Type	0-10	0: Non-standard motor 1: PM DC Motor 2: FC DC Motor 3: PM Synchronous Motor 4: FC Synchronous Motor 5: Switched Reluctance Motor 6: Wound Rotor Induction Motor 7: Squirrel Cage Induction Motor 8: Stepper Motor 9: Sinusoidal PM BL Motor 10: Trapezoidal PM BL Motor
6	Get/Set	Motor Rated Curr	1.0-1000.0	[Get] Reads the value of the [MOT1-26] Rated Current. [Set] Set value is reflected to [MOT1-26] Rated Current. Scale 0.1
7	Get/Set	Motor Rated Volt	180-480	[Get] Reads the value of the [MOT1-27] Rated Voltage. [Set] Set value is reflected to [MOT1-27] Rated Voltage. Scale 1

Service

Service code	Definition	Support for class	Support for instance
0x0E	Get Attribute Single	No	Yes
0x10	Set Attribute Single	No	Yes

③ Control Supervisor Objects (Class 0x29, Instance 1)

Attribute

Attribute ID	Access	Attribute Name	Range	Definition
3	Get/Set	Forward Run Cmd.	0	Stopped
			1	Forward Run [7]
4	Get/Set	Reverse Run Cmd.	0	Stopped
			1	Running Reverse [7]
5	N/A	Net Control	-	Configurable only with the inverter parameter.

[7] Drive Run Command
Inverter operation using Forward Run Cmd. and Reverse Run Cmd

Run1	Run2	Trigger Event	Run Type
0	0	Stop	NA
0 → 1	0	Run	Run1
0	0 → 1	Run	Run2
0 → 1	0 → 1	No Action	NA
1	1	No Action	NA
1 → 0	1	Run	Run2
1	1 → 0	Run	Run1

In the table above, Run1 indicates Forward Run Cmd. and Run 2 indicates Reverse Run Cmd. Commands are made by the Ethernet communication board when the value changes from 0 (FALSE) to 1 (TRUE). The Forward Run Cmd. value does not indicate the present operation status of the inverter; it indicates the operation command value on the Ethernet communication board.

Attribute ID	Access	Attribute Name	Range	Definition
6	Get	Drive State	0	Vendor Specific
			1	Startup
			2	Not Ready (resetting in progress)
			3	Ready (stopping in progress)
			4	Enabled (running, not applicable to deceleration stop)
			5	Stopping (decelerating)
			6	Fault Stop
			7	Faulted (trip occurred)
7	Get	Running Forward	0	Operation stopped
			1	Running Forward
8	Get	Running Reverse	0	Operation stopped
			1	Running Reverse
9	Get	Drive Ready	0	Resetting in progress or trip occurred
			1	Inverter is ready for operation
10	Get	Drive Fault	0	Trip has not occurred
			1	Trip has occurred
12	Get/Set	Drive Fault Reset	0	Trip reset to release the trip. Trip reset is triggered when entering a TRUE value in a FALSE status or vice versa. [8]
			1	
13	Get	Drive Fault Codes		Refer to the following Drive Fault Code [8]

[8] Drive Fault
The Drive Fault becomes TRUE when the inverter is tripped.
The Drive Fault Codes for the trips are as shown on the following page.

Attribute ID	Access	Attribute Name	Range	Definition
15	Get	Control From Net.	0	Operation command are made from the source other than RAPIEnet network (local network, including Smart Loader Operator). Control is from local
			1	Commands are made using the RAPIEnet communication as the source. Control is from Network

Drive Fault Codes

Fault Code Number	Description		
0x0000	None		
0x1000	MainFanFault		
0x2120	GroundFault		
0x2200	ARMShort	FuseOpen	HWOcsFail
0x2220	InverterOverLoad		
0x2300	OverCurrent		
0x2310	OverLoad		
0x3110	OverVoltage		
0x3120	LowVoltage		
0x3130	InPhaseOpen	NoMotor	
0x3131	OutPhaseUOpen		
0x3132	OutPhaseVOpen		
0x3133	OutPhaseWOpen		
0x3230	PrechargeFail	MCFail	
0x4300	DrvOverHeat		
0x5100	STOP24Fault	STOP5Fault	
0x5200	IOBoard		
0x5210	ADCOffset		
0x5400	GatePowerLoss		

Fault Code Number	Description		
0x6010	Watchdog		
0x6100	MainOSError		
0x6200	TRTuneFail	RSTuneFail	SLSTuneFail
	LSTuneFail	IFTuneFail	
0x6310	LoadDefaultPara		
0x7000	Option1	Option2	Option3
	AUXFanFault	ControlFanFault	
0x7120	EThermal	MotorOverHeat	
0x7200	NTCOpen	NTCShort	
0x7300	Encoder		
0x7301	EncoderNoConnection		
0x7302	EncoderWrongDir		
0x7510	LostIntComm		
0x7520	LostOptComm		
0x7530	LostSmart Loader Operator		
0x7540	LostUSB		
0x7600	ParameterWrite	DataStorage	
0x8321	UnderLoad		
0x8401	SpeedDeviation		
0x8402	OverSpeed		
0x9000	BX	MechanicalBrake	External1
	External2	External3	External4
	PrePIDFail	LostSensor	LostAI1
	LostAI2	LostAI3	LostAI4
	LostExtAI1	LostExtAI2	LostExtAI3
	LostExtAI4	STOFeedbackA	STOFeedbackB
	LostP24V		
0xF000	ResetRestartFail		

Drive Fault Reset

The Drive Fault Reset gives TRIP RESET reference to the inverter when the setting value changes from 0 to 1 (FALSE to TRUE). Or, it gives TRIP RESET reference to the inverter when setting value changes from 1 to 0 (TRUE to FALSE). Overwriting 1 (TRUE) over 1 (TRUE) or 0 (FALSE) over 0 (FALSE) does not generate RESET reference for a trip.

Service

Service Code	Definition	Support for class	Support for instance
0x0E	Get Attribute Single	No	Yes
0x10	Set Attribute Single	No	Yes

④ AC Drive Object (Class 0x2A, Instance 1)

Attribute

Attribute ID	Access	Attribute Name	Range	Definition
3	Get	At Reference	0	The output frequency has not reached the reference frequency.
			1	The output frequency has reached the reference frequency.
4	N/A	Net Reference	-	
6	Get	Drive Mode	0	Vendor Specific Mode
			1	Open Loop Speed (Frequency)
			2	Closed Loop Speed Control
			3	Torque Control
			4	Process Control (e.g. PI)
7	Get	SpeedActual	0-24000	Displays the present output frequency in [rpm].
8	Get/Set	SpeedRef	0-24000	Displays the reference frequency in [rpm]. [DRV-11] The 1st Frequency Reference Source must be set to Option Comm. for it to take effect.
9	Get	Actual Current	0-111.0 A	Monitors the present current in 0.1 A increments/decrements.

Attribute ID	Access	Attribute Name	Range	Definition
29	Get	Ref.From Network	0	The frequency command source is not DeviceNet communication.
			1	The frequency command source is DeviceNet communication.
100	Get	Actual Hz	0-400.00 Hz	Monitors the current operating frequency (in Hz).
101	Get/Set	Reference Hz	0-400.00 Hz	When [DRV-11] 1st Freq Ref Src is set to 8. Option Comm., the command frequency can be set via communication.
102	Get/Set	Acceleration Time [9]	0-6000.0 sec	Sets/monitors the acceleration time of the inverter.
103	Get/Set	Deceleration Time [10]	0-6000.0 sec	Sets/monitors the deceleration time of the inverter.

Service

Service code	Definition	Support for class	Support for instance
0x0E	Get Attribute Single	No	Yes
0x10	Set Attribute Single	No	Yes

[9] This is the [DRV-05] Acc Time value.
[10] This is the [DRV-06] Dec Time value.

⑤ Inverter Object (Class 0x65) – Manufacture Profile

This object is used to access the operation Parameters of the Smart Loader Operator.

Attribute

Instance	Access	Attribute Number	Attribute Name	Attribute Value
1 (16bit)	Get/ Set	Same as the 16-bit address of the S300 Parameter	S300 Smart Loader Operator Title (Refer to the S300 inverter user manual)	Setting scope of the S300 Parameter (Refer to the S300 inverter user manual)
2 (32bit)		The 16/32-bit address of the S300 Parameter is the same (designed to be compatible with both 32-bit and 16-bit addresses)		

Service

Service Code	Definition	Support for class	Support for instance
0x0E	Get Attribute Single	No	Yes
0x10	Set Attribute Single	No	Yes

3.3 Modbus TCP

3.3.1 ModbusTCP frame structure

MBAP Header (7 bytes)	PDU (5 bytes or greater)

In general, Ethernet communication uses Ethernet II frames.

MODBUS Application Protocol header (MBAP header)

The following table explains the components of a MBAP header.

Section	Length	Description
Transaction Identifier	2 Bytes	The unique transmission number increases by 1 each time a Data Frame is sent from the Client to the Server.
Protocol identifier	2 Bytes	Fixed at 0.
Length	2 Bytes	In Modbus, the Data Frame length indicates the byte length starting from the Unit Identifier in the MBAP Header.
Unit identifier	1 Byte	When Modbus TCP and Modbus RTU are connected through a gateway, the Slave number will be specified. The address is fixed to 0xFF when Modbus TCP communication is used alone.

Protocol Data Unit (PDU)

PDU is the actual data in the Modbus TCP in the communication, which is composed of a function code and data.

A detailed explanation will be provided below in the "3.3.2 Function codes" section.

3.3.2 Function codes

The Modbus TCP involves clients and a server. During communication, clients send commands to the server, and the server responds to the commands. In general, devices such as a PLC, HMI, and PC are used as the client, and the inverter works as a server.

① Read Holding Registers

Read Input registers are functions used to read the server (inverter) data.

The following table explains the components of a request data frame from a client to a server.

