Schlumberger

Instruct Controller User Manual

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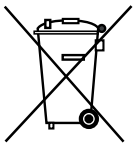
Revision History

Version	Date	Description	Prepared by
1.0	16-Dec-2013	Initial release.	**Author:** Ian Roberge, Jeffery P. Anderson
1.1	24-Jan-2014	Updated VSD retrofit procedure, updated Instruct specific HSE considerations, corrected User Interface section and corrected Analog Output configuration.	**Author:** Ahmed El-Kadri, Ian Roberge, Jeffery P. Anderson, Devon Perry
1.2	24-Mar-2014	Added Software Attributions to Appendix and Trend Sampling Time section to Configuration chapter.	**Author:** Jeffery P. Anderson
1.3	05-Jun-2014	Added jump frequency explanation and updated retrofit procedure.	**Author:** Ahmed El-Kadri
1.4	16-Apr-2015	Added the Configuring Endurant Card section to the Configuration section. Updated the Analog Signal Connections section in the Installation section. Added Endurant Card and MVD Card description to the Theory of Operations section. Updated Digital Output (Relays) and temperature specification.	**Author:** Ahmed El-Kadri
1.5	18-May-2015	Added a note to inspect PCB and bezel during retrofit process in the Installation section. Added caution, do not connect USB cable to controller before it boots up, in the Installation section.	**Author:** Ahmed El-Kadri
1.6	11-Jan-2016	Updated all screen shots and procedures to reflect GUI 2.0 display. Added sections for the Switchboard card. Added new Charting and Trending features. InTouch ticket 6772807.	**Author:** David Kushnir
1.7	07-Dec-2016	Added Gas Lock Protection section and updated USB Connectors section to the Theory of Operations section. Updated the Controller Compatibility section in the Installation section. Added Gas Lock Protection section in the Configuration section. Updated the VSD Settings, updated the Switchboard and the Configuring the PIC Using Instruct sections in the Configuration section. InTouch ticket 6942302.	**Author:** Tengyun CHU
1.8	14-May-2018	Corrected security classification.	**Author:**

Version	Date	Description	Prepared by
1.9	29-Mar-2019	Added Slot A/B alarm function. Added Theory of operations for Switchboard functions, IOs functions, VSD functions, PIC functions, Phoenix function, Power Ride Through function. Added ABB ACS880 VSD information. Added steps for updating the firmware with StraView . Added Controller Statistics information. InTouch ticket 7282821.	**Author:** Tengyun CHU
2.0	26-Jan-2021	Updated Instruct AC and DC power supply can be used at the same time.	**Author:** Tengyun Chu

Regulatory Compliance

Waste management



IMPORTANT INFORMATION FOR CORRECT DISPOSAL OF THE EQUIPMENT

This symbol means that the equipment cannot be discarded in a rubbish-bin. At its end of life, the equipment and/or its components must be treated, following Schlumberger Environmental procedures, in compliance with Schlumberger QHSE Policy and applicable laws and regulations on waste management.

Table of Contents

List of Figures

List of Tables

Product Description

1 Product Description

1.1 Overview

The Instruct Controller provides protection, monitoring and control, and data acquisition for fixed-speed and variable-speed three-phase induction motor systems. This unit and its optional expansion cards monitor:

- Variable Speed Drive (VSD) parameters
- Control supply voltage
- Motor currents and voltages
- External switch contacts
- Process analog signals
- Data from downhole tool systems/gauges
- Remote SCADA I/O channels

The Instruct Controller provides motor and drive shutdown under adverse conditions and enables safe, automatic system restarts. The expansion card system allows interfacing to downhole tools, VSDs, instrumentation and communication systems. The controller is particularly suited for controlling oilfield production pump motors for electric submersible pump (ESP) systems using either fixed speed or VSD systems. The self-contained unit incorporates a display and keypad for local control and operation. The integrated keypad and display incorporates full Hand-Off-Auto and Start control for the motor, eliminating the need for externally wired switches. The control wiring for the Instruct Controller is connected to removable terminal assemblies on the unit. Terminal assemblies snap in and out for easy connection or removal. These assemblies are organized logically according the function they perform. External annunciation lamps can be connected to the outputs on optional I/O cards for improved visibility to on-site personnel.

Figure 1-1: Instruct Controller

1.2 Features and Benefits

- Intuitive, user-friendly color graphic display and menu system.
- Plain-language, multilingual alarms and prompts, at-a-glance wellsite assessment, and dedicated function keys.
- Centralized data gathering and storage for troubleshooting and engineering analysis, eliminating multiple surface components.
- PC-based StarView wellsite display software for device configuration, operation, and troubleshooting
- Modular design that increases reliability, expandability, and serviceability
- 1 GB of internal memory with a removable USB drive option and multiprocessor architecture ensuring smooth performance data logging and trending for millions of data points.
- Remote access and control capability from multiple SCADA systems and LiftWatcher surveillance and control system in parallel
- Utilizes the Phoenix Interface Card to provide acquisition platform for Phoenix artificial lift downhole monitoring equipment and cable-to-surface (CTS) gauges.

- Retrofit kit available for UniConn-equipped drive systems

1.3 Limitations

Refer to the Instruct Firmware (InTouch ID 6145281) for the latest release notes and firmware upgrades.

Health, Safety, and Environment (HSE)

2 Health, Safety, and Environment (HSE)

2.1 Overview

There are four indicators of the special type of care needed with equipment that are used in the text of this manual:

Danger

Potential Severity: Catastrophic
Potential Loss: Personnel
Hazard Category: Electrical

Indicates major or catastrophic severity with high potential loss.

Warning

Potential Severity: Serious
Potential Loss: Personnel
Hazard Category: Electrical

Indicates danger to personnel and could possibly result in loss of life or serious injury.

Caution

Potential Severity: Light
Potential Loss: Personnel
Hazard Category: Electrical

Indicates danger to equipment and could result in relatively serious or minor injury, or faulty operation.

Note

Indicates special care needs to be taken.

Note: Location Responsibility

Prepare a HARC for the related activity: Prior to starting rig activities, the team must review and sign off the generic HARC. The crew chief should hold a tool box talk with the team to assign clear responsibilities for the activities that will be carried out.

It is the operator's responsibility to ensure that all personnel working with or near the equipment are aware of the risk described. Failure to heed precautions provided in this manual can result in serious or possibly even fatal injury to personnel, and/or damage to the products or to the related equipment and systems.

Danger

Using this product in a manner not specified by the manufacturer could result in protection impairment.

Note

Only qualified personnel are eligible to install equipment described in this manual, paying special attention to warning notes located throughout the manual.

Danger

Potential Severity: Major
Potential Loss: Environmental
Hazard Category: Electrical, Machinery equipment hand tools, Toxic corrosive hazardous substances

All field users should use their local electrical standards, technical guidelines, and laws unless Schlumberger's standards are more stringent in which case they should be used.

Danger

Potential Severity: Catastrophic
Potential Loss: Personnel
Hazard Category: Electrical

Be aware of the Electrical Shock Hazards when working with Permanent Magnet Motor (PMM). Follow the PMM Precautions and electrical test procedures (InTouch ID 7455173).
The PMM (Permanent Magnet Motor) is an alternating voltage generator when the shaft is rotated by external forces. Lethal High AC Voltage resulting from PMM motor rotation can be present even if the surface power is isolated, in absence of a power supply even if is disconnected.
The resulting voltage value is directly proportional to the shaft rotation frequency and is usually 80% to 90% of the rated motor voltage for the specified frequency. The high AC voltage as a result will be present on the terminals of the stator winding and respectively similarly in all electrical cables connected to the PMM motor.
Rotation of the shaft can occur in several cases as long as turbine rotation take effect on pump, for example: During fluid circulation, self-flowing wells, pressure test, slick line or wireline operations in the well, run in hole installation, pulling, flushing activities, ESP is shut down (backflow), during operations in the absence of check and bleeder valves or even in the event of valve malfunction. In general turbine effect can happen in any operation/activity that can cause ESP shaft rotation.
Always insulate and ensure Zero Voltage State before handling cables and electrical connections.

Note

Most of Schlumberger guidelines are based on the NFPA 70 (NEC) book.

Note

Qualified personnel are people entrusted by their employer with installation, assembly, commissioning, and operation of the equipment within the intent and constraints of the operating instructions in this manual and the warning information on the equipment itself. Qualified personnel must have the following minimum training and qualifications:

- Special training in electrical equipment, in accordance with the standards of safety engineering
- Hydrostatic pressure testing mandatory training as specified by Artificial Lift Pressure Operations Manual (InTouch ID 4392112)
- CPR training
- First aid training
- Personal protective equipment (PPE) training
- Fire safety training.

Note

For reasons of clarity, these operating instructions do not contain all details of all types of equipment and cannot take into account every conceivable installation, operation, or maintenance circumstance. Consult InTouchSupport.com if further information is required or if problems occur that are not adequately detailed in the operating instructions. The contents of this instruction manual shall not become part of, or modify any prior or existing agreement, commitment, or legal relationship.

2.2 Danger to Personnel

Danger

Potential Severity: Catastrophic
Potential Loss: Assets, Environmental, Personnel
Hazard Category: Electrical, Explosives

This product is not suitable for operation in hazardous locations or areas with an explosive atmosphere.

Warning

Potential Severity: Serious
Potential Loss: Personnel
Hazard Category: Electrical

Lethal voltages are present when equipment is running. Do not open panels or remove protective coverings until equipment is powered down.

The following precautions should be followed by qualified personnel when working on or around a unit.

- Never work alone on equipment that has power applied to it. Be sure someone is nearby to give assistance in case of an accident.
- Ensure lock-out, tag-out (LOTO) procedures are used whenever possible.
- Beware of defective equipment. If equipment components or connections look loose, corroded, or damaged in any way, do not operate. Contact InTouchSupport.com immediately for further action.
- Ensure that power to the system is OFF when connecting or disconnecting equipment.
- The power terminals and control terminals may carry a voltage even when the connected equipment is not active.
- Non-observance of warning notices can result in death, severe personal injury, or considerable property damage.

2.3 Danger to the Environment

Caution

Potential Severity: Light
Potential Loss: Assets, Environmental
Hazard Category: Machinery equipment hand tools

Failure to observe the following precautions may result in damage to the environment.

The following information pertains to the safe disposal of the equipment manufactured by Schlumberger in accordance with environmental standards. Operators are required to follow safe disposal methods.

2.3.1 Circuit Boards

Circuit boards require additional disposal care. Circuit boards require disposal, and in some cases, recycling by an approved waste vendor. Refer to local law and the law of the manufacturing country for details.

Note

Check with local environmental law and Schlumberger HSE advisor for specific procedures for disposal of above mentioned component.

The circuit boards used in this equipment may contain lead solder and solder paste. The boards should be disposed of according to local regulations.

2.4 Controller Specific HSE

This section covers all safety hazards and precautions not mentioned above, which is specific to the controller.

2.4.1 Danger to Personnel

Warning

Potential Severity: Serious
Potential Loss: Personnel
Hazard Category: Electrical

Lethal voltages are present when equipment is running. Do not adjust wire connections until equipment is powered down.

The following precautions should be followed by qualified personnel when working on or around a controller:

- Do not touch the power connections on the AC power terminals while the controller is in operation. High voltages, 110VAC to 240VAC, exist on these terminals.
- Do not touch the power connections on the DC power terminals while the controller is in operation. Low voltage (24VDC), exists on these terminals, but the potential for high current exists. These voltages may exist even when the system is powered down, due to capacitor charge.

- Do not touch the connections on the I/O Card relay terminals 1, 2, 3, 4, 5, 6, 7, 8, 9 while the controller is in operation. These relay connections may be switching high voltages. These voltages may exist even when the controller is powered down as these switched voltages may not be part of the controller power. Check all externally connected device power supplies.
- Do not touch the connections on the Switchboard Card relay terminals 1, 2, 3, 4, 5, 6, 7, 8, 9 while the controller is in operation. These relay connections may be switching high voltages. These voltages may exist even when the controller is powered down as these switched voltages may not be part of the controller power. Check all externally connected device power supplies.

2.4.2 Danger to Equipment

Caution
Potential Severity: Light
Potential Loss: Assets
Hazard Category: Electrical

Failure to observe the following precautions can result in damage or destruction of equipment.

Observe the following precautions when working on or around a controller:

- Ensure that the operating facility is dry and dust-free. Incoming air flow must not contain any gases, vapors, or dusts that are electrically conductive or detrimental to functioning. Air containing dust must be filtered.
- The unit should be stored in its transportation packaging to prevent damage during handling.

2.4.3 Danger to the Environment

Caution
Potential Severity: Light
Potential Loss: Environmental
Hazard Category: Electrical, Fire flammable

The controller uses a lithium battery and capacitors which may be damaging to the environment if not properly handled.

Observe the following when working with the controller and replacement parts:

- The controller uses a lithium battery. Ensure battery replacement is of the identical type as issued by Schlumberger or this may void the warranty.
- Do not puncture or incinerate the battery.

- The battery is safe for disposal. Follow local safety practices for the proper disposal of Lithium batteries or return to Schlumberger for disposal.
- Do not incinerate to dispose of the controller as the electrical components inside may give off harmful gasses. Follow local safety practices for the proper disposal of electronic equipment or return to Schlumberger for disposal.

2.4.4 Safety Symbols

Symbol	Summary	Description
	Potential hazard	The area near this symbol may contain a hazard. Consult the User Manual for more information.
	Protective earth	This terminal is connected to protective earth.
	Earth (ground)	This terminal is connected to earth (ground).
	Direct current	The signal is a direct current signal.
	Alternating current	The signal is an alternating current signal.

2.4.5 Radio Frequency Regulatory Compliance

2.4.5.1 Canada

This product complies with Industry Canada radio frequency regulations CAN ICES-3 (A)/NMB-3(A).

2.4.5.2 United States of America — Federal Communications Commission (FCC)

Note: This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

Specifications

3 Specifications

3.1 Operating Specifications

Table 3-1: Instruct Controller Operating Environment

Humidity % (Percent)	Maximum relative humidity (RH) of 80 percent (non condensing) at 31 degC decreasing linearly to 50 percent at 40 degC
Altitude (Meters)	10,000 ft (3,000 m).
Environmental Pollution Degree	Pollution degree 2 according To IEC/CSA /UL 61010-1
Temperature Operating CE/CSA Compliant	-40 degF (-40 degC) to 158 degF (70 degC)
Temperature Operating Absolute Maximum	-40 degF (-40 degC) to 158 degF (70 degC)
Temperature Storage	-40 degF (-40 degC) to 158 degF (70 degC)
Installation	Non-hazardous locations

Table 3-2: Instruct Controller Operating Specifications

Power Supply Rated Input (AC)	100 to 240 volts AC, 50/60 Hz, 75W
Power Supply AC Typical	100 to 240 volts AC, 50/60 Hz, 3W
24 Volt DC Power	Up to 120W at 24 VDC +/- 10% can be externally supplied
Protection	Ingress protection rating of IP20 (no special protection)
StarView Maintenance Port	USB-B
USB Flash Drive Port	USB-A
Expansion Chassis	24 volts DC

Table 3-3: Optional I/O Card Operating Specifications

Digital Outputs (Relays)	1 – 250 volts AC, 8 A maximum 1 – 30 volts DC, 5 A maximum
Digital Inputs	Power for the digital inputs comes from the 24 VDC terminal DPWR. Only dry contacts such as relays or mechanical switches are to be connected to these inputs.

Analog Outputs	0 to 20 mA
Analog Inputs	0 to 10 volts DC (maximum 12 VDC) , 0 to 20 mA (maximum 24mA)

Table 3-4: Optional Switchboard Card Operating Specifications

Digital Outputs (Relays)	1 – 250 volts AC, 8 A maximum 1 – 30 volts DC, 5 A maximum
Digital Inputs	Power for the digital inputs comes from the 24 VDC terminal DPWR. Only dry contacts such as relays or mechanical switches are to be connected to these inputs.
Analog Outputs	0 to 20 mA
Analog Inputs	0 to 10 volts DC (maximum 12 VDC) , 0 to 20 mA (maximum 24mA)
PT Inputs	120 volts AC CATIII

Table 3-5: Optional Backspin Module Operating Specifications

High Voltage Inputs	5000 volts AC CATIII

3.2 Equipment Specifications

Table 3-6: Instruct Controller Equipment Specifications

Dimensions Box	7.1 in (180 mm) H x 8.5 in (215.8 mm) W x 7.37 in (187.2 mm) D
Dimensions Faceplate	7.64 in (194 mm) H x 10.59 in (269 mm) W x 0.71 in (18 mm) D
Mounting	Indoor use only. External applications must be mounted in NEMA 3R or NEMA 4X rated enclosure.
Shipping Weight	9.5 lb (4.3 kg) *subject to change

Table 3-7: Optional Backspin Module Equipment Specifications

Dimensions Box	4.25 in (108 mm) H x 8.5 in (216 mm) W x 1.75 in (44.5 mm) D
Mounting	Indoor use only. External applications must be mounted in NEMA 3R or NEMA 4X rated enclosure.
Shipping Weight	1 lb (0.454 kg) *subject to change

Theory of Operations

4 Theory of Operations

4.1 Overview

The Instruct Controller provides a single platform for all ESP motor controller applications, both for fixed and variable speed application, while retaining and enhancing the functionality of the systems it replaces. The controller also provides a unified platform for all required data acquisition and transmission required for ESP and CTS applications, with "plug-and-play" expansion capability. It can replace any of the currently deployed Schlumberger motor controllers and data acquisition systems for artificially lifted wells. The Instruct controller provides a reliable, cost effective, functional-expandable platform for all artificial lift controller and data acquisition requirements.

Expansion of functionality is achieved by inserting one or more of the expansion cards in the available slots. Currently, the following expansion cards are available:

- I/O Card
- Switchboard Card
- Communication Card
- TCP/IP Card
- MVD Card
- Phoenix Interface Card
- Hotline Extreme Interface Card

4.1.1 ESP Control

The universal design allows the controller to use the same hardware platform for ESP control and downhole monitoring applications.

4.1.1.1 Logging and Trending

The controller can maintain a record alarms and events in internal memory, a valuable tool in the troubleshooting process. The logging system retains the last 50,000 events, including setpoint changes, starts, stops, and alarms. The

trending system collects data on the following 93 critical channels at sample rates varying from 1 sample per second to 1 sample per 300 seconds (sample rate depends on the channel).

Active Current Leakage	IO Din5 Input	SWB BSM VOLTS UNB LIVEVAL
AnalogIn1	IO Din6 Input	SWB CURRENT A LIVEVAL
AnalogIn2	IO B Din1 Input	SWB CURRENT B LIVEVAL
AnalogIn3	IO B Din2 Input	SWB CURRENT C LIVEVAL
AnalogIn4	IO B Din3 Input	SWB CURRENT AVERAGE LIVEVAL
AnalogBIn1	IO B Din4 Input	SWB CURRENT UNB LIVEVAL
AnalogBIn2	IO B Din5 Input	SWB FREQ LIVEVAL
AnalogBIn3	IO B Din6 Input	SWB LEG GROUND LIVEVAL
AnalogBIn4	MBM FLOAT 0	SWB LIVE POWER LIVEVAL
DH Cf	MBM FLOAT 1	SWB POWER CONSUMPTION LIVEVAL
DH Cz	MBM FLOAT 2	SWB POWER FACTOR LIVEVAL
DHDifferentialPressure	MBM FLOAT 3	SWB ROTATION IDIR LIVE
DHDischargePressure	MBM FLOAT 4	SWB ROTATION VDIR LIVE
DHDischargeTemperature	MBM FLOAT 5	SWB STALL TIME LIVEVAL
DHFlow	MBM FLOAT 6	SWB START CURRENT LIVEVAL
DHIntakePressure	MBM FLOAT 7	SWB VOLTS AB LIVEVAL
DHIntakePressure2	MBM FLOAT 8	SWB VOLTS BC LIVEVAL
DHIntakeTemp	MBM FLOAT 9	SWB VOLTS CA LIVEVAL
DHMotorTemp	Mono-to-UTC Offset	SWB VOLTS AVERAGE LIVEVAL
DHMotorYpoint	Motor Load	SWB VOLTS UNB LIVEVAL
DHVibration	Passive Current Leakage	Temperature
DHVibrationAX1	PIC1 Status Live	VsdAmps
DHVibrationAY1	PIC1 Tr2 Live	VsdFreqOut
DHVibrationY	RTC Battery Live	VSDG7 Excite Amps
DHVibrationZ	Starts	VSDG7 Load
FW Rel Code	SupplyVolts	VsdMotAmps
FW Ver Code	SWB BACKSPIN FREQ LIVEVAL	VSD Power In
IO Din1 Input	SWB BSM VOLTS AB LIVEVAL	VSD Power Out

IO Din2 Input	SWB BSM VOLTS BC LIVEVAL	VsdTorqueAmps
IO Din3 Input	SWB BSM VOLTS CA LIVEVAL	VSD Volts In
IO Din4 Input	SWB BSM VOLTS AVERAGE LIVEVAL	VSD Volts Out

Trend capacity in the controller varies based on many factors but typical durations for the standard trend configuration are between 2–4 months of data.

The StarView PC software offers enhanced onsite data viewing, downloading, and controller programming capabilities.

4.1.1.2 Asset Protection

The controller can monitor multiple well and pump operating data points. It helps protect the total pump system from fault conditions on any of the monitored signals. The controller can be configured to send alarms, await user intervention, or shut down the system to prevent restart until the alarm or fault situations have been rectified.

4.1.1.3 Gas Lock Protection

Gas lock is a condition in which a pump is no longer able to move any fluid due to the buildup of gas in the pump itself. Since fluid is no longer being moved the well's production becomes minimal, and if left in this condition long enough equipment damage could result.

The Instruct has a gas lock protection feature, which can automatically detect and deal with this condition. For details about the Gas Lock Protection feature and operational guide, refer to Instruct Gas Lock Protection(GLP)- User Guide (InTouch 6923767).

4.1.2 User Interface

The controller display and interface provides user-friendly access for data display, parameter set-point adjustment, and FSD or VSD control functionality. The backlit liquid crystal screen has an enhanced data display. In addition to fixed-function and multifunction keys, there is a numerical keypad provided to facilitate simple control and configuration. Standard FSD and VSD instrumentation, including status lights, mode selection, and start-stop controls, have been incorporated into the interface. The display, diagnostics, and alarms are in plain language rather than codes, eliminating the need for cross-reference tables or manuals.

4.1.3 Expansion Card Options

4.1.3.1 I/O Card

The optional I/O card provides digital and analog connectivity for interfacing with external devices.

- Digital Output (Relays): The digital outputs on the controller are relay outputs capable of switching either AC (1-250 V) at loads of up to 8 A or DC (1-30 V Extra Low Voltage) at loads of up to 5 A. The outputs are ‘dry contacts’ meaning the switching voltage is not supplied from the controller and must be supplied as part of the drive wiring. All digital outputs have the relay normally open (Relay x NO), common (Relay x COM), and normally closed (Relay x NC) contacts brought out to terminals.

Warning
Potential Severity: Serious
Potential Loss: Assets
Hazard Category: Electrical

Hazardous voltages can exist on the digital output terminals.

- Analog Output: The controller contains two analog outputs with a 12 bit digital to analog converter. Each of these outputs operate independently to control the 0–20mA loop current. The controller can optionally provide power for the loop current.
- Digital Input: Digital inputs are designed to provide logic information in the form of Open / Close, On / Off, High / Low, 1 / 0, etc. The controller contains 6 digital inputs which are designed to be switched with dry contacts. The switching voltage, 24 V, is supplied internally from the controller via the Digital Power terminal. These inputs can be independently configured to respond to either an Open or Close condition.

Caution
Potential Severity: Light
Potential Loss: Assets
Hazard Category: Electrical

The Digital Power terminal is current limited and is not intended for powering external devices. Only use this terminal for dry contacts connecting to Digital Inputs.

- Analog Input: The controller contains four differential analog inputs with a 12 bit analog to digital converter. Each of these inputs can independently operate in voltage or current mode.

Note

Unlike UniConn, the Instruct IO card analog inputs do not provide power for the loop current. The user must have an external power supply.

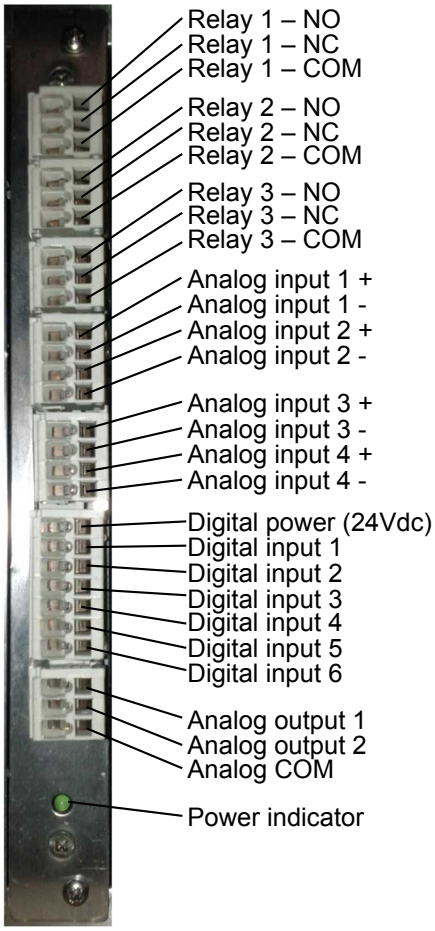


Figure 4-1: I/O Card (optional)

4.1.3.2 Switchboard Card

The Switchboard Card (P/N 100840440) provides 3-phase power monitoring (including 3-phase voltage measurement and 3-phase current measurement), digital and analog connectivity for interfacing with external devices, and Backspin Module interface.

- I/O:
  - Digital Output (Relays): The digital outputs on the controller are relay outputs capable of switching either AC (120/240 V) or DC (10-28 V) at loads of up to 6 A. The outputs are ‘dry contacts’ meaning the switching

voltage is not supplied from the controller. All digital outputs have normally open (Relay x NO), common (Relay x COM), and normally closed (Relay x NC) contacts.

– Relay 1 is dedicated for switchboard contactor control.

– Relay 2 and Relay 3 are configurable digital outputs, named Dout1 and Dout2.

– Analog Output: The Switchboard Card has one analog output, which can provide 0–20mA loop current output.

– Analog Input: The Switchboard Card contains one differential analog input. It can operate in voltage or current mode. In voltage mode, the input voltage can vary between 0V to 10VDC. In current mode, the input current can vary between 0mA to 20mA DC.

– Digital Inputs: Digital inputs are designed to provide logic information in the form of Open/Close, On/Off, High/Low, 1/0, etc. The controller contains 4 digital inputs which are typically interfaced with dry contacts. The switching voltage, 24 V, is supplied internally from the controller via the Digital Power terminal. These inputs can be independently configured to respond to either an Open or Close condition.

Caution

Potential Severity: Light
Potential Loss: Assets
Hazard Category: Electrical

The Digital Power terminal is current limited and is not intended for powering external devices. Only use this terminal for dry contacts connecting to Digital Inputs.

- Backspin Module interface: The switchboard card can read the backspin information through this interface. Pin 10 to Pin 21 is for backspin module connection. The Backspin Module is an optional module located in the high voltage compartment of the switchboard. Note that no field wiring of these pins is necessary as a cable is provided with the Backspin Module.
- Current Input: The Switchboard Card contains three AC current transformer (CT) inputs for the purpose of measuring and monitoring 3 phase motor current via the CT Burden Module.
- Voltage Input: the switchboard card contains three AC potential transformer (PT) voltage inputs for the purpose of measuring and monitoring 3 phase motor voltage.

Figure 4-2: Switchboard Connection Pin Assignment shows the Switchboard Card connector pin assignment. This can be used as a reference for wiring.

	1		Contactor -NO
	2		Contactor -NC
	3		Contactor -COM
	4		Relay 1 -NO
	5		Relay 1 -NC
	6		Relay 1 - COM
	7		Relay 2 -NO
	8		Relay 2 -NC
	9		Relay 2 - COM
BSM Reset	10	11	RXTX1
RXTX2	12	13	RXTX3
No Connect	14	15	3.3V
BSM Rotation	16	17	BSM Frequency
No Connect	18	19	No Connect
GND	20	21	24V
Analog In +	22	23	Analog In -
Analog Out	24	25	Analog COM
No Connect	26	27	Digital PWR
Digital In 1	28	29	Digital In 2
Digital In 3	30	31	Digital In 4
	32		CT - A
	33		CT - B
	34		CT - C
	35		CT - Ref
	36		CT - Shield
	37		PT - A
	38		PT - B
	39		PT - C
	40		PT - N

Figure 4-2: Switchboard Connection Pin Assignment

4.1.3.3 # Communication Cards

Comm Card

The Comm card interfaces the controller with land-line and satellite-based SCADA systems. Individually configurable expansion card slots, allow the controller to support up to four independent communication systems simultaneously. Standard Modbus® protocol over an RS-232 or RS-485 connector is used. The Comm card provides the connection to the site communication box (SCB) used for data transmission to facilitate the LiftWatcher surveillance and control system. For Comm Card Installation Manual, refer to InTouch Content 6238940.

TCP/IP Card

The Modbus TCP/IP card interfaces the controller to Ethernet-based TCP/IP networks for expanded client SCADA applications. It uses transmission control protocol (TCP) in accordance with standard RFC 793 and Internet protocol in accordance with standard RFC 791. Modbus protocol is encapsulated within the TCP/ IP protocol; therefore, the end device must be capable of decoding Modbus.

For TCP/IP Card Installation Manual, refer to InTouch Content 6470145.

MVD Card

The Medium Voltage Drive Card (MVD Card) is designed to interface to the Medium Voltage Drive using standard User Datagram Protocol (UDP). The MVD Card is factory configured for the MVD and no field configuration is possible. The Ethernet communication interface is isolated for enhanced noise immunity. For MVD Card Installation Manual, refer to InTouch Content 4461916.

4.1.3.4 DHT Interface Cards

PIC

The PIC is the electronic interface between the Phoenix downhole monitoring systems and the controller. The unified interface shares the controller's local display and keypad, providing access to all controller, downhole pressure, temperature, and vibration data and associated protection parameters. The card provides the direct current power required by Phoenix downhole sensors, and also acquires the measurement outputs from the sensors. For PIC Installation Manual, refer to InTouch Content 6470183

Extreme Card

The Extreme Card is the electronic interface between the Hotline downhole monitoring systems and the controller. The unified interface shares the controller's local display and keypad, providing access to all controller, downhole pressure, temperature, and associated protection parameters. The card provides the direct current power required by Hotline downhole sensors, and also measures the outputs from the sensors.

For Extreme Card User Manual, refer to InTouch Content 5447042.

4.1.4 Slot A/B Alarm

The Instruct Controller has two dedicated slots – Slot A and Slot B, for either Switchboard (SWB) or IO card. When any of these cards are installed, Instruct Controller detects the cards automatically. A new feature is introduced in the firmware revision v2.115r002 (or later), which allows for an alarm, in case Slot A or Slot B cards malfunction.

Note

The Slot A and Slot B alarms are disabled by default. Therefore, users who do not wish to use Slot A or Slot B alarms, are NOT required to follow the configuration steps described in this document.

Warning

Potential Severity: Serious
Potential Loss: Assets, Personnel
Hazard Category: Electrical

The expansion cards, for all the slots (including Slot A and Slot B), are NOT “hot-swappable”. Make sure that the power to the Instruct Controller is switched off, before insertion or removal of an expansion card.

4.2 Basic Controller Functions

4.2.1 Automatic Start

Automatic start is a function that will permit a start after the processing of a trip or alarm condition. This provides some autonomous control to the controller to start systems with user defined conditions.

These menu parameters define the criteria for shutdowns and represent global default settings. There is some overlap in functionality of each global parameter and specific alarm options. Most of the controller operating parameters have a user setting for a restart.

The automatic start controls are:

- Shutdown cause
- Starts
- Progressive time delay

4.2.2 Event Log

The event log is designed to maintain a record of recent controller activity. These events can be user parameter changes, user activity, analog I/O changes, alarms, starts, shutdowns, etc. The log is stored in internal memory and will wrap to the start of memory once the log space is full. Optionally, the event log can be manually cleared. Each event is logged with a date and time. Each event is logged with a date and time-stamp accurate to 1/100th of a second to capture the order of the events that occur. Logs can be viewed on the Instruct Controller under the Logs/Trends menu.

Only alarms with the alarm action parameter set to LOG or LOG+STOP are logged. An alarm that is set to STOP will be logged if it is the cause of a shutdown. Alarm logging events occur when the alarm condition is entered (a set point is violated). The length of time the alarm condition was active and the magnitude of the violation are logged as part of the event for certain alarms. If the alarm did not clear before the alarm time parameter timed out, the alarm will cause a shutdown that will be logged immediately following the alarm condition log entry.

Parameter changes by the user are also recorded in the event log. However, since it is not possible to store a descriptive tag name with every parameter, the telemetry location is used to identify the parameter. Telemetry locations are identified by [ ] brackets.

4.2.3 Statistics

The controller contains statistics on the health and cycle operation of the system. These parameters represent the present state of operation of the controller. They are available under the Controller -> Settings/Info menu.

4.2.4 Alarms

Alarms are associated with all measured and monitored values. These alarms have parameters that define when and what they do when they become active.

Alarms with the “Hi” or “Lo” label are the alarms associated with the high and low limits on the metered variable. If the alarm condition is currently active, it will appear on the Home screen and on the Alarms screen. Navigate to the associated function’s alarm screen to edit the alarm set points and actions.

Each alarm has the following settings associated with it:

Term	Definition
NAME	A user-editable name associated with the alarm. This is the label that will be displayed on the screen when the alarm is active and that will be entered into the log.
ACTION	The action that the alarm performs. Selectable alarm actions are:

Term	Definition
BYPASS	Perform no action. Nothing is logged and a shutdown will not occur.
LOG	Logs the occurrence of the alarm condition in the Event Log.
STOP	Performs a shutdown of the motor. Automatic restarts can occur in Auto mode.
LOG+STOP	Performs a shutdown of the motor and logs the shutdown and alarm occurrence in the Event Log. Automatic restarts can occur in Auto mode.

SETPOINT	The alarm becomes active when the metered live value violates this set point value. The set point has the same units as the metered value. For analog variables there are two types of set points: high and low. High set points trigger an alarm when the metered value exceeds the value of the set point. Low set points trigger an alarm when the metered value falls below the set point. For digital inputs, the set point is the digital state the controller will alarm on: either ‘OPEN’ or ‘CLOSE’.
TRIP TIME (seconds)	The time duration that the alarm must be active before STOP actions occur. Timing begins each time the metered value violates the set point. This value can be used to reduce nuisance trips in metered variables that are ‘noisy’ or have a lot of variation in the live reading.
RESTARTS	The maximum number of restarts allowed for shutdowns by this alarm before a lockout condition is generated to prevent automatic restarts. This feature is provided to limit the number of manual and automatic starts of a motor to a safe level. It prevents excessive cycling that could lead to equipment damage.
RESTART DELAY (minutes)	The countdown time that must elapse before an automatic restart can occur. All alarms must also be clear before the restart occurs. The restart countdown can be manually bypassed by pressing the Start key from the Control Screen during the countdown.
START BYPASS (seconds)	A temporary bypass time delay added to the Trip Time for starting only. A setting of 0.0 seconds disables this function. Any other number bypasses the alarm to allow a start and keeps it bypassed for the time set. A temporarily bypassed alarm will be displayed on the Status Screen when active but will not cause a shutdown. When Start Bypass is enabled, starting can occur when an active alarm is present.

MAINTENANCE BYPASS (minutes)	Maintenance Bypass allows for the temporary bypass of a specific alarm, during operation, for on the fly wiring changes or maintenance procedure such as chemical injection. This bypass timer is available for Digital Input Alarms, Underload Alarm and VSD Underload Alarm. To activate a Maintenance Bypass for an alarm, the Maintenance Bypass timer value must be entered. While the motor is running, the 'Maint. Bypass' button will be enabled on the Start screen pop-up indicating that this feature is available but not active. This button must be pressed to activate. The controller will display the message `MaintBypass` in the marquee area during Maintenance Bypass. Once the timer has expired the bypassed alarm will become active. The Maintenance Bypass function must be reset and activated each time it is to be used as the controller clears the timer value and deactivates this function after each use.

4.2.5 Reset to Factory Defaults

The controller has the Reset to Factory Defaults function. It is available under the **Controller -> Expert/Updates**. This function restores the controller to the set point values it shipped with, all user edit and configuration changes are lost. However the Instruct Modbus Master, Modbus Slave, Custom Screen configuration functions are not affected.

4.3 Controller Components

4.3.1 Power Supply

The controller has an internal 75W AC to DC power supply. Alternatively, the controller can be powered by an external 24 VDC supply. The controller can be powered by both AC and DC at the same time.

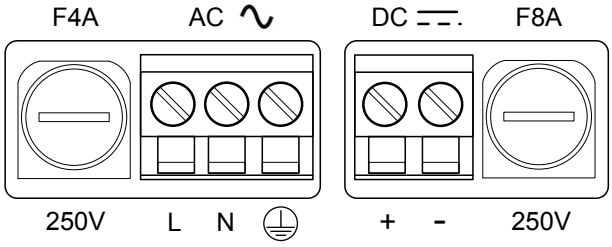


Figure 4-4: Power Supply Inputs

4.3.2 Control Card

The control card performs all processing, logging, and communications in the controller. The Control Card has two external communication interfaces: RS-232 and RS-485. The RS-232 port uses a DB-9 connector and is primarily intended for maintenance and diagnostics. The RS-485 port is implemented in a 4-wire configuration and uses a terminal block connector. The RS-485 port is primarily intended for connections to VSDs or SCADA systems.

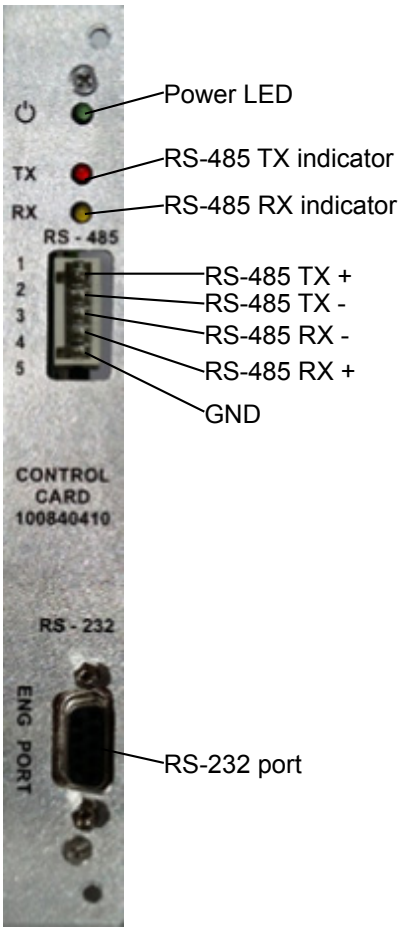


Figure 4-5: Control Card

4.3.3 Display Card

The display card provides the user interface for the controller. It has a 5.7-in color VGA LCD display, keypad interface USB maintenance port, and USB flash drive port. The USB ports are the only ports accessible once the controller is installed in a cabinet. They serve as the interface for optional connection to a PC or USB flash drive for maintenance, data retrieval, or software configuration.

- Maintenance Port: The USB-B connector is located on the front of the controller. This port is designed for configuration and commissioning and works best with the configuration software (StarView).
- USB Flash Drive Port: The USB-A connector is located on the front of the connector. This port will accept most USB flash drives compatible with USB 2.0 and is formatted as FAT32.

4.3.4 Expansion Slots

There are four expansion ports for use with proprietary expansion cards. These cards provide added functionality for communications and downhole tool (DHT) interface. Each port operates independently and can be configured for either RS-232 or RS-485.

4.3.5 Enclosure

The enclosure provides the facility to mount the controller inside the cabinet and provides a protective earth terminal for connecting the ground strap to the cabinet.

4.4 User Interface

4.4.1 Overview

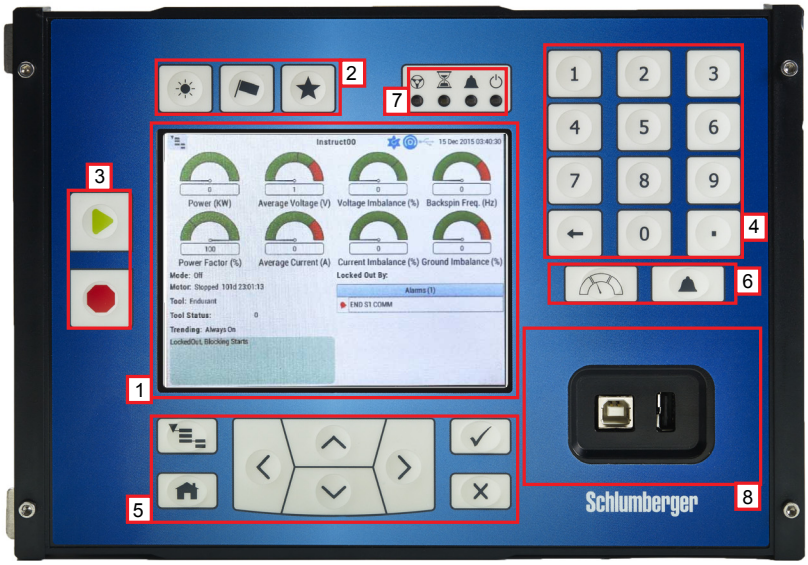


Figure 4-6: Controller Interface

Item	Name
1	Graphical Display
2	Utilities Keys
3	Start/Stop Keys
4	Numeric Keypad
5	Navigation Keys
6	Live/Alarm Keys
7	Status Indication
8	USB Connectors

4.4.2 Graphical Display

The Graphical Display is a color liquid crystal display that provides graphical representation of different states, parameters, and alarms. It also provides menu structures which give access to different setting and controls in the controller.

The Home screen displays the key information on the status of the wellsite.

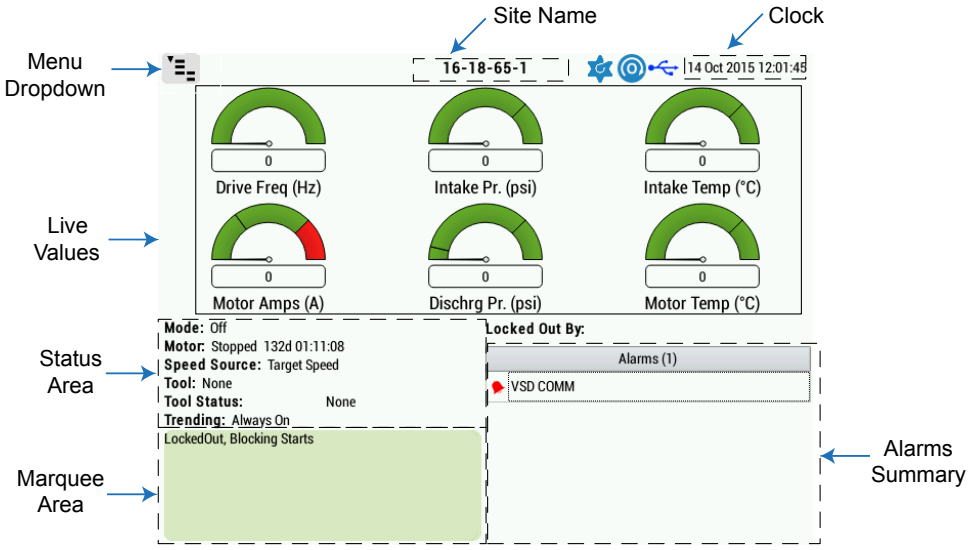


Figure 4-7: Home Screen

Term	Definition
Menu Dropdown	The location from which the menu is displayed when the Menu button is pressed.
Site Name	The name of the wellsite.
Clock	The current date and time.
Live Values	Six key live values are shown in this area.
Status Area	The status of the motor and downhole tool (if applicable), operating mode and trending status is shown in this area.
Marquee Area	Specific conditions that the operator needs to be aware of are shown here.
Alarms Summary	A summary of active alarms is shown in this area.

The display changes as the operator navigates through the controller.

4.4.3 Utilities Keys

Key	Name	Function
	Backlight	Enables/disables display backlight
	Language	Changes language on Graphical Display

Key	Name	Function
	Favorites	Reserved for Favorites function Screenshot: with the Instruct fully booted, insert the removable USB Drive into Instruct Controller. The USB symbol on the display will turn blue when the Instruct recognizes the USB drive. Press the key for 3 seconds, it will save the current Instruct screen as a picture to the USB drive.

4.4.4 Start/Stop Keys

These Start and Stop keys are fixed-function, and will achieve their intended function regardless of which menu screen the user has currently navigated to on the Graphical Display.

Key	Name	Function
	Start	Starts Controller
	Stop	Stops Controller

4.4.4.1 Start Key

When the Start key is pressed, the Start screen pop-up is displayed at the bottom of the Graphical Display.

Figure 4-8: Start Screen Pop-up

In order for the Start key to start the pump, there must be no alarms present, and the HOA (hand-off-auto) Switch must be in either the Hand or Auto positions. Table 4-1: Operating Modes explains the different HOA switch modes (operating modes).

Table 4-1: Operating Modes

HAND	The motor can only be started by pressing the Start key.
AUTO	The motor will start automatically when all alarms are clear and when the restart timer completes its countdown cycle. If all alarms are clear, the Start key in the Control Menu can also be used to bypass the restart timer countdown. Remote Start/Stop commands from SCADA communication systems are only allowed in Auto mode.
OFF	The motor is OFF and all starts (local, remote, and automatic) are prevented.

When the controller is OFF (with no alarms latched from the last shutdown), the Control Screen appears, with three keys labeled for actions (‘Hand’, ‘Off’ and ‘Auto’). The Menu key will take the user into the Main Menu Screen.

Pressing either the “1” key or left arrow key puts the controller into Hand mode. The HOA switch points to Hand to indicate that the controller is in Hand mode. Pressing either the “2” key or right arrow key puts the controller into Auto mode. The HOA switch points to Auto to indicate that the controller is in Auto mode. The controller can be placed in Auto mode from either Hand or Off mode, including while the motor is running in Hand mode. Pressing the Stop key will place the controller into Off mode and the Start screen pop-up will close. The OFF time of the controller will be indicated in the lower left section of the Home screen.

When the mode is switched from Off to Auto, the controller will automatically restart when the restart timer countdown has completed.

Latched alarms are listed in the Alarms area and are indicated with an asterisk. If latched alarms exist, they can be cleared by selecting Unlatch Alarms. This is performed by pressing the ‘3’ key (Figure 4-8: Start Screen Pop-up).

During a Lockout condition, the Home screen will have the word ‘Locked Out’ in the marquee area. On the Start screen pop-up, the Unlock graphic will have a Start key icon underneath. This indicates that the Start key must be pressed to clear the Lockout condition. The Lockout condition must be cleared to enable the “Start” key in both Hand and Auto mode. Lockout prevents automatic restarting of the motor. Once the Start key is pressed, the Lockout condition will be cleared and the Start key icon will move to underneath the Start graphic, indicating that the Start key can now start the motor.

Pressing the Start key will start the motor. The lower left section of the Home screen will change to indicate that the motor is running along with an animation. The run time of the motor is also indicated. In the same section of the Home screen the controller mode (Hand or Auto) is also indicated.

4.4.4.2 Stop Key

Pressing this key will stop the ESP. It should be noted that once this key is pressed, it is not possible to remote start the ESP unless it is manually placed in auto mode using the keypad.

4.4.5 Numerical Keypad

The number keys allow the user to enter numbers or alphabetical characters in certain setting areas of the controller that require user input.

The keys can also be used as shortcuts for quick access to certain parameters and settings displayed on the Graphical Display. For example, by pressing the “2” key, the Graphical Display will display the Alarms menu.

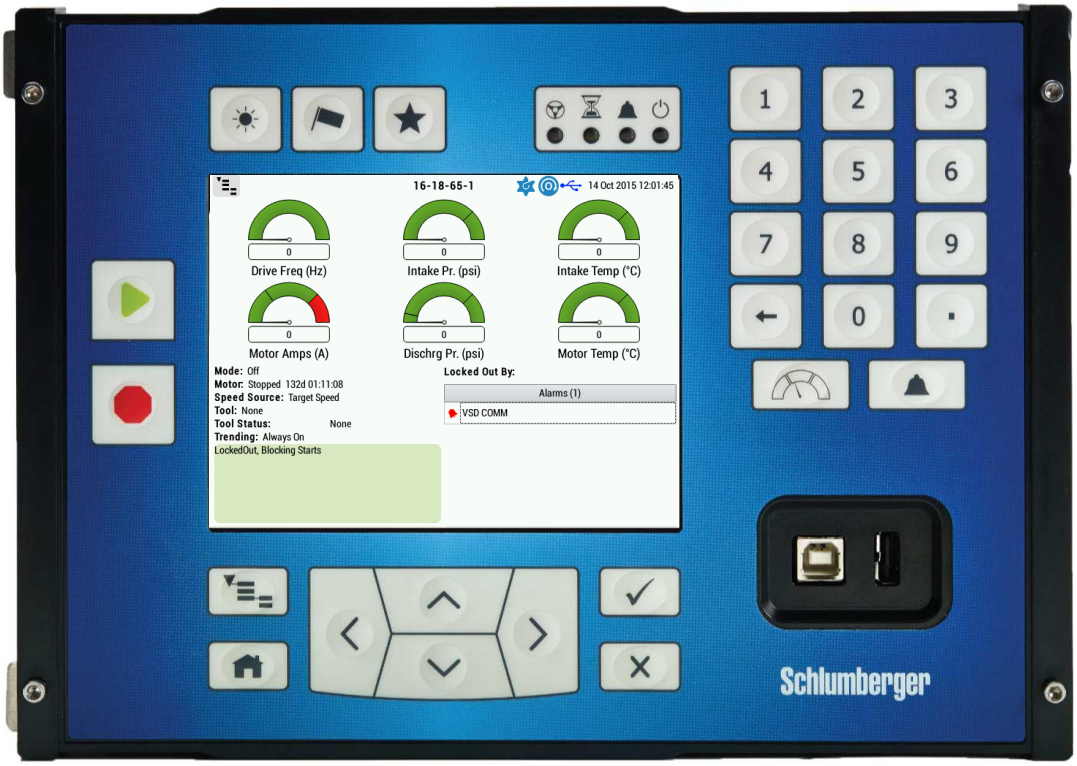
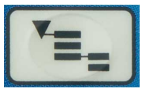


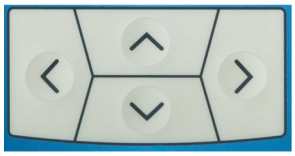
Figure 4-9: Numerical Keypad Menu Shortcut

4.4.6 Navigation Keys

These keys allow the user to navigate through the menu-driven interface of controller. Most of these keys, with the exception of the Home and Menu keys, are multi-function and perform different functions depending on the current display on the Graphical Display.

Key	Name	Function
	Home	Changes the display on Graphical Display to the “home” screen.
	Menu	Displays the currently-navigated-to menu on Graphical Display. If a sub-menu is open, pressing this key will close the sub-menu and show the higher-level menu. Pressing this key when the main menu is displayed will close the main menu.
	Accept	This multi-function key will select an option depending on the current content displayed on the Graphical Display.

Key	Name	Function
	Reject	This multi-function key will de-select an option depending on the current content displayed on the Graphical Display.

Key	Name	Function
	Arrow	These multi-function keys allow the user to select different options on the menu screen and other areas of the Graphical Display. In places that only vertical movements are possible (i.e. it is only possible to use the Up Arrow and Down Arrow keys to make selections), the Right Arrow key can be used to select an option, and the Left Arrow key can be used to de-select an option.

4.4.7 Live/Alarm Keys

Key	Name	Function
	Live	Displays graphical representation of different parameters and the status of Controller on Graphical Display
	Alarm	Display alarms on Graphical Display

4.4.8 Status Indicators

Indicator	Name	Function
	Run Status	Green if Controller running. Unlit if Controller stopped.
	Automatic Restart Status	Light is on when the controller is counting down to an auto-restart. Light is off if controller is not counting towards an auto-restart.

Indicator	Name	Function
	Alarm Status	Red if Controller in alarm state. Unlit if no alarms.
	Controller Power	Green if controller power is ON and screen is OFF.

4.4.9 USB Connectors

These connectors are used to connect the controller to a PC or a storage device. The USB A-to-B cable is required to connect a PC to the Instruct Controller front panel.

To improve the USB connection reliability during a VSD operation, USB active extension cable or USB isolators are recommended. These devices can help reduce the noise and improve the connection reliability. Refer Instruct Connection Issues (InTouch ID 6925630) for detailed solution.

Caution

Potential Severity: Light
Potential Loss: Assets
Hazard Category: Electrical

Do not connect the USB cable or a USB drive to the Instruct controller before it fully boots up. Otherwise, the controller may not be able to boot up successfully, detect USB drives, or communicate with StarView.

