

RS485/Modbus-RTU Option Card for SV-iP5A Series



Read this manual carefully before using the RS485/Modbus-RTU Option Card and follow the instructions exactly.

After reading this manual, keep it at handy for future reference.

SAFETY PRECAUTIONS

- Always follow safety precautions to prevent accidents and potential hazards from occurring.
- In this manual, safety messages are classified as follows:



WARNING

Improper operation may result in serious personal injury or death.



CAUTION

Improper operation may result in slight to medium personal injury or property damage.

- Throughout this manual we use the following two illustrations to make you aware of safety considerations:



Identifies potential hazards under certain conditions

Read the message and follow the instructions carefully.



Identifies shock hazards under certain conditions

Particular attention should be directed because dangerous voltage may be present.

- Keep operating instructions handy for quick reference.
- Read this manual carefully to maximize the performance of SV-IP5A series inverter and ensure its safe use.



CAUTION

- **Do not touch the CMOS components unless the board is grounded.**
Otherwise, ESD could cause break down of CMOS components.
- **Do not change the communication cable when the inverter power is turned on.**
Otherwise, there is a danger of connecting error and damage to the board.
- **Make sure to precisely insert the connector of inverter and option board**
Otherwise, there is a danger of connecting error and damage to the board.
- **Check the parameter unit when setting the parameters.**
Otherwise, there is a danger of connecting error and damage to the board.

1. INTRODUCTION

SV-iP5A inverter can be controlled and monitored by the sequence program of the PLC or other master module. The option card provides a terminal block for an RS-485/Modbus-RTU interface. Drives or other slave devices may be connected in a multi-drop fashion on the RS-485/Modbus-RTU network and may be monitored or controlled by a single PLC or PC.

1.1. Features

Inverter can be easily applicable to Factory Automation because operation and monitoring is available by User-program.

* Parameter setting and monitoring is available via computer.

(Ex: Freq. Command, Run/Stop etc.)

* Interface type of RS485 reference:

- 1) Allows the drive to communicate with any other computers.
- 2) Allows one computer to control up to 31 drives with multi-drop link system.
- 3) Noise-resistant interface.

Users can use any kind of RS232-485 converters. The specifications and performances of converters depend on the manufacturers, but the basic functions are the same. Refer to the converter manual for detailed specifications and instructions on how to use.

1.2. Before Installation

Before installation and operation, this manual should be read thoroughly. If not, it could cause personal injury or damage other equipment.

2. SPECIFICATION

2.1. Performance specification

Items	Specifications
Communication method	RS485 (RS232-485 converter)
Transmission form	Bus method, Multi-drop Link System
Applicable inverter	SV-iP5A series
Converter	Converter with RS232 card embedded
Number of inverters connected	Maximum 31 drives connectable ^{note1)}
Transmission distance	Max. 1200m (Less than 700m recommended) ^{note2)}

^{note1)} The number of inverters to be connected is up to 31.

^{note2)} The specification of length of the communication cable is max, 1200m, To ensure stable communication, limit its length below 700m.

2.2. Hardware Specifications

Items	Specifications	
Installation	Use option connector on the inverter control board	
Power Supply	Control B/D	From inverter power supply
	Comm. B/D	From control board (insulated)

2.3. Communication Specification

Items	Specifications
Communication speed	1200 /2400/4800/9600/19200/38400 bps Selectable
Control procedure	Asynchronous communication system
Communication system	Half duplex system
Character system	RS485 : ASCII(8bit), Modbus-RTU : Binary (7/8 bit)
Start/Stop bit	Start 1bit, Stop 1/2bit
Error check	RS485 : Checksum(2byte) Modbus-RTU : CRC16(2byte)
Parity check	Even/Odd

3. PRODUCT DETAIL

3.1. Layout and detail

Name	Description		
Connector	Connector to inverter main PCB		
Signal connection terminal	Communication signal connection terminal	P	485 signal - high
		N	485 signal - low
		GND	485 Ground
		S	Shield
		T1	Connect a internal termination resistor
		T2	Short T1 and T2