Request frame	Length	Value
Function code	1 Byte	0x03
Comm. address	2 Bytes	0x0000–0xFFFF
Number of data requests	2 Bytes	1-16 (LS ELECTRIC inverters)

The following table explains the components of a response data frame from a server to a master.

Response frame	Length	Value
Function code	1 Byte	0x03
Byte Count	1 Byte	The number of 2 x data requests
Data value	The number of data requests x 2 bytes	Data value of the given number from the comm. address

② Read Input registers

Read Input registers are functions used to read the server (inverter) data.

The following table explains the components of a request data frame from a client to a server.

Request frame	Length	Value
Function code	1 Byte	0x04
Comm. address	2 Bytes	0x0000–0xFFFF
Number of data requests	2 Bytes	1-16 (LS ELECTRIC inverters)

The following table explains the components of a response data frame from a server to a master.

Response frame	Length	Value
Function code	1 Byte	0x04
Byte Count	1 Byte	The number of 2 x data requests
Data value	The number of data requests x 2 bytes	Data value of the given number from the comm. address

③ Write Single Register

Write Single registers are functions used to write a single server (inverter) data.

The following table explains the components of a request data frame from a client to a server.

Request frame	Length	Value
Function code	1 Byte	0x06
Comm. address	2 Bytes	0x0000–0xFFFF
Data value	2 Bytes	0x0000–0xFFFF

The following table explains the components of a response data frame from a server to a master.

Response frame	Length	Value
Function code	1 Byte	0x06
Comm. address	2 Bytes	0x0000–0xFFFF
Data value	2 Bytes	0x0000–0xFFFF

④ Write Multiple Register

Write Multiple registers are functions used to write 1 to 16 consecutive data items on the server (inverter).

The following table explains the components of a request data frame from a client to a server.

Request frame	Length	Value
Function code	1 Byte	0x10
Comm. address	2 Bytes	0x0000–0xFFFF
Amount of data to write	2 Bytes	1-16 (LS ELECTRIC inverters)
Byte Count	1 Byte	Amount of 2 x data
Amount of data to write	Amount of data x 2 bytes	Amount of data to write

The following table explains the components of a response data frame from a server to a master.

Response frame	Length	Value
Function code	1 Byte	0x10
Comm. address	2 Bytes	0x0000–0xFFFF
Amount of data to write	2 Bytes	1-16 (LS ELECTRIC inverters)

⑤ Read/Write Multiple Registers

Read/Write Multiple Registers are functions used to write 1 to 16 consecutive data items on the server (inverter) and

used to read the server (inverter) data at the same time

The following table explains the components of a request data frame from a client to a server.

Request frame	Length	Value
Function code	1 Byte	0x17
Comm. address	2 Bytes	0x0000–0xFFFF
Amount of data to write	2 Bytes	1-16 (LS ELECTRIC inverters)
Byte Count	1 Byte	Amount of 2 x data
Amount of data to write	Amount of data x 2 bytes	Amount of data to write

The following table explains the components of a response data frame from a server to a master.

Response frame	Length	Value
Function code	1 Byte	0x17
Byte Count	1 Byte	The number of 2 x data requests
Data value	The number of data requests x 2 bytes	Data value of the given number from the comm. address

3.3.3 Exception Frame

An exception frame is a response frame from a server when an error occurs while responding to the client.

The following table explains the components of an exception frame.

Error frame	Length	Value
Error code	1 Byte	0x80 + function code requested by the client
Exception code	1 Byte	0x00-0xFF

Exception code types

Type	Code	Description
ILLEGAL FUNCTION	0x01	An unsupported function has been requested
ILLEGAL DATA ADDRESS	0x02	Attempting to request or modify data at an unused address
ILLEGAL DATA VALUE	0x03	A data modification request has been made out of the range of the available value.
SLAVE DEVICE FAILURE	0x04	Server error (CAN communication error with the drive, communication board initialization error, or data communication error with the drive)
SLAVE DEVICE BUSY	0x06	The server is busy with other tasks and cannot respond (in the middle of a drive parameter initialization or the initial setting of the communication board)
WRITE PERMITION ERROR	0x14	Attempting to modify a read-only parameter using a code specific to LS ELECTRIC inverters

4 LED Indications and troubleshooting

4.1 LED Indications

LED name	Color	Status Description	Status	Description
LINK1	Green	Network normal	ON	Network connection at LINK 1 is operating normal
	Orange	Check network settings	ON	When the communication cycle stops for longer than one second.
	-	LINK 1 Not connected	OFF	Network connection at LINK 1 is disconnected and not operating normally
LINK2	Green	Network normal	ON	Network connection at LINK 2 is operating normally
	Orange	Check network settings	ON	When the communication cycle stops for longer than one second.
	-	LINK 2 Not connected	OFF	Network connection at LINK 2 is disconnected and not operating normal

LED name	Color	Status Description	Status	Description
ERROR	-	Normal operation	OFF	Normal communication between the S300 RAPIEnet+ communication option board and the inverter
	Red	Network fault	Flashing (1 second interval, Synchronous flashing with the CPU LED)	Communication between the S300 RAPIEnet+ communication board and the inverter is abnormal.
			Flashing (1 second interval, Asynchronous flashing with the CPU LED)	EIP instance setting values mismatch
			Flashing (2-second interval)	The communication parameters set by the Smart Loader Operator are different from those set on the S300 RAPIEnet+ communication option board
			ON	EEPROM failure No network connection to LINK 1 and LINK 2 IP collision occurred
CPU	Green	Normal operation	Flashing (1 second interval)	The S300 RAPIEnet+ communication option board has been properly installed on the inverter.

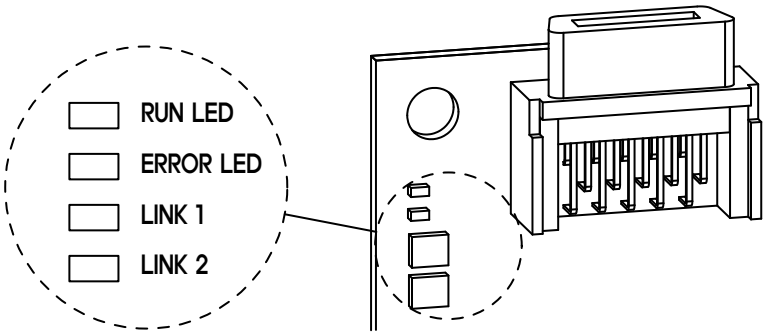
4.2 Troubleshooting

No.	Issue	Troubleshooting
1	When both the ERROR LED and CPU LED are off	This issue may occur if the power is not supplied properly to the S300 RAPIEnet+ communication option board. 1) Ensure that the S300 RAPIEnet+ communication option board is correctly installed in the main inverter unit. 2) Check if the pins of the connector on the S300 RAPIEnet+ communication option board connected to the main unit are not damaged or bent. 3) If the same issue persists after taking the above measures, it indicates a hardware failure of the S300 RAPIEnet+ communication option board. Contact the LS ELECTRIC service center or Customer Service.
2	When the ERROR LED is on and the CPU LED is off,	It is a hardware failure of the S300 RAPIEnet+ communication option board. Contact the LS ELECTRIC service center or Customer Service.
3	When the ERROR LED is on and the CPU LED is flashing at 1-second intervals	1) Check if the LINK LED on the port where the LAN cable is connected is lit. If it is not lit, ensure that the LAN cable is securely connected to the port on the S300 RAPIEnet+ communication option board. 2) Make sure the IP assigned to the S300 RAPIEnet+ communication option board does not conflict with the IP of another device on the same network. 3) If the same issue persists after taking the above measures, it indicates a hardware failure of the S300 RAPIEnet+ communication option board. Contact the LS ELECTRIC service center or Customer Service.
4	When both the ERROR LED and CPU LED are flashing simultaneously at 1-second intervals	1) Check if the pins of the connector on the S300 RAPIEnet+ communication option board connected to the main inverter unit are not damaged or bent. 2) If the same issue persists after taking the above measures, it indicates a hardware failure of the S300 RAPIEnet+ communication option board. Contact the LS ELECTRIC service center or Customer Service.

No.	Issue	Troubleshooting
5	When the ERROR LED and CPU LED are flashing alternately at 1-second intervals	Check if the EIP communication instance settings configured in the PLC match [OPC1-52] OptParameter02 and [OPC1-53] OptParameter03. After confirming, set [OPC1-99] Comm Update to [Yes] to apply the settings. Refer to “PART 2-1.3 OPC1, OPC2 Groups” in this document.
6	When the CPU LED is flashing at 1-second intervals and the ERROR LED is flashing at 2-second intervals	Set [OPC1-99] Comm Update to [Yes] to synchronize the communication parameters set by the Smart Loader Operator with those configured on the S300 RAPIEnet+ communication option board.

PART3 PROFINET Communication Functions

1 Information on the PROFINET Mode LED Display



	LED name	Color	Status Description	Status	Description
LED0	LINK1/ ACT1	Green	Normal operation	ON	Network Link 1 is connected
				OFF	Network Link 1 is not connected
		Red	Normal operation	OFF	No data transmission/ reception on Network Link 1
				Flash	Data transmission/reception with the communication master is in progress on Network Link 1
LED1	LINK 2/ ACT 2	Green	Normal operation	ON	Network Link 2 is connected
				OFF	Network Link 2 is not connected
		Red	Normal operation	OFF	No data transmission/ reception from Network Link2
				Flash	Network Link 2 transmits/ receives data from the network master module

	LED name	Color	Status Description	Status	Description
LED2	ERROR	Red	Normal operation	OFF	Normal communication between the S300 RAPIEnet+ communication option board and the inverter
			Network fault	Simultaneous flashing of CPU and ERROR LED	Indicates a communication failure between the S300 RAPIEnet+ communication option board and the inverter.
				The ERROR LED flashes more slowly than the CPU LED (2-second intervals).	The PLC and PROFINET communication settings are not normal
				ON	Not booting
LED3	CPU	Green	Abnormal operation	ON	CPU operation halted
				OFF	
			Normal operation	Flash (1 second interval)	The S300 RAPIEnet+ communication option board has been properly installed on the inverter.