4.4.10 Menu Structure

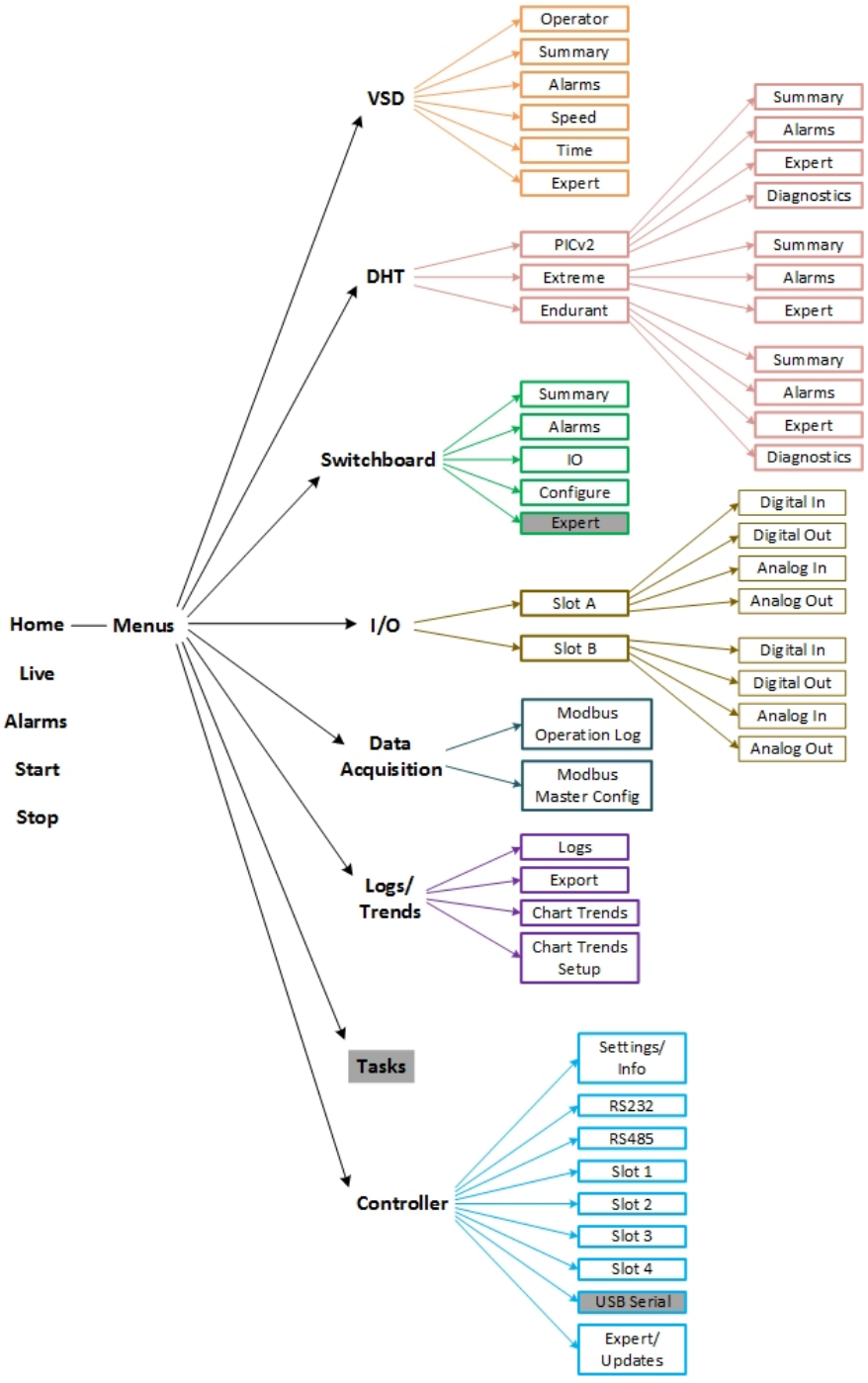


Figure 4-10: Instruct Controller Menu Structure. *The "gray boxes" highlight menus that are not available yet but will be in a future release.*

4.5 Switchboard Functions

4.5.1 Voltage Input

The Instruct Switchboard Card contains three AC potential transformer (PT) voltage inputs for the purpose of measuring and monitoring 3 phase motor voltage. The monitored parameters are:

Table 4-2: Voltage Input Parameters

Parameter	Operation
Overvolts	Monitor condition where voltage exceeds a specified maximum value. The three phase RMS average or each individual phase RMS voltage is monitored for overload. Used to protect a system from voltage surges.
Undervolts	Monitor condition where voltage drops below a specified minimum value and apply the deviation to a six point curve to determine the alarm duration. Used to protect a system from voltage droops and brown-outs. The alarm curve is designed to account for the voltage drop during a motor or system start.
Rotation	Monitor the phase voltage sequence A-B-C to ensure the motor is powered in the correct sequence. This prevents the motor from running backwards if the power supply to the motor is reversed. **Note** The detection of rotation change will not work if the cable phases were reversed beyond the switchboard PT or CT sensing connections. Rotation can be detected from either the current or voltage and thus appears in both the Load and Volts screens.
Unbalance	Monitor condition where voltage A-B-C magnitude are no-longer matched and apply the deviation to a six point curve to determine the alarm duration. The three phase RMS average is compared to the individual phases to calculate unbalance. The unbalance is displayed as a percent of line voltage. The alarm curve is designed to account for the voltage unbalance during a motor or system start.

The results of these measurements can be combined with the current inputs to determine the system power and power factor.

The potential transformer (PT) inputs are located on terminals PT-A, PT-B, PT-C and PT-N (PIN 37 - 40) and operate in a WYE “Y” configuration.

Term	Definition
PT-A, B, C	PT inputs for phase voltage A, B, C
PT-N	The neutral point connection for the three phase voltage.

The front end voltage divider circuitry in the Switchboard Card convert the 120V to small signals, and the 3-phase measuring chip on the Switchboard Card measured the voltage values.

The PT input voltage is limited, the maximum voltage should be 120VAC. Additional Potential Transformer exists in Switchboard HV cabinet in order to interface to high voltage systems as shown in Figure 4-11.

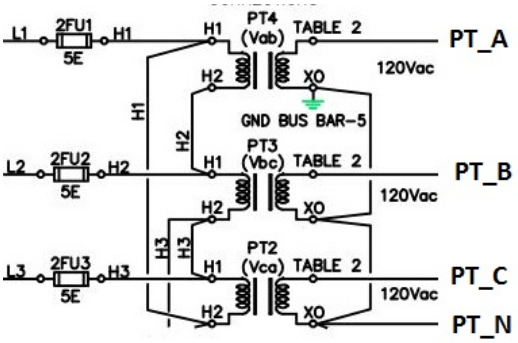


Figure 4-11: PT inputs cascade to 4000VAC

The PT inputs can be scaled to match external PTs and calibrated to account for transformer tolerance.

4.5.2 Current Input

The Switchboard Card contains three AC current transformer (CT) inputs for the purpose of measuring and monitoring 3 phase motor current. A proprietary current transformer burden module is required to connect the external CT to the Instruct Switchboard Card. The monitored parameters are:

Table 4-3: Current input parameters

Parameter	Description
OVERLOAD	Monitor condition where current exceeds a specified maximum value. The three phase RMS average or each individual phase RMS current is monitored for overload. Used to protect a system from a failing motor or motor cable while still permitting a motor start. The overload alarm has a 16 point time curve associated with it. The individual points in this curve can be edited for special applications. The set point is typically set to 15% higher than the *motor running current*. The alarm appears as **OVERLOAD** on the display.

Parameter	Description
UNDERLOAD	Monitor condition where current drops below a specified minimum value. Used to indicate a motor is not efficiently pumping fluid or has air-locked. The set point is typically set to 20% below the *motor running current*. The alarm appears as **UNDERLOAD** on the display.
ROTATION	This feature is shared with the voltage inputs. Monitoring of rotation can be either voltage mode or current mode. For details see . The alarm appears as **ROTATION** on the display.
UNBALANCE	Monitor condition where current A-B-C magnitude are no-longer matched. The three phase RMS average is compared to the individual phases to calculate unbalance. The set point is typically set to 20%. The alarm appears as **C_UNBAL** on the display.
STALL	Stall is a condition where the motor stops rotating. The impedance of the power cables and motor winding create a scenario where the power requirements are high but this is not a short circuit. The criteria used to define a stall condition must consider the OVERLOAD current required during a motor start. The set point must be set less than the name plate *motor start amps* and is typically set to three times the *motor rated current*. The alarm appears as **STALL** on the display.
SHORT CIRCUIT	This is a condition where a short circuit occurs. This indicates a serious fault has occurred in the cable to the motor or within the motor. The criteria used to define a short circuit must consider the current used in a STALL condition. The set point is typically set to six times the *motor rated current*. The alarm appears as **SHORT_CCT** on the display.
Motor Amps	This is the nameplate rating of the maximum continuous motor amps. This value is used to calculate STALL and SHORT_CCT.

The results of these measurements can be combined with the voltage inputs to determine the system power and power factor.

The CT inputs are located on terminals CT-A, CT-B, CT-C, CT-REF and CT-SHIELD (PIN 32 - 36).

Term	Definition
CT-A, B, C	CT inputs for phase current A, B, C
CT-REF	Reference signal point for the three phase current measurement.
CT_SHIELD	A ground shield to protect the current signals from electrical noise.

Warning
Potential Severity: Serious
Potential Loss: Assets, Information
Hazard Category: Electrical

These inputs are designed for the burden module only. Do not directly connect the CT leads to the controller.

The CT inputs can be scaled to match external CTs and calibrated to account for transformer tolerances.

4.5.2.1 Under Load Tracking

The controller can optionally use under load tracking feature to characterise over time an acceptable under load value up to a minimum setting. This characterised value becomes the reference point for the under load alarm. This accounts for motor current drift over time due to changing well characteristics and permits the controller to not alarm on a set under load value but to follow the drift, and alarm based on the drift point value.

Note
When the under load tracking is activated, the normal under load setting is bypassed for the under load tracking setting.

4.5.3 Burden Module

The CT inputs measure voltage. A burden module is required to convert the current from the CT into a voltage prior to interfacing to the Instruct. There exists a unique 1000:1 Burden Module (PN: 100468928, UNICONN CT 5A BURDEN MODULE).

4.5.4 CT Module

This current transformer is designed to only operate with the Standard 200A Switchboards. The CT module is actually 3 individual 200:5 Current Transformer (PN: 100667780).

4.5.5 Backspin Module

4.5.5.1 Backspin Inputs

The Backspin Module contains a 3 phase backspin input for the purpose of detecting motor rotation while the motor is not powered. The motor rotation may be the result of well characteristics continuing to flow or fluid in the pipe draining back into the formation. Depending on the requirement, the Instruct can be configured to not start the motor while rotation is present or start only if below a rotation threshold.

The backspin input measures the frequency of the motor rotation and has alarm parameters associated with the frequency detection setting. There is a configurable time delay that the controller must wait before starting once the alarm has cleared. This timer will not start during a spin condition and the Controller will remain in the alarm state until the rotation drops below threshold, at which point the timer will start

Backspin detection is designed to detect very small signals and functions with the system off. During system operation, system harmonics can create false triggers on frequency measurement.

The backspin module contains a DC blocking filter. For applications where a downhole tool (DHT) is used with an electric submersible pump (ESP), the DC power for the DHT will not affect the Backspin Module. The motor rotation signal pass through the DC blocking filter unaffected.

Warning

Potential Severity: Serious
Potential Loss: Assets, Process
Hazard Category: Electrical, Machinery equipment hand tools

Starting a motor which is spinning in reverse direction creates a very large current in order to stop the motor, then start the motor in the correct direction. Damage to motor winding may result.

4.5.5.2 Leg Ground

The Instruct Switchboard Card performs leg ground measurement using the Backspin Module. Leg ground measures the phase-ground voltage and unbalance which indicates insulation degradation and ground fault problems. A single-phase dead short will show a 100% reading.

The measurements of frequency and voltage can determine motor rotation and line voltage.

4.6 IO Functions

4.6.1 Digital Outputs

The digital outputs on the Instruct Switchboard Card or IO cards are relay outputs capable of switching either AC (120/240 V Hazardous Circuits) or DC (10-28 V Extra Low Voltage) at loads of up to 8 A. The outputs are ‘dry contacts’ meaning the switching voltage is not supplied from the card and must be supplied as part of the switchboard wiring. All digital outputs have the relay normally open (RLYx NO), common (RLYx COM), and normally closed (RLYx NC) contacts brought out to terminals.

Caution
Potential Severity: Light
Potential Loss: Personnel
Hazard Category: Electrical

Digital outputs must be connected to 120/240 V Hazardous Circuits OR 10–28 V Extra Low Voltage circuits exclusively. **Do not mix control voltage types**. In order to operate the controller within the CE certification the digital outputs must not be connected to more than 240 volts AC.

The first digital output on the Switchboard Card is reserved for switchboard contactor control. This relay has additional hardware to prevent contactor dropout in brown-out or low-power conditions. This output is also tied to the motor shutdown event from alarms and the Off key. The green LED displays the status of this relay. In VSD applications this relay still operates as a contactor that can be used to indicate VSD run status (i.e., if power is applied to the motor).

Term	Definition
OFF	Relay operation is disabled and left in the OFF position. The normally open terminal is electrically open, and the normally closed terminal is closed.
ON	The relay is held in the ON position. The normally open terminal is closed and the normally closed terminal is open. This can be used for an external device to detect power failure to the controller as the relay will go OFF when power is removed.
BLINK	The relay turns ON and OFF at a one-second interval.
COIL	The relay behaves as a SCADA output coil for remote control applications. The SCADA system writes to a telemetry register as a bit value 0 or 1 to control this output.

CONTACTOR	The relay follows the motor contactor relay status (i.e., ON when the contactor is ON). This also follows the green LED on the controller faceplate. This function is often used to control an external lamp for improved visibility of the controller run status.
RESTART	The relay is ON when the controller restart timer is counting down for an automatic restart. This follows the flashing red LED status. This function is often used to control an external lamp for improved visibility of the controller status.
On Alarm	The relay is ON when the controller is in an alarm condition. This function follows the solid red LED status. This function is often used to control an external lamp for improved visibility of the controller status.
BLOCKING	The relay is ON when something (alarm, hold start, etc.) is blocking an automatic restart and also when the motor is running. The relay is OFF when the contactor is OFF and no alarms are present.
SOFTSTART_DONE	The relay turns ON when the Soft-start Delay has expired. During a soft-start application, Relay1 (CONTACTOR) is connected to the soft-start relay and turns ON when a start occurs. This parameter is used to turn on a second relay to control the full operation. This relay will drop out when Relay1 drops out to stop the motor.

4.6.2 Analog Input

The Switchboard Card or IO card Analog input contains differential analog inputs, each of these inputs can independently operate in voltage or current mode.

The analog input channels are used to interface to external analog devices or Remote Telemetry Devices (RTD) like pressure or temperature units. The range and scale settings for the analog inputs operate in a similar manner to the analog outputs.

The analog inputs operate in the range of 0–10V or 0–22mA current loop measurement. These operating ranges can be scaled to function as 0–5V, 2–8V, 4–20mA, etc.

For voltage measurements the inputs are differential with an operating range up to 10V. Each input contains over-voltage protection which activate in the 20 to 24 VDC range. Therefore the differential data of 10V can swing up to the 20V without data corruption.

Each analog input can be configured with parameters shown in the following table.

Table 4-4: Analog Input Settings

Parameter	Description
Name	Name the data type, i.e. Pressure, temperature, Temp1, etc.
Input type	Voltage or current mode, i.e. 0-10 V or 0-20 mA.
Raw Maximum	Configuration setting on controller to map to Scaled Maximum
Raw Minimum	Configuration setting on controller to map to Scaled Minimum
Scaled Maximum	Maximum reading of device in engineering units, i.e. 200 psi
Scaled Minimum	Minimum reading of device in engineering units, i.e. 0 psi

The ‘Name’ parameter can be used to change the name of the analog input channel to something more descriptive on the display. For example, a wellhead pressure sensor might be labeled ‘WH Press’. The maximum number of characters permitted is ten.

The ‘Input Type’ parameter determines whether the analog input channel operates as a voltage input or current loop input. This parameter can be set to either '0–10v' for voltage mode or '0-20 mA' for current mode.

The ‘Raw Maximum’ and ‘Raw Minimum’ parameters are used to set the 0-10 volts and 0-20 mA ranges to other ranges. The raw values are expressed as a percentage of the maximum input voltage or current. This is used to interface to devices that have ranges like 0-1 volts, 1-5 volts, or 4-20 mA.

The ‘Scaled Maximum’ and ‘Scaled Minimum’ parameters are used to set the Engineering units the user wishes to see within the bounds of 0% and 100%. These Engineering units may represent pressure, temperature, voltage, current, etc.

The configuration of these inputs can be performed using the Controller interface or the StarView program utility.

4.6.2.1 Voltage Mode

The analog inputs configured for voltage inputs have a basic circuit topology shown in Figure 4-12. This is not entirely accurate as the end device would typically require a power supply.

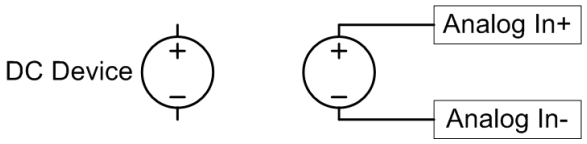


Figure 4-12: Analog input voltage mode single device

Figure 4-13 shows an external power supply which provides power to the device.

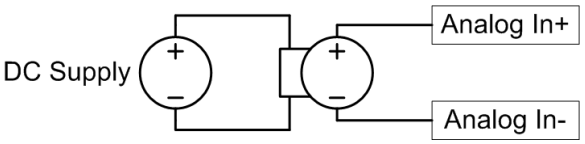


Figure 4-13: Analog input voltage mode DC powered device

4.6.2.2 Current Mode

The analog inputs configured for current inputs have a basic circuit topology shown in Figure 4-14. For the current loop to function a power supply is required to drive it.

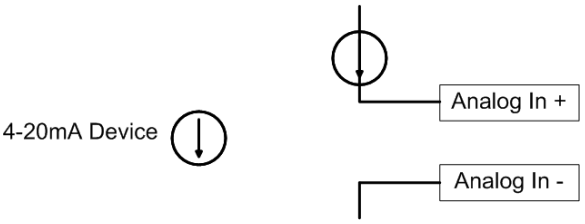


Figure 4-14: Analog input current mode single device

4.6.3 Digital Input

Digital inputs are designed to provide logic information in the form of Open / Close, On / Off, High / Low, 1 / 0, etc. The digital inputs are designed to be switched with dry contacts. The switching voltage, 24 volts DC available on DPWR pin, is supplied internally from the card via the DIGITAL PWR terminal. These inputs can be independently configured to respond to either an Open or Close condition. A sample digital input circuit is shown in Figure 4-15.

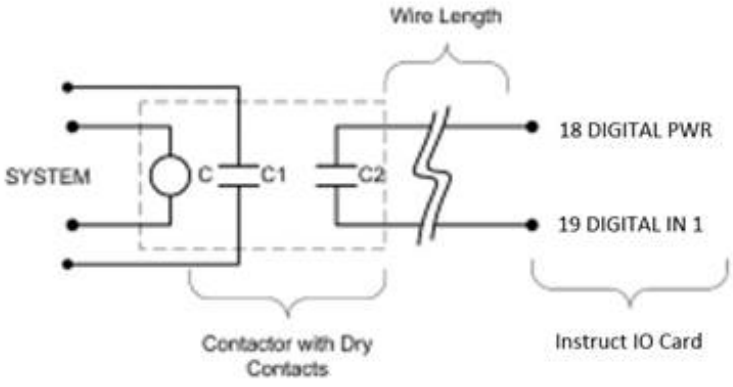


Figure 4-15: Digital input dry contacts

The digital inputs contain internal alarms to indicate power and voltage faults.

If the length of the digital input wiring is very long, the DC switching power can be subject to significant voltage droop. The recommendation is to use an additional relay to provide the switched signal to the card. The power to drive the relay would be according to the clients' discretion. The placement of the relay would be near to the controller as shown in Figure 4-16.

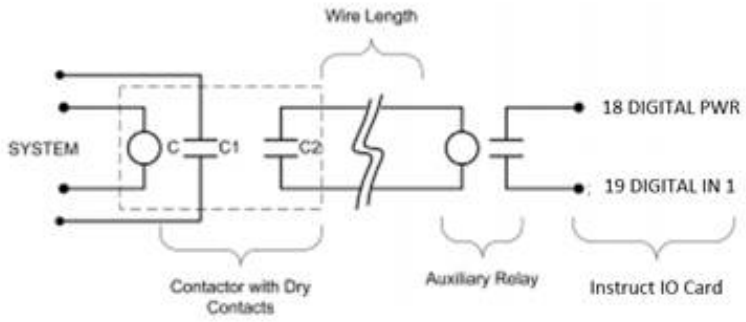


Figure 4-16: Digital input with auxiliary relay

The digital inputs should always be wired in a fail safe connection so that loss of power or a break in the digital input wiring will trigger the input. The controller should be set to alarm on a switch open condition and the external switch set to hold the switch closed during normal operation. In addition to catching a fault condition from the external device, the controller will also receive an alarm condition in the case of external device power failure or a break in the signal wires.

The controller configuration can accept both types of inputs, normally open and normally closed.

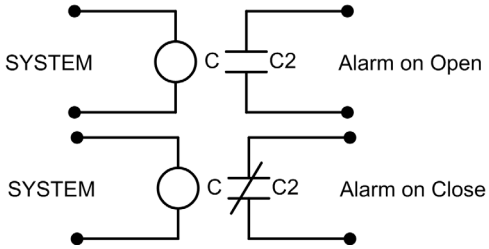


Figure 4-17: Digital input fail safe considerations

4.6.3.1 Digital Input HOA

Hand, Off, Auto (HOA) represents a traditional mechanical switch to ensure that only one of the three modes function at one time. The HOA functions on the keypad already emulate this operation. Alternately the digital input may be configured to operate as a HOA permitting the use of traditional mechanical switches.

The digital input Hand, Off, Auto operational features are summarised in Table 4-5.

Table 4-5:

HOA Function	Description
NORMAL	The digital input is configured for normal operation. HOA mode is disabled.
START	Momentary closure on any digital input configured for START will place the controller in START mode provided the controller is in HAND or AUTO mode and no alarms are present. If the controller is in a lockout condition, activating a START will first clear the lockout, a subsequent START will place the controller in START mode. Latched alarms are automatically cleared during a START. Maintenance Bypass mode can be activated if START is held closed more than 5 seconds. If digital inputs are used for HAND and AUTO mode selection and there is a requirement to toggle between these modes, this can be done by holding in START while switching modes. **Note** Recommendation is to not configure more than one input for START. Once a digital input is configured for START, normal digital operation (Alarming and Restarting) for that input will be disabled. START from the controller's keypad will function normally when using START from digital input. START from digital input is activated by closing the circuit and cannot be configured to START on open circuit.

HOA Function	Description
HAND	Closing the circuit will place the controller in HAND mode and override HAND/AUTO control from the controller's keypad. Once a digital input is configured for HAND, normal digital operation (Alarming and Restarting) for that input will be disabled. HAND mode can only be activated by closing the circuit and cannot be configured to activate on open circuit **Note** Only one digital input should be configured for HAND mode. When HAND is not activated (open circuit) and AUTO mode is not activated, the controller will be placed in MANUAL OFF mode.
AUTO	Closing the circuit will place the controller in AUTO mode and override HAND/AUTO control from the controller's keypad. Once a digital input is configured for AUTO, normal digital operation (Alarming and Restarting) for that input will be disabled. AUTO mode can only be activated by closing the circuit and cannot be configured to activate on open circuit. **Note** Only one digital input should be configured for AUTO mode. When AUTO mode is not activated (open circuit) and HAND mode is not activated, the controller will be placed in MANUAL OFF mode.

4.6.3.2 Digital Input Alarm

The digital inputs have been designed to survive wiring faults and high voltage transients. There are two digital alarms:

Alarm Label	Description
U_IO_PFail	Indicates that a short to ground has occurred somewhere on the digital inputs (DIGITAL IN pin 22 to 27). With this alarm active, the entire digital input system may be effected as the digital power (DIGITAL PWR pin 21) is shared amongst all inputs.
U_IO_V_HI	Indicates that a high voltage fault exists somewhere on the digital inputs (DIGITAL IN pin 22 to 27). This may be due to a wiring fault where high voltage or AC voltage has been connected to the digital input.

4.6.4 Analog Output

The analog outputs operate to control the 0–20mA loop current. The Analog output cannot provide power for the loop current.

The analog output channels can be used for external control of devices such as an electronic valve or meter. The range and scale settings for the analog outputs operate in a similar manner to the analog inputs.

The analog outputs operate in the range of 0-22mA and can be configures to operate in 4–20mA, 10–15mA, etc. An external power supply may be used to power the current loop. Each output contains over-voltage protection which activate in the 20 to 24 VDC range so the external power supply must operate below this value.

Each analog output can be configured with the parameters shown in Table 4-6.

Table 4-6: Analog Output Settings

Parameter	Description
Name	Name of the data type, i.e. Pressure, temperature, Temp1, etc.
Source	Parameter that drives the analog output value, i.e. Analog In 1, Power Factor, etc. see Table 4-7.
Scaled Maximum	Maximum reading of the device in engineering units, i.e. 200 PSI
Scaled Minimum	Minimum reading of the device in engineering units, i.e. 0 PSI
Raw Maximum	Configuration setting on the controller to map to Scaled Maximum
Raw Minimum	Configuration setting on the controller to map to Scaled Minimum

The ‘Name’ parameter can be used to change the name of the analog output channel to something more descriptive on the display. For example, average voltage might be labeled ‘Avg Volts’. The maximum number of characters possible is ten.

The 'Source' parameter represents analog outputs that may be bound to the parameters shown in Table 4-7. In this manner live data may be mapped to auxiliary displays or other devices.

Table 4-7: Analog Output Source Settings

Remote input	Manual setting of the analog output using the set point. This can be performed using the keypad, StarView or remote SCADA.
Analog 1 to 4	Analog output can be mapped to the controller analog inputs.
Fixed Speed parameters	Power factor, Average Volts, Average Amps, etc.

VSD parameters	Variable speed drive parameters such as Run frequency, etc.
DHT	Downhole tool interface card parameters such as Pump intake pressure, Bottom hole temperature, Vibration, etc.

4.7 Variable Speed Drive

Variable speed motor control uses a variable speed drive (VSD) to control speed/frequency of the motor. The controller changes modes to operate as a VSD controller. All the motor protection requirements are set using the controller and using the feedback from the VSD the controller performs the motor protection. The available voltage and frequency can be changed by the VSD. In the event a VSD trip situation occurs the VSD turns off the output. In the event the controller detects a trip condition, the VSD is instructed to turn off the output. Figure 4-18 shows a simplified block diagram of a controller VSD system.

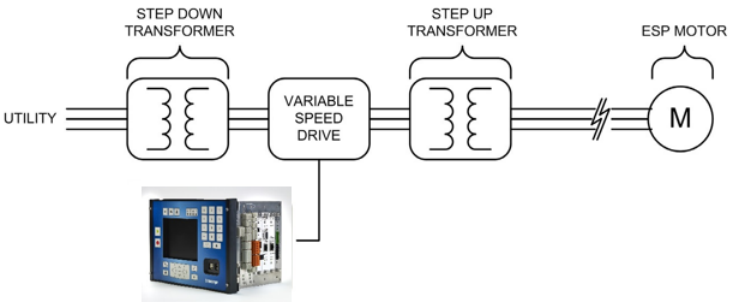


Figure 4-18: VSD interface

The controller uses a serial communication cable to interface to the VSD. The RS485 port on the control card can be used for the communication. Or a communication card is required which can be inserted into one of four slots in the controller.

Warning
Potential Severity: Serious
Potential Loss: Assets
Hazard Category: Electrical, Machinery equipment hand tools

The controller can operate as a fixed speed motor controller or a variable speed motor controller. Configuration parameters exist for both modes of operation and care should be taken not to confuse the two types. Ensure motor protection parameters for VSD are used when operating with a VSD. Vice-versa for fixed speed motor control.

4.7.1 Variable Speed Drive Controls

The variable Speed drive (VSD) is a self contained drive system controlled by the controller. The controller accepts operation / configuration parameters via the keypad, SCADA or StarView and sends these parameters to the VSD. Table 4-8 summarises these parameters as viewed on the controller display.

Table 4-8: VSD control parameters

Parameter	Description
Ramp Frequency	The **Ramp Frequency** is used to calculate the acceleration / deceleration times during operation. This parameter sets the frequency at which the **Acceleration Ramp Time** and **Deceleration Ramp Time** parameters occur. The **Ramp Frequency** is fixed at 90.00Hz and cannot be changed.
Maximum Speed	The maximum speed is used to set the upper operating frequency limit. The VSD will not operate above this limit. This parameter cannot be changed while the VSD is running. For fields or wells with 60 Hz power, the speed should be set as Equation 4-2. For fields or wells with 50 Hz power, the speed should be set as Equation 4-1 – i.e., conditions where motor loading reaches 100%. Load HP includes HP consumption of pump, protector, intake/gas separator and gas handling device (AGH/Poseidon – when used). **Equation 4-1:** $50 \times \sqrt{(\text{Motor HP at 50 Hz/Load HP at 50 Hz})}$ **Equation 4-2:** $60 \times \sqrt{(\text{Motor HP at 60 Hz/Load HP at 60 Hz})}$ **Note** An applications Engineer should be consulted to verify the above calculations are applicable to the ESP system as a whole.
Minimum Speed	The minimum speed is used to set the lower operating frequency limit. The VSD will not operate below this limit except when performing a ramp from a start or to a stop. This parameter cannot be changed while the VSD is running.
Target Speed	This setting allows adjustment of the desired VSD / motor running frequency in Hertz. When the VSD is running, changing this setting ramps the VSD to the new frequency as soon as the ACCEPT key is pressed. The ramp rate depends on the acceleration / deceleration settings. This screen is also accessible from the live values screen in the motor table.

Parameter	Description
90 Hz Accel Ramp Time	This parameter sets the time to accelerate from 0 Hz to the **Ramp Frequency**. Target speed changes are affected by this value. 90 Hz represents the maximum frequency. *Acceleration time to x Hz (seconds) = Accel Ramp Time * (x – Start-Up freq.)/Ramp freq.*
90 Hz Decel Ramp Time	This parameter sets the time to decelerate from the **Ramp Frequency** to 0 Hz. Target speed changes are affected by this value. 90 Hz represents the maximum frequency. *Deceleration time to x Hz (seconds) = Decel Ramp Time * (x / Ramp freq.)*
Base Speed	This value sets the frequency at which the maximum output voltage of the VSD is output. The Volts/Hertz curve for the VSD is constructed using these parameters. • Base Speed • VSD Base Frequency Voltage Selection (for applicable VSDs) • Fixed Base Voltage
VSD Base Freq Volt Sel	The **VSD Base Frequency Voltage Selection** parameter determines how the output voltage of the VSD behaves. The following three options are available for the **S3**: • Input: The output voltage tracks the input voltage to the VSD. ESP applications typically use this setting. • Fixed: The VSD maintains a fixed output voltage according to the **Fixed Base Voltage** parameter. For the **SpeedStar S7+/VariStar ST7**: This parameter Enables/Disables the Voltage Compensation function. This function provides an output waveform adjustment that compensates for changes in the input voltage.
Base Voltage	**S3** - This parameter sets the output voltage of the VSD when the **Base Frequency Voltage Selection** is set to **Fixed**. **S7+** - This parameter sets the maximum value of the output voltage of the drive. With Voltage Compensation disabled, this value is the output voltage at the base frequency. Regardless of the programmed value, the output voltage cannot be higher than the input voltage. The actual output voltage will be influenced by the input voltage of the VSD and the Supply Voltage Compensation setting above. See InTouch ID# 5709381 for more details on voltage compensation. **MVD** - Sets the value for motor rated voltage and the voltage at the base speed.
PWM Carrier Freq	**S3/S7+/ST7** - This PWM Carrier Frequency sets the pulse width modulation (PWM) carrier frequency (the frequency at which the VSD transistors switch). This parameter can be changed while running on SS2K VSDs. This parameter is fixed and cannot be changed on SWD VSDs to protect the SWD filter. **MVD** - The carrier freq is fixed and cannot be changed with or without a SW filter.

Parameter	Description
V/Hz Pattern	**S3/S7+/ST7** - The Volts/Hertz Pattern selects one of six different voltage/frequency characteristics for motor control. For ESP applications the setting 'Constant Torque' is recommended. • Constant Torque • Variable Torque • Automatic Torque Boost • Automatic Torque Boost with Energy Savings • Vector Control • Vector Control with Energy Savings This is a feature of the VSD drive and the VSD manual should be consulted for further details. **MVD** - • Constant Torque • Square Function - This values for this pattern need to be set using WiTool. • Five Point - The values for the 5 points need to be set using WiTool **Tip** For ESP applications the setting "Constant Torque" is recommended.
Startup Frequency	This setting controls the frequency at which the inverter begins to operate during a start. The VSD starts at this frequency and ramps to the **Target Speed**. This parameter can be set between 0 and 10 Hz, and is typically set to around 7 Hz for ESP applications. **Warning** Potential Severity: Serious Potential Loss: Assets Hazard Category: Electrical, Machinery equipment hand tools For DHT applications where a three-phase choke is used with the DHT interface card, setting this frequency too low may result in damage to the DHT interface card.
Startup Voltage Boost	This parameter controls the amount of voltage added to the starting voltage to provide increased torque for acceleration. For LV VSDS you may change voltage Boost anywhere from 0–30%. MVDs are limited to 0–10%.
Catch A Spinning Motor	This setting allows the VSD to start safely into a spinning motor (either forward or reverse direction). The VSD will detect the rotation speed and adjust the VSD output voltage and frequency to match before applying power.
Stop Mode	This parameter controls how the VSD stops the motor in a shut down. The two options are: • Coast: Power is removed from the motor allowing it to coast to a stop. • Decel: The VSD powers the motor to a controlled stop according to the **Ramp Frequency** and **Deceleration Ramp Time**.

Parameter	Description
Rotation Direction	This parameter allows the VSD to run in the opposite direction. This can be toggled between '0' and '1' to change the rotation from the previous operating condition. This is used during commissioning in the event the pump operates backwards, to avoid having to make wiring changes. The change to the rotation direction takes effect on the next start. The **Rotation Direction** is also controlled by **Reverse While Running**.
Reverse While Running	This is a one-shot parameter used to reverse the direction of motor operation while the VSD is running. The VSD will decelerate and start in the other direction automatically. The **Rotation Direction** parameter will automatically be changed to indicate the new direction.
Accel/Decel Pattern	The **Acceleration / Deceleration Pattern** sets the acceleration and deceleration patterns used to ramp up/down the frequency according to the acceleration and deceleration times on the voltage / frequency curve. The following options can be selected: • Linear (recommended for ESP applications) • S-Pattern **Danger** Potential Severity: Major Potential Loss: Assets Hazard Category: Electrical Consult InTouch before using a pattern other than 'linear'
VSD Thermal OL	This parameter sets the thermal overload protection level for the motor. **S3** - This is adjustable from 10% to 100% of the VSD rated current. **S7+/ST7** - This feature can only be turned ON/OFF
VSD Thermal Stall	**S3/S7+/ST7** - This setting controls the activation level of the stall protection. It is adjustable from 10% to 200% of the rated VSD current. When the stall level is reached the VSD will begin stalling by lowering the frequency and voltage to prevent overcurrent tripping. If the stall does not clear within the time limits of the VSD a trip will occur **MVD** - This setting is triggered due to an overload or high temperature. When turned on and the conditions are present the drive will decelerate the motor speed to the value set in overload speed reduction level to protect the equipment against overload. If the stall does not clear within the time limits of the VSD a trip will occur.
Overload Speed Reduction level	**MVD** - This setting sets the speed reduction level as a percentage when Thermal Stall is ON.
Speed Force	This feature is used to force the VSD to operate at a specific frequency during an event captured on the controller digital inputs. For details see section 4.7.2: Speed Force.
Rocking Starts	This feature rotates the motor in short bursts in the even of a stuck motor or heavy load. For details see section 4.7.3: Rocking Start.

Parameter	Description
VSD Jump Frequency VSD Jump Width	These screens allow setting of up to 3 frequency bands that act as dead zones for the **Target Speed.** For details see section 4.7.4: Jump Frequency.
Feedback	Feedback Parameters For details see section 4.7.5: Feedback.
Extended Ramp	This feature permits customizing the ramp rate beyond the capability of the VSD. For details see section 4.7.6: Extended Ramp Rate.
TypeForm Reset	Reset the VSD to the VSD factory defaults.
VSD Information	These screens contain information on the VSD. These are viewable parameters only. This is typically used for troubleshooting purposes.

Operating parameters are summarized in Table 4-9.

Table 4-9: VSD operating parameters

Parameter	Description
VSD Frequency	This is the VSD run frequency, i.e. the frequency output by the VSD. This should typically be the same as the **Target Speed** while the VSD is running, although the value will change as the VSD ramps up or down.
VSD Load	This is the live value of the VSD output current and the percentage loading of the full rated VSD output current. The current is an average of all three of the VSD phases measured by the drive and displayed by the controller. There are no controller alarms associated with this parameter. Alarming is performed using the **VSD Motor Amps**.
VSD Motor Amps	This screen displays the calculated value of the current delivered by the VSD to the motor. This value is calculated from the VSD Drive Amps read from the drive and the VSD Transformer Ratio. Two alarms are associated with this parameter: • VSD Underload (VSD UL) Typically set to 85% of nominal operating current. Setting this value is subjective as there are dependencies on pumping fluid. However, VSD Underload should not be less than 60% of motor nameplate current. • VSD Overload (VSD OL) Typically set to 110% of nominal operating current. Using a VSD, there is no issue with motor inrush currents. These two alarms use the standard controller alarm configurations detailed in section 4.2.4: Alarms. The VSD Overload alarm uses an inverse time curve. For proper operation these parameters require the output transformer ratio to be set. The VSD can only monitor the output power which is not necessarily the motor power if a transformer is used. The controller can provide the motor protection taking into account the transformer ratio.

Parameter	Description
VSD Voltage	The controller displays VSD voltage which represents the incoming RMS voltage to the drive and the output RMS voltage. The output voltage will vary during motor operation.
VSD Power	The controller displays VSD Power which represents the incoming power to the drive and the output power to the motor. The output power will vary during motor operation
VSD Alarm Control	VSD Alarm Control provides access to settings that control how the controller acts on alarms from the VSD and on the communication link between the controller and VSD. For more information consult the VSD Operating Manual.

4.7.2 Speed Force

Speed Force is used to force the VSD to change to a specific frequency during an alarm event. The controller digital inputs are used as the alarm source.

When the selected digital input goes into an alarm condition the VSD **Target Speed** will change to the **Speed Force Frequency**. If the input alarm clears the **Target Speed** will return to its normal setting. During the change in motor speed the **Accel/Decel Ramp Times** are used.

Note

The speed force function will not work if the associated digital input alarm is set to bypass.

Table 4-10: Speed force

Parameter	Description
Speed Force Source	This sets which digital input is used for the speed force. Digital inputs 1 to 6 are available.
Speed Force Freq	This sets the VSD output frequency / motor speed to use when speed force is activated..

4.7.3 Rocking Start

The rocking start is used to agitate a stuck pump or used during a pump startup in sanded well condition. The rocking start feature once configured, operates only once and must be re-configured if repeat rocking starts are required. The parameters are summarized in Table 4-11.

Table 4-11: Rocking start parameters

Parameter	Description
Rocking Cycles	Rocking cycles represents how many rotation pulses are to occur. This does not represent a change in direction.
Rocking Target Freq	The rocking target frequency represents the frequency the VSD drive will generate for the motor during the rocking feature.
Rocking Method	The rocking method represents different rocking patterns. • 1: STOP – JOG REVERSE – STOP – JOG FORWARD • 2: JOG REVERSE – JOG FORWARD • 3: JOG REVERSE – JOG REVERSE – JOG FORWARD – JOG FORWARD

The **Rocking Method** is performed by the number of **Rocking Cycles** at the frequency set by **Rocking Target Frequency**. Refer to Figure 4-19.

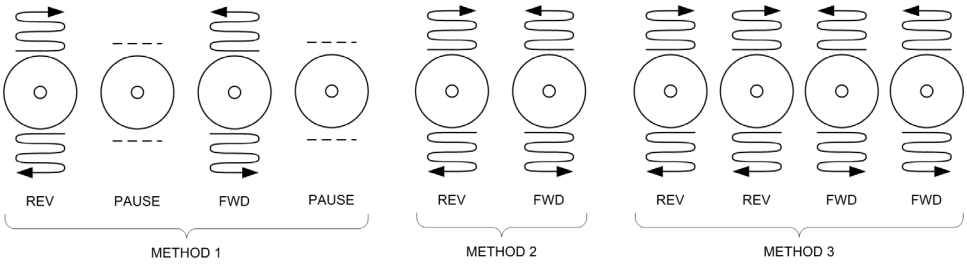


Figure 4-19: Rocking methods

Refer to InTouch Content ID 3928493 for important information on using Rocking Start.

Warning

Potential Severity: Serious
Potential Loss: Assets
Hazard Category: Machinery equipment hand tools

Rocking Start should only be used as a last resort for starting.

4.7.4 Jump Frequency

The jump frequency applies to the frequency zones, or motor speed, where the VSD drive is not to operate. This is used to prevent the VSD from changing to a motor speed that would resonate the ESP pump.

The controller can configure up to 3 frequency bands that act as dead zones for the target frequency. The VSD will not operate in these dead bands except during acceleration ramp up on start and decelerate ramp down on stop.

Example

Setting the VSD Jump Frequency to 10 Hz with a width of 2 Hz will result in a dead band from 8-12 Hz.

Table 4-12: Jump frequency parameters

Parameter	Description
VSD Jump Frequency	The centre frequency location where the jump is to occur.
VSD Jump Width	The spread from the centre frequency the dead band occupies.

4.7.5 Feedback

The controller provides a feedback feature to control motor speed to attain a target value. Using feedback , the controller constantly monitors the feedback data and incrementally changes the VSD output frequency. The rate of change and the amount of change is configurable. During operation the VSD output frequency will fluctuate up and down.

Table 4-13 describes the configuration parameters.

Table 4-13: Feedback parameters

Parameter	Description
VSD Speed Source	• Analog input 1 to 4 as a target. The controller will control the VSD speed/frequency based on the value on this input. • Analog input 1 to 4 as feedback. The controller will control the VSD speed/frequency to try and match the value of the analog input. • Pump intake pressure for when a Phoenix Interface Card is used. This parameter acts similar to **Analog input 1 to 4 as feedback**. If the intake pressure increases the controller can be configured to slow down the VSD. • Pump discharge pressure for when a Phoenix Interface Card is used. This parameter acts similar to **Analog input 1 to 4 as feedback**. If the discharge pressure increases the controller can be configured to slow down the VSD. • VSD motor amps. This parameter acts similar to **Analog input 1 to 4 as feedback**. If the motor amps increase the controller can be configured to slow down the VSD. • Target speed. Feedback is disabled and the controller will control the VSD to match this frequency.
If Feedback Increases	This parameter defines the action the controller should perform with a analog input change. The sensor operation may be proportional or inversely proportional with changes to motor speed. So basically, if analog feedback increases, what should the controller do?
Feedback Set point	The analog input target value. The VSD will change motor speed to attempt to match the target value. This value is an engineering unit which is defined by the analog input configuration. For details see section 4.6.2: Analog Input.
Feedback Step Size	This parameter defines by what amount the motor speed should change during each change step. If configured too large for the application the feedback will constantly hunt and exceed the feedback value. If configured too small the controller will not be able to maintain control, the feedback data will exceed **Feedback Values** and the system will alarm.
Feedback Step Interval	This parameter defines how often the change step takes place. This time takes into account how long a change in motor speed will take to effect the sensor on the analog input. Configuration considerations are similar to **Feedback Step Size**. **Note** A change in motor speed may take 10 minutes for a pressure change on surface to be detected.
Feedback Values	These parameters set the maximum and minimum range of the feedback window. The controller will perform feedback operations within this range. If the controller is unable to maintain control within range, the system will alarm. These parameters have no units associated with them as the data type will vary.

Parameter	Description
Feedback Deadband	The deadband is a range of values around the target value for which the controller will make no speed adjustments to the VSD. Outside of the deadband range, the controller will make an adjustment in an attempt to reach the target value. **Note** Starting with firmware version 1.401r1, the controller is able to adjust the deadband of the VSD feedback mode between the range of 0.1% and 10.0%, with a factory default setting of 1.0%. Previous versions of firmware were limited to a non-adjustable 1.0% deadband.

The implementation of the feedback parameters are very flexible and can best be explained with examples.

Example

A remote analog signal on analog input 1 will control the speed of the VSD. The controller feedback parameters will be configured as:

Parameter	Configuration
VSD Speed Source	Analog input 1 as target
Analog input 1	Configure to ensure engineering units reflect the engineering units of Hz.
If Feedback Increases Feedback Set point Feedback Step Size Feedback Step Interval Feedback Values Feedback Deadband	N/A

Example

The controller analog 1 is connected to a surface pressure sensor. The controller is expected to operate the VSD to maintain a specific surface pressure.

The controller feedback parameters will be configured as:

Parameter	Configuration
VSD Speed Source	Analog input 1 as feedback.
Analog input 1	Configure the analog input 1 to ensure the input data is converted to engineering units that reflect the pressure readings of the sensor.
If Feedback Increases	If feedback increases (pressure rises) then the controller should control the VSD to reduce motor speed.
Feedback Step Size	Configure the controller to increment motor speed changes by a specific value.
Feedback Step Interval	Configure the controller to perform the **Feedback Step Size** in a specific interval.
Feedback Values	Configure the maximum and minimum pressure values in which the system will operate.
Feedback Deadband	Set the desired deadband value.
Feedback set point	Set the desired operating pressure.

Additional information can be found InTouch Content ID 4193860

4.7.6 Extended Ramp Rate

The extended ramp rate (ERR) is an enhancement to the standard ramp rate available on the VSD. This feature provides the ability to customize a ramp rate far longer than what the VSD can normally provide. The ERR operates in the region between **Min Speed** and **Target Speed**. The VSD will use the standard ramp process from the **Start Up Frequency** to the **Min Speed** then switch to ERR to the **Target Speed**. Table 4-14 summarizes these parameters.

Table 4-14: Extended ramp rate parameters

Parameter	Description
Extended Ramp Rate	Function to enable or disable this feature
Extended Ramp Step Size	The amount the speed/frequency will change during each step. This entry is limited to 0.01Hz ↔ 1Hz.
Extended Ramp Step Interval	The time duration between each step change. This entry is limited to 1s ↔ 1000s.

The **Extended Ramp Rate** target is the **Target Speed**. To calculate the duration of a ramp use the following.

Equation 4-3: VSD ramp time

$$\frac{Target\ Speed - Min\ Speed}{Step\ Size} \times Step\ Interval = Ramp\ Time$$

To calculate the **Extended Ramp Step Size** and **Extended Ramp Step Interval** based on a target ramp time use the following:

Equation 4-4: VSD ramp time using Step Interval and Step Size

$$Step\ Interval = \frac{Ramp\ Time \times Step\ Size}{Target\ Speed - Min\ Speed}$$

$$Step\ Size = \frac{Target\ Speed - Min\ Speed}{Ramp\ Time} \times Step\ Interval$$

For configuration information see section 4.7.6: Extended Ramp Rate.

4.7.7 Power Ride Through

Power Ride Through feature is added into Instruct as of FW 2.117r002. The Power Ride Through feature is to enable a VSD to continue running through power sags, without causing any trips.

The ride-through function once triggered, will slow down the VSD to preserve power, as long as the DC bus voltage remains higher than 66%, the drive will continue to run without stopping.

Below this 66% threshold the drive will stop until power is restored. If power is restored and the controller remains powered without rebooting, the drive will automatically restart the ESP within 3 seconds of it being stopped using catch a spinning motor feature. The power sag should not last more than 250ms and for it to successfully work is highly dependent on the loading of the drive at the time of the power dip and how long the power dip remains.

Note

Using ride-through mode under certain conditions could cause the volts/herz curve to the motor to be off resulting in the motor amps being higher than usual. Activating VSD input voltage alarm is recommended in these cases, to avoid prolonged power sags.

The feature can be found under Instruct Menu->VSD->Configure.

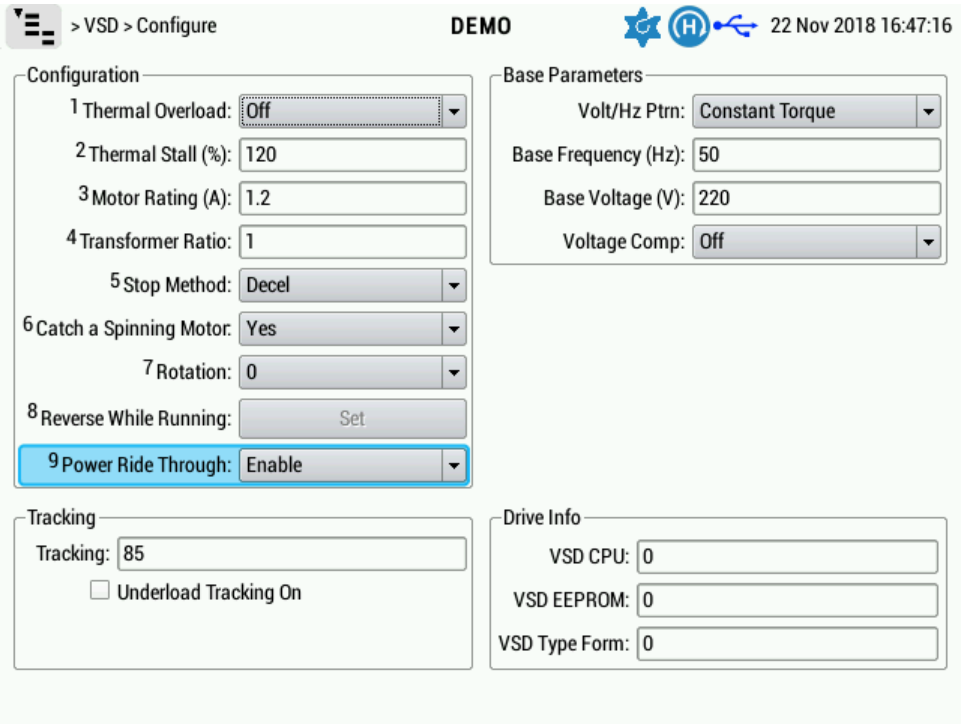


Figure 4-20: Power Ride Through

4.8 Phoenix Interface Card

The Phoenix Interface Card (PIC) is used to provide an interface between the controller and a Phoenix Downhole Tool (DHT). The PIC enables the acquisition, viewing, storage of downhole parameters (pressure, temperature, flow rate, vibration, etc.) from the Phoenix DHT, by the controller. This section describes the operation and readings obtained from the Phoenix DHT.

Figure 4-21: Phoenix Interface Card version 2 (PICv2)

In addition to monitoring and control PICv2 has the following features.

- Dry contact relay output (compatible with SoloConn only)
- Single firmware to operate with all Phoenix DHT equipment
- Real time clock and standby battery
- Standard DB9 serial RS232 engineering port access

The connection diagram Figure 4-22 shows a complete system required to acquire data from a DHT installed with an ESP.

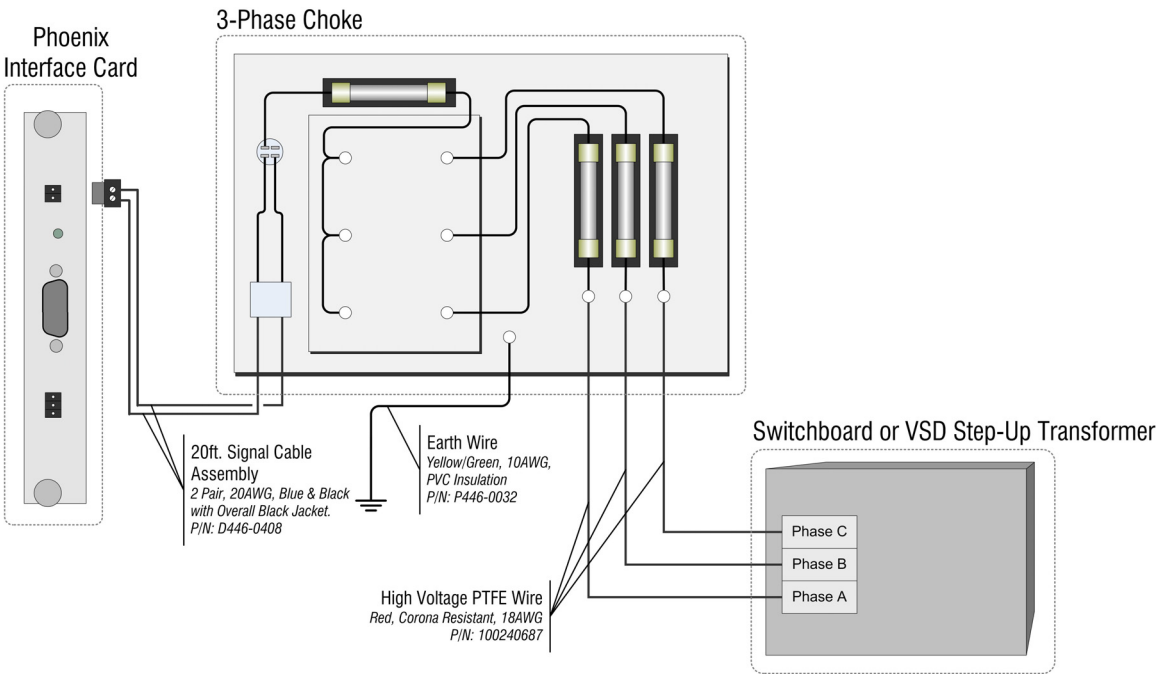


Figure 4-22: PIC Connections Diagram. *ESP System equipped with Phoenix gauges.*

The interface card operates as part of a system. Therefore, it is imperative that the user be familiar with the operation of both the system and the interface card, for both the safety of the operator and the protection of the equipment.

4.8.1 Functional Overview

Upon power up the PICv2 cards conduct an internal diagnostics. This is observed by the audible clicks emitted by the relay switching the calibration circuit. Once calibration is complete, the PICv2 generates approximately 100 VDC onto the downhole tool (DHT) output with a current output limited to maximum 30mA. This 100 VDC not only energizes the DHT but provides a return path for the communications system.

The constant current generated by the PICv2 is modulated by the DHT to generate the data packet. The PIC deciphers this modulation into engineering values. The DHT can take approximately one minute to receive the initial data packet.

Note

The surface equipment may need to receive 2 or 3 packets before displaying valid data to the user.

Periodically the PIC reverses the 100 VDC to -100 VDC. This reverses the current in order to conduct cable integrity measurements. For many Electric Submersible Pump (ESP) applications a choke is used to superimpose the power / signal onto the 3-phase power system, allowing the same cable that provide motor power to carry the data from the DHT. Some DHT applications use a dedicated cable-to-surface (CTS) and do not require a choke.

4.8.2 Downhole Tool (DHT)

4.8.2.1 Tool Types

The PIC design has evolved over time and can support both analog and digital Phoenix tool types. The PICv2 can interface to a wide range of tools listed below.

- Phoenix xt150
- Phoenix CTS
- Legacy Gauges:
  - Phoenix MultiSensor XT
  - Phoenix UltraLite
  - Phoenix Select

4.8.2.2 Phoenix DHT Summary

A summary of the tool and sensor options is show in Table 4-15.

Table 4-15: Phoenix Sensor Summary

DHT Type	MultiSensor XT		xt150		Phoenix Select / CTS					
	XT-0	XT-1	Type-0	Type-1	Lite	Standard	Advance	CTS-0	CTS-1	Ultra-Lite
Select Tool Type	N/A				0	2	3	4	5	6
Pump Intake Pressure	x	x	x	x	x	x	x	x	x	x
Bottomhole Temperature	x	x	x	x	x	x	x	x	x	
Pump Discharge Pressure		x		x		x	x		x	
Pump Discharge Temperature						x	x		x	
Pump Discharge Flowrate										
Motor Winding Temperature	x	x	x	x	x	x	x			x
Motor Star-Point Voltage					x	x	x			
ESP DC Active Current Leakage	x	x	x	x	x	x	x	x	x	x
ESP DC Passive Current Leakage	x	x	x	x	x	x	x	x	x	x

DHT Type	MultiSensor XT		xt150		Phoenix Select / CTS					
	XT-0	XT-1	Type-0	Type-1	Lite	Standard	Advance	CTS-0	CTS-1	Ultra-Lite
Select Tool Type	**N/A**				**0**	**2**	**3**	**4**	**5**	**6**
Cz	x	x	x	x	x	x	x	x	x	x
Cf	x	x	x	x	x	x	x	x	x	x
Pump / Motor X-axis Vibration	x	x	x	x	x	x	x	x	x	x
Motor Y-axis Vibration					x	x	x	x	x	
Motor Z-axis Vibration					x	x	x	x	x	
Remote-1 X-axis Vibration						x	x			
Remote-1 Y-axis Vibration						x	x			
Remote-1 Z-axis Vibration						x	x			
Remote-2 Pressure							x			
Remote-2 Temperature							x			
Remote-2 X-axis Vibration							x			
Remote-2 Y-axis Vibration							x			
Remote-2 Z-axis Vibration							x			

4.8.3 DC Power

The default DC voltage (105 V) should operate all compatible tool types. The voltage setting can be adjusted to suit the tool or installation conditions.