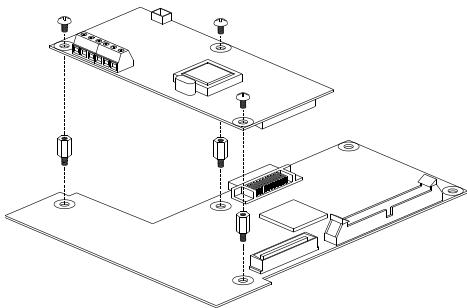


Figure 1. RS485/Modbus-RTU Option Card Installation

3.2. Status LED

CPU LED	Indicates the option card works normally.	
RXD LED	Receiving 485 signal	
TXD LED	Sending 485 signal	
ERR LED	Blinking intermittently	Receiving wrong DATA (Normal operation)
	Blinking simultaneously with CPU LED	DPRAM communication malfunction
	Blinking oppositely to CPU LED	Network Connection TimeOut

4. INSTALLATION

4.1. Installing RS485/Modbus-RTU card

- ① Connect the option card to the inverter control board using each connector on their boards (See the Figure 1).
- ② Power up the inverter after verifying the option card is installed properly.
- ③ When powering up the inverter, CPU LED is blinking per second after all LEDs blink one after another.
- ④ If "CPU LED" is not blinking, power down the inverter swiftly and check for the proper installation of the option card.

(Caution: The inverter and option card may get damaged in case that power is applied to the inverter for a long time when CPU LED is not blinking.)

* If this problem occurs continuously, contact LS distributors.

- ⑤ Verify RS485 is displayed in <COM-01> of iP5A.
- ⑥ Set the parameters as below when the above steps are all done.

1. SV-iP5A Setting

Parameter code	Display	Setting Value
< COM-01 >	Opt B/D	RS485 displayed automatically
< COM-02 >	Opt mode	Set Commands controlled via communication
< I/O- 90 >	Inverter Number	1~250 (Verify the assigned number is not duplicated)
< I/O- 91 >	Baud-rate	9600 bps (Factory default)
< I/O- 92 >	COM Lost Cmd ^{note3)}	User setting
< I/O- 93 >	COM Time Out ^{note3)}	0.1 sec (Factory default)

^{note3)} It is used for Emergency Stop when communication between inverter and Master is not done properly. It is activated when communication is not done even once for the set time. It indicates the inverter is not controlled by Remote. Set this value for safety.

- ⑦ Power down the inverter for the connection of converter when step ⑥ is finished.
- ⑧ If the inverter is to be placed at the end of the network trunk line, install a jumper on the option card to enable the termination resistor(120 Ω). (See the Figure 3).

4.2. RS232-485 Converter Installation

The installation of converters depends on the manufacturers. Refer to the converter installation manual for detailed converter installation.

4.3. Connection guide for the communication card, the computer and the converter

4.3.1. System Configuration

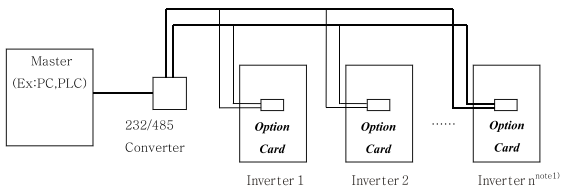


Figure 2. System Configuration

^{note1)} The number of inverters to be connected is up to 31.

4.3.2. Termination Configuration

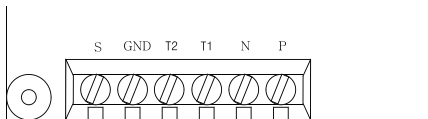


Figure 3. Termination Configuration

Pin	S	GND	T2	T1	N	P
Role	Shield	Ground	Termination		Signal line	

S : Use **only** one point in the whole network lines for grounding.

Connect to the screw next to the shield terminal when grounding through the inverter.

GND : Ground of 485 communication terminal.

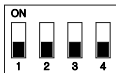
T1, T2 : If the option card is installed within the inverter which is to be placed at the end of the network trunk line, short terminals T1 and T2. This allows the internal termination resistor(120Ω) to be connected.

4.3.3. Communication Protocol Selection (RS485/Modbus-RTU)

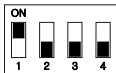
- Setting method

The Modbus-RTU protocol is selected when the No.1(among the DIP switches located on the lower right corner of the option card) is ON, and the LS bus protocol is selected when the No.1 is OFF.

