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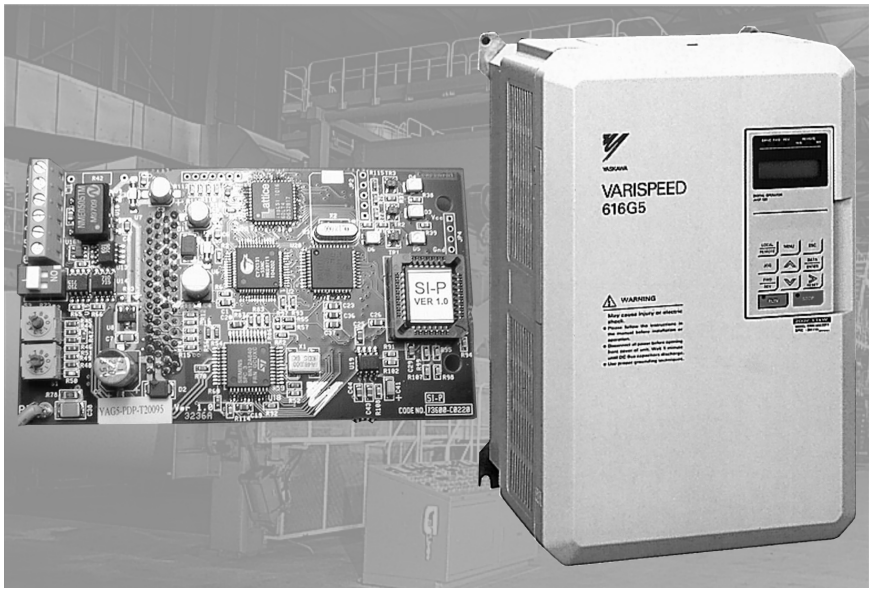


VS-616G5
Option Instruction Manual

Profibus-DP Control Card SI-P

⚠WARNING

PRECAUTIONS

1. Read this instruction manual in its entirety before installing the Profibus-DP Control Card SI-P or operating the inverter with this card installed.

2. DO NOT connect or disconnect wiring, or perform signal checks while the electrical power is turned ON.

Failure to observe these and other precautions indicated in this manual will expose the user to high voltages, resulting in serious injury or death. Damage to equipment may also occur.

⚠CAUTION

NOTE

The Option Card uses CMOS IC chips. Therefore, the card could become damaged when physically handled if static electricity is present. The person handling the card should wear a discharge strap to eliminate the possibility of static charge (if present) affecting the card.

Failure to observe this precaution may result in equipment damage.

NOTICE

No patent liability is assumed with respect to the uses of the information contained herein. Moreover, because Yaskawa is constantly improving its high quality product, the information contained in this manual is subject to change without notice. Every precaution has been taken in the preparation of this document. Nevertheless, Yaskawa assumes no responsibility for errors or omissions. Neither is any liability assumed for damages resulting from the use of the information contained in this publication.

INTRODUCTION

The Profibus-DP Control Card SI-P is used to connect the VS-616G5 inverter to a Profibus-DP network. The option card supports 32 bytes of input data, 32 bytes of output data, data transmission rates of up to 12 Mbps, and uses a RS-485 electrical interface.

Description of the Profibus-DP Option Card (SI-P) for the VS-616G5

Name	YEA Code Number	Functions
Profibus-DP Option Card SI-P	YAG5-PDP	• Connects inverter to and communicates with a Profibus-DP communication network. • Option card plugs into 2CN connector on the control board. • Option card supports 32 bytes of input data and 32 bytes of output data. • The card requires VS-616G5 Flash # VSG101042 or higher.