Table 4-16: DHT Power Requirements

Tool Type	Tool Power Normal (mA)	Telemetry Power (mA)	Tool Power Total (mA)
MultiSensor XT	10	8	18–21
UltraLite	16–21	2–4	21–25
10 bps CTS	16–21	2–4	21–25
12.5 bps CTS	26–28	2–4	28–32
Select	16–21	2–4	21–25
xt150	16–21	2–4	21–25

Note

Maximum DHT power = Tool Power Normal + Telemetry Power.

The PICv2 provides the DC power which passes through the choke onto the 3-phase AC power system. The entire 3-phase AC power system is offset by the DC volts. Figure 4-23 shows the 3-phase AC power (phase A, B and C) as what the user would measure in the field.

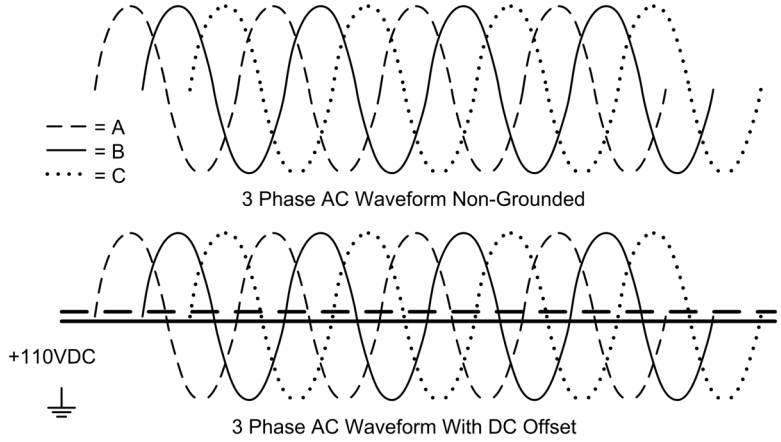


Figure 4-23: 3 Phase Power Offset by DC

The DC offset has no effect on the 3-phase power system. The AC power loop stays within the 3-phase AC system and the DC power loop stays within the DC power system. This works as long as the AC system remains non-grounded.

The PICv2 contains current limiting circuitry to limit current to 30 mA that can be pulled by the DHT. Current used beyond the tool power and telemetry power can be attributed to the 3-phase power system cable leakage or other faults.

4.8.4 DHT Communication

The downhole tool and surface system need a physical element to provide a communication path to transmit data from downhole to the user interface at surface. For ESP applications, a 3 phase ESP power cable is used. For CTS applications, a ¼-in instrument line runs from the downhole tool to surface system.

The DHT telemetry can be of two types; digital and analog. The MultiSensor XT is analog, and the CTS, xt150 are digital. Other legacy digital gauges include the UltraLite, and , Select, xt85.

Telemetry communication from the DHT is received by the PIC as modulated current pulses on the DC power. For the ESP tools such as xt150 , the communications path is show in Figure 4-24.

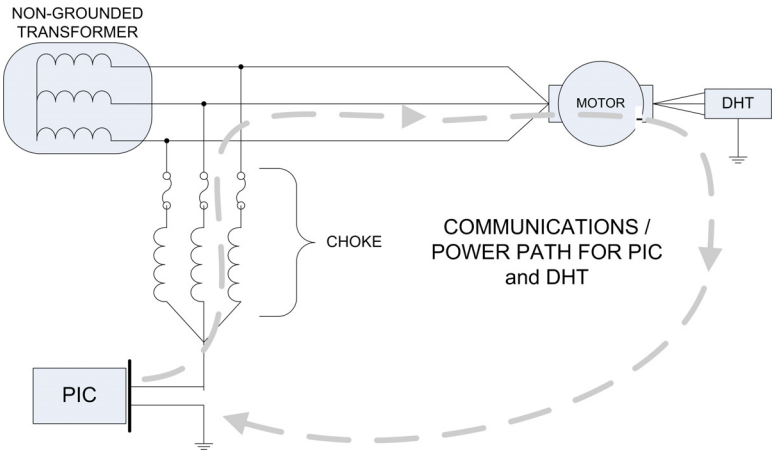


Figure 4-24: ESP DHT Communication Loop

For the CTS tools the path is a single wire-line connection between the PIC and the DHT, as shown in Figure 4-25.

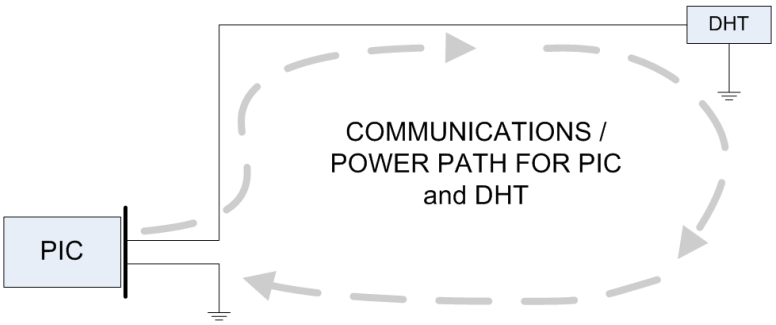


Figure 4-25: CTS DHT Communication Loop

4.8.4.1 Analog Tools

Data from the analog DHT (i.e., MultiSensor XT) is sent in frames. Every frame is 20 seconds long which consists of one set of analog readings of every parameter monitored by the DHT (Cz, Cf, Pi, Pd, Ti, Tm, Q, and Vi), see Table 4-17.

Table 4-17: MultiSensor data packet

Data Packet	Definition
Cz	Calibration value zero scale
Cf	Calibration value full scale
Pi	Intake pressure
Pd	Discharge pressure
Ti	Intake temperature

Data Packet	Definition
Tm	Motor temperature
Q	Flow rate
Vi	Vibration
CI	Current leakage

Data transmission is in analog form and thus preceded by the two calibration values Cz and Cf. These calibration values establish the maximum and minimum range where the next data pulses will appear. The PIC then measures the size of the data pulses within this range and stores each pulse as Pi, Pd, etc. Over time the maximum and minimum range values may change, but this will not effect the data. A single MultiSensor XT data frame is shown in Figure 4-26.

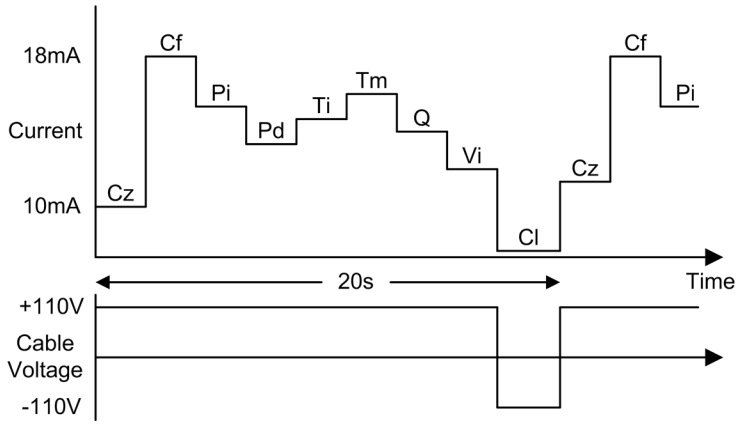


Figure 4-26: Analog tool data frame (example)

As shown in Figure 4-26, the end of every 20 second data frame the PICv2 reverses the polarity of the DC volts transmitted to the DHT. The DHT is equipped with a blocking circuit so all the current flow is stopped. This procedure is to:

- Conduct the current leakage (CI) measurement. This indicates the health of the ESP power cable.
- Reset the communication status with the DHT to restart the data packet.

4.8.4.2 Digital Tools

Digital DHTs (i.e., UltraLite, CTS, Select, xt150) represent a large range of deployment options. The available sensors per tool is shown in Table 4-15.

These tools use digital communications so there is no need for calibration data on each frame. The data is modulated on top of the DHT DC power and consists of a “0” or “1”. A sample data segment is shown in Figure 4-27.

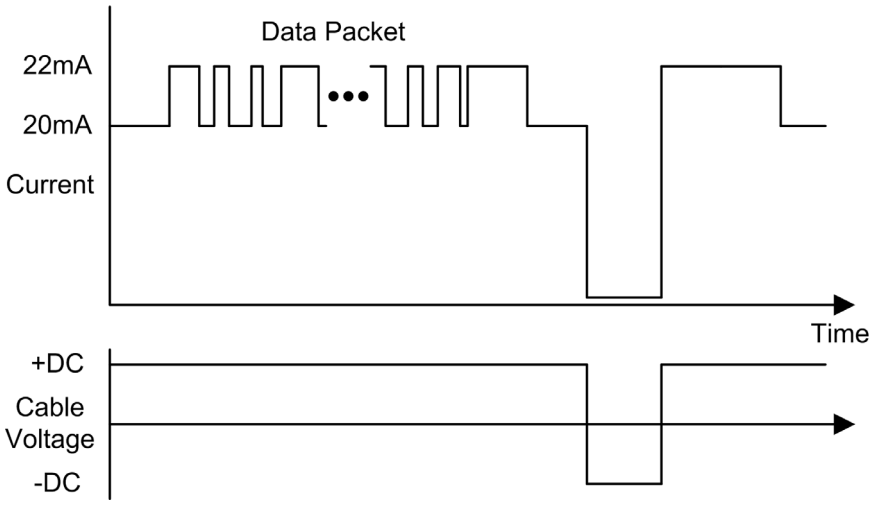


Figure 4-27: Digital tool data segment (example)

On powers up the DHT transmits a synchronizing packet and then the data stream begins. The data stream consists of pressure, temperature, vibration, vibration spectrum and diagnostics.

To optimize data performance the DHT telemetry has been broken up and prioritized. Depending on the tool type, some measurements like pressure and temperature are sent to PICv2 more often while the rest are sent less often and interleaved with the pressure and temperature telemetry.

At the end of each data cycle (that is, all measurements have been received at least once) the PICv2 reverses the polarity of the DC volts transmitted to the DHT, shown in Figure 4-27, to measure current leakage of the system. This process lasts for two seconds and then returns to normal data transmission mode.

4.8.5 Current Leakage

The Phoenix Interface Card telemetry system operates as a current loop. For the analog tools (MutliSensor XT), all data parameters are represented as varying magnitude of current. For the digital tools (UltraLite, CTS, Select and xt150) the data parameters are represented as fixed changes in current. For either system, current loop calibration is performed prior to data transmissions to null out the system leakage. These values are represented as Cz and Cf (calibration zero scale and calibration full scale).

The PIC also monitors system leakage and stores these values:

- Current Leakage Active
- Current Leakage Passive

The system leakage indicates the health of the system. Cable degradation, wire splice degradation, motor winding degradation, etc. all contribute to current leakage.

Note

Excessive current leakage, as in a system failure condition, may push the analog telemetry beyond the current limit point (section 4.8.3: DC Power) resulting in corrupted data.

4.8.5.1 Current Leakage Active

This is a PICv2 measured value during the -DC application of power. This determines how much of the current is not used by the DHT, but lost to the system. These measured values lose accuracy during the operation of an ESP. Figure 4-26 shows where the CI is acquired in the data frame.

4.8.5.2 Current Leakage Passive

Current Leakage Passive (CLP) is is used to determine the leakage within the running system. This is a PICv2 calculated value based on the change in Cz when the ESP is running. See section 4.8.4: DHT Communication for details. CLP is set at the factory during PIC calibration. The sensitivity of the PIC current measurement is very high so a 'set CLP' is performed to 'zero' the PIC. During field commissioning a 'set CLP' is performed to 'zero' the entire current loop system. The CLP must be set prior to running the tool.

Over time the system leakage may increase. See Figure 4-28. The present CLP value can be compared to the previous CLP value to show the amount the leakage has changed. Performing a 'set CLP' zeros this reference point. Alarm points may be set based on the CLP value.

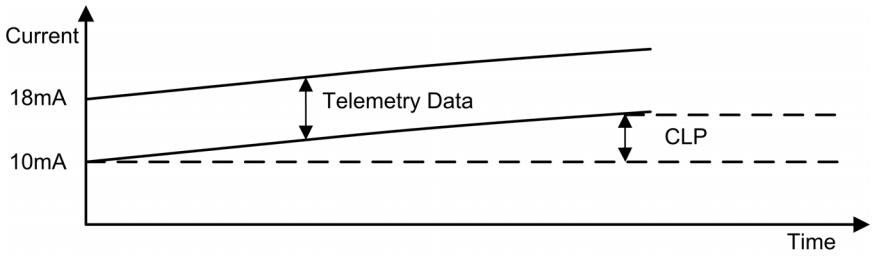


Figure 4-28: CLP

4.8.6 Rapid Sampling Rate

The Phoenix Interface Card and the Multisensor XT tools support a rapid sampling mode for intake pressure only.

There may be circumstances in which more detail is required for intake pressure. Enabling this feature causes the DHT to transmit intake pressure continuously and will remain locked in this mode until the feature is disabled. This mode changes the telemetry time from 20 seconds per frame to 1 second per frame.

Example

During commissioning the operator wishes to view the intake pressure of the ESP motor. Rather than waiting 20 seconds per update, RSR can provide updated information every second.

Note

RSR mode only provides intake pressure telemetry.

Hint

Recommendation is to limit RSR mode to 30 minutes or less to ensure the other DHT sensor readings are updated. During RSR mode the Cz, Cf reference parameters are not used and hence an accuracy drift may occur over time. If left unchecked, the actual monitored data in RSR mode will become inaccurate. Additionally the temperature, vibration, etc., are not monitored in RSR mode. See InTouch Content ID 3914646 for further details.

4.8.7 Vibration Averaging

The vibration averaging was introduced to reduce transient spikes in the vibration. This command sets the vibration average of vibration readings from downhole tool. Its range is from 1 to 32 and default is 16. Vibration Averaging of 1 removes averaging. This command is for digital tools only.

4.8.8 Post Averaging

The post averaging, also called smoothing algorithm, was introduced due to high sensitivity to noise in XT tools. Post averaging is a filter in the firmware that further reduces the noise in the signals. This command is for analog tool XT only.

Installation

5 Installation

5.1 Controller Mounting

This section applies to all activities related to retrofitting Drives and Switchboards, currently using UniConn controllers, with the Instruct controller.

The controller must be installed in an enclosure to be used. Typically, this is done at the factory or the ART (Assembly, Repair, and Test) Center.

Caution

Potential Severity: Light
Potential Loss: Assets, Reputation
Hazard Category: Machinery equipment hand tools

If the PCB on the Instruct Bezel is not attached properly due to a gluing issue, raise a RAN to SPE with a picture of the PCB and Bezel for replacement.

Figure 5-1: Keypad Inspection

Warning

Potential Severity: Serious
Potential Loss: Personnel
Hazard Category: Electrical, Machinery equipment hand tools

Do NOT install Instruct in 200 kVA or smaller 12-pulse SineWave/Non SineWave VSDs, as the spacing to live components inside the VSD is not adequate to ensure safe operation.

Caution

Potential Severity: Light
Potential Loss: Assets
Hazard Category: Machinery equipment hand tools

Installation can only be performed by authorized factory or service personnel. Operators only have access to the front panel of the controller. No installation or retrofit can be carried out by the operator.

5.1.1 Required Equipment

Caution

Potential Severity: Light
Potential Loss: Assets
Hazard Category: Electrical

All wiring to the controller must use copper wires rated for minimum 90 degC.

Part Number	Description	Qty
101224847	Instruct Retrofit Drill Template, 18 Ga Steel, Galvanized	1
101224844	Drill Bit, 5/32" X 2-1/16"L, Black Oxide	1
101206590	Operating Tool For WAGO 3.5mm Terminals ROHS	1
AC21259	MS Binding 10-32 x 1/2” Slot Drive	4
AC21063	Locknut Hex 10-32 Steel Zinc KEPS	4

The following tools/equipment will be required for the procedure.

- Volt meter
- 3/8-in nut driver
- Drill
- Vacuum
- 5/16-in slotted screwdriver
- 7/64-in hex key
- 0.4 x 2.5 slotted screwdriver
- Electrical tape

5.1.2 Mounting

The controller is mounted into the Drive/Switchboard enclosure with the following procedure. It is recommended that two people perform this procedure.

1. Using the appropriate procedures, ensure the Drive/Switchboard is stopped and that input power supplies are OFF before proceeding with the procedure.
2. Using the appropriate procedures, open cabinet door and use a volt meter to verify all power is OFF on the Drive/Switchboard prior to proceeding with remaining procedure.
3. Remove all connectors from bottom and sides of UniConn, including any connectors on option cards.
4. Ensure the door on the UniConn front panel is closed.
5. Using an 11/32-in nut driver, remove the four (4) nuts that secure the UniConn to the enclosure.
6. Open the door for the UniConn front panel, and remove the UniConn.
7. Using 5/16-in slotted screwdriver, insert 10-32 x 5/8-in screws into the existing mounting holes. Ensure the screws are inserted from the exterior.
8. Place from the inside the drill template over the four screws, ensuring that the notch in the template is in the top left corner.
9. Using a 3/8-in nut driver, secure the drill template with 10-32 locknuts.
10. Using a drill and 4-mm drill bit, drill four holes through the enclosure using the holes in the drill template as a guide.
11. Vacuum up any metal shavings from the inside and outside of enclosure.
12. Using a 3/8-in nut driver, remove locknuts and then remove the drilling template, leaving the 10-32 screws in place.
13. Using a 3/8-in nut driver, install the controller with bezel removed from the inside of the enclosure using the locknuts.

Caution

Potential Severity: Light
Potential Loss: Assets, Personnel
Hazard Category: Electrical, Electrical

Ensure there is enough clearance between the Instruct and any live components inside the Drive/Switchboard, prior to energizing the Drive/Switchboard.

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14. Using a 7/64-in hex key, install controller bezel from the front using the provided 4-40 x 1-1/8-in screws.

5.2 VSD Controller Wiring

Warning
Potential Severity: Serious
Potential Loss: Personnel
Hazard Category: Electrical, Machinery equipment hand tools

Do NOT install Instruct in 200 kVA or smaller 12-pulse SineWave/Non SineWave VSDs, as the spacing to live components inside the VSD is not adequate to ensure safe operation.

Caution
Potential Severity: Light
Potential Loss: Assets
Hazard Category: Machinery equipment hand tools

Installation can only be performed by authorized factory or service personnel. Operators only have access to the front panel of the controller. No installation or retrofit can be carried out by the operator.

5.2.1 Wiring

1. Using a 0.4 x 2.5 slotted screwdriver, remove wires from UniConn connector.
2. Using the Wago connector tool, re-install wires on Instruct Controller I/O card connector.

Note

- Relay 1 NO/NC/COM – The Instruct controller will need to be configured to have the same function as the UniConn Relay 1 terminals.
- Analog Pwr/Out1/Out2 – The function of the Instruct analog output is different than the UniConn analog output. If using these connections, refer to 6.9: Analog Output.

Table 5-1: Controller Wiring Cross Reference

Instruct	
Description	**Pin**
Relay 1 – NO	1
Relay 1 – NC	2
Relay 1 – COM	3
Relay 2 – NO	4

Instruct	
Description	**Pin**
Relay 2 – NC	5
Relay 2 – COM	6
Relay 3 – NO	7
Relay 3 – NC	8
Relay 3 – COM	9
Analog input 1 +	10
Analog input 1 –	11
Analog input 2 +	12
Analog input 2 –	13
Analog input 3 +	14
Analog input 3 –	15
Analog input 4 +	16
Analog input 4 –	17
Digital power	18
Digital input 1	19
Digital input 2	20
Digital input 3	21
Digital input 4	22
Digital input 5	23
Digital input 6	24
ANALOG OUT1	25
ANALOG OUT2	26
ANALOG GND	27

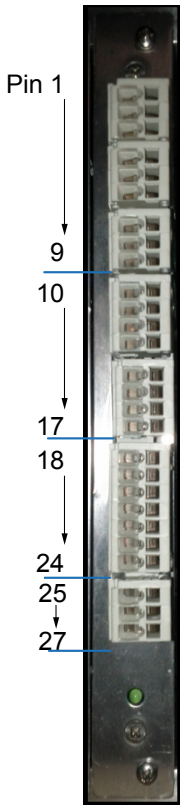

Figure 5-2: Controller Wiring Diagram (I/O Card)

Note

For Analog Out connections, ensure that the shield wire is connected to the Analog GND pin (pin 27) of the Instruct I/O card. Do not connect the shield to Chassis GND.

3. Using a 0.4 x 2.5 slotted screwdriver, remove wires from UniConn Comm Card connector.
4. Using the Wago connector tool, re-install wires on Instruct Control Card.

Table 5-2: RS-485 Wiring Cross Reference

Description	Cable Color Code		
	CAT 5	CAT 6	Pin
RS-485 TX	Blue	Blue	1
RS-485 TX-	Orange	Blue/White	2
RS-485 RX-	White/Orange	Green	3
RS-485 RX+	White/Blue	Green/White	4
GND	Green	Brown	5

Description	Cable Color Code		
	CAT 5	CAT 6	Pin
Shield Wire			5

Figure 5-3: RS-485 Wiring Diagram

Note

The RX+ and RX- terminals are reversed as compared to the Communication Card (101120028).

Note

For RS-485 connections, ensure that the shield wire is connected to the RS-485 GND pin (pin 5) of the Instruct Control card. Do not connect the shield to Chassis GND.

5. Using a 0.6 x 3.5 slotted screwdriver, remove wires from UniConn AC power supply terminals 46, 47 and 48.
6. Using a 0.6 x 3.5 slotted screwdriver, re-install the wires on the Instruct Controller power supply inputs.

Table 5-3: AC Input Wiring Cross Reference

Instruct	
Description	**Pin**
GND	GND
AC-N	N
AC-L	L

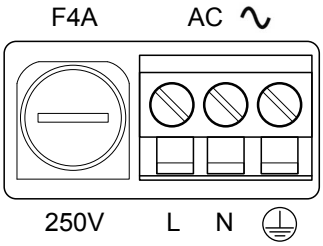

Figure 5-4: AC Input Wiring Diagram

5.3 Switchboard Controller Wiring

This section applies to all activities related to retrofitting the Instruct Controller into a Switchboard with a UniConn Controller. It is similar to retrofitting a VSD, except for the wiring process. The user should refer to the following wiring procedure for a Switchboard Instruct controller.

Note

For the K095 retrofit kit, refer to the Instruct Reference Page (InTouch ID 6023027).

Before installing the Instruct Controller, ensure that the Switchboard Card is installed in Slot A of the Instruct Controller.

Caution

Potential Severity: Light
Potential Loss: Assets
Hazard Category: Electrical

The Switchboard Card will only function in Slot A.

5.3.1 Wiring

1. Using a 0.4 x 2.5 slotted screwdriver, remove wires from UniConn connector.

2. Using the Wago connector tool, re-install wires on Instruct Controller I/O card connector.

Note

- Relay 1 NO/NC/COM – This relay can only be used for Contactor control.
- Analog Pwr/Out1/Out2 – The function of the Instruct analog output is different than the UniConn analog output. If using these connections, refer to 6.9: Analog Output or contact InTouch.

Table 5-4: Digital Outputs — Wiring Cross Reference

UniConn		Instruct Switchboard	
Description	**Pin**	**Description**	**Pin**
RLY1 NO	1	RLY1 NO	1
RLY1 NC	2	RLY1 NC	2
RLY1 COM	3	RLY1 COM	3
RLY2 NO	4	RLY2 NO	4
RLY2 NC	5	RLY2 NC	5
RLY2 COM	6	RLY2 COM	6
RLY3 NO	7	RLY3 NO	7
RLY3 NC	8	RLY3 NC	8
RLY3 COM	9	RLY3 COM	9
RLY4 NO	10	N/A	
RLY4 NC	11	N/A	
RLY4 COM	12	N/A	

Table 5-5: Analog/Digital — Wiring Cross Reference. *Analog inputs and outputs and digital inputs*

UniConn		Instruct Switchboard	
Description	**Pin**	**Description**	**Pin**
Analog in 1+	13	Analog In+	22
Analog in 1-	14	Analog In-	23
Analog PWR	28	Analog Out	24
Analog Out1	29	Analog COM	25
DIGITAL PWR	21	DIGITAL PWR	27
DIGITAL IN 1	22	DIGITAL IN 1	28
DIGITAL IN 2	23	DIGITAL IN 2	29
DIGITAL IN 3	24	DIGITAL IN 3	30
DIGITAL IN 4	25	DIGITAL IN 4	31

UniConn		Instruct Switchboard	
Description	**Pin**	**Description**	**Pin**
DIGITAL IN 5	26	N/A	
DIGITAL IN 6	27	N/A	

Table 5-6: PT/CT and Backspin Connections - Wiring Cross Reference

UniConn		Instruct Switchboard	
Description	**Pin**	**Description**	**Pin**
SPIN-A	31	N/A	
SPIN-B	32	N/A	
SPIN-C	33	N/A	
CT-A	34	CT_A	32
CT-B	35	CT_B	33
CT-C	36	CT_C	34
CT-PWR	37	N/A	
CT-REF	38	CT_REF	35
CT-SHIELD	39	SHIELD	36
PT-N	40	PT-N	40
PT-A	41	PT-A	37
PT-B	42	PT-B	38
PT-C	43	PT-C	39

	1		Contactor -NO
	2		Contactor -NC
	3		Contactor -COM
	4		Relay 1 -NO
	5		Relay 1 -NC
	6		Relay 1 - COM
	7		Relay 2 -NO
	8		Relay 2 -NC
	9		Relay 2 - COM
BSM Reset	10	11	RXTX1
RXTX2	12	13	RXTX3
No Connect	14	15	3.3V
BSM Rotation	16	17	BSM Frequency
No Connect	18	19	No Connect
GND	20	21	24V
Analog In +	22	23	Analog In -
Analog Out	24	25	Analog COM
No Connect	26	27	Digital PWR
Digital In 1	28	29	Digital In 2
Digital In 3	30	31	Digital In 4
	32		CT - A
	33		CT - B
	34		CT - C
	35		CT - Ref
	36		CT - Shield
	37		PT - A
	38		PT - B
	39		PT - C
	40		PT - N

Figure 5-5: Switchboard Card

5.3.2 Current Transformers and Burden Module

The Instruct Switchboard Card interfaces with conventional 0-5 A current transformers (CTs) using the CT Burden Module. The motor leads must pass through the CTs, which are installed in the high voltage compartment, for measurement of motor currents. The CT outputs must be connected to the input terminals of the CT Burden Module. The measurement connection to the Instruct is brought back on a low-voltage signal cable. This cable must be wired to the CT input plug (pins 32-36) of the Instruct Switchboard Card. The CT ratio must be correctly configured for the Instruct readings to be valid.

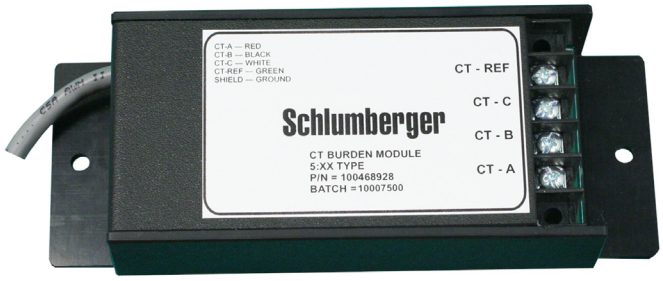

Figure 5-6: Burden Module. *5 amp input type*

5.3.3 Potential Transformers

The PT outputs are connected to the Switchboard card PT inputs, pin 36 through pin 40.

The voltage inputs on the Instruct Switchboard card accept 120 volts AC nominal voltage levels for monitoring the three-phase supply voltages. Since switchboard voltages are typically much higher than this, external potential transformers (PTs) are used to provide voltage level translation from the high-voltage signals. Three individual PTs are required for full high-speed three-phase monitoring applicable with both switchboards and VSDs.

The PT secondary windings must be connected to the Instruct in a Wye configuration with the neutral point terminated at the instrumentation transformer secondary winding common point.

The connection to the motor cables should be a Delta configuration to allow the Instruct to read line-to-line voltages. Refer to the following figure for the normal 3 PT configuration wiring diagram.

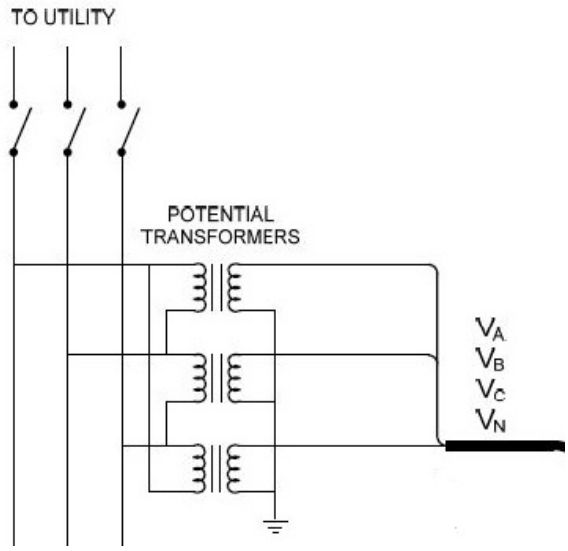

Figure 5-7: PT Configuration

For K095 backward compatibility, The Instruct controller has 2 PT configuration option, which allows the user to use only 2 PTs, Refer to the following figure for the 2 PT configuration wiring diagram.

Note

In a two PT system the third reading (Vbc) is extrapolated from the other two. If there is significant voltage imbalance, this reading may not be accurate within specification.

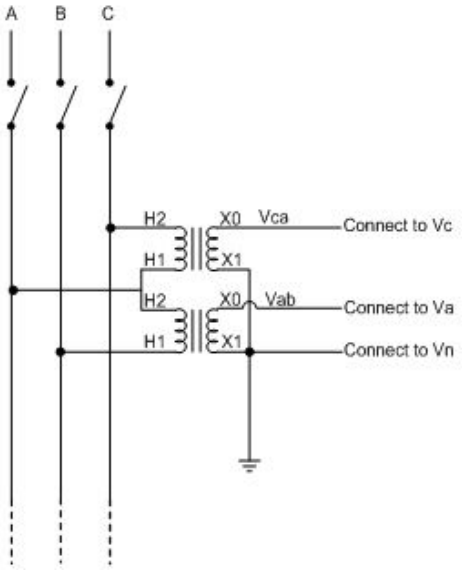

Figure 5-8: 2 PT Configuration (for K095 retrofit kit)

5.3.4 Backspin Module

The Backspin Module (100840441) is installed in the high-voltage compartment of a Switchboard. The three high voltage inputs cables are connected to the motor leads, and the ground line is connected to the 'star-point' transformer, switchboard or system ground.

The Backspin Module is connected to the Switchboard Card via the Backspin Cable. The Backspin Cable is available in lengths of 2.5 m, 4 m and 8 m. The cable is NOT reversible. The end that connects to the Backspin Module is labelled “BSM”, and the end that connects to the Switchboard Card (which has the cable shielding connection) is labelled “SWB”. Connector pins 10 to 21 of the Switchboard card are for the Backspin Module connection.

Note

The new Backspin Module completely replaces the A095 Backspin Shunt. The A095 is not compatible with the Instruct. There is only one model of the new Backspin Module - it covers the entire 400V-5000V range.

For UniConn Compatibility use, the voltage range is 800V – 5000V

Caution

Potential Severity: Light
Potential Loss: Assets, Personnel
Hazard Category: Electrical

The 3 pin black connector is for UniConn compatibility use. The output signals (BS-A, BS-B & BS-C) are hazardous voltage (40VAC) circuit and are not used in this actual Instruct Switchboard application. J2 connector removable part shall always be fully inserted before use, in order to prevent access to hazardous voltage circuit.

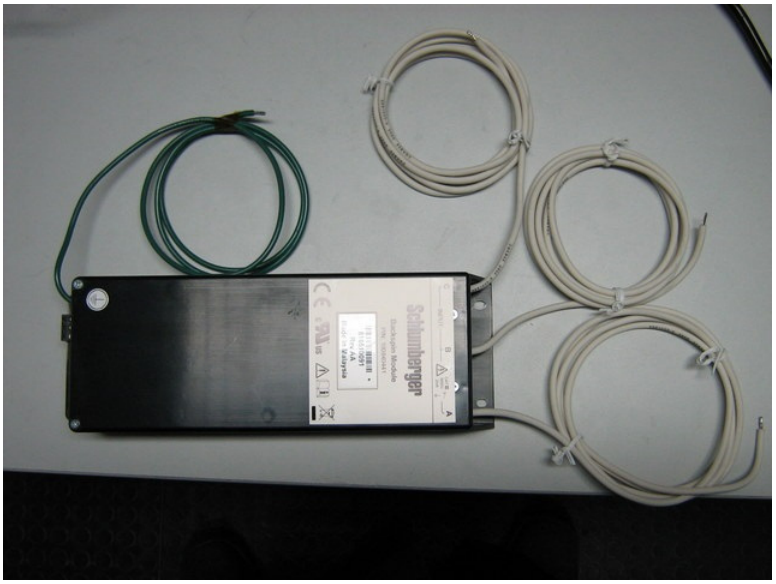

Figure 5-9: Backspin Module

Figure 5-10: Backspin Cable

5.4 Controller Connections

5.4.1 Protective Earth and Power Connections

The controller must have its protective earth terminal connected to the cabinet earth terminal. The protective earth terminal is marked on the chassis, located on the left side of the unit.

The controller is typically installed in a drive enclosure and the protective earth terminal must be securely connected to a terminal block that is solidly connected to the system earth ground. Proper connection from the controller protective

earth terminal to system earth ground must be using 14 AWG green/yellow wire terminated with a #8 ring lug. The provided pressure ring washer (lock washer) must be installed along with the 6-32 machine screw to secure the ring lug to the protective earth terminal.

Connection of the controller to the supply source (power) is made to the power supply input on the bottom of the controller. If the controller is supplied with AC voltage (the typical scenario for VSD applications), the supply is connected to the AC inputs. For SpeedStar S7 VSDs, the AC supply is labeled Control Voltage; if required, consult the SpeedStar S7 VSD three-line diagram for details. For special applications where the controller is supplied with DC voltage, the supply is connected to the DC inputs.

Caution
Potential Severity: Light
Potential Loss: Assets
Hazard Category: Electrical

The controller cannot be supplied with both AC and DC supply voltage simultaneously. The input connections are labeled on the controller.

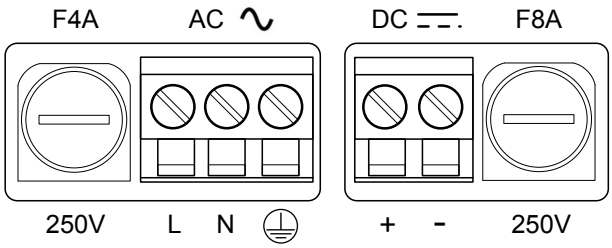

Figure 5-11: Power Supply Inputs

Wiring to the power supply input terminal blocks must be made using 14-18 AWG stranded wire. A means of disconnecting the controller from the supply must be provided. In a SpeedStar S7 VSD application, the supply source can be disconnected via MCCB1. Refer to Figure 5-12: SpeedStar S7 VSD Three-line Diagram for details. If the controller is being installed in a special or standalone application, a switch or circuit breaker must be included in the installation and it must be easily accessed and marked as a disconnecting device.

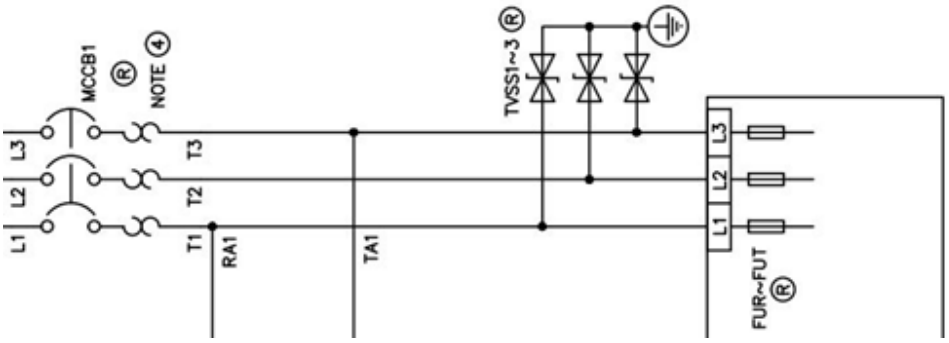

Figure 5-12: SpeedStar S7 VSD Three-line Diagram

5.4.2 Analog Signal Connections

Special consideration is needed when using the analog input and output connections (pins 10 to 17 and 25 to 27) on the I/O card to interface with other equipment at the wellsite.

- Analog inputs are differential.
- Analog outputs must use the Analog Common (pin 27).
- Interface cables typically use a shield and must be grounded.

Note

When shielded cables are used the shield must be grounded at one point only. For Analog Inputs, this point is close to the source device. For Analog Outputs, this point is Analog GND (pin 27).

5.4.2.1 Electrical Noise and Shields

Electrical noise, either radiated or conducted as electromagnetic interference (EMI), can often cause issues retrieving data from sensors. The cable can either conduct noise to other equipment or act as an antenna radiating noise. It can also pick up EMI radiated from other sources. A twisted pair wire with a shield is used to protect against these sources.

The shield can reflect energy or conduct it to ground. Shields typically comes in two types, foil and braid. Foil shielding uses a thin layer of aluminum with a carrier such as polyester for added strength and ruggedness. This offers 100% coverage however difficult to terminate. A braid is a woven mesh of bare or tinned copper wires, providing a coverage typically 70-95% coverage of the signal cable depending on the tightness of the weaves. A braid allows for easier termination. Some cable manufacturers even offer a combination of both foil and braid.

Cable routing is another important aspect of reducing cross talk and interference. Placing signal cables next to power cables can allow power-line nose to couple onto the signal lines causing interference.

Ground loops are another potential cause of noise, in order to avoid creating ground loops only ground the signal cable at one end. The other end of the cable the shield is considered “floating” i.e. not tied to anything.

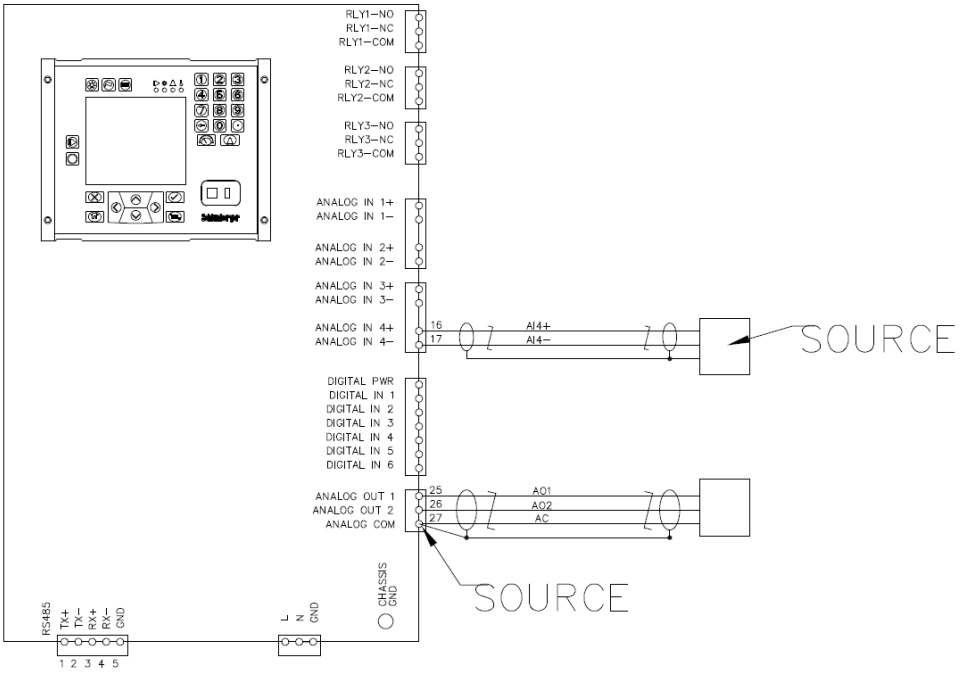

Figure 5-13: Analog In/Out Wiring

5.4.2.2 Analog Input

The controller employs full-differential inputs on the front end of the Analog Inputs. The negative input should not be connected to the controller earth ground when used with single-ended output devices. These devices should be grounded to earth at their location and their ground signal connected to the controller analog input negative terminal only. This will help to avoid ground loop currents that can potentially affect the operation of the equipment.

Note

For analog inputs the shield should be terminated at the source and left floating at the controller side. It’s advised that heat shrink is applied to the shield at the controller side in order not to be left exposed.

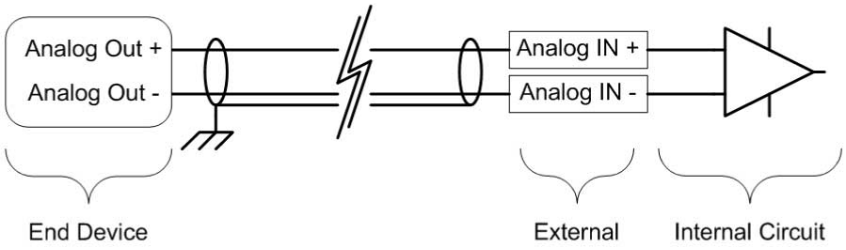

Figure 5-14: Differential inputs on differential devices

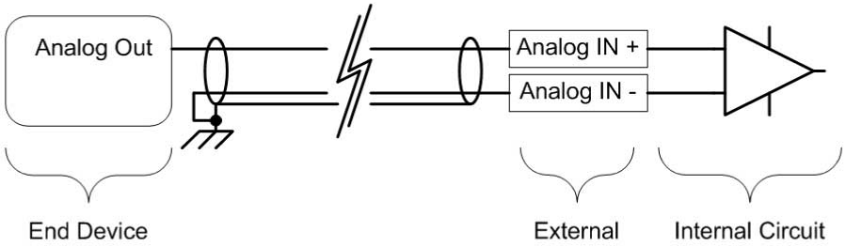

Figure 5-15: Differential inputs on single end device

5.4.2.3 Analog Output

The controller employs a single ended output for both Analog Outputs. The Analog Common (pin 27) must be used as the return path for both outputs. The shield must be connected to the Analog Common pin at the controller and be left floating at the device end. The shield must not be used as the return path.

Note

For analog outputs the shield should be terminated to the analog com of the controller and left floating at the receiving end. It is advised that heat shrink is applied to the shield at the receiving side in order for it not to be left exposed.

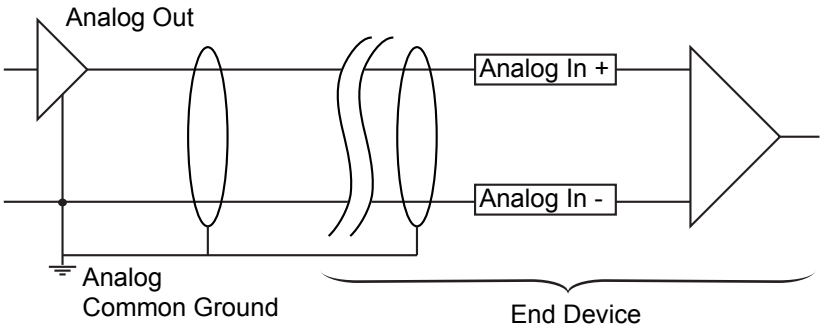

Figure 5-16: Analog Output

5.4.2.4 Surface Chokes

The shield should be terminated at the choke side to the ground and left floating at the controller side. It's advised that heat shrink is applied to the shield at the controller side in order not to be left exposed.

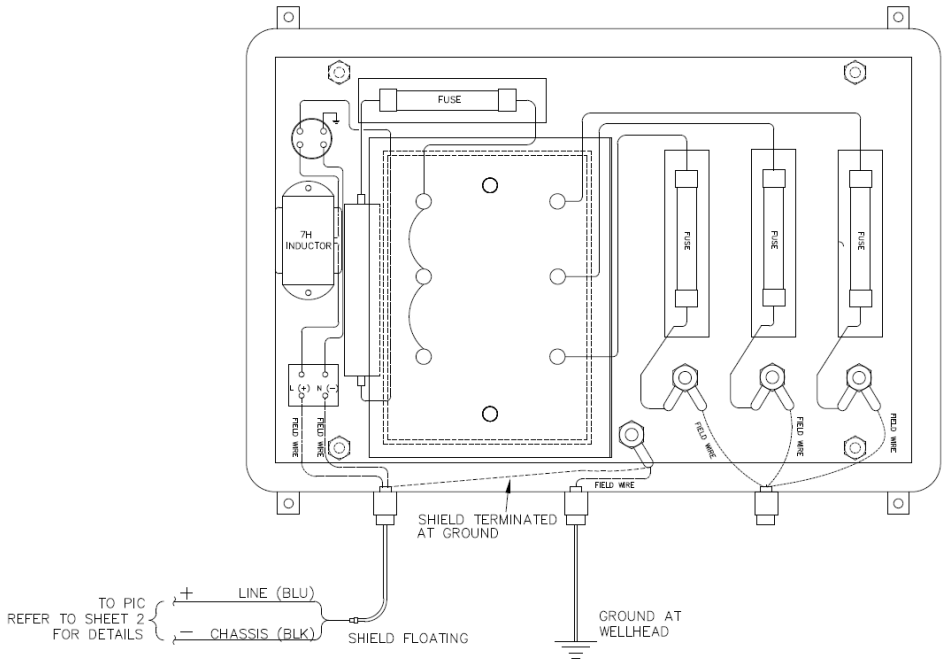

Figure 5-17: Choke to PICv2 Connection

5.4.2.5 Endurant Telemetry Filter

For the Endurant Telemetry Filter, there are two signal cables:

- One shield should be terminated at the choke side to the ground and left floating at the controller side.
- Another shield should be terminated at the Telemetry Filter side to the ground post and left floating at the controller side. It is advised that heat shrink is applied to the shield at the controller side in order not to be left exposed.

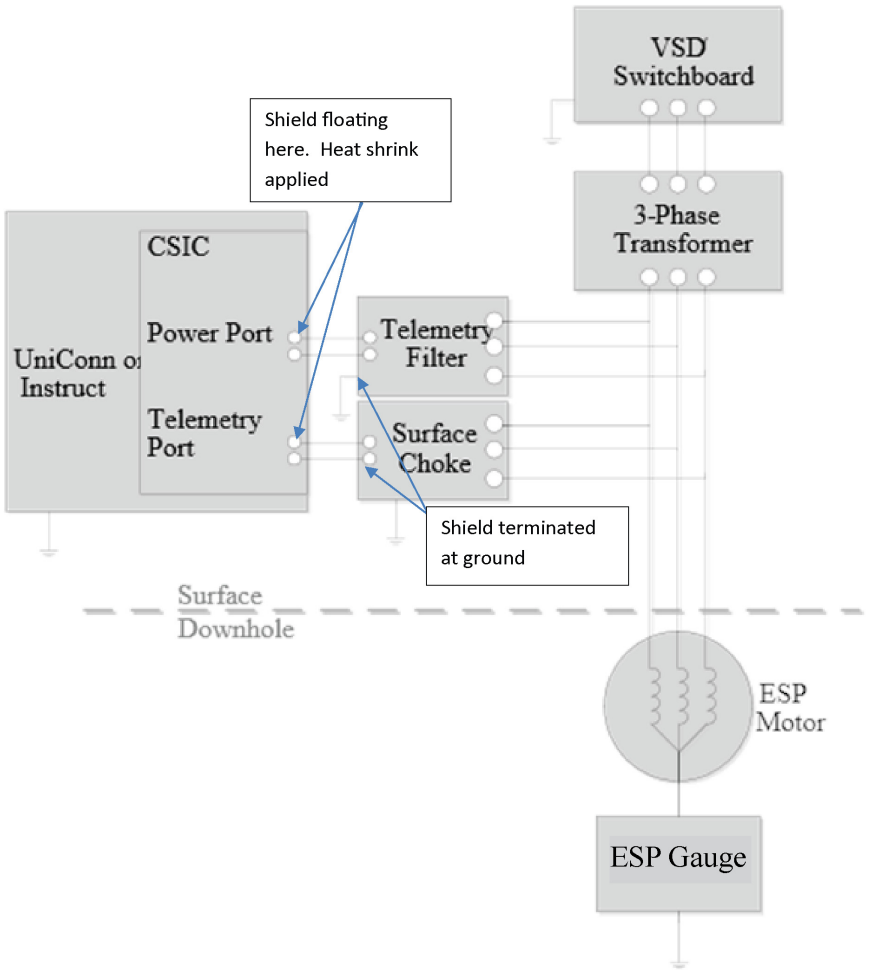

Figure 5-18: Telemetry Filter, Choke and Interface Card Connection

5.4.3 Digital Signal Connections

5.4.3.1 Digital Input

The digital inputs operate with external dry contacts using the controller's digital power to drive the logic. A shielded cable must be grounded at one point either near the end device or on the controller's system ground.

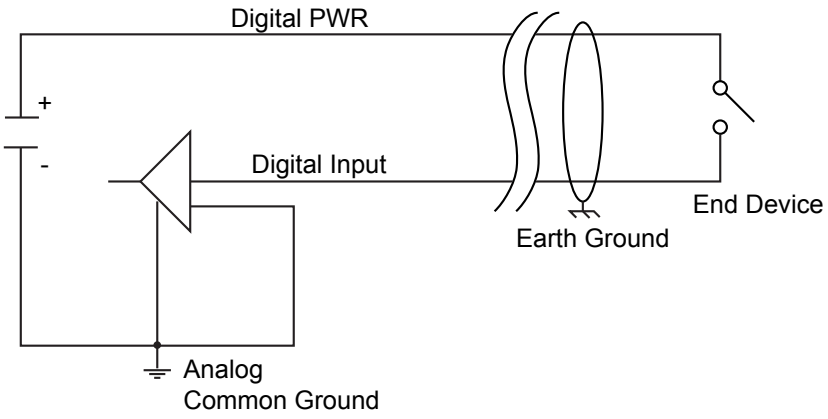

Figure 5-19: Digital Input

5.4.3.2 Digital Input HOA

The following is an example of a wiring connection for digital input Hand, Off, Auto connection.

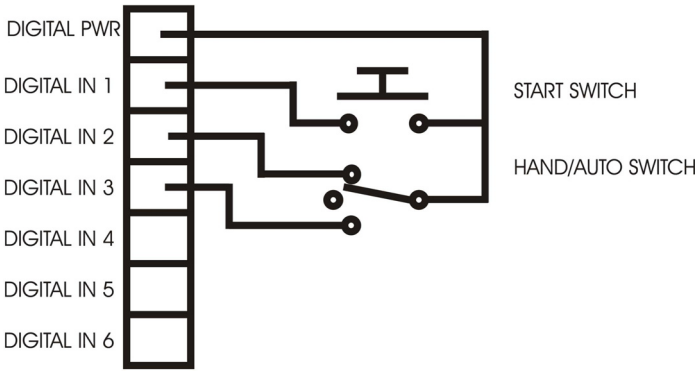

Figure 5-20: Digital Input HOA Wiring Connection

5.4.4 Control Card RS-485 Wiring Connection

The control card has two external communication interfaces: RS-232 and RS-485. The RS-485 port is implemented in a 4-wire configuration and uses a terminal block connector. The RS-485 port is primarily intended for connections to VSDs or SCADA systems.

Note

This control card port has no "terminator resistor". If a termination is needed, it must be added externally.

Table 5-7: Control Card Pin Assignment

PIN Number (top to bottom)	PIN NAME	FUNCTION
1	TX+	RS-485 Transmit Positive
2	TX-	RS-485 Transmit Negative
3	RX-	RS-485 Receive Negative
4	RX+	RS-485 Receive Positive
5	GND	Isolated Signal Ground (Connect the cable shield to this pin at the controller end only).

5.5 Controller Compatibility

This following is a list of the minimum firmware versions required for proper operation of the controller.

Table 5-8: Firmware Compatibility

Device	Required Firmware Version					
	S7 VSD	**S3 VSD** [1]	**AS1/AS3 VSD**	**Switchboard**	**MVD/MV2** [1]	**ACS880/PMM** [1]
Instruct	2.100r027 or later	2.105r012 or later	V2.109r006 or later	V2.105r012 or later	2.105r012 or later	2.117r003 or later
PICv2	1.30					
Extreme	1.382					
S7 VSD	R16					
Multi-PIC [1]	2.106r012 or later					

[1] Currently under field trial.

5.6 Expansion Card Installation

Caution
Potential Severity: Light
Potential Loss: Assets
Hazard Category: Electrical

The expansion cards are not “hot-swappable”. Power to the controller must be turned off prior to insertion of the card into an expansion card slot.

Expansion cards are installed in the controller by removing the cover plate on one of the card slots and sliding the card firmly into the slot. The card should slide freely along the guides and be seated so that the faceplate is flush with the controller enclosure. The card thumbscrews should be tightened to hold the card in place, but should not be used to seat the card.

Expansion card wiring should be performed in accordance with the specific requirements of that card.

5.6.1 Comm Card Installation

For detailed installation procedures refer to the Comm Card manual (InTouch ID 6238940).

Caution

Potential Severity: Light
Potential Loss: Assets
Hazard Category: Electrical

The card is not “hot-swappable”. Power to the card must be turned off prior to insertion of the card into an expansion card slot.

---

1. Turn off the power to the controller or acquisition system.
2. Remove the cover plate or existing card from the expansion slot, if applicable.
3. Insert the card in the slot make sure the faceplate labels appear right side up. Rails inside the expansion card chassis ensure that the card connector will line up and mate with the socket.

   Caution

   Potential Severity: Light
   Potential Loss: Assets
   Hazard Category: Machinery equipment hand tools

   The card should never be forcefully pushed in. If an alignment issue does not allow the card to properly mate the card should be retracted and slowly pushed into the socket.

   ---

4. Tighten the thumbscrews to ensure a good connection to the socket. Alternate tightening of the thumbscrews to ensure a flush fit.

Note: For Comm Card (100228568) without Dip Switches.
The RX- and RX+ inputs are differentially terminated internally with a 220-ohm load. DO NOT terminate this line externally. Remove any termination resistor that may be present on the communications cable.