(At this time the ON/OFF status of the No.2, 3, 4 DIP switches has not an effect on the protocol selection.)



→ RS485 protocol selection



→ Modbus-RTU protocol selection

- Precautions when setting

Even if the Master's protocol is changed during communication between Master and slaves (LS inverters), the communication is resumed automatically in case of adjusting the DIP switch on the option card in accordance with the master's protocol.

5. COMMUNICATION PROTOCOL

- Use RS485 protocol (for LS only) and Modbus-RTU protocol. The both of them are Open protocol. For more information, contact LS distributor.
- Computer or other host acts as Master while inverters act as slaves. The inverter responds to Read/Write command from Master.

5.1. RS485 Protocol

5.1.1. Basic format

- Command message (Request):

ENQ	Inverter No.	CMD	Data	SUM	EOT
1 byte	2 byte	1 byte	n byte	2 byte	1 byte

- Normal response (Acknowledge Response):

ACK	Inverter No.	CMD	Data	SUM	EOT
1 byte	2 byte	1 byte	n * 4 byte	2 byte	1 byte

- Negative response (Negative Acknowledge Response):

NAK	Inverter No.	CMD	Error code	SUM	EOT
1 byte	2 byte	1 byte	2 byte	2 byte	1 byte

- Description:

- * Request starts with "ENQ" and ends with "EOT".
- * Acknowledge Response starts with "ACK" and ends with "EOT".
- * Negative Acknowledge Response starts with "NAK" and ends with "EOT".
- * "Inverter Number" represents the number of Inverters and indicates in 2 byte ASCII-HEX. (ASCII-HEX: Hexadecimal consists of '0' ~ '9', 'A' ~ 'F')
- * CMD: Capital letter ("IF Error" when small letter is used.)

Character	ASCII-HEX	Command
'R'	52h	Read
'W'	57h	Write
'X'	58h	Request for Monitor Register
'Y'	59h	Action for Monitor Register

- * Data: ASCII-HEX
Ex) when data value is 3000: 3000 → '0' 'B' '8'h → 30h 42h 42h 38h
- * Error code: ASCII (20h ~ 7Fh)
- * Receive/Send buffer size: Receive= 39 byte, Send=44 byte
- * Monitor register buffer: 8 Word
- * SUM: to check the communication error
SUM= ASCII-HEX format of lower 8 bit of (Inverter No. + CMD + DATA)

Ex) Command Message (Request) for reading one address from address "9000"

ENQ	Inverter No.	CMD	Address	Number of address	SUM	EOT
05h	"01"	"R"	"3000"	"1"	"AC"	04h
1	2	1	4	1	2	1

$$\begin{aligned} \text{SUM} &= '0' + '1' + 'R' + '3' + '0' + '0' + '0' + '1' \\ &= 05h + 30h + 31h + 52h + 33h + 30h + 30h + 30h + 31h \\ &= 1A7h \text{ (Except Control value. : ENQ, ACK, NAK, etc.)} \end{aligned}$$

5.1.2. Detailed Read protocol

- Request for Read: Request for reading Word data of the successive 'n' number from address "XXXX"

ENQ	Inverter No.	CMD	Address	Number of Address	SUM	EOT
05h	"01" ~ "1F"	"R"	"XXXX"	"1" ~ "8" = n	"XX"	04h
1	2	1	4	1	2	1

Total byte = 12, The quotation marks (" ") mean character.

