Honeywell

Installation and
User Manual

62-0351-01

Modbus protocol

for Variable Frequency Drives

INDEX

1.   Safety

This manual contains clearly marked cautions and warnings which are intended for your personal safety and to avoid any unintentional damage to the product or connected appliances.

Please read the information included in cautions and warnings carefully.

The cautions and warnings are marked as follows:

⚠	**= DANGER! Dangerous voltage**
⚠	**= WARNING or CAUTION**
⚠	**= Caution! Hot surface**

Table 1. Warning signs

1.1   Danger

⚠	The **components of the power unit of drive are live** when the AC drive is connected to mains potential. Coming into contact with this voltage is **extremely dangerous** and may cause death or severe injury.
⚠	The **motor terminals U, V, W and the brake resistor terminals are live** when drive is connected to mains, even if the motor is not running.
⚠	**After disconnecting** the AC drive from the mains, **wait** until the indicators on the keypad go out (if no keypad is attached see the indicators on the cover). Wait 5 more minutes before doing any work on the connections of drive. Do not open the cover before this time has expired. After expiration of this time, use a measuring equipment to absolutely ensure that no voltage is present. **Always ensure absence of voltage before starting any electrical work!**
⚠	The control I/O-terminals are isolated from the mains potential. However, the **relay outputs and other I/O-terminals may have a dangerous control voltage** present even when drive is disconnected from mains.
⚠	**Before connecting** the AC drive to mains make sure that the front and cable covers of drive are closed.
⚠	During a ramp stop (see the Application Manual), the motor is still generating voltage to the drive. Therefore, do not touch the components of the AC drive before the motor has completely stopped. Wait until the indicators on the keypad go out (if no keypad is attached see the indicators on the cover). Wait additional 5 minutes before starting any work on the drive.

1.2   Warnings

⚠	Drive is meant for **fixed installations only**.
⚠	**Do not perform any measurements** when the AC drive is connected to the mains.
⚠	The **ground leakage current** of drives exceeds 3.5mA AC. According to standard EN61800-5-1, **a reinforced protective ground connection** must be ensured. See chapter 1.3.
⚠	If the AC drive is used as a part of a machine, the **machine manufacturer is responsible** for providing the machine with a **supply disconnecting device** (EN 60204-1).
⚠	Only **spare parts** delivered by Honeywell can be used.
⚠	At power-up, power brake or fault reset **the motor will start immediately** if the start signal is active, unless the pulse control for Start/Stop logic has been selected. Futhermore, the I/O functionalities (including start inputs) may change if parameters, applications or software are changed.Disconnect, therefore, the motor if an unexpected start can cause danger.
⚠	The **motor starts automatically** after automatic fault reset if the auto restart function is activated. See the Application Manual for more detailed information.
⚠	**Prior to measurements on the motor or the motor cable**, disconnect the motor cable from the AC drive.
⚠	**Do not touch the components on the circuit boards**. Static voltage discharge may damage the components.
⚠	Check that the **EMC level** of the AC drive corresponds to the requirements of your supply network.

1.3   Grounding and ground fault protection

⚠	**CAUTION!**

The drive must always be earthed with an grounding conductor connected to the grounding terminal marked with ⏚.

The ground leakage current of drive exceeds 3.5mA AC. According to EN61800-5-1, one or more of the following conditions for the associated protective circuit shall be satisfied:

a) The protective conductor shall have a cross-sectional area of at least 10 mm^2 Cu or 16 mm^2 Al, through its total run.

b) Where the protective conductor has a cross-sectional area of less than 10 mm^2 Cu or 16 mm^2 Al, a second protective conductor of at least the same cross-sectional area shall be provided up to a point where the protective conductor has a cross-sectional area not less than 10 mm^2 Cu or 16 mm^2 Al.

c) Automatic disconnection of the supply in case of loss of continuity of the protective conductor.

The cross-sectional area of every protective grounding conductor which does not form part of the supply cable or cable enclosure shall, in any case, be not less than:

- 2.5mm^2 if mechanical protection is provided or
- 4mm^2 if mechanical protection is not provided.

The ground fault protection inside the AC drive protects only the drive itself against ground faults in the motor or the motor cable. It is not intended for personal safety.

Due to the high capacitive currents present in the AC drive, fault current protective switches may not function properly.

⚠	**Do not perform any voltage withstand tests** on any part of drive. There is a certain procedure according to which the tests shall be performed. Ignoring this procedure may result in damaged product.

2.   Modbus - general info

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 this, Modbus gives the possibility to easily upgrade the hardware structure of an industrial network, 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, without the need to use a different protocol for every connection.
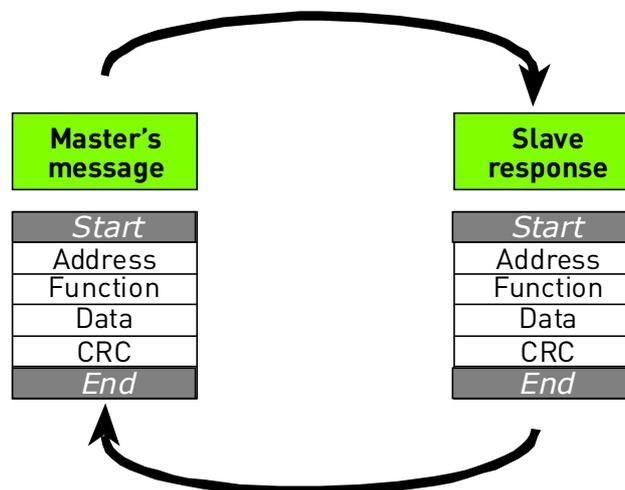
Figure 1. Basic structure of Modbus frame

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. A conversation is always started by a master in the Modbus network. A Modbus master sends a message and — depending of the contents of the message — a slave takes action and responds to it. There can be more masters in a Modbus network. Addressing in the message header is used to define which device should respond to a message. All other nodes on the Modbus network ignore the message if the address field doesn't match their own address.

Your drive is equipped with Modbus support as standard.
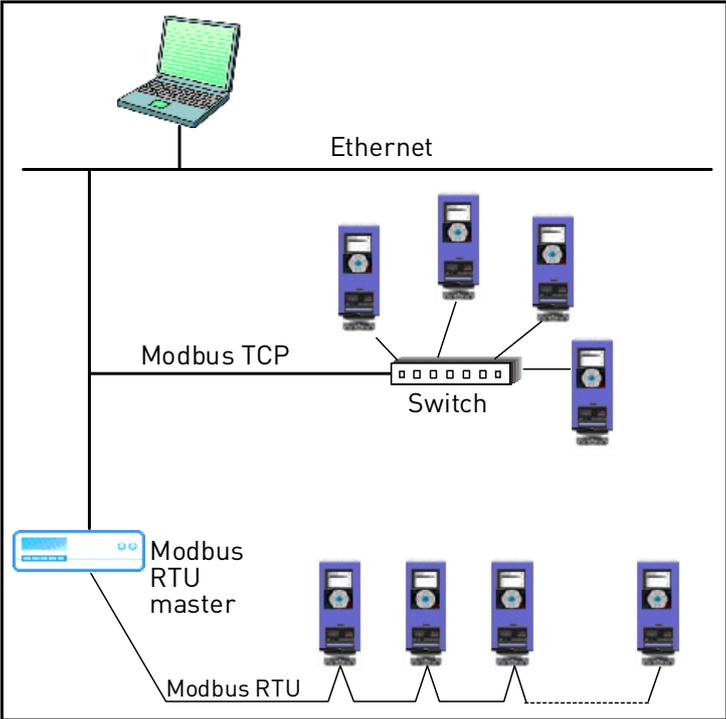
Figure 2. Principal example diagram of Modbus

If you need to contact Honeywell service in problems related to Modbus, please call Honeywell Technical Support at 888-516-9347 "Option 4".