5. Front plate connection.
   - The top terminal block receptacle is specifically for RS-232 functionality.
   - The bottom terminal block receptacle is specifically for RS-485 functionality.

Caution
Potential Severity: Light
Potential Loss: Information
Hazard Category: Electrical

The RS-232 and RS-485 ports cannot be used simultaneously on a single communication card. Doing so will corrupt data.

To remove the card from the system:

1. Turn off the power to the controller or acquisition system.
2. Unscrew the thumbscrews.
3. Slowly pull on both thumbscrews simultaneously until the card is freed from the socket connection.

5.6.1.1 Wiring Connections RS-232

Table 5-9 shows the Communication Card connector assignments for the RS-232 interface. The fourth column represents an example of pin assignment for DE9 receptacle. Figure 5-21 shows the wiring connections.

Table 5-9: Communicaiton Card RS-232 Connector Pin Assignment

PIN Number (top to bottom)	PIN NAME	FUNCTION	DE9 receptacle female
1	RTS	Request to Send	7
2	TXD	RS-232 Transmit Data	2
3	DCD	Data Carrier Detect	8
4	RXD	RS-232 Receive Data	3

PIN Number (top to bottom)	PIN NAME	FUNCTION	DE9 receptacle female
5	GND	Isolated Signal Ground (do not use to ground the shield, as this will introduce noise).	5

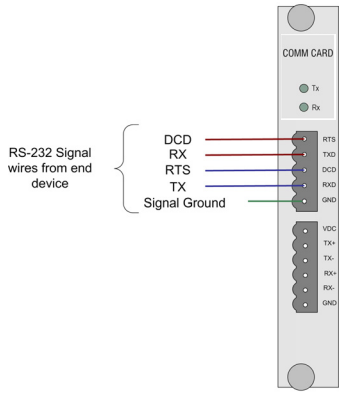

Figure 5-21: Communication Card and RS-232

Note

The transmit signals from the end device connect to the receive pins on the Communication Card.

5.6.1.2 Wiring Connection RS-485

Table 5-10: Communication Card RS-485 Pin Assignment shows the Communication Card connector assignments for the RS-485 interface.

Table 5-10: Communication Card RS-485 Pin Assignment

PIN Number (top to bottom)	PIN NAME	FUNCTION
1 [1]	VDC	Isolated DC supply voltage (normally not connected)
2	TX+	RS-485 Transmit Positive
3	TX-	RS-485 Transmit Negative
4	RX+	RS-485 Receive Positive
5	RX-	RS-485 Receive Negative
6	GND	Isolated Signal Ground (do not use to ground the shield, as this will introduce noise).

[1] This pin is not connected for 4th generation cards.

The 4th Generation Communication Card (101120028) has DIP switches which allow for the configuration for most use cases. Table 5-11: Hardware settings for the Communication Card lists the 8 DIP switches which are available to be configured on the Communication Card and offers an explanation on the function of each switch. The Communication Card ships with the RX termination resistor on (switche 1 off and 2 turned on), 4–wire mode on (switches 3 and 4 turned off), and RX bias resistors on (switches 5 and 6 on, switches 7 and 8 turned off). The configuration of the card will need to be decided and changed based upon installation conditions.

Table 5-11: Hardware settings for the Communication Card

DIP Switch	Default Setting	Switch Off	Switch On
1	Off	No Tx Term. No resistive termination on differential transmit pair.	Tx Term. 220 Ohm terminates differential transmit pair.
2	On	No Rx Term. No resistive termination on differential receive pair.	Rx Term. 220 Ohm terminates differential receive pair.
3	Off	4 Wire. No short circuit.	2 Wire. Short circuit between Tx- and Rx- pair.
4	Off	4 Wire. No short circuit.	2 Wire. Short circuit between Tx+ and Rx+ pair.
5	On	No Rx bias. No pull-up resistor.	Rx bias. 4.75kohm pull-up resistor on Rx+ to 5V.
6	On	No Rx bias. No pull-down resistor.	Rx bias. 4.75kohm pull-down resistor on Rx- to signal ground.
7	Off	No Tx bias. No pull-up resistor.	Tx bias. 4.75kohm pull-up resistor on Tx+ to 5V.
8	Off	No Tx bias. No pull-down resistor.	Tx bias. 4.75kohm pull-down resistor on Tx- to signal ground.

RS-485 can be operated in two modes, 2-wire or 4-wire. To use the two-wire mode, ensure that the termination resistors on switches 3 and 4 are turned on and connect the RS-485 cable as shown in Figure 5-22: Communication Card and 2-Wire RS-485.

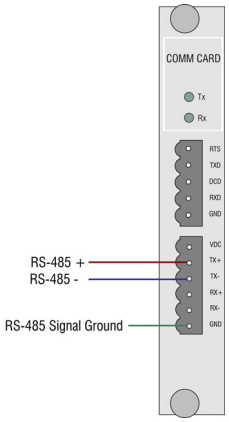

Figure 5-22: Communication Card and 2-Wire RS-485

To use 4-wire mode ensure that the termination resistors on switches 3 and 4 are turned off and connect the RS-485 cable as shown in Figure 5-23: Communication Card and 4-Wire RS-485. The RS-485 4–wire connection can be used for interfacing to RS-422 networks as well.

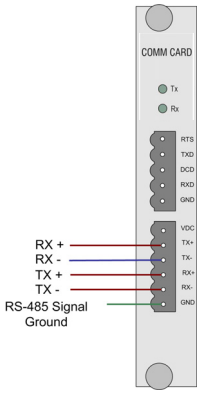

Figure 5-23: Communication Card and 4-Wire RS-485

The RS-485 network topology requires a daisy chained serial style connection between nodes. Ensure that the differential receive pair of the last Communication Card node in the chain is terminated and that all other cards are not terminated. In other words, switch 2 should be turned on for the last Communication Card in the daisy chain and turned off for all other Communication Cards.

Hint

Do not follow a star and hub network topology. This topology is not supported by RS-485 standards and will lead to reflection issues resulting in poor communication performance.

Biasing should be turned on only as required by the installation in order to force all nodes into listen mode. In electrically noisy environments or with long cable runs, biasing may be required.

5.6.1.3 Recommended Cabling

RS-485 is recommended for most SCADA applications, as well as connecting to a Site Communication Box (SCB), since it provides greater noise immunity and supports longer cable distances than RS-232. For RS-485 applications, shielded twisted pair cable is recommended.

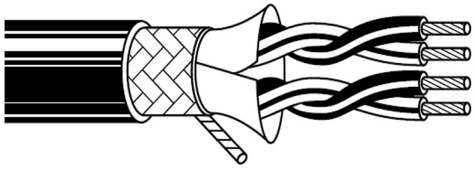

Figure 5-24: Shielded Twisted Pair Cable

For maximum effectiveness, the shield on the shielded twisted pair cable should be connected to earth ground at one end only. Do not confuse earth ground with signal ground. Connecting the shield to the RS-485 or RS-232 signal ground may introduce noise into the communication card.

Note
The system must be earth grounded in order to meet CE requirements.

5.6.2 Modbus® TCP/IP Card Installation

5.6.2.1 Install the Modbus TCP/IP Card

Caution
Potential Severity: Light
Potential Loss: Assets
Hazard Category: Electrical

The card is not “hot-swappable”. Power to the card must be turned off prior to insertion of the card into an expansion card slot. Failure to do so could result in equipment damage to either the card or the controller.

1. Turn off the power to the controller or acquisition system.
2. Remove the cover plate or existing card from the expansion slot, if applicable.

3. Insert the card in the slot make sure the faceplate labels appear right side up. Rails inside the expansion card chassis ensure that the card connector will line up and mate with the socket.

Caution

Potential Severity: Light
Potential Loss: Assets
Hazard Category: Machinery equipment hand tools

The card should never be forcefully pushed in. If an alignment issue does not allow the card to properly mate the card should be retracted and slowly pushed into the socket.

---

4. Tighten the thumbscrews to ensure a good connection to the socket. Alternate tightening of the thumbscrews to ensure a flush fit.
5. Front plate connection.
   - The 8P8C modular connector (“RJ45”) connection on the front plate can be connected to a network hub, switch, or router using a standard Ethernet cable.
   - For connection to the Engineering Port, a standard male to female RS-232 serial cable is required.

To remove the card from the system:

1. Turn off the power to the controller or acquisition system.
2. Unscrew the thumbscrews.
3. Slowly pull on both thumbscrews simultaneously until the card is freed from the socket connection.

5.6.2.2 Wiring Connection

The card has two connections on the front plate:

- RJ45 connection (standard Ethernet connection): Used to connect to TCP/IP networks. The end device must be capable of decoding Modbus.
- Engineering Port (standard RS-232): Used to configure the Ethernet interface IP address.

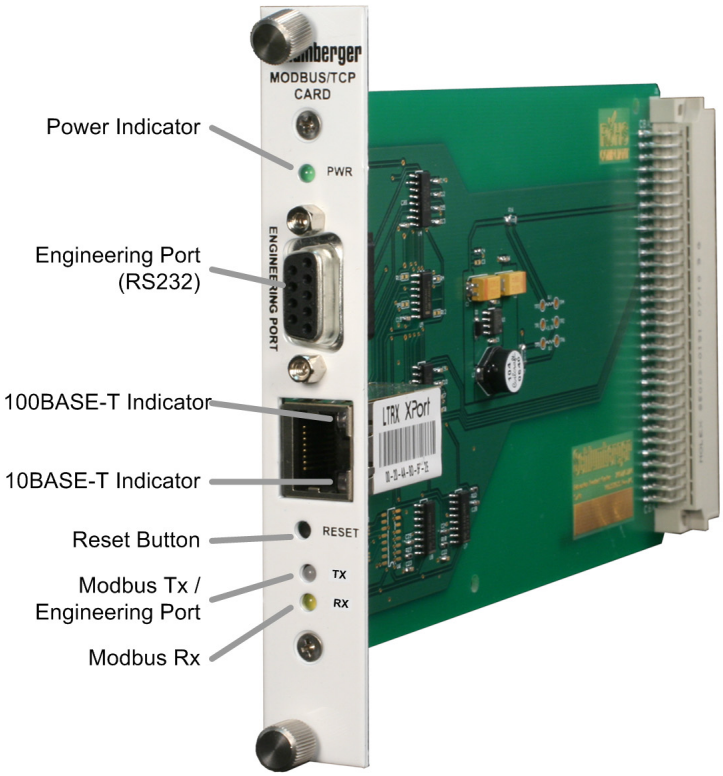

Figure 5-25: Modbus TCP/IP Card

Note

These connections cannot be used simultaneously. The Modbus data interface on the host system must be disabled prior to using the Engineering port.

5.6.3 Phoenix Interface Card Installation

This section describes how to install and the Phoenix Interface Card (PIC).

5.6.3.1 Install the PIC

Caution
Potential Severity: Light
Potential Loss: Assets
Hazard Category: Electrical

The Phoenix Interface Card (PIC) is not “hot-swappable”. Power must be turned off prior to insertion of the card into an expansion card slot.

To install the PIC in the card slot:

1. Turn off the power to the controller or acquisition system.
2. Remove the cover plate or existing card from the expansion slot, if applicable.
3. Insert the card in the slot make sure the faceplate labels appear right side up. Rails inside the expansion card chassis ensure that the card connector will line up and mate with the socket.

Caution
Potential Severity: Light
Potential Loss: Assets
Hazard Category: Machinery equipment hand tools

The card should never be forcefully pushed in. If an alignment issue does not allow the card to properly mate the card should be retracted and slowly pushed into the socket.

4. Tighten the thumbscrews to ensure a good connection to the socket. It is normal for the card to be tightly fit when installed.
5. Connect the downhole tool wires from surface choke.

Table 5-12: Downhole Tool Connection Terminals

Pin	Pin Name	Description
C	DH CHASSIS	Downhole Tool power return connection. This connection is made via terminal blocks to the TB1-2 terminal of the Phoenix three-phase choke console/plate.
L	DH LINE	Downhole Tool power connection. This connection is made via terminal blocks to the TB1-1 terminal of the Phoenix three-phase choke console/plate.

To remove the card from the system:

1. Turn off the power to the controller or acquisition system.

2. Disconnect downhole tool wires, if applicable.
3. Unscrew the thumbscrews.
4. Slowly pull on both thumbscrews simultaneously until the card is freed from the socket connection.

5.6.4 Install the Extreme Card

Caution
Potential Severity: Light
Potential Loss: Assets
Hazard Category: Electrical

The Extreme Card is not “hot-swappable.” Power to the system must be turned off prior to insertion of the card into an expansion card slot.

To install the card in the expansion slot:

1. Turn off the power to the controller or acquisition system.
2. Remove the cover plate or existing card from the expansion slot, if applicable.
3. Insert the card in the slot make sure the faceplate labels appear right side up. Rails inside the expansion card chassis ensure that the card connector will line up and mate with the socket.

Caution
Potential Severity: Light
Potential Loss: Assets
Hazard Category: Machinery equipment hand tools

The card should never be forcefully pushed in. If an alignment issue does not allow the card to properly mate the card should be retracted and slowly pushed into the socket.

4. Tighten the thumbscrews to ensure a good connection to the socket. It is normal for the card to be tight when installed.

To remove the card from the system:

1. Turn off the power to the controller or acquisition system.
2. Unscrew the thumbscrews.
3. Slowly pull on both thumbscrews simultaneously until the card is freed from the socket connection.

5.7 USB Serial Driver Installation

The following procedure describes how to install the Instruct USB-Serial driver required to communicate with the controller and StarView on a Windows machine (PC).

Caution
Potential Severity: Light
Potential Loss: Assets, Reputation
Hazard Category: Electrical

Do not connect the USB cable to the Instruct controller before it fully boots up. Otherwise, the controller may not be able to boot up successfully.
This is applicable to the installation of USB Serial Driver and connection to the controller using StarView.

1. Power up the controller.
2. Using a USB 2.0 A-Male to B-Male, connect the PC to the controller port.

Note
After a few seconds, “Device driver software was not successfully installed” will be displayed.

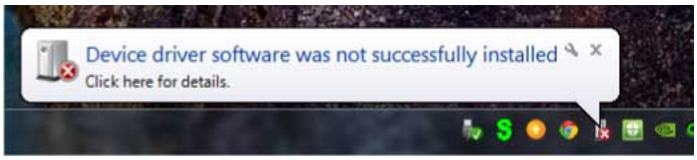

Figure 5-26: Device Driver

3. Open the Device Manager, right click on My Computer and select Properties.

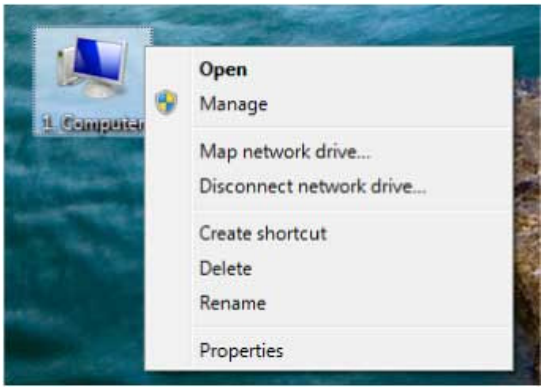

Figure 5-27: Go to My Computer

4. In the Device Manager under Other Devices, right click on “CDC Serial” and select Update Driver Software.

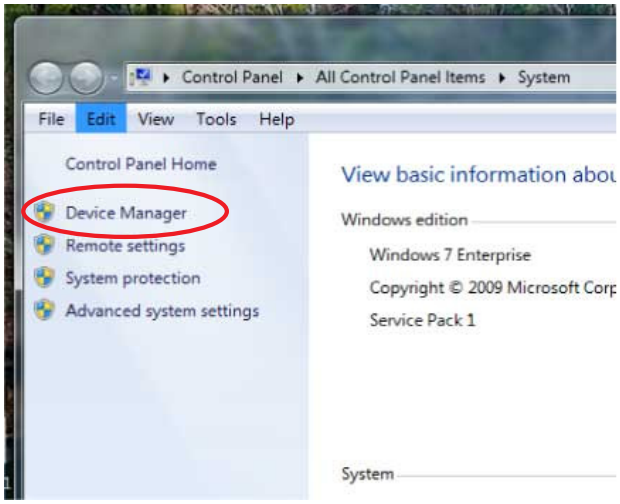

Figure 5-28: Go to Device Manager

5. Click on “Browse my computer for driver software.”

Note

The controller should be recognized as a USB mass-storage device under “My Computer”. In the following figure the computer assigned the controller to disk “F.”

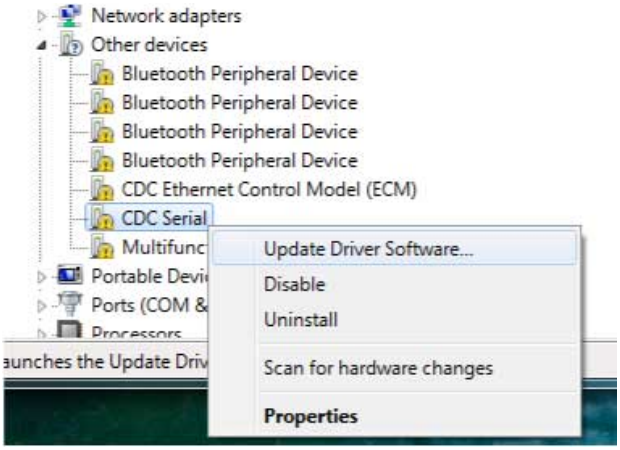

Figure 5-29: Update Driver Software

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6. Select the appropriate disk to install the driver on the controller.

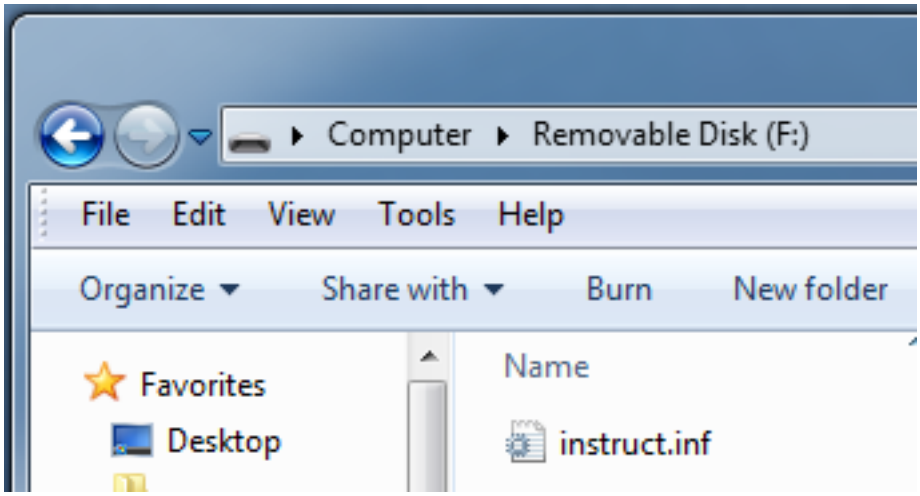

Figure 5-30: Select Appropriate Disk

Note

Windows will not be able to verify the publisher.

7. Select “Install this driver software anyway.”

Figure 5-31: Install Driver Software

8. Upon successful driver installation, in the Device Manager, a Gadget Serial (COMx) device will appear under the “Ports (COM & LPT)” section.

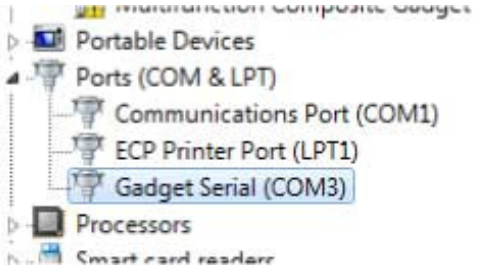

Figure 5-32: Gadget Serial (COMx)

9. Record the COM number before exiting the Device Manager.
10. If required, open StarView and use the COM number to configure a connection.

Note
Windows will request a new installation of the Instruct Serial Driver if using a new USB port on the same computer.

5.8 Upgrading the Controller Embedded Software (Firmware)

5.8.1 Updating the firmware with USB flash drive

1. Download the latest Instruct Embedded Software Image (firmware) from InTouch Content ID 6145281.

2. Copy the .fw file onto a FAT32–formatted removable USB drive.

Note

The file cannot renamed or it will not be recognized by the controller.

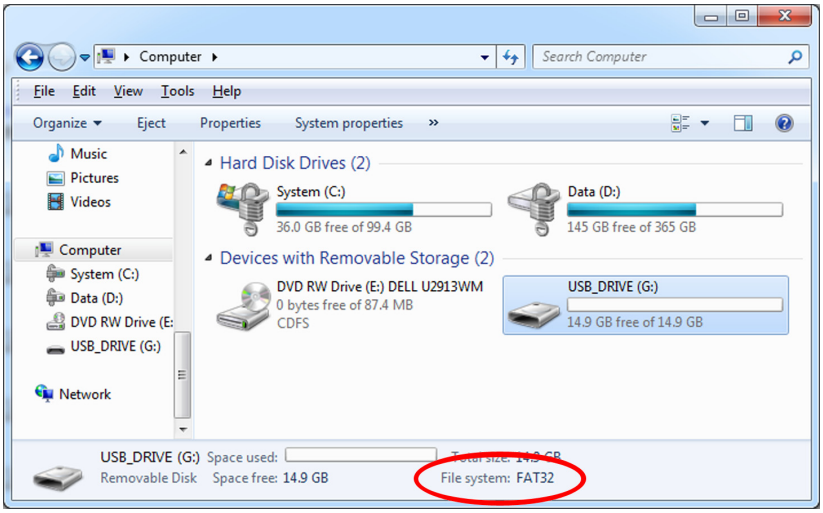

Figure 5-33: Removable USB Drive with FAT32 File System

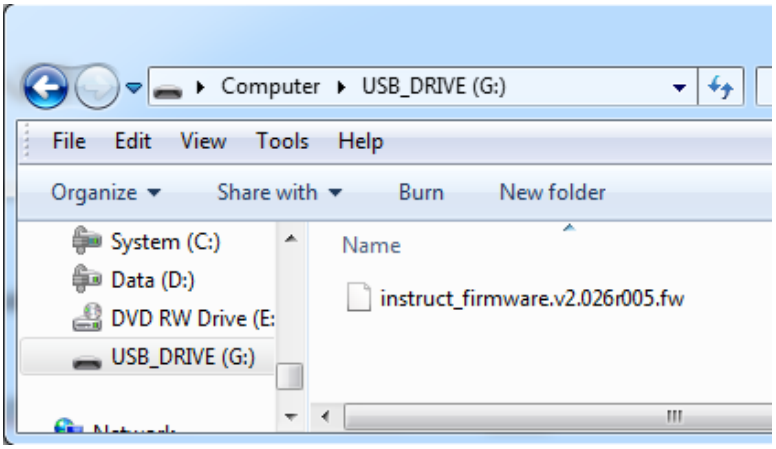

Figure 5-34: Instruct Firmware on Removable USB Drive

3. After the file has been copied to the removable USB drive, safely remove the USB drive.

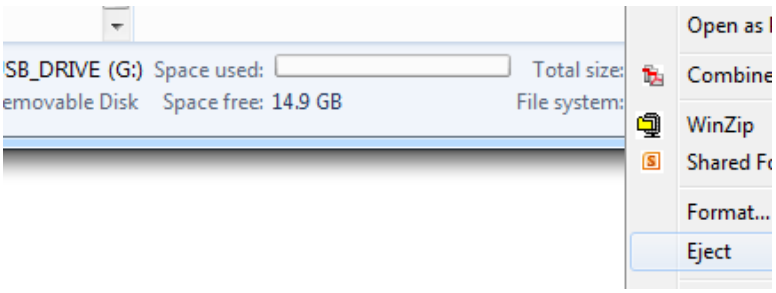

Figure 5-35: Safely Ejecting a Removable USB Drive

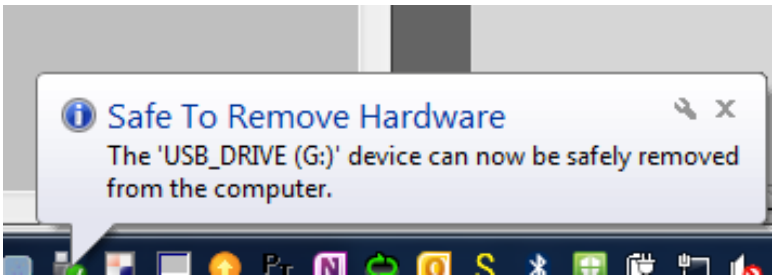

Figure 5-36: Confirmation that the Removable USB Drive May Be Safely Removed

4. Insert the removable USB Drive into the Instruct Controller.
5. Navigate to **Controller > Expert/Updates**.
6. Check the existing firmware version number. If it is below 2.103, you will need to prepare trending after the upgrade.
7. After a few seconds the controller will display the latest available firmware on the USB drive.
8. Decide if the firmware upgrade should be applied on next power cycle (default, no selection needed), or immediately after the file transfer progress has completed (check the box with “reboot after image has updated”).
9. Once the selection has been made, select the “Update to USB Image” button. This process will take approximately 18 minutes. The Instruct will continue to protect a running drive during the firmware loading process and will only reboot and trip the drive if the “reboot after image has updated” option has been selected.
10. Once the upgrade is complete and the controller has been rebooted the new firmware version may be verified from the **Controller > Settings** screen.
11. If you have upgraded from a version lower than 2.103, you will need to prepare trends. This copies trend files from the old trend system and prepares the controller for the new trend system. Open StarView (version 5.2.62.r1972 or higher) and navigate to **Utilities -> Prepare Trending**.

12. Download the trend data by clicking “Read From Instruct.” Save the file on your computer.
13. Open the downloaded file by clicking “Open in Viewer” and check that the trend data is available.

5.8.2 Updating the firmware with StarView

1. Ensure that you have the latest version of the StarView v5 Tool Kit installed. This can be found on InTouch Content 6031798. The earliest version that supports Instruct firmware upgrades is 5.2.181.2135.
2. With the Instruct controller fully booted (gauges visible on the Home screen), insert the USB A-B cable between your computer and the Instruct. Do not insert the USB cable before the controller is fully booted.
3. Open StarView v5 and connect to the controller. See the Quick Start Help in the Help menu of StarView v5 if you are not familiar with this process.
4. If this is the first time connecting an Instruct to the computer for firmware upgrades or downloading trends, you will need to configure the network. Under the Utilities menu, select Instruct – Download Trends. A window will appear for downloading data from the Instruct. Select **Utilities -> Configure Instruct Network**. When it is complete, you can close this window.

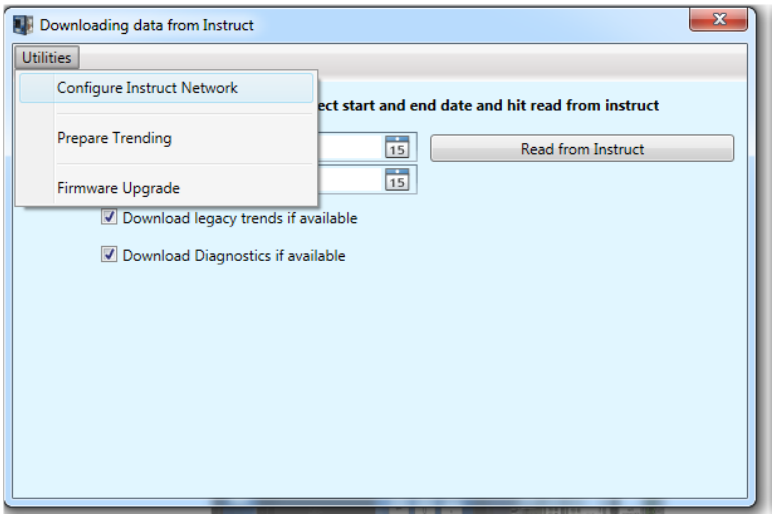

Figure 5-37: Configuring the Instruct Network

5. Click on the Configuration menu on the left-hand side of the screen and then click Controller. Check the existing firmware version number. If it is below 2.103, you will need to prepare trending after the upgrade. On the right-hand side of the screen, you will see Upgrade Firmware under the Special Features panel.

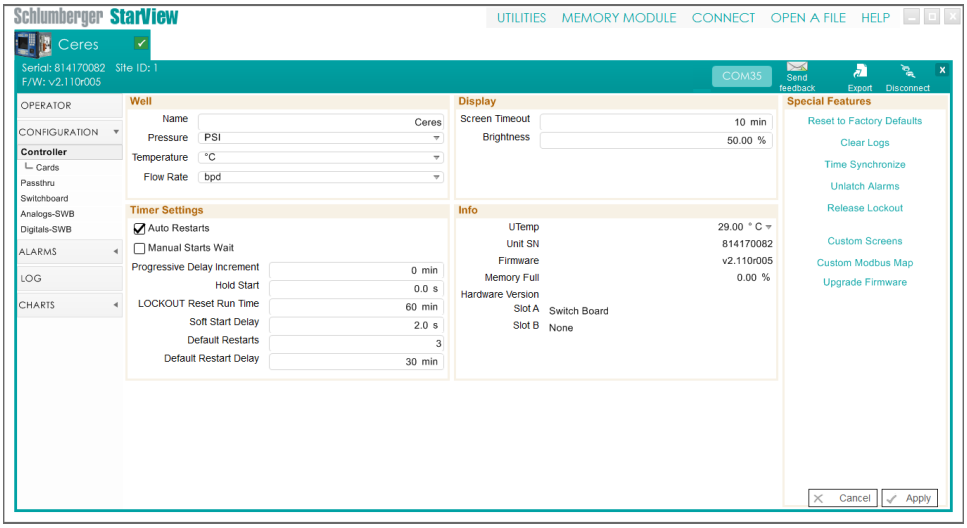

Figure 5-38: Configuration -> Controller Screen

6. Click on Select FW file. Choose the firmware file that you wish to apply to the Instruct Controller.

7. Click Start FW Upload. The status of the upgrade is shown with the latest message at the top of the window.

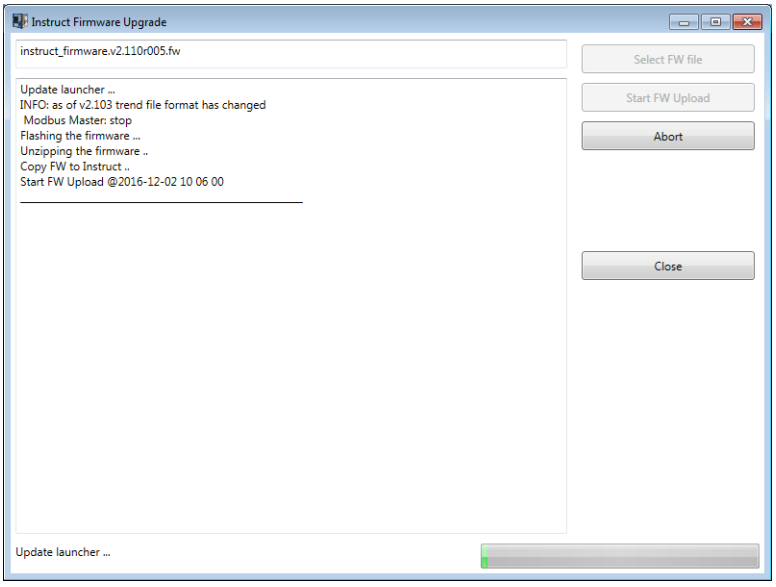

Figure 5-39: Firmware update in progress

8. The upload takes about 18 minutes. If you wish to abort the upgrade, click the Abort button.

9. Once finished, a pop-up window will appear indicating that the firmware upload is complete. Remove the USB cable from the Instruct and reboot the controller to apply the update.
10. If you have upgraded from a version lower than 2.103, you will need to prepare trends. This copies trend files from the old trend system and prepares the controller for the new trend system. Open StarView (version 5.2.62.r1972 or higher) and navigate to Utilities -> Prepare Trending.
11. Download the trend data by clicking “Read From Instruct.” Save the file on your computer.
12. Open the downloaded file by clicking “Open in Viewer” and check that the trend data is available.

Configuration

6 Configuration

This section contains configuration information and instructions for the controller systems, using the controller interface. For configuration instructions using a PC refer, to the StarView User Guide. StarView is the software program used to interface the PC with the controller for configuration and diagnostics. This section assumes that the controller, expansion card(s), and latest firmware have been installed.

Tip

The menu dropdown can be navigated using either the numerical keypad or the navigation keys.

Caution

Potential Severity: Light
Potential Loss: Assets, Reputation
Hazard Category: Electrical

Do not connect the USB cable to the Instruct controller before it fully boots up. Otherwise, the controller may not be able to boot up successfully.

6.1 Controller Settings

The controller settings screen displays the well settings, display settings, rating of unit, serial number, firmware version, hardware version, memory usage, etc.

To navigate to the controller settings screen using the controller:

1. Press the **Home** button on the keypad.
2. Press the **Menu** button on the keypad to bring up the top-level menu.

3. Select the **Controller** menu item, using either the numeric keypad or the up/down/left/right navigation keys on the keypad.

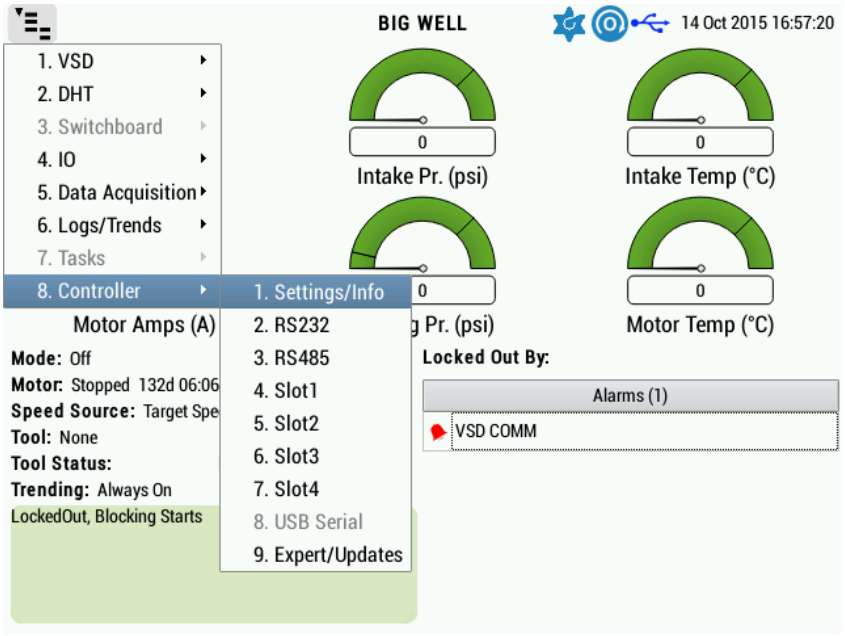

Figure 6-1: Controller Menu Tree

4. Select the **Settings** menu item.
5. Select the parameter using navigation keys. Press the **Enter** (✓) button to confirm selection.
6. Enter the parameter value. Press the **Enter** (✓) button to confirm value.

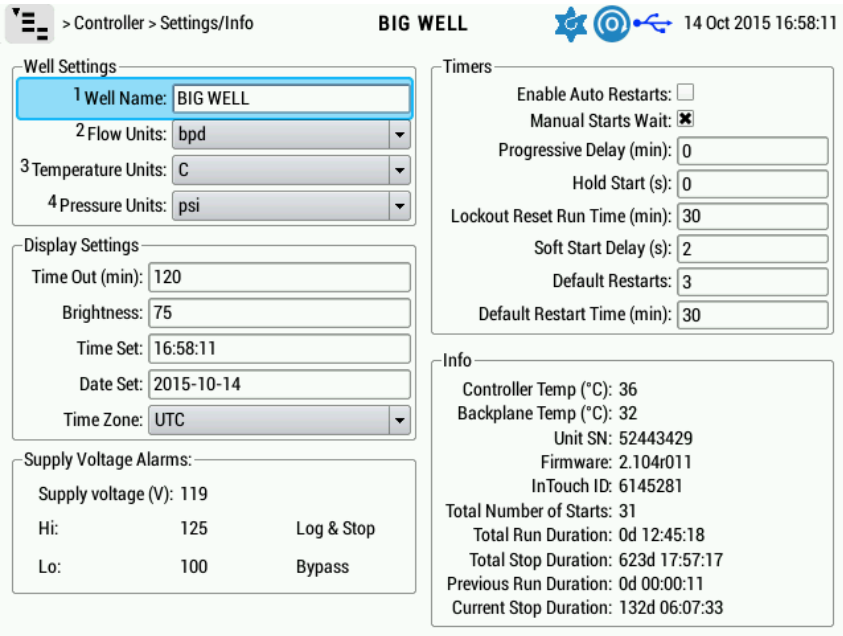

Figure 6-2: Controller Settings Screen

7. Repeat step 5 to 6 for each required parameter.

The following are some of the settings that can be configured in the controller settings menu:

- Automatic start
- Well Settings (Well name, Flow Units, Temperature Units, and Pressure Units)
- Display related settings
- Enable/Disable Auto Restarts
- Enable/Disable Manual Starts Wait
- Progressive Delay
- Hold Start
- Lockout Restart (Reset Run Time)
- Soft Start Delay
- Default Restarts

6.2 Automatic Start

Automatic start is a controller function that will permit a start after the processing of a trip or alarm condition.

These parameters can be configured using the controller keypad or StarView.

To configure the auto restart settings:

1. Press the **Home** button on the keypad.
2. Press the **Menu** button on the keypad to bring up the top-level menu.
3. Select the **Controller** menu item, using either the numeric keypad or the up/down/left/right navigation keys on the keypad.

4. Select the **Settings** menu item.

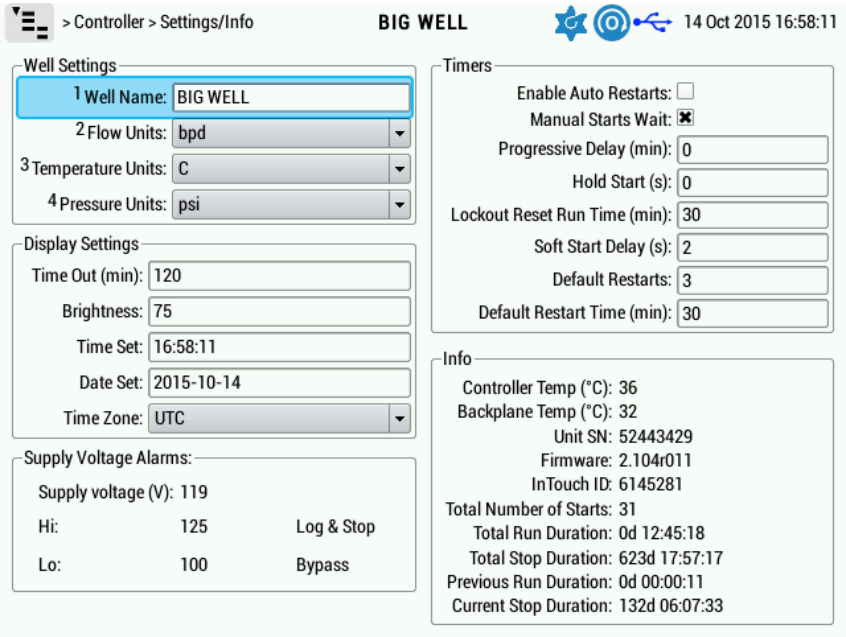

Figure 6-3: Controller Settings Screen

5. Select **Enable Auto Restarts**. Select the parameter using navigation keys. Press the **Enter** (✓) button to confirm selection.
6. Select the auto restart parameters using navigation keys. Press the **Enter** (✓) button to confirm selection.
7. Enter the auto restart parameters. Press the **Enter** (✓) button to confirm value.

Note

For the Soft-start delay, one of the I/O Card's digital relay outputs (RL1, RL2, or RL3) must be configured to use this feature. Refer to the Digital Output section for details.

6.3 Release Lockout

This function is currently unavailable.

6.4 Motor Amps

The controller displays motor load as a percent of rated motor current. This is on the motor name plate. To configure the motor rating:

1. Press the **Home** button on the keypad.

2. Press the **Menu** button on the keypad to bring up the top-level menu.
3. Select the **VSD** menu item, using either the numeric keypad or the up/down/left/right navigation keys on the keypad.
4. Select the **Configure** menu item.

Figure 6-4: VSD Menu Tree

5. Select the **Motor Rating** option using navigation keys. Press the **Enter** (✓) button to confirm selection.

6. Enter the name plate rating. Press the **Enter** (✓) button to confirm value.

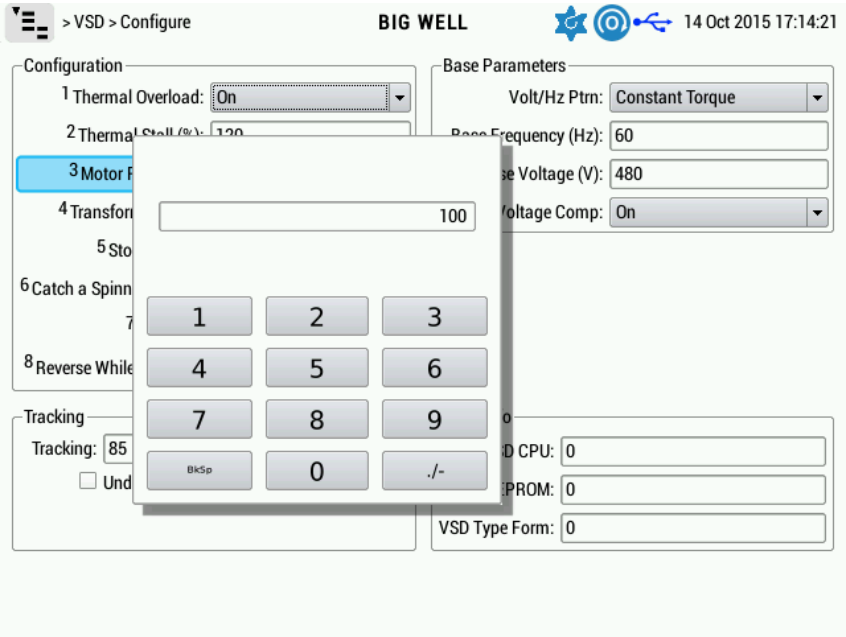

Figure 6-5: VSD Configure Screen

6.5 Trend Sampling Time

The controller automatically logs data from a pre-defined list of I/Os. The default logging rates depend on the channel being logged, but these rates may be modified through the StarView software by setting a new value in the Sampling Time field presented on the Configuration>Internal Trends panel. Refer to the StarView User Guide (InTouch ID 6031798) for details.

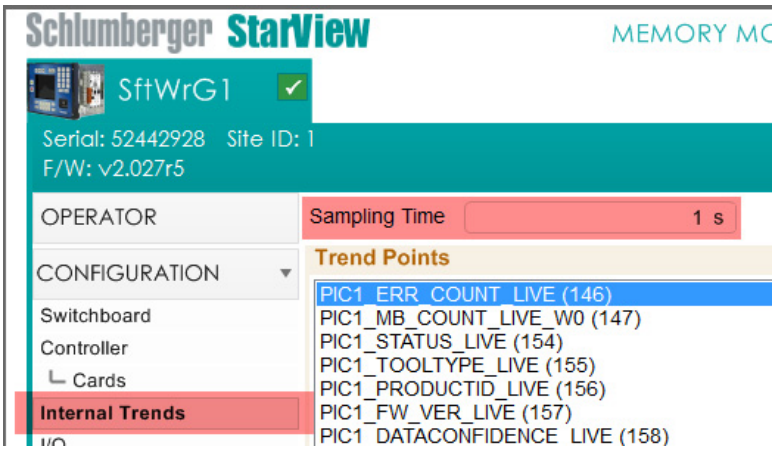

Figure 6-6: Configure Sampling Time in StarView

6.6 Digital Output

All three digital outputs on the I/O card (RELAY1, RELAY2, and RELAY3) are configurable. The relays all have normally open and normally closed terminals.

To configure digital outputs:

1. Press the **Home** button on the keypad.
2. Press the **Menu** button on the keypad to bring up the top-level menu.
3. Select the **IO** menu item, using the keypad or navigation keys.
4. Select the appropriate **Slot (Slot A or Slot B)** menu item.

Figure 6-7: IO Menu Tree

5. Select the appropriate digital output using the navigation keys.

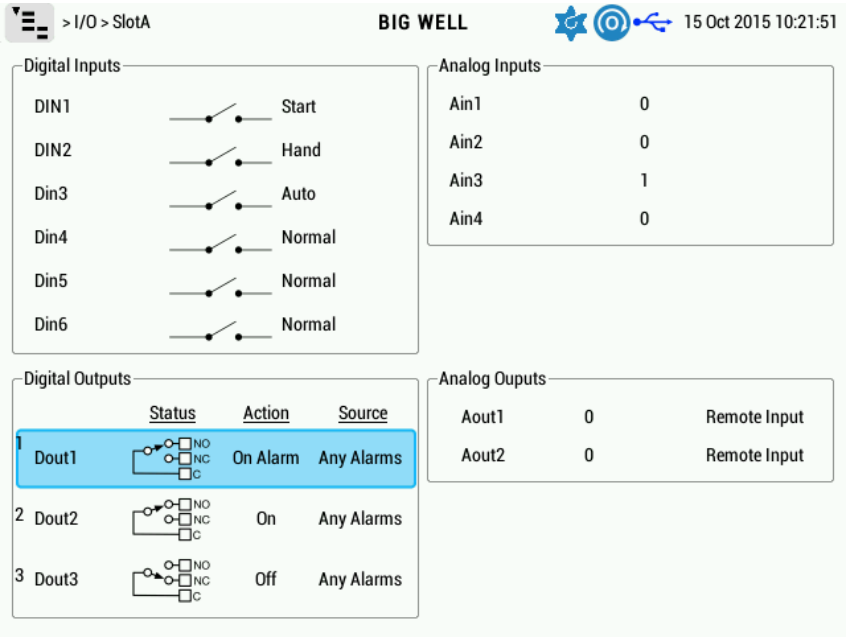

Figure 6-8: IO Screen (Digital Outputs)

6. Press the **Enter** (✓) button to confirm selection and access the parameters.
7. Enter the parameter values using numerical keypad. Press the **Enter** (✓) button to confirm each value.
8. Press the **Exit** (X) button to exit parameters screen.
9. Repeat step 5 to 8 for each digital output.

6.7 Analog Input

The analog inputs are 0–10 VDC or 4-20 mA current loops that can be used to monitor external sensors and RTDs. The parameters can be configured using the controller keypad or StarView.

To configure analog inputs:

1. Press the **Home** button on the keypad.
2. Press the **Menu** button on the keypad to bring up the top-level menu.
3. Select the **IO** menu item, using the keypad or navigation keys.

4. Select the appropriate **Slot (Slot A or Slot B)** menu item.

Figure 6-9: IO Menu Tree

5. Select the appropriate analog input using the navigation keys.

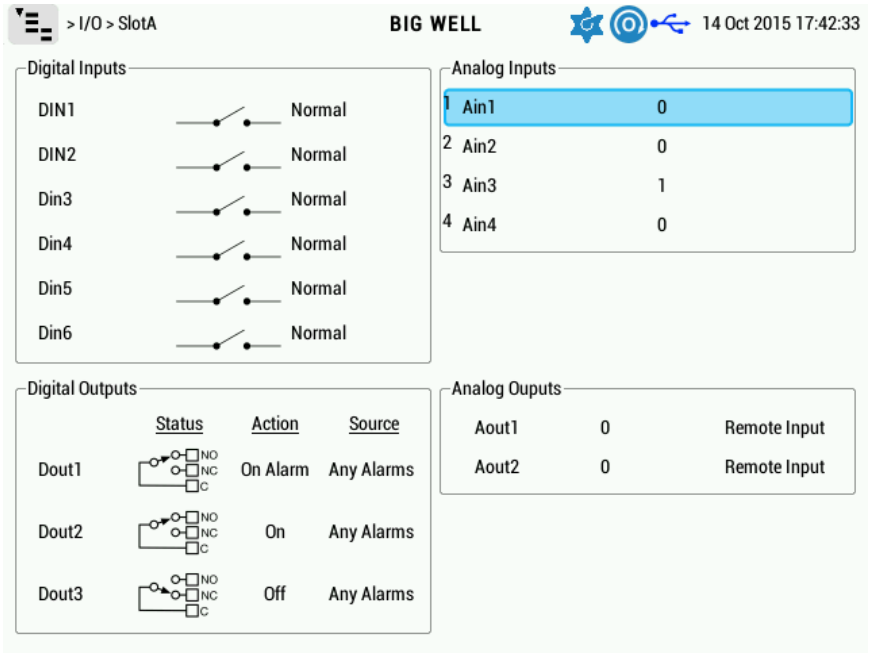

Figure 6-10: IO Screen (Analog Inputs)

6. Press the **Enter** (✓) button to confirm selection and access the parameters.

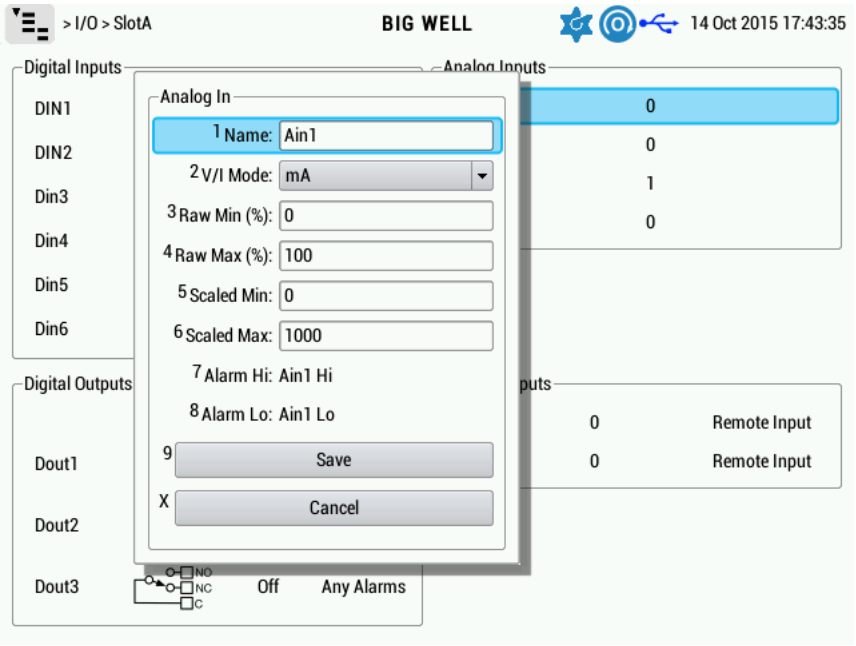

Figure 6-11: Analog Inputs

7. Enter the parameter values using numerical keypad. Press the **Enter** (✓) button to confirm each value.
8. Press the **Exit** (X) button to exit parameters screen.
9. Repeat steps 5 to 8 for each analog input.

6.7.1 Decimal Places

Special care must be applied when using numbers and decimal places on the controller. The numbers are arbitrarily stored in the Modbus table / memory map based on the specific data type requirements.

The decimal point "." is not incorporated into the controller and values are displayed as determined from the data type in memory.

Example

Data type for frequency is XX.X. This is stored in memory as XXX with a type parameter to indicate a decimal place.

Example
For values expected to be XX.XX, the user settings on the controller would be XXXX.

To incorporate a decimal in the analog readings the user must perform the scaling. For analog data which becomes incorporated into additional controller controls as feedback parameters, IE surface pressure, speed settings, etc., the decimal values must be carefully evaluated to ensure that the analog data provided is in the expected scaling of the controller's feedback system.

6.7.2 Alarms

Each analog channel has two alarms associated with it:

- the high set point alarm
- the low set point alarm.

Each set point can be configured for an alarm action. Each of these alarms may be bypassed if not required.

Note
ESP mode supports alarming on the analog inputs.

6.7.3 Examples

Configuration of the analog input parameters using the controller can best be explained with the following examples.

Example: Sensor with 0 V reference
A pressure sensor measures 0-1000 psi and sends out a proportional 0-10 V signal.
Pressure gage specification:

- 0 psi at 0 V
- 1000 psi at 10 V

There is a direct relationship to the controller analog input voltage and the Raw % range.

$$\frac{0V}{10V} \equiv \frac{0\%}{100\%}$$

Applying these two relationships results in:

$$\frac{0\%}{100\%} \equiv \frac{0\,psi}{1000\,psi}$$

These values correspond to the Scaled analog settings (Scaled Min and Scale Max).

Setting Summary:

Raw Maximum = 100%

Raw Minimum = 0%

Scaled Maximum = 1000

Scaled Minimum = 0

---

eg **Example: Sensor with 0mA reference**

A temperature probe measures a 25-150 degC (77 to 302 degF) range on a 0-20 mA loop.

Temperature probe specifications:

- 25 degC at 0 mA
- 150 degC at 20 mA

There is a direct relationship to the controller analog input current and the Raw % range.

$$\frac{0mA}{20mA} \equiv \frac{0\%}{100\%}$$

Applying these two relationships results in:

$$\frac{25°C}{150°C} \equiv \frac{0\%}{100\%}$$

Setting Summary:

Raw Maximum = 100%

Raw Minimum = 0%

Scaled Maximum = 150

Scaled Minimum = 25

Example: Sensor with two points, voltage mode

A pressure sensor measures 3000-12000 psi and sends out a proportional 1-5 V signal.

Pressure gauge specification:

- 3000 psi at 1 V
- 12000 psi at 5 V

controller analog input specification:

- 0 to 10 V, 4096 discrete data points
- 1% accuracy

There is a direct relationship to the controller analog input voltage and the Raw % range:

$$\frac{0V}{10V} \equiv \frac{0\%}{100\%}$$

To restrict the display range to match that of the pressure sensor, the following ratio must be maintained.

$$\frac{1V}{5V} \equiv \frac{10\%}{50\%}$$

The 10% and 50% values are entered for the Raw % values.

$$\frac{10\%}{50\%} \equiv \frac{3000\,psi}{12000\,psi}$$

These values correspond to the Scaled analog settings.

Setting Summary:

Raw Maximum = 50%

Raw Minimum = 10%

Scaled Maximum = 12000

Scaled Minimum = 3000

A chart representing the data points is shown in Figure 6-12. The data is linear but does not equal zero at 0% full scale.

