Data Flow Systems

Installation and Operation Manual

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Notice

Data Flow Systems assumes no responsibility for any errors that may appear in this document, nor does it make any commitment to update the information contained herein. However, questions regarding the information contained in this document are welcomed.

Data Flow Systems also reserves the right to make changes to the specifications of the TCU800 and to the information contained in this document at any time without notice.

This document contains information related to special features and functions that are only available when the TCU is utilized in a DFS TAC II SCADA System. These special features and functions may not be available when the TCU800 is utilized in a 3rd party SCADA System. If you are unsure about the availability of a feature or function, please contact DFS for clarification.

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Quick Start Reference

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Preface

Purpose of this Manual

This manual is a reference guide for installing and operating the TCU800 (Telemetry Control Unit). It contains information meant to guide and assist in the installation and configuration procedure. This includes mounting and wiring instructions, product features and specifications, I/O listings, instructions for integrating with telemetry, information on Modbus compatibility, and instructions for configuring and using the TCU's pump control process. Refer to this manual when designing, installing, configuring, or troubleshooting systems that use Data Flow Systems' TCU. For information on customizing the TCU's operations, contact DFS.

Document Conventions

The following conventions are used throughout this manual:

- Bulleted lists provide information, not procedural steps.
- Numbered lists provide sequential steps or hierarchal information.
- Bold italic type is used for emphasis.
- All *CAPITALIZED ITALIC* type is used for terminal names.

Abbreviations Used in this Manual

H-O-A – Hand-Off-Auto

I/O – Input/Output

PCU – Pump Control Unit

PLC – Programmable Logic Controller

RTU – Remote Terminal Unit

SCU – Supervisory & Control Unit

TCU – Telemetry Control Unit

BEM – Bus Extender Module

STAT – Status

SSH – Secure Shell

RX – Receive

TX – Transmit

VAC – Voltage Alternating Current

VDC – Voltage Direct Current

VFD – Variable-Frequency Drive

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1. Safety Precautions

Review the following information before installing, servicing, or replacing the TCU or any of its components.

General Precautions

- Carefully read the installation and wiring instructions before connecting the TCU to its power source.
- If the TCU is to be installed into an existing control panel, make sure all sources of power are de-energized (including those fed by external sources) before starting the installation.
- Do not work on the TCU or connect/disconnect any of its cables during periods of lightning activity.
- To prevent overheating the TCU, do not operate it in an area that exceeds the recommended temperature range of -10°C to 60°C (14°F to 140°F). When using the recommended backup battery, the upper temperature limit is 50°C (122°F).
- Ensure that the unit is connected to earth ground during normal use.
- Precautionary measures must be observed when installing, operating, and servicing the TCU in order to prevent shock.
- All wiring should conform to federal, state, and local electrical codes.
- Read and follow all precautions displayed on the TCU's side-mounted labels.

Connecting/Disconnecting the TCU

When connecting the TCU:

1. Ensure the cables to be connected to the TCU are routed with sufficient strain relief.
2. Integrate all required wires and connect to the TCU.
3. Close circuit breakers as required; the TCU will start up as soon as power is applied.

When disconnecting the TCU:

1. Power down the unit by holding down the button on the front overlay.
2. Remove all sources of power, including those fed by external sources.
3. Remove all cables connected to the TCU including the ground cable.
4. Move the cables ensuring they will not become entangled in or caught on anything in the surrounding area.

Even if the LCD screen and status LED are not lit, assume the TCU is still powered. The TCU may be in the off state, and AC power may still be present. To remove power, the external circuit breaker must be opened. Note that TCU power and 3 phase power may be on separate circuit breakers.

2. Product Overview

Description

The TCU800 is a highly integrated pump controller running an embedded Linux operating system. It is designed to be backward compatible with its predecessor (TCU001) while including additional feature enhancements to expand its operability.

There are several options for using the TCU's multiple input/output (I/O) points:

- They can be used in the default pump control application.
- They can be used with custom logic (i.e. Ladder logic). Contact DFS for more information.

Additionally, the TCU:

- Can communicate with and manipulate the I/O points of up to 15 remote modules via a radio or network link.
- Can be incorporated into a Remote Terminal Unit (RTU) by using a Bus Extender Module (BEM).

The default pump control application program enables the TCU to be easily implemented in lift station or storage tank applications. The TCU contains all the hardware and software needed to control up to three motor starters.

Placing custom logic on the TCU enables it to perform a variety of automated tasks when interfaced with other telemetry Modbus-capable devices and equipment (DFS equipment or other devices using RS-485 or RS-232). Custom logic can control and monitor the six onboard digital outputs, 18 digital inputs and four analog inputs. It also features an expansion card slot which can be used to add additional I/O points for specialized applications, such as controlling VFD pumps.

Features

True RMS AC Phase Monitor	True RMS AC phase monitor produces voltage readings for single- and three-phase power. Three-phase current can also be monitored using external current transformers.
H-O-A Switches	The H-O-A switches are fail-safe; they remain operational even if the TCU fails or loses power. They will continue to function in the “Hand” and “Off” positions with the TCU in a faulted state or powered down.
Integrated Radio	The TCU’s integrated digital radio is on-site programmable and can run in legacy or a high-speed mode.
Battery Backup with Integrated Charger	The TCU supports a 12VDC sealed lead acid battery that supports a maximum charge current of 3A.
Display / Interface	A touch screen LCD provides a large area for displaying data and menu navigation. One soft-touch home button allows the user to power up/down the TCU with a single touch, and seven LEDs provide system status at a glance.
Serial Connectivity	Standard RS-232 Modbus radio interface acts as an interface (slave only) to external industry standard radios. RS-485 Modbus half-duplex serial interface (master only) enables communication with industry standard devices and VFD motor controllers.
Network Adapter	An integrated 10/100 network adapter allows remote access via SSH client over a local area network.
USB/Service Port	Three full speed USB 2.0 ports (2 external/1 internal) storing station address, configuration profiles, and pump statistics. Provides Ethernet connectivity with additional USB-to-ETH adapter.
Protection	Protective features include an integrated, regulated power supply, surge protection, and isolation on all I/Os, and an externally-accessible fuse.
Protocols Supported	Protocols supported are Modbus (ASCII/RTU) over RS485 or RS232, TAC II and DFP 3.0 over radio and BEM, and DFS NIM and Modbus TCP over TCP/IP.

Pump Run Time Meters	Elapsed run time, average run time, and pump cycle counters are provided in software for each pump.
Self-Monitoring	Self-monitoring capabilities include radio current, temperature, battery voltage/ charging current, AC power, bias fault, process and error logging with option to backup to a USB drive.
Connectorized Wire Terminals	Four connectorized wire terminals allow servicing or replacement of the unit without disconnecting wires.
Mounting Options	Mounting options allow the TCU to be mounted to a front panel as well as mounted flush against or stood off from the back plate of a control panel.
Legacy TCU001 Operation	The TCU800 is backward compatible with the TCU001. Existing TCU001 configurations can be transferred to the TCU800. For detailed instructions, see the compatibility chart below.
Enclosure	Anodized aluminum, sealed and shielded when connected to Earth ground via grounding screw.

Compatibility

Please note that the PCU, PCU TAC Pack, SCU, and SCU TAC Pack are not “upward” compatible with the TCU800. DFS’ Sales Department can provide assistance with ensuring that your system has appropriate replacement units on hand. Contact DFS’ Sales Department (321-259-5009 or sales@dataflowsys.com) for more information.

When comparing the TCU001 and the TCU800, use the following table to review features that have been removed, replaced, and added to the TCU800.

By default, the TCU800’s new digital and analog inputs are disabled so as not to conflict with any pre-configured MODBUS devices that may be occupying modules H through O. In order to enable the new I/O, which will be dynamically assigned at the next available module space, see Chapter 6: Operating Procedures.

Telemetry Control Unit Comparison

TCU001

TCU800

Dual-20 MHz 8051 Microcontroller	**Processing Core**	1 GHz ARM Cortex A8 Microprocessor
120VAC, 60Hz	**Voltage**	120VAC, 60Hz
150 mA (typical) 200 mA (maximum)	**Current**	**300 mA** (typical) **750 mA** (maximum)
10-30 VDC/VAC 30-300 VDC/VAC with external resistors	**Digital Input Rating**	10-30 VDC/VAC up to 300 VDC/VAC with external resistors **Aux Input accepts only DC voltage**
6 kΩ	**Digital Input Impedance**	**5.5 kΩ**
(3) Motor run status (6) Float contacts (1) External phase monitor bypass (1) Auxiliary input (pulse-counting capable) (1) Alarm silence override	**Digital Monitoring**	(3) Motor run status (6) Float contacts (1) External phase monitor bypass (1) Auxiliary input (pulse-counting capable) (1) Alarm silence override **(3) Seal failure trip** **(3) Thermal overload trip**
4-20 mA @ 250 Ω 1-5 V @ 100 kΩ 12-bit precision	**Analog Input Rating**	4-20 mA @ 250 Ω 1-5 V or **0-10 V @ 120 kΩ** **15-bit precision**
(Analog1) Voltage or current mode (using shunt pin) (Analog2) Current mode only	**Analog Monitoring**	(Analog1) Voltage or current mode (using shunt pin) (Analog2) Current mode only **(Analog3) Voltage or current mode (using shunt pin)** **(Analog4) Voltage or current mode (using shunt pin)**
24 VDC 100 mA	**DC Bias**	24 VDC **300 mA**
3 x 3-position switches for Hand-Off-Auto operation	**H-O-A Switches**	3 x 3-position switches for Hand-Off-Auto operation

120-240 VAC, 60 Hz, 1 A, Pilot Duty	**Pump Output Rating**	120-240 VAC, 60 Hz, 1 A, Pilot Duty
120 VAC, 60 Hz @ 0.5 A 24 VDC @ 1 A	**Alarm Output Rating**	120VAC, 60Hz @ **1 A** 24VDC @ 1 A
240VAC single- or three-phase 480VAC three-phase using external resistors	**3-Phase Voltage Monitoring**	240VAC single- or three-phase 480VAC three-phase using external resistors
---	**3-Phase Current Monitoring**	0-100A per-phase using external current transformers (USE ONLY DFS-SUPPLIED CTs)
Supports external 12V sealed lead-acid battery	**Battery Backup**	Supports external 12V sealed lead-acid battery
MOV, TVS, Opto-isolated	**Input Protection**	MOV, TVS, **on-chip transformer isolation** **Tested to IEC 61000-4-5 (Level 4)**
2W @ 200 MHz	**Integrated Radio**	2W @ 200 MHz **5W @ 400 MHz**
9600 baud (MODBUS slave)	**RS-232**	**9600-115200 baud** (MODBUS slave)
9600 baud (MODBUS master)	**RS-485**	**9600-115200 baud** (MODBUS master)
10 Mbit/s	**Ethernet**	100 Mbit/s
RJ-11 Modular	**Service Port**	**Dual USB 2.0**
Address Strap 	**Station Addressing**	USB Configuration Stick 
LCD w/ soft-touch keypad	**Display**	5” TFT LCD w/ capacitive touchscreen Resolution: 800 x 480 Brightness: 750 nits
Expandable with RS485 modules (RDP, RIO, etc.)	**Expandability**	Expandable with RS485 modules (RDP, RIO) **Extension card slot for future integrated I/O products**
-10°C (14°F) to 60°C (140°F) (up to 50°C when using recommended backup battery)	**Operating Temperature**	-10°C (14°F) to 60°C (140°F) (up to 50°C when using recommended backup battery)
Relative Humidity: 0-100% Atmosphere Pressure: 75-106 KPa Pollution Degree 2	**Environmental Rating**	Relative Humidity: 0-100% Atmosphere Pressure: 75-106 KPa Pollution Degree 2
Factory-applied acrylic conformal coating	**Environmental Protection**	Sealed enclosure with EPDM rubber gaskets
5.75” x 8.75” x 5.45”	**Dimensions**	5.75” x 8.75” x 5.45”
Black Anodized Aluminum	**Enclosure**	Black Anodized Aluminum

PIN Names/Wiring Definitions

Pump Control Applications

Top Connector 1: P1				
PIN#	**Name**	**Description**	**Electrical Rating**	**Module Address**
P1-1	PHASE_C	Phase C of the three-phase power monitor	120-240VAC, 60HZ, 10mA, 3-phase	C4
P1-2	PHASE_B	Phase B of the three-phase power monitor	120-240VAC, 60HZ, 10mA, 3-phase	C3
P1-3	PHASE_A / PHASE_N	Phase A of the three-phase power monitor in 3-Wire (delta) Neutral of the three-phase power monitor in 4-Wire (wye)	120-240VAC, 60HZ, 10mA, 3-phase	B11
P1-4	PHASE_A	Phase A of the three-phase power monitor in 4-Wire (wye) only	120-240VAC, 60HZ, 10mA, 3-phase	--
P1-5	AC_PWR	AC power	120VAC, 60HZ, 0.5-1.5A	B9
P1-6	AC_NEUT	AC neutral	120VAC, 60HZ, 0.5-1.5A	--
P1-7	TGND	Safety ground (Earth)	Ground	--
P1-8	BAT+	Backup battery positive terminal	<24V / Not Rated	--
P1-9	BAT-	Backup battery negative terminal	<24V / Not Rated	--
P1-10	BEMGND	Isolated ground (wire to BEM001, pin 12)	<24V / Not Rated	--
P1-11	BEM_PWR	Isolated power (wire to BEM001, pin 10)	<24V / Not Rated	--
P1-12	BEM_CTS	Isolated clear to send (wire BEM001, pin 6)	<24V / Not Rated	--
P1-13	BEM_RXD	Isolated receive data (wire to BEM001, pin 4)	<24V / Not Rated	--
P1-14	BEM_TXD	Isolated transmit data (wire to BEM001, pin 2)	<24V / Not Rated	--
P1-15	BEM_RTS	Isolated request to send (wire to BEM001, pin 8)	<24V / Not Rated	--
P1-16	ALM_HORN	Load side of alarm horn relay (NO)	120VAC, 60HZ, 0.5A, 0-24VDC, 1A	B5
P1-17	ALM_LITE	Load side of alarm light relay (NC)	120VAC, 60HZ, 0.5A, 0-24VDC, 1A	B6
P1-18	ALM_PWR	Line side of alarm relays	120VAC, 60HZ, 1A, 0-24VDC, 2A	--
P1-19	AUX_OUT	Load side of auxiliary relay	120-240VAC, 60HZ, 1A, Pilot Duty	B4
P1-20	AUX_PWR	Load side of auxiliary relay	120-240 VAC, 60HZ, 1A	--
P1-21	MTR3_STR	Load side of motor starter 3 relay	120-240 VAC, 60HZ, 1A, Pilot Duty	B3
P1-22	MTR2_STR	Load side of motor starter 2 relay	120-240 VAC, 60HZ, 1A, Pilot Duty	B2
P1-23	MTR1_STR	Load side of motor starter 1 relay	120-240 VAC, 60HZ, 1A, Pilot Duty	B1
P1-24	STRT_PWR	Line side of motor start relays	120-240 VAC, 60HZ, 3A	--

Top Connector 2: P3				
PIN#	**Name**	**Description**	**Electrical Rating**	**Module Address**
P3-1	C_CT+	C-phase current transformer positive connection	<24V / Not Rated	
P3-2	C_CT-	C-phase current transformer negative connection	<24V / Not Rated	
P3-3	B_CT+	B-phase current transformer positive connection	<24V / Not Rated	
P3-4	B_CT-	B-phase current transformer negative connection	<24V / Not Rated	
P3-5	A_CT+	A-phase current transformer positive connection (wye setup only)	<24V / Not Rated	
P3-6	A_CT-	A-phase current transformer negative connection (wye setup only)	<24V / Not Rated	
P3-7	ANALOG3+	0-5VDC or 0-10VDC or 4-20mA signal from transducer; return signal at P3-8; jump P3-9 to P3-8 to use as a 4-20mA input	<24V / Not Rated	I1*
P3-8	ANALOG3-	- return signal for ANALOG3+ (P3-7)	<24V / Not Rated	
P3-9	SHUNT	250Ω shunt resistor; jump to P3-8 to use a 4-20mA signal for ANALOG3+ (P3-7)	<24V / Not Rated	
P3-10	ANALOG4+	0-5VDC or 0-10VDC or 4-20mA signal from transducer; return signal at P3-11; jump P3-12 to P3-11 to use as a 4-20mA input	<24V / Not Rated	I2*
P3-11	ANALOG4-	- return signal for ANALOG4+ (P3-10)	<24V / Not Rated	
P3-12	SHUNT	250Ω shunt resistor; jump to P3-11 to use a 4-20mA signal for ANALOG4+ (P3-10)	<24V / Not Rated	
P3-13	SHIELD	Internally connected to chassis ground; cable shield for analog monitor signals	Ground	
P3-14	IN_COM_3	Common return for thermal and seal failure digital outputs	10-30VAC/DC, 100mA RTN	
P3-15	MTR3_ THERM	Motor 3 temperature monitor input	10-30VAC/DC, 10mA	H6*
P3-16	MTR2_ THERM	Motor 2 temperature monitor input	10-30VAC/DC, 10mA	H5*
P3-17	MTR1_ THERM	Motor 1 temperature monitor input	10-30VAC/DC, 10mA	H4*
P3-18	MTR3_SEAL	Motor 3 moisture seal monitor input	10-30 VAC/DC, 10mA	H3*
P3-19	MTR2_SEAL	Motor 2 moisture seal monitor input	10-30 VAC/DC, 10mA	H2*
P3-20	MTR1_SEAL	Motor 1 moisture seal monitor input	10-30 VAC/DC, 10mA	H1*

*When the new I/O is enabled, it will move to the next available module if H and I are already configured.

Bottom Connector 1: P2				
PIN#	**Name**	**Description**	**Electrical Rating**	**Module Address**
P2-1	MTR1_RUN	Motor 1 run digital monitor input	10-30VAC/DC, 10mA	A1
P2-2	MTR2_RUN	Motor 2 run digital monitor input	10-30VAC/DC, 10mA	A2
P2-3	MTR3_RUN	Motor 3 run digital monitor input	10-30VAC/DC, 10mA	A3
P2-4	EXT_PM	External phase monitor digital monitor input	10-30VAC/DC, 10mA	A4
P2-5	IN_COM_1	Common return for motor run and external phase monitor input	10-30VAC/DC, 100mA RTN	--
P2-6	LOW_LVL	Low Level digital monitor input	10-30VAC/DC, 10mA	A5
P2-7	OFF_LVL	Off Level digital monitor input	10-30VAC/DC, 10mA	A6
P2-8	LEAD_LVL	Lead Level digital monitor input	10-30VAC/DC, 10mA	A7
P2-9	LAG1_LVL	Lag1 Level digital monitor input	10-30VAC/DC, 10mA	A8
P2-10	LAG2_LVL	Lag2 Level digital monitor input	10-30VAC/DC, 10mA	A9
P2-11	HIGH_LVL	High Level digital monitor input	10-30VAC/DC, 10mA	A10
P2-12	AUX_IN	Auxiliary digital monitor input; supports pulse counting	10-30VDC, 10mA	A12
P2-13	ALM_SIL	Alarm Silence Switch digital monitor input	10-30VAC/DC, 10mA	B7
P2-14	IN_COM_2	Common return for input level, aux inputs, and alarm silence switch	10-30VAC/DC, 100mA RTN	--
P2-15	ISOGND	Internally supplied 24VDC bias source return (isolated)	<24V / Not Rated	--
P2-16	ISO+24V	Internally supplied 24VDC bias source voltage (isolated)	<24V / Not Rated	B10
P2-17	TXD_232	RS-232 transmit data to external device	<24V / Not Rated	--
P2-18	RXD_232	RS-232 receive data from external device	<24V / Not Rated	--
P2-19	GND	RS-232 ground	<24V / Not Rated	--
P2-20	SHIELD	Internally connected to chassis ground; cable shield for analog monitor signals	Ground	--
P2-21	ANALOG2+	4-20 mA signal from transducer; - signal at pin P2-23; internal 250Ω shunt permanently connected	<24V / Not Rated	C2
P2-22	ANALOG1+	0-5VDC or 0-10VDC or 4-20 mA signal from transducer; - signal at pin P2-24 to P2-23 to use as 4-20 mA input	<24V / Not Rated	C1
P2-23	ANALOG-	- signal return for both ANALOG1+ at P2-22 and ANALOG2+ at P2-21	<24V / Not Rated	--
P2-24	SHUNT	250Ω shunt resistor; jump to P2-23 to use a 4-20 mA signal for ANALOG1+ at P2-22	<24V / Not Rated	--

Bottom Connector 2: P4				
PIN#	**Name**	**Description**	**Electrical Rating**	**Module Address**
P4-1	Unused	Reserved for future use; do not connect	Not connected	--
P4-2	RS485_GND	RS-485 serial ground reference	<24V / Not Rated	--
P4-3	RS485_B	RS-485 serial interface B	<24V / Not Rated	--
P4-4	RS485_A	RS-485 serial inferface A	<24V / Not Rated	--
P4-5	SHIELD	Internally connected to chassis ground; Cable shield for RS-485 or RS-232	Ground	--
P4-6	EX_GND_ RAD	RS-232 signal ground	<24V / Not Rated	--
P4-7	RTS_RAD	RS-232 request to send	<24V / Not Rated	--
P4-8	EX_TXD_ RAD	RS-232 transmit data to external device	<24V / Not Rated	--
P4-9	EX_RXD_ RAD	RS-232 recieve data from external device	<24V / Not Rated	--
P4-10	CTS_RAD	RS-232 clear to send	<24V / Not Rated	--
P4-11	SDI12_GND	SDI-12 return/ground	<24V / Not Rated	--
P4-12	SDI12_DATA	SDI-12 data	<24V / Not Rated	--
P4-13	SDI12_PWR	12VDC power supply for SDI-12 bus devices	<24V / Not Rated	--
P4-14	Unused	Reserved for future use; do not connect	Not Connected	--

3. Unit Overview

The following sections describe what the available features of the TCU800 are and how they monitor and operate various parts of the pump control systems. The descriptions are from the perspective of the TCU800 as a unit interacting with a pump control system.

User Interaction

The TCU800 provides local statuses and has mechanisms for user control locally and remotely. The interaction points are the following: faceplate, USB ports, touch screen, and serial connectivity. The front of the TCU800 is called the faceplate. It consists of LEDs, a soft touch button, access for USB ports, HOA switches, and a touch screen. The main purposes of the faceplate are to provide the user with the status of the system at a glance, TCU800 operation, manual pump operation, and configuration access.

LEDs

LEDs allow the user to quickly determine the statuses of pumps, pump control processes, radio traffic, and alarms. All LEDs are red.

Pump Status
On/Off: A pump status LED, located under each HOA switch, is on when an associated pump is running. The LED is off when an associated pump is stopped. The running/stopped status of a pump is provided via the digital input Motor # Status, where # is the associated pump number 1, 2, or 3. Flashing: A pump status LED will flash when an associated pump is overridden via telemetry or a motor start or stop fault has occurred. Flashing will continue for a fault until the pump has properly run or the HOA switch for that pump is taken out of Auto.
Alarm
On/Off: The alarm LED is on when any alarming condition is active, and all active alarming conditions have been acknowledged. The LED is off when all alarming conditions are clear. Flashing: The alarm LED will flash when there is an alarming condition that has not been acknowledged or cleared. Flashing will continue until every alarming condition present has been acknowledged or cleared. Some alarms clear without user action, causing the alarm light to stop flashing and clear (if no other alarming conditions are present).
Status
On/Off: The status LED is used to verify the control program is running. When the status LED is not illuminated, the logic process is no longer running. Flashing: The status LED will flash during system start up. Start up Sequence: The status LED (with all other LEDs) illuminates when the power is applied to the TCU800. The LEDs will remain on for 15 seconds and then turn off. After an additional 5 seconds, the status LED will flash until the system has completed the start up. The status LED will now remain illuminated.

RX/TX
Blinking: The RX/TX LEDs blink (on to off) when a message is received or transmitted, respectively.
Stuck On/Off: If either LED is constantly on or off, there may be an issue in hardware or software.

Hand-Off-Auto (HOA) Switches

The TCU800 face plate has three fail-safe HOA switches corresponding to the three pumps it can control. Each switch controls only the associated pump, individually. The switches have three positions: left (Hand), center (Off), and right (Auto). If pump starter power is present, then the switches allow hand and off operation of pumps regardless of the state of the software or power to the unit.

Hand

Placing the switch in the hand position overrides the automatic output of the TCU800 and forces the corresponding pump on.

Off

Placing the switch in the off position overrides the automatic output and remote control of the TCU800 and forces the corresponding pump off.

Auto

Placing the switch in the auto position allows automatic operation of the corresponding pump. The state of the pump is being controlled by the operating logic program and telemetry override and disabled statuses. See the telemetry control section for more information.

Motor Fault Reset

If a motor starter fault occurs, it is reset by placing the corresponding HOA switch in Hand or Off.

Soft Touch Button

The TCU800 has a single soft touch button labeled with a home symbol. The button is located on the right side of the face-plate, below the Alarm LED and above the USB ports. The purposes of the button are as follows: to power the unit on or off, to wake up the display, to return to the home screen, and to acknowledge alarms to prevent the alarm horn sounding.

Powering Off a Unit

Press and hold the button for approximately 3 to 5 seconds. When the blue TCU800 screen appears, release the button. Failure to release the button within 6 seconds will cause a complete reboot instead of a shut down.

Powering On a Unit

If the unit was powered off according to the previous section, then the unit will power on with a single press of the button.

Rebooting a Unit (with Software Timer)

Press and hold the button for approximately 10 seconds. The unit will shut down as in the previous section, however, it will

immediately illuminate all LEDs. This shows the system was rebooted.

Rebooting a Unit (with Hardware Timer)

Press and hold the button for approximately 20 seconds. At the 20 second point, all LEDs will illuminate. Note: this length of time will only occur if one holds the button down through the software reset window. The purpose behind the hardware reset is to allow the user to reboot the box even if the software has been locked.

Sleep and Wake

When the unit is powered and running, the screen will sleep after 15 minutes of user inactivity. Momentarily pressing the button will wake the screen.

Silencing the Alarm Horn

If the alarm horn sounds, it can be silenced by momentarily pressing the button.

Returning to the Home Screen

To return to the Home screen, press the button once.

USB Ports

The TCU800 faceplate has two USB ports: the Configuration port and the Service port. Their purposes are station addressing and configuration, backup logs, service port access, and updating the TCU800 software.

Configuration Port

A removable USB drive replaces the address strap functionality and adds the ability to alter all TCU800 profile configuration options. A congifuration USB can be placed in either of the two USB ports.

Boot-Up: When the TCU800 boots up, it checks for a USB with a configuration, loads it, and saves it internally. If no configuration USB drive is available or the USB drive has failed, the TCU800 will use the last stored configuration.

Configuration Change: When a configuration change occurs, the USB and internal configurations are updated.

Never remove a USB drive under power. Ensure the TCU is in a shutdown state before removing the USB-- failure to do so may corrupt the configuration or damage the drive.

Service Port

The TCU800's service port is used for debug access and as a secondary method of configuration.

Touch screen

The TCU800 has an LCD with an integrated, capacitive touch screen. This displays all information pertinent to the pump control algorithm as well as providing an interaction point for many operations and configurations (discussed in the detailed operation section).

Operation

With a single finger, touch and release the screen over the desired option. Wait a moment for the operation to load and complete.

Sleep and Wake

After 15 minutes of no activity, the screenwill sleep. While the screen appears black, the normal TCU800 operations are continuing. The screen sleeps to improve product longevity. To wake the screen, tap the screen gently or press the home button. The screen may take a few seconds to illuminate.

Monitoring and Control

The TCU800 is capable of monitoring and controlling various interfaces for input/output logical operation and communication. It interacts with digital inputs, digital outputs, analog inputs, serial communication, phase voltages, and various internal features. The discussion in this section is limited to the default operation of the TCU800; contact Data Flow Systems to discuss alternative operations.

Digital Input Monitoring

The TCU800 can monitor digital input devices such as contact closures, float switches, pressure switches, pump seal and thermal overload contacts designed for mechanical and solid state signal closures. These input devices are used to determine various statuses of the pump control system or its auxiliary components to maintain proper operation.

Float Inputs: Level sensing is provided via float switches when configured. Six discrete inputs are provided as float level inputs with a common ground. The digital ground is also common to the auxiliary input and alarm silence inputs.

Auxiliary Input: The auxiliary input provides the ability to monitor an input and control an output (aux out) based on it's status, with several configurable options; see the auxiliary control configuration section. The digital ground is common with the six discrete float and the alarm silence inputs. This input can also be used as a pulse counter.

Alarm Silence: The alarm silence input provides a connection for an external momentary switch. Additionally, the home button is provided to silence alarms.

Motor Run Status: There are three motor run status inputs, one for each pump. These provide the statuses from the pump starter relays. This allows for pump start and stop fault determination; see the Pump Start and Stop Fault section for more information.

External Phase Monitor: The external phase monitor input is provided as both an internal bypass and an alarm input. The purpose of this input is to allow a system to use either the TCU800's phase monitoring system or an external phase monitor whose alarming condition is passed through the TCU800's alarms.

> Phase Monitor Bypass: The input is held in the on (high) state, this causes the internal phase voltage monitoring to be bypassed - no alarms will occur by internal phase voltage faults.
>
> External Phase Monitoring: An external phase monitoring device can provide an input to the TCU800 to make use

of the TCU800's alarm system. The input is normally held high with no phase voltage fault. When an alarming condition occurs on the external monitoring system, bringing the input low will cause an alarm on the TCU800.

Digital Output Control

The TCU800 controls digital outputs via two methods: solid-state relays and mechanical relays. The purpose of these outputs is to provide pump start, auxiliary output, alarm light, and alarm horn control.

Solid State Relays

There are four solid-state relay outputs used to control the three pump starter signals and one auxiliary output.

Pump Starters

The three pump start signals are independently powered via externally supplied Starter Power. The output control is provided automatically or can be overridden using the HOA switches. See chapter 6 for HOA control.

Auxiliary Output

The auxiliary output is independently powered via auxiliary output power. There are several configuration options available for its operation. See chapter 6: "Operating Procedures" for more information on configuration options.

P1-16	ALM_HORN	Load side of alarm horn relay (NO)
P1-17	ALM_LITE	Load side of alarm light relay (NC)
P1-18	ALM_PWR	Line side of alarm relays
P1-19	AUX_OUT	Load side of auxiliary relay
P1-20	AUX_PWR	Load side of auxiliary relay
P1-21	MTR3_STR	Load side of motor starter 3 relay
P1-22	MTR2_STR	Load side of motor starter 2 relay
P1-23	MTR1_STR	Load side of motor starter 1 relay
P1-24	STRT_PWR	Line side of motor start relays

Analog Input Monitoring

The TCU800 monitors four analog inputs. These inputs can be used for different sensing devices such as level, pressure, or flow. These inputs support 4-20mA, 0-5VDC, or 0-10VDC devices.

Level Sensing

Two analog inputs are used as normal and optional backup transducers. The transducers must be configured for the type of input and well level correlation. See chapter 6: "Operating Procedures" for more information on configuration options.

Auxiliary Analog Inputs

Two additional analog inputs are not used in the default pump control operation but can be configured for monitoring via telemetry. Contact DFS for custom control program options.

Serial Connectivity

Serial connectivity is provided on two interfaces to the TCU800: external RS-232 (slave) and isolated RS-485 (master).

External RS-232

The RS-232 connection is provided for an external radio or similar device. The connection is compatible with Modbus protocol as a slave port. See chapter 8 for additional information. Additional configuration is required for operation. See section 2 for installation instructions and section 6 for information on how to configure specific devices.

- Supports flow control
- Not isolated, but protected from voltage transients
- Supports baud rates 1200-115200

Isolated RS-485

The RS-485 connection is provided to connect an RS-485 device. The connection is compatible with Modbus protocol as a master port. See chapter 8 for additional information. Additional configuration is required for operation. See section 2 for installation instructions and section 6 for information on how to configure specific devices.

- 2.5kVrms isolated RS485 bus that can be used to communicate with standard RS485 sensors as well as other DFS telemetry equipment
- Protected from voltage transients
- Half duplex
- Supports baud rates 1200-115200

P4-2	RS485_GND	RS-485 serial ground reference
P4-3	RS485_B	RS-485 serial interface B
P4-4	RS485_A	RS-485 serial interface A
P4-5	SHIELD	Internally connected to chassis ground; Cable shield for RS-485 or RS-232
P4-6	EX_GND_RAD	RS-232 signal ground
P4-7	RTS_RAD	RS-232 request to send
P4-8	EX_TXD_RAD	RS-232 transmit data to external device
P4-9	EX_RXD_RAD	RS-232 recieve data from external device
P4-10	CTS_RAD	RS-232 clear to send

Phase Voltage Monitoring

The TCU800 has an internal system to monitor phase voltages and provide fault detection for several faults. The TCU800's internal phase monitoring can also be bypassed and an external phase monitor can be used.

Internal

The TCU800 has an internal phase monitoring chip capable of monitoring several types of phase voltage configurations and supplying failure conditions dependent upon those configurations.

Single/Three Phase: Single or three-phase voltage systems can be monitored with ranges of nominal 240 and 480 VAC. The 480 VAC systems require external resistors installed on each phase.

Fault Detection: Fault detection is provided for loss of a phase, phase reversal, and low/high voltage conditions. Faults will automatically stop all pumps from running to prevent damage.

External

The external phase monitor must provide a closed set of contacts that open during a phase fault. The voltage used to monitor the set of contacts must be the same voltage used to monitor the pump run statuses.

Internal Monitoring

The TCU800 monitors several internal features to provide the user with the status of how the unit is operating. These statuses are internal temperature, AC Power Fault, DC Bias Fault, and Process Fault.

Internal Temperature

Internal temperature monitors the TCU800's temperature.

AC Power Fault

AC Power fault is provided when no AC power is applied to the unit. This will only be available when the TCU800 is on battery backup.

DC Bias Fault

The DC Bias fault is active when the 24VDC bias power supply drops below 20VDC.

Process Fault

The process fault is active when the control program is detected as no longer operating.

Automatic/Manual Control

When the TCU's Hand-Off-Auto (H-O-A) switches are in the "Auto" position, the TCU provides automatic control over a pump system. However, there are two ways to partially or completely override the TCU and manually control the system: the H-O-A switches and telemetry interface.

H-O-A Switches

Three H-O-A switches on the TCU's face plate are provided to manually override the TCU's automated control.

Hand	Placing a switch in the "Hand" position overrides the TCU's control and forces the corresponding pump on.
Off	Placing a switch in the "Off" position overrides the TCU's control and forces the corresponding pump off.
Auto	The H-O-A switch for a pump must be in the "Auto" position for the TCU to provide automatic control whether manually over telemetry or automatically via the TCU coontrol programming.

The H-O-A switches are fail-safe; they remain operational even if the TCU fails or loses power. They will continue to function in the "Hand" and "Off" positions with the TCU in a faulted state or powered down. Motor Starter faults are reset when the corresponding H-O-A switch is moved from the "Auto" position.

Telemetry Interface

Connecting to a telemetry system provides the ability to remotely control the individually pumps with two software switches: Override – (when tuned on) remotely forces a pump On, and Disable - (when tuned on) remotely forces a pump Off, and effectively disables the the TCU from automatically controlling a pump. The H-O-A switch on the TCU must be in the Auto position for either of these switches to have any effect, and both of these switch need to be in their off state for the TCU to automatically control the pumps.

All three H-O-A switches must be in the "Hand" or "Off" position before any changes can be made to the TCU's configurations.

Local H-O-A control will always override any telemetry control.

Level Sensing Devices

The TCU features interfaces to several industry-standard level-sensing devices.

Discrete (Contact Closure) Devices

The TCU can accommodate digital-type devices such as contact closures, float switches, and pressure switches. Several digital-type devices can be connected to up to six discrete digital monitoring points to control the operation of pumps. The TCU is designed to handle simplex, duplex, and triplex configurations.

Analog Level-Sensing Devices

The TCU provides the option to monitor analog level-sensing devices, including ultrasonic, hydraulic pressure, and pneumatic pressure transducers through an industry-standard 4-20mA / 0-5V interface. Any analog level-detection transducer (self-powered or TCU powered) that supplies a 0-5V, 0-10V, or 4-20mA current signal can be used as an analog-level input device and can be loop-powered using the provided 24VDC bias on the P2 connector.

A station can be controlled by:

1. Connecting an analog-type device to the TCU's analog input terminals
2. Calibrating the maximum, minimum, and intermediate staging points

Internal Phase Monitor

A single- or three-phase 240 VAC power monitor is provided. An optional three-phase 480 VAC (using external resistors) power monitor is also available (see "Appendix D: Parts List" for information on the 480 VAC Phase Monitor Kit). All versions of the phase monitor detect phase loss and high and low line voltage phase faults. The three-phase 240 VAC and optional 480 VAC power monitor also detect phase reversal. A fault of phase reversal, phase loss, or line voltage results in an alarm and shuts down all automatically controlled pumps. The TCU has inputs for current transformers (CT) and can support 3-phase 3-wire (delta) or 3-phase 4-wire (wye) setups. Active, reactive, and apparent power or energy can be measured. The power factor can be measured when the CT inputs are used.

The TCU reads and displays True RMS voltages much the same as modern voltmeters. Readings from older voltmeters that display RMS, but not True RMS, might differ from the TCU's readings.

Outputs

Solid-State Control

The TCU features four solid-state (120-240VAC only) digital outputs. Three of these are used for Motor Start (P1-21 through 24) with the other used by the Aux Output (P1-19). The output for the Motor Starts are gated/switched through the TCU's H-O-A switches. In Auto the solid-state switches are used by the TCU to control the pumps, In Off no power is permitted to the Motor Start outputs, and the solid-state relays are manually bypassed and Motor Start pins are electrically energized by placing an H-O-A switch in the Hand position.

Mechanical Relay Outputs

The TCU's two mechanical relay output are for the Alarm signals, both horn and light. They can be VAC or VDC with recommended wiring instructions and relays rating listed elsewhere in this manual. Ifnot used for Alarms, either can be configured for manual control, via telemetry.

USB Ports and Configuration

The TCU's face plate features two USB type-A ports that can be used for diagnostics, configuration storage, and updating. A USB flash drive correctly formatted and loaded with appropriate files will allow easy transfer of pump configuration parameters from one TCU to another.

The *TAC Pack TCU Configuration Connector* or address card is not used in the TCU800. Instead, the USB configuration stick will replace this method of setting the TCU's station address.

Service Port

The USB ports can be used to serially connect to the TCU's core through a USB-to-Ethernet adapter. This will allow the user to SSH into the unit at the IP address registered to the adapter and access the logs on the unit. If the TCU is already connected to the internet (via the Ethernet) then the USB-to-Ethernet adapter is not necessary.

TCU800 Service Adapter

Touch screen

A 5" capacitive touch screen provides an interface for configuring the TCU, viewing and resetting alarms, and analyzing status information.

Electrical Protection

The TCU has an external cartridge fuse as well as an internal AC/DC power supply with overcurrent protection. The TCU shuts down logic and 9.5VDC and should the voltage continue to fall to 9.1 will shut down theTCU. Likewise, the TCU will recover from the logic shutdown at 11.0VDC and resume control. However, if complete shutdown occurred it will not turn back on until 12.3VDC.

Battery Backup (Optional)

An input is provided for connecting a battery to the TCU at connections P1-8 and P1-9. Connecting a battery to the TCU allows it to communicate and operate (albeit without the ability to run pumps) when primary AC power is lost. The alarm horn and light can be powered from the battery to provide alarm functionality during a power outage. All digital monitor inputs using ISO+24V (P2-16) as a bias-voltage source continue to function. If power fails, and the TCU is connected to telemetry, the power outage is reported to the central site.

The TCU includes a battery charger circuit that can be used to float charge a battery for backup operations. Note that statistical and configuration data is retained even without a backup battery. The purpose of the battery is to maintain telemetry functions during a power loss.

Operating run times for a typical application running on battery power:

- 12V, 2.6Ah battery - 2 to 3 hours
- 12V, 7.0Ah battery - 6 to 8 hours

These numbers are for a new, well-maintained, and fully charged battery. As the battery ages, operating run times may diminish. Larger capacity batteries can be substituted for longer lifespans. Please contact DFS if specific lifespans are required.

The TCU monitors the voltage and will begin a safe shutdown if the battery voltage drops below 9.1 VDC. It will not come back up until the voltage reaches 12.3 VDC.

Principles of Operation

Simplex, Duplex, and Triplex Stations

The station type is determined by the number of pumps at the station.

Simplex	A simplex station consists of one pump. At a minimum, a simplex station uses the Off and Lead staging levels.
Duplex	A duplex station consists of two pumps. At a minimum, a duplex station uses the Off, Lead, and Lag staging levels.
Triplex	A triplex station consists of three pumps. At a minimum, a triplex station uses the Off, Lead, Lag, and Lag2 staging levels.

The staging levels above are the required for a discrete float type system. For Analog systems the above settings must be programmed into the TCU as set points with the exception of the Off. The additional set points; Lead Off, Lag Off, and Lag2 Off, replace the single Off Float in the discrete float system. Both discrete and analog systems can use the option Low Level and High Level discrete inputs as a backup alarm system.

Pumping Modes

The TCU can be configured to operate in two different pumping modes, “Pump Down” or “Pump Up.”

Pump Down	Pump Down mode is used to empty a well (as is typical in a lift station) by maintaining the well level between the Off and Lead staging levels.
Pump Up	Pump Up mode fills a tank by maintaining the tank level between the Off and Lead levels.

Level-Sensing Systems - Discrete vs. Analog

A discrete system uses a device that provides an On/Off signal. These are typically float balls submerged into a wet well. The floats are wired to the appropriate inputs on the TCU. The TCU then controls the operation of up to three pumps based on input signals from these floats.

In an analog system, a variable, transducer-supplied 4-20mA or 0-5 V input that is wired to the TCU’s analog input is used to control up to three pumps. The input is typically supplied by a pressure, level, or ultrasonic transducer. Analog systems use Lead Off, Lag Off, and Lag2 Off set points in addition to the staging levels used by a discrete system.

Staging levels can be monitored using either a discrete system or an analog system. Pumps are automatically started and stopped based on these staging levels.

Discrete System (Contact Closure Devices)

In a discrete system, the TCU controls the pumps based on up to six discrete input signals, typically float balls submerged into a wet well. The floats are positioned at designated levels in the well to enable the pumps to be started and stopped based on the detected contact closure. The float contact closures can be monitored with various voltage levels.

Low and High floats can be added as optional backup and alarm systems. When a low or high-level float is activated, an

alarm is issued and normal pump control is overridden.

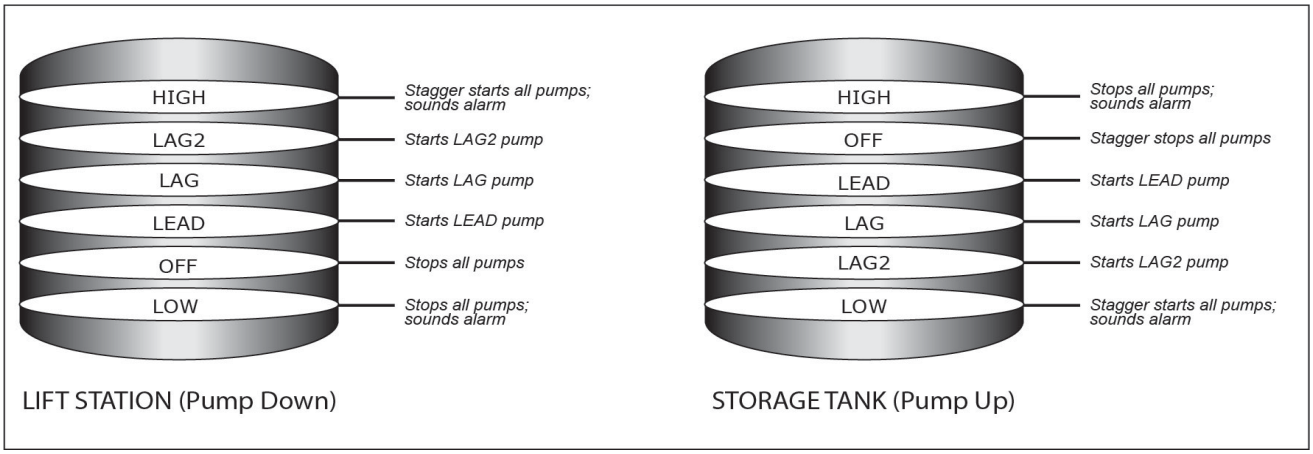
Note: If the Low float is not going to be used, it must be disabled in the TCU's local configuration for the TCU's pump control operations to function normally in automatic. Failing to disable the Low float configuration in this situation, results in a false alarm condition. This false alarm condition occurs because an unconnected Low Float input signal indicates to the TCU that the wet well is too low to operate pumps, or OFF, therefore the TCU will not permit pumps to operate. The TCU expects Low float input's normal/safe state to be ON which indicates the Low Float floating, to permit automatic pump operation.

