



# Installation & Operating Instructions

## 00e™ Series VR3452 Controller

302-369

SUPERSEDES: November 20, 2015

EFFECTIVE: February 29, 2016

Plant ID No. 001-3452

## VR3452-HY1-FC1A01 and VR3452-HB1-FC1A01



# CONTENTS

<b>1. Symbols and conventions used in this document.....</b>	<b>3</b>	<b>6. Ethernet.....</b>	<b>19</b>
1.1. Abbreviations and conventions.....	3	6.1. Bus topology.....	20
<b>2. Introduction.....</b>	<b>3</b>	6.2. Connecting to pump ad-hoc.....	20
2.1. System diagram.....	4	6.3. Connecting to pump via router.....	20
2.2. Specifications.....	4	6.4. Pump configuration over Ethernet.....	20
<b>3. Module layout.....</b>	<b>6</b>	<b>7. Modbus.....</b>	<b>22</b>
3.1. Connection considerations.....	7	7.1. Modbus related interface.....	22
3.2. Connecting the module wiring.....	8	7.2. Bus topology.....	22
3.3. Connection examples.....	10	7.3. Connection to Modbus.....	22
<b>4. Control modes and priorities.....</b>	<b>12</b>	7.4. Speed, parity and address.....	22
4.1. Priority of settings.....	12	7.5. Termination.....	22
4.2. Control variables.....	12	7.6. Register block overview.....	23
4.3. Module mode selection.....	13	7.7. Configuration register block.....	23
4.4. Mode 1.....	14	7.8. Status register block.....	24
Digital (switch) control.....	14	7.9. Pump control register block.....	25
0-10 VAC control.....	16	7.10. Pump status register block.....	26
4.5. Mode 2.....	18	7.11. Pump data register block.....	27
<b>5. Relay output.....</b>	<b>18</b>	<b>8. Fault finding.....</b>	<b>28</b>
		8.1. Error codes.....	28



## WARNING!

Installation and use of this product requires experience and knowledge of this or similar products. Persons with reduced physical, mental or sensory capabilities must not use this product, unless properly instructed and supervised. Children must not be allowed to play with this product.



## WARNING!

Prior to installation and commissioning, read these instructions first. Installation and operation must comply with local regulations.

# 1. SYMBOLS AND CONVENTIONS USED IN THIS DOCUMENT



**WARNING!** Denotes that a failure to observe those instructions might cause damage to equipment or pose danger to the user.

**NOTE:** - Gives additional tips or instructions that might ease the job and ensure proper operation.

## 1.1 ABBREVIATIONS AND CONVENTIONS

Abbreviation	Description
Baud, Baud rate	Serial communication speed, in bits per second including start, parity and stop bits.
CRC	Cyclic Redundancy Check, additional bytes used to confirm valid data transmission.
Ethernet	IEEE 802.3, mostly referring to 10BASE-T RJ-45 connector present on board.
H	Differential pressure, often called Head.
LED	Light Emitting Diode.
Modbus	A serial communication protocol used for device automation and remote access.
NMTC	NMT pump Communication module.
Q	Pump flow or flow rate.
RTU	Remote Terminal Unit.
RS-485	Multi drop serial network wiring, used to transfer Modbus data.

For Modbus use, this manual assumes that the reader is familiar with commissioning and configuring of Modbus devices. It is also assumed that an existing Modbus RTU network on RS-485 wiring with Modbus master is present.

For Ethernet and web interface use, this manual assumes that the reader knows how to configure or already has preconfigured Ethernet network.

For use of analog signals and relay output signals, external controller needs to be configured and used. Proper operating mode must also be selected for the module.

### NOTE:

- Data in this document are subject to change.
- Actual implementation might differ by pump model and software revision.
- Make sure you are using the right manual for your product.
- Verify proper operation in the final system.
- Manufacturer cannot be held responsible for problems caused either directly or indirectly by the use of information in this manual.

# 2. INTRODUCTION

This manual describes the FCIAOI module for VR 3452 range of pumps. This module is used for various remote control applications, including:

- Remote on/off
- Analog 0..10 V voltage control
- Modbus remote control
- Status relay feedback
- Web access over Ethernet

## 2.1 SYSTEM DIAGRAM

There are several possible connection configurations. Not all functions can be used simultaneously.

- on/off + 0..10 V + relay output
- Modbus RTU + Relay output
- Ethernet + on/off + 0..10
- Modbus RTU + Ethernet
- Ethernet + on/off + relay output



## 2.2. SPECIFICATIONS

The table below is an overview of NMTD specifications. For details, please refer to appropriate sections of this manual.

GENERAL DATA		
Ambient humidity	< 95 % relative, non-condensing	Also see appropriate pump data for other ambient specifications.
Dimensions [--- x H]	4 1/2" x 1 1/4" (1 3/4) inches	Dimensions without wiring adapters.
Power supply and connection	5 V@500 mA supplied by the pump	6-pin connector further extended for display.

<b>MODBUS SPECIFICATIONS</b>		
Data protocol	Modbus RTU	
Modbus connector	Screwless terminals	2+1 pins. See section 7.3 "Connection to Modbus"
Modbus connection type	RS-485	
Modbus wire configuration	Two-wire + common	Conductors: A, B and COM (Common). See section 7.3 "Connection to Modbus".
Communication transceiver	Integrated, 1/8 of standard load	Connect either via passive taps or daisy chain.
Maximum cable length	1200 m	See section 7.5 "Termination".
Slave address	1-247	Default is 245, settable over Modbus. See section 7.4 "Speed, parity and address".
Line termination	Not present	Line termination is not integrated. For low speed/short distance, termination can be omitted. Otherwise, terminate the line externally on both ends.
Supported transmission speeds	1200, 2400, 4800, 9600, 19200, 38400 baud	Settable over Modbus register [default=19200].
Start bit	1	Fixed.
Data bits	8	Fixed.
Stop bits	1 or 2	1 stop bit minimum, up to 2 when parity not enabled [default=1]
Parity bit	Even/odd/none	[default=Even]
Modbus visual diagnostics	LED2	Flashing yellow when data reception detected. Combined (OR) with Ethernet ACT function.
Maximum number of Modbus devices	247	Limited by possible Modbus addresses to 247. 1/8 nominal load enables 256 devices.
Maximum Modbus packet size	256 bytes	Including address (1) and CRC (2) bytes.
Isolation	Common ground (COM) with SET1, SET2 and SET3.	Modbus shares common ground with other signals.