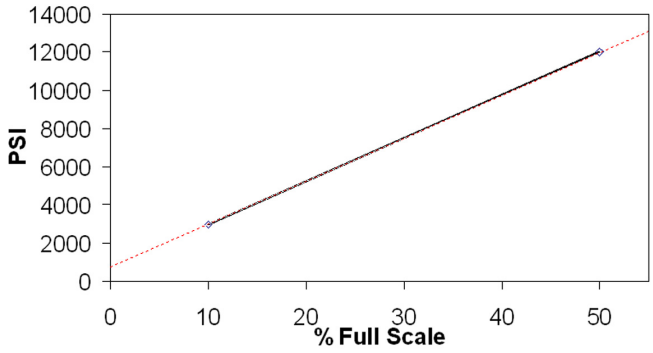

Figure 6-12: 10-50% vs 3000-12000psi

The resolution for this configuration follows this relationship:

$$\frac{100\%}{4096\,points} \equiv \frac{50\%}{x} \rightarrow x = 2048\,points$$

$$\frac{100\%}{4096\,points} \equiv \frac{10\%}{x} \rightarrow x = 409.6\,points \approx 410\,points$$

$$\therefore \frac{12000\,psi}{2048\,points} \Leftrightarrow \frac{3000\,psi}{410\,points} \rightarrow \frac{9000\,psi}{(2048-410)\,points}$$

$$\rightarrow \frac{9000\,psi}{1638\,points} = 5.49\,{}^{psi}\!/_{point}$$

The engineering units for this pressure transducer on the controller will have a resolution of approximately 5 psi.

Alarm trigger points can be set to client requirements.

Example: Sensor with two points, current mode

A temperature sensor generates a 4-15 mA signal to measure a 10-200 degC (50 to 392 degF) signal.

Temperature sensor specification:

- 10 degC at 4 mA
- 200 degC at 15 mA

controller analog input specification:

- 4 to 20 mA (26 mA over-range or 130%), 4096 discrete data points. Determine how many points available within the 100% range.

$$\frac{20mA}{100\%} \equiv \frac{26}{130\%} \rightarrow \frac{130\%}{4096\text{points}} \equiv \frac{100\%}{3151\text{points}}$$

- 5% accuracy.

There is a direct relationship to the controller analog input current and the Raw % range.

$$\frac{0mA}{20mA} \equiv \frac{0\%}{100\%}$$

To relate 4 mA to the Raw % range:

$$4mA \rightarrow \frac{4mA}{20mA} \equiv \frac{x}{100\%} \rightarrow x = 20\%$$

To relate the 15 mA to the Raw % range:

$$15mA \rightarrow \frac{15mA}{20mA} \equiv \frac{x}{100\%} \rightarrow x = 75\%$$

For a loop current of 4 mA the temperature is 10 degC. For a loop current of 15 mA the temperature is 200 degC. This results in:

$$\frac{10°C}{200°C} \equiv \frac{20\%}{75\%}$$

Setting Summary:

Raw Maximum = 75%

Raw Minimum = 20%

Scaled Maximum = 200

Scaled Minimum = 10

The measurement resolution for this configuration follows the relationship:

$$\frac{130\%}{4096\,points} \equiv \frac{75\%}{x} \rightarrow x = 2363\,points$$

$$\frac{130\%}{4096\,points} \equiv \frac{20\%}{x} \rightarrow x = 630.15 = 630\,points$$

$$\frac{200°C}{2363\,points} \Leftrightarrow \frac{10°C}{630\,points} \rightarrow \frac{(200-10)°C}{(2363-630)\,points}$$

$$\rightarrow \frac{190°C}{1733\,points} = 0.109\,{}^{°C}\!/_{point}$$

The engineering units for this temperature transducer on the controller will have a resolution of approximately 0.11 degC.

6.8 Digital Inputs

The six digital inputs on the I/O card are used to monitor external switches for a status change. These status changes can be used to activate alarms. The following describes the basic alarm features of the controller. The Digital input alarm has an additional parameter called ‘Alarm On’ and can be configured either as open or closed.

OPEN	The alarm occurs when the switching power, from the DIGITAL PWR terminal, is not detected on the input terminal. i.e., the switch is open.
CLOSE	The alarm occurs when switching power, from the DIGITAL PWR terminal, is detected on the input terminal. i.e., the external switch has closed.

To configure digital inputs:

1. Press the **Home** button on the keypad.
2. Press the **Menu** button on the keypad to bring up the top-level menu.
3. Select the **IO** menu item, using the keypad or navigation keys.

4. Select the appropriate **Slot (Slot A or Slot B)** menu item.

Figure 6-13: IO Menu Tree

5. Select the appropriate digital input using the navigation keys.

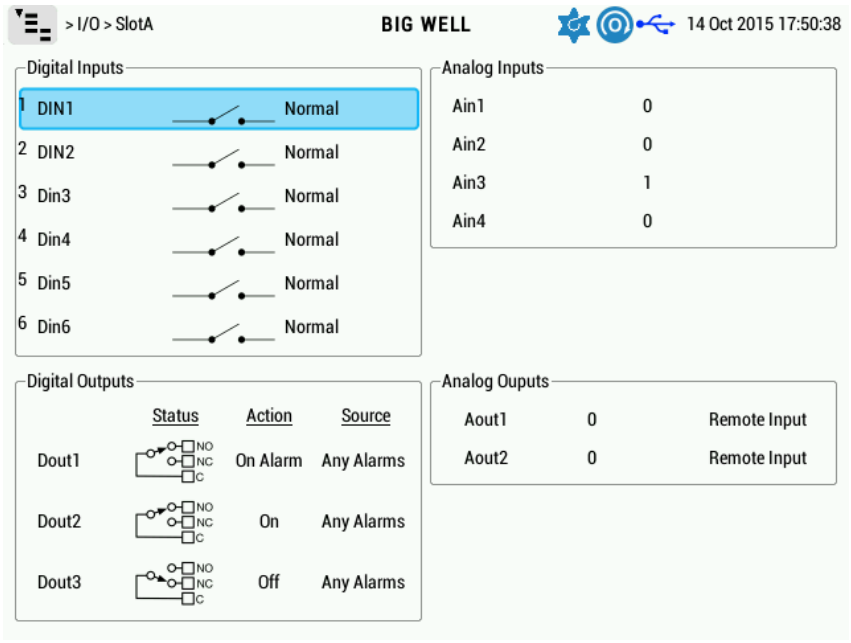

Figure 6-14: IO Screen (Digital Inputs)

6. Press the **Enter** (✓) button to confirm selection and access the parameters.
7. Enter the parameter values using numerical keypad. Press the **Enter** (✓) button to confirm each value.

8. Press the **Exit** (X) button to exit parameters screen.
9. Repeat step 5 to 8 for each digital input.

6.8.1 Digital Input HOA

The HOA (Hand, Off, Auto) parameters can be configured using the controller or StarView. The HOA parameters should correspond with the Digital input HOA wiring installation.

To configure the digital inputs for HOA, select the digital input switch setting.

Note

Ensure the digital location of the HOA functions match the wire connections to the switches.

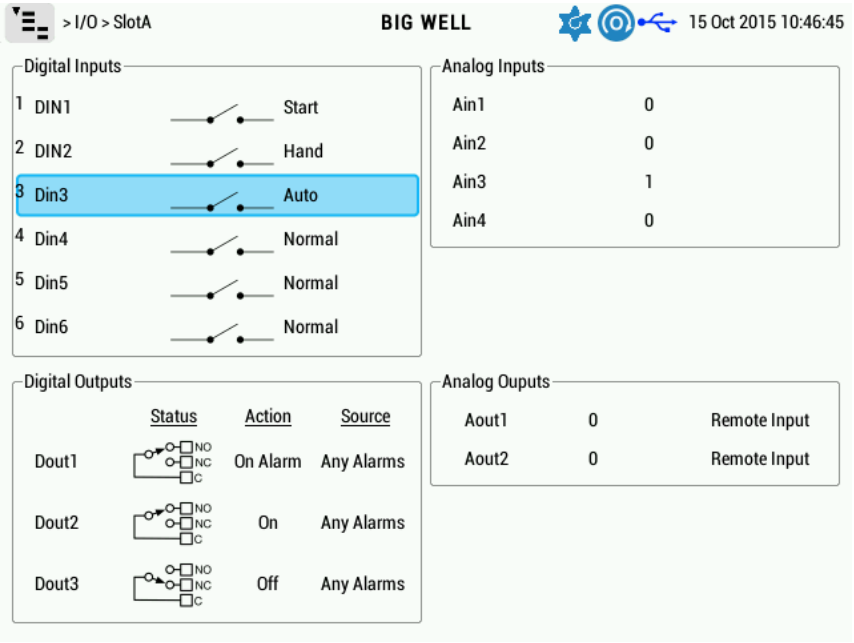

Figure 6-15: HOA Settings Example

6.9 Analog Output

The user analog outputs are 4-20 mA current loops that can be used by a SCADA system for external control of other devices like an electronic valve or meter. The output value may also be set from the controller keypad.

Caution

Potential Severity: Light
Potential Loss: Assets
Hazard Category: Machinery equipment hand tools

Failure to observe the following precautions may result in damage to the controller and connected equipment.

The controller provides current sourced analog outputs. The 4-20mA current loop must be referenced to Analog Common (I/O card pin 27).

The range and scale settings for the analog outputs operate in a similar manner to the analog inputs. The controller analog output currents are capable of 1 to 20 mA full scale.

To configure the analog outputs using the controller keypad:

1. Press the **Home** button on the keypad.
2. Press the **Menu** button on the keypad to bring up the top-level menu.
3. Select the **IO** menu item, using the keypad or navigation keys.
4. Select the appropriate **Slot (Slot A or Slot B)** menu item.

Figure 6-16: IO Menu Tree

5. Select the appropriate analog output using the navigation keys.

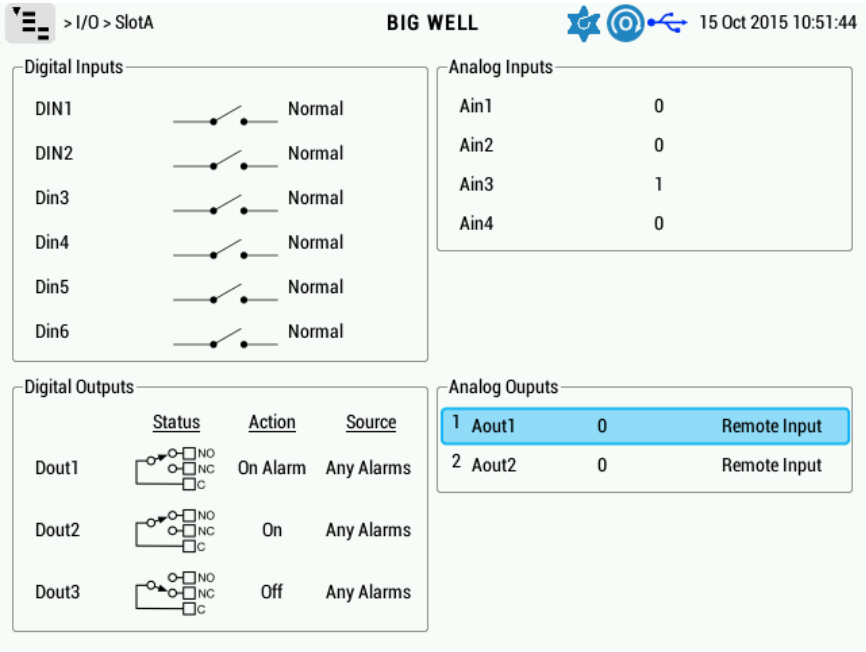

Figure 6-17: IO Screen (Analog Outputs)

6. Press the **Enter** (✓) button to confirm selection and access the parameters.

7. Enter the parameter values using numerical keypad. Press the **Enter** (✓) button to confirm each value.

Note

The Source options only functions when the application supports it. For example, Pump Intake Pressure is functional when a Phoenix Interface Card is installed.

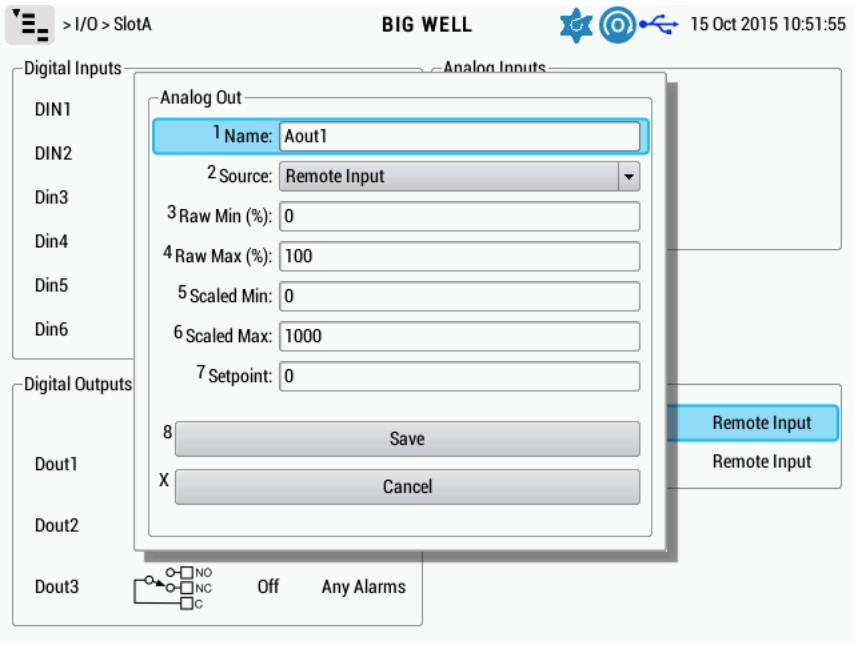

Figure 6-18: Analog Outputs Screen

8. Press the **Exit** (X) button to exit parameters screen.
9. Repeat step 5to 8 for each analog output.

6.9.1 Alarms

There are no alarm points associated with the analog outputs. These values are generated by the controller, not monitored like the input parameters, and therefore have no alarms.

6.9.2 Examples

The following examples demonstrate the use of scaling and manipulating raw values.

Example

Average voltage mapped to 0-20 mA

The controller is operating with 120 VAC rated PT inputs. Map the 3 phase average voltage within a range of 0-200 VAC to represent 0-20 mA. Analog output requirement:

- 0 mA at 0 V
- 20 mA at 200 V

There is a direct relationship to the controller analog output current and the Raw % range.

$$\frac{0mA}{20mA} \equiv \frac{0\%}{100\%}$$

Applying these two relationships results in:

$$\frac{0\%}{100\%} \equiv \frac{0V}{200V}$$

These values correspond to the Scaled analog settings as shown below.

Setting summary:

- Raw Maximum = 100%
- Raw Minimum = 0%
- Scaled Maximum = 200
- Scaled Minimum = 0

Example

Analog input mapped to analog output

The values of analog input 1 are to be mapped to analog output 1. Analog 1 has been scaled to read 0-1000. Analog output requirement:

- 0 mA at 0 analog input
- 20 mA at 1000 analog input.

There is a direct relationship to the controller analog input current and the Raw % range.

$$\frac{0mA}{20mA} \equiv \frac{0\%}{100\%}$$

Applying these two relationships results in:

$$\frac{0mA}{20mA} \equiv \frac{0}{1000}$$

Setting summary:

- Raw Maximum = 100%
- Raw Minimum = 0%
- Scaled Maximum = 1000
- Scaled Minimum = 0

6.9.2.1

More Examples

Example: Intake pressure mapped to analog output

Require a 4–20mA signal for a pressure range of 0 to 5000psi. Review of the Modbus register for the DHT tool indicates a decimal placement of X.X.

Setting summary:

- Raw Maximum = 100%
- Raw Minimum = 20%
- Scaled Maximum = 50000
- Scaled Minimum = 0

Example: Motor temperature mapped to analog output

Require a 4–20mA signal for a temperature range of 0 to 400F. Review of the Modbus register for the DHT tool indicates a decimal placement of X.X.

Setting summary:

- Raw Maximum = 100%
- Raw Minimum = 20%
- Scaled Maximum = 4000
- Scaled Minimum = 0

Example: Vibration mapped to analog output

Require a 4–20mA signal for a vibration range of 0 to 5G. Review of the Modbus register for the DHT tool indicates a decimal placement of X.XXX.

Setting summary:

- Raw Maximum = 100%
- Raw Minimum = 20%
- Scaled Maximum = 5000
- Scaled Minimum = 0

Example: VSD Running Frequency mapped to analog output

Require a 4–20mA signal for a frequency range of 0 to 90Hz. Review of the Modbus register for the DHT tool indicates a decimal placement of X.XX.

Setting summary:

- Raw Maximum = 100%
- Raw Minimum = 20%
- Scaled Maximum = 9000
- Scaled Minimum = 0

6.10 VSD

The Variable Speed Drive (VSD) should arrive pre-configured for VSD operation. In the event that this is not the case, or a new controller is being commissioned, this section will detail how to set up and configure the controller for a VSD.

The VSD interfaces with the controller using the RS-485 connection on the control card or a communication card installed in an expansion port.

The MVD card is required for interfacing with Medium Speed Drive (MVD). For MVD specific configuration with Instruct, refer to InTouch Content 7215430.

For Toshiba T300MV2 MVD (MV2) set up and configuration, refer to InTouch Content 6966405.

Instruct can support ABB ACS880 SWD, ABB ACS880 SWD support both induction motor and Permanent Magnetic Motor (PMM), please refer to InTouch Content 7275535 for ACS880 SWD operation manual, for Instruct Controller communication setting and basic VSD configuration, refer to Communication Settings and Basic VSD Configuration sections of InTouch Content 7275535.

6.10.1 VSD Communication Settings

To configure the controller for a VSD application using the control card:

1. Press the **Home** button on the keypad.
2. Press the **Menu** button on the keypad to bring up the top-level menu.
3. Select the **Controller** menu item, using either the numeric keypad or the up/down/left/right navigation keys on the keypad.

4. Select the **RS485** menu item.

Figure 6-19: Controller Menu Tree

5. To rename a slot, select the **Name** option using navigation keys. Press the **Enter** (✓) button to confirm selection. Enter the name using numerical keypad. Press the **Enter** (✓) button to confirm value.

6. Select the **Function** option, using navigation keys. Press the **Enter** (✓) button to confirm selection.

7. Select the VSD type. Press the **Enter** (✓) button to confirm each value.

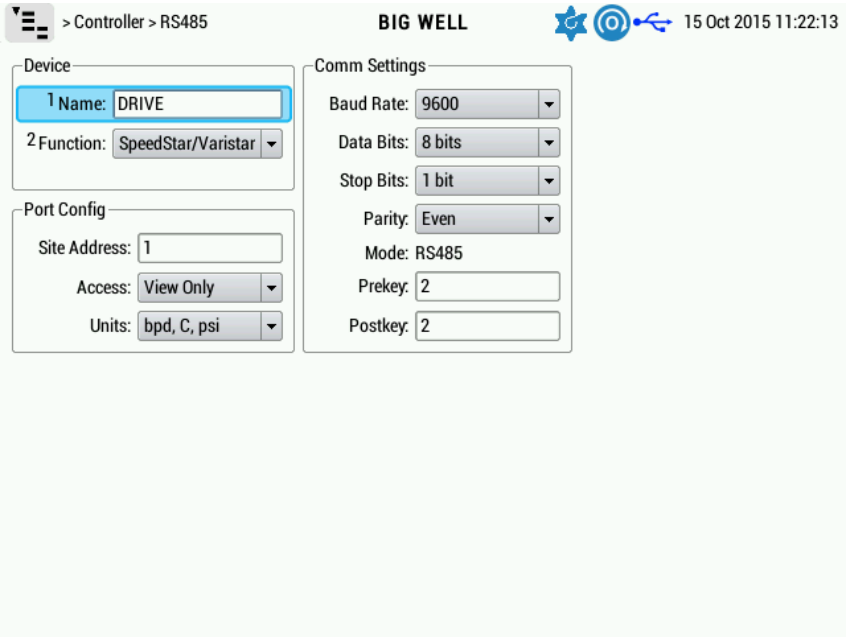

Figure 6-20: Slot Configuration

6.10.2 VSD Settings

The following menus are available for VSD applications:

1. Operator:
2. Summary:
3. Alarms:
4. Speed:
5. Time:
6. Configure:
7. Expert:

For AS1 VSD settings, refer to the Instruct AS1 VSD Addendum (InTouch ID 6932447) for details.

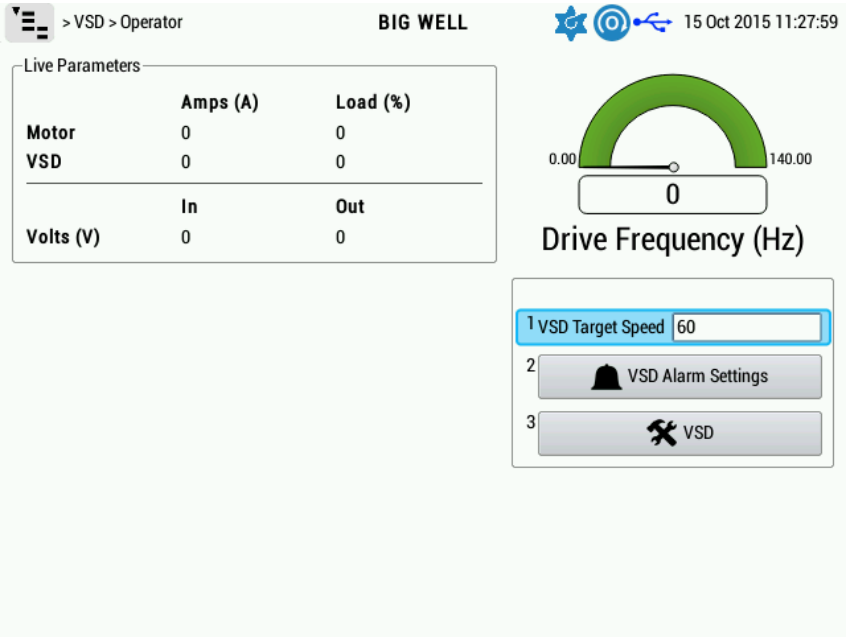

Figure 6-21: Operator Screen

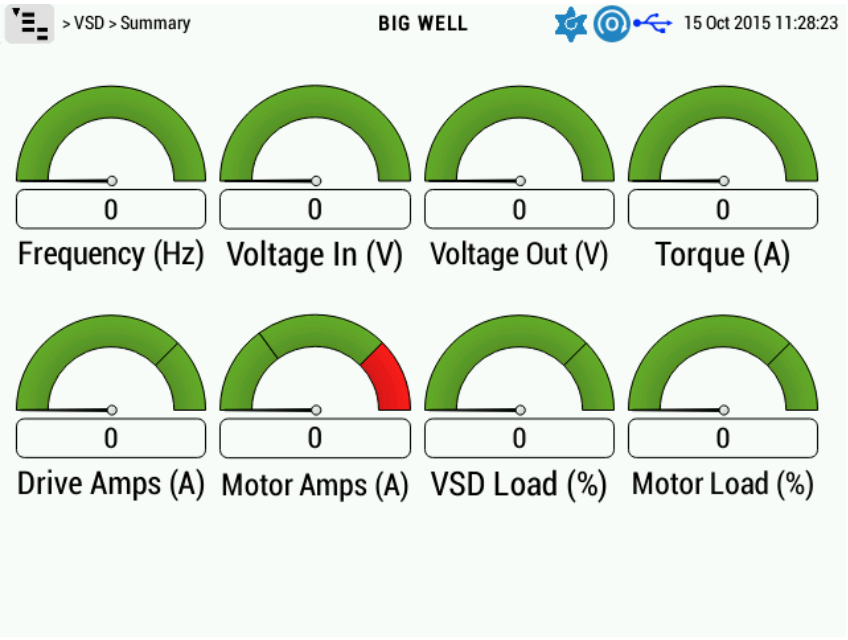

Figure 6-22: Summary Screen

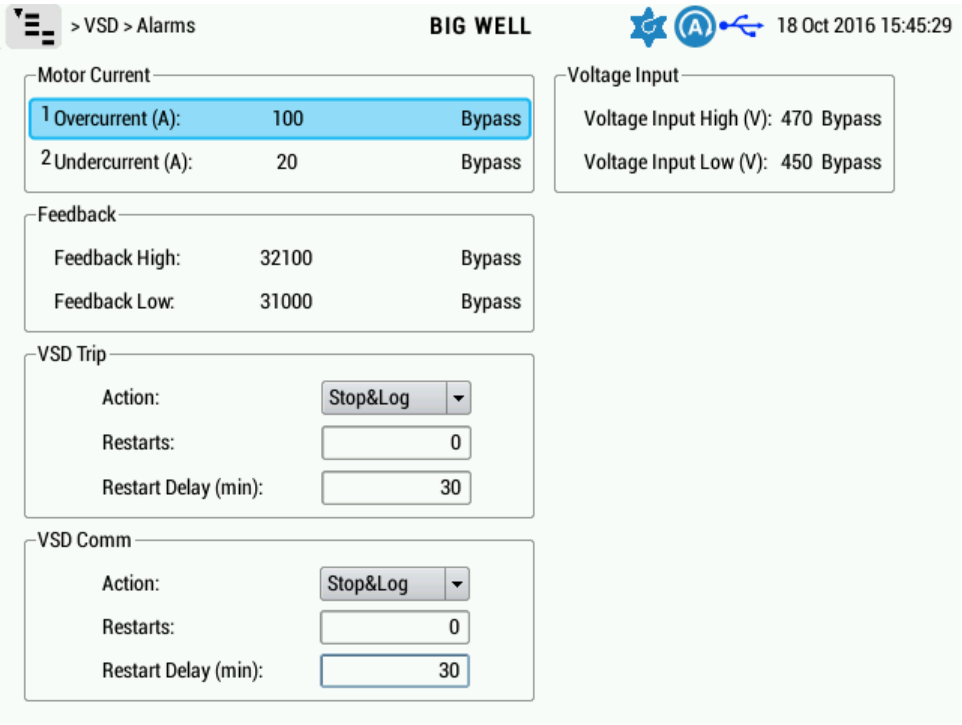

Figure 6-23: Alarms Screen

Figure 6-24: Speed Screen

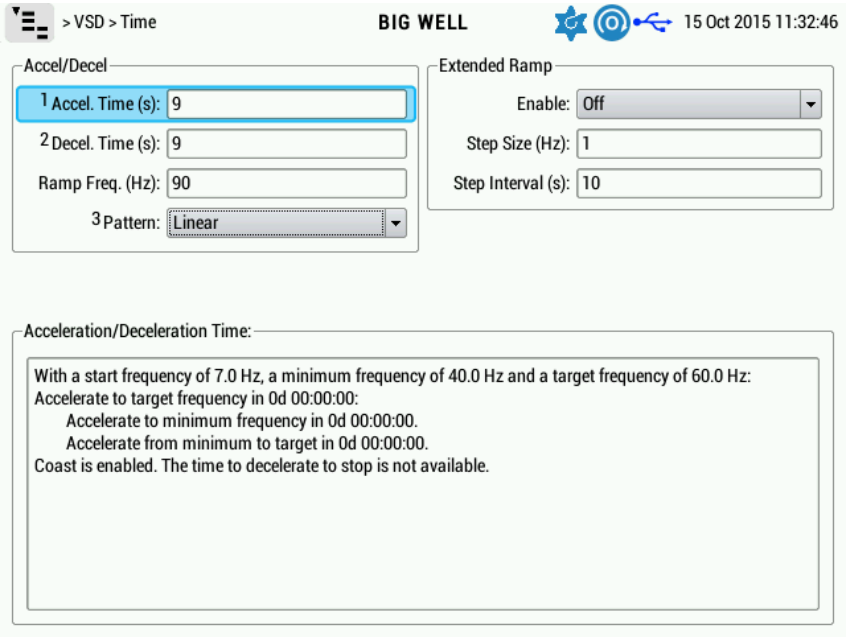

Figure 6-25: Time Screen

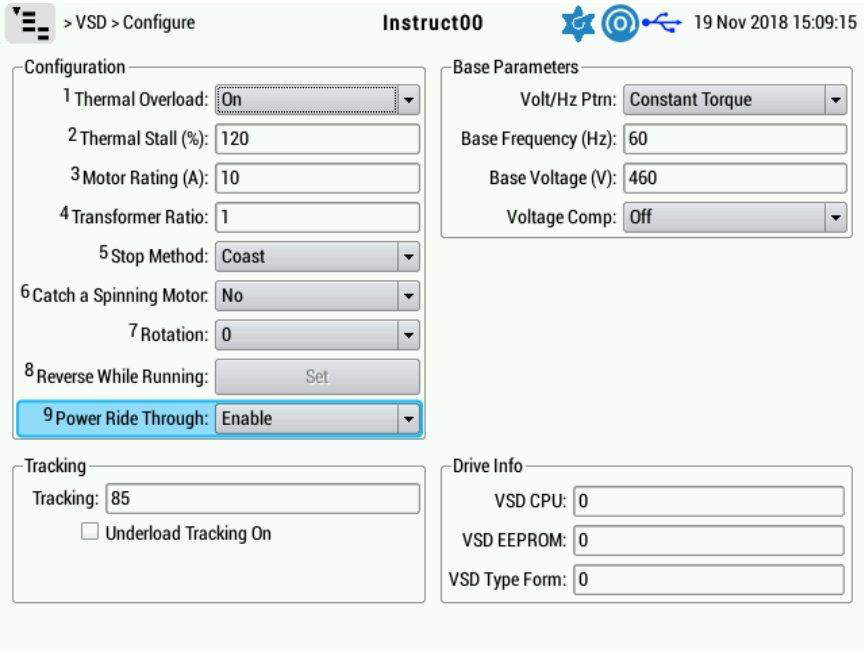

Figure 6-26: Configure Screen

Figure 6-27: Expert Screen

6.10.2.1 Feedback

1. Press the **Home** button on the keypad.
2. Press the **Menu** button on the keypad to bring up the top-level menu.
3. Navigate to the Operator screen for the analog input. Select **IO > Slot #**.

4. Set the scaled minimum and maximum settings.

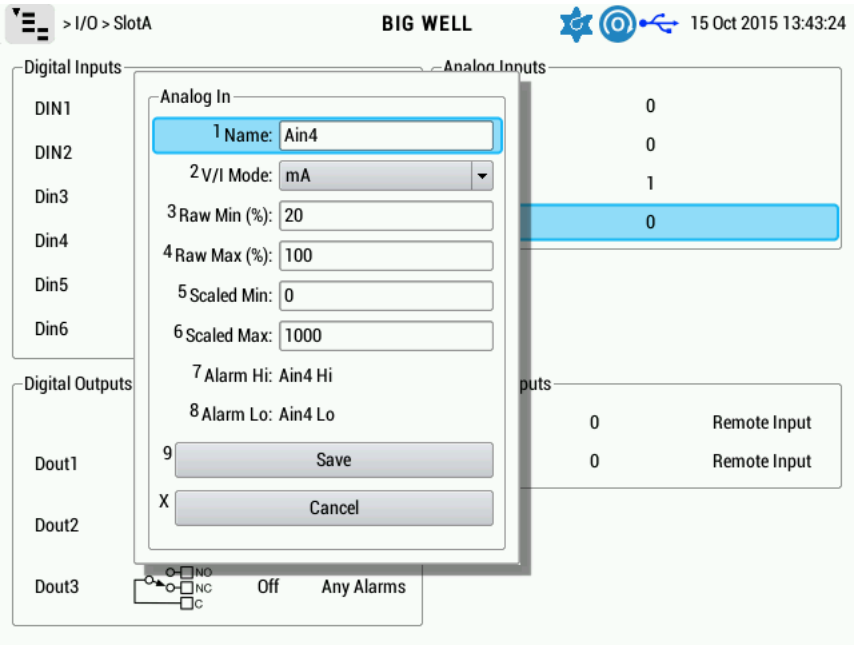

Figure 6-28: Analog Input Settings

5. Press the **Menu** button.

6. Navigate to the controller settings menu item. Select **Controller > Setting/Info**.

7. Set pressure units to psi.

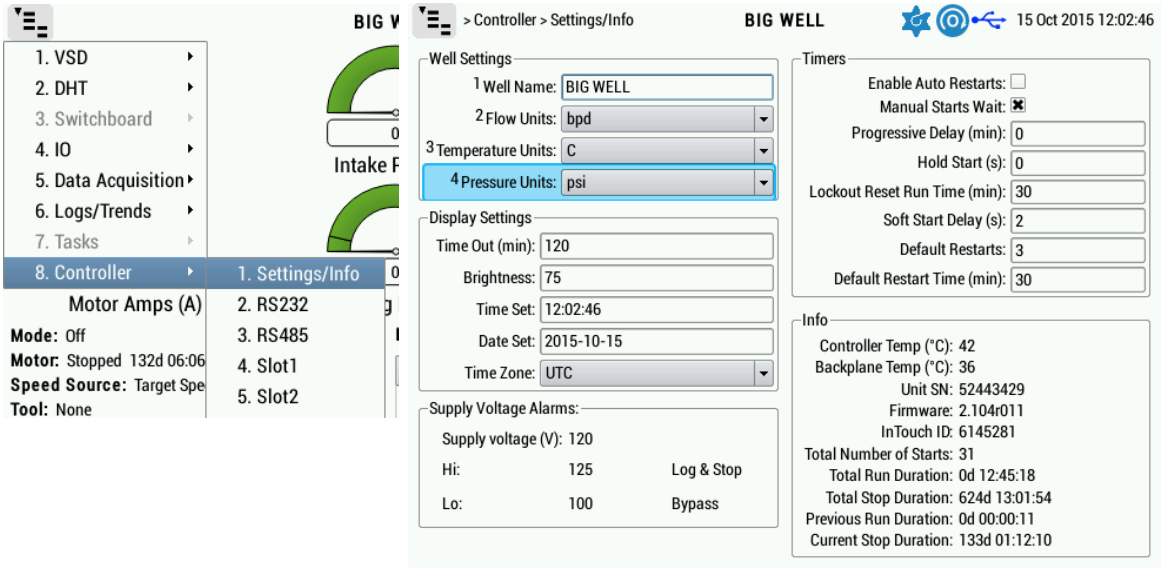

Figure 6-29: Controller Settings

8. Press the **Menu** button.

9. Navigate to the VSD speed menu item. Select **VSD > Speed**.

Figure 6-30: VSD Menu Tree

10. Select the **Source** option and enter the appropriate feedback source.

11. Enter the feedback parameters.

Figure 6-31: Speed Screen

Feedback Example

The configuration of feedback is best explained using an example.

Example

Using a surface pressure transducer connected to the controller analog input 4, configure the controller to maintain a surface pressure of 150 psi. The surface pressure takes approximately 30 seconds to reflect downhole changes. The rate of change the motor will be defaulted to is 1 Hz and the change interval will be 40 seconds.

Pressure transducer specifications:

- 4 to 20 mA
- 0 to 1000 psi

1. Configure the analog input 4 for the pressure transducer.
   Set the raw minimum and raw maximum (0% to 100%) based on specifications.

$$4mA \rightarrow \frac{4mA}{20mA} \equiv \frac{x}{100\%} \rightarrow x = 20\%$$

   - Raw minimum = 20%
   - Raw maximum = 100%

   Set the scaled minimum and scaled maximum. These represent the Engineering units to associate with the 20% and 100%.
   - Scaled minimum = 0
   - Scaled maximum = 1000

2. On the controller ensure the units are correctly set to PSI. Change or confirm PSI.
3. Configure the feedback parameters. On the controller navigate to the VSD Speed screen.
   - If Feedback Increases = Decrease Speed
   - Feedback set point = 150
   - Feedback step size = 1 Hz
   - Feedback Step Interval = 40 s

6.10.2.2 Gas Lock Protection

Multiple parameters can be configured to control the Gas Lock Protection feature, located on the Gas Lock screen.

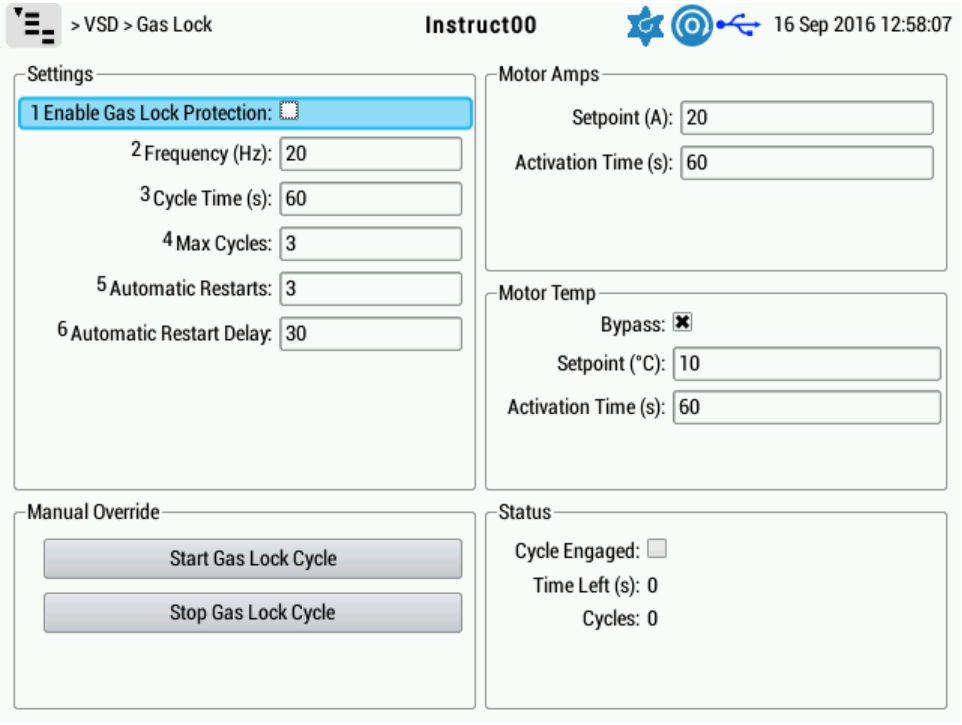

Figure 6-32: Gas Lock Screen

Refer to the Gas Lock Protection guidelines (InTouch ID 6923767) for details.

Note

The motor undercurrent alarm is automatically bypassed whenever GLP is enabled, even if the action for the motor undercurrent alarm is configured to a non-bypass setting. That is, when GLP is enabled, it supersedes the normal motor undercurrent alarm.

6.11 Switchboard

The Instruct FixStar adds the Switchboard menu to the top level menu structure.

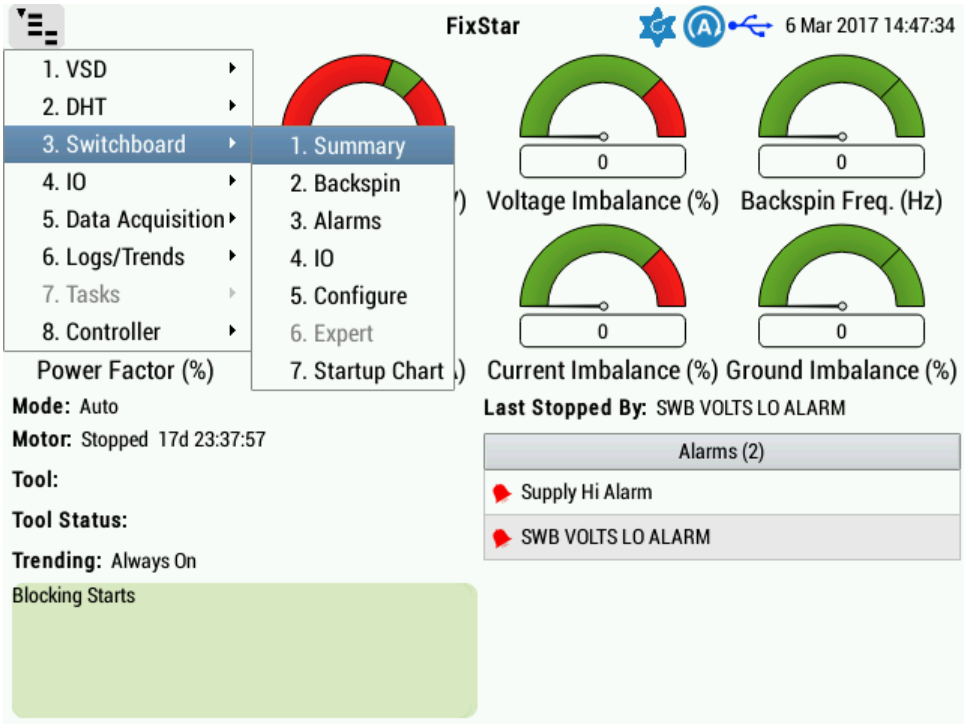

Figure 6-33: Switchboard Menu Tree

The home screen shows the fixed speed-specific parameters (as opposed to VSD parameters) if a Switchboard Card is installed.

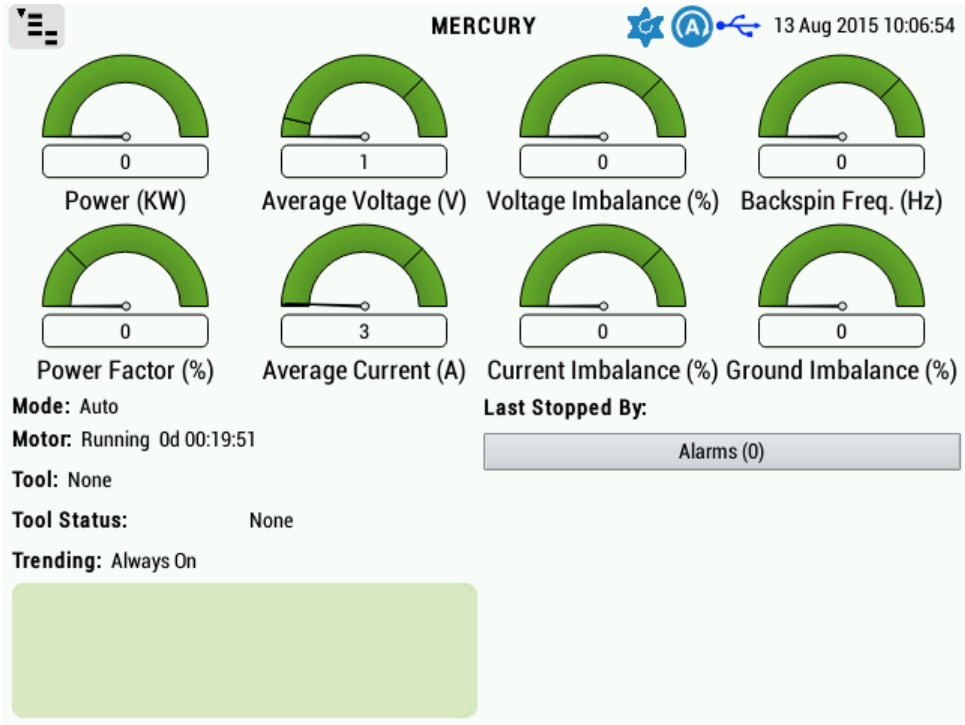

Figure 6-34: FixStar Home Screen

6.11.1 Summary Screen

The summary screen displays detailed information about the FixStar operating status.

1. Press the **Home** button on the keypad.
2. Press the **Menu** button on the keypad to bring up the top-level menu.
3. Select the **Switchboard** menu item, using either the numeric keypad or the up/down/left/right navigation keys on the keypad.
4. Select the **Summary** menu item.

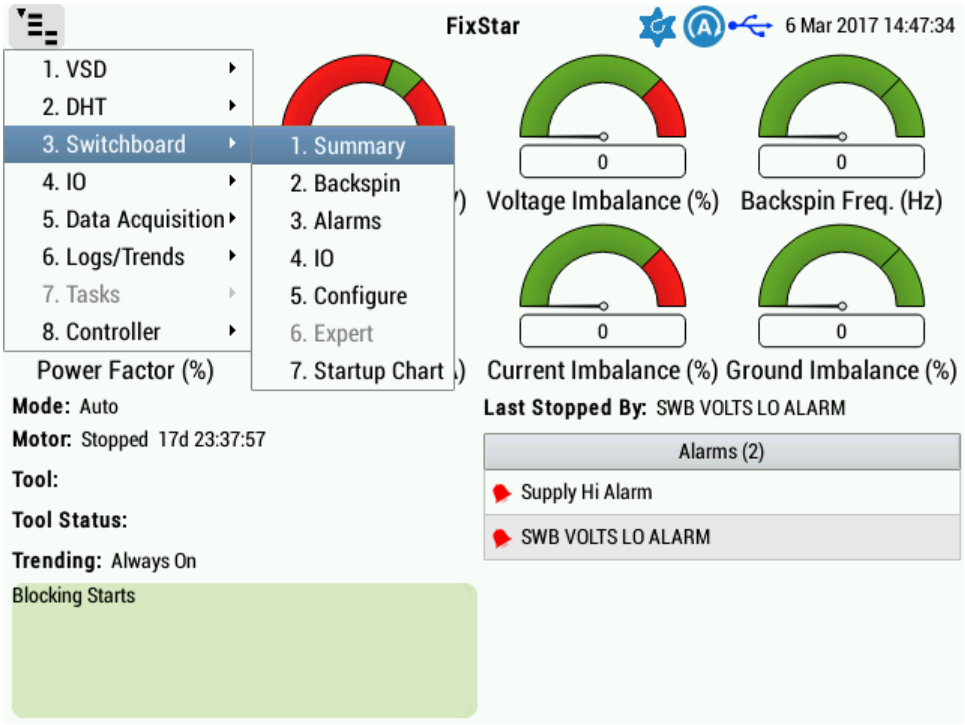

Figure 6-35: Switchboard Summary Menu Tree

6.11.2 Switchboard I/O

1. Press the **Home** button on the keypad.
2. Press the **Menu** button on the keypad to bring up the top-level menu.
3. Select the **Switchboard** menu item, using either the numeric keypad or the up/down/left/right navigation keys on the keypad.

4. Select the **IO** menu item.

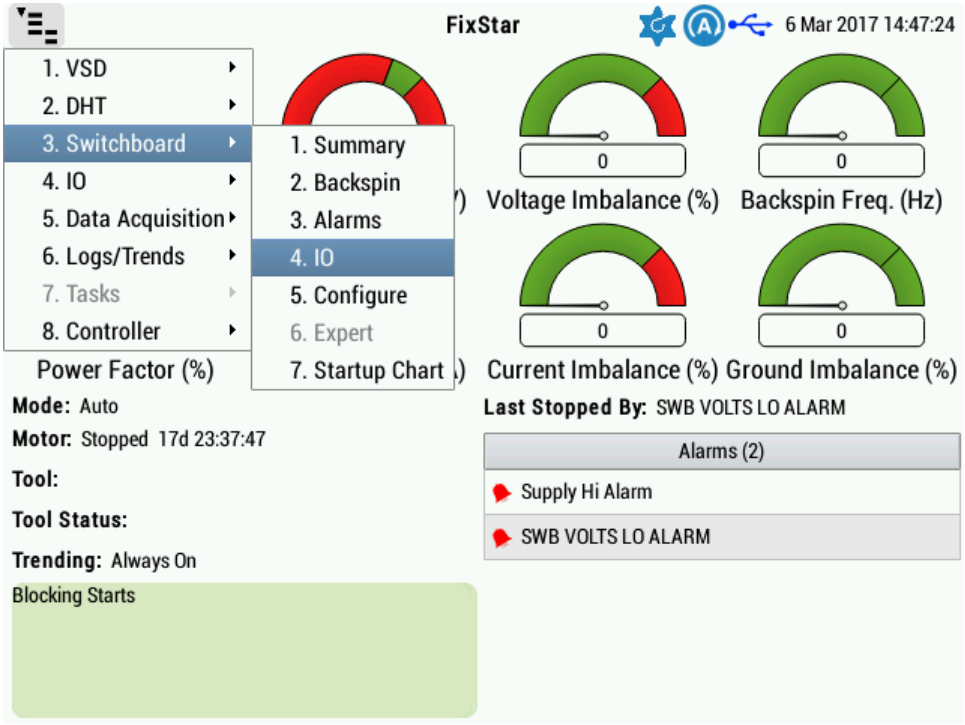

Figure 6-36: Switchboard I/O Menu Tree

There are some minor differences between the I/O Card and Switchboard Card with respect to the available I/O. The Switchboard Card has 4 Digital Inputs, 3 Digital Outputs, 1 Analog Input and 1 Analog Output compared to the I/O Card's 6 Digital Inputs, 3 Digital Outputs, 4 Analog Inputs and 2 Analog Outputs. Configuration of the Switchboard Card I/O is similar to the configuration of the standard I/O expansion card.

The first Switchboard Card relay output is for Contactor, and its status is displayed on the I/O screen. Control of the contactor is provided by the Start and Stop buttons on the Instruct keypad. The normal pump start HOA pop-up will appear when you press Start.

HOA operation can also be configured externally. Refer to the Digital Input HOA instructions in the Installation section for wiring examples. Refer to the Digital Input HOA instructions in the Configuration section for configure examples.

For the other digital outputs (relays), analog and digital inputs, the configuration is the same as Instruct I/O card. Refer to the Digital I/O and Analog I/O instructions in the Configuration section of this manual for details

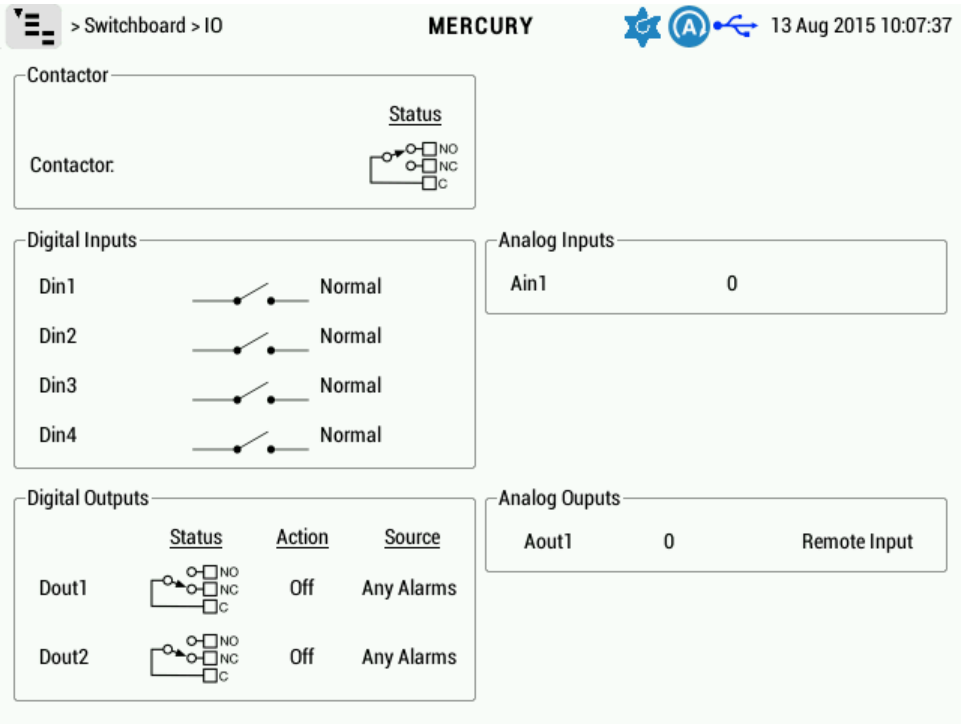

Figure 6-37: Switchboard I/O Screen

6.11.3 Switchboard Alarms

1. Press the **Home** button on the keypad.
2. Press the **Menu** button on the keypad to bring up the top-level menu.
3. Select the **Switchboard** menu item, using either the numeric keypad or the up/down/left/right navigation keys on the keypad.

4. Select the **Alarms** menu item.

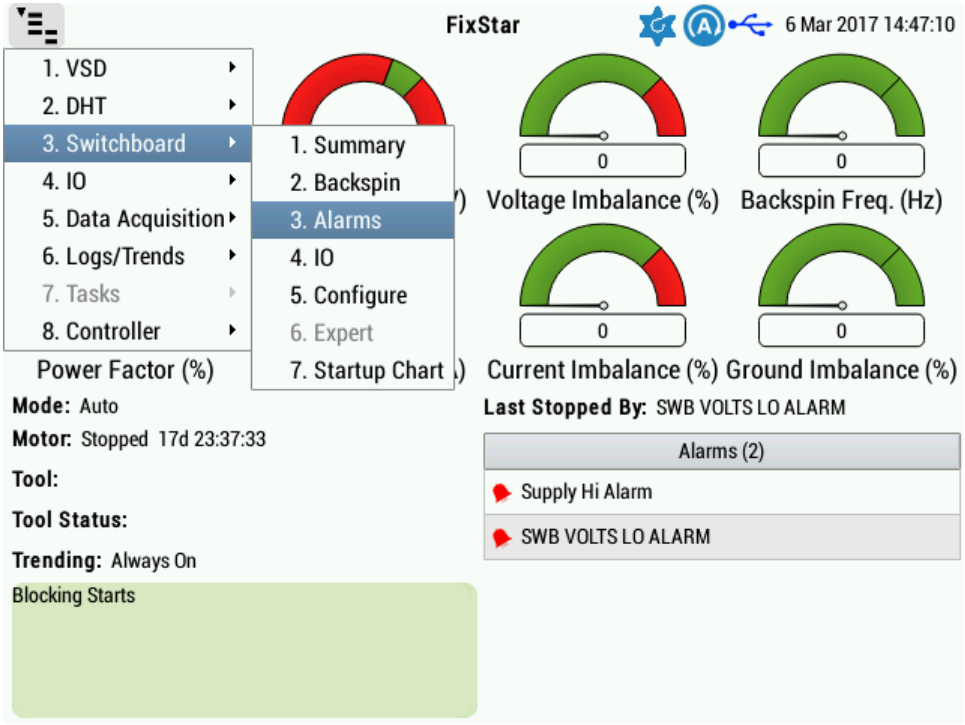

Figure 6-38: Switchboard Alarms Menu Tree

The Source section allows the configuration of the 3-phase voltage input alarms (Undervoltage, Overvoltage, Voltage Imbalance, Low Frequency and Hi Frequency).

The Load Section allows the configuration of the 3-phase current alarms (Underload, Overload, Current Imbalance, Power Factor, Stall and Short Circuit).

Note

There is a known issue for the SWB Rotation Alarm on Current. This issue exist in firmware version 2.110r010 or earlier. If the user has set a rotation alarm and the alarm happens to be active due to the last read rotation value, the user cannot start the SWB. To work around the issue, the user needs to bypass the alarm, start the SWB and re-enable the alarm.