3. Modbus technical data

3.1 Modbus RTU protocol

Connections and communications	Interface	RS-485
	Data transfer method	RS-485 MS/TP, half-duplex
	Transfer cable	STP (Shielded Twisted Pair), type Belden 9841 or similar
	Connector	2.5 mm^2
	Electrical isolation	Functional
	Modbus RTU	As described in "Modicon Modbus Protocol Reference Guide"
	Baud rate	300, 600, 1200, 2400, 4800, 9600, 19200, 38400 and 57600 baud
	Addresses	1 to 247

Table 2.

3.2 Modbus TCP protocol

Connections and communications	Interface	100BaseTX, IEEE 802.3 compatible
	Data transfer method	Ethernet half/full -duplex
	Data transfer speed	10/100 MBit/s, autosensing
	Protocol	Modbus TCP
	Connector	Shielded RJ45 connector
	Cable type	CAT5e STP
	Modbus TCP	As described in Modbus Messaging Implementation Guide
	Default IP	Selectable: Fixed or DHCP (AutoIP)

Table 3.

4.   Modbus installation

1	Open the cover of the AC drive.

⚡ **DANGER**	The relay outputs and other I/O-terminals may have a dangerous control voltage present even when drive is disconnected from mains.
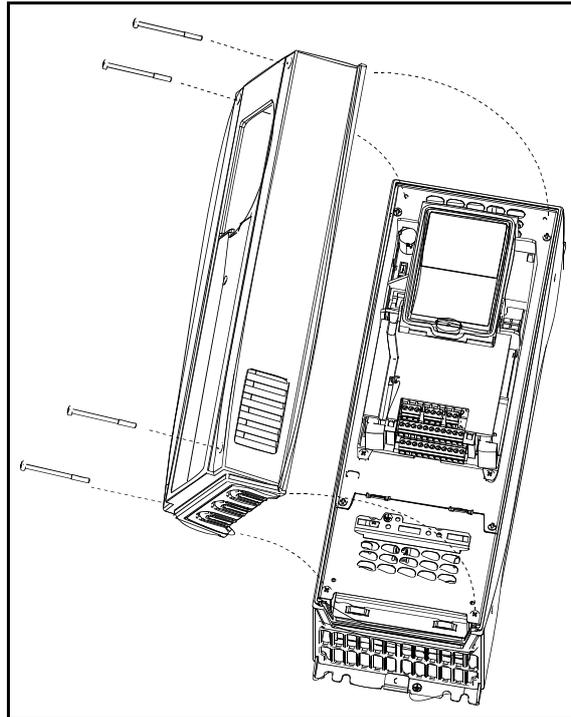
Figure 3.

2	Locate the components that you will need on the AC drive to connect and run the Modbus cables.

⚠ **WARNING**	**Be sure not to** plug the Modbus TCP cable to the terminal under the keypad! This might harm your personal computer.
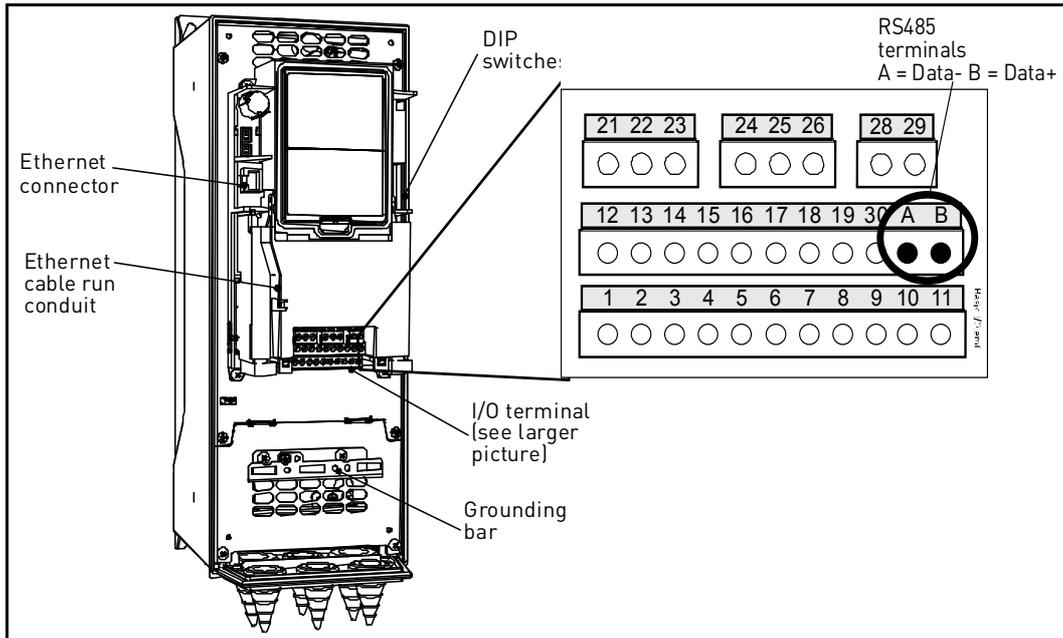
Figure 4.

You can use the Modbus communication protocol through Ethernet and RS485.

4.1   Prepare for use through ethernet

3	Connect the Ethernet cable (see specification on page 7) to its terminal and run the cable through the conduit as shown in Figure 5.
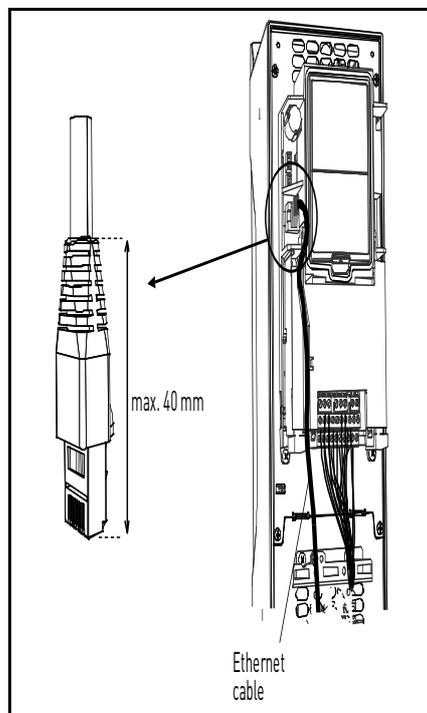
Figure 5.

4	Cut free the opening on the AC drive cover for the Ethernet cable (protection class IP21).
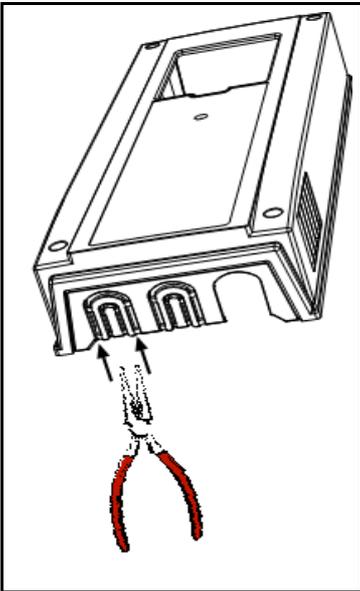
Figure 6.

5	Remount the AC drive cover. **NOTE:** When planning the cable runs, remember to keep the distance between the Ethernet cable and the motor cable at a **minimum of 30 cm**.