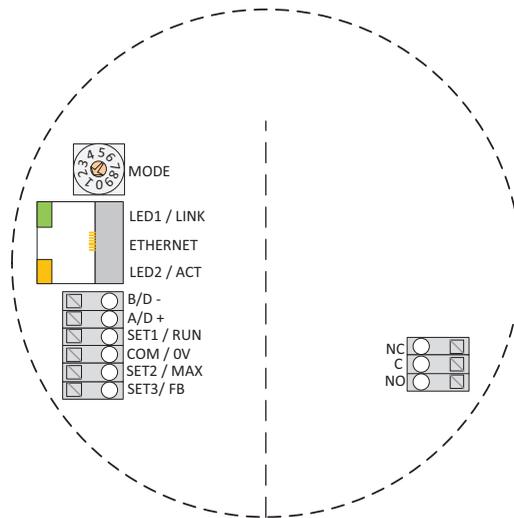
<b>ETHERNET SPECIFICATIONS</b>		
Ethernet connector	RJ-45	10BASE-T, 10Mbit/s connection.
Connection type and services	<ul style="list-style-type: none"> <li>- Web server (port 80)</li> <li>- Firmware update over web interface</li> <li>- Optional Modbus RTU over TCP/IP</li> </ul>	
Default IP address	192.168.0.245	192.168.0.246 for right twin pump.
Ethernet visual diagnostics	LED1 / LINK	Slowly blinking when module is powered, permanently lit when link established.
	LED2 / ACT	Flashing yellow when data reception detected. Combined (OR) with Modbus data reception indication.

<b>MODE SELECTION SWITCH</b>		
Adjustment	10 position rotary switch	Position read at power-on. Used for relay configuration and module configuration reset.

Analog signals (SET1, SET2, SET3)		
Input voltage range	-1..32 VDC	When used as input.
Output voltage range	0..12 V	When used as output. 5 mA max. Load allowed per output.
Input resistance	~100 kΩ	0.5 mA load is added for most configurations.
Output current sink range	0..33 mA (4-20 mA)	Current sink to COM if configured as output.

Relay specifications		
Connection type	Screwless terminals	
Rating	- 230 VAC, 3 A, AC1	Potential free changeover contact.
	- 32 VDC, 3 A	

### 3. MODULE LAYOUT



Terminal Designation	Description
MODE	Mode selection rotary switch. Used to configure mode of operation for the circuit. See section 4.3 "Module mode selection"
LED1 / LINK	Slowly blinking when module is powered. Blinking fast when Modbus Error. Permanently lit when Ethernet link established.
Ethernet	10BASE-T RJ-45 connector.
LED2 / ACT	Indicates Ethernet activity or Modbus activity.
B/D-	RS-485 negative data signal for Modbus.
A/D+	RS-485 positive data signal for Modbus.
SET1 / RUN	Control signal 1.
COM / 0V	RS-485 common and analog input common (ground).
SET2 / MAX	Control signal 2.
SET3 / FB	Control signal 3.
NC	Normally closed relay contact. Opens when relay is active.
C	Relay common contact.
NO / OK	Normally open relay contact. Closes when relay is active.

### 3.1. CONNECTION CONSIDERATIONS

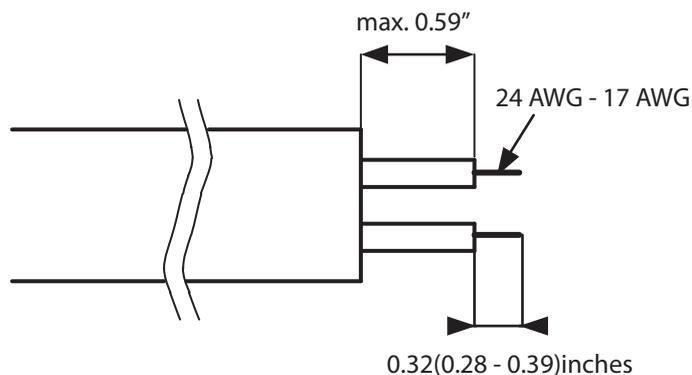
- All cables connected must be heat-resistant to at least +185 °F.
- All cables connected must be installed in accordance with EN 60204-1.
- All wires to the communications module must be connected to the terminals or cut. No loose wiring permitted.
- If voltages over 24 VAC/DC are possible on NO, C, NC terminals:



#### WARNING!

- Wires should be routed so no wire crosses the center barrier.
- Relay cable (NO, C, NC) must be separated from all other wiring with reinforced insulation.
- Cable outer layer must not be stripped longer than 15 mm. See "Cabling preparation" below.

### CABLING PREPARATION



Cable for the screwless terminals should be prepared as shown on the left.

### TOOLS



1/10 " wide flat-bladed screwdriver is needed to press the terminal spring while inserting the cable. Same tool is also used to rotate the Mode switch.

## 3.2. CONNECTING THE MODULE WIRING

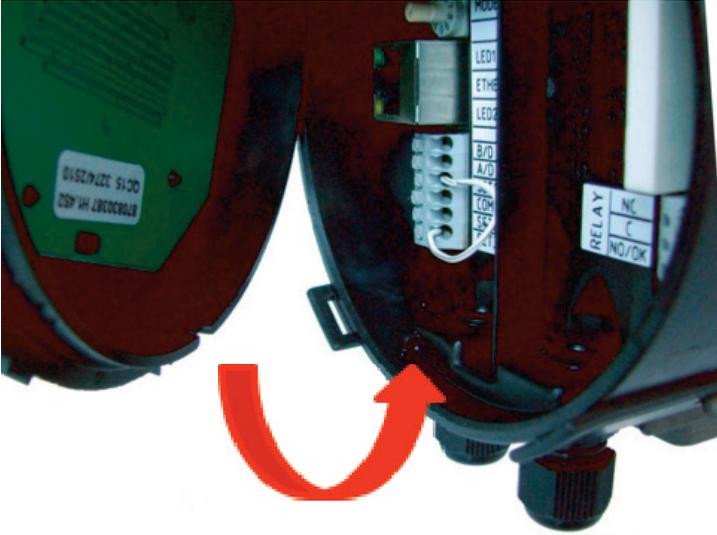
### OPENING THE COVER



**WARNING!** Before performing any work on the module, make sure that the pump and module electricity supply has been switched off and that it cannot be accidentally switched on.

Press two top hooks on the display panel (Use flat tip screwdriver if needed) and simultaneously pull display panel away from the pump.

## CLOSING THE COVER



**WARNING!** Before performing any work on the module, make sure that the pump and module electricity supply has been switched off and that it cannot be accidentally switched on.