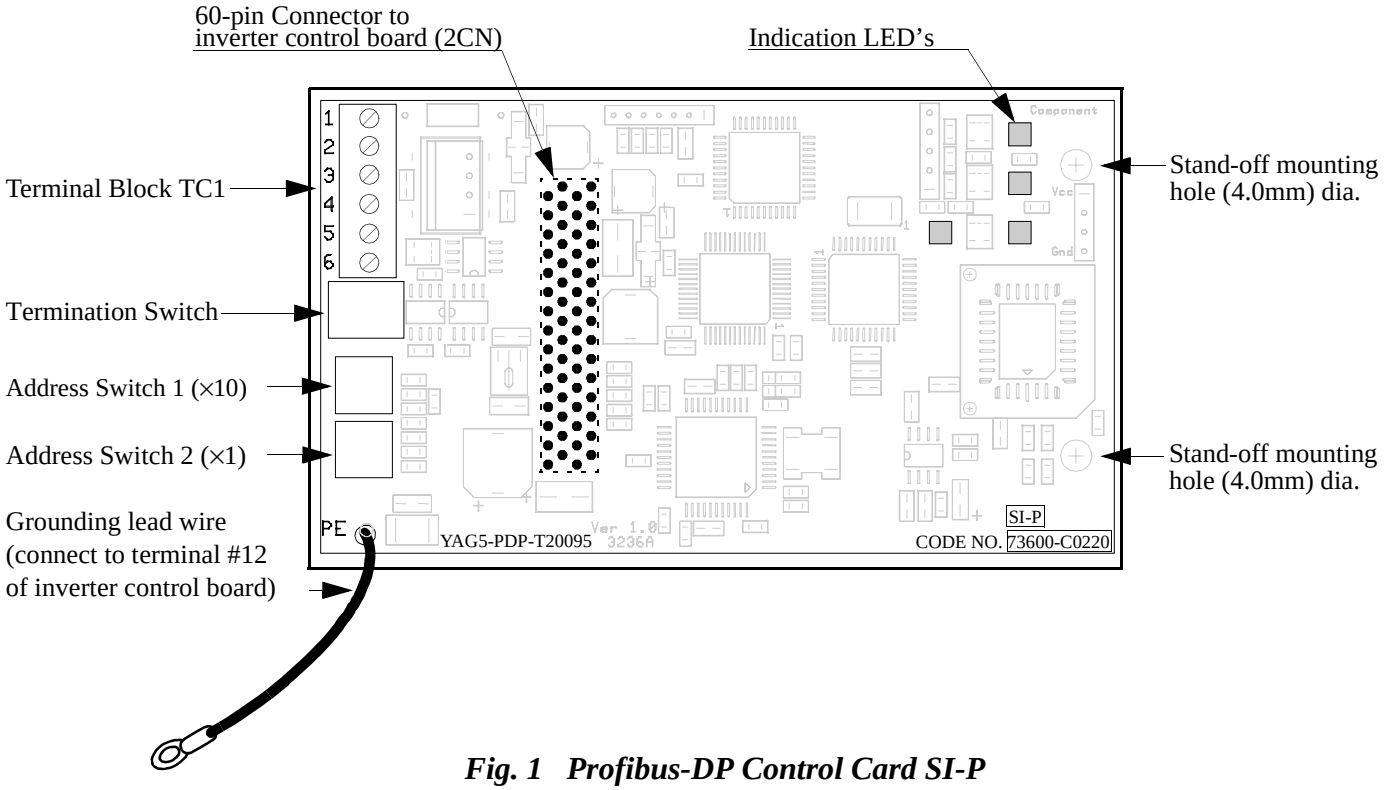


Fig. 1 Profibus-DP Control Card SI-P

INSTALLATION

1. Before attempting to install or use the Profibus-DP Control Card SI-P, please read these instructions.
2. After unpacking the card, verify that the code number is correct and that no damage has occurred during shipping. Contact your YASKAWA representative if you should require any assistance.
3. Turn OFF the main electrical power to the inverter.
4. Remove the inverter's digital operator. Then remove the inverter's front cover. Refer to the VS-616G5 User's Manual for specific removal instructions for your particular inverter size.
5. Check that the indicator CHARGE lamp is OFF (power OFF indication).
6. Plug the 2CN connector of Profibus-DP Control Card SI-P into the 2CN connector (60 pins) on the control board of the inverter. Gently push the SI-P card until the stand-off posts engage the two holes on the option card. Secure the SI-P card (See part of the side view).
7. Attach the green PE (Protected Earth) cable to terminal 12 of the VS-616G5 control board. The SHIELD is connected to pin 5 in the BUS connector.
8. Replace the inverter's cover. Refer to Fig. 4 for correct wiring of the Profibus-DP Control Card and the Control Board.