Ethernet cable
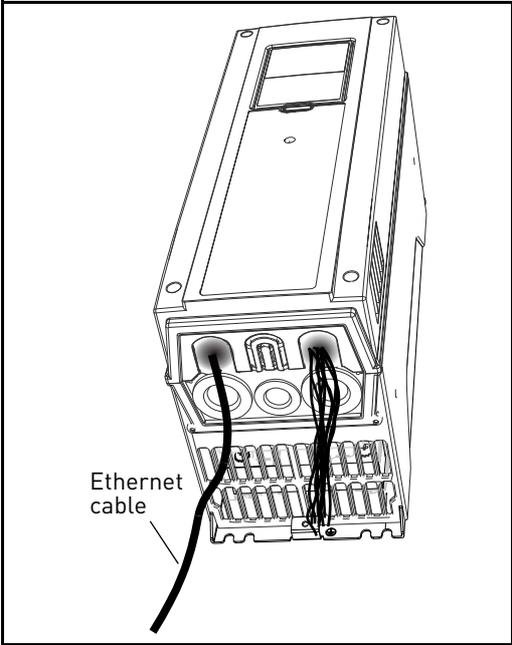
Figure 7.

4.2 Prepare for use through RTU

3	Strip about 15 mm of the RS485 cable (see specification on page 7) and cut off the grey cable shield. Remember to do this for both bus cables (except for the last device). Leave no more than 10 mm of the cable outside the terminal block and strip the cables at about 5 mm to fit in the terminals. See picture below. Also strip the cable now at such a distance from the terminal that you can fix it to the frame with the grounding clamp. Strip the cable at a maximum length of 15 mm. **Do not strip the aluminum cable shield!**
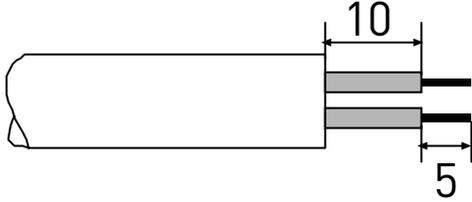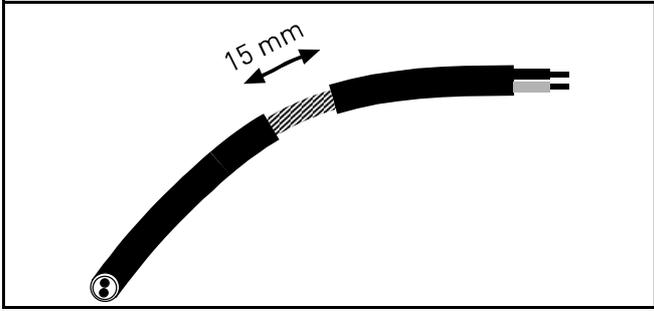
4	Then connect the cable to its appropriate terminals on drive standard terminal block, terminals **A and B** (A = negative, B = positive). See Figure 8.
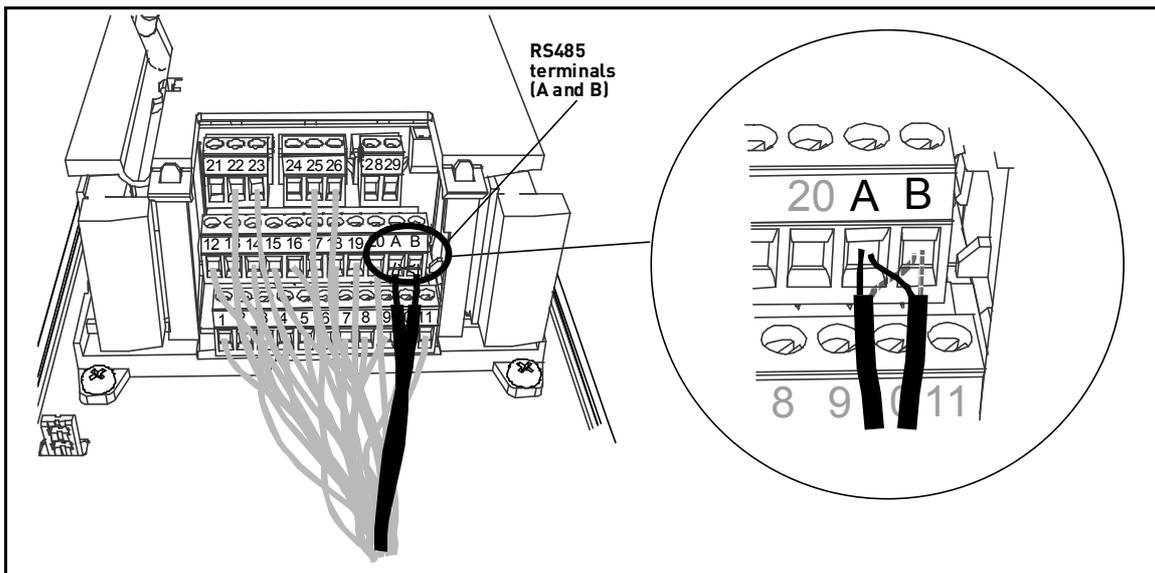
Figure 8.

5	Using the cable clamp included in the delivery of the drive, ground the shield of the RS485 cable to the frame of the AC drive. Cable clamp
6	**If drive is the last device on the bus,** the bus termination must be set. Locate the DIP switches to the right of the control keypad of the drive and turn the switch for the RS485 bus termination resistor to position ON. Biasing is built in the ter-mination resistor. See also step 9 on page 13. ON ← RS485* → OFF Current ← AO1 → Voltage Current ← AI2 → Voltage Current ← AI1 → Voltage * Bus termination resistor
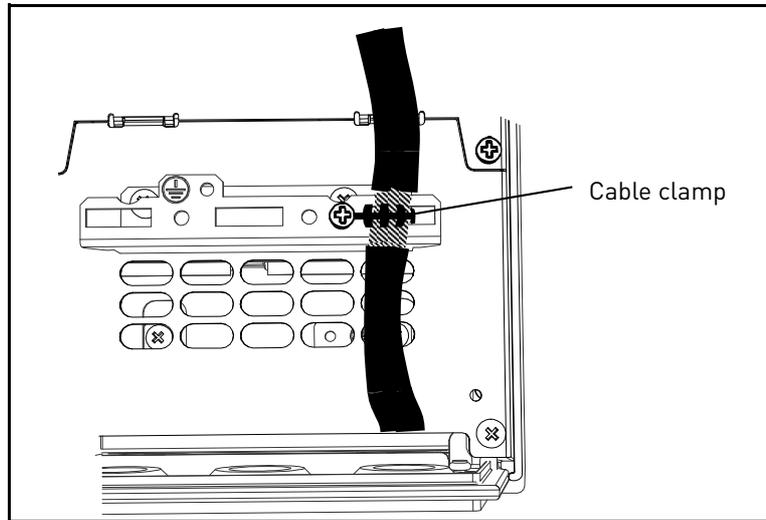
7	Unless already done for the other control cables, cut free the opening on the AC drive cover for the RS485 cable (protection class IP21).
8	Remount the AC drive cover and run the RS485 cables as shown in picture. **NOTE:** When planning the cable runs, remember to keep the distance between the fieldbus cable and the motor cable at a **minimum of 30 cm**. RS485 cables
9	The bus termination must be set for the first and the last device of the fieldbus line. See picture below. See also step 6 on page 12. We recommend that the first device on the bus and, thus, terminated was the Master device. Drive Drive Drive Drive Drive Termination **activated** Fieldbus ≋ = Bus termination Termination **deactivated** Termination **activated** with DIP switch
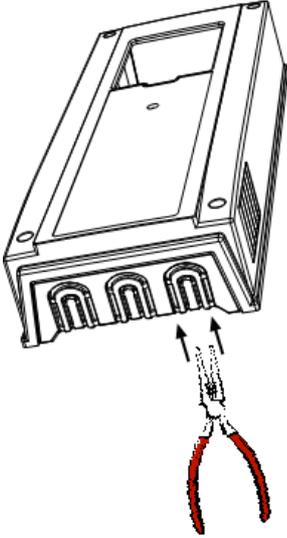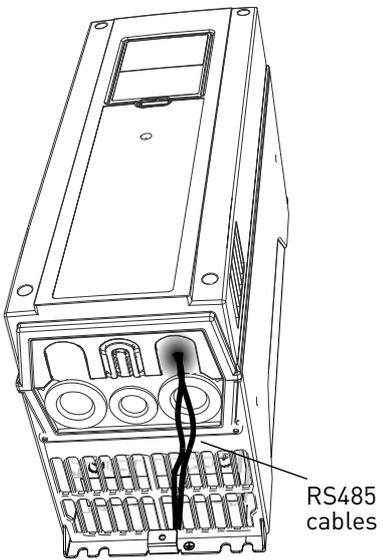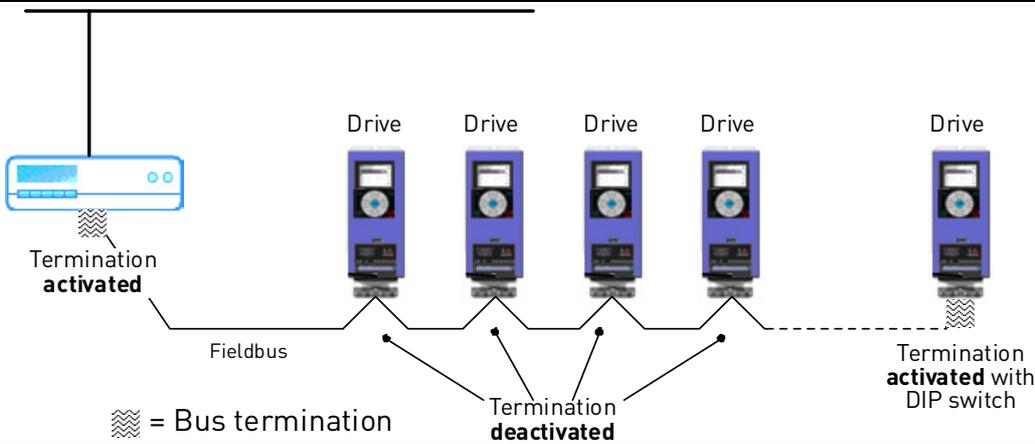
5.   Programming

