Tornado F-5
Motor Controller

Operator Manual

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Global Production Solutions

Tornado F-5 Motor Controller
OPERATOR MANUAL

Revision 8.5

Change Log

Rev	Date	By	Description
8.5	Apr-25-2012		Updated schematics: switchboard app specific fuses & noted wider allowed 3-phase voltage range. GPS. Added RS-485 pin descriptions. DI & AI examples clarified. Noted firmware version. Formatting.

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Chapter

1 Specifications

Motor Controller Unit

- Size (w x l x h): 5.87" x 7.62" x 2.00" (base plate dimensions)
- Weight: 2.5 pounds
- NEMA rating: NEMA 1
- Power: 110V AC (+- 10%), 0.25A load
- Digital Inputs: 2 Each 120 Volts AC Inputs
- Analog Inputs: 2, 0-10VDC full scale. Only AI1 has high and low set points.
- Current Transformer (CT) Inputs: 3: one for each phase. CT range is 0-5 Amps and should be set according to the tap point during installation to obtain correct operation.
- Power Transformer (PT) Input: 1: PT input is at Pins 1 and 2 on the Control Unit, and monitors the voltage between Phase A and Phase C.
- Hand/Off/Auto: Control Unit has inputs for manual (Hand) or auto (Auto) operational control.
- Outputs: 3: Motor Contactor, Amber indicator and Red indicator closure for front panel indicators. Output may be 110VAC or Ground, depending on relay common configuration.

Communications Ports: Comm 1a, Comm 1b, and Comm 2.

Motor Controller Comm 1 has two connectors for serial communications ports 1a and 1b. The RS-232 serial protocol is available at the Comm 1b port or the RS-485 protocol is available at the Comm 1a port. The RS-232 Comm1b port uses a DE9 9-pin connector. The RS-485 protocol port Comm1a use a 5-pin Phoenix connector. Comm 1 is the primary channel for external communications.

The Comm 2 port is configured only for RS-485 (with two RJ45 type connectors), and is used to interface to the Operator Display, Backspin Relay and/or Data Logger unit for Modbus messaging.

Standard protocol control serial port settings are 9600 bps baud rate, 8 data bits, no parity bit, one stop bit, and no flow control.

The operation described is that of firmware version 9.1.

Display Unit Specs

- Size (w x l x h): 3.10" x 4.25" x 1.37" (excludes mounting tabs)
- Weight: 0.5 pounds
- NEMA Rating: NEMA 1
- Power: Derives power via the RJ45/CAT5 communications cable from the motor controller. Approximately 0.05 A load.
- Display: The unit is equipped with an operator's panel equipped with four pushbutton micro-switches and one display and a four-line 20-Character Display. The micro-switches enable the user to scroll through the unit’s parameters, their settings & status.
- Communications: 1 port. Comm. 1 has two RS-485 ports (RJ45 type connectors) either of which may be used interchangeably. Comm. 1 interfaces to the Motor Controller.

Chapter

2 Overview

Safety Warnings

Read and follow all Warnings, Precautions, Notes, and Instructions included in this document.

- A Warning identifies an immediate hazard that exists that poses some probability of causing death or serious injury.
- A Caution identifies potential conditions and actions that have the possibility of death or severe injury.
- A Note identifies the need for general safety practices which, if violated, could cause injury to personnel or damage to equipment.

High voltages are exposed during operation. Do not touch exposed surfaces during test.

Caution Verify wiring connections prior to applying power to the system. Damage to the equipment could result from incorrect connections.

Note Inspect system ground and bonds prior to power application. Shock hazard could exist if proper ground is not maintained.

Motor Control Unit

Warning

The Motor Control unit derives its power from the Power Transformer (PT), which is connected to the high voltage lines into the switchboard. High voltages are present during operation and set-up, and should be considered hazardous.

Specific connections for the Motor Control unit as well as parameter definition and values are given in other sections in this manual. In this section, an overview will be provided as an introduction to the operation of the Motor Control unit. See figure 1 and pin descriptions.

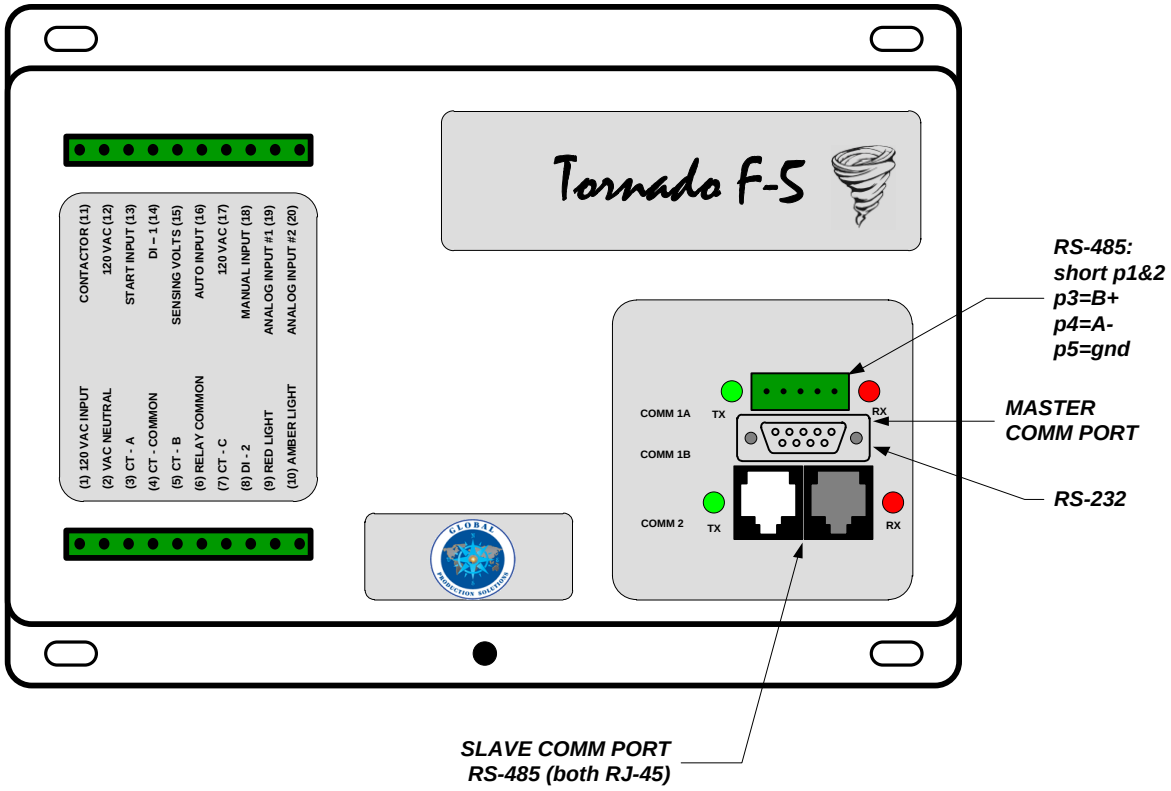


Figure 1 - Motor Controller Unit Connectors

PINS 1 & 2 (Power Transformer (PT) Down-Stepped F-5 Input: Phases A and C)	These two pins are connected to the PT, and provide the voltage base between Phase A and Phase C of the motor input power. The voltage is expected to be 120 VAC, and achieves this value through tap settings on the PT. Care must be taken to ensure the correct PT tap is set to prevent possible damage to the Motor Control unit.
PINS 3, 4, 5, & 7 (Current Transformer)	These pins are associated with the Current Transformers (CT). Pins 3, 5, and 7 are the inputs from the CT's associated with the three phases of current flowing to the motor. Pin 4 is the common for the three taps. The CT's are all 0-5 amp range, and must have the proper tap setting to provide the correct sensing and check values during system operation. The tap setting should be the lowest that will permit the CT to maximize the amps/amp range of the input, with some allowance for over current occurrences. In conjunction with the CT inputs, the Motor Controller has parameter set points for over and under current sensing conditions. These provide motor shutdown signals as required for motor safe operation. There is also a start-up time delay that allows the motor to come to normal operation before the over/under sensing begins.
PINS 6, 12, & 17 (AC Power & Common for External Devices)	These pins provide AC power and Common for use with switches, relays, or other devices requiring AC power. Pin 6 can be tied to Pin 1 to switch hot, or Pin 2 to switch neutral.
PINS 8 & 14 (Digital Inputs)	These are the Digital Inputs and can be used with dry type contacts. They can be used as normally open (NO) or normally closed (NC) configured sensors, as determined by the parameter setting for each. Their use is installation requirement driven.
PIN 9 (RED Indicator Output)	Will normally be ON in any of these cases: - An alarm is active - Last shutdown caused by alarm configured as Lockout - Hand/Off/Auto switch is in OFF or HAND position
PIN 10 (Amber Indicator Output)	Will normally be on for any of the following conditions: - All alarms are clear - Automatic restart will occur on delay timeout complete if H/O/A switch in Auto position
PIN 11 (Contactor Output & Green Indicator Output)	Enables motor contactor to energize, turning on motor. A green indicator may be tied to this AC line for a motor running indication.
PIN 13 (Start Input)	Start button at front of switchboard. Causes motor to start if all conditions are correct.
PIN 15 (Phase AB Input)	Sensing input point if phase AB is to be sensed and monitored. A second PT will have to be installed for this function.
PIN 16 (Auto Input)	Input from AUTO position of the Hand/Off/Auto (H/O/A) switch.
PIN 18 (Manual Input)	Input from the HAND position of the H/O/A switch.
PIN 19 & 20 (Analog Input)	0-10 VDC analog input control signals. Or, 4-20mA when using high-precision shunt resistors.

Operator Display

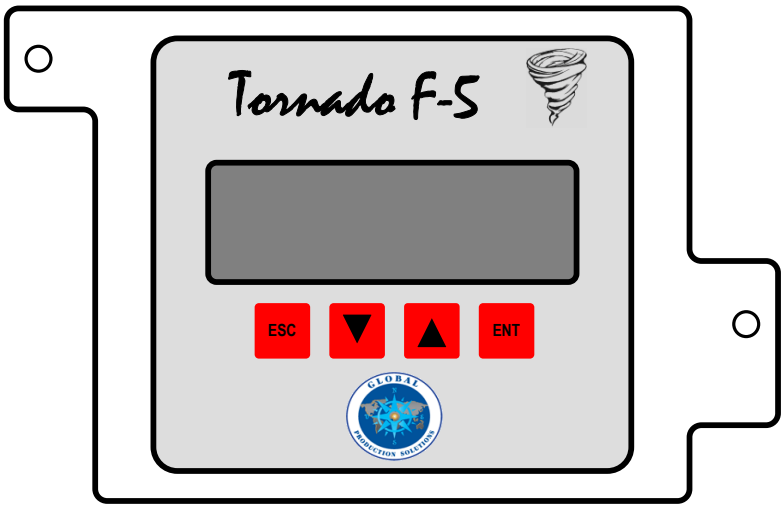


Figure 2 - Operator Display

The Operator Display unit can be either a permanently installed device, or plugged in as desired to check and/or set system operating parameters. The unit is plugged into the Comm. 2 port using an RJ-45 type connector. The ESC arrow key permits the operator to switch back to the last menu. Once the selection is made via the ENT (Enter) key, the UP and DOWN arrow keys permit the operator to increase the displayed value (UP) or decrease the value (DOWN) to arrive at the desired parameter or set point. Once the desired point is reached, the ENT (Enter) key can be pressed to enter the data into the motor controller memory.

Chapter

3 Personal Computer (PC) Interface

An application support program is provided to support the Motor Controller in a fashion similar to the Operator Display. Through the Comm. 1 interface (either RS-232 or RS-485), a PC can, using the same key convention as the Operator Display unit, select, view, and set the various parameters in the Motor Controller. Standard RS-232 serial port settings are listed in the specs section at the beginning of this document.

In addition to the functions of the Operator Display, a PC can also make status checks of analog and digital inputs, check the current value of current measurements on CT1, CT2, and CT3, check the status of the light outputs (RED and AMBER), and other items of operational interest that have been saved in the Motor Controller memory.

Chapter

4 Installation

The Motor Control unit derives its power from the Power Transformer (PT), which is connected to the high voltage lines into the switchboard. High voltages are present during operation and set-up, and should be considered hazardous.

Control Unit Installation

The Motor Controller is easy to install. A typical switchboard wiring diagram is in Figure 4. The settings required for the parameter list must be determined prior to turning on the unit, and must be entered prior to attempting to operate a downhole motor unit.

Any fault that cannot be cleared must be resolved before continuing in the operation. Faults should not be bypassed or overridden without explicit understanding of the underlying reasons for that fault.

Operator Display Installation

The Operator Interface can be mounted inside the ammeter enclosure using the existing hardware.

There are no special connections required for the Operator Display. A typical installation is shown in Figure 3, with the cable being an industry standard UTP patch cord.

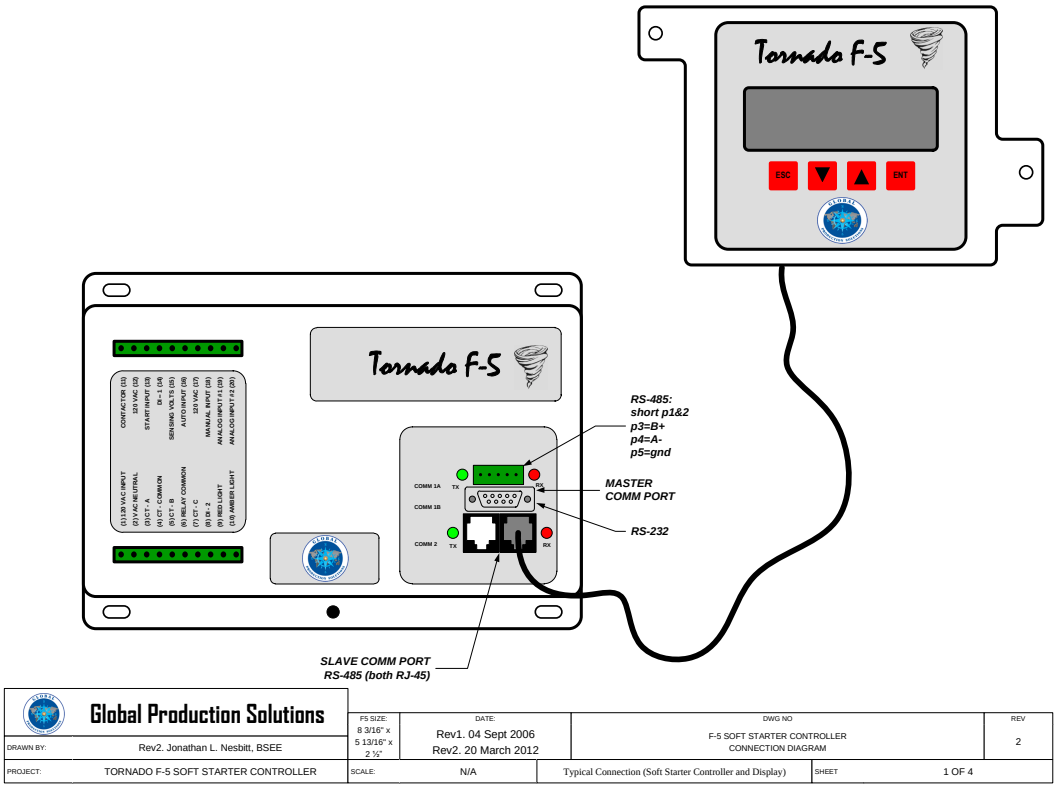


Figure 3 - Display & Controller Comm Port Connections

See the next figure for typical switchboard schematic connections to the motor controller. This configuration is often used in Electric Submersible Pump (ESP) applications.

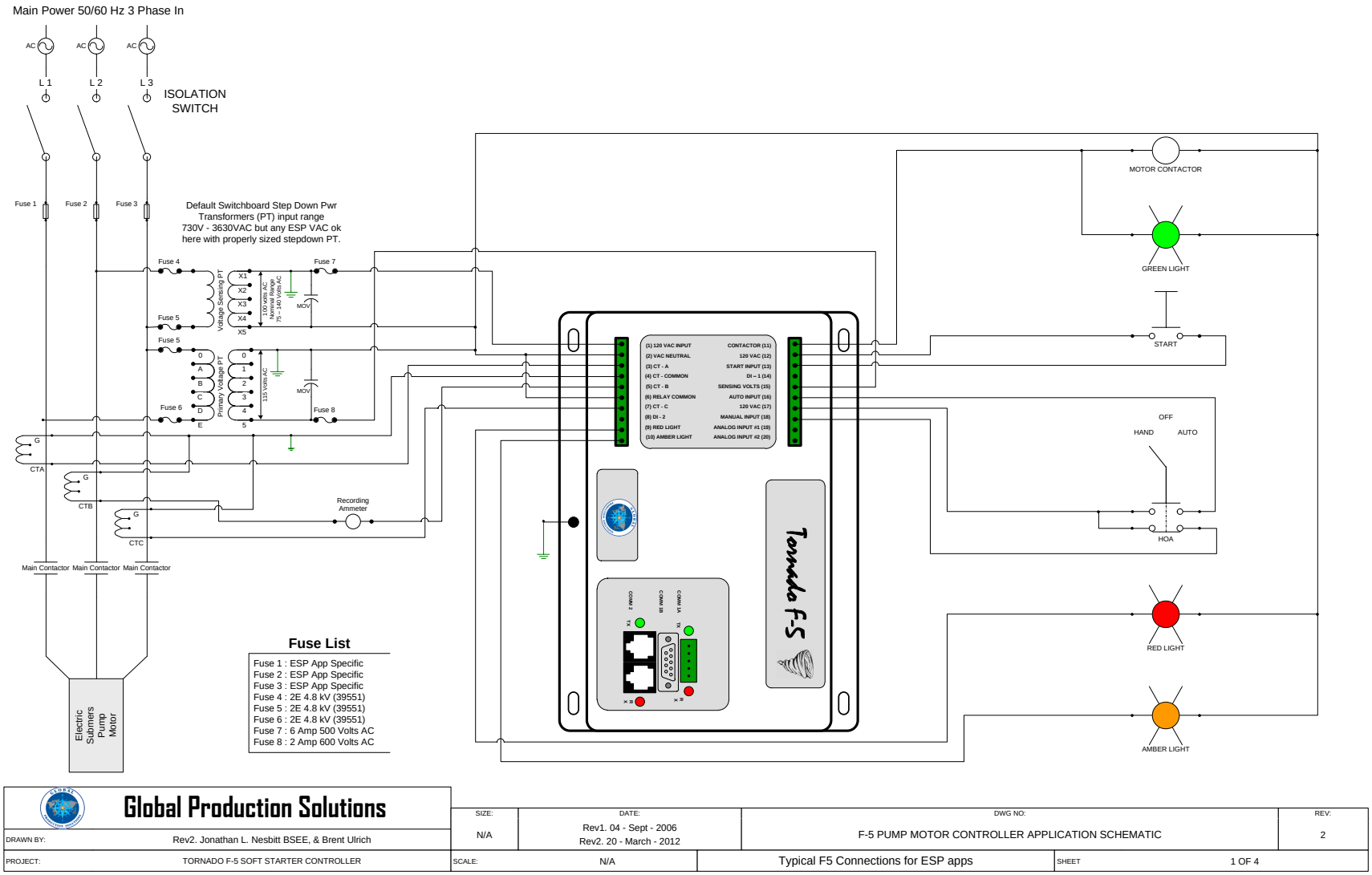


Figure 4 – Typical Switch Board Connections

Chapter

5 Digital Inputs (DI)

The Motor Controller has two digital input pairs pictured in the diagram below. These can be utilized for dry contact remote shutdowns. The digital inputs can be configured for either Normally Open (N/O) or N/C operations via software parameter list. The Motor Controller parameter list default setting is N/O. An example of the DI setup follows.

