

ENGINEERING
TOMORROW



Operating Guide

VACON® 1000 Fieldbus Options



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1 Introduction

1.1 Purpose of this Guide

This operating guide provides information about the available fieldbus options for VACON® 1000.

The guide provides information for configuring the fieldbus protocols, lists and descriptions of the parameters related to the communication protocols, and information to support in daily operations and troubleshooting.

1.2 Additional Resources

Other resources are available to understand advanced AC drive functions and operation.

- The VACON® 1000 Operating Guide provides detailed information for the installation, commissioning, and start-up of the drive.
- The VACON® 1000 Application Guide provides greater detail on how to work with the application and how to set the parameters of the AC drive.

Supplementary publications and manuals are available from Danfoss. See www.danfoss.com for listings.

1.3 Version History

This guide is regularly reviewed and updated. All suggestions for improvement are welcome.

The original language of this guide is English.

Table 1: Version History

Version	Remarks
172K1112A	First version of this guide.

1.4 Abbreviations and Acronyms

Term	Definition
AC	Alternating current
ASCII	American standard code for information interchange
CAN	Controller area network
CIP	Common industrial protocol
COB	Communication object
CPU	Central processing unit
CRC	Cyclic redundancy check
DC	Direct current
DCS	Digital control signal
DSP	Digital signal processor
EIP	EtherNet/IP™
EMC	Electromagnetic compatibility
ESD	Electrostatic discharge
GND	Ground
HEX	Hexadecimal
HMI	Human machine interface
HV	High voltage

Term	Definition
I/O	Input/output
IP	Internet protocol
LED	Light-emitting diode
LSB	Least significant bit
LSS	Layer setting services
MCB	Mains circuit breaker
MSB	Most significant bit
MVD	Medium-voltage drive
NMT	Network management object
OSI	Open Systems Interconnection
PDO	Process data object
PID	Proportional integral derivative
PLC	Programmable logic controller
RPI	Requested packet interval
RTU	Remote terminal unit
SDO	Service data object
SW	Software
TCP	Transmission control protocol
UPS	Uninterruptible power supply
USB	Universal serial bus
VFD	Variable frequency drive

2 Overview

2.1 VACON® 1000 Fieldbus Options

This guide describes the available fieldbus options for VACON® 1000.

Table 2: VACON® 1000 Fieldbus Options

Option code	Fieldbus option
+S_E2	Modbus RTU
+S_E5	PROFIBUS DP-V0
+S_E6	CANopen
+S_E7	DeviceNet™
+S_EC	EtherCAT
+S_EI	Modbus TCP
+S_EP	PROFINET I/O
+S_EQ	EtherNet/IP™

2.2 Modbus RTU/TCP

Modbus is a communication protocol developed by Modicon systems. In simple terms, it is a way of sending information between electronic devices. The device requesting the information is called the Modbus Master (or the Client in Modbus TCP) and the devices supplying information are Modbus Slaves (in Modbus TCP servers). In a standard Modbus network, there is one Master and up to 247 Slaves, each with a unique Slave Address from 1 to 247. The Master can also write information to the Slaves. Modbus is typically used to transmit signals from instrumentation and control devices back to a main controller or data gathering system.

The Modbus communication interface is built around messages. The format of these Modbus messages is independent of the type of physical interface used. The same protocol can be used regardless of the connection type. Because of it, Modbus gives the possibility to upgrade the hardware structure of an industrial network easily, without the need for large changes in the software. A device can also communicate with several Modbus nodes at once, even if they are connected with different interface types. There is no need to use a different protocol for every connection.

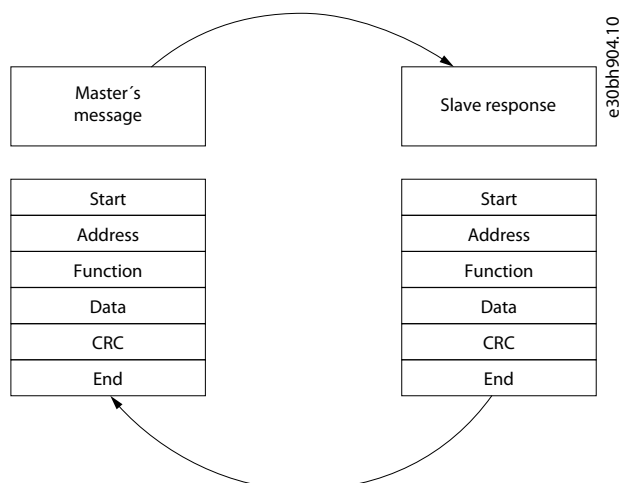


Illustration 1: Basic Structure of Modbus Frame

On simple interfaces like RS485, the Modbus messages are sent in plain form over the network. In this case, the network is dedicated to Modbus. When using more versatile network systems like TCP/IP over Ethernet, the Modbus messages are embedded in packets with the format necessary for the physical interface. In that case Modbus and other types of connections can co-exist at the same physical interface at the same time. Although the main Modbus message structure is peer-to-peer, Modbus is able to function on both point-to-point and multidrop networks.

Each Modbus message has the same structure. Four basic elements are present in each message. The sequence of these elements is the same for all messages, to make it easy to parse the content of the Modbus message. In the Modbus network, the master always starts the conversation. A Modbus master sends a message and depending on the contents of the message, a slave reacts to it. There can be more masters in a Modbus network. Addressing in the message header is used to define which device must respond to a message. If the address field does not match their own address, all other nodes on the Modbus network ignore the message. VACON® 1000 is equipped with Modbus RTU support as standard. In case, there are problems related to Modbus, contact Danfoss Drives. Provide a description of the problem and the Drive Info File.

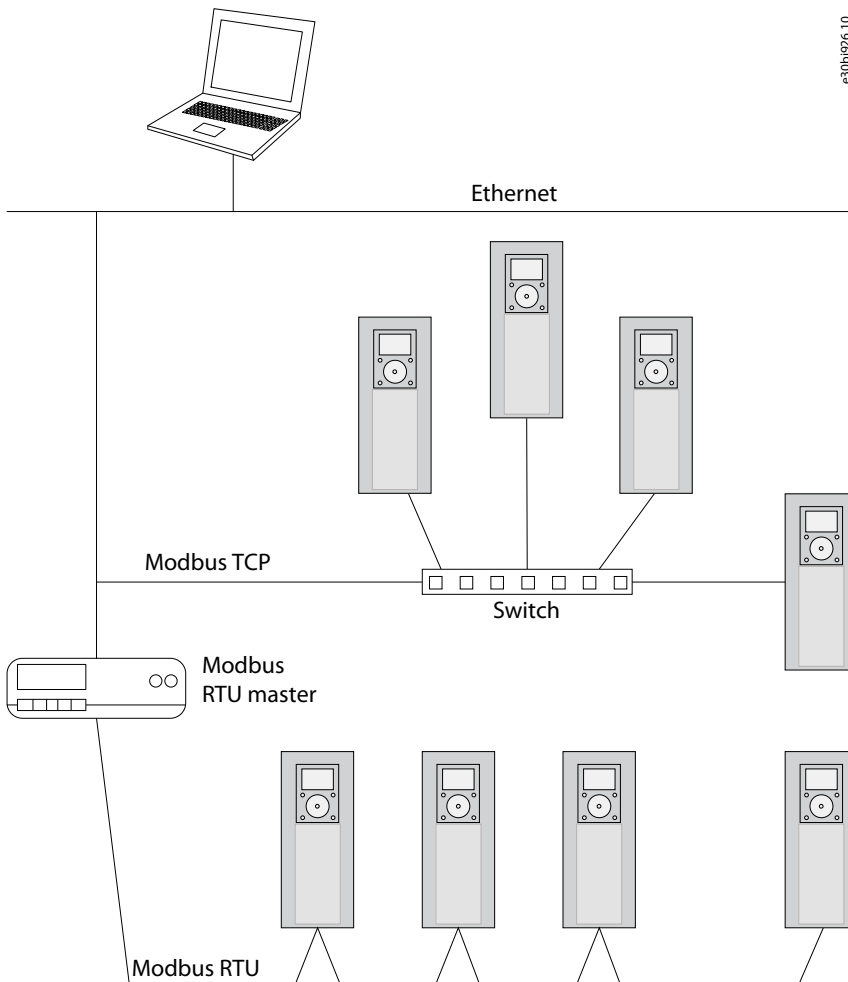


Illustration 2: Principal Example Diagram of Modbus

2.3 PROFIBUS DP

PROFIBUS (process fieldbus) is a standard for fieldbus communication in automation technology. PROFIBUS DP (Decentralized Peripherals) is a protocol made for (deterministic) communication between PROFIBUS masters and their remote I/O slaves, such as sensors or actuators in production automation applications.

PROFIBUS DP is standardized under IEC 61158 and IEC 61784, which guarantees compatibility with devices from various manufacturers.

The PROFIBUS protocol implements 3 of the 7 layers defined in the OSI layer model (Open Systems Interconnection Reference Model).

- Layer 1 defines the physical transmission. The physical layer for PROFIBUS DP is RS485.
- Layer 2 defines the description of the bus access method. With PROFIBUS, this is the master/slave method with the token method.
- Layer 7 forms the interface to the application and shows the link between the application and communication. With PROFIBUS, the communication protocol PROFIBUS DP-V0 is used here.

2.4 CANopen

The CAN (controller area network) fieldbus only defines the physical layer and the data-link layer of a network. See the ISO 11898 standard for information. The CAN fieldbus does not define the application layer. In practice, the hardware contains the physical

layer and the data-link layer. The CAN fieldbus itself is not complete, and needs a superior protocol to define the use of 11/29-bit identifier and 8-byte data.

The CANopen protocol is the superior protocol based on the CAN fieldbus. It is one of the protocols defined and maintained by CiA (CAN-in-Automation) and was developed based on the CAL (CAN application layer) protocol, using a subset of the CAL communication and service protocols.

The CANopen protocol contains the application layer and the communication profile (CiA DS 301). It also contains a framework for programmable devices (CiA 302), recommendations for cables and connectors (CiA 303-1), and SI units and prefix representations (CiA 303-2).

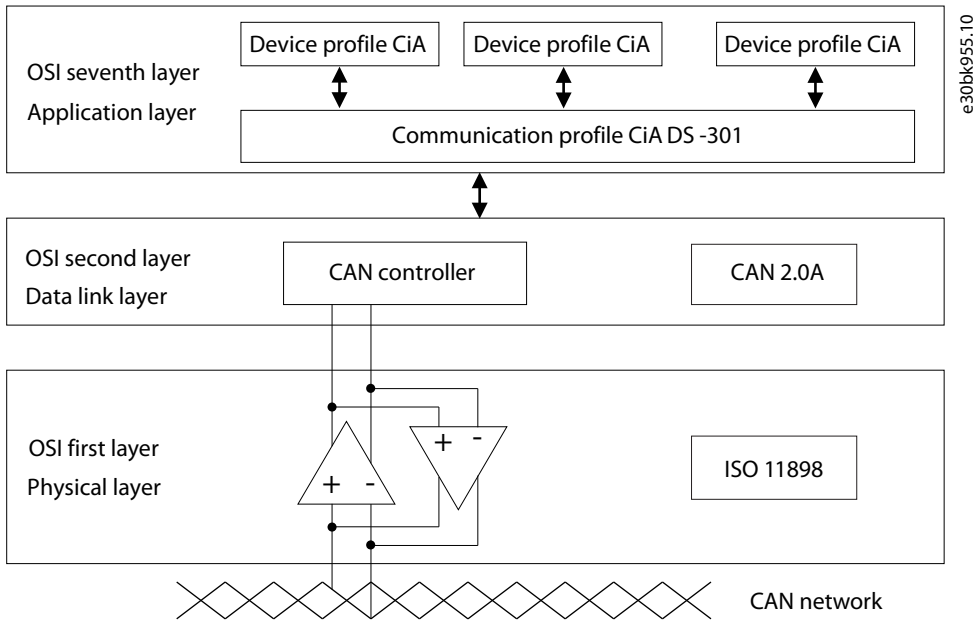


Illustration 3: OSI Model of the Relation between the CAN Standard and the CANopen Protocol

CANopen uses an object-based method to define a standard device. There is a set of objects for every device, which the network can visit. [Illustration 4](#) shows the CANopen device model. The object dictionary is the interface between the communication program and the superior application program.

The core concept of CANopen is the device object dictionary (OD). It is an orderly set of objects. Every object has a 16-bit index for addressing and also defines an 8-bit sub-index. Every node in the CANopen network has an object dictionary that includes the parameters that describe the device and the network behavior. The object dictionary of a node is also described in the electronic data-sheet (EDS) for the device.

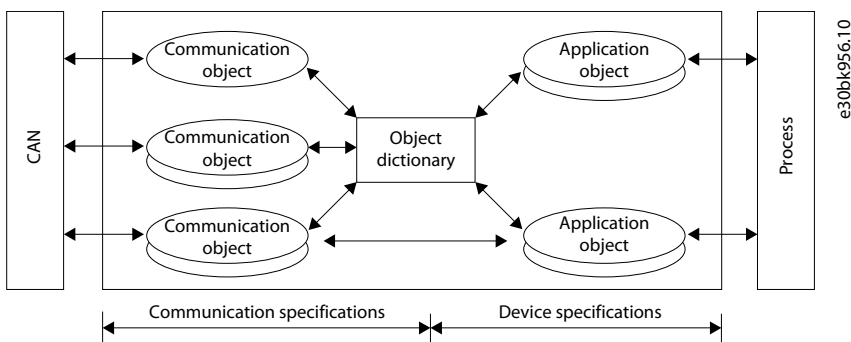


Illustration 4: CANopen Device Model

2.5 DeviceNet™

DeviceNet™ is a member of a family of networks that implements the Common Industrial Protocol (CIP™) at its upper layers. DeviceNet is managed by ODVA, Inc. (formerly Open DeviceNet Vendors Association, Inc.), a global trade and standards development organization.

DeviceNet™, like other CIP Networks, follows the Open Systems Interconnection (OSI) model, which defines a framework for implementing network protocols in seven layers: physical, data link, network, transport, session, presentation, and application. Networks that follow this model define a complete suite of network functionality from the physical implementation through the application

or user interface layer. As with all CIP Networks, DeviceNet™ implements CIP at the Session layer and above while adapting CIP to the specific DeviceNet™ technology at the Transport layer and below.

The DeviceNet™ network infrastructure is passive, making node functionality independent of physical location and the network itself inherently tolerant to individual lost node connections. Although the network infrastructure is passive, the network cable can convey device power over the same cable with communication messages.

DeviceNet™ systems require only a single point of connection for both configuration and control. This is because DeviceNet™ supports both I/O (or implicit) messages, which typically contain time-critical control data, and explicit messages, in which the data field carries both protocol information and specific service requests. DeviceNet™ systems can be configured to operate either in a controller/device or distributed control architecture using peer-to-peer communication.

2.6 PROFINET I/O

PROFINET is an industry technical standard for data communication over Industrial Ethernet. It is designed for collecting data from, and controlling equipment in industrial systems, with a particular strength in delivering data under tight time constraints.

PROFINET is standardized in IEC 61158 and IEC 61784.

PROFINET implements the interfacing to peripherals. It defines the communication with field connected peripheral devices. Its basis is a cascading real-time concept. PROFINET defines the entire data exchange between IO-Controllers and IO-Devices, as well as parameter setting, and diagnosis. IO-Controllers are typically a PLC, DCS, or IPC. IO-Devices can be varied: I/O blocks, drives, sensors, or actuators.

The PROFINET protocol is designed for fast data exchange between Ethernet-based field devices and follows the provider-consumer model. Field devices in a subordinate PROFIBUS line can be integrated in the PROFINET system seamlessly via an IO-Proxy.

2.7 EtherNet/IP™

EtherNet/IP™ (“IP” stands for “Industrial Protocol”) is an industrial Ethernet network managed by ODVA, Inc. (formerly Open DeviceNet Vendors Association, Inc.), a global trade and standards development organization.

EtherNet/IP™ works on a TCP/UDP/IP based Ethernet network and uses the most widely deployed collections of Ethernet standards to provide a broad range of applications in different industries that require high-speed and stability. Common applications include factory automation, building automation, and process automation.

The typical EtherNet/IP™ architecture includes a scanner and adapters. Data exchange is achieved between devices through an I/O connection and explicit messaging. The EtherNet/IP™ option for VACON® 1000 supports single port Ethernet. Thus, devices can be installed and configured with embedded switch technology over EtherNet/IP™.

Applicable networks include linear topology, ring topology, star topology, Ethernet, EtherNet/IP™, one or more LANs, and so on. The configuration can be set through USB or an interface.

3 Modbus RTU/TCP

3.1 Cable Selection

The maximum allowed length of a single CAT5 Ethernet cable is 100 m.

The maximum length of an RS485 cable depends on the bitrate used, the cable (gauge, capacitance, or characteristic impedance) and the number of devices in the bus. The Modbus RTU specification states that the maximum cable length is 1000 m when using maximum 9600 bit/s bitrate and AWG26 or wider gauge cable. The actual cable length which can be used in an installation can be lower than this number depending on the previously mentioned parameters.

3.2 Programming

3.2.1 Ethernet Setting

For basic information on how to use the HMI, see the VACON® 1000 Application Guide or Operating Guide.

Procedure

1. To enter the *Ethernet Setting* window, select *Setup & Service* → *Commissioning* → *Ethernet Setting*.
2. Set the Ethernet address and click *Save*.

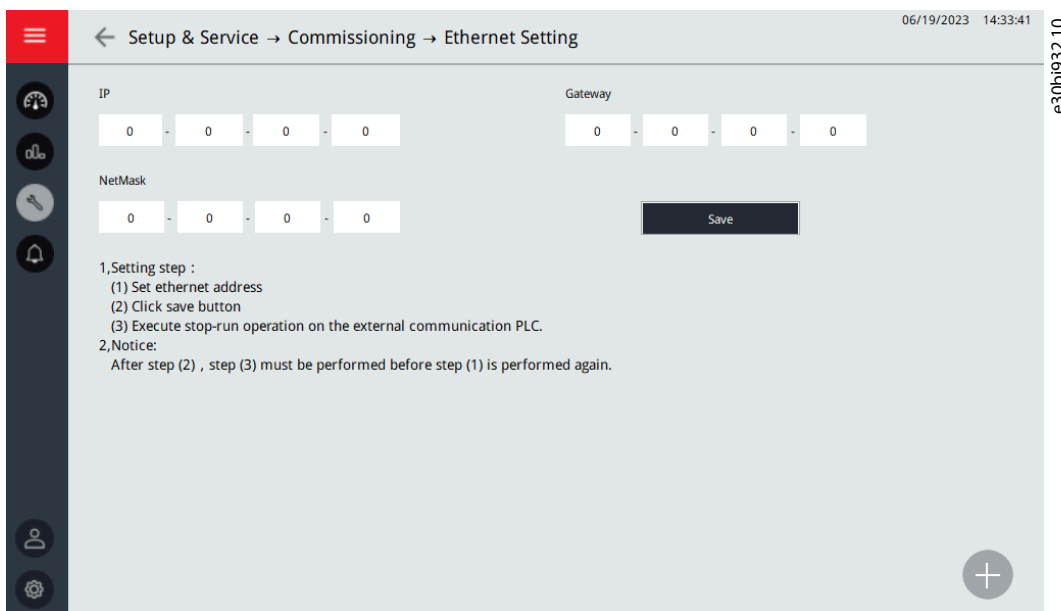


Illustration 5: Ethernet Setting Window

- To enter the *Operation Mode* window, select *Setup & Service* → *Operation Mode*.

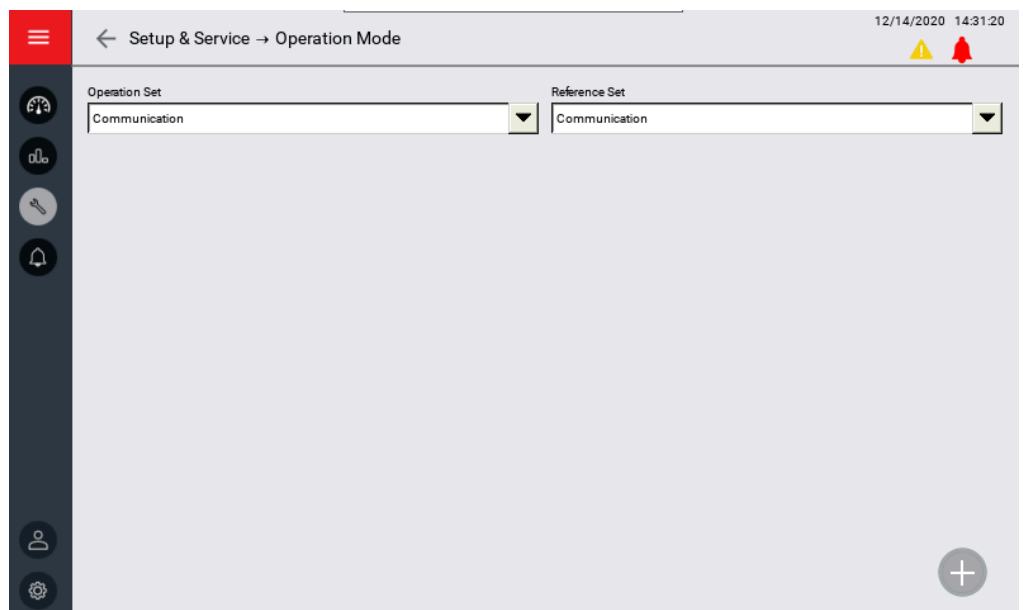


Illustration 6: *Operation Mode* Window

- To send a start/stop command with Modbus communication, select "Communication" in *Operation Set* options.
- To send a speed command with Modbus communication, select "Communication" in *Reference Set* options.

3.2.2 Setting the IP Address with HMI

Procedure

- To access the *IP Setting* menu, Select *Setup* → *Commissioning* → *Ethernet setting*.
- Set the Ethernet address.

Modbus RTU: Slave ID 2, 9600 bps, 8 bits, 1 bit stop, Even (configurable)
 Modbus TCP: IP address: 192.168.1.5 (configurable), Port: 502

- Select *Save*.
- Execute Stop-Run operation on the external communication PLC.

After saving, the Stop-Run operation must be performed before setting the Ethernet address again.

3.2.3 Modbus RTU Configuration

Table 3: Slave ID1 Setting – ID Setup in COM Mode

ID1/ID2	Node ID Setup
0	Use ISPSOft (HWCONFIG)
1–F	Manual setting

Table 4: Format1 Setting – Modbus in COM Mode

FORMAT 1/2	Baud rate (bps)	Data (bits)	Parity	Stop (bits)	ASCII/RTU
0	Software setting				
1	9600	7	Even	1	ASCII
2	9600	8	Even	1	RTU
3	9600	7	None	2	ASCII

FORMAT 1/2	Baud rate (bps)	Data (bits)	Parity	Stop (bits)	ASCII/RTU
4	9600	8	None	1	RTU
5	19200	7	Even	1	ASCII
6	19200	8	None	1	RTU
7	19200	8	Odd	2	RTU
8	38400	8	None	2	RTU
9	38400	8	None	1	RTU
A	38400	7	Even	1	ASCII
B	57600	8	None	1	ASCII
C	76800	8	None	1	RTU
D	115200	7	None	1	ASCII
E	115200	8	Even	1	RTU
F	115200	7	None	2	ASCII

3.2.4 Parameters

Table 5: Parameters Related to Modbus RTU

Parameter	Min.	Max.	Unit	Default	ID	Description
Slave address	1	247		1	2320	Unique slave device address
Baud rate	300	230400	bps	9600	2378	Communication speed 300 600 1200 2400 4800 9600 19200 38400 57600 76800 115200 230400
Parity type	0	2		0	2379	0 = Even 1 = Odd 2 = None
Stop bits	1	3		3	2380	1 = 1 stop bit 2 = 1.5 stop bits 3 = 2 stop bits
Communication timeout	0	65535	s	10	2321	0 = Not used
Operate Mode	0	1		0	2374	0 = Slave

Parameter	Min.	Max.	Unit	Default	ID	Description
						1 = Master
IDMap IDs	0	65535		0		IDMap IDs

3.2.5 Monitoring Values

Table 6: Monitoring Values Related to Modbus RTU

Parameter	Min.	Max.	Unit	Default	ID	Description
Fieldbus protocol status	1	3		1	2381	0 = Init 1 = Stopped 2 = Operational 3 = Faulted
Communication status	0.0	99.999		0.0	2382	0–99 Number of messages with errors 0–999 Number of messages without communication errors
Illegal functions	0				2383	
Illegal data addresses	0				2384	
Illegal data values	0				2385	
Slave device busy	0				2386	
Memory parity error	0				2387	
Slave device failure	0				2388	
Last fault response	0				2389	
Control word			HEX		2390	
Status word			HEX		2391	

3.2.6 Parameter Descriptions

3.2.6.1 (P2320) Slave Address

Use this parameter to select the slave address. Each slave must have a unique address (1–247) so that it can be addressed independently from other nodes.