Basic information on how to use the control keypad you will find in the Application Manual.

The navigation path to the fieldbus parameters may differ from application to application. The exemplary paths below apply to the drive.

1.   First ensure that the right fieldbus protocol is selected.

> ***Navigate: Main Menu > I/O and Hardware (M5) > RS-485 (M5.7) OR Ethernet (M5.8) > Common settings (M5.7.1) > Protocol (P5.7.1.1) > Edit > (Choose protocol)***

2.   Select *'Fieldbus control'* as the *Remote Control Place*.

> ***Navigate: Main Menu > Quick Setup (M1) > Rem. Ctrl. Place (P1.15)***
> OR
> ***Navigate: Main Menu > Parameters (M3) > Start/Stop Setup (M3.2) > Rem. Ctrl. Place (P3.2.1)***

3.   Choose source of reference.

> ***Navigate: Main Menu > Parameters (M3) > References (M3.3)***

4.   Set fieldbus parameters (M5.7 and M5.8). See below.

5.1   Modbus RTU parameters and monitoring values (M5.7.3)

Code	Parameter	Min	Max	Unit	Default	ID	Description
PARAMETERS							
P5.7.3.1.1	Slave address	1	247		1		Unique slave device address.
P5.7.3.1.2	Baud rate	1	9	bd	6	2236	Communication speed 1 = 300 2 = 600 3 = 1200 4 = 2400 5 = 4800 6 = 9600 7 = 19200 8 = 38400 9 = 57600
P5.7.3.1.3	Parity type	0	2		0	2239	0 = None 1 = Odd 2 = Even
P5.7.3.1.4	Communication time-out	0	65535	s	10		0 = Not used

Code	Parameter	Min	Max	Unit	Default	ID	Description
MONITORING VALUES							
P5.7.3.2.1	Fieldbus protocol status	1	3		1		0 = Init 1 = Stopped 2 = Operational 3 = Faulted
P5.7.3.2.2	Communication status	0.0	99.999		0.0		0-99 Number of messages with errors 0-999 Number of messages without communication errors
P5.7.3.2.3	Illegal functions	0					See page 18.
P5.7.3.2.4	Illegal data addresses	0					See page 18.
P5.7.3.2.5	Illegal data values	0					See page 18.
P5.7.3.2.6	Slave device busy	0					See page 18.
P5.7.3.2.7	Memory parity error	0					See page 18.
P5.7.3.2.8	Slave device failure	0					See page 18.
P5.7.3.2.9	Last fault response	0					See page 18.
P5.7.3.2.10	Control word			hex			See page 25 and page 26.
P5.7.3.2.11	Status word			hex			See page 25 and page 26.

Table 4. Parameters related with Modbus used through RTU

5.2   Modbus TCP parameters and monitoring values

5.2.1   Ethernet common settings (M5.8.1)

Code	Parameter	Min	Max	Unit	Default	ID	Description
P5.8.1.1	IP address mode						See page 19.
P5.8.1.2	IP address						See page 19.
P5.8.1.3	Subnet mask						See page 19.
P5.8.1.4	Default gateway						See page 19.
P5.8.1.5	MAC address						See page 19.

Table 5. Common settings for Modbus TCP (Ethernet)

5.2.2   Modbus TCP settings (M5.8.2)

Code	Parameter	Min	Max	Unit	Default	ID	Description
PARAMETERS (Common settings M5.8.2.1)							
P5.8.2.1.1	Connection limit	0	2		2		Number of allowed connections
P5.8.2.1.2	Unit identifier number	0	255		1		See chapter 5.4.2 Modbus TCP settings
P5.8.2.1.3	Communication time-out	0	65535	s	0		0 = Not used
MONITORING VALUES (Connection 1, Monitoring M5.8.2.2.1)*							
P5.8.2.2.1.1	Fieldbus protocol status	1	3				1 = Stopped 2 = Operational 3 = Faulted
P5.8.2.2.1.2	Communication status	0.0	99.999		0.0		0-99 Number of messages with errors 0-999 Number of messages without communication errors
P5.8.2.2.1.3	Illegal functions	0					See page 21.
P5.8.2.2.1.4	Illegal data addresses	0					See page 21.
P5.8.2.2.1.5	Illegal data values	0					See page 21.
P5.8.2.2.1.6	Slave device busy	0					See page 21.
P5.8.2.2.1.7	Memory parity error	0					See page 21.
P5.8.2.2.1.8	Slave device failure	0					See page 21.
P5.8.2.2.1.9	Last fault response	0					See page 21.
P5.8.2.2.1.10	Control word			hex			See page 25.
P5.8.2.2.1.11	Status word			hex			See page 26.
MONITORING VALUES (Connection 2, Monitoring M5.8.2.3.1)*							
All parameters are the same as those for Connection 1.							

* Will appear only after connection has been established

Table 6. Parameters related with Modbus used through Ethernet

5.3   Modbus RTU parameter descriptions

5.3.1   Modbus RTU Parameters

P5.7.3.1.1   SLAVE ADDRESS

Each slave must have a unique address (from 1 to 247) so that it can be addressed independently from other nodes.

P5.7.3.1.2   BAUD RATE

Select the communication speed for the network. The default value is 9600 baud.

P5.7.3.1.3   PARITY TYPE

Users can select the parity type for the network.

Parity type	Stopbits
None	0
Odd	1
Even	2

Table 7. Parity type

P5.7.3.1.4   COMMUNICATION TIME-OUT

Modbus board initiates a communication error for a time defined with this parameter. '0' means that no fault is generated.

5.3.2   Modbus RTU monitoring values

P5.7.3.2.1   FIELDBUS PROTOCOL STATUS

Fieldbus Protocol Status tells the status of the protocol.