Staging Levels in Discrete System

Pumps are automatically started and stopped based on staging levels. The illustration below shows the behavior of pumps at each staging level in a discrete system. Both a lift station (pump down mode) and a storage tank (pump up mode) are shown.

Staging Levels in Pump Down Mode (Discrete System)	
This chart describes the normal function of the TCU's eight staging levels when used in Pump Down mode, such as that used in a lift station. Note that not all of these levels must be configured for a lift station. The minimum number of levels required depends on the type of station – simplex (one pump), duplex (two pumps), or triplex (three pumps).	
Low Level	All pumps are stopped and alarms are activated. Low is active when the well's level is *below* Low level. Must be set below all other levels.
Off Level	Minimum operational level of a well. All pumps are stopped when the well's level is *below* the Off level.
Lead Level	Lead (first) pump is started. Lead is active when the well's level is *above* the Lead level.
Lag Level (duplex and triplex stations only)	Lag (second) pump is started. Lag is active when the well's level is *above* the Lag level.
Lag2 Level (triplex stations only)	Lag2 (third) pump is started. Lag2 is active when the well's level is *above* the Lag2 level.
High Level	All pumps are stagger started and alarms are activated. High is active when the well's level *reaches* High level. Must be set above all other levels.

Staging Levels in Pump Up Mode (Discrete System)	
The following paragraphs describe the function of the TCU's eight staging levels when used in Pump Up mode, such as that used in a storage tank. Note that not all of these levels must be configured for a lift station. The minimum number of levels required depends on the type of station – simplex (one pump), duplex (two pumps), or triplex (three pumps).	
High Level	All pumps are stopped and alarms are activated. Low is active when the tank's level is *above* High level. Must be set above all other levels.



Off Level	Minimum operational level of a tank. All pumps are stopped when the tank's level is *above* the Off level.
Lead Level	Lead (first) pump is started. Lead is active when the tank's level is *below* the Lead level.
Lag Level (duplex and triplex stations only)	Lag (second) pump is started. Lag is active when the tank's level is *below* the Lag level.
Lag2 Level (triplex stations only)	Lag2 (third) pump is started. Lag2 is active when the tank's level is *below* the Lag2 level.
Low Level	All pumps are stagger started and alarms are activated. Low is active when the tank's level is *below* Low level. Must be set below all other levels.

Analog System (Pressure Transducer)

In an analog system, pumps are controlled by a variable, transducer-supplied 4-20 mA or 0-5 V input that is wired to the TCU's analog input. The operator sets the 4 mA or the 1 V input equal to the transducer's low range (in feet) and the 20 mA or 5 V input equal to the transducer's high range (in feet). Low and High levels, as well as staging levels for the Lead, Lag, and Lag2 pumps are also set by the operator. The TCU interprets the input signal and starts or stops pumps according to the configured staging levels.

The TCU pump control operation functions with eight possible staging levels: Low, Lead Off, Lead, Lag Off, Lag, Lag2 Off, Lag2, and High.

An analog system has several options available for handling transducer faults:

- High and/or Low Float Override. Use a high and/or a low float to issue an alarm and override normal pump control.
- Switch to normal float behavior (Floats). This option requires an Off float to shut off the pumps and a minimum of one float (Lead to High) to start the pumps.
- Switch to a second analog input (Analog2).

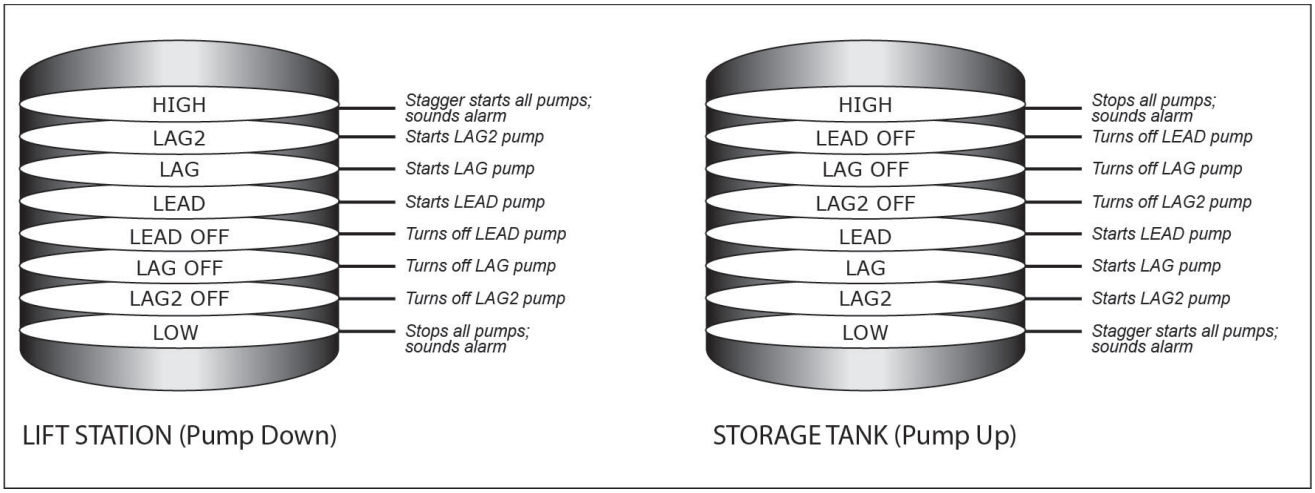
Note: If the Low float is not going to be used, it must be disabled in the TCU's local configuration for the TCU's pump control operations to function normally in automatic. Failing to disable the Low float configuration in this situation, results in a false alarm condition, which fails the transducer.

Staging Levels in Analog System

Pumps are automatically started and stopped based on staging levels. The illustration below shows the behavior of pumps at each staging level in an analog system. Both a lift station (pump down mode) and a storage tank (pump up mode) are shown.

Staging Levels in Pump Down Mode (Analog System)	
This chart describes the normal function of the TCU's eight staging levels when used in Pump Down mode, such as that used in a lift station. Note that not all of these levels must be configured for a lift station. The minimum number of levels required depends on the type of station – simplex (one pump), duplex (two pumps), or triplex (three pumps).	
Low Level	All pumps are stopped and alarms are activated. Low is active when the well's level is *below* Low level. Must be set below all other levels.
Lead Off Level	Minimum operational level of a well. Lead pump is stopped when the well's level is *below* the Lead Off level.
Lag Off Level (duplex and triplex stations only)	Lag (second) pump is stopped. Lag Off is active when the well's level is *below* Lag Off level.
Lag2 Off Level (triplex stations only)	Lag2 (third) pump is stopped. Lag2 Off is active when the well's level is *below* Lag2 Off level.
Lead Level	Lead (first) pump is started. Lead is active when the well's level is *above* the Lead level.
Lag Level (duplex and triplex stations only)	Lag (second) pump is started. Lag is active when the well's level is *above* the Lag level.
Lag2 Level (triplex stations only)	Lag2 (third) pump is started. Lag2 is active when the well's level is *above* the Lag2 level.
High Level	All pumps are stagger started and alarms are activated. High is active when the well's level *reaches* High level. Must be set above all other levels.

Staging Levels in Pump Up Mode (Analog System)	
This chart describes the normal function of the TCU's eight staging levels when used in Pump Up mode, such as that used in a storage tank. Note that not all of these levels must be configured for a lift station. The minimum number of levels required depends on the type of station – simplex (one pump), duplex (two pumps), or triplex (three pumps).	
High Level	All pumps are stopped and alarms are activated. High is active when the tank's level is *above* High level. High must be set *above* all other levels.



Lead Off Level	Lead Off is the maximum operational level of a tank. Lead pump is stopped when the well's level is *above* the Lead Off level.
Lag Off Level (duplex and triplex stations only)	Lag (second) pump is stopped. Lag Off is active when the tank's level is *above* Lag Off level.
Lag2 Off Level (triplex stations only)	Lag2 (third) pump is stopped. Lag2 Off is active when the tank's level is *below* Lag2 Off level.
Lead Level	Lead (first) pump is started. Lead is active when the tank's level is *below* the Lead level.
Lag Level (duplex and triplex stations only)	Lag (second) pump is started. Lag is active when the tank's level is *below* the Lag level.
Lag2 Level (triplex stations only)	Lag2 (third) pump is started. Lag2 is active when the tank's level is *below* the Lag2 level.
Low Level	All pumps are stagger started and alarms are activated. Low is active when the tank's level is *below* Low level. Must be set below all other levels.

Pump Alternation

The TCU includes a pump alternator function that can be used to minimize pump cycle times or equalize pump run times. When enabled, the alternator updates each time it starts a pump. If a pump fails to start, the alternator advances to the next available pump. Pumps can be taken out of service with the H-O-A switches and the TCU will continue to alternate the remaining pumps.

The following alternation options are available:

- Alternate among all available pumps.
- Alternate between pumps 1 and 2 (High Service Pump option).
- Alternate between pumps 2 and 3 (Jockey Pump option).
- Disable pump alternation

The TCU uses a numeric alternation scheme. With numeric alternation, the pump assigned as the new Lead pump is always the next in the numeric order. For example, in a triplex lift station, if pump 2 (current Lead pump) and pump 3 (current Lag pump) are running when the Lead Off level is reached, pump 3 would become the new Lead pump regardless of the number of pumps running.

If the Jockey Pump or High Service Pump options are enabled, the remaining pumps will alternate per the selected scheme. When the alternator is disabled, Pump 1 is used as the Lead pump, Pump 2 as the Lag pump, and Pump 3 as the Lag2 pump.

Use of Unused Pump Outputs

Unused pump outputs can be connected to any other type of control device. These devices can be turned on using the pump override points. For example, in a duplex station (two pump operation), the third pump output could be connected to an odor control injection.

Phase Monitor Options

In addition to the TCU's internal phase monitor (see page 18), the TCU can use an external phase monitor or the internal phase monitor can be bypassed.

External Phase Monitor

The TCU features an input at P2-4 that can accommodate the use of an external phase monitor where one is required. The external phase monitor must provide a closed set of contacts that open during a phase fault. The voltage used to monitor the set of contacts must be the same used to monitor the pump run statuses.

Phase Monitor Bypass

The TCU's phase monitor can be bypassed if the internal phase monitor function is not required and there is no external phase monitor. To bypass the TCU's internal phase monitor, wire the phase monitor input (P2-4) in the ON state. The voltage used to bias this point ON must be the same voltage used to monitor the pump run statuses.

Motor Run-Time Monitor

The TCU provides three digital monitor inputs for monitoring the status of the motors controlled by the TCU's starter relays:

- P2-1, *MTR1_RUN*
- P2-2, *MTR2_RUN*
- P2-3, *MTR3_RUN*

The Motor 1 Run input (MTR1_RUN) monitors the circuit controlled by the Motor 1 Starter output (MTR1_STR). Correspondingly, MTR2_RUN monitors MTR2_STR, and MTR3_RUN monitors MTR3_STR.

Care should be taken to avoid cross-wiring the motor run inputs and starter outputs. For each pump controlled by the TCU, the corresponding motor run input must be connected. After the TCU starts a pump, it checks the motor run input to verify that the pump is running. If the signal is not present, it:

1. Shuts down the pump
2. Activates the pump's motor-starter alarm

3. Tries the next pump

The preferred method for monitoring motor run is to use phase A at the load side of the motor breaker as motor run bias, and feed the bias through the starter auxiliary contacts to the TCU's motor run input terminal with a proper bias resistor in the circuit. Monitoring the starter auxiliary contacts by using Phase A as bias can provide fault detection of the TCU's starter relays, the motor-starter coils, and heater overloads, as well as an open breaker.

Solid State Motor Starter Control Relays

The TCU features three solid-state relays, capable of controlling up to three motor starters. STR_PWR (starter power), terminal P1-24, will be switched to the starter coils when the TCU's starter relays are energized, or when the H-O-A switches are placed in the "Hand" position. The TCU controls 120-240 VAC starter coils, with each output supporting a maximum of one amp. A one-amp slow-blow fuse is required to protect the TCU's relays from short-circuited motor-starter coils. Size 3 or larger starters should be isolated with a relay. If starters are not maintained over time, they can draw over one ampere.

Auxiliary Input and Output

The TCU's auxiliary digital input (AUX_IN; P2-12) and output (AUX_OUT; P1-19) can function together as a programmable time delay relay or work independently as general monitor and control points for telemetry. Additionally, the auxiliary input can operate as a pulse counter and be used with pulse-type flow meters and rain gauges.

To use AUX_IN and AUX_OUT as general monitor and control points, or to use AUX_IN as a pulse input, the time delay relay function must be disabled. This is done by setting the function's delay time to 0 (zero).

Time Delay Relay

An example of an auxiliary relay application is switching on a backup compressor for a bubbler system. The backup compressor is connected to the AUX_OUT terminal, and an airflow switch for the primary compressor is connected to the AUX_IN terminal. The Time Delay Relay function can then be configured to turn on the AUX_OUT when the flow switch detects no airflow. The Time Delay Relay can also be configured to start the backup compressor only when the flow stops for longer than a set time. This is accomplished by configuring the Time Delay Relay with the ON delay mode and setting the desired delay time.

Pulse Counting

For the auxiliary input to be used as a pulse input, its corresponding HT3 point (point 12 of Module A, a DMM002) must be configured as a digital pulse point (select DP for the Point Type). Additionally, the time delay relay function must be disabled in the TCU.

The specifications for the pulse input are as follows:

- Supply voltage: 8 to 14 VDC
- Minimum pulse width: 25 ms

Alarm Light & Horn/Bell Outputs

The TCU contains two mechanical relays for controlling an alarm light and horn. Alarm devices can be AC or DC powered for operation during power outages. If the TCU is connected to telemetry, these devices are not necessary and may be

disabled from the TCU's local configuration. All conditions that activate the alarm horn and alarm light are reported through the telemetry system.

Alarm outputs are activated only when the TCU detects an alarm condition, such as phase faults, high and low-well conditions, and internal TCU faults. The alarm horn can be silenced by pressing the TCU's Silence switch, by viewing the TCU's alarm screen from a telemetry-provided alarm silence control point or from a momentary switch connected to the TCU's Alarm Silence input. Any new alarm condition reactivates the alarm horn.

Failure Modes

Pump Failure

The TCU can operate around a pump that has failed and can be configured to retry the failed pump after a delay. If the retry function is disabled, the TCU will alternate around the faulted pump until it is taken out of service via its corresponding H-O-A switch.

Phase Fault

The TCU's phase monitor is designed to detect phase losses, high and low phase faults, and phase sequence faults. When the TCU detects a phase fault, it disables the pump motor outputs and activates the alarm light and horn relays. The TCU's H-O-A switches can be used to override the TCU's phase monitor and control the pumps during a phase fault.

Analog Transducer Fault

The conditions that cause a transducer fault alarm to be generated are based on the TCU's configuration. A few of the conditions that can cause a transducer fault are:

- Transducer low condition
- High float condition

The TCU provides several options for maintaining well and tank levels when a transducer fault occurs. Control pumps using:

- High and/or low float
- Second analog transducer
- Float system (Off float and at a minimum a Lead or High float)
- Combination of a high and/or low float and the desired fault mode (timer, second transducer, floats)

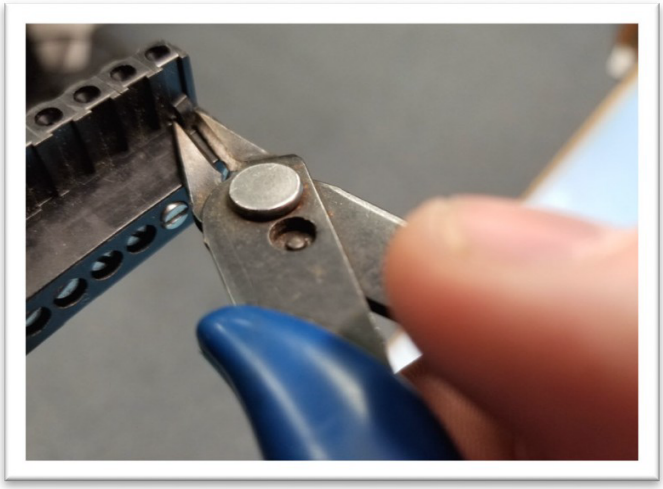
4. Setup

This information is provided for qualified personnel only. Improper installation, service, or maintenance can cause property damage, injury, or death. Read the installation and operating instructions thoroughly before installing or servicing this equipment.

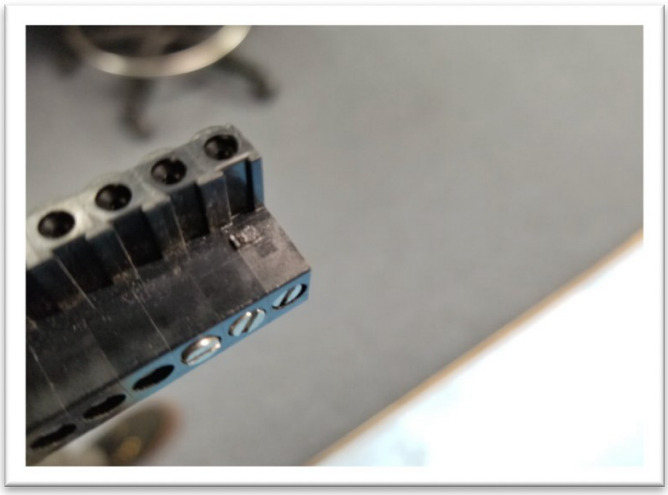
Precautionary measures must be observed when installing, operating, and servicing the TCU in order to prevent shock from voltages present. If the TCU is to be installed into an existing control panel, make sure that all breakers are shut off before starting the installation. All wiring must conform to federal, state, and local electrical codes.

Pre-Installation Modifications

The connectors used for the TCU001 harness had locking clips to hold the female plug in place. The new TCU800 does not need these clips, and due to the additional thickness of the sealing gasket the connector may not properly seat completely in the TCU800. Therefore, these clips must be removed to ensure proper connection for P1 through P4.



Use snips, pliers, or a razor to remove the retention clips from P-connectors.



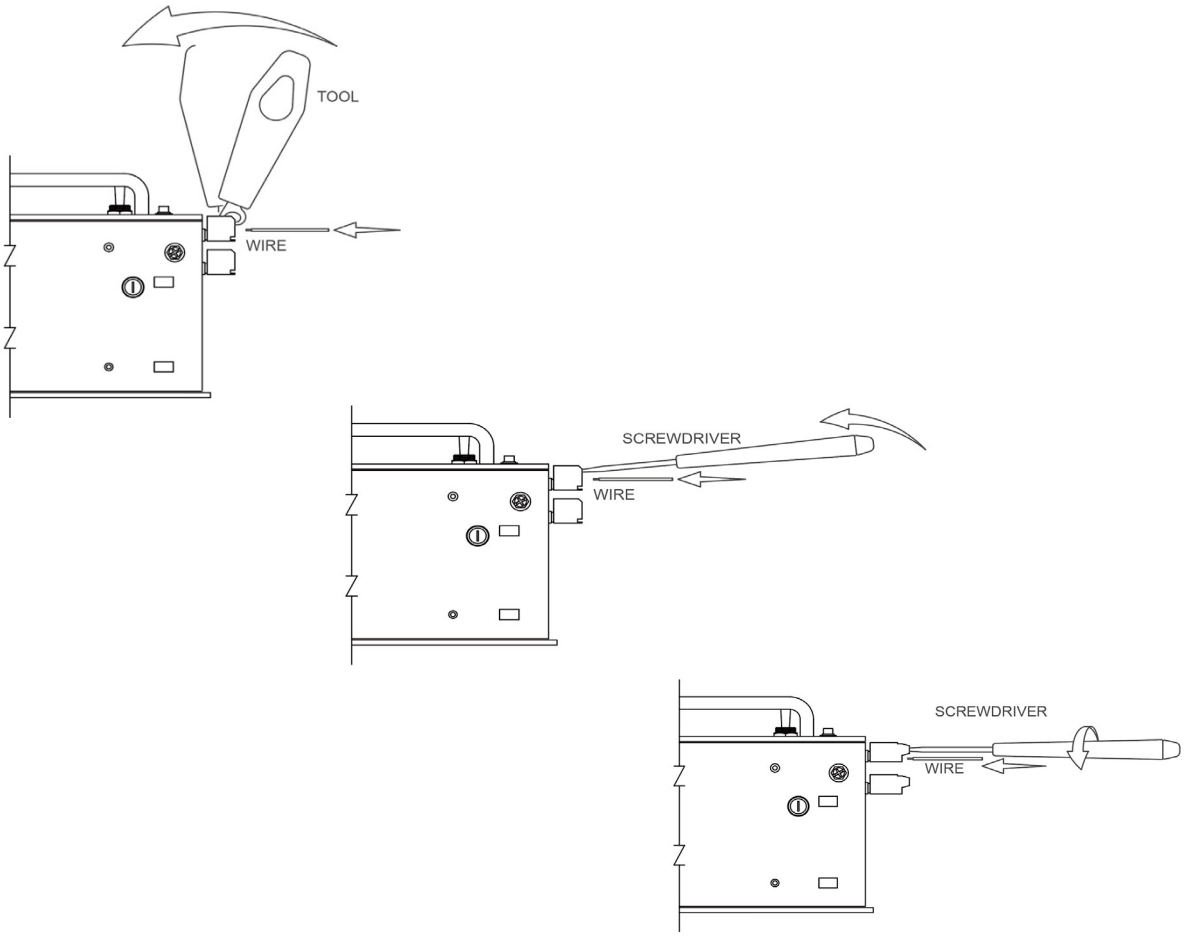
Once the retention clip is removed, the P-connector will be able reliably work with the TCU800.

Mounting Instructions

The TCU is intended to be permanently installed in a NEMA 12 or higher rated panel that prevents access to live parts without a tool. The TCU can be mounted in a control panel in several different ways. The unit can be mounted flush to the back plate of the panel, stood off the back plate, or mounted to a front panel. Mounting brackets that can be used to mount the TCU in any of these positions are available and provided separately. Detailed diagrams of mounting options can be found in "Appendix E: Mounting Instructions." Optional connectors to facilitate the various types of mountings are available and may be specified as described in "Appendix D: Parts List" of this document.

Attention should be given to the location of the TCU to provide accessibility for wiring and servicing. Leave enough space around the TCU to access the TCU's fuse and to remove the connectorized terminal strips. Install the TCU in the panel at a position where the LCD display can be read comfortably. The LCD is best viewed at slightly below eye level.

The graphic below depicts how each of the TCU's three optional connector types can be attached to the unit. The first option uses the Spring-Clamp connector tool, which can be ordered from DFS. See "Appendix D: Parts List" for information on ordering connectors and the connector tool.



Electrical Installation and Wiring Diagrams

The electrical interface to the TCU is broken down into several groups of signals. The wiring of each group is detailed in the following paragraphs.

These instructions are written specifically for a TCU using the built-in pump control process. Although many of them apply to custom applications as well, the Applications Engineer will be primarily responsible for defining and implementing the TCU's inputs and outputs. In this chapter, functions specific to the pump control process are noted as such.

- **Maximum wire size to TCU connectors is 12 AWG.**
- **Use copper conductors only with a minimum rating of 75C.**
- **The recommended circuit breaker is 10 Amp maximum.**
- **When using connectors with screw-type terminals, tighten screw terminals to a maximum 7 in-lb (.79 Nm).**
- **All AC source power wired to the TCU should be from the same leg of the three-phase system.**
- **The Power LED does not indicate that AC power has been removed. Even if the TCU's Power LED is not lit, you should assume that the TCU is still powered. To remove power, you must turn off the external circuit breaker.**

AC Power

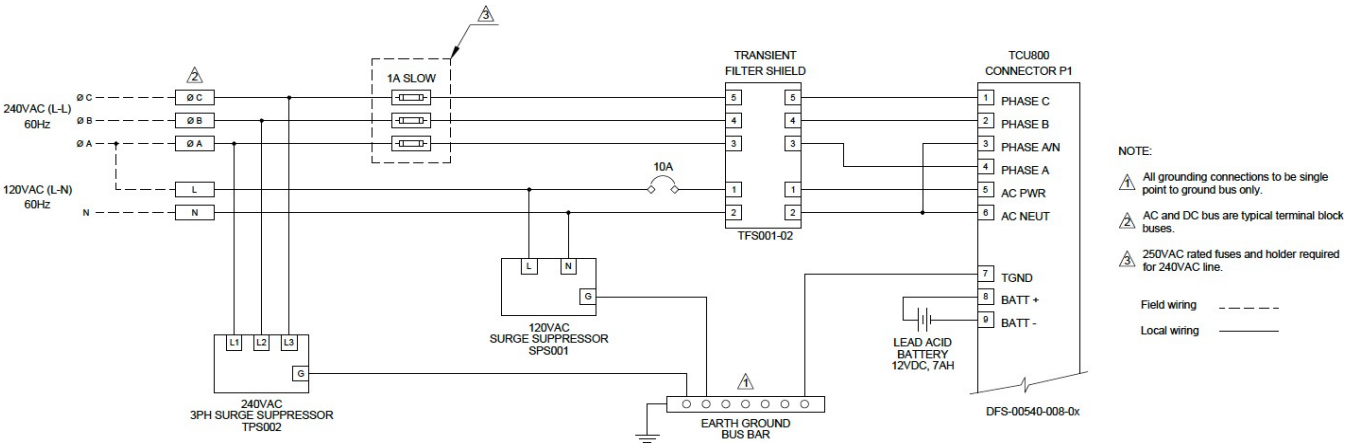
The TCU operates from 120 VAC. Verify the input voltage on the TCU's connector label before wiring. Three terminals are provided for wiring power:

- P1-5, AC_PWR (AC power)
- P1-6, AC_NEUT (AC neutral)
- P1-7, TGND (earth ground)

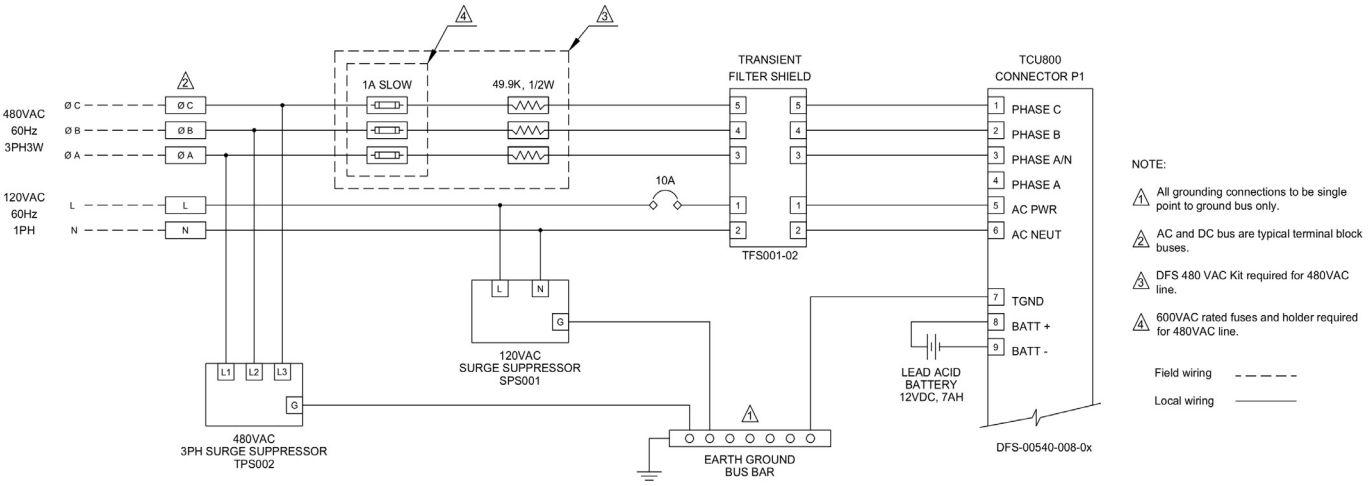
Terminal P1-7 is designated Earth or Safety ground. The TCU's case is also connected to the TGND terminal. Wire in accordance with Federal, State, and Local Electrical Codes.

The transformer must provide AC neutral. When wiring to a typical three-phase, 4-wire, 240 V transformer that provides AC neutral, refer to "Wiring AC Power (typical 240V, 4-wire transformer)." Refer to "Wiring AC Power (typical 480 V, 3-wire transformer)" when connecting to a typical three-phase, 3-wire 480 V transformer with no neutral provided.

Note that these diagrams are for typical installations. If your installation deviates from what is shown here, then refer to the National Electrical Code® (NEC®) Handbook.



Wiring AC Power (typical 240 V, 4-wire transformer)



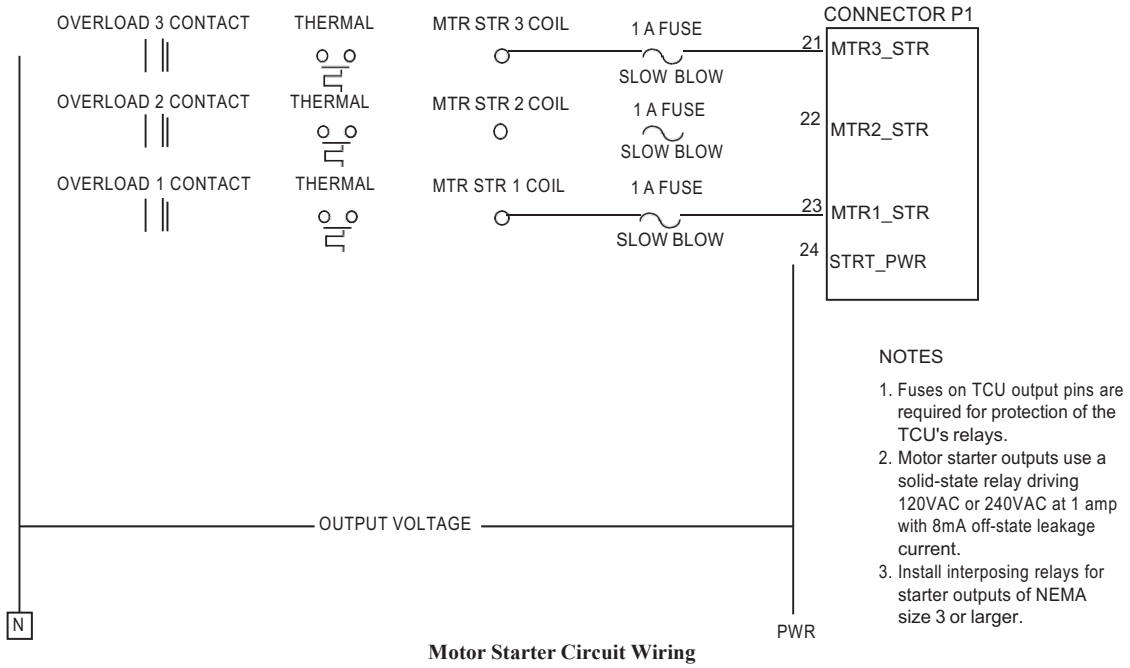
Wiring AC Power (typical 480 V, 3-wire transformer)

Motor Starter Outputs

1. Connect control power to the STR_PWR terminal (P1-24).
2. Connect the MTR1_STR terminal (P1-23) through a 1 A slow-blow fuse to the coil of the motor starter or the control relay designated as Pump 1. (This fuse protects the TCU relays from short-circuited coils).
3. Connect the other side of the motor starter coil through appropriate disabling contacts to control power neutral. Make similar connections for Pump 2 and Pump 3 for duplex and triplex stations.

When the alternator function is disabled through the TCU's configuration, MTR1_STR controls the Lead pump, MTR2_ STR controls the Lag pump, and MTR3_STR controls the Lag2 pump. They should be wired accordingly.

Simplex stations use only MTR1_STR. Duplex stations use MTR1_STR and MTR2_STR. Triplex stations use all of the motor starter outputs. Unused starter outputs can be used as auxiliary outputs with control provided by telemetry.

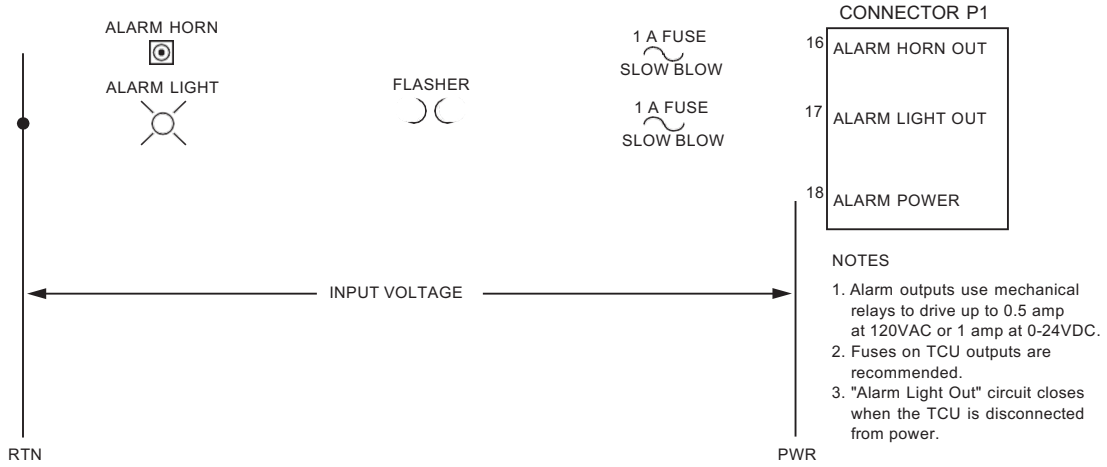


Motor Starter Circuit Wiring

Alarm Light and Horn Outputs

The alarm outputs use mechanical relays to drive up to 0.5 A at 120 VAC or 1 A at 0-24 VDC. The addition of 1 A slow blow fuses on the TCU outputs is recommended to protect the TCU's alarm relays from short circuits. The alarm light output is a set of contacts that are closed when the TCU is powered down.

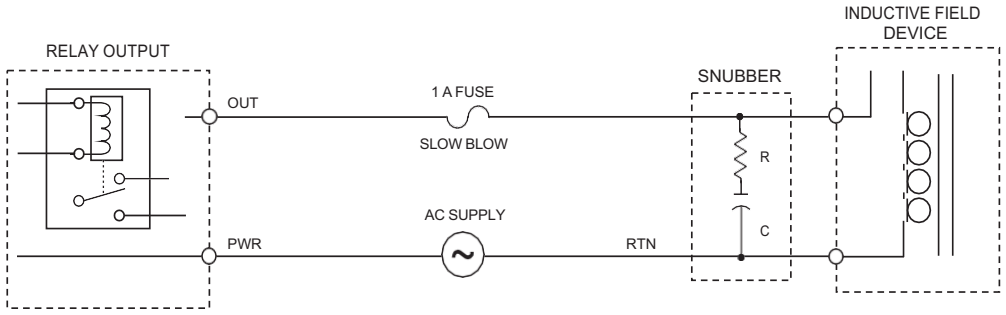
The alarm light output is designed to energize an incandescent lamp. Any other application requires an interposing relay, especially strobe lights due to their high peak current demands.



Alarm Horn and Alarm Light Wiring

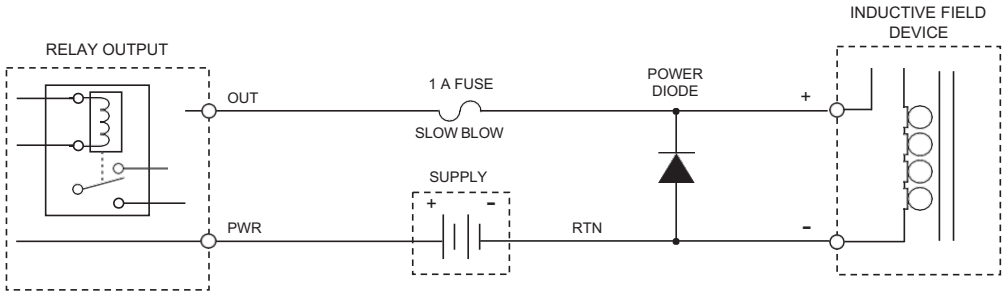
Using Snubbers When Connecting Alarm Outputs

For AC applications, we recommend an RC snubber (DFS # 007-0084) using a 0.1uF capacitor in series with a 47 Ω ½ W resistor, such as that manufactured by RED LION (Model # SNUB0000).



Snubber in AC Alarm Output Application

For DC applications, we recommend a power diode (DFS # 006-0019) with a minimum 3 A 100 peak inverse voltage (PIV) fast acting rating, such as the industry standard 1N4004 (DIGIKEY # 1N4004CT-ND).



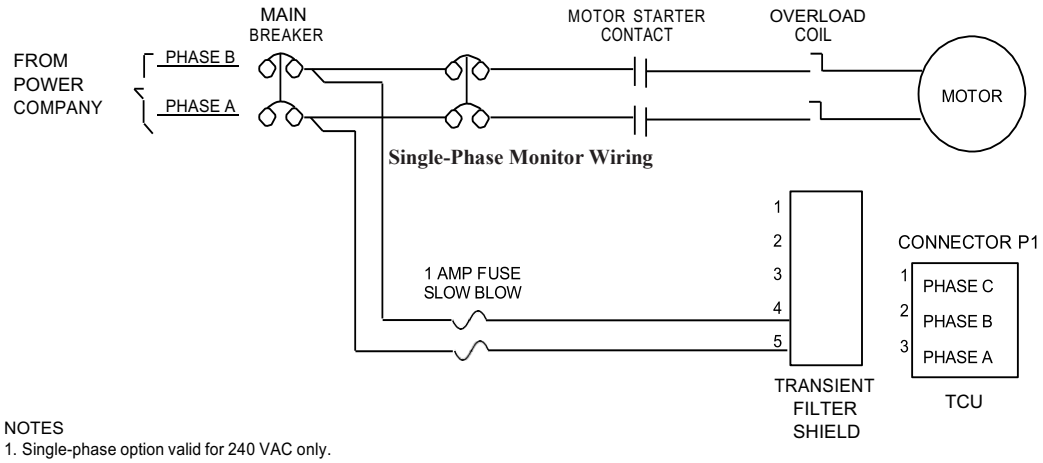
Snubber in DC Alarm Output Application

DC polarity is important. The diode must be connected in reverse bias across the coil terminals or as close as is practical. That is, the cathode (the side with the white band on the diode body) must be connected to the (+) supply power and the anode connected to the (-) supply power. Most DC relays do not have a polarity requirement on their coils, so you must trace out the polarity or use a Voltmeter. Remember that the inductive transient is a reverse voltage, which causes the diode to conduct and short out the voltage.

Phase Monitor

Single Phase Option (240 VAC only)

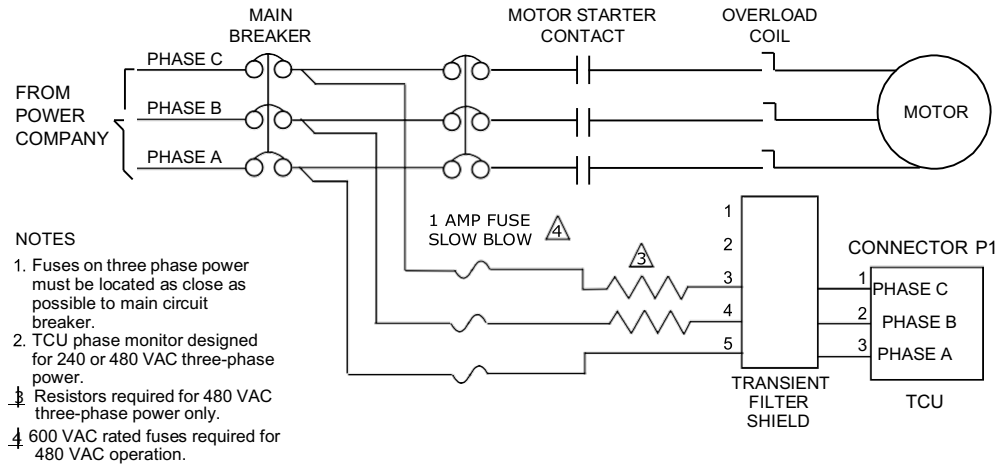
The single-phase 240 VAC connection is to the TCU's A and B phase inputs only. The C phase input must not be connected. A phase sequence/phase voltage fault will occur if the TCU is configured for single-phase and the C phase is connected. When configured for single-phase, the TCU's phase monitor detects phase voltage failures and displays phase A-B readings only.



NOTES
1. Single-phase option valid for 240 VAC only.
2. Fuses on phase power must be located as close as possible to the main circuit breaker.

Three Phase Option

Connections to the three-phase lines are used for monitoring phase sequence and voltage levels of the incoming power. The TCU's phase monitor is labeled for clockwise phase sequence. If the three-phase power is labeled for counter-clockwise rotation and is connected in accordance to the TCU's terminal label, the TCU will detect a phase sequence fault. To correct this condition, reverse any two leads connected to the TCU's phase monitor.



NOTES
1. Fuses on three phase power must be located as close as possible to main circuit breaker.
2. TCU phase monitor designed for 240 or 480 VAC three-phase power.
3. Resistors required for 480 VAC three-phase power only.
4. 600 VAC rated fuses required for 480 VAC operation.

Digital Monitor Point Inputs

The TCU has 18 digital monitor point inputs. These monitor points require an input and a return. All digital inputs support 10-30VAC/DC or 30-300VAC with external resistors. Note that the auxiliary input (P2-12) supports pulse input capture instead of VAC. These inputs are organized into groups, or "banks," that are electrically isolated from one another and equipped with chip scale transformers that protect up to 3.7kVrms.

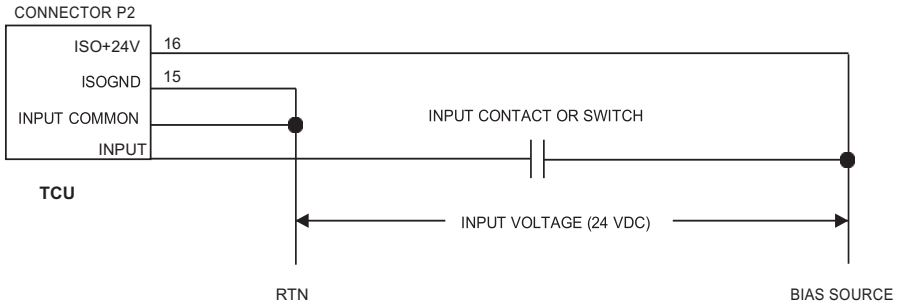
Bank 1		Bank 2		Bank 3	
MTR 1 RUN	P2-1	LOW LVL	P2-6	MTR 1 SEAL	P3-20
MTR 2 RUN	P2-2	OFF LVL	P2-7	MTR 2 SEAL	P3-19
MTR 3 RUN	P2-3	LEAD LVL	P2-8	MTR 3 SEAL	P3-18
EXT PM	P2-4	LAG1 LVL	P2-9	MTR 1 THERM	P3-17
INPUT COM 1	P2-5	LAG2 LVL	P2-10	MTR 2 THERM	P3-16
		HIGH LVL	P2-11	MTR 3 THERM	P3-15
		AUX IN	P2-12	INPUT COM 3	P3-14
		ALM SIL	P2-13		
		IN COM 2	P2-14		

*MTR RUN (Motor Run) inputs are used to detect if a particular pump is running.
*EXT PM (External Phase Monitor) is an input for an external phase monitor alarm.
*LVL inputs are used as markers to determine the current level of the well. Using information from these inputs, pump control logic decides if pumps need to be turned on or off.
*MTR SEAL (Motor Seal) inputs must be connected to a seal sensor. This detects the presence of water inside the pump housing which typically leaks past the shaft seal. The sensor will activate if a leak in the seal is detected.
*MTR THERM (Motor Thermal Overload) inputs must be connected to a thermal sensor. The sensor will activate if the internal temperature of a pump gets too high.
*ALM SIL (Alarm Silence) is an input that allows an activated alarm to be silenced from a source other than the soft-touch button on the overlay.
*AUX INPUT can be used for general-purpose inputs (e.g. pulse meters or rain gauges).