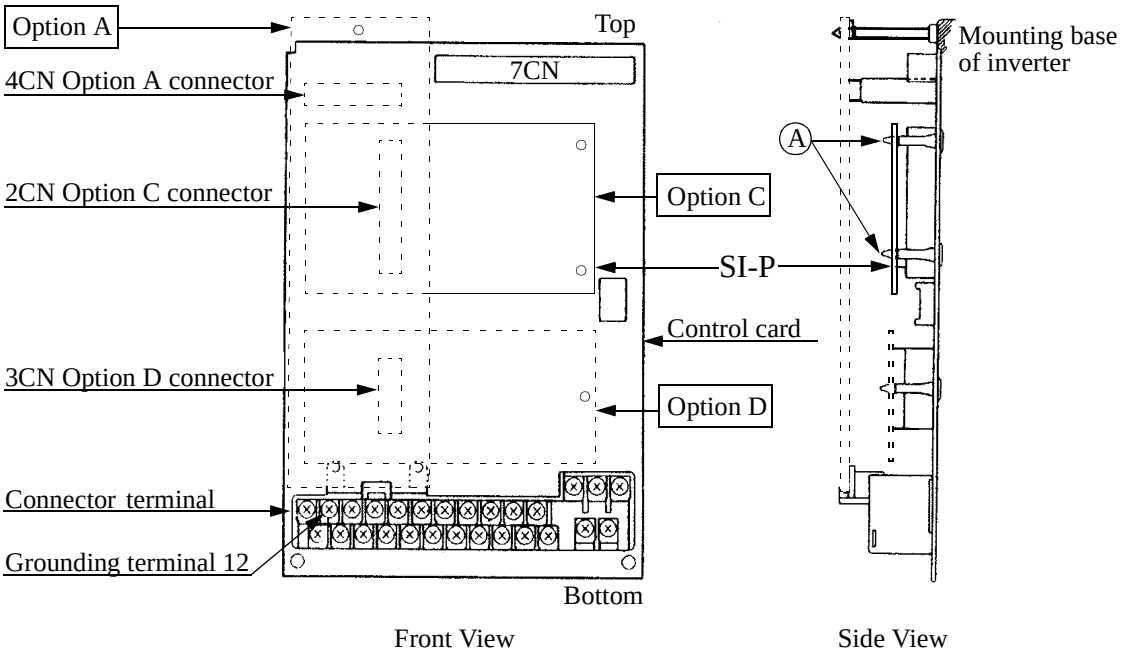


Fig. 2 Installation of the Profibus-DP Control Card SI-P

⚠CAUTION

WIRING NOTES

1. Separate the control signal wires (from terminal block TC1 on the option card) from the main circuit wires and other power cables.
2. Use twisted shielded wire to connect the communication signals. Prepare the wire as shown in Fig. 3 to prevent noise interference.

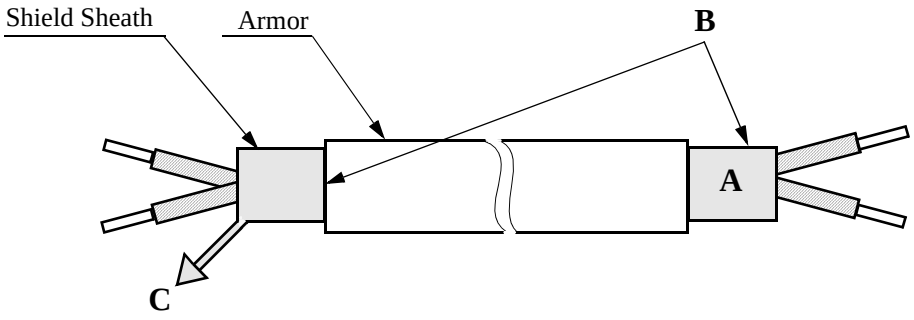


Fig. 3 Shielded Wire

A. **NEVER** connect the wire's shield to ground.

B. **WRAP** insulating tape around shielded areas and wires where termination occurs.

C. **CONNECT** the shielded wire end to the Grounding Terminal (E) on the inverter's Terminal E (G).

3. Care must be taken in the selection of the twisted shielded wire in lengths over 50 ft. The impedance of the wire should be low enough to insure sufficient signal amplitude for proper operation of all communication equipment connected to the SI-P card. In general, as the length of wire is increased, the cross section or gauge must also increase.
4. Please observe National Electrical Code (NEC) and any other governing regional or local code when wiring electrical devices.

Wiring Connection Notes:

1. To prevent noise, use shielded wire as specified in Fig. 3. Separate from the power circuits (100VAC or greater).
2. Terminate shielded wire correctly (Refer to Fig. 3).
3. Applicable wire sizes for terminal block TC1 is listed in Table 1.

Table 1: Applicable Wire Sizes for Terminal Block TC1

Wire / Installation Type	Cross-sectional Area [mm^2]	AWG	I [A]	VAC [V]
Thin twisted wire	1	16	12	125
Solid Wire	1.5	16	12	125
UL	—	22-16	10	300
CSA	—	26-16	10	300
CSA	—	26-16	10	150