INITIALIZING	Protocol is starting up
STOPPED	Protocol is timeouted or not used
OPERATIONAL	Protocol is running
FAULTED	Major fault in protocol, requires restarting. If fault remains call Honeywell Technical Support at 888-516-9347 "Option 4".

Table 8. FB protocol statuses

P5.7.3.2.2   COMMUNICATION STATUS

0The *Communication status* shows how many error and how many good messages the drive has received. The Communication status includes a common error counter that counts CRC and parity errors and a counter for good messages.

Only messages to the current slave in use are counted in the good messages.

Good messages	
0…999	Number of messages received without errors
Bad Frames	
0…99	Number of messages received with errors

Table 9.

P5.7.3.2.3 ILLEGAL FUNCTIONS

The function code received in the query refers to an unallowed action for the server (or slave).

P5.7.3.2.4 ILLEGAL DATA ADDRESSES

The data address received in the query refers to an unallowed address for the server (or slave).

P5.7.3.2.5 ILLEGAL DATA VALUES

A value contained in the query data field refers to an unallowed value for server (or slave).

P5.7.3.2.6 SLAVE DEVICE BUSY

The server (or slave) is engaged in processing a long–duration program command. The client (or master) should retransmit the message later when the server (or slave) is free.

P5.7.3.2.7 MEMORY PARITY ERROR

The server (or slave) attempted to read record file but detected a parity error in the memory.

P5.7.3.2.8 SLAVE DEVICE FAILURE

An unrecoverable error occurred while the server (or slave) was attempting to perform the requested action.

P5.7.3.2.9 LAST FAULT RESPONSE

Shows the last fault response as *Fault code*.

P5.7.3.2.10 CONTROL WORD

Shows the *Control Word* received from the bus.

P5.7.3.2.11 STATUS WORD

Shows the current *Status Word* that is sent to the bus.

5.4   Modbus TCP parameter descriptions

5.4.1   Ethernet common settings

P5.8.1.1   **IP** *ADDRESS MODE*

Selectable alternatives are *DHCP* (Dynamic Host Configuration Protocol) and *Fixed*.

DHCP protocol gives IP addresses to new devices connecting to local network. This address is valid for a certain period of time. If no DHCP server is found an automatic random IP is given.

A fixed IP address is specified manually and it does not change.

When the mode is changed from DHCP to Fixed the addresses will read

IP: 192.168.0.10
Subnet mask: 0.0.0.0
Default gateway: 0.0.0.0

P5.8.1.2   **IP** *ADDRESS*

An *IP address* is a series of numbers (like above) specific to the device connected to the Internet.

P5.8.1.3   *SUBNET MASK*

The network mask marks all the bits of an IP address for the identification of the network and the subnetwork.

P5.8.1.4   *DEFAULT GATEWAY*

Gateway address is the IP address of a network point that acts as an entrance to another network.

P5.8.1.5   **MAC** *ADDRESS*

The MAC address of the control board.

MAC address (Media Access Control) is a unique address given to each network host. It is not editable.

5.4.2   Modbus TCP settings

<u>5.4.2.1   Common settings</u>

P5.8.2.1.1   CONNECTION LIMIT

Defines how many clients can access the server simultaneously.

P5.8.2.1.2   UNIT IDENTIFIER NUMBER

The Modbus 'slave address' field usually used on Modbus Serial Line is replaced by a single byte 'Unit Identifier'.

On TCP/IP, the Modbus server is addressed using its IP address; therefore, the Modbus Unit Identifier is useless.

P5.8.2.1.3   COMMUNICATION TIME-OUT

Modbus board initiates a communication error if the Ethernet connection is lost. Communication time-out parameters define the minimum delay between packages received from the client. The timer is reset and started after each received package. This parameter can be used if the client is periodically polling the slaves.

5.4.3   Modbus TCP monitoring values

These values will not appear before the connection is established.

<u>5.4.3.1   Connection 1</u>

P5.8.2.2.1.1   FIELDBUS PROTOCOL STATUS

Fieldbus Protocol Status tells the status of the protocol.

INITIALIZING	Protocol is starting up
STOPPED	Protocol is timeouted or not used
OPERATIONAL	Protocol is running
FAULTED	Major fault in protocol, requires restarting. If fault remains Call Honeywell Technical Support at 888-516-9347 "Option 4".

Table 10. FB protocol statuses

P5.8.2.2.1.2   COMMUNICATION STATUS

The *Communication status* shows how many error and how many good messages the drive has received. The Communication status includes a common error counter that counts errors and a counter for good messages.

Good messages	
0…999	Number of messages received without errors
Bad Frames	
0…99	Number of messages received with errors

Table 11. Communication status

P5.8.2.2.1.3   ILLEGAL FUNCTIONS

The function code received in the query refers to an unallowed action for the server (or slave).

P5.8.2.2.1.4   ILLEGAL DATA ADDRESSES

The data address received in the query refers to an unallowed address for the server (or slave).

P5.8.2.2.1.5   ILLEGAL DATA VALUES

A value contained in the query data field refers to an unallowed value for server (or slave).

P5.8.2.2.1.6   SLAVE DEVICE BUSY

The server (or slave) is engaged in processing a long–duration program command. The client (or master) should retransmit the message later when the server (or slave) is free.

P5.8.2.2.1.7   MEMORY PARITY ERROR

The server (or slave) attempted to read record file but detected a parity error in the memory.

P5.8.2.2.1.8   SLAVE DEVICE FAILURE

An unrecoverable error occurred while the server (or slave) was attempting to perform the requested action.

P5.8.2.2.1.9   LAST FAULT RESPONSE

Shows the last fault response as *Fault code*.

P5.8.2.2.1.10   CONTROL WORD

Shows the Control Word received from the bus.

P5.8.2.2.1.11   STATUS WORD

Shows the current Status Word that is sent to the bus.

5.4.3.2   Connection 2

The monitoring values are the same as those for Connection 1 (chapter 5.4.3.1), only with a different code (P5.8.2.*3*.1.X).

6. Communications

Features of the Modbus-drive interface:

- Direct control of drive (e.g. Run, Stop, Direction, Speed reference, Fault reset)
- Full access to all drive parameters
- Monitor drive status (e.g. Output frequency, Output current, Fault code)

6.1 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).

6.2 Modbus memory map

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

Function code	Current terminology	Access type	Address range (hex)	TCP/RTU
1 (0x01)	Read coils	Discrete	00000-0FFFF	TCP
2 (0x02)	Read Input Discrete	Discrete	10000-1FFFF	TCP
3 (0x03)	Read holding registers	16bit	40000-4FFFF	TCP&RTU
4 (0x04)	Read input registers	16bit	30000-3FFFF	TCP&RTU
5 (0x05)	Force single coils	Discrete	00000-0FFFF	TCP
6 (0x06)	Write single register	16bit	40000-4FFFF	TCP&RTU
15 (0x0F)	Force multiple coils	Discrete	00001-0FFFF	TCP
16 (0x10)	Write multiple registers	16bit	40000-4FFFF	TCP&RTU
23 (0x17)	Read/Write multiple registers	16bit	40000-4FFFF	TCP&RTU
NOTE: Broadcasting not supported in TCP. Broadcast supported with function code 06 and 16 in RTU				

Table 12. Supported functions

6.3 Modbus data mapping

6.3.1 Coil registers

Coil registers contain binary data (Read/Write). See page 25.

Address	Function	Purpose
0001	RUN/STOP	Control Word, bit 0
0002	Direction	Control Word, bit 1
0003	Fault reset	Control Word, bit 2

Table 13. Defined coil registers

6.3.2 Input discrete registers

Input discrete registers contain binary data (Read). See page 26.