**Note:** 7/8" max length Ethernet connector recommended. The Ethernet connection has a sharp cable bend angle and reducing the connection terminal length reduces this problem.

Make sure that the position tab and position slot are aligned.

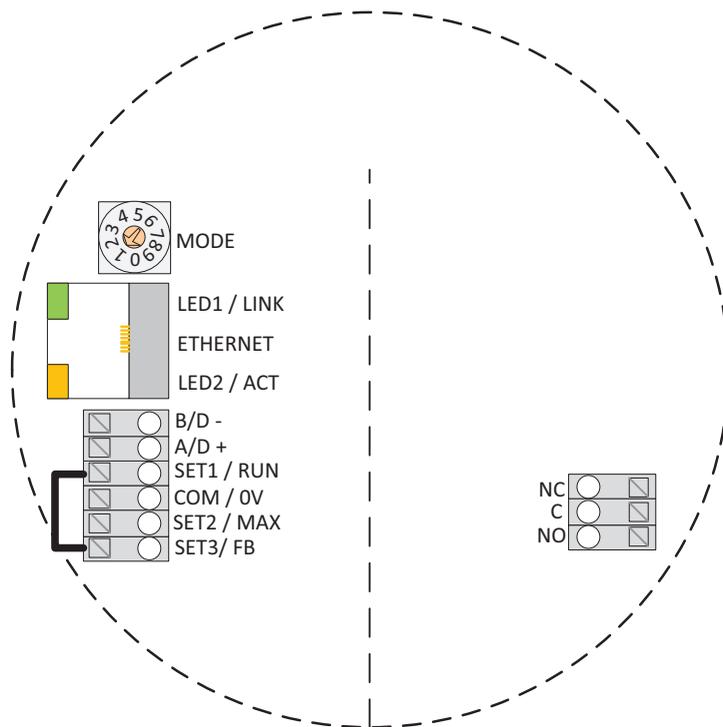


Make sure that the hooks are aligned.

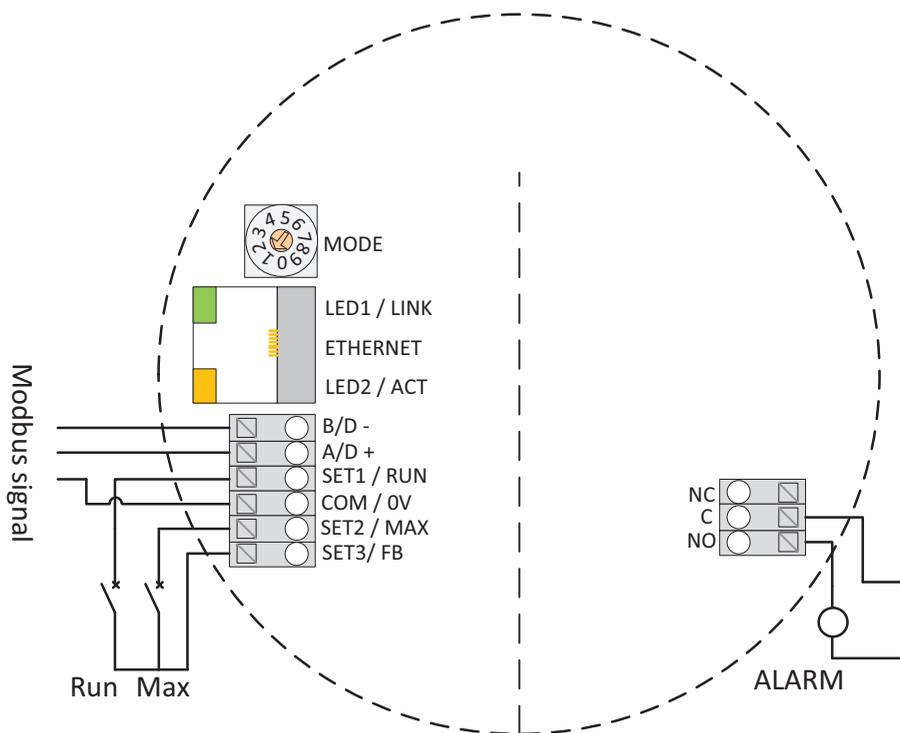
Push the display back to the NMTC module.

### 3.4. CONNECTION EXAMPLES

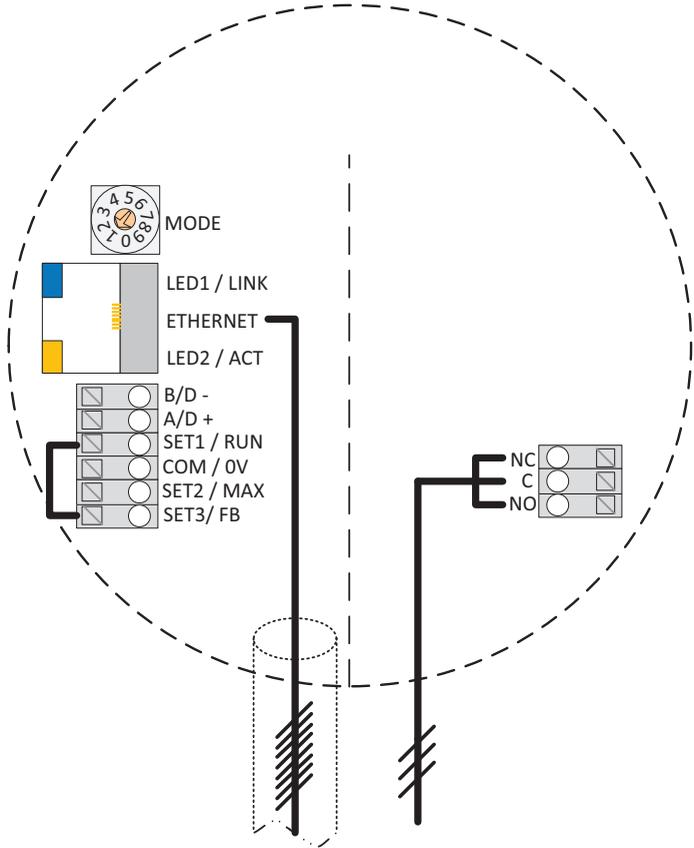
#### DEFAULT (FACTORY) CONFIGURATION



#### RELAY AND MODBUS CONNECTION



### RELAY AND ETHERNET CONNECTION



**NOTE:** To maintain pump IP protection, the network cable should be pulled through the gland inlet and then crimped to a connector.

## 4. CONTROL MODES AND PRIORITIES

### 4.1. PRIORITY OF SETTINGS

Several signals will influence the pump operation. For this reason, settings have priorities as shown in the table below. If two or more functions are active at the same time, the one with highest priority will take precedence.