Bias Voltage Source Options

Internally-Supplied Bias Voltage Source

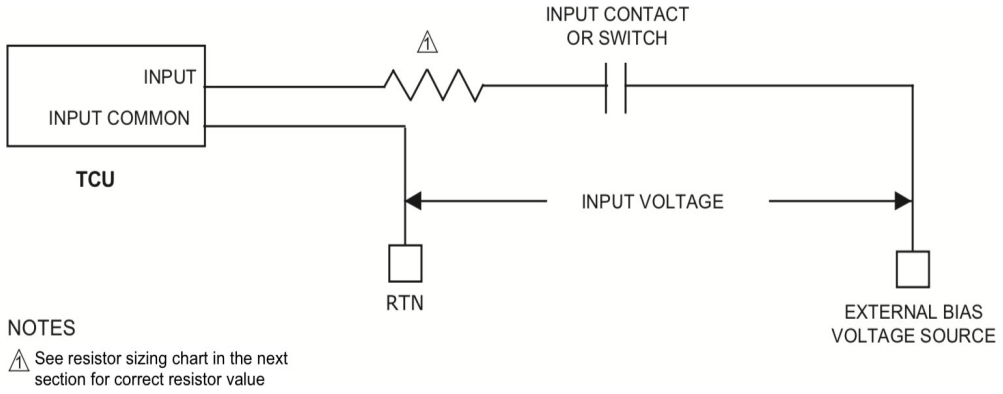
A voltage of 10-30 VAC or VDC will bias the digital monitor inputs in the ON state. Any voltage less than 4 VAC or 4 VDC will force the digital monitor inputs to the OFF state. The internal bias source is the ISO+24V terminal (P2-16) and the ISOGND terminal (P2-15).



Biasing an Input with ISO+24V / ISOGUND Voltage

Externally-Supplied Bias Voltage Source

Externally supplied bias voltages can be used to bias the inputs. If the voltage is greater than 30 VAC/VDC, a voltage-dropping resistor must be placed in line with the input. A minimum voltage of 10 VAC/VDC is required to indicate an ON state for the digital monitor inputs.



Biasing an Input with an External Source

Input commons on the TCU must be either AC neutral (with no voltage potential when referenced to earth ground) or the negative terminal of a DC power supply.

Motor Run Monitoring Signal

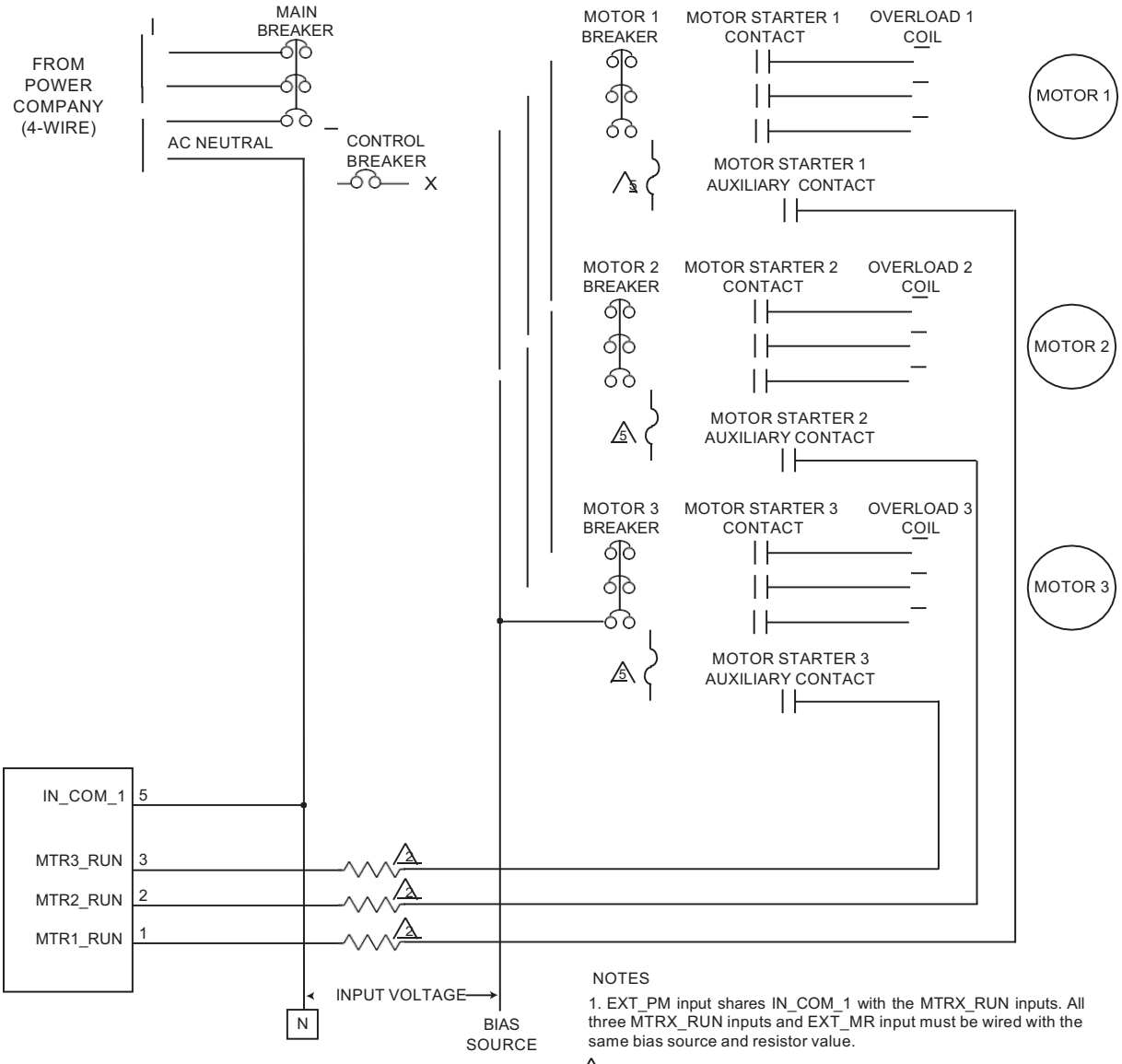
For each pump controlled by the TCU, a corresponding motor run input (MTRx_RUN) must be connected. The bias voltage for the motor run input (MTRx_RUN) is taken from one phase of the motor power at the output of the motor breaker and through the motor starter auxiliary contact. Connect a wire from this point, through a voltage-dropping resistor, to the corresponding motor run input (P2-1 for MTR1_RUN, P2-2 for MTR2_RUN, and P2-3 for MTR3_RUN). Connect the IN_COM_1 terminal (P2-5) to the neutral.

The transformer must provide AC neutral. When wiring to a typical three-phase, 4-wire, 240 V transformer that provides AC neutral, refer to "Motor Run Monitoring Signal (4-wire transformer)". Refer to "Motor Run Monitoring Signal (3-wire transformer)" when connecting to a typical three-phase, 3-wire 480 V transformer with no neutral provided. Input commons on the TCU must be either AC neutral (with no voltage potential when referenced to earth ground) or the negative terminal of a DC power supply.

These diagrams are for typical installations. If your installation deviates from that shown here, then refer to the National Electrical Code® (NEC®) Handbook.

Resistor Sizing Chart

Input Bias Voltage	Resistor Size
BIAS +	None
10-30 VDC/VAC	None
31-100 VDC/VAC	22K, 1/2 W
101-200 VDC/VAC	47K, 1/2 W
201-300 VDC/VAC	100K, 1 W



NOTES

1. EXT_PM input shares IN_COM_1 with the MTRX_RUN inputs. All three MTRX_RUN inputs and EXT_MR input must be wired with the same bias source and resistor value.

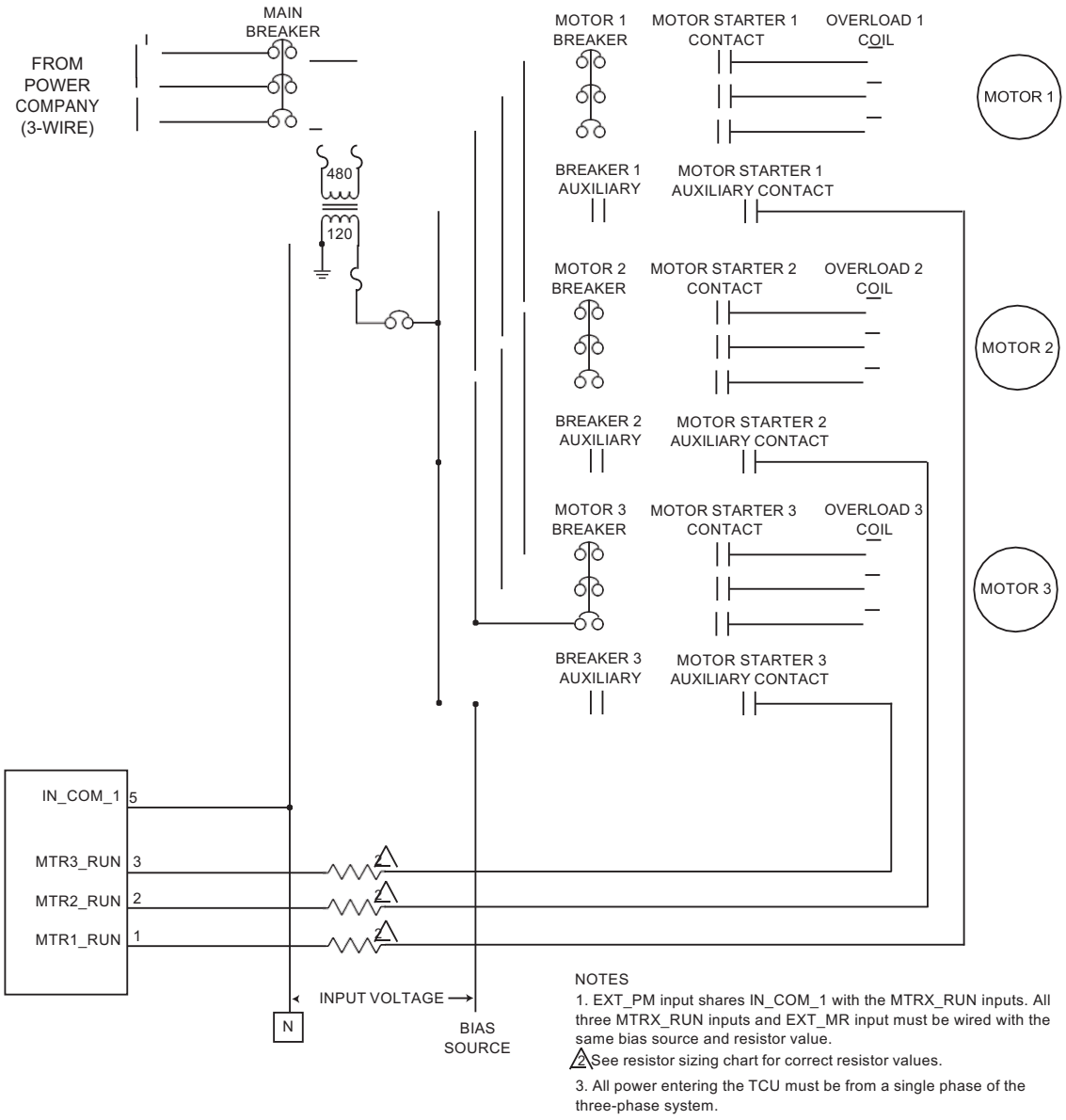
2 See resistor sizing chart for correct resistor values.

3. All power entering the TCU must be from a single phase of the three-phase system.

4. Transformer must provide AC neutral (4-wire).

5 1 A 600V fuse

Motor Run Monitoring Signal (4-wire transfer)



Motor Run Monitoring Signal (3-wire transformer)

Level Sensing Transducers

A TCU using the pump control process can accommodate two different types of input-supported transducers.

- Digital-type devices such as contact closures, float switches, and pressure switches
- Analog-type devices that are either analog current (4-20 mA) or analog voltage (0-5 V)

Floats

The input terminals for the contact closure devices are:

LOW_LVL (P2-6)

OFF_LVL (P2-7)

LEAD_LVL (P2-8)

LAG1_LVL (P2-9)

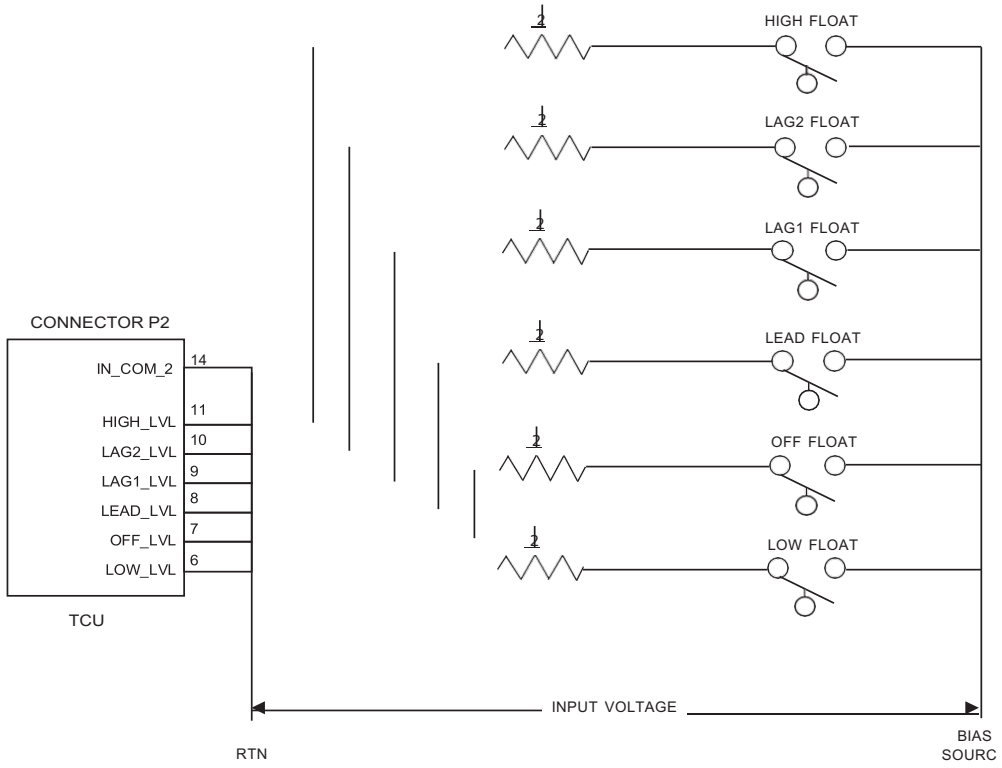
LAG2_LVL (P2-10)

HIGH_LVL (P2-11)

These six inputs, plus the AUX_IN (P2-12) and ALM_SIL (P2-13) inputs, are internally connected to IN_COM_2 (P2-14). All eight of these inputs must be biased with the same voltage source.
Simplex stations use input terminals LOW_LVL (P2-6), OFF_LVL (P2-7), LEAD_LVL (P2-8), and HIGH_LVL (P2-11).
Duplex stations add input LAG1_LVL (P2-9).
Triplex stations add input LAG2_LVL (P2-10).

It is recommended that you use LOW_LVL and HIGH_LVL inputs. However, HIGH_LVL can be omitted but should be disabled in the configurations, which will allow the input to be used to detect other signals. If a LOW_LVL is not used, the LOW_LVL function must be disabled in the TCU's configuration as the TCU will not function and control pumps unless this is done.

1. Connect the bias source to one side (line side) of the floats or pressure switches being monitored and the bias return to the IN_CON_2 (P2-14).
2. Connect the other side (load side) of the float or switch to the corresponding input terminal on the TCU. Use voltage dropping resistors if required.



NOTES

1. All six level inputs (XXX_LVL) shown here can monitor the status of dry contact switches. See functional description of these inputs for more information.
2. See resistor sizing chart for correct resistor values.
3. ALM_SIL, AUX_IN, and all level inputs share IN_COM_2 as a return. These inputs must all be wired with the same bias source and resistor value.
4. Diagram shows wiring for normally open switches. For normally closed switches, see Appendix F, Connecting a TCU to a Remote RTU.

Monitoring Circuit for a Contact-Closure Level Detection Device

The voltage-dropping resistors are only necessary for input voltages greater than 30VDC/AC. It is not recommended to use voltages higher than these for typical float contacts.

Input commons on the TCU must be either AC neutral (with no voltage potential when referenced to earth ground) or the negative terminal of a DC power supply.

Analog Level Transducer

The terminals for the analog interface are:

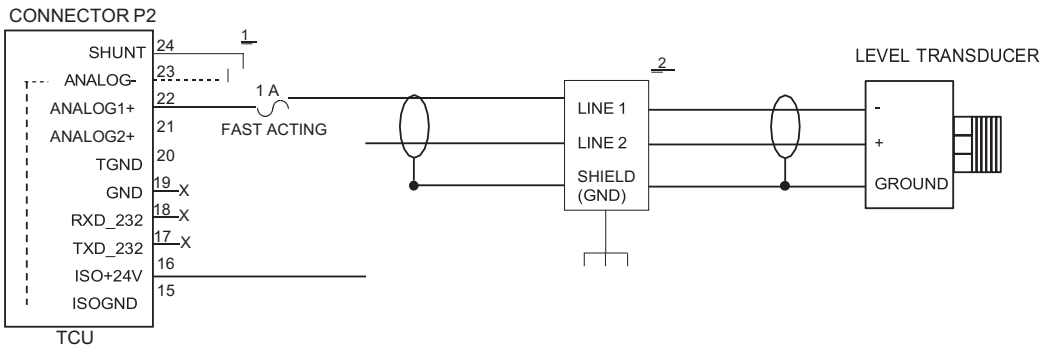
- ISO+24V (P2-16) – ISO+24V is a 24 VDC bias source voltage with a maximum source current of 100 mA.
- TGND (P2-20) – TGND is provided to terminate the shield of a shielded transducer cable. This terminal is connected to the TGND terminal (P1-7) and the case of the TCU.
- ANALOG1+ (P2-22) – ANALOG1+ is the positive input for current and voltage signals.
- ANALOG2+ (P2-21) – ANALOG2+ is the positive input for current signals for an optional backup analog transducer.
- ANALOG- (P2-23) – ANALOG- is the return terminal for current and voltage signals. Additionally, ANALOG- is the common return for both ANALOG 1+ and ANALOG2+.
- SHUNT (P2-24) – SHUNT must be tied to ANALOG- for current signals for ANALOG1.

Jumping SHUNT to ANALOG- places a 250 Ω load across the ANALOG1+ and ANALOG- terminals, which converts the voltage input to a current input.

1. Wire the power for the analog transducer according to the transducer manufacturer's instructions.
2. Connect the positive current or voltage signal from the transducer to the terminal ANALOG1+ (P2-22).
3. If required by the transducer, connect from the ANALOG- terminal (P2-23) back to the return on the transducer.
4. For current signals, jumper the ANALOG- terminal (P2-23) to the SHUNT terminal (P2-24).

Wiring Notes:

- Because ANALOG1+ and ANALOG2+ are tied to a common isolated ground (ANALOG-), the TCU must be the last device in a multiple device analog loop (As in Figure "Externally Powered Nonsubmersible Transducer").
- When using the isolated bias to power monitor points and the analog loop, the device can't exceed 100 mA at 24 VDC. Exceeding 100 mA will cause the analog signal to not operate correctly.
- Each digital input biased by the same 24 V can use up to 4 mA each.



NOTES

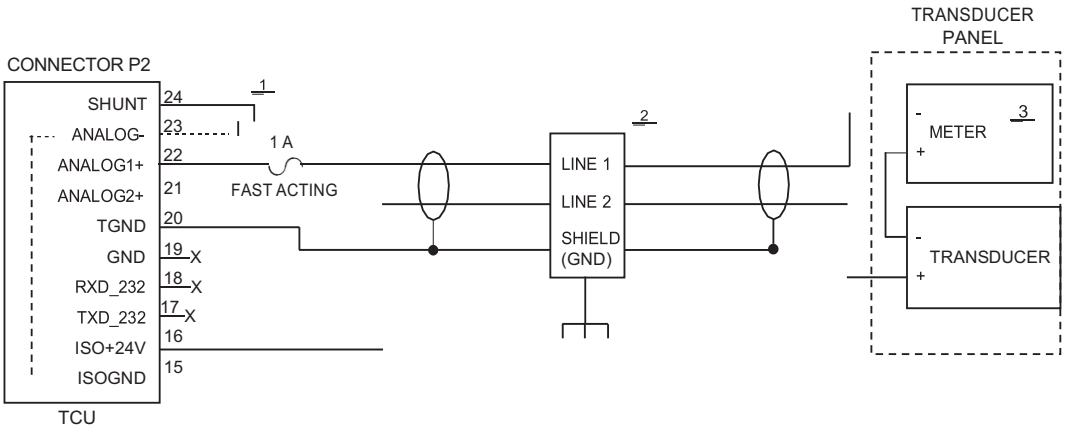
1 4-20mA interface shown. Remove jumper from P2-24 to P2-23 for 0-5V interface.

2 Surge arrestor required. Installation without required surge protection will void the surge and lightning damage warranty.

3. Analog- is bonded internally to ISOGND.

4. The analog shield wire must only be grounded at one end.

TCU Powered Submersible Transducer



NOTES

1 4-20mA interface shown. Remove jumper from P2-24 to P2-23 for 0-5V interface.

2 Surge arrestor required. Installation without required surge protection will void the surge and lightning damage warranty.

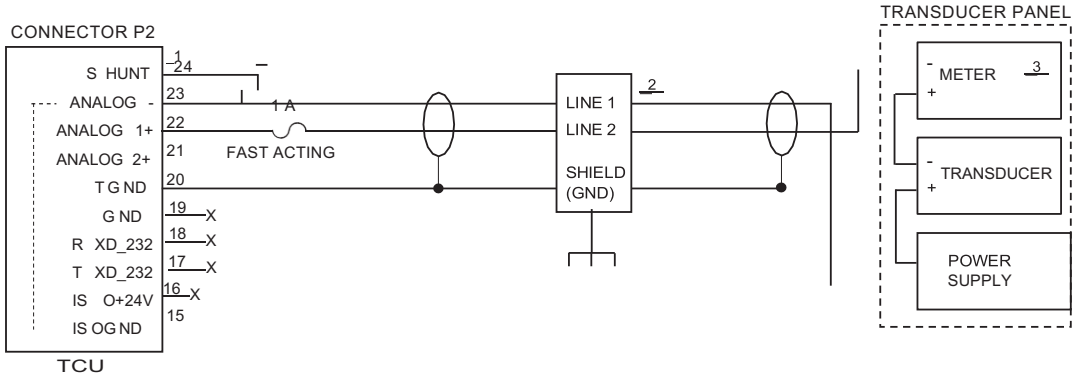
3 Meter is optional.

4. Do not ground cable shield in transducer panel.

5. Analog- is bonded internally to ISOGND.

6. The analog shield wire must only be grounded at one end.

TCU Powered Non-submersible Transducer



NOTES

1 4-20mA interface shown. Remove jumper from P2-24 to P2-23 for 0-5V interface.

2 Surge arrestor required. Installation without required surge protection will void the surge and lightning damage warranty.

3 Meter is optional.

4. Do not ground cable shield in transducer panel.

5. The analog shield wire must only be grounded at one end.

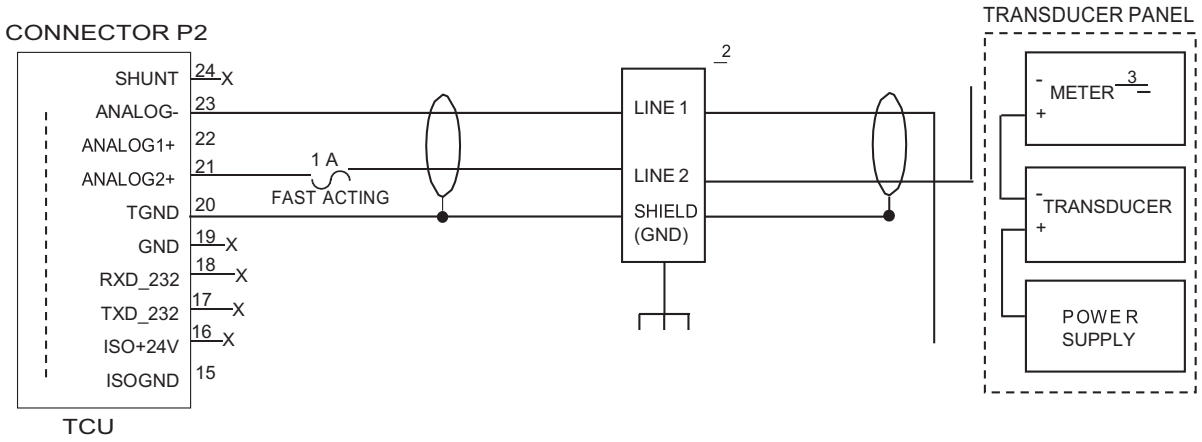
Externally Powered Non-submersible Transducer

Auxiliary Analog Inputs

The TCU's secondary analog input (ANALOG2) can be used as a backup to the primary analog level transducer or can be used for a general purpose monitoring (for example, a flow transducer). ANALOG2 has the same return (ANALOG-) as ANALOG1. For more information on using this auxiliary input to connect a backup to the primary transducer, see "Transducer Fault Mode" section.

It is important to note that ANALOG2 supports 4-20 mA only; 0-5 V is not supported.

The diagram here presents a simplified wiring example. Refer to the diagrams in the previous section for information on using the auxiliary analog input in different applications – for example, when using the TCU as the power source for the



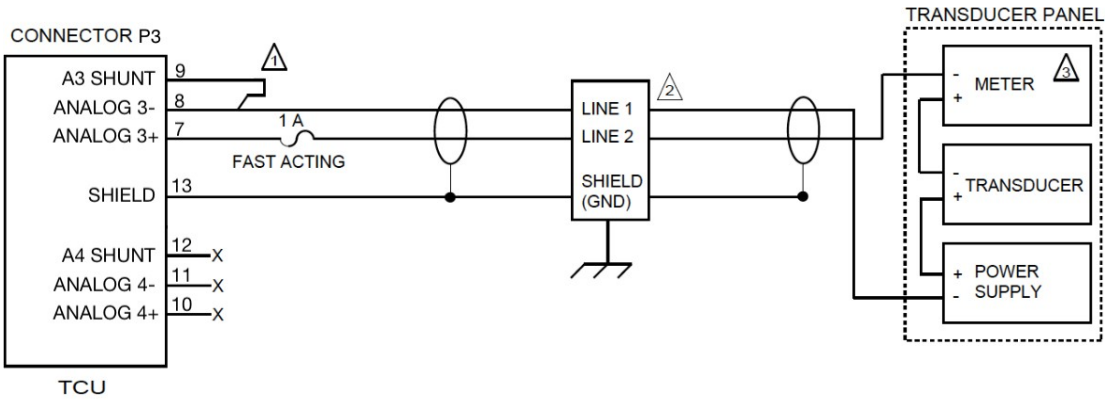
NOTES

1. 4-20 mA interface only; 0-5 V not supported.
2. Surge arrestor required. Installation without required surge protection will void the surge and lightning damage warranty.
3. Meter is optional.
4. Do not ground cable shield in transducer panel.
5. The analog shield wire must only be grounded at one end.

Auxiliary Analog Input

The TCU800 features two additional general-purpose analog inputs (ANALOG3 and ANALOG4) which are capable of current or voltage inputs. They are individually isolated and have their own individual returns; they do NOT share the same bias return as ANALOG1 and ANALOG2.

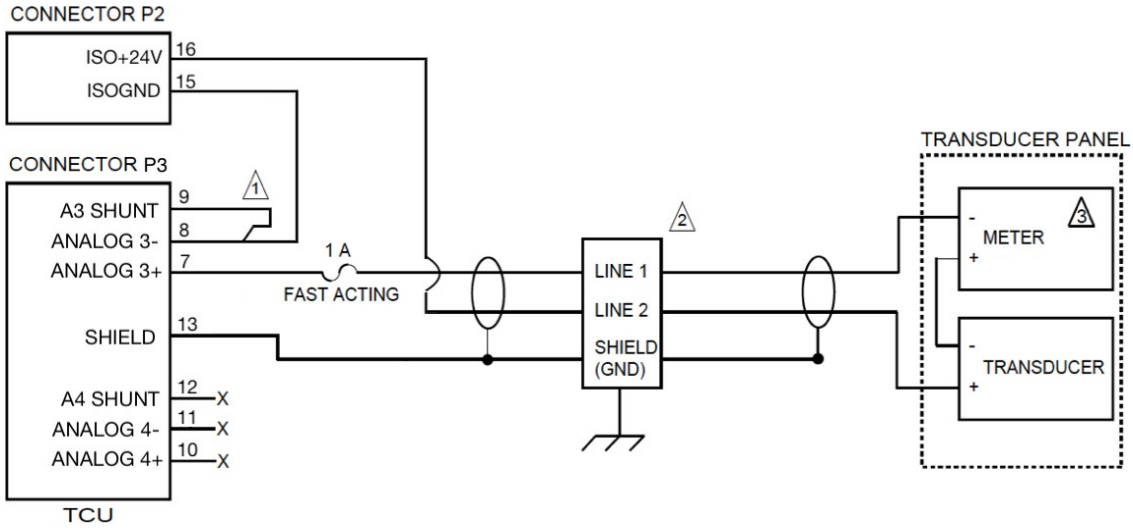
For backwards compatibility, Analog Inputs 3 and 4 are disabled by default on any new TCU800. They can be enabled in the Pump Monitoring Settings Screen (page 59).



NOTES

1. 4-20mA interface shown. Remove jumper from P3-9 to P3-8 for 0-5V interface.
2. Surge arrestor required. Installation without required surge protection will void the surge and lightning damage warranty.
3. Meter is optional.
4. Do not ground cable shield in transducer panel.
5. The analog shield wire must only be grounded at one end.

Externally Powered Auxiliary Transducer



NOTES

1. 4-20mA interface shown. Remove jumper from P3-9 to P3-8 for 0-5V interface.
2. Surge arrestor required. Installation without required surge protection will void the surge and lightning damage warranty.
3. Meter is optional.
4. Do not ground cable shield in transducer panel.
5. The analog shield wire must only be grounded at one end.

TCU Powered Auxiliary Transducer

Optional Configurations and Hookups

Backup Battery

Two optional backup batteries are available for use with the TCU. Although a backup battery is not necessary for operation of the TCU, it is recommended to prevent telemetry data loss from a power failure. Note that statistical and configuration data is retained even without a backup battery. The purpose of the battery is to maintain telemetry functions during a power loss.

Based on intended usage, the selected battery can be one of the following:

- 12 V, 2.6 Ah model – part number DFS-00363-008-02; rated at 12 V, 2.6 Ah
- 12 V, 7.0 Ah model – part number DFS-00363-008-01; rated at 12 V, 7.0 Ah

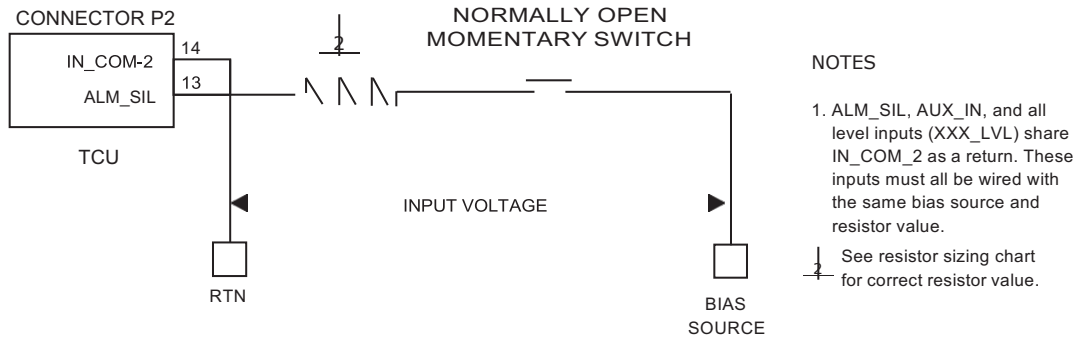
These batteries are interchangeable and maintenance-free. Connect terminal P1-8 (BAT+) to the positive terminal of the battery. Connect terminal P1-9 (BAT-) to the negative terminal of the battery. It is important to observe polarity when connecting the backup battery, since this circuit is not diode protected.

Alarm Silence Switch

The alarm horn, if installed, can be silenced in three ways: through the ALM_SIL input, by pressing the TCU's Power/ Home button, or by navigating to the TCU's Alarm screen and viewing the alarm. The following describes the wiring of a momentary alarm silence switch.

ALM_SIL (P2-13), AUX_IN (P2-12), and the six level (xxx_LVL) input circuits (P2-6, P2-7, P2-8, P2-9, P2-10, P2-11) are internally connected to the IN_COM_2 terminal (P2-14). Each of these inputs must be wired with the same bias voltage and use the same voltage-dropping resistor value for proper operation.

Connect a momentary switch from the bias voltage source through the proper voltage-dropping resistor, if required, to the ALM_SIL terminal (P2-13). The return for the bias voltage must be connected to the IN_COM_2 terminal (P2-14).



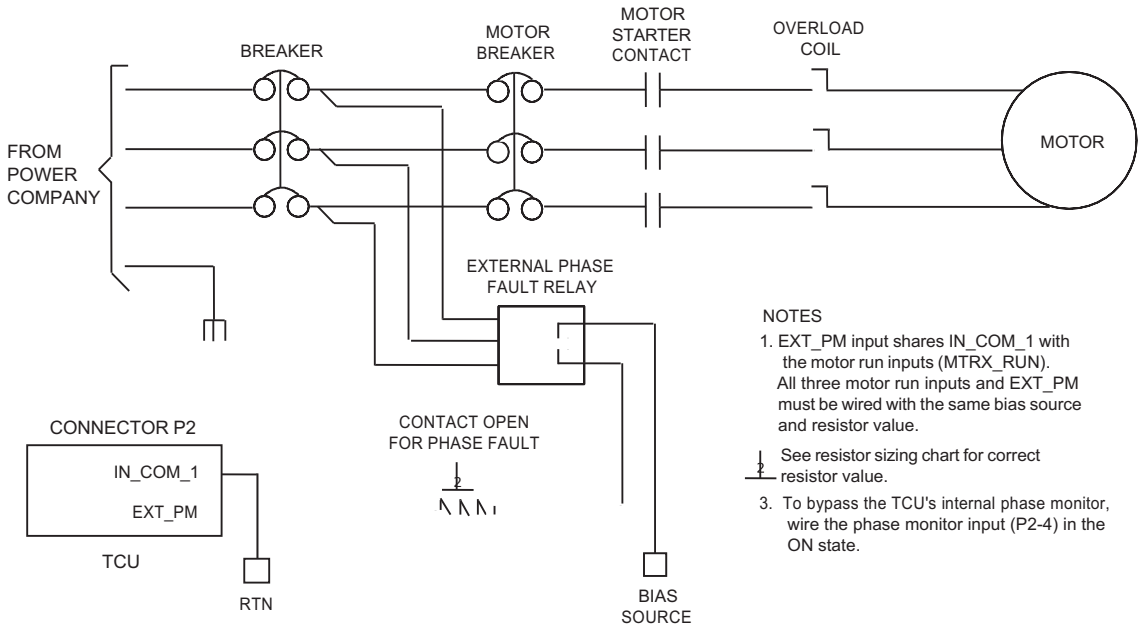
Alarm Silence Switch

Input commons on the TCU must be either AC neutral (with no voltage potential when referenced to earth ground) or the negative terminal of a DC power supply.

External Phase Monitor

Connect a bias voltage to one side of the external phase monitor contacts. Connect the opposite side of the contacts through the proper voltage-dropping resistor to the EXT_PM terminal (P2-4).

Use the same bias voltage source as used to bias the motor run inputs. The return for the bias voltage must be connected to the IN_COM_1 terminal (P2-5). The MTRx_RUN (P2-1, P2-2, P2-3) and EXT_PM (P2-4) input circuits are internally connected to the IN_COM_1 terminal (P2-5). Phase Monitor contacts must open when a phase fault occurs.



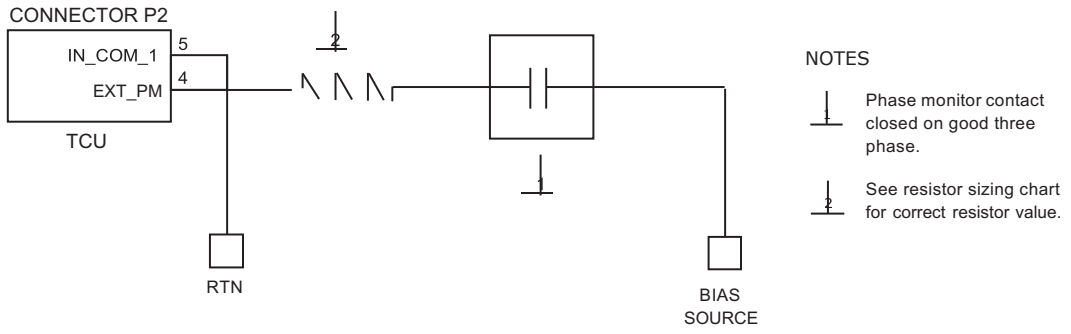
External Phase Monitor

Input commons on the TCU must be either AC neutral (with no voltage potential when referenced to earth ground) or the negative terminal of a DC power supply.

Phase Monitor Bypass

The TCU's internal phase monitor can be bypassed (i.e., disabled) if it is not required. To bypass the TCU's phase monitor, connect a bias voltage (through a voltage-dropping resistor if required) directly into the EXT_PM terminal (P2-4). Use the same bias voltage source that was used to bias the motor run (MTRx_RUN) inputs (P2-1, P2-2, P2-3). The return for the bias voltage must be connected to the IN_COM_1 terminal (P2-5). The MTRx_RUN and EXT_PM input circuits are internally connected to the IN_COM_1 terminal (P2-5). Note that the TCU's Phase Monitor is designed for 200-240 VAC or 480 VAC (using external resistors) 3-phase only.

If you are using an external phase monitor and would like to have the voltage values available to HT3 for monitoring and trending purposes, you can wire the TCU's three phase inputs. For this option to work correctly you must also configure the TCU's phase monitor range and alarm trip points. This is necessary, because if the external phase monitor trips, the TCU will apply these user-configured, internal phase monitor settings when deciding whether or not to run the pumps. Consider the acceptable run conditions for your system when selecting phase monitor settings.



Phase Monitor Bypass

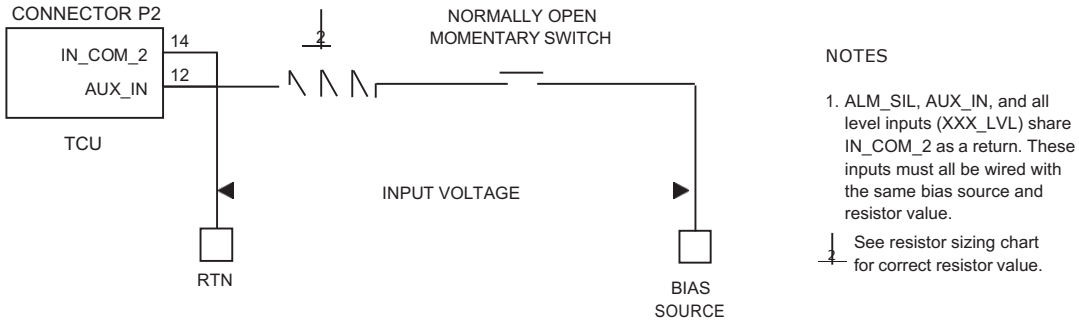
Input commons on the TCU must be either AC neutral (with no voltage potential when referenced to earth ground) or the negative terminal of a DC power supply.

Auxiliary Input and Output Connections

The TCU provides an auxiliary digital input and output that can be configured together to function as an auxiliary relay. The AUX_IN terminal (P2-12) functions as one side of a relay coil and the IN_COM_2 terminal (P2-14) as the other. The AUX_PWR terminal (P1-18) and AUX_OUT terminal (P1-19) function as contacts for the relay.

Auxiliary Digital Input

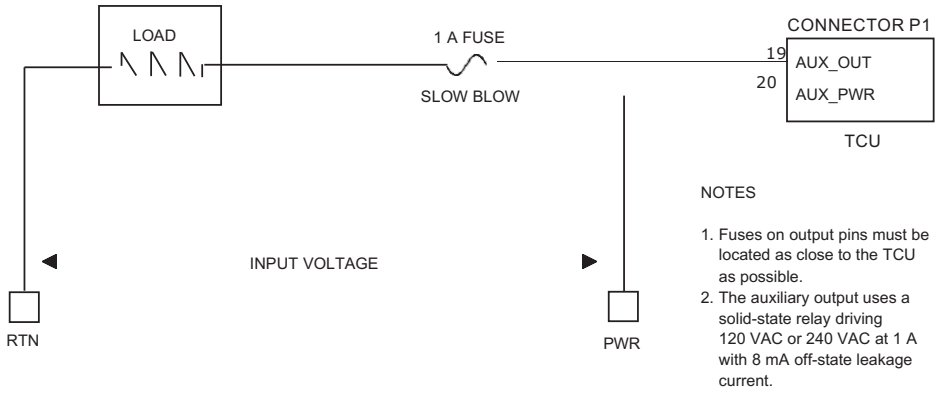
AUX_IN is an optically isolated digital monitor point and is wired the same as the other monitor points. Connect a bias voltage to one side of a contact closure device. Connect the other side through a voltage-dropping resistor, if required, to the AUX_IN terminal (P2-12).



Auxiliary Digital Input

Auxiliary Digital Output

AUX_OUT is a solid-state relay. Power is connected to the AUX_PWR terminal (P1-20). A load is connected between the AUX_OUT terminal (P1-19) and the power source return.



Auxiliary Digital Output

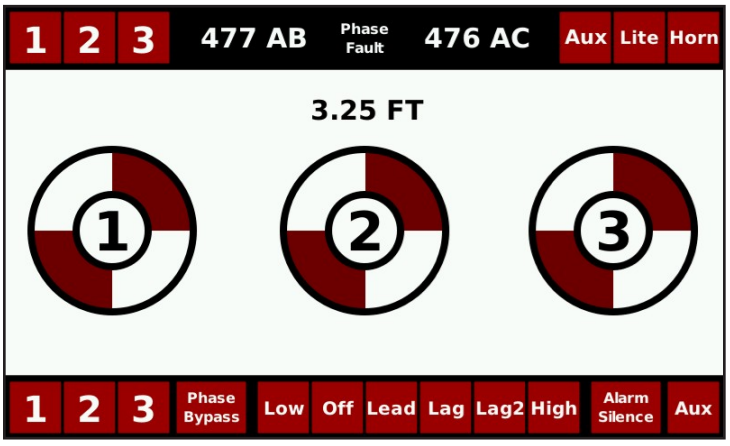
Input commons on the TCU must be either AC neutral (with no voltage potential when referenced to earth ground) or the negative terminal of a DC power supply.