Address	Function	Purpose
10001	Ready	Status Word, bit 0
10002	Run	Status Word, bit 1
10003	Direction	Status Word, bit 2
10004	Fault	Status Word, bit 3
10005	Alarm	Status Word, bit 4
10006	At reference	Status Word, bit 5
10007	Zero speed	Status Word, bit 6
10008	Flux ready	Status Word, bit 7

Table 14. Defined Input Discrete

6.3.3 Holding and input registers

All values can be read with function codes 3 and 4 (all registers are 3X and 4X reference). Modbus registers are mapped to drive ID's as follows:

Address range	Purpose	Access type	See
0001 - 2000	Drive Application ID´s	16bit	Table 16
2001 - 2050	FBProcessDataIN	16bit	Table 17
2051 - 2099	FBProcessDataIN	32bit	Table 17
2101 - 2150	FBProcessDataOUT	16bit	Table 19
2151 - 2199	FBProcessDataOUT	32bit	Table 19
2200 - 10000	Drive Application ID´s	16bit	Table 16
10501 - 10530	IDMap	16bit	Table 22
10601 - 10630	IDMap Read/Write	16bit	Table 23

Table 15. Defined input holding registers

Address range	Purpose	Access type	See
10701 - 10760	IDMap Read/Write	32bit	Table 23
20001 - 40000	Drive Application ID's	32bit	Table 16
40001 - 40007	Operation day counter	16bit	Table 25
40101 - 40107	Resettable operation day counter	16bit	Table 26
40201 - 40203	Energy counter	16bit	Table 27
40301 - 40303	Resettable energy counter	16bit	Table 28
40401 - 40430	Fault history	16bit	Table 29

Table 15. Defined input holding registers

6.3.3.1   Drive Application ID's

Application ID's are parameters that depend on the drive's application. These parameters can be read and written by pointing the corresponding memory range directly or by using the so-called ID map (more information below). It is easiest to use a straight address if you want to read a single parameter value or parameters with consecutive ID numbers. It is possible to read 12 consecutive ID addresses.

Address range	Purpose	ID
0001-2000	Application parameters	1-2000
2200-10000	Application parameters	2200-10000

Table 16. Parameter ID's

6.3.3.2   FB Process data IN

The process data fields are used to control the drive (e.g. Run, Stop , Reference, Fault Reset) and to quickly read actual values (e.g. Output frequency, Output current, Fault code). The fields are structured as follows:

Process Data Master -> Slave (max 22 bytes)

Address		Name	Range/Type
16-bit[*]	32-bit		
2001	2051 = High data 2052 = Low data	FB Control Word	Binary coded
2002	-	Reserved	Binary coded
2003	2053 = High data 2054 = Low data	FB Speed Reference	0…10000 %

Table 17. Fieldbus Process Data IN

Address		Name	Range/Type
16-bit[*]	**32-bit**		
2004	2055 = High data 2056 = Low data	FB Process Data In 1	See chapter 9
2005	2057 = High data 2058 = Low data	FB Process Data In 2	See chapter 9
2006	2059 = High data 2060 = Low data	FB Process Data In 3	See chapter 9
2007	2061 = High data 2062 = Low data	FB Process Data In 4	See chapter 9
2008	2063 = High data 2064 = Low data	FB Process Data In 5	See chapter 9
2009	2065 = High data 2066 = Low data	FB Process Data In 6	See chapter 9
2010	2067 = High data 2068 = Low data	FB Process Data In 7	See chapter 9
2011	2069 = High data 2070 = Low data	FB Process Data In 8	See chapter 9

Table 17. Fieldbus Process Data IN

[*] . In drive, the Control Word and the Status Word are formed of 32 bits.
Only the initial 16 bits can be read in the 16-bit area.

Control word bits

The Control word is composed of 32 bits. Meanings of bits are described below. Unused bits have to be set to zero.

Bit	Name	Value = 1	Value = 0	Description
B0	Start/Stop	Start request	Stop request	Start/Stop command to application
B1	Direction	Reverse	Forward	Command to change rotational direction
B2	Fault reset	Reset faults	No action	Command to reset fault
B3-B31	Not used			

Table 18. Control Word bits

6.3.3.3   FB Process data OUT

Process Data Slave -> Master (max 22 bytes)

Address		Name	Range/Type
16-bit	**32-bit**		
2101	2151 = High data 2152 = Low data	FB Status Word	Binary coded
2102	-	Reserved	Binary coded
2103	2153 = High data 2154 = Low data	FB Actual Speed	0…10000 %
2104	2155 = High data 2156 = Low data	FB Process Data Out 1	See chapter 9
2105	2157 = High data 2158 = Low data	FB Process Data Out 2	See chapter 9
2106	2159 = High data 2160 = Low data	FB Process Data Out 3	See chapter 9
2107	2161 = High data 2162 = Low data	FB Process Data Out 4	See chapter 9
2108	2163 = High data 2164 = Low data	FB Process Data Out 5	See chapter 9
2109	2165 = High data 2166 = Low data	FB Process Data Out 6	See chapter 9
2110	2167 = High data 2168 = Low data	FB Process Data Out 7	See chapter 9
2111	2169 = High data 2170 = Low data	FB Process Data Out 8	See chapter 9

Table 19. Fieldbus Process Data Out

Status Word bits

The Status word is composed of 32 bits. The meanings of bits are described below.

Bit	Name	Value = 1	Value = 0	Description
B0	Ready	Ready	Not ready	Indicates whether the drive is ready or not
B1	Run	Running	Stop	Indicates whether the drive is running or stopped
B2	Direction	Counterclockwise	Clockwise	Indicates the rotation direction of the motor
B3	Fault	Faulted	Not faulted	Indicates if a fault is active
B4	Alarm	Alarm	No alarm	Indicates if an alarm is active
B5	AtReference	True	False	Reference frequency reached

B6	ZeroSpeed	True	False	Motor running at zero speed
B7	FluxReady	True	False	Motor is magnetized
B8-B28	Not used			

Table 20. Status Word bits B1-B28

B29 Control place	B30 Control place	B31 Control place	Description
0	0	1	Fieldbus
0	1	0	Keypad
0	1	1	PC tool
1	0	0	I/O terminals

Table 21. Status Word bits B29-B31, descriptions of bit connections

The use of process data depends on the application. In a typical situation, the device is started and stopped with the ControlWord (CW) written by the Master and the Rotating speed is set with Reference (REF). With PD1…PD8 the device can be given other reference values (e.g. Torque reference).

With the StatusWord (SW) read by the Master, the status of the device can be seen. Actual Value (ACT) and PD1…PD8 show the other actual values.

6.3.3.4   ID map

Using the ID map, you can read consecutive memory blocks that contain parameters whose ID's are not in a consecutive order. The address range 10501 - 10530 is called 'IDMap', and it includes an address map in which you can write your parameter ID's in any order. The address range 10601 to 10630 is called 'IDMap Read/Write,' and it includes values for parameters written in the IDMap. As soon as one ID number has been written in the map cell 10501, the corresponding parameter value can be read and written in the address 10601, and so on.
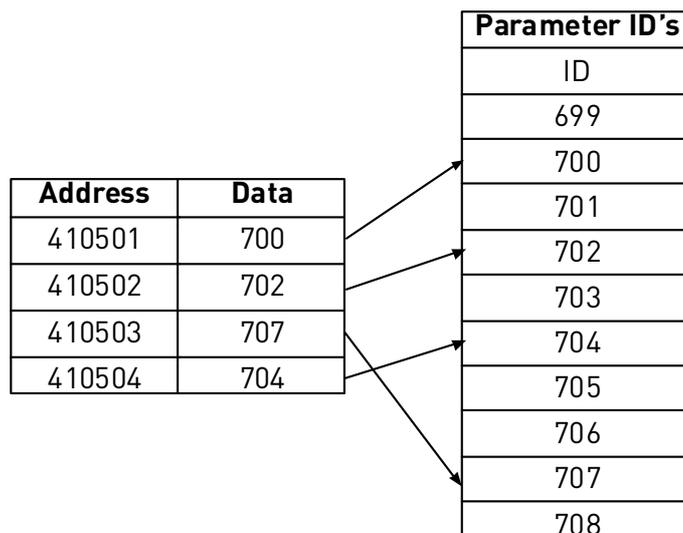
Table 22. IDMap initialization

Once the IDMap address range has been initialized with any parameter ID number, the parameter value can be read and written in the IDMap Read/Write address range address IDMap address + 100.