3.2.6.2 (P2378) Baud Rate

Use this parameter to select the communication speed for the network. The default value is 9600 bps.

3.2.6.3 (P2379) Parity Type

Use this parameter to select the parity type for the network. Modbus RTU specifies the stop bit configuration as shown in the table. This stop bit configuration can be modified manually using a specific parameter.

Table 7: Parity Type and Stop Bits

Parity type	Stop bits
Even	1
Odd	1
None	2

3.2.6.4 (P2380) Stop Bits

Use this parameter to select the stop bit amount for the Modbus RTU network.

3.2.6.5 (P2321) Communication Timeout

Modbus initiates a communication timeout error for a time defined with this parameter.

- 0 = No fault is generated.

3.2.6.6 (P2374) Operate Mode

Use this parameter to select the operate mode of the Modbus RTU protocol (slave/master). The default VACON® 1000 application supports only slave mode. A special application is required for the master functionality.

- 0 = Slave
- 1 = Master

3.2.6.7 IDMap IDs

See [3.3 Communications](#).

3.2.7 Parameter Addresses

Table 8: Parameter Modbus Addresses

#	Parameter name	Modbus Address	Function Code	Data Format	Data description
MVD input parameters					
1	Input voltage (V)	258	3(Read)	Word	
2	Input current (A)	260	3(Read)	Word	
3	Reference speed (RPM)	263	3(Read)	Word	
4	Reference Frequency (0.01 Hz)	265	3(Read)	Word	
5	Input power (kVA)	262	3(Read)	Word	
MVD output parameters					
1	Output voltage (V)	259	3(Read)	Word	
2	Output current (A)	261	3(Read)	Word	
3	Output speed (RPM)	264	3(Read)	Word	
4	Output Frequency (0.01 Hz)	266	3(Read)	Word	
Transformer Temperature					
1	Transformer temperature T31 A (0.1 °C)	267	3(Read)	Word	
2	Transformer temperature T31 B (0.1 °C)	268	3(Read)	Word	
3	Transformer temperature T31 C (0.1 °C)	269	3(Read)	Word	
System status					
1	bit0: Startup ready bit1: VFD running bit2: Reserved bit3: Local/Remote bit4: Fault bit5: Alarm	257	3(Read)	Word	"1" is ok

#	Parameter name	Modbus Address	Function Code	Data Format	Data description
	bit6: Reserved bit7: MCB closed bit8: Reserved bit9: MCB Close allowed bit10: Reserved bit11: Reserved bit12: Reserved bit13: Reserved bit14: Reserved bit15: Reserved				
Command					
1	VFD start	1	6(Read/Write)	Word	bit0: 2 s Rising edge pulse
2	VFD coast stop	1	6(Read/Write)	Word	bit1: 2 s Rising edge pulse
3	VFD ramp stop	1	6(Read/Write)	Word	bit2: 2 s Rising edge pulse
4	System reset	1	6(Read/Write)	Word	bit3: 2 s Rising edge pulse
5	Reference speed (RPM)	2	6(Read/Write)	Word	
6	Reference Frequency (0.01 Hz)	3	6(Read/Write)	Word	
System alarm/fault					
1	bit0: Input Over Current(Software) bit1: Input Phase Loss bit2: Input Power Loss bit3: Input undervoltage bit4: Input overvoltage bit5: Input Grounding bit6: Input Sequence Fault bit7: Reserved bit8: Output Over Current(Software) bit9: Output Over Load bit10: Output Phase Loss bit11: Output Grounding bit12: Output Phase Imbalance Alarm bit13: Output Phase Imbalance Fault bit14: Output Under Load bit15: Electronic Motor Thermal Protection	273	3(Read)	Word	"1" is fault, "0" is ok
2	bit0: Motor Stall bit1: Motor Reverse bit2: Motor Over Speed bit3: Motor Under Speed bit4: Analog Reference Loss	274	3(Read)	Word	"1" is fault, "0" is ok

#	Parameter name	Modbus Address	Function Code	Data Format	Data description
	bit5: Encoder Abnormal bit6: Input Over Current(Hardware) bit7: Output Over Current(Hardware) bit8: External Fault bit9: Current Sensor Power Fault bit10: Fault Code Query Failure bit11: Bypassed Cell Quantity Over Limit bit12: Power On With MCB Signal Loss bit13: Reserved bit14: Transformer Temperature Sensor Loss bit15: Reserved				
3	bit0: Auto Tuning Failure bit1: Flying Start Failure bit2: Automatic Restart Failure bit3: Synchronous Transfer Failure bit4: Reserved bit5: Reserved bit6: Failure Of Motor Selection bit7: LVRT Failure bit8: Reserved bit9: Bypass Derating Failure bit10: Input Current Sampling Fault bit11: Output Current Sampling Fault bit12: Power Cell Overload bit13: Software And Hardware Versions Are Inconsistent bit14: Software And Hardware Versions Are Incompatible bit15: Switch of Synchronous transfer Action Failure	275	3(Read)	Word	"1" is fault, "0" is ok
4	bit0: External/Customer Control Power Loss bit1: Internal Control Power Loss bit2: PLC Battery Voltage Low bit3: UPS undervoltage bit4: Control Power Loss Overtime bit5: UPS undervoltage Overtime bit6: HV Cabinet Door Open bit7: Air Filter Clogged bit8: Cooling Fan Abnormal bit9: Fan Internal Power Loss bit10: Fan External Power Loss bit11: Transformer T31 overtemperature Alarm bit12: Transformer T31 overtemperature Fault bit13: Transformer T31 Temperature Sensor Loss bit14: Emergency Stop bit15: Remote Emergency Stop	276	3(Read)	Word	"1" is fault, "0" is ok
5	bit0: PLC-DSP Communication Failure bit1: PLC-HMI Communication Failure bit2: DSP Fault(X1.1) bit3: DSP Alarm(X1.2)	277	3(Read)	Word	"1" is fault, "0" is ok

#	Parameter name	Modbus Address	Function Code	Data Format	Data description
	bit4: DSP Bypass(X1.4) bit5: DSP Trip(X1.5) bit6: Upstream Main Circuit Breaker Abnormal Open bit7: Upstream Main Circuit Breaker Close Failure bit8: Upstream Main Circuit Breaker Open Failure bit9: KM41 Close Failure bit10: KM41 Open Failure bit11: KM42 Close Failure bit12: KM42 Open Failure bit13: KM43 Close Failure bit14: KM43 Open Failure bit15: Startup Cabinet Switch Abnormal Open				
6	bit0: Startup Cabinet Switch Open Failure bit1: Startup Cabinet Switch Close Failure bit2: Minimum Precharge Waiting Time Not Reached! bit3: No start-up Cabinet Switch Close Command bit4: DSP Trip(COM) bit5: DSP Bypass(COM) bit6: Reserved bit7: Reserved bit8: Reserved bit9: Reserved bit10: Reserved bit11: Reserved bit12: Reserved bit13: Reserved bit14: Reserved bit15: Reserved	278	3(Read)	Word	"1" is fault, "0" is ok
7	bit0: Reserved bit1: Reserved bit2: Cooling Fan21 Failure bit3: Cooling Fan22 Failure bit4: Cooling Fan23 Failure bit5: Cooling Fan24 Failure bit6: Cooling Fan25 Failure bit7: Cooling Fan26 Failure bit8: Cooling Fan27 Failure bit9: Cooling Fan28 Failure bit10: Cooling Fan29 Failure bit11: Number of Cooling Fan For Power Cell Cabinet is Insufficient bit12: Cooling Fan31 Failure bit13: Cooling Fan32 Failure bit14: Cooling Fan33 Failure bit15: Cooling Fan34 Failure	279	3(Read)	Word	"1" is fault, "0" is ok
8	bit0: Cooling Fan35 Failure bit1: Number of Cooling Fan For Transformer T31 Cabinet Is Insufficient	280	3(Read)	Word	"1" is fault, "0" is ok

#	Parameter name	Modbus Address	Function Code	Data Format	Data description
	bit2: Cooling Fan36 Failure bit3: Cooling Fan37 Failure bit4: Cooling Fan38 Failure bit5: Cooling Fan39 Failure bit6: Cooling Fan310 Failure bit7: Number of Cooling Fan For Transformer T32 Cabinet Is Insufficient bit8: Cooling Fan71 Failure bit9: Cooling Fan72 Failure bit10: Number of Cooling Fan For Filter Cabinet Is Insufficient bit11: Cooling Fan81 Failure bit12: Cooling Fan82 Failure bit13: Number of Cooling Fan For Reactance Cabinet Is Insufficient bit14: Reserved bit15: Reserved				
9	bit0: Reserved bit1: Reserved bit2: Reserved bit3: KM41 Abnormal Close bit4: KM42 Abnormal Close bit5: KM43 Abnormal Close bit6: KM43 Abnormal Open bit7: Auto Bypass Transfer Failure bit8: Start Overtime bit9: KM41 Abnormal Open bit10: KM42 Abnormal Open bit11: QS41 Abnormal Open bit12: QS42 Abnormal Open bit13: Auto Bypass Condition Is Not Satisfied bit14: Auto Grid To VFD Overtime bit15: Synchronous Transfer Overtime	281	3(Read)	Word	"1" is fault, "0" is ok
10	bit0: Speed Stable Timeout bit1: Voltage Synchronize Timeout bit2: Current Stable Timeout bit3: System is Not Running bit4: System is Running bit5: System is During Input undervoltage Derating bit6: System is During Low Voltage Ride Through bit7: Bypassed Cell Quantity Over Limit bit8: Reserved bit9: Reserved bit10: Reserved bit11: Reserved bit12: Reserved bit13: Reserved bit14: Reserved bit15: Reserved	282	3(Read)	Word	"1" is fault, "0" is ok

#	Parameter name	Modbus Address	Function Code	Data Format	Data description
11	Reserved	283	3(Read)	Word	
12	bit0: External Fault bit1: Arc Flash Relay Error bit2: Arc Flash Relay Tripped bit3: Transformer T32 overtemperature Alarm bit4: Transformer T32 overtemperature Fault bit5: Transformer T32 Temperature Sensor Loss bit6: Filter Cabinet overtemperature bit7: Reactance Cabinet overtemperature bit8: Motor Winding overtemperature bit9: Motor Winding Ultra overtemperature bit10: Motor Bearing overtemperature bit11: Motor Bearing Ultra overtemperature bit12: Motor Temperature Sensor Loss bit13: Control Cabinet Low Temperature Alarm, MCB Close Forbidden bit14: Control Cabinet Low Temperature Fault bit15: Control Cabinet Temperature Sensor Loss	284	3(Read)	Word	"1" is fault, "0" is ok
13	bit0: Control Cabinet overtemperature Alarm bit1: Control Cabinet overtemperature Fault bit2: Control Cabinet Temperature Sensor Loss bit3: Control Cabinet cooling Fan Power Loss bit4: PLC Module Error bit5: PLC Remote Module Error bit6: PID Analog Feedback Loss bit7: Reserved bit8: Control Cabinet Low Temperature Alarm, Start Forbidden bit9: Remote Signal Select Motor Failure bit10: Remote Signal Select Motor Direction Failure bit11: Remote Signal Select Motor Speed Ramps Failure bit12: Control Cabinet Low Temperature Alarm bit13: Reserved bit14: Reserved bit15: Reserved	285	3(Read)	Word	"1" is fault, "0" is ok
14	bit0: KM42 Abnormal Open (DSP) bit1: KM42 Abnormal Close (DSP) bit2: KM43 Abnormal Open (DSP) bit3: KM43 Abnormal Close (DSP) bit4: Reserved bit5: Reserved bit6: Reserved bit7: Reserved bit8: Reserved bit9: Reserved bit10: Reserved bit11: Reserved bit12: Reserved	286	3(Read)	Word	"1" is fault, "0" is ok

#	Parameter name	Modbus Address	Function Code	Data Format	Data description
	bit13: Reserved bit14: Reserved bit15: Reserved				
15	bit0: Reserved bit1: Reserved bit2: KM42 Close Failure (DSP) bit3: KM42 Open Failure (DSP) bit4: KM3 Close Failure (DSP) bit5: KM3 Open Failure (DSP) bit6: KM43 Close Failure (DSP) bit7: KM43 Open Failure (DSP) bit8: Reserved bit9: Reserved bit10: Reserved bit11: Reserved bit12: Reserved bit13: Reserved bit14: Reserved bit15: Reserved	287	3(Read)	Word	"1" is fault, "0" is ok
Power cell alarm/fault					
	U1	297	3(Read)	Word	For fault/alarm descriptions, refer to HMI.
	V1	298	3(Read)	Word	
	W1	299	3(Read)	Word	
	U2	300	3(Read)	Word	
	V2	301	3(Read)	Word	
	W2	302	3(Read)	Word	
	U3	303	3(Read)	Word	
	V3	304	3(Read)	Word	
	W3	305	3(Read)	Word	
	U4	306	3(Read)	Word	
	V4	307	3(Read)	Word	
	W4	308	3(Read)	Word	
	U5	309	3(Read)	Word	
	V5	310	3(Read)	Word	
	W5	311	3(Read)	Word	
	U6	312	3(Read)	Word	
	V6	313	3(Read)	Word	
	W6	314	3(Read)	Word	

#	Parameter name	Modbus Address	Function Code	Data Format	Data description
	U7	315	3(Read)	Word	
	V7	316	3(Read)	Word	
	W7	317	3(Read)	Word	
	U8	318	3(Read)	Word	
	V8	319	3(Read)	Word	
	W8	320	3(Read)	Word	
	U9	321	3(Read)	Word	
	V9	322	3(Read)	Word	
	W9	323	3(Read)	Word	
	U10	324	3(Read)	Word	
	V10	325	3(Read)	Word	
	W10	327	3(Read)	Word	
Power cell bus voltage (V)					
	U1	327	3(Read)	Word	
	V1	328	3(Read)	Word	
	W1	329	3(Read)	Word	
	U2	330	3(Read)	Word	
	V2	331	3(Read)	Word	
	W2	332	3(Read)	Word	
	U3	333	3(Read)	Word	
	V3	334	3(Read)	Word	
	W3	335	3(Read)	Word	
	U4	336	3(Read)	Word	
	V4	337	3(Read)	Word	
	W4	338	3(Read)	Word	
	U5	339	3(Read)	Word	
	V5	340	3(Read)	Word	
	W5	341	3(Read)	Word	
	U6	342	3(Read)	Word	
	V6	343	3(Read)	Word	
	W6	344	3(Read)	Word	
	U7	345	3(Read)	Word	

#	Parameter name	Modbus Address	Function Code	Data Format	Data description
	V7	346	3(Read)	Word	
	W7	347	3(Read)	Word	
	U8	348	3(Read)	Word	
	V8	349	3(Read)	Word	
	W8	350	3(Read)	Word	
	U9	351	3(Read)	Word	
	V9	352	3(Read)	Word	
	W9	353	3(Read)	Word	
	U10	354	3(Read)	Word	
	V10	355	3(Read)	Word	
	W10	356	3(Read)	Word	

3.3 Communications

3.3.1 Features

Features of the Modbus-VACON® interface:

- Direct control of the VACON® drive (for example, run, stop, direction, speed reference, fault reset)
- Full access to all the VACON® parameters
- Monitor the VACON® status (for example, output frequency, output current, fault code)

3.3.2 Data Addresses in Modbus Messages

All data addresses in Modbus messages are referenced to zero. The first occurrence of a data item is addressed as item number zero. For example:

- The coil known as "Coil 1" in a programmable controller is addressed as "Coil 0000" in the data address field of a Modbus message.
- Coil 127 decimal is addressed as "Coil 007E hex" (126 decimal).
- Holding register 40001 is addressed as register 0000 in the data address field of the message. The function code field already specifies a "holding register" operation. Therefore the "4XXXX" reference is implicit.
- Holding register 40108 is addressed as register 006B hex (107 decimal).

3.3.3 Supported Modbus Functions

The VACON® variables, fault codes, and parameters can be read and written from Modbus. The parameter addresses are determined in the application. Every parameter and actual value have an ID number in the application. The ID numbering of the parameter and the parameter ranges and steps can be found in the application manual in question. The parameter value must be given without decimals. If several parameters/actual values are read with one message, the addresses of the parameters/actual values must be consecutive.

Table 9: Supported Functions

Function (dec)	Function (hex)	Modbus Function Name	TCP/RTU	Access type	Address range (hex)
1	1	Read coils	TCP only	Discrete (1 bit)	00000- 0FFFF
2	2	Read Discrete Inputs	TCP only	Discrete (1 bit)	10000- 1FFFF
3	3	Read Holding Registers	TCP and RTU	Register (16 bit)	40000- 4FFFF

Function (dec)	Function (hex)	Modbus Function Name	TCP/RTU	Access type	Address range (hex)
4	4	Read Input Registers	TCP and RTU	Register (16 bit)	30000- 3FFFF
5	5	Write Single Coils	TCP only	Discrete (1 bit)	00000- 0FFFF
6	6	Write Single Register	TCP and RTU	Discrete (1 bit)	40000- 4FFFF
15	F	Write Multiple Coils	TCP only	Discrete (1 bit)	00000- 0FFFF
16	10	Write Multiple Registers	TCP and RTU	Register (16 bit)	40000- 4FFFF
23	17	Read/Write Multiple Registers	TCP and RTU	Register (16 bit)	40000- 4FFFF

Broadcasting is not supported in TCP. Broadcast is supported with function codes 06 and 16 in RTU.

The address ranges of the different function codes are often not relevant to the user and can be ignored. The targeted information type (coil, register, and so on) can be selected separate from the address.

3.3.4 Modbus Data Mapping

3.3.4.1 MVD Input Parameters

Table 10: MVD Input Parameters

Number	Parameter	Modbus Address	Function Code	Data Format	Data description
1	Input current (A)	9004	3 (Read)	Word	
2	Input voltage (V)	9002	3 (Read)	Word	
3	Reference speed (RPM)	9101	3/6 (Read/Write)	Word	
4	Reference Frequency (0.01 Hz)	9103	3/6 (Read/Write)	Word	MUL100
5	Input power (kVA)	9006	3 (Read)	Word	

3.3.4.2 MVD Output Parameters

Table 11: MVD Output Parameters

Number	Parameter	Modbus Address	Function Code	Data Format	Data description
1	Output current (A)	9005	3 (Read)	Word	
2	Output voltage (V)	9003	3 (Read)	Word	
3	Output Frequency (0.01 Hz)	9010	3 (Read)	Word	DIV100
4	Output speed (RPM)	9008	3 (Read)	Word	

3.3.4.3 Transformer Temperature

Table 12: Transformer Temperature

Number	Parameter	Modbus Address	Function Code	Data Format	Data description
1	Transformer temperature T31 A (0.1°C)	9011	3 (Read)	Word	DIV 10
2	Transformer temperature T31 B (0.1°C)	9012	3 (Read)	Word	DIV 10
3	Transformer temperature T31 C (0.1°C)	9013	3 (Read)	Word	DIV 10

3.3.4.4 Digital Output

Table 13: Digital Output

Number	Parameter	Modbus Address	Function Code	Data Format	Data description
1	bit0: Startup ready bit1: VFD running bit2: Reserved bit3: Local/Remote bit4: Fault bit5: Alarm bit6: Reserved bit7: MCB closed bit8: Reserved bit9: MCB Close allowed bit10: Reserved bit11: Reserved bit12: Reserved bit13: Reserved bit14: Reserved bit15: Reserved	9001	3 (Read)	Word	"1" is OK

3.3.4.5 Digital Input

Table 14: Digital Input

Number	Parameter	Modbus Address	Function Code	Data Format	Data description
1	VFD start	2011	5 (Write)		"1" is OK, 2 s pulse
2	VFD ramp stop	2013	5 (Write)		"1" is OK, 2 s pulse
3	VFD coast stop	2012	5 (Write)		"1" is OK, 2 s pulse
4	System reset	2014	5 (Write)		"1" is OK, 2 s pulse

3.3.4.6 System Alarm/Fault

Table 15: System Alarm/Fault

Number	Parameter	Modbus Address	Function Code	Data Format	Data description
1	bit0: Input Over Current(Software) bit1: Input Phase Loss bit2: Input Power Loss bit3: Input Under Voltage bit4: Input Over Voltage bit5: Input Grounding bit6: Input Sequence Fault bit7: Reserved bit8: Output Over Current(Software) bit9: Output Over Load bit10: Output Phase Loss bit11: Output Grounding bit12: Output Phase Imbalance Alarm bit13: Output Phase Imbalance Fault	27073	3 (Read)	Word	"1" is fault, "0" is OK

Number	Parameter	Modbus Address	Function Code	Data Format	Data description
	bit14: Output Under Load bit15: Electronic Motor Thermal Protection				
2	bit0: Motor Stall bit1: Motor Reverse bit2: Motor Over Speed bit3: Motor Under Speed bit4: Analog Reference Loss bit5: Encoder Abnormal bit6: Input Over Current(Hardware) bit7: Output Over Current(Hardware) bit8: External Fault bit9: Current Sensor Power Fault bit10: Fault Code Query Failure bit11: Bypassed Cell Quantity Over Limit bit12: System Running With MCB Open bit13: Synchronous Switch Status Error bit14: Transformer Temperature Sensor Loss bit15: Reserved	27074	3 (Read)	Word	"1" is fault, "0" is OK
3	bit0: Auto Tuning Failure bit1: Flying Start Failure bit2: Automatic Restart Failure bit3: Synchronous Transfer Failure bit4: Reserved bit5: Reserved bit6: Failure Of Motor Selection bit7: LVRT Failure bit8: Reserved bit9: Bypass Derating Failure bit10: Output Current Sampling Fault bit11: Input Current Sampling Fault bit12: Power Cell Overload bit13: Software And Hardware Versions Are Inconsistent bit14: Software And Hardware Versions Are Incompatible bit15: Reserved	27075	3 (Read)	Word	"1" is fault, "0" is OK
4	bit0: External/Customer Control Power Loss bit1: Internal Control Power Loss bit2: PLC Battery Voltage Low bit3: UPS Under Voltage bit4: Control Power Loss Overtime bit5: UPS Under Voltage Overtime bit6: HV Cabinet Door Open bit7: Air Filter Clogged bit8: Cooling Fan Abnormal bit9: Fan Internal Power Loss bit10: Fan External Power Loss bit11: Transformer T31 Over Temperature Alarm	27076	3 (Read)	Word	"1" is fault, "0" is OK