Priority	Pump control panel & Ethernet settings	External signals <sup>1</sup>	Modbus control
1	Stop (OFF)		
2	Night mode active <sup>2</sup>		
3	Max. RPM (Hi)		
4		Min. curve <sup>4</sup>	
5		Stop (Run not active)	
6		Max. curve <sup>4</sup>	Stop <sup>3</sup>
7		Set point setting <sup>4</sup>	Set point setting <sup>3</sup>
8	Set point setting <sup>4</sup>		

Examples:

- Stop on the pump display panel will stop the pump, regardless of external set point.
- If External Run input is inactive, the pump cannot be started over Modbus, but can be set to max RPM on the display panel.

### 4.2. CONTROL VARIABLES

Pump will respond to external controls according to selected pump operating mode. Consult proper pump operating manual for explanation.

Symbol	Regulation mode	Module set point controls:
	Auto mode	- (RUN ONLY)
	Proportional pressure	Maximum head
	Constant pressure	Maximum head
	Constant speed	Speed (RPM)
	Combined <sup>5</sup>	- (Web interface only)
	Night mode <sup>6</sup>	- (RUN only)

<sup>1</sup>Not all inputs are available in all modes.

<sup>2</sup>External and Modbus Stop signals become active in night mode. Due to possible confusion, use of night mode is discouraged while using external control.

<sup>3</sup>Only available when pump is bus controlled.

<sup>4</sup>Not available when pump is bus controlled.

<sup>5</sup>Multiple limits can be set. Not available on all pumps.

<sup>6</sup>Night mode is not independent regulation mode.

### 4.3. MODULE MODE SELECTION



**WARNING!** Before performing any work on the module, make sure that the pump and module electricity supply has been switched off and that it cannot be accidentally switched on.

There is a mode selection rotary switch in the terminal box. It can be rotated by gently inserting a screwdriver into the arrow mark on top and rotating the switch to desired value.

Mode switch position	Function	Description
0	Free configuration	Terminal functions are configured over Ethernet interface.
1	Mode 1 Factory Default	SET1 = RUN input SET2 = MAX input SET3 = FB (10.5 V) output, used to supply RUN and MAX inputs. External voltage source can also be used. RS-485 = Modbus interface. See section "4.4 Mode 1". <b>Application: 0-10 VDC Speed or head control, external OFF</b>
2	Mode 2	SET1 = RUN input SET2 = SPEED input SET3 = FB (10.5 V) output, used to supply RUN and MAX inputs. External 5-24 V voltage source can also be used. RS-485 = Modbus interface See section "4.5 Mode 2".
3...5	RESERVED	Reserved for future or customer specific use.
6	Show relay configuration	LED1 and LED2 will show relay configuration. See section "5 Relay output".
7	Change relay configuration	Relay configuration will be increased (0->1, 1->2, 2->0) when electricity is turned on. LED1 and LED2 will show current relay configuration. See section "5 Relay output".
8	Twin reset to factory	Same as Mode 9, with exception of: module IP address is set to 192.168.0.246 Twin IP address is set to 192.168.0.245
9	Reset to factory	This mode will set communication interface to default values. Main purpose is to restore default settings.  <b>NOTE:</b> <ul style="list-style-type: none"> <li>• Disconnect any SET1, SET2 and SET3 connections when using this mode to prevent possible harm to controller. SET1, SET2, SET3 will output test voltages of 10 V, 7 V and 5 V respectively. RS-485 port is actively driven. Relay will cycle. This is used for testing purposes.</li> <li>• It is recommended that all module wires are disconnected to prevent possible harm to external controllers.</li> </ul>

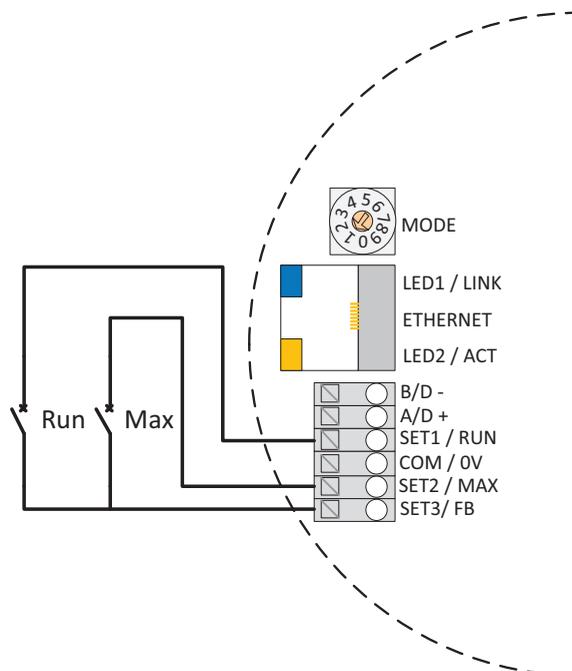
## 4.4. MODE 1

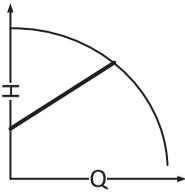
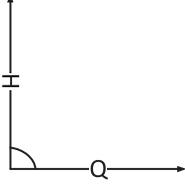
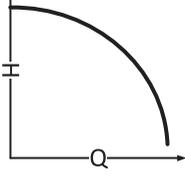
Mode 1 is most often used mode of operation. It has 2 pre-prepared inputs that can be used for either digital control or with analog control voltages. Additional 10.5V output provides voltage feedback for analog or digital control.

Terminal designation	Signal function
SET1 / RUN	RUN input. Signal load 0.5 mA.
COM / 0V	Common ground for voltage input.
SET2 / MAX	MAX input. Signal load 0.5 mA
SET3 / FB	10.5 V feedback voltage for SET1 and SET2.