Address	Data
410601	Data included in parameter ID700
410602	Data included in parameter ID702
410603	Data included in parameter ID707
410604	Data included in parameter ID704

Table 23. Parameter Values in 16-bit IDMap Read/Write registers

If the IDMap table has not been initialized, all fields show the index '0'. If the it has been initialized, the parameter ID's included in it are stored in the flash memory of the OPT-CI board.

Example of 32Bit IDMap

Address	Data
410701	Data High, parameter ID700
410702	Data Low, parameter ID700
410703	Data High, parameter ID702
410704	Data Low, parameter ID702

Table 24. Example of parameter values in 32-bit IDMap Read/Write registers

6.3.3.5   Operation day counter

Address	Register	Purpose
40001	440001	Years
40002	440002	Days
40003	440003	Hours
40004	440004	Minutes
40005	440005	Seconds

Table 25. Operation day counter

6.3.3.6   Resettable operation day counter

Reset the counter by writing "1" for parameter ID2311.

Address	Register	Purpose
40101	440101	Years
40102	440102	Days
40103	440103	Hours
40104	440104	Minutes
40105	440105	Seconds

Table 26. Resettable operation day counter

6.3.3.7   Energy counter

The last number of the *Format* field indicates the decimal point place in the *Energy* field. If the number is bigger than 0, move the decimal point to the left by the number indicated. For example, Energy = 1200, Format = 52. Unit = 1. Energy = 12.00kWh.

Address	Register	Purpose
40201	440201	Energy
40202	440202	Format
40203	440203	Unit 1 = kWh 2 = MWh 3 = GWh 4 = TWh

Table 27. Energy counter

6.3.3.8   Resettable energy counter

Reset the counter by writing "1" for parameter ID2312.

Address	Register	Purpose
40301	440301	Energy
40302	440302	Format
40303	440303	Unit 1 = kWh 2 = MWh 3 = GWh 4 = TWh

Table 28. Resettable energy counter

6.3.3.9   Fault history

The fault history can be viewed by reading from address 40401 onward. The faults are listed in chronological order so that the latest fault is mentioned first and the oldest last. The fault history can contain 29 faults at the same time. The fault history contents are represented as follows.

Address	Register	Purpose
40401	440401	
40402	440402	
40403	440403	
...	...	
40429	440429	

Table 29. Fault history

6.4   Example messages

Example 1

Write the process data 42001…42003 with command 16 (Preset Multiple Registers).

<u>Command Master - Slave:</u>

ADDRESS		01 hex Slave address 1 hex (= 1)
FUNCTION		10 hex Function 10 hex (= 16)
DATA	Starting address HI	07 hex Starting address 07D0 hex (= 2000)
	Starting address LO	D0 hex
	No. of registers HI	00 hex
	No. of registers LO	03 hex Number of registers 0003 hex (= 3)
	Byte count	06 hex Byte count 06 hex (= 6)
	Data HI	00 hex Data 1 = 0001 hex (= 1). Setting control word run bit to 1.
	Data LO	01 hex
	Data HI	00 hex Data 2 = 0000 hex (= 0).
	Data LO	00 hex
	Data HI	13 hex Data 3 = 1388 hex (= 5000), Speed Reference to 50.00%
	Data LO	88 hex
ERROR	CRC HI	C8 hex CRC field C8CB hex (= 51403)
CHECK	CRC LO	CB hex

Message frame:

01	10	07	D0	00	03	06	00	01	00	00	13	88	C8	CB

The reply to Preset Multiple Registers message is the echo of 6 first bytes.

<u>Answer Slave - Master:</u>

ADDRESS		01 hex Slave address 1 hex (= 1)
FUNC-TION		10 hex Function 10 hex (= 16)
DATA	Starting address HI	07 hex Starting address 07D0 hex (= 2000)
	Starting address LO	D0 hex
	No. of registers HI	00 hex Number of registers 0003 hex (= 3)
	No. of registers LO	03 hex
ERROR	CRC HI	80 hex CRC 8085 hex (= 32901)
CHECK	CRC LO	85 hex

Reply frame:

01	10	07	D0	00	03	80	85

Example 2:

Read the Process Data 42103…42104 with command 4 (Read Input Registers).

Command Master - Slave:

ADDRESS		01 hex Slave address 1 hex (= 1)
FUNCTION		04 hex Function 4 hex (= 4)
DATA	Starting address HI	08 hex
	Starting address LO	36 hex
	No. of registers HI	00 hex Number of registers 0002 hex (= 2)
	No. of registers LO	02 hex
ERROR	CRC HI	93 hex CRC field 93A5 hex (= 37797)
CHECK	CRC LO	A5 hex

Message frame:

01	04	08	36	00	02	93	A5

The reply to the Read Input Registers message contains the values of the read registers.

Answer Slave - Master:

ADDRESS		01 hex Slave address 1 hex (= 1)
FUNCTION		04 hex Function 4 hex (= 4)
DATA	Byte count	04 hex Byte count 4 hex (= 4)
	Data HI	13 hex Speed reference = 1388 hex (=5000 => 50.00%)
	Data LO	88 hex
	Data HI	09 hex Output Frequency = 09C4 hex (=2500 =>25.00Hz)
	Data LO	C4 hex
ERROR	CRC HI	78 hexCRC field 78E9 hex (=30953)
CHECK	CRC LO	E9 hex

Reply frame:

01	04	04	13	88	09	C4	78	E9

Example of an exception response

In an exception response, the Slave sets the *most-significant bit (MSB)* of the function code to 1. The Slave returns an exception code in the data field.

Command Master - Slave:

ADDRESS		01 hex Slave address 1 hex (= 1)
FUNCTION		04 hex Function 4 hex (= 4)
DATA	Starting address HI	17 hex Starting address 1770 hex (= 6000)
	Starting address LO	70 hex
	No. of registers HI	00 hex Invalid number of registers 0005 hex (= 5)
	No. of registers LO	05 hex
ERROR	CRC HI	34 hex
CHECK	CRC LO	66 hex CRC field 3466 hex (=13414)

Message frame:

01	04	17	70	00	05	34	66

Exception response:

Answer Slave - Master:

ADDRESS	01 hex Slave address 1 hex (= 1)
FUNCTION	84 hex Most significant bit set to 1
ERROR CODE	04 hex Error code 04 => Slave Device Failure
ERROR CRC HI	42 hex CRC field 42C3 hex (= 17091)
CHECK CRC LO	C3 hex

Reply frame:

01	84	04	42	C3

7.   Fault tracing

When an unusual operating condition is detected by the AC drive control diagnostics, the drive initiates a notification visible, for example, on the keypad. The keypad will show the ordinal number of the fault, the fault code and a short fault description.

The fault can be reset with the Reset button on the control keypad or via the I/O terminal. The faults are stored in the Fault history menu which can be browsed. The different fault codes you will find in the table below. This fault table presents only the faults related to the fieldbus in use.

Note: When contacting distributor or factory because of a fault condition, always write down all texts and codes on the keypad display and call Honeywell Technical Support at 888-516-9347 "Option 4".