- Acknowledge Response:

ACK	Inverter No.	CMD	Data	SUM	EOT
06h	"01" ~ "1F"	"R"	"XXXX"	"XX"	04h
1	2	1	N * 4	2	1

Total byte = 7 * n * 4 = Max. 39

- Negative Acknowledge Response:

NAK	Inverter No.	CMD	Error code	SUM	EOT
15h	"01" ~ "1F"	"R"	"**"	"XX"	04h
1	2	1	2	2	1

Total byte = 9

5.1.3. Detailed Write protocol

- Request for Write:

ENQ	Inverter No.	CMD	Address	Number of Address	SUM	EOT	EOT
05h	"01" ~ "1F"	"W"	"XXXX"	"1" ~ "8" = n	"XXXX..."	"XX"	04h
1	2	1	4	1	n * 4	2	1

Total byte = 12 + n * 4 = Max. 44

- Acknowledge response:

ACK	Inverter No.	CMD	Data	SUM	EOT
06h	"01" ~ "1F"	"W"	"XXXX..."	"XX"	04h
1	2	1	n * 4	2	1

Total byte = 7 + n * 4 = Max. 39

- Negative response:

NAK	Inverter No.	CMD	Error code	SUM	EOT
15h	"01" ~ "1F"	"W"	"**"	"XX"	04h
1	2	1	2	2	1

Total byte = 9

5.1.4. Detailed Monitor Register protocol

- Monitor Register

* Request for Monitor Register:

Monitor Register has the function to update data periodically after assigning the necessary data to be monitored continuously.

Request for registering the 'n' number of Address (non-successive)

ENQ	Inverter No.	CMD	Number of Address	Address	SUM	EOT
05h	"01" ~ "1F"	"X"	"1" ~ "8"=n	"XXXX..."	"XX"	04h
1	2	1	1	n = 4	2	1

Total byte = 8 + n + 4 = Max 40

* Acknowledge Response:

ACK	Inverter No.	CMD	SUM	EOT
06h	"01" ~ "1F"	"X"	"XX"	04h
1	2	1	2	1

Total byte = 7

* Negative Acknowledge Response:

NAK	Inverter No.	CMD	Error code	SUM	EOT
15h	"01" ~ "1F"	"X"	"**"	"XX"	04h
1	2	1	2	2	1

Total byte = 9

- Monitor Action

* Action Request for Monitor Register:

Request for reading data of address registered by Monitor Register.

ENQ	Inverter No.	CMD	SUM	EOT
05h	"01" ~ "1F"	"Y"	"XX"	04h
1	2	1	2	1

Total byte = 7

* Acknowledge response:

ACK	Inverter No.	CMD	Data	SUM	EOT
06h	"01" ~ "1F"	"Y"	"XXXX..."	"XX"	04h
1	2	1	n = 4 byte	2 byte	1 byte

Total byte = 7 + n + 4 = Max 39

* Negative response:

NAK	Inverter No.	CMD	Error code	SUM	EOT
15h	"01" ~ "1F"	"Y"	"**"	"XX"	04h
1	2	1	2	2	1

Total byte = 9

5.1.5. Error code

Error code _e	Display	Description
ILLEGAL FUNCTION	IF	When the command received cannot be executed in the option card. It means that there is no corresponding command.
ILLEGAL DATA ADDRESS	IA	When parameter address received is invalid. When monitor is executed without Monitor Register.
ILLEGAL DATA VALUE	ID	When the data received is invalid.
WRITE MODE ERROR	WM	In case of Read Only or Write Disabled during operation.
FRAME ERROR	FE	When the frame size, internal Num or Sum is incorrect.
TIME OUT ERROR	TO	When DPRAM communication is not working within a certain time.
DPRAM OFF LINE	DO	When DPRAM is Off Line.
INVALID ID NUMBER	IN	When Inverter Number is incorrect.
UNDEFINED CONDITION	UC	Except for the above cases.

5.2. Modbus-RTU Protocol

- Use Modbus-RTU protocol. This is Open protocol.
- Computer or other host acts as Master while inverters act as slaves. The inverter responds to Read/Write command from Master.

5.2.1. Available Function code

Function code	Description
0x03	Read Hold Register
0x04	Read Input Register
0x06	Preset Single Register
0x10	Preset Multiple Register

5.2.2. Exception code

Exception code	Description
0x01	ILLEGAL FUNCTION
0x02	ILLEGAL DATA ADDRESS
0x03	ILLEGAL DATA VALUE
0x06	SLAVE DEVICE BUSY
User define	0x14 1. Write Disable (Address 0x0004 value is 0). 2. Read Only or Not Program during Running.