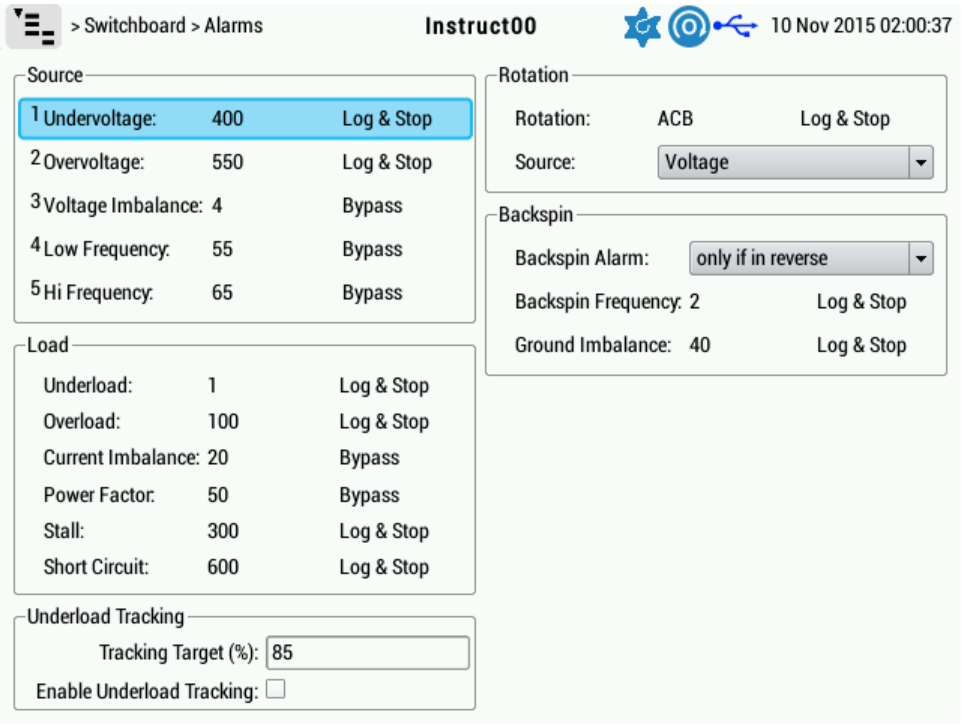

Figure 6-39: Switchboard Alarms Screen

To edit an alarm, use the navigation or numerical keys to choose the alarm you wish to edit. A configuration menu will be displayed to allow the user to enter configuration parameters.

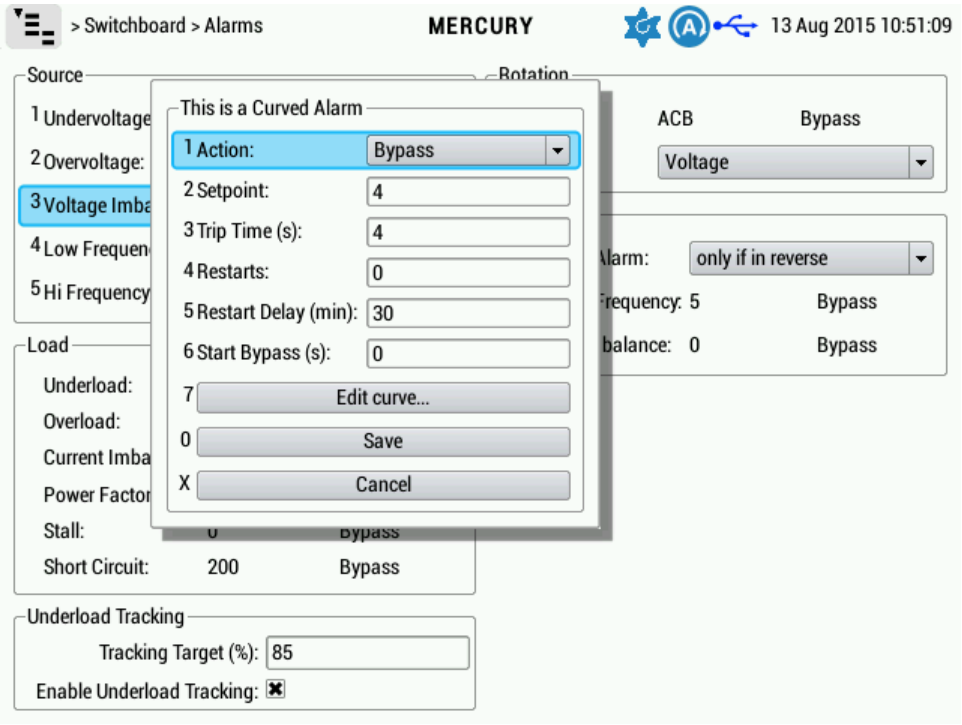

Figure 6-40: Switchboard Alarms Configuration Screen

Term	Definition
Underload Tracking	The Switchboard has underload tracking features. Users can enable and disable it by selecting the Enable Underload Tracking check box. The Tracking Target can be set anywhere from 1% to 100%.
Rotation	The Switchboard has a Current and Voltage rotation direction detection feature. In the Rotation section, users can choose the source as either Current or Voltage, and choose to alarm on a specific direction, ABC or ACB.

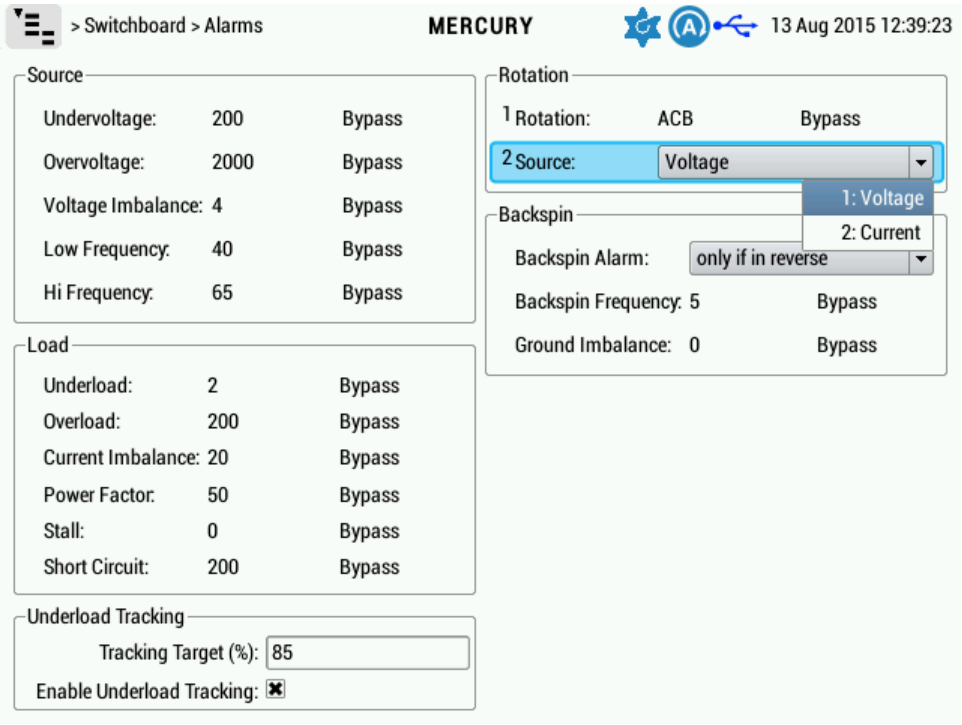

Figure 6-41: Switchboard Rotation Source Configuration

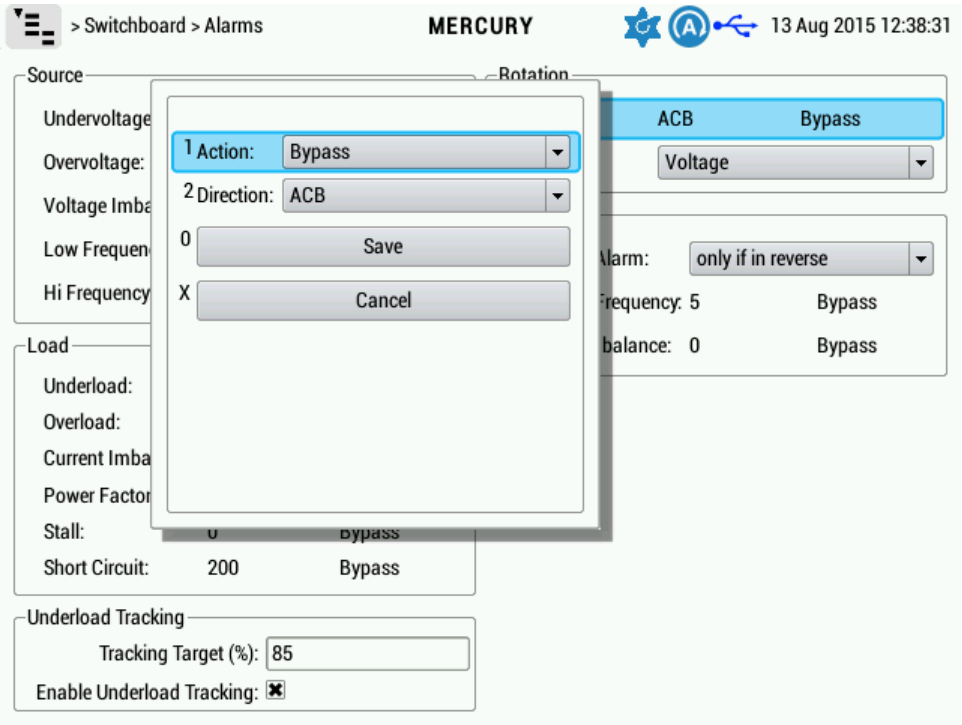

Figure 6-42: Switchboard Rotation Action Configuration

Term	Definition
Backspin Alarms	The Switchboard also provides a Backspin detection alarm. In the Backspin section, the user can configure the Backspin Alarm direction, Backspin Frequency alarm and Ground Imbalance alarm.

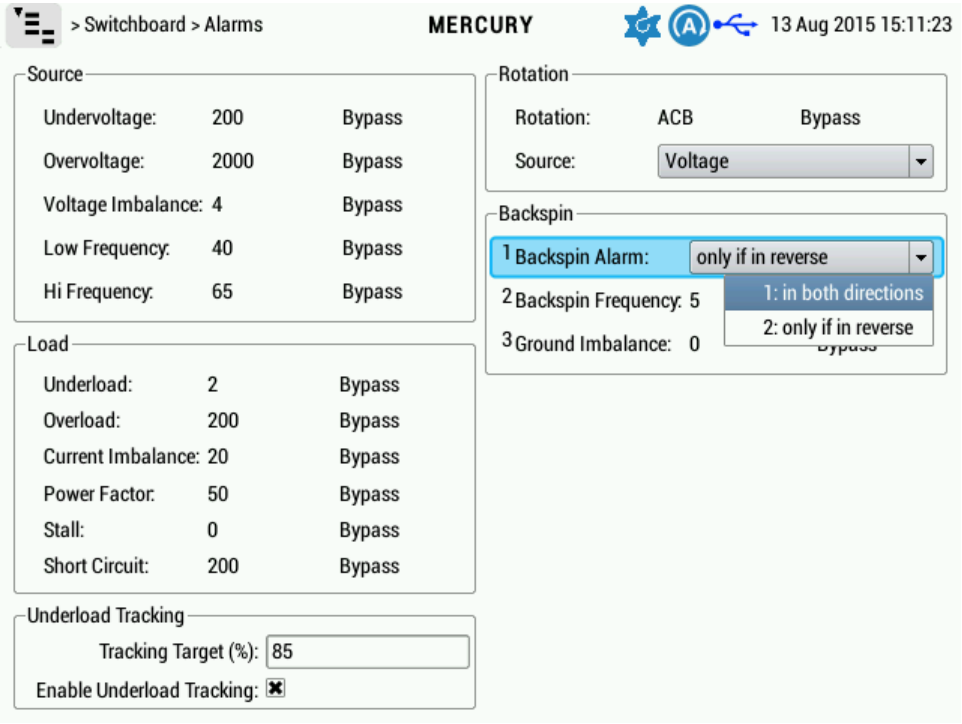

Figure 6-43: Backspin Direction Alarm Configuration

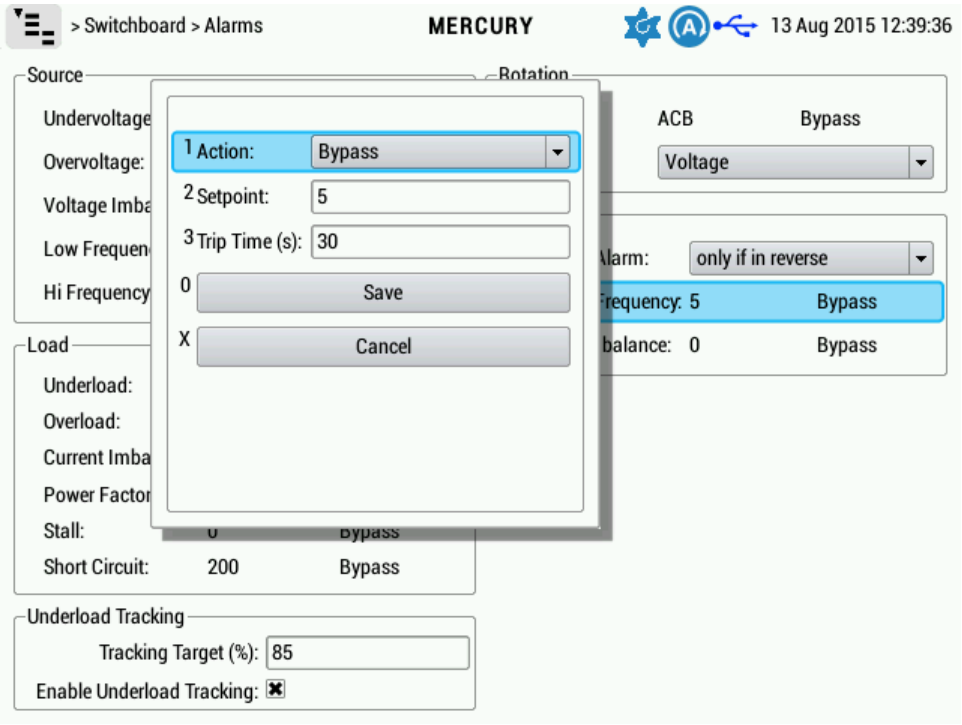

Figure 6-44: Backspin Frequency Alarm

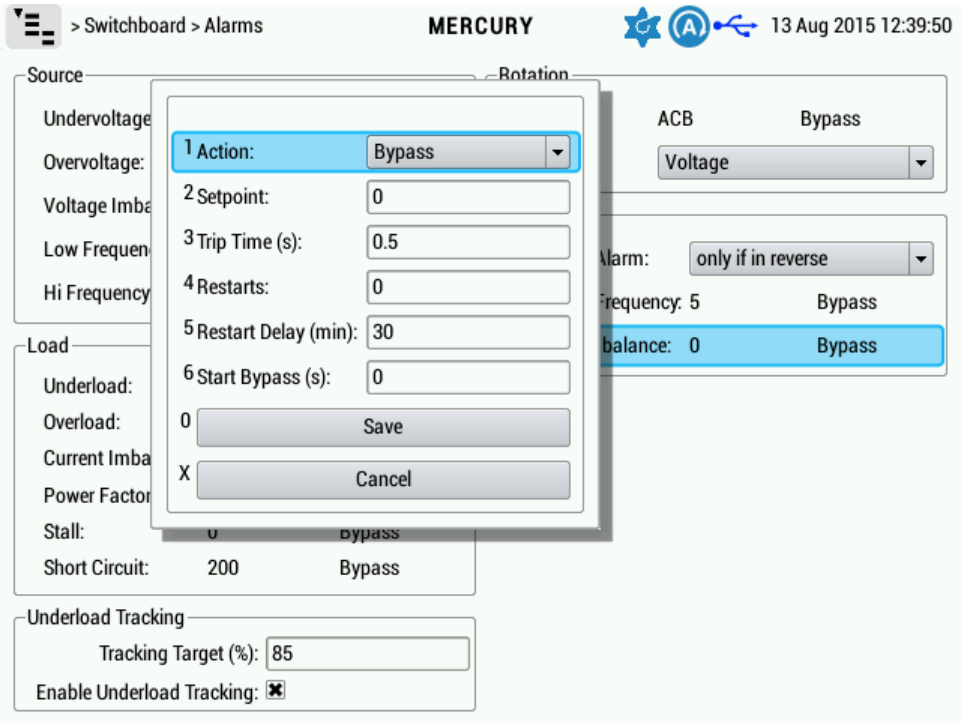

Figure 6-45: Backspin Leg Ground Imbalance Alarm

6.11.4 Switchboard Configuration and Calibration

1. Press the **Home** button on the keypad.
2. Press the **Menu** button on the keypad to bring up the top-level menu.
3. Select the **Switchboard** menu item, using either the numeric keypad or the up/down/left/right navigation keys on the keypad.
4. Select the **Configure** menu item.

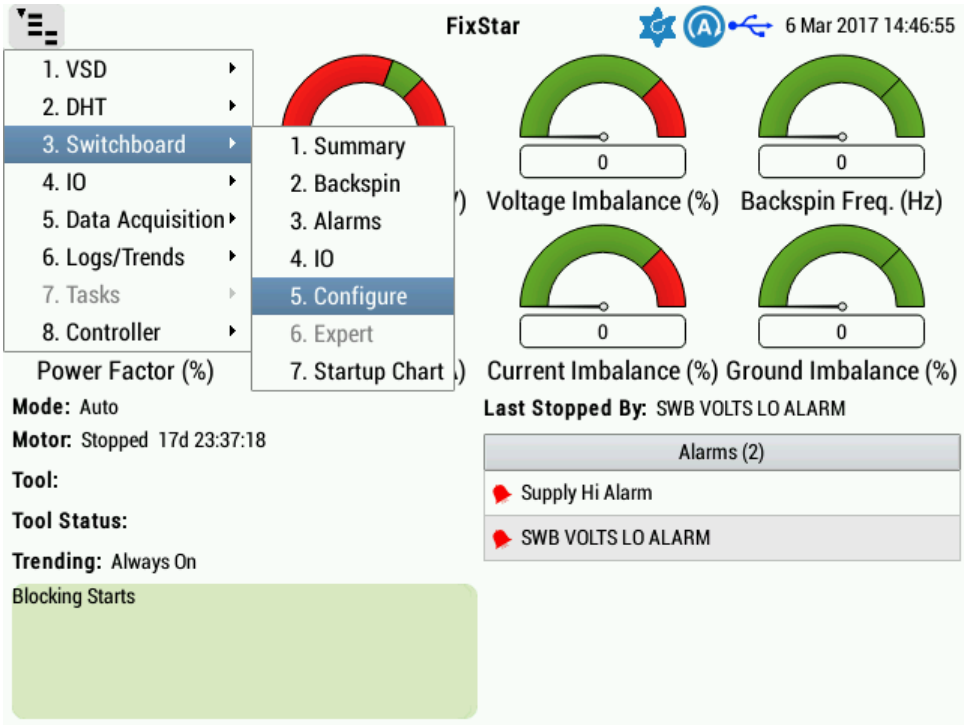

Figure 6-46: Switchboard Configuration Menu Tree

The Switchboard Configure screen allows the user to set the PT and CT ratios and motor nameplate rating. The PT ratio and CT ratio should correspond to the CTs and PTs used in the switchboard. The motor nameplate rating should correspond with the actual motor used in the ESP.

The user can also choose to enable or disable the equipment according to different installations. They can choose if the Backspin Module is installed, and enable/disable the CT or PT readings. For K095 retrofits where only 2 PTs are installed, select 2 under the Number of PTs. For all other standard systems with 3 PTs, select 3.

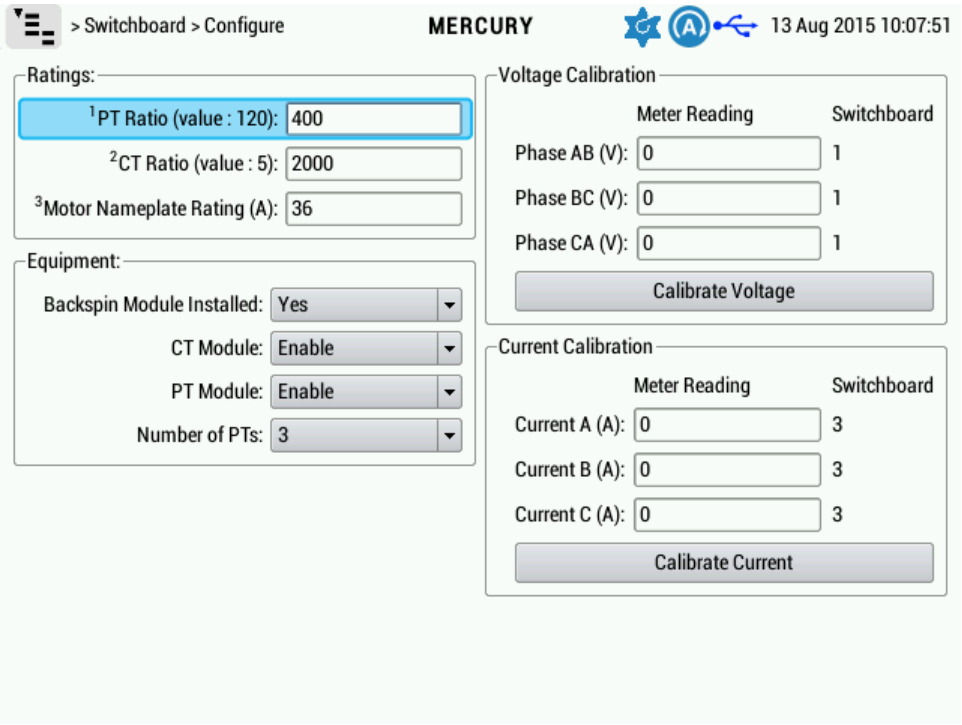

Figure 6-47: Switchboard Configuration Screen

The voltage and current inputs are pre-calibrated during the manufacturing process. However the user can still recalibrate them according to their own needs to account for instrumentation tolerance.

Warning

Potential Severity: Serious
Potential Loss: Personnel
Hazard Category: Electrical

The calibration procedure involves live measurements on a high voltage system. Only to be performed by qualified personnel with the appropriate PPE.

Note: PT Calibration Procedure

1. Ensure that the PTs are correctly wired to the Switchboard Card and that the system voltage is stable.
2. Measure the voltage with a calibrated voltmeter. Record the values for each line-line measurement.
3. Enter the recorded values in the Meter Reading fields.
4. Press the Calibrate Voltage button.
5. Confirm that the Switchboard Card readings match the entered values, they are shown to the right.

Note: CT Calibration Procedure

1. Ensure that the CTs are correctly wired to the CT Burden Module, and the low-voltage cable from the CT Burden Module is correctly wired to the Switchboard Card.
2. Ensure that the load is stable so that the current will not significantly fluctuate during the calibration process.
3. Measure the current with a calibrated clamp-on ammeter. Record the values for each phase measurement.
4. Enter the recorded values in the Meter Reading fields.
5. Press the Calibrate Current button.
6. Confirm that the Switchboard Card readings match the entered values, they are shown to the right.

6.11.5 Switchboard Startup Chart

The Instruct Startup Chart shows waveforms for the Switchboard PT and CT readings for a motor start up.

Note

The Startup Chart is only available in firmware version 2.110r010 and later.

1. Press the **Home** button on the keypad.
2. Press the **Menu** button on the keypad to bring up the top-level menu.

3. Select the **Switchboard** menu item, using either the numeric keypad or the up/down/left/right navigation keys on the keypad.
4. Select the **Startup Chart** menu item.

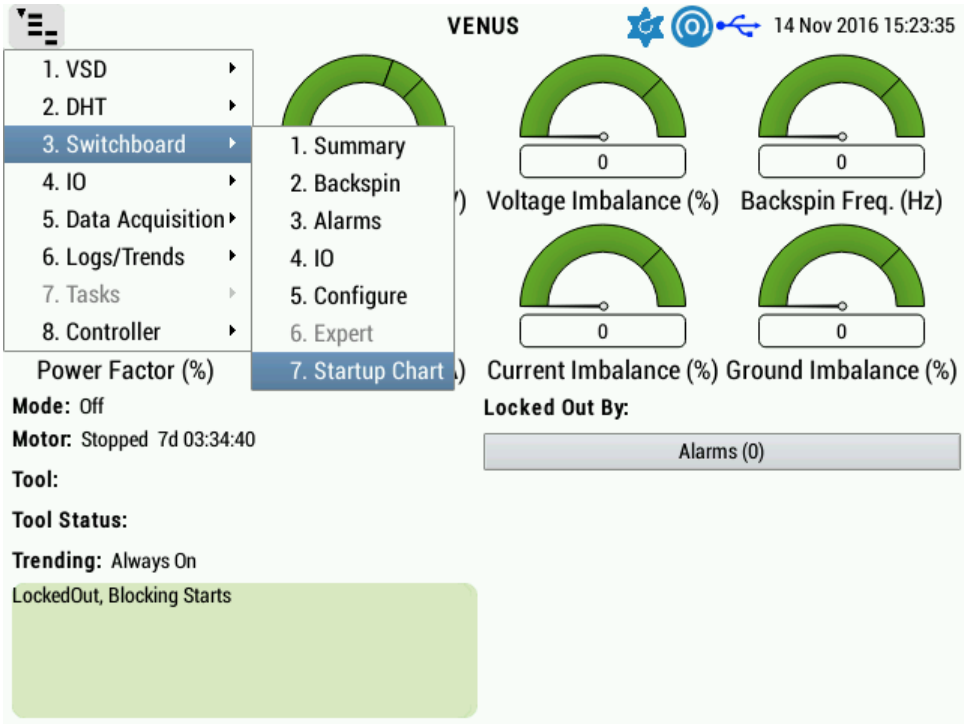

Figure 6-48: Switchboard Startup Chart Menu Tree

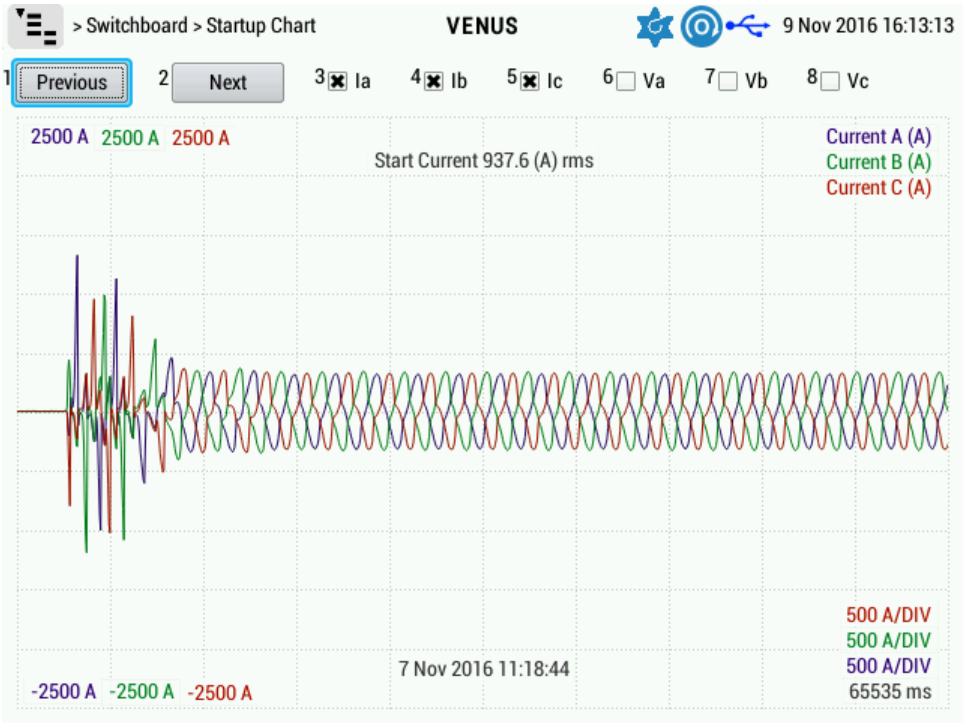

Figure 6-49: Switchboard Startup Chart Screen

Startup Chart can also be viewed through Instruct Viewer from an exported H5 file. For details, refer to Instruct Viewer user manual embedded inside the software.

6.12 Expansion Port

The expansion port parameters can be configured using the controller or StarView. Detailed configuration requirements can be found in each expansion card section.

To configure the expansion port:

1. Press the **Menu** key.
2. Select **Controller**, using the keypad or navigation keys.
3. Select the **Slot**. Select Slot 1–4 depending on which slot contains the card.

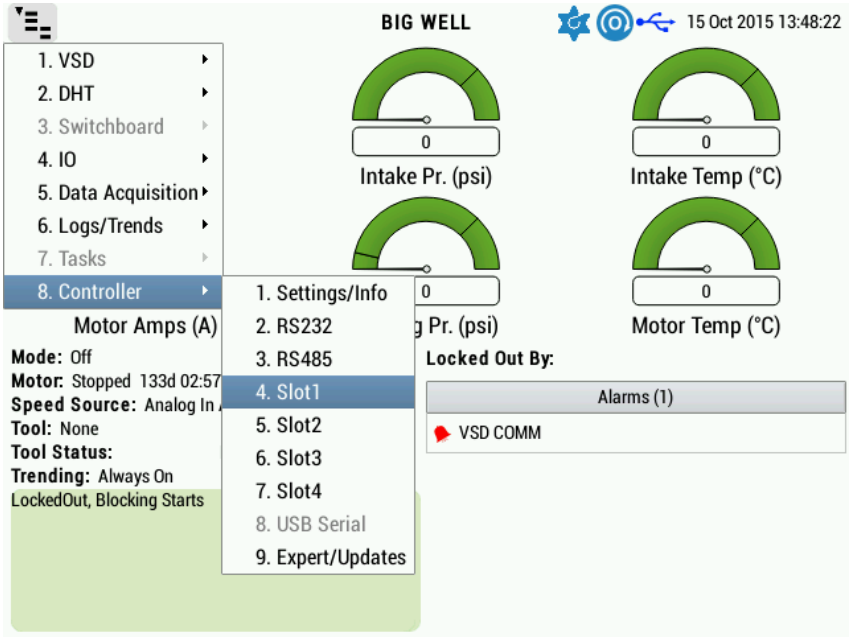

Figure 6-50: Configure Menu Tree

4. Enter the slot/card parameters. The communications configuration screens are generic for all communications settings.

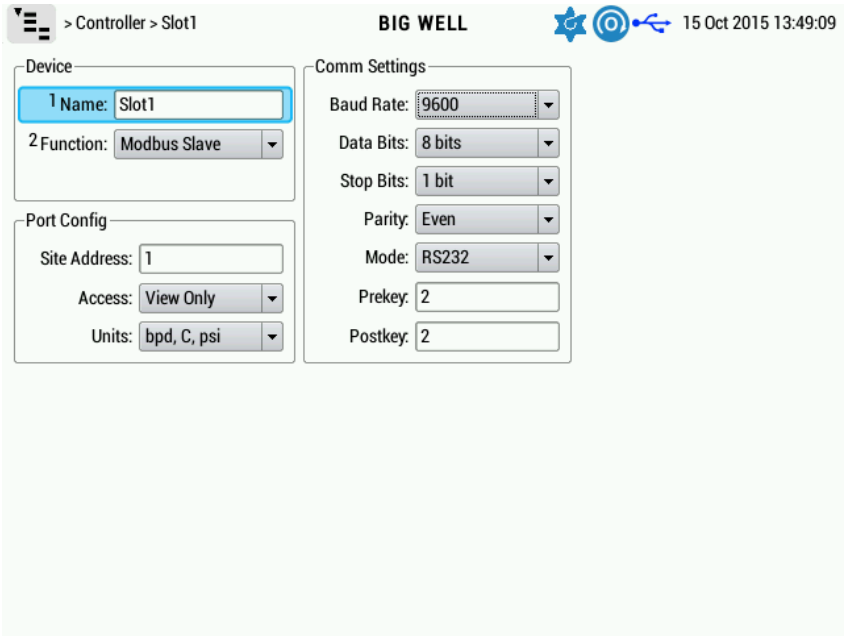

Figure 6-51: Slot Configuration Screen

6.13 Expansion Cards

This section covers the configuration procedure for the optional expansion cards using the controller user-interface. Most card parameters can be configured using the controller interface or StarView. Refer to the StarView user guide for StarView configuration details.

Caution

Potential Severity: Light
Potential Loss: Assets, Reputation
Hazard Category: Electrical

Do not connect the USB cable to the Instruct controller before it fully boots up. Otherwise, the controller may not be able to boot up successfully.

6.13.1 Configuring the Communications Card

1. Press the **Home** button on the keypad.
2. Press the **Menu** button on the keypad to bring up the top-level menu.
3. Select the **Controller** menu item using either the numeric keypad or the up/down/left/right navigation keys on the keypad.
4. Select the appropriate **Slot** *n* menu item using either the numeric keypad or the up/down/left/right navigation keys on the keypad.

   The expansion slot closest to the front of the unit (display) is Slot 1 and the expansion slot at the back of the unit is Slot 4.
5. Rename the slot as needed by the application. For example, it may be useful to name the port “SCADA 1” or “LiftWatcher SCB.” To rename a slot, select the **Device>Name** option using the up/down/left/right navigation keys on the keypad. press the **Enter** (✓) button.
6. Change the function to Modbus Slave by selecting the **Device>Function>Modbus>Modbus Slave** option. Press the **Enter** (✓) button to confirm the selection.
7. Change the Modbus Slave ID by selecting the **Port Config>Site Address** option, using the numeric keypad to enter the desired value. Press the **Enter** (✓) button to confirm the selection.
8. Change the Read/Write Access Level by selecting a **Port Config>Access>Full/View Only** option. Press the **Enter** (✓) button to confirm the selection.

9. Change the Units configuration by selecting a **Port Config>Units>** option. Press the **Enter** (✓) button to confirm the selection.
10. Change the Baud Rate by selecting a **Comm Settings>Baud Rate>** option. Press the **Enter** (✓) button to confirm the selection.

    Available options range from 300 to 57,600 baud. As a general rule it is recommended that the fastest speed that can be reliably supported by the cabling/noise environment is selected.
11. Change the Data Bits by selecting a **Comm Settings>Data Bits>** option. Press the **Enter** (✓) button to confirm the selection.

    Available options are 7 and 8 bits. 8 bits is the default.
12. Change the Stop Bits by selecting a **Comm Settings>Stop Bits>** option. Press the **Enter** (✓) button to confirm the selection.

    Available options are 1 and 2 bits. 1 bit is the default.
13. Change the Parity by selecting a **Comm Settings>Parity>** option. Press the **Enter** (✓) button to confirm the selection.

    Available options are None, Even, and Odd. None is the default.
14. Change the Mode to RS-232 by selecting **Comm Settings>Mode>RS232**. Press the **Enter** (✓) button to confirm the selection.

    Available options are RS485 and RS232.

Note

It is important to note that RS232 must always be selected for the Isolated Comm Card, even when the card will be used in RS-485 mode.

---

15. Change the Prekey value by entering a **Comm Settings>Prekey>** value, using the numeric keypad to enter the desired value. Press the **Enter** (✓) button to confirm the selection.

    Longer delays may be necessary for serial links with intermediate equipment such as modems, repeaters, and protocol converters or older legacy acquisition systems. If no intermediate or legacy equipment is present a value of 10ms is recommended for 9,600 baud and 2ms for 57,600 baud.

16. Change the Postkey value by entering a **Comm Settings>Prekey>** value, using the numeric keypad to enter the desired value. Press the **Enter** (✓) button to confirm the selection.

    Longer delays may be necessary for serial links with intermediate equipment such as modems, repeaters, and protocol converters or older legacy acquisition systems. If no intermediate or legacy equipment is present a value of 10ms is recommended for 9,600 baud and 2ms for 57,600 baud.

6.13.2 Configuring the Instruct for the Modbus TCP/IP Card

Configuring the controller to use the Modbus TCP/IP card with specific operation parameters such as baud rate, data bits, and parity may be done in one of two ways — either directly on the controller or by way of the StarView PC software.

Note

Prior to configuring the Instruct controller it is necessary to check and/or set the Modbus TCP/IP card settings, using a terminal program.

1. Insert the card into the controller and power on the controller,
2. Connect a serial cable between PC and the card RS-232 Engineering Port.
3. Start a serial console application, using the following settings; Baud: 9600, Format: 8, N, 1, No Parity Flow Control: None
4. Hold the x key on the PC keyboard and hit the reset button on the Modbus TCP/IP card.
5. While holding the x key, release the reset button. The card should boot into configuration mode. Press Enter to go into Setup Mode.
6. Make note of the Serial and Mode Settings.

---

1. Press the **Home** button on the keypad.
2. Press the **Menu** button on the keypad to bring up the top-level menu.
3. Select the **Controller** menu item using either the numeric keypad or the up/down/left/right navigation keys on the keypad.
4. Select the appropriate**Slot** *n* menu item using either the numeric keypad or the up/down/left/right navigation keys on the keypad.

   The expansion slot closest to the front of the unit (display) is Slot 1 and the expansion slot at the back of the unit is Slot 4.

5. Rename the slot as needed by the application. For example, it may be useful to name the port “SCADA 1” or “LiftWatcher SCB.” To rename a slot, select the **Device>Name** option using the up/down/left/right navigation keys on the keypad and press the **Enter** (✓) button.
6. Change the function to Modbus Slave by selecting the **Device>Function>Modbus>Modbus TCP/IP** option. Press the **Enter** (✓) button to confirm the selection.
7. Change the Modbus Slave ID by selecting the **Port Config>Site Address** option, using the numeric keypad to enter the desired value. Press the **Enter** (✓) button to confirm the selection.
8. Change the Read/Write Access Level by selecting a **Port Config>Access>Full/View Only** option. Press the **Enter** (✓) button to confirm the selection.
9. Change the Units configuration by selecting a **Port Config>Units>** option. Press the **Enter** (✓) button to confirm the selection.
10. Change the Baud Rate to 57,600 baud by selecting the **Comm Settings>Baud Rate>57600** option. Press the **Enter** (✓) button to confirm the selection.
11. Change the Data Bits to 8 by selecting the **Comm Settings>Data Bits>8** option. Press the **Enter** (✓) button to confirm the selection.
12. Change the Stop Bits to 1 by selecting the **Comm Settings>Stop Bits>1** option. Press the **Enter** (✓) button to confirm the selection.
13. Change the Parity by selecting a **Comm Settings>Parity>** option. Press the **Enter** (✓) button to confirm the selection.

    Available options are None, Even, and Odd. None is the default.
14. Change the Mode to RS-232 by selecting **Comm Settings>Mode>RS232**. Press the **Enter** (✓) button to confirm the selection.

    Available options are RS485 and RS232.

Note

It is important to note that RS232 must always be selected for the Modbus TCP/IP Card.

---

15. Change the Prekey value by entering a value of 2 into **Comm Settings>Prekey>**, using the numeric keypad to enter the desired value. Press the **Enter** (✓) button to confirm the selection.
16. Change the Postkey value by entering a value of 2 into **Comm Settings>Postkey>**. Use the option using the up/down/left/right navigation keys on the keypad, the numeric keypad to enter the desired value, and the **Enter** (✓) button to confirm the selection.

6.13.3 Configuring the PIC Using Instruct

Note

The Instruct can support up to 4 PIC cards.

Configure the appropriate expansion port communication parameters for Function – PIC (or multi-PIC PIC #2, multi-PIC PIC #3, multi-PIC PIC #4,), Site Address = 1, 9600 baud, 8 bits, No parity, 1 stop bit, RS-485 (8,NONE,1,RS485). Prekey delay = 2ms, Postkey delay = 2ms.

For field Multi-PIC Case History and Best Practice, refer to InTouch Content 7117156 and InTouch Content 7119771.

To use Multi-PIC function with LiftWatcher system, the user need to manually add the needed Modbus register of the additional PIC cards in the Liftwatcher System.

Caution

Potential Severity: Light
Potential Loss: Assets, Reputation
Hazard Category: Electrical, Temperature

The maximum ambient temperature rating for two PICs inside instruct is 65 degC. This can be increased to 75 degC by adding a fan inside Instruct enclosure. Contact InTouch for details of fan solution. The software that support Multi_PIC function is V2.106r012 or later.

1. Press the **Home** button on the keypad.
2. Press the **Menu** button on the keypad to bring up the top-level menu.
3. Select the **DHT** menu item.
4. Select the **PIC** menu item.

Note

When using the multi-PIC function, choose the slot according to physical hardware setup.

5. Select the **Expert** menu item.

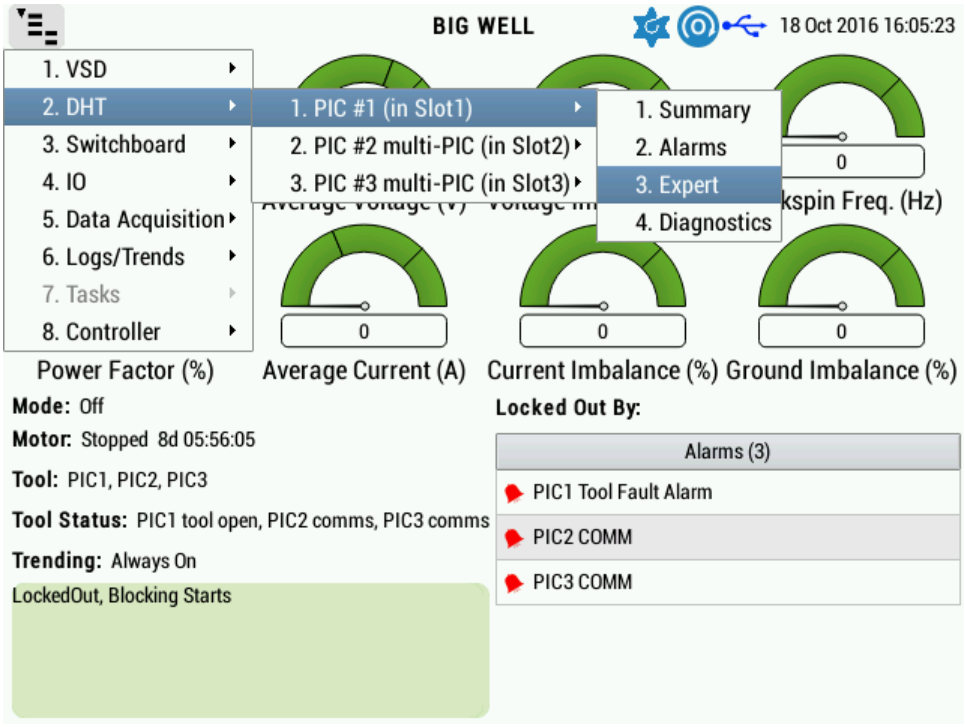

Figure 6-52: PIC Menu Tree

6. Verify tool type and status.

7. Verify the DHT parameters. If required, modify parameters using the keypad or navigation keys.

Note

Depending on the DHT in use some parameters may be nonfunctional as the DHT does not support the data.

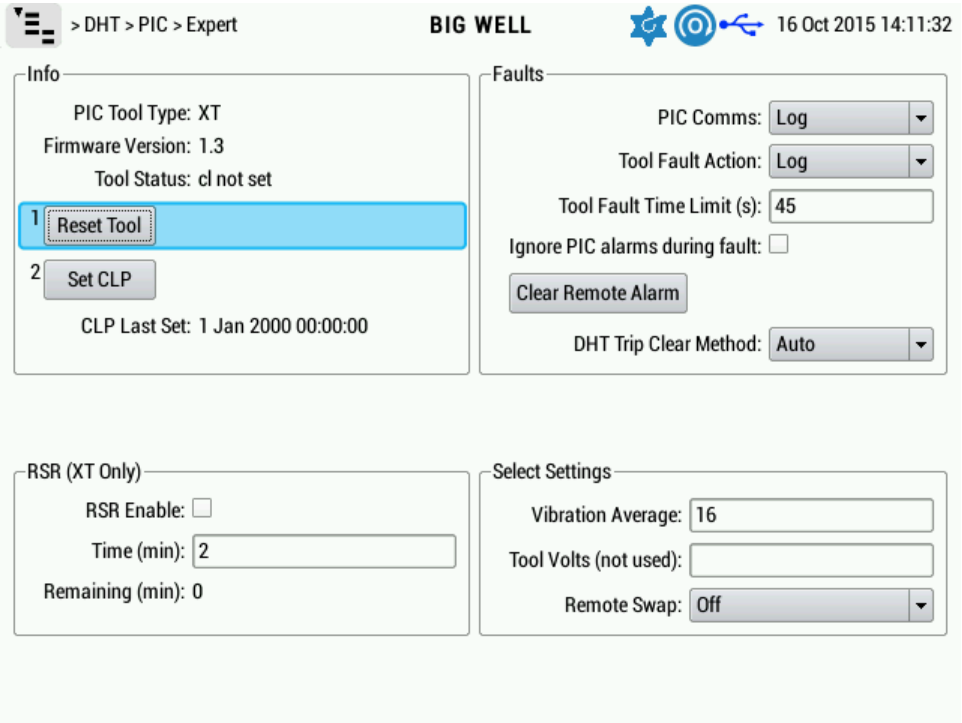

Figure 6-53: PIC Expert Screen

8. Press the **Menu** button on the keypad to bring up the top-level menu.
9. Select the **Alarms** menu item.

10. Verify the alarm parameters. If required, modify parameters using the keypad or navigation keys.

Note

Depending on the DHT in use some parameters may be nonfunctional as the DHT does not support the data.

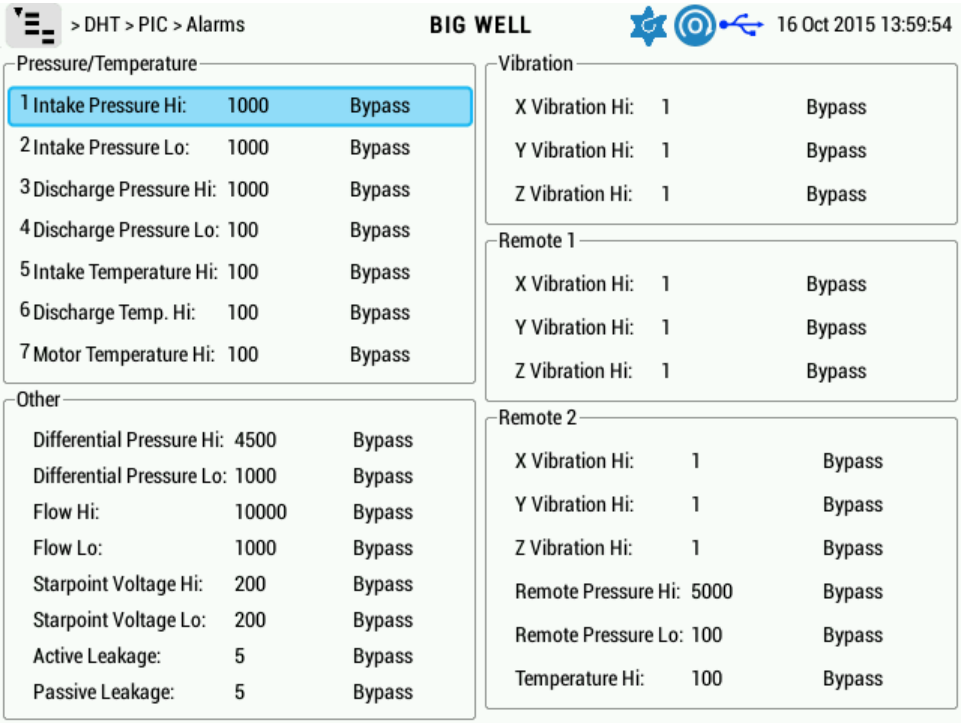

Figure 6-54: PIC Alarms Screen

11. Press the **Menu** button on the keypad to bring up the top-level menu.

12. Select the **Summary** menu item.

13. Verify parameters and readings.

Note

Depending on the DHT in use some parameters may be nonfunctional as the DHT does not support the data.

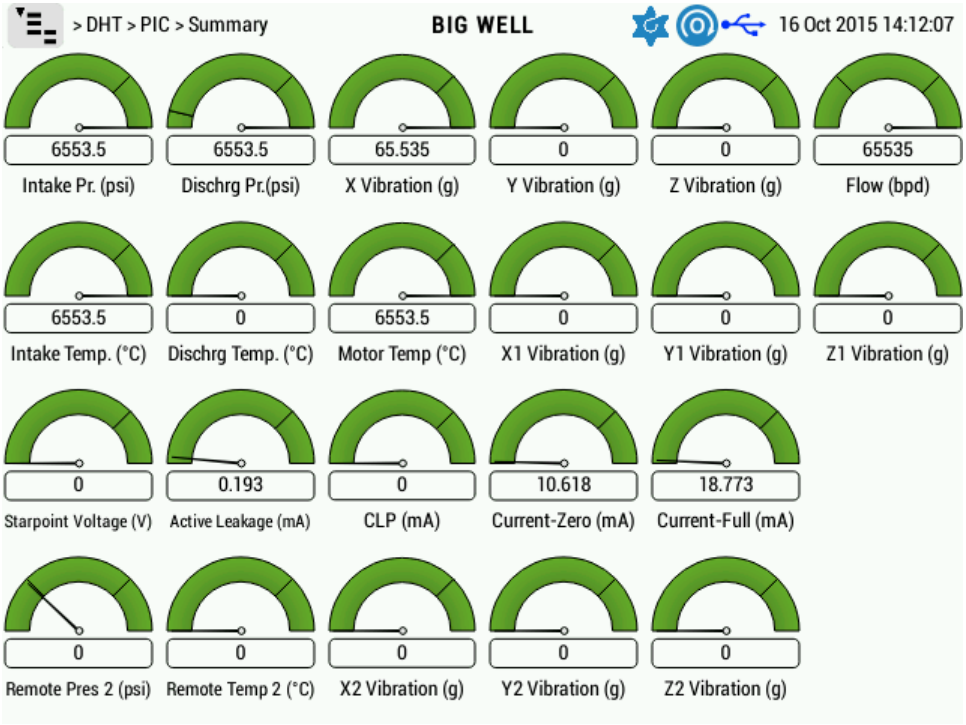

Figure 6-55: PIC Summary Screen

6.13.4 Configuring the Extreme Card Using Instruct

Note

Configure the appropriate expansion port communication parameters for Site Function – Extreme, Address = 1, 9600 baud, 8 bits, No parity, 1 stop bit, RS-485 (8,NONE,1,RS485). Prekey delay = 2ms, Postkey delay = 2ms.

1. Press the **Home** button on the keypad.
2. Press the **Menu** button on the keypad to bring up the top-level menu.
3. Select the **DHT** menu item.
4. Select the **Extreme** menu item.

5. Select the **Expert** menu item.

Figure 6-56: Extreme Menu Tree

6. Verify tool type and status.

7. Verify the DHT parameters. If required, modify parameters using the keypad or navigation keys.

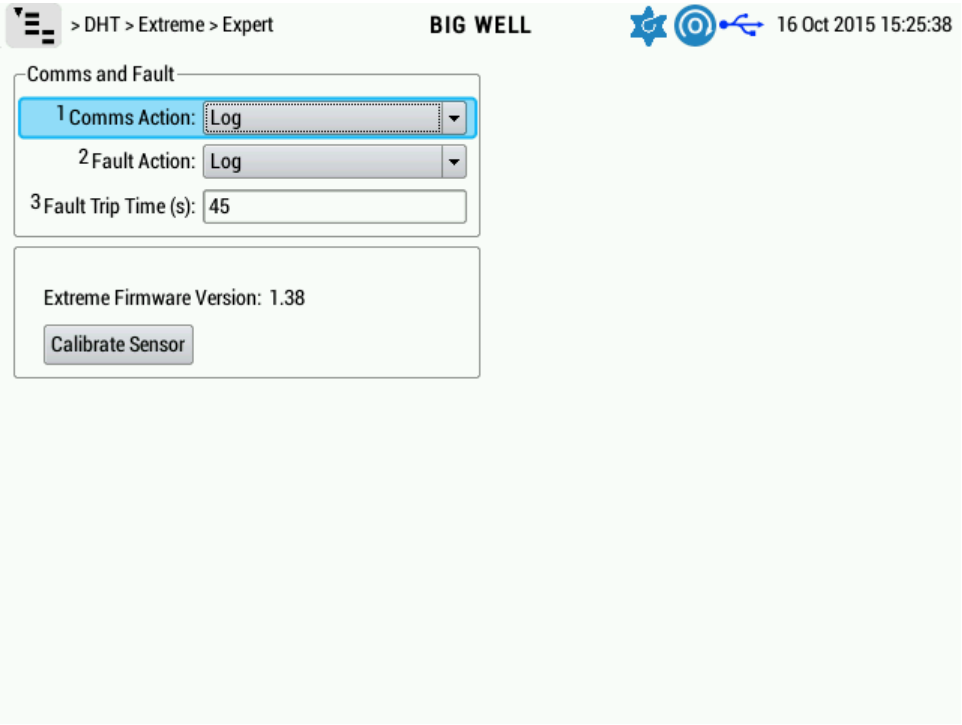

Figure 6-57: Extreme Expert Screen

8. Press the **Menu** button on the keypad to bring up the top-level menu.
9. Select the **Alarms** menu item.

10. Verify the alarm parameters. If required, modify parameters using the keypad or navigation keys.

Note

Depending on the DHT in use some parameters may be nonfunctional as the DHT does not support the data.

Figure 6-58: Extreme Alarms Screen

11. Press the **Menu** button on the keypad to bring up the top-level menu.

12. Select the **Summary** menu item.

13. Verify parameters and readings.

Note

Depending on the DHT in use some parameters may be nonfunctional as the DHT does not support the data.

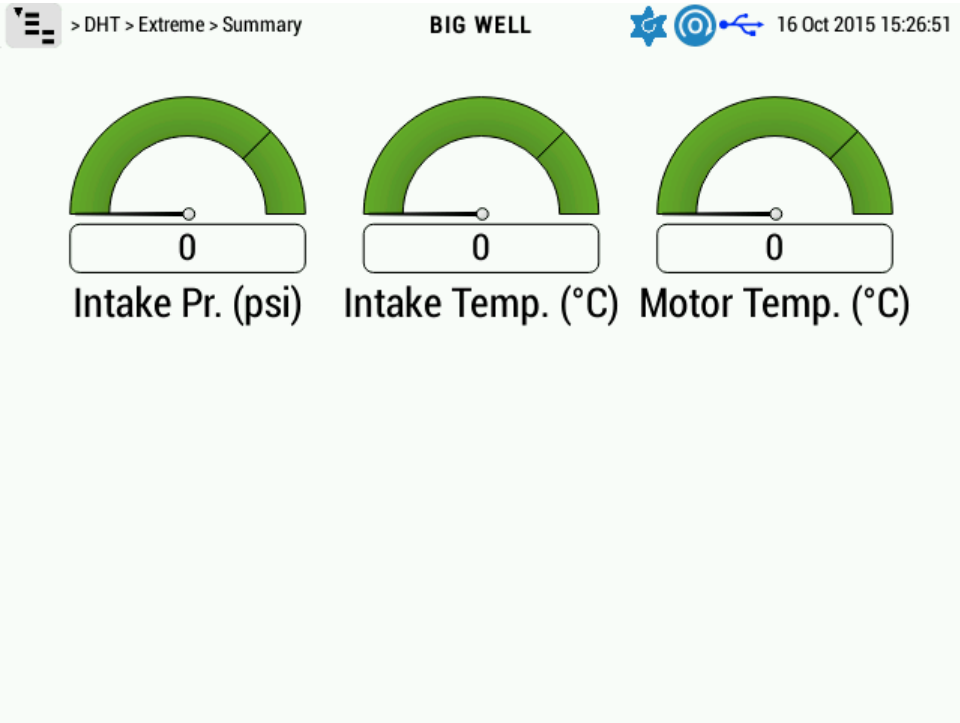

Figure 6-59: Extreme Summary Screen

6.14 Slot A/B

The Slot A/B alarms can be configured with the following steps:

1. Press the **Home** button on the keypad.
2. Press the **Menu** button on the keypad to bring up the top-level menu.
3. Select the **Controller** menu item.