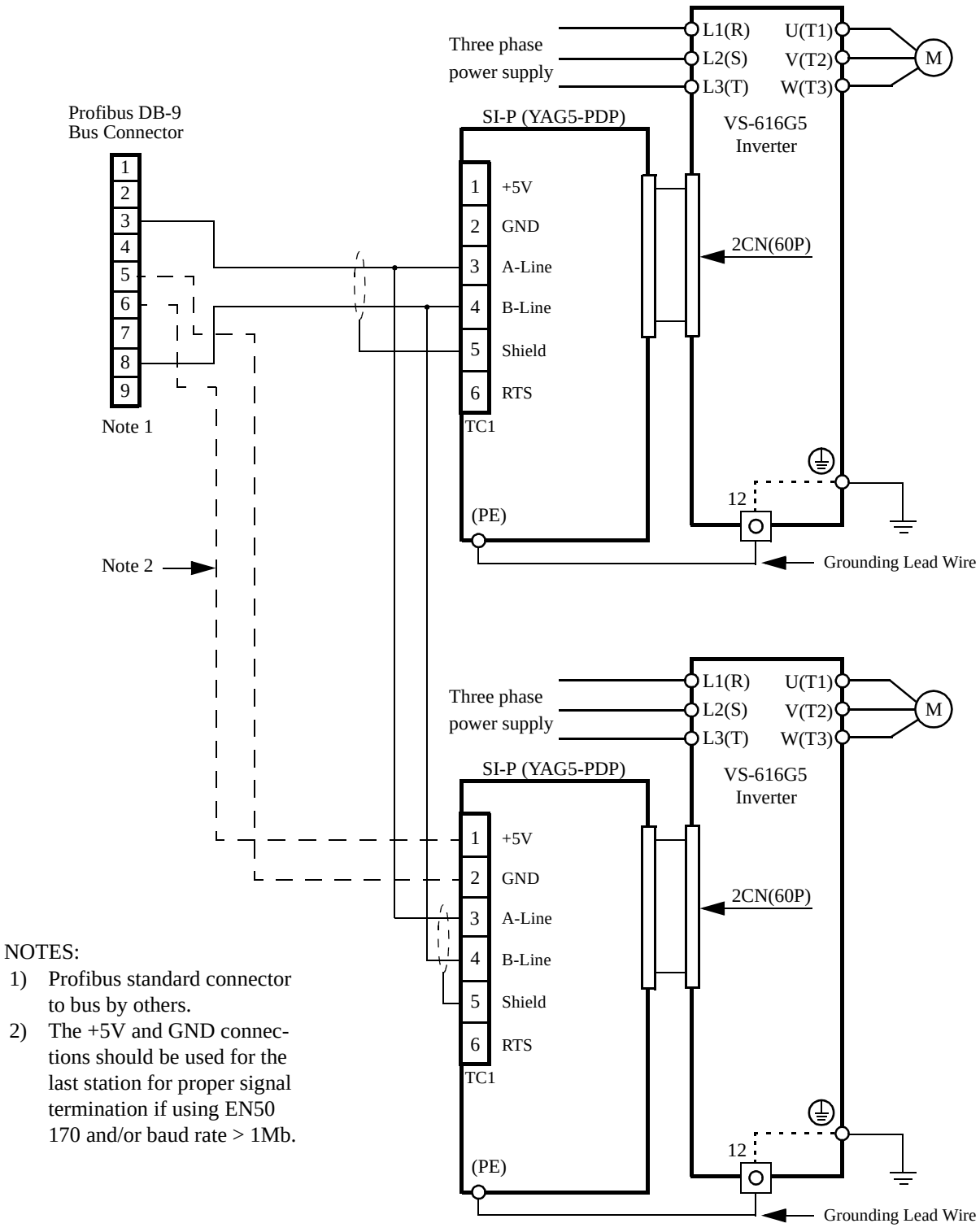
Wiring Terminal Block TC1

The Profibus organization only specifies the pin layout of a 9-pin D-SUB for the terminal block. The terminal block on the option card follows the pin layout of the connector on the SI-P option card which has been tested and approved by the Profibus organization.

Table 2: External Function Terminals of the SI-P Option Card

Pin #	Name	Function
1	+5V BUS	Isolated +5V from RS 485 side *
2	GND BUS	Isolated GND from RS 485 side *
3	A-Line	Positive RxD/TxD according RS 485 specification
4	B-Line	Negative RxD/TxD according RS 485 specification
5	Shield	BUS cable shield. Connected to PE internally on the option card
6	RTS	Request To Send *

* Optional pins. Not used in a standard RS 485 Profibus-DP installation.



NOTES:

1) Profibus standard connector to bus by others.
2) The +5V and GND connections should be used for the last station for proper signal termination if using EN50 170 and/or baud rate > 1Mb.

Fig. 4 Connection between VS-616G5 units with SI-P option cards and Profibus-DP network

Termination resistor

The option card is equipped with an internal termination resistor that is activated by a DIP switch located next to terminal block TC1. The bus cable has to be terminated at both ends of the cable. If the option card is connected as the last unit on the bus, the termination switch must be in the ON position. Note that if EN50 170 is to be followed, then Pin 1 +5V BUS and Pin 2 GND BUS must be utilized.

Address configuration

The card is equipped with two decimal (0-9) rotary switches for address set-up. The switches are located next to the termination switch.

The address is calculated in the following way:

Address = (Switch 1 x 10) + (Switch 2 x 1)

Baud Rate

The baud rate settings are handled automatically by hardware. The ASIC on the option card listens for valid Profibus-DP (PDP) telegrams from the master PLC on each from 9600 to 12Mbits/s. When a correct PDP telegram has been received from the master PLC, it will lock onto the current baud rate. The master PLC is continuously sending PDP telegrams.

Option Card LED's

The option card is equipped with four LED's for indicating option card and Profibus-DP status. The LED's are located on the card according to Fig. 5.