2 PROFINET Mode Related Smart Loader Operator Parameters

To operate the S300 inverter using the S300 RAPIEnet+ communication option board, set the DRV-10 1st Command Source of the Smart Loader Operator to [6 Option Comm.).

To give frequency commands to the inverter using the S300 RAPIEnet+ communication option board, set DRV-11 Freq Ref Src to [8 Option Comm.].

Code	Parameter Name	Initial Value	Range
Setting	Drive Set-36	-	PROFINET
DRV	10 1st Command Source	1 Fx/Rx-1	0: Keypad
			1: Fx/Rx-1
			2: Fx/Rx-2
			3: 3-Wire
			4: Internal Comm.
			5: USB Comm.
			6: Option Comm
			7: UserSequence
	11 1st Freq Ref Src	0 Keypad	0: Keypad
			1: Analog Input 1
			2: Analog Input 2
			3: Analog Input 3
			4: Pulse Input
			5: Up Down Drive
			6: Internal Comm.
			7: USB Comm.
			8: Option Comm.
	20 Max Frequency	60.0	40.0-590.0 LSE new mode: When using Standard Telegram 1, it is used as the ref value. LSE new mode: When using Standard Telegram 20, it is used as the ref value.

Code	Parameter Name	Initial Value	Range
OPC1	01 Fbus Option Type	0	Selects the protocol you want to use. 0: RAPIEnet+ 1: PROFINET
	02 FBus S/W Ver	-	-
	03 FBus H/W Ver	-	-
	04 FBus Led	-	-
	07 FBus IP Addr1	0	IP - 1
	08 FBus IP Addr2	0	IP – 2
	09 FBus IP Addr3	0	IP – 3
	10 FBus IP Addr4	0	IP - 4
	11 FBus Subnet Mask1	0	Subnet Mask - 1
	12 FBus Subnet Mask2	0	Subnet Mask - 2
	13 FBus Subnet Mask3	0	Subnet Mask – 3
	14 FBus Subnet Mask4	0	Subnet Mask - 4
	15 FBus Gateway Addr1	0	Gateway - 1
	16 FBus Gateway Addr2	0	Gateway - 2
	17 FBus Gateway Addr3	0	Gateway - 3
	18 FBus Gateway Addr4	0	Gateway – 4
	21 Profile CSM *CSM: Compatibility support mode	0	0: LSE new mode 1: LSE old mode

Code	Parameter Name	Initial Value	Range
OPC1	22 Telegram	0	**Profile CSM 0 LSE new mode** 0: Standard Telegram1 1: Standard Telegram20 2: Vendor Specific Telegram88 3: Vendor Specific Telegram1616 4: Vendor Specific Telegram3232 5: LSE Telegram **Profile CSM 1 LSE old mode** 0: Standard Telegram1 1: Vendor Specific Telegram
	26 Password	xxxx	This is the password used to access the built-in web server, and it will automatically change after each reboot, but if the user sets it manually, it will remain fixed. Resumed to random operation upon parameter initialization.
	27 SSQ Push	0	Sends status data to LSE cloud. 0: disable 1: enable
	28 SSQ Control	0	Accept control through LS cloud. Displayed if OPC1-27 (SSQ Push) is enabled. 0: disable 1: enable
	29 Webserver enable	0	Enable the default webserver. 0: disable 1: enable
	31 MB Timeout	60	This is the time setting for terminating the session when the communication is idle in Modbus TCP. 1 - 120 [s]

Code	Parameter Name	Initial Value	Range
PRT	21 Lost OptComm Mode	0 None	0: None 1: Free-Run 2: Trip Dec Time Stop 3: Warning 4: Lost Preset
	22 Lost OptComm Time	1.0	0.1 - 120.0 [s]
	14 Lost Preset Freq	0.00	0. 0 - Max Frequency

3 Details for of PROFINET Mode Related Smart Loader Operator Parameters

3.1 Driveset Group

① [Driveset-36] Option-1 Type: Displays the option slot-1 type

This automatically displays the communication option board installed in the current S300. It is displayed as "PROFINET."

3.2 DRV group

① [DRV-10] 1st Command Source

Select the command source for the S300 inverter. To input an operation command via communication using the S300 communication option board, select [6 Option Comm.].

② [DRV-11] 1st Freq Ref Src: Frequency Settings

Select the frequency command source for the S300 inverter. Set to “[8 Option Comm.]” to set the S300 communication option board as the frequency command source and provide frequency commands via a network.

③ [DRV-20] Max Frequency: Set maximum frequency

Used as a reference for target speed when using (New) Standard Telegram 1/ Standard Telegram 20 Execute Comm Update (OPC1-99) after setting the value.

Motor operation frequency = Setpoint value* max_Frequency(DRV-20: Max Freq)/0x4000

e.g., motor operation frequency 60Hz, when DRV-20: 60Hz, Setpoint value: 0x4000

e.g., motor operation frequency 30Hz, when DRV-20: 60Hz, Setpoint value: 0x2000

e.g., motor operation frequency 400Hz, when DRV-20: 400Hz, Setpoint value: 0x4000

e.g., motor operation frequency -400Hz, when DRV-20: 400Hz, Setpoint value: 0xC000

3.3 OPC1 group

① [OPC1-02] FBus S/W Ver: PROFINET S/W version

Automatically indicate the version of the PROFINET mode of the communication board installed on the S300 inverter.

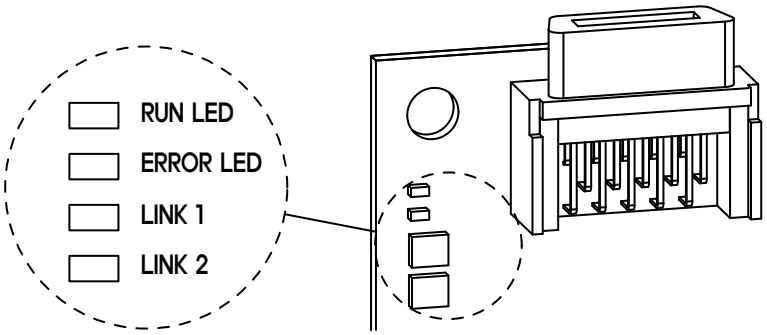
② [OPC1-03] FBus H/W Ver: Communication option board H/W version

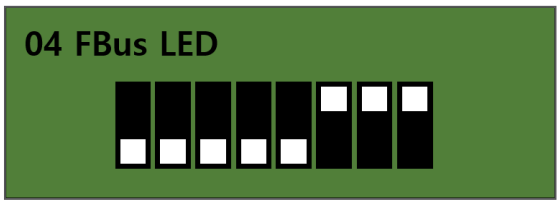
Automatically indicate the version of the communication board installed to the S300 inverter.

③ [OPC1-04] FBus Led: S300 RAPIEnet+ Communication Option Board LED Indications

The LED display section of the S300 RAPIEnet+ communication option board can be checked through the Smart Loader Operator. Refer to "PART3 Chapter 1 Information on the PROFINET Mode LED Display" for operations related to the LED display.

Example of the [OPC1-04] FBus LED indication



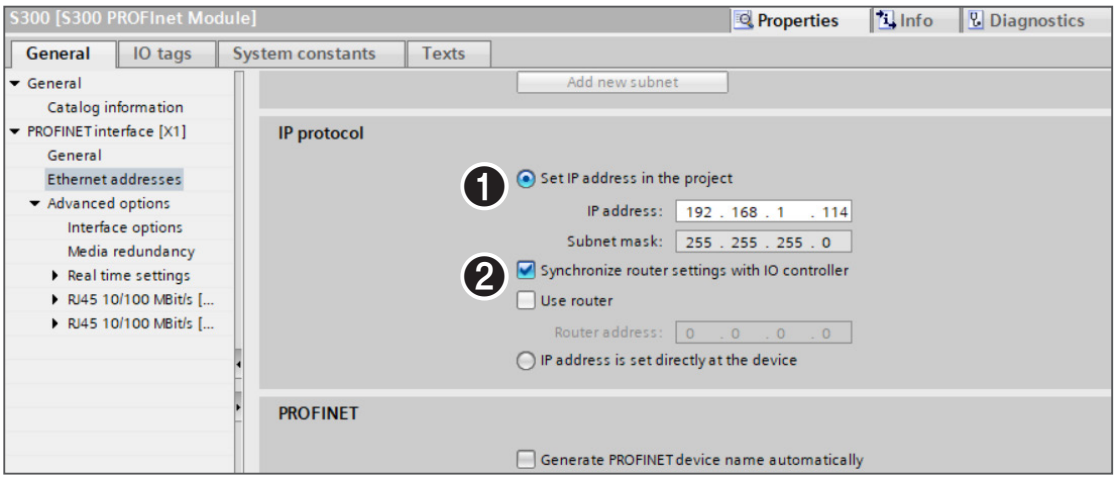


Reserved	Reserved	Reserved	Reserved	LINK1	LINK2	ERROR LED	CPU LED
Not used (indicates off)				LED is OFF	LED is ON	LED is ON	LED is ON

④ [OPC1-7 - 18] Set up IP Address, Subnet Mask, and Gateway

The IP version supported by the S300 RAPIEnet+ communication option board is v4. All network and mask addresses are expressed in four decimal numbers between 0 and 255 (i.e. 255.255.255.255). The set IP addresses may be forced to change the value set by PLC through its DCP packet.

Example: When programming a PLC in Siemens' TIA, if you select option ① as shown in the image below, the PLC will record the IP information indicated below onto the S300 RAPIEnet+ communication option board through a DCP packet and set the IP accordingly. If you select option ②, the PLC will attempt to establish a PROFINET communication connection with the S300 RAPIEnet+ communication option board after reading the IP information already recorded on the S300 RAPIEnet+ communication option board, without following the process described earlier.



