SD 500
Series

ACCESSORIES

Ethernet Communication

Communication Network

POWER ELECTRONICS®

SD500 Series

ACCESSORIES

Communication Network

Ethernet Communication

Edition: November 2016

SD50BC03BI Rev. B

SAFETY SYMBOLS

Always follow safety instructions to prevent accidents and potential hazards from occurring.

In this manual, safety messages are classified as follows:

 **WARNING**	Identifies potentially hazardous situations where dangerous voltage may be present which if not avoided could result in minor personal injury, serious injury or death Be extremely careful and follow the instructions to avoid the risk of electrical shocks.
 **CAUTION**	Identifies potentially hazardous situations which if not avoided could result in product damage or minor or moderate personal injury. Read the message and follow the instructions carefully.
 **NOTICE**	Identifies important measures to take in order to prevent damage equipment and warranty lost, as well as encouraging good use and environmental practices.

Other symbols used in this manual for CAUTION messages are the following:

	Hot surface. Be careful and follow the instructions to avoid burns and personal injuries.
	Risk of fire. Be careful and follow the instructions to prevent causing an unintentional fire.

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Revisions

Date	Revision	Description
02 / 05 / 2012	A	First edition
17 / 11 / 2016	B	Misprints and contents update.

TABLE OF CONTENTS

ENGLISH

SAFETY INSTRUCTIONS

IMPORTANT!

Read carefully this manual to maximize the performance of the product and to ensure its safe use.

In order to use appropriately the drive, please, follow all instructions described in the installation manual referred to transport, installation, electrical connection and commissioning of the equipment.

Power Electronics accepts no responsibility or liability for partial or total damages resulting from inappropriate equipment use.

Please, pay careful attention to the following recommendations:

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WARNING

Make sure to take ESD (Electrostatic Discharge) protection measures when you touch the board.
Otherwise, the optional board may get damaged due to static charges.

Implement wiring change on the optional board after checking that the power supply is off.
Otherwise, there is a danger of connecting error and damage to the board.

Be sure to connect correctly the optional board to the inverter.
Otherwise, there is a danger of connecting error and damage to the board.

Do not remove the cover while the power is applied or the unit is in operation.
Otherwise, electric shock could occur.

Do not run the inverter with the front cover removed.
Otherwise, you may get an electric shock due to the high voltage terminals or exposure of charged capacitors.

Do not remove the cover except for periodic inspections or wiring, even if the input power is not applied.
Otherwise, you may access the charged circuits and get an electric shock.

Wiring and periodic inspections should be performed at least 10 minutes after disconnecting the input power and after checking the DC Link voltage is discharged with a meter (below 30VDC).
Otherwise, you may get an electric shock.

Operate the switches with dry hands.
Otherwise, you may get an electric shock.

Do not use cables with damaged insulation.
Otherwise, you may get an electric shock.

Do not subject the cables to the abrasions, excessive stress, heavy loads or pinching.
Otherwise, you may get an electric shock.

CAUTION

Install the drive on a non-flammable surface. Do not place flammable material nearby. Otherwise, a fire could occur.

Disconnect the input power if the drive gets damaged.
Otherwise, it could result in a secondary accident or fire.

Do not allow lint, paper, wood chips, dust, metallic chips or other foreign matter into the drive. Otherwise, a fire or accident could occur.

The inverter becomes hot during operation. Wait until it cools down before performing any actions.
Touching hot parts may result in skin burns.

Do not apply power to a damaged drive or to a drive with parts missing, even if the installation is complete.
Otherwise, you may get an electric shock.

NOTICE

RECEPTION

- Material of Power Electronics is carefully tested and perfectly packed before leaving the factory.
- In the event of transport damage, please ensure that you notify the transport agency and POWER ELECTRONICS: 902 40 20 70 (International +34 96 136 65 57) or your nearest agent, within 24hrs from receipt of the goods.

UNPACKING

- Make sure received merchandise corresponds with delivery note, models and serial numbers.
- Each board is supplied with a technical manual.

RECYCLING

- Packing of the equipment should be recycled. For this, it is necessary to separate the different included materials (plastic, paper, cardboard, wood, …) and deposit them in corresponding containers.
- Waste products of electric and electronic devices should be selectively collected for their correct environmental management.

SAFETY

Before operating the inverter, read this manual thoroughly to gain and understanding of the unit. If any doubt exists then please contact POWER ELECTRONICS, (902 40 20 70 / +34 96 136 65 57) or your nearest agent.

- Wear safety glasses when operating the inverter with power applied or the front cover is removed.
- Handle the inverter with care according to its weight.
- Install the inverter according to the instructions within this manual.
- Do not place heavy objects on the inverter.
- Ensure that the mounting orientation is correct.
- Do not drop the inverter or subject it to impact.
- The SD500 drives contain static sensitive printed circuits boards. Use static safety procedures when handling these boards.

ENGLISH

CONNECTION PRECAUTIONS

- To ensure correct operation of the inverter it is recommended to use a SCREENED CABLE for the control wiring.
- For EMERGENCY STOP, make sure supply circuitry is open.
- Do not disconnect motor cables if input power supply remains connected. The internal circuits of the drive will be damaged if the incoming power is connected and applied to output terminals (U, V, W).
- It is not recommended to use a 3-wire cable for long distances. Due to increased leakage capacitance between conductors, over-current protective feature may operate malfunction.
- Do not use power factor correction capacitors, surge suppressors, or RFI filters on the output side of the inverter. Doing so may damage these components.
- Always check whether the DC Link LED is OFF before wiring terminals. The charge capacitors may hold high-voltage even after the input power is disconnected. Use caution to prevent the possibility of personal injury.

COMMISSIONING

- Follow the steps described in this manual.
- Always apply voltage and current signals to each terminal that are within levels indicated within this manual. Otherwise, damage to the optional board may result.

OPERATION PRECAUTIONS

- When the Auto Restart function is enabled, keep clear of driven equipment, as the motor will restart suddenly after a fault is reset.
- The "STOP / RESET" key on the keypad is active only if the appropriate function setting has been made. For this reason, install a separate EMERGENCY STOP push button that can be operated at the equipment.
- If a fault reset is made with the reference signal still present, then a restart will occur. Verify that it is permissible for this to happen, otherwise an accident may occur.
- Do not modify or alter anything within the drive.
- Before programming or operating the SD500 Series, initialise all parameters back to factory default values.

EARTH CONNECTION

- The inverter is a high frequency switching device, and leakage current may flow. Ground the inverter to avoid electrical shock. Use caution to prevent the possibility of personal injury.
- Connect only to the dedicated ground terminal of the inverter. Do not use the case or the chassis screw for grounding.
- When installing, grounding wire should be connected first and removed last.
- The earth cable must have a minimal cross sectional area that meets local country electrical regulations.
- Motor ground must be connected to the drive ground terminal and not to the installation's ground. We recommend that the section of the ground connection cable should be equal or higher than the active conductor.
- Installation ground must be connected to the inverter ground terminal.

ENGLISH

PART I

ETHERNET BOARD

1. INTRODUCTION

1.1. Ethernet Networks

1.1.1. Introduction

Ethernet is used to designate a family of frame-based computer networking technologies for local area networks (LANs). It was mainly developed by Xerox Corporation, Intel Corporation and Digital Equipment Corporation (DEC) companies in 1980, and has continued evolving since then.
Ethernet defines a number of wiring and signalling standards for the physical layer and the frame formats of the data link layer of the OSI model.
Ethernet is the most commonly used LAN technology because it achieves a good balance between speed, cost and installation easiness. Additionally, it is very accepted in the market and supports all popular virtual network protocols.

Some of the advantages of Ethernet that makes it the ideal network technology for most current computer users are:

- Easy installation and maintenance, together with their low cost.
- Flexibility for interconnecting different topologies.
- Stable standard that allows interconnecting devices from different manufacturers.