Number	Parameter	Modbus Address	Function Code	Data Format	Data description
	bit12: Transformer T31 Over Temperature Fault bit13: Transformer T31 Temperature Sensor Loss bit14: Emergency Stop bit15: Remote Emergency Stop				
5	bit0: PLC-DSP Communication Failure bit1: PLC-HMI Communication Failure bit2: DSP Fault(X1.1) bit3: DSP Alarm(X1.2) bit4: DSP Bypass(X1.4) bit5: DSP Trip(X1.5) bit6: Upstream Main Circuit Breaker Abnormal Open bit7: Upstream Main Circuit Breaker Close Failure bit8: Upstream Main Circuit Breaker Open Failure bit9: KM41 Close Failure bit10: KM41 Open Failure bit11: KM42 Close Failure bit12: KM42 Open Failure bit13: KM43 Close Failure bit14: KM43 Open Failure bit15: Startup Cabinet Switch Abnormal Open	27077	3 (Read)	Word	"1" is fault, "0" is OK
6	bit0: Startup Cabinet Switch Open Failure bit1: Startup Cabinet Switch Close Failure bit2: Minimum Precharge Waiting Time Not Reached! bit3: PLC-DSP Communication Failure. Unable To Close Startup Cabinet bit4: DSP Trip(COM) bit5: DSP Bypass(COM) bit6: Reserved bit7: Reserved bit8: Reserved bit9: Reserved bit10: Reserved bit11: Reserved bit12: Reserved bit13: Reserved bit14: Reserved bit15: Reserved	27078	3 (Read)	Word	"1" is fault, "0" is OK
7	bit0: Reserved bit1: Reserved bit2: Cooling Fan21 Failure bit3: Cooling Fan22 Failure bit4: Cooling Fan23 Failure bit5: Cooling Fan24 Failure bit6: Cooling Fan25 Failure bit7: Cooling Fan26 Failure bit8: Cooling Fan27 Failure bit9: Cooling Fan28 Failure	27079	3 (Read)	Word	"1" is fault, "0" is OK

Number	Parameter	Modbus Address	Function Code	Data Format	Data description
	bit10: Cooling Fan29 Failure bit11: Number of Cooling Fan For Power Cell Cabinet is Insufficient bit12: Cooling Fan31 Failure bit13: Cooling Fan32 Failure bit14: Cooling Fan33 Failure bit15: Cooling Fan34 Failure				
8	bit0: Cooling Fan35 Failure bit1: Number of Cooling Fan For Transformer T31 Cabinet Is Insufficient bit2: Cooling Fan36 Failure bit3: Cooling Fan37 Failure bit4: Cooling Fan38 Failure bit5: Cooling Fan39 Failure bit6: Cooling Fan310 Failure bit7: Number of Cooling Fan For Transformer T32 Cabinet Is Insufficient bit8: Cooling Fan71 Failure bit9: Cooling Fan72 Failure bit10: Number of Cooling Fan For Filter Cabinet Is Insufficient bit11: Cooling Fan81 Failure bit12: Cooling Fan82 Failure bit13: Number of Cooling Fan For Reactance Cabinet Is Insufficient bit14: Reserved bit15: Reserved	27080	3 (Read)	Word	"1" is fault, "0" is OK
9	bit0: Reserved bit1: Reserved bit2: Reserved bit3: Reserved bit4: Reserved bit5: Reserved bit6: Reserved bit7: Auto Bypass Failure bit8: Start Overtime bit9: KM41 Abnormal Open bit10: KM42 Abnormal Open bit11: QS41 Abnormal Open bit12: QS42 Abnormal Open bit13: Auto Bypass Condition Is Not Satisfied bit14: Auto Bypass Overtime bit15: Synchronous Transfer Start Overtime	27081	3 (Read)	Word	"1" is fault, "0" is OK
10	bit0: Reserved bit1: Reserved bit2: KM42 Close Failure(DSP) bit3: KM42 Open Failure(DSP) bit4: Reserved bit5: Reserved bit6: KM43 Close Failure(DSP) bit7: KM43 Open Failure(DSP)	27082	3 (Read)	Word	"1" is fault, "0" is OK

Number	Parameter	Modbus Address	Function Code	Data Format	Data description
	bit8: Speed Error Over Limit bit9: Reactance Compensation Failure bit10: Load Transfer Failure bit11: Reserved bit12: Reserved bit13: Reserved bit14: Reserved bit15: Reserved				
11	Reserved	27083	3 (Read)	Word	
12	bit0: External Fault bit1: Arc Flash Relay Error bit2: Arc Flash Relay Tripped bit3: Transformer T32 Over Temperature Alarm bit4: Transformer T32 Over Temperature Fault bit5: Transformer T32 Temperature Sensor Loss bit6: Filter Cabinet Over Temperature bit7: Reactance Cabinet Over Temperature bit8: Motor Winding Over Temperature bit9: Motor Winding Ultra Over Temperature bit10: Motor Bearing Over Temperature bit11: Motor Bearing Ultra Over Temperature bit12: Motor Temperature Sensor Loss bit13: Ambient Low Temperature Alarm, MCB Close Forbidden bit14: Ambient Low Temperature Fault bit15: Ambient Temperature Sensor Loss	27084	3 (Read)	Word	"1" is fault, "0" is OK
13	bit0: Control Cabinet Over Temperature Alarm bit1: Control Cabinet Over Temperature Trip bit2: Control Cabinet Temperature Sensor Loss bit3: Control Cabinet Cooling Fan Failure bit4: PLC Module Error bit5: PLC Remote Module Error bit6: PID Analog Feedback Loss bit7: PLC Stop bit8: Ambient Low Temperature Alarm, Start Forbidden bit9: Remote Signal Select Motor Failure bit10: Remote Signal Select Motor Direction Failure bit11: Remote Signal Select Motor Speed Ramps Failure bit12: Reserved bit13: Reserved bit14: Reserved bit15: Reserved	27085	3 (Read)	Word	"1" is fault, "0" is OK

3.3.4.7 Power Cell Alarm/Fault

Table 16: Power Cell Alarm/Fault

Number	Parameter	Modbus Address	Function Code	Data Format	Data description
	U1	15141	3 (Read)	Word	Fault/alarm description: refer to HMI.
	U2	15144	3 (Read)	Word	
	U3	15147	3 (Read)	Word	
	U4	15150	3 (Read)	Word	
	U5	15153	3 (Read)	Word	
	U6	15156	3 (Read)	Word	
	U7	15159	3 (Read)	Word	
	U8	15162	3 (Read)	Word	
	U9	15165	3 (Read)	Word	
	U10	15168	3 (Read)	Word	
	U11	15171	3 (Read)	Word	
	U12	15174	3 (Read)	Word	
	V1	15142	3 (Read)	Word	
	V2	15145	3 (Read)	Word	
	V3	15148	3 (Read)	Word	
	V4	15151	3 (Read)	Word	
	V5	15154	3 (Read)	Word	
	V6	15157	3 (Read)	Word	
	V7	15160	3 (Read)	Word	
	V8	15163	3 (Read)	Word	
	V9	15166	3 (Read)	Word	
	V10	15169	3 (Read)	Word	
	V11	15172	3 (Read)	Word	
	V12	15175	3 (Read)	Word	
	W1	15143	3 (Read)	Word	
	W2	15146	3 (Read)	Word	
	W3	15149	3 (Read)	Word	
	W4	15152	3 (Read)	Word	
	W5	15155	3 (Read)	Word	
	W6	15158	3 (Read)	Word	
	W7	15161	3 (Read)	Word	
	W8	15164	3 (Read)	Word	

Number	Parameter	Modbus Address	Function Code	Data Format	Data description
	W9	15167	3 (Read)	Word	
	W10	15170	3 (Read)	Word	
	W11	15173	3 (Read)	Word	
	W12	15176	3 (Read)	Word	

3.3.4.8 Power Cell Bus Voltage

Table 17: Power Cell Bus Voltage

Number	Parameter	Modbus Address	Function Code	Data Format	Data description
	U1	15101	3 (Read)	Word	
	U2	15104	3 (Read)	Word	
	U3	15107	3 (Read)	Word	
	U4	15110	3 (Read)	Word	
	U5	15113	3 (Read)	Word	
	U6	15116	3 (Read)	Word	
	U7	15119	3 (Read)	Word	
	U8	15122	3 (Read)	Word	
	U9	15125	3 (Read)	Word	
	U10	15128	3 (Read)	Word	
	U11	15131	3 (Read)	Word	
	U12	15134	3 (Read)	Word	
	V1	15102	3 (Read)	Word	
	V2	15105	3 (Read)	Word	
	V3	15108	3 (Read)	Word	
	V4	15111	3 (Read)	Word	
	V5	15114	3 (Read)	Word	
	V6	15117	3 (Read)	Word	
	V7	15120	3 (Read)	Word	
	V8	15123	3 (Read)	Word	
	V9	15126	3 (Read)	Word	
	V10	15129	3 (Read)	Word	
	V11	15132	3 (Read)	Word	
	V12	15135	3 (Read)	Word	
	W1	15103	3 (Read)	Word	

Number	Parameter	Modbus Address	Function Code	Data Format	Data description
	W2	15106	3 (Read)	Word	
	W3	15109	3 (Read)	Word	
	W4	15112	3 (Read)	Word	
	W5	15115	3 (Read)	Word	
	W6	15118	3 (Read)	Word	
	W7	15121	3 (Read)	Word	
	W8	15124	3 (Read)	Word	
	W9	15127	3 (Read)	Word	
	W10	15130	3 (Read)	Word	
	W11	15133	3 (Read)	Word	
	W12	15136	3 (Read)	Word	

3.4 Troubleshooting

3.4.1 General Instructions

When the AC drive control diagnostics detects an unusual operating condition, the drive initiates a notification visible, for example, on the HMI. The display shows the number of the fault, the fault code, and a short fault description.

The fault can be reset with the Reset button or via the I/O terminal. The faults are stored in the Fault history menu which can be browsed. For a list of all fault codes, see the VACON® 1000 Application Guide and Operating Guide.

When contacting Danfoss because of a fault condition, always provide:

- Texts and fault codes on the HMI
- Description of the problem
- Drive Info file

3.4.2 RS485 Bus Biasing

When none of the devices on the RS485 bus is sending data, all devices are in idle status. This being the case, the bus voltage is in indefinite state, usually near 0 V due to the termination resistors. This can cause problems in character reception because the single characters in serial communication begin with start bit referring to bus status '0' with voltage of less than -200 mV. Bus status '1' corresponds to bus voltage of more than +200 mV. The RS485 standard considers the voltage interval -200 mV...+200 mV as an undefined state. Therefore, bus biasing must maintain the voltage in status '1' (above +200 mV) also between the messages.

To bias the bus, add a separate active termination resistor designed for the RS485 bus (for example, Siemens active RS485 terminating element 6ES7972-0DA00-0AA0).

3.5 Specifications

Table 18: Modbus RTU Protocol Specifications

Data	Details
Interface	RS485
Data transfer method	RS485 MS/TP, half duplex
Transfer cable	STP (Shielded Twisted Pair), type Belden 9841 or similar
Connector	2.5 mm ²
Electrical isolation	Functional

Data	Details
Modbus RTU	As described in "Modicon Modbus Protocol Reference Guide"
Bitrate	300, 600, 1200, 2400, 4800, 9600, 19200, 38400, 57600, 76800, 115200, and 230400 bits/s
Addresses	1-247

4 PROFIBUS DP

4.1 Function Description

The PROFIBUS DP option implements data communication between serial port and PROFIBUS DP. Four serial devices can be connected to PROFIBUS DP network and converted to PROFIBUS DP network devices. The PROFIBUS DP option has RS232/RS485/RS422 serial interface.

4.2 Specifications

- Acts as a PROFIBUS DP Slave at the side of PROFIBUS DP. Acts as a Modbus Master or universal mode at the side of serial port.
- When acting as a Modbus Master at the side of serial port:
 - Transparent communication between PROFIBUS DP and Modbus can be established through the mapping relationship between PROFIBUS DP data communication area and Modbus data communication area.
 - 01H, 02H, 03H, 04H, 05H, 06H, 0FH, and 10H functions are supported.
 - Up to 48 Modbus commands can be configured.
 - Modbus function codes 03H and 04H support function of "Byte-Swapping", which can easily solve the problem of large-end and small-end format between two networks.
- When set in universal mode, the control modes of time interval between characters, frame length, and delimiter are supported with automatic transmission function.
- Completes PROFIBUS DP-V0 slave functionality according to EN 50170 (IEC 61158).
- As a PROFIBUS DP slave: Automatic baud rate detection on PROFIBUS DP (9600 bit/s – 12 Mbit/s).
- PROFIBUS input/output byte number is free to set through STEP7. The maximum number of bytes:
 - Input Bytes ≤244 bytes
 - Output Bytes ≤244 bytes
 - Data Bytes ≤488 bytes
- Maximum Modules: 50
- Serial port is able to support 3 models of electrical interfaces: RS232, RS485, and RS422.
- Multiple formats of serial port communication parameters are supported.
 - Available baud rates: 300, 600, 1200, 2400, 9600, 19200, 38400, 57600, and 115200 bps
 - Available parity check modes: None, Odd, Even, Mark, and Space
- Power supply: 24 V DC (11–30 V), 80 mA (24 V DC)
- Operating temperature: -40...60 °C (-40...140 °F), humidity 5–95%
- External dimensions (WxHxD): 25 x 100 x 90 mm (0.98 x 3.94 x 3.54 in)
- Installation on 35 mm DIN rail
- Protection Level: IP20

4.3 Hardware Description

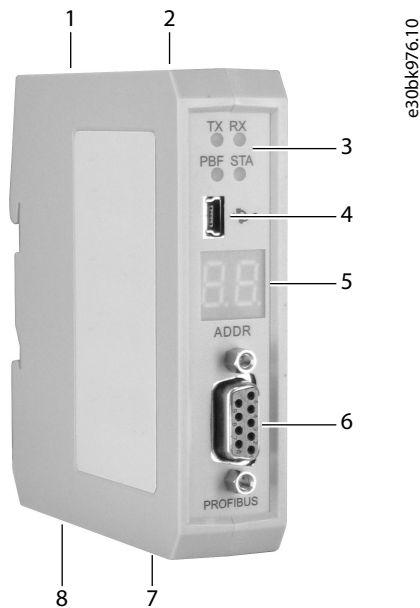


Illustration 7: Components of the PROFIBUS DP Option

1	Power supply terminal	5	LED display
2	Button	6	PROFIBUS DP terminal
3	Indicator lights	7	RS485/RS422 terminal
4	Mini-B USB terminal	8	RS232 terminal

4.3.1 Indicator Light Definitions

Table 19: Indicator Light Definitions

Indicator	Color	Status	Description
STA	Green	Blinking	PROFIBUS DP is communicating
		Off	No data communication
PBF	Red	On	PROFIBUS DP communication fails
		Off	Normal data communication
RX	Green	Blinking	Serial port is receiving data
		Off	No data receiving
TX	Green	Blinking	Serial port is sending data
		Off	No data sending

4.3.2 Button and LED Display

The LED display on the front of the PROFIBUS DP module shows the current PROFIBUS DP address and the configuration state.

The button on top of the PROFIBUS DP module has 2 modes:

- Mode switch
- Modify the PROFIBUS DP address

Mode switch

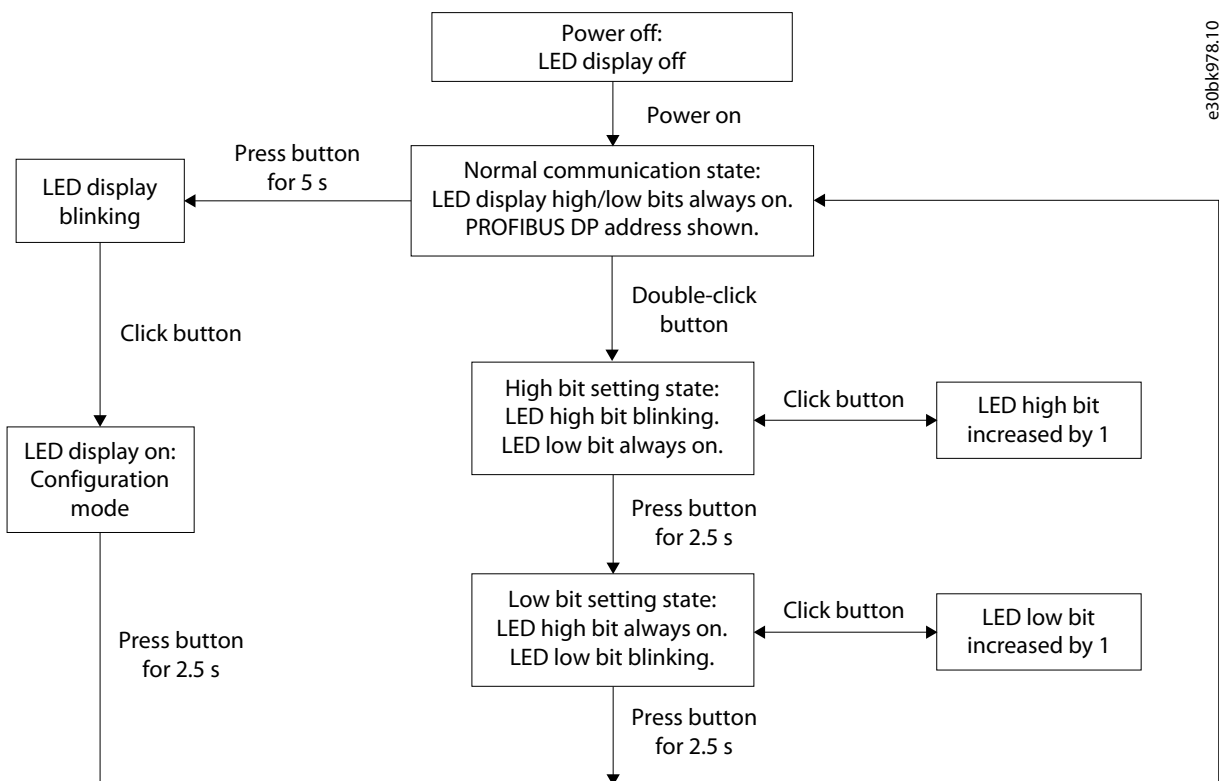
Use mode switch to move to the configuration mode.

- After powering on, the LED display shows the PROFIBUS DP address when acting as a slave.
- Press the button for 5 s, and the LED display starts to blink.
- Click the button once, and the LED display enters configuration mode.
- Connect to the serial port of a PC through any one of the RS232/RS485/RS422 serial ports on the PROFIBUS DP module, and finish configuration uploading and downloading.
- After downloading, press the button for 2.5 s to enter the normal communication mode.
- To finish uploading and downloading, connect the USB port of the PROFIBUS DP module to a PC. Select whether to enter into the communication mode according to hints from the software.

Modifying the PROFIBUS DP address

- After powering on, the LED display shows the PROFIBUS DP address when acting as a slave.
- To enter the PROFIBUS DP address modifying state, double-click the button.
 - The high bit of the DP address starts blinking and low bit is always on.
 - To make the number increase by one, press the button once.
- To switch to the setting state for the low bit, press the button for 2.5 s.
 - When setting the low bit state, the LED for the high bit is always on and low bit is blinking.
 - To make the number increase by one, press the button once.
- To save the new address and enter the normal communication state, press the button for 2.5 s.
 - The high bit and low bit of the LED display are always on.

If there is no operation of the button for over 10 s when changing the DP address, the LED display automatically returns to the normal communication state. If this happens, the previous operations are invalid.



e30bk978.10

Illustration 8: Flowchart of the LED Display States

4.3.3 Power Supply Terminal

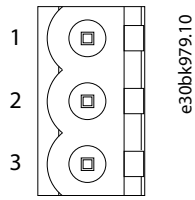


Illustration 9: Power Supply Terminal Pinout

Table 20: Power Supply Terminal Specification

Pin	Function
1	Ground
2	Not connected
3	+24 V DC (range 9–30 V)

4.3.4 RS485/RS422 Terminal

The PROFIBUS DP module has a standard RS485 interface.

Table 21: RS485 Characteristics

Item	Specification
Network topology	Linear bus with active bus termination resistors at both sides
Baud rate	1.2–115.2 kbps
Media	Shielded twisted-pair cable
Site number	32 stations per subsection (without repeater), and up to 127 stations (with repeater)
Plug connection	5-pin pluggable terminal

Installation:

- Connect all equipment with RS485 bus.
- There is a bus terminal resistor at each end of the bus (120 Ω, 1/2 W) to ensure reliable operation of the network.

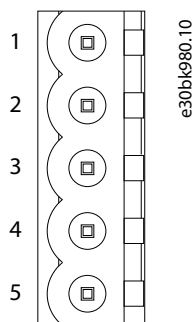


Illustration 10: RS485/RS422 Terminal Pinout

Table 22: RS485/RS422 Terminal Specification

Pin	Function
1	R-, RS422 Receive Negative
2	R+, RS422 Receive Positive

Pin	Function
3	GND
4	D-, RS485 Data Negative/RS422 Transmit Negative
5	D+, RS485 Data Positive/RS422 Transmit Positive

4.3.5 RS232 Terminal

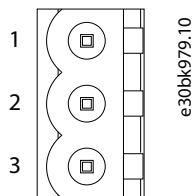


Illustration 11: RS232 Terminal Pinout

Table 23: RS232 Terminal Specification

Pin	Function
1	TX, serial port transmit, connect serial receive RX of user device
2	RX, serial port receive, connect serial transmit TX of user device
3	Ground

4.3.6 PROFIBUS DP Terminal

PROFIBUS DP uses DB9 hole pattern interface.

- PROFL_B, PROFL_A, and Shield must be connected.
- RTS can be used to determine the transmit direction by some devices.
- +5 V and GND are used in the bus termination or as power supply for Fiber Optical Transceiver (FOT). The maximum output current of pins 5 and 6 is 80 mA.

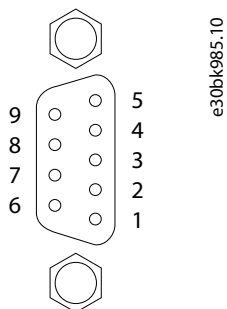


Illustration 12: PROFIBUS DP Terminal Pinout

Table 24: PROFIBUS DP Terminal Specification

Pin	Definition
3	PROFL_B, Data+ (required)
4	RTS
5	Ground

Pin	Definition
6	+5 V output
8	PROFI_A, Data- (required)
Bolt	Shield

4.3.7 Mini-B USB Terminal

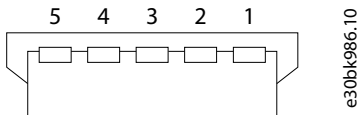


Illustration 13: Mini-B USB Terminal Pinout

Table 25: Mini-B USB Terminal Specification

Pin	Definition	Description
1	VBUS	+5 V
2	D-	Data Negative
3	D+	Data Positive
4	ID	No connection
5	GND	Signal Ground

4.4 Quick Start Guide

Following these steps to configure the PROFIBUS DP module quickly.