⑤ [OPC1-21, 22] Profile CSM, Telegram Mode Settings

The S300 RAPIEnet+ communication option board supports two modes: LSE new mode and LSE old mode. The telegrams supported by each mode are listed in the table below. For details on the types and content of the supported telegrams, refer to "PART3 4.4 Telegram"

Set value		Selected Telegram
OPC1-21 Profile CSM	OPC1-22 Telegram	
LSE new mode	0	Standard Telegram 1
	1	Standard Telegram 20
	2	Vendor Specific Telegram 88
	3	Vendor Specific Telegram 1616
	4	Vendor Specific Telegram 3232
	5	LSE Telegram
LSE old mode	0	Standard Telegram 1
	1	Vendor Specific Telegram

⑥ [OPC1-31] MB Timeout Settings

This is the time setting for terminating the session when the communication is idle in the Modbus TCP used in PROFINET mode.

The communication session will be terminated after the specified time has elapsed since the last data was received from the client. The time setting is in seconds.

3.4 PRT Group

① [PRT-21] Lost OptComm Mode: Decelerated operation mode for a command loss

Choose the operation mode for a command loss. The table below presents the available operation mode.

Set value		Description
0	None	The speed reference immediately becomes the operation frequency without any protective operation.
1	Free-Run	The inverter blocks the output. The motor makes a free run.
2	Trip Dec Time Stop	The motor decelerates and then stops at the time set at Trip Dec Time.
3	Warning	Trigger a warning for a command loss.
4	Lost Preset	The inverter operates with frequency reference set at PRT-14 (Lost Preset Frequency).

② [PRT-22] (Lost OptComm Time): decision time for a command loss

Set the time duration until the operation mode set with PRT-22 will be reflected following a command loss (Lost Command). You can set a value between "0.1" and "120" seconds.

③ [PRT-14] Lost Preset Frequency: Operation frequency for a command loss

A protective function is activated and the inverter continues to operate using the frequency set with PRT-14 following a command loss (Lost Command). The setting value is from the start frequency to the max frequency [Hz].

4 Communication Profile

Communication Profile displays the procedures between master and slaves (inverter), including command (control word, status word, references and actual values, etc.). Data transmission between the PROFINET master and slaves is made through IN/Out data fields. The master records and controls the slaves' (drive) OUT data, while the slaves (drive) deliver IN data to respond to the master.

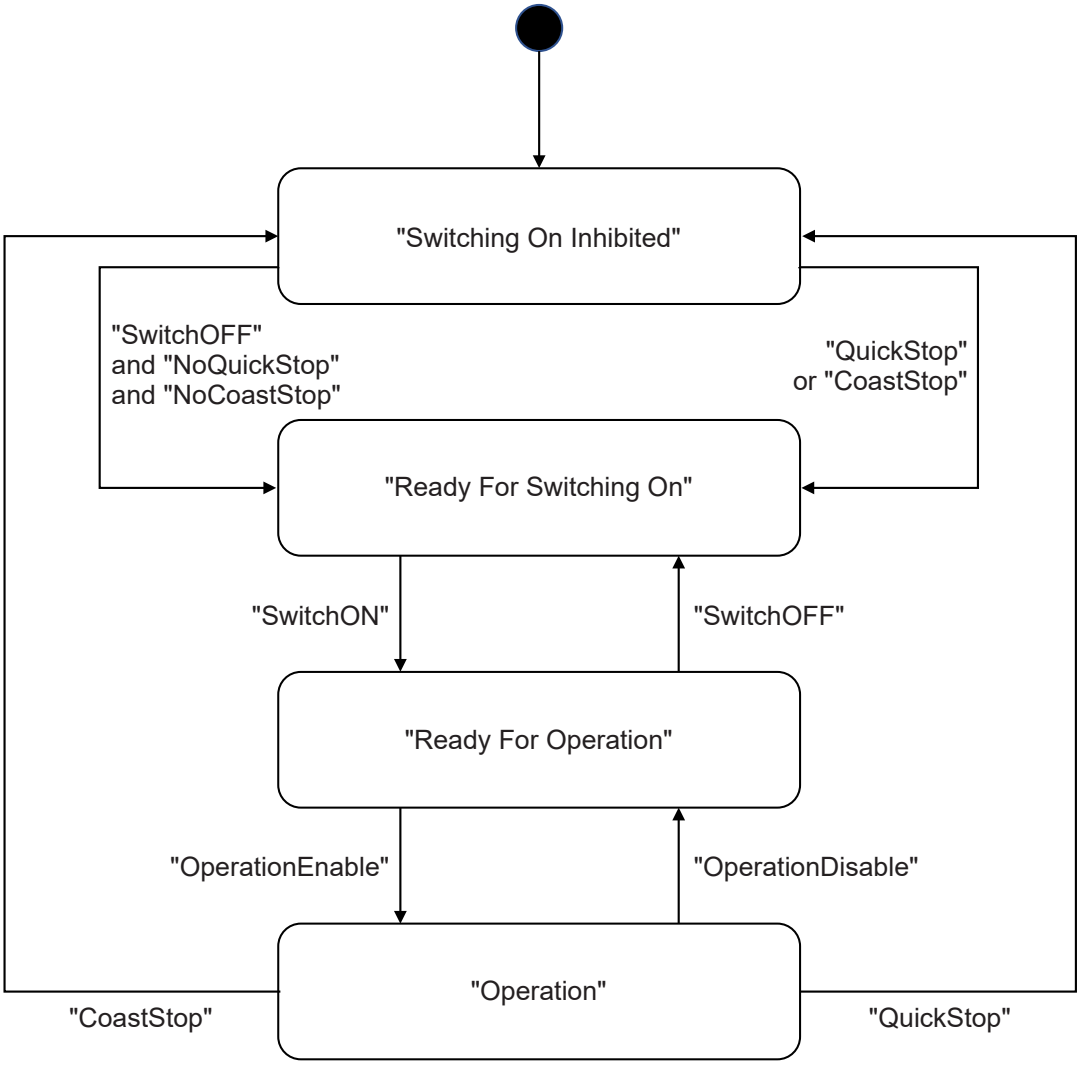
The S300 RAPIEnet+ communication option board supports the I/O Profile, PROFIdrive Profile, and LS Drive Profile, and each profile selects and uses telegram accordingly.

Set value			Selected Telegram
OPC-21 Profile CSM		OPC-22 Telegram	
LSE new mode	PROFIdrive Profile	0	Standard Telegram 1
		1	Standard Telegram 20
	I/O Profile	2	Vendor Specific Telegram 88
		3	Vendor Specific Telegram 1616
		4	Vendor Specific Telegram 3232
	LS Drive profile	5	LSE Telegram
LSE old mode	PROFIdrive Profile	0	Standard Telegram 1
		1	Vendor Specific Telegram

4.1 PROFIdrive Profile

The control word is used in the control system according to the PROFIdrive Profile and the status word indicates changed status by control word, etc. Accessing the control parameter (0h0005, 0h000A, 0x0381, 0x0015) for inverter operation and target frequency is not recommended when using the PROFIdrive Profile.

The diagram below represents the state transitions for each condition when using the PROFIdrive Profile.



PROFIdrive State-machine

Status	Description
S1: Switching On Inhibited	The current state of the S300 RAPIEnet+ communication option board means that it cannot be switched on.
S2: Ready For Switching On	Ready to change to the "Switch on" state any time.
S3: Ready For Operation	Ready to change to the "Operation enable" state any time.
S4: Operation enable	The motor is running.

The periodic command from PLC changes the states. The types of commands are as follows, and detailed information is explained in the "Control word (STW1)" section on the following page.

① NoQuickStop command

② NoCoastStop command

③ SwitchOFF command

④ SwitchON command

⑤ OperationEnable command

⑥ OperationDisable command

⑦ QuickStop command

⑧ CoastStop command

The table below lists the events and operation for each state.

Source State	Target State	Event	Action
"Switch On Inhibited"	"Ready For Switching On"	"SwitchOFF" and "NoQuickStop" and "NoCoastStop"	None (the motor stopped)
"Ready For Switching On"	"Switch On Inhibited"	"QuickStop" or "CoastStop"	None (the motor stopped)
"Ready For Switching On"	"Ready For Operation"	"SwitchON"	None (the motor stopped)
"Ready For Operation"	"Ready For Switching On"	"SwitchOFF"	None (the motor stopped)

Source State	Target State	Event	Action
"Ready For Operation"	"Operation"	"OperationEnable"	Motor runs.
"Operation"	"Ready For Operation"	"OperationDisable"	Motor stop (The motor is stopped using the method set in BAS-2 Stop Mode in the S300 inverter parameters).
"Operation"	"Switch On Inhibited"	"CoastStop"	Motor stops (Free Run Stop)
"Operation"	"Switch On Inhibited"	"QuickStop"	Motor stop (The motor is stopped using the method set in BAS-2 Stop Mode in the S300 inverter parameters).

Control word (STW1)

Bit	Name	Value	Description
0	ON	1	Ready to operation (Operational state enabled by PLC)
	OFF1	0	NOT Ready to operation (Operational state disabled by PLC)
1	No OFF2	1	The OFF2 (Coast Stop) function is not configured. Maintain the current operation.
	OFF2 (Coast Stop)	0	The motor will stop using Free Run Stop (emergency stop).
2	No OFF3	1	The OFF3 (Quick Stop) function is not configured. Maintain the current operation.
	OFF3(Quick Stop)	0	The motor is stopped using the method set in the S300 inverter parameter BAS-02 Stop Mode.