1.1.2. Types of Ethernet Networks

There are different implementations for Ethernet network, according to the physical environment referred. The existing Ethernet technologies differ in the following characteristics:

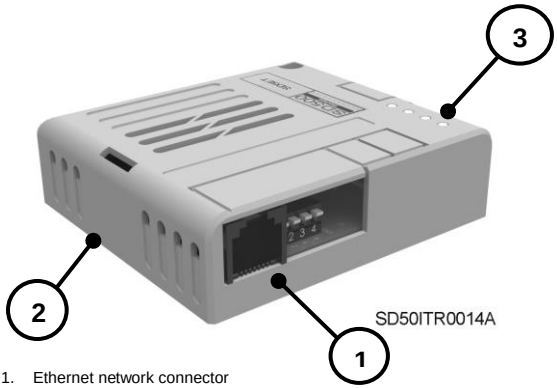
- **Transmission speed:** Transmission capacity of the environment in Mbps.
- **Cable type:** Used technology of the physical layer.
- **Maximum length:** Maximum allowed distance between two adjacent nodes (without repeaters).
- **Typology:** Defines the performance of the central linking points.

Technology	Transmiss. speed	Cable type	Maximum distance	Typology
10Base2	10 Mbps	Coaxial	185m	Connector T
10BaseT	10 Mbps	Twisted Pair	100m	Hub or Switch
10BaseF	10 Mbps	Fibre Optics	2000m	Hub or Switch
100BaseTX	100 Mbps	Twisted Pair (5UTP category)	100m	Half Duplex (Hub) and Full Duplex (Switch)
100BaseT4	100 Mbps	Twisted Pair (3UTP category)	100m	Half Duplex (Hub) and Full Duplex (Switch)
100BaseFX	100 Mbps	Fibre Optics	2000m	Hubs use is not allowed

1.2. Description of the Ethernet Board

The Ethernet board for SD500 drives allows integrating the drive in a LAN (Local Area Network). It supports the TCP/IP standard communication protocol and the industrial application layer protocol Ethernet/IP for industrial automation applications.

Thanks to this board, the drive can be controlled and monitored by the user or through a PLC sequence program or any master device (client).



1. Ethernet network connector
2. Connector for drive
3. Status leds

Figure PI-1.1 Ethernet board description

2. TECHNICAL CHARACTERISTICS

2.1. General Information

2.1.1. Contents of the Ethernet Board Kit

The kit of the Ethernet board contains:

- 1 Ethernet board.
- 1 Fixation screw.
- 1 Technical manual.

2.1.2. Specifications of Ethernet Board

- Device Type: Network adapter.
- Shape Factor: Inserted board.
- Wiring Type: Ethernet 10Base-T, Ethernet 100Base-TX.
- Data Exchange Protocol: Modbus TCP/IP, Ethernet/IP.
- Auto-addressing Protocol DHCP supported.
- Data Transmission Speed: 10Mbps, 100Mbps
- Standards: IEEE 802.3, IEEE 802.3u (only for 100Base-TX).
- Cable Lengths: Maximum 100m per network segment.

2.1.3. Local indicators

The Ethernet board includes 4 leds that supply information about the communication status and speed and, depending on the communication case (Modbus/TCP or Ethernet IP), information about the working status. To obtain more detailed information about leds, please, see section *'3.2.3. Description of Leds'*.

2.1.4. Requirements

To establish communication with SD500 Series drives via Modbus TCP/IP, the user should have one Modbus TCP/IP client. For example:

- PLC + Ethernet board for PLC + Client software Modbus TCP/IP
- PC + Ethernet board + Client application Modbus TCP/IP

To establish communication with SD500 Series drives via Ethernet/IP, the user should have one client that supports Ethernet/IP protocol and also:

- Explicit Connected Messaging: non-temporal information data (configuration, diagnosis, data collection).
- Connected I/O Messaging: I/O data online, functional safety data, motion control data.

3. INSTALLATION AND CONNECTION

3.1. Installation of Ethernet Board

The Ethernet board is directly connected to the drive of the SD500 Series from Power Electronics (through a connector) with the purpose of integrating the equipment in an Ethernet local area network (LAN) with TCP/IP or Ethernet/IP as network protocol. Therefore, one Ethernet board will be necessary per each equipment which is going to be connected to the network.

CAUTION

Power Electronics motor controllers operate with a high electric energy. Make sure the power supply has been disconnected and wait for at least 10 minutes to guarantee that DC Link voltage is discharged before installing the Ethernet board. Otherwise, you may get personal injuries or an accident could occur.

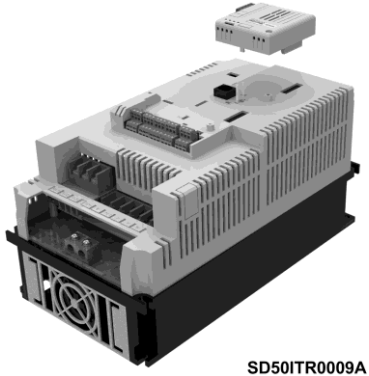
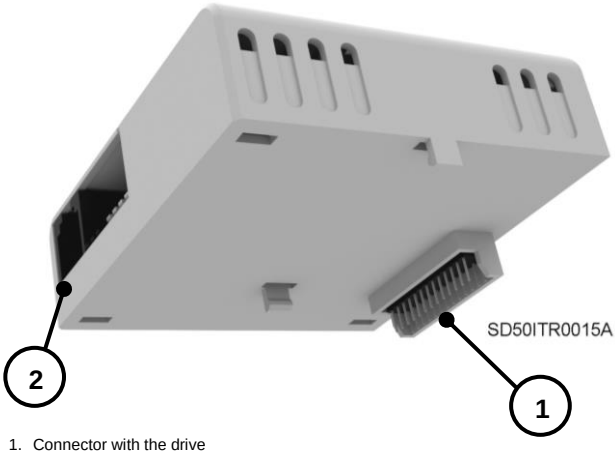


Figure PI-3.1 Installation of Ethernet Board in the drive

3.2. Connections of the Ethernet Board

There are connectors, four leds and four switches on Ethernet board. There is a connector used to connect the board to the SD500 drive and a RJ45 connector for connecting it to the Ethernet network. Switches are used to set the communication protocol. On the other hand, the leds supply different information depending on the active communication protocol.

3.2.1. Connectors description



1. Connector with the drive
2. Ethernet connector

Figure PI-3.2 Connectors location in the Ethernet Board

3.2.2. Switches description

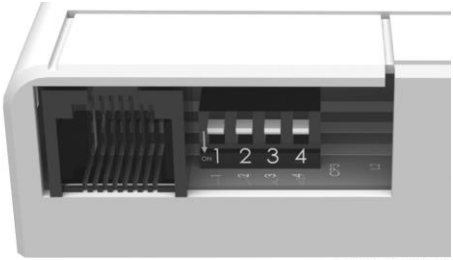


Figure PI-3.3 Location of switches on Ethernet Board

There are two communication protocols for using the SD500 Ethernet optional board: Modbus TCP and Ethernet IP. Switch 1 controls the communications protocol. Switches 2, 3 and 4 are not available.

Switch State	Protocol
OFF (switch at the upper position)	Modbus TCP
ON (switch at the lower position)	Ethernet IP

The communications protocol cannot be changed while the variable frequency drive is working. Protocol is determined by the state of the switch 1 when the module is turned on or is initialized by setting the subgroup [G21.1.1 Comm Update] to “Yes”.

3.2.3. Leds description

The Ethernet board has four leds that show, at all times, its status. Led1 and Led2 behaviour depends on the active communication protocol (Modbus TCP or Ethernet IP), while the remaining two leds, number 3 and 4 have the same behaviour in both protocols

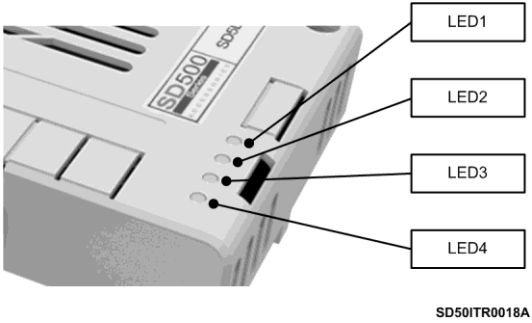


Figure PI-3.4 Location of leds on Ethernet Board

Case of Modbus/TCP communication

LED1 (green)	CPU led	**Flashing:** the Ethernet board is correctly power supplied and CPU Modbus/TCP communication card operates normally. **OFF:** the CPU is not supplied with power. Reinstall the card.
LED2 (red)	Error led	**ON:** IP address is set to 0.0.0.0 or 255.255.255.255 (using these addresses is not recommended). **CPU and ERROR flash alternatively:** the EEPRom of the Ethernet board is in bad condition. Replace the EEPRom. **CPU and ERROR flash simultaneously:** Ethernet has lost communication with the card. Reinstall the card. **ERROR flashes at longer intervals than that of the CPU:** IP conflict (there is another device in the network with the same IP) **OFF:** the Ethernet communication card is operating normally without error.