Procedure

- Connect the power.
 - a.** Connect the 24 V DC power. See [4.3.3 Power Supply Terminal](#).
 - b.** Connect the PROFIBUS DP module USB terminal to a PC USB interface with a USB cable (USB standard A model to USB Mini-B model).
- Use configuration software SST-MP-CFG to configure serial port parameters (subnet) and Modbus read/write command. There are 2 ways to upload/download configuration of the PROFIBUS DP module. Using USB to configure the PROFIBUS DP module is recommended.
 - Use a USB cable to configure.
 - Connect the PROFIBUS DP module with a USB cable to a PC which has software SST-MP-CFG installed.
 - Power on the device.
 - Click upload/download in the software and finish the configuration according to the instruction.
 - After upload/download, the PROFIBUS DP module enters normal communication mode.
 - Use serial port to configure.
 - Connect any of the RS232/RS485/RS422 serial ports of the PROFIBUS DP module to a PC which has software SST-MP-CFG installed.
 - Power on the device and the LED display shows the DP address.
 - Press the button for 5 s, and the LED display starts to blink.
 - Click the button, and the LED display enters the configuration mode.
 - Click upload/download in the software.
 - To finish upload/downloading, select the correct COM port.
 - After upload/download, press the button for 2.5 s to enter the communication mode.

3. Modify the PROFIBUS DP address. There are 2 ways to modify the address.
 - Modifying by software.

In configuration software SST-MP-CFG, select *Custom* for PROFIBUS address in the fieldbus.
Write the DP address and download the configuration to the PROFIBUS DP module.
 - Modifying by button.

To enter the PROFIBUS DP address setting state, double-click the button (LED high bit is blinking, and low bit is on).
To increase the digit by 1, click the button once.
Press the button for 2.5 s to switch to the setting state for the low bit of the address.
To increase the digit by 1, click the button once.
Press the button for 2.5 s to save and apply the new address.
4. Configure the hardware in the PROFIBUS master modeling software.
 - a. Install the GSD file.
 - b. Drag the input/output module to the required slot. Compile and download.
 - c. Compile and download.
5. Connect the PROFIBUS DP module with serial port devices through the RS485/RS422/RS232 terminals.
 - a. Turn off the power.
 - b. Correctly connect the terminals.
6. Connect the PROFIBUS DP module with the PROFIBUS DP master station. Use the PROFIBUS DP terminal. See [4.3.6 PROFIBUS DP Terminal](#).
7. Power on the PROFIBUS DP module and enter the normal communication state.

4.5 Software Configuration

4.5.1 Fieldbus Configuration

To access fieldbus configuration, select *Fieldbus* in the device view. The configurable items include:

- Input valid data length
 - Valid only when subnet protocol type is "User Config".
 - Open: The first byte of PROFIBUS input data is used to indicate the length of the serial port received data.
 - Close: There are no bytes of the PROFIBUS input data which indicate the length of the serial port received data.
- PROFIBUS address
 - "Setting by Hardware": Modify the PROFIBUS DP slave address with the button on the PROFIBUS DP option.
 - "Customized": Input the DP address in the textbox of "PROFIBUS Address".

4.5.2 Subnet Configuration

The Subnet configuration depends on the selected protocol type.

Protocol type: Modbus Master

- Modbus communication baud rate: 300, 600, 1200, 2400, 9600, 19200, 38400, 57600, or 115200 bps
- Data bits: 8 bits
- Parity check mode: None, odd, even, mark, or space
- Stop bits: 1 or 2
- Transmission mode: RTU or ASCII
- Response timeout: When the Modbus master sends commands, the range of the time waiting for response from the slave is 300–60000 ms.
- Delay between polls: After one Modbus command has been sent and has received correct response, or the response has timed out, the range of the delay time before next command being sent is: 0–2500 ms.
- Output mode: Modbus writing command (output command) has 3 output modes.

- Cycle: The same with Modbus read command, and output according to the scanning ratio.
- Forbidden: Prohibit outputting Modbus write command.
- Change of Value: When the output data has changed, it outputs the write command and stop outputting after receiving correct response.
- Scan rate: Ratio of slow scan cycle to fast scan cycle. If the quick scan command sends 10 times, slow scan command sends 1 time.

Protocol type: User Config

- Modbus communication baud rate: 300, 600, 1200, 2400, 9600, 19200, 38400, 57600, or 115200 bps
- Data bits: 8 bits
- Parity check mode: None, odd, even, mark, or space
- Stop bits: 1 or 2
- Frame type: The method of PROFIBUS DP option serial port receiving data frame from user serial devices. Time interval between characters, frame length, and delimiter can be selected.
- Time interval between characters: The interval time among characters while transmitting data. Default value is 10. The range is 10–60000 ms.
- Frame length: Valid only when the frame type is frame length. The range is 1–166.
- Start delimiter: Valid when frame type is delimiter. The range is 0–255.
- End delimiter: Valid when frame type is delimiter. The range is 0–255.
- Enable auto sending: The mode of PROFIBUS DP option serial port sending data to user serial devices. Open and close can be selected.
- Period auto sending: Default value is 1000. The range is 10–60000 ms. Valid only when auto sending is opened.
- CRC check: Valid when frame type is “time interval between characters” and “frame length”. Open and close are optional.

4.5.3 Command Configuration

To access command configuration, set the protocol type to Modbus master. The configurable items include:

- The starting address of Modbus register
 - The starting address of register/switching value/loop in Modbus slave in the range of 0–65535 (decimal).
 - For example, if the PROFIBUS DP option collects the flow of a certain flow meter, and the corresponding Modbus register address is 40035, set it to 34.
 - The address provided by the corresponding data address table of user device can be a PLC address or protocol address. Fill the protocol address in the PROFIBUS DP option.

Table 26: PLC and Protocol Address Examples

Command	PLC address examples	Corresponding protocol address
Coil state	00001–00010	00000–00009
Input state	10001–10010	00000–00009
Holding register	40001–40010	00000–00009
Input register	30001–30010	00000–00009

- The number of data
 - The number of register/switching value/coil in Modbus slave device.
 - The maximum number of write registers is 45 under ASCII mode.
- The starting address of memory mapping
 - The starting address of data read from devices or written to the devices in memory buffer of the module.
 - The devices are the user devices connected at the serial side.
 - The address range of data mapping in the module memory:

- Read command: 0x0000–0x00F3
- Write command: 0x4000–0x40F3
- Complete the function of mapping address without conflict by software through “calculate mapping address automatically”.
- When using “auto mapping function”, first configure the corresponding Modbus register address and data numbers.
- Mapping bit
 - For the bit operation commands, the position range of start-bit is in byte 0–7.
- Byte swap
 - There are 3 kinds of types: Non-exchange, Double-byte-exchange, and four-byte-exchange.
 - In Modbus and PROFIBUS DP byte order, the most significant bit (MSB) takes precedence.
 - In DeviceNet™ byte order, the least significant bit (LSB) takes precedence.
 - If necessary, exchange the byte order to get the correct value.
- Type of scan
 - There are 2 kinds of scanning mode: Quick-scan and slow-scan.
 - Slow-scan is equal to quick-scan being multiplied by scan rate. Set the scan rate in Subnet configuration.

4.6 Working Principle of the Modbus Master Station

A mapping relation establishes the data conversion between Modbus and the PROFIBUS DP module. The PROFIBUS DP module has 2 data buffers:

- PROFIBUS network input buffer with address of 0x00-0xF3
- PROFIBUS network output buffer with address of 0x4000-0x40F3

Commands 1, 2, 3, and 4 of Modbus write the data read from the Modbus slave station into the network input buffer. Then the PROFIBUS network reads the data. Commands 5, 6, 15, and 16 of the Modbus write the data from the network output buffer into the Modbus slave station. The data saved in the network output buffer is the data that the PROFIBUS master station writes to the PROFIBUS DP module.

48 commands can be configured. Every command can read a set of continuous Modbus registers.

4.7 Universal Mode

4.7.1 Data Conversion

The PROFIBUS DP module implements data conversion between PROFIBUS DP fieldbus protocol and serial port devices with RS232/RS485/RS422 serial interface. The conversion and transmission between PROFIBUS DP data and serial port data is bidirectional.

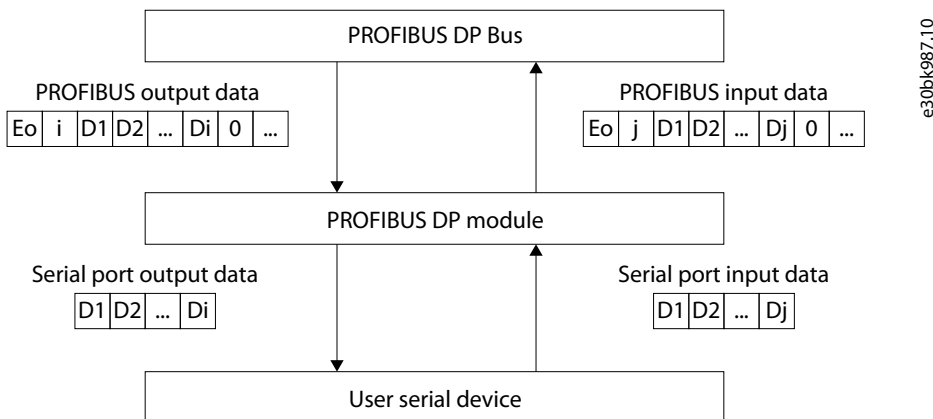


Illustration 14: Data Conversion Block Diagram

D1–Di	Data that the PROFIBUS DP module sends to serial devices	Eo	Transaction ID of PROFIBUS output data
D1–Dj	Data that the PROFIBUS DP module receives from user serial devices	i	Number of serial port data which must be sent contained in output data
Ei	Transaction ID of PROFIBUS input data	j	Number of serial port data which has been received in input data

No matter what control mode the serial port side uses, when the PROFIBUS DP module receives a frame of correct data from a serial device, the data is packaged as “PROFIBUS Input Data” and transmitted to the PROFIBUS DP master station (normally PLC). If the length of data received from the serial port is shorter than the length of DP conversion data, the PROFIBUS DP module sets other bytes to 0. For example, the data length of each conversion by DP is 10 bytes. If serial devices transmit 3 bytes data, except 2 frame headers and 3 bytes data, the PROFIBUS DP module sets other 5 bytes data to 0 and saved DP data into buffer.

NOTICE

The control mode of universal mode is valid only for the data transmitted from serial devices to the PROFIBUS DP module. The PROFIBUS DP module only sends raw data to serial devices without limits from the control mode.

After the PROFIBUS DP master station sends data to the PROFIBUS DP module, according to the “PROFIBUS output data” format, the first byte of DP output buffer is output transaction ID and the second byte is the length of output data marked as N. If any change happened to transaction ID, the PROFIBUS DP module transmits the N bytes data starting from the third byte of DP output buffer to serial devices regardless of what control mode the serial devices use to transmit data to the PROFIBUS DP module. For example, suppose that the data length of DP master station output buffer is 6 bytes and the data sent from DP to the PROFIBUS DP module is (HEX) 10 02 11 22 00 00, which means output data transaction number is 16. The real length of valid data is 2 bytes. Then the PROFIBUS DP module only sent (HEX) 11 22 to serial devices regardless of the control mode, time interval between characters, or delimiter.

Notes:

- Control mode is the control method including time interval between characters, frame length, and delimiter.
- There are 2 ways to send data through serial port.
 - The default one is transaction ID detection: Data is sent out from serial port when transaction number changed.
 - The other is automatic sending: Data is sent out according to sending period.
- The data saved in DP input buffer is the data which is sent from the PROFIBUS DP module to DP master station.
- The data saved in DP output buffer is the data which is sent from DP master station to the PROFIBUS DP module.

4.7.2 PROFIBUS Output Data Format

[Transaction ID] [Serial output data length n] [Serial output data 1]...[Serial output data n] [0x00]...[0x00]

Notes:

- Select the number of PROFIBUS output bytes as equal to or more than n+2.
- Numbers m of [0x00] is padding data.
- n+m+2 = The number of PROFIBUS output bytes
- When a new frame of data is started, the transaction ID increases by 1.

Example

If PROFIBUS output byte selected is 8 bytes output, serial output data length is 3, data is 01 02 03, and the current transaction ID is 0. Output data format: [01] [03] [01] [02] [03] [00] [00] [00]

4.7.3 PROFIBUS Input Data Format

[Transaction ID] [Serial input data length n] [Serial input data 1]...[Serial input data n] [0x00]...[0x00]

Notes:

- Select the number of PROFIBUS input bytes as equal to or more than n+2.
- Numbers m of [0x00] is padding data.
- n+m+2 = The number of PROFIBUS input bytes

- When a new frame of data is started, the transaction ID increases by 1.
- Serial input data length: Select “Close” in input data length when configuring fieldbus part in software. The data length is not shown in the DP input area. Instead, it shows transaction plus data. Select “Open” and DP input area shows data length.

Example

If PROFIBUS input byte selected is 8 bytes input, serial input data length is 3, data is 04 05 06, and the current transaction ID is 0.
Input data format: [01] [03] [04] [05] [06] [00] [00] [00]

4.7.4 Frame Type

Frame type is used for the PROFIBUS DP module to define the end of a data frame sent from a user serial device.

Frame type includes:

- Time interval between characters
- Frame length
- Delimiter

4.7.4.1 Time Interval Between Characters

When a serial device sends data to the PROFIBUS DP module, the module starts timing for every byte that the serial device sends out. If the arrival time of the next byte exceeds the set time interval (timeout time), the PROFIBUS DP module considers the previous received N continuous bytes as a data frame. Then, it combines this N or N-2 bytes into one “PROFIBUS input data frame” and sends it to the PROFIBUS master. If “Use CRC check” is selected, the PROFIBUS DP module executes a CRC check of the former N-2 bytes:

- If the check is correct, data is sent to the PROFIBUS master.
- If the check is incorrect, this data frame is discarded.

For example, time interval between characters is set to 10 ms, no CRC check, input and output bytes length of PROFIBUS master is 8 bytes. The serial device first sends out byte 0x11. After the PROFIBUS DP module receives 0x11, it starts the character interval timer. If the PROFIBUS DP module receives the next byte within 10 ms, it restarts the character interval timer. Otherwise, it considers receiving one complete data frame. The data word is all HEX.

The data length that the PROFIBUS DP module sends to the serial device depends on the data value in the frame that PROFIBUS sends to the PROFIBUS DP module.

4.7.4.2 Frame Length

This frame type is suitable for receiving serial data frame of specific length. When receiving bytes from serial devices, the PROFIBUS DP module automatically launches the time interval between characters function. Under the following two conditions, the PROFIBUS DP module considers that it has received one frame data:

- The adjacent bytes received from user serial devices do not time out; the receiving bytes number is equal to “frame length”. Or,
- The bytes received from the serial device characters times out.

When the PROFIBUS DP module has received one frame data, it disposes of this frame if data numbers equal to the set frame length. Otherwise, discard the frame directly. If selecting “Use CRC Check”, it does the CRC check first and discards the frames that did not pass the CRC check.

For example, set frame type to “Frame length”, the length of characters is 4 bytes, time interval between characters is 10 ms, no CRC check, and input and output bytes length of PROFIBUS master is 8 bytes. If receiving 4 bytes continuously with no characters time-out, the PROFIBUS DP module packages this frame data into one “PROFIBUS input data” frame and sends it to PROFIBUS master. If characters time out, it directly discards the data less than 4 bytes. The data are HEX.

The data length that the PROFIBUS DP module sends to the serial device depends on the data value in the frame that PROFIBUS sends to the PROFIBUS DP module.

4.7.4.3 Delimiter

This frame type is suitable for receiving the data frame with fixed frame header and end. It requires the serial devices to first send one “start byte” to indicate. Serial devices start to send one frame and continue to send one “end byte” when considering one frame data is over. If this frame type is selected, the PROFIBUS DP module automatically launches the character timeout function.

Under the following conditions, the PROFIBUS DP module considers that it has received one frame data:

- No character timeout happens in the process of receiving bytes. And,
- One correct “start byte” is received. And
- One correct “end byte” is received.

Under other conditions, the PROFIBUS DP module directly discards the incomplete data frame.

For example, set frame type to “delimiter”, “start character” is 0xff, “end character” is 0xfe, “time interval between characters” is 10 ms, and input and output bytes length of PROFIBUS master is 8 bytes. The PROFIBUS DP module receives the data correctly only if the serial devices send FF xx xx xx FE with no timeout. The data are all HEX.

The data length that the PROFIBUS DP module sends to the serial device depends on the data value in the frame that PROFIBUS sends to the PROFIBUS DP module.

5 CANopen

5.1 Function Description

The CANopen gateway can act as two different communication gateways:

- As a communication gateway between CANopen master protocol and Modbus slave protocol, the gateway can establish connections between many CANopen slaves and a Modbus master device.
- As a communication gateway between Modbus master protocol and CANopen slave protocol, the gateway can establish connections between many Modbus slave devices and a CANopen master device.

5.2 Specifications

5.2.1 CANopen Master/Modbus Slave

- The gateway can achieve data communication between many CANopen slaves and a Modbus master.
- CANopen master features:
 - CANopen supports DS301V4.02; Supports NMT, PDO, SDO, Heartbeat, and Guardlife.
 - CANopen interface supports: 5, 10, 20, 50, 100, 125, 250, 500, and 1000 kbps.
 - CAN interface supports CAN2.0A protocol.
 - Supports maximum 8 bytes TPDO and RPDO, fast Download SDO, and fast Upload SDO.
 - TPDO and RPDO can use default COBID, or use user-defined COBID, default COBID:
 - TPDO COBID: 384 + node address (0x180+node address), or 640 + node address (0x280+node address), or 896 + node address (0x380+node address), or 1152 + node address (0x480+node address)
 - Default value of RPDO: 512 + node address (0x200+node address), or 768 + node address (0x300+ node address), or 1024 + node address (0x400+ node address), or 1280 + node address (0x500+node address)
 - Supports TPDO, RPDO, SDO command numbers configuration, configure up to 128 commands (not limited to command numbers of one kind).
- Modbus slave features:
 - Supports function code: 03H, 04H, 06H, 10H
 - Supports communication mode: RTU and ASCII
 - Supports RS485 or RS232 interface, half-duplex, baud rate: 1200–115200 bps; (Supports baud rate: 1200, 2400, 4800, 9600, 19200, 38400, 57600, 115200 bps)
 - Data bits: 8
 - Parity: None, Odd, and Even optional
 - Stop bits: 1 and 2 optional
- Operating environment:
 - REL Humidity: 5–95% (non-condensing)
 - Working circumstance temperature: -20...+60 °C (-4...+140 °F)
 - Pollution level: class 3
- Power: 24 V DC (11–30 V), maximum 60 mA (24 V)
- External dimensions (WxHxD): 25 x 100 x 90 mm (0.98 x 3.94 x 3.54 in)
- Installation: 35 mm DIN rail

5.2.2 CANopen Slave/Modbus Master

- The gateway can achieve data communication between many Modbus slaves and a CANopen master.
- CANopen slave features:
 - CANopen supports DS301V4.02; Supports NMT, PDO, SDO, Heartbeat, and Guardlife, The cycle for TPDO transmission, and Timestamp.
 - CANopen interface supports: 5, 10, 20, 50, 100, 125, 250, 500, and 1000 kbps.
 - CAN interface supports CAN2.0A protocol.

- Acts as a CANopen slave, supports Pre-operational or Operational state optional after power-on.
- Acts as a CANopen slave, supports LSS function.
- Supports maximum 8 bytes TPDO and RPDO, 4 bytes fast Download SDO, and fast Upload SDO.
- TPDO and RPDO can use default COBID, or use user-defined COBID, default COBID:
 - TPDO COBID: 384 + node address (0x180+node address), or 640 + node address (0x280+node address), or 896 + node address (0x380+node address), or 1152 + node address (0x480+node address)
 - Default value of RPDO: 512 + node address (0x200+node address), or 768 + node address (0x300+ node address), or 1024 + node address (0x400+ node address), or 1280 + node address (0x500+node address)
- Supports at most 64 TPDO, 64 RPDO commands.
- Modbus master features:
 - Function code of Modbus master supports: 01H, 02H, 03H, 04H, 05H, 06H, 0FH, and 10H
 - Supports communication mode: RTU and ASCII
 - Write command output mode: Cycle, forbidden, or change of value optional
 - Modbus master can configure at most 48 commands
 - Supports RS485 or RS232 interface, half-duplex, baud rate: 1200–115200 bps; (Supports baud rate: 1200, 2400, 4800, 9600, 19200, 38400, 57600, 115200 bps)
 - Data bits: 8
 - Parity: None, Odd, and Even optional
 - Stop bits: 1 and 2 optional
- Operating environment:
 - REL Humidity: 5–95% (non-condensing)
 - Working circumstance temperature: -40...+60 °C (-40...+140 °F)
 - Pollution level: class 3
- Power: 24 V DC (11–30 V), maximum 60 mA (24 V)
- External dimensions (WxHxD): 25 x 100 x 90 mm (0.98 x 3.94 x 3.54 in)
- Installation: 35 mm DIN rail

5.3 Hardware Description

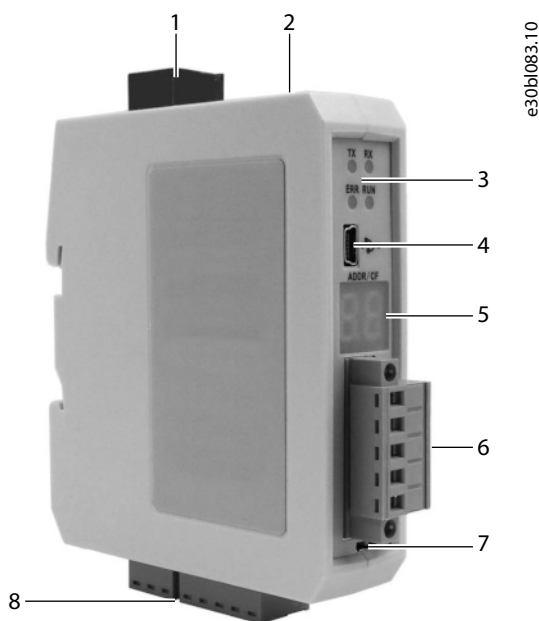


Illustration 15: Components of the CANopen Option

1	Power supply terminal	5	LED display
2	Configuration button	6	CANopen terminal
3	Indicator lights	7	Terminal resistor switch
4	USB terminal	8	Modbus terminals

5.3.1 Indicator Light Definitions

Table 27: Indicator Light Definitions

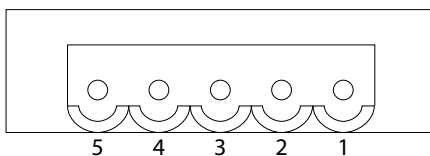
Indicators		Status	Description
CANopen status	ERR	Red off	CAN network is normal
		Red on	CAN port error (baud rate error, Bus off)
		Red blinking	The error counter of CAN controller reach or exceed alarm value
	RUN	Green on	Operation state
		Green on every 200 ms, off every 1000 ms	Stop state
		Green on every 200 ms, off every 200 ms	Preoperation state
Serial status	TX	Green blinking	Serial port is sending data
		Green off	Serial port no connection or error
	RX	Green blinking	Serial port is receiving data
		Green off	Serial port no connection or error

5.3.2 LED Display

Table 28: LED Display Definitions

LED Display	Description
01–99	The slave address when the gateway acts as a CANopen slave or a Modbus slave
CF	The gateway is in the configuration state
Eo	CAN sending error
88 (blink once)	Restarting

5.3.3 CANopen Terminal



e30b1084.10

Illustration 16: CANopen Terminal Pinout

Table 29: CANOpen Terminal Specification

Pin	Wiring
1	24V+
2	CAN-H
3	NC
4	CAN-L
5	GND

Voltage between 24V+ and GND is 24 V. Power range is 11–30 V.