### DIGITAL (SWITCH) CONTROL

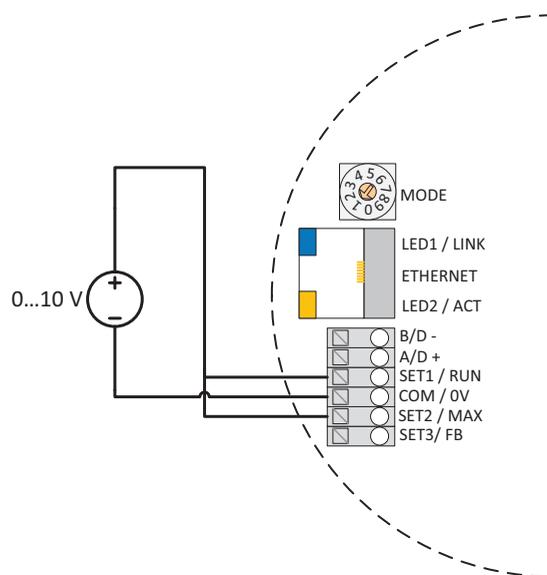
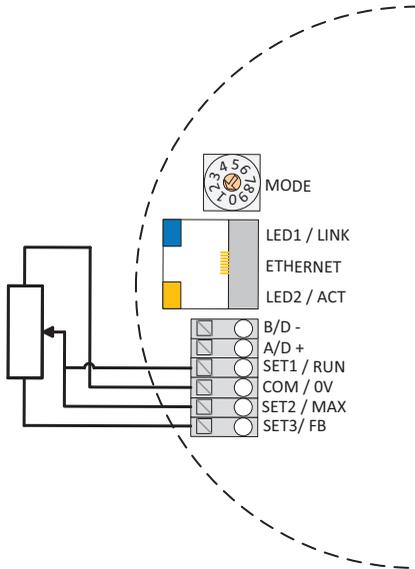
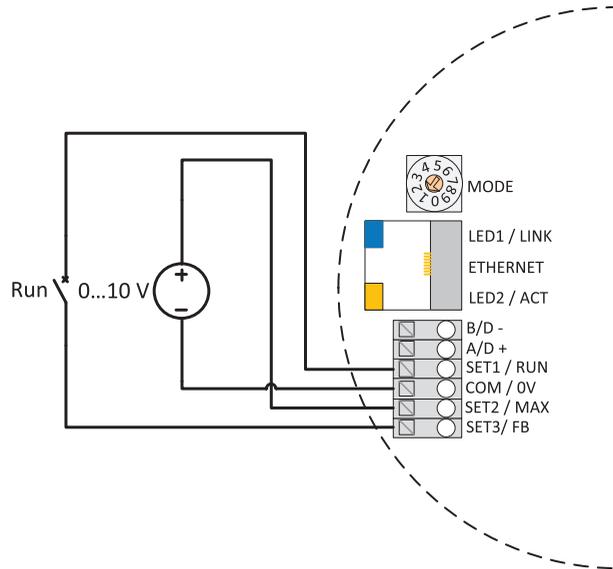
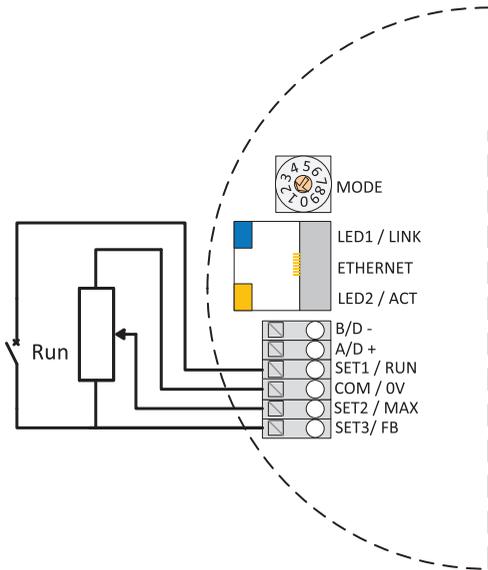
#### COMMON MODE 1 CONNECTION CONFIGURATIONS (SWITCH)



Contact position		Function	Description
RUN	MAX		
SET 3/FB  SET 1/RUN	SET 3/FB  SET 2/MAX	Stop the pump	The pump is stopped
SET 3/FB  SET 1/RUN	SET 3/FB  SET 2/MAX	Start the pump	The pump will run with internal set point 
		Minimum curve	The pump will run with minimal speed for selected regulation mode 
		Maximum curve	The pump will run with maximum speed form selected regulation mode 

# ANALOG (SWITCH) CONTROL

## OPTIONAL MODE 1 CONNECTION CONFIGURATIONS (ANALOG)



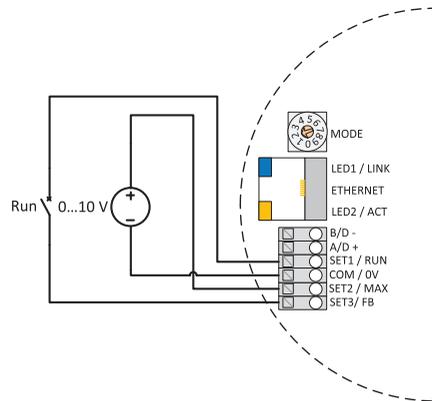


## 4.5. MODE 2

Mode 2 is used for external 0..10V voltage control.

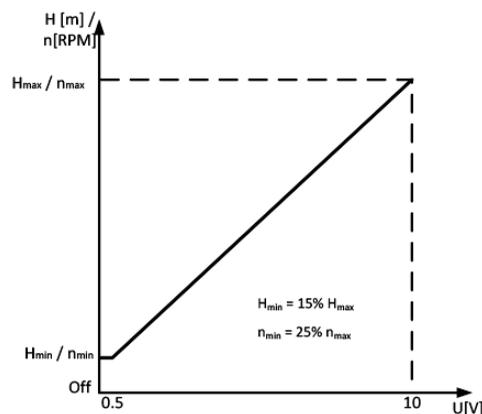
Terminal designation	Signal function
SET1 / RUN	RUN input. Signal load 0.5 mA.
COM / 0V	Common ground for voltage input.
SET2 / MAX	SPEED input. Signal load 0.5 mA
SET3 / FB	10.5 V feedback voltage for SET1 and SET2.

### MODE 2 CONNECTION CONFIGURATIONS



RUN voltage	MAX voltage	Function
< 2 V	0..10 V	Pump stopped
> 3 V	0..10 V	

Figure 3: External 0..10 V transfer curve for Mode 2



## 5. RELAY OUTPUT

Terminal designation	Terminal description
MODE	Mode selection rotary switch. Used to show and configure mode of operation for relay.
LED1 / LINK	Slowly blinking when module is powered, permanently lit when link established <sup>7</sup> .
LED2 / ACT	Flashing yellow when data reception detected. Combined (OR) with Modbus data reception indication <sup>7</sup> .
NC	Normally closed relay contact. Opens when relay is active.
C	Relay common contact.
NO / OK	Normally open relay contact. Closes when relay is active.

The module contains one status relay, used to signal pump operation or malfunction. See table following for functionality.