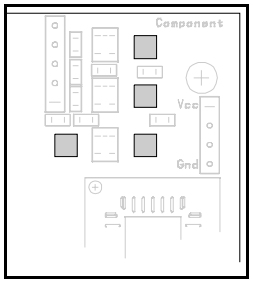


Table 3: Profibus-DP Status - LED Indication

LED	Color	Indication/Function
COMM	Green	On during data exchange with the Profibus-DP master
ERR	Red	On when no data exchange occurs

Option card status indications

The following LED's indicate the option card status.

Table 4: Option Card Status - LED Indication

LED	Color	Light Indication	Function
PWR	Green	ON OFF	+5V power to the electronics is OK. +5V is below +4.5V (min)
WD	Two color Red/Green	OFF Lit Green Flashing Green Lit Red Flashing Red Other	Option card CPU not running Initialization Normal operation Internal option card error G5 error detected Unspecified, option card error

Profibus-DP Data and I/O Map

The SI-P option card supports an I/O map of 32 bytes input data and 32 bytes of output data. This data map is fixed and must be used as described. The I/O map is divided into two sections which are described below.

- **Fast I/O data area** - Byte 0 - 15.

  Parameters in this area are directly transferred to/from the inverter. Information in these registers is updated every 5ms.

- **MODBUS message area** - Byte 16 - 31.

  This area is used to transfer MODBUS messages to the inverter. All inverter parameters and data can be accessed within this area. Since the data in this area is processed by the inverter, it may take several Profibus communication cycles depending on baud rate before the inverter responds. Therefore, a handshake procedure between master and slave is used to coordinate data. This handshake is utilized in byte 31 and is described in the **MODBUS Message Area** section.

Table 5: SI-P Option Card I/O Memory Map

OUTPUT DATA
PDP Master ⇒ G5 SI-P option card

Byte	Function
0	Operation Command
1	*(Inverter address 10H)*
2	Speed Command
3	*(Inverter address 12H)*
4	Torque Reference
5	*(Inverter address 14H)*
6	Torque Compensation
7	*(Inverter address 16H)*
8	Not Used
9	*(Inverter address 18H)*
10	AO CH1 (Terminal 21) Output
11	*(Inverter address 1AH)*
12	AO CH2 (Terminal 23) Output
13	*(Inverter address 1CH)*
14	DO Output
15	*(Inverter address 1EH)*
16	MODBUS Function Code (Command)
17	MODBUS Starting Address (Upper)
18	MODBUS Starting Address (Lower)
19	MODBUS Data Length (2 to 8)
20	MODBUS Data 1
21	MODBUS Data 1
22	MODBUS Data 2
23	MODBUS Data 2
24	MODBUS Data 3
25	MODBUS Data 3
26	MODBUS Data 4
27	MODBUS Data 4
28	Not used
29	Not used
30	Not used
31	Handshake register

INPUT DATA
G5 SI-P option card ⇒ PDP Master

Byte	Function
0	Inverter Status
1	*(Inverter address 30H)*
2	Speed Feedback
3	*(Inverter address 32H)*
4	Torque Reference
5	*(Inverter address 34H)*
6	Speed Detection PG count
7	*(Inverter address 36H)*
8	Speed Reference
9	*(Inverter address 38H)*
10	Output Frequency
11	*(Inverter address 3AH)*
12	Output Current
13	*(Inverter address 3CH)*
14	AI-CH2 Input
15	*(Inverter address 3EH)*
16	MODBUS Function Code (Response)
17	MODBUS Starting Address (Upper)
18	MODBUS Starting Address (Lower)
19	MODBUS Data Length (2 to 8)
20	MODBUS Data 1
21	MODBUS Data 1
22	MODBUS Data 2
23	MODBUS Data 2
24	MODBUS Data 3
25	MODBUS Data 3
26	MODBUS Data 4
27	MODBUS Data 4
28	Not used
29	Not used
30	Not used
31	Handshake register

Fast I/O Data Details

Table 6: Fast I/O Output Data Details (PDP Master ⇒ G5 SI-P)

Byte #	Function	Contents	Description
0	Inverter Status	High byte of the Inverter Status	See Table 7
1		Low byte of the Inverter Status	
2	Speed Feedback	High byte of the 16bit Hexadecimal data	1 / 0.01Hz
3		Low byte of the 16bit Hexadecimal data	
4	Torque Reference	High byte of the 16bit Hexadecimal data	FVC mode only 1 / 0/1%
5		Low byte of the 16bit Hexadecimal data	
6	Speed Detection PG Count	High byte of the 16bit Hexadecimal data	with PG only 1 / 0.01Hz
7		Low byte of the 16bit Hexadecimal data	
8	Speed Reference	High byte of the 16bit Hexadecimal data	1 / 0.01Hz
9		Low byte of the 16bit Hexadecimal data	
10	Output Frequency	High byte of the 16bit Hexadecimal data	1 / 0.01Hz
11		Low byte of the 16bit Hexadecimal data	
12	Output Current	High byte of the 16bit Hexadecimal data	0.4 to 7.5kW - 1 / 0.01A 11kW or greater - 1 / 0.1A
13		Low byte of the 16bit Hexadecimal data	
14	AI-CH2 (Terminal 14) Input	High byte of the 16bit Hexadecimal data	1 / 0.1%
15		Low byte of the 16bit Hexadecimal data	