Case of Ethernet IP communication

LED1 (green and red)	NS led	Green	**OFF:** client and TCP are not in connection. **Flashing:** client and TCP are connected and registered. Communication is possible. **ON:** connection has been made and it is communicating.
		Red	**OFF:** the network has no problem. **Flashing:** connection was disconnected abnormally. Check Network cables and their connection. **ON:** IP conflicts with another device having the same IP in the Network.
LED2 (green and red)	MS led	Green	**ON:** the option is in normal condition. **OFF:** the option is in problem.
		Red	**ON:** the IP address is set since 0.0.0.0 to 255.255.255.255 (it is not recommended to use them). **Flashing:** Ethernet has lost communication with the card. Reinstall the Option. **OFF:** the card is in normal condition.

Note: When Ethernet IP is selected and the card is initialized, the LEDs light up and out in the following sequence:
MS GREEN→MS RED→NS GREEN→NS RED

Common working sequence

LED3 (green)	Speed led	**ON:** communication speed is 100Mbps. **OFF:** communication speed is 10Mbps
LED4 (green)	Link led	**ON:** ready for communication. **OFF:** The communication cable has a problem.

4. ETHERNET BOARD CONFIGURATION

4.1. Ethernet Parameters Setting

There are several parameter groups used to configure SD300 drives operation in a communication network:

[G3 References]
[G4 Inputs ➔ G4.1 Digital Inputs]
[G21 Net Comms ➔G21.1 General,
➔G21.2 Modbus TCP/IP,
➔G21.3 Ethernet IP].
[G11 Protections]

4.1.1. Group 3: References

Speed reference mode must be defined in order to cede drive control to the communication network.

Display	Name / Description	Range	Function	Set on RUN
1 REF1 SP=LOCAL	**G3.1 /** Speed reference source 1	LOCAL AI1 AI2 AI3 AI4 MDBUS COMMS PLC	To control the speed reference using Ethernet communications this parameter must be set as "COMMS".	NO

4.1.2. Subgroup 4.1 – G4.1: Digital Inputs

Drive control modes need to be defined in order to cede the control to the communication network.

<table>
<tr><th>Display</th><th>Name / Description</th><th>Range</th><th>Function</th><th>Set on RUN</th></tr>
<tr><td>1 CNTROL MODE1=1</td><td>G4.1.1 / Main Control Mode</td><td>0-3</td><td>Set the control mode for sending commands to the drive (Start/Stop, Reset, ...).

<table><tr><th>OPT.</th><th>DESCRIPTION</th><th>FUNCTION</th></tr><tr><td>0</td><td>LOCAL</td><td>Drive is controlled by keypad.</td></tr><tr><td>1</td><td>REMOTE</td><td>Drive controlled through control terminals.</td></tr><tr><td>3</td><td>Modbus</td><td>Drive controlled through Modbus.</td></tr><tr><td>4</td><td>COMMS</td><td>Drive controlled through communication bus.</td></tr><tr><td>5</td><td>PLC</td><td>Drive controlled through PLC.</td></tr></table>To control the inverter using Ethernet communications this parameter must be set as “COMMS”.</td><td>NO</td></tr>
</table>

After connecting the Ethernet board to the drive, a new parameter group called ‘G21 NET COMMS’, with the corresponding parameter subgroups, is available. Use these parameters to configure the drive to operate in an Ethernet network.

4.1.3. Subgroup 21.1 – G21.1: General

Parameter	Description	Range	Function	Set on RUN
1 ComUpdate=NO Comm Update	**G21.1.1** / To enable communication update	N Y	OPT. / FUNCTION: NO – Disabled; YES – Enabled. When the equipment is running, the Option parameters are expressed by the values set up in the Option, however, they are not reflected immediately when they are set. If this parameter is set "YES" the Modbus/TCP communication card will be restarted and this problem solved.	YES
2 LEDStatus=1 LEDs Status	**G21.1.2** / Status of the LEDs	0 to 15	Displays the ON/OFF statuses of the 4 LEDs on the communication card.	NO
3 CommsRt= Eth. Comms Rate	**G21.1.3** / Ethernet communications rate	0 to 2	OPT. / FUNCTION: 0 – Set speed automatically; 1 – 100Mbps; 2 – 10Mbps. Automatic speed setting function sets up the highest speed in the network.	YES
4 IP A.B= IP Address A.B	**G21.1.4** / IP address (A.B)	0 to 65535	Set the IP address assigned to the equipment in the user local network. This address must be provided by the network administrator. The IP address format is: A.B.C.D. Therefore, this address is set by introducing a value in each parameter that configures the complete address, this is, by assigning a value to each one of the 2 parameters.	YES
5 IP C.D= IP Address C.D	**G21.1.4** / IP address (C.D)	0 to 65535		YES

ENGLISH

Parameter	Description	Range	Function	Set on RUN
6 NET A.B= Subnet Mask A.B	**G21.1.4** / Subnet mask address (A.B)	0 to 65535	Set the Subnet Mask address of the local network of the user. This address must be provided by the network administrator of the own user.	YES
7 NET C.D= Subnet Mask C.D	**G21.1.4** / Subnet mask address (C.D)	0 to 65535	The format of the Subnet Mask address is the following one: A.B.C.D. Therefore, the setting of this address is realized by introducing a value in each parameter that configures the complete address, this is, by assigning a value to each one of the 2 parameters.	YES
8 GWAYA.B= Gateway Add. A.B	**G21.1.4** / Subnet mask address (A.B)	0 to 65535	Set the Gateway address of the local network of the user. This address is needed to the drive access to an external network. This address must be provided by the network administrator of the own user.	YES
7 GWAYC.D= Gateway Add. C.D	**G21.1.4** / Subnet mask address (C.D)	0 to 65535	The Gateway address format is: A.B.C.D. Therefore, this address is set by introducing a value in each parameter that configures the complete address, this is, by assigning a value to each one of the 2 parameters.	YES

4.1.4. Subgroup 21.2 – S21.2: Modbus TCP/IP

Screen / Default value	Name / Description	Range	Function	Set during Run
1 Slave Addr=1 Int485 SlaveAddr	**G21.2.1** / Modbus slave address	1 to 250	Modbus address. It is used for RTU and TCP protocols.	YES

4.1.5. Subgroup 21.3 – S21.3: Ethernet IP

Screen / Default value	Name / Description	Range	Function	Set during Run
1 ComUpdate=0 **Comm Update**	**G21.3.1** /Comm. update	N Y	Enable or disable communications update.	YES
2 RdInstance=70 **Read Instance**	**G21.3.2** / Ethernet input instance	70 71 110 111 141 142 143 144 145 146 147 148	Select the Ethernet communication input instance.	YES
3 ParamRdNum= 3 **Param Read Num**	**G21.3.3** / Parameter Reading number	0 to 8	Visualize the number of Reading addresses to communicate. This value changes depending on the input instance set in the parameter [G20.4.5 'RdInstance'].	NO
4 ParaRd1=0x000A **Param Read 1**	**G21.3.4** / Read address 1	0x0000 to 0xFFFF	Read input address 1.	YES
5 ParaRd2=0x000D **Param Read 2**	**G21.3.5** / Read address 2	0x0000 to 0xFFFF	Read input address 2.	YES
6 ParaRd3=0x000F **Param Read 3**	**G21.3.6** / Read address 3	0x0000 to 0xFFFF	Read input address 3.	YES
7 ParaRd4=0x0000 **Param Read 4**	**G21.3.7** / Read address 4	0x0000 to 0xFFFF	Read input address 4.	YES
8 ParaRd5=0x0000 **Param Read 5**	**G21.3.8** / Read address 5	0x0000 to 0xFFFF	Read input address 5.	YES
9 ParaRd6=0x0000 **Param Read 6**	**G21.3.9** / Read address 6	0x0000 to 0xFFFF	Read input address 6.	YES
10 ParaRd7=0x0000 **Param Read 7**	**G21.3.10** / Read address 7	0x0000 to 0xFFFF	Read input address 7.	YES