5.3.4 Modbus Terminals

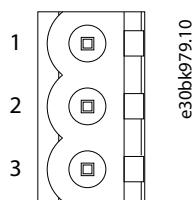


Illustration 17: RS232 Terminal Pinout

Table 30: RS232 Terminal Specification

Pin	Function
1	TX, Connect to RS232 RX of user device
2	RX, Connect to RS232 TX of user device
3	GND, Connect to RS232 GND of user device

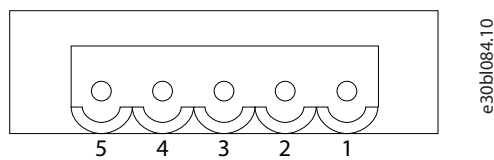


Illustration 18: RS485/RS422 Terminal Pinout

Table 31: RS485/RS422 Terminal Specification

Pin	Symbol	RS485 Function	RS422 Function
1	D+	Connect A+ of user device	Connect D+ of user device
2	D-	Connect B- of user device	Connect D- of user device
3	GND	Connect shielding ground (optional)	Connect shielding ground (optional)
4	R+	Reserved	Connect R+ of user device
5	R-	Reserved	Connect R- of user device

5.3.5 Power Supply Terminal

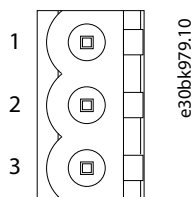


Illustration 19: Power Supply Terminal Pinout

Table 32: Power Supply Terminal Specification

Pin	Function
1	GND
2	Not connected
3	24V+, DC positive 24 V

5.3.6 Configuration Button

To enter the configuration mode, double-press the configuration button. In configuration mode, the LED display shows "CF". Configure the relevant communication parameters through configuration software.

In configuration mode, double-press the button and the gateway keeps the current configuration, restart after a while, and enters the operation state.

5.4 Quick Start Guide

5.4.1 Wiring

Procedure

1. Install the wiring to the Modbus terminals. See [5.3.4 Modbus Terminals](#).
2. Install the wiring to the CANopen terminal. See [5.3.3 CANopen Terminal](#).
3. Install the wiring to the power supply terminal. See [5.3.5 Power Supply Terminal](#).

5.4.2 Configuration

Procedure

1. Power on the module.
2. To enter configuration (CF) state, double-click the configuration button. See [5.3.6 Configuration Button](#).
3. Connect a PC to the USB port of the gateway.
4. Open the SSTCM-CFG configuration software on the PC.
5. In the *Select Device* menu, select "GT200-CO-RS".
6. In the *Select Mode* menu, select "CANopen Master/Modbus Slave" or "CANopen Slave/Modbus Master".
7. If "CANopen Master/Modbus Slave" mode is selected, configure the CANopen commands.

Supported CANopen commands:

- Upload SDO
- Download SDO
- Transmit PDO
- Receive PDO

8. If "CANopen Slave/Modbus Master" mode is selected, configure the CANopen and Modbus commands.

Supported Modbus commands:


- 01 Read Coil Status
- 02 Read Input Status
- 03 Read Holding Registers

- 04 Read Input Registers
 - 05 Force Single Coil
 - 06 Preset Single Register
 - 15 Force Multiple Coils
 - 16 Preset Multiple Registers
- Supported CANopen commands:
- Transmit PDO
 - Receive PDO

9. Download the configuration to the gateway.

Check that the port in *COM Config* is the port that is used before downloading the configurations.

10. When the configuration is done, double-click the configuration button on the gateway.

 The gateway restarts and the configuration takes effect.

5.5 Software Configuration

5.5.1 CANopen Master/Modbus Slave

Modbus Configuration

- Baud Rate: 1200, 2400, 4800, 9600, 19200, 38400, 57600, and 115200 bps
- Data Bits: 8
- Check Bit: None, Even, or Odd
- Slave Address: 1–99, default value is 1
- Stop Bits: 1 or 2
- Transmission Mode: RTU or ASCII

CANopen Configuration

- CANopen Baud Rate: 5, 10, 20, 50, 100, 125, 250, 500, and 1000 kbps. Default value is 250 kbps.
- Control & Monitor Status: When the Control & Monitor Status is set to be Enable, Modbus master station can read the states of CANopen slaves, and also change the states of CANopen slaves.
- Guard Life Time: Guard life is used when input value is non-zero, else heartbeat is used. The default is 0, which adopts the heartbeat protocol (range from 0–2000).
- Enable NMT: Start all CANopen nodes on the network or not. The default is disable.
- CANopen Node ID: The address of the gateway as CANopen node. The range is 1–127. The default value is 127.
- SDO Response Timeout: This parameter is based on 10 ms. The range of the parameter value is 1–2000. Default value is 200.
- Delay to Start up:
 - 0: Do not use the function.
 - Nonzero value: Use the function, and the delay value is nonzero integral multiple of 10 ms. The range is 0–2000. The default is 100. When the value of "Enable NMT" is "Enable", the parameter is valid.
- SYNC Cycle:
 - 0: Do not use synchronizing cycle function.
 - Nonzero value: Use the function, and the synchronizing cycle is nonzero integral multiple of 10 ms. The range is 1–2000. The default is 0.
- Clear Data Time for TPDO:
 - 0: Do not use this function.
 - Nonzero value: Use this function, and the time is nonzero integral multiple of 10 ms. Range is 0–2000. Default value is 0.

Command Configuration

- Index value: Object index value in object dictionary (decimal)
- Sub-index value: Object sub-index value in object dictionary (decimal)
- Number of Bytes: Number of bytes of mapping item
- Mapping address: Memory address mapped in the gateway (Read only)
- COB-ID: The CAN ID (decimal) of CANopen PDO
 - Default value of Transmit PDO command: $384(0x180) + \text{node ID}$ or $640(0x280) + \text{node ID}$ or $896(0x380) + \text{node ID}$ or $1152(0x480) + \text{node ID}$
 - Default value of Receive PDO: $512(0x200) + \text{node ID}$ or $768(0x300) + \text{node ID}$ or $1024(0x400) + \text{node ID}$ or $1280(0x500) + \text{node ID}$

5.5.2 CANopen Slave/Modbus Master

Modbus Configuration

- Baud Rate: 1200, 2400, 4800, 9600, 19200, 38400, 57600, and 115200 bps
- Response Timeout: After the gateway sends request, it waits for the response of the Modbus slave for maximum time which is in 10 ms. The range of the parameter value is 30–6000.
- Delay between Polls: Delay between a response has been received and sending next request. The range of the parameter value is 0–250 in units of ms.
- Check Bit: None, Even, or Odd
- Output Mode:
 - Cycle: The write commands are sent periodically.
 - Forbidden: The gateway does not send write commands.
 - Change of Value: When the output data changes, the write commands are sent.
- Scan Rate: Ratio of fast scan to slow scan. Every Modbus command can be set to fast scan or slow scan. If this parameter value is set to 10, then every fast scan command are sent 10 times and those slow commands are sent once. The range of the parameter is 1–255.
- Stop Bits: 1 or 2
- Transmission Mode: RTU or ASCII

CANopen Configuration

- CANopen Baud Rate: 5, 10, 20, 50, 100, 125, 250, 500, and 1000 kbps. Default value is 250 kbps.
- Delay to Start up: The parameter is based on 10 ms. The gateway sends bootup message after a time. The range of the parameter value is 0–200. Default value is 100.
- CANopen Node ID: The address of the gateway as CANopen slave node. The range is 1–99. The default value is 1.
- The Cycle of TPDO Transmission: The gateway has two modes for TPDO Transmission, Change of Value and Cycle. If the parameter is non-zero the gateway sends TPDO according to the parameter value. This parameter is based on 10 ms. The range of the parameter value is 0–60000. Default value is 0.
- Power-on Status: The status when the gateway powers on.
- Guard Life Time: Guard life is used when input value is non-zero, else heartbeat is used. The default is 0, which adopts the heartbeat protocol (range from 0–60000).
- Timestamp: Disable or Enable. The default is Disable.

Command Configuration

- Starting Address: The starting address of the register/switching value/coil in Modbus slave device. The range of the parameter value is 0–65535. Notes: This item of the gateway indicates the protocol address. When a PLC address is put in, it must be converted and the blanks filled in. PLC address range is 1–65535.
 - PLC address range: (4) 00001–(4) 65535
 - Protocol address range: 00000–65535
 - PLC address = (4) Protocol address + 00001

Table 33: Example of PLC Address and Corresponding Protocol Address

Command	PLC address	Corresponding protocol address
Coil Status	00001–00010	00000–00009
Input Status	10001–10010	00000–00009
Holding Register	40001–40010	00000–00009
Input Register	30001–30010	00000–00009

- Number of Data: Number of Data (Register or coils)
 - When the Modbus function code is 3, 4, or 16, the range is 1–127.
 - When the Modbus function code is 1, 2, or 15, the range is 1– 2000.
 - Others must be 1.
- Mapping address: There are 2 buffers in the gateway, input buffer and output buffer. Here the mapping address refers to the address of the 2 buffers. It bases zero.
- Byte Swap: Enable or Disable
- Type of Scan: Every Modbus command can be set to fast scan or slow scan. The gateway sends Modbus command according to the Scan Rate. Scan Rate is ratio of fast scan to slow scan.
- COB-ID: COBID (decimal) is CAN ID.
 - Default value of Transmit PDO command: 384(0X0180) + node ID, or 640(0X0280) + node ID, or 896(0X0380) + node ID, or 1152(0X0480) + node ID.
 - Default value of Receive PDO command: 512(0X0200) + node ID, or 768(0X0300) + node ID, or 1024(0X0400) + node ID, or 1280(0X0500) + node ID.
- Number of Bytes: The range is 1–8.

5.6 Working Principle

5.6.1 CANopen Master/Modbus Slave

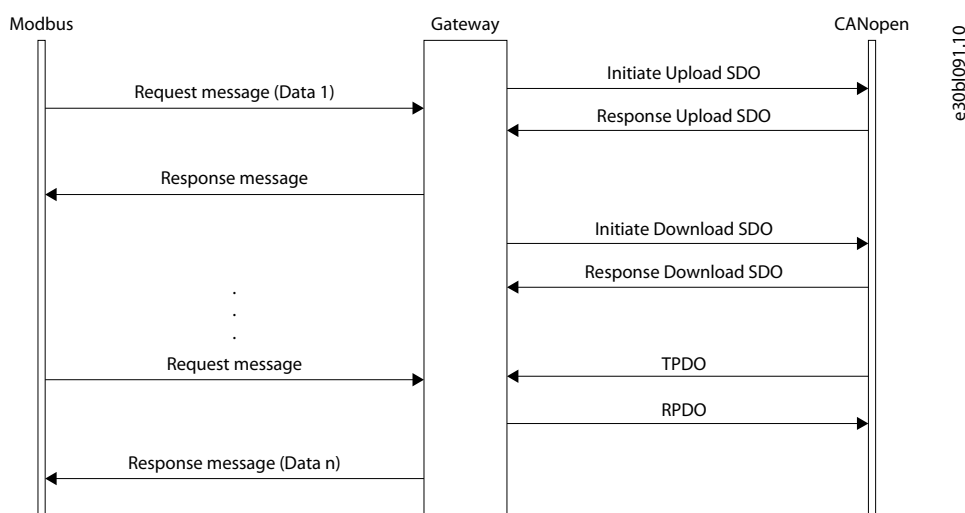


Illustration 20: CANopen Master/Modbus Slave Communication Mode

“Data 1” shows the data transfer process from Modbus to CANopen. “Data 2” shows the data transfer process from CANopen to Modbus.

Communication mode between CANopen and Modbus is asynchronous mode. The gateway runs on CANopen network independently, and transmits Upload SDO commands of CANopen parameters periodically according to object dictionary, also transmits and receives PDO (Process Data Object) commands. When receiving I/O request from Modbus, the gateway instantly responds with the latest CANopen data to realize the matching of network speed.

TPDO and RPDO apply to producer/consumer mode, and is often used in occasions with high requirement for speed. Upload SDO and Download SDO apply to client/server mode, the mode can guarantee safety of data, and is often used in occasions with low requirement for speed.

The data in Modbus output buffer of the gateway is the data being mapped to RPDO or Download SDO commands of CANopen slave. Output mode of the gateway is "change of value". Until the Modbus output data is changed, the gateway transmits corresponding commands (RPDO or Download SDO) to the CANopen network. For Modbus input data, the gateway receives data through TPDO or Upload SDO commands configured in the configuration software SST-CM-CFG and saves the data to Modbus input buffer.

The data exchange mode of Modbus and CANopen is shown in the following illustration. The data exchange buffer size is 1 kB, input buffer is 512 bytes, and output buffer is 512 bytes.

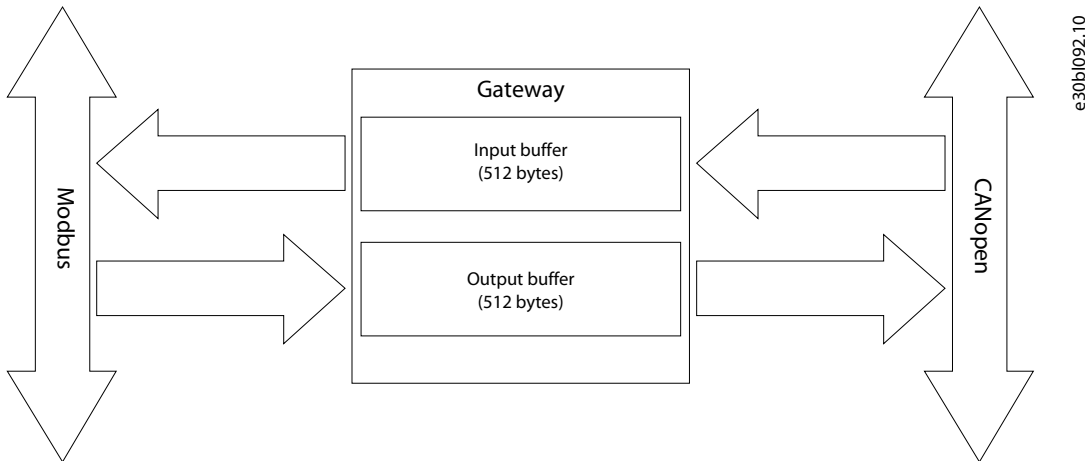


Illustration 21: CANopen Master/Modbus Slave Data Exchange Mode

Modbus master reads 512 bytes input buffer data through function code 04, writes data into 512 bytes output buffer through function code 06/16, and reads 512 bytes output buffer data through function code 03.

- Input buffer address range: 0x0000–0x01FF
- Output buffer address range: 0x0000–0x01FF

Table 34: Input and Output Buffer Starting Address

	Input Buffer	Output Buffer
Memory mapping address	0000H–00FFH	0000H–00FFH
Modbus slave PLC address	30001–30256	40001–40256
Modbus slave protocol address	0000H–00FFH	0000H–00FFH

Each Modbus command can read one continuous Modbus register.

When the “Control & Status” bit is “Enable” in configuration software, there are 2 bytes in the end of input and output buffer of the gateway showing status of CANopen slaves and controlling status of CANopen slave. Modbus master can get the state (Operation, Preoperation, Stop state) of CANopen through the gateway. Meanwhile, it can also change the operation state (Reset slave, Reset Communication, and change the slave state) of the CANopen slave through the gateway by sending NMT control command.

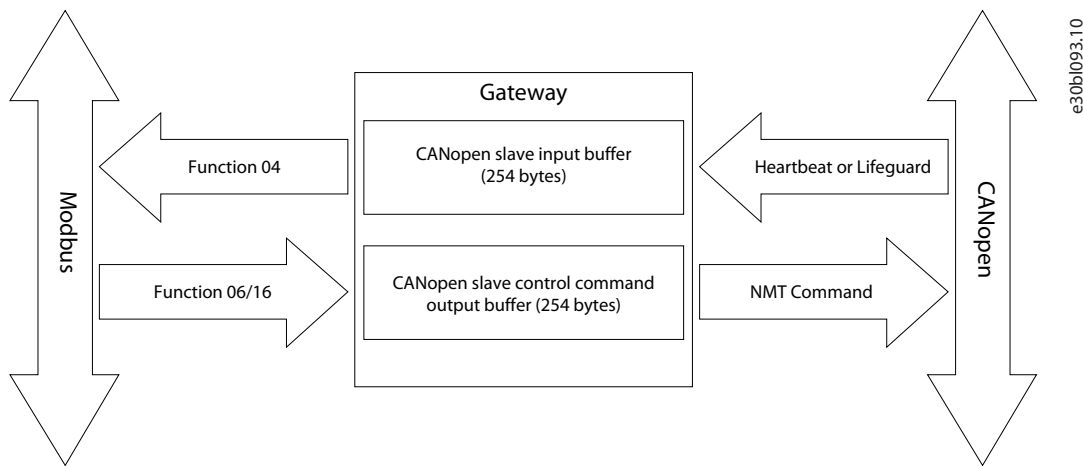


Illustration 22: CANopen Master/Modbus Slave Communication

As shown in the previous illustration, the gateway assigns 2-byte status input buffer and 2-byte control command output buffer (it can have up to 127 nodes in CANopen, so the aggregate is 254 bytes) for each CANopen slave respectively. So, Modbus master can use function 04 to read status of each CANopen slave and also can use function 06/16 to control the running state of CANopen slave.

- The address range of status input buffer of CANopen slave: 0x0200–0x02FD byte
- The address range of control command output buffer of CANopen slave: 0x0200–0x02FD byte

Table 35: Starting Address of Input/Output Buffer

	CANopen slave status input buffer	Control command output buffer
Memory mapping address	0100H–017EH	0100H–017EH
Modbus slave PLC address	30257–30383	40257–40383
Modbus slave protocol address	0100H–017EH	0100H–017EH

Table 36: Input/Output Buffer Status and Command Specifications

Memory mapping address (DEC)	CANopen slave status input buffer		Control command output buffer	
256-257	1 (256)	node state (257)	1 (256)	control command (257)
258-259	2	node state	2	control command
260-261	3	node state	3	control command
262-263	4	node state	4	control command
264-265	5	node state	5	control command
266-267	6	node state	6	control command
268-269	7	node state	7	control command
270-271	8	node state	8	control command
272-273	9	node state	9	control command
...
378-379	125	node state	125	control command
380-381	126	node state	126	control command
382-383	127	node state	127	control command

5.6.2 CANopen Slave/Modbus Master

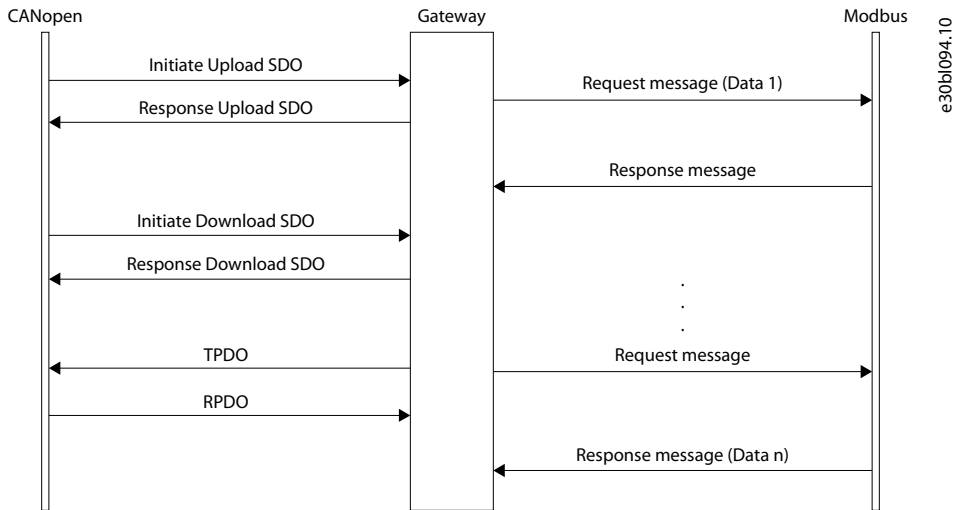


Illustration 23: CANopen Slave/Modbus Master Communication Mode

Communication mode between CANopen and Modbus is asynchronous mode.

“Data 1” shows the data transfer process from CANopen to Modbus. “Data 2” shows the data transfer process from Modbus to CANopen.

TPDO and RPDO apply to producer/consumer mode, and is often used in occasions with high requirement for speed. Upload SDO and Download SDO apply to client/server mode, the mode can guarantee safety of data, and is often used in occasions with low requirement for speed.

The data exchange mode between Modbus and CANopen is shown in the following illustration. The data exchange buffer size is 1 kB, input buffer is 512 bytes (Modbus slave sent, gateway received), and output buffer is 512 bytes (CANopen master sent, gateway received).

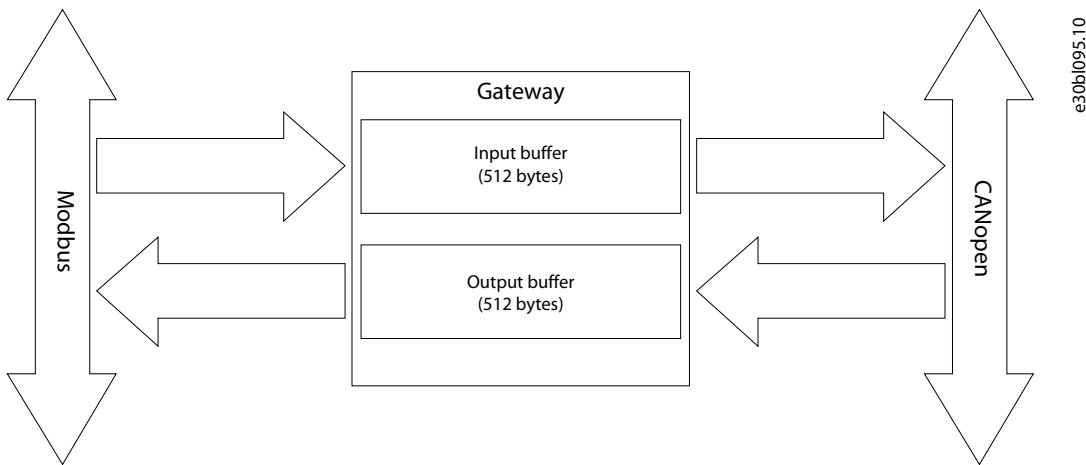


Illustration 24: CANopen Slave/Modbus Master Data Exchange Mode

5.6.2.1 SDO Visit

Input/output buffer supports fast SDO visit, the position where input/output buffer is in the object dictionary is listed in the following table.

Table 37: Locations of Input/Output Buffer

Index	Sub-index	Description
0x2000	0	Input No.0–No.3 byte of 512 bytes (4 bytes, readable)
0x2001	0	Input No.4–No.7 byte of 512 bytes (4 bytes, readable)
...	0	...