Table 7: Bytes 0 and 1 of Fast I/O Output Data

Byte #	Bit #	Description
0	0	Running
	1	Zero Speed
	2	Reverse Running
	3	Reset Command Receiving
	4	Speed Agree
	5	Inverter Ready
	6	Minor Fault
	7	Major Fault
1	0	OPE Error
	1	During Momentary Power Loss Ridethrough
	2	Local / Remote
	3	Terminal 9-10 Output
	4	Terminal 25 Output
	5	Terminal 26 Output
	6	Motor Selection
	7	Zero Servo Completion (Flux Vector control mode only)

Table 8: Fast I/O Input Data Details (G5 SI-P ⇒ PDP Master)

Byte #	Function	Contents	Description
0	Operation Command	High byte of the Operation Command	See Table 9
1		Low byte of the Operation Command	
2	Speed Command	High byte of the 16bit Hexadecimal data	1 / 0.01Hz
3		Low byte of the 16bit Hexadecimal data	
4	Torque Reference / Limit	High byte of the 16bit Hexadecimal data	FVC mode only 1 / 0/1%
5		Low byte of the 16bit Hexadecimal data	
6	Torque Compensation	High byte of the 16bit Hexadecimal data	with PG only 1 / 0.01Hz
7		Low byte of the 16bit Hexadecimal data	
8	Not Used	—	—
9	Not Used	—	—
10	AO CH1 (Terminal 21) Output	High byte of the 16bit Hexadecimal data	-726 (-11V) to 726 (11V) Effective when H4-01=”1F”
11		Low byte of the 16bit Hexadecimal data	
12	AO CH1 (Terminal 23) Output	High byte of the 16bit Hexadecimal data	-726 (-11V) to 726 (11V) Effective when H4-04=”1F”
13		Low byte of the 16bit Hexadecimal data	
14	DO Output	Bit 0 = Terminal 9-10 Effective when H2-01=”F” Bit 1 = Terminal 25-27 Effective when H2-02=”F” Bit 2 = Terminal 26-37 Effective when H2-03=”F” Bit 3 to F must be “0”	—
15	—	Must be “0”	

Table 9: Bytes 0 and 1 of Fast I/O Input Data

Byte #	Bit #	Description	Remarks
0	0	Forward Run	Effective when the setting B1-02=3
	1	Reverse Run	Effective when the setting B1-02=3
	2	Terminal 3 Function	Depends on H1-01 setting
	3	Terminal 4 Function	Depends on H1-02 setting
	4	Terminal 5 Function	Depends on H1-03 setting
	5	Terminal 6 Function	Depends on H1-04 setting
	6	Terminal 7 Function	Depends on H1-05 setting
	7	Terminal 8 Function	Depends on H1-06 setting
1	0	External Fault	—
	1	Fault Reset	—
	2	Not Used	—
	3	Not Used	—
	4	Not Used	—
	5	Not Used	—
	6	Not Used	—
	7	Not Used	—

MODBUS Message Area

This area is used to transfer MODBUS messages to the inverter. The Profibus-DP master places the MODBUS command in the output area. The response generated by the inverter is placed in the input area. The messages can contain 1 - 4 words of data. Since this procedure may take several Profibus communication cycles, a handshaking protocol is required. The protocol indicates when new commands and responses are available in the input and output area. Please refer to Yaskawa technical document PI#95029 entitled "MODBUS Communication for the VS-616G5 inverter" for details and parameter register addresses.

MODBUS command message structure

The MODBUS command message is built up as shown in Table 10.

Table 10: MODBUS Command Message Structure (PDP Master ⇒ G5 SI-P)

Byte	Name	Function
16	MODBUS Function Code	MODBUS command code. 03H: Read command 10H: Write command Other: Not supported
17	MODBUS Starting address HI	Inverter start address reference, HI byte
18	MODBUS Starting address LOW	Inverter start address reference, LOW byte
19	MODBUS Data Length	Write: No of valid bytes in the data area Read: No. of requested bytes for read operation.
20	MODBUS Data 1	HI byte for Data word 1. Write operation
21	MODBUS Data 1	LOW byte for Data word 1. Write operation
22	MODBUS Data 2	HI byte for Data word 2. Write operation
23	MODBUS Data 2	LOW byte for Data word 2. Write operation
24	MODBUS Data 3	HI byte for Data word 3. Write operation
25	MODBUS Data 3	LOW byte for Data word 3. Write operation
26	MODBUS Data 4	HI byte for Data word 4. Write operation
27	MODBUS Data 4	LOW byte for Data word 4. Write operation
28	Not used	Reserved for future use
29	Not used	Reserved for future use
30	Not used	Reserved for future use
31	Handshake register	See **Handshaking Register** section