Relay configuration	Output status	Description	Relay position	LED status <sup>7</sup>	
				LED 1	LED 2
0	Error [default]	Only active when the pump is powered up and detects a problem with operation.			
1	Ready	The relay signal is active when the pump is ready for operation.			
2	Operation	The relay signal is active as long as the pump is operating. If the pump comes to a stop or an error occurs, relay will deactivate.			
-	-	Relay output not active.			

Relay configuration number can be modified by either the web interface, Modbus register 012 or the Mode switch.

## 6. ETHERNET

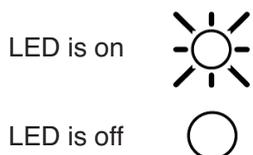
Terminal designation	Description
MODE	Can be used to reset network configuration
LED1 / LINK	Slowly blinking when module is powered, permanently lid when link established.
Ethernet	10BASE-T RJ-45 connector.
LED2 / ACT	Indicates Ethernet activity or Modbus reception.

The communications module has a built in web server which allows you to access your pump directly from an existing Ethernet network. Direct connection to a computer is also possible with a crossover cable.

The web server uses HTML pages to set/view:

- Regulation mode settings
- Regulation parameters (power, RPM, head, flow, efficiency)
- Relay settings
- External control inputs
- Current and previews error
- Pump statistics (power consumption, run time and other).

<sup>7</sup>When mode Mode 6 or Mode 7 is selected, LED1 and LED2 will show relay configuration. See section “4.3 Module mode selection”



## 6.1. BUS TOPOLOGY

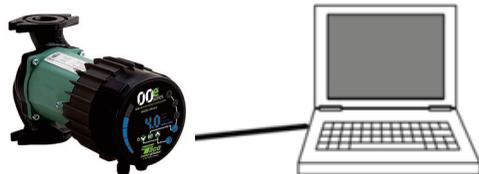


Figure 4: connecting to a computer with a crossover cable

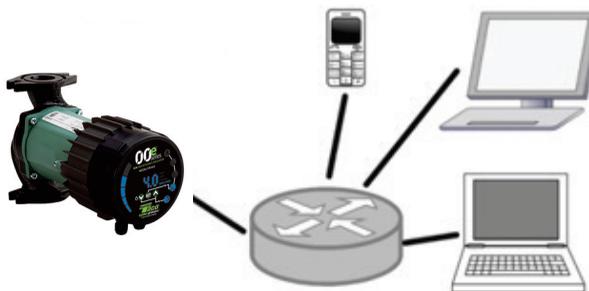


Figure 5: connecting to a network via router

## 6.2. CONNECTING TO PUMP AD-HOC

When connecting directly with the computer, Ethernet must be used to connect with the pump. The pump can then be accessed by typing IP address “192.168.0.245” or “00e” (or “192.168.0.246” or “00e2” if it is a left twin pump) in to your web browsers address bar.

The computer must be set up to have a dynamic IP address.

## 6.3. CONNECTING TO PUMP VIA ROUTER

When connecting via a router, Ethernet must be used to connect with the pump. The pump can then be accessed by typing IP address “192.168.0.245” or “00e” or “192.168.0.246” or “00e2” if it’s a left twin pump in to your web browser’s address bar. The computer must be set up to have a dynamic IP address.

## 6.4. PUMP CONFIGURATION OVER ETHERNET

Pump configuration is possible via HTML pages that offer different options:

1. **Overview** (default page when you connect to the pump, web page OVERVIEW) displays pump operation summary i.e.:

- Operating mode,
- Power consumption,
- Head,
- Estimated flow,
- RPM
- Estimated efficiency,
- Priority set point,
- Mode switch position
- Input/output status
- Replay status
- Error code
- Twin pump status
- Night mode status
- Motor temperature
- Heat sink temperature,
- Number of restarts.

2. **Pump settings** (web page PUMP) is meant to provide regulation and control (input and output) settings. It has control over:
- Operation mode
  - Head limit(depending on pump mode)
  - RPM limit (depending on pump mode),
  - Ratio between head and flow HQ (depending on pump mode)
  - Input/output control.
  - Relay control.

Setting can be saved to permanent memory by pressing the SAVE button.

3. **Network settings** (web page NETWORK) provide a way to change network configuration:
- NetBIOS name - is a local network name service. Instead of '192.168.0.245' you can for example use 'http://00e'. Default: 00e,
  - Pump IP address - is a pump network address. The pump is seen as http server on this address, default: 192.168.0.245,
  - DHCP server - provides lease for "point to point" connection (cross-over cable to computer for example). Will disable itself if another DHCP server is found,
  - DHCP client will automatically acquire DHCP address from the network,
  - Default gateway – provides connection route to larger networks. This is usually a router address, default: 192.168.0.1,
  - Subnet mask - sets subnet address range that is on the same subnet and can be reached directly. The rest of communication goes over the gateway, default: 255.255.255.0,
  - Twin mode with IP - will connect two pumps for alternating operation. When two pumps are configured for twin mode, they will switch about once per day. Setting this field to inexistent IP will disable this option! Set it so the first pump references the second and vice versa. Default: 192.168.0.246.

Setting can be saved to permanent memory by pressing the SAVE button.

4. **Log** (web page LOG) displays possible previous and current errors.
5. **MORE** (web page MORE) has link to additional manuals and tools that might be available. Has an option to update NMTC modules software, by user inputted software file (available at your local serviceman or our webpage).
-

## 7. MODBUS

### 7.1. MODBUS RELATED INTERFACE

Designation	Description
MODE	Can be used to reset network configuration.
LED2 / ACT	Indicates Ethernet activity or Modbus reception.
B/D-	RS-485 negative data signal for Modbus.
A/D+	RS-485 positive data signal for Modbus.
COM/0V	RS-485 common and analog input common (ground).

### 7.2. BUS TOPOLOGY

NMTC is a Modbus slave, connected directly to a Modbus RTU network. Connection can be made in either daisy chain style (if cabling allows such a connection) or a limited length passive tap. Schematic example is in Figure 6.