Index	Sub-index	Description
0x207e	0	Input No.504–No.507 byte of 512 bytes (4 bytes, readable)
0x207f	0	Input No.508–No.511 byte of 512 bytes (4 bytes, readable)
0x2080	0	Input No.0–No.1 byte of 512 bytes (2 bytes, readable)
0x2081	0	Input No.2–No.3 byte of 512 bytes (2 bytes, readable)
...	0	...
0x217e	0	Input No.508–No.509 byte of 512 bytes (2 bytes, readable)
0x217f	0	Input No.510–No.511 byte of 512 bytes (2 bytes, readable)
0x2180	0	Input No.0 byte of 512 bytes (1 bytes, readable)
0x2181	0	Input No.1 byte of 512 bytes (1 bytes, readable)
...	0	...
0x237e	0	Input No.510 byte of 512 bytes (1 bytes, readable)
0x237f	0	Input No.511 byte of 512 bytes (1 bytes, readable)
0x3000	0	Output No.0–No.3 byte of 512 bytes (4 bytes, writable)
0x3001	0	Output No.4–No.7 byte of 512 bytes (4 bytes, writable)
...	0	...
0x307e	0	Output No.504–No.507 byte of 512 bytes (4 bytes, writable)
0x307f	0	Output No.508–No.511 byte of 512 bytes (4 bytes, writable)
0x3080	0	Output No.0–No.1 byte of 512 bytes (2 bytes, writable)
0x3081	0	Output No.2–No.3 byte of 512 bytes (2 bytes, writable)
...	0	...
0x317e	0	Output No.508–No.509 byte of 512 bytes (2 bytes, writable)
0x317f	0	Output No.510–No.511 byte of 512 bytes (2 bytes, writable)
0x3180	0	Output No.0 byte of 512 bytes (1 bytes, writable)
0x3181	0	Output No.1 byte of 512 bytes (1 bytes, writable)
...	0	...
0x337e	0	Output No.510 byte of 512 bytes (1 bytes, writable)
0x337f	0	Output No.511 byte of 512 bytes (1 bytes, writable)

SDO read command (Upload SDO) request format:

- COBID=0x600+nodeID 8 bytes data 40 mm mm nn yy yy yy yy
 - 40 = fast read command
 - mm mm = index
 - nn = sub-index
 - yy yy yy yy = any value

SDO read command response format:

- COBID=0x580+nodeID 8 bytes data 43 mm mm nn dd dd dd dd
 - 43 = response of fast read command
 - mm mm = index
 - nn = sub-index
 - dd dd dd dd = data read from output buffer

Example

nodeID = 1, read output buffer index through SDO read command = 0x2000, sub-index = data of 00

- Request: COBID=0x601 8 bytes data 40 00 20 00 yy yy yy yy
 - Response: COBID=0x581 8 bytes data 43 00 20 00 01 02 03 04
- 01 02 03 04 is the data read from the output buffer.

SDO write command (Download SDO) format:

- COBID=0x600+nodeID 8 bytes data 23 mm mm nn dd dd dd dd
 - 23 = fast read command
 - mm mm = index
 - nn = sub-index
 - dd dd dd dd = data to be written to input buffer

SDO write command format:

- COBID=0x580+nodeID 8 bytes data 60 mm mm nn 00 00 00 00
 - 60 = fast write response
 - mm mm = index
 - nn = sub-index
 - 00 00 00 00 = default value

Example

nodeID = 1, write data (01 02 03 04) to input buffer index through SDO write command = 0x3000, sub-index = 00

- Request: COBID=0x601 8 bytes data 23 00 30 00 01 02 03 04
 - Response: COBID=0x581 8 bytes data 60 00 30 00 00 00 00 00
- 01 02 03 04 is the data to be written to input buffer.

5.6.2.2 LSS Introduction

The LSS (Layer Setting Services) protocol is a CANopen proprietary subprotocol, which provides the function of querying and changing the underlying parameters of the CANopen module. Only one node in a CANopen network can provide LSS master service, and this node must also be an NMT master. All other nodes on the network provide LSS slave service. The LSS function occupies two CAN-IDs, namely 0x7E4 (for slave) and 0x7E5 (for master), and the total length of the message is 8 bytes. The first byte is an identifier, which is used to identify the instruction or status information involved.

CANopen LSS slave function is as below.

- State switching: Supports global state switching and selected state switching.
- Configuration service: Supports setting the node address and baud rate through the network. No need to download the settings with configuration software.
- Query service: Supports the query of vendor-id, product-code, revision-number, and serial-number identifiers.
- Identity Service: Supports the identification of remote slave nodes.

Table 38: Function Codes

Code (HEX)	Function
4	Enter into LSS standby state
11	Configure new Node ID

Code (HEX)	Function
13	Configure new baud rate
15	Start new baud rate
17	Save LSS configuration

Table 39: Index Values for Baud Rates

Baud Rate [kbps]	Index Value
1000	0
800	1
500	2
250	3
125	4
100	5
50	6
20	7
10	8

Table 40: LSS Switches Slave Node ID (Default Factory Node ID 0X7F, Set Node ID 0X44)

Send:	00	80 7F	→ Push node to Pre-operational state
Send:	7E5	04 01 00 00 00 00 00 00	→ Set configuration mode
Send:	7E5	11 44 00 00 00 00 00 00	→ Set node address 0x44
Receive:	7E4	11 00 00 00 00 00 00 00	→ Success
Send:	7E5	17 00 00 00 00 00 00 00	→ Store configuration
Receive:	7E4	17 00 00 00 00 00 00 00	→ Success
Send:	7E5	04 00 00 00 00 00 00 00	→ Waiting state
Send:	00	81 7F	→ Reset node
Receive:	744	00	→ New boot-up message

NewNode ID will take effect after reset or power off and power on the gateway.

Table 41: LSS Switches Slave Baud Rate

Send:	7E5	04 01 00 00 00 00 00 00	→ Set configuration mode
Send:	7E5	13 00 02 00 00 00 00 00	→ Set 500 kBits
Receive:	7E4	13 00 00 00 00 00 00 00	→ Success
Send:	7E5	15 10 00 00 00 00 00 00	→ switch on 500 kBits

Table 42: LSS Inquires Vendor-ID, Product-code, Revision-number, and Serial Number

Send:	7E5	5A 00 00 00 00 00 00 00	→ Read Vendor-ID
Receive:	7E4	5A 1B 00 00 00 00 00 00	→ Success (Vendor-ID=0X1B)
Send:	7E5	5B 00 00 00 00 00 00 00	→ Read product-code
Receive:	7E4	5B 04 00 00 00 00 00 00	→ Success (product-code=0X04)
Send:	7E5	5C 00 00 00 00 00 00 00	→ Read revision-number
Receive:	7E4	5C 1B 00 00 00 00 00 00	→ Success
Send:	7E5	5D 00 00 00 00 00 00 00	→ Read serial-number
Receive:	7E4	5D xx xx xx xx 00 00 00	→ Success xx means product serial number

Table 43: LSS Switches Selected State of Node

Send:	7E5	40 1B 00 00 00 00 00 00	→ Match VENDOR_ID
Send:	7E5	41 04 00 00 00 00 00 00	→ Match PRODUCT_CODE
Send:	7E5	42 00 04 00 00 00 00 00	→ Match REV_NUMBER
Send:	7E5	43 xx xx xx xx 00 00 00	→ Match SERIAL_NUMBER
Receive:	7E4	44 01 00 00 00 00 00 00	→ Success 01 means configuration mode

5.7 Troubleshooting

Table 44: Troubleshooting

Number	Description	Suggestions
1	ERR red indicator light on in operation state	CAN bus BUS OFF or sending/receiving error counter exceed alarm value. Check whether CAN baud rate of gateway is the same as in other nodes on CAN network.
2	ERR red indicator light blinking in operation state	Need a terminal resistance on CAN network or the gateway has no connection to CAN network.
3	ERR red indicator light off in operation state, but sending/receiving of CAN error	Need a terminal resistance on CAN network or the node connected with gateway fail.
4	ERR red indicator light blinking occasionally	There is error frame form CAN network, but does not affect communication.
5	ERR red indicator light always blinking, no data sending to Modbus	Check the baud rate of all the nodes on the CAN network. If they are all the same, change a lower baud rate and try again.
6	Serial indicators (TX) green blinking	Modbus slave address on Modbus network is not the same with the gateway ready to read
7	Serial indicators (TX) green blinking	Modbus slave device on Modbus network does not support the function code configured in the gateway

N O T I C E**TERMINAL RESISTANCE**

CAN is differential level communication. When communication distance is long or communication baud rate is high, there exists echo interference on communication line.

- A terminal resistance (120 Ω /2 W) is required in both terminals of communication lines.

6 DeviceNet™

6.1 Function Description

The gateway can connect multiple devices with Modbus (RS485/RS232) interface to a DeviceNet™ network. It acts as a master at the side of the Modbus network, and a slave at the side of the DeviceNet™ network. It supports RS485 and RS232 at the serial interface. RS485 can be configured as a communication interface and RS232 as a debug interface. Or the other way round. RS232 interface is a dedicated interface for configuration mode.

The DeviceNet™ gateway establishes the data mapping among the Modbus parameters and DeviceNet™ I/O data.

6.2 Specifications

- Acts as a DeviceNet™ slave: Group 2 only adapter.
- Supports all the baud rates which accord with the DeviceNet™ protocol, and supports sensing baud rate automatically.
- Acts as a Modbus master, and supports the 01, 02, 03, 04, 05, 06, 15, and 16 function codes.
- The range of input voltage is 8–30 V, and the standard working voltage is 24 V DC.
- Supports debugging without PLC.
- Communication rate:
 - DeviceNet™ interface supports: 125 kbit/s, 250 kbit/s, and 500 kbit/s, auto baud rate.
 - The default parameters of Modbus interface are 19200 bps, 8 bits, no parity, 1 stop bit.
 - The Modbus baud rate: 300, 600, 1200, 2400, 9600, 19200, 38400, 57600, and 115200 bps.
- DeviceNet topology:
 - Trunk lines: Thick cable and thin cable both can be used to build the trunk lines. When the thick cable and thin cable are mixed to build the trunk lines, the longest cable length can be calculated through the following formulas:
 - $L_{\text{thick}} + 5 \times L_{\text{thin}} = 500 \text{ m}$, 125 kbit/s
 - $L_{\text{thick}} + 2.5 \times L_{\text{thin}} = 250 \text{ m}$, 250 kbit/s
 - $L_{\text{thick}} + L_{\text{thin}} = 100 \text{ m}$, 500 kbit/s
 - Here L_{thick} is the length of the thick cable, and L_{thin} is the length of the thin cable.
 - Drop lines: The length of drop lines is the distance from tap of the trunk lines to the transceiver of every device, and it must be less than 6 m. The length of drop lines is related to baud rate. The maximum lengths with different baud rates are:
 - Baud rate 125 kbit/s = 156 m cable
 - Baud rate 250 kbit/s = 78 m cable
 - Baud rate 500 kbit/s = 39 m cable
- Working mode: DeviceNet™ interface only support: Group 2 only adapter.
- Operating temperature: -20...60 °C (-4...140 °F). Humidity: 5–95% (non-condensing).
- EMC testing standard compliant.
- Power: 24 V DC (11–30 V DC), maximum 80 mA (24 V DC).
- Dimensions (WxHxD): 40x125x110 mm (1.6x5.0x4.4 in).
- Pollution level: 3.

6.3 Hardware Description

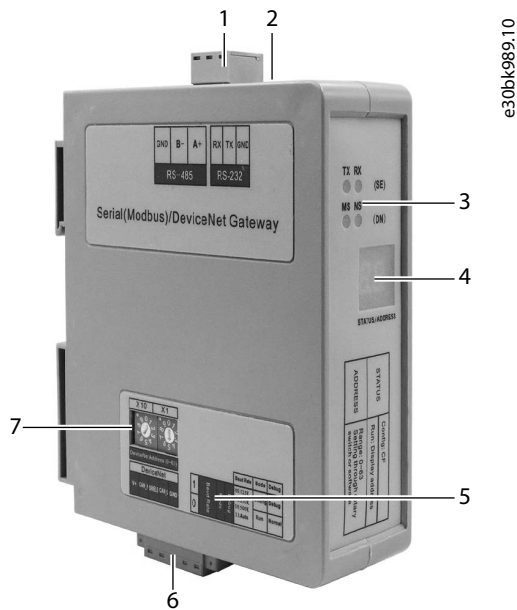


Illustration 25: Components of the DeviceNet™ Option

1	RS485 terminal	5	DIP Switch
2	RS232 terminal	6	DeviceNet terminal
3	Indicator lights	7	DeviceNet address
4	LED display		

6.3.1 Indicator Light Definitions

Table 45: Indicator Light Definitions

Indicators	Status	Description
MS	Off	No power supply or indicators are not working normally.
	Green on	Working normally.
	Green blinking	Not correctly configured.
	Red blinking	Modbus communication faults (such as no slave station can be scanned).
	Red on	Error occurred. Contact support.
	Red+Green blinking	Self-testing is ongoing.
NS	Off	The repetitive MAC ID detection is not successful or no power supply.
	Green blinking	The devices are online but there are no connections established.
	Green on	The devices are online and there are connections established.
	Red blinking	One or more I/O connections have timed out.
	Red on	The device detects errors and cannot communicate, such as there is repetitive DeviceNet address on the network.
RX	Green blinking	Serial port is receiving data.

Indicators	Status	Description
	Off	Serial port is not receiving data.
TX	Red blinking	Serial port is sending data.
	Off	Serial port is not sending data.

6.3.2 LED Display

When the gateway is starting up, the LED display shows the current DeviceNet™ baud rate setting.

When the gateway is running, the LED display shows the DeviceNet™ address.

6.3.3 DIP Switch

The DIP switch has 3 functions.

- Modify DeviceNet™ baud rate
- Set working mode: Configuration and run mode are optional. In configuration mode, the LED display shows “CF”.
- Set debugging: Debug and normal mode are optional. Use the debugging mode to debug Modbus network data communications. In debugging mode, the LED display shows “db”.

The priority of configuration mode is higher than debugging. When configuring the gateway, set the debug switch to normal. When debugging the gateway, set the mode switch to run. The status setting switches are at the bottom of the gateway.

If the status switch settings are changed, restart the gateway (power off, and power on) to make the settings take effect.

Table 46: DIP Switch Settings

Switch	4	3	2	1
Setting	(Baud Rate)		(Mode)	(Debug)
1	11: Automatic		Config	Debug
0	10: 500 kbit/s 01: 250 kbit/s 00: 125 kbit/s		Run	Normal

6.3.4 DeviceNet™ Address Switches

Set the DeviceNet™ address by rotating the switches. The DeviceNet™ address is calculated as follows:

- DeviceNet™ address = (A × 10) + (B × 1)

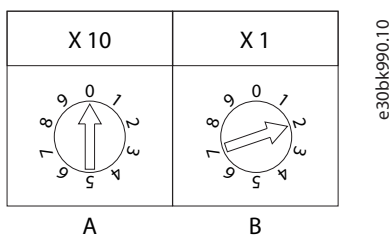


Illustration 26: DeviceNet™ Address Switches

6.3.5 RS485 Terminal

The RS485 interface uses an open 3-pin pluggable terminal.

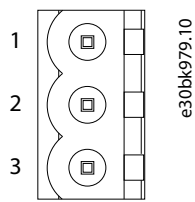


Illustration 27: RS485 Terminal Pinout

Table 47: RS485 Terminal Specification

Pin	Function
1	GND
2	B-, RS485
3	A+, RS485

6.3.6 RS232 Terminal

The RS232 interface uses an open 3-pin pluggable terminal.

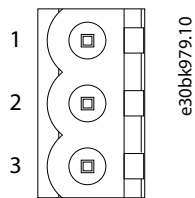


Illustration 28: RS232 Terminal Pinout

Table 48: RS232 Terminal Specification

Pin	Function
1	RX, connects to RX of user device RS232
2	TX, connects to TX of user device RS232
3	GND, connects to GND of user device GND

6.3.7 DeviceNet™ Terminal

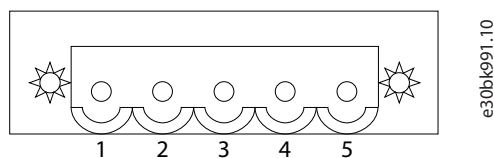


Illustration 29: DeviceNet™ Terminal Pinout

Table 49: DeviceNet™ Terminal Specification

Pin	Wiring
1	GND (24 V)
2	CAN-
3	Shielding
4	CAN+
5	+24 V

6.4 Quick Start Guide

6.4.1 Connection

Procedure

1. Before connecting the DeviceNet™ master, set the DeviceNet™ address with the rotary switches on the gateway.

The range of the effective address is 0–63. See the calculation method of the address in [6.3.4 DeviceNet™ Address Switches](#).
 When using the rotary switches to modify the DeviceNet™ address, restart the gateway for the new address to take effect. To supply power to this module, the LED shows a blinking “bT”, and then shows “12”, “25”, or “50”, respectively indicating 125 kbit/s, 250 kbit/s, and 500 kbit/s. Finally, it shows the set DeviceNet address. When the baud rate is set to Automatic baud rate sensing state, and if there is no other CAN node on the network to send data, it shows “bT”.

2. Set the DeviceNet™ baud rate with the DIP switches below the gateway.

See the instructions in [6.3.3 DIP Switch](#).

3. Connect the RS485/RS232 and DeviceNet™ interfaces.

See [6.3.5 RS485 Terminal](#) and [6.3.6 RS232 Terminal](#).
 The RS232 interface is a specialized configuration interface. In configuration mode, pay special attention to the wiring.

4. Power on.

↻ The module enters Run mode (DIP switch 2 = Off).
 Note the settings of the other DIP switches. See [6.3.3 DIP Switch](#).

6.4.2 Configuration

Use the configuration software SST-MD-CFG.

Procedure

1. Set the DIP switch 2 to "On".
2. Power on.

↻ The LED display shows “CF”, which means that the gateway is in the configuration state.

3. Open the SST-MD-CFG software on a PC.

When using the gateway for the first time, click the *Upload* button to upload the example configuration for reference.

4. Click *Fieldbus* in the tree view on the left and set the corresponding parameters.

Device	Configuration
Fieldbus	Type of Protocol
Subnet	DeviceNet
	DeviceNet Address(0-63)
	0
	DeviceNet Baud Rate
	Automatic
	Size of DeviceNet Input Buffer
	64
	Size of DeviceNet Output Buffer
	64

e30bk992.10

Illustration 30: Fieldbus Parameter Settings

- Click *Subnet* in the tree view on the left and set the corresponding parameters.

Device	Configuration	
Fieldbus Subnet	Protocols Mode	Modbus Master
	Baud Rate	19200
	Data Bits	8
	Parity Check	None
	Stop Bits	1
	Slave Address	
	Transmission Mode	RTU
	Response Timeout(5~60000ms)	300
	Delay Between Polls(0~2500ms)	0
	Output Mode	Change of Value
	Output Pulse(200~2500ms)	
	Scan Rate(1~255)	10
	Communication Interface	RS485
	Debug Interface	RS232

Illustration 31: Subnet Parameter Settings

- Add *Node* and *Command*.
- Fill in the *Starting Address* of the command and enter the *Number of Data* of the command.

To calculate the non-conflicting mapped memory address for each command automatically, click *Auto Mapping*. The data can also be mapped manually.

- To check the mapping address in the Conflict Detection window, click the *Conflict Detection*.
- Click *Download*.
- Select the serial port to which the gateway is connected to the computer.
- After configuring and downloading the configuration into the gateway, restart the gateway to run normally.

If the upload/download failed, check for the following issues:

- Make sure that the gateway is in configuration mode.
 - Set DIP switch 2 to "Off", and when the LED display shows "CF", the gateway is in configuration mode.
- Make sure that the RS232 port is wired correctly.
 - If necessary, try replacing the cable.
 - If a USB to RS232 connection cable is used, pay attention to the installation of the USB driver.
- Make sure that the COM port used by the computer is correct.
 - Try to reconnect using other COM ports of the computer.

6.5 Working Principle

6.5.1 Data Exchange Mode

The data exchange between Modbus and DeviceNet™ is established by mapping. The gateway has 2 data buffers:

- DeviceNet™ network input buffer
- DeviceNet™ network output buffer

Modbus read commands read the data and then write the data into the input buffer for DeviceNet™ network reading. Modbus write commands get data from the network output buffer, and then output the data to Modbus devices by writing commands.

48 commands can be configured. A Modbus command can be used to read serial Modbus registers.

If there is something wrong with Modbus communication, DeviceNet I/O data cannot be effectively collected, and the data received through I/O scanning is zero.

When the DeviceNet™ interface of the gateway receives network output data, the Modbus interface sends writing commands. After DeviceNet master station sends data, the Modbus interface of the gateway sends writing commands, and transmits data to Modbus slave devices. If the PLC is in programming mode, there is no network output data.

During the configuration of the gateway, when the polling mode of output commands is set to "Change of State", the function of the local data exchange cannot be used. Local data exchange configures writing commands to the input area (0000-3FF0).

6.5.2 Terminal Resistor

The DeviceNet™ network requires 120 Ω terminal resistors at the two end terminals of the network. Modbus also requires terminal resistors. The gateway has a terminal resistor at the side of the Modbus interface. Add a 120 Ω terminal resistor at the other side of the Modbus network.

6.5.3 I/O Configuration

DeviceNet™ input bytes can be configured as 8 bytes, 16 bytes, 32 bytes, 64 bytes, 96 bytes, 128 bytes, or 160 bytes.

DeviceNet™ output bytes can be configured as 8 bytes, 16 bytes, 32 bytes, 64 bytes, 96 bytes, and 112 bytes.

6.5.4 DeviceNet™ Parameters

- *Modbus_status*: The value shows the status of Modbus communications. If it stays zero, the Modbus communication is OK. If it is a non-zero value, the communication of the command has failed.
- *Input bytes*: Number of DeviceNet™ I/O input bytes.
- *Output bytes*: Number of DeviceNet™ I/O output bytes.

NOTICE

The parameter settings for Input bytes and Output bytes must be the same as the input/output bytes in the DeviceNet™ master scanning list, or the connection cannot be established.

- *Mod_Output_Ctrl*: Modbus output control.
 - Continuous Output
 - Disable Output
 - Output of Status Change: When the network output data has changed, Modbus commands can be sent.

NOTICE

If the output mode is set to Disable Output, the gateway does not send Modbus output commands even if it has configured Modbus output commands.

- To ensure the security of the output data, if the PLC has no effective output data, Modbus output commands are not sent. This can happen, for example, if the PLC is in programming mode or no DeviceNet™ device has been connected.

7 PROFINET I/O

7.1 Function Description

The PROFINET I/O gateway provides a connection between a PROFINET network and serial (Modbus RTU/ASCII and generic). The product has three serial interfaces, and it supports 2 kinds of serial port types: RS232 and RS485.