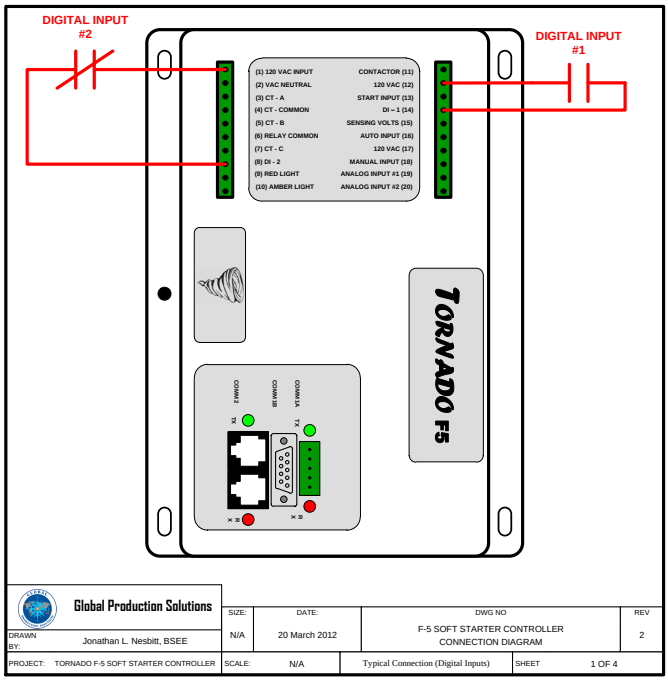


Figure 4 – Motor Controller Digital Inputs

In the example, DI #1 is set to Normally Open (N/O) and DI #2 is set to Normally Closed (N/C). If the input to DI #1 is high, the motor controller will time out and shutdown. If the input to DI #2 is low, the motor controller will wait the preset time and shutdown. This is an example of N/O versus N/C configuration.
As mentioned above, there are shutdown timers for each DI input. These are determining factors in how long the motor controller will operate the equipment in alarm status. Additionally, there is a separate DI1 fault handling timer and a DI2 fault handling timer. The purpose of these timers is to allow the equipment to reach normal operating status after start-up. It must be noted on startup that both timers are cumulative. The shutdown timer will not initiate its timing function until the delay on start timer has reached its preset value. Start W/1 Active designates restart capability with active alarm on the respective DI. Since the delay on start timer minimum value is 1 second, this Start W/1 Active parameter gives the user greater control over restart and fault handling of the DI events.

Digital Input Example #1:

The control parameter Start W/1 Active is set to NO. This commands the controller to not start the motor if DI1 is active. If the Motor Controller receives a fault on DI #1 (e.g. a remote Normally Open switch sensor closes), then the motor contactor switch is opened (powering down the motor) and the alarm remains active for DI #1. The restart timer will then count down from 1 minute and then cease timing. The motor will stay in this dormant state until the controller's alarm is cleared on DI #1.

The control parameter Start W/1 Active is set to YES. This commands the controller to attempt to start the motor after a one minute delay, even if DI1 is still active. If a DI #1 fault input is received (e.g. a remote Normally Open switch sensor closes), the unit will attempt to restart automatically after 1 minute regardless of the active alarm state of DI #1. The actual restart event also depends on the absence of other fault states.

Chapter

6 Analog Inputs (AI)

The Motor Controller provides two each Analog Inputs. The potential reference is based on neutral, which should be bonded to earth ground. The standard configuration is 0-10vdc. However, with the use of a shunt resistor and the correct setup of the offset menus, a 4-20ma signal can also be accepted.
It must be noted that Analog Input #1 is the only analog that can be configured to stop the equipment. Analog Input #2 is strictly for monitoring and has no control capability. With that exception both Analog Inputs have identical functionality.

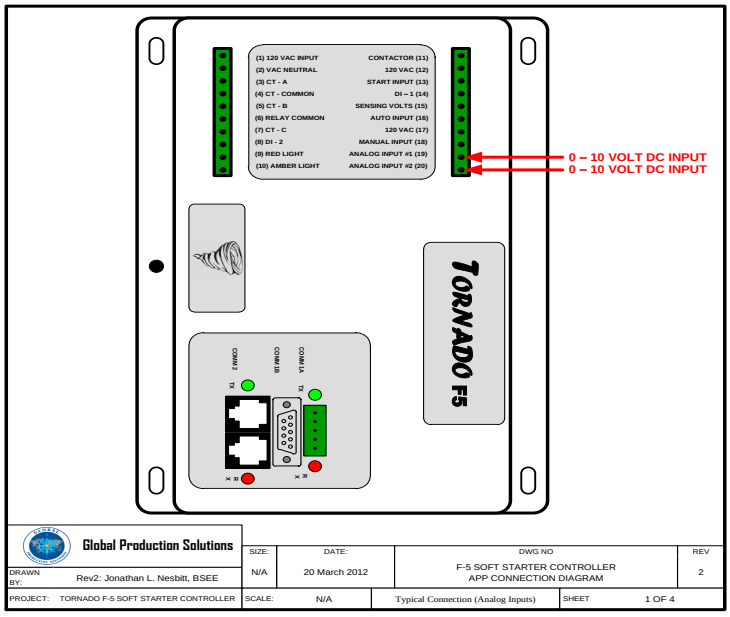


Figure 5: 0-10VDC Analog Input Pins

AI EXAMPLE#1: Scaled analog input trips motor kill

An external 0-10VDC signal from a pressure instrument has been connected to Analog Input #1. The external device is pressure sensor rated at 0-5000 PSI. Conditions dictate that if the pressure falls below 500 PSI or increases above 4900 PSI (indication of a loss of sensor signal) the Motor Controller must stop operation of the equipment.

SETUP

- **Analog 1 Span = 5000** (Full Scale 10 VDC at AI1 = 5000 PSI)
- **Analog 1 Offset = 0** (0 VDC at AI1 = 0 PSI)
- **AN. 1 High Trip = 4900**
- **AN. 1 Low Trip = 500**

The actual engineering value can be seen in `Analog 1 Level`.

If a 4-20ma current loop signal is used instead of a 0-10VDC, the offset and span can be adjusted accordingly. Shunt resistor tolerance is critical to accuracy in this format.

Chapter

7 Panel Light Indication and Auto Restarts

The indicators lights in a typical motor control application are Red, Amber, and Green.

The Green indicator is normally wired in parallel with the motor contactor off of pin 11 of the Motor Controller and it indicates that the motor unit is operating.

The Amber indicator is connected to pin 10 of the Motor Controller. An Amber indicator illuminated informs the operator that there are no active alarms and the Motor Controller is near the end of its count down and WILL allow an automatic restart when the restart timer has reached zero. Note: The Amber indicator is no longer used in the Kratos functionality mode where it was previously used to indicate an Underload condition in previous products.

The Red indicator is connected to terminal 9 of the Motor Controller. A Red indication illuminated indicates to the user that an active alarm is present and an automatic restart WILL NOT be allowed. The Red indicator is no longer used in Kratos functionality mode where it was used to indicate an overload condition in previous products.

Automatic restarts are allowed only if no active alarms are present OR an active alarm has been approved in the Parameter list to allow a restart. DI1 Example: `Start W/1 Active = YES`.

EXAMPLE #1:

Volt UNBAL Set (Voltage Unbalance Setpoint) ~ 10%
Restart Set (Restart Time) ~30 Minutes

A voltage unbalanced event occurs due to an overhead line fuse opening. The Motor Controller ceases motor operation. The Red indicator will illuminate. The restart timer will count from the preset interval of 30 minutes. Once the restart timer has counted down to 1 minute, and if the active alarm has not cleared, the timer will stop. If the alarm clears, the timer will continue its count and restart in 1 minute. If however between its counts from 1 minute to zero an alarm becomes active, the count will automatically be reset to 1 minute.

CAUSE CODES DISPLAYED FOR STATE: NO RESTART

Current Detected
Phase Error
Too Many UL Restarts
HOA Wiring Error
Too Many OL Restart
Current Unbalance
Too Many OV Restart
Too Many UV Restart
Too Many VUB Restart
Too Many DI 1 Restart
Too Many DI 2 Restart
Too Many AI 1 Restart
Waiting On Timeout
Over Voltage
Under Voltage
Voltage Unbalance
Digital Input 1 Active
Digital Input 2 Active
Analog 1 To High
Analog 1 To Low
Backspin Active
Backspin Voltage
OK – Ready To Start

Table 1 – Cause Codes For State: No Restart

Chapter

8 Shutdowns and Fault Handling

Each Fault has its own specific set of allowable restart counters in the Menu list.

UnderLoad (UL) is used strictly to control the maximum allowed Underload restarts.

3-Phase Current Unbalanced (I UB) input parameter is the maximum number of Current Unbalance events allowed to still enable auto restarts when in the H/O/A switch is in the Auto position.

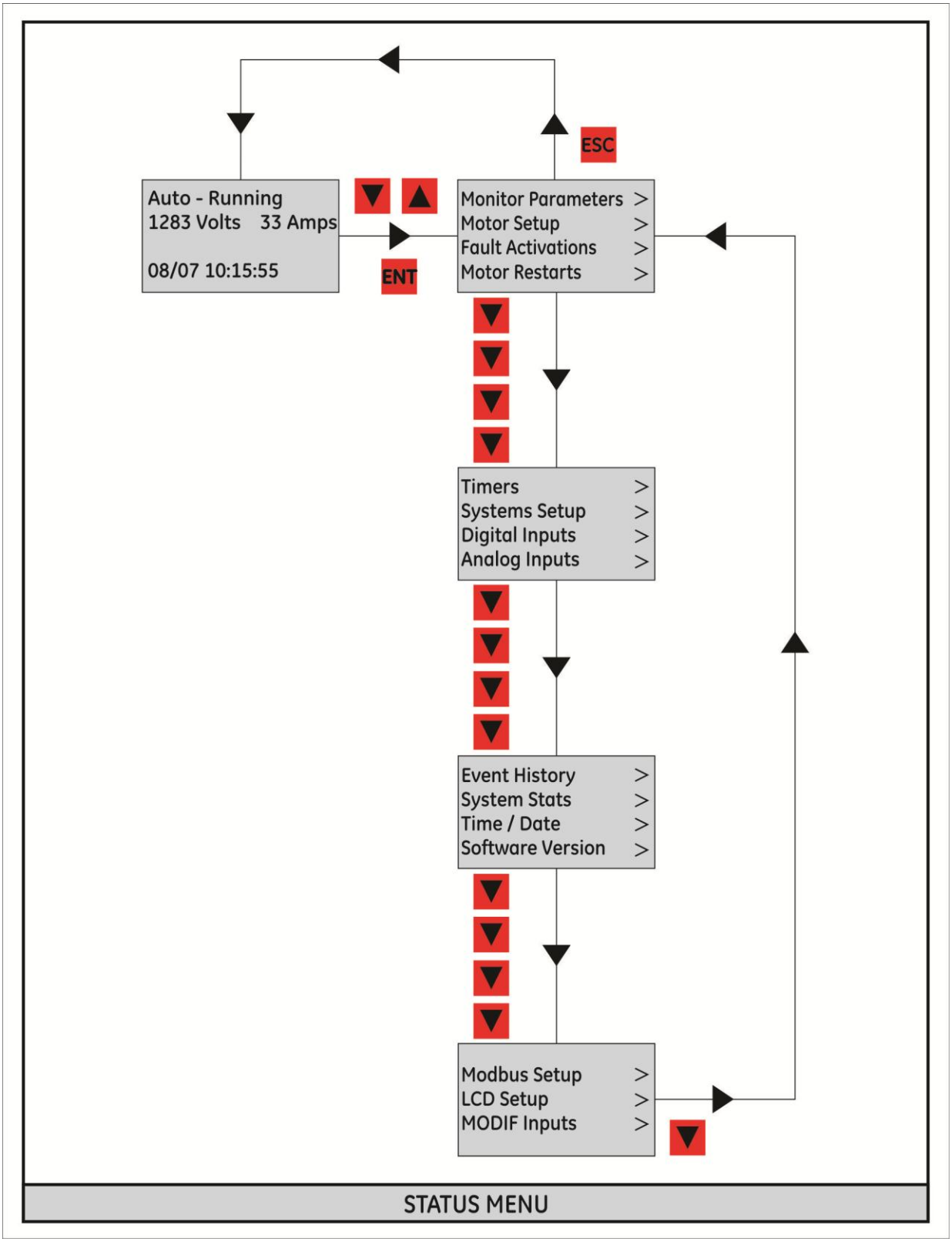
The Reset Time parameter is an internal time based counter reset value to clear all categories of start counters. If the motor controller operates the motor for a time interval exceeding the value in reset time then all internal shutdown counters are reset.