ENGLISH

Screen / Default value	Name / Description	Range	Function	Set during Run
11 ParaRd8=0x0000 Param Read 8	**G21.3.11** / Read address 8	0x0000 to 0xFFFF	Read input address 8.	YES
12 WrInstanc=20 Write Instance	**G21.3.12** / Ethernet output instance	20 21 100 101 121 122 123 124 125 126 127 128	Select the output instance of the Ethernet communications.	YES
13 ParaWrNum= 2 Param Write Num	**G20.3.13** / Number of writing addresses	0 to 4	Visualize the number of Writing addresses to communicate. This value changes depending on the input instance set in parameter [G20.4.11 'WrInstanc'].	NO
14 ParWr1=0x0005 Param Write 1	**G20.3.14** / Writing address 1	0x0000 to 0xFFFF	Write in output address 1.	YES
15 ParWr2=0x0006 Param Write 2	**G20.3.15** / Writing address 2	0x0000 to 0xFFFF	Write in output address 2.	YES
16 ParWr3=0x0000 Param Write 3	**G20.3.16** / Writing address 3	0x0000 to 0xFFFF	Write in output address 3.	YES
17 ParWr4=0x0000 Param Write 4	**G20.3.17** / Writing address 4	0x0000 to 0xFFFF	Write in output address 4.	YES
18 ParWr5=0x0000 Param Write 5	**G20.3.18** / Writing address 5	0x0000 to 0xFFFF	Write in output address 5.	YES
19 ParWr6=0x0000 Param Write 6	**G20.3.19** / Writing address 6	0x0000 to 0xFFFF	Write in output address 6.	YES
20 ParWr7=0x0000 Param Write 7	**G20.3.20** / Writing address 7	0x0000 to 0xFFFF	Write in output address 7.	YES
21 ParWr8=0x0000 Param Write 8	**G20.3.21** / Writing address 8	0x0000 to 0xFFFF	Write in output address 8.	YES

4.2. Lost Command Mode

The action that should be taken by the drive in case the communication is lost must be defined. This is done using the following parameters:

Screen / Default value	Name / Description	Range	Function	Set during Run
2 RIRLs= None **ResponIf_REF_Lsf**	**G11.1 /** Response in case of a Speed Reference Loss	NONE FREE RUN DEC HOLD I/P HOLD O/P LOSTPRST	In the case of Ethernet communications, this parameter executes the speed reference loss protection when the I/O poll connection is lost. For more information, refer to the SD300 Programming and software manual.	
3 RfLsDly= 1.0s **Ref Loss Dly**	**G11.3 /** Trip delay time due to speed reference loss	0.1 to 120s	Set delay time after which the speed reference loss protection will enable.	YES
4 RefLRf= 0.00Hz **Ref Loss Ref**	**G11.4 /** Speed in case of reference loss	[G19.2.5] to [G10.1] (Hz)	Set the frequency value at which the drive will operate in case of a speed reference loss. Therefore, parameter [G11.1 'RIRLs'] must be set to the value 'LostPrst'.	YES

Case of Modbus/TCP communication

When Modbus TCP is not receiving data for 100msec, the Option becomes Lost Command status, and after the time set up in parameter [G11.3], the inverter operates according to the setting of parameter [G11.2].

Case of Ethernet IP communication

When there is no Implicit Message Connection between the Originator and the inverter, the Option becomes Lost Command status, and when the time set up in parameter [G11.3] is elapsed, the inverter operates according to the setting of parameter [G11.2].

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PART II

MODBUS TCP/IP PROTOCOL

1. INTRODUCTION

1.1. Modbus TCP/IP Protocol

TCP/IP (Transmission Control Protocol / Internet Protocol) is a set of protocols that define a group of rules and premises to allow the interchange of information between heterogeneous systems by means of local area nets (LAN), wide area nets (WAN), telephonic public networks, etc. For example, Internet is built over TCP/IP protocol.

This protocol provides a safe connection that allows delivering byte flows from one machine to another without errors. The information is divided in data strings, forming separate packages that will be assembled in destination, managing at the same time, flow control.

1.1.1. Modbus Protocol TCP/IP Architecture

The TCP/IP protocol will be distributed in several lays or levels.

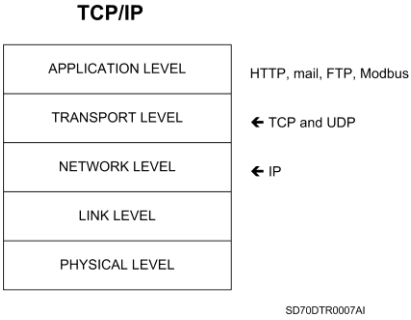

Figure PII-1.1 TCP/IP Protocol levels

TCP/IP layers or levels are following:

- **Application Level:** encompasses applications that make easy the user life, such as email, Web navigator, FTP files interchange, Modbus, etc.
- **Transport Level:** this is, in fact, the level which allows two TCP/IP connected systems to talk between them. In this level, two type of protocols can operate:
  - TCP (Transmission Control Protocol); provides a safe connection and guarantees packet delivery without errors. Data is divided in separate packages that will be assembled again in destination. It also manages the flow control.
  - UDP (User Datagram Protocol), this is a protocol not oriented to connection, therefore it does not guarantee safe data delivery. Generally, UDP is use when the application installed in the upper lay requires very short response times, and this is more important than the reliability of the delivery.
- **Net Level (IP):** The 'hosts' can enter packages in the net which will arrive to destination in a separate way. There is no guarantee of delivery or order (IP is not aimed to connection), it simply administrates package routes and controls congestion.
- **Link Level:** Prepares date packages to be sent through the physical mean, solves collisions and corrects package errors (or requests them to be sent again).
- **Physical Level:** Defines the physical media types (pair of cables, coaxial cable, optic fibre cable, etc.) and defines the signal levels that will be entered on them.

The TCP/IP protocol has been designed to transfer huge data amounts between two systems.

1.2. Modbus TCP/IP

Modbus TCP/IP is an extension of Modbus protocol that allows using it over the TCP/IP transport layer. Therefore, Modbus TCP can be used in Internet.

There are many advantages for people who install lines and automation companies:

- It is possible to repair and provide remote maintenance from the office using a PC, reducing costs and improving customers' service.
- The user can access the control system remotely from anywhere, avoiding displacements.
- Allows administrating globally distributed systems by means of using any available Internet/Intranet technologies.

Modbus TCP/IP has become an industrial standard due to its simplicity, low cost, minimum hardware components requirements and because it is an open protocol. This protocol it is used for data interchange between devices, and also for monitoring and administration. It can also be used to control peripheral inputs / outputs, being the most popular protocol between manufactures of this kind of components.

The combination of a versatile and scalable physical net as Ethernet, joint to the universal standard of inter-nets TCP/IP and a manufacturer independent data representation as Modbus TCP/IP, provides an open network accessible for interchanging process data.

1.2.1. Modbus TCP/IP Protocol Description

Modbus messenger service provides a Client/Server communication model between devices connected in an Ethernet network.