5.3. BaudRate

1200, 2400, 4800, 9600, 19200, 38400 bps (Default value: 9600bps)

5.4. BroadCast Function

- The broadcast function is used when Command is given to **all** inverters connected to network.
- In the case of RS485, **all** inverters run without response(Slave->Master) when Command is given to Inverter Number 255(0xFF).
- In the case of Modbus-RTU, **all** inverters run without response(Slave->Master) when Command is given to Inverter Number 0(0x00).

6. TROUBLE SHOOTING

Refer to this chapter when occurring problem in communication with computer while using this option card.

- CPU LED malfunction

Expected State	The inverter is not working normally or the inverter and the option card are not connected properly.
Corrective Measures	1. Verify the power is applied to the inverter. 2. Verify the option card is installed properly within the inverter when the inverter is working normally.

- RXD and TXD LEDs malfunction

Check Points	Corrective Measures
Is the power applied to the converter?	Apply power to the converter.
Is the connection between the converter and computer correct?	Refer to the converter manual
Is the communication card installed within the inverter properly?	Refer to "4. Installation".
Does Master start the communication?	Start the communication.
Is the communication speed setting of the inverter correct?	Refer to "4. Installation".
Is the data format of User program correct?	Modify User program ^{note4)} .
Is the connection between the converter and the option card correct?	Refer to "4. Installation".

^{note4)} User program is User-made S/W for PC.

- ERR LED is working

State	Corrective Measures
Blinking intermittently	In case that the option card is receiving wrong data due to Noise or other causes. It is normal.
Blinking oppositely to CPU LED	Network is not communicated during TimeOut setting. Verify the state of Master. (iP5A : I/O-93)
Blinking simultaneously CPU LED	In case of occurring the communication trouble between the option card and the inverter. Power up and down the inverter. If this problem occurs continuously, contact LS distributor.

* Refer to COM group of iP5A for Frequency(Speed)/Run command given by the option card.

7. PARAMETER CODE (All parameter addresses are Hex values)

<Common Area> : Common Area is addresses to be used commonly regardless of inverter models. Some addresses are used only for specific inverter models. ^{note5)}

^{note5)} When the data is changed by Common Area parameter, its data is not saved.

That is, the changed data is effective in the present state but the data is reset to the previous value after the inverter is reset or powered up / down.

Even though the inverter is reset or powered up / down, the changed data is effective in case of changing the data by each group parameter, not the Common Area.

7.1. iP5A Common Area

Address	Parameter	Unit	R/W	Data value						
0x0000	Inverter model	-	R	9 : SV-iP5A						
0x0001	Inverter capacity	-	R	SV-iP5A 4: 5.5 8: 18.5 C: 45 10: 110 14: 280 (Unit : kW)	5: 7.5 9: 22 D: 55 11: 132 15: 315	6: 11 A: 30 E: 75 12: 160 16: 375	7: 15 B: 37 F: 90 13: 220 17: 450			
0x0002	Inverter	-	R	0: 220V Class 1: 440V Class						
0x0003	S/W Version	-	R	Ex) 0x0100 : Ver 1.00, 0x0110 : Ver 1.10						
0x0005	Freq. Command	0.01Hz	R/W							
0x0006	Run/Stop Command	-	R/W	BIT 0	Stop					
				BIT 1	Forward Run (FX)					
				BIT 2	Reverse Run (RX)					
				BIT 3	Fault Reset (0—1)					
				BIT 4	Emergency Stop					
				BIT 5	Not used					
			R	BIT 6	Run/Stop Command Information	0	Terminal			
						1	Keypad			
						2	Option			
				BIT 7	Information	3	Int. 485			
						BIT 8	Freq. Command Information	0~16	Multi-step Speed Freq.	
								17~19	Up/Down Operation (Up, Down, UD Zero)	
				BIT 9		20~21	Not used			
				BIT 9		22~25	Analog Operation (V1, V1S, I, V1I)			
				BIT 10		26	Pulse			
BIT 11	Information	27	Sub							
		28	Int. 485							
		29	Option							
BIT 12		30	Jog							
		31	PID							
BIT 13	Not used									
BIT 14	Not used									
BIT 15	Set when Network malfunction occurs									
0x0007	Acceleration Time	0.1 sec	R/W							
0x0008	Deceleration Time	0.1 sec	R/W							
0x0009	Output Current	0.1 A	R							
0x000A	Output Frequency	0.01 Hz	R							
0x000B	Output Voltage	0.1 V	R							
0x000C	DC Link Voltage	0.1 V	R							
0x000D	Output Power	0.1 kW	R							
0x000E	Operating Status	-	R	BIT 0	Stop					
				BIT 1	Forward Run (FX)					
				BIT 2	Reverse Run (RX)					
				BIT 3	Fault (Trip)					
				BIT 4	Accelerating					
				BIT 5	Decelerating					
				BIT 6	Speed Arrival					