Installed in RTU

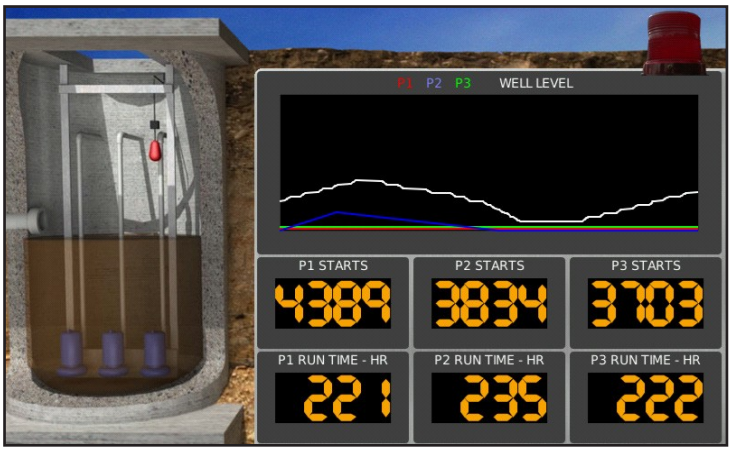
When a TCU is included in an RTU via a BEM, it is important to remember that the TCU defines its internal modules without exception. Any additional modules added to the RTU must be addressed beginning with the module letter after the last dummy module defined in the TCU.

5. User Interface

Quick View



Graphical View



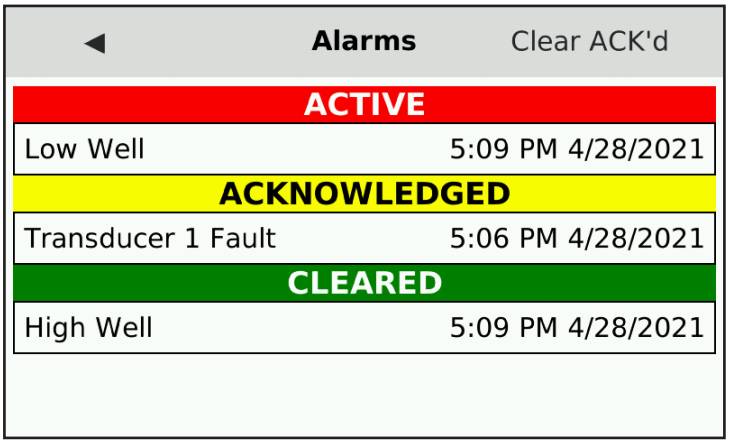
Analog View

Station	Analog	
Well Level 13.95 FT	Analog 1 11.44 mA	Analog 3 0.04 mA
AB Voltage 493 V	Analog 2 0.06 mA	Analog 4 0.04 mA
AC Voltage 485 V	Remote 0.00 mA	

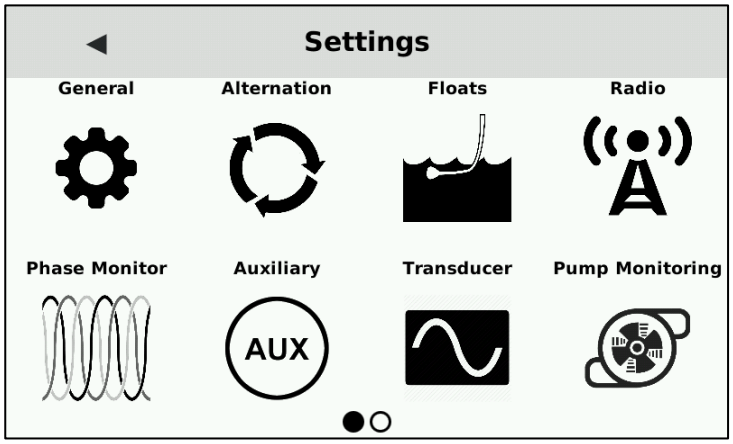
Pump Statistics

	Total Starts	Total Run Hours	Avg Run Minutes	Avg Rate MGD
1	7466	438:24	2:22	157.4
2	7511	784:39	3:50	152.8
3	7481	441:16	3:56	155.1

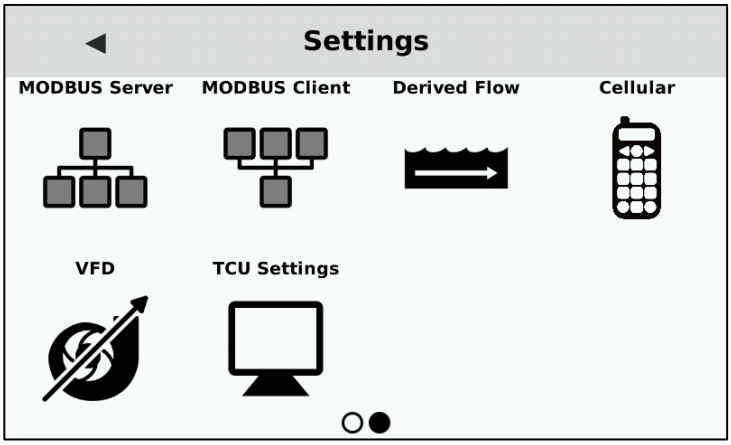
Alarms



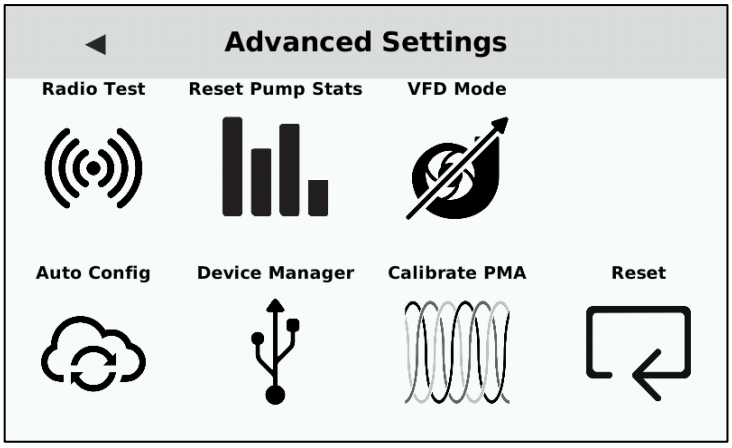
Settings, Screen 1



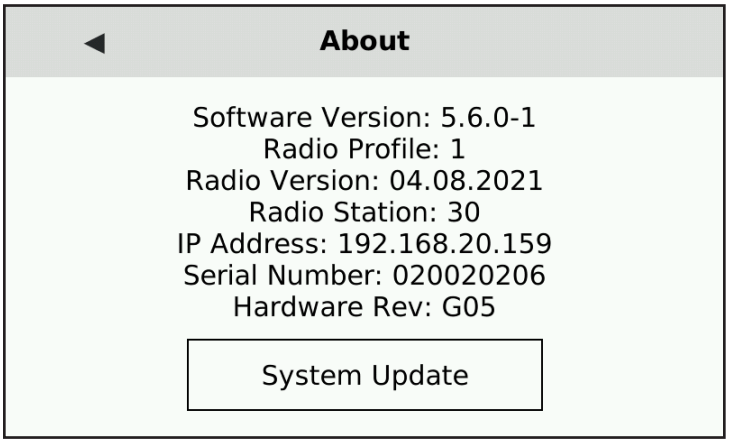
Settings, Screen 2



Advanced Settings



About



6. Operating Procedures

Configuring the Pump Control Process

The information in this section refers to the TCU's built-in pump control process. It does not apply to a TCU with a custom program installed.

Setting up the TCU as a component of the telemetry system enables you to remotely monitor conditions at the site and control equipment from a central location via the HyperTAC SCADA software. For example, you can determine if a pump is currently running and manually turn it on if necessary. In order for the TCU to interface with the central site and the HyperTAC server, it must have access to radio or network communications and be properly configured in HyperTAC's Configuration Editor.

There are several options for connecting the TCU to the telemetry system. A TCU can be installed with a DFS RTU station, or it can interface with industry standard radios using the TCU's RS-232 Modbus radio interface. Alternately, the TCU can operate as a stand-alone unit and communicate with the central computer or server via its integrated radio or network interface.

Using the TCU in conjunction with a radio-based telemetry system requires that you obtain an FCC-licensed radio frequency if you do not already have a licensed frequency that can be used. Even when adding a site to an existing frequency, the FCC requires that a complete application be submitted. DFS can assist you in obtaining a new licensed frequency or adding a site to an existing frequency.

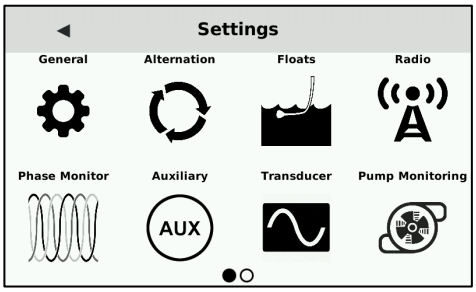
Configuration Setup

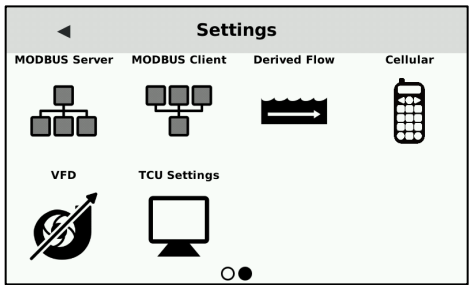
Configuring the TCU800 is done from the Settings screen. First, ensure the H-O-A switches are all in the HAND or OFF position. Then navigate to the Settings screen by tapping the screen, opening the left Navigation Menu by tapping  , scroll down using an upward swipe, and tap to select Settings.

After making changes, select the to exit the Settings screen. A confirmation window will appear summarizing the changes made and offer three options to continue: Discard (exit without saving), Save (save and implement changes), or Edit (return to Settings Screen to further make changes before applying).

If the Save option is selected, a window will appear confirming the TCU800 and the Configuration USB have been updated successfully.

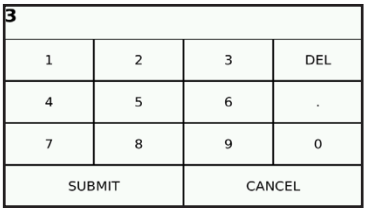
Moving the H-O-A switches to Auto at any point while in the Settings or Advanced Settings screen will terminate the session and return to the last viewed screen without saving any changes.



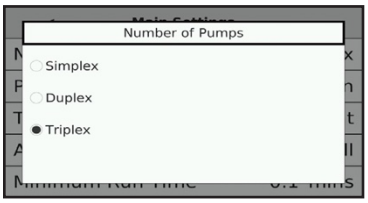


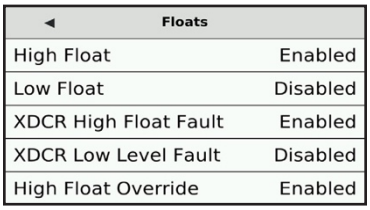
Methods of Changing Configuration Values

Each editable value under any of the above menus can be changed by choosing the new value on a bullet list, toggling between enabled and disabled, or entering the value on the digital keypad that appears. When a value the requires a numerical entry is selected, a numbered keypad will appear on the screen. Each option can be changed by clicking on the individual setting and typing the new value in on the keypad that appears. Once the input is correct press the *SUBMIT* key to save the new value.



Another setup for changing configuration values is through a bullet list. Any configurable value with multiple options will be presented in this way. When the new value to be configured is selected, the window will disappear. Lastly, the values can be altered via a digital switch. This method is presented when a configuration option only has two options. In this editing process, no additional window will appear. Clicking the configuration option will cause it to toggle between the two options: Enabled and Disabled.





Remote Configuration Changes

Changing configuration values using the PLC editor is supported but requires that the settings be transferred initially from the TCU800 to the remote PLC editor (once). If taking this step, disregard the configuration values listed in the Autodialer section of the editor as the TCU800 does not support Autodialer and the settings have been re-purposed for other use. This workaround is temporary. If only changing a few configuration values, this step can be bypassed as only the changed values need to be selected and sent.

General

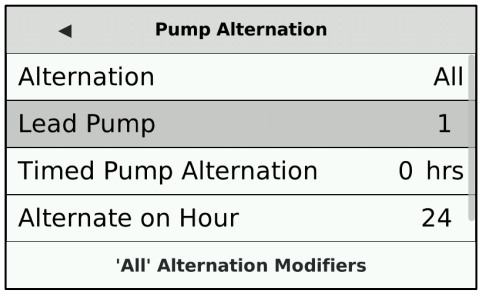
◄ General Settings	
Number of Pumps	3 (Triplex)
Pump Mode	Down
Transducer Type	4-20mA
Minimum Run Time	0.1 min
Minimum Off Time	0.2 min

General Settings are used to configure the main pump-control functions of the unit, such as the number of pumps, the pump mode, transducer type, and pump fault and run timers.

Number of Pumps	The TCU can be configured to control one, two, or three pumps for simplex, duplex, or triplex stations, respectively.
Pump Mode	The TCU can operate in two pump arrangements: “pump up” or “pump down.” Pump up is used to maintain a fill level in a tank system. Pump down is used to keep a well below a set level.
Transducer Type	The TCU provides four options for configuring a transducer: • 4-20 mA – analog current-type device. • 0-5 V – analog voltage-type device (pressure or linear resistive). • Remote – device located at a remote location; data is sent to the TCU via telemetry. • Floats – digital-type device, such as contact closures, float switches, and pressure switches.
Minimum Run Time	To prevent short cycling of the pumps, a minimum run time can be configured. When used, this option will cause a started pump to run for the specified time before it can be turned off. The minimum run time can be set between 0 and 2 hours in one-tenth minute increments. Setting this parameter to 0 disables the function, which allows the pump to be turned off at any time after it has been started.
Minimum Off Time	This option causes a pump that has been turned off to remain off for the specified time before it can be started again. It can be set between 0 and 2 hours in one-tenth minute increments. Setting this parameter to 0 disables the function, which allows the pump to be turned on at any time after it has been stopped.
Start Fault Alarm	The amount of time the alarm will sound before the pump starts. The value can be set between 0 and 510 seconds.
Stop Fault Alarm	The amount of time the alarm will sound before the pump stops. The value can be set between 0 and 510 seconds.
Stagger Start Delay	After any pump has been started, this setting configures the minimum number of seconds to wait before turning on the next pump in the alternation scheme. This value can be set between 0 and 30 seconds.

Pump Auto Retry (Disabled/Enabled)	The TCU can be configured to retry a faulted pump - one that fails to start when called (Motor Start Fault) or one that is running when it has not being called to run (Motor Stop Fault). The TCU's responses to Motor Start Faults and Motor Stop Faults with the Auto Retry function enabled are identical. The response to Motor Stop Faults differs if the Auto Retry function has been disabled.
Alarm Horn Output (Disabled/Enabled)	When enabled, certain high-priority alarms will cause the alarm horn relay to energize (close) and send power to the alarm-horn output. If there are active alarms when the TCU's alarm horn option is enabled, the alarm horn will not sound until the existing alarms have cleared and a new alarm occurs. Disabling the alarm horn option does not prevent alarms from being reported via telemetry.
Alarm Light Output (Disabled/Enabled)	When enabled, all alarms generated at the station cause the alarm light relay to energize (close) and send power to the alarm-light output. Disabling the alarm light option does not prevent alarms from being reported via telemetry.

Alternation



Pump alternation settings control how the pumps are cycled in subsequent calls when running in AUTO. Though most of these settings are compatible with each other – care should be taken in combining several settings of alternation in a single scheme.

Alternation	Configures which pumps alternate between being the Lead in subsequent pump calls • Disabled – Pump 1 is always Lead / Pump 2 is Lag / Pump 3 is Lag2 • All – Alternate between all available pumps • 1+2 (High Service) – Alternate between Pumps 1 and 2 only. • 2+3 (Jockey Pump) - Alternate between Pumps 2 and 3 only.
Lead Pump	Forced a specific pump to always be the lead pump. Pumps will then always cycle on in normal, ascending order (1 → 2 → 3 or 2 → 3 → 1 or 3 → 1 → 2). This setting only applies when Alternation is disabled, and will override the default fixed pump rotation.
Timed Pump Alternation	Delays the next pump alternation cycle until the specified number of hours have elapsed (up to 24 hours). A value of "0" disables this setting. This setting has no effect if the Alternation setting is disabled.

Alternate on Hour	This setting holds off alternation of the pumps until the specified hour of the day. The value of "0" corresponds to 12:00am TCU local time, and a value of "24" disables this option. This function is only applied if Timed Pump Alternation is disabled and Alternation is enabled.
Lag2 Standby (Disabled/Enabled)	When enabled, the Lag2 pump is treated as a standby/backup pump and is only called if the Lead or Lag pump experiences a fault (i.e. Pump Start Fault). This setting only applies if Alternation is enabled.
Pump 3 Lag Only (Disabled/Enabled)	When enabled, pump #3 will always be called to run in the Lag position, regardless of alternation scheme. If VFD mode is enabled, this pump will **always** run at the *Override Speed*.

Floats

◄ Floats	
High Float	Enabled
Low Float	Disabled
XDCR High Float Fault	Enabled
XDCR Low Level Fault	Disabled
High Float Override	Enabled

Float settings are used to enable or disable float inputs and configure the faults associated with these conditions.

High Float (Disabled/Enabled)	If a high level float is being used, High Float must be enabled. If a high level float is not connected and High Float is enabled, there is no effect on the operation of the TCU. In a Pump Down Mode (Lift Station) system, all pumps are stagger-started on a high float condition. In a Pump Up Mode (Storage Tank) system, all pumps are stopped on a high float condition. A high float condition generates a high well alarm and an optional transducer fault alarm.
Low Float (Disabled/Enabled)	This setting **must** be enabled if a low level float is used, and disabled if a low level float is not used. (If this setting is not disabled, the Low Well alarm will interfere with station operation.) In Pump Down Mode (Lift Station) system, all pumps are stopped on a low float condition. In Pump Up Mode (Storage Tank) system, all pumps are stagger-started on a low float condition.A low float condition generates a low well alarm and an optional transducer fault alarm.
XDCR High Float Fault (Disabled/Enabled)	When this option is enabled, a high float condition generates a transducer fault and switches control to the configured fault mode. Leaving the option disabled leaves pump control on the primary transducer whenever a high float condition occurs or the transducer reaches or exceeds 20 mA.

Radio

◄	Radio
Station	511
Data Invert	0
Data Swap	0
Tx Invert	1
Rx Invert	0

Radio settings are used to configure the TCU800's station address and radio protocol settings. There are also several read-only parameters displayed for debugging purposes.

Station	The number assigned to the pump station.
Data Invert	Data Invert and Data Swap are used to prevent cross-talk from other DFS radio systems on the same frequency. Although uncommon, atmospheric conditions can occur that allow low power transmitters to 'skip' and reach distances much farther than designed. Inverting or swapping the data on one of the radio systems will prevent the two systems from communicating with each other. A value of '0' indicates it is disabled. A value of '1' indicates it is enabled.
Data Swap	
Tx Invert (view only)	Tx Invert indicates that the serial messages sent from the TCU to the radio module are inverted. A value of '0' indicates it is disabled. A value of '1' indicates it is enabled.
Rx Invert (view only)	Rx Invert indicates that the serial messages sent from the radio module to the TCU are inverted. A value of '0' indicates it is disabled. A value of '1' indicates it is enabled.
Async Baud (view only)	The serial baud rate that the TCU is using to communicate with the radio. Typically, 9600 indicates that the radio is operating in "High-speed" mode.
Dash Number (view only)	Internal use - indicates the model and mode of the radio installed in the unit.
Global Delay (Module) (view only)	Global Module Delay. The Global Delay settings are automatically assigned based on the model and mode of the radio installed.
Global Delay (Fixed) (view only)	Fixed Offset Delay Timer. The Global Delay settings are automatically assigned based on the model and mode of the radio installed.
Global Delay (Station) (view only)	Global Station Delay. The Global Delay settings are automatically assigned based on the model and mode of the radio installed.
Radio Freq (view only)	Indicates the frequency at which the radio has been factory-configured to operate at.

Phase Monitor

◄ Phase Monitor	
Mode	240V Delta (3-Wire)
Undervoltage Alarm	200 VAC
Overvoltage Alarm	260 VAC
Phase Current	
CT Module	

Phase Monitor Settings are used to configure the voltage mode, out-of-range alarm settings, and enable/configure the CT (Current Transformer) inputs. These settings also adjust the Power View display.

Mode	The transformer arrangement and voltage of the three-phase voltage to be monitored. This is important for proper accuracy of the phase monitor display. • 2-Wire modes expect a single phase (A & B) connected between P1-2 and P1-3 respectively. • 3-Wire modes expect a 3 phase delta (A, B, C) wired according to the P1 label on the side of the TCU marked with "3P3W" • 4-Wire modes expect a 3 phase wye (A, B, C, N) wired according to the P1 label on the side of the TCU (marked with "3P4W").
Undervoltage Alarm	Minimum phase voltage allowed before an alarm is triggered. Valid ranges are 151-300 for a 240 VAC phase monitor and 0-600 for a 480 VAC phase monitor.
Overvoltage Alarm	Maximum phase voltage allowed before an alarm is triggered. Valid ranges are 151-300 for a 240 VAC phase monitor and 0-600 for a 480 VAC phase monitor.
CT Module	Enables the additional CT (current transformer) inputs for monitoring 3-phase current. These inputs will occupy the next available module address [H-O].

- Reference "Appendix H" for additional configuration modes available

Auxiliary

◄ Auxiliary I/O	
Aux Output Turns	On
Delay After	0 sec
Aux Input Turns	On
Aux Input Alarm	Disabled
Aux Alarm On	Close

Auxiliary settings are used to configure the auxiliary input, auxiliary output, time delay relay, and pulse counting.

Aux Output Turns (Off/On)	Together, the settings AuxOut Turns (On/Off) and AuxIn Turns (On/Off) define how AUX_OUT responds when the state of AUX_IN changes. (e.g. AUX_OUT turns OFF when AUX_IN turns OFF or AUX_OUT turns OFF when AUX_IN turns ON.)
Delay After	This setting determines the amount of time that is allowed to pass before turning the auxiliary output on or off. Seconds after can be set between 0 and 510 seconds in one-second increments. Assigning this setting a value of zero disconnects the AUX_IN and the AUX_OUT and makes them available to telemetry as general monitor and control points.
Aux Input Turns (Off/On)	Together, the settings AuxOut Turns (On/Off) and AuxIn Turns (On/Off) define how AUX_OUT responds when the state of AUX_IN changes. (e.g. AUX_OUT turns OFF when AUX_IN turns OFF or AUX_OUT turns OFF when AUX_IN turns ON.)
Aux Input Alarm (Disabled/Enabled)	The TCU monitors the AUX_IN terminal (p2-12), and it can be configured to activate the AuxIn alarm when the terminal is open or closed. If the auxiliary input alarm has been enabled and AUX_IN enters its configured alarm state (open or closed), an auxiliary input alarm is generated.
Aux Alarm On (Close/Open)	Determines if the AUX Alarm activates when AUX_IN closes (low) or opens (high). Aux Input Alarm must be enabled for this setting to take effect.
Aux Pulse Counting (Disabled/Enabled)	When enabled, this option enables the AUX input pin to count pulses, for sensors such as a rain gauage.

Transducer

◄ Transducer Setpoints	
High Level	25 ft
Lag 2 On Level	20 ft
Lag 2 Off Level	5 ft
Lag 1 On Level	15 ft
Lag 1 Off Level	5 ft

Transducer settings are used to configure the setpoints for pump activation when using a 4-20mA/0-5V transducer to measure the well level.

High Level	• Pump Up mode – In tank filling operations, the TCU stops all three pumps and activates alarms when the tank's level rises above this set point. This level must be set above all other levels. • Pump Down mode – In well emptying operations, the TCU starts all three pumps and activates alarms when the well's level rises above this set point. This level must be set above all other levels.
Lag 2 On Level	Note: This setting is used for triplex (three-pump) stations only. • Pump Up mode – In tank filling operations, the TCU starts the Lag2, or third, pump when the tank's level falls below this set point. • Pump Down mode – In well emptying operations, the TCU starts the Lag2, or third, pump when the well's level rises above this set point.
Lag 2 Off Level	Note: This setting is used for triplex (three-pump) stations only. • Pump Up mode – In tank filling operations, the TCU turns off the Lag2, or third, pump when the tank's level rises above this set point. • Pump Down mode – For well emptying operations, the TCU turns off the Lag2, or third, pump when the well's level falls below this set point. • This can be set to the same value as Lead Off Pt for either operation.
Lag 1 On Level	Note: This setting is used for duplex (two-pump) and triplex (three-pump) stations only. • Pump Up mode – In tank filling operations, the TCU starts the Lag, or second, pump when the tank's level falls below this set point. • Pump Down mode – In well emptying operations, the TCU starts the Lag, or second, pump when the well's level rises above this set point.
Lag 1 Off Level	Note: This setting is used for duplex (two-pump) and triplex (three-pump) stations only. • Pump Up mode – In tank filling operations, the TCU turns off the Lag, or second, pump when the tank's level rises above this set point. • Pump Down mode – In well emptying operations, the TCU turns off the Lag, or second, pump when the well's level falls below this set point. • This can be set to the same value as Lead Off Pt for either operation.

Lead On Level	• Pump Up mode – In tank filling operations, the TCU starts the Lead, or first, pump when the tank's level falls below this set point. • Pump Down mode – In well emptying operations, the TCU starts the Lead, or first, pump when the well's level rises above this set point.
Lead Off Level	• Pump Up mode – For tank filling operations, this is the tank's maximum operational level. The TCU turns off the Lead, or first, pump when the tank's level rises above this set point. • Pump Down mode – For well emptying operations, this is the well's minimum operational, or Off, level. The TCU turns off the Lead, or first, pump when the well's level falls below this set point.
Flow Equalization	The Flow Eq Lead option is a function utilized by the DFS patented "Symphony - Harmonious Pump & Flow Management" technology. For more information about Symphony please contact the DFS Sales Department at 321-259-5009 or by email at sales@dataflowsys.com.
Low Level	• Pump Up mode – In tank filling operations, all pumps are running and alarms are activated when the tank's level falls below this set point. This level must be set below all other levels. • Pump Down mode – In well emptying operations, pumps are shut down and alarms are activated when the well's level falls below this set point. This level must be set below all other levels.
XDCR 1 Low Cal Point	The depth of the well when the value measured on Analog1 is at its lowest signal level (4 mA or 0 V, depending on transducer type).
XDCR 1 High Cal Point	The depth of the well when the value measured on Analog1 is at its highest signal level (20 mA or 5 V, depending on transducer type).
XDCR 2 Low Cal Point	The depth of the well when the value measured on Analog2 is at its lowest signal level (4 mA or 0 V, depending on transducer type). This is mainly for using a backup/redundant transducer on the Analog2 input.
XDCR 2 High Cal Point	The depth of the well when the value measured on Analog2 is at its highest signal level (20 mA or 5 V, depending on transducer type). This is mainly for using a backup/redundant transducer on the Analog2 input.
XDCR Fault Mode	• Disable – Set to disable if the station will not be using one of the other fault mode options (Analog2 or Floats). If this option is set to Disable and high and/or low floats have not been enabled, the system will shut down when a transducer fault occurs in either pump up or pump down station operation. • Analog2 – When an auxiliary transducer is connected and this option is selected, a fault with the primary transducer will cause the TCU to switch to the backup transducer. • Floats – When this option is selected, a fault with the primary transducer will cause the TCU to switch to normal float behavior. This mode requires an Off float to shut off the pumps and a miniumum of one float (Lead to High) to start the pumps.

Transducer Fault Mode

Configuration option: *Fault Mode*

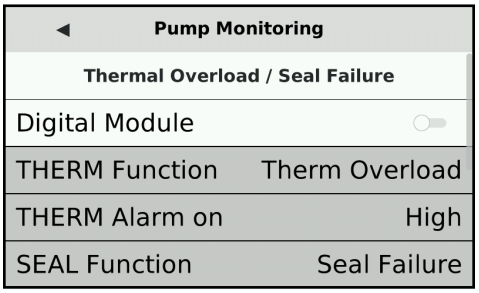
Modes: Disable, Timer, Analog2 or Floats

Note: High and/or low floats can be used for backup operation in addition to the configured Transducer Fault Mode (Timer, Analog2, or Floats). If the primary transducer were to fail, the TCU would switch to the configured mode (Timer, Analog2, or Floats). If the level were to reach the high or low stage while in one of these modes, the TCU would begin operating the pumps based on the float reading. It would continue operating this way until the float cleared.

Transducer Fault Mode provides four options for operation when a transducer fault occurs.

- ***Disable*** – Set Transducer Fault Mode to Disable if the station will not be using one of the other fault mode options (**Timer**, **Analog2**, or **Floats**). If this option is set to Disable and high and/or low floats have not been enabled, the system will shut down when a transducer fault occurs in either pump up or pump down station operation.
- ***Timer*** – For each pump, the TCU maintains a log of average run time and average off time for each hour of the day. When the Timer option is selected and a transducer fault occurs, the TCU will turn the pumps on and off based on the averages for each hour recorded in the log.
- ***Analog2*** –When an auxiliary transducer is connected and this option is selected, a fault with the primary transducer will cause the TCU to switch to the backup transducer.
- ***Floats*** – When this option is selected, a fault with the primary transducer will cause the TCU to switch to normal float behavior. This mode requires an Off float to shut off the pumps and a minimum of one float (Lead to High) to start the pumps.

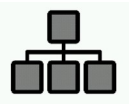
Pump Monitoring



Pump Monitoring settings are used to enable and configure the new extended digital and analog inputs (thermal/seal failure inputs and auxiliary analog inputs 3 and 4)

Digital Module	Select this option to enable the new (extended) digital inputs (Seal Fail/Therm Overload) on the P3 connector. These inputs will occupy the next available module address [H-O].
THERM Function	When Digital Module is enabled, set to one of two failure alert options for a thermal failure. Generic Input passes the value through to telemetry. Thermal Overload generates an alarm and stop pumps when the input reaches the state indicated by the THERM Alarm On option.
THERM Alarm On (High/Low)	The digital state of the input pin which will generate an alarm for the THERM Function (Thermal Overload function only).
SEAL Function	When Digital Module is enabled, set to one of two failure alert options for a seal failure. Generic Input passes the value through to telemetry. Seal Failure generates an alarm and stop pumps when the input reaches the state indicated by the SEAL Alarm On option.
SEAL Alarm On (High/Low)	The digital state of the input pin which will generate an alarm for the SEAL Function (SEAL Failure function only).
Analog Module	Select this option to enable the new (extended) analog inputs (Analog3 and Analog4) on the P3 connector. These inputs will occupy the next available module address [H-O].
Analog 3 Type	If applicable, 4-20 mA, 0-5 VDC, or 0-10 VDC.
Analog 4 Type	If applicable, 4-20 mA, 0-5 VDC, or 0-10 VDC.

Modbus Server



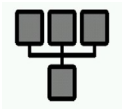
◄ Modbus Server	
Protocol	ASCII (Odd Parity)
Baud Rate	9600
H Address	0.0
H Length	0.0
I Address	0.0

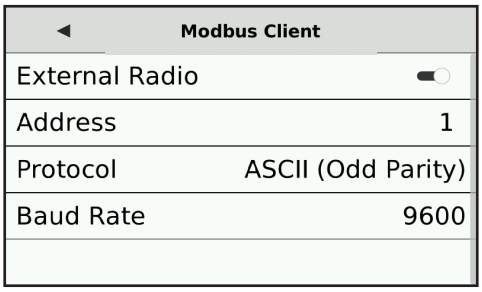
Modbus Master settings are used to configure the TCU800 to poll additional Modbus slave devices connected to the RS485 port on the P4 connector.

Protocol	Modbus protocol and relateds serial settings used to communicate with slave devices. ASCII protocols always use 7 data bits and 2 stop bits. RTU protocols always use 8 data bits and 1 stop bit.
Baud Rate	The serial baud rate at which to communicate. Options are 1200, 2400, 4800, and 9600 (default).
[H-O] Address	Assigns a particular Modbus device and register to Module H in telemetry Notation: <Device ID>.<Start Register> *Example: 1.10001 would poll register 10001 (digital inputs) at device 1. Valid range for IDs is 1-250; valid range for starting registers is 0001 to 49999.*
[H-O] Length	Configures the number of subsequent registers to poll after the starting register, as well as the number of bits to associate with the values (for analogs only). Notation: <Number of registers>.<bit mask> *Example: 6.0 would indicate 6 registers being polled. The bit mask is 0 because these are digital inputs/outputs being polled.* *Example: 2.12 would indicate 2 registers being polled. The bit mask is 12 because these are 12-bit analog inputs/outputs being polled.* Valid ranges for the <Number of registers> are as follows: • 1-12 for digital status registers • 1-8 for digital control registers • 1-4 for analog status registers 1-4 for analog control registers

All modules marked (internal) have been reserved for internal I/O that has been enabled within the TCU settings (i.e. CT module). To free or move these modules, the additional I/O must be disabled. If re-enabled, they will automatically occupy the next available module.

Modbus Client

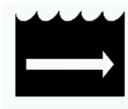


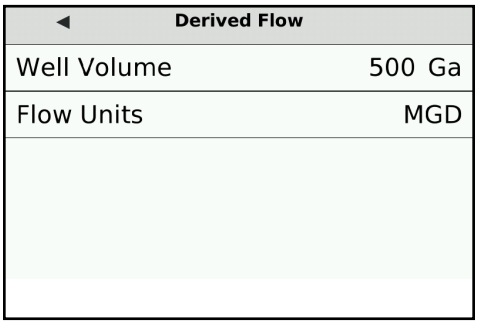


Modbus Slaves settings are used to allow the TCU to be polled by a Modbus Master radio connected on its RS232 port on the P4 connector.

External Radio	Enables Modbus Slave mode - This is only compatible with an external radio connected to the serial RS232 port on the P4 connector.
Address	The Modbus device ID that the TCU should respond as.
Protocol	Modbus protocol and related serial settings used to communicate with slave devices. ASCII protocols always use 7 data bits and 2 stop bits. RTU protocols always use 8 data bits and 1 stop bit.
Baud Rate	The serial baud rate at which to communicate. Options are 1200, 2400, 4800, 9600 (default), 19200, and 38400.

Derived Flow

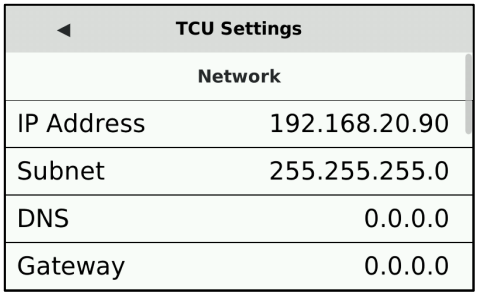




Derived Flow settings are used to configure how the total station flow and average pump rate statistics are calculated.

Well Volume	The well volume, from 0 to 9999, in the units configured as Flow Units. It must be set as calculated between the Lead Off and Lead levels of a well or tank. If set to 0, total station flow and average pump rate are not updated on the statistics view.
Flow Units	Specify if flow is measured in millions of gallons per day (MGD) or gallons per minute (GPM).

TCU Settings



TCU Settings are used to adjust the local area network settings, the default home screen, system time, and a few debugging options.

IP Address	IP address assigned by the Network Administrator.
Subnet	Network netmask (subnet mask) assigned by your Network Administrator. Leave at the default value (255.255.255.0) if not required.
DNS	Domain Name System
Gateway	If the TCU800-IP is operating through a gateway, the gateway's full IP address must be entered here.
Time	Allows manual editing of the TCU's local time. Tap to edit and scroll down to see all options. **Since the time and date are synchronized periodically from the server, if the time or date continues to adjust incorrectly it should probably be adjusted in the server**. This setting however can be used to properly initialize the time for a TCU that has not yet connected with the server.
Home Screen	Options for home screen designs displaying a range of data on the pump.
Backlight (Enable/Disable)	Allows users to adjust the brightness of the device's display to suit their preferences and lighting conditions.
Backlight Timeout	Enables users to specify the duration of inactivity before the device's backlight automatically turns off to conserve power.
Display Touch Gestures (Off/On)	Touch gestures are subtle animations displayed when the TCU800 detects a touch on the interface. Use this feature to ensure the unit is properly reading touches.
Debug Logging (Off/On)	Debug Logging refers to the internal logging for the unit. When Debug Logging is on, bug reports will be sent to the manufacturer for review and fixing.
Back	Return to the previous screen

Auto-Configuring

At this time, using a TCU001 PLC configuration will cause an error in the TCU800. To avoid this, first transfer the existing configuration of the TCU800 using HyperTAC PLC editor. Then save the .plc file, create an auto-config file, and upload it to the appropriate station you want to auto-config.

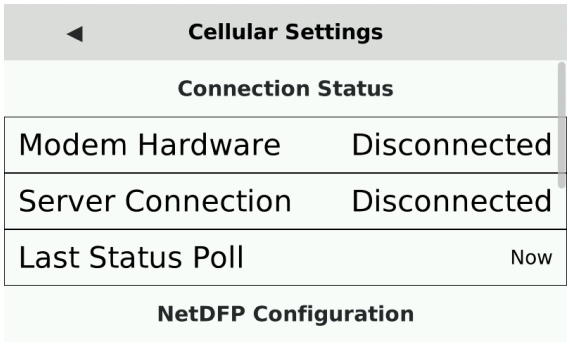
Remote Configuration Changes

Changing configuration values using the PLC editor is supported but requires that the settings be transferred initially from the TCU800 to the remote PLC editor (once). If taking this step, disregard the configuration values listed in the Autodialer section of the editor as the TCU800 does not support Autodialer and the settings have been repurposed for other use. This workaround is temporary. If only changing a few configuration values, this step can be bypassed as only the changed values need to be selected and sent. *For more detail on remote configuration changes see the HT4 User Guide, available on dataflowsys.com.*

Utilizing the USB Ports for Configuration

When saving TCU settings for future use or transfer to another unit, a USB drive is needed. Insert the USB into the top port on the face of the TCU. Then, navigate to the Advanced Settings and select the 'Device Manager' icon. On the screen that appears, select 'Export Settings.' If the export to the USB drive was successful, a notification reading "Export successful."

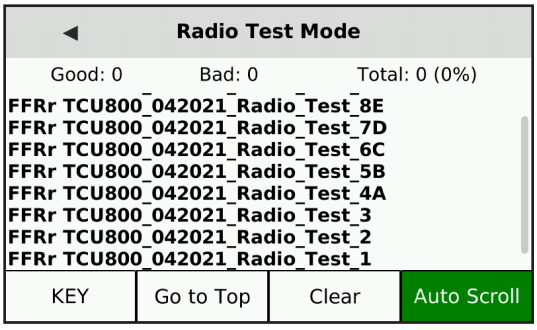
Cellular



Cellular settings are used to enable and configure compatible TCU800 cellular modem devices to be used with the NetDFP protocol.

Configuration Name	Expected Values	Description
Modem Hardware	Disconnected/Connected	Notifies the user when a compatible TCU800 cellular modem is detected and recognized by the device.
Server Connection	Disconnected/Connected	Notifies the user of a valid connection to the server specified in the *Server hostname* configuration.
Last Status Poll	Date	Shows the user the most recent connection attempt time for the server specified in the *Server hostname* configuration, updating every minute.
Enabled	On/Off	Enables or disables NetDFP configuration.
Station	0-250	Sets the NetDFP station number.
Server hostname	Valid server domain name or IP address	Sets NetDFP server address TCU800 will connect to.
Port	Non-configurable	Displays the NetDFP port.
Report Time Interval	300-999 seconds	Sets NetDFP maximum number of seconds before reporting events.
Number of Events	10-500	Sets NetDFP maximum number of events to store before reporting events.

Radio Test Mode

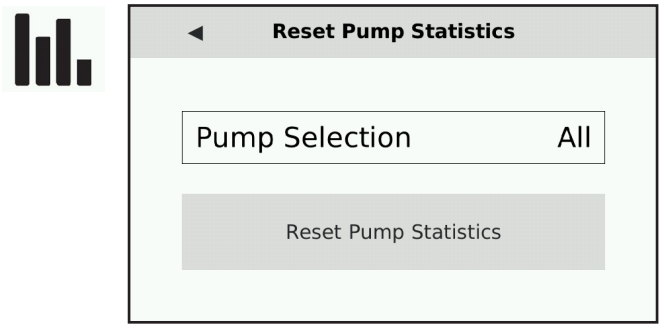


Utility mode to help with installing and aligning a directional radio antenna. Radio traffic will temporarily be displayed in the view.

KEY can be used to manually force the radio to transmit.

Station telemetry will be temporarily disabled in this mode. Selecting ◄ will exit the mode and return to normal operation.

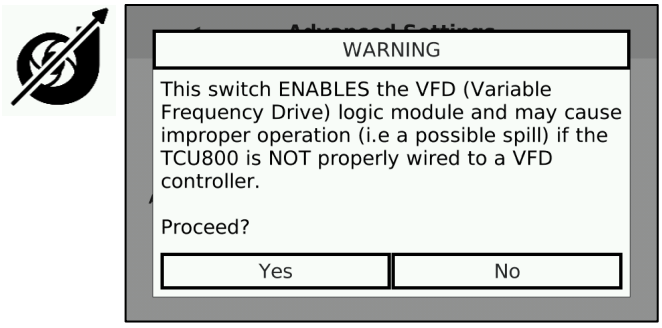
Reset Pump Stats



Chose to reset (clear) the locally stored pump statistics for either all pumps or the selected pumps. This is useful if replacing or removing a physical pump.

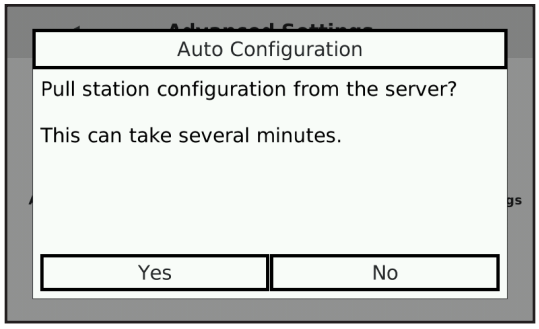
This will NOT erase pump statistics stored on the server.

VFD Mode



Tap to toggle VFD mode on or off. When enabled, the internal pump control algorithm is adjusted to for controlling Variable Frequency Drive pumps using an external MODBUS device. *Reference Appendix J in this manual for more information on how this mode operates.*

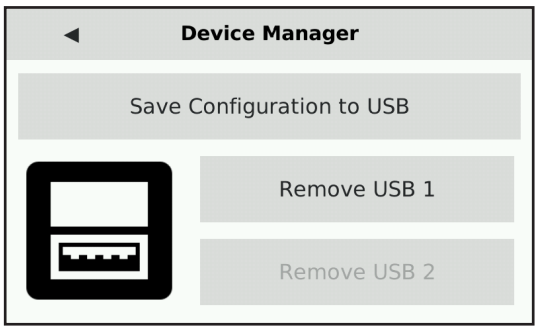
Auto Configuration



Be sure to configure the proper station of the TCU before activating this feature.

If an auto-configuration file has been created (using the PLC Editor) on the server, select 'Yes' to synchronize the configuration for this station. *For more information on the PLC editor, refer to the HyperTAC User Guide.*

Device Manager



Use this screen to force a save of the local configuration to the USB (if present). The image of the front USB ports will display a solid block if that particular port has a detected drive there.

It is important to avoid potential drive corruption to NEVER remove a USB device from the TCU without first selecting "Remove USB x" using this menu

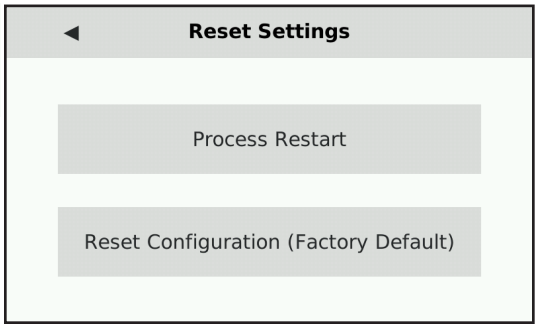
Calibrate PMA

This menu is reserved for factory use.

Attempting to run this in the field will result in a very inaccurate 3-phase voltage reading.

There should be no need to calibrate your PMA as this is already done at the factory. If 3-Phase readings are inaccurate, please contact DFS Support for help troubleshooting your panel

Reset



Process Restart will reboot the internal pump controller software. This is useful for clearing certain alarms without needing to power-cycle the whole unit (i.e Transducer Alarm).

Reset Configuration will reset the TCU's settings to their factory-default values. This does NOT affect the units station address, nor does it affect the network parameters in the TCU Settings menu.