Bit	Name	Value	Description
3	Enable Operation	1	The motor is operated based on the Setpoint value (command frequency) received from the PLC via PROFINET communication.
	Disable Operation	0	The motor is stopped using the method set in the S300 inverter parameter ADV-8 Stop Mode.
4	Enable Ramp Generator	1	The motor accelerates and decelerates according to the Acc Time and Dec Time settings in the S300 inverter parameters (PAR→DRV) to reach the Setpoint Value (command frequency).
	Reset Ramp Generator	0	The motor command value is forcibly set to 0 (the frequency decelerates to 0 Hz according to the Dec Time setting).
5	Unfreeze Ramp Generator	1	Without fixing the ramp generator operation, refer to Acc Time and Dec Time of drive group (PAR->DRV) among the parameters of the S300 inverter, and accelerate/decelerate a certain amount of time to reach the motor command value (Setpoint value).
	Freeze Ramp Generator	0	Through PROFINET, the motor command value from the PLC is ignored, and the Ramp Generator operation is fixed so that the motor is operated at its current rotation frequency.
6	Enable Setpoint	1	Operate the motor according to the motor command from PLC.
	Disable Setpoint	0	Force to set the motor command value to 0.
7	Fault Acknowledge	(0 → 1)	When changing from 0 to 1, turn off the S300 inverter's fault.
8	Jog1 ON/OFF	-	Not available
9	Jog2 ON/OFF	-	Not available
10	Control By PLC	1	Controls the S300 inverter using control word (STW1) received from the PLC via PROFINET communication.
	No Control By PLC	0	Ignores the control word (STW1) received from the PLC via PROFINET communication.
11 - 15	-	-	Reserved

The status change shown in "PROFIdrive State-machine" can be modified by changing the value of the control word according to values of Bits 0-3. For example, to change the status to "Operation," the control word must be "XXXX XXXX XXXX 1111" in bits.

Note

The "X" symbol means that this value does not make any difference (whether it is set to "0" or "1").

The Bits 0–3 values define the change status command.

Command	Bit3	Bit2	Bit1	Bit0
QuickStop	X	0	X	X
CoastStop	X	X	0	X
NoQuickStop	X	1	X	X
NoCoastStop	X	X	1	X
SwitchOFF	X	1	1	0
SwitchON	X	1	1	1
OperationEnable	1	1	1	1
OperationDisable	0	1	1	1

This command internally uses the inverter communication address 0x0382 as the operational command, and the default Control word (STW1) Bit for motor operation is 0x47F (Bit 0,1,2,3,4,5,6,10). Setting the command frequency will enable basic motor operations when operation command Bit (0x47F) is set by PLC.

e.g., Bit settings for motor operation

Bit types	Bit10	Bit9	Bit8	Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
Set Value	1	- [1]	- [1]	0	1	1	1	1	1	1	1

[1] Motor operation is available regardless of "-" settings.

Status word(ZSW1)

Bit	Name	Value	Description
0	RDY_ON	1	Ready To Switch ON (Operational status)
		0	Not Ready to Switch OFF (Inoperable state)
1	RDY_OPERATION	1	Indicates the value of bit 0 of the currently received Control word (STW1).
		0	
2	OPERATION	1	Indicates the value of bit 3 of the currently received Control word (STW1).
		0	
3	Fault Present	1	Indicates inverter fault.
	No Fault	0	Indicates that there is no fault.
4	No OFF2	1	Indicates the value of bit 1 of the currently received Control word (STW1).
	OFF2	0	
5	No OFF3	1	Indicates the value of bit 2 of the currently received Control word (STW1).
	OFF3	0	
6	SWC_ON_INHIB	1	Switching On inhibited (Out of control)
		0	Switching On Not inhibited (Controllable status)
7	Warning Present	1	Indicates inverter warnings.
	No Warning Present	0	Indicates no inverter warnings exist.
8	Speed Error within tolerance	1	Indicates that the motor's actual rotation frequency has reached the command frequency (“Setpoint value”).
	Speed Error out of tolerance	0	Indicates that the motor's actual rotation frequency has not reached the command frequency (“Setpoint value”).
9	Control Requested	1	Indicates the value of bit 10 of the currently received Control word (STW1).
	No Control Requested	0	
10	ABOVE_LIMIT	-	Not Supported
11 to 15	-	-	Reserved

According to the state shown in the "PROFIdrive State-machine," Bits 0-2 and Bit 6 indicate the state value of the communication option board as shown in the table below.

Status Word	Status
xxxx xxxx x1xx x000 [2]	"Switching On Inhibited"
xxxx xxxx x0xx x001	"Ready For Switching On"
xxxx xxxx x0xx x011	"Ready for Operation"
xxxx xxxx x0xx x111	"Operation"

Setpoint value

Indicate inverter's operation command frequency, the unit is Hz, and the scale is 0.01.

* When using New Standard Telegram 1/20, the DRV-20 value is referenced and used in percentage units (0xC000-0x4000).

Motor operation frequency = Setpoint value* max_Frequency(DRV-20: Max Freq)/0x4000

e.g., motor operation frequency 60Hz, when DRV-20: 60Hz, Setpoint value: 0x4000

e.g., motor operation frequency 30Hz, when DRV-20: 60Hz, Setpoint value: 0x2000

e.g., motor operation frequency 400Hz, when DRV-20: 400Hz, Setpoint value: 0x4000

e.g., motor operation frequency -400Hz, when DRV-20: 400Hz, Setpoint value: 0xC000

Actual speed value

This indicates the inverter's actual output frequency; the unit is Hz, and the scale is 0.01.

* When using New Standard Telegram 1/20, the DRV-20 value is referenced and used in percentage units (0xC000-0x4000).

[2] "X" marked Bit means it doesn't affect the operation.

Alarm Info

Bit	Name	Description
0 to 7	FAULT/WARNING codes	Refer to addresses for the communication common compatible area parameter starting with 0h0400 Refer to addresses starting with 0h0420
8 to10	The number of faults currently occurring	0 - 6
11 to 13	The number of warnings currently occurring	0 - 6
14 to 15	01xx: Fault occurred 10xx: Warning occurred	Fault occurred Warning occurred

① Torque

Indicates the output torque; the unit is %, and the scale is 0.1.

ⓘ Caution

The normal torque output is only shown when control mode is sensorless, vector.

② Current

Indicates the output current; the unit is % at the maximum output, and the scale is 0.1.

The output unit in the Profile CSM Old Telegram is in Amperes (A).

③ Power

Indicates the output power; the unit is % at the maximum output, and the scale is 0.1.

The output unit in the Profile CSM Old Telegram is in kilowatts (kW).

④ Fault

Indicates information about the currently occurring faults.

Bit 15	Bit 14 - Bit 0
Whether fault occurred 1: Occurred 0: Not occurred	Fault number

⑤ Dummy: Not used

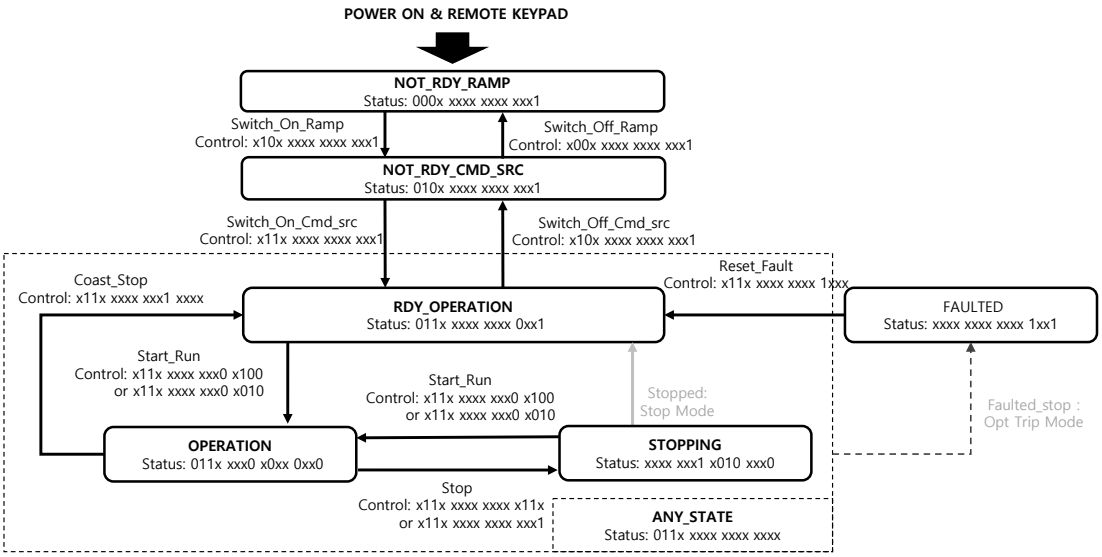
4.2 I/O Profile

Proceed data exchange without applying a profile. Exchange data with master according to the para control from OPC parameter and parameter address designated for para status and applied when using the telegram below.

Set value			Selected Telegram
OPC-21 Profile CSM		OPC-22 Telegram	
New	I/O Profile	2	Vendor Specific Telegram 88
		3	Vendor Specific Telegram 1616
		4	Vendor Specific Telegram 3232

4.3 LS Drive Profile

A standard profile set by LS ELECTRIC. It is used for drive speed control mode and offers control/status checks with a control and status words. Accessing the control parameter (0h0005, 0h000A) for inverter operation and target frequency is not recommended when using the LS Drive Profile.



Control word

Bit	Name	Value	Description
0	Stopped	0	No control command
		1	Stop operation command
1	Forward operation	0	No control command
		1	Forward operation command
2	Reverse operation command	0	No control command
		1	Reverse operation command
3	Resolve faults	0	No control command
		1	Initialize faults status
4	Emergency stop	0	No control command
		1	Forced emergency stop (Coast Stop)
5-12	-	-	-
13	Operation command authority	-	
		1	Authorize operation command DRV→1st Command Source → Option Comm.
14	Speed source command authority	-	
		1	Speed source command authority DRV→1st Freq Ref Source → Option Comm.
15	-	-	-

Status Word

Bit	Name	Value	Description
0	Stopped	0	Not stopped
		1	Stopped by the stop mode
1	Forward operation in progress	0	Forward operation not in progress
		1	Forward operation in progress
2	Reverse operation in progress	0	Reverse operation not in progress
		1	Reverse operation in progress

Bit	Name	Value	Description
3	Fault occurred	0	No fault exists
		1	Fault occurred
4	Accelerating	0	Not accelerating
		1	Accelerate according to the target command
5	Decelerating	0	Not Decelerating
		1	Decelerate according to the target command
6	Speed reached	0	Target speed not reached
		1	Target speed reached
7	DC braking	0	No DC braking
		1	DC braking in progress
8	Stop operation in progress	0	Stop mode not occurred
		1	Initiate stop mode
9	Jog mode	0	Turn off jog mode
		1	Turn on jog mode
10	reserved		
11	Forward operation command	0	No control command
		1	Forward operation command received
12	Reverse operation command	0	No control command
		1	Reverse operation command received
13	Prepare for operation command	-	
		1	Authorized for remote operation command
14	Prepare for speed source command	-	
		1	Authorized for speed source command
15	Keypad control mode	0	Remote operation in progress
		1	Controlled by a keypad local

Setpoint value

This indicates the inverter's operation command frequency and uses decimal values; the unit is Hz, and the scale is 0.01.