This model of Client / Server is based on four types of messages:

- **Modbus Request**
- **Modbus Confirmation**
- **Modbus Indication**
- **Modbus Response**

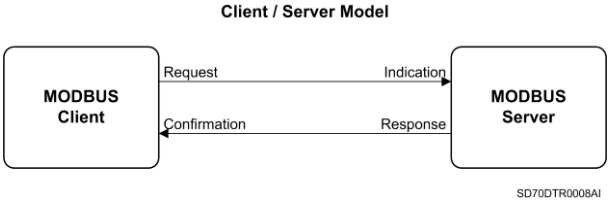

Figure PII-1.2 Modbus TCP/IP. Client / Server model

A Modbus request is the message sent to the net by the client to start one transaction.

A Modbus Indication is the Request message received in the server side.

A Modbus Response is the Response message sent by the Server.

The Modbus Confirmation is the Response message received in the client side.

Modbus messenger services (Client/Server model) are used for real time data interchange:

- Between two device applications.
- Between one device application and one device.
- Between HMI / SCADA applications and devices.
- Between one PC and one device program providing "online" services.

A communication system over Modbus TCP/IP can include different device types:

- Modbus TCP/IP Client and Server devices connected to a TCP/IP network.

Interconnection devices such as bridges, routers or gateways to connect the TCP/IP network and one sub-net serial line where there are Modbus Client and Server serial devices.

1.2.2. Modbus TCP/IP Protocol Architecture

The Modbus TCP protocol just encapsulates one Modbus frame in one TCP segment. TCP provides one service aimed to a reliable connection. That means that each request requires a response.

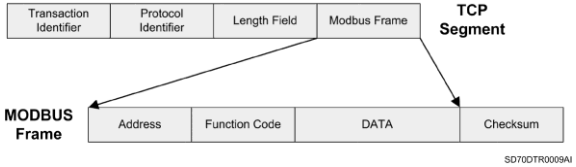

Figure PII-1.3 Modbus frame encapsulated in TCP

2. MODBUS TCP PARAMETERS SETTING

an extension of Modbus protocol that allows using it over the TCP/IP transport layer and, therefore, in Internet.

There is a parameter group in the SD300 drive used to configure it to operate with Modbus TCP connected to an Ethernet network with TCP/IP protocol. Concretely, parameter subgroup 'S21.2 Modbus TCP' which is available when connecting the Ethernet board to the drive, and is shown below.

2.1. Modbus Frame composition

MBAP Header (7 bytes)	PDU (5 bytes)

Generally, Ethernet uses Ethernet II Frame.

Modbus Application Protocol Header (MBAP Header)

Section	Length	Value
Transaction Identifier	2 Bytes	Unique transmission number which is increased by 1 each time the Client sends data frame to the server.
Protocol Identifier	2 Bytes	Fixed at 0.
Length	2 Bytes	Modbus data frame length.
Unit Identifier	1 Byte	When the Modbus TCP and Modbus RTU are connected via gate. If only Modbus TCP is used, this is fixed to 0xFF.

Protocol Data Unit

This is the practical data of Modbus TCP, consisting of Function Code and Data.

2.2. Function Code description

Modbus TCP is divided into Client and Server. The Client sends a command and the Server replies to it. Generally, Clients can be PLC, HMI, or PC and the Server is the VFD.

2.2.1. Read holding registers

Frame structure of a request from Client to Server

Section	Length	Value
Function code	1 Byte	3
Comm. Address	2 Bytes	0x0000 to 0xFFFF
The number of data requested	2 Bytes	1 to 16 (inverter standard)

Frame structure of a response from Server to Master.

Section	Length	Value
Function code	1 Byte	3
Comm. Address	1 Byte	2x The requested number of data
The number of data requested	The requested number of data x 2 Bytes	Value of the data of the given number from the communication address.

2.2.2. Read input registers

Frame structure of a request from Client to Server

Section	Length	Value
Function code	1 Byte	6
Comm. Address	2 Bytes	0x0000 to 0xFFFF
Data value	2 Bytes	0x0000 to 0xFFFF

Frame structure of a response from Server to Master

Section	Length	Value
Function code	1 Byte	6
Comm. Address	2 Bytes	0x0000 to 0xFFFF
Data Value	2 Bytes	0x0000 to 0xFFFF

2.2.3. Write multiple register

Frame structure of a request from Client to Server

Section	Length	Value
Function code	1 Byte	16
Comm. Address	2 Bytes	0x0000 to 0xFFFF
The number of data to revise	2 Bytes	1 to 16 (inverter standard)
Byte count	1 Byte	2 x the number data
Data value to revise	The number of data x 2 bytes	Data to revise

Frame structure of a response from Server to Master

Section	Length	Value
Function code	1 Byte	16
Comm. Address	2 Bytes	0x0000 to 0xFFFF
The number of data to revise	2 Bytes	1 to 16 (inverter standard)

2.3. Exception frame

Exception frame is for the response of the Server in case of an error occurred in the execution of the frame requested by a client.

Exception frame structure

Error Frame	Length	Value
Error code	1 Byte	128 + requested function code from client
Exception code	1 Byte	0x0000 to 0xFFFF

Exception code type

Exception code type	Code	Value
Illegal function	1	When an unsupported function is requested.
Illegal data address	2	Request or modification of data in an unused address.
Illegal data value	3	When trying to modify data to a value out of the permissible range.
Slave device failure	4	Server has an error (communication error, error in Option initialization, failure in data communication with inverter).
Slave device busy	6	Server is unable to respond because it is executing another process (inverter parameter initializing, initial Set Option, etc.).
Write permition error	32	When trying to change a parameter that is read-only.

3. MODBUS ADDRESS LIST

3.1. Common Area

Address	Parameter	Scale	Units	R/W	Data value
40001	Inverter model			R	B: SD500
40002	Inverter capacity			R	0: 0.75kW 1: 1.5kW 2: 2.2kW 3: 3.7kW 4: 5.5kW 5: 7.5kW 6: 11kW 7: 15kW 8: 18.5kW 9: 22kW A: 30kW B: 37kW C: 45kW D: 55kW E: 75kW
40003	Inverter input voltage			R	0: 220VAC 1: 400VAC
40004	SW version			R	(Ex) 0x0100: Version 1.0 (Ex) 0x0101: Version 1.1
40005	Reserved				
40006	Reference frequency	0.01	Hz	R/W	FStart freq. To Max. Freq.

Address	Parameter	Scale	Units	R/W	Data value
40007	Run command			R/W	Bit 0: Stop
					Bit 1: Forward run
					Bit 2: Reverse run
					Bit 3: Fault reset
					Bit 4: Emergency stop
				-	Bit 5: Not used
				R	Bit 6 – 7: Reference introduction 0: Terminals 1: Keypad 2: Reserve 3: Communication
					Bit 8 – 14: Reference frequency 0: DRV-00 1: Not used 2: Step frequency 1 3: Step frequency 2 4: Step frequency 3 5: Step frequency 4 6: Step frequency 5 7: Step frequency 6 8: Step frequency 7 9: Step frequency 8 10: Step frequency 9 11: Step frequency 10 12: Step frequency 11 13: Step frequency 12 14: Step frequency 13 15: Step frequency 14 16: Step frequency 15 17: Up speed 18: Down speed 19: Up/Down Zero 20 – 21: Reserve 22: Analogue V1 23: Analogue V1S 24: Analogue I 25: V1 + I 26: Pulses 27: Option 28: Communication 29: Option 30: Jog frequency 31: PID
					Bit 15: Network error

ENGLISH

Address	Parameter	Scale	Units	R/W	Data value
40008	Acceleration time	0.1	Sec	R/W	
40009	Deceleration time	0.1	sec	R/W	
40010	Output current	0.1	A	R	
40011	Output frequency	0.01	Hz	R	
40012	Output voltage	1	V	R	
40013	DC link voltage	1	V	R	
40014	Output power	0.1	kW	R	
40015	Inverter status			R	Bit 0: Stop
					Bit 1: Forward run
					Bit 2: Reverse run
					Bit 3: Fault
					Bit 4: Accelerating
					Bit 5: Decelerating
					Bit 6: Steady status
					Bit 7: DC braking
					Bit 8: Stopping
					Bit 9: Fixed frequency
					Bit 10: Brake open
					Bit 11: Forward run command
					Bit 12: Reverse run command
					Bit 13: Start / Stop with Communication
					Bit 14: Ref. freq. with communication
					Bit 15: 0-Remote; 1-Local
40017	Digital inputs status			R	Bit 0: P1
					Bit 1: P2
					Bit 2: P3
					Bit 3: P4
					Bit 4: P5
					Bit 5: P6
					Bit 6: P7
					Bit 7: P8
40018	Digital outputs status			R	Bit 0: Relay 1
					Bit 1: Relay 2
					Bit 2: Digital output 1 (Q1)
					Bit 3: Relay 3 (Option E/S)
					Bit 4: Relay 4 (Option E/S)
					Bit 5: Relay 5 (Option E/S)

Address	Parameter	Scale	Units	R/W	Data value
40019	V1			R	Voltage input V1
40020	V2			R	Voltage input V2 (Option E/S)
40021	I			R	Current input I1
40022	RPM			R	Output speed
40027	Display unit			R	0: Hz 1: rpm
40028	Number of poles			R	Motor poles visualization

Notes:

1. Start / Stop command with communications (address 40007)

   All bits are enabled when they change their status from 0 to 1. For example, if the VFD stops because of a fault while it is started, it won't be able to restart until the fault is reset and the start command made.