7.2 Specifications

- At PROFINET side, the gateway is PROFINET slave and acts as Modbus master or Modbus slave at serial side.
- Supports standard PROFINET I/O protocol.
- PROFINET:
 - Supports up to 32 slots.
 - Input/output data buffer is up to 384 bytes (the length is limited to specific PLC and PDU size of communication module).
 - The length of input/output bytes can be set by configuration software of PROFINET Master such as STEP7 or TIA Portal.
- Includes 3 serial ports. Supports RS232 and RS485 serial interfaces.
- Serial port support of the protocol type: Modbus Master, Modbus Slave, Custom Protocol, User Config.
- Serial port parameters:
 - Operation mode: Half duplex
 - Baud rate: 300, 600, 1200, 2400, 4800, 9600, 19200, 38400, 57600, and 115200 bps optional
 - Data bits: 7, 8 optional
 - Parity: None, Odd, Even, Mark, and space optional
 - Stop bits: 1, 2 optional
- Modbus master:
 - Function code: 01H, 02H, 03H, 04H, 05H, 06H, 0FH, and 10H
 - Format: RTU and ASCII
 - Function: Cycle output, forbidden output, and change of value output of write command
 - Each master can configure up to 48 Modbus commands.
 - Supports auto demotion function of Modbus commands.
 - Supports I/O status word.
- Modbus slave:
 - Function code: 03H, 04H, 06H, and 10H
 - Format: RTU and ASCII
- Power supply: 24 V DC (11–30 V DC), 250 mA (24 V DC).
- Operating temperature: -20...60 °C (-4...140 °F)
- Humidity: 5–95% (non-condensing)
- Built-in electrostatic protection: 15 kV ESD
- Communication interface isolation: 3 kV
- Dimensions (WxHxD): 34x116x108 mm (1.33x4.56x4.22 in)
- Installation: 35 mm (1.4 in) DIN rail
- Protection level: IP20

7.3 Hardware Description

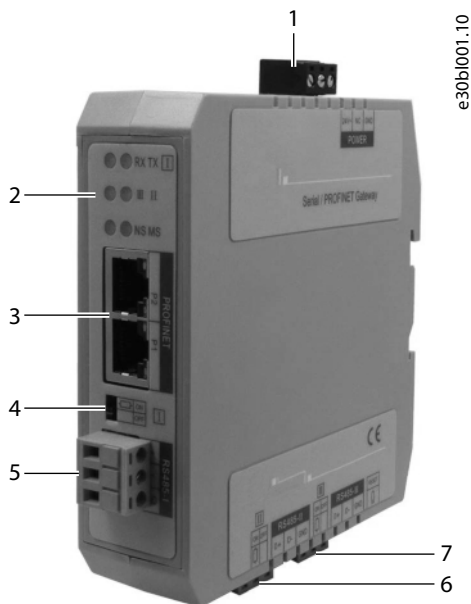


Illustration 32: Components of the PROFINET I/O Option

1	Power supply terminal	5	Serial terminal I
2	Indicator lights	6	Serial terminal II
3	Ethernet terminals	7	Serial terminal III
4	Terminal resistor switch		

7.3.1 Indicator Light Definitions

Table 50: Indicator Light Definitions

Indicators	State	Description
Serial I TX	Green blinking	Serial port sending data
	OFF	No data is sent
Serial I RX	Green blinking	Serial port receiving data
	OFF	No data is received
Serial II/III	Green blinking	Serial port sending data
	Red blinking	Serial port receiving data
	OFF	No data is sent or received
MS	See below table	
NS	See below table	

Table 51: Module and Network Indicator Light Definitions

Module indicator (MS) state	Network indicator (NS) state	Description
OFF	Red blinking	Start-up state, waiting to initialize
Green on	Red blinking	Initialization complete, but no connection yet with PLC
Green on	Green on	PLC has connected
Other	Other	Undefined state

7.3.2 Power Supply Terminal

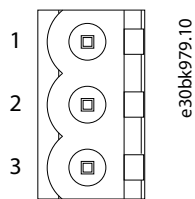


Illustration 33: Power Supply Terminal Pinout

Table 52: Power Supply Terminal Specification

Pin	Function
1	Power GND
2	Not connected
3	+24 V DC

7.3.3 Serial I/II/III Terminal

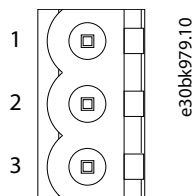


Illustration 34: Serial I/II/III Terminal Pinout

Table 53: Serial I/II/III Terminal Specification

Pin	RS485 Function	RS232 Function
1	D+, RS485 data positive	TX, RS232 data transmit (connect to RX of user device)
2	D-, RS485 data negative	RX, RS232 data receive (connect to TX of user device)
3	GND	GND (connect to user device RS232 GND)

7.3.4 RS485 Characteristics

- Network topology: Linear bus, there are active bus terminal resistors at both ends. If the communication quality is unstable, it is recommended to add terminal resistors (120 Ω, ½ W) in parallel with the 2 data wires at both ends of the bus. Serial interfaces I/II/III all have a built-in terminal resistor.
- Media: Shielded twisted-pair cable. Shielding can be canceled, depending on environmental conditions (EMC).
- Station number: 32 stations per subsection (without repeater), and can increase up to 127 stations (with repeater).
- Plug connection: 3-pin pluggable terminal. Each terminal is equipped with a 120 Ω terminal resistor switch.

- When the switch is turned on, the terminal resistance is connected.
- When the switch is turned off, the terminal resistance is disconnected.

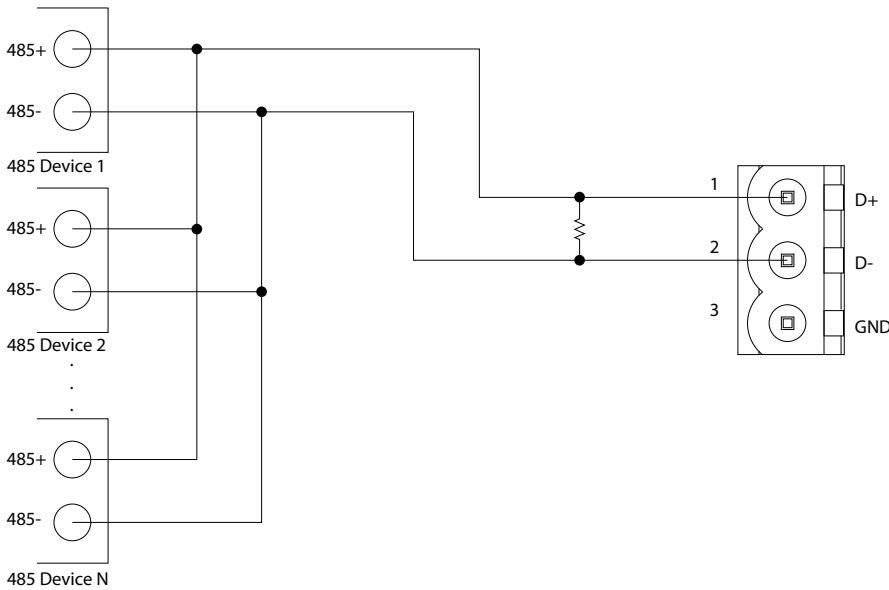


Illustration 35: RS485 Network Topology

7.3.5 Ethernet Terminals

The Ethernet interface uses an RJ45 interface and follows the IEEE802.3u 100BASE-T standard. The pinout (standard Ethernet signal) is defined in the following table.

Table 54: Ethernet Terminal Specification

Pin	Signal Description
S1	TXD+, Transmit Data+
S2	TXD-, Transmit Data-
S3	RXD+, Receive Data+
S4	Bi-directional Data+
S5	Bi-directional Data-
S6	RXD-, Receive Data-
S7	Bi-directional Data+
S8	Bi-directional Data-

7.4 Quick Start Guide

The gateway configuration in the SST-TS-CFG software must be consistent with the configuration of the PROFINET Master station.

- Device IP Address
- Device Name
- The type and order of the "PROFINET Configuration Module".

Procedure

1. Connect the network port of the gateway to the PC with a network cable for downloading the configuration.

Another network port can be connected to PROFINET master equipment such as PLC for data communication.

2. Connect the serial port of the gateway to the serial device for communication with the serial port device.
3. Connect the gateway power supply and power on.

4. Download and install the SST-TS-CFG software.
5. Build the configuration using SST-TS-CFG and download it to the gateway.
6. When the download is completed, select *Yes* when prompted to restart the gateway.
7. Install the appropriate device description file in the PROFINET configuration tool.
8. Configure the PROFINET network as required. Make sure that the configuration matches the configuration present in the gateway.

When the gateway establishes a connection with the PROFINET master, the gateway shows:

- NS green indicator = On
- MS green indicator = On

7.5 Software Configuration

7.5.1 Ethernet Configuration

- IP Address: IP address of gateway
- Subnet Mask: Subnet mask of gateway
- Gateway Address: Network gateway address for the LAN in which the gateway is located.
- Number of Input Bytes: The length of the input data that is exchanged between gateway and PLC. The length depends on the PROFINET configuration.
- Number of Output Bytes: The length of the output data that is exchanged between gateway and PLC. The length depends on the PROFINET configuration.
- PROFINET Config: Input/output bytes length of gateway. The PROFINET configuration in the gateway must match the configuration set in the PLC software of PROFINET Master station.

7.5.2 Subnet Configuration - Modbus Master

7.5.2.1 Modbus Master Configuration

- Baud Rate: 300, 600, 1200, 2400, 4800, 9600, 19200, 38400, 57600, or 115200 bps
- Data Bits: 7 or 8
- Parity Check: None, Odd, Even, Mark, or Space
- Stop Bits: 1 or 2
- Transmission Mode: RTU or ASCII
- Response Timeout: After the Modbus Master sends request, it waits the response time from the Modbus slave. The range is 300–60000 ms.
- Delay between Polls: Delay between a response has been received and sending next request. The range is 0–2500 ms.
- Output Mode:
 - Cycle: Same as Modbus read command output way, start scan output according to scan rate.
 - Forbidden: Disable output of Modbus write command.
 - Change of Value: When the output data changes, the write command is sent and stops to output when receiving the right response.
- Scan Rate: Scan Rate is the ratio of fast scan cycle to slow scan cycle. If this parameter value is set to 10, then every fast scan command is sent 10 times and slow scan commands are sent once.
- I/O Channel Status Word:
 - In Modbus Master and User Config mode (Poll mode of Output mode only), each command has 1 bit data to indicate the execution status.
 - The bit is 1 when the command status is normal, otherwise is 0.
 - The length of the status word is 2 bytes.
 - In Modbus Slave and Customer Protocol mode, the 2-byte word is used to indicate the number of times the frame has been correctly received.
- Enable Auto Demotion:

- Default value is Disable.
- When Enable Auto Demotion and a command is a fast scan command without correct response for N times, then the command demotes a slow scan command.
- This parameter is valid for Modbus Reading command and cycle Writing command.
- Auto Demotion:
 - If a fast-scan command gets an incorrect response for N times, this command is demoted to a slow-scan command.
 - The range of the parameter value is 1–255.
 - The default value is 3.
- Auto Demotion Time:
 - The amount of time a demoted command stays in slow-scan state.
 - Automatically returns to the state at the end of the time.
 - If it receives the correct response when demoted, it immediately returns to the fast-scan state.
 - The range is 100–3600000 ms.
 - The default value is 10000 ms.

7.5.2.2 Node Configuration

- Slave address:
 - Valid when the subnet protocol mode is set to “Modbus Master”.
 - The range is 0–247.

7.5.2.3 Command Configuration

Supported Command numbers: 01, 02, 03, 04, 05, 06, 15, and 16.

Command configuration parameters:

- Modbus Register Starting Address:
 - Modbus slave register or coils starting address.
 - The range of the parameter value is 0–65535.
- Numbers of Data:
 - Modbus function code 3, 4, 16: 1–127
 - Modbus function code 1, 2, 15: 1–2000
- Memory Mapped Starting Address (HEX):
 - The address range of data mapping in the module memory.
 - Read command (1, 2, 3, 4): 0x0000–0x03FF
 - Write command (5, 6, 15, 16): 0x4000–0x43FF
 - This area can also be used when write command is used as local data exchange: 0x0000–0x03FF.
- Memory Mapped Bit Offset:
 - For the bit operation command, the position where the start bit is located.
 - The range is 0–7.
- Byte Swap:
 - There are 4 modes of Byte Swap: No swap, Double-byte swap, Four-byte swap, Four-Byte Big-endian and Little-endian Swap.
 - Double-byte swap: The high and low bytes of 2 bytes (one register) are exchanged, for example, 0x1234–0x3412.
 - Four-byte swap: The first 2 bytes are exchanged with the last 2 bytes, for example, 0x12345678–0x56781234.
 - Four-byte Big-endian and Little-endian Swap: For example, 0x12345678–0x78563412.
- Scan Mode:
 - Every Modbus command can be set to fast scan or slow scan.
 - The gateway sends Modbus command according to the “Scan Rate”.
 - Scan Rate is the ratio of fast scan to slow scan (configured in the subnet configuration interface).

- Fast Output:
 - Valid only in Change of Value - write command mode.
- Response Timeout Processing:
 - The processing mode when the gateway does not receive the response within response wait time (set in "Response Timeout" of the subnet).
 - Clear: Sets the response data in the input buffer to zero.
 - Hold: The data in the input buffer remains the same.

7.5.3 Subnet Configuration - Modbus Slave

- Baud Rate: 300, 600, 1200, 2400, 4800, 9600, 19200, 38400, 57600, or 115200 bps
- Data Bits: 7 or 8
- Parity Check: None, Odd, Even, Mark, or Space
- Stop Bits: 1 or 2
- Slave Address: 0–247
- Transmission Mode: RTU or ASCII
- I/O Channel Status Word:
 - In Modbus Master and User Config mode (Poll mode of Output mode only), each command has 1 bit data to indicate the execution status.
 - The bit is 1 when the command status is normal, otherwise is 0.
 - The length of the status word is 2 bytes.
 - In Modbus Slave and Customer Protocol mode, the 2-byte word is used to indicate the number of times the frame has been correctly received.
- Byte Swap:
 - There are 4 modes of Byte Swap: No swap, Double-byte swap, Four-byte swap, and Four-Byte Big-endian and Little-endian Swap.
 - Double-byte swap: The high and low bytes of 2 bytes (one register) are exchanged, for example, 0x1234–0x3412.
 - Four-byte swap: The first 2 bytes are exchanged with the last 2 bytes, for example, 0x12345678–0x56781234.
 - Four-byte Big-endian and Little-endian Swap: for example, 0x12345678–0x78563412.

7.5.4 Subnet Configuration - Custom Protocol

- Baud Rate: 300, 600, 1200, 2400, 4800, 9600, 19200, 38400, 57600, or 115200 bps
- Data Bits: 7 or 8
- Parity Check: None, Odd, Even, Mark, or Space
- Stop Bits: 1 or 2
- I/O Channel Status Word:
 - In Modbus Master and User Config mode (Poll mode of Output mode only), each command has 1 bit data to indicate the execution status.
 - The bit is 1 when the command status is normal, otherwise is 0.
 - The length of the status word is 2 bytes.
 - In Modbus Slave and Customer Protocol mode, the 2-byte word is used to indicate the number of times the frame has been correctly received.
- Byte Swap:
 - There are 4 modes of Byte Swap: No swap, Double-byte swap, Four-byte swap, and Four-Byte Big-endian and Little-endian Swap.
 - Double-byte swap: The high and low bytes of 2 bytes (one register) are exchanged, for example, 0x1234–0x3412.
 - Four-byte swap: The first 2 bytes are exchanged with the last 2 bytes, for example, 0x12345678–0x56781234.
 - Four-byte Big-endian and Little-endian Swap: For example, 0x12345678–0x78563412.

7.5.5 Subnet Configuration - User Config

- Baud Rate: 300, 600, 1200, 2400, 4800, 9600, 19200, 38400, 57600, or 115200 bps
- Data Bits: 7 or 8
- Parity Check: None, Odd, Even, Mark, or Space
- Stop Bits: 1 or 2
- Transmission Mode:
 - RTU or ASCII
 - Valid when communication mode is poll mode.
- Response Timeout:
 - After the Modbus Master sends a request, it waits the response time of the Modbus slave.
 - The range is 300–60000 ms.
- Delay between Polls:
 - Delay between a response has been received and sending next request.
 - The range is 0–2500 ms.
 - Valid when communication is poll mode.
- Output Mode:
 - Valid when communication is poll mode.
 - Write command (command with data in request).
 - There are 3 types of output command:
 - Cycle: Same as Modbus read command (command without data in request) output way.
 - Forbidden: Disable output of Modbus write command.
 - Change of Value: When the output data change, the write command is sent, and stops to output when receiving the right response.
- Communication Mode:
 - There are two kinds of communication modes: Poll Mode and Receiving only Mode.
 - Poll Mode is similar to the Modbus communication.
 - Receiving only Mode is that the gateway only receives data.
- Time Interval Between Characters:
 - In Receiving only Mode, it is the maximum time interval between characters and used to decide whether a frame is terminated or not.
 - The range is 1–300 ms.
- Check Mode:
 - There are 3 check modes: None check, CRC check, and Sum check.
 - The check mode is effective in Receiving Only mode of communication.
- I/O Channel Status Word:
 - In Modbus Master and User Config mode (Poll mode of Output mode only), each command has 1 bit data to indicate the execution status.
 - The bit is 1 when the command status is normal, otherwise is 0.
 - The length of the status word is 2 bytes.
 - In Modbus Slave and Customer Protocol mode, the 2-byte word is used to indicate the number of times the frame has been correctly received.

7.6 Working Principle

7.6.1 Data Exchange

Mapping establishes the data conversion between PROFINET network and serial of the gateway. The gateway has two data buffers:

- Input buffer (1 kbyte) with address range 0x0000–0x03FF
- Output buffer (1 kbyte) with address range 0x4000–0x43FF

PROFINET Slave

If the configured input data length is N1, the output data length is N2. The gateway periodically sends the data within the address range of [0x0000, N1] to the PROFINET network. When receiving data from the PROFINET network, the gateway writes the data to the address range of [0x4000, 0x4000+N2].

Modbus Master

When one serial runs the Modbus master protocol, for all write registers, write coils command the gateway supports, the gateway can get data from address range 0x0000–0x03FF, 0x4000–0x43FF, and send them to the Modbus slave. For all read registers, read coils command, the gateway can write the data returned from Modbus slave to address range 0x0000–0x03FF.

Each Modbus master can configure 48 commands, and every command can get one continuous Modbus register.

Modbus Slave

When one serial runs a Modbus slave protocol, for numbers 01 and 03 commands master sent, the gateway gets data from address range 0x0000–0x03FF. For numbers 02 and 04 commands, it gets data from 0x4000–0x43FF and returns them to the Modbus master. For numbers 05, 06, 15, 16 command, it writes the Modbus master data to the address range of 0x0000–0x03FF.

Custom Protocol

When one serial runs a self-defined protocol, the serial device can read/write data to any address of two buffers of 0x0000–0x03FF and 0x4000–0x43FF.

User Config-Poll Mode

When one serial runs universal mode-ask and answer, the request part of a command can get data from any address of buffer 0x0000–0x03FF and 0x4000–0x43FF, and send data to the serial slave device. If serial slave devices do not respond, if there exists data in response, the gateway writes them to the address range of 0x0000–0x03FF. The specific data size depends on the configuration.

User Config-Receiving Only Mode

When one serial runs universal mode-receive, it receives data sent from the serial master device, and does not give any response. In this way, the gateway writes the data which it received to some address areas of 0x0000–0x03FF.

7.6.2 Custom Protocol

Definition

- User device acts as initiator, and sends output data in the request frame.
- The gateway acts as responder which sends input data in the response frame.
- Communication way is point to point.
- Time interval between bytes in request frame must be less than 50 ms, or the gateway disposes this frame data.
- For every valid request frame, the gateway must respond in 200 ms.
- Supports communication baud rate range 300–115200 bps, 8 data bits, parity (None, Odd, Even, Mark, Space), and 1 or 2 stop bits.

Communication Message Format

Request Frame Message

- [Output data length] [High byte of output data address] [Low byte of output data address] [Input data length] [High byte of input data address] [Low byte of input data address] [Output data 1]...[Output data n] [Parity]
- Output is the data that the user device writes to the gateway.
- Input is the data that the user device gets from the gateway.
- Data number n equals output data length.
- Output data address range: 0x0000–0x03FF, 0x4000–0x43FF.
- Input data address range: 0x0000–0x03FF, 0x4000–0x43FF.

Response Frame Message

- Correct response: [Input data length] [High byte of input data address] [Low byte of input data address] [Input data 1]...[Input data n] [Parity]
- Data number n equals input data length.
- Wrong response: [0x00] [0xFF] [0xFF] [error code] [parity]

Parity

- Accumulated sum of 8 bits of all data, ignore the flow bit.
- [Message parity code] = [output data length] + [high byte of output data address] + [low byte of output data address] + [input data length] + [high byte of input data address] + [low byte of input data address] + [output data 1] +...+ [output data n]
- [Response parity code] = [input data length] + [high byte of input data address] + [low byte of input data address] + [output data 1] +...+ [output data n]

Error Code

- 0x01: Output data length error
- 0x02: Accumulated sum parity error
- 0x03: Output data address error or illegal output data area
- 0x04: Input data address error or illegal input data area

7.6.3 User Config

Definition

Common-mode protocol message of the gateway can be set freely, which solves the communication problem between Modbus standard protocol and Modbus nonstandard protocol devices. There are two operation modes under common mode: POLL and READ.

The working principle of POLL mode is similar with Modbus communication protocol, which uses request and response communication way and every subnet can set 30 commands under common mode.

READ mode only receives stored data and does not respond after receiving data, such as bar code scanner and device communication.

User Configuration - POLL Mode

Before using common mode-POLL, configure the request message and response message.

- Frame header: HEX input, maximum bytes number: 8
- Data: HEX input, every item occupies 2 bytes
- Constant: HEX input, maximum bytes number: 8
- Parity: None, CRC check, LRC check, Sum check
- End of Frame: HEX input, maximum bytes number: 3
- Send order in RTU format: header, data, constant, parity, and end
- Receive order in RTU format: header, data, constant, parity, and end
- Send order in ASCII format: header, constant, data, parity, and end
- Receive order in ASCII format: header, constant, data, parity, and end

User Configuration - Receiving only Mode

Receiving only Mode only receives data and does not respond. Each subnet of receiving only mode has 16 group data receiving buffer and receiving data buffer of each group is 255 bytes.

Communication way: One subnet of the gateway is configured as user config-read and connects to the communication device. Another subnet is configured as Modbus slave and connects to the gateway with Modbus master. Modbus master uses 04H function code to read the data beginning from register 0. Register 0 is a transaction sequence number. Every time it reads a new message, the transaction number increases by 1 and it recycles from 0 to 255. Registers 1-n are the data which they receive from the communication device. The specific number of data depends on Modbus master configuration. The maximum valid bytes is 255.

If only one serial port is configured as receiving only mode, this serial writes the data it read to the address range 0x000-0x0FF. If more than 1 serial port is configured as receiving only mode, the mapping address range by size according to the subnet number is: 0x000-0x0FF, 0x100-0x1FF, and 0x200-0x2FF.

8 EtherNet/IP™

8.1 Installation

8.1.1 EtherNet/IP™ Device

The EtherNet/IP™ (EIP) device allows you to build linear topology, ring topology, and star topology networks. The EIP device includes the EIP Builder software, EIP Scanner, EIP Adapter, EIP Tap, and an Ethernet switch. The EIP Scanners and EIP Adapters are single port devices.

8.1.2 Network Cable Installation

Each EtherNet/IP™ device is connected to an Ethernet switch with a CAT 5e cable.

You can use a single port device to build up either a linear or a star network topology. An Ethernet switch and an Ethernet tab are required to create a star topology.



Illustration 36: Linear Topology

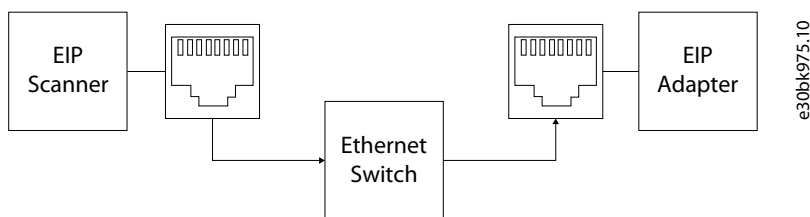


Illustration 37: Star Topology

8.1.3 Setting the IP Address with HMI

Procedure

1. To access the *IP Setting* menu, Select *Setup* → *Commissioning* → *Ethernet setting*.
2. Set the Ethernet address.

IP address: 192.168.1.5 (configurable)
Port: 502

3. Select *Save*.
4. Execute Stop-Run operation on the external communication PLC.

After saving, the Stop-Run operation must be performed before setting the Ethernet address again.

8.1.4 Network Communication Parameter Setting

Install the EIP editing software on a PC to monitor and configure the EIP devices and use a switch to connect to the EIP Scanner and EIP Adapter.

In ISPSOFT you can edit, upload, download, and monitor PLC CPU programs through Ethernet communication. Refer to the ISPSOFT User Manual for more details. Go to ISPSOFT -> Help -> ISPSOFT User Index and then find section concerning Communication Parameter Setting – Ethernet for more details.

8.1.5 Network Security

To enhance security and performance of the system, use a closed network or LAN with firewall protection to prevent cyber-attacks.