4. Select the **Slot A/B** menu item.

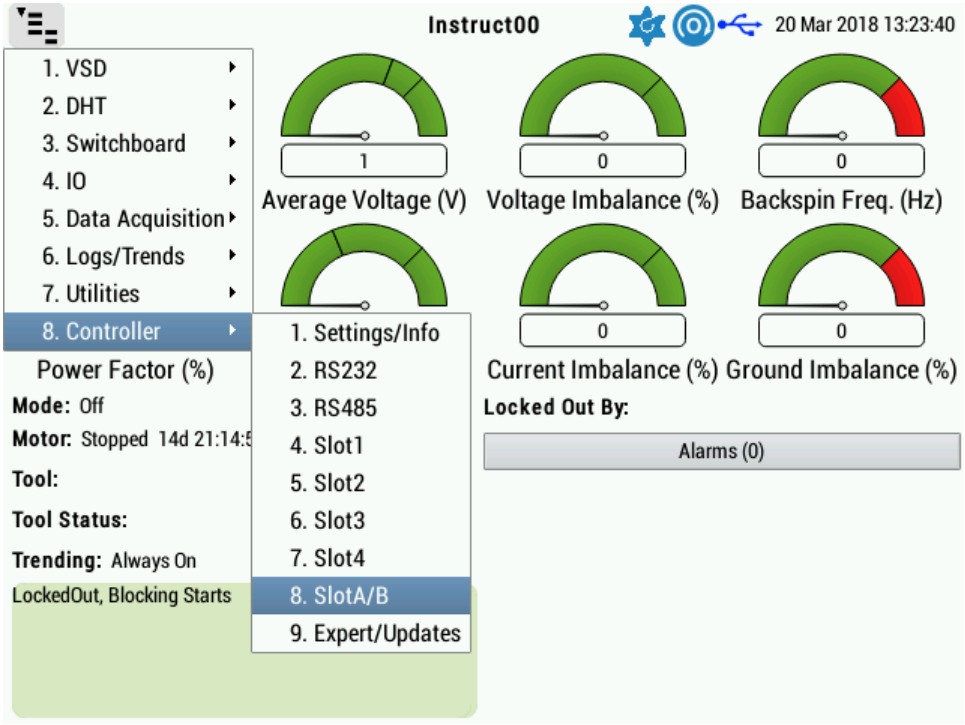

Figure 6-60: SlotA/B Menu Tree

Figure 6-61: SlotA/B Screen

5. Set the “Action” field as the intended action to be taken, when the “Expected HW” field setting is different from the HW detected by Instruct. It can be individually configured for both Slot A and Slot B, as – Bypass, Log, Stop, Stop & Log.

Figure 6-62: SlotA/B Action

Note

If the “Action” field is set to “Bypass”, Slot A/B alarm will not be triggered in any case. It should be set to “Bypass”, only if the application does not require Slot A/B alarm under any situation.

6. Set the “Expected HW” field to comply with the type of card, physically inserted into the respective Slot. It can be individually configured for both Slot A and Slot B, as – None, Any, IO Card, SWB card. If the “Expected HW” field setting does not match with the card detected by Instruct, or if the cards in Slot A or Slot B malfunction, an alarm is raised for the respective slot. The action taken by Instruct for this alarm, will depend on the setting in “Action” field (refer to “Example scenario for Slot A alarm” section below).

Figure 6-63: SlotA/B Expected HW

Table 6-1: Expected HW Options

S. No.	Option	Description
1.	None	No card shall be inserted
2.	Any	Either of the cards can be inserted.
3.	IO Card	IO card shall be inserted.
4.	SWB Card	SWB card shall be inserted.

7. Set the “Trip Time (s)” to define a definite delay (in seconds) before stopping the drive. In case of a Slot A/B alarm, the time delay can provide a window for an application specific corrective action (e.g. manual intervention), before stopping the drive. The delay holds a significance only if “Action” field is either set to “Stop” or “Stop & Log”, as the drive will not be stopped in other cases.

6.15 Controller Statistics

The Controller Statistics features are available in FW 2.117r002 and later version. The statistic screen is under Instruct **Menu-> Controller-> Statistics**.

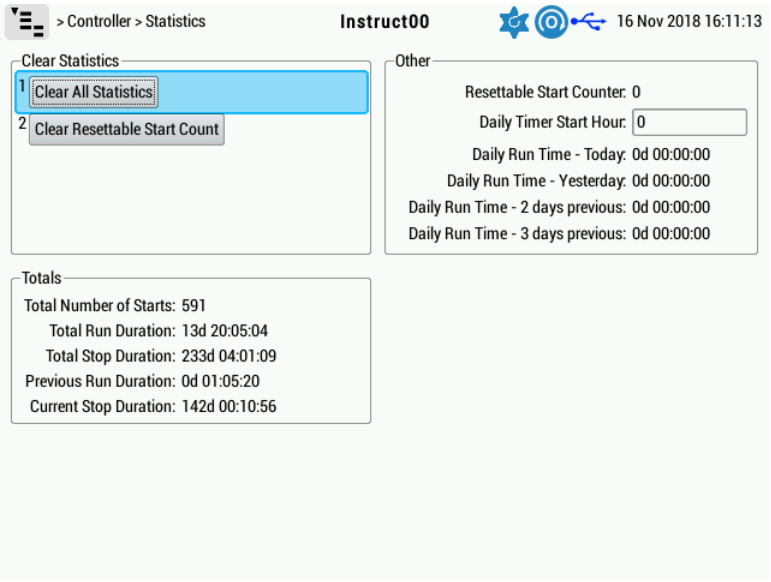

Figure 6-64: Controller Statistics

The following functions are available.

- Clear All Statistics: resets all the historical statistics to zero including all the data in the Totals group, and the resettable start counter and all four daily run timers in the Other group. This function can only be used when the Instruct is set to Manual Off mode. Please note that the statistics displayed in the Totals group is the same information that is available in the Instruct **Menu -> Controller -> Settings/Info** screen, which would also be reset.
- Clear Resettable Start Count: resets the Resettable Start Counter in the Other group to zero. Note the Total Number of Starts in the Totals group will be unaffected by this reset. This function can only be used if the Instruct is set to Manual Off mode.

The following setting is available:

- Daily Timer Start Hour: specifies the hour when all four daily timers will roll over, and today's timer will start again at zero; note that the valid range is 0 – 23. For example, if the setting is 7 then every day at 07:00:00 the Daily Run Time – Today will start again at zero. The value previously displayed in Daily Run Time – Today will roll over to Daily Run Time – Yesterday.

The following statistics are available:

- Total Number Of Starts: The total number of start commands issued from the Instruct since the last time this statistic was cleared.
- Total Run Duration: the total amount of time the VSD/SWB has been running.
- Total Stop Duration: the total amount of time the VSD/SWB has been stopped. Please note that any time the Instruct is powered down will be included as stop time.

- Previous/Current Run Duration: the amount of time that the VSD/SWB was or has been continually running since the most recent start attempt. The Instruct display will show Current or Previous depending on whether the VSD/SWB is currently running or not.
- Previous/Current Stop Duration: the amount of time that the VSD/SWB was or has been continually stopped, since the most recent stoppage. Note, that the period when the Instruct is powered down will be included as stop time. The Instruct display will show Current or Previous depending on whether the VSD/SWB is currently stopped or not.
- Resettable Start Counter: the number of start attempts since this statistic was last cleared.
- Daily Run Time – Today: the amount of time the VSD/SWB has run in the last 24 hours, as defined by the Daily Timer Start Hour setting.
- Daily Run Time – Yesterday: the amount of time the VSD/SWB ran yesterday.
- Daily Run Time – 2 Days Previous: the amount of time the VSD/SWB ran two days ago.
- Daily Run Time – 3 Days Previous: the amount of time the VSD/SWB ran three days ago.

Example

When the Daily Timer Start Hour is adjusted, the daily timers are not immediately affected. Daily Run Time – Today will continue to accumulate until the newly set start hour is reached, upon when all the timers will roll-over as usual.

This could therefore, cause the “daily” timer to count either less or more than a full 24h even if the system was running uninterrupted the entire time, depending on the setting change and when it occurred.

- Suppose the Instruct was set to roll-over at 7:00am and at 7:30 am the Daily Timer Start Hour was changed to 8am. At 8:00am, the timers would roll-over as usual, thereby resulting in a “daily” run time of 1 hour.
- Suppose the Instruct was set to roll-over at 7:00am, and at 6:30am the Daily Timer Start Hour was changed to 6am. If the Instruct runs uninterrupted the entire time, the timers would roll-over at 6:00am the next morning. The result would be a “daily” run time of 47 hours.

Note

In a similar fashion as the above note, when the Instruct system time is adjusted, or if the Instruct was reset to factory defaults, the timers are not immediately affected. After a factory reset, the Daily Timer Start Hour is set to default, which is 0 (i.e.: midnight).

Example

The Instruct will count time even when it is powered off, and therefore will roll the timers.

If the Instruct was powered off for 1 full day the timers will all roll-over once, with Daily Run Time – Today becoming at zero. If the Instruct is powered off continuously for more than 4 days, all the timers would be zero

Commissioning

7 Commissioning

7.1 Switchboard Commissioning Process

Fixed speed represents controller operation configured for switchboards or non - variable speed drive applications.

7.1.1 Controller/Switchboard Verification

For the safety of the ESP equipment and operating personnel it is important to perform a series of routine checks before startup.

Warning

Potential Severity: Serious
Potential Loss: Personnel
Hazard Category: Electrical

Ensure that lockout/tagout procedures are followed at all times per the Artificial Lift Electrical Operations Standard (InTouch ID 4283852).

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1. Once the switchboard is installed at the site it is necessary to check all wiring connections, including the grounding connection between the switchboard and earth ground. A ‘tug and pull’ test will locate any loose connections.
2. The PT settings must be verified against the *Controller Commissioning Record*. Refer to drawing located on the inside door of the high-voltage compartment of the switchboard.
3. The CT Burden Module rating must be consistent with the motor current rating in the *Controller Commissioning Record*. The CT Burden Module is connected to the controller CT Inputs and is mounted with the controller inside the switchboard low-voltage compartment. The ampere rating of the switchboard must not exceed the range of the CT Burden Module.
4. Ensure that the main disconnect, breaker CT-1, and breaker CT-2 are all OPEN.
5. Verify the phase wiring is correct: Phase A (RED) on the left, Phase B (BLACK) in the center, and Phase C (BLUE) on the right. It is important to ensure that the phase wiring is correct at the main disconnect, vacuum contactor, transformer primary inputs, transformer secondary inputs, wellhead junction box, and motor lead connections.

6. With power applied to the switchboard, a qualified electrician should verify the incoming voltage at the main disconnect.
7. With the disconnect closed, the voltages on the PT primaries should be verified to be within the controller input range (0-120 volts AC).

7.1.2 Controller Parameter Setup

Perform the following steps to set up controller parameters:

1. After verifying the checks in the *Controller/Switchboard Verification* section, close the CT-1 breaker. The controller will display the Status Screen after the firmware loads. It is common to have active alarms displayed at this time.
2. The parameters in the Motor Table should be set according to the values in the *Controller Commissioning Record*.

Note
The PT Ratio should be set to the highest voltage within the range of PT2, PT3, and PT4 taps. Refer to the diagram posted inside the switchboard to find this value.

3. Compare the controller voltage readings with measurements taken with a calibrated voltmeter by a qualified electrician. Adjust the controller configuration and settings as required.
4. The supply voltage should not be within 5% of either the High or Low alarm levels. Adjust these alarm settings if required.
5. The phase rotation must be ABC. Check the phasing if the controller displays ACB for the rotation value.
6. The settings in the Field Table must be set according to the site specific equipment connected to the analog and digital inputs.

Note
After all parameters are set there should be no active alarms.

1. Go into the Switchboard Configure screen (Menu->Switchboard->Configure), and set the following parameters at the minimum, for typical Switchboard applications:

   Backspin Module Installed
   Select Yes if a Backspin Module is installed and connected to the Switchboard Card.

   CT Module
   Select Enable if CTs or a CT Burden Module is installed and connected to the Switchboard Card.

   PT Module
   Select Enable if PTs are installed and connected to the Switchboard Card.

   Number of PTs
   Select 2 or 3 PTs depending on the installation configuration.

   PT Ratio
   Enter the transformer ratio of the PTs here.

   CT Ratio
   Enter the transformer ratio of the CTs for CT Burden Module here.

   Motor Nameplate Rating
   Enter the current rating found on the motor nameplate.

2. Go into the Switchboard IO screen (Menu>Switchboard>IO), and set the following parameters for typical Switchboard applications:

   Digital Inputs
   Configure any Digital Input connected to the Switchboard Card. Each input can be given a name and the input's function, action, alarm trip, trip time, number of allowable restarts, restart delay, start bypass and maint. bypass must all be configured.

   Digital Outputs
   The Switchboard Card provides 3 digital outputs. The first (Relay 1) is preconfigured for contactor operation. The other 2 (if used) must be configured for name, action and activation source alarm.

   Analog Input
   Configure the Analog Input for name, voltage/current mode, raw input min/max percentage, scaled value min/max and hi/lo protection alarms. The alarms can be configured for action, setpoint, trip time, allowable restarts, restart delay, start bypass and name.

   Analog Output
   Configure the Analog output for name, source, raw value min/max percentage, scaled value min/max and setpoint.

3. Go into the Switchboard Alarms screen (Menu>Switchboard>Alarms), and set the following parameters for typical Switchboard applications:

Source Alarms

Set the Undervoltage, Overvoltage, Voltage Imbalance and Hi/Lo Frequency protection set points, along with their associated protection setup – action, trip time, number of allowed auto restarts, auto restart delay, and bypass time during startup.

Load Alarms

Set the Underload, Overload, Current Imbalance, Power Factor, Stall and Short Circuit protection set points, along with their associated protection setup – action, trip time, number of allowed auto restarts, auto restart delay, and bypass time during startup.

Underload Tracking

Enable Underload Tracking if desired and enter Tracking Target percentage.

Rotation

Select the Rotation Direction and Source.

Backspin

Set the Backspin Alarm, Backspin Frequency, and Ground Imbalance protection set points, along with their associated protection setup – action, trip time, number of allowed auto restarts, auto restart delay, and bypass time during startup.

7.1.2.1 Fixed Speed Controller Settings

Table 7-1: Recommended FSD Controller Settings

Switchboard Controller Recommended Settings			Alarm Settings				
Parameter	**Setpoint**	**Action**	**Setpoint**	**Trip time (sec)**	**No. of auto restart allowed**	**Restart Delay (min)**	**Start bypass (sec)**
Current	Current unbalance	Log and Stop	20.00%	2.0	0	30	0.0
	Overload	Log and Stop	1.15* Running Amp	16.0	0	30	0.0
	Underload	Log and Stop	0.80* Running Amp	8.0	3	30	0.0
	Short Circuit	Bypass	6* Motor NamePlate Amps	0.4			
	Stall	Bypass	3* Motor NamePlate Amps	0.5			

Switchboard Controller Recommended Settings			Alarm Settings				
Parameter	**Setpoint**	**Action**	**Setpoint**	**Trip time (sec)**	**No. of auto restart allowed**	**Restart Delay (min)**	**Start bypass (sec)**
Voltage	Voltage Unbalance	Log and Stop	5.00%	4.0	3	30	0.0
	Overvolt	Log and Stop	1.1 * Surface voltage	1.0	3	30	0.0
	Undervolt	Log and Stop	0.9 * Surface voltage	4.0	3	30	0.0
Frequency	High frequency	Log and Stop	Supply frequency + 5Hz	0.2	3	30	0.0
	Low frequency	Log and Stop	Supply frequency - 5Hz	0.2	3	30	0.0
Supply volt	High supply volt	Log and Stop	Supply volt + 10V	0.5	3	30	0.0
	Low supply volt	Log and Stop	Supply volt - 10V	9.0	3	30	0.0
Others	Power factor	Log and Stop	50%	0.2	0	30	0.0
	Leg Ground	Log and Stop	40.00%	0.5	3	30	0.0
				Clear Time (sec)	Alarm on Reverse Spin Only		
	Spin	Log and Stop	2.0 Hz	30.0	No		
				Detection			
	Rotation	Stop	ACB	Current			

7.1.3 Startup Procedures

Perform the following procedures to start up a controller:

1. Set up the controller with all the minimum parameters described in the controller (Switchboard) Parameter Setup section.

2. Verify that no alarm(s) are active and/or latched and the unit is not locked out. If any of these condition(s) are active, unlock the unit, unlatch the active latched alarm(s) and clear all other active alarm(s) by rectifying their cause(s).

   a. Select HAND/AUTO operation mode, then press START. If the unit is locked out or any alarm is still latched, the START button will not appear in the display when HAND/AUTO mode is selected.

   b. Calibrate the Switchboard Current Amps and Switchboard Phase Voltage readings by adjusting CT Ratio and PT Ratio setpoints. Do this by comparing displayed initial Switchboard current and voltage values to the values obtained using a multimeter. Further refinement of the readings is possible using the calibration feature found on the Switchboard Configure screen (Menu>Switchboard>Configure). For voltage calibration, enter the meter readings for each phase and select Calibrate Voltage. For current calibration, enter the meter readings for each phase and select Calibrate Current.

   c. Reset the Under/Overload and Under/Overvoltage settings of the Switchboard card accordingly.

   d. Once all external signals and subsystems have been connected to the drive, run the drive for a reasonable period of time to confirm proper operation and that no faults or shutdowns occur.

   e. Download the configuration/history/data for future reference.

7.2 VSD Commissioning Process

Variable speed drive (VSD) represents the controller operation configured for VSD.

7.2.1 Controller/VSD Verification

For the VSD, perform all relevant Startup and Commissioning steps as detailed in the respective drive manual. For example:

☐ **1.** *Section 8 of the SpeedStar and VariStar 2000+ and SWD Operations Manual* (InTouch ID 4197006)

☐ **2.** *Section 8 of SpeedStar 519 VSD - SWD Operations Manual* (InTouch ID 4933237)

Disregard any procedures for the HMI in the drive manuals.

1. Verify that power is available on the controller. Simply check whether the Power Status LED is lit.

2. Verify that communication between the drive inverter control board and the controller is established properly. To do this, ensure that VSD Comm (*) alarm does not appear (along with other active alarm(s)). If VSD Comm* appears, go to the Alarms screen and select Unlatch then ensure that VSD Comm (*) alarm has disappeared.

Note

This step assumes that the controller has been setup properly for a VSD application. If communications was not setup for a VSD, VSD Comm* will not appear. Refer to 6.10.1: VSD Communication Settings.

---

3. If the VSD Comm display still blinks:
   a. Check that the proper communication cable is used between the controller and the Toshiba inverter control board, and that it is securely connected. Also ensure that the cable is firmly connected at both ends.
   b. If an option card is being used to interface with the VSD, ensure that the correct Communication Card is used and it has been inserted properly into one of controller expansion card slots. Both screws on the card face plate should be screwed in until the face plate is flush with the controller side wall.
   c. Check the Function setting of the communications port connected to the VSD or expansion card slot where the Communication Card is inserted. All default communication settings should be used, a factory reset may be required if they have been changed.

Note

This step assumes that the controller has been setup properly for a VSD application.

7.2.2 Controller Parameter Setup

1. Go into the VSD Speed screen (Menu>VSD>Speed), and set the following parameters at the minimum, for typical ESP applications:

VSD Speed Source

For most applications, setting this to **Target Speed** means the drive will run on the speed entered in **Target Speed** parameter. Setting this to **Analog In 1/2/3/4** means the running speed will be following the signal level connected to the selected Analog Input channel.

Target Speed

Set as the desired operating speed.

Maximum Speed

Set according to the following equations:

Equation 7-1:

$$50 \times \sqrt{(\text{Motor HP at 50 Hz/Load HP at 50 Hz})}$$

Equation 7-2:

$$60 \times \sqrt{(\text{Motor HP at 60 Hz/Load HP at 60 Hz})}$$

Minimum Speed

Should be set at the minimum frequency where the ESP can still pump fluid to surface. This needs to be confirmed through the DesignPro software or other sizing program used.

Startup Frequency

Should be set between 7-10 Hz for most ESP applications; setting this too low could lead to the pump stalling during start-up.

Carrier Frequency

Required only when used with SpeedStar 2000 or VariStar 2000+. With SpeedStar SWD or VariStar SWD, it's locked at 2.2 kHz to enable the Sinewave output filter on the drive to properly filter the output harmonics. The SpeedStar MVD is fixed at 2.048 kHz.

Changing the carrier frequency should only be done by a trained personnel, consult InTouch before doing so.

2. Go into the VSD Time screen (Menu>VSD>Time), and set the following parameters at the minimum, for typical ESP applications:

Ramp Frequency and Accel Ramp Time
Should be set to reflect how fast or slow the user would like to ramp up from **Start-Up Frequency** to **Target Speed**.

Decel Ramp time
Should be set as per the formula above, ONLY if **Stop Mode** is set to **DECEL**.

Accel/Decel Pattern
Default should be set to **Linear**.

3. Go into the VSD Configure screen (Menu>VSD>Configure), and set the following parameters at the minimum, for typical ESP applications:

V/Hz pattern
Default should be set to **Constant Torque**.

Note
If another pattern is desired consult InTouch before using it.

Base Frequency
Should be set to the maximum planned running speed. This is the frequency at which the drive is capable of delivering its full power rating – the speed where its output voltage equals input voltage for LV VSD.

Base Voltage
S7+/ST7 - Default should be set to **Voltage Compensation On**.

Catch a Spinning Motor
For most applications, set to **ON**, to enable restart without having to wait for the whole fluid column to drop through the pump.

Stop Method
For ESP applications, by default this should be set as **Coast**. **Controlled** mode should only be used in some horizontal pumping applications, where **Ramp Frequency** and **Decel Ramp Time** parameters determine the deceleration rate.

VSD Thermal Stall
For the S7+/ST7 it should be set just below **(VSD_OL/Transformer Ratio)/VSD Current Rating**, which will reduce the number of shutdowns caused by temporary overload conditions.

Transformer Ratio
As an initial value enter the nameplate voltage rating at input/nameplate voltage rating at output tap selected.

Example
The step-up transformer used has input voltage nameplate rating of 480 V and the output voltage nameplate rating on the selected tap is 2650 V. The **Transformer Ratio** should be set as *480 V/2650 V = 0.18*.

---

4. Go into the VSD Expert screen (Menu>VSD>Expert, screen 16), and set the following parameters at the minimum, for typical ESP applications:

Term	Definition
Rocking Method, Rocking Target Frequency and Number of Rocks	Set **Number of Rocks** to 0 in order to deactivate the rocking start. **Warning** Potential Severity: Serious Potential Loss: Assets Hazard Category: Machinery equipment hand tools Rocking Start should only be used as a last resort for starting. The rocking start is used to agitate a stuck pump or used during a pump startup in sanded well condition. The rocking start feature once configured, operates only once and must be re-configured if repeat rocking starts are required.

Table 7-2: Rocking start parameters

Parameter	Description
Rocking Cycles	Rocking cycles represents how many rotation pulses are to occur. This does not represent a change in direction.
Rocking Target Freq	The rocking target frequency represents the frequency the VSD drive will generate for the motor during the rocking feature.
Rocking Method	The rocking method represents different rocking patterns. • 1: STOP – JOG REVERSE – STOP – JOG FORWARD • 2: JOG REVERSE – JOG FORWARD • 3: JOG REVERSE – JOG REVERSE – JOG FORWARD – JOG FORWARD

The **Rocking Method** is performed by the number of **Rocking Cycles** at the frequency set by **Rocking Target Frequency**.

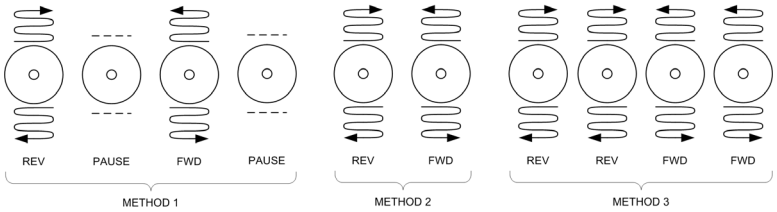

Figure 7-1: Rocking Methods

VSD Jump Frequency 1	The jump frequency applies to the frequency zones, or motor speed, where the VSD drive is not to operate. This is used to prevent the VSD from changing to a motor speed that would resonate the ESP pump. The controller can configure up to 3 frequency bands that act as dead zones for the target frequency. The VSD will not operate in these dead bands except during acceleration ramp up on start and decelerate ramp down on stop.

Example
Setting the VSD Jump Frequency to 10 Hz with a width of 2 Hz will result in a dead band from 8-12 Hz.

Table 7-3: Jump frequency parameters

Parameter	Description
VSD Jump Frequency	The centre frequency location where the jump is to occur.
VSD Jump Width	The spread from the centre frequency the dead band occupies.

5. Enable the **Tracking Underload** feature, which can be accessed through the VSD Configure screen (Menu>VSD>Configure).
6. Go into the VSD Alarms screen (Menu>VSD>Alarms), set the **Motor Current Hi** and **Motor Current Lo** setpoints, along with their associated protection setup - number of allowed auto restarts, auto restart delay, and bypass time during startup. By default, for overload, the number of auto restart attempts should be set to zero.
7. Go into the Controller Settings/Info screen (Menu>Controller>Settings/Info), set the **Supply Voltage Hi** alarm and **Supply Voltage Lo** protection set points associated with **Supply Volt level**, along with their associated protection setup - number of allowed auto restarts, auto restart delay, and bypass time during startup. This only applies to the controller supply voltage.

7.2.3 Startup Procedures

To start up the controller, perform the following procedures:

1. Ensure that all the Controller/VSD verification steps have been carried out and no problems are encountered.
2. Set up the controller with all the minimum parameters described in controller Parameter Setup section.

3. Verify that no alarm(s) are active and/or latched and the unit is not locked out. If any of these condition(s) are active, unlock the unit, unlatch the active latched alarm(s) and clear all other active alarm(s) by rectifying their cause(s).

   a. Select **HAND/AUTO** operation mode, then press **START**. If the unit is locked out or any alarm is still latched, the **START** button will not appear in the display when **HAND/AUTO** mode is selected.

   b. Calibrate the **VSD Motor Amps** reading by adjusting **Transformer Ratio**. Do this by comparing displayed initial VSD Motor Amps value to the average of three-phase measured motor current obtained using a multimeter.

   c. Reset the **Underload** and **Overload current** settings of the VSD. The settings should be a percent of the stable **VSD Motor Amps** on the final set **Target Speed**.
      - Underload = 85%
      - Overload = 110%

   d. Once all external signals and subsystems have been connected to the drive, run the drive for a reasonable period of time to confirm proper operation and that no faults or shutdowns occur.

   e. Download the configuration/history/data for future reference.

7.3 PIC Commissioning Process

Phoenix represents controller operation configured for Phoenix downhole monitoring applications using the PIC. The PIC commissioning process can be done using the StarView or the controller.

1. Configure the controller engineering port (Menu>Controller>RS232) for StarView connection.

   Site Address =1, 57600 baud, Prekey delay = 2ms, Postkey delay = 2ms.

2. Start StarView and connect the serial cable to the controller Engineering port. In StarView choose **File** — **New** , confirm site 1 — **OK**.

3. Configure communications parameters for the port (1–4) that contains the PICv2.

   Site Address = 1, 57600 baud, 8 bits, No parity, 1 stop bit, RS-485 (8,NONE,1,RS485). Prekey delay = 2ms, Postkey delay = 2ms.

4. Set the controller clock.

5. If not already done, configure the PIC. Use StarView to connect to controller engineering port and configure the PIC.
   a. Verify/set StarView communication parameters for PIC engineering port.
   b. Update PIC firmware. Refer to InTouch Content ID 4456403.
   c. Set the PICv2 Gauge Coefficients. (analog tools only)
   d. Verify coefficients. (analog tools only)
6. Connect cable from the choke to PIC downhole tool (DHT) connector. The screw terminal pin out is available on the PIC front plate (use L and C terminals).

Note
For Phoenix CTS tools the choke is not used.

Danger
Potential Severity: Major
Potential Loss: Personnel
Hazard Category: Electrical

For ESP applications high voltage may be present on the DHT choke. Ensure the power system is powered down prior to connecting DHT cable to the PIC.

7. Confirm that the correct tool type is displayed.
8. Confirm that RSR is off.
9. Reset the PIC. Wait for 1 minute while the PIC performs self diagnostics.
10. Verify Cz and Cf values, etc. Refer to downhole gauge or tool manual for specific values.
11. Set the Cl_P. Passive leakage will change to match active leakage. Ensure the VSD and ESP are not powered. (ESP tools only)
12. Set alarm parameters as necessary.
13. If required, provide MODBUS map of the PIC registers to the client, so that master system can be programmed.

Note
The PIC will start acquiring data the moment the monitoring system is connected.

Once the commissioning process is complete, the system can be started.

7.4 Hotline (Extreme Tool) Commissioning Process

Hotline represents controller operation configured for Hotline downhole monitoring applications using the Hotline Extreme card. The Extreme card commissioning process can be done using the StarView or the controller.

Note

This configuration procedure assumes that the Extreme card contains no configuration information beyond factory defaults.

1. Configure the controller engineering port (Menu>Controller>RS232) for StarView connection.

   Site Address =1, 57600 baud, Prekey delay = 2ms, Postkey delay = 2ms.
2. Start StarView and connect the serial cable to the controller Engineering port. In StarView choose **File** — **New** , confirm site 1 — **OK**.
3. Configure communications parameters for the port (1–4) that contains the Extreme card.

   Site Address = 1, 57600 baud, 8 bits, No parity, 1 stop bit, RS-485 (8,NONE,1,RS485). Prekey delay = 2ms, Postkey delay = 2ms.
4. Set the controller clock.
5. If not already done, configure the Extreme card. Use StarView to connect to controller engineering port and configure the Extreme card.
   a. Upgrade Extreme card firmware if required.
   b. Reset to Factory Defaults.
   c. Load the gauge coefficients from the provided file or by cutting and pasting from Excel.
   d. Send the coefficients to the Extreme card.
   e. Save the settings by writing to EEPROM.
6. Connect wires from downhole sensor to Extreme card.
7. Configure the measurement settings and unit preferences. Set to RTD only if required.
8. View the gauge data on the live view screen. Proper data may not appear for 1 to 2 measurement cycles. Measurement cycle time is located in Configure menu, Measurement Settings command.

9. If required, provide MODBUS map of the Extreme registers to the client, so that master system can be programmed.

Note

The Extreme card will start acquiring data the moment the monitoring system is connected.

Once the commissioning process is complete, the system can be started.

Operations

8 Operations

8.1 StarView-Enabled and StarView-Configured Features

Several controller features require the StarView PC software for configuration or viewing. Users should familiarize themselves with the list of features that require StarView for configuration or viewing and ensure a PC with StarView is available for any cases where these features must be utilized.

Table 8-1: StarView-Enabled and StarView-Configured Features

Feature Name	Feature Function	StarView Implementation
Log & Site File Retrieval	Enables users to download and save the site logs and site configurations to their local PC.	Required to initiate log and site file download. Site file saved with “Export” option in StarView, Logs exported using “Export to CSV” option.
Applying StarView STE File	Allows a saved site file to be applied to a controller. This will apply the saved configuration/settings to the controller.	Required to apply site (.STE) file.
Shutdown Curves	Enables a shutdown curve to be configured so that trip times may be more precisely controlled based on the magnitude of the high current alarm.	Required to view and adjust shutdown curves in the Alarms>VSD>Motor Current HI screen.
VSD Underload Tracking	Enables the VSD to adjust the underload trip point over time based on nominal operating parameters.	Required to enable this option in the Alarms > VSD > Tracking screen.
Runtime Statistics	Indicate runtime statistics such as total runtime, total off time, and number of starts.	Statistics are shown in the Operator screen.
Gauge Diagnostics Screen	Lists diagnostic parameters from the DHT board. Parameters include supply voltage, regulated and unregulated voltages, and remote sensor currents.	Available in the Configuration > Phoenix DHT > Gauge Diagnostics screen.

8.2 Behavior and Feature Differences Between UniConn and Instruct

Refer to the latest Firmware Release Notes (InTouch ID 6145281) for the latest differences between the UniConn and the Instruct.

8.3 Charting and Trending

8.3.1 Chart Trends

The Charting screen allows up to 8 channels of data to be displayed simultaneously, in real time.

1. Press the **Home** button on the keypad.
2. Press the **Menu** button on the keypad to bring up the top-level menu.
3. Select the **Logs/Trends** menu item using either the numeric keypad or the up/down/left/right navigation keys on the keypad.
4. Select the appropriate **Chart Trends** menu item.

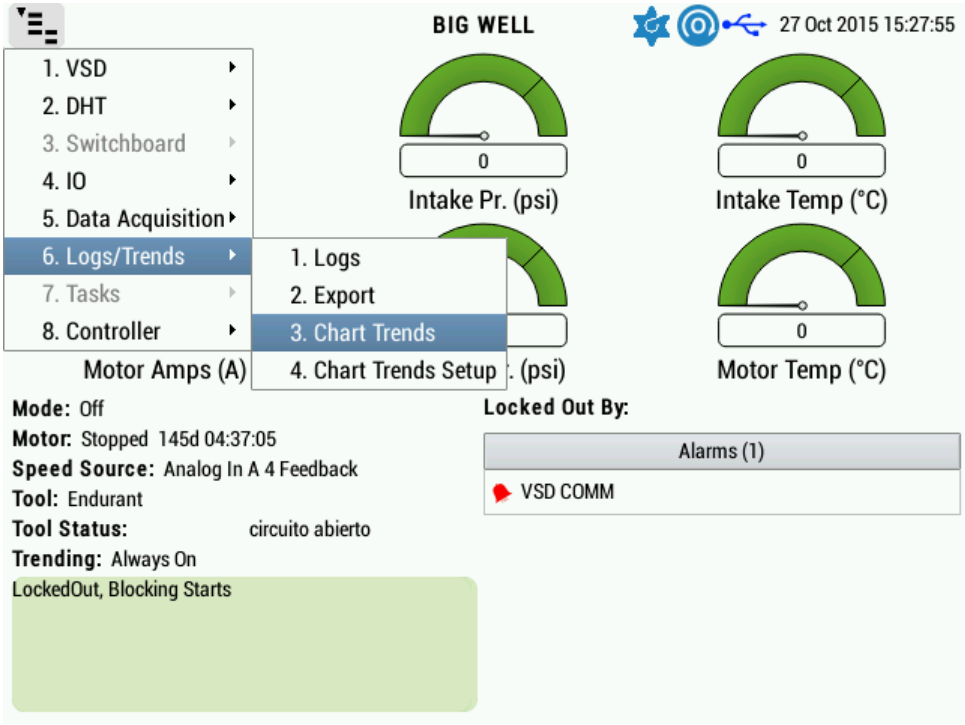

Figure 8-1: Chart Trends Menu Tree

8.3.1.1 Real Time Charting

By default, real-time charting is enabled. The user can pause and resume the chart. The chart can be reconfigured by selecting the “Configure” button to go to the “Chart Trends Setup” screen.

In the top-right corner are the channel names and their current values. In the bottom right-hand corner are the value ranges, per division, for each channel. The chart display has 10 divisions both across and up-and-down. The minimum and maximum range displayed on the chart, for each channel, is shown on the left-hand side at the bottom and top.

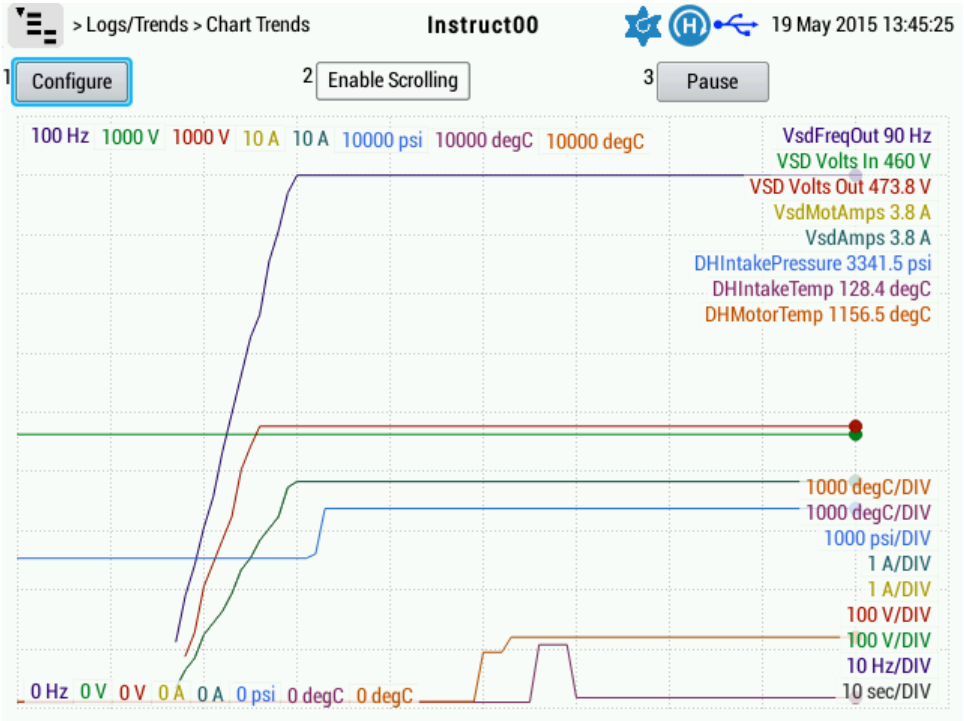

Figure 8-2: Charting Screen

8.3.1.2 Chart Scrolling

Select the “Enable Scrolling” button to change the input mode and allow the chart to be scrolled using the left and right arrow keys. You can zoom in and out of the chart using the up and down arrow keys. As the image is scrolled, the values of the cursors on the centerline are displayed in the top right corner of the chart. Disable scrolling by selecting the “Enable Scrolling” button again.

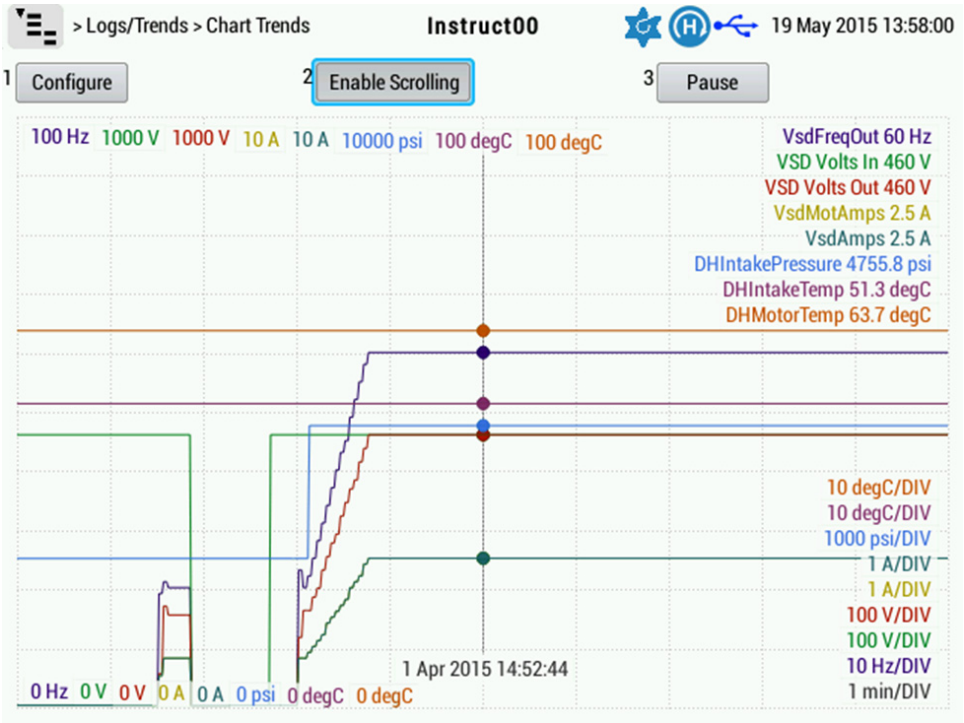

Figure 8-3: Chart Scrolling

Charting can be paused by selecting the “Pause” button. Select the “Pause” button again to resume charting.

Note

When the “Pause” button is selected to pause charting, it changes to a “Resume” button.

8.3.2 Chart Trends Setup

1. Press the **Home** button on the keypad.
2. Press the **Menu** button on the keypad to bring up the top-level menu.
3. Select the **Logs/Trends** menu item using either the numeric keypad or the up/down/left/right navigation keys on the keypad.

4. Select the appropriate **Chart Trends** menu item.

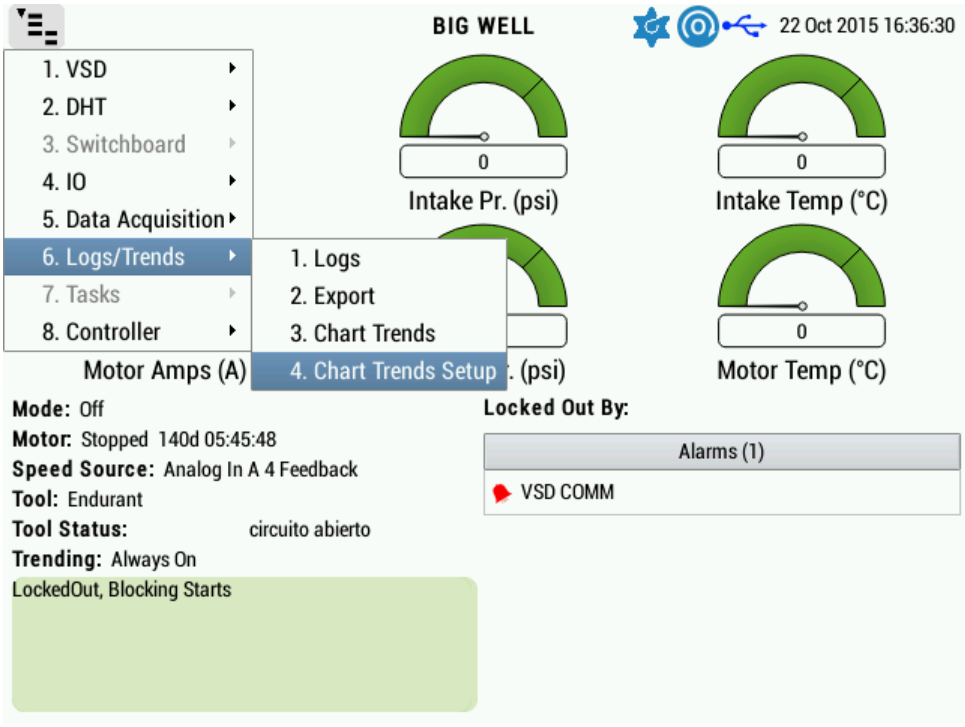

Figure 8-4: Chart Trend Setup Menu Tree

8.3.2.1 Presets

1. Select the **Preset** channel for configuration.

Note

Several presets are provided to allow quick reconfiguration of the channels to be charded. In addition to the 5 predefined presets, 8 user customizable presets are provided.

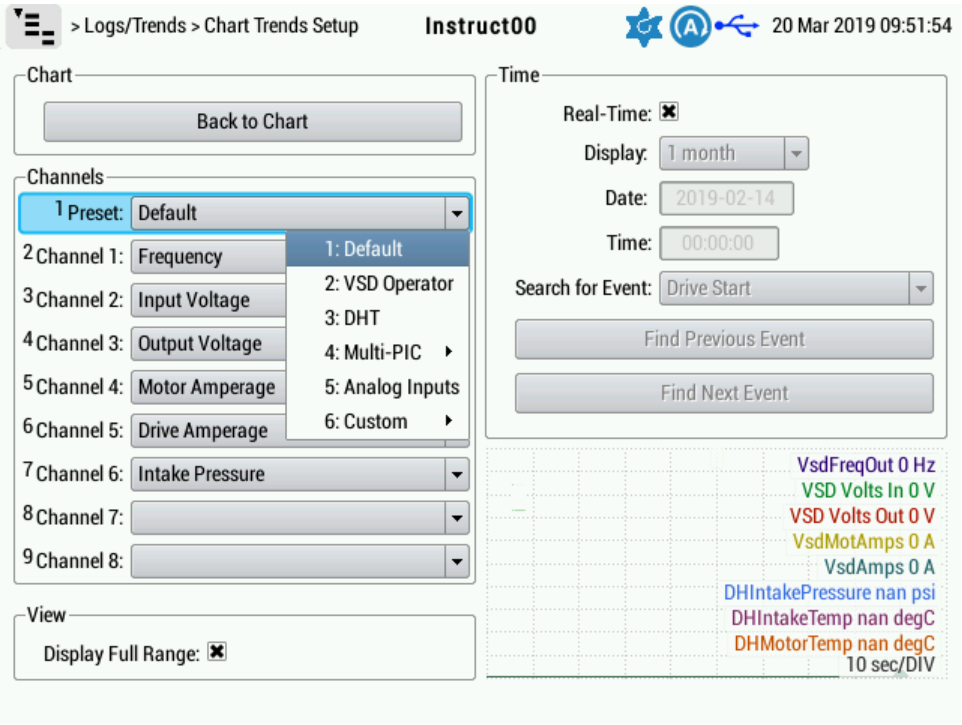

Figure 8-5: Default/Custom Presets Menu Tree

2. Selecting a preset configures all of the channels.

Example

Selecting the “Analog Inputs” preset configures Channels 1 – 8 to be Analog Inputs.

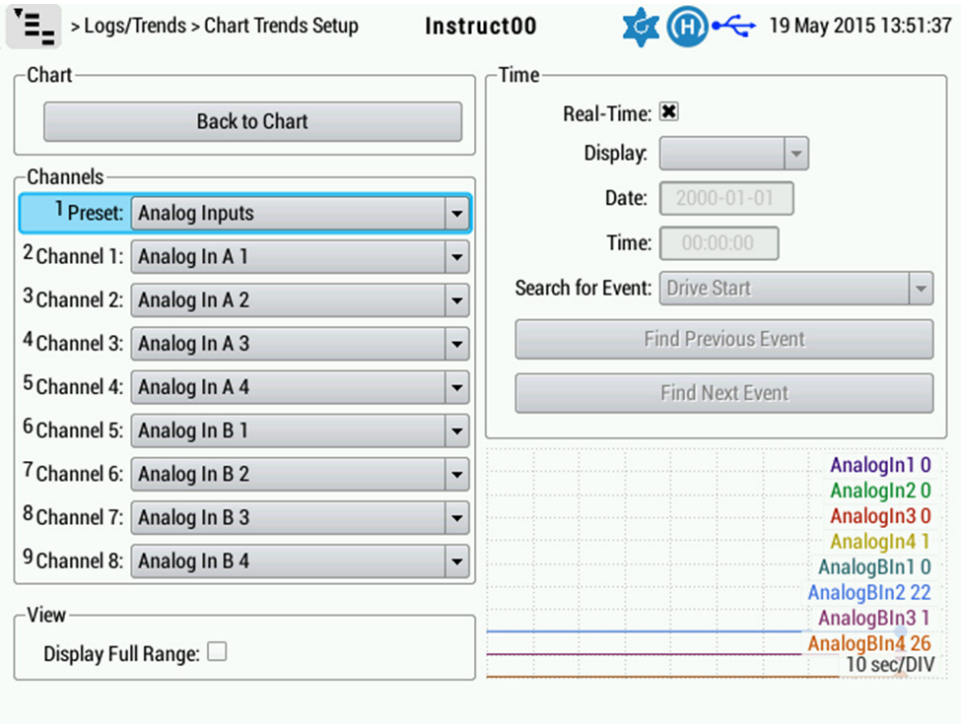

Figure 8-6: Analog Inputs Preset

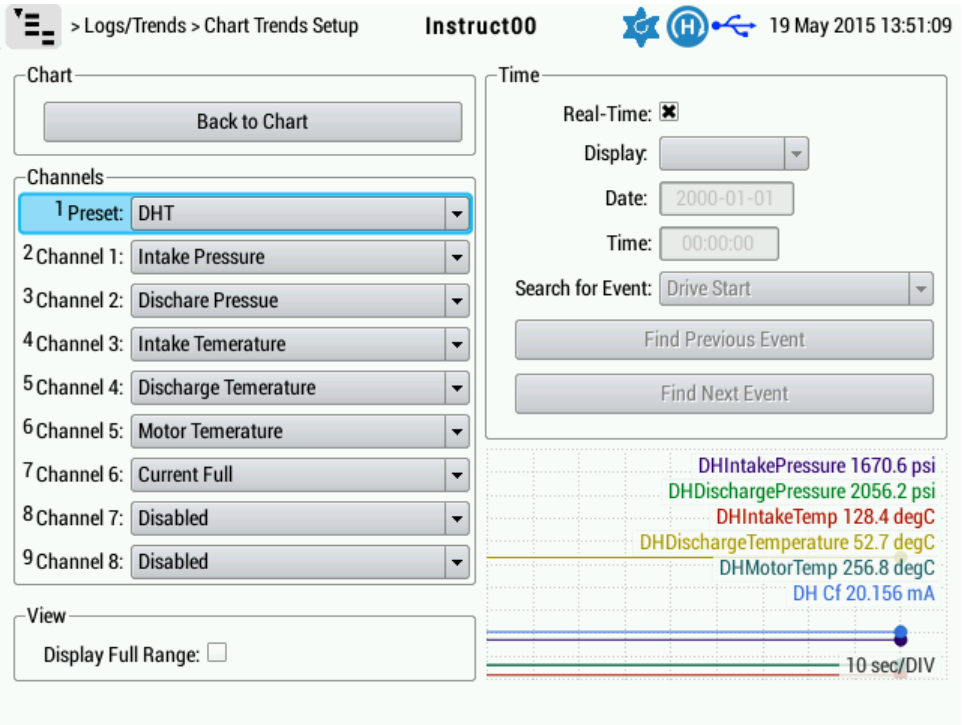

Figure 8-7: DHT Preset

8.3.2.2 Individual Channels

1. Select the appropriate **Channel** for configuration. Each channel can be individually selected. Chartable channels are selectable by categories.

Note

Each channel can be individually selected. Chartable channels are selectable by categories (i.e., Drive, DHT, IO and Controller).

2. Select the **Channel Category** to display the parameters that can be charted.

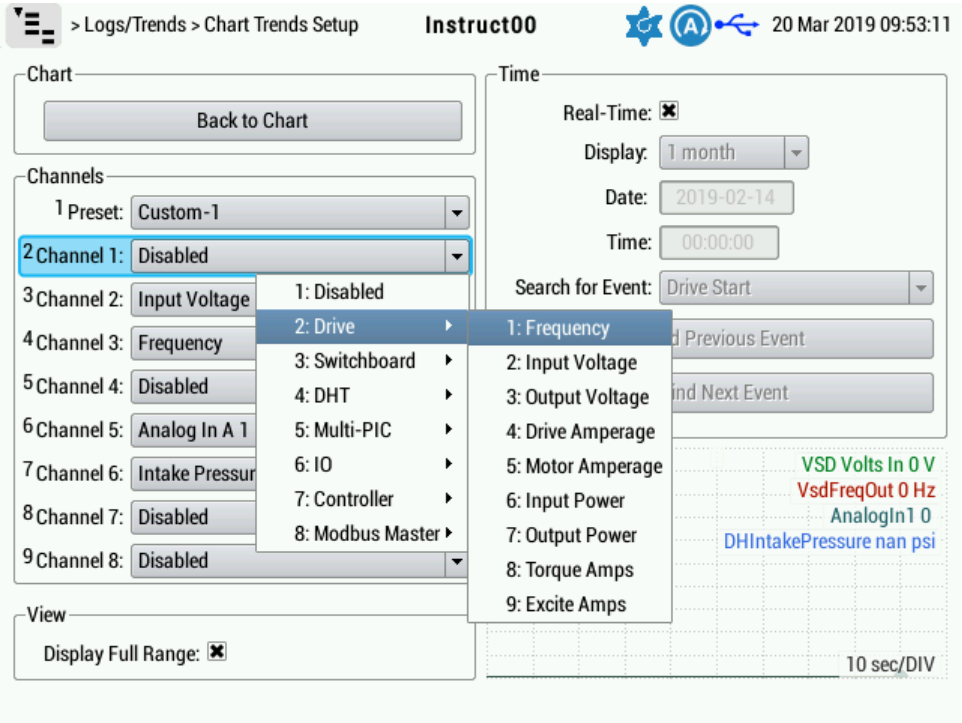

Figure 8-8: Channel Configuration Menu Tree

Note

Display Full Range" option will plot the channels from zero rather than auto scale them.

8.3.2.3 Charting Duration

1. If **Real-Time** charting is enabled (“X” is displayed in the Real Time option), toggle it off by selecting the **Real-Time** option.

2. Select the **Display** option to select the duration of the chart. The duration can be 1 minute, 10 minutes, 1 hour, 1 day, 1 week or 1 month.