7.1   Typical fault conditions

Fault condition	Possible cause	Remedy
Termination resistor	Missing or excessive termination resistor.	Install termination resistors at both ends of the fieldbus line.
Cabling	• Supply or motor cables are located too close to the fieldbus cable • Wrong type of fieldbus cable • Too long cabling	
Grounding	Inadequate grounding.	Ensure grounding in all points on the net
Connections	Faulty connections. • Excessive stripping of cables • Conductors in wrong terminals • Too loose connections of conductors	
Parameter	• Faulty address • Overlapping slave addresses • Wrong baud rate • Wrong control place selected	

Table 30. Typical fault conditions

7.2   RS-485 bus biasing

When none of the devices on the RS-485 bus is sending data all devices are in idle status. This being the case, the bus voltage is in indefinte state, usually near 0 V due to the termination resistors. This may cause problems in character reception because the single characters in serial communcation begin with start bit referring to bus status '0' with voltage of less than -200mV whereas the bus status '1' corresponds to bus voltage of more than +200mV. The RS-485 standard considers the voltage interval -200mV...+200mV as undefined state. Bus biasing is therefore needed to maintain the voltage in status '1' (above +200mV) also between the messages.

To bias the bus you will have to add a separate active termination resistor specifically designed for the RS-485 bus (e.g. Siemens active RS 485 terminating element (6ES7972-0DA00-0AA0z).

7.3   Other fault conditions

The following fault tracing diagram will help you to locate and fix some of the most usual problems. If the problem persists contact your local distributor.
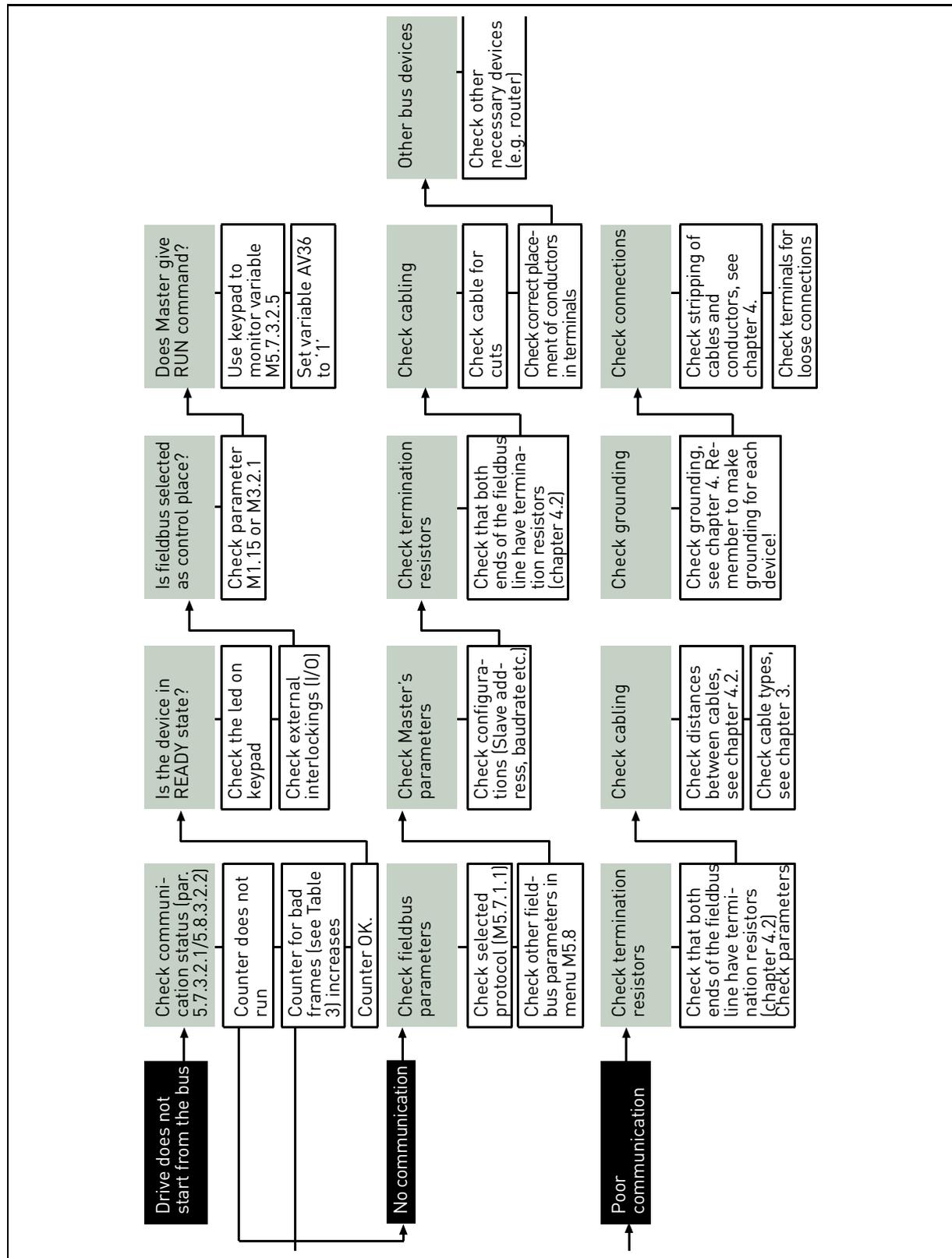

Figure 9. Fault tracing diagram for Modbus RTU

Drive does not start from the bus	Check communication status (par. 5.7.3.2.1/5.8.3.2.2)	Is the device in READY state?	Is fieldbus selected as control place?	Does Master give RUN command?
	Counter does not run	Check the led on keypad	Check parameter M1.15 or P3.2.1	Use keypad to monitor variable M5.7.3.2.5
	Counter for bad frames (see Table 3) increases	Check external interlockings (I/O)		Set variable AV36 to '1'
	Counter OK.			

No communication	Check fieldbus parameters	Check Master's parameters	Check cabling	Other bus devices
	Check selected protocol (M5.7.1.1)	Check IP address, gateway etc.	Check cable for cuts	Check other necessary devices (e.g. switches)
	Check other fieldbus parameters in menu M5.8		Check correct placement of conductors in terminals	

Poor communication	Check cabling	Check connections
	Check distances between cables, see chapter 4.2.	Check stripping of cables and conductors, see chapter 4.
	Check cable types and lengths, see chapter 3.	Check e.g WLAN or other routers

*Figure 10. Fault tracing diagram for Modbus TCP*

8.   Quick setup

Following these instructions, you can easily and fast set up your Modbus for use:

1	Choose control place. A. Press LOC/REM button on keypad to select *Remote Control Place* B. Select *Fieldbus* as remote control place: *Main Menu > Quick Setup (M1) > Rem. Ctrl. Place (P1.15) > FieldbusCTRL*
2	Make these settings in the master software C. Set *Control Word* to '**0**' (2001) D. Set *Control Word* to '**1**' (2001) E. Drive status is RUN F. Set Reference value to '**5000**' (50.00%) (2003). G. *Actual speed* is **5000** (25.00 Hz if MinFreq is 0.00 Hz and MaxFreq is 50.00 Hz) H. Set *Control Word* to '**0**' (2001) I. Drive status is STOP.

9.   Annex

Process Data IN (Master to Slave)

Use of Process Data In variables depends on the used application. The configuration of the data is free.

Process Data OUT (Slave to Master)

Use of Process Data Out variables depends on the used application.

The Fieldbus Master can read the drive's actual values using process data variables. Control applications use process data as follows:

ID	Data	Value	Unit	Scale
2104	Process data OUT 1	Output Frequency	Hz	0,01 Hz
2105	Process data OUT 2	Motor Speed	rpm	1 rpm
2106	Process data OUT 3	Motor Current	A	0,1 A
2107	Process data OUT 4	Motor Torque	%	0,1 %
2108	Process data OUT 5	Motor Power	%	0,1 %
2109	Process data OUT 6	Motor Voltage	V	0,1 V
2110	Process data OUT 7	DC link voltage	V	1 V
2111	Process data OUT 8	Active Fault Code	-	-

Table 31. Process Data OUT variables

Honeywell