Actual speed value

This indicates the inverter's actual operation frequency and uses decimal values; the unit is Hz, and the scale is 0.01.

4.4 Telegram

The supported types of Cyclic Telegrams are the standardized “Standard Telegram” and the manufacturer-defined “Vendor Specific Telegram.” The S300 PROFINET can exchange Cyclic Telegrams with the PLC at a minimum cycle of 4 ms. Each Telegram is expressed as a Submodule in PROFINET communication and can be selectively used by the user by being assigned to Slot1/Subslot2 of the S300 RAPIEnet+ communication option board in the PROFINET network Configuration Tool. [3]

The S300 RAPIEnet+ communication option board provides Telegram in two groups to maintain compatibility with our existing products iS7/S100 PROFINET.

If OPC-21 Profile CSM is set to the LSE new mode, S300 telegrams can be selected, and if set to the LSE old mode, telegram mode used in iS7/S100 can be selected.

Profile CSM - LSE new mode

Standard Telegram 1 (Mode : 0)

Standard Telegram 1	Byte 1-2	Byte 3-4
PLC to S300	Control word (STW1)	Setpoint value [4] 0xC000-0x4000 (-16384 - 16384)
S300 to PLC	Status word(ZSW1)	Actual speed value (Hz) 0xC000-0x4000 (-16384 - 16384)

[3] Refer to the example in Section 18 of Siemens TIA Portal V13 on connecting S7-1200 and PROFINET

[4] Setpoint
A speed setpoint expressed as a percentage of the maximum rated speed of the drive referred by (DRV-20: Max freq.)

Standard Telegram 20 (Mode : 1)

Standard Telegram 20	Byte 1-2	Byte 3-4	Byte 5-6	Byte 7-8	Byte 9-10	Byte 11-12
PLC to S300	Control word (STW1)	* Setpoint value [4] 0xC000-0x4000 (-16384 - 16384)	Dummy	Dummy	Dummy	Dummy
S300 to PLC	Status word(ZSW1)	Actual speed value 0xC000-0x4000 (-16384 - 16384)	Current	Torque	Power	Fault

Vendor Specific Telegram 88 (Mode: 2)

Vendor Specific Telegram 88	Byte 1-2	Byte 3-4	Byte 5-6	…	Byte 15-16
PLC to S300	user defined-01	user defined-02	user defined-03	…	user defined-08
S300 to PLC	user defined-01	user defined-02	user defined-03	…	user defined-08

The use of user defined value is as follows:

Control **PLC to S300**		Monitor the S300 to PLC status	
Address	**Set value**	**Address**	**Set value**
OPC2-52	Set a random control value (e.g., 0x383)	OPC2-02	Set a random monitor value (e.g., 0x302)
OPC2-53	Set a random control value (e.g., 0x384)	OPC2-03	Set a random monitor value (e.g., 0x303)
OPC2-54	Set a random control value (e.g., 0x385)	OPC2-04	Set a random monitor value (e.g., 0x304)
OPC2-55	Set a random control value (e.g., 0x386)	OPC2-05	Set a random monitor value (e.g., 0x305)
OPC2-56	Set a random control value (e.g., 0x387)	OPC2-06	Set a random monitor value (e.g., 0x306)
OPC2-57	Set a random control value (e.g., 0x388)	OPC2-07	Set a random monitor value (e.g., 0x307)
OPC2-58	Set a random control value (e.g., 0x389)	OPC2-08	Set a random monitor value (e.g., 0x308)
OPC2-59	Set a random control value (e.g., 0x38a)	OPC2-09	Set a random monitor value (e.g., 0x309)

Vendor Specific Telegram 1616 (Mode: 3)

Vendor Specific Telegram 1616	Byte 1-2	Byte 3-4	…	Byte 29-30	Byte 31-32
PLC to S300	User defined	User defined	…	User defined	User defined
S300 to PLC	User defined	User defined	…	User defined	User defined

The use of user defined value is as follows:

Control PLC to S300		Monitor the S300 to PLC status	
Address	Set value	Address	Set value
OPC2-52	Set a random control value (e.g., 0x381)	OPC2-02	Set a random monitor value (e.g., 0x300)
OPC2-53	Set a random control value (e.g., 0x382)	OPC2-03	Set a random monitor value (e.g., 0x301)
OPC2-54	Set a random control value (e.g., 0x383)	OPC2-04	Set a random monitor value (e.g., 0x302)
OPC2-55	Set a random control value (e.g., 0x384)	OPC2-05	Set a random monitor value (e.g., 0x303)
…	…	…	…
OPC2-66	Set a random control value (e.g., 0x395)	OPC2-16	Set a random monitor value (e.g., 0x314)
OPC2-67	Set a random control value (e.g., 0x396)	OPC2-17	Set a random monitor value (e.g., 0x315)

Vendor Specific Telegram 3232 (Mode: 4)

Vendor Specific Telegram 3232	Byte 1-2	Byte 3-4	…	Byte 61-62	Byte 63-64
PLC to S300	User defined	User defined	…	User defined	User defined
S300 to PLC	User defined	User defined	…	User defined	User defined

The use of user defined value is as follows:

Control PLC to S300		Monitor the S300 to PLC status	
Address	Set value	Address	Set value
OPC2-52	Set a random control value (e.g., 0x381)	OPC2-02	Set a random monitor value (e.g., 0x300)
OPC2-53	Set a random control value (e.g., 0x382)	OPC2-03	Set a random monitor value (e.g., 0x301)
OPC2-54	Set a random control value (e.g., 0x383)	OPC2-04	Set a random monitor value (e.g., 0x302)
OPC2-55	Set a random control value (e.g., 0x384)	OPC2-05	Set a random monitor value (e.g., 0x303)
…	…	…	…
OPC2-82	Set a random control value (e.g., 0x395)	OPC2-32	Set a random monitor value (e.g., 0x314)
OPC2-83	Set a random control value (e.g., 0x396)	OPC2-33	Set a random monitor value (e.g., 0x315)

LSE Telegram (Mode : 5)

LSE Telegram	Byte 1-2	Byte 3-4
PLC to S300	LSE Control word	Setpoint value (Hz), e.g.,) 0x1770: 60Hz
S300 to PLC	LSE Status word	Actual speed value (Hz)

Profile CSM - LSE old mode

Standard Telegram1 (Mode : 0)

Standard Telegram 1	Byte 1-2	Byte 3-4
PLC to S300	Control word (STW1)	Setpoint value (Hz), e.g.,) 0x1770: 60Hz
S300 to PLC	Status word(ZSW1)	Actual speed value (Hz)

Vendor Specific Telegram (Mode: 1)

Vendor Specific Telegram	Byte 1-2	Byte 3-4	Byte 5-6	Byte 7-8	Byte 9-10
PLC to S300	Control word (STW1)	Setpoint value (Hz) 0x1770: 60Hz	Dummy	Dummy	Dummy
S300 to PLC	Status word(ZSW1)	Actual speed value (Hz)	Alarm Info	Torque	Current

5 PROFIdrive parameters

Parameters		
PNU	**R/W**	**Description**
922	R	Display the type of the selected PROFIdrive Cyclic Telegram No. 1 → Standard Telegram 1 (LSE old mode/LSE new mode) No. 20 → Standard Telegram 20 No. 100 → Vendor Specific Telegram (LSE old mode) No. 998 → Vendor Specific Telegram 88 No. 999 → Vendor Specific Telegram 1616 No. 1000 → Vendor Specific Telegram 3232 No. 1100 → LSE telegram * Writing via the PROFIdrive protocol is not supported; however, it can be configured through the Smart Loader Operator. It includes No. 21 and 22 Profile CSM and telegram for OPC1 group.
944	R	This is a parameter based on the fault message counter value, which increments by 1 each time a fault occurs. By monitoring the increase in this parameter, the PROFINET Controller, such as a PLC, can determine whether a new fault has occurred in the inverter.
947	R	Fault number * Refer to the description about PNU[944] Fault Message Counter and PNU[947] Fault Number
953	R	Warning word Displays the "Warning information" parameter value located at inverter communication address 0h0420.