Telemetry Configuration

Setting up the TCU as a component of the telemetry system enables you to remotely monitor conditions at the site and control equipment from a central location via the HyperTAC SCADA software. For example, you can determine if a pump is currently running and force it on if necessary. For the TCU to interface with the central site and the HyperTAC server, it must have access to radio or network communications and be properly configured in HyperTAC's Configuration Editor.

Hardware Configuration

There are several options for connecting the TCU to the telemetry system. A TCU can be installed with a DFS RTU station, or it can interface with industry standard radios using the TCU's RS-232 Modbus radio interface. Alternately, the TCU can operate as a stand-alone unit and communicate with the central computer or server via its integrated radio or network interface.

Using the TCU in conjunction with a radio-based telemetry system requires that you obtain an FCC-licensed radio frequency if you do not already have a licensed frequency that can be utilized. Even when adding a site to an existing frequency, the FCC requires that a complete application be submitted. DFS can assist you in obtaining a new licensed frequency or adding a site to an existing frequency.

TCU Installed with DFS RTU

If the TCU is being interfaced with an RTU station, a Bus Extender Module (BEM) must be installed in the RTU and connected to the TCU.

If the TCU's pump controller process is being used, the TCU must be configured with the number of real modules already on the bus. The TCU will then occupy the next available module addresses. If there are already four modules on the bus (A, B, C, D), the TCU will start at module E. Note that this module offset also applies to a TCU configured as a legacy PCU.

If the TCU is being used as a pump controller or a legacy PCU, it must be configured as such in HyperTAC. A legacy PCU occupies a single module address. A pump controller TCU occupies seven module addresses starting at the next available modules address. The TCU responds as individual modules or a single PCU module based on how it is polled.

If the TCU is running a custom program, it is important to remember that the TCU defines its internal modules without exception. Any additional modules added to the RTU must be addressed beginning with the module letter after the last dummy module defined in the TCU.

Instructions for installing the Bus Extender Module appear on the next page.

Installing the BEM

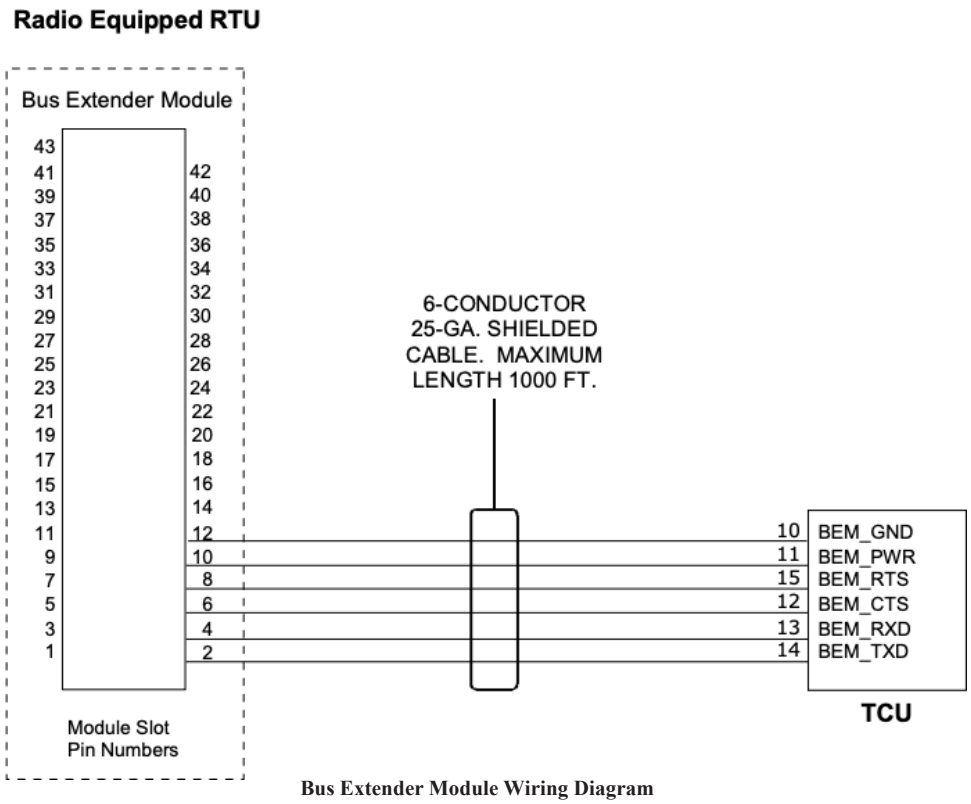
Place the BEM in one of the RTU's unused module slots.

Remove the corresponding address block or strap for the selected module slot.

Make the following connections:

BEM	Description	TCU
P1-2	Telemetry TX	P1-14
P1-4	Telemetry RX	P1-13
P1-6	Telemetry CTS	P1-12
P1-8	Telemetry RTS	P1-15
P1-10	Telemetry PWR	P1-11
P1-12	Telemetry GND	P1-10

Do not jumper pins 43, 41, 39, 37, and 35 on the BEM.



Bus Extender Module Wiring Diagram

TCU Used With A Modbus Compatible Radio

The TCU includes an RS-232 Modbus radio interface, which acts as an interface to industry standard radios. Pins on the TCU's second bottom connector, P-4, are provided for connecting the TCU to an external RS-232 Modbus compatible radio. For more information on this option, see the "Modbus Support" section.

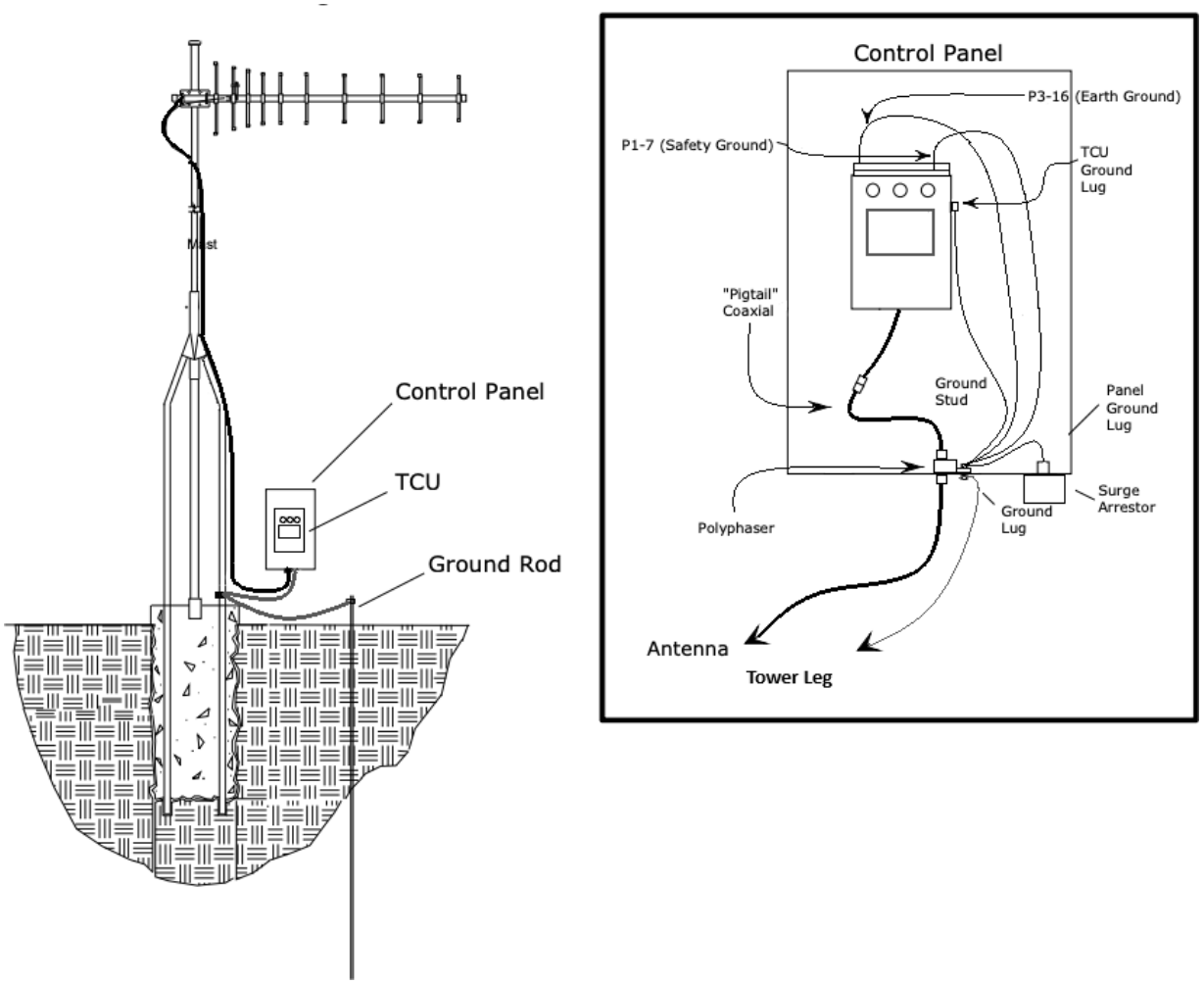
PIN#	Name	Description
P4-1	Unused	Reserved for future use; do not connect
P4-2	RS485_GND	RS-485 serial ground reference
P4-3	RS485_B	RS-485 serial interface B
P4-4	RS485_A	RS-485 serial inferface A
P4-5	SHIELD	Internally connected to chassis ground; Cable shield for RS-485 or RS-232
P4-6	EX_GND_RAD	RS-232 signal ground
P4-7	RTS_RAD	RS-232 request to send
P4-8	EX_TXD_RAD	RS-232 transmit data to external device
P4-9	EX_RXD_RAD	RS-232 recieve data from external device
P4-10	CTS_RAD	RS-232 clear to send

TCU as Stand Alone Unit

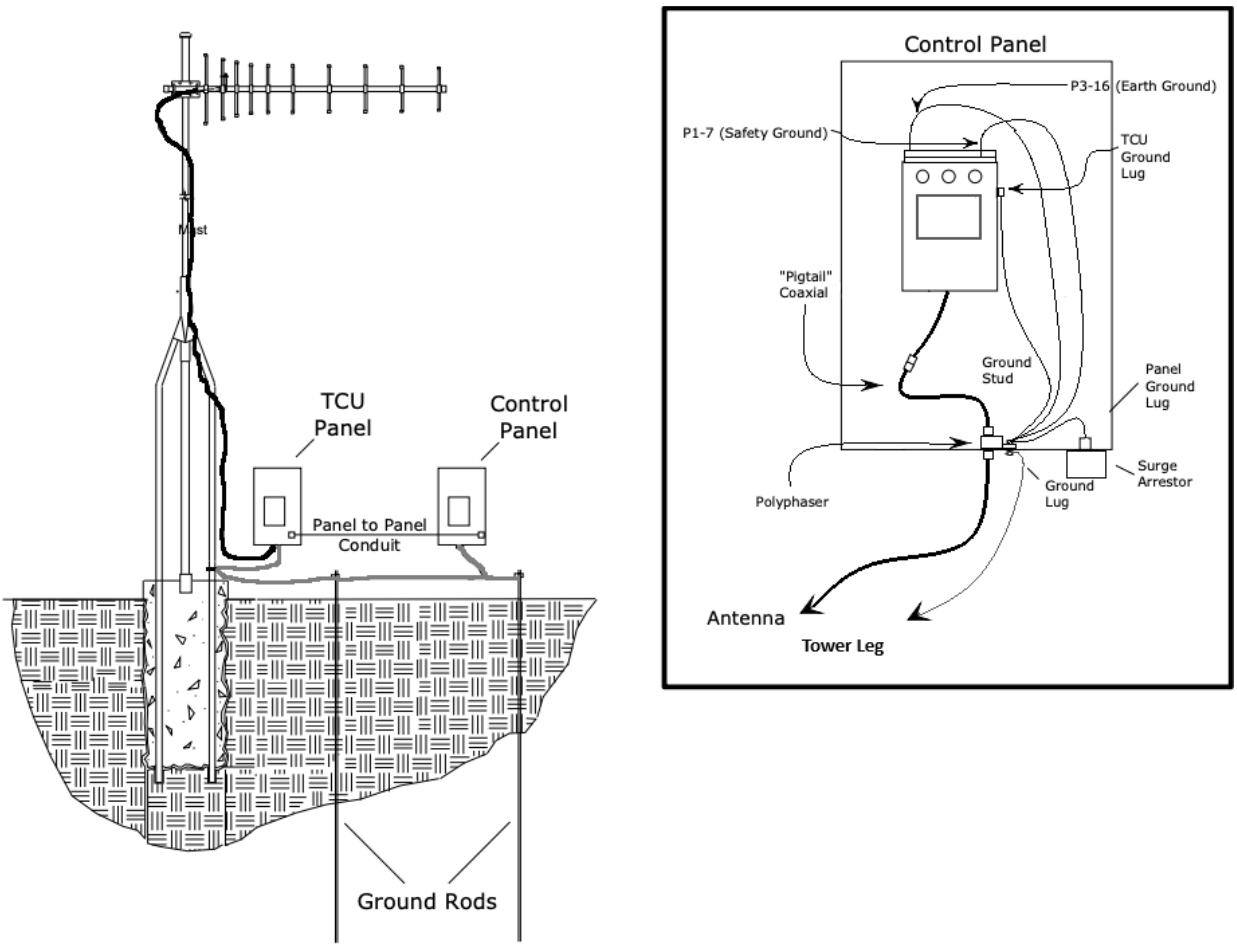
The TCU can be ordered with an integrated 2 W, 200 MHz radio or 5 W, synthesized 400 MHz radio and operate independently of an RTU. The TCU's integrated digital radio enables radio communication between the TCU and the HyperTAC central computer or server (Hyper SCADA Server). Through this radio link, you can remotely monitor and control TCU operations.

Typical Setups

Refer to the TAC II Telemetry System Installation Planning Guide supplied with the TAC II telemetry equipment for detailed wiring instructions.



TCU Installed in Existing Control Panel



TCU Installed in Separate Control Panel

TCU Used without Telemetry

The TCU can operate independent of telemetry with limited data logging capabilities. Historical data can be accessed via WinRTU Test or the TCU's status screens. Historical data that can be reviewed includes:

- Derived total flow for the station
- Elapsed run time for each configured pump
- Average run time for each configured pump
- Average amount of flow each configured pump moves per pumping cycle
- Total cycles for each configured pump

The TCU begins logging these running totals and averages when the unit is installed. The unit continues accumulating data until the time meters are reset.

HyperTAC Software Configuration

Telemetry components (drivers, stations, modules, points, etc) are configured using HyperTAC's Configuration Editor. To access Configuration Editor, log in to HyperTAC, click the "Configuration Tools" button, and then click the "View and Configure Telemetry" button.

7. Viewing and Troubleshooting Alarms

The information contained in this chapter refers to the TCU's built-in pump control process. It does not apply to a TCU with a custom program installed.

The TCU's Alarm LED illuminates if there are any alarms to view. The LED flashes for active alarms and is steady for inactive (cleared) alarms that have not been viewed from the TCU's Alarm screen or acknowledged via telemetry.

Following is a list of possible alarms:

- FltSeq – Floats are out of sequence
- Strt – Pump did not start
- Stop – Pump did not stop (this alarm message is displayed in the same location as Strt)
- HiWell – High well condition
- LoWell – Low well condition (this alarm message is displayed in the same location as HiWell)
- DCBias – DC bias (ISO+24V) failed
- ACPwr – AC power loss
- Xducer – Transducer fault
- PhaVol – Phase voltage fault
- PhaSeq – Phase sequence fault (this alarm message is displayed in the same location as PhaVol)
- AuxIn – Auxiliary input alarm

An alarm message flashes if there is an active alarm. If the alarm condition clears while the alarm message is being viewed, the alarm message stops flashing. Messages for inactive (cleared) alarms are static (non-flashing). These messages are stored in the TCU's alarm log until they are viewed. Once a message for an inactive alarm condition has been viewed, it is cleared from the TCU's display. The Alarm LED flashes when there are active alarms and is static on (continuously lit) until all alarms have cleared and all corresponding alarm messages have been viewed. The Alarm LED is cleared when the alarm screen is exited and there are no active alarms.

When the TCU is used as a remote in conjunction with the telemetry system, active alarms will be displayed both locally (at the TCU) and via the telemetry system at workstation computers. Note that the TCU's alarm messages and alarm LED are not cleared via telemetry; they must be cleared locally.

AC Power Fault

The ACPwr alarm is activated when the TCU determines AC power has been interrupted. The TCU must be on backup battery power in order for this fault to function when the primary AC power fails.

If an AC power fault alarm occurs at a TCU that is connected to a backup battery:

- Check that all circuit breakers are on.
- Check if any circuit breaker has tripped. If a station control panel breaker has tripped, resolve the problem.
- Check if the TCU's replaceable fuse has blown.

Be sure that *STRT_PWR* (P1-24) and *AC_PWR* (P1-5) are both connected to the station's control power. This ensures that all pumps under local control receive an emergency shutdown when AC power drops. If this is not done, multiple pumps could be commanded to start at the same time.

Auxiliary Input Alarm

The TCU monitors the AUX_IN terminal (p2-12), and it can be configured to activate the AuxIn alarm when the terminal is open or closed. If the auxiliary input alarm has been enabled and AUX_IN enters its configured alarm state (open or closed), an auxiliary input alarm is generated.

DC Bias Fault

The ISO+24V voltage, which is provided for biasing the digital monitor inputs and/or powering up to two analog transducers, is monitored by the TCU. If a fault occurs with the ISO+24V voltage, the DCBias alarm is activated.

If a DC bias fault alarm occurs, measure the voltage between the ISO+24V and ISOGND terminals. The voltage should be 20-24 VDC.

- Check for a short circuit condition between the ISO+24V and ISOGND terminals if the measured voltage is 0 (zero) VDC.
- If the voltage is low, check the current load on the ISO+24V source. It should be less than 100 mA. If the current load is excessive, disconnect and isolate ISO+24V and ISOGND terminals to determine if the fault is with the bias source or in the external circuitry. If the fault appears to be with the external circuitry, try isolating each input connected to the ISO+24V voltage until the problem is found. If the problem cannot be isolated, the TCU may require factory service. See "Appendix K: Support, Service, and Warranty" for removal, replacement, and servicing instructions.

ISO+24V is provided only for biasing the 12 digital monitor inputs of the TCU and/or powering up to two analog transducers while not exceeding the maximum current of 300 mA.

Float Sequence Fault

If the TCU detects floats out of sequence, it issues a FltSeq alarm. A FltSeq fault is not cleared at the TCU until the alarm message is viewed or after 24 hours have passed. A float sequence fault that is reported through telemetry clears on the next valid pump cycle (one without a float sequence fault).

When a float sequence fault alarm occurs:

- Check the floats or pressure switches for the fault. Verify that the corresponding Well Level LED illuminates when each float or pressure switch is on.
- Measure the voltage between the corresponding level input terminal and the IN_COM_2 terminal. The voltage should be 10-30 VAC or VDC with the switch closed and 0 (zero) V with the switch opened.
- Check the wiring and verify all of the following:
  - Only one bias source is used to bias all floats or pressure switches.
  - The same voltage-dropping resistor is used for all floats or pressure switches.
  - The return for the bias voltage is properly connected to the IN_COM_2 terminal.
  - If ALM_SIL and AUX_IN are used, verify that they use the same bias voltage and dropping resistor value as the level inputs.

High Well Alarm

The HiWell fault indicates that the HI_LVL input terminal is ON. Alternatively, if an analog transducer is being used, HiWell indicates that the level has risen above the High-level set point

If an erroneous alarm occurs, check the high float or pressure switch and wiring.

- When the switch is opened, 0 (zero) VAC/VDC, should be measured at the HIGH_LVL input.
- Measure the voltage between the HIGH_LVL and IN_COM_2 terminals.
- Make sure the high float or pressure switch is not fouled or shorted.
- If necessary, disconnect the HIGH_LVL input to isolate the problem further.

Phase Sequence Fault

The TCU's phase monitor is designed to detect phase losses, high and low phase faults, and phase sequence faults.

When the TCU detects a phase fault, it disables the pump motor outputs and activates the alarm light and horn relays. If a phase is missing or the power is interrupted, the TCU also indicates that a phase sequence fault has occurred by issuing a PhaSeq alarm.

If a sequence fault occurs, check the phase rotation of the incoming power. The label on the TCU's connector indicates the connection for clockwise phase rotation.

If the incoming power is labeled for counter-clockwise phase rotation, two of the leads wired into the TCU must be swapped. Be sure to turn off the main breaker before making any wiring changes.

If the problem cannot be resolved, the TCU may require factory service. See "Appendix K: Support, Service, and Warranty" for removal, replacement, and servicing instructions.

Phase Voltage Fault

The TCU's phase monitor is designed to detect phase losses, high-and low-phase voltage faults and phase sequence faults. When the TCU detects a phase fault, it disables the pump motor outputs and activates the alarm light and horn relays. The H-O-A switches can be used to override the TCU's phase monitor and control the pumps during a phase fault.

If a fault occurs, measure the TCU's Phase A-B and Phase A-C line-to-line voltages. If a voltage is missing, turn off the main breaker and check the external phase monitor fuses.

The phase voltage set points establish the range used by the TCU to detect a phase voltage fault. If an erroneous alarm occurs, check to see that the overvoltage and undervoltage limits are set properly. See pages 59-60 in Chapter 6: Operating Procedures" for instructions on setting voltage limits.

If the problem cannot be resolved, the TCU may require factory service. See "Appendix K: Support, Service, and Warranty" for removal, replacement, and servicing instructions.

Motor Starter Fault

A motor starter fault indicates that the TCU's motor run inputs do not agree with its motor run outputs when the H-O-A switch is in the "Auto" position. The default time allowed for the input to follow the output is two seconds, but the start delay and stop delay time intervals can be configured from 2-510 seconds. Zero disables the starter fault alarm, and the output remains on regardless of the run status input.

To accommodate applications where the run signal may not be immediate, such as soft starts or Run signals from check valves, you can configure the TCU with a longer start and stop delay.

A pump that experiences a Motor Start Fault (with or without Auto Retry enabled) remains faulted by the TCU (and the PCU) until the pump sequence is complete (tank or well reaches the Off level set point; no pumps are running in automatic). The TCU attempts to start the failed pump during the next regular pump cycle. Be aware that the Motor Start Fault will not clear until the pump actually runs or the H-O-A switch is moved out of Auto.

The TCU requires proper feedback to monitor pump motor run status. If the feedback signal malfunctions, the TCU activates the Strt alarm. The LED of the faulted pump (located under its H-O-A switch) flashes when a motor starter fault occurs.

The TCU's starter relays are solid-state devices with up to 0.1 mA off-state leakage current. This should not cause any problems with starter coils. However, it may force a solid-state starter with a high-input impedance to energize. If this occurs, there are two options to try.

- Try connecting a bleed resistor across the solid-state starter input. Select a resistance and wattage to shunt the leakage current.
- Install isolating relays between the TCU and the solid-state starter. Connect the TCU's starter relays to the coils of the isolating relays and control power through the isolating relay contacts to the solidstate starter inputs.

Check the starter circuit for faults by using the H-O-A switches to control the pumps. Verify that the pump run LED and the corresponding pump motor turn on when the H-O-A switch is in the “Hand” position and off when the switch is in the “Off” position. Switching the H-O-A switch out of the “Auto” position should clear the flashing pump run LED. If the LED does not turn on when the motor starts and turn off when the motor stops, check the wiring and verify that:

- Only one bias source is used to bias all motor run inputs.
- The same voltage-dropping resistor is used for all motor run inputs.
- The return for the bias voltage is properly connected to the IN_COM_1 terminal.
- If the EXT_PM input is used, make sure that it uses the same bias voltage and dropping resistor as the motor run inputs.

Verify that the TCU’s configured motor start fault delay (Start Fault) is set to an adequate length of time. If necessary, increase the Start Fault delay.

If the problem cannot be resolved, the TCU may require factory service. See “Appendix K: Support, Service, and Warranty” for removal, replacement, and servicing instructions.

Motor Stop Fault

A motor stop fault indicates that either the TCU sent a signal to turn off a pump and the pump remained on, or a pump came on without the TCU calling it. When this occurs, the LED under the faulted pump’s H-O-A switch flashes.

The default time allowed for the input to follow the output is two seconds. To accommodate applications where the stop signal may not be immediate, such as occurs with solid-state motor controllers, you can configure the TCU with a start and stop delay from 2-510 seconds.

If the Auto Retry function is enabled (see Auto Retry, page 53), the TCU will attempt to use the faulted pump the next time its turn comes up in the alternation order. If the TCU is successful at calling the pump to run and receives a pump run status, it will clear the Motor Stop Fault. This response is identical to that of the PCU.

If the Auto Retry function is disabled, the TCU will not clear a Motor Stop Fault and will not use a faulted pump until the pump’s operation is overridden (by moving the corresponding H-O-A switch to the Off or Hand position, or by overriding the pump via telemetry). The TCU considers the pump failed and will take the failed pump out of rotation and assign a new lead pump to start with the lead level. A PCU with Auto Retry disabled also will not clear the Motor Stop Fault. However, the PCU will attempt to start the faulted pump the next time its turn comes up in the alternation order. The PCU makes the assumption that the pump run status is accurate and will delay another pump from starting until the number of pumps required is one more than the failed number of pumps. For example if pump 2 has failed, and pump 1 is the lead pump, pump 1 will not start until the Lag 1 level is reached.

If a motor stop fault occurs, verify that:

- The TCU’s configured motor stop fault delay (Stop Fault) is set for an adequate length of time. If necessary, increase the Stop Fault delay.

- The mechanical auxiliary contacts on the motor controller's starter contactor are functioning properly. If they have been damaged and are stuck in the closed position, the motor controller will not receive the pump stop signal.
- The motor controller's starter contactor is functioning properly. If it has been damaged and is stuck in the closed position, the motor controller will not receive the pump stop signal.

If a sufficient Stop Fault has been configured and the starter contactor and its mechanical auxiliary contacts are determined to be functional, the TCU may require factory service. See "Appendix K: Support, Service, and Warranty" for removal, replacement, and servicing instructions.

Transducer Fault

The conditions that cause a transducer fault to be generated are based on the TCU's configuration. A few of the conditions that can cause a transducer fault are:

- Transducer low condition
- High float condition
- Absence of bubbler noise

The TCU provides several options for maintaining well and tank levels when a transducer fault occurs. Control pumps using:

- High and/or low float
- Timer based on the station's pumping history (average cycle per each hour of the day)
- Second analog transducer
- Float system (Off float and at a minimum a Lead or High float)
- Combination of a high and/or low float and the desired fault mode (timer, second transducer, floats)

The TCU uses the selected backup scheme until the problem with the transducer has been identified and fixed, and the TCU has been reset.

These options and the conditions that generate a transducer fault are described in more detail in "Chapter 6: Operating Procedures."

If none of these options have been implemented (floats, timer, secondary transducer) and the primary analog transducer malfunctions, the TCU will be unable to provide automatic control until the malfunction is resolved. The alarm light and horn relays may be activated.

When using an analog transducer, measure the voltage across the ANALOG1+ and ANALOG- terminals. This voltage should be 1-5 VDC for a 4-20 mA transducer and 0-5 VDC for a 0-5 VDC transducer. The voltage measured between the ANALOG1+ and ANALOG- terminals should vary according to the well or tank level.

Only 4-20 mA transducers should have a jumper installed between the ANALOG- and SHUNT terminals. If you are using a 0-5 VDC transducer, verify that the jumper is not installed.

If the transducer is determined to be functional, the TCU may require factory service. See “Appendix K: Support, Service, and Warranty” for removal, replacement, and servicing instructions.

Leaving the Alarms Screen

Use the TCU’s navigation keys to exit the Alarms screen. All inactive alarms are cleared from the TCU’s alarm log when the Alarms screen is exited. Additionally, if no active alarm conditions exist, leaving the Alarms screen clears the Alarm LED.

8. Modbus Support

Modbus Support

The TCU provides support for Modbus slave and master devices via its RS-232 and RS-485 serial interfaces.

Note that the TCU can be used as both simultaneously. For example, it could respond to queries from a Modbus master HMI software package (via RS-232) while querying DIN-rail mounted RS-485 slave devices.

RS-232 Modbus Slave Interface	The TCU's standard RS-232 serial interface allows it to be polled by devices that use 9600 baud and numerous Modbus protocol configurations. See "TCU as Modbus Slave (RS-232 Interface)," below. Note: The TCU must be factory configured by DFS to provide Modbus slave support.
RS-485 Modbus Slave Interface	The TCU's RS-485 Modbus serial interface enables it to act as a Modbus master device and poll devices at 1200-9600 baud using Modbus serial ASCII or RTU protocol. The baud rate and protocol selected for your installation must be identified in the TCU's configuration.

TCU as Modbus Slave (RS-232 Interface)

The TCU's RS-232 Modbus interface acts as an interface to industry standard Modbus-compatible devices, including radios, modems, and PLCs. Connecting a serial Modbus device to the TCU's RS-232 interface (connector P4) enables the TCU to operate as a Modbus slave device and respond to queries of its I/O.

The following Modbus configurations are available:

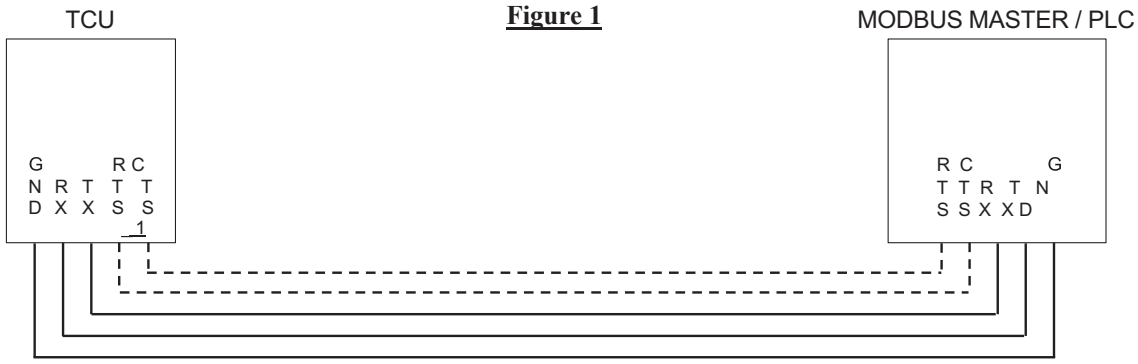
	Protocol	Baud Rate	Data Bits	Parity	Stop Bits
Option 1	Modbus ASCII	9600	7	Odd	2
Option 2	Modbus RTU	9600	8	No	1
Option 3	Modbus RTU	9600	8	Even	1
Option 4	Modbus RTU	9600	8	Odd	1

The illustrations below and on the next page show several examples of how the TCU can be integrated with a Modbus master device.

- Figure 1, "TCU Communicating with Modbus Master / PLC"
- Figure 2, "TCU Communicating with Modbus Master via Modem"
- Figure 3, "TCU Communicating with Modbus Master via Radio"

To disable hardware flow control/hardware handshaking in any of these configurations, place a jumper between the TCU's RTS and CTS pins (as shown in each drawing).

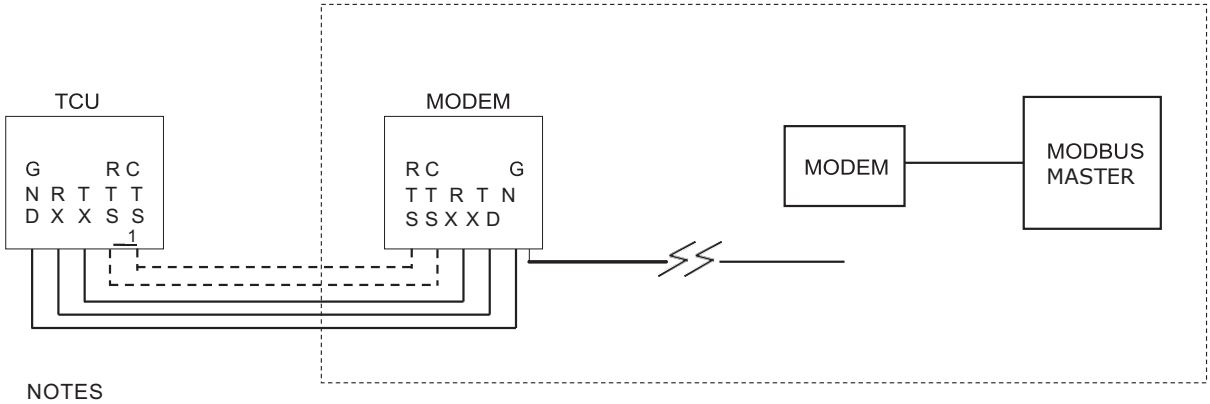
Figure 1



NOTES

1 Jumper RTS - CTS on TCU side to disable hardware flow control

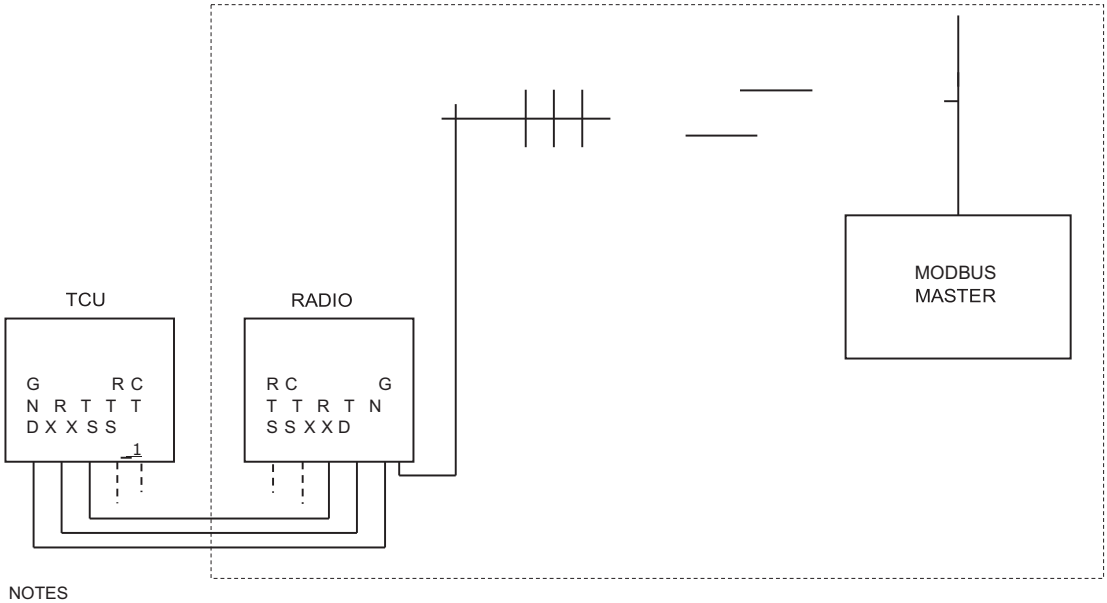
Figure 2



NOTES

1 Jumper RTS - CTS on TCU side to disable hardware flow control/hardware handshaking.

Figure 3



NOTES

1 Jumper RTS - CTS on TCU side to disable hardware flow control/hardware handshaking.

Do not use the TCU to power an external RS-232 Modbus-compatible device (for example, a radio, modem, or PLC). The device must be powered by a source other than the TCU.

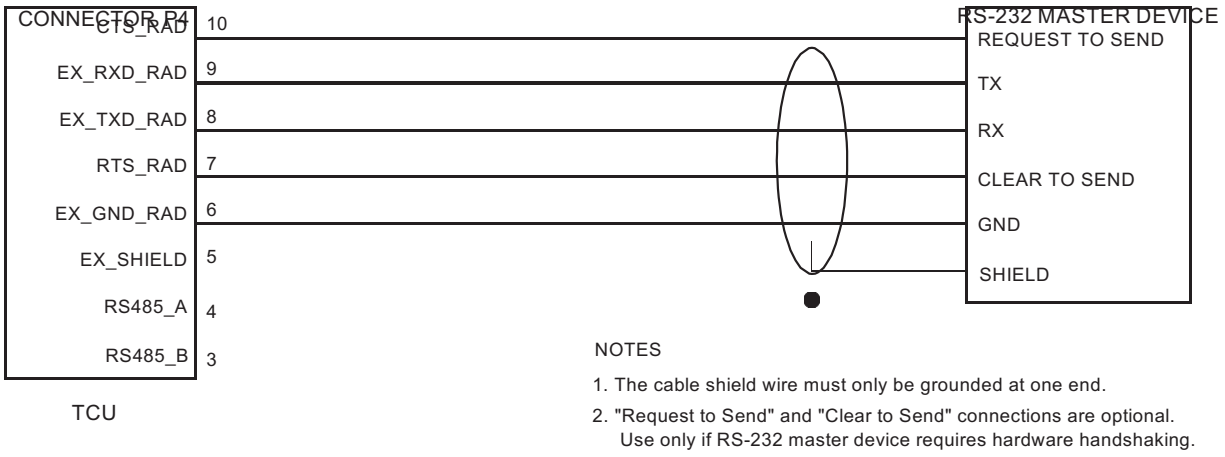
Wiring External Modbus-Compatible RS-232 Device

The TCU's P-4 connector provides pins for connecting the TCU to an external RS-232 Modbus compatible device (see table below for pin descriptions for connector P-4).

PIN #	Name	Description
P4-1	Unused	Reserved for future use; do not connect
P4-2	RS485_GND	RS-485 serial ground reference
P4-3	RS485_B	RS-485 serial interface B
P4-4	RS485_A	RS-485 serial inferface A
P4-5	SHIELD	Internally connected to chassis ground; Cable shield for RS-485 or RS-232
P4-6	EX_GND_RAD	RS-232 signal ground
P4-7	RTS_RAD	RS-232 request to send
P4-8	EX_TXD_RAD	RS-232 transmit data to external device
P4-9	EX_RXD_RAD	RS-232 receive data from external device
P4-10	CTS_RAD	RS-232 clear to send

In Figure 4, note that the RTS (request to send) and CTS (clear to send) connections are optional. They are only used for master devices that require hardware handshaking.

Figure 4



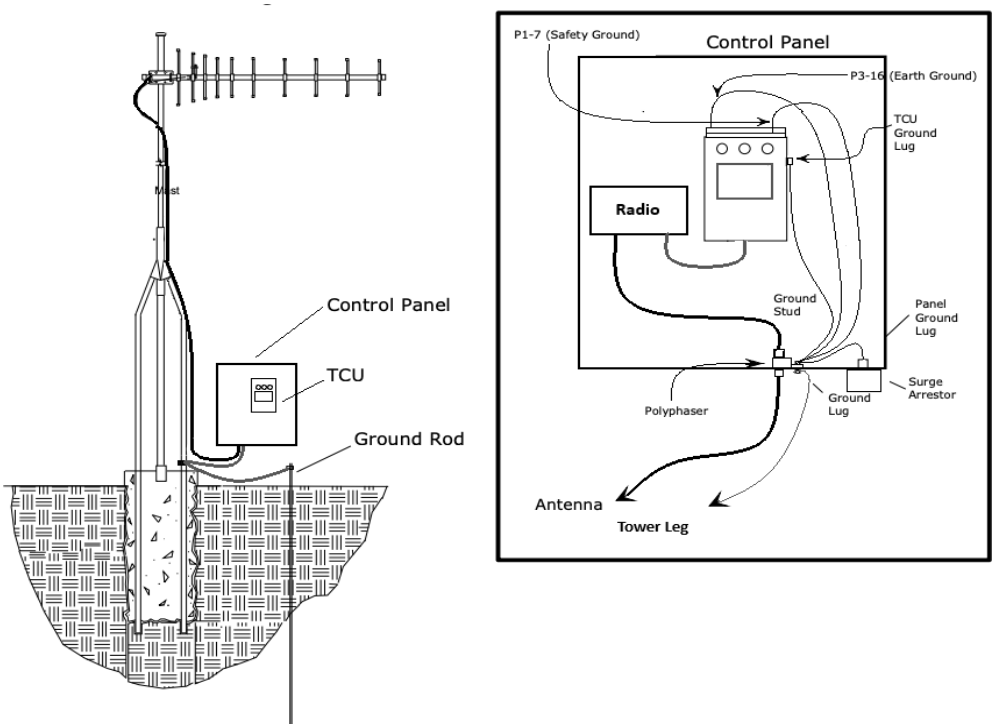
Configuring Modbus Device ID

The valid device ID range for the TCU is 1-250.

TCU Radio System Setup

Radio communication requires that the TCU be installed in a location, preferably a control panel, with access to an antenna. This illustration provides details on grounding a TCU that is installed in a control panel. Refer to the documentation for your radio and antenna system for details on wiring and installing those parts of your system.

Figure 5



Querying the TCU

When communicating with the TCU via Modbus radio or as a Modbus slave device via the RS-232 port, you must query the TCU using the equivalent Modbus register.

The TCU supports the following Modbus functions on its RS-232 serial slave port:

01	Read Coil Status (read digital control registers 1-9999)
02	Read Input Status (read digital status registers 10001-19999)
03	Read Holding Registers (read analog control registers 40001-49999)
04	Read Input Registers (read analog input registers 30001-39999)
05	Force Single Coil (control single control register)
06	Preset Single Register (control single analog control register)

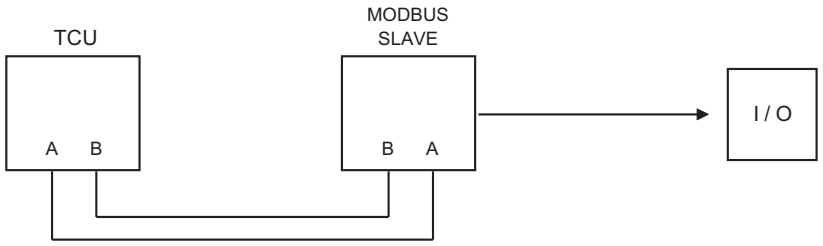
The TCU does not support:

15	Force Multiple Coils (control multiple control registers)
16	Preset Multiple Registers (control multiple analog control registers)

TCU as a Modbus Master Device (RS-485 Interface)

When the TCU is used as a fixed-speed pump controller, it can poll modbus slave devices and place their register data in the TCU's unused registers. Modbus polling is activated by entering the Modbus information (address and length) into the TCU's configuration registers. The TCU will then poll the device(s) automatically.

Figure 6



RS-485 Serial Settings

As a Modbus master device, the TCU can communicate with Modbus slave devices at 1200-9600 baud using either ASCII or TRU protocol. The baud rate and protocol selected for your installation must me identified in the TCU's configuration.

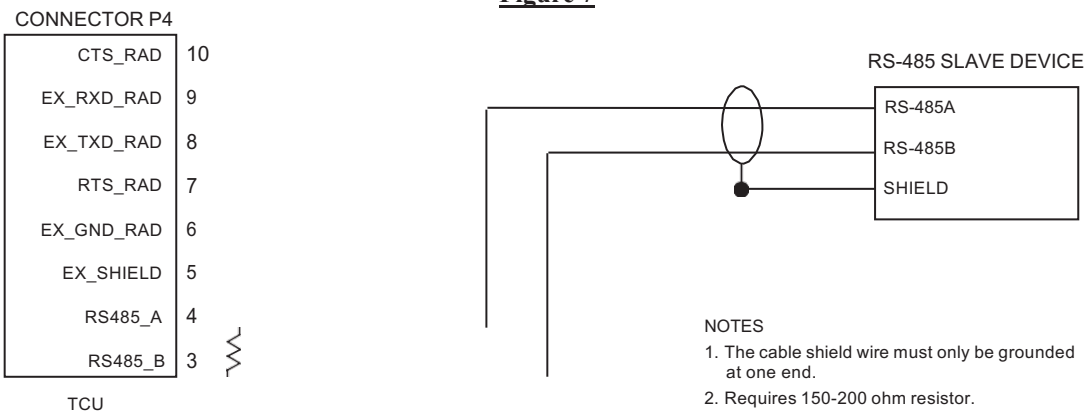
The protocol options are:

	Protocol	**Data Bits**	**Parity**
Option 1	ASCII	7	No
Option 2	ASCII	7	Even
Option 3	ASCII	7	Odd
Option 4	RTU	8	No
Option 5	RTU	8	Even
Option 6	RTU	8	Odd

Wiring an RS-485 Slave Device

The TCU's P4 connector is its interface to RS-485 devices. Refer to the pin definitions for the TCU's Bottom Connector 2: P4 provided on page 8. A wiring diagram is provided below.