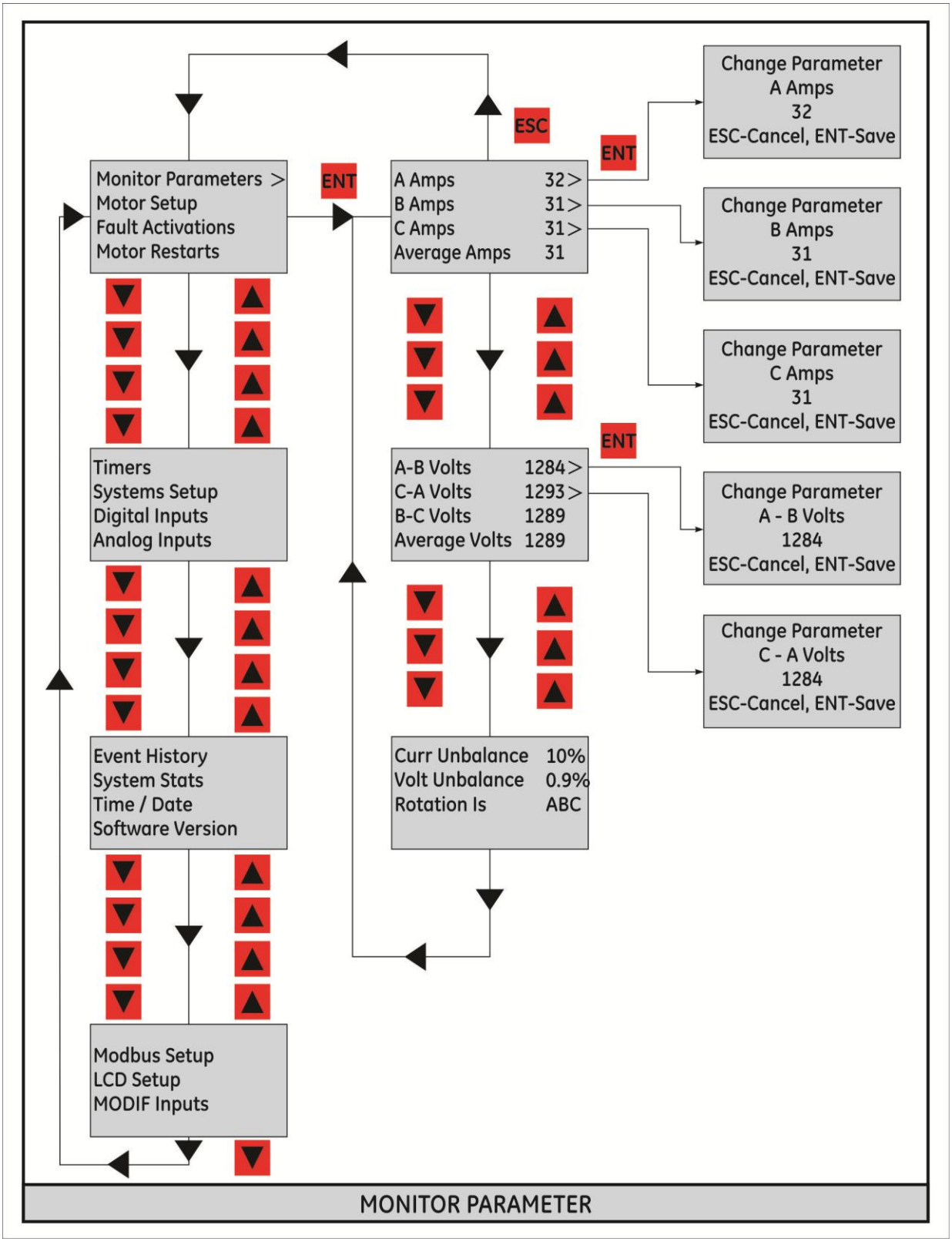
Chapter

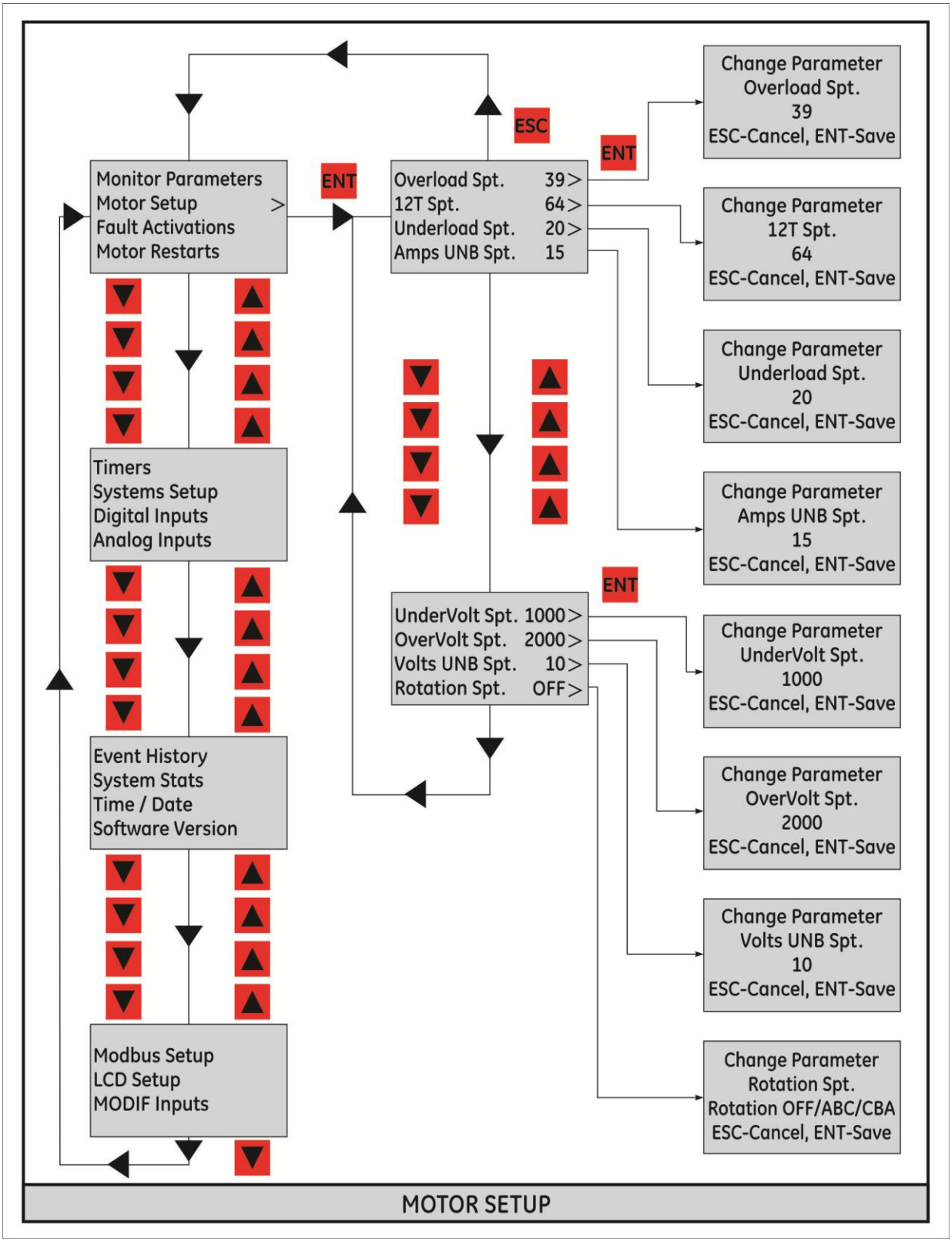
9 Menu List

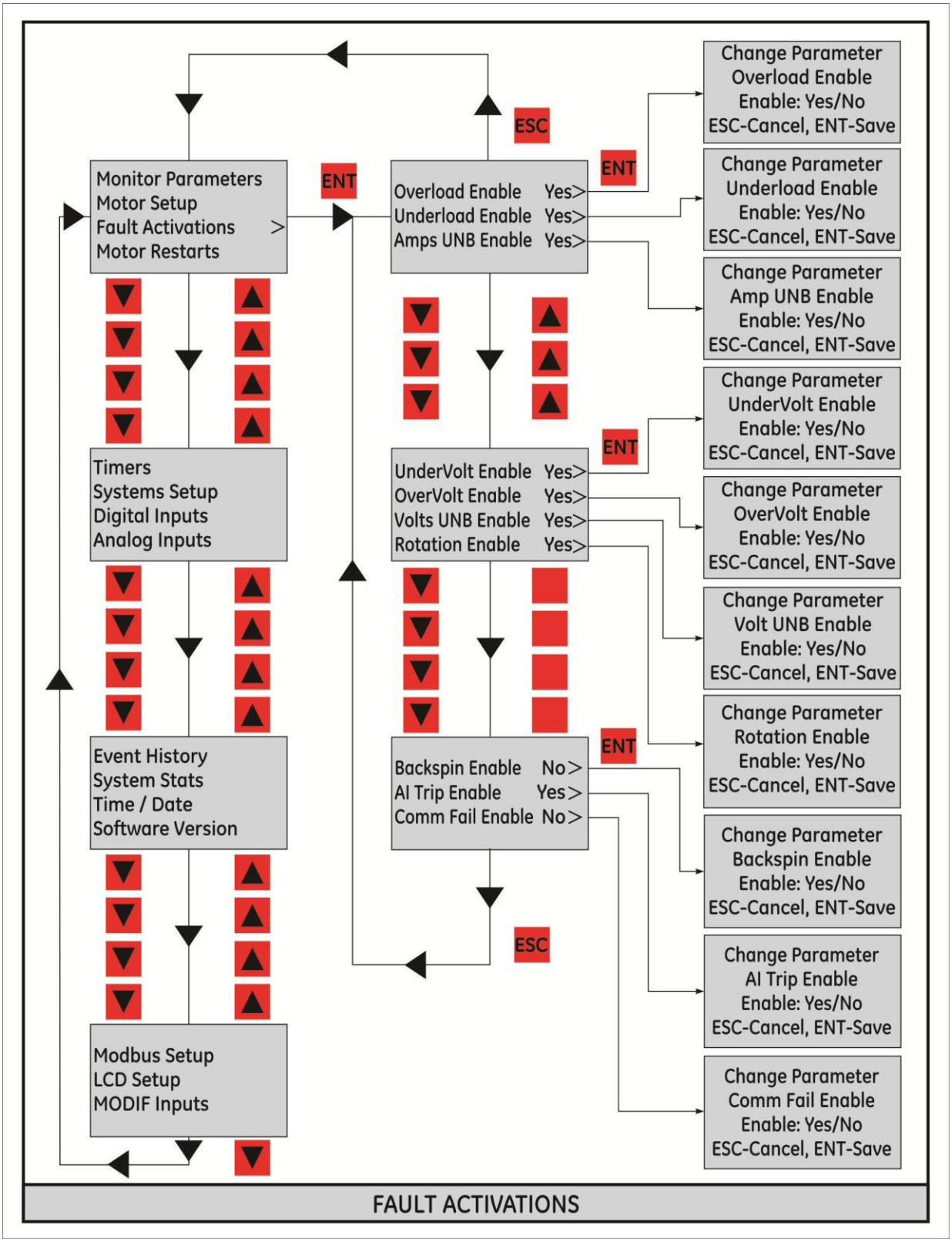
The following pages help an operator navigate the Motor Controller menu settings. The menus include:

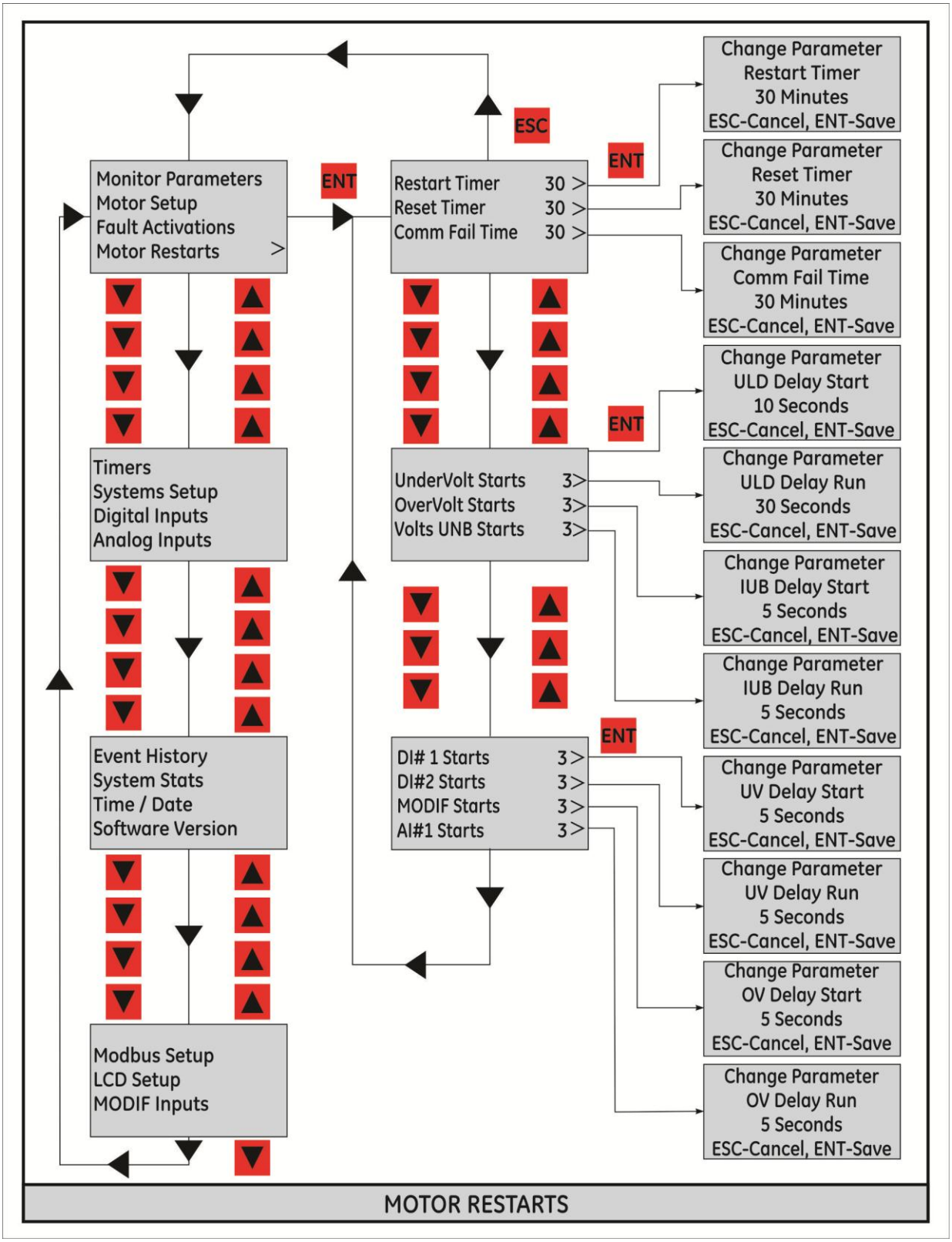
- Status: Run Mode, 3 Phase Voltage & Amps; Top Level menu
- Monitor Parameters
- Motor Setup
- Fault Activations
- Motor Restarts
- Timers (Page 1)
- Timers (Page 2)
- Timers (Page 3)
- System Setup
- Digital Inputs
- Analog Inputs
- Event History
- System Stats
- Time / Date
- Software Versions
- Modbus Setup
- LCD Setup
- MODIF Setup

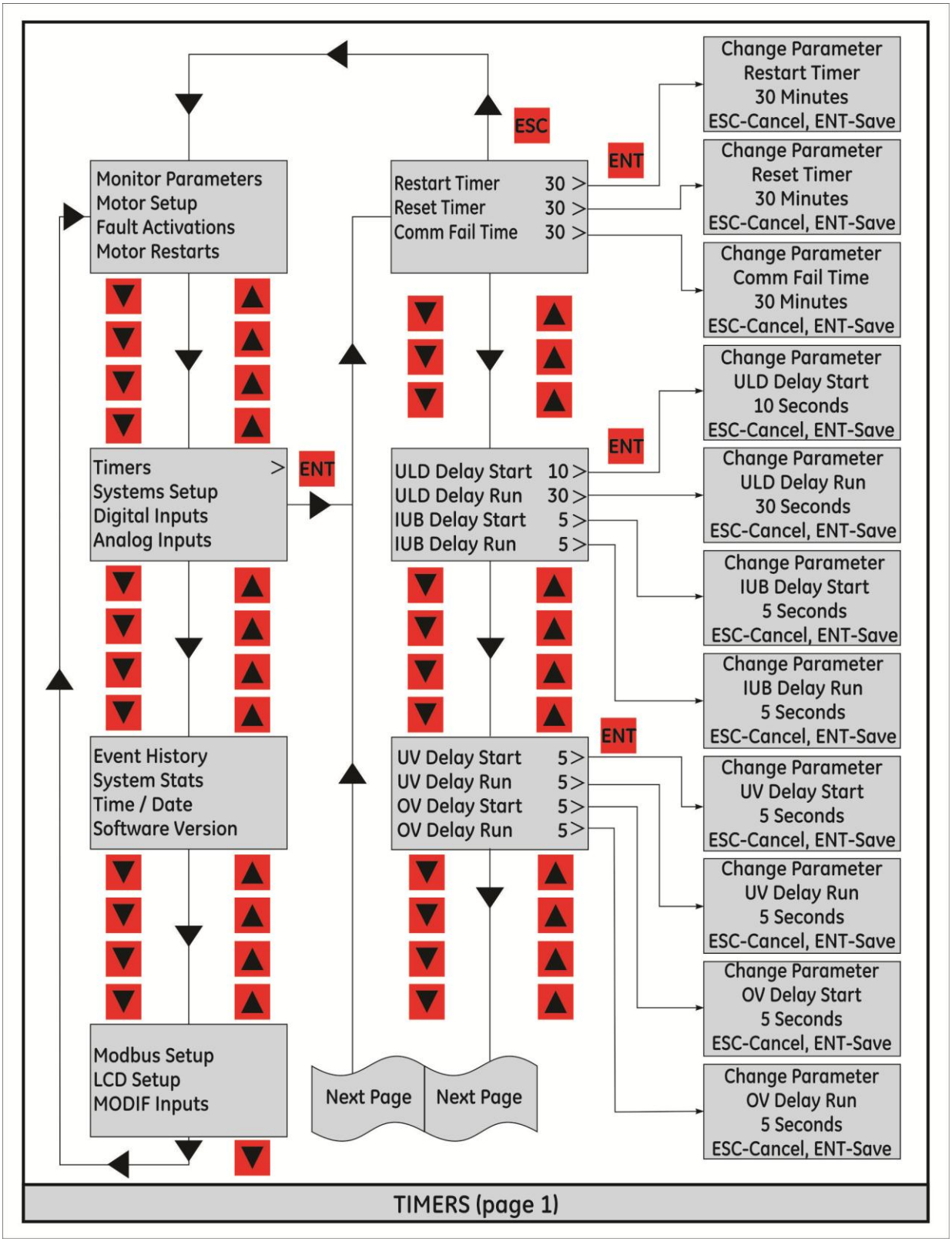

ESC
Auto - Running
1283 Volts 33 Amps
08/07 10:15:55
ENT
Monitor Parameters >
Motor Setup >
Fault Activations >
Motor Restarts >
Timers >
Systems Setup >
Digital Inputs >
Analog Inputs >
Event History >
System Stats >
Time / Date >
Software Version >
Modbus Setup >
LCD Setup >
MODIF Inputs >
STATUS MENU

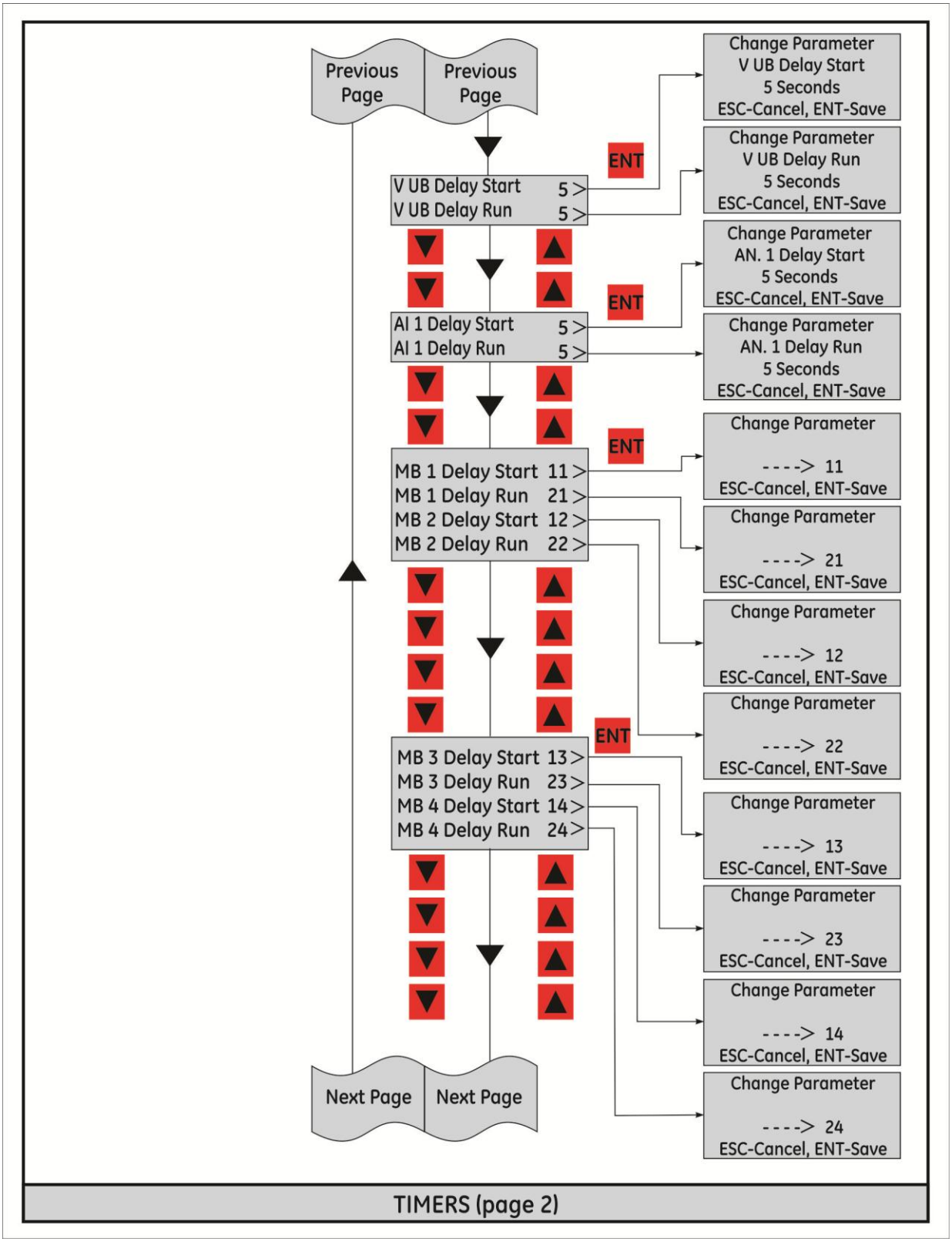

Monitor Parameters >
Motor Setup
Fault Activations
Motor Restarts
ENT
ESC
A Amps 32>
B Amps 31>
C Amps 31>
Average Amps 31
ENT
Change Parameter
A Amps
32
ESC-Cancel, ENT-Save
Change Parameter
B Amps
31
ESC-Cancel, ENT-Save
Change Parameter
C Amps
31
ESC-Cancel, ENT-Save
Timers
Systems Setup
Digital Inputs
Analog Inputs
A-B Volts 1284>
C-A Volts 1293>
B-C Volts 1289
Average Volts 1289
ENT
Change Parameter
A - B Volts
1284
ESC-Cancel, ENT-Save
Change Parameter
C - A Volts
1284
ESC-Cancel, ENT-Save
Event History
System Stats
Time / Date
Software Version
Curr Unbalance 10%
Volt Unbalance 0.9%
Rotation Is ABC
Modbus Setup
LCD Setup
MODIF Inputs
MONITOR PARAMETER