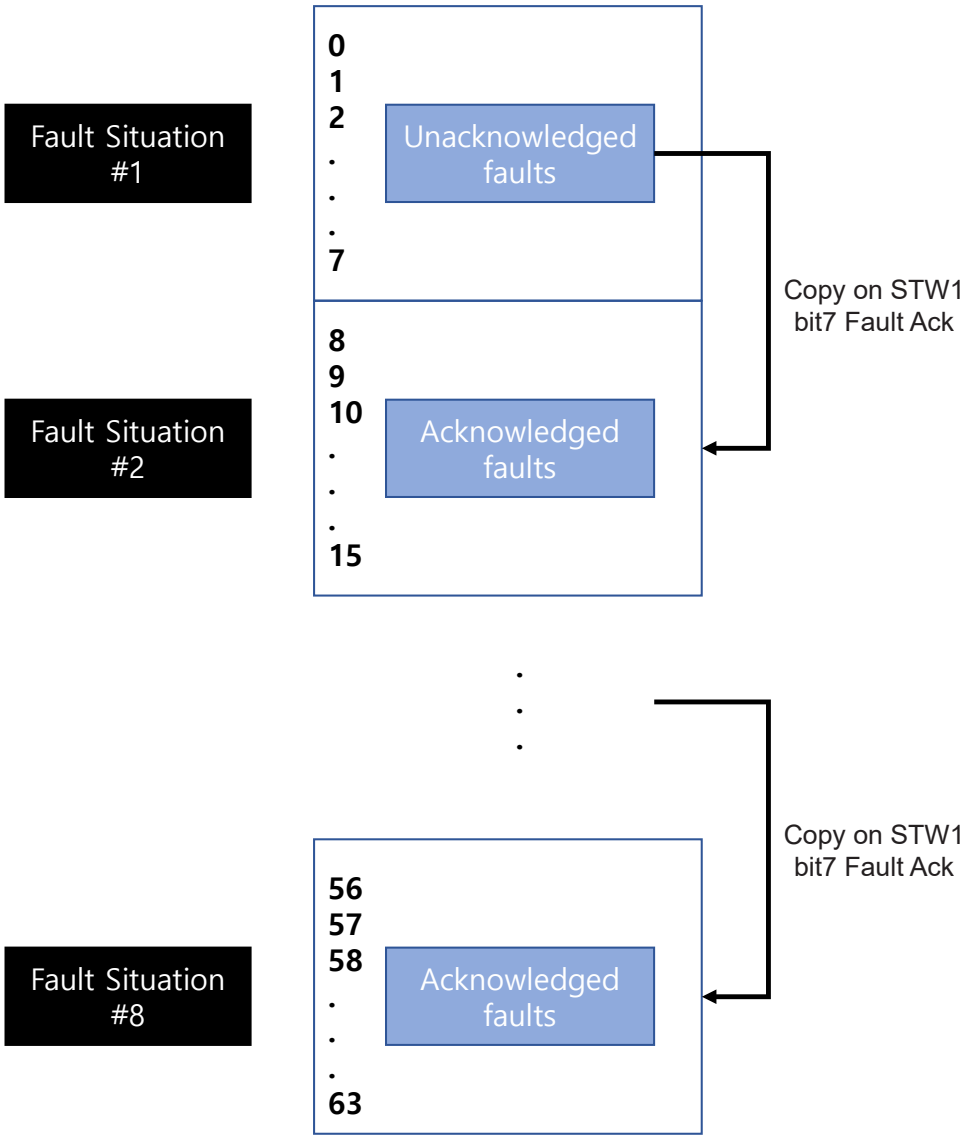
Parameters		
PNU	**R/W**	**Description**
964	R	This is a 5-Word (16-bit) array value that displays information about the S300 RAPIEnet+ communication option board. 0: This displays the Manufacturer value (the PROFINET vendor ID of LS ELECTRIC defined by Profibus.org as 849[0h351]). 1: Device Type: displays "4" for S300 RAPIEnet+ communication option board. 2: Version: indicates the S/W version. e.g., version 1.0 is displayed as 100. 3: Firmware Date (yyyy): indicates when the S/W was made in year. e.g., 2024 will be displayed as 2024. 4: Firmware Data (dd/mm): indicates when the S/W was made in date and month. For example, if the date is April 12, it is displayed as 0412.
965	R	Displays the Profile ID. (0h328 – Profile 3 v4.0)
967	R	Displays the current Control word (STW1) value received via PROFINET.
968	R	Displays the current Status word (ZSW1) value being transmitted via PROFINET.
972	R/W	When the value changes from 0 to 1, the S300 RAPIEnet+ communication option board is reset.
61000	R	This displays the device name of the S300 RAPIEnet+ option board.
61001	R	This displays the IP address of the S300 RAPIEnet+ option board.
61002	R	Displays the MAC address of the S300 RAPIEnet+ communication option board.
61003	R	Displays the Gateway IP address of the S300 RAPIEnet+ communication option board.
61004	R	This displays the subnet mask of the S300 RAPIEnet+ option board.
1000	R/W	S300 Parameter Access Address (The communication address of the inverter parameter to be read or written)

Parameters		
PNU	**R/W**	**Description**
1001	R/W	S300 Parameter Access Data (Value the inverter parameter to be read or written)
1002	R/W	S300 Parameter Access Command 1: write 2: read
1003	R/W	S300 Parameter Access Acknowledge 0: not completed 1: OK completed 2: Not OK completed
1100	R	Port Status 0x0000: no connected. 0x0100: port 1 is connected. 0x0200: port 2 is connected. 0x0300: both ports are connected.
2000	R	Max frequency reference for Standard Telegram 20
2002	R	Max current reference for Standard Telegram 20
2003	R	Max torque reference for Standard Telegram 20
2004	R	Max power reference for Standard Telegram 20

Indicates the description about PNU[944] Fault Message Counter and PNU[947] Fault Number

Whenever a fault occurs, the PNU[944] Fault Message Counter will increase by 1, and the fault will be saved for the PNU[947] Fault Number parameter.

The PNU[947] Fault Number can have eight fault situations, and each fault situation can have eight fault messages. Each fault message comprises 16 bits and 1 word; therefore, the PNU[947] Fault Number consists of 64 words. The figure below shows a default configuration.



Fault Situation #1 shows a situation in which currently occurring fault messages are saved. Each fault message is saved to the memory starting from the first one (index: 0) to the order of the occurrence and overwritten to the eighth memory (index: 7) when more than eight notifications are sent. When a fault ark is made by setting bit 7 to 1 from the control word (STW1) of the PLC, the values in Fault Situation #1 will move to Fault Situation #2. The movement is repeated in the Fault Situation #7.

Fault name	Code
ADC Offset	0
Watchdog	1
Gate Power Loss	2
Main OS Error	3
Over Load	4
Under Load	5
Inverter Over Loa	6
E-Thermal	7
Ground Fault	8
Out Phase U Open	9
In Phase Open	10
Over Speed	11
Speed Deviation	12
Drv Over Heat	13
NTC Open	14
NTC Short	15
Over Current	16
Over Voltage	17
IO Board	18
BX	19
Mechanical Brake	20
External 1	21
External 2	22
External 3	23

Fault name	Code
External 4	24
Arm Short	25
Fuse Open	26
Encoder	27
Encoder No Conne	28
Encoder Wrong Di	29
Motor Over Heat	30
Main Fan Fault	31
Parameter Write	32
Pre PID Fail	33
No Motor	34
Option 1	35
Option 2	36
Option 3	37
Low Voltage	38
Lost Sensor	39
Lost Int Comm	40
Lost Opt Comm	41
Lost Keypad	42
Lost USB	43
Lost AI 1	44
Lost AI 2	45
Lost AI 3	46
Lost AI 4	47
Lost Ext AI 1	48
Lost Ext AI 2	49
Lost Ext AI 3	50
Lost Ext AI 4	51
STO Feedback A	52

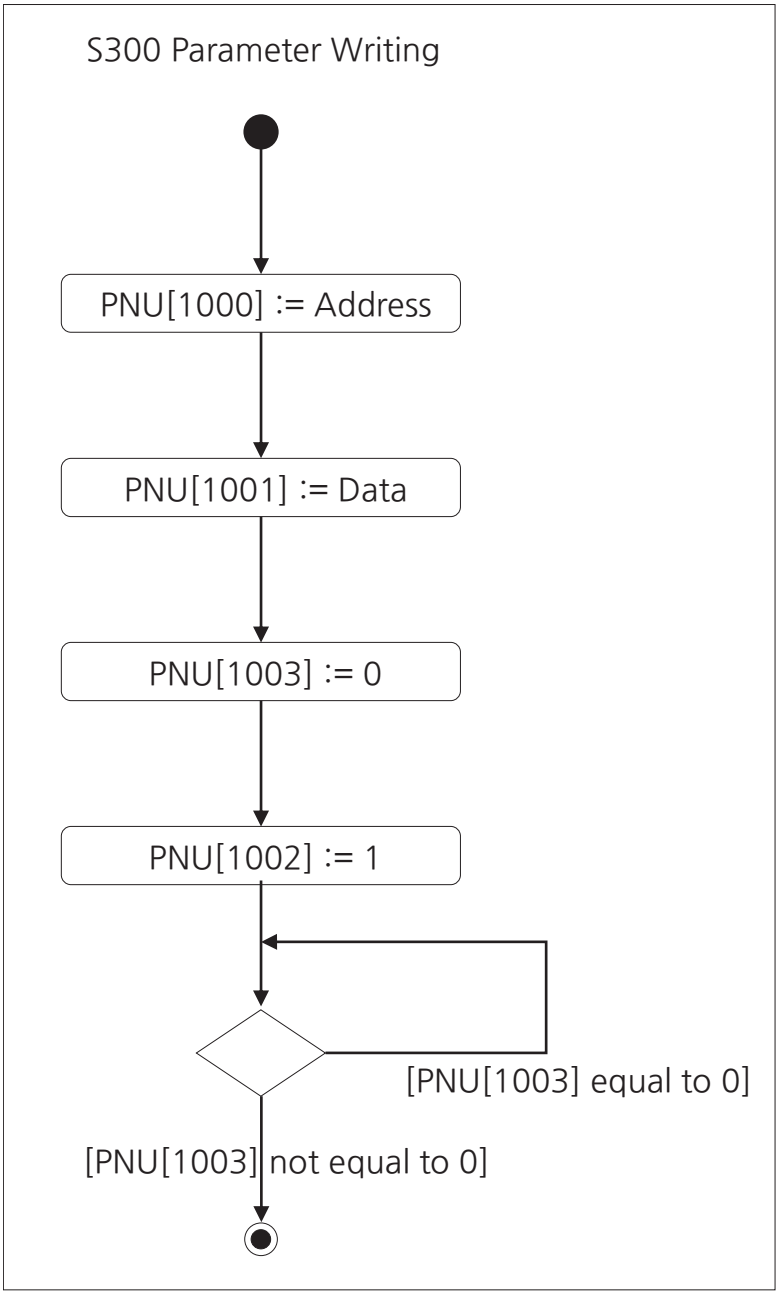
Fault name	Code
STO Feedback B	53
STO P24 Fault	54
STO P5 Fault	55
Aux Fan Fault	56
Control Fan Faul	57
Data Storage	58
Precharge Fail	59
H/W OCS Fail	60
TR Tune Fail	61
RS Tune Fail	62
SLS Tune Fail	63
LS Tune Fail	64
IF Tune Fail	65
MC Fault	66
Load Default Par	67
Lost P24V	68
Out Phase V Open	69
Out Phase W Open	70
Reset/Restart Fa	71
Outline Short	72
KEB Safety Stop	73
Protect System 1	74
Internal communication error between body of the communication board	255
None	0xFFFF