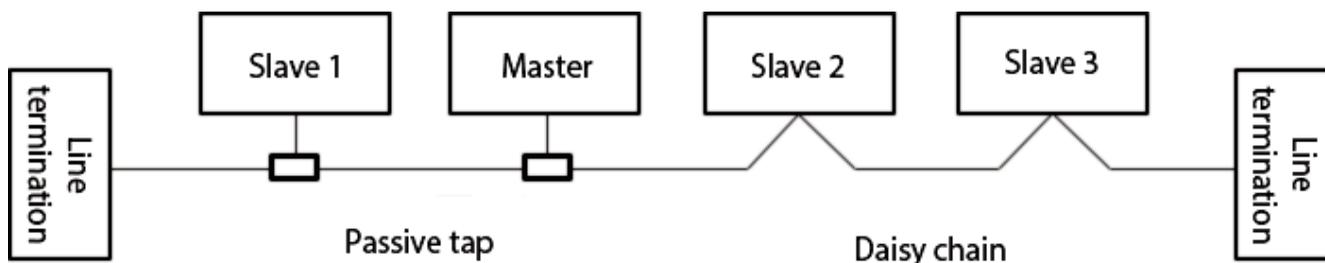


Figure 6: Example of Modbus network

Typically, only one master device is connected to the serial bus, and one or several slaves are also connected to the bus. Slaves do not communicate with each other and will never transmit data without receiving a proper request from the master device.

Up to 32 single load devices can be connected to one RS-485 Modbus system without using a repeater. As this module is a 1/8 load device, up to 256 modules can be connected to the bus. Repeaters can be used to extend the maximum transmission distance and increase device count if needed.

### 7.3. CONNECTION TO MODBUS

A screened, twisted-pair cable should be used. The cable screen must be connected to the COM terminal and connected to safety ground at one point.

### 7.4. SPEED, PARITY AND ADDRESS

By default, each device is set to 19200-E-1 (even parity), address 245.

Properly set registers in section “7.7 Controller Configuration register block” to configure each device before connecting it to existing network. Optionally power each device one by one, configuring the settings before adding another one.

There are several ways to restore forgotten Modbus connection settings:

- 1) Configure the module over Web interface. See section 6 “Ethernet”.
- 2) Reset the module to factory defaults. See Mode 9, section “4.3 Module mode selection”.
- 3) If only address is unknown, Modbus “broadcast” (0x00) address can be used to write new address. Use carefully as the value will be written to all connected devices.

### 7.5. TERMINATION

Control module contains neither termination nor bias circuitry. RS-485 wiring should be externally terminated if needed.

For short wiring and/or low baud rate, interface can operate without termination. However it is recommended that termination (~150 ohm resistor) is added on both ends of bus wiring. There are wiring length limits regarding to speed and termination:

Maximum speed [baud]	Maximum cable length [ft]
38400	4000, terminated cable
9600	4000
19200	1800
38400	900

**NOTE:** Any branch/derivative cable is considered unterminated. Keep them short, below 250m combined for maximum speed and reliability.

## 7.6. REGISTER BLOCK OVERVIEW

Controller Modbus RTU registers are grouped in the following register blocks:

Start address	Register block	Readable/Writable	Description
001	Controller configuration	R/W	Configuration of the Controller module.
021	Controller status	R	Status registers for the Controller module.
101	Pump control	R/W	Pump control registers.
201	Pump status	R	Status data from the pump.
301	Pump data	R	Measured data from the pump.

All addresses contain 16 bit (one Word) registers. Some are bit interpreted while others are combined for a 32 bit value.  
**NOTE:** All register addresses are 1-based. Address 001 is thus transmitted over bus as 0x0000.

## 7.7. CONTROLLER CONFIGURATION REGISTER BLOCK

Registers in this block are read with either function codes 0x03 or 0x04. They can be written as holding registers with function codes 0x06 and 0x10.

**NOTE:** All values in this block are stored in nonvolatile memory immediately after write.

**NOTE:** See section “4.3 Module mode selection” and use Mode 8 or 9 to restore default settings if you cannot access the controller after writing to these registers.

Address	Register name	Range	Resolution	Description
001	SlaveDelay	0..10000	1 ms	Delay in milliseconds for slave reply. This delay will be added to every Modbus reply [default = 0].
002	RESERVED			
003	ModbusAddress	1..247	1	Modbus address [default = 245].
004	BitRate	0..5	1	Modbus transmission speed enumeration. 0 = 1200 baud 1 = 2400 baud 2 = 4800 baud 3 = 9600 baud 4 = 19200 baud [default] 5 = 38400 baud
005..008	RESERVED			
009	Parity	0..2	1	Parity setting to be used for communication. 0 = No parity 1 = Even parity [default] 2 = Odd parity
010	StopBits	1..2	2	Stop bits used for communication. 2 stop bits will only be used when "Parity" is set to 0. 1 = 1 stop bit [default] 2 = 2 stop bits
011	RESERVED			
012	RelayControl	0..2	1	Configures module relay output. 0 = indicates fault 1 = indicates pump ready 2 = indicates pump operation See section "5 Relay output".

## 7.8. CONTROLLER STATUS REGISTER BLOCK

Registers in this block are read with either function codes 0x03 or 0x04. They are read-only. This block can be used for various kinds of fault finding.

Address	Register name	Resolution	Description
021..022	RESERVED		
023	SoftwareVersion	0.1	Module software version
024..029	RESERVED		
030	ProductVersion	1	Product version [32x for NMTC module, x denotes hardware revision]
031	RESERVED		
032	SoftwareVersion	0.1	Module software version [10 = 1.0]

## 7.9. PUMP CONTROL REGISTER BLOCK

Registers in this block are read with either function codes 0x03 or 0x04. They can be written as holding registers with function codes 0x06 and 0x10

Address	Register name	Range	Description
101	ControlReg	b0: RemoteAccess	Control bit that sets local or remote control. Setting this bit will enable pump control over Modbus. 0 = Local 1 = Remote (controlled by Modbus master).
		b1: OnOffReq	Control bit that switches the pump on or off. 0 = Off (stop) 1 = On (start).
		b2..15: RESERVED	-
102	AltControlMode		Alternative Control mode. Use of register 108 is preferred. Sets the control mode enumeration. 0 = ConstantRPM 1 = ConstantRPM 3 = ConstantHead 4 = ConstantHead 5 = ConstantHead 6 = ProportionalHead 128 = AutoHeadMode <b>NOTE:</b> values outside this range reserved.
103	OperationMode		RESERVED
104	SetPoint	0.. 10000	Sets desired pump set point. 0 will stop the pump. 10000 will set the pump to maximum output for desired mode. Values outside of valid range will cause the pump to operate with front panel set values.
105	RelayControl	0..2	Configures relay output. 0 = indicates fault 1 = indicates pump ready 2 = indicates pump operation See section "5 Relay output".
106...107	RESERVED		
108	ControlMode	0..3	Sets the pump control mode. 0 = AutoHeadMode (Automatic head mode) 1 = ProportionalHead (Head proportional to flow) 2 = ConstantHead (Head is kept constant) 3 = ConstantRPM (Speed is kept constant)  <b>NOTE:</b> values outside this range reserved. See section "4.2 Control variables" for exact parameter to be controlled.