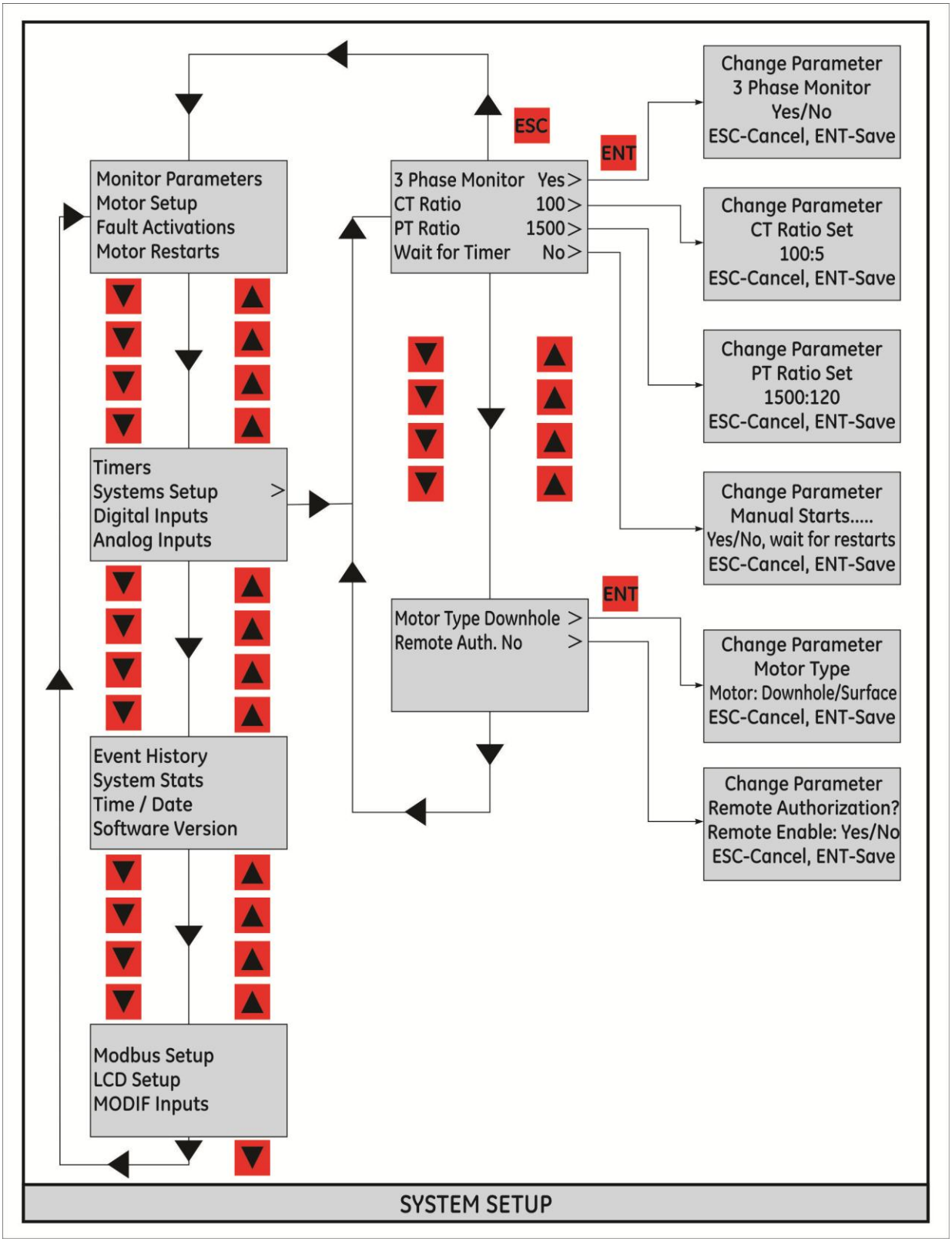

Monitor Parameters
Motor Setup >
Fault Activations
Motor Restarts
ENT
ESC
Overload Spt. 39 >
12T Spt. 64 >
Underload Spt. 20 >
Amps UNB Spt. 15
ENT
Change Parameter
Overload Spt.
39
ESC-Cancel, ENT-Save
Change Parameter
12T Spt.
64
ESC-Cancel, ENT-Save
Change Parameter
Underload Spt.
20
ESC-Cancel, ENT-Save
Change Parameter
Amps UNB Spt.
15
ESC-Cancel, ENT-Save
Timers
Systems Setup
Digital Inputs
Analog Inputs
UnderVolt Spt. 1000 >
OverVolt Spt. 2000 >
Volts UNB Spt. 10 >
Rotation Spt. OFF >
ENT
Change Parameter
UnderVolt Spt.
1000
ESC-Cancel, ENT-Save
Change Parameter
OverVolt Spt.
2000
ESC-Cancel, ENT-Save
Change Parameter
Volts UNB Spt.
10
ESC-Cancel, ENT-Save
Change Parameter
Rotation Spt.
Rotation OFF/ABC/CBA
ESC-Cancel, ENT-Save
Event History
System Stats
Time / Date
Software Version
Modbus Setup
LCD Setup
MODIF Inputs
MOTOR SETUP

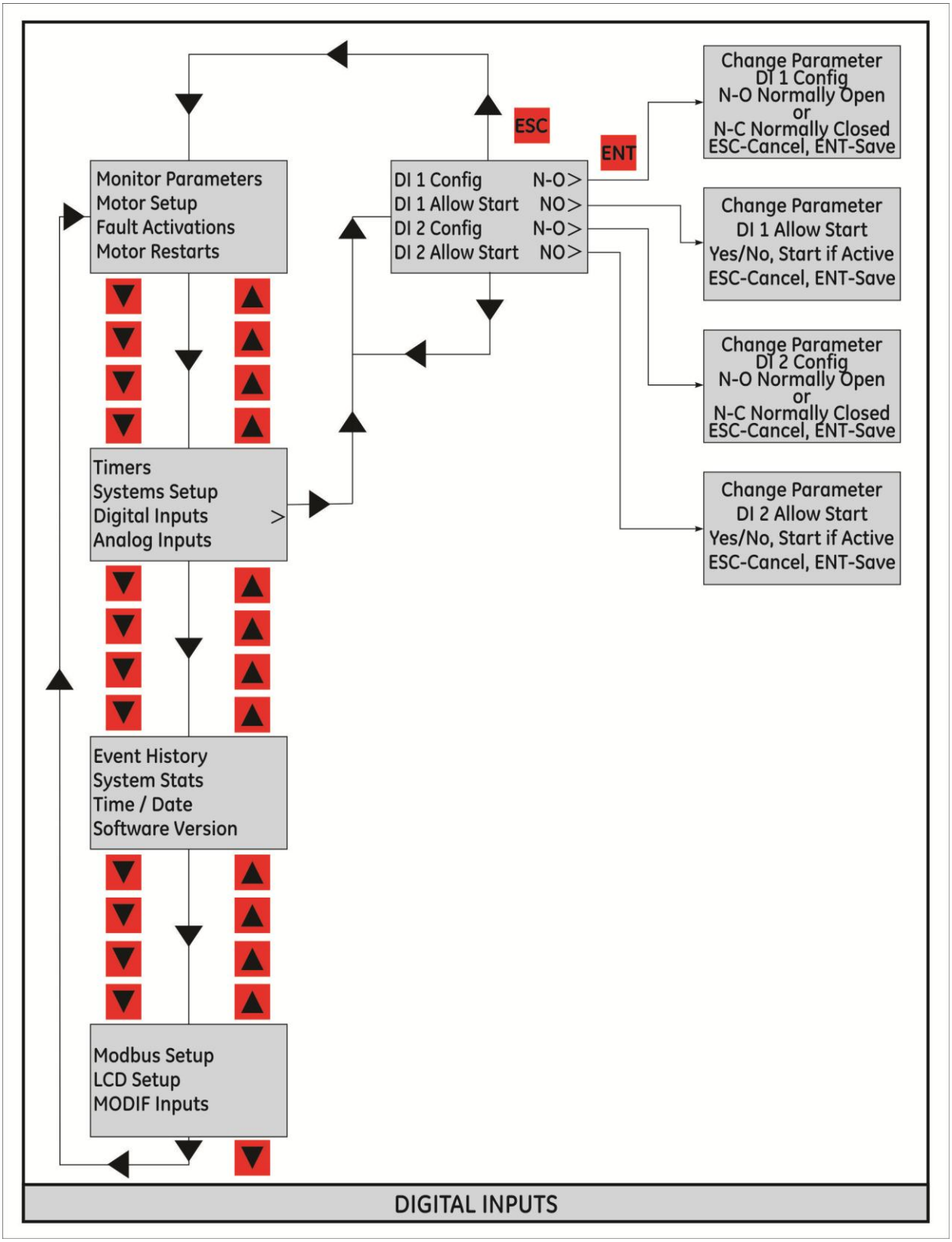

Monitor Parameters
Motor Setup
Fault Activations
Motor Restarts
ENT
ESC
Overload Enable Yes>
Underload Enable Yes>
Amps UNB Enable Yes>
ENT
Change Parameter
Overload Enable
Enable: Yes/No
ESC-Cancel, ENT-Save
Change Parameter
Underload Enable
Enable: Yes/No
ESC-Cancel, ENT-Save
Change Parameter
Amp UNB Enable
Enable: Yes/No
ESC-Cancel, ENT-Save
Timers
Systems Setup
Digital Inputs
Analog Inputs
UnderVolt Enable Yes>
OverVolt Enable Yes>
Volts UNB Enable Yes>
Rotation Enable Yes>
ENT
Change Parameter
UnderVolt Enable
Enable: Yes/No
ESC-Cancel, ENT-Save
Change Parameter
OverVolt Enable
Enable: Yes/No
ESC-Cancel, ENT-Save
Change Parameter
Volt UNB Enable
Enable: Yes/No
ESC-Cancel, ENT-Save
Event History
System Stats
Time / Date
Software Version
Backspin Enable No>
AI Trip Enable Yes>
Comm Fail Enable No>
ENT
Change Parameter
Rotation Enable
Enable: Yes/No
ESC-Cancel, ENT-Save
Change Parameter
Backspin Enable
Enable: Yes/No
ESC-Cancel, ENT-Save
ESC
Change Parameter
AI Trip Enable
Enable: Yes/No
ESC-Cancel, ENT-Save
Modbus Setup
LCD Setup
MODIF Inputs
Change Parameter
Comm Fail Enable
Enable: Yes/No
ESC-Cancel, ENT-Save
FAULT ACTIVATIONS

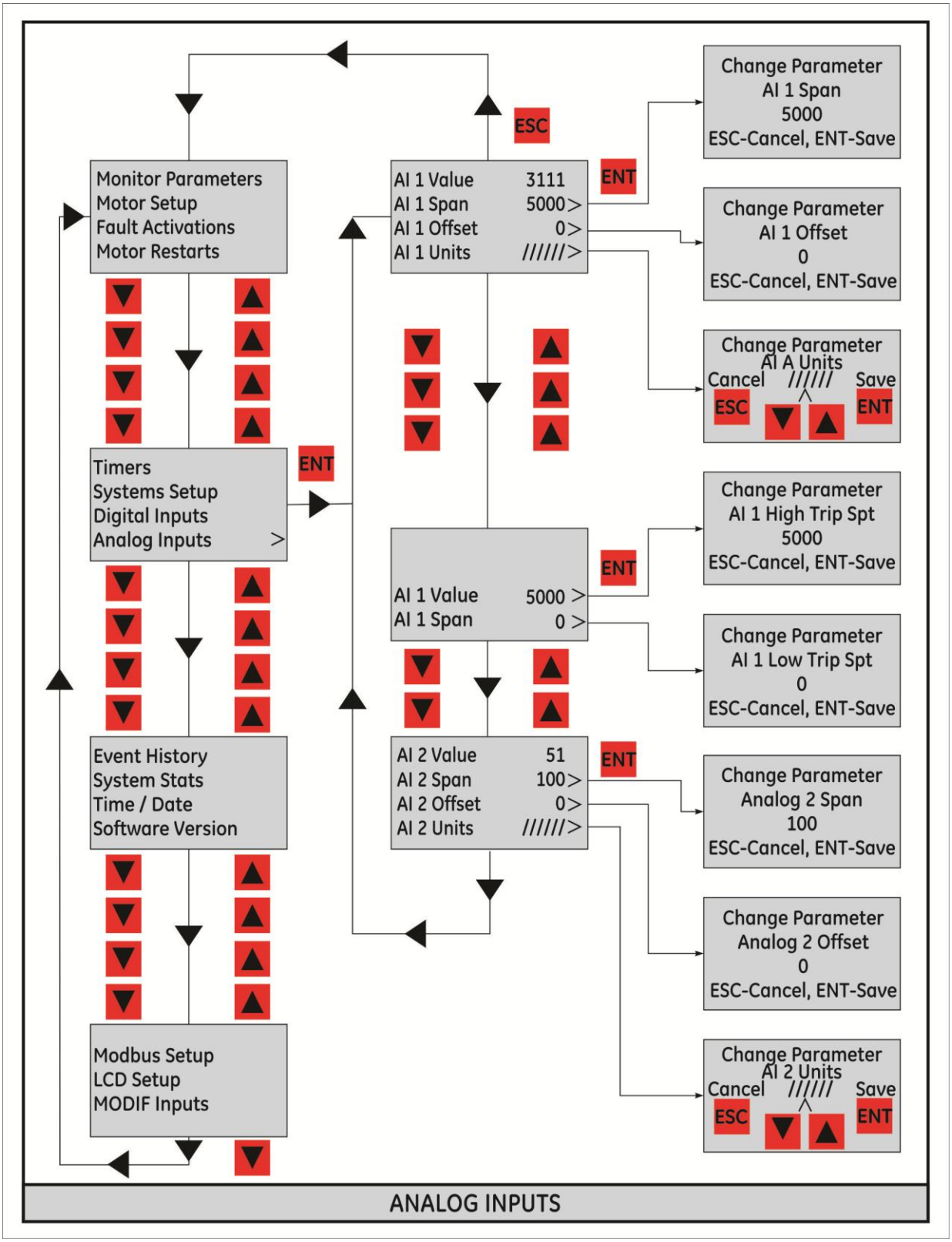

Monitor Parameters
Motor Setup
Fault Activations
Motor Restarts >
Timers
Systems Setup
Digital Inputs
Analog Inputs
Event History
System Stats
Time / Date
Software Version
Modbus Setup
LCD Setup
MODIF Inputs
ENT
ESC
Restart Timer 30 >
Reset Timer 30 >
Comm Fail Time 30 >
UnderVolt Starts 3>
OverVolt Starts 3>
Volts UNB Starts 3>
DI# 1 Starts 3>
DI#2 Starts 3>
MODIF Starts 3>
AI#1 Starts 3>
Change Parameter
Restart Timer
30 Minutes
ESC-Cancel, ENT-Save
Change Parameter
Reset Timer
30 Minutes
ESC-Cancel, ENT-Save
Change Parameter
Comm Fail Time
30 Minutes
ESC-Cancel, ENT-Save
Change Parameter
ULD Delay Start
10 Seconds
ESC-Cancel, ENT-Save
Change Parameter
ULD Delay Run
30 Seconds
ESC-Cancel, ENT-Save
Change Parameter
IUB Delay Start
5 Seconds
ESC-Cancel, ENT-Save
Change Parameter
IUB Delay Run
5 Seconds
ESC-Cancel, ENT-Save
Change Parameter
UV Delay Start
5 Seconds
ESC-Cancel, ENT-Save
Change Parameter
UV Delay Run
5 Seconds
ESC-Cancel, ENT-Save
Change Parameter
OV Delay Start
5 Seconds
ESC-Cancel, ENT-Save
Change Parameter
OV Delay Run
5 Seconds
ESC-Cancel, ENT-Save
MOTOR RESTARTS