2. Addresses 40006 and 40007

   The values of these addresses will be deleted if the VFD loses power supply. These addresses will only maintain their values while the equipment is connected to power supply.

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PART III

ETHERNET/IP PROTOCOL

1. INTRODUCTION

1.1. Ethernet/IP Protocol

Ethernet/IP is an application layer protocol that was designed for the industrial environment. It is the finished product from four groups that have joined forces to develop and promote for industrial automation applications: The Open Device Vendor Association (ODVA), the Industrial Automation Open Networking Alliance (IOANA), Control Net International (CI) and the Industrial Ethernet Association (IEA).

Ethernet/IP is used in industrial automation applications and is based on the standard TCP/IP protocols. It uses Ethernet hardware and software to define an application layer protocol to configure, access and control the industrial automation devices.

The Ethernet/IP application layer protocol is based on the Control and Information Protocol (CIP) layer used in DeviceNet and ControlNet. Ethernet/IP provides a total integrated system from the industrial floor to the company network.

At factory, controllers must access data from drive systems, workstations and I/O devices. In normal operation, the user has to wait while a software task is being performed. On the other hand, factory data is time sensitive and requires real-time communications

1.1.1. Ethernet/IP Technology

Introduced at the beginning of 2000, Ethernet/IP is one of the pioneers in Ethernet solutions for industrial environment. The main reason is that it is based on open technology, using the same application layer as DeviceNet and ControlNet, and it is called Common Industrial Protocol (CIP). This offers many advantages to users and automation manufacturers, such as a low-cost product development, use easiness, simple integration of devices and networks and interoperability among suppliers.

As has been mentioned before, Ethernet/IP uses an open protocol as application layer (CIP). Therefore, Ethernet/IP network can be defined as the application protocol CIP implemented in an Ethernet TCP/IP. For example, DeviceNet is CIP implemented in a CAN network (Controller Area Network).

Regarding the operation, Ethernet/IP uses TCP/IP to send explicit messages, where each package includes application data, data meaning and the service to be executed over data. With explicit messages the nodes have to interpret each message, execute the requested task and generate responses. This type of messages is variable in size and frequency, and they are used to configure devices and make diagnosis.

Ethernet/IP also uses the standard transport service User Datagram Protocol/Internet Protocol (UDP/IP, part of TCP/IP), which provides high performance and functionality of multicast messaging in real time, also known as I/O messaging

With I/O messages, the application data field only contains input/output data in real time. The meaning of data is linked to an identifier defined when connection is established, reducing the processing time in the node at execution time. This type of messages provides high efficiency, low load and the required performance for real-time control.

As both protocols are used, TCP/IP and UDP, to encapsulate the messages, Ethernet/IP can be used in control and information applications.

1.2. CIP Protocol

The basis of the integration of real business networks lies in the application layer. The CIP protocol (Common Industrial Protocol) has been designed for this purpose. It is based on a single platform independent of communications means and protocols and allows reducing the costs of engineering and installation optimizing profits.

This protocol covers a broad range of messages and services for many manufacturing applications (control, safety, synchronization, motion, configuration and verification). The CIP protocol allows users to integrate these manufacturing applications with business networks and Internet. This means that unified communications architecture can be used in the companies, benefiting them by using open networks.

The CIP standard organizes devices in network as objects collection (or elements) and defines the accesses, attributes and extensions, to access a broad range of mechanisms by means of the utilization of a protocol in common.

The CIP model is, on the upper layers, a model only focused to objects. Each object has attributes (data), services (instructions), connections and behaviours (relations between the values of the attributes and the services). Objects implement basic functions of:

- Communications
- File transference
- Device control

Many libraries of commonly used objects which can be set in several devices allow them to operate together. The group of objects set in a device is known as the 'model' of the device. This model is the basis for the direct communication between the devices that generate signals and the devices which are receivers, without needing delivery repetitions from an origin from one origin to several destinations.

When using devices from different suppliers, the device profiles are employed. These profiles are specific objects collections. This way, all devices with the same profile operate in the same way. The profiles contain, besides objects, the configuration options and the input/output formats.

The layers of this model are:

- Devices profiles
- Objects library
- Data services
- Router functions for packages

As this model is independent of the communication means, it allows selecting the required network type, being possible to operate jointly and exchange different network types such as Ethernet/IP or ControlNet or DeviceNet.

1.2.1. CIP Protocol for Ethernet/IP

The advantages of the CIP protocol layer over Ethernet/IP are abundant. Offering consistent device access means that one configuration tool can be used to configure CIP devices on different networks from one access point without proprietary software. Classifying all devices as objects decreases the training and start-up costs required when new devices are incorporated into the network.

Ethernet/IP reduces response times and increases the capacity to transfer data regarding DeviceNet or ControlNet networks. Ethernet/IP links different industrial devices from bus level, to the control level, and to the enterprise level with a consistent application interface.

2. CIP OBJECTS

Next, the different objects implemented by the drive are listed. In order to obtain detailed information about these objects and attribute, refer to the CIP specifications.

Name	Class ID
Identity Object	0x01
Motor Data Object	0x28
Control Supervisor Object	0x29
AC Drive Object	0x2A

Details about implemented attributes for these objects are shown below.

2.1. Identity Object

Instance number 1 is implemented for this standard object and the following attributes are supported.

Attribute	Description	Type	GET/SET	Value
1	Vendor ID	UINT	Get	1104: Power Electronics
2	Device Type	UINT	Get	2: AC Drive
3	Product Code	UINT	Get	500
4	Revision	STRUCT of:	Get	
	Revision (High Byte)	UINT		1
	Revision (Low Byte)	UINT		1
5	Status	WORD	Get	Drive Status
6	Serial Number	UDINT	Get	0x12345678
7	Product Name	SHORT_STRING	Get	PESD500Drive

Product Code 11 designates the SD500 Inverter.

Revision depends on the Ethernet communication card version.

The upper byte stands for the major revision, and the lower byte stands for the minor revision.
For example, 0x0102 means 2.01.

Definition of Status bit:

Bit	Meaning
0	0: master is not connected with any device 1: master is connected with a device
1	Reserved
2	Configured (always '0' because Ethernet IP is not supported).
3	Reserved
4	0: Unknown 2: in case of incorrect IO connection 3: in case no IO connection has ever been made 5: major fault 6: IO in connection
5	
6	
7	
8	Minor Recoverable Fault (warning status)
9	Minor Unrecoverable Fault
10	Major Recoverable Fault
11	Major Unrecoverable Fault

The serial number uses the last 4 digits of the MAC ID.
For example, if MAC ID is 00:0B:29:00:00:22, the serial number is 0x29000022.

Service Name	Service Code	Support for:	
		Class	Instance
Get_Attribute_Single	0x0E	No	Yes
Reset	0x05	No	Yes
Get_Attribute_All	0x01	No	Yes

2.2. Motor Data Object

Instance number 1 is implemented for this standard object and the following attributes are supported.