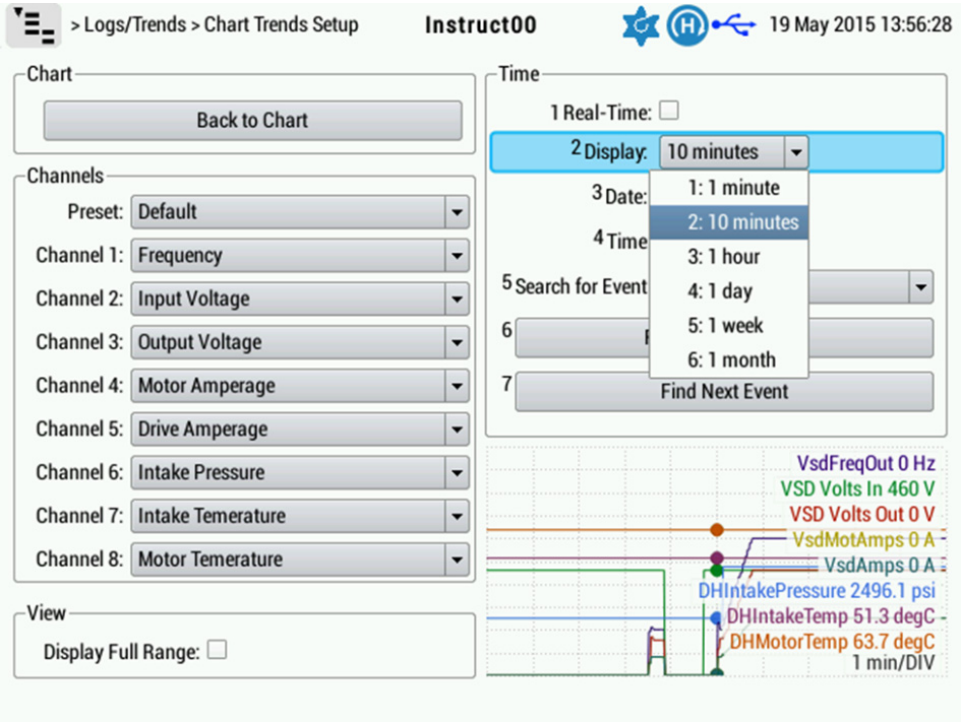

Figure 8-9: Chart Duration Menu Tree

3. Select **Search for Event** option to center the chart on a drive start or drive stop event.

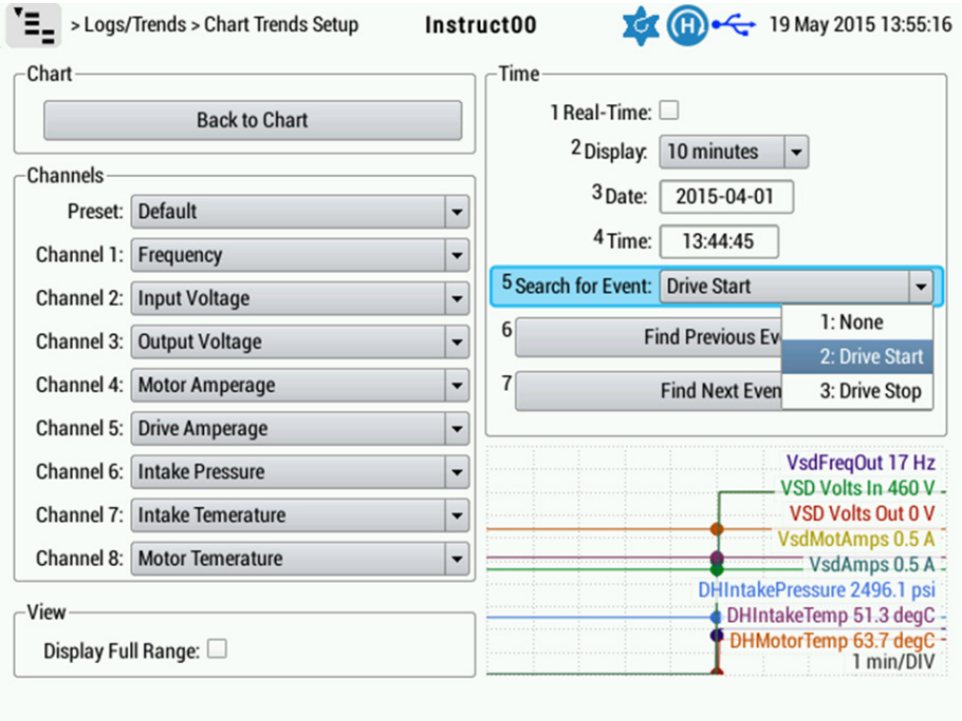

Figure 8-10: Event Trigger Menu Tree

4. Select the **Find Next/Previous Event** buttons to move to the next or previous occurrence of that event.

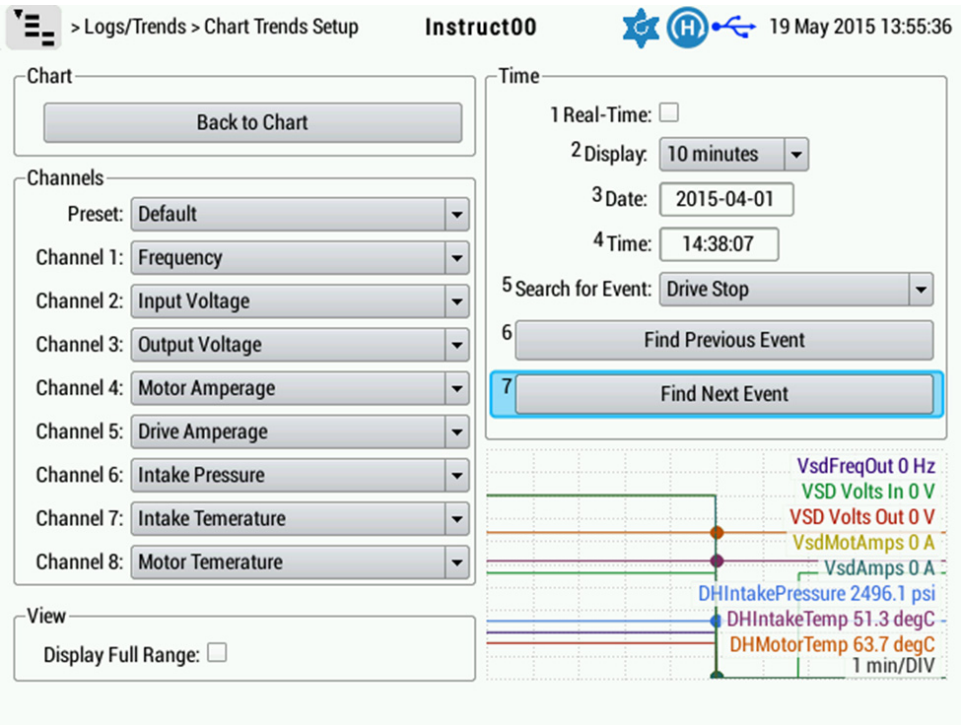

Figure 8-11: Find Previous/Next Event

8.3.3 Viewing Logs

1. Press the **Home** button on the keypad.
2. Press the **Menu** button on the keypad to bring up the top-level menu.
3. Select the **Logs/Trends** menu item using either the numeric keypad or the up/down/left/right navigation keys on the keypad.

4. Select the appropriate **Logs** menu item.

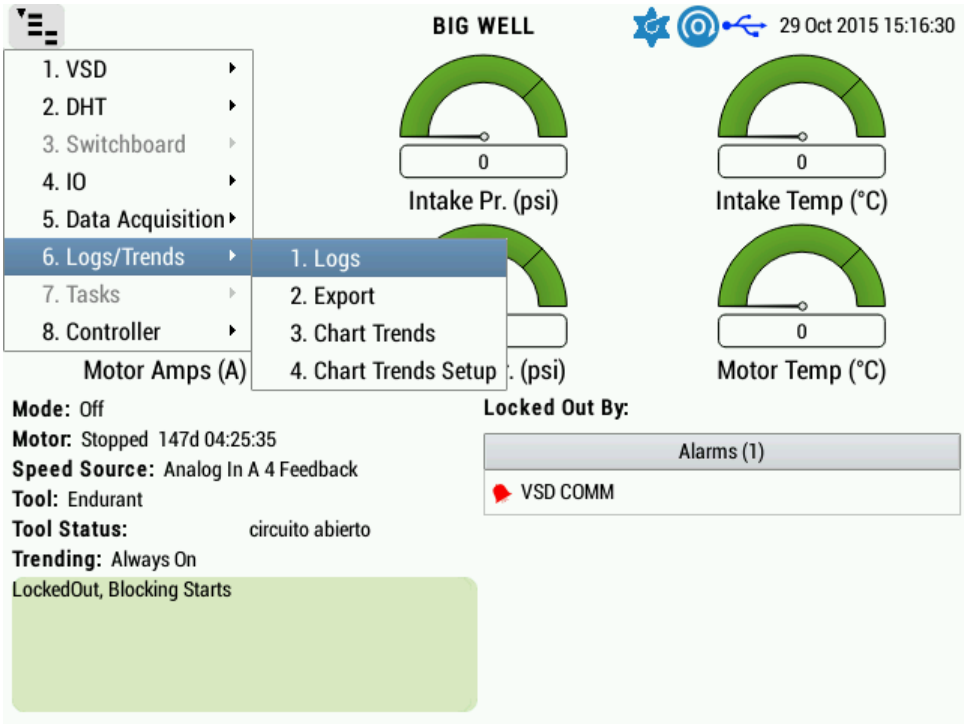

Figure 8-12: Logs Menu Tree

5. All of the logs since the last firmware update will be visible. Use the arrow buttons on the right side of the screen to scroll the list up and down.

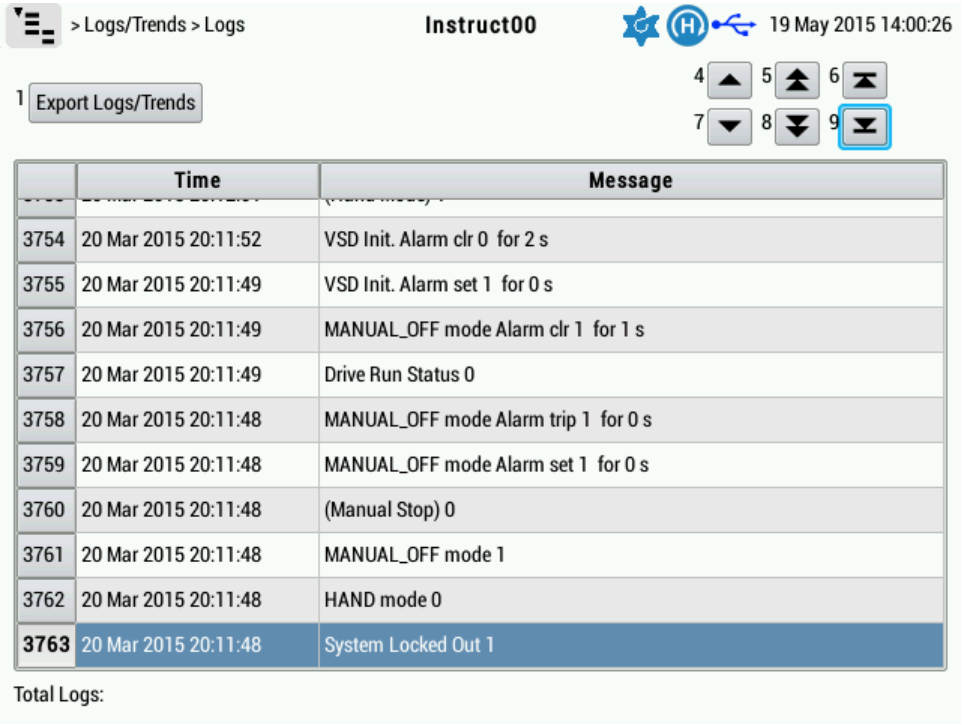

Figure 8-13: Display Logs Screen

8.4 Exporting Logs and Trends

1. Select a 1GB/1GiB or larger removable USB drive.
2. Ensure the removable USB drive intended for historical data download has been formatted for the FAT32 file system, and has at least 600MB of free space. Note that the file export will not affect files already on the USB drive.
3. With the Instruct fully booted, insert the removable USB Drive into the Instruct Controller. The USB symbol on the display will turn blue when the Instruct recognizes the USB drive.
4. Press the **Home** button on the keypad.
5. Press the **Menu** button on the keypad to bring up the top-level menu.
6. Select the **Logs/Trends** menu item using either the numeric keypad or the up/down/left/right navigation keys on the keypad.

7. Select the appropriate **Export** menu item.

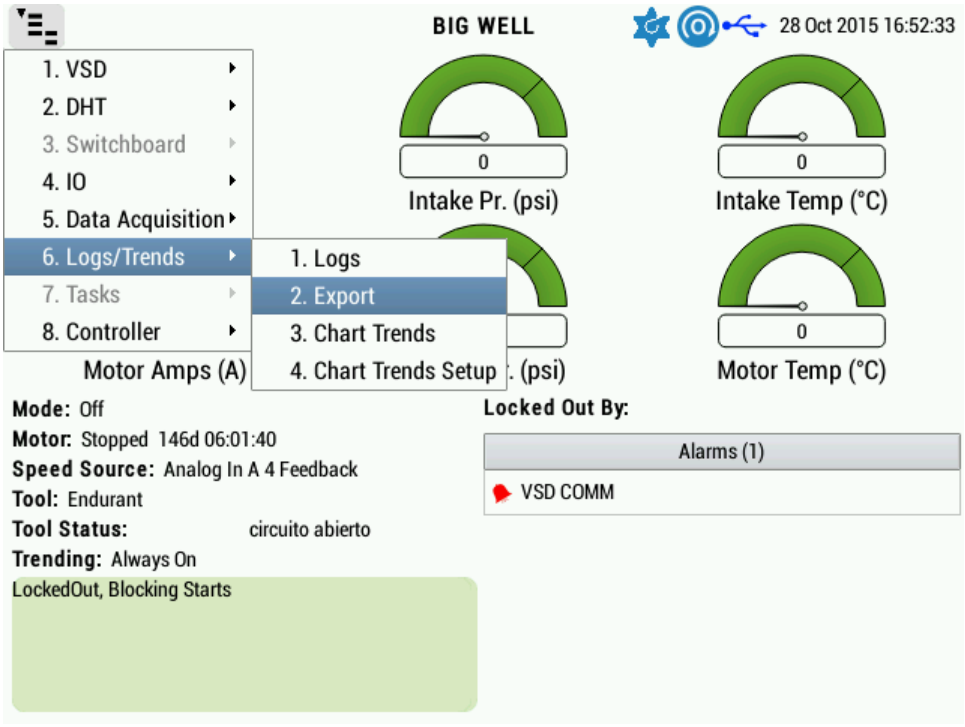

Figure 8-14: Export Log/Trends Menu Tree

8. Enter the **From Date** and **To Date** to select the data to export.

Note

When entering the Export screen, by default, the “From Date” and “To Date” are set to export all available data. The size of the .h5 file and the length of the export duration can be reduced by exporting only the data for the date range you require.

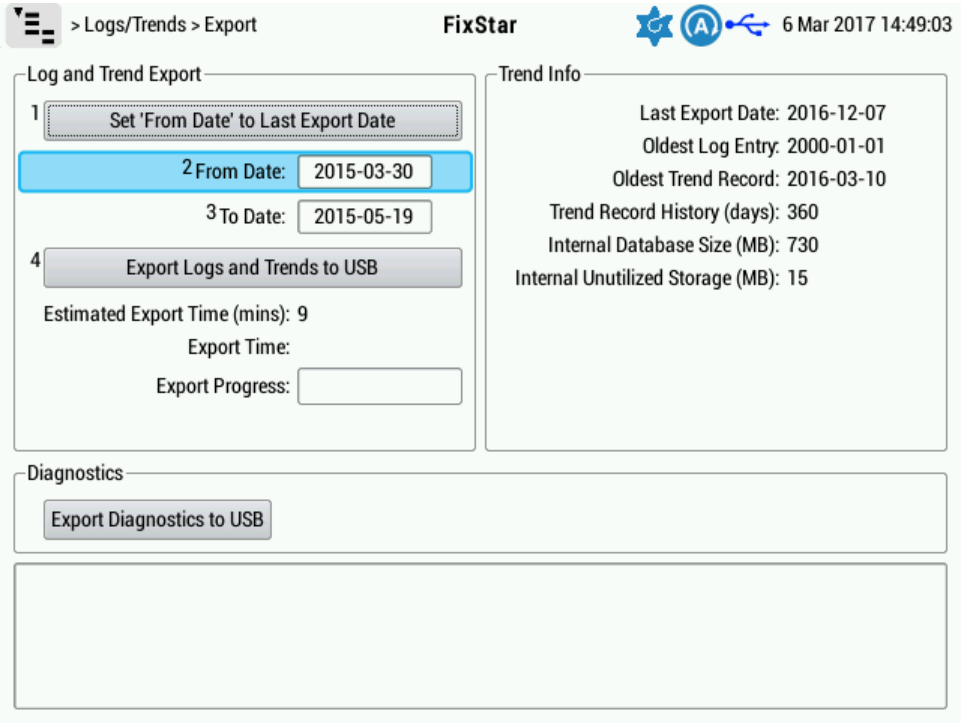

Figure 8-15: Log/Trends Export Screen

9. Select the Export menu item to begin the export of the log and channel data. Progress is indicated by a progress bar and export timer.

Note

The **Export Logs and Trends to USB** button is disabled until a USB drive is plugged in.

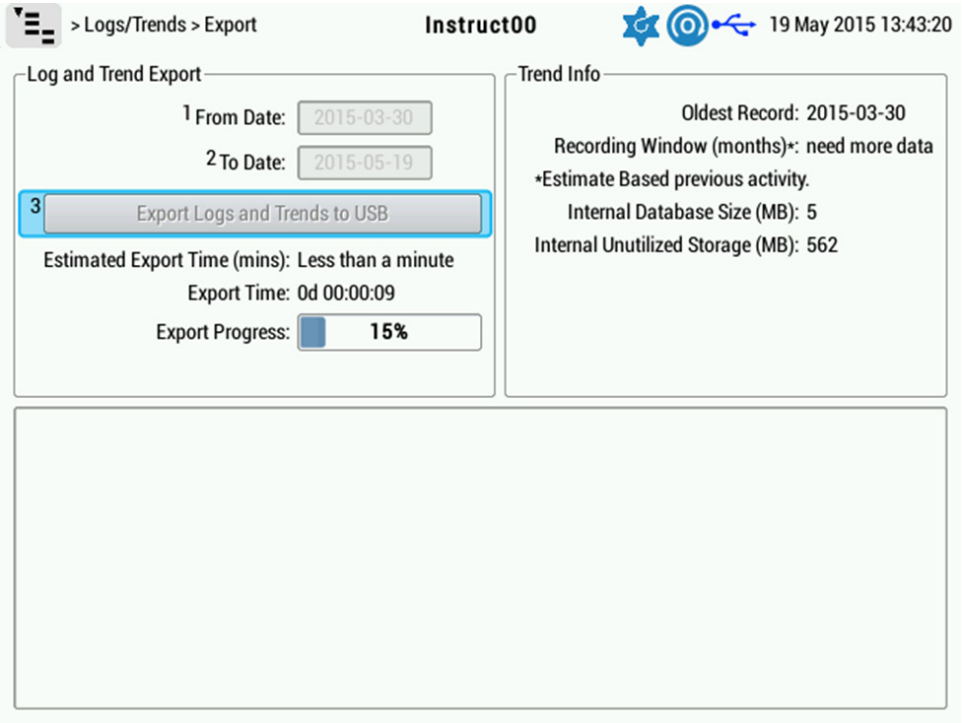

Figure 8-16: Exporting Logs/Trends Screen

10. When the export is finished, the progress bar remains at 100% until the USB key is removed. The logs and trends are combined into a single file in the format: Site Name-From Date-To Date.h5.

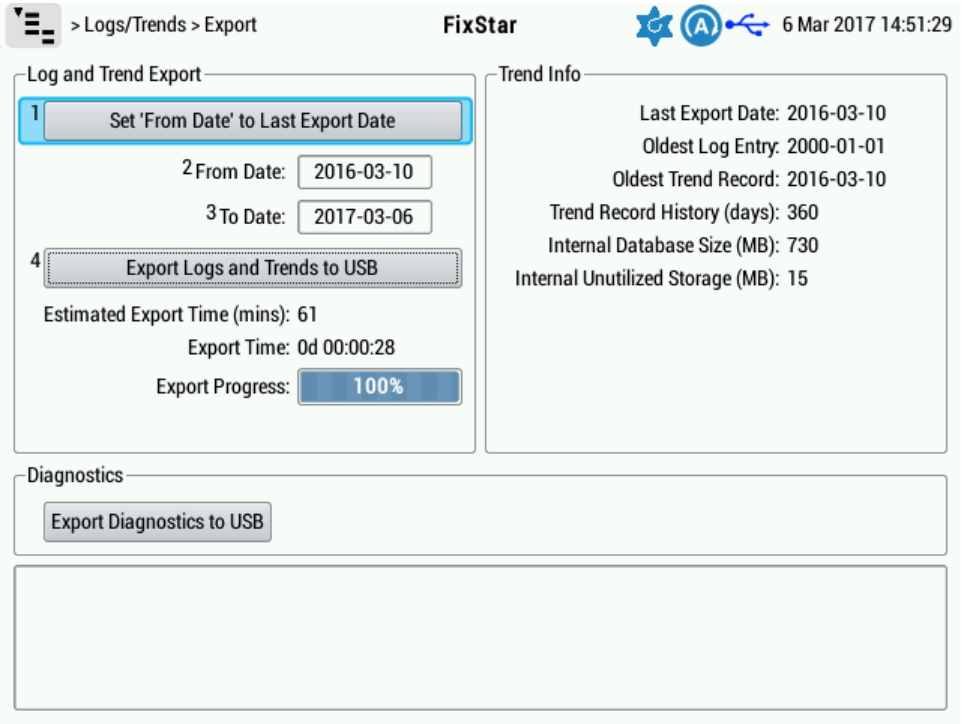

Figure 8-17: Export Complete Screen

11. Insert the USB flash drive into your computer. The .h5 file will be available on the main directory of the USB flash drive. It can be opened using the Instruct Data Viewer software.

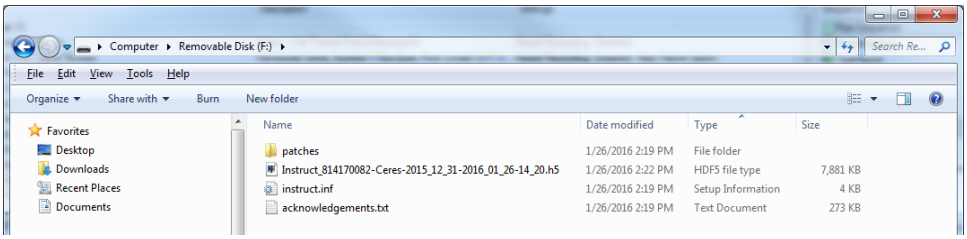

Figure 8-18: Insert USB Flash Drive

Note

In addition to the .h5 log/trend file, a few other items will be copied to the USB flash drive. The patches directory and acknowledgements.txt file are provided as part of software license requirements. The instruct.inf file is the device driver that is required for StarView to communicate with the Instruct None of these additional files contain wellsite data and can be safely deleted if desired.

Note

'Export Diagnostics' function is available for troubleshooting purpose for firmware version 2.106r012 and later. The user can go to Logs/Trends -> Export Screen, and click on the 'Export Diagnostics'. The exported file will be saved on a USB. Then the field user can send the file to engineering team for analysis.

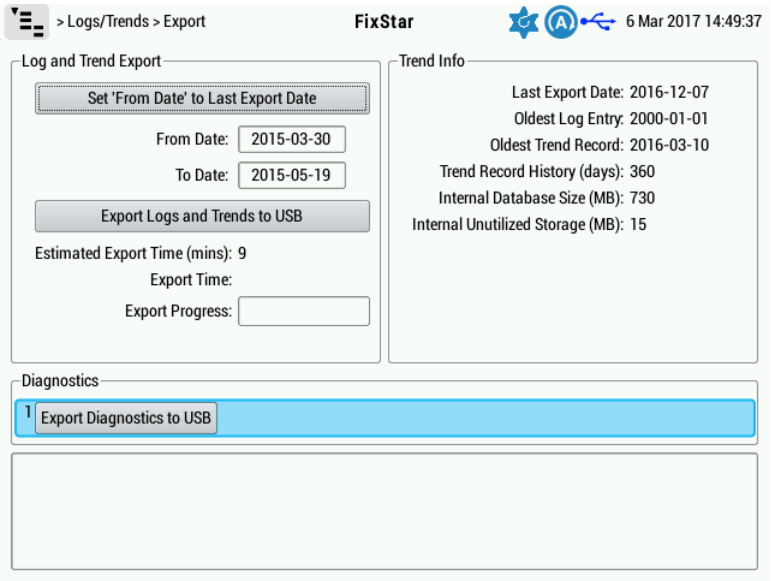

Figure 8-19: Export Diagnostics Screen

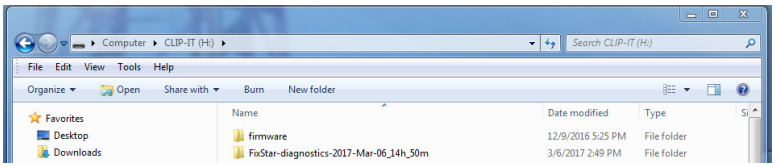

Figure 8-20: Export Diagnostics File

Note

StarView software can also be used to download logs and trends, for details, refer to StarView User Manual embedded in the software. Refer to InTouch Content 6031798.

8.5 Pass-through Mode

Caution

Potential Severity: Light
Potential Loss: Assets
Hazard Category: Electrical

Use this feature with caution. The controller will pass traffic regardless of the configuration, while the feature is active.

8.5.1 Modbus-based Traffic

Modbus mode is suitable when Modbus like traffic is expected. For example, when reading PIC Coefficients. In this mode, the Nexus will receive an entire Modbus packet on the “Source Port” from a master (ex. StarView on the USB port), and then re-transmit this entire packet to the “Target Port” and on to the slave (ex. PIC, in a slot). Note that generic pass-through can be used to carry Modbus traffic, but the resulting link will not be 100% stable (resulting in a high number of retransmissions and failed packets).

1. Ensure that the controller is communicating with the target option card. Configure the proper expansion slot and ensure no COMM alarms are present.
2. Start and connect StarView NG to the USB-B port at the front of the controller.
3. On the left Navigation pane, select CONFIGURATION -> Passthru.
4. In the Target field, select the expansion slot that the target option card is installed in.
5. In the Source field, select “USB PORT”. This is the front USB port that the PC running StarView software is connected to.

6. Set the Timeout field. This is the amount of time that the pass-thru will be active. After this period of time is up, the Instruct will drop the pass-thru and go back to regular operating mode.
7. Set the Activity Timeout field. This is the amount of time the Instruct will allow the passthru to be idle (ie: no serial traffic) before it drops out of pass-thru.
8. Press the “Apply” button in SVNG, so that the settings are sent to the Instruct.

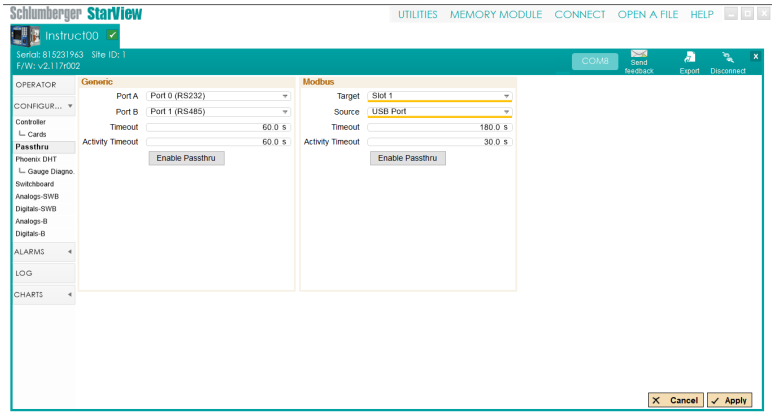

Figure 8-21: Modbus Passthru

9. Click the “Enable Passthru” button in StarView.
10. Note the COM port number at the top of the screen in StarView. Press the “Disconnect” button in StarView.

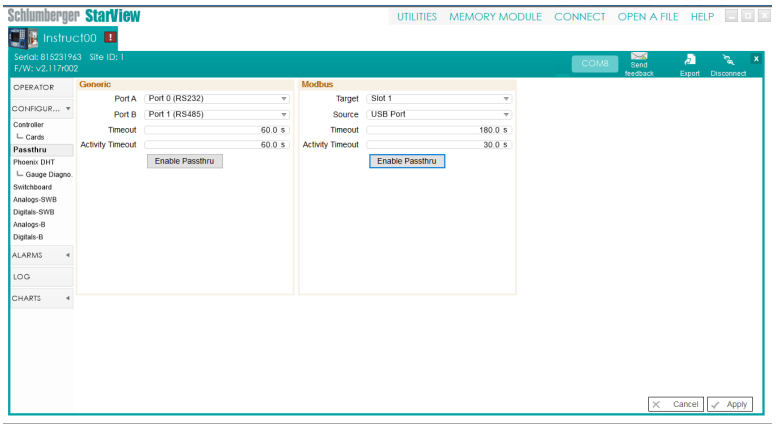

Figure 8-22: Enable Modbus Passthru

11. Open up the Modbus Master application, and select the COM port advertised in StarView.
12. Pass-through mode is now enabled and the Modbus traffic is now being directed to the target option card.
13. After pass-thru mode expires, disconnect the terminal program, and press the “Connect” button in StarView. The serial connection is now reconnected to the controller.

8.5.2 Generic Console Traffic

Generic mode is best used when a user prompt is expected. For example, when using the PIC engineering prompt. In generic mode, the Nexus simply listens for serial traffic on the pass-thru ports, and resends it out the other one.

1. Ensure that the controller is communicating with the target option card. Configure the proper expansion slot and ensure no COMM alarms are present.
2. Start and connect StarView NG to the USB-B port at the front of the Instruct.
3. On the left Navigation pane, select CONFIGURATION -> Passthru
4. In the PORT A field, select the expansion slot that the target option card is installed in.
5. In the PORT B field, select “USB PORT”. This is the front USB port that the PC running StarView software is connected to.
6. Set the Timeout field. This is the amount of time that the pass-thru will be active. After this period of time is up, the Instruct will drop the pass-thru and go back to regular operating mode.
7. Set the Activity Timeout field. This is the amount of time the Instruct will allow the passthru to be idle (ie: no serial traffic) before it drops out of pass-thru.
8. Press the “Apply” button in SVNG, so that the settings are sent to the Instruct.

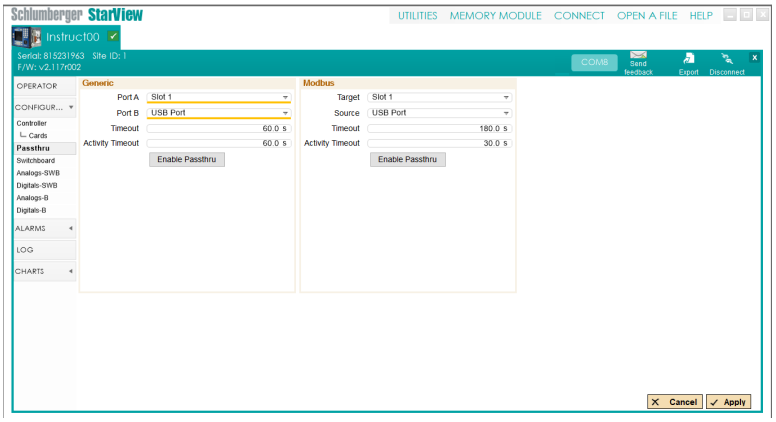

Figure 8-23: Generic Passthru

9. Click the “Enable Passthru” button in StarView.

10. Note the COM port number at the top of the screen in StarView. Press the “Disconnect” button in StarView.

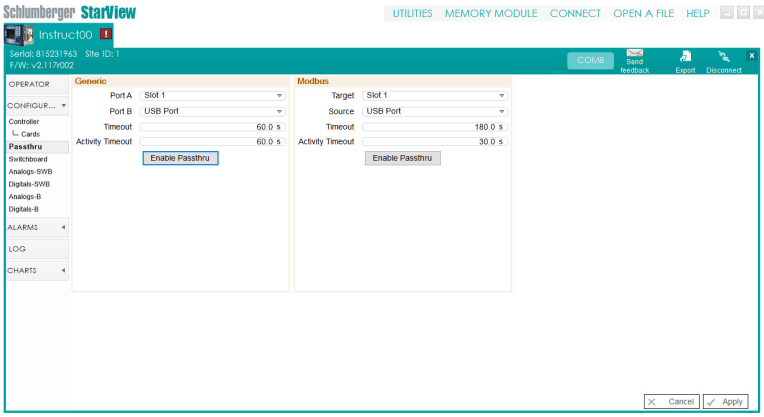

Figure 8-24: Enable Generic Passthru

11. Open up your terminal program, and select the COM port advertised in StarView.

12. Pass-through mode is now enabled and the traffic is now being directed to the target option card.

Note

In the case of a Cyclops Surface Interface Card, Enter $$$, then press the Enter key to obtain the console prompt.

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13. After pass-thru mode expires, disconnect the terminal program, and press the “Connect” button in StarView. The serial connection is now reconnected to the controller.

Troubleshooting

9 Troubleshooting

9.1 Motor Controller

Table 9-1: Drive Controller Troubleshooting Chart. *Troubleshooting controller installed fixed speed or variable speed drive.*

Symptom	Cause and Remedy
The controller has power on the AC or DC terminals but the display does not turn on and the unit does not operate.	The fuse for the power supply has blown. Check and change the fuse according to section 10: Maintenance. Test and ensure that the fuse does not blow immediately on power-up. If this happens, the controller must be returned to the factory.
The controller is in Hand Mode, but there is no 'START' key.	Two causes: 1) The unit is in a lockout condition. Clear the lockout by pressing the 'UNLOCK' button. If the 'START' key appears, the controller may be started. 2) There is an active alarm that is preventing a start. The red alarm LED will be ON in this situation and the name of the alarm(s) will be flashing on the status screen. Once the alarm condition clears or is bypassed the 'START' key will appear and the unit can be started.
The controller can be started locally, but cannot be started by SCADA.	Two causes: 1) The controller must be in AUTO mode for remote starts to work. 2) The Access setting on the Option Port the SCADA is connected to must be set to 'FULL'. 'VIEW-ONLY' access will prevent the remote start command from being written to the controller.
The phase voltages read steady but incorrect.	Check that the PT Ratio in the Motor Table is correct. If the errors are the same for all phases, adjust the PT Ratio. For fine tuning of individual phases the Voltage Calibration screen may be used.
Motor currents read steady but incorrect.	Check that the CT Ratio is correct in the Motor Table. If the errors are the same for all phases, adjust the CT Ratio. For fine tuning of individual phases the Load Calibration screen may be used.

Symptom	Cause and Remedy
As motor load increases the Power Factor decreases. This is opposite of what should occur.	The PTs have not been phased correctly. The Rotation must be ABC for correct power factor readings. If it is ACB, the PT phasing must be changed. Power down and change the phasing.
Analog Input values do not correspond to the actual measured values.	The Engineering min/max and Raw min/max values for the Analog Input channel are not set correctly. Configure the Analog Input using the controller or StarView.
The temperature displays wrong.	The temperature measured is the controller internal temperature. This may appear higher than the ambient due to the power dissipated by the controller electrical systems.
Expansion Cards are installed but do not operate.	Two causes: 1) The fuse on the expansion card power supply has blown and needs to be replaced. See section 10: Maintenance for information on how to replace the fuse. 2) The communications settings required by that card are not set properly in the Options Ports menus. Refer to the documentation that came with the Expansion cards for instructions on the required settings.
A SCADA system can read values from the controller, but is unable to write any changes.	The Option Port that the SCADA is connected to has its Access set to 'VIEW-ONLY'. For writes to take effect this set point must be 'FULL'.

Note

For advanced troubleshooting, please Contact InTouchSupport.com

9.2 Switchboard Card

Table 9-2: Switchboard Card Troubleshooting Chart

Problem	Symptoms	Cause	Solution
Controller not detecting Switchboard card	Switchboard menu item "greyed out" in controller menu	Switchboard card is not fully inserted into the expansion slot	Ensure the Switchboard card is fully inserted into the expansion slot
		Switchboard card in wrong expansion slot	Ensure Switchboard card is installed in SLOT A
		PIC Card and Extreme card present in controller	
		Bad Switchboard card	Replace Switchboard card
		Firmware out of date	Ensure controller and Switchboard card have the latest firmware

Problem	Symptoms	Cause	Solution
Incorrect data or no data displayed on controller	Card Status LED not blinking correctly (0.5sec on / 0.5sec off.	Bad Switchboard card	Replace Switchboard card
		Firmware out of date	Ensure controller and Switchboard card have the latest firmware

9.3 Communication Card

9.3.1 Troubleshooting Chart

Table 9-3: Comm Card Troubleshooting Chart

Symptom	Cause	Solution
Card not communicating properly	Incorrect port setting	Make sure port is set to RS-232.
	Incorrect port configuration	Make sure function is set to Modbus slave.
	Incorrect port configured	A system can have multiple comm cards. Make sure the port and installed comm card is properly configure for the connected SCADA system.
	Incorrect wiring	RS-232: Verify wiring, typically a 3 or 4 wire configuration. Refer to master device and/or intermediate device manual. RS-485: Verify wiring, typically a 4 or two wire configuration. Refer to master device and/or intermediate device.
SCADA system not communicating properly	SCADA system application problem	Verify that controller/acquisition system and comm card have been successfully connected to a similar SCADA system and send Modbus map to SCADA team.
	Incorrect Modbus slave (site) address	Make sure comm card port and SCADA sytem are set to the same slave (site) address.
	Incorrect Modbus map	Make sure the correct Modbus map is used by the SCADA system. For example, UniConn and Instruct have different Modbus maps.
SCADA system not sending remote commands	Cannot stop, clear, and start system remotely.	Make sure the controller/acquisition system port setting is set to FULL Access. Make sure the correct Modbus map is used. Make sure the proper coils are used. Refer to Modbus map. Make sure the SCADA system is using the proper logic sequence.

Symptom	Cause	Solution
SCADA system cannot interface with controller/acquisition system	SCADA system does not support Modbus RTU protocol.	Additional hardware is required to connect to non-Modbus systems.
	SCADA system does not support RS-232 or RS-485.	Additional hardware is required to connect to convert the RS-232 or RS-485 connections.

9.4 TCP/IP Card

9.4.1 Troubleshooting Chart

Table 9-4: TCP/IP Card Troubleshooting Chart

Symptom	Cause	Solution
Card not communicating properly	Incorrect port configuration	Make sure TCP/IP, Gateway, and/or Netmask are valid.
	Incorrect port configured	A system can have multiple cards. Make sure the port and installed card is properly configure for the connected SCADA system.
	Incorrect wiring	Make sure RJ45 Ethernet cable is used.
SCADA system not communicating properly	SCADA system application problem	Verify that controller/acquisition system and card have been successfully connected to a similar SCADA system and send Modbus map to SCADA team.
	Incorrect Modbus slave (site) address	Make sure card port and SCADA system are set to the same slave (site) address.
	Incorrect Modbus map	Make sure the correct Modbus map is used by the SCADA system. For example, UniConn and Instruct have different Modbus map.
SCADA system not sending remote commands	Cannot stop, clear, and start system remotely.	Make sure the controller/acquisition system port setting is set to FULL Access. Make sure the correct Modbus map is used. Make sure the proper coils are used. Refer to Modbus map. Make sure the SCADA system is using the proper logic sequence.
SCADA system cannot interface with controller/acquisition system	SCADA system does not support Modbus RTU protocol.	Additional hardware is required to connect to non-Modbus systems.
	SCADA system does not support RS-232 or RS-485.	Additional hardware is required to connect to convert the RS-232 or RS-485 connections.

9.5 Phoenix

9.5.1 Phoenix Interface Card (PIC)

Refer to InTouch Content ID 4349867 for detailed troubleshooting instructions.

Table 9-5: PIC Troubleshooting Chart

Symptom	Cause	Solution
Card has no power	Fuse for AC output blown.	Check short condition, replace fuse and try it again.
	Fuse for DC output is open.	Check short condition, unplug power, wait for few minutes then try it again.
Card will not reboot	May not have a bootloader installed.	Return card to product center.
	Program corrupt	Update card firmware.
	Card is damaged.	Replace card.
Card running fine but no measurement available	Tool open	Secure tool connection
	No coefficients for XT	Load coefficients and restart the card.
	Relay is damaged	Replace card.
	Downhole tool or cable is damaged	Fix cable if possible. Downhole tool can't be fixed.
One or more self test failed	Component failure.	Replace card.
Engineering port works but no communication to SCADA system	Site ID of card is set wrong in SCADA.	Correct site ID.
	Invalid start address.	Change start address to 1 and retry.
	Port settings are mismatched.	Use the same settings for card RS-485 port and SCADA system.
	Damaged converter or serial cable.	Replace converter or cable.
	Card is damaged.	Replace card.

Table 9-6: PIC StarView Troubleshooting Chart

Symptom	Cause	Solution
Status messages do not update	The PIC status messages are slow.	The operator must wait 30 seconds for each displayed status to be valid. Ex: **No Comms** may change to another message after 30 seconds to indicate the true status.

Symptom	Cause	Solution
Status shows **PIC Fault**	Incorrect tool type specified.	Reset the PIC.
	DHT cable connection is reversed.	Verify cable is connected properly.
Status shows **Tool Open**	DHT cable is disconnected from PIC.	Verify cable is connected properly.
	Choke cable is disconnected from power system.	Verify cable is connected properly
Tool Type not in pick list	Incorrect firmware in PIC.	Install correct PIC firmware type necessary for tool type.
StarView not connected	StarView does not connect to the controller or PIC.	Verify the “Using a Direct One to One Link” check box is checked.

9.6 Hotline

9.6.1 Troubleshooting Chart

Table 9-7: Hotline Extreme Card Troubleshooting Chart

Problem	Symptoms	Cause	Solution
Controller not detecting Extreme card	Firmware and Extreme parameters not showing in controller	Wrong port settings	Ensure port is set to "Extreme Card"
		Multiple Extreme cards enabled	Ensure only one is Extreme card enabled and disable all PIC cards
		PIC Card and Extreme card present in controller	
		Bad Extreme card	Replace Extreme card
		Firmware out of date	Ensure controller and Extreme card have the latest firmware
StarView unable to load Extreme screen (raw data screen)	Error when loading StarView, no data showing	Wrong StarView communication settings	Confirm proper communication settings enabled for Extreme card
		Pass through mode not enabled or timed out	If connected to maintenance port, ensure pass through mode is enabled to Extreme card
		Cable not securely connected	Ensure cable is properly connected
		Old StarView version	Ensure latest StarView version

Problem	Symptoms	Cause	Solution
Incorrect or unbalanced raw data	Extreme screen showing all 0 or near 0 values	If Extreme screen bottom right shows "Offline", there is a StarView to Extreme card communication issue	Refer to “StarView unable to load Extreme screen” above
		If Extreme screen bottom right shows "Live", then there is an open loop between the Extreme card and the downhole gauge	Ensure Extreme card connection and wire continuity Ensure junction box connection and wire continuity Ensure controller and Extreme card have the latest firmware Replace Extreme card.
	Sensor(s) showing unbalanced raw data	Cable integrity compromised	Confirm downhole resistance values against table of know resistances
		Incorrect or loose wiring from junction box to Extreme card	Confirm all connections firm & Secure
			Confirm proper wiring diagram is being used at the junction box and Extreme card
		Open wire in quick connector (RIH only)	Confirm quick connector is ok using continuity checks for each wire (RIH only)
	ESP motor temperature trend fluctuating or approaching intake temperature (Hotline ESP gauge only)	Excitation current for motor winding sensor set to 750 micro amps	Change excitation current for motor winding sensor to 500 micro amps (Hotline ESP gauge only)
Balanced raw data but bad or no engineering values in StarView	Raw data balanced but engineering values not reasonable	Wrong coefficients	Re-download coefficients from Intranet. Follow coefficient uploading procedure.
		Lost decimal places in coefficients (need at least 8 digit before and 12 after decimal)	Upload coefficients Do not use Read From File button (F.W. 3.800r12), use paste from excel.
		Coefficients uploaded but not saved to card (EEPROM)	Upload coefficients, make sure to save coefficients to card (Write to EEPROM) before closing StarView
	Engineering value of sensor 1 is zero but raw data is balanced	RTD only mode enabled	Disable RTD only mode

Problem	Symptoms	Cause	Solution
Balanced raw data but bad or no engineering values on controller	Extreme screen shows temperature values but controller reads 0	Old firmware will not allow controller to display negative values (cold weather installations)	Ensure both controller and Extreme card have the latest firmware
	Controller displays EXT_SENSOR Alarm	RTD only ESP motor configuration	Disable alarm by enabling RTD only mode
		Sensor(s) disconnected	

Table 9-8: Extreme Card Alarm Codes

Alarm	Description
EXT_SENSOR	Caused when the extreme card loses communication with one or more sensors
EXT_COMM	Caused when the controller loses communication with the extreme card
EXT_TI	Extreme Card Intake Temperature alarm
EXT_TM	Extreme Card Motor Winding Temperature alarm
EXT_PI_HI	Extreme Card Intake Pressure High alarm
EXT_PI_LO	Extreme Card Intake Pressure Low alarm
DHT_MULTI	More than one port configured for Extreme card, or both Extreme card and PIC are configured on two ports.

Maintenance

10 Maintenance

10.1 Overview

The controller is composed of sensitive electronics as part of an integrated assembly and as such maintenance and service is not intended to be performed onsite. The only maintenance that can be performed is fuse replacement.

Warning

Potential Severity: Serious
Potential Loss: Personnel
Hazard Category: Electrical

Fuse replacement can only be performed by authorized service personnel. Operators only have access to the front panel of the controller. No maintenance or service can be carried out by the operator.

10.2 Maintenance Schedule

Details the routine maintenance that should be provided at different time intervals throughout the life of the tool or system.

Fuse Replacement: When required

Real-Time Clock: Once per year

Firmware Upgrade: Per notification and/or prior to troubleshooting

10.3 Fuse Replacement

The controller fuses can be replaced by authorized service personnel using the following procedure. The following tools/equipment will be required for the procedure.

- Volt meter
- 5/16-in slotted screwdriver

Warning

Potential Severity: Serious
Potential Loss: Personnel
Hazard Category: Electrical

Hazardous voltages can exist on the power supply AC input terminals.

1. Using the appropriate procedures, ensure the VSD is stopped and that input power supplies are OFF before proceeding with the procedure.
2. Using the appropriate procedures, open cabinet door and use a volt meter to verify all power is OFF on the VSD prior to proceeding with remaining procedure.
3. Remove the input connectors to the power supply.
4. Identify the appropriate fuse to be replaced.
   - If system is powered via AC, the correct fuse is left of the AC input.
   - If system is powered via DC, the correct fuse is right of the DC input.

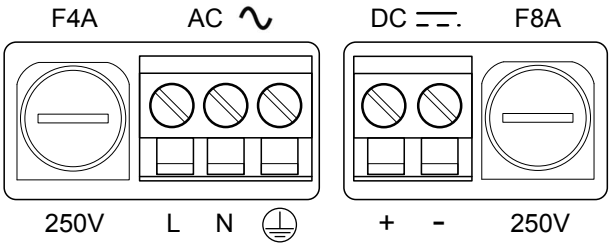

Figure 10-1: Power Supply Inputs

5. Remove the appropriate fuse by using a 5/16-in slotted screwdriver to turn the fuseholder a half-turn counterclockwise.
6. Remove the fuse from the fuseholder.
7. Install a new fuse in the fuseholder. For AC powered applications, install a fast-acting 4A fuse rated for 250V. For DC powered applications, install a fast-acting 8A fuse rated for 250V.
8. Install the fuseholder back into the controller power supply. Use the 5/16” slotted screwdriver to turn the fuseholder clockwise until the fuseholder will no longer turn.
9. Reconnect the input connectors to the power supply.

Parts, Spares, Tools, and Supplies

A Parts, Spares, Tools, and Supplies

A.1 Controller

Table A-1: General Spare Parts

Part Number	Description
100840484	Instruct Keypad/Bezel Assembly
101017503	PLUG FEMALE 3PIN 300V 10A 3.5MM CSA/UL ROHS WAGO PN:734-103
101017504	TERMINAL BLOCK 10A 160V 4POS RoHS
101156134	TERMINAL BLOCK 10A 160V 5POS RoHS
101156136	TERMINAL BLOCK 10A 160V 7POS RoHS
101216378	MS Socket Cap 6-32x1.125 SS Hex Drive
101216382	Terminal block plug 3pos 5.08sp 30.1len Sn RoHS
101216384	Terminal block plug 2pos 5.08sp 30.1len Sn RoHS
101155848	FUSE 4A 250V FAST ACTING 5 x 20mm RoHS
101155863	FUSE 8A 250V FAST ACTING 5 x 20mm RoHS

A.1.1 Variable Speed Controller

Table A-2: Spare parts for artificial lift variable speed

Part Number	Description
100220873	Comm Cable: UniConn – G7 control board
101227522	Instruct Controller VSD Retrofit Toolkit (tools and template)

A.2 Tools

Table A-3: UniConn Phoenix spare parts

Part Number	Description
100040150	CABLE TIE 113 x 2.4mm BLACK TYCO TY100-18X
100175242	Tape, Electrical, 3/4" x 60', Vinyl, Temflex General Purpose
100192475	50 ft. DB9 Male-DB9 Female Straight Serial Cable.
100194667	24 AWG Shielded Twisted Pair (STP) 2 Pair communication cable. PVC jacket. 100% foil shield. 90% braid shield. Tinned copper drain wire. 12 Twists/Foot. -30 to 80C.

Part Number	Description
100354442	RS-485 or RS-422 to RS-232 Converter. DB9 to TB. B&B Electronics. Port Powered.
100354454	16-26 AWG IDEAL T-Strippper Wire Strippers
100356131	3.5mm Screw Driver. 1000V Insulated.
100356141	Alligator Clip Leads. 10 Pack. 18" Long, 24AWG
100356501	DE-9 Male-Male Gender Changer DB9
100356503	DE-9 Female-Female Gender Changer DB9
100404877	2.5mm Screw Driver RoHS WAGO 210-719
100541774	Cable Network CAT5e UTP 3m RoHS Straight RJ45 8P8C Gray
101206590	OPERATING TOOL FOR WAGO 3.5MM TERMINALS ROHS
101413628	HEX SOCKET DRIVER, 7/64" HEX KEY/ALLEN, 60MM

A.3 Switchboard Card

Table A-4: Switchboard Card Spare Parts

Part Number	Description
100840440	Schlumberger Switchboard Card
101017503	Plug Female 3PIN 300V 10A 3.5MM CSA/UL ROHS WAGO PN:734-103
101754940	Terminal Block FEM 3.81mm 28-14AWG 4POS RoHS
101156134	Terminal Block 10A 160V 5POS RoHS
101754969	Terminal Block PLUG 3.5mm 24-16AWG 5POS RoHS

A.4 Communication Card (Comm Card)

Table A-5: Communication Card Spare Parts

Part Number	Description
101120028 [1]	Schlumberger Communications Card
100030934	Plug 5.08 mm 5 pin
100367386	Plug 5.08 mm 6 pin
100078327	Thumb Screw

[1] Replaces the UniConn Communications Card (100228568).

A.5 Modbus TCP/IP Card

Table A-6: Modbus TCP/IP Card spare parts

Part Number	Description
100419643	UniConn Modbus TCP/IP Card
AC21228	Dust cover for engineering port
100267826	RS232 Serial Cable
100078327	Thumb Screw

A.6 MVD Card

Table A-7: UniConn MVD Card spare parts

Part Number	Description
100357924	UniConn MVD Card
100448078	Cross-Wired Ethernet Cable 15 feet
100078327	Thumb Screw

A.7 Phoenix Interface Card (PIC)

Table A-8: PICv2 Spares

Part Number	Description
100324335	Phoenix Interface Card
100052238	PIC to PC Data Cable for PIC
100346634	Relay connector plug 3 pin
100346638	DHT connector plug 2 pin
AC21228	Dust cover for engineering port DB9
100078327	Thumb Screw

A.8 Hotline Extreme Interface Card

Table A-9: Hotline Extreme Card Spares

Part Number	Description
100408570	AL Extreme Card
100713305	Extreme Face Plate Only

Part Number	Description
100241377	DHT Connector 2x4 Pin 3.5mm
AC21228	Engineering port dust cover
100078327	Thumb Screw

A.9 Backspin Module

Table A-10: Backspin Module Spare Parts

Part Number	Description
100840441	Instruct Backspin Module 800V-5000V
100367410	TERMINAL BLOCK FEM STRAIGHT 5.08mm 300V 10A 3POS RoHS
101803790	Backspin Module Signal Cable, 2.5m
101947881	Backspin Module Signal Cable, 4m
101947905	Backspin Module Signal Cable, 8m

A.10 Switchboard Retrofit Kit Parts

Table A-11: Switchboard UniConn Retrofit Kit Parts

Part Number	Description
100840400	Instruct
100840440	Schlumberger Switchboard Card
100840441	Backspin Module 400- 5000V
101947881	Backspin Signal Cable, 4m Note: for a standard Switchboard, the 4m backspin signal cable is recommended. There exists also 2.5m and 8m cable length if needed. 101803790: 2.5m Backspin Signal Cable 101947905: 8m Backspin Signal Cable

Note

Check the CT burden Module in the retrofit system, it should be PN: 100468928. If not, change the CT Burden Module to PN: 100468928.

Table A-12: Switchboard K095 Retrofit Kit Parts

Part Number	Description
101764633	Instruct Retrofit Kit for K095

Part Number	Description
100840440	Schlumberger Switchboard Card
100840441	Backspin Module 400-5000V
101947905	Backspin Signal Cable, 8m Note: for a standard K095 retrofit kit, the 8m backspin signal cable is recommended. There exists also 2.5m and 4m cable length if needed. 101803790: 2.5m Backspin Signal Cable 101947881: 4m Backspin Signal Cable

Modbus Master

B Modbus Master

The Instruct can be configured to read data to external Modbus devices and alarm on those readings. In this configuration Instruct will be the Modbus master device and the external device will be the slave. To use this function, either use the RS232 port or RS485 port on the Controller Cards, or install a Comm Card in the option port. The slave device would then be connected to the configured MBM port.

The StarView Tool Kit (Instruct MBM) will be needed for the configuration of Modbus Master. For the instruction about how to configure Modbus Master, please refer to Instruct MBM Quick Start Help Manual inside the software.

Modbus Slave

C

Modbus Slave

The Instruct can also be configured as Modbus Slave to create Custom Modbus Map. Custom Modbus Map provides a flexible Modbus map that adapts to your needs.

This can be helpful to:

- Improve SCADA bandwidth utilization. The data required by the SCADA system can be grouped in one contagious block. Thus making it possible to acquire all data with one simple query.
- Provide backward compatibility with some legacy products.

Note

Custom Modbus Slave is supported on Instruct starting form firmware release V2.108

StarView Tool Kit (Instruct MBS) is the software used to configure Custom Modbus Map. For instruction about how to configure MBS, please refer to Instruct MBS QstartHelp Manual embedded in the software.

Custom Screen

D Custom Screen

The Instruct screen can be customized through StarView Tool Kit (Instruct Screens). For instruction about how to use Instruct Screen software, please refer the QstartHelp Manual embedded in the software.

References

E References

User Manual, Instruct Controller (InTouch ID 6128576)

Reference Page, Instruct Controller (InTouch ID 6023027)

Modbus Map, Instruct Controller (InTouch ID 6352449)

Installation Manual, Hotline Extreme Interface Card (InTouch ID 5447042)

User Manual, UniConn Controller (InTouch ID 3953183)

User Guide, StarView (InTouch ID 6031798)

Instruct USB connection Best Practice (InTouch ID 6925630)

User Guide, Gas Lock Protection (InTouch ID 6923767)

User Guide, AS1 VSD (InTouch ID 6932447)