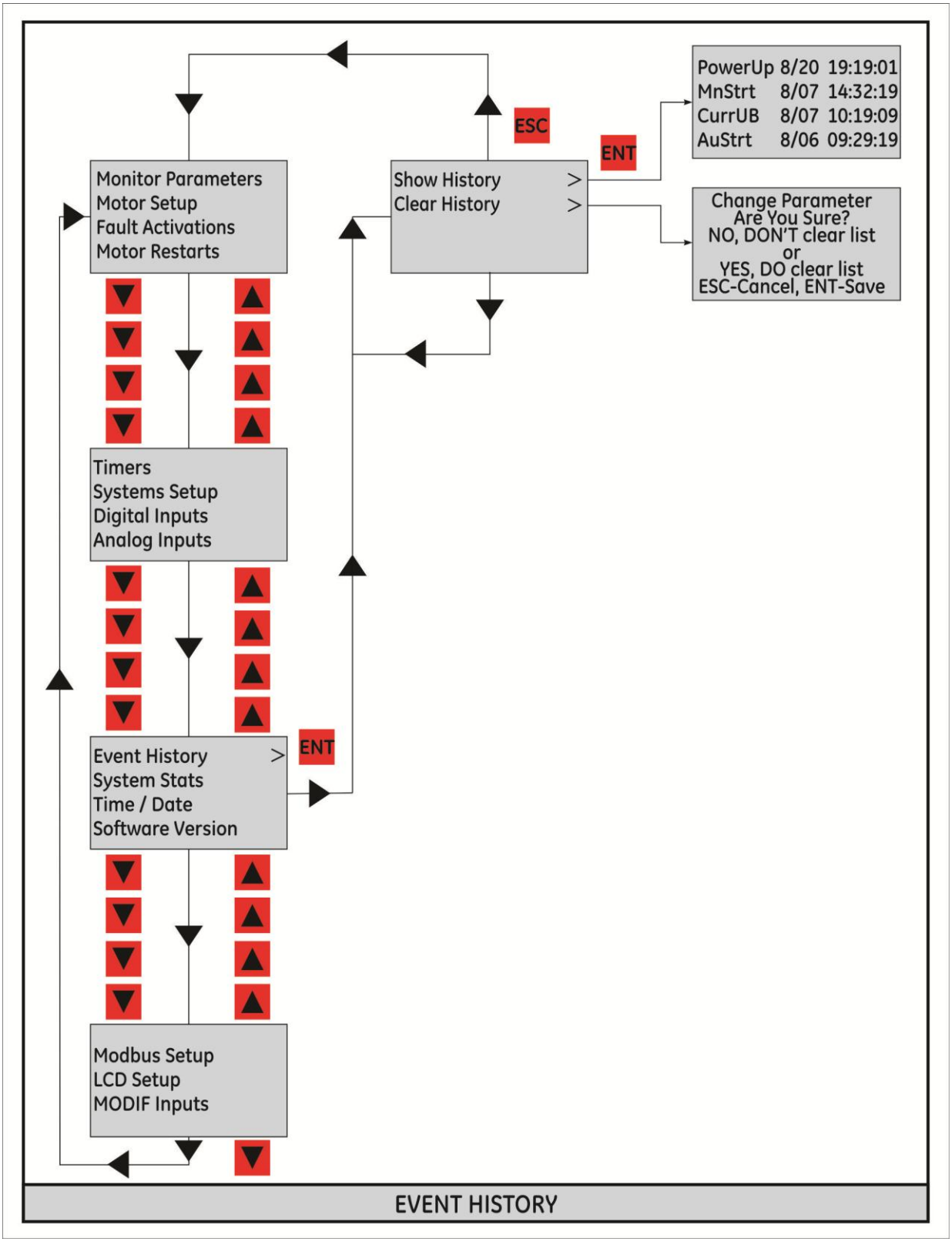

Monitor Parameters
Motor Setup
Fault Activations
Motor Restarts
Timers
Systems Setup
Digital Inputs
Analog Inputs
Event History
System Stats
Time / Date
Software Version
Modbus Setup
LCD Setup
MODIF Inputs
ENT
ESC
Restart Timer 30 >
Reset Timer 30 >
Comm Fail Time 30 >
ULD Delay Start 10 >
ULD Delay Run 30 >
IUB Delay Start 5 >
IUB Delay Run 5 >
UV Delay Start 5 >
UV Delay Run 5 >
OV Delay Start 5 >
OV Delay Run 5 >
Next Page
Next Page
Change Parameter Restart Timer 30 Minutes ESC-Cancel, ENT-Save
Change Parameter Reset Timer 30 Minutes ESC-Cancel, ENT-Save
Change Parameter Comm Fail Time 30 Minutes ESC-Cancel, ENT-Save
Change Parameter ULD Delay Start 10 Seconds ESC-Cancel, ENT-Save
Change Parameter ULD Delay Run 30 Seconds ESC-Cancel, ENT-Save
Change Parameter IUB Delay Start 5 Seconds ESC-Cancel, ENT-Save
Change Parameter IUB Delay Run 5 Seconds ESC-Cancel, ENT-Save
Change Parameter UV Delay Start 5 Seconds ESC-Cancel, ENT-Save
Change Parameter UV Delay Run 5 Seconds ESC-Cancel, ENT-Save
Change Parameter OV Delay Start 5 Seconds ESC-Cancel, ENT-Save
Change Parameter OV Delay Run 5 Seconds ESC-Cancel, ENT-Save
TIMERS (page 1)

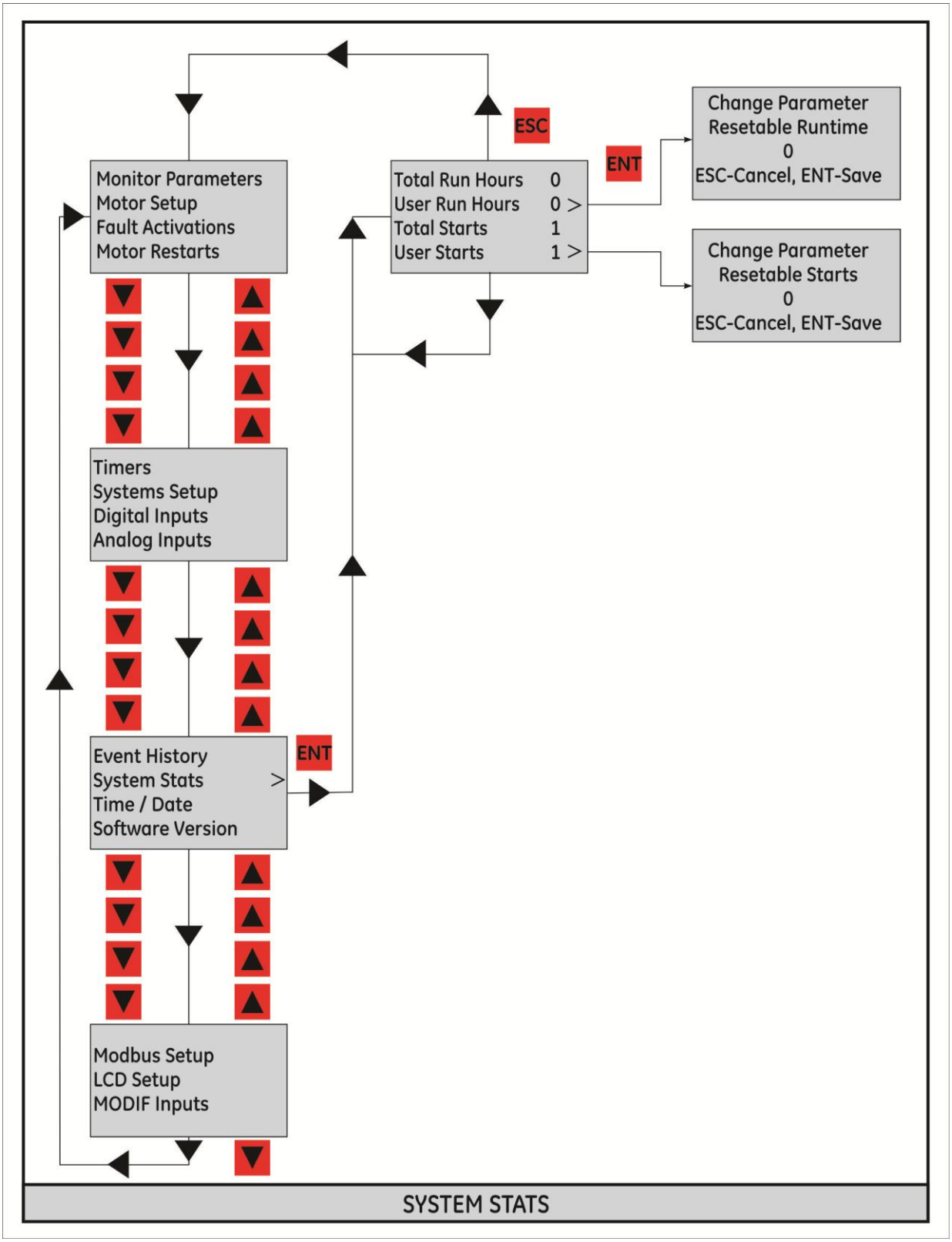

Previous Page
Previous Page
V UB Delay Start 5 >
V UB Delay Run 5 >
ENT
Change Parameter
V UB Delay Start
5 Seconds
ESC-Cancel, ENT-Save
Change Parameter
V UB Delay Run
5 Seconds
ESC-Cancel, ENT-Save
AI 1 Delay Start 5 >
AI 1 Delay Run 5 >
ENT
Change Parameter
AN. 1 Delay Start
5 Seconds
ESC-Cancel, ENT-Save
Change Parameter
AN. 1 Delay Run
5 Seconds
ESC-Cancel, ENT-Save
MB 1 Delay Start 11 >
MB 1 Delay Run 21 >
MB 2 Delay Start 12 >
MB 2 Delay Run 22 >
ENT
Change Parameter
----> 11
ESC-Cancel, ENT-Save
Change Parameter
----> 21
ESC-Cancel, ENT-Save
Change Parameter
----> 12
ESC-Cancel, ENT-Save
Change Parameter
----> 22
ESC-Cancel, ENT-Save
MB 3 Delay Start 13 >
MB 3 Delay Run 23 >
MB 4 Delay Start 14 >
MB 4 Delay Run 24 >
ENT
Change Parameter
----> 13
ESC-Cancel, ENT-Save
Change Parameter
----> 23
ESC-Cancel, ENT-Save
Change Parameter
----> 14
ESC-Cancel, ENT-Save
Change Parameter
----> 24
ESC-Cancel, ENT-Save
Next Page
Next Page
TIMERS (page 2)

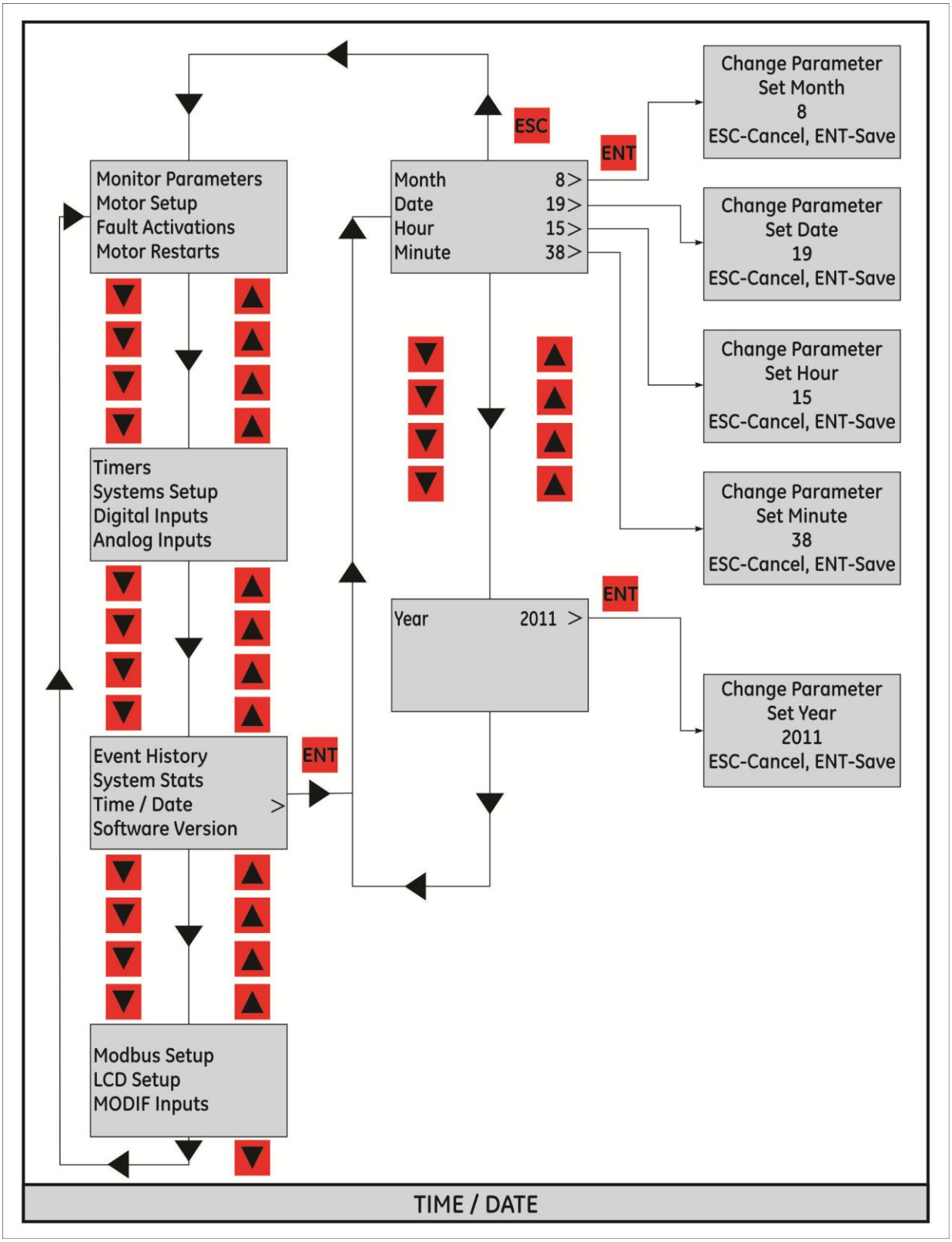

Monitor Parameters
Motor Setup
Fault Activations
Motor Restarts
Timers
Systems Setup >
Digital Inputs
Analog Inputs
Event History
System Stats
Time / Date
Software Version
Modbus Setup
LCD Setup
MODIF Inputs
ESC
ENT
3 Phase Monitor Yes >
CT Ratio 100 >
PT Ratio 1500 >
Wait for Timer No >
Motor Type Downhole >
Remote Auth. No >
ENT
Change Parameter
3 Phase Monitor
Yes/No
ESC-Cancel, ENT-Save
Change Parameter
CT Ratio Set
100:5
ESC-Cancel, ENT-Save
Change Parameter
PT Ratio Set
1500:120
ESC-Cancel, ENT-Save
Change Parameter
Manual Starts.....
Yes/No, wait for restarts
ESC-Cancel, ENT-Save
Change Parameter
Motor Type
Motor: Downhole/Surface
ESC-Cancel, ENT-Save
Change Parameter
Remote Authorization?
Remote Enable: Yes/No
ESC-Cancel, ENT-Save
SYSTEM SETUP


Change Parameter
DI 1 Config
N-O Normally Open
or
N-C Normally Closed
ESC-Cancel, ENT-Save
ESC
ENT
Monitor Parameters
Motor Setup
Fault Activations
Motor Restarts
DI 1 Config N-O>
DI 1 Allow Start NO>
DI 2 Config N-O>
DI 2 Allow Start NO>
Change Parameter
DI 1 Allow Start
Yes/No, Start if Active
ESC-Cancel, ENT-Save
Change Parameter
DI 2 Config
N-O Normally Open
or
N-C Normally Closed
ESC-Cancel, ENT-Save
Timers
Systems Setup
Digital Inputs >
Analog Inputs
Change Parameter
DI 2 Allow Start
Yes/No, Start if Active
ESC-Cancel, ENT-Save
Event History
System Stats
Time / Date
Software Version
Modbus Setup
LCD Setup
MODIF Inputs
DIGITAL INPUTS


Monitor Parameters
Motor Setup
Fault Activations
Motor Restarts
Timers
Systems Setup
Digital Inputs
Analog Inputs >
Event History
System Stats
Time / Date
Software Version
Modbus Setup
LCD Setup
MODIF Inputs
ESC
ENT
AI 1 Value 3111
AI 1 Span 5000 >
AI 1 Offset 0 >
AI 1 Units ////// >
AI 1 Value 5000 >
AI 1 Span 0 >
AI 2 Value 51
AI 2 Span 100 >
AI 2 Offset 0 >
AI 2 Units ////// >
Change Parameter
AI 1 Span
5000
ESC-Cancel, ENT-Save
Change Parameter
AI 1 Offset
0
ESC-Cancel, ENT-Save
Change Parameter
AI A Units
Cancel ////// Save
ESC ENT
Change Parameter
AI 1 High Trip Spt
5000
ESC-Cancel, ENT-Save
Change Parameter
AI 1 Low Trip Spt
0
ESC-Cancel, ENT-Save
Change Parameter
Analog 2 Span
100
ESC-Cancel, ENT-Save
Change Parameter
Analog 2 Offset
0
ESC-Cancel, ENT-Save
Change Parameter
AI 2 Units
Cancel ////// Save
ESC ENT
ANALOG INPUTS


PowerUp 8/20 19:19:01
MnStrt 8/07 14:32:19
CurrUB 8/07 10:19:09
AuStrt 8/06 09:29:19
ESC
ENT
Monitor Parameters
Motor Setup
Fault Activations
Motor Restarts
Show History >
Clear History >
Change Parameter
Are You Sure?
NO, DON'T clear list
or
YES, DO clear list
ESC-Cancel, ENT-Save
Timers
Systems Setup
Digital Inputs
Analog Inputs
Event History >
System Stats
Time / Date
Software Version
ENT
Modbus Setup
LCD Setup
MODIF Inputs
EVENT HISTORY


Monitor Parameters
Motor Setup
Fault Activations
Motor Restarts
Timers
Systems Setup
Digital Inputs
Analog Inputs
Event History
System Stats
Time / Date
Software Version
Modbus Setup
LCD Setup
MODIF Inputs
ESC
ENT
Total Run Hours 0
User Run Hours 0 >
Total Starts 1
User Starts 1 >
Change Parameter
Resetable Runtime
0
ESC-Cancel, ENT-Save
Change Parameter
Resetable Starts
0
ESC-Cancel, ENT-Save
SYSTEM STATS