8.2 Specifications

8.2.1 Ethernet Specification

Table 55: Ethernet Specification

Item	Specification
Communication Protocols	EtherNet/IP™ Scanner/Adapter, Modbus TCP
Protocols	BOOTP, DHCP, SMTP, NTP, Socket, HTTP
Communication Speed	10/100 Mbps Auto-detection
Communication Interface	RJ45 with Auto MDI/MDIX
Numbers of the Ethernet Port	1

8.2.2 Ethernet/IP™ Specification

Table 56: Ethernet/IP™ Specification

Item	Scanner	Adapter	
General	Device type	Scanner/Adapter	
	Topology type	Star topology	
CIP Network I/O Connection	CIP connection number (data exchange)	32	8
	TCP connection number	16 (Clients + Servers)	
	Requested Packet Interval (RPI)	5–1000 ms	
	Maximum Transmission Speed	3000 pps	
	Maximum Data Length/per transmission	500 bytes	
	Supported devices, registers, and flags	FMV1.08 or previous versions: D FW V1.10 or later: D/M ⁽¹⁾	D, X, Y, SR
CIP Network Explicit Message	Class 3 (Connected Type)	16	8
	UCMM (Non-Connected Type, only uses TCP connections)	Total 16 (for all connection types)	
	CIP Objects	Identity Object (16#01) Message Router Object (16#02) Assembly Object (16#04) Connection Manager Object (16#06) Port Object (16#F4) TCP/IP Interface Object (16#F5) Ethernet Link Object (16#F6)	
CIP Network Tag	Maximum Consumed Tag Number	32	
	Maximum Produced Tag Number	32	
	Maximum Data Length	500 bytes (I/O Connection)	

Item	Scanner	Adapter
	400 bytes (Explicit Message) ⁽²⁾	
	Requested Packet Interval (RPI)	
	5–1000 ms	

¹ Using device D or device M takes 2 bytes (16 bits) as a unit in data length for I/O connections, for example M0 to M15 (16 bits), or M12 to M43 (32 bits). If you must store the data of 200 bits from M100, the data length must be set in a value larger than 200 bits, and in bytes it is 26 bytes (26 bytes = 208 bits). The actual devices to be mapped are M100 to M307. D0.0 is stored in M100 (the first bit).

² Array-typed tags are NOT supported in explicit messages.

Maximum number of connections when using the PLC to connect to other devices through Ethernet/IP™:

- The PLC can act as a Scanner and an Adapter simultaneously. It can be connected up to 16 devices (for example 8 Scanners and 8 Adapters).
- When the PLC acts as a Scanner, it can connect to up to 16 devices. Each device can establish up to 32 connections for data exchange. Data exchange types can be I/O connection and Consumed Tag. You can use explicit message for data exchange at the same time, up to 16 explicit message connections can be created.
- When the PLC acts as an Adapter, it can connect to up to 16 devices. Each device can establish up to 8 connections for data exchange. Data exchange types can be I/O connection and Produced Tag. You can use explicit message for data exchange at the same time, up to 8 explicit message connections can be created.

8.2.3 Communication Port Pin Assignment

The EtherNet/IP™ device uses CAT5e industrial Ethernet cables and can be connected via RJ45 communication port.

Table 57: Communication Port Pin Assignment

Pin	Signal	Description
1	Tx+	Transmit plus
2	Tx-	Transmit negative
3	Rx+	Receive plus
4	-	N/C
5	-	N/C
6	Rx-	Receive negative
7	-	N/C
8	-	N/C

8.2.4 Communication Indicator Light

The indicator light is at the RJ45 connection of the EtherNet/IP™ device.

Table 58: Communication Indicator Light Specification

LED Indicator	LED Status	Description
LINK (green)	ON	Communication port is connected. Connected to Ethernet.
	OFF	Communication port is not connected. Not Connected to Ethernet.
ACK (yellow)	Blinking	Packets transmitting/receiving.

LED Indicator	LED Status	Description
		Packets transmitting/receiving over Ethernet.
	OFF	No packets transmitting/receiving. No packets transmitting/receiving over Ethernet.

8.3 EtherNet/IP™ Software

EtherNet/IP™ related parameters are set through HWCONFIG, which is embedded in ISPSOFT.

HWCONFIG provides a graphical user interface, which shows the devices and their EtherNet/IP connections in the Network View.

8.3.1 Running HWCONFIG via an EtherNet/IP™ Scanner

Run HWCONFIG from the ISPSOFT project of the EIP Scanner. The EIP Scanner is the EtherNet/IP™ communication PLC and the EIP module. When using an EIP Scanner, an EIP module is set up through HWCONFIG in ISPSOFT. Make sure that the current communication is via Ethernet in ISPSOFT.

Procedure

1. Open COMMGR.
2. Add a Driver with Type: Ethernet.
3. Search for IP addresses of the current devices.
4. Open ISPSOFT.
5. Select *Tools -> Communication Settings*.
6. Select the previously set Ethernet driver and the IP address.
7. Create a project. In the *File* menu, select *New* to show the *Create a New Project* dialog box.
8. Select a PLC. In the *Create a New Project* dialog box, select a PLC that supports EtherNet/IP™.
9. Open HWCONFIG by double-clicking HWCONFIG in the *Project* window.
10. Upload the settings to HWCONFIG. Select *Upload* to copy the parameters from the PLC to HWCONFIG.

If there are any changes on the module configuration, use *Scan* to update the parameters in HWCONFIG.

11. Save and download the settings from HWCONFIG. In the *File* menu, select *Save* to save the settings and then click the *Download* button on the toolbar to download the file to the PLC.

The configuration must be saved in HWCONFIG before opening the other communication tools. It is not possible to work in HWCONFIG while working in the communication tools.

12. Open the EtherNet/IP™ editing page. To see the *EtherNet/IP* button, right-click the CPU module in the system configuration area. Click the button to open the EtherNet/IP™ editing page.

8.3.2 Adding Devices

Add devices manually or by scanning the network. When the devices are added, create the network, and set the parameters.

8.3.2.1 Adding Devices Manually

1. Select the devices to be added from the Product List. You can also enter the module name in the search bar. Drag the device onto the Network View.
2. To edit the IP address, double-click the IP address of the added device.

8.3.2.2 Adding Devices by Scanning the Network

1. To scan the network, click the *Scan* button. The scanned devices are shown in the Adapter Scan.
2. Select the devices, and then click OK to add the selected devices to the Network view.

8.3.2.3 Creating the Network

1. To create a connection, drag the Ethernet communication port of the device to the network.
2. To see the *Fast Connect* option, right-click on the blank area. Click it to see a list of available devices. Select the ones to be added. Multiple devices can be added at the same time to the network.

- Once the connection is established, click the network line "Network_0" to see all the connected devices in this network in the Information window.

8.3.2.4 Setting the Parameters

To view and edit the *Data Exchange*, *Information*, and the *Device Parameter*, click the tabs in the Information window.

Data Exchange

The tab is functional only when the selected device is an EIP Scanner.

Information/EIP Parameter

When offline, this tab is shown as *Information*. Check the information in the EDS file. When adding an EIP Adapter, set up the IP address of the device here.

When the device is connected, this tab is shown as EIP Parameter. To upload the related parameters from the device, click the *Upload* button. To download the related parameters to the device, click the *Download* button.

8.3.3 Diagnosis

HWCONFIG provides diagnostic information on the connection and data exchange status. For the connection status, refer to the Adapter connection status and indicator. For data exchange status and error codes, refer to the Data Exchange tab.

To view the connection status information, click *On-line Mode* on the tool bar. Check the device status from the indicators. See, for example, the RUN/STOP and Error indicators for the PLC.

The connection status is the network connection status. It has nothing to do with EtherNet/IP data exchange. HWCONFIG sends an ICMP request (ping) to devices, and if nothing returns, it is seen as disconnected from the network. A connection error is shown with a dotted line and a warning sign.

8.4 Parameter Addresses

Table 59: Parameter EtherNet/IP Addresses

-	EN	Address	Data Format	Data description
MVD input parameters				
1	Input voltage (V)	D257	Word	
2	Input current (A)	D259	Word	
3	Reference speed (RPM)	D262	Word	
4	Reference Frequency (0.01 Hz)	D264	Word	
5	Input power (kVA)	D261	Word	
MVD output parameters				
1	Output voltage (V)	D258	Word	
2	Output current (A)	D260	Word	
3	Output speed (RPM)	D263	Word	
4	Output Frequency (0.01 Hz)	D265	Word	
Transformer Temperature				
1	Transformer temperature T31 A (0.1 °C)	D266	Word	
2	Transformer temperature T31 B (0.1 °C)	D267	Word	
3	Transformer temperature T31 C (0.1 °C)	D268	Word	
System status				
1	bit0: Startup ready	D256	Word	"1" is ok

-	EN	Address	Data Format	Data description
	bit1: VFD running bit2: Reserved bit3: Local/Remote bit4: Fault bit5: Alarm bit6: Reserved bit7: MCB closed bit8: Reserved bit9: MCB Close allowed bit10: Reserved bit11: Reserved bit12: Reserved bit13: Reserved bit14: Reserved bit15: Reserved			
Command				
1	VFD start	D0	Word	bit0: 2 s Rising edge pulse
2	VFD coast stop	D0	Word	bit1: 2 s Rising edge pulse
3	VFD ramp stop	D0	Word	bit2: 2 s Rising edge pulse
4	System reset	D0	Word	bit3: 2 s Rising edge pulse
5	Reference speed (RPM)	D1	Word	
6	Reference Frequency (0.01 Hz)	D2	Word	
System alarm/fault				
1	bit0: Input overcurrent (Software) bit1: Input Phase Loss bit2: Input Power Loss bit3: Input undervoltage bit4: Input overvoltage bit5: Input Grounding bit6: Input Sequence Fault bit7: Reserved bit8: Output overcurrent (Software) bit9: Output Over Load bit10: Output Phase Loss bit11: Output Grounding bit12: Output Phase Imbalance Alarm bit13: Output Phase Imbalance Fault bit14: Output Under Load bit15: Electronic Motor Thermal Protection	D272	Word	"1" is fault, "0" is ok
2	bit0: Motor Stall	D273	Word	"1" is fault, "0" is ok

-	EN	Address	Data Format	Data description
	bit1: Motor Reverse bit2: Motor Over Speed bit3: Motor Under Speed bit4: Analog Reference Loss bit5: Encoder Abnormal bit6: Input overcurrent (Hardware) bit7: Output overcurrent (Hardware) bit8: External Fault bit9: Current Sensor Power Fault bit10: Fault Code Query Failure bit11: Bypassed Cell Quantity Over Limit bit12: Power On With MCB Signal Loss bit13: Reserved bit14: Transformer Temperature Sensor Loss bit15: Reserved			
3	bit0: Auto Tuning Failure bit1: Flying Start Failure bit2: Automatic Restart Failure bit3: Synchronous Transfer Failure bit4: Reserved bit5: Reserved bit6: Failure Of Motor Selection bit7: LVRT Failure bit8: Reserved bit9: Bypass Derating Failure bit10: Input Current Sampling Fault bit11: Output Current Sampling Fault bit12: Power Cell Overload bit13: Software And Hardware Versions Are Inconsistent bit14: Software And Hardware Versions Are Incompatible bit15: Switch of Synchronous transfer Action Failure	D274	Word	"1" is fault, "0" is ok
4	bit0: External/Customer Control Power Loss bit1: Internal Control Power Loss bit2: PLC Battery Voltage Low bit3: UPS undervoltage bit4: Control Power Loss Overtime bit5: UPS undervoltage Overtime bit6: HV Cabinet Door Open bit7: Air Filter Clogged bit8: Cooling Fan Abnormal bit9: Fan Internal Power Loss bit10: Fan External Power Loss bit11: Transformer T31 overtemperature Alarm bit12: Transformer T31 overtemperature Fault bit13: Transformer T31 Temperature Sensor Loss bit14: Emergency Stop bit15: Remote Emergency Stop	D275	Word	"1" is fault, "0" is ok

-	EN	Address	Data Format	Data description
5	bit0: PLC-DSP Communication Failure bit1: PLC-HMI Communication Failure bit2: DSP Fault(X1.1) bit3: DSP Alarm(X1.2) bit4: DSP Bypass(X1.4) bit5: DSP Trip(X1.5) bit6: Upstream Main Circuit Breaker Abnormal Open bit7: Upstream Main Circuit Breaker Close Failure bit8: Upstream Main Circuit Breaker Open Failure bit9: KM41 Close Failure bit10: KM41 Open Failure bit11: KM42 Close Failure bit12: KM42 Open Failure bit13: KM43 Close Failure bit14: KM43 Open Failure bit15: Startup Cabinet Switch Abnormal Open	D276	Word	"1" is fault, "0" is ok
6	bit0: Startup Cabinet Switch Open Failure bit1: Startup Cabinet Switch Close Failure bit2: Minimum Precharge Waiting Time Not Reached! bit3: No start-up Cabinet Switch Close Command bit4: DSP Trip(COM) bit5: DSP Bypass(COM) bit6: Reserved bit7: Reserved bit8: Reserved bit9: Reserved bit10: Reserved bit11: Reserved bit12: Reserved bit13: Reserved bit14: Reserved bit15: Reserved	D277	Word	"1" is fault, "0" is ok
7	bit0: Reserved bit1: Reserved bit2: Cooling Fan21 Failure bit3: Cooling Fan22 Failure bit4: Cooling Fan23 Failure bit5: Cooling Fan24 Failure bit6: Cooling Fan25 Failure bit7: Cooling Fan26 Failure bit8: Cooling Fan27 Failure bit9: Cooling Fan28 Failure bit10: Cooling Fan29 Failure bit11: Number of Cooling Fan For Power Cell Cabinet is Insufficient bit12: Cooling Fan31 Failure bit13: Cooling Fan32 Failure bit14: Cooling Fan33 Failure	D278	Word	"1" is fault, "0" is ok

-	EN	Address	Data Format	Data description
	bit15: Cooling Fan34 Failure			
8	bit0: Cooling Fan35 Failure bit1: Number of Cooling Fan For Transformer T31 Cabinet Is Insufficient bit2: Cooling Fan36 Failure bit3: Cooling Fan37 Failure bit4: Cooling Fan38 Failure bit5: Cooling Fan39 Failure bit6: Cooling Fan310 Failure bit7: Number of Cooling Fan For Transformer T32 Cabinet Is Insufficient bit8: Cooling Fan71 Failure bit9: Cooling Fan72 Failure bit10: Number of Cooling Fan For Filter Cabinet Is Insufficient bit11: Cooling Fan81 Failure bit12: Cooling Fan82 Failure bit13: Number of Cooling Fan For Reactance Cabinet Is Insufficient bit14: Reserved bit15: Reserved	D279	Word	"1" is fault, "0" is ok
9	bit0: Reserved bit1: Reserved bit2: Reserved bit3: KM41 Abnormal Close bit4: KM42 Abnormal Close bit5: KM43 Abnormal Close bit6: KM43 Abnormal Open bit7: Auto Bypass Transfer Failure bit8: Start Overtime bit9: KM41 Abnormal Open bit10: KM42 Abnormal Open bit11: QS41 Abnormal Open bit12: QS42 Abnormal Open bit13: Auto Bypass Condition Is Not Satisfied bit14: Auto Grid To VFD Overtime bit15: Synchronous Transfer Overtime	D280	Word	"1" is fault, "0" is ok
10	bit0: Speed Stable Timeout bit1: Voltage Synchronize Timeout bit2: Current Stable Timeout bit3: System is Not Running bit4: System is Running bit5: System is During Input undervoltage Derating bit6: System is During Low Voltage Ride Through bit7: Bypassed Cell Quantity Over Limit bit8: Reserved bit9: Reserved bit10: Reserved bit11: Reserved bit12: Reserved bit13: Reserved	D281	Word	"1" is fault, "0" is ok

-	EN	Address	Data Format	Data description
	bit14: Reserved bit15: Reserved			
11	Reserved	D282	Word	
12	bit0: External Fault bit1: Arc Flash Relay Error bit2: Arc Flash Relay Tripped bit3: Transformer T32 overtemperature Alarm bit4: Transformer T32 overtemperature Fault bit5: Transformer T32 Temperature Sensor Loss bit6: Filter Cabinet overtemperature bit7: Reactance Cabinet overtemperature bit8: Motor Winding overtemperature bit9: Motor Winding Ultra overtemperature bit10: Motor Bearing overtemperature bit11: Motor Bearing Ultra overtemperature bit12: Motor Temperature Sensor Loss bit13: Control Cabinet Low Temperature Alarm, MCB Close Forbidden bit14: Control Cabinet Low Temperature Fault bit15: Control Cabinet Temperature Sensor Loss	D283	Word	"1" is fault, "0" is ok
13	bit0: Control Cabinet overtemperature Alarm bit1: Control Cabinet overtemperature Fault bit2: Control Cabinet Temperature Sensor Loss bit3: Control Cabinet cooling Fan Power Loss bit4: PLC Module Error bit5: PLC Remote Module Error bit6: PID Analog Feedback Loss bit7: Reserved bit8: Control Cabinet Low Temperature Alarm, Start Forbidden bit9: Remote Signal Select Motor Failure bit10: Remote Signal Select Motor Direction Failure bit11: Remote Signal Select Motor Speed Ramps Failure bit12: Control Cabinet Low Temperature Alarm bit13: Reserved bit14: Reserved bit15: Reserved	D284	Word	"1" is fault, "0" is ok
14	bit0: KM42 Abnormal Open (DSP) bit1: KM42 Abnormal Close (DSP) bit2: KM43 Abnormal Open (DSP) bit3: KM43 Abnormal Close (DSP) bit4: Reserved bit5: Reserved bit6: Reserved bit7: Reserved bit8: Reserved bit9: Reserved bit10: Reserved bit11: Reserved	D285	Word	"1" is fault, "0" is ok

-	EN	Address	Data Format	Data description
	bit12: Reserved bit13: Reserved bit14: Reserved bit15: Reserved			
15	bit0: Reserved bit1: Reserved bit2: KM42 Close Failure (DSP) bit3: KM42 Open Failure (DSP) bit4: KM3 Close Failure (DSP) bit5: KM3 Open Failure (DSP) bit6: KM43 Close Failure (DSP) bit7: KM43 Open Failure (DSP) bit8: Reserved bit9: Reserved bit10: Reserved bit11: Reserved bit12: Reserved bit13: Reserved bit14: Reserved bit15: Reserved	D286	Word	"1" is fault, "0" is ok
Power cell alarm/fault				
	U1	D296	Word	For fault/alarm descriptions, refer to HMI.
	V1	D297	Word	
	W1	D298	Word	
	U2	D299	Word	
	V2	D300	Word	
	W2	D301	Word	
	U3	D302	Word	
	V3	D303	Word	
	W3	D304	Word	
	U4	D305	Word	
	V4	D306	Word	
	W4	D307	Word	
	U5	D308	Word	
	V5	D309	Word	
	W5	D310	Word	
	U6	D311	Word	
	V6	D312	Word	

-	EN	Address	Data Format	Data description
	W6	D313	Word	
	U7	D314	Word	
	V7	D315	Word	
	W7	D316	Word	
	U8	D317	Word	
	V8	D318	Word	
	W8	D319	Word	
	U9	D320	Word	
	V9	D321	Word	
	W9	D322	Word	
	U10	D323	Word	
	V10	D324	Word	
	W10	D325	Word	
Power cell bus voltage (V)				
	U1	D326	Word	
	V1	D327	Word	
	W1	D328	Word	
	U2	D329	Word	
	V2	D330	Word	
	W2	D331	Word	
	U3	D332	Word	
	V3	D333	Word	
	W3	D334	Word	
	U4	D335	Word	
	V4	D336	Word	
	W4	D337	Word	
	U5	D338	Word	
	V5	D339	Word	
	W5	D340	Word	
	U6	D341	Word	
	V6	D342	Word	
	W6	D343	Word	

-	EN	Address	Data Format	Data description
	U7	D344	Word	
	V7	D345	Word	
	W7	D346	Word	
	U8	D347	Word	
	V8	D348	Word	
	W8	D349	Word	
	U9	D350	Word	
	V9	D351	Word	
	W9	D352	Word	
	U10	D353	Word	
	V10	D354	Word	
	W10	D355	Word	

8.5 Troubleshooting

8.5.1 Error Code Classification

There are two types of error code categories:

- Configuration errors
- Application errors

These error codes are defined by the ODVA for EtherNet/IP errors. Refer to the following table for the error codes. Only the last 2 bytes of the error code are shown. For example, only 011C appears for the error code H'1101011C.

Table 60: Error Code Classification

1st Phase category	2nd Phase item	Description
Configuration error	EDS files mismatched	Mismatched EDS files lead to I/O connection failure.
	Data exchange setup error	Data exchange setup error lead to I/O connection failure.
Application error	EtherNet/IP error	EtherNet/IP communication failure

8.5.2 Configuration Errors

Table 61: Configuration Error Descriptions

Category	Error code	Description	Troubleshooting
EDS Files Mismatched	H'1101011C	The Transport Class field values of the Transport Class and Trigger in the EDS file are mismatched.	Check if the product information and the EDS file match. Reload the EDS file. Ask the vendor of the device for the EDS file.
	H'11010114	The Vendor ID or the Product Code in the EDS file is mismatched.	

Category	Error code	Description	Troubleshooting
	H'11010115	The device type parameters in the EDS file are mismatched.	
	H'11010116	The revision parameters in the EDS file are mismatched.	
	H'1101011E	The direction parameters in the EDS file are mismatched.	
	H'1101011F	The fixed/variable output flag in the EDS file is mismatched.	
	H'11010120	The fixed/variable input flag in the EDS file is mismatched.	
	H'11010121	The output priority in the EDS file is mismatched.	
	H'11010122	The input priority in the EDS file is mismatched.	
	H'11010123	The output connection type parameters in the EDS file are mismatched.	
	H'11010124	The input connection type parameters in the EDS file are mismatched.	
	H'11010125	The redundant ownership output parameters in the EDS file are mismatched.	
	H'11010126	The configuration size parameters in the EDS file are mismatched.	
	H'11010129	The configuration path parameters in the EDS file are mismatched.	
	H'11010132	The EDS file does not support Null forward open.	
Data Exchange Setup Error	H'12010100	I/O connections duplicated	Check if the system has created the I/O connections. Change the connection type to Listen Only.
	H'12010106	Scanner ownership of I/O connections conflicts	Check the scanner owner. Reconfigure the invalid scanner. Change the connection to multicast.
	H'12010110	Incorrect adapter configuration	Check the I/O connection status. Activate the I/O connections again.
	H'12010111	Adapter RPI not supported	Check the RPI for the adapter.
	H'12010113	Insufficient I/O connections	Check if the number of connections exceeds the limit. Reduce the number of the product connections.

Category	Error code	Description	Troubleshooting
	H'12010119	The connection of non-Listen only is not established.	Check if the system has created the I/O connections. Check the scanner I/O connection status.
	H'12010127	Incorrect adapter input size	Check the module number and the product setup file, and see if they match.
	H'12010128	Incorrect adapter output size	Check the output size in the connection parameters.
	H'1201012D	Consumed Tag does not exist.	Check if the parameters in the Consumed tag are set correctly.
	H'1201012E	Produced Tag does not exist.	Check if the parameters in the Produced tag are set correctly.
	H'12010204	I/O connection connecting timeout	No response from the adapter; check if the power and the network connection for the adapter are working properly.
	H'12010302	Network bandwidth NOT available for data	Check the I/O connection limit between the scanner and the adapter. Increase the RPI value or reduce the number of connections.
	H'12010315	Incorrect adapter input/output- tinstance	Check the module number and the product setup file, and see if they match.

8.5.3 Application Error

Table 62: Application Error Description

Category	Error Code	Description	Troubleshooting
EtherNet/IP Error	H'00010203	I/O connection timeout	Check the network connection status. Check if the module is working properly. Increase the RPI value.

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