Figure 7



Configuring the TCU to Poll Modbus Slave

Pump Control Process

When using the TCU as a fixed-speed pump controller, you configure the TCU to poll Modbus slave devices using one of the following methods:

- Through the TCU's configuration screens
- Via the TCU editor included in WinTRU Test. WinRTU Test is included in the TCU, PCU and SCU Test kit. The Help files included with WinRTU Test provide details on configuring the TCU for Modbus polling.

The TCU polls Modbus registers as follows:

Digital Status (10001-19999) and Analog Status (30001-39999)	Registers are polled continually
Digital Control (0001-9999) and Analog Control (40001-49999)	Registers are updated using the multiple register update command. At TCU power up, the status of the Control registers is read once.

After TCU power up, Modbus control registers are updated whenever the corresponding TCU registers are changed via telemetry. Similarly, when Modbus status registers change, their corresponding TCU registers are updated. One module of Modbus data is processed approximately every 2 seconds.

Appendix

A. Technical Specifications

Box Dimensions	5.75” x 8.75” x 5.45”
Supply Voltage	120VAC +/-10%, 60Hz
Supply Current	0.5-1.5A
Processor Core	AM335x SoC, 512MB of memory and 1GHz
Operating System	Linux
Internal Phase Monitor	240VAC @ 60Hz single- or three-phase; 480VAC @ 60Hz three-phase using external resistors
Battery Backup	12V, sealed, lead-acid battery
Analog Inputs	(3) 4-20mA @ 250Ω / 0-5V or 0-10V @ 120KΩ, 15-bit precision (1) 4-20mA @ 250Ω / 0-5V, 15-bit precision
Digital Inputs	(17) 10-30VDC/AC; 30-300VAC/DC with external resistors (1) 10-30VDC / pulse input <1000 PPS
Digital Input Impedance	5.5k
Digital Outputs	(4) Solid State Relays, 120-240VAC @ 60Hz, 1A, Pilot Duty
Alarm Relays	(2) Electromechanical Relays, 120VAC @ 60Hz, 1A / 0-24VDC, 1.0A; NO (Alarm Horn), NC (Alarm Light)
Integrated Radio	2W @ 200 MHz or 5W @ synthesized 400 MHz
RS-232 Interface	9600-115200 baud serial interface for Modbus ASCII devices (RTU protocol option available)
RS-485 Interface	9600-115200 baud serial interface for Modbus ASCII/RTU devices
Ethernet Interface	10/100base-T
USB 2.0 (Full Speed)	2 ports external, 1 port internal
Isolated 24VDC Bias	300 mA current limited and regualted
Input Protection	MOV (Metal Oxide Varistor), TVS (Transient Voltage Suppressor), and on-chip transformer isolation
Display	5” TFT LCD w/ capacitative touchscreen and overlay push-button Resolution: 800 x 480 Brightness: 750 nits
H-O-A Switches	3 x 3-position switches for Hand-Off-Auto operation
Environmental Conditions	Ambient Operating Temperature Range: -10C to 60C (14F to 140F). The upper temperature limit is 50C (122F) when using the recommended backup battery. Relative Humidity: 0-100% Atmosphere Pressure: 75-106 KPa Overvoltage Catgeory II Pollution Degree 2
Safety Approval	UL listed for process control management (UL1092)

B. Checkout Procedure for Pump Controller

Step 1: Electrical Termination Review

NEC code and OSHA safety standards should be observed during all installation, grounding and testing procedures. Modifications to the following should be made as necessary to stay within NEC and OSHA guidelines. Confirm with DFS regarding proper procedure if the following becomes obsolete due to code or regulation changes.

1. Visually inspect all wiring. Check for loose wires and short circuits.

2. Verify 120 VAC exists at the line termination and between neutral and ground terminals on the TCU's P1 connector.

3. Verify proper voltage dropping resistors are in place on all TCU digital input pins where voltage exceeds 30 VAC/VDC.

4. Verify that surge arrestor components are installed correctly as detailed in DFS approved drawings.

5. Verify that DFS onboard 24 VDC supply is not being used for any control devices. This onboard source is for biasing analog and digital monitor inputs to the TCU only.

6. Verify that grounding is installed correctly. Bonding should occur between the DFS tower ground rod and Power Company ground rod and finally to the DFS supplied Polyphaser. Refer to illustrations provided in "Chapter 7: Telemetry Configuration."

7. If 3-phase power is input directly to the TCU, verify that:

- Voltage exists at the P1 terminals for the appropriate phases.
- 3-phase power is fused and correctly routed through the TFS supplied by DFS.

If the TCU shows an active 3-phase error, follow the steps provided in "Chapter 6: Operation Procedures" to adjust the Low Phase and High Phase limits. To facilitate a start-up, the 3-phase limits can initially be adjusted fully open, and then later adjusted for less tolerance.

8. If the Phase Monitor Bypass is used to monitor third party 3-phase monitors with contacts that remain closed when the 3-phase is within specifications, wire the contacts using the same common as the pump run input circuits. The TCU will only run the pumps if the Phase Monitor Bypass input is ON. If the third party phase monitor contacts should open, all Auto operation will cease. This input takes precedence over the direct 3-phase input. Although the on-board 3-phase monitor and phasemonitor-bypass input can be used simultaneously, we do not recommended that configuration.

9. Verify that the level detection device(s) connected to the TCU are properly wired. If floats or pressure switches are used, check that they are in the correct sequence. If an analog 4-20 mA transducer is used, check that the jumper between the ANALOG- and SHUNT terminals is installed. If an analog 0-5 V transducer is used, you must check that the jumper between the ANALOG- and SHUNT terminals is removed. Verify the wiring of the alarm light and horn, if used. The voltage connected to ALM_PWR is switched to the ALM_LITE and ALM_HORN terminals when the alarms are activated. The returns for the light and horn must be connected to the return of the source used to power them.

10. Verify that the proper fuses are installed in the output circuits of the motor starter, alarm light and horn, and auxiliary.

11. If telemetry is used, verify the wiring of the interface cable.

Step 2: Operations Testing

Test all of the TCU functions listed below. If the tested function fails, first verify the circuit between the TCU and the device. When verifying the circuit, check fuses, resistors, signal contacts, isolators, relays bias, and return voltages and conductors, where applicable, as these components are occasionally subject to failure.

1. Before powering the TCU, place all three H-O-A switches in the Off position.

2. Turn circuit breakers on one at a time. Turn the TCU on last.

3. Verify Hand operation of the contactors (pumps) by placing each of the TCU's H-O-A switches in the Hand position.

4. Verify that each Pump Run LED illuminates when its respective control is engaged in Hand operation. If the LED flashes, the TCU has failed to receive the Motor Run Input for the contactor. If this occurs, verify the pump run circuit integrity.

5. Check float input operation by tipping the floats and verifying that the correct, corresponding, Float Input LED is illuminated.

- When the High float is tipped and the high float is enabled, the bell or alarm should go on.
- If the Low float's contact is open, the bell or alarm should go on.
- If the TCU is using an analog input for level control, refer to "Chapter 6: Operation Procedures" for information on setting the level set points along with other options for analog and float back-up operation.

Note: The alarm light and alarm horn have to be enabled in the TCU's configuration in order for them to operate.

6. If an alarm silence button is wired, verify the Alarm Silence input is operational by attempting to silence the bell or alarm. The bell/alarm is silenced by pressing and holding the Alarm Silence Button for 2 seconds after the High float is tipped. The Alarm Silence input shares the same common, and therefore the same voltage source, as the float inputs.

7. Configure the TCU for the site (station) in which it is installed.

8. Check the TCU's Alarm screen to verify that all alarms have cleared.

9. Place the necessary TCU H-O-A switches in the Auto position. Allow the water level to rise, or manipulate the level inputs manually, to verify Auto operation.

10. Verify alternation of the pumps by manipulating the "OFF" and "LEAD" inputs to the TCU in the correct and natural order based on what pump mode you have selected in the configuration. The TCU control outputs should respond by alternating the lead pump position with alternation enabled. Allow for some delay on pump start after the level input is activated.

11. Verify, as the LAG1 and LAG2 inputs are toggled, that the TCU starts additional pumps that the level input demands. Allow for some delay on pump start after the level input is activated.

12. After the system is checked out, connect the backup battery, if used. Make sure the battery is properly connected. Observe polarity markings.

13. If the battery is charged, cycle the TCU's AC power off and verify battery backup operation. Make sure to turn the TCU on when finished with the checkout procedure.

C. Maintenance and Troubleshooting

Blown Fuse

The TCU800 includes one 2A replaceable fuse. The fuse is located on the side of the TCU and is labled F601. The fuse is designed to protect the TCU's DC power circuitry from its operating AC input voltage.

If this fuse blows, you will see one of the following responses depending on the status of the TCU's backup battery:

Functioning DC Battery	TCU triggers a local AC Power alarm and reports an AC Power Fault to the central SCADA system. TCU indicators, such as LED lights and LCD screen, will be normal.
DC Battery Dead or Below Tolerance	No local AC Power alarm is generated; No AC Power Fault is reported to the central SCADA system. TCU indicators, such as LED lights and LCD screen, will be off. The TCU station will eventually be shown as Offline in HT3.

Conditions that could cause the fuse to blow:

- Incorrect operating voltage
- Surge in operating AC power voltage greater than .375 A
- Heat condition that exceeds designed operating temperature of 160 degrees
- Incorrect control voltage wiring
- Shorted circuit within the TCU

Before replacing the fuse:

- Inspect the TCU site and wiring to see if any of the conditions listed above may have occurred.
- If you received an offline alarm for this station, check the battery to verify it is functioning properly. Replace the battery if you find it is unable to hold a charge.
- Measure the input voltage and check the wiring to the TCU's connector. The operating voltage is marked on the connector label. Try replacing the fuse only when the proper voltage is connected.

Replacing the fuse:

Replace the fuse with a new identical one.

After replacing the fuse, verify that the TCU is functioning properly (LED lights are lit; LCD screen is working).

If the TCU isn't working after you've replaced the fuse, the TCU may require Factory service. See "Appendix O: Support, Service, and Warranty" for removal, replacement, and servicing instructions.

TCU Replacement

The TCU can easily be removed and replaced with a backup TCU if it is determined that the TCU needs servicing.

1. Before removing the TCU, either make a note of the TCU configuration or download the configuration to a computer.*

2. Turn off all circuit breakers before attempting to remove the TCU.

3. The terminals are connectorized for removal. Use an insulated screwdriver and gently pry the connectors free.

4. Remove the mounting fasteners that connect the TCU to its mounting brackets. You should be able to easily lift the TCU from its mounting brackets.

5. Install the replacement TCU, replace the fasteners, and reconnect the terminals.

6. Place the replacement TCU's three H-O-A switches into the "Off" position and turn the breakers back on.

7. Reconfigure the replacement TCU. If the faulted TCU's configuration was backed up on a portable computer, it can be restored on the replacement TCU.*

8. After configuring the replacement TCU, place the required H-O-A switches in the "Auto" position.

*TCU configurations can be uploaded/downloaded through telemetry using PCU Editor. You can also connect the TCU directly to a laptop computer and use the WinRTU Test software to download/upload configurations. Refer to the help files of these applications for more information.

D. Parts List

Furnished Parts

TAC Pack Telemetry Control Unit (TCU)

DFS-00540-008-01(NO RADIO)
DFS-00540-008-03 (EXTERNAL RADIO)
DFS-00540-008-16 (IP)
DFS-00540-008-21 (145-225 MHZ RADIO)
DFS-00540-008-22 (450-470 MHZ RADIO)
DFS-00540-008-26 (LEGACY XT200 RADIO)

Optional Parts

Batteries

12V, 7.0Ah Rechargable Battery
Part # DFS-00363-008-01

ery

Rail Pressure Transducer (RPT)
Small Parts Kit
Part # DFS-00546-008-02

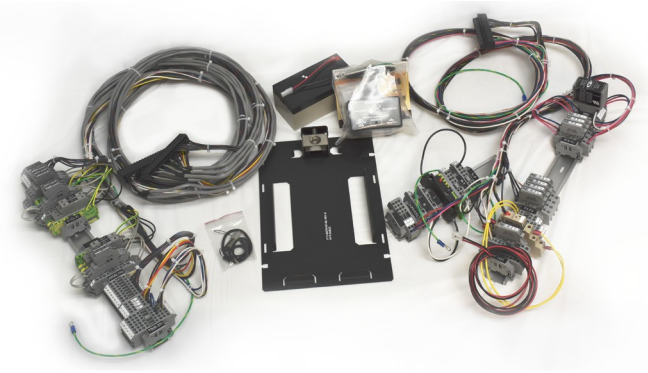
Network Surge protection for
1000/100/10-Base-T
Part # DFS-002-0584

TCU Polyphaser Kit
Part # DFS-00392-008-01

Split-Core Current Transformer
Part # 008-0076 (**20A**)
Part # 008-0077 (**50A**)*
Part # 008-0078 (**100A**)

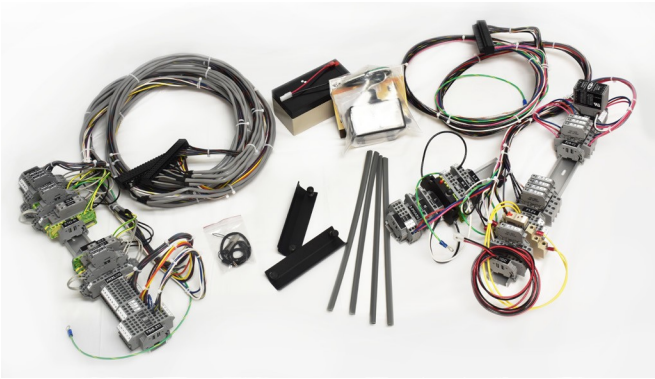
**The TCU800's default configuration expects 50A CTs*

TCU800 Basic Snap-In Install Kit
Part # DFS-00552-008-08



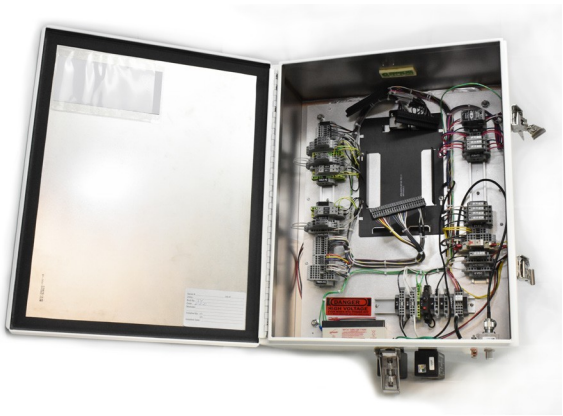
TCU800 Deluxe Snap-In Install Kit
Part # DFS-00552-008-09
(Pre-Assembled Wiring Harness)

TCU800 Basic Front Mount Install Kit
Part # DFS-00552-008-10

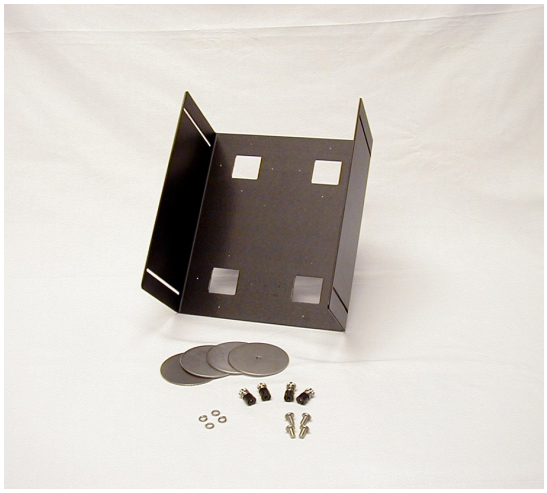


TCU800 Deluxe Front Mount Install Kit
Part # DFS-00552-008-11
(Pre-Assembled Wiring Harness)

TCU800 Fiberglass Enclosure Assembly
Part # DFS-00552-008-06

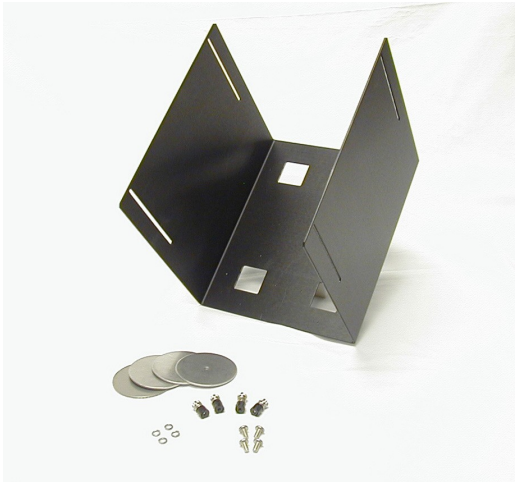


TCU800 316SS Enclosure Assembly
Part # DFS-00552-008-07



Adjustable Mounting Bracket (Short)
Part # DFS-00394-008-01

480 VAC Phase Monitor Kit
Part # DFS-00393-008-05
(Kit includes 480 VAC, three-phase surge arrestor, three DIN-rail mounted terminal blocks with integrated 49.9k resistors, and fuse block with three 1 Amp fuses)



Adjustable Mounting Bracket (Medium)
Part # DFS-00394-008-02

Adjustable Mounting Bracket (Long)
Part # DFS-00394-008-03

RC Snubber
Part # 007-0084

Service Adapter
Part # 002-0540

120V Surge Protector (SPS001)
Part # 005-0061

240V 3-Phase Surge Protector (TPS001)
Part # 005-0062

240V Single Phase Surge Protector
Part # 005-0120

480V 3-Phase Surge Protector (TPS002)
Part # 005-0063

Spring-Clamp Connector Tool
Part # DFS-00389-008-01

USB Configuration Thumb Drive
Part # DFS-00540-108-06

E. Mounting Instructions

The TCU is intended to be permanently installed in a NEMA 12 or higher rated panel that prevents access to live parts without a tool. The TCU can be mounted in a control panel in several different ways. The unit can be mounted flush to the back plate of the panel, stood off the back plate, or mounted to a front panel. Mounting brackets are provided with the TCU that can be used to mount it in any of these positions. Optional connectors to facilitate the various types of mountings are available as shown in "Appendix D: Parts List."

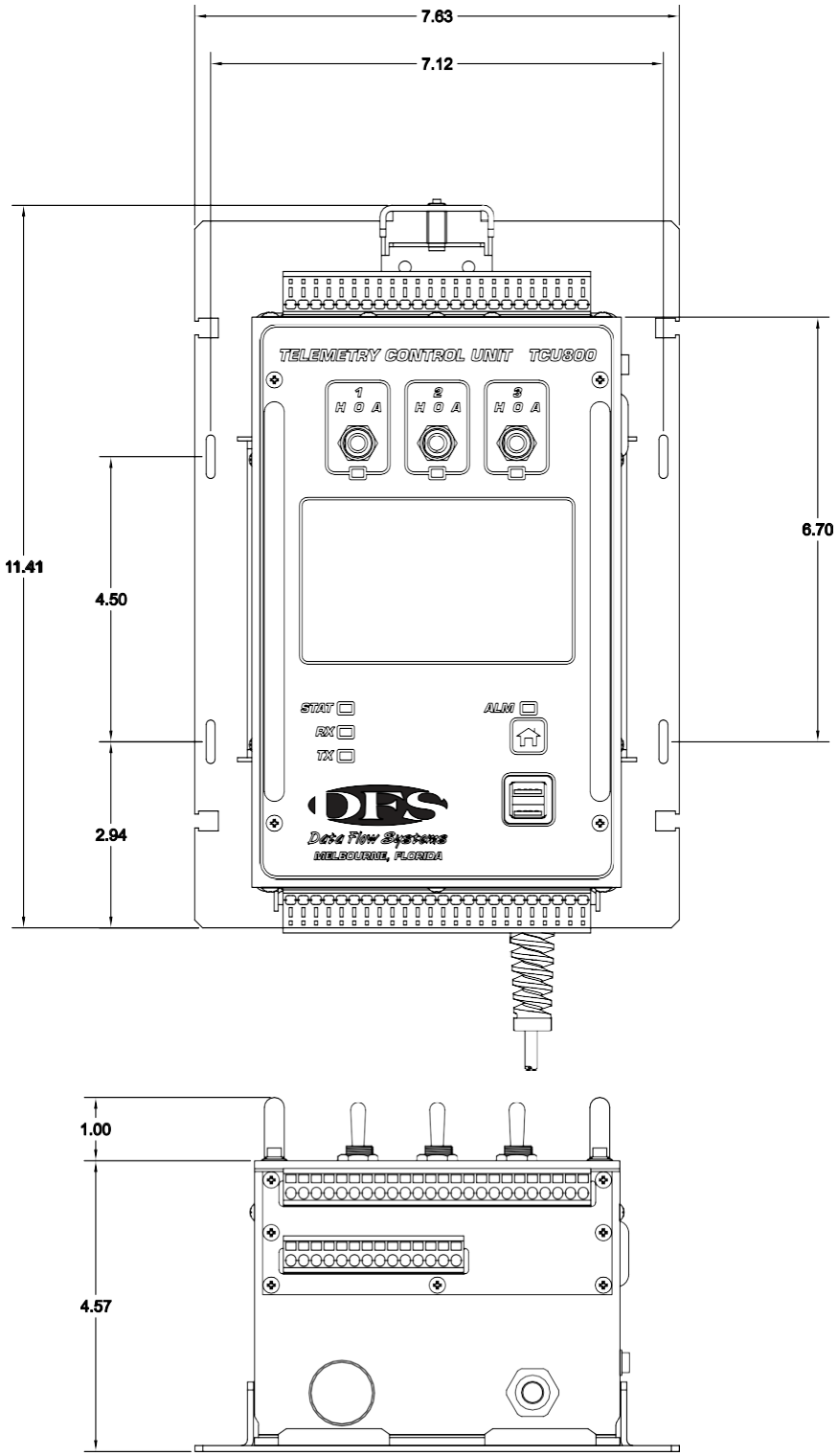
This information is provided for qualified personnel only. Improper installation, service, or maintenance can cause property damage, injury, or death. Read the installation and operating instructions thoroughly before installing or servicing this equipment.

Precautionary measures must be observed when installing, operating, and servicing the TCU in order to prevent shock from voltages present. If the TCU is to be installed into an existing control panel, make sure that all breakers are shut off before starting the installation. All wiring must conform to federal, state, and local electrical codes.

- A qualified technician should install the TCU.
- Precautionary measures must be observed when installing, operating, and servicing the TCU in order to prevent shock from voltages present.
- The TCU is intended to be permanently installed in a NEMA 12 or higher rated panel that prevents access to live parts without a tool..
- If the TCU is to be installed into an existing control panel, make sure that all breakers are shut off before starting the installation.
- All wiring should conform to federal, state, and local electrical codes.
- Attention should be given to the location of the TCU to provide accessibility for wiring and servicing. Leave enough space around the TCU to access the TCU's fuse (located on the side of the TCU and labled F601) and to remove the connectorized terminal strips. Install the TCU in the panel at a position where the LCD display can be read comfortably. The LCD is best viewed at slightly below eye level.

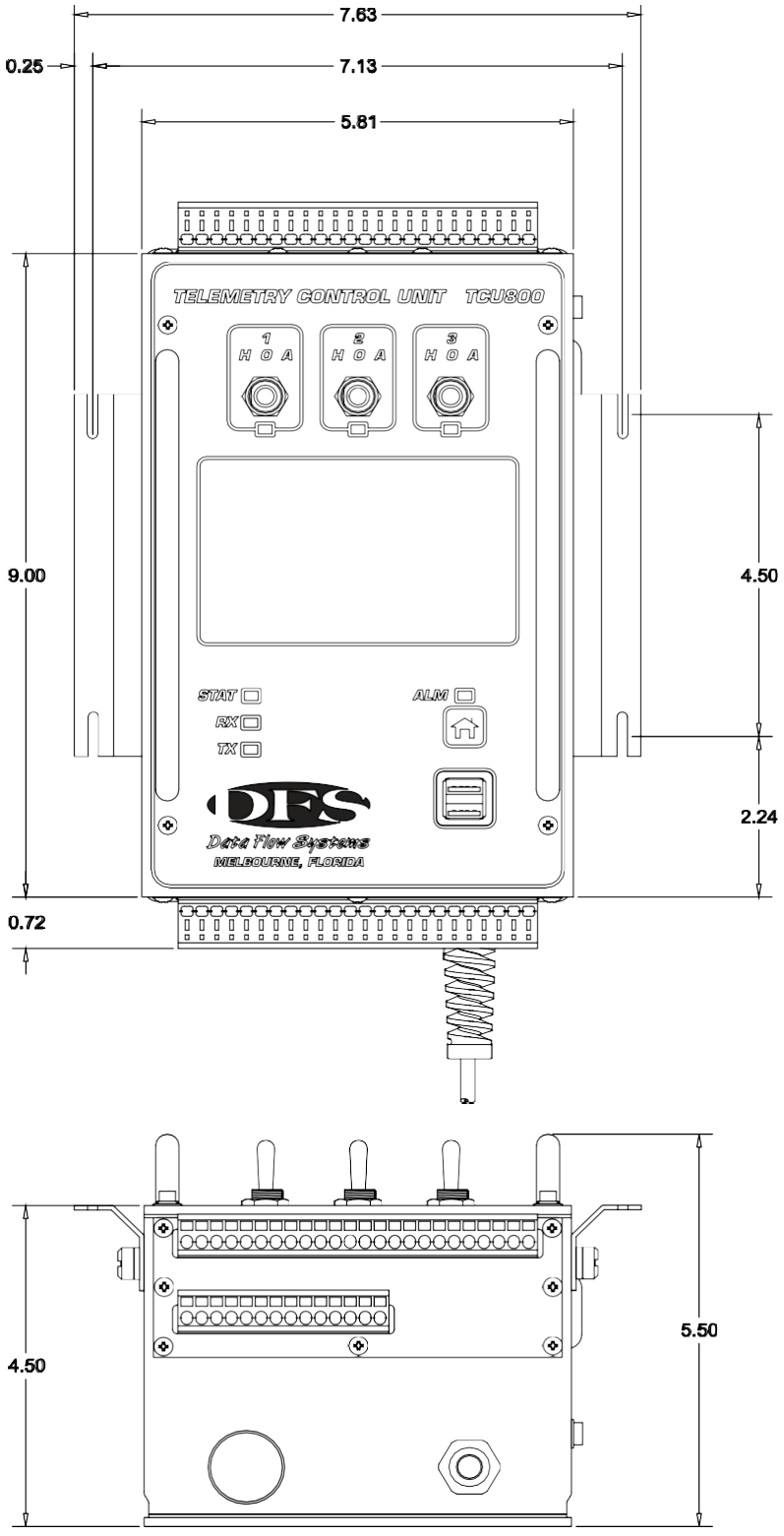
Snap-In (Back Panel) Mount

The mounting bracket is attached to the back of the control panel, and the TCU is snapped into place. With this mounting option, the TCU can be installed and removed quickly and easily. This option uses the Snap In installation kit (Basic Install Kit or Full Install Kit). See “Appendix D: Parts List.”



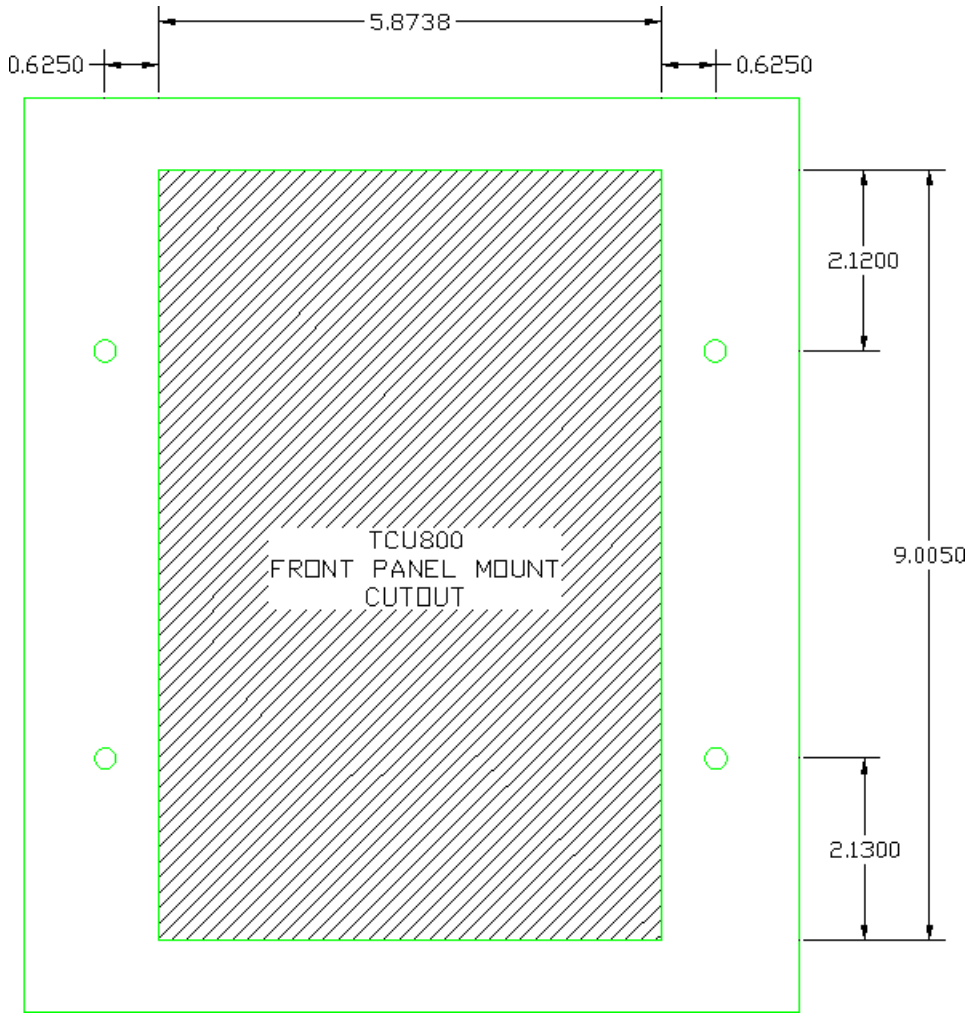
TCU Front Panel Mount

With this mounting option, the TCU is attached to the mounting bracket with screws instead of being snapped into place. This option uses the Front Mount installation kit (Basic Install Kit or Full Install Kit). See “Appendix D: Parts List.”



Suggested Panel Cutout

For front-mounting the TCU, the below cutout is suggested for optimal fit.

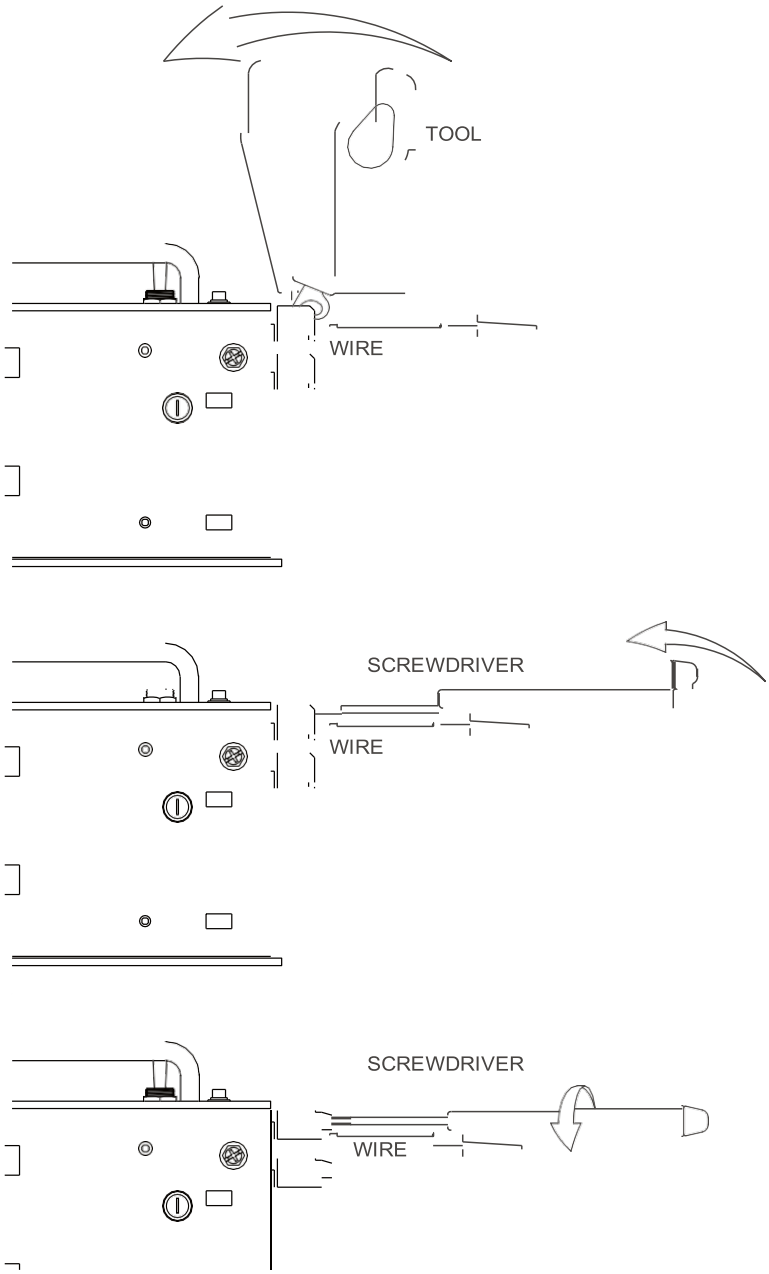


Suggested Panel Cutout for TCU Front Panel Mount

The front overlay of the TCU800 is slightly larger than that of the TCU001. This was done in order to properly seal the unit.

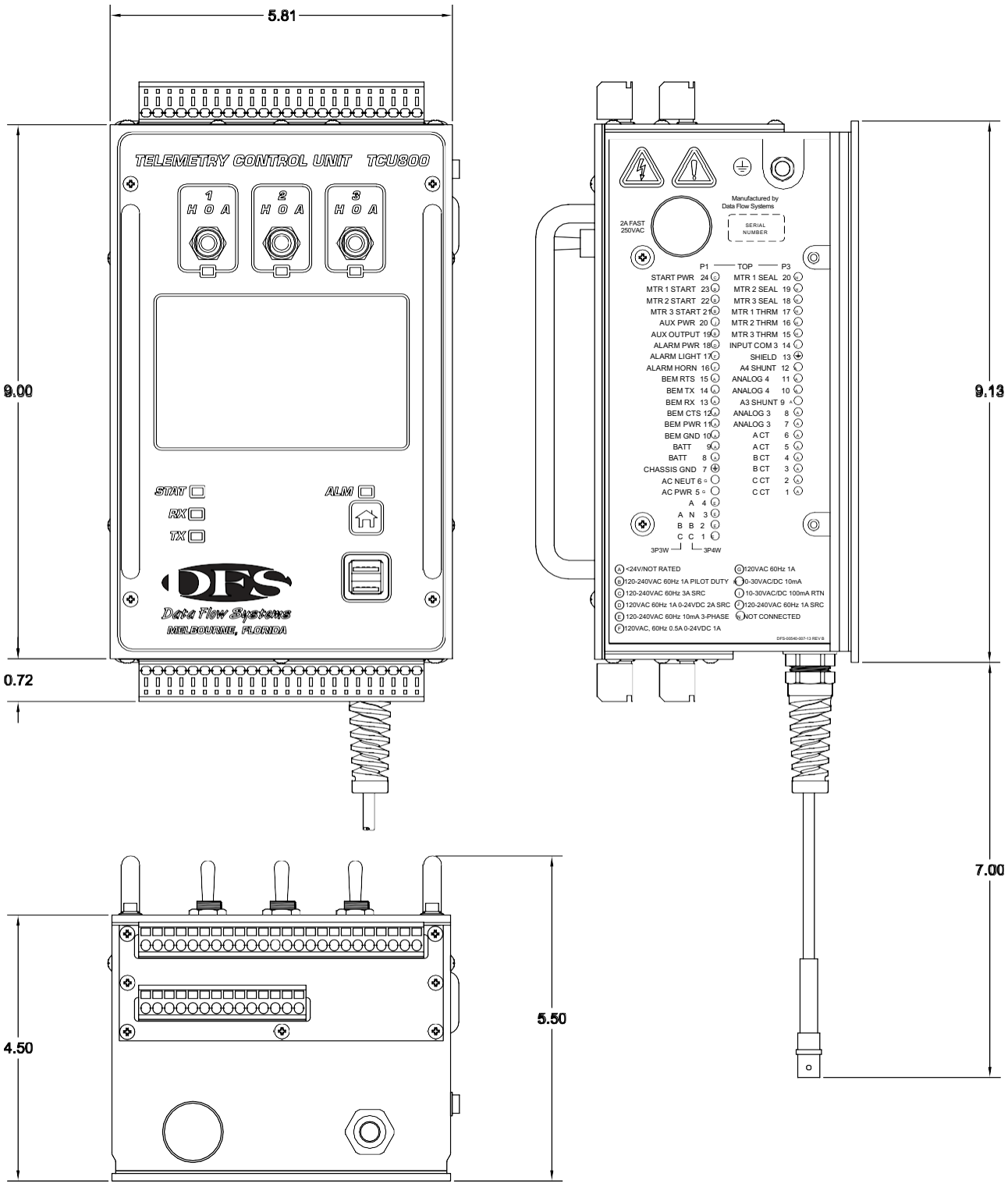
Attaching Connectors

The graphic below depicts how each of the TCU's three optional connector types can be attached to the unit. The first option uses the Spring-Clamp Connector Tool. See "Appendix D: Parts List" for information on ordering connectors and the connector tool.



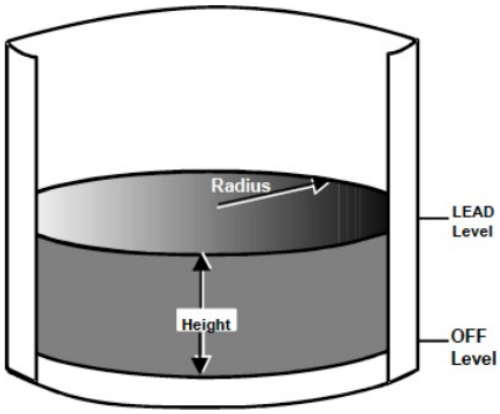
Dimensional Drawing

A dimensional drawing is provided to aid in installation. If a panel cutout is required, the TCU can be installed with or without edge molding around the front-panel opening. The panel cutout is different for each mounting configuration.



F. Well Volume Calculations

To calculate Well Volume, determine the well volume between the Off Level (*LeadOff Pt*) and the Lead Level (*LeadOn Pt*).



1. Determine the difference between the Off Level and the Lead Level (height) in feet.

2. Determine the area of the well. For a rectangular well, multiply width times length; for a circular well, square the radius and multiply by 3.14.

3. Multiply height by area to give volume in cubic feet. To convert to gallons, multiply the volume in cubic feet by 7.48.

IMPORTANT: Well volumes less than 500 gallons or 37 ft3 are prone to accuracy errors.

Example: Assume a circular well of 10 feet diameter (5-foot radius) with Off Level at 2 feet and Lead Level at 5 feet.

Calculate Liquid Height

Lead Level	5 feet
- Off Level	-2 feet
Liquid Height	3 feet

Calculate Area of Well

Well radius (5') squared	25 ft^2
x conversion constant (pi)	x 3.14
Area	78.5 ft^2

Calculate Volume

Liquid Height	3 feet
x Area	x 78.5 ft^2
Volume (cu. ft)	235.5 ft^3 (Enter 236 if configuring Volume in cubic feet)

Convert Volume to Gallons

Volume	235.5 ft^3
x conversion constant (7.48 gal/ft^3)	x 7.48 gal/ft^3
Volume (gallons)	1761.54 gallons (Enter 1762 if configuring Volume in gallons)

The display shows VOLUME in the same terms as you have entered. For instance, if you entered "236" in this example, VOLUME would display in cubic feet; if you entered 1762, VOLUME would display in gallons.

G. Adding a RIO to the TCU

The TCU can poll Modbus slave devices, such as the RIO032 and RIO128, and store their data in the TCU's unused modules (referred to as modules H-O in the TCU's configuration screen). This information can then be made available to your telemetry system by adding and configuring the modules in HT3.

More information on the TCU's Modbus capabilities can be found in "Chapter 7: Programming."

Notes:

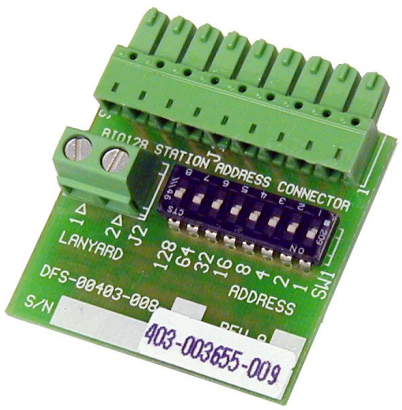
- The instructions below are for the typical application of adding a RIO032 to the TCU. The procedure for adding a RIO128 would be similar except for the additional I/O that must be configured in the TCU and your telemetry system (HT3 or third-party HMI).
- If you are using an HMI other than HT3, you will need to configure that software with the correct Modbus register information in order to poll the TCU as a Modbus slave.
- If the TCU is configured for PCU emulation, it must be changed to the TCU module configuration in order to add a RIO, or any other Modbus slave device.

The steps required to add a RIO to a TCU are:

1. Set RIO's device/station address (typically 1).
2. Configure RIO for Learn mode.
3. Mount RIO and I/O as detailed in the *RIO032 Installation and Operation Manual*.
4. Connect RIO to TCU via RS-485 interface.
5. Place RIO in Learn mode.
6. Configure the TCU to poll the RIO by entering and saving RIO's I/O information in the TCU.
7. Verify communication between TCU and RIO.
8. Add and configure the RIO's I/O in HT4.

RIO Replacement

The RIO032 features a detachable address board used to configure the RIO032's device/station address. The address board's screw-terminal lanyard enables you to tether it to the control panel (for example, to the panel's earth ground). In the event the RIO032 needs to be replaced, the address board can be disconnected from the RIO032 and attached to a new RIO032. This ensures that the device/station address remains with the site; the new RIO032 doesn't have to be addressed.



The device/station address is configured by turning off switch positions that add up to the desired station number. Each bit (pin on the separate address board – P6-1 through P6-8) has a corresponding value (see table below). The RIO032 is set to a specific device/station address by leaving particular pins on the address board's DIP switch ungrounded, or in the Off position.

The device/station address is calculated by totaling the bit values of the pins that are not grounded. The valid device/station address range for the RIO032 is 1-255.

Pin #	Name	Description
P6-1	ADDR0	Station address bit 0 (value=1 bit)
P6-2	ADDR1	Station address bit 1 (value=2 bit)
P6-3	ADDR2	Station address bit 2 (value=4 bit)
P6-4	ADDR3	Station address bit 3 (value=8 bit)
P6-5	ADDR4	Station address bit 4 (value=16 bit)
P6-6	ADDR5	Station address bit 5 (value=32 bit)
P6-7	ADDR6	Station address bit 6 (value=64 bit)
P6-8	ADDR7	Station address bit 7 (value=128 bit)

To give the RIO032 a device address of one (1), leave the bits for the P6-1 pin (bit value=1) ungrounded (in the Off position). Leave the remaining bits grounded (in the ON position).

Configure RIO for Learn Mode

The RIO032 features an auto configuration, or learn, mode that enables it to automatically detect baud rate and protocol parameters and begin communicating using these parameters.

To configure the RIO for Learn mode, place all the BPS and Protocol switches in the Up (Off) position (value = 1 / TRUE). Refer to the illustration below.

Mount RIO and I/O

Refer to the RIO032 Installation and Operation Manual for detailed instructions.