MODBUS response message structure

The MODBUS response message is built up in the following way:

Table 11: MODBUS Response Message Structure (G5 SI-P ⇒ PDP Master)

Byte	Name	Function
16	MODBUS Function Code	MODBUS Response code. 00H: Waiting for response from inverter. 03H: Response for read operation. 10H: Response for write operation. 83H: Read command error. 90H: Write command error. Other: Not supported
17	MODBUS Starting address HI	Inverter start address reference, HI byte
18	MODBUS Starting address LOW	Inverter start address reference, LOW byte
19	MODBUS Data Length	Write: No of bytes written to inverter. Read: No. of valid bytes in the data area
20	MODBUS Data 1	HI byte for Data word 1. Read operation
21	MODBUS Data 1	LOW byte for Data word 1. Read operation
22	MODBUS Data 2	HI byte for Data word 2. Read operation
23	MODBUS Data 2	LOW byte for Data word 2. Read operation
24	MODBUS Data 3	HI byte for Data word 3. Read operation
25	MODBUS Data 3	LOW byte for Data word 3. Read operation
26	MODBUS Data 4	HI byte for Data word 4. Read operation
27	MODBUS Data 4	LOW byte for Data word 4. Read operation
28	Not used	Reserved for future use
29	Not used	Reserved for future use
30	Not used	Reserved for future use
31	Handshake register	See **Handshaking Register** section

If a fault occurs, the option card responds with an ERROR by setting the MSB bit in the MODBUS Response code to one (1). When this occurs, the MODBUS data length is set to 02H and the LOW byte for Data word 1 contains the ERROR code.

Table 12: Error Code Descriptions

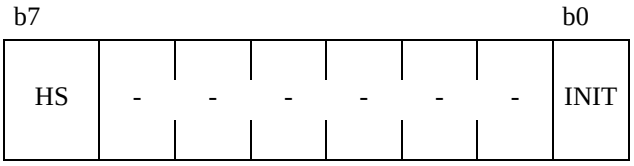
Error	Error Code	Description
Function error	01H	Unregistered MODBUS function code.
Address fault	02H	Parameter address (Starting address) is greater than 600H Designate unused parameter address.
No. of Data Faults	03H	Read more than 4 words Write more than 4 words
Data content Fault	21H	Parameter contents exceed the upper or lower limit.
—	22H	Parameters are changed during running or undervoltage condition.
Write Fault	23H	Write parameter during undervoltage
—	24H	Write parameter during calculating parameter.

Handshaking Register

The handshaking protocol is used synchronises the MODBUS data exchange between the Profibus-DP master and the option card. The handshaking protocol is simple to use and implement in a PLC program. One register (byte 31) in the input and output area is dedicated to this protocol.

HANDSHAKE OUTPUT REGISTER

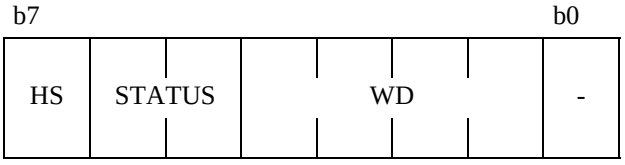
PDP Master ⇒ G5 SI-P option card



Bit	Name	Function
7	HS	Handshaking bit. Used to synchronize the data exchange. Toggled when a new command is transmitted. **NOTE**: This bit **must** be cleared after power-up or reinitialization by the PLC program.
6 - 1	—	Not used
0	INIT	Used for reinitialization of the handshaking protocol