Attribute	Description	Type	GET / SET	Value
3	Motor Type	USINT	Get	0: Non Standard 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	Rated Current	UINT	Get/Set	Rated Stator Current Units: 100mA
7	Rated Voltage	UINT	Get/Set	Rated Base Voltage Units: V

Service Name	Service Code	Support for:	
		Class	Instance
Get_Attribute_Single	0x0E	No	Yes
Set_Attribute_Single	0x10	No	Yes

2.3. Control Supervisor Object

Instance number 1 is implemented for this standard object and the following attributes are supported.

Attribute	Description	Type	GET / SET	Value
3	Run1	BOOL	Set	RUN_FWD Command
4	Run2	BOOL	Set	RUN_REV Command
5	NetCtrl	BOOL	N/A	It can be set up as inverter parameter only.
6	Status	USINT	Get	Drive Status. 0: Vendor Specific 1: Start-up 2: Not Ready 3: Ready 4: Enabled 5: Stopping 6: Fault Stop 7: Faulted
7	Running1	BOOL	Get	Drive Running RUN_FWD
8	Running2	BOOL	Get	Drive Running RUN_REV
9	Ready	BOOL	Get	1: Ready or Enabled or Stopping 0: Not ready
10	Faulted	BOOL	Get	1: Fault (latched) 0: No Faults Present
12	FaultRst	BOOL	Set	0 ➔ 1: Fault Reset 0: No action
13	Fault Code	UINT	Get	Currently Active Fault Code. See section '5.2 PE – CIP Fault Code Mapping.
14	Control from Net	UINT	Get	0: Provide operation reference through a source other than Ethernet communication. 1: Provide operation through Ethernet communication source.

ENGLISH

Drive run command

The drive has two operation modes, forward run (Run1) and reverse run (Run2).

Run1	Run2	Trigger Even	Run type
0	0	Stop	No Action
0→1	0	Run	Run1
0	0→1	Run	Run2
0→1	0→1	No Action	No Action
1	1	No Action	No Action
1→0	1	Run	Run2
1	1→0	Run	Run1

In the table above, Run1 stands for the Forward Run Command and Run2 stands for the Reverse Run Command. In other words, the Option gives an operation reference to the Inverter at the moment of change from 0 (FALSE) to 1 (TRUE). When the Forward Run Command value has been read, it does not represent the present operation status of the Inverter, but the operation command value of the Option.

Drive Fault Code

Fault Code Number	Description		
0x0000	None		
0x1000	Ethermal InPhaseOpen ParaWriteTrip OptionTrip1 LostCommand	Out Phase Open ThermalTrip IOBoardTrip OptionTrip2 UNDEFINED	InverterOLT UnderLoad PrePIDFail OptionTrip3 LostKeypad
0x2200	Overload		
0x2310	Overcurrent1		
0x2330	GFT		
0x2340	Overcurrent2		
0x3210	OverVoltage		
0x3220	LowVoltage		
0x3230	GroundTrip		
0x4000	NTCOpen		
0x4200	OverHeat		
0x5000	FuseOpen		
0x7000	FanTrip		
0x7120	No Motor Trip		
0x7300	Encoder Trip		
0x8401	SpeedDevTrip		
0x8402	OverSpeed		
0x9000	ExternalTrip		

Drive fault reset

At 0 → 1 (FALSE → TRUE), the Drive Fault Reset resets the fault reference for the VFD. Overwriting 1 (TRUE) on 1 (TRUE) does not reset the VFD fault reference. To reset the reference from Option to VFD in 1 (TRUE) status, write 0 (FAULT) and then write 1 (TRUE) again

Service Name	Service Code	Support for:	
		Class	Instance
Get_Attribute_Single	0x0E	No	Yes
Set_Attribute_Single	0x10	No	Yes

2.4. AC Drive Object

Instance number 1 is implemented for this standard object and the following attributes are supported.

Attribute	Description	Type	GET / SET	Value
3	AtReference	BOOL	Get	1: Drive running at actual reference
4	NetRef	BOOL	N/A	-
6	Drive Mode	USINT	Get	0: Vendor specific mode 1: Open loop speed (frequency) 2: Closed loop speed control 3: Torque control 4: Process control
7	SpeedActual	UINT	Get	Actual drive speed
8	SpeedRef	UINT	Get/Set	Speed Reference (RPM)
9	CurrentActual	INT	Get	Actual phase current in 0.1A units
29	RefFromNet	BOOL	Get	Status of torque / speed reference. 0: Local torque / speed reference 1: Network torque / speed reference

Attribute	Description	Type	GET / SET	Value
100	Actual Frequency	UINT	Get	Actual running frequency (Hz)
101	Reference Frequency	UINT	Get/Set	Reference working frequency (Hz)
102	Acceleration time (G5.1)	UINT	Get/Set	Set-up/monitor VFD acceleration time.
103	Deceleration time (G5.2)	UINT	Get/Set	Set-up/monitor VFD deceleration time.

Service Name	Service Code	Support for:	
		Class	Instance
Get_Attribute_Single	0x0E	No	Yes
Set_Attribute_Single	0x10	No	Yes

3. PARAMETER OBJECT INSTANCES

3.1. Input Instance

Input instance is the data of inverter status periodically sent from the inverter to a 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						Running 1 (Fwd)		Faulted
	1	-							
	2	Actual Speed (Low Byte) – RPM unit							
	3	Actual Speed (High Byte) – RPM unit							
71	0	At Reference	Ref From Net	Ctrl From Net	Ready	Running 2 (Rev)	Running 1 (Fwd)	Warning	Faulted
	1	Drive State							
	2	Actual Speed (Low Byte) – RPM unit							
	3	Actual Speed (High Byte) – RPM unit							
110	0						Running 1 (Fwd)		Faulted
	1	-							
	2	Actual Speed (Low Byte) – Hz unit							
	3	Actual Speed (High Byte) – Hz unit							
111	0	At Reference	Ref From Net	Ctrl From Net	Ready	Running 2 (Rev)	Running 1 (Fwd)	Warning	Faulted
	1	Drive State							
	2	Actual Speed (Low Byte) – Hz unit							
	3	Actual Speed (High Byte) – Hz unit							
141	0	Status Parameter – 1 data (Low Byte)							
	1	Status Parameter – 1 data (High Byte)							
142	0	Status Parameter – 1 data (Low Byte)							
	1	Status Parameter – 1 data (High Byte)							
	2	Status Parameter – 2 data (Low Byte)							
	3	Status Parameter – 2 data (High Byte)							
143	0	Status Parameter – 1 data (Low Byte)							
	1	Status Parameter – 1 data (High Byte)							
	2	Status Parameter – 2 data (Low Byte)							
	3	Status Parameter – 2 data (High Byte)							
	4	Status Parameter – 3 data (Low Byte)							
	5	Status Parameter – 3 data (High Byte)							