Address	Parameter	Unit	R/W	Data value	
0x000E	Operating Status	-	R	BIT 7	Forward Command
				BIT 8	DC Braking
				BIT 9	Not Used
				BIT10	Brake Open
				BIT11	Forward Run Command
				BIT12	Reverse Run Command
				BIT13	REM, R/S (Int. 485, OPT)
				BIT14	REM, Freq., (Int. 485, OPT)
0x000F	Trip Information	-	R	BIT15	Not used
				BIT 0	OCT1
				BIT 1	OV
				BIT 2	EXT-A
				BIT 3	BX
				BIT 4	LV
				BIT 5	Not Used
				BIT 6	GF(Ground Fault)
				BIT 7	OH (Inverter overheat)
				BIT 8	ETH (Motor overheat)
				BIT 9	OLT (Overload trip)
				BIT10	HW-Diag
				BIT11	Not Used
				BIT12	OCT2
				BIT13	OPT (Option error)
BIT14	PO (Phase Open)				
BIT15	IOLT				
0x0010	Input Terminal Information	-	R	BIT 0	M1
				BIT 1	M2
				BIT 2	M3
				BIT 3	M4
				BIT 4	M5
				BIT 5	M6
				BIT 6	M7
				BIT 7	M8
				BIT 8	P4
				BIT 9	P5
				BIT 10	P6
				0x0010	Output Terminal Information
BIT 0	AUX1				
BIT 1	AUX2				
BIT 2	AUX3				
BIT 3	AUX4				
BIT 4	Q1 (OC1)				
BIT 5	Q2 (OC2)				
BIT 6	Q3 (OC3)				
BIT 7	30AC				
BIT 8~15	Not used				
0x0012	V1	-	R	0 ~FFC0	
0x0013	V2	-	R	0 ~FFC0	
0x0014	I	-	R	0 ~FFC0	
0x0015	RPM	-	R		

Address	Parameter	Unit	R/W	Data value
0x001A	Unit display	-	R	0 : Hz, 1 : Rpm
0x001B	Pole number	-	R	
0x001C	Custom Version	-	R	

※ Refer to the main manual for the communication address regarding iP5A Function Code.

7.1.1. iP5A Communication Option Setting

< COM Group >

Address	NO.	Description	Default	Maximum	Minimum
9601	COM #01	Opt B/D	0	7	0
9602	COM #02	Opt mode	0	3	0
9603	COM #03	Opt version	2,2	-	-
963C	COM #60	Parity/Stop	0	3	0

* Inverter Number or communication speed is set in I/O-90, 91.

COM-01 [Opt B/D]

- Indicates the type of the option card installed.
- This value is automatically displayed when the option card is installed.

COM-02 [Opt Mode]

- Determines whether Run/Stop and Freq. command are set via communication.

Setting	Display	Description
0	None	None command
1	Command	Run/Stop command via communication
2	Freq	Frequency command via Communication
3	Cmd + Freq	Run/Stop and Frequency command via Communication

COM-03 [Opt Version]

- Displays the version of the option card.

COM-60 [Parity/Stop]

- Sets Stop Bite or Parity Check

Setting	Display	Description
0	8None/1Stop	Data: 8bit, Stop: 1bit, Parity: None.
1	8None/2Stop	Data: 8bit, Stop: 2bit, Parity: None
2	8Even/1Stop	Data: 8bit, Stop: 1bit, Parity: even
3	8 Odd/1Stop	Data: 8bit, Stop: 1bit, Parity: odd

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