HANDSHAKE INPUT REGISTER

G5 SI-P option card ⇒ PDP Master



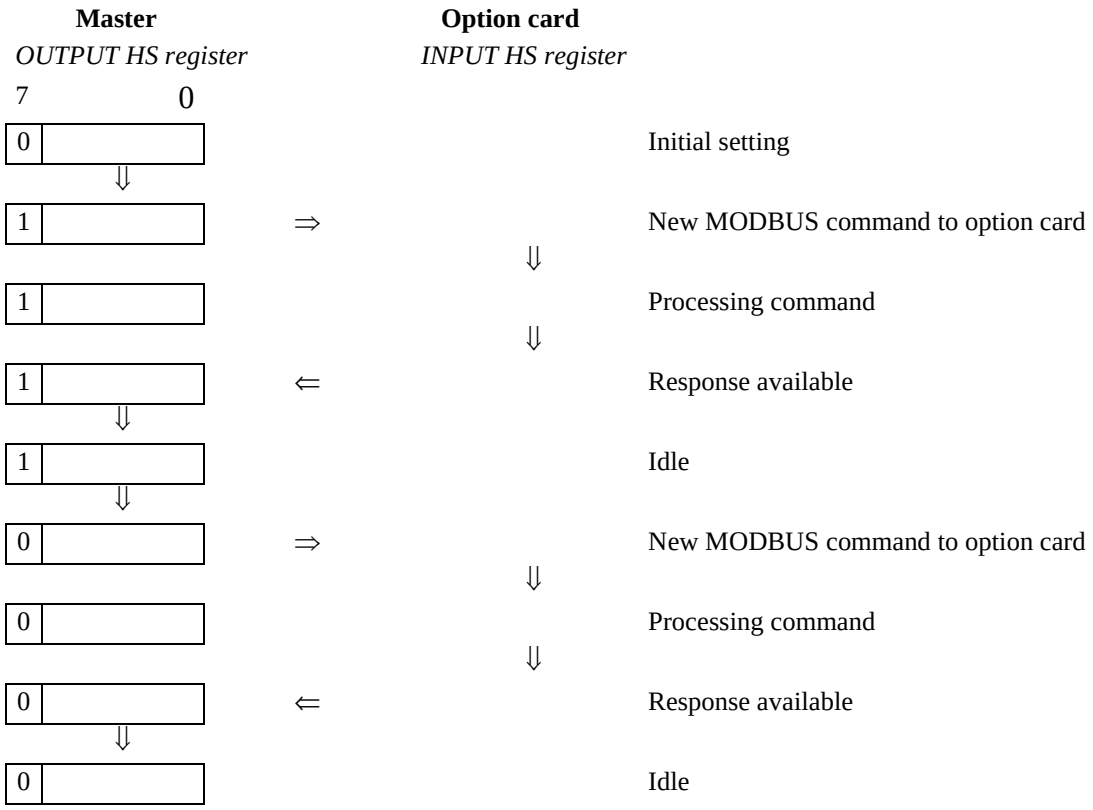
Bit	Name	Function
7	HS	Handshaking bit. Used to synchronize the data exchange. Toggled when a new response is transmitted.
6 - 5	STATUS *	Status of data exchange between option card and inverter. 00H: Idle 01H: Sending MODBUS command to inverter 10H: Waiting for MODBUS response 11H: Response received
4 - 1	WD *	Counter incremented approximately each 64ms.
0	—	Not used

* The STATUS and WD bits give additional information about the option card. The user does not have to access or use these bytes in the PLC program to exchange data using MODBUS messages.

Example of handshaking protocol

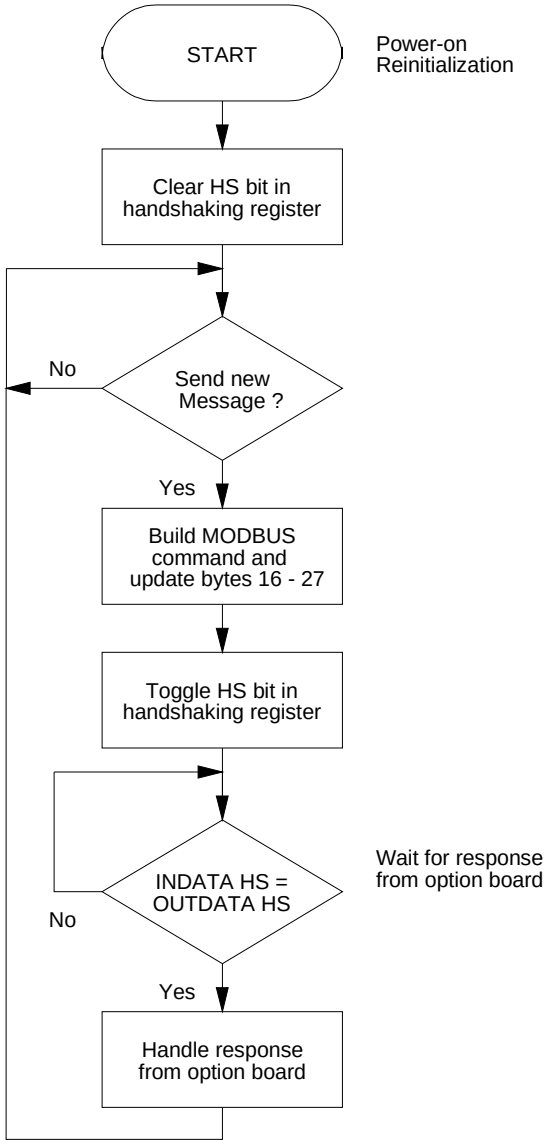
After power-up or reinitialization, the PLC program has to clear the HS bit (bit 7) in the handshaking register.

Below is a example of how handshaking is done. The arrows indicate which side has control of the protocol.



Flowchart

The flowchart below describes an implementation of the handshaking procedure for MODBUS messages in the Profibus master controller.



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