Monitor Parameters
Motor Setup
Fault Activations
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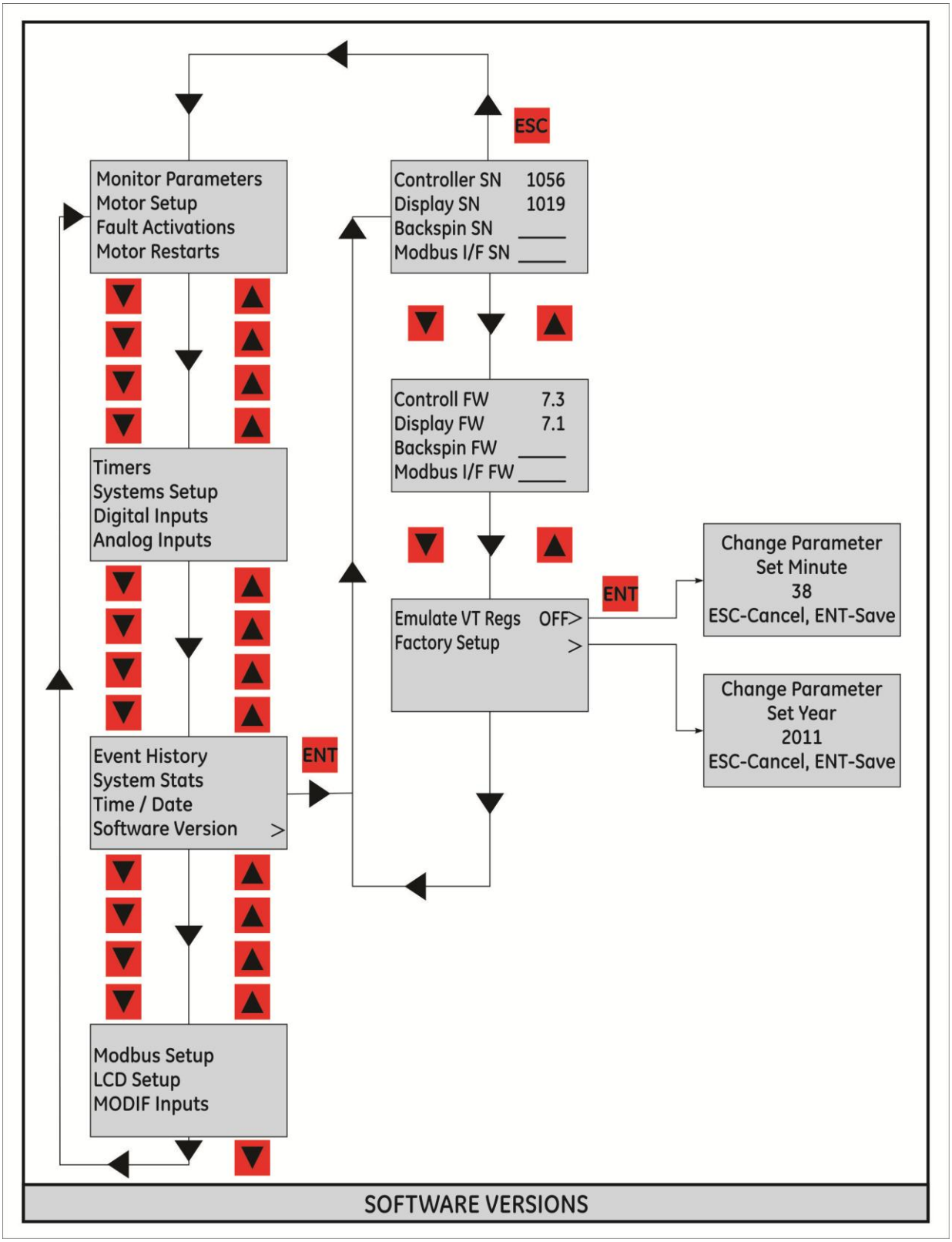
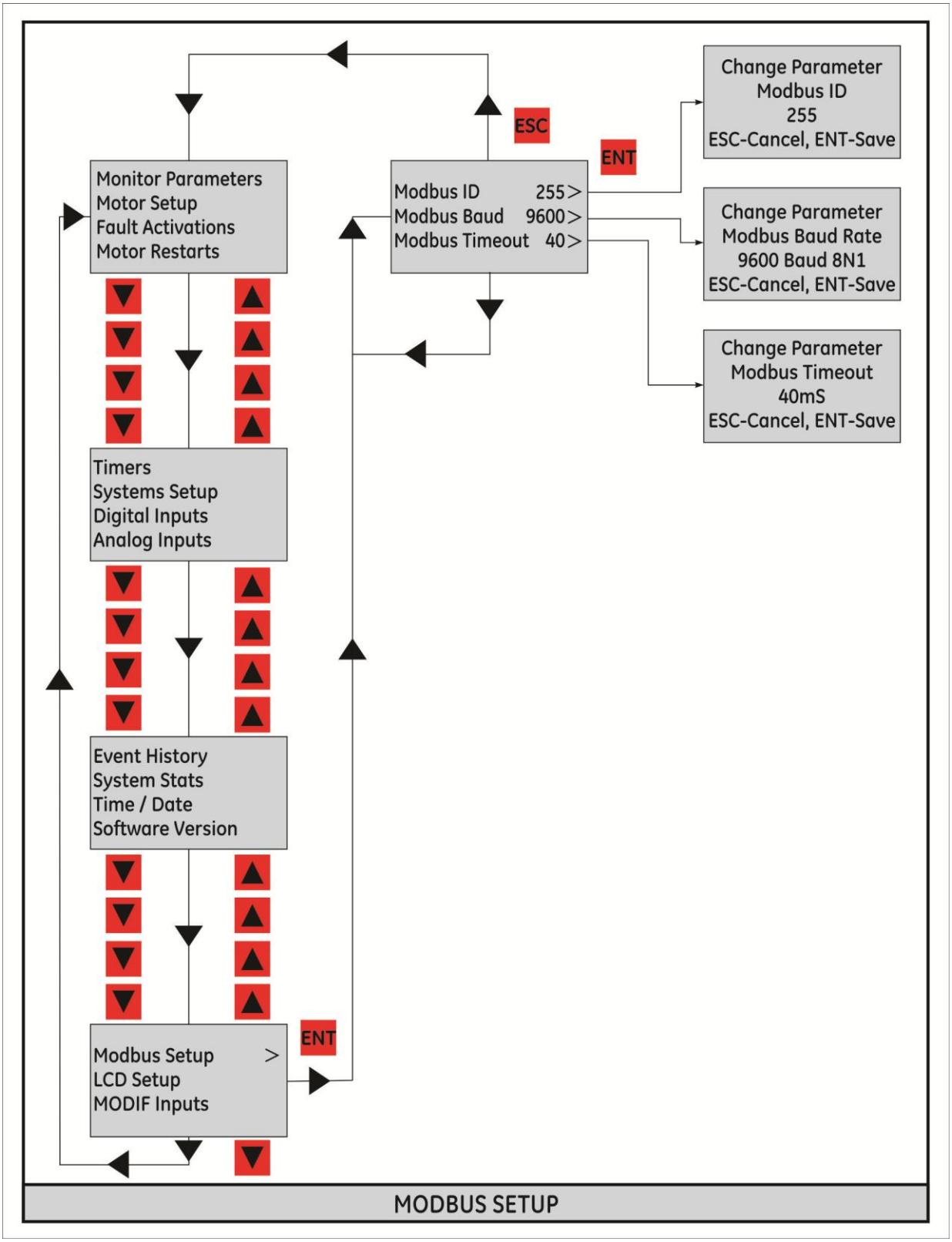
Systems Setup
Digital Inputs
Analog Inputs
Event History
System Stats
Time / Date
Software Version
Modbus Setup
LCD Setup
MODIF Inputs
ESC
ENT
Month 8>
Date 19>
Hour 15>
Minute 38>
Year 2011 >
Change Parameter
Set Month
8
ESC-Cancel, ENT-Save
Change Parameter
Set Date
19
ESC-Cancel, ENT-Save
Change Parameter
Set Hour
15
ESC-Cancel, ENT-Save
Change Parameter
Set Minute
38
ESC-Cancel, ENT-Save
Change Parameter
Set Year
2011
ESC-Cancel, ENT-Save
TIME / DATE


ESC
Monitor Parameters
Motor Setup
Fault Activations
Motor Restarts
Controller SN 1056
Display SN 1019
Backspin SN ____
Modbus I/F SN ____
Controll FW 7.3
Display FW 7.1
Backspin FW ____
Modbus I/F FW ____
Timers
Systems Setup
Digital Inputs
Analog Inputs
ENT
Emulate VT Regs OFF>
Factory Setup >
Change Parameter
Set Minute
38
ESC-Cancel, ENT-Save
Change Parameter
Set Year
2011
ESC-Cancel, ENT-Save
Event History
System Stats
Time / Date
Software Version >
ENT
Modbus Setup
LCD Setup
MODIF Inputs
SOFTWARE VERSIONS


Monitor Parameters
Motor Setup
Fault Activations
Motor Restarts
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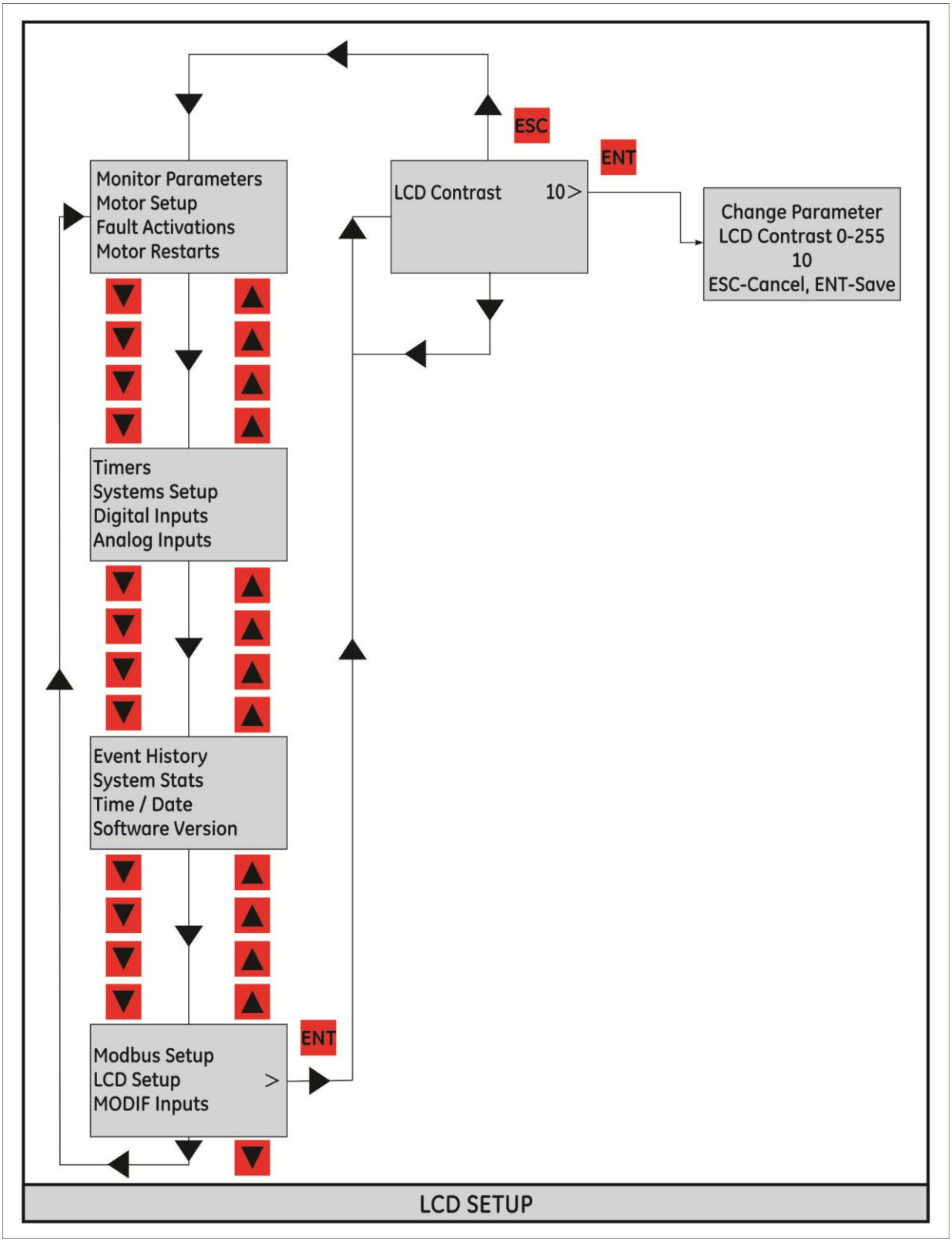
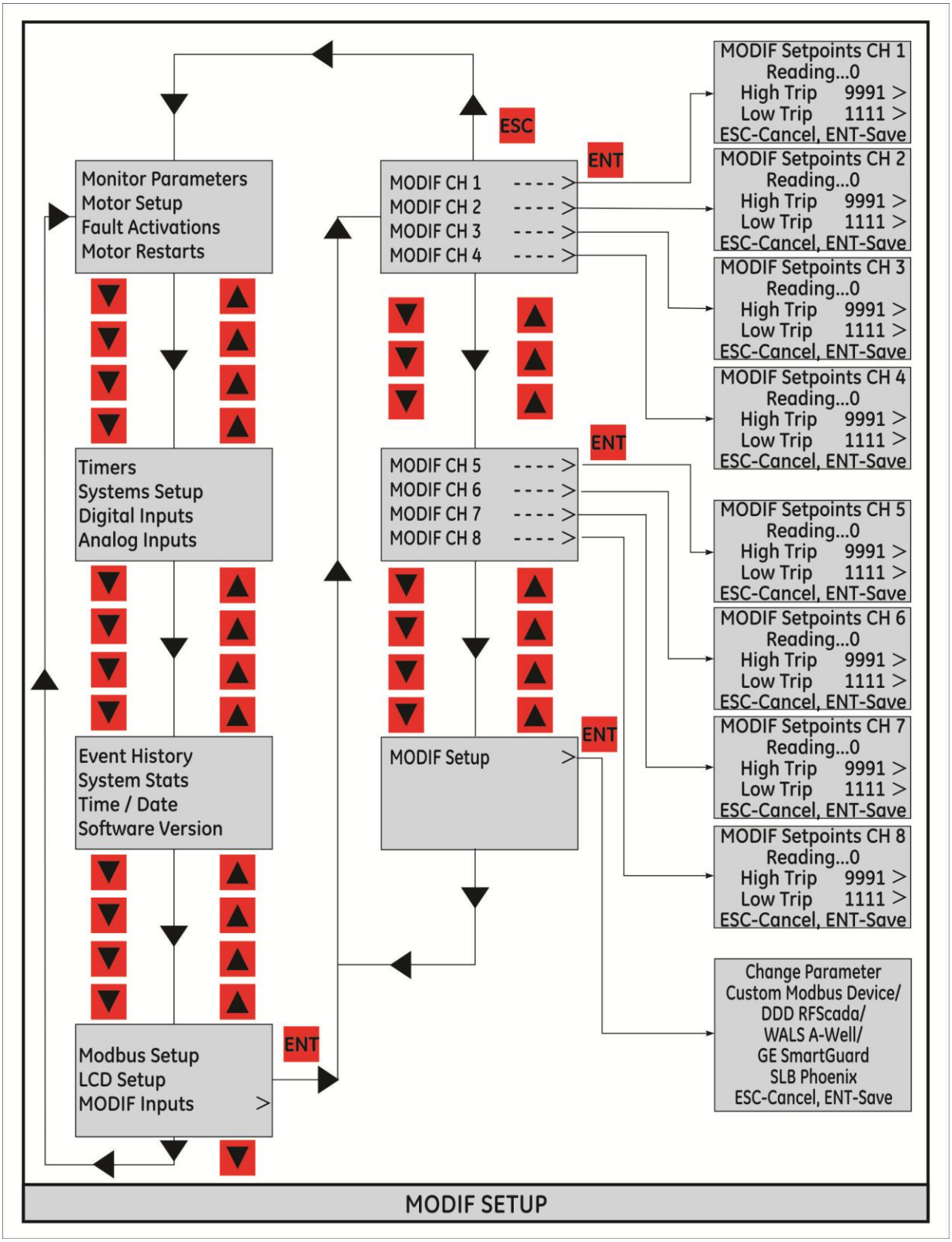
Systems Setup
Digital Inputs
Analog Inputs
Event History
System Stats
Time / Date
Software Version
Modbus Setup >
LCD Setup
MODIF Inputs
ENT
ESC
ENT
Modbus ID 255>
Modbus Baud 9600>
Modbus Timeout 40>
Change Parameter
Modbus ID
255
ESC-Cancel, ENT-Save
Change Parameter
Modbus Baud Rate
9600 Baud 8N1
ESC-Cancel, ENT-Save
Change Parameter
Modbus Timeout
40mS
ESC-Cancel, ENT-Save
MODBUS SETUP


ESC
ENT
Monitor Parameters
Motor Setup
Fault Activations
Motor Restarts
LCD Contrast 10>
Change Parameter
LCD Contrast 0-255
10
ESC-Cancel, ENT-Save
Timers
Systems Setup
Digital Inputs
Analog Inputs
Event History
System Stats
Time / Date
Software Version
ENT
Modbus Setup
LCD Setup >
MODIF Inputs
LCD SETUP


Monitor Parameters
Motor Setup
Fault Activations
Motor Restarts
Timers
Systems Setup
Digital Inputs
Analog Inputs
Event History
System Stats
Time / Date
Software Version
Modbus Setup
LCD Setup
MODIF Inputs >
ESC
ENT
MODIF CH 1 ---- >
MODIF CH 2 ---- >
MODIF CH 3 ---- >
MODIF CH 4 ---- >
MODIF CH 5 ---- >
MODIF CH 6 ---- >
MODIF CH 7 ---- >
MODIF CH 8 ---- >
MODIF Setup >
MODIF Setpoints CH 1
Reading...0
High Trip 9991 >
Low Trip 1111 >
ESC-Cancel, ENT-Save
MODIF Setpoints CH 2
Reading...0
High Trip 9991 >
Low Trip 1111 >
ESC-Cancel, ENT-Save
MODIF Setpoints CH 3
Reading...0
High Trip 9991 >
Low Trip 1111 >
ESC-Cancel, ENT-Save
MODIF Setpoints CH 4
Reading...0
High Trip 9991 >
Low Trip 1111 >
ESC-Cancel, ENT-Save
MODIF Setpoints CH 5
Reading...0
High Trip 9991 >
Low Trip 1111 >
ESC-Cancel, ENT-Save
MODIF Setpoints CH 6
Reading...0
High Trip 9991 >
Low Trip 1111 >
ESC-Cancel, ENT-Save
MODIF Setpoints CH 7
Reading...0
High Trip 9991 >
Low Trip 1111 >
ESC-Cancel, ENT-Save
MODIF Setpoints CH 8
Reading...0
High Trip 9991 >
Low Trip 1111 >
ESC-Cancel, ENT-Save
Change Parameter
Custom Modbus Device/
DDD RFScada/
WALS A-Well/
GE SmartGuard
SLB Phoenix
ESC-Cancel, ENT-Save
MODIF SETUP