- Chapter 4: Mounting the RIO032
- Chapter 5: Electrical Installation

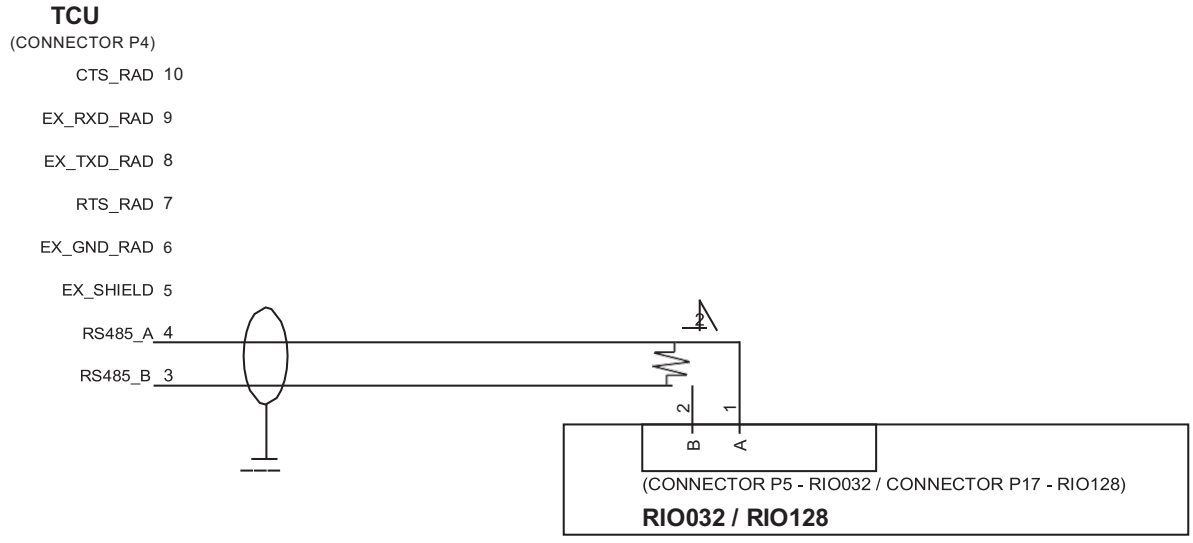
Connect RIO to TCU

The TCU's RS-485 interface is located on the TCU's P4 connector. Pin definitions for the TCU, RIO032, and RIO128 RS-485 interfaces appear below followed by a wiring diagram.

RS-485 Pins

Name	Description	TCU Pin #	RIO032 Pin #	RIO128 Pin #
A	RS-485 serial interface A	P4-4	P5-1	P17-1
B	RS-485 serial interface B	P4-3	P5-2	P17-2
Ground	RS-485 ground (optional; as required)	P4-5	P5-3	P17-3

Wiring



NOTES:

1. The cable shield wire must only be grounded at one end (as close as possible to the selected end).
2. Optional 150-200 ohm resistor designed to eliminate ringing and match impedance on longer cable runs. For short (within the same enclosure) distances, this resistor is not necessary.

Place the RIO in Learn Mode

When all of the RIO's communication configuration switches are left in the Off position (see step 2, Configure RIO for Learn Mode, above) and the RIO's configuration button is held down during power up, the RIO enters learn mode. The RIO then attempts to determine baud and protocol settings within three to ten polling loops (depending on settings such as baud rate).

1. Hold down the configuration button while powering up the device. All of the RIO032's LED's come on.

2. Release the configuration button when the RXD, TXD, and Status LED's go off.

3. The TXD will flash rapidly and then the TXD, RXD, and Status LED's will blink.

4. After a minimum of three polls are received (may take up to ten polls), the RXD will blink three times. The TXD, RXD and Status LED's will turn on and then off indicating that Learn (auto configuration) is complete.

During the Learn process, the RIO032 uses the CTS (clear to send) signal to determine if it is connected to a radio. Radios, unlike other devices, don't activate the CTS signal until an RTS (request to send) is asserted. If the RIO032 determines that is it connected to a radio, it will communicate using the RTU Radio protocol. This protocol is identical to RTU protocol except that the RIO expects a CTS to occur whenever it asserts an RTS, and it will wait for the CTS signal before it transmits any data. This protocol allows the RIO032 to be connected to an RDR (Rail Data Radio) or other manufacturer radio without using special cabling.

Configuring the TCU to Poll the RIO

In order for the TCU to poll the RIO and make the RIO's data available to HT3, the RIO's I/O information must be added to the TCU's configuration.

Modules H-O in the TCU are reserved for Modbus slave devices. Each module can accommodate up to:

- Twelve (12) digital status registers, or
- Eight (8) digital control registers, or
- Four (4) analog status registers, or
- Four (4) analog control registers

The instructions below are for a TCU using the built in pump control application.

1. Page through the TCU's configuration screens until you reach the screen that includes the "Configure Modbus" option. Navigate to the Configure Modbus line and press Enter.

2. The first screen allows you to configure the Module H and Module I registers. Use the right navigation button to page to the screens for the remaining modules (J-O). When configuring for Modbus polling, we recommend that you use the first available TCU module. For example, if modules J-O are available, configure module J; don't skip to M.

3. For each module you want to configure, you must enter an address (ModX Adr) and length (ModX Lth):

- Address is the RIO's device number and the first of the range of registers being added to the current module. For example, ModH Adr would be 1.10001 when adding digital inputs to device 1, module H.
- Length is the number of registers being added to the current module. Length can be 1-12 for digital input (status) registers, 1-8 for digital output (control) registers, and 1-4 for analog registers. For example, ModH Lth would be 8 when adding 8 digital inputs to module H.
- For Analog registers, the Length field requires an additional value that represents resolution (a TCU communicating with a RIO uses a signed 15-bit resolution). For example, ModJ Lth would be 4.15 when adding 4 analog inputs to module J.

The table below provides the information required for a RIO032 using all 32 I/O points.

I/O Type	Module Letter	Module Type	Address (ModX Adr)	Length (ModX Lth)
8 digital inputs	H	DMM	1.10001	8
8 digital outputs	I	DCM	1.00001	8
4 analog inputs	J	AMM	1.30001	4.15
4 analog inputs	K	AMM	1.30005	4.15
4 analog outputs	L	ACM	1.40001	4.15
4 analog outputs	M	ACM	1.40005	4.15

4. After adding all of the required module and register information, navigate through the TCU's configuration screens until you reach the screen that reads Press Enter to Save, Esc to Abort.

Press Enter to replace the TCU's existing configuration with the changes made during the current session. After the settings are successfully save, you must cycle power to the TCU.

IMPORTANT: When the new settings are saved, they are written to a temporary memory location. In order for the TCU to begin running on the new configurations, you must cycle power to the TCU. If the TCU's power is cycled before selecting the Save command, the last saved values are loaded on power up.

Verify Communication Between TCU and RIO

After cycling the TCU's power, observe the TCU and RIO's TX and RX LEDs to verify communications are occurring between the two devices.

Refer to the troubleshooting sections of the TCU and RIO manuals if you encounter communication problems.

Add and Configure the RIO's I/O in HT4 or Third-Party HMI

In your HT3 software, browse to the TCU's configuration. Add and configure the modules and I/O that were added to the TCU's settings in step 3, above. The configuration in HT3 should exactly match the settings entered in the TCU.

For a RIO032 using all 32 I/O points, add the following:

Module Letter	Module Type (Number of I/O Points)
Module H	DMM (8 digital input points)
Module I	DCM (8 digital output points)
Module J	AMM (4 analog input points)
Module K	AMM (4 analog input points)
Module L	ACM (4 analog output points)
Module M	ACM (4 analog output points)

If you are using an HMI other than HT3, you will need to configure that software with the correct Modbus register information for the RIO's additional I/O.

Module Letter	Module Type (Number of I/O Points)	Modbus Registers Used for Polling
Module H	DMM (8 digital input points)	14337 - 14344
Module I	DCM (8 digital output points)	2305 - 2312
Module J	AMM (4 analog input points)	35505 - 35508
Module K	AMM (4 analog input points)	35761 - 35764
Module L	ACM (4 analog output points)	44065 - 44068
Module M	ACM (4 analog output points)	44321 - 44324

H. CT Module

Definitions

• CT = Current Transformer

• Smoothed realtime = measurement which is actually and average of many realtime samples over one second.

Features

• Triplex pump currents can be measured with only one set (of 3) external CTs.

• Flexible configuration options to provide for a variety of use-cases.

• Alarming can be configured on overcurrent, undercurrent, and phase imbalance measurements.

• A new screen displays all three-phase information (voltage and currents).

Supported CT Part Numbers

Model	CT Rating	DFS Part Number
Accu-CT ACTL-0750-020	20 A	008-0076
Accu-CT ACTL-0750-050	50 A	008-0077
Accu-CT ACTL-0750-100	100 A	008-0078

Note: Any CT model can be utilized as long as it abides by the following requirements:

1. The CT **must** have a built-in shunt resistor (the limits of the TCU800 CT inputs are 0.35 VAC).

2. The CT **should** output its maximum current at 333 mVAC (the “CT Rating” configuration parameter is based on the CT current at 333 mVAC, so having a CT output its maximum current at 333 mVAC will make configuration easier).

Installing CTs

- (Caution)

1. CTs will be mounted in a separate panel (where the 3 phase main breaker is located) from the TCU800.

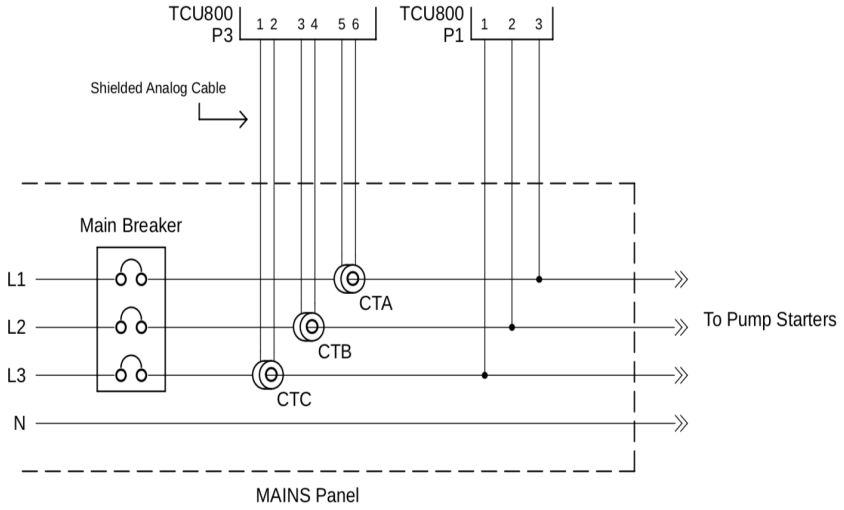
2. CTs will be attached to the lines **after** the main breaker but **before** the individual pump starters.

3. A CT harness kit is available including the CTs and related terminal blocks for easy “snap in” assembly (the CTs are split core so no rewiring is necessary).

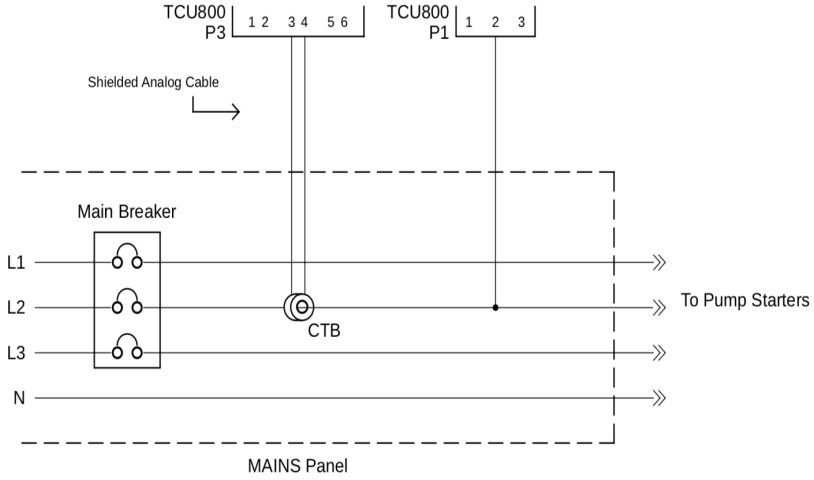
4. CT secondary wirings will travel through shielded cable into the TCU800 enclosure through a separate conduit (the CT signals are very low voltage - they must stay away from high voltage lines).

5. Single phase connections will only use the Phase B CT (P3-3 and P3-4) and Voltage (P1-2) wiring.

6. CT secondary cable must **not** travel in the same conduit as high-voltage cable (such as motor starter outputs).



3-Phase CT Installation



Single Phase CT Installation

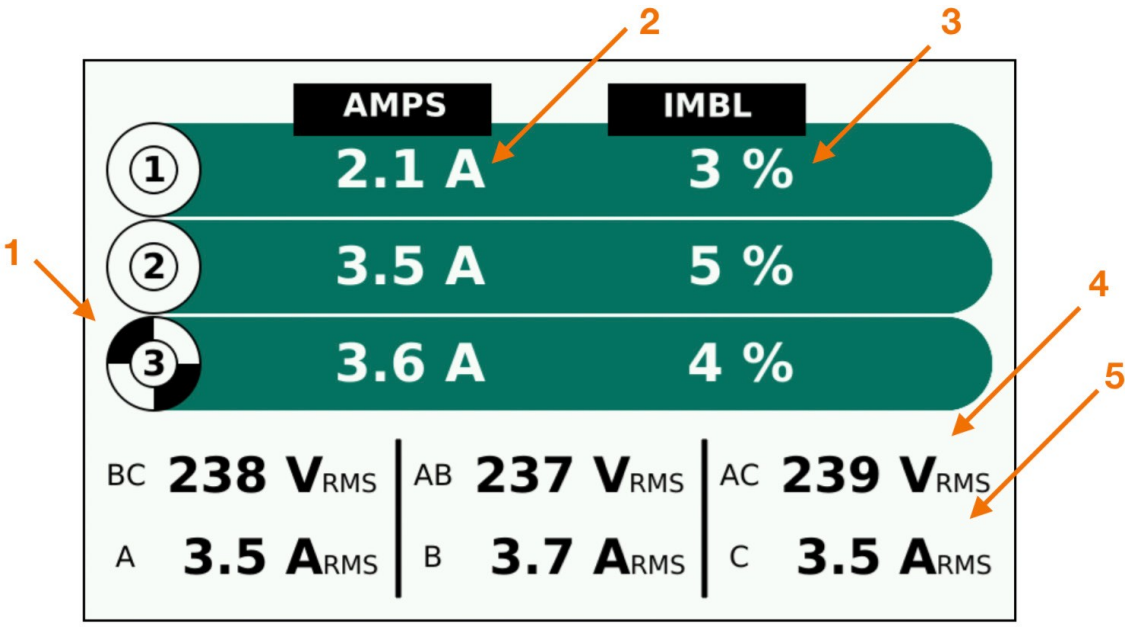
Configuration

All configuration settings are located in the “PMA Settings” of the TCU800’s “Settings” menu. The settings below become available only when the CT Module is enabled.

Configuration	Description	Options	Default
CT Module	Enables or disables the new CT features of the TCU800. This will use the next available module letter.	Enabled/ Disabled	Disabled

CT Function	Motor current mode will derive each pump current as the pump is on as long as the CTs are installed per Figure 1. Direct Input will simply measure the average total current being read from the CTs (i.e. to measure station current). This setting will change how the display screen looks (see "Power View Screen" section) this can be used to determine in which mode the TCU is operating.	Motor Currents Direct Input	Motor Currents
CT Rating	The maximum current the CTs will read when outputting 333 mVAC. If the CTs being used do not output 333mVAC at full scale, they either cannot be used or a calculation must be done to determine what the current would be at 333mVAC. The maximum voltage the TCU CT Inputs can tolerate is 353 mVAC.	5 - 100	100
Full Load Current [1-3]	The average current drawn from pump [1-3] (or the station if in Direct Input mode) while running at full capacity. This setting is used to determine the thresholds for the undercurrent and overcurrent alarms. Alarming can be disabled by setting this to 0.	0 - 100	0
Undercurrent Alarm	The percentage of Full Load Current where an undercurrent alarm is generated. Can be disabled with 0.	0 - 99%	3%
Overcurrent Alarm	The percentage of Full Load Current where an overcurrent alarm is generated.	100 - 200%	110%
Phase Current Alarm	The number of seconds that an Undercurrent or Overcurrent alarm must be active before throwing a Phase Current Alarm. This setting is used to filter nuisance phase alarms in telemetry.	0-999	45

Power View Screen



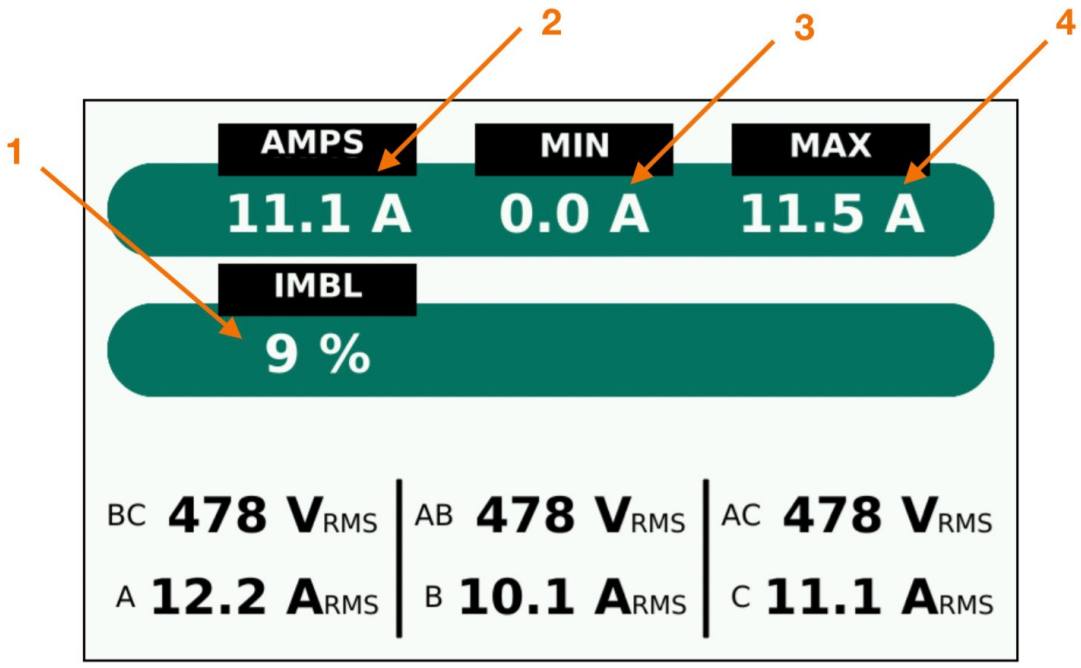
CT Function = Motor Currents

1. Pump Number and Run Indicator
2. Average Current while the pump is RUNNING*
3. Average phase imbalance exhibited while the pump is RUNNING**
4. 3-Phase voltage (smoothed realtime)
5. 3-Phase current (smoothed realtime)

* The average current reflects the average of the most recent 2 minutes of pump runtime. The average current is only measured when all other pumps are off. The average current will continue to display and be reported to telemetry even when the
pump is off.

** The average phase imbalance is calculated using the worst (maximum) phase to phase current imbalance (difference) measured during the most recent 2 minute of pump runtime.

Note: This screen may display less data depending on the configuration of the TCU (i.e. single phase will only show AB voltage and B current).



CT Function = Direct Input

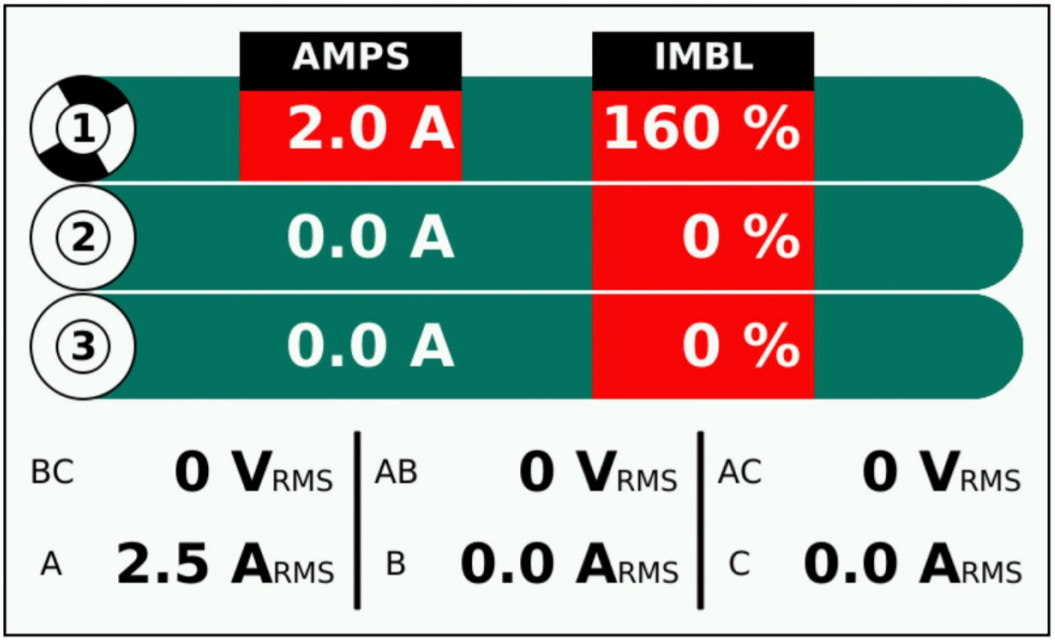
1. 3-Phase current imbalance (smoothed realtime)
2. Average current (smoothed realtime)
3. Minimum current measured in the last 24 hours
4. Maximum current measured in the last 24 hours

Alarms

None of the faults triggered from this module interrupt the pump control operation - they are warnings only (sent via telemetrey) and notice on GUI.

Configuration	Description	Stops Pumps?	Disable
Amp 1 Fault	Triggers when the AMPS reading goes above the overcurrent limit (% of FLC 1) or below the undercurrent limit (% of FLC 1). Also acts as the singular AMPS fault for Direct Input mode.	No	Set FLC 1 = 0
Amp 2 Fault	Triggers when the AMPS reading goes above the overcurrent limit (% of FLC 2) or below the undercurrent limit (% of FLC 2).	No	Set FLC 2 = 0

Amp 3 Fault	Triggers when the AMPS reading goes above the overcurrent limit (% of FLC 3) or below the undercurrent limit (% of FLC 3).	No	Set FLC 2 = 0
Phase Current Fault	Generic fault that indicate other misc. issues with the current module (i.e. Phase Imbalance).	No	Set Imbalance Alarm = 0



Faults will be indicated on the screen in the same way other alarms are (with a notice pop-up) and will highlight the surrounding screen number in flashing red (see above).

I. TCU Transducer Configuration Examples

The examples in this appendix are the most typical applications and can be used as a guide for configuring your system to obtain the pump control and fault mode behavior required.

Note: The examples provided here are for systems in “pump down” mode (used to empty a well as is typical in a lift station).

4-20 mA or 0-5 VDC Transducer with High Float (Pump Down Mode)

This is the most common configuration, combining a 4-20 ma or 0-5 VDC transducers with a high level float in the well to prevent overflow and generate a high well alarm. Fault mode is disabled in this configuration. An optional low level float to prevent pumping the well dry can also be applied.

High float events generate a transducer fault and high well alarm and stagger on all configured pumps. The pumps will remain on as long as the high float condition exists. To prevent short cycling on high float transitions, the pumps adhere to the configured minimum run and minimum off timers. In the example below the pumps will run a minimum of one minute and remain off a minimum of 30 seconds regardless of the frequency of float transitions. Minimum run and off timers apply to all pump operations – not just fault conditions – so these timers should be set considering the pump and well characteristics during normal pump cycles. Conversely, low float events shut off all pumps.

Note: If a high and low float condition exist simultaneously the low float condition takes precedence and no pumps will be started.

Example Configuration

Name	Setting	Description	For more information, see...
Transducer Type	4-20 mA or 0-5 V	Select 4-20 mA or 0-5 V for systems using analog transducers.	page 52
Low Float	Enabled or Disabled	Enable this setting to use a lowlevel float to override normal pump control if a transducer fault occurs.	page 54
High Float	Enabled	Enable this setting to use a highlevel float to override normal pump control if a transducer fault occurs.	page 54
XDCR Fault Mode	Disabled	Disable this setting if there is no backup transducer (Analog 2, Lead/Lag/Lag2 Floats).	page 58
XDCR High Float Fault	Enabled	Enable to generate a transducer fault when a high float condition occurs.	page 54
XDCR Low Level Fault	Enabled	Enable to generate a transducer fault when a low float condition occurs.	page 54

High Float Override	Disabled	Disable for systems not using a float system as the primary or backup method of pump control.	page 54
Minimum Run	1.0	Minimum time pumps should run. Used to prevent short cycling.	page 52
Minimum Off	0.5	Minimum time pumps should remain off. Used to prevent short cycling.	page 52

Response to Fault Conditions (TCU with High Float)

Fault(s)	Alarms	Pump Operation	Behavior
Transducer low condition	• Transducer fault alarm • Low well alarm	All pumps off	Low well and transducer fault alarms are generated. All pumps are turned off. When the transducer level returns to the normal range, the low well alarm clears and normal pump operation resumes. The transducer fault alarm remains active until the TCU has been reset.
Transducer high condition	High well alarm	All pumps on	A high well alarm is generated and all pumps are staggered on. When the transducer level returns to the normal range, the high well alarm clears and normal pump operation resumes.
High float condition	• Transducer fault alarm • High well alarm	All pumps on	High well and transducer fault alarms are generated. All pumps are staggered on. Minimum pump run and off timers are applied. When the High float turns off, the high well alarm clears and normal pump operation resumes. The transducer fault alarm remains active until the TCU has been reset.
Concurrent transducer high and high float conditions	High well alarm	All pumps on	A high well alarm is generated. All pumps are staggered on. A transducer fault alarm is not generated if events occur in the following sequence: Transducer high condition precedes the high float condition; and the high float OFF precedes transducer normal. When the high float condition clears, normal pump operation resumes.
Concurrent transducer low and high float conditions	• Transducer fault alarm • Low well alarm • High well alarm	All pumps on	Low well, high well, and transducer fault alarms are generated. High float condition takes precedence over the transducer low condition and all pumps are staggered on. Minimum run and off timers are applied. Normal pump operation resumes if both conditions clear. The transducer fault alarm remains active until the TCU has been reset.

Low float condition	Low well alarm	All pumps off	A low well alarm is generated. All pumps shut off. When the low float condition clears, normal pump operation resumes. IMPORTANT: Low float condition has precedence over all other faults and alarms, including high float and high level. If a low float condition exists, no pumps are allowed to start.

4-20 mA or 0-5 VDC Transducer with Floats Backup (Pump Down Mode)

This configuration is for a system using 4-20 mA or 0-5 VDC transducers. It uses float inputs to operate the pumps in the event of a transducer fault.

Float Fault Mode requires an OFF float to shut off pumps, and a minimum of one float (Lead to High) to start pumps. Do not configure Float Fault Mode if there is not an OFF and Start float wired!

Float sequence faults are disabled in this mode. Minimal floats can be used to operate the station until the transducer fault has been resolved, but the TCU utilizes all the float inputs the samecf as if configured for Floats. The Off through Lag2 float inputs are ignored when the transducer is not faulted, but these inputs can only be used for the specified floats. The High Float Override can be enabled to allow pumping if the off float fails.

To prevent short cycling on high float transitions, the pumps adhere to the configured minimum run and minimum off timers. In the example below the pumps will run a minimum of one minute and remain off a minimum of 30 seconds regardless of the frequency of float transitions. Minimum run and off timers apply to all pump operations – not just fault conditions – so these timers should be set considering the pump and well characteristics during normal pump cycles.

Notes:

- If a high and a low float condition exist simultaneously, the low float condition takes precedence and no pumps will be started. If the transducer is a bubbler system, an optional Noise Fault configuration can be enabled to sense a bubbler pump failure and generate a transducer fault alarm.
- If a high float condition exists and the Off float is off, no pumps will be started unless the High Float Override option has been enabled.
- Once a transducer fault has occurred the TCU will remain on float control until it has been reset.

TCU Settings (Transducer with Floats Backup)

Name	Setting	Description	For more information, see...
Transducer type	4-20 mA or 0-5 Volts	Select 4-20 mA or 0-5 Volts for systems using analog transducers.	page 52
Low Float	Enabled or Disabled	Enable this setting to use a low level float to override normal pump control if a transducer fault occurs.	page 54

High Float	Enabled	Enable this setting to use a high level float to override normal pump control if a transducer fault occurs.	page 54
Fault Mode	Floats	Select Floats to have the TCU switch to float control when a transducer fault occurs.	page 58
Transducer High Float Fault	Enabled	Enable to generate a transducer fault when a high float condition occurs.	page 54
Transducer Low Level Fault	Enabled	Enable to generate a transducer fault when a low float condition occurs.	page 54
Bubbler Noise Fault	Enabled or Disabled	Enable only if the system is a bubbler system and you want to generate a transducer fault when the TCU doesn't detect air-pump induced noise.	page 54
High Float Override	Enabled or Disabled	Enable this setting to give the High float precedence in the event of an Off float failure when the TCU is in Floats fault mode.	page 54
Minimum Run	1.0	Minimum time pumps should run. Used to prevent short cycling.	page 52
Minimum Off	0.5	Minimum time pumps should remain off. Used to prevent short cycling.	page 52

Response to Fault Conditions (Transducer with Floats Backup)

Fault(s)	Alarms	Pump Operation	Behavior
Transducer low condition	• Transducer fault alarm • Low well alarm	All pumps off	Control switches to float inputs. Low well and transducer fault alarms are generated. If float inputs agree, all pumps are turned off. The low well alarm clears if the transducer returns to normal range. However, the transducer fault alarm remains active and control remains with floats until the TCU has been reset.
Concurrent off float and lead float conditions	Transducer fault	Normal pump operation	Example of normal operation under floats control, regardless of which event triggered the transducer fault.
Concurrent transducer low, off float, and high float conditions	• Transducer fault alarm • Low well alarm • High well alarm	All pumps on	Control switches to float inputs. Low well, high well, and transducer fault alarms are generated. All pumps are staggered on. Low and high well alarms clear if the transducer and the High float return to normal. However, the transducer fault alarm remains active and control remains with floats until the TCU has been reset.

Transducer high condition	High well alarm	All pumps on	Control remains with the transducer. All pumps are staggered on. A transducer fault is not generated unless the analog input reaches maximum (20 mA or 5 VDC). When the high transducer condition clears, the high well alarm clears and normal pump operation resumes.
Concurrent transducer high and high float conditions	High well alarm	All pumps on	Control remains with transducer. A high well alarm is generated. All pumps are staggered on. A transducer fault is not generated if events occur in the following sequence: transducer high condition precedes high float condition; and High float clears prior to tranducer returning to normal range. When high conditions clear, normal pump operation resumes.
High float condition and Off float is off (with high float override option disabled)	• Transducer fault alarm • High well alarm	All pumps on/off	Control switches to float inputs. High well and transducer fault alarms are generated. All pumps are staggered on and then shut off after minimum pump run time, even if the High float remains on. High float transitions do not restart pumps. If Off/Lead float activity does not occur, the TCU will not start the pumps until a reset clears the transducer fault.
High float condition and Off float is off (with high float override option disabled)	• Transducer fault alarm • High well alarm	All pumps on	Control switches to float inputs. High well and transducer fault alarms are generated. All pumps are staggered on and remain on if the High float remains true. High float transitions re-start pumps and minimum pump run and off timers are applied. The high well alarm clears if the High float turns off. However, the transducer fault alarm remains active and control remains on floats until the TCU has been reset.
Low float condition (with low float option enabled)	• Transducer fault alarm • Low well alarm	All pumps off	Control switches to float inputs. Transducer fault and low well alarms are generated. The Low float takes precedence, and all pumps are turned off. Pumps remain off while the Low float is off. If Off/Lead float activity does not occur, the TCU will not start the pumps until a reset clears the transducer fault.
Concurrent transducer high and low float conditions (with low float option enabled)	• Transducer fault alarm • Low well alarm • High well alarm	All pumps off	Control switches to float inputs. Transducer fault, low well, and high well alarms are generated. The Low float takes precedence, and all pumps are turned off. Pumps remain off while the Low float is off. If Off/Lead float activity does not occur, the TCU will not start the pumps until a reset clears the transducer fault.

Concurrent low float and high float conditions (with low float option and enabled and high float override option disabled)	• Transducer fault alarm • Low well alarm • High well alarm	All pumps off	Control switches to float inputs. High well, low well, and transducer fault alarms are generated. The Low float takes precedence, and all pumps are turned off. If the low float condition clears, but the high float condition remains, the pumps are not started. If Off/Lead float activity does not occur, the TCU will not start the pumps until a reset clears the transducer fault.
Concurrent low float and high float conditions (with low float option and high float override options enabled)	• Transducer fault alarm • Low well alarm • High well alarm	All pumps off	Control switches to float inputs. High well, low well, and transducer fault alarms are generated. The Low float takes precedence, and all pumps are turned off. If the low float condition clears, but the high float condition remains, the pumps are not started. If Off/Lead float activity does not occur, the TCU will not start the pumps until a reset clears the transducer fault.

4-20 mA or 0-5 VDC Transducer with Analog Input 2 as Backup (Pump Down Mode)

This configuration applies to 4-20 mA or 0-5 VDC transducers. It uses the TCU's second analog input to operate the pumps in the event of a transducer fault. The second analog input can be wired to any analog level transducer, including a redundant bubbler system, but the signal must be 4-20 mA. Optional High and Low level floats can be used for alarm and limited backup control to prevent overflow in the event of both transducers failing.

Notes:

- The TCU will locally alarm the second analog input if the input is not within operational 4-20 mA range. There is not a separate "Analog Input 2 Fault" I/O point for telemetry as of this code revision. It is recommended that the second analog input be configured in telemetry to alarm on Low and High thresholds when configured as the backup transducer.
- Once a transducer fault has occurred, the TCU will remain on second analog input control until it has been reset.

Response to Fault Conditions (Transducer with Floats Backup)

Name	Setting	Description	For more information, see...
Transducer type	4-20 mA or 0-5 Volts	Select 4-20 mA or 0-5 Volts for systems using analog transducers.	page 52
Low Float	Enabled or Disabled	Enable this setting to use a lowlevel float to override normal pump control if a transducer fault occurs.	page 54
High Float	Enabled or Disabled	Enable this setting to use a highlevel float to override normal pump control if a transducer fault occurs.	page 54
Fault Mode	Analog2	Select Analog2 to have the TCU switch to the second analog input for pump control when a transducer fault occurs.	page 58

Transducer High Float Fault	Enabled	Enable to generate a transducer fault when a high float condition occurs.	page 54
Transducer Low Level Fault	Enabled	Enable to generate a transducer fault when a low float condition occurs.	page 54
Bubbler Noise Fault	Enabled or Disabled	Enable only if the system is a bubbler system and you want to generate a transducer fault when the TCU doesn't detect air-pump induced noise.	page 52
High Float Override	Enabled or Disabled	Enable this setting to give the High float precedence in the event of an Off float failure when the TCU is in Floats fault mode.	page 54
Minimum Run	1.0	Minimum time pumps should run. Used to prevent short cycling.	page 52
Minimum Off	0.5	Minimum time pumps should remain off. Used to prevent short cycling.	page 52

Response to Fault Conditions (Transducer with Floats Backup)

Fault(s)	Alarms	Pump Operation	Behavior
Transducer Low Condition		Normal pump operation	Low well alarm and transducer fault alarms are generated. Control switched to second transducer. When the transducer level returns to normal range, the Low well alarm clears and normal pump operation resumes. Transducer fault alarm remains active and control remains on second transducer until the TCU has been reset.
Transducer High Condition		All pumps on	A high well alarm is generated, and all pumps are staggered on. When the transducer level returns to normal range, the High well alarm clears and normal pump operation resumes.
Transducer noise fault	Transducer fault	Normal pump operation	A transducer fault is generated, and the TCU switches pump control to the second analog input. Pumps operate normally under this condition. The transducer fault alarm remains active until the TCU has been reset.
High float condition	• Transducer fault alarm • High well alarm	All pumps on	High and transducer fault alarms are generated. All pumps are staggered on. The TCU switches pump control to the second analog input. Minimum pump run and off timers are applied. When the high float turns off, the high well alarm clears and normal pump operation resumes. The transducer fault alarm remains active and control remains with the second analog input until the TCU has been reset.

Concurrent transducer high and high float conditions	High well alarm	All pumps on	A high well alarm is generated, and all pumps are staggered on. A transducer fault is not generated if events occur in the following sequence: transducer high condition procedes high float coming on; and high float going off precedes transducer returning to normal level. When all high conditions clear, normal pump operation resumes.
Concurrent transducer low and high float conditions	• Transducer fault alarm • Low well alarm • High well alarm	All pumps on	Low, high, and transducer fault alarms are generated. The TCU switches pump control to the second analog input. The high float on condition takes precedence over the transducer low condition, and all pumps are staggered on. Minimum pump run and off timers are applied. Normal pump operation resumes on the second analog input if both conditions clear. The transducer fault alarm remains active and pump control remains with second analog input until the TCU has been reset.
Low float conditions	Low well alarm	All pumps off	A low well alarm is generated, and all pumps are shut off. When the low float condition clears, normal pump operation resumes. **IMPORTANT:** A low float condition has precedence over *all* other faults and alarms, including high float and high level. If a low float condition exists, no pumps will be allowed to start.

Discrete System (Pump Down Mode)

A discrete system uses contact closure devices that provide an On/Off signal. These are typically float balls submersed into a wet well. The floats are wired to the appropriate inputs on the TCU. The TCU then controls the operation of up to three pumps based on input signals from these floats.

The number of floats required depends on the number of pumps at a station.

- A simplex station (one pump) requires floats at the Lead and Off staging levels.
- A duplex station (two pumps) requires floats at the Lead, Off, and Lag staging levels.
- A triplex station (three pumps) requires floats at the Lead, Off, Lag, and Lag2 staging levels.

A discrete system requires that all float devices be wired to the appropriate TCU inputs, and the transducer type in the TCU's configuration be set to Floats.

In addition to the floats described above, a discrete system has the option of using a Low float and a High float as a backup

and alarm system. The behavior of the pumps depends on the pumping mode - pump down mode (used to empty a well) or pump up mode (used to fill a tank).

To use High and/or Low floats as a backup and alarm system, the floats must be wired to the corresponding input on the TCU and the Low Float and/or High Float option must be enabled in the TCU.

To prevent the pumps from short cycling on a High float condition, minimum run and off times can be configured for the pumps. The same pump timer rules apply to the Low float. In the event of a High and Low float condition at the same time, the high float condition takes precedence and pumps will continue to run until the high float condition clears.

TCU Settings (Discrete System)

Name	Setting	Description	For more information, see...
Transducer Type	Floats	Select floats for a discrete system.	page 52
Number of Pumps	1, 2, or 3	Select the number of pumps at the station.	page 52
Low Float	Enabled or Disabled	Enable this setting to use a low level float to override normal pump control if a transducer fault occurs.	page 54
High Float	Enabled or Disabled	Enable this setting to use a high level float to override normal pump control if a transducer fault occurs.	page 54
High Float Override	Enabled or Disabled	Enable this setting to give the High float precedence in the event of an Off float failure when the TCU is in Floats fault mode.	page 54
Minimum Run	1.0	Minimum time pumps should run. Used to prevent short cycling.	page 52
Minimum Off	0.5	Minimum time pumps should remain off. Used to prevent short cycling.	page 52

Response to Fault Conditions (Discrete System)

Fault(s)	Alarms	Pump Operation	Behavior
High float condition	High well alarm	All pumps on	A high well alarm is generated. All pumps are staggered on. When the high float turns off, the high well alarm clears and normal pump operation resumes.

Low float condition	Low well alarm	All pumps off	A low well alarm is generated, and all pumps are shut off. When the low float condition clears, normal pump operation resumes. **IMPORTANT:** A low float condition has precedence over all other faults and alarms, including high float and high level. If a low float condition exists, no pumps will be allowed to start.
Concurrent high float and low float conditions	High well alarm Low well alarm	All pumps on	High well and low well alarms are generated. The high float condition takes precedence, and the pumps will continue to run until the high float condition clears.

J. VFD Operation

The VFD-TCU800 is a configurable option that provides automated control of up to three Variable Frequency Drive (VFD) pumps. It is **not** designed to control VFD pumps directly but to communicate with a third-party VFD controller.

When the TCU800 unit is configured for VFD control, internal modifications are made to the pump control logic to allow the unit to send and receive pump speed controls to an external interface module or an extension card. An external interface module or extension card is required for VFD control to be activated.

Differences from a VFD-TCU001

1. All-new display that shows:
    - Pump status (speeds in Hz or %)
    - External MODBUS speeds can now be monitored.
2. The extra pump alternation methods (**Pump 3 Lag**, **Lag2 Standby**, and **Lead Pump**) are now available for both VFD and Standard TCU800s. These options are found in the *Alternation* settings menu.
3. The VFD mode in the TCU800 is now **software configurable** and no longer requires specific factory programming. This enables customers to keep any TCU800 as a spare for both VFD and standard sites. The configured mode *should* be selected before installing on the panel. The operation mode will save through power cycles and can be backed up onto a Configuration USB.
    - **Caution: Factory Reset will remove VFD mode update to TCU if downloaded.**

VFD-TCU800 RTU

- All standard pump functions are available in VFD mode **except float mode**. It is recommended to set floats as **auxiliary digital inputs** to bypass the pump run detection system.

Process Control

The VFD-TCU800 has two modes of process control: **Fixed Set Point** and **Variable Level Control**. In the VFD configuration menu, select *Process Control* to set the mode.

In both modes, pumps are staged **ON** via the well level measurement on the ANALOG1+ (C1) input reaching either of the **ON** setpoints (***LeadOn***, ***LagOn***, ***Lag2On***).

Fixed Set Point Controller

The fixed set point controller matches the **Process control Variable** (*PV*) to the **Process Set Point** (*Proc Setpt*). This allows the VFD-TCU800 configuration to either maintain a fixed well level or flow rate based on the ***PID PV*** configuration.

If the VFD-TCU800 is expected to maintain a fixed well level:

1. The ***PID PV*** configuration must be set to **Analog1**.
2. The ***Proc Setpt*** should be configured to indicate the target well level (in ft).

If the VFD-TCU800 is expected to maintain a fixed flow rate:

1. The ***PID PV*** configuration must be set to **Analog2**.
2. The ***Proc Setpt*** should be configured to indicate the target flow rate (in GPM).
    a. The **Analog1** signal is still used to monitor the well level, which is required to stage the pumps on or off.