Name of the Warning	Code
Over Load	0
Under Load	1
Inverter Over Load	2
Lost Int Comm	3
Lost Opt Comm	4
Lost Keypad	5
Lost USB	6
Dynamic Brake	7
Lost AI 1	8
Lost AI 2	9
Lost AI 3	10
Lost AI 4	11
Lost Ext AI 1	12
Lost Ext AI 2	13
Lost Ext AI 3	14
Lost Ext AI 4	15
Main Fan Lock	16
Aux Fan Lock	17
Control Fan Lock	18
Main Fan Replace	19
Au484eplaceepalce	20
Control Fan Replace	21
Precharger Replace	22
Supply P24V	23
None	0xFFFF

Access procedures for the S300 common parameters using PROFIdrive parameter

Users can read and write the parameters of the S300 inverter body using the PNU [1000 - 1003].

Below is the flowchart of the inverter parameter write requests.



1 Set the inverter communication address for the PNU [1000] parameter.

2 Set the inverter settings data for the PNU [1001] parameter.

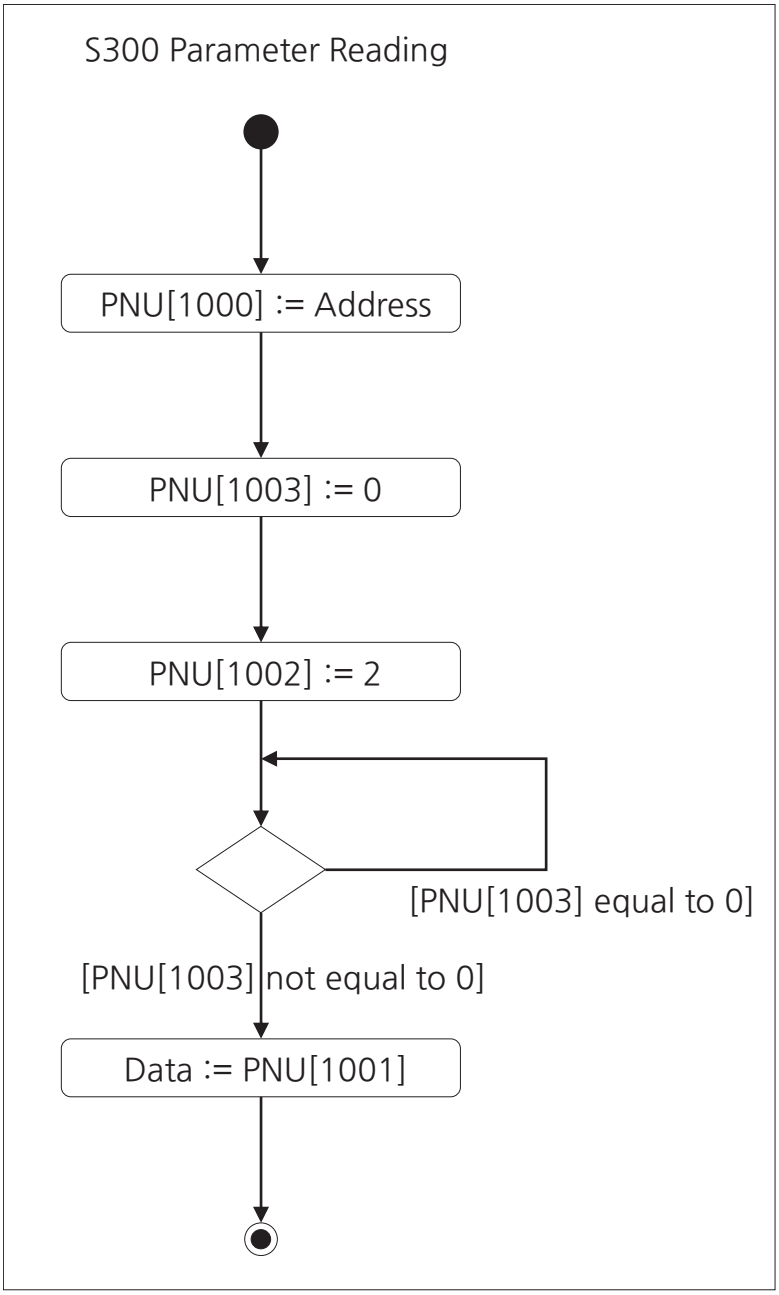
3 Set 0 for the PNU [1003] parameter.

4 Setting the PNU [1002] parameter to 1 causes the S300 RAPIEnet+ communication option board to store the parameter values of PNU [1000] and PNU [1001] in the inverter body parameters.

5 The S300 RAPIEnet+ communication option board stores the inverter parameter values and stores the operation results in PNU [1003].

6 Check the PNU [1003] value to verify whether the data write request was made without any issue.

Below is the flowchart of the inverter parameter read requests.



1 Set the inverter communication address for the PNU [1000] parameter.

2 Set 0 for the PNU [1003] parameter.

3 Setting the PNU [1002] parameter to 2 causes the S300 RAPIEnet+ communication option board to reference the PNU [1000] value and read the inverter body value indicated by the PNU [1000] value.

4 The S300 RAPIEnet+ communication option board stores the execution result of the inverter parameter read request in PNU [1003]. When the request is made without any issue, it will save the reading in the [1001].

5 It checks the PNU [1003] to verify whether the read request for the inverter parameter is made without any issue. When it is made without any issue, the PLC reads the PNU [1001].

6 Dealing with Alarm

When a fault occurs or is cleared in the inverter, the S300 RAPIEnet+ communication option board will deliver the PROFINET Alarm notification to the PLC.

Details about Alarm packet for fault occurrence

Alarm category	API	Slot Number	Subslot Number	Alarm Specifier	UserStructure Identifier	Channel Properties	Channel ErrorType
Fault occurred	0h3A00	1	2	Diagnosis	0h8000	0h0800	9012
Resolve faults	0h3A00	1	2	Diagnosis	0h8000	0h1000	9012

7 GSDML File

It is a file containing information about the S300 RAPIEnet+ communication option board. This file is required by the PROFINET network configuration software.

** Download the document at https://www.ls-electric.com.

8 Troubleshooting

Step	Issue	Troubleshooting
1	When both the ERROR LED and CPU LED are off	This issue may occur if the power is not supplied properly to the S300 RAPIEnet+ communication option board. 1) Ensure that the S300 RAPIEnet+ communication option board is correctly installed in the main inverter unit. 2) Check if the pins of the connector on the S300 RAPIEnet+ communication option board connected to the main unit are not damaged or bent. 3) If the same issue persists after taking the above measures, it indicates a hardware failure of the S300 RAPIEnet+ communication option board. Contact the LS ELECTRIC service center or Customer Service.
2	When the ERROR LED is on and the CPU LED is off,	it is a hardware failure of the S300 RAPIEnet+ communication option board. Contact the LS ELECTRIC service center or Customer Service.
3	When both the ERROR LED and CPU LED are flashing simultaneously at 1-second intervals	1) Check if the pins of the connector on the S300 RAPIEnet+ communication option board connected to the main inverter unit are not damaged or bent. 2) If the same issue persists after taking the above measures, it indicates a hardware failure of the S300 RAPIEnet+ communication option board. Contact the LS ELECTRIC service center or Customer Service.
4	When the CPU LED flashes at 1-second intervals and the ERROR LED flashes more slowly at 2-second intervals	1) Check if the LINK LED on the port where the LAN cable is connected is lit. If it is not lit, ensure that the LAN cable is securely connected to the port on the S300 RAPIEnet+ communication option board. 2) Check if the device name of the S300 RAPIEnet+ communication option board and the [OPC1-22] telegram mode setting match the network configuration set in the PLC program. 3) Verify that the IP assigned to the S300 RAPIEnet+ communication option board does not conflict with the IP of another device on the same network. 4) If the same issue persists after taking the above measures, it indicates a hardware failure of the S300 RAPIEnet+ communication option board. Contact the LS ELECTRIC service center or Customer Service.

Step	Issue	Troubleshooting
5	If the communication board's IP address experiences unintended changes	1) The PLC can forcibly change the IP address of the S300 RAPIEnet+ communication option board based on its settings, so check the IP address configuration method in the PLC program. 2) If you do not want the IP address of the S300 RAPIEnet+ communication option board to be changed arbitrarily, select the “Use the communication module's IP as is” option in the PLC software menu.

9 Other Protocols

9.1 Modbus TCP

If the inverter is operating in PROFINET mode, it supports the protocol described in the "PART2 Chapter 3 3.3 Modbus TCP " section.

9.2 Embedded Web/Cloud

Refer to the link for the dedicated User Manual.

Global	https://sol.ls-electric.com/ww/en/rd/550/EmbeddedWeb_Cloud
USA	https://sol.ls-electric.com/us/en/rd/550/EmbeddedWeb_Cloud

9.3 SSQ Asset Insight

Refer to the link for the dedicated User Manual. The service's operational policies are subject to change in the future.

Global	https://sol.ls-electric.com/ww/en/rd/550/AIManual
USA	https://sol.ls-electric.com/us/en/rd/550/AIManual