Chapter

10 Parameter Definitions

Monitoring Parameters	
A Amps	This is a real time value of the actual current passing through the A Phase Current transformer. This parameter is adjustable for fine tuning purposes
B Amps	This is a real time value of the actual current passing through the B Phase Current transformer. This parameter is adjustable for fine tuning purposes.
C Amps	This is a real time value of the actual current passing through the C Phase Current transformer. This parameter is adjustable for fine tuning purposes.
Average Amps	This is a real time value. It is the average of A, B, and C Phase Currents.
A-B Volts	This is a real time value of the voltage potential between A Phase and B Phase line. This reading is a product of the actual voltage scaled via the PT Ratio. This parameter is adjustable for fine tuning. *Not available in menu list if Three Phase Set is set to 'NO'.*
C-A Volts	This is a real time value of the voltage potential between C Phase and A Phase line. This reading is a product of the actual voltage scaled via the PT Ratio. This parameter is adjustable for fine tuning. This is also the input that provides the primary power for the Motor Controller. *Not available in menu list if Three Phase Set is set to 'NO'.*
B-C Volts	This is a real time value of the voltage potential between B Phase and C Phase line. This reading is a calculated voltage based off of A-B and C-A inputs. *Not available in menu list if Three Phase Set is set to 'NO'.*
Average Volts	This is a real time value the Average of the three line voltages. *Not available in menu list if Three Phase Set is set to 'NO'.*
Amps Unbalance	This is a real time value and represents the % of imbalance between the highest and lowest of the Three Currents.
Volt Unbalance	This is a real time value representing the % of imbalance between the highest and lowest of the Three Line Voltages. *Not available in menu list if Three Phase Set is set to 'NO'.*
Rotation Is	This is a real time value representing the actual rotation sequence of the incoming line. Selectable between ABC and CBA. *Not available in menu list if Three Phase Set is set to 'NO'.*

Motor Setup	
Overload Spt.	This is a user defined parameter. If the Average Current exceeds this setpoint the Motor Controller will stop the operation of the equipment. The time it takes to initiate an overload trip depends on the amount the Average Current exceeds the Overload setpoint and the (I2T) Factor.
I2T Spt.	This is a user defined parameter. The controller keeps an array that is from 1 to 128 values long; the length is set by the user I2T parameter. Each of the values stored in the array is the maximum measured current of all 3 phases sampled during the last 128 mS. Every 128mS it adds up the total of the array; so if the user i2t parameter is set to 10 it calculates the average of the last 10 peak readings (1.25 seconds worth). It compares this to the Overload setting and shuts down if it exceeds the Overload setting. *An i2t Spt value of 8 uses 1 second worth of samples; a max i2t Spt value of 128 uses 16 seconds of samples.* When the motor starts the array is already filled with zeros (for no current); so this makes the startup less sensitive as the heavy starting currents are offset by the rest of the array beginning with zero readings. *The only difference between surface and downhole is the sample time; it is half the sample rate for surface apps, so the time can extend up to 32 seconds.*
Underload Spt.	This is a user defined value. If the Average Current falls below this setpoint for duration that exceeds the Underload Delay Timer, the Motor Controller will stop the operation of the equipment.
Amps UNB	This is a user defined setpoint. If the actual Current Unbalance exceeds this setpoint for duration greater than the Current Unbalance delay timer the Motor Controller will stop the operation of the equipment.
Undervolt Spt	This is a user defined setpoint. If the actual Under Voltage exceeds this setpoint for duration greater than the Current Unbalance delay timer the Motor Controller will stop the operation of the equipment.
Overvolt Spt.	This is a user defined setpoint. If the actual Over Voltage exceeds this setpoint for duration greater than the Current Unbalance delay timer the Motor Controller will stop the operation of the equipment.
Volt UNB Spt.	This is a user defined setpoint. If the actual Voltage Unbalance exceeds this setpoint for duration greater than the Current Unbalance delay timer the Motor Controller will stop the operation of the equipment.
Rotation Spt.	This is a user defined setpoint. If the actual rotation is different than the value entered into this setpoint the Motor Controller will stop the operation of the equipment.

Fault Activations	
Overload Enable	This is a user-defined parameter. If a “YES” is entered the Overload Fault Option is enabled. If “NO” the Overload Fault Option is disabled.
Underload Enable	This is a user-defined parameter. If a “YES” is entered the Underload Fault Option is enabled. If “NO” the Underload Fault Option is disabled.
Amps UNB Enable	This is a user-defined parameter. If a “YES” is entered the Current Unbalance Fault Option is enabled. If “NO” the Current Unbalance Fault Option is disabled.
Undervolt Enable	This is a user-defined parameter. If a “YES” is entered the Under Voltage Fault Option is enabled. If “NO” the Under Voltage Fault Option is disabled.
Overvolt Enable	This is a user-defined parameter. If a “YES” is entered the Over Voltage Fault Option is enabled. If “NO” the Over Voltage Fault Option is disabled.
Volt UNB Enable	This is a user-defined parameter. If a “YES” is entered the Voltage Unbalance Fault Option is enabled. If “NO” the Voltage Unbalance Fault Option is disabled.
Rotation Enable	This is a user-defined parameter. If a “YES” is entered the Rotation Fault Option is enabled. If “NO” the Rotation Fault Option is disabled.
Backspin Enable	This is a user-defined parameter. If a “YES” is entered Backspin Detection is enabled. If “NO” Backspin Detection is disabled.
A1 Trip Enable	This is a user-defined parameter. If a “YES” is entered the Analog #1 Trip Fault Option is enabled. If “NO” the Analog #1 Trip Fault Option is disabled.

Motor Restarts	
Overload Starts	This is a user defined parameter. The maximum number of allowed Overload Restarts before the Motor Controller will perform a lockout condition.
Underload Starts	This is a user defined parameter. The maximum number of allowed Underload Restarts before the Motor Controller will perform a lockout condition.
Amps UNB Starts	This is a user defined parameter. The maximum number of allowed Current Unbalance Restarts before the Motor Controller will perform a lockout condition.
Undervolt Starts	This is a user defined parameter. The maximum number of allowed Under Voltage Restarts before the Motor Controller will perform a lockout condition.
Overvolt Starts	This is a user defined parameter. The maximum number of allowed Over Voltage Restarts before the Motor Controller will perform a lockout condition.
Volt UNB Starts	This is a user defined parameter. The maximum number of allowed Voltage Unbalance Restarts before the Motor Controller will perform a lockout condition.
DI#1 Starts	This is a user defined parameter. The maximum number of allowed Digital Input #1 Restarts before the Motor Controller will perform a lockout condition.
DI#2 Starts	This is a user defined parameter. The maximum number of allowed Digital Input #2 Restarts before the Motor Controller will perform a lockout condition.
A1 Trip Starts	This is a user defined parameter. The maximum number of allowed Analog Input #1 Trip Restarts before the Motor Controller will perform a lockout condition

Timers	
Restart Timer	This is a user defined parameter. The value entered in this parameter is the time the Motor Controller must wait before it attempts an automatic restart
Reset Timer	This is a user defined parameter. The value entered in this parameter is the time the Motor Controller must be operating the equipment (RUNNING) before the Fault counters are reset.
ULD Delay Start	This is a user defined parameter. The value entered in this parameter is the time the Motor Controller will ignore an active Underload Fault ON STARTUP before it initiates a stop command.
ULD Delay Run	This is a user defined parameter. The value entered in this parameter is the time the Motor Controller will ignore an active Underload Fault WHILE RUNNING before it will initiate a stop command.
IUB Delay Start	This is a user defined parameter. The value entered in this parameter is the time the Motor Controller will ignore an active Current Unbalance Fault ON STARTUP before it initiates a stop command.
IUB Delay Run	This is a user defined parameter. The value entered in this parameter is the time the Motor Controller will ignore an active Current Unbalance Fault WHILE RUNNING before it will initiate a stop command.
UV Delay Start	This is a user defined parameter. The value entered in this parameter is the time the Motor Controller will ignore an active Under Voltage Fault ON STARTUP before it initiates a stop command.
UV Delay Run	This is a user defined parameter. The value entered in this parameter is the time the Motor Controller will ignore an active Under Voltage Fault WHILE RUNNING before it will initiate a stop command.
OV Delay Start	This is a user defined parameter. The value entered in this parameter is the time the Motor Controller will ignore an active Over Voltage Fault ON STARTUP before it initiates a stop command.
OV Delay Run	This is a user defined parameter. The value entered in this parameter is the time the Motor Controller will ignore an active Over Voltage Fault WHILE RUNNING before it will initiate a stop command.
VUB Delay Start	This is a user defined parameter. The value entered in this parameter is the time the Motor Controller will ignore an active Voltage Unbalance Fault ON STARTUP before it initiates a stop command.
VUB Delay Run	This is a user defined parameter. The value entered in this parameter is the time the Motor Controller will ignore an active Voltage Unbalance Fault WHILE RUNNING before it will initiate a stop command.
AI 1 Delay Start	This is a user defined parameter. The value entered in this parameter is the time the Motor Controller will ignore an active Analog Input #1 Fault ON STARTUP before it initiates a stop command.
AI 1 Delay Run	This is a user defined parameter. The value entered in this parameter is the time the Motor Controller will ignore an active Analog Input #1 Fault WHILE RUNNING before it will initiate a stop command.

Timers	
DI 1 Delay Start	This is a user defined parameter. The value entered in this parameter is the time the Motor Controller will ignore an active Digital Input #1 Fault ON STARTUP before it initiates a stop command.
DI 1 Delay Run	This is a user defined parameter. The value entered in this parameter is the time the Motor Controller will ignore an active Digital Input #1 Fault WHILE RUNNING before it will initiate a stop command.
DI 2 Delay Start	This is a user defined parameter. The value entered in this parameter is the time the Motor Controller will ignore an active Digital Input #2 Fault ON STARTUP before it initiates a stop command.
DI 2 Delay Run	This is a user defined parameter. The value entered in this parameter is the time the Motor Controller will ignore an active Digital Input #2 Fault WHILE RUNNING before it will initiate a stop command.

System Setup	
3 Phase Monitor	This is a user defined parameter. Entering "Single Phase" into this parameter indicates nothing is connected to the sensing volts terminal. Therefore you do not have the capability to monitor three voltages. Entering "Three Phase" into this parameter indicates sensing volts terminals are connected. Therefore you have the capability to monitor three voltages.
CT Ratio (X:5)	This is a user defined parameter. The actual current transformer value is entered in this parameter. It is based on X:5. If you are using 75:5 CT's, then the value of 75 will be entered.
PT Ratio (X:120)	This is a user defined parameter. The actual PT tap setting is entered in this parameter. It is based on X:120. If your PT's are tapped at 1200 volts, then the value of 1200 will be entered.
Wait for Timer	This is a user defined parameter. If a "YES" is entered into this parameter the Motor Controller will not allow a manual restart via the HOA and Start button. The unit can not be started until the restart timer has timed out.
Motor Type	This is a user defined parameter. This parameter is selectable between Downhole Motor (ESP) and Surface Motor.
Remote Auth.	This is a user defined parameter. If a "YES" is entered into this parameter the Motor Controller will allow Starts & Stop from a Remote Location via serial communications.

Digital Inputs	
DI 1 Config	This is a user defined parameter. If "N/C" is entered into this parameter the Motor Controller will stop operation of the equipment if 120VAC IS NOT present on Digital Input terminal #14.
DI 1 Allow Start	If "N/O" is entered into this parameter the Motor Controller will stop operation of the equipment if 120VAC IS present on Digital Input terminal #14.
DI 2 Config	This is a user defined parameter. If "N/C" is entered into this parameter the Motor Controller will stop operation of the equipment if 120VAC IS NOT present on terminal #14. If "N/O" is entered into this parameter the Motor Controller will stop operation of the equipment if 120VAC IS present on DI 2 terminal #14.
DI 2 Allow Start	This is a user defined parameter. If this parameter is set to "NO" the Motor Controller will not allow an automatic restart or a manual start with Digital Input alarm (Dig 1 alarm) active.

Analog Inputs	
AI 1 Value	This parameter displays the real time engineered value of Analog Input #1.
AI 1 Span	This is a user defined value. The maximum number displayed when the raw value input of 10vdc is applied to terminal #19 of the Motor Controller
AI 1 Offset	This is a user defined value. When utilizing this analog input with a process value where 0 engineered value is not equivalent to a raw value of zero. Calculating the offset will allow the user to make a positive process value be displayed as zero without distorting the linear display to span.
AI 1 Units /////	This is a user defined setpoint. Use the Up and Down arrows on the Display to enter a text that will describe Analog Input #1.
AI 1 High Trip	This is a user defined setpoint. If the engineered value exceeds this setpoint for a duration greater than the fault shutdown delay timer the Motor Controller will stop the operation of the equipment.
AI 1 Low Trip	This is a user defined setpoint. If the engineered value exceeds this setpoint for a duration greater than the fault shutdown delay timer the Motor Controller will stop the operation of the equipment.
AI 2 Value	This parameter displays the real time engineered value of Analog Input #2.
AI 2 Span	This is a user defined value. The maximum number displayed when the raw Analog Input value of 10VDC is applied to terminal #19 of the Motor Controller.
AI 2 Offset	This is a user defined value. For utilizing analog input 2 with a process value where 0 engineering unit value is not equivalent to a raw value of zero. Calculating the offset will allow the user to make a positive process value be displayed as zero without distorting the linearity span on display.
AI 2 Units //////	This is a user defined setpoint. Use the Up and Down arrows on the display to enter text describing Analog Input #2.

<table>
<tr><th colspan="2">Event History</th></tr>
<tr><td rowspan="2">Display History</td><td>Display History: This parameter displays the last 200 Shutdowns and Faults that occurred. Date and Time stamps are also provided.</td></tr>
<tr><td>
<table>
<tr><td>Overld</td><td>Overload</td></tr>
<tr><td>Undrld</td><td>Underload</td></tr>
<tr><td>CurrUB</td><td>Current Unbalance</td></tr>
<tr><td>OverVo</td><td>Over Voltage</td></tr>
<tr><td>UnderV</td><td>Under Voltage</td></tr>
<tr><td>VoltUB</td><td>Voltage Unbalance</td></tr>
<tr><td>Rotate</td><td>Rotation error</td></tr>
<tr><td>Dig. 1</td><td>Digital Input 1 Active</td></tr>
<tr><td>Dig. 2</td><td>Digital Input 2 Active</td></tr>
<tr><td>AI 1 Lo</td><td>Analog 1 Below "Low Setpoint"</td></tr>
<tr><td>AI 2 Hi</td><td>Analog 1 Above "Hi Setpoint"</td></tr>
<tr><td>Pwr On</td><td>Power On</td></tr>
<tr><td>Pwr Off</td><td>Power Off</td></tr>
<tr><td>MnStrt</td><td>Manual Start</td></tr>
<tr><td>MnStop</td><td>Manual Stop</td></tr>
<tr><td>AuStrt</td><td>Auto Start</td></tr>
<tr><td>RmStrt</td><td>Remote Start</td></tr>
<tr><td>RmStop</td><td>Remote Stop</td></tr>
</table>
Table 2 – Legend for Historical Data
</td></tr>
<tr><td>Clear History</td><td>This is a user defined setpoint. If “YES Clear History” is selected then all the Historical Data will be cleared.</td></tr>
</table>

System Stats	
Total Rub Hours	This displays the TOTAL number of hours the Motor Controller has run. This is not changeable. To zero this parameter the Motor Controller must be defaulted to Factory Setup.
User Run Hours	This displays the number of hours the Motor Controller has ran since being reset.
Total Starts	This displays the TOTAL number of starts the Motor Controller has performed. This is not changeable. To zero this parameter the Motor Controller must be defaulted to Factory Setup.
User Starts	This displays the number of start the Motor Controller has performed since being reset.

Time / Date	
Month	This is a user defined value. The Month in a number format is entered into this parameter.
Date	This is a user defined value. The Day of the month in a number format is entered into this parameter.
Hour	This is a user defined value. The Hour of the day in a number format is entered into this parameter. The time is kept in a 24 hour format. Example if the time is 3:00pm then the hour would be 15.
Minute	This is a user defined value. The Minutes of the hour is entered into this parameter.
Year	This is a user defined value. The Year in a number format is entered into this parameter. The Year is not displayed in the controller, but is needed to calculate Leap Years.

Software Versions	
Controller SN	Displays the Serial Number of the Motor Controller
Display SN	Displays the Serial Number of the Display
Backspin SN	Displays the Serial Number of the Backspin Module
Modbus I/F SN	Displays the Serial Number of the Modbus I/F
Controller FW	Displays the Firmware residing in the Motor Controller
Display FW	Displays the Firmware residing in the Display
Backspin FW	Displays the Firmware residing in the Backspin Module
Modbus I/F FW	Displays the Firmware residing in the Modbus I/F
Emulate VT Regs	This is a user defined value. If “ON” the Motor Controller registers will mimic a Vortex Motor Controller. This is used when replacing a Vortex controller that is being monitored thru SCADA via serial communication.
Factory Setup	This is a user defined value. By entering the Password and Pressing “ENT” the Motor Controller will default to Factory Settings.

Modbus Setup	
Modbus ID	This is a user-defined parameter. Enter the MODBUS Slave ID Number.
Modbus Baud	This is a user-defined parameter. Enter the Baud Rate from 1200 to 28800.
Modbus Timeout	This is a user-defined parameter. Comms timeout value in mS.

LCD Contrast	
LCD Contrast	This is a user-defined parameter. Enter the amount of Contrast from 0 to 255.

Chapter

11 Modbus Registers & Bittfields

The following Modbus commands are supported in the motor controller: 2, 3, 4, 5, 6 and 16.

There are two modes of Modbus registers supported, the standard full function motor controller mode and a second, reduced set of basic commands which are compatible with the Vortex motor controller. Since many of the register addresses overlap between the two modes only one mode may be selected at time. The controller defaults to the full function mode, but it may be changed by using the display to set Emulate VT Regs in the software version menu; the mode may also be changed via a Modbus command. The full function mode should be used if possible, as it offers much more functionality and accuracy. The VT mode supports 6 limited history events with no date or time; the full function mode provides the last 128 events with dates and times; the VT mode only allows current readings or adjustments to 1 Amp resolution; the full function mode to 0.1 Amp resolution, and many of the motor controller settings cannot be changed at all in VT mode.