## 7.10. PUMP STATUS REGISTER BLOCK

Registers in this block can be read by means of function codes 0x03 and/or 0x04. They are read-only.

Address	Register name	Description
201	StatusReg	
	b0..b5: RESERVED	-
	b6: Rotation	Indicates if the pump is rotating (running) or not. 0 = No rotation 1 = Rotation.
	b7: RESERVED	
	Bit 8: AccessMode	Indicates if the pump is locally or remotely controlled. 0 = Local (a source with higher priority controls the pump) 1 = Remote (controlled by Modbus master).
	Bit 9: IsOn	Indicates if the pump is on or off. 0 = Off 1 = On It not necessarily indicate rotation as an error might stop the pump.
	Bit 10: Error	Indicates if there is a problem with proper operation. 0 = No problem 1 = Error present. Pump might still run.
	Bit 11: RESERVED	-
	Bit 12: RESERVED	-
	Bit 13: NearMaxSpeed	Indicates if the pump is running near maximum speed. 0 = No 1 = Yes. This flag is set when power or speed is over 95% of rated maximum.
	Bit 14: RESERVED	-
	Bit 15: NearMinSpeed	Indicates if the pump is running near minimum speed. 0 = No 1 = Yes. This flag is set when speed falls below 1/3 of rated maximum.
202	RESERVED	(TBD)
203	ControlMode	Indicates the actual control mode. 0 = ConstantRPM 1 = ConstantRPM 3 = ConstantHead 4 = ConstantHead 5 = ConstantHead 6 = ProportionalHead 128 = AutoHeadMode.
204	RESERVED	
205	ErrorCode1	Current first error code. 0 - when pump is operating without problems. This value will always be non-zero when there is an error present. See section "8.1 Error codes" for code details.

206	ErrorCode2	Second error code. Non-zero when there is more than one error. See section “8.1 Error codes” for code details.
207	ErrorCode3	Third error code. Non-zero when there is more than two errors. See section “8.1 Error codes” for code details.
208	Control Mode	Indicates the actual control mode. 0 = AutoHeadMode (Automatic head mode) 1 = ProportionalHead (Head proportional to flow) 2 = ConstantHead (Head is kept constant) 3 = ConstantRPM (Speed is kept constant). NOTE: values outside this range reserved. See section “4.2 Control variables” for exact parameter to be controlled.

## 7.11. PUMP DATA REGISTER BLOCK

Registers in this block can be read by means of function codes 0x03 and/or 0x04. They are read-only.

Modbus address	Register name	Range	Resolution	Description
301	Head		0.01 m	Pump head estimation in meters of water column.
302	Flow		0.1 m <sup>3</sup> /h	Pump flow estimation.
303	Efficiency		0.01 %	Estimated pump efficiency.
304	Speed		1 rpm	Motor speed.
305	Frequency		0.1 Hz	Motor frequency [100.0 Hz for 3000 rpm and 4 pole motor].
306..307	RESERVED			
308	ActualSetPoint	0..10000	0.01 %	Indicates actual set point of the pump. (-1 for internal pump regulation). tbd
309..311	RESERVED			
312 313	PowerHI PowerLO	0..2 <sup>32</sup>	1 W	Total power consumption of the system.
314..317	RESERVED			
318	CircuitTemp	-5500.. 16000	0.01 °C	Power electronics hotspot temperature.
319	MotorTemp	-5500.. 16000	0.01 °C	Motor compartment temperature.
320..321	RESERVED			
322	LiquidTemp	-5500.. 16000	0.01 °C	Liquid temperature.
323..326	RESERVED			
327 328	OperationTimeHI OperationTimeLO		1 hour	Total operation time (above zero speed) of the pump. <sup>8</sup>
329 330	TotalPoweredTimeHI TotalPoweredTimeLO		1 hour	Total power-on time of the module. <sup>8</sup>
331	RESERVED			
332 333	EnergyHI EnergyLO		1 kWh	Total energy consumption of the system. <sup>8</sup>

<sup>8</sup> Not available on all models.

## 8. FAULT FINDING

### 8.1. ERROR CODES

The following codes will show up on display panel and on the appropriate Modbus registers to help you diagnose the cause of improper operation.

Error code	Description	Probable cause
<i>E1x</i>	<i>Load errors</i>	
E10 (drY)	Low motor load	Low load detected. Pump is running dry.
E11	High motor load	Motor might be faulty or viscous medium is present.
<b>E2x</b>	<b>Protection active</b>	
E22 (hot)	Converter temperature limit	Circuit is too hot and power was reduced to less than 2/3 of rated power.
E23	Converter temperature protection	Circuit is too hot to run, pump stopped.
E24	Converter overcurrent	Hardware overcurrent protection triggered.
E25	Overvoltage	Line voltage is too high.
E26	Undervoltage	Line voltage is too low for proper operation.
<i>E3x</i>	<i>Pump errors</i>	
E31	Software motor protection active	Average motor current was too high, pump load is much higher than expected.
<b>E4x</b>	<b>Device specific error codes</b>	<b>Electrical circuitry did not pass self-test.</b>
E40	General frequency converter error	One of the display segment diodes is faulty (open/short).
E42 (LEd)	LED faulty	Display board does not detect proper connection to main board, but power supply is present.
E43 (con)	Communications failed	Voltage on DC link shunt (R34) not in expected range.
E44	DC link current offset	During MFG. TEST, this is 10 kΩ, 1% resistor for 10 °C..30 °C During operation, expected values are -55 °C..150 °C.
E45	Motor temperature outside limits	During MFG. TEST, this is 0 °C..50 °C. During operation, expected values are -55 °C..150 °C.
E46	Circuit temperature outside limits	During MFG. TEST, this is 0 °C..50 °C. During operation, expected values are -55 °C..150 °C.
E47	Voltage reference outside limits.	Comparison between internal references does not match.
E48	15V outside limits	15 V supply not 15 V.
E49	Test load does not match	No test load detected or current measurement does not work properly (MFG. TEST).
<b>E5x</b>	<b>Motor error codes</b>	
E51	Motor parameters out of range	Motor does not operate as expected.



Taco, Inc., 1160 Cranston Street, Cranston, RI 02920 | Tel: (401) 942-8000 | FAX: (401) 942-2360

Taco (Canada), Ltd., 8450 Lawson Road, Suite #3, Milton, Ontario L9T 0J8 | Tel: (905) 564-9422 | FAX: (905) 564-9436

Visit our web site: [www.TacoComfort.com](http://www.TacoComfort.com) | Printed in USA | ©2015 Taco, Inc.