Instance	Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
144	0	Status Parameter – 1 data (Low Byte)							
	1	Status Parameter – 1 data (High Byte)							
	2	Status Parameter – 2 data (Low Byte)							
	3	Status Parameter – 2 data (High Byte)							
	4	Status Parameter – 3 data (Low Byte)							
	5	Status Parameter – 3 data (High Byte)							
	6	Status Parameter – 4 data (Low Byte)							
	7	Status Parameter – 4 data (High Byte)							
145	0	Status Parameter – 1 data (Low Byte)							
	1	Status Parameter – 1 data (High Byte)							
	2	Status Parameter – 2 data (Low Byte)							
	3	Status Parameter – 2 data (High Byte)							
	4	Status Parameter – 3 data (Low Byte)							
	5	Status Parameter – 3 data (High Byte)							
	6	Status Parameter – 4 data (Low Byte)							
	7	Status Parameter – 4 data (High Byte)							
	8	Status Parameter – 5 data (Low Byte)							
	9	Status Parameter – 5 data (High Byte)							
146	0	Status Parameter – 1 data (Low Byte)							
	1	Status Parameter – 1 data (High Byte)							
	2	Status Parameter – 2 data (Low Byte)							
	3	Status Parameter – 2 data (High Byte)							
	4	Status Parameter – 3 data (Low Byte)							
	5	Status Parameter – 3 data (High Byte)							
	6	Status Parameter – 4 data (Low Byte)							
	7	Status Parameter – 4 data (High Byte)							
	8	Status Parameter – 5 data (Low Byte)							
	9	Status Parameter – 5 data (High Byte)							
	10	Status Parameter – 6 data (Low Byte)							
	11	Status Parameter – 6 data (High Byte)							
147	0	Status Parameter – 1 data (Low Byte)							
	1	Status Parameter – 1 data (High Byte)							
	2	Status Parameter – 2 data (Low Byte)							
	3	Status Parameter – 2 data (High Byte)							
	4	Status Parameter – 3 data (Low Byte)							
	5	Status Parameter – 3 data (High Byte)							
	6	Status Parameter – 4 data (Low Byte)							
	7	Status Parameter – 4 data (High Byte)							
	8	Status Parameter – 5 data (Low Byte)							
	9	Status Parameter – 5 data (High Byte)							
	10	Status Parameter – 6 data (Low Byte)							
	11	Status Parameter – 6 data (High Byte)							
	12	Status Parameter – 7 data (Low Byte)							
	13	Status Parameter – 7 data (High Byte)							

Instance	Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
148	0	Status Parameter – 1 data (Low Byte)							
	1	Status Parameter – 1 data (High Byte)							
	2	Status Parameter – 2 data (Low Byte)							
	3	Status Parameter – 2 data (High Byte)							
	4	Status Parameter – 3 data (Low Byte)							
	5	Status Parameter – 3 data (High Byte)							
	6	Status Parameter – 4 data (Low Byte)							
	7	Status Parameter – 4 data (High Byte)							
	8	Status Parameter – 5 data (Low Byte)							
	9	Status Parameter – 5 data (High Byte)							
	10	Status Parameter – 6 data (Low Byte)							
	11	Status Parameter – 6 data (High Byte)							
	12	Status Parameter – 7 data (Low Byte)							
	13	Status Parameter – 7 data (High Byte)							
	14	Status Parameter – 8 data (Low Byte)							
	15	Status Parameter – 8 data (High Byte)							

ENGLISH

Description of the 0, 1 byte of 70, 71, 110, 111.

Name	Description	Related Attribute	
		Class	Attr. ID
Faulted	Inverter Error	0x29	10
Warning	Not Supported	0x29	11
Running 1	Motor is running Forward	0x29	7
Running 2	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	Reach at reference Speed	0x2A	3
Drive State	Current Motor State	0x29	6
Speed Actual	Speed Command	0x2A	7

3.2. Output Instance

Instance	Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
20	0						Fault Reset		Running 1 (Fwd)
	1	0							
	2	Speed Reference (Low Byte) – RPM unit							
	3	Speed Reference (High Byte) – RPM unit							
21	0		Ref From Net	Ctrl From Net			Fault Reset	Running 2 (Rev)	Running 1 (Fwd)
	1	0							
	2	Speed Reference (Low Byte) – RPM unit							
	3	Speed Reference (High Byte) – RPM unit							
100	0						Fault Reset		Running 1 (Fwd)
	1	0							
	2	Speed Reference (Low Byte) – Hz unit							
	3	Speed Reference (High Byte) – Hz unit							
101	0		Ref From Net	Ctrl From Net			Fault Reset	Running 2 (Rev)	Running 1 (Fwd)
	1	0							
	2	Speed Reference (Low Byte) – Hz unit							
	3	Speed Reference (High Byte) – Hz unit							
121	0	Control Parameter – 1 data (Low Byte)							
	1	Control Parameter – 1 data (High Byte)							
122	0	Control Parameter – 1 data (Low Byte)							
	1	Control Parameter – 1 data (High Byte)							
	2	Control Parameter – 2 data (Low Byte)							
	3	Control Parameter – 2 data (High Byte)							
123	0	Control Parameter – 1 data (Low Byte)							
	1	Control Parameter – 1 data (High Byte)							
	2	Control Parameter – 2 data (Low Byte)							
	3	Control Parameter – 2 data (High Byte)							
	4	Control Parameter – 3 data (Low Byte)							
	5	Control Parameter – 3 data (High Byte)							

Instance	Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
144	0	Control Parameter – 1 data (Low Byte)							
	1	Control Parameter – 1 data (High Byte)							
	2	Control Parameter – 2 data (Low Byte)							
	3	Control Parameter – 2 data (High Byte)							
	4	Control Parameter – 3 data (Low Byte)							
	5	Control Parameter – 3 data (High Byte)							
	6	Control Parameter – 4 data (Low Byte)							
	7	Control Parameter – 4 data (High Byte)							
145	0	Control Parameter – 1 data (Low Byte)							
	1	Control Parameter – 1 data (High Byte)							
	2	Control Parameter – 2 data (Low Byte)							
	3	Control Parameter – 2 data (High Byte)							
	4	Control Parameter – 3 data (Low Byte)							
	5	Control Parameter – 3 data (High Byte)							
	6	Control Parameter – 4 data (Low Byte)							
	7	Control Parameter – 4 data (High Byte)							
	8	Control Parameter – 5 data (Low Byte)							
	9	Control Parameter – 5 data (High Byte)							
146	0	Control Parameter – 1 data (Low Byte)							
	1	Control Parameter – 1 data (High Byte)							
	2	Control Parameter – 2 data (Low Byte)							
	3	Control Parameter – 2 data (High Byte)							
	4	Control Parameter – 3 data (Low Byte)							
	5	Control Parameter – 3 data (High Byte)							
	6	Control Parameter – 4 data (Low Byte)							
	7	Control Parameter – 4 data (High Byte)							
	8	Control Parameter – 5 data (Low Byte)							
	9	Control Parameter – 5 data (High Byte)							
	10	Control Parameter – 6 data (Low Byte)							
	11	Control Parameter – 6 data (High Byte)							
147	0	Control Parameter – 1 data (Low Byte)							
	1	Control Parameter – 1 data (High Byte)							
	2	Control Parameter – 2 data (Low Byte)							
	3	Control Parameter – 2 data (High Byte)							
	4	Control Parameter – 3 data (Low Byte)							
	5	Control Parameter – 3 data (High Byte)							
	6	Control Parameter – 4 data (Low Byte)							
	7	Control Parameter – 4 data (High Byte)							
	8	Control Parameter – 5 data (Low Byte)							
	9	Control Parameter – 5 data (High Byte)							
	10	Control Parameter – 6 data (Low Byte)							
	11	Control Parameter – 6 data (High Byte)							
	12	Control Parameter – 7 data (Low Byte)							
	13	Control Parameter – 7 data (High Byte)							

ENGLISH

Instance	Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
148	0	Control Parameter – 1 data (Low Byte)							
	1	Control Parameter – 1 data (High Byte)							
	2	Control Parameter – 2 data (Low Byte)							
	3	Control Parameter – 2 data (High Byte)							
	4	Control Parameter – 3 data (Low Byte)							
	5	Control Parameter – 3 data (High Byte)							
	6	Control Parameter – 4 data (Low Byte)							
	7	Control Parameter – 4 data (High Byte)							
	8	Control Parameter – 5 data (Low Byte)							
	9	Control Parameter – 5 data (High Byte)							
	10	Control Parameter – 6 data (Low Byte)							
	11	Control Parameter – 6 data (High Byte)							
	12	Control Parameter – 7 data (Low Byte)							
	13	Control Parameter – 7 data (High Byte)							
	14	Control Parameter – 8 data (Low Byte)							
	15	Control Parameter – 8 data (High Byte)							

Description of the 0 byte of 20, 21, 100, 101.

Name	Description	Related Attribute	
		Class	Attr. ID
Running 1	Forward Run Command	0x29	3
Running 2	Reverse Run Command	0x29	4
Fault reset	Fault Reset Command	0x29	12
Ctrl From Net	Not used	0x29	5
Ref From Net	Not used	0x2A	4
Speed Reference	Speed Command	0x2A	8

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