Cautions when writing Modbus Commands: When a successful Modbus write occurs, the data is immediately saved to the motor controller's non-volatile memory; whereas with previous versions of motor controller firmware, a separate Modbus store command was required to save the parameters to non-volatile memory. Modbus masters that write to the motor controller should ensure that they do not keep continually writing to the motor controller, as there is a finite number of writes allowed to the motor controller's non-volatile storage device.

Full Function Mode

Modbus Address 0 to 9 Read with Command 3 or 4	
0	Digital Input Status (0=open, 1 = closed). Bit 0 = Start, 1 = Pressure, 2=Hand, 3=Auto, 4=Spare
1	Digital Output Status (0=open, 1 = closed) Bit 0 = Contact, 1 = Red, 2 = Amber
2	Runtime since last start, in hours.

Modbus Address 0 to 9 Read with Command 3 or 4	
3	Time until start, in seconds.
4	Present motion state of the controller has the following definitions: 1. Power coming up 2. Auto mode - may restart 3. Auto mode - shutdown 4. Auto mode – running 5. Switched off 6. Manual mode not running 7. Manual mode running 8. Changing from manual to auto with start button pressed 9. Changing from auto to manual with start button pressed 10. Brown out
5	Reason cannot start, more than one condition may exist at the same time but just the first one will be reported, has the following definitions: 0. No reason 1. Current still exists 2. Phase error 3. UL restarts exceeded 4. HOA wiring error (Hand and Auto active at the same time) 5. OL restarts exceeded 6. Locked out 7. Over Voltage detected 8. Under Voltage detected 9. Voltage Unbalance detected 10. Digital Input 1 Active 11. Digital Input 2 Active 12. Analog 1 Too High 13. Analog 1 Too Low 14. Backspin Active 15. Too many current unbalance restarts have occurred 16. Too many under Voltage restarts have occurred 17. Too many over Voltage restarts have occurred 18. Too many Voltage unbalance restarts have occurred 19. Too many Digital Input 1 restarts have occurred 20. Too many Digital Input 2 restarts have occurred 21. Too many Analog 1 restarts have occurred
6	Number of Underload restarts that have occurred.
7	Number of overload restarts that have occurred
8	Spare
9	Rotation, following definitions: 0. ABC 1. CBA 2. Unknown (PT missing or reversed)

Modbus Address 200 to 456 Read with Command 3 or 4	
Registers 200 to 456 contain history events with time/date stamps. There are 128 events, each with the time and date is contained in two consecutive registers.	
200 & 201	Most recent history event.
202 & 203	Next most recent history event
454 & 456	Oldest history event
Extract the event and data as follows:	
First Register	Bits 0-5: Seconds Bits 6 to 11: Minutes Bits 12 to 15: Least significant bits of hours
Second Register	Bit 0: Most significant bit of hours Bits 1 to 5: Day Bits 6 to 9: Month Bits 10 to 15: Contain the event code as follows: 1 Overload 2 Underload 3 Current Unbalance 4 Voltage Overload 5 Voltage Underload 6 Voltage Unbalance 7 Rotation 8 Digital Input 1 9 Digital Input 2 10 Analog Input High 11 Analog Input Low 12 Manual Stop 13 Power Restored 14 Power Fail 15 Brown-out 16 Manual Start 17 Auto Start 18 Remote (Modbus) Start 19 Remote (Modbus) Stop

Modbus Address 460 to 480 Read with Command 3 or 4	
460	Backspin module serial number.
461	Backspin module software version, e.g. 14 = V1.4
462	Backspin time. A factory set time in seconds that the backspin device will activate its relay to prevent a start after backspin conditions clear. This only relates to the backspin modules internal relay and not the motor controller backspin related time delays.
463	Backspin CA time period, in milliseconds. This is the time period detected by the backspin module of a spinning motor, calculated from phases A and C. The motor rpm may be determined as rpm = 1 / time period. Delays longer than 500mS are ignored; so the backspin module can detect motors turning down to 2 Hz.
464	Backspin AB time period; similar to 463.
465	Backspin module detected by the motor controller. 1 = detected, 0 = not found. Note that the backspin module may be detected but disabled by the motor controller (see register 530)
466	Backspin clamped Voltage from C-A phases; for factory use.
467	Backspin clamped Voltage from A-B phases; for factory use.
468	468 Backspin clamped Voltage from B-C phases; for factory use.
469	Backspin condition active; either frequency or Voltage detected. (1 = active, 0 = inactive)
470	Backspin BC time period; similar to 463.
475	Real time clock month.
476	Real time clock date.
477	Real time clock hour
478	Real time clock minute
479	Real time clock second
480	Real time clock year

Modbus Address 500 to 560 Read with Command 3 or 4 Write with Command 6 or 16	
500	Modbus ID, 1 to 254. The controller will also always respond to Modbus address 99 with relaxed timing settings. This is so the controller may be accessed even if timing settings have been entered that are too stringent for the connected equipment, such as modems.
501	0 = ignore Modbus broadcast commands, 1= accept broadcast commands. Not presently used
502	Emulation mode; 0 = Full Function, 1 = VT Mode
503	Modbus silent time in mS. Handles breaks in packets caused by modems etc
504	Current overload set point. Scaled, CT adjusted, 10 times actual amps. E.g. 1234 = 123.4 amps
505	I2T Parameter. Lower value is the faster response. 1 to 127
506	Current under load set point. Scaled, CT adjusted, 10 times actual. E.g. 789 = 78.9 amps
507	Current under load startup ignores time, in seconds. 0 – 65535
508	Reset Time. If motor runs for this time the restart counts are cleared. In minutes.
509	Restart Time in seconds. 0 – 65535
510	Modbus baud rate. 0 = 1200, 1 = 2400, 2 = 4800, 3 = 9600, 4 = 19200.
511	Current under load active time. Time condition must be active to cause a shutdown, in seconds.
512	Current under load fault enable. 0 = disabled, 1= enabled.
513	Input one stop/active time. Time condition must be active to cause a shutdown, in seconds.
514	Input two stop/active time. Time condition must be active to cause a shutdown, in seconds.
515	Current overload fault enable set Time condition must be active to cause a shutdown, in seconds

Modbus Address 500 to 560 Read with Command 3 or 4 Write with Command 6 or 16	
516	Input one startup time. Time condition will be ignored after a start, in seconds.
517	Input two startup time. Time condition will be ignored after a start, in seconds.
518	Input One NC/NO shutdown state. NO = 0, NC = 1
519	Input Two NC/NO shutdown state. NO = 0, NC = 1
520	Maximum number of overload restarts allowed
521	Maximum number of under load restarts allowed.
522	Users re-settable start count.
523	Wait for timer before starting 0 = wait, 1 = don't wait
524	Rotation setting 0 = ABC, 1 = CBA, 2 = ignore.
525	Three phase setting. 0 = three phase, 1 = single phase.
526	Under voltage set point. Scaled, PT adjusted, 10 times actual. E.g. 15857 = 1585.7 Volts
527	Over voltage set point. Scaled, PT adjusted, 10 times actual. E.g. 15857 = 1585.7 Volts
528	Voltage imbalance set point. 10 times percent. E.g. 123 = 12.3%
529	Current imbalance set point. 10 times percent. E.g. 123 = 12.3%
530	Backspin shutdown enabled. 1 = enabled, 0 = disabled. (465 indicates physical existence of backspin module)
531	Current unbalance fault enable. 0 = disabled, 1= enabled.
532	Under Voltage fault enable. 0 = disabled, 1= enabled.
533	Over Voltage fault enable. 0 = disabled, 1= enabled.
534	Voltage unbalance fault enable. 0 = disabled, 1= enabled.
535	Rotation fault enable. 0 = disabled, 1= enabled.
536	Analog 1 trip fault enable. 0 = disabled, 1= enabled.
537	Maximum number of current unbalance restarts.
538	Maximum number of over Voltage restarts.

Modbus Address 500 to 560 Read with Command 3 or 4 Write with Command 6 or 16	
539	Maximum number of under Voltage restarts.
540	Maximum number of Voltage unbalance restarts.
541	Maximum number of Digital 1 restarts.
542	Maximum number of Digital 2 restarts.
543	Maximum number of Analog 1 restarts.
544	Current unbalance start delay. Time condition will be ignored after a start, in seconds.
545	Current unbalance stop delay. Time condition must be active to cause a shutdown, in seconds.
546	Under Voltage start delay. Time condition will be ignored after a start, in seconds.
547	Under Voltage stop delay. Time condition must be active to cause a shutdown, in seconds.
548	Over Voltage start delay. Time condition will be ignored after a start, in seconds.
549	Over Voltage stop delay. Time condition must be active to cause a shutdown, in seconds.
550	Voltage unbalance start delay. Time condition will be ignored after a start, in seconds.
551	Voltage unbalance stop delay. Time condition must be active to cause a shutdown, in seconds.
552	Analog 1 trip start delay. Time condition will be ignored after a start, in seconds.
553	Analog 1 trip stop delay. Time condition must be active to cause a shutdown, in seconds.
554 - 559	Contains the ASCII text assigned to the Analog 1 and Analog 2 engineering units. Each register contains two characters, with the right character being the least significant byte. E.g. ASCII “A” is 0x41 and “S” is 0x53, so write 0x4153 (16723 decimal) to register 554 to make the Analog 1 last two characters “AS”. Note that it may take up to a minute before the characters appear in the display after changing them.
554	ASCII Analog 1 characters 5 & 6
555	ASCII Analog 1 characters 3 & 4

Modbus Address 500 to 560 Read with Command 3 or 4 Write with Command 6 or 16	
556	ASCII Analog 1 characters 1 & 2
557	ASCII Analog 2 characters 5 & 6
558	ASCII Analog 2 characters 3 & 4
559	ASCII Analog 2 characters 1 & 2
560	Re-settable motor runtime in hours, 0 to 65355. Note the display can only show up to 9999 hours.

Modbus Address 600 to 607 Read with Command 3 or 4	
600	Motor controller serial number.
601	Motor controller software version. E.g. 12 = 1.2
602	Motor controller total starts. (See 522 for user re-settable start counter)
603	Motor controller total running hours. (non re-settable).
604	Display serial number
605	Display software version. E.g. 18 = 1.8
606	Display EEPROM Fastest update rate
607	Display power on hours. (Non re-settable).

Modbus Address 700 to 707 Read with Command 3 or 4 Write with Command 6 or 16	
700 - 704	700-704 are calibration factors, used to correct for CT/PT variations.
700	Calibration factor CA Voltage. 32768 default, 49152 max, 16384 minimum
701	Calibration factor AB Voltage. 32768 default, 49152 max, 16384 minimum

Modbus Address 700 to 707 Read with Command 3 or 4 Write with Command 6 or 16	
702	Calibration factor A Phase. 32768 default, 49152 max, 16384 minimum
703	Calibration factor B Phase. 32768 default, 49152 max, 16384 minimum
704	Calibration factor C Phase. 32768 default, 49152 max, 16384 minimum
705	PT Ratio 1 to 600 multiplies 10 Volts rms. E.g. 48 = 480:120 PT's.
706	Spare.
707	CT Ratio 1 to 250, multiply by 5A for 5-1250 Amp setting. E.g. 20 = 200:5 CT's.

Modbus Address 715 to 720 Write with Command 6 or 16	
To set the clock the following registers need to be written; then write to register 998.	
715	RTC month write
716	RTC date write
717	RTC hour write
718	RTC minute write
719	RTC second write
720	RTC year write

Modbus Address 998 Write with Command 5, 6 or 16	
998	RTC Modbus write update, write 4321 to force RTC update from Modbus registers 715-720

Modbus Address 999 Write with Command 6 or 16

Modbus Address 999 Write with Command 6 or 16	
999	Remote start / stop command. If using command 5 force the coil on to start, off to stop. If using commands 6 or 16 write 65280 to start, 0 to stop. Remote authorization has to be enabled for this command to have any effect. Remote Modbus starts can only occur if the HOA switch is in the 'Auto' position and all other conditions would allow a manual start. Writing the Modbus start command has the effect of pressing the start button for 0.5 second.

Modbus Address 1000 to 1021 Read with Command 3 or 4	
1000-1016	Intended for factory use. These raw values are not adjusted for PT/CT ratios etc.
1000	Last reading. Phase A current, scaled. 0 - 0xFFFF 0xFFFF = 15 Amps AC; 0x5555 = 5 Amps.
1001	Last reading. Phase B current, scaled. 0 - 0xFFFF 0xFFFF = 15 Amps AC; 0x5555 = 5 Amps.
1002	Last reading. Phase C current, scaled. 0 - 0xFFFF 0xFFFF = 15 Amps AC; 0x5555 = 5 Amps.
1003	Last reading. Voltage A-B. Scaled, 0 - 0xFFFF 0xFFFF = 240 Volts AC; 0x7FFF = 120 VAC
1004	Last reading. Voltage C-A. Scaled, 0 - 0xFFFF 0xFFFF = 240 Volts AC; 0x7FFF = 120 VAC
1005	Last reading. Analog Input 1, 0 - 0xFFFF
1006	Last reading. Analog Input 2, 0 - 0xFFFF
1007	Last second average reading Phase A Current. Scaled. 0 - 0xFFFF
1008	Last second hi reading.
1009	Last Second low reading.
1010	Last second average reading Phase B Current. Scaled. 0 - 0xFFFF

Modbus Address 1000 to 1021 Read with Command 3 or 4	
1011	Last second hi reading.
1012	Last Second low reading.
1013	Last second average reading Phase C Current. Scaled. 0 - 0xFFFF
1014	Last second hi reading.
1015	Last Second low reading.
1016	Running I2tcurrent.
1017	Last second average phase A current, scaled, CT adjusted. 10x reading, E.g. 5678 = 567.8Amps
1018	Last second average phase B current, scaled, CT adjusted. 10x reading, E.g. 5678 = 567.8Amps
1019	Last second average phase C current, scaled, CT adjusted. 10x reading, E.g. 5678 = 567.8Amps
1020	Last voltage A-B reading, scaled, PT adjusted. 10x reading, E.g. 17575 = 1757.5 Volts
1021	Last voltage C-A reading, scaled, PT adjusted. 10x reading, E.g. 17575 = 1757.5 Volts

VT Mode

The following VT Registers are supported.

56 - 271	Input Status Coils. Read with Command 2
257 - 262	Analog Values, read with Command 3 or 4
264 - 273	Analog Values, read with Command 3 or 4
792 – 796	Last Alarms, read with Command 3 or 4
513 – 519	Set-points, read with Command 3 or 4, write with Command 6 or 16
521 – 525	Set-points, read with Command 3 or 4, write with Command 6 or 16
557	Set-point, read with Command 3 or 4, write with Command 6 or 16

560	Set-point, read with Command 3 or 4, write with Command 6 or 16
512	Force coil, write with Command 5.
In addition, the following register may be written to allow full-function Modbus control. This way, even if the device is being used in VT mode it may be switched remotely to full function mode to access registers not available in VT mode, then may be switched back to VT mode afterwards.	
502	Emulation mode. Write 0 for full function, 1 for VT mode. Read with Command 3 or 4, write with Command 6 or 16

Appendix

A Product Warranty

Warranty Coverage:

Global Production Solutions Inc. ("GPS") warrants GPS manufactured products ("Product") to be free of workmanship and material defects for a period of eighteen (18) months from the date of shipment to Buyer or twelve (12) months from the date of installation.

GPS, at its option, will at no charge either repair, replace, or refund the purchase price of the Product during the warranty period, provided it is returned in accordance with the terms of this warranty to 35431 Hardesty Road, Shawnee, OK 74801, at GPS option, may include the replacement of parts or boards with functionally equivalent reconditioned or new parts or boards. Replaced parts or boards are warranted for the balance of the original applicable warranty period. All replaced parts, boards or Product shall become the property of GPS. Shipping costs are to be borne by the purchasing party.

This express warranty is extended by GPS to the party purchasing the Product ("Buyer") and is not assignable or transferable to any other party. This is the complete warranty for the Products, except as modified by separate agreement between GPS and Buyer.

GPS is not responsible under this warranty for ancillary equipment, whether or not manufactured by GPS, which is attached to or used in connection with the Product, nor for operation of the Product with any such with any such ancillary equipment.

Because each Product system is unique, GPS disclaims liability for range, coverage, or operation of the system as a whole under this warranty.

This warranty applies within the fifty (50) United States and the District of Columbia.

What this warranty does not cover:

Defects or damage resulting from use of the Product in other than its normal and customary manner, (b) Defects or damage from misuse, accident or neglect, (c) Defects or damage from improper testing, operation, maintenance, installation, alteration, modification or adjustment, (d) Product disassembled or repaired in such a manner as to adversely affect performance or prevent adequate inspection and testing to verify any warranty claim, (e) Product which has had the serial number removed or made illegible.

General Provisions:

This warranty sets forth the full extent of GPS' responsibilities and liability regarding the Product, and repair, replacement, or refund of the purchase price, at GPS' option, is Buyer's exclusive remedy.

THIS WARRANTY IS GIVEN IN LIEU OF ALL OTHER WARRANTIES, EXPRESS OR IMPLIED, WHICH ARE SPECIFICALLY EXCLUDED INCLUDING, WITHOUT LIMITATION, IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE IN NO EVENT SHALL GPS BE LIABLE FOR DAMAGES IN EXCESS OF THE PURCHASE PRICE OF THE PRODUCT, FOR ANY LOSS OF USE, LOSS OF TIME, INCONVENIENCE, COMMERCIAL LOSS, LOST PROFITS OR SAVINGS OR OTHER INCIDENTAL, SPECIAL OR CONSEQUENTIAL DAMAGES ARISING OUT OF THE USE OR INABILITY TO USE SUCH PRODUCT.

Patent and Software Provisions:

GPS will defend at its own expense any suit brought against Buyer to the extent that it is based on a claim that the Product or parts infringes a United States patent, and GPS will pay those costs and damages finally awarded against Buyer in any such suit which are attributable to any such claim, but such defense and payments are conditioned on the following: (i) that GPS will be notified promptly in writing by Buyer of any notice of such claim; and (ii) that GPS will have sole control of the defense of such suit and all negotiations for its settlement or compromise; and (iii) should the Product or parts become, or in GPS' opinion be likely to become, the subject of a claim infringement of a United States patent, that Buyer will permit GPS, at its option and expense, either to procure for Buyer the right to continue using the Product or parts or to replace or modify the same so that it becomes non-infringing or to grant Buyer a credit for the Product or parts as depreciated and accept its return. The depreciation will be an equal amount per year over the lifetime of the Product or parts as established by GPS.

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