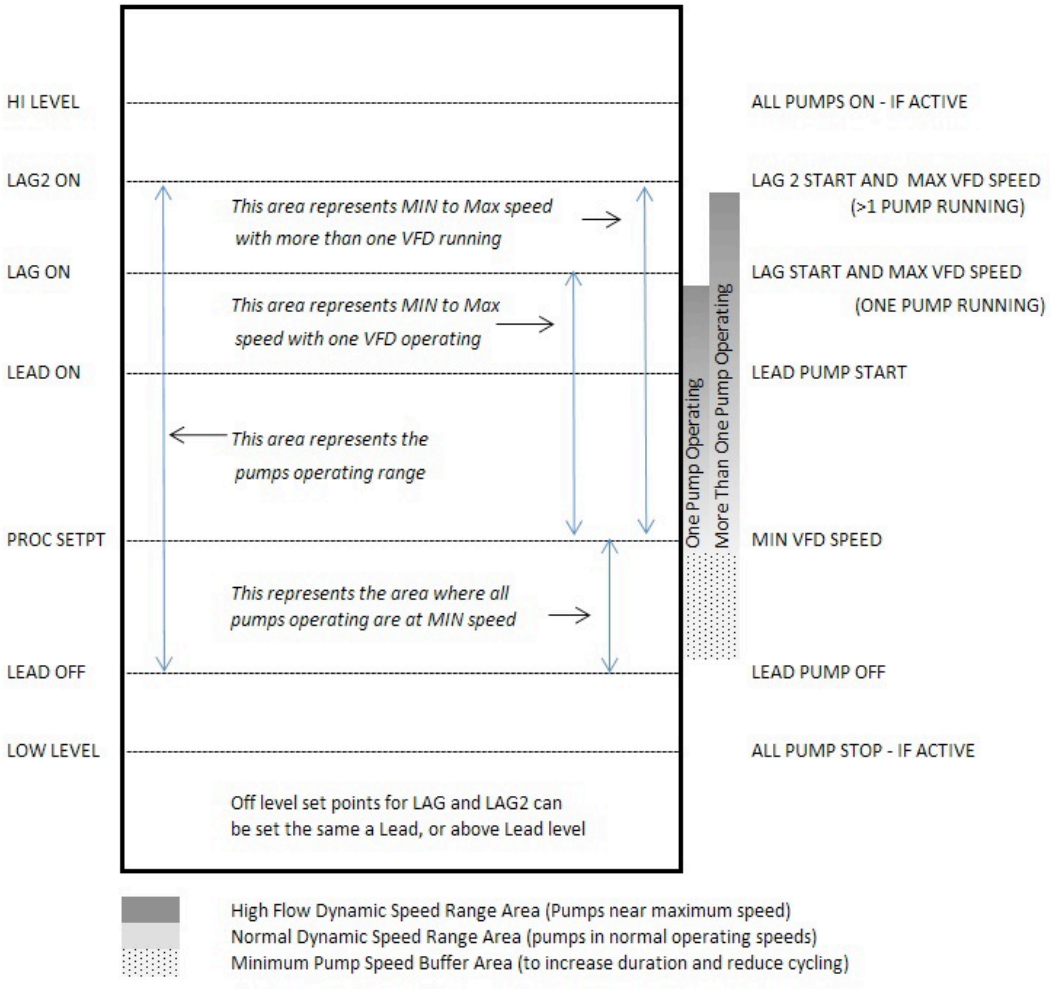
The VFD-TCU800 uses a tunable PID algorithm to vary the VFD pump speed between the *Min Speed* and *Max Speed* configurations. By adjusting the *P Gain*, *I Gain*, and *D Gain* configuration parameters These values are measured in (%) of maximum speed which is determined by the third-party VFD drive controller.

Variable Level Controller

The VFD-TCU800's variable level mode allows the well level to travel up and down between two configurable set points with the speed of the pumps being directly proportional to the well level.

The ***Proc Setpt*** is used to denote the well level at which the pumps must operate at their minimum speed (as set by the *Min Speed* configuration). If only the lead pump is running, the ***LagOn*** **Pt** level is used as the level threshold for maximum speed (as set by the *Max Speed* configuration). Once the lag pump is called, the threshold for maximum speed is **increased** to use the ***Lag2On*** **Pt** level instead. The lead pump will reduce its current speed and both pumps will operate using ***Lag2On*** **Pt** level as the threshold for maximum speed.

The opposite applies when staging the pumps off. When the threshold for maximum speed is **decreased** back to the ***LagOn*** **Pt** level, the lead pump will increase its current speed.



Variable Level Operations Diagram

As the wet well level reaches the ***LeadOn* Pt**, the first pump will start. The VFD pump's start speed is determined by the level of the ***Proc Setpt*** and the ***LagOn* Pt**. The closer the ***LeadOn* Pt** is to the ***LagOn* Pt**, the closer the VFD's start speed is to the maximum speed (*Max Speed*). Likewise, the closer the ***LeadOn* Pt** is set to the ***Proc Setpt***, the closer the VFD's start speed is to the minimum speed (*Min Speed*).

With this control arrangement, the system can use more of the wet well area to modulate the VFD speeds and reduce system surges. Smaller pumps or a lower *Min Speed* setpoint may need to be considered to limit pump starts and increase the duration of pump operation cycles.

During periods of low flow, pump starts or short cycles can be minimized. The **Variable Level Process** was implemented to permit the pumps to operate at minimum speed. This area, which is controlled by the distance between the ***LeadOff*** and ***Proc Setpt***, can be used as a buffer to prevent pump cycling and increase run durations when moving into periods of low and very low flows.

VFD Speed Control

The VFD-TCU800 has two configurations that determine the range of speeds of the VFD drive controller: *Min Speed* and *Max Speed*. These settings control the percentage of full-scale output that the VFD-TCU800 sends to the external MODBUS device.

When pumps are called, the speed of each will gradually increase from 0% to their intended speed in increments based on the *Pump (1-3) Acceleration* configurations. This gradual ramping will apply to pumps called both in automated (AUTO) or manual (HAND) control.

When pumps are being automated (HOA switches are in AUTO), all pumps will operate at the same speed once ramping is complete. There are two events which can cause the pumps to adjust their speed during runtime outside of normal pump staging:

1. If the VFD-TCU800's HOA selector switch for *any* pump is placed in **HAND**, *all* pumps will operate at the speed set for the *Override Speed* setting.
2. If the *Pump 3 Lag* setting is enabled, pump 3 will **always** ramp up to the speed set for the *Override Speed*.
3. If the High Float is tipped, all pumps will turn on at override speed setting.
4. If the Low Float is untipped, all pumps will turn off with no ramp.

Pump Staging Control

The VFD-TCU800 has two modes of pump staging controls: *Level* and *Speed*. This mode is configured via the *Pumps Off* setting in the VFD configuration menu. The table below describes the specific functions of each option.

Level	Pumps are staged using the **ON** and **OFF** set points that correspond to the **Lead**, **Lag**, and **Lag2** levels of the **ANALOG+ (C1)** input. This is the default and most common staging process.
Speed	Pumps are staged **ON** using the ***LeadOn***, ***LagOn***, and ***Lag2On*** setpoints in the same way as Level mode. Pumps will be staged **OFF** when the controlled speed is at or below the *Speed Set Point* configuration as long as both of the following conditions are met: • The well level is *not* above the **ON** setpoint. • The *Minimum Run Time* for that pump has completed. The *Minimum Run Time* is configured in the TCU800's **Main settings** menu. Each pump maintains its own separate timer so that the starting and stopping of other pumps has no effect on a pump's run time measurement.

Disabled Backup Mode

The **Disabled Backup Mode** is the default setting of the *XDCR Fault Mode* in the *Transducer configuration menu*.

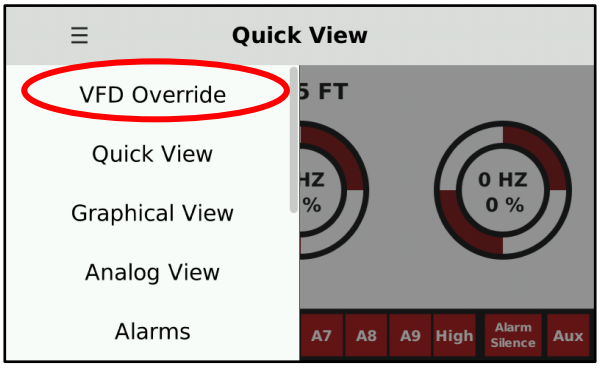
High Float Enabled*	Calls **all** pumps at the speed set in the *Override Speed* setting.
Low Float Disabled*	Pumps are run until the High Float is no longer actuated.
Low Float Enabled*	Stages all pumps **off**.

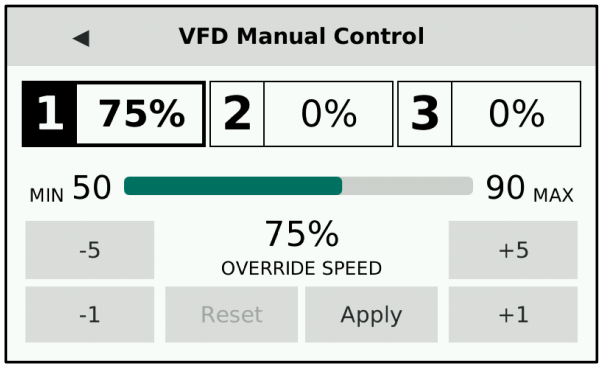
* Details of these settings can be found in the **Floats** section of the "Chapter 6: Operating Procedures"

Manual VFD Control

When the VFD-TCU800's HOA selector switch is placed in the HAND position (or overridden via telemetry when the selector switch is in the AUTO position), the pump runs at the *Override Speed* set in the VFD configuration menu. All other pumps running in AUTO will match this speed.

The manual speed can be adjusted by using the *VFD Override* screen (top left of navigation bar).



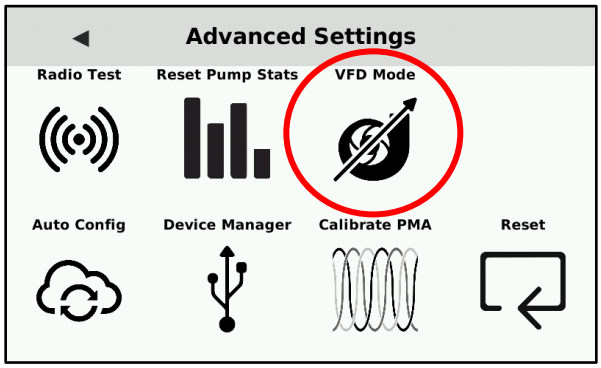


You can increase or decrease the *Override Speed* of the pumps by selecting the ***+5, +1, -1 or -5*** buttons. Changes will not take effect until you tap *Apply*. Tap *Reset* to return to the previously stored *Override Speed*.

Backing out of this screen (arrow in the top left corner) will prompt you to save the new speed if you've changed it. If you chose to save it, this will overwrite the *Override Speed* setting with the new value you've applied. If you choose not to save, it will only be applied until a process restart

Configuring the TCU800 for VFD Operation

The VFD Mode of any TCU800 can be enabled or disabled in the *Advanced* settings menu. This setting will persist through reboots and power-cycles, and is also backed up on the Configuration USB. When enabling VFD Mode, you will be prompted to select the external interface module connected to the TCU800. Selecting an option will automatically pre-populate the TCU800 with the settings required to communicate with the external interface module.



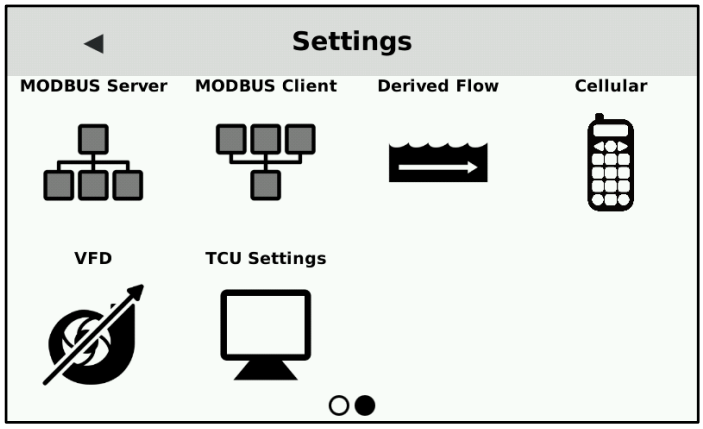
Because the VFD-TCU800 now has a software configurable VFD mode, it is IMPERATIVE that the user ensures this mode matches the corresponding field installation of the panel.

IF THE UNIT IS WIRED FOR A VFD PANEL BUT IS NOT PLACED IN VFD MODE, YOUR PUMPS WILL NOT BE CALLED.

Performing a factory reset on a TCU800 will revert the unit back to standard operation.

IF YOU PERFORM A FACTORY RESET ON A VFD TCU800, YOU MUST RE-ENABLE VFD MODE BEFORE RESUMING NORMAL OPERATION.

When VFD mode is enabled, the configuration settings can be accessed on the second page of the *Settings* screen.



VFD Settings

◄ VFD Settings	
Process Control	Variable Level
Process Set Point	5 ft
Min Speed	50 %
Max Speed	90 %
Override Speed	75 %

These settings become available once the TCU800 has been configured to enable VFD Mode via the Advanced settings menu. They control various aspects of the automation process when controlling variable frequency drive pumps.

Process Control	Selects the VFD process control algorithm to either Variable Level or Fixed Set Point. These modes are described in detail in the "Process Control" section of the "VFD Operation" chapter.
Process Set Point	Sets the target level for the algorithm when running as a Fixed Set Point controller. Sets the level to at which pumps at *Min Speed* for a Variable Level controller.
Min Speed	Sets the minimum speed signal that can be sent to any pump (0-100% of full-scale signal output)
Max Speed	Sets the maximum speed signal that can be sent to any pump (0-100% of full-scale signal output)
Override Speed	Sets the speed used when pumps are manually actuated (HOA in HAND or via telemetry) or in special circumstances that call for it, such as Pump 3 Lag.
Pumps Off	Sets if the pumps are staged off based on the transducer level or pump speed feedback. This setting applies to both Variable Level and Fixed Set Point controller modes.
Speed Set Point	Sets the speed threshold that pumps will stage off when *Pumps Off* is set to *Speed*. This setting has no effect if *Pumps Off* is set to *Level*.
PID PV Signal	For Fixed Set Point control, sets the input signal that the PID loop will use match the Process Set Point. Options are Analog1 (default) and Analog2 (Aux). When this is set to Analog2, the algorithm will still use Analog1 to stage the pumps on and off.
P Gain	Sets the reaction of the proportional part of the PID algorithm. (0-999)
I Gain	Sets the reaction of the integral part of the PID algorithm. (0-999)
D Gain	Sets the reaction of the derivative part of the PID algorithm. (0-999)

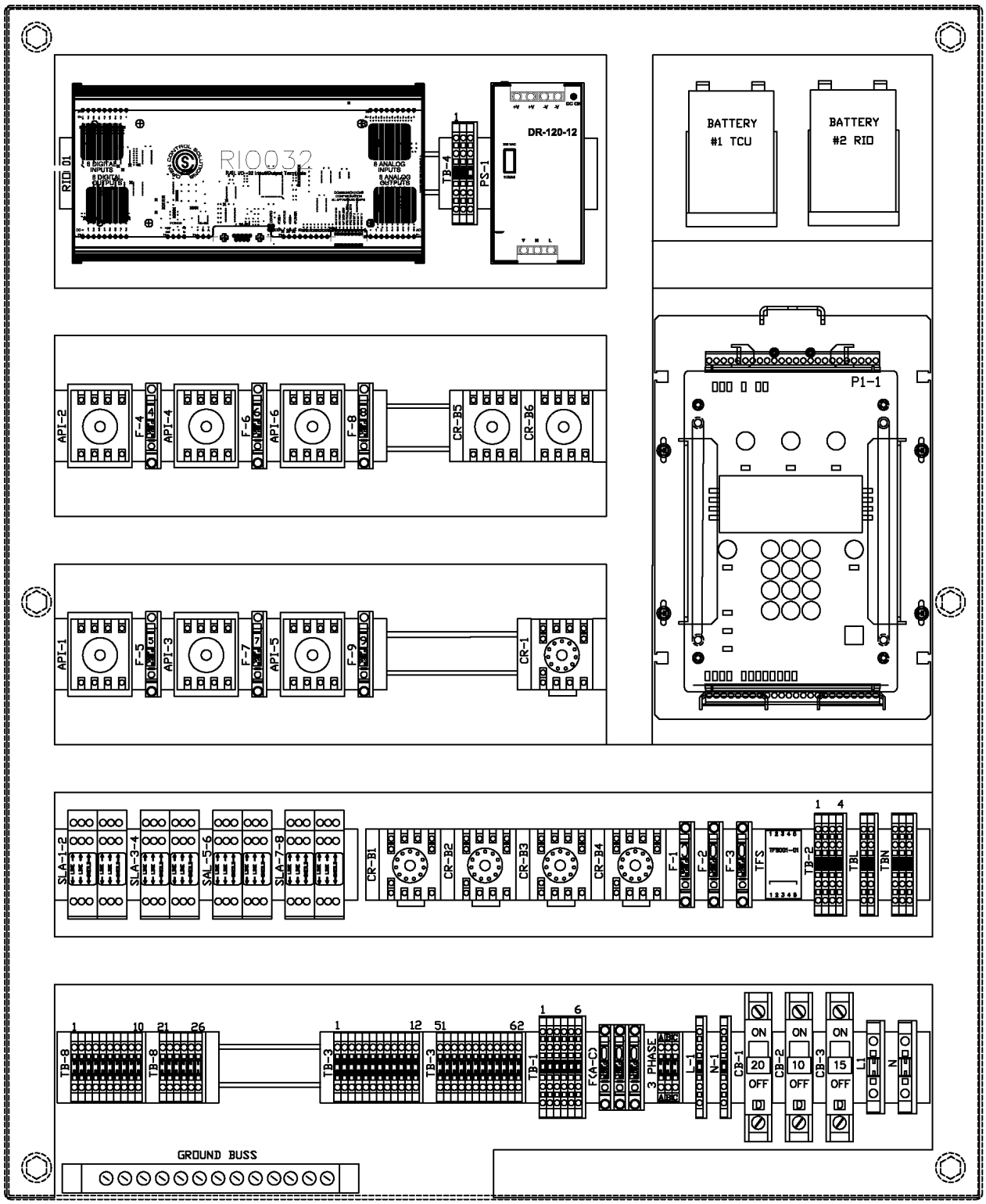
Direction	Determines how the PID will operate relative to the PV. When set to *Direct*, pump speed will **increase** as the PV **increases**. When set to *Indirect*, pump speed will **decrease** and PV **increases**.
Pump Acceleration	Determines how quickly to increase **pump** speed per 5-second interval for all pumps. (1-100% increase per 5-seconds)
Pump Speed Display	Determines if the Quick View Screen displays the control signals (Control) or the feedback signals (Feedback). By default, the unit is set to **Control**

Additional Notes & Limitations

- When VFD mode is enabled, the MODBUS modules H through K are reserved and automatically set for proper operation with a DFS controller. This can be observed by navigating to the MODBUS Server menu in the *Settings* menu and scrolling down to view the MODBUS address reservations noted by a **VFD** designation.
- For a MODBUS-compatible external interface module, the H to K modules are preset for DFS controller integration. Check the MODBUS Server under Settings to see VFD-designated MODBUS address reservations.
- The *Override Speed* setting can be configured outside the *Min Speed* and *Max Speed* settings.
- The automation logic will still not exceed these limits when controlling pump speeds.
- Due to the nature of the TCU800's processor architecture, the PID algorithm for the Fixed Set Point Controller may not function suitably for applications requiring extremely tight feedback loops. It is recommended to evaluate the TCU800 in a realistic test environment before deploying it as a Fixed Set Point Controller.

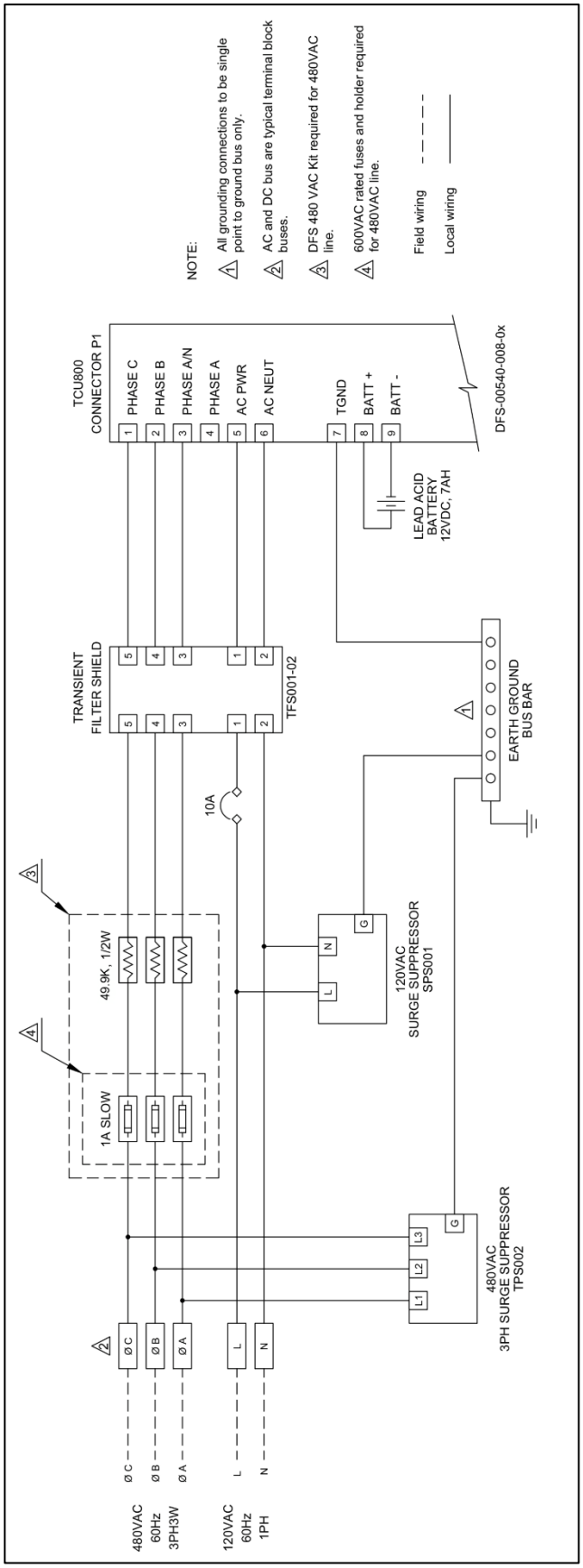
Wiring

Control Panel Overview for VFD Operation

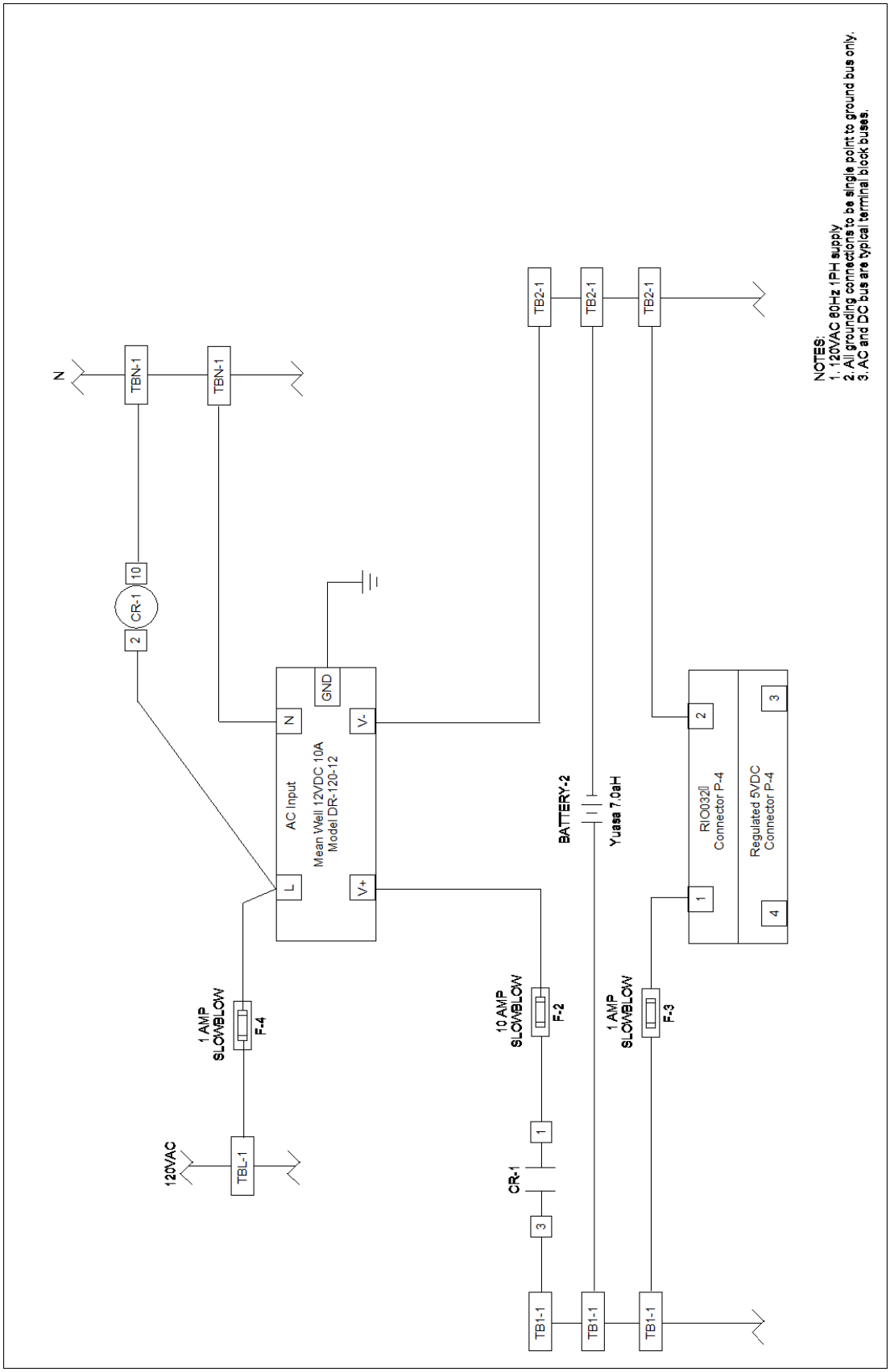


PANEL IS FOR 36X30 ENCLOSURE

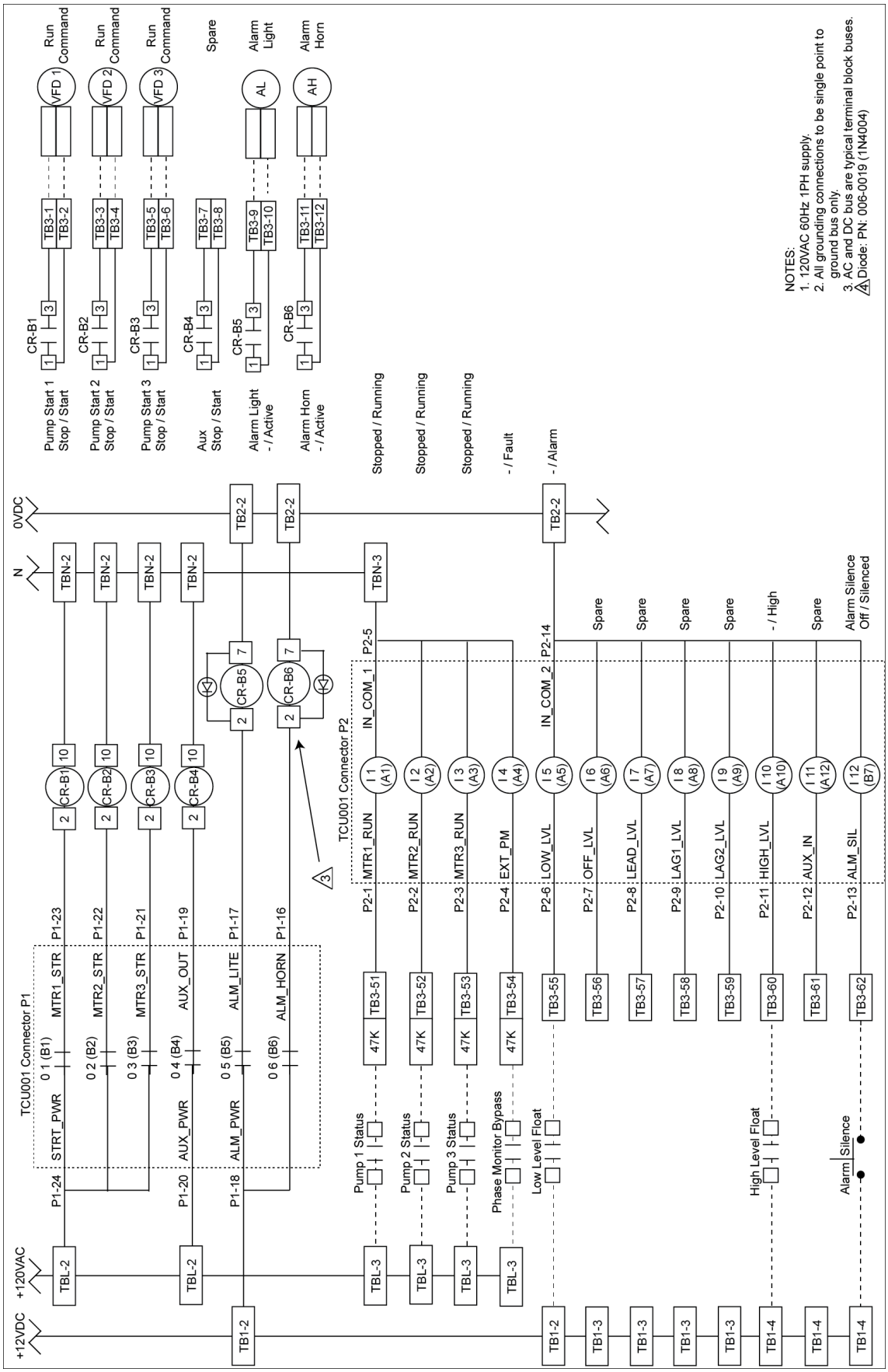
Powering the TCU800 with a typical 480V, 3-Wire Transformer



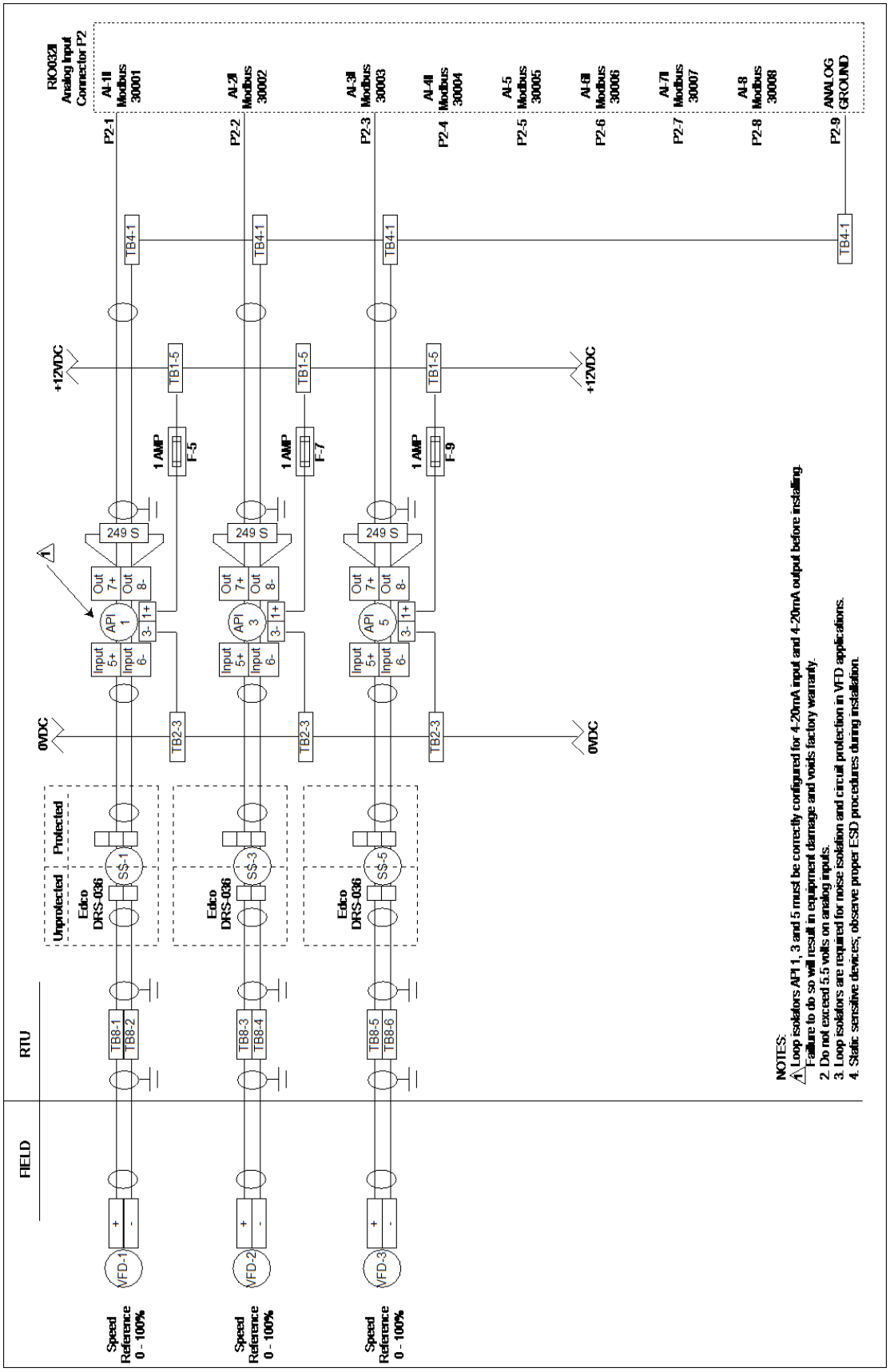
DC Power Wiring for VFD Operation



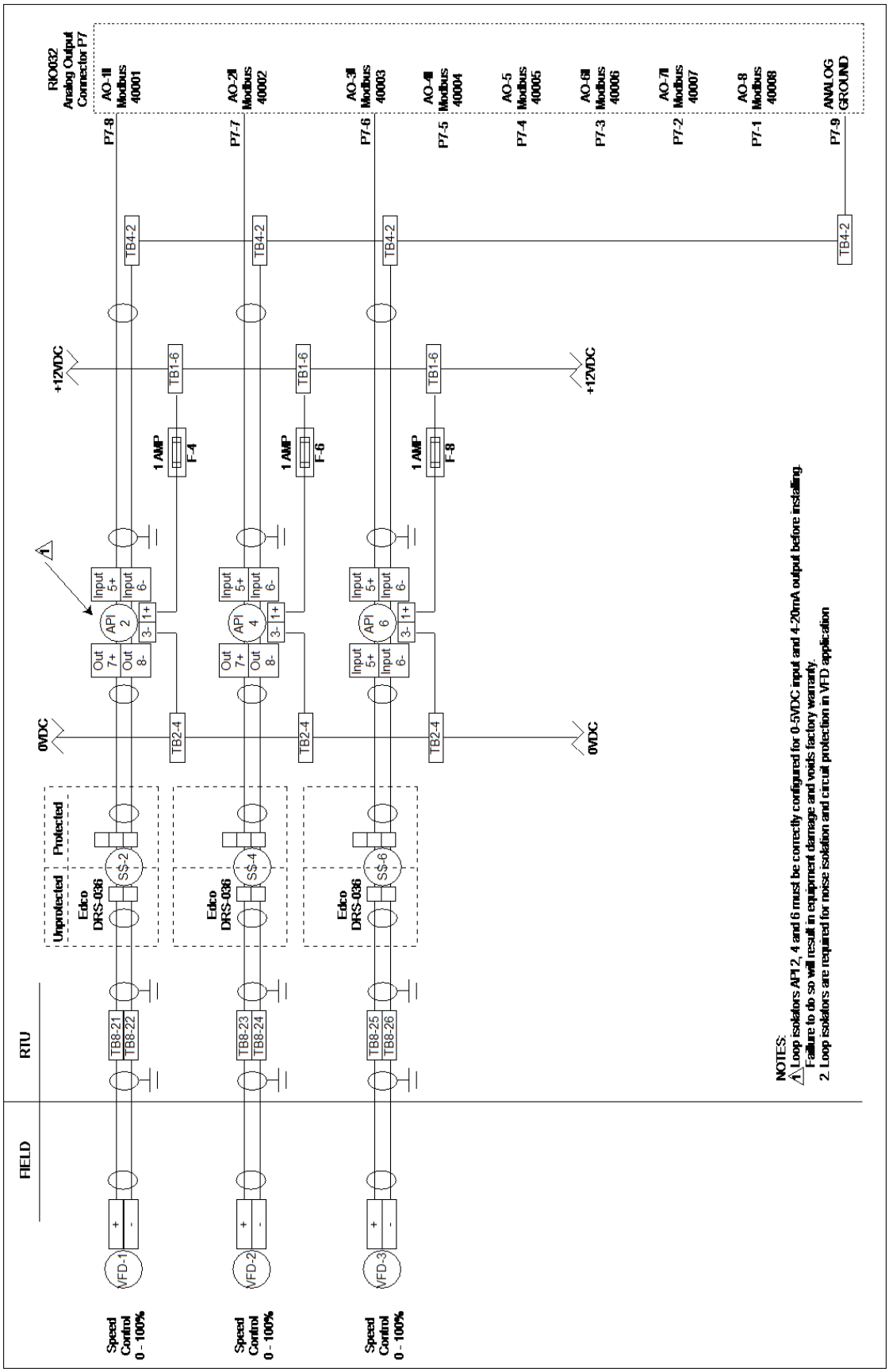
TCU800 Digital Output (DO) / Digital Input (DI) Wiring for VFD Operation



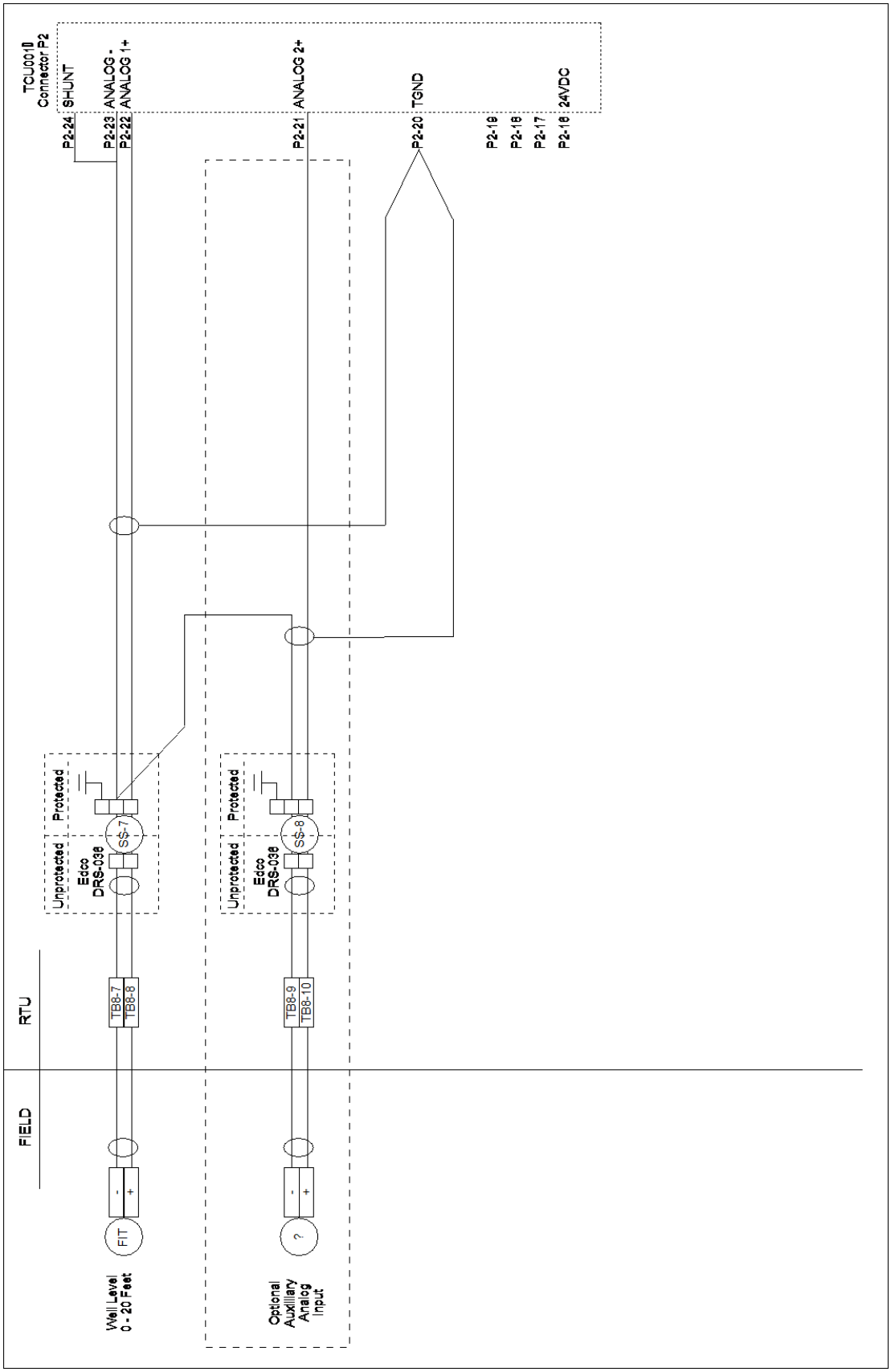
RIO32 Analog Input (AI) Wiring for VFD Operation



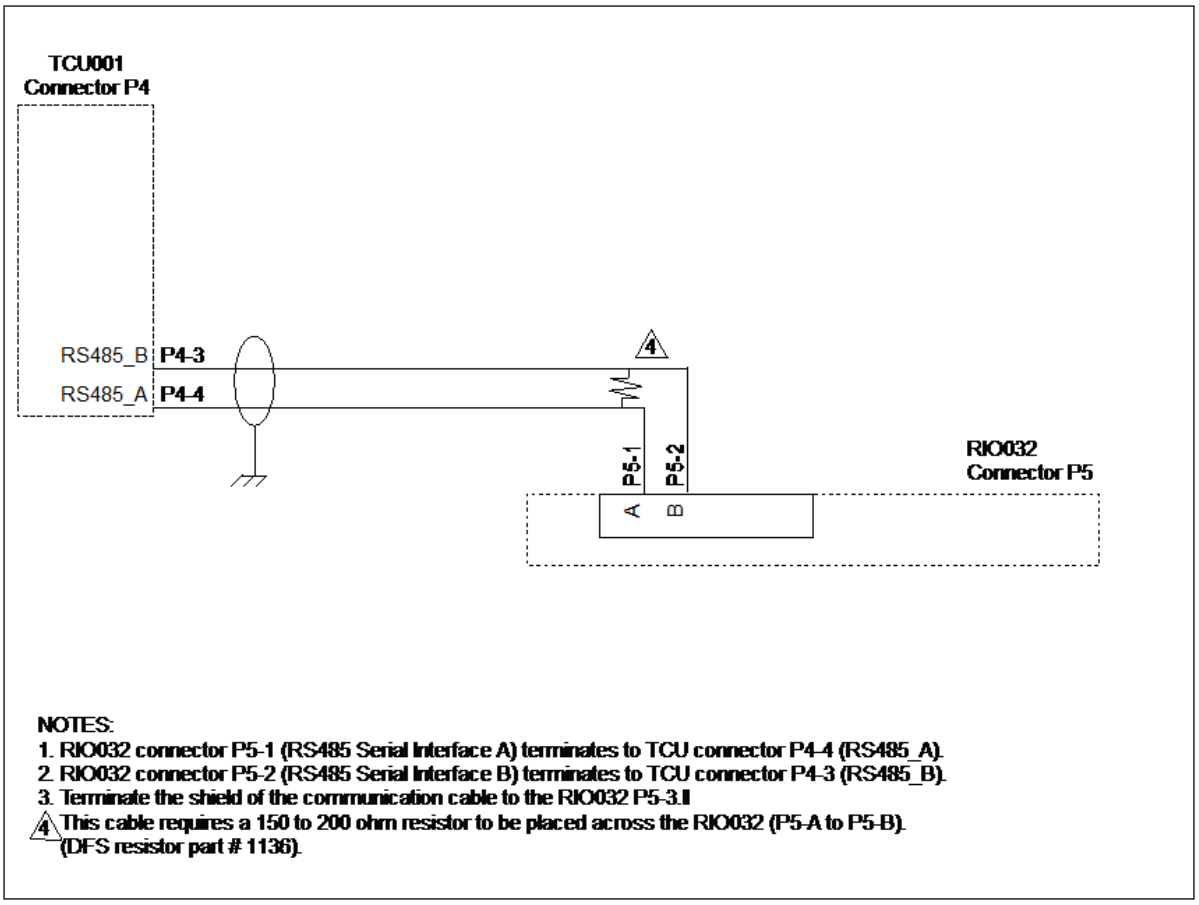
RIO32 Analog Output (AO) Wiring for VFD Operation



TCU800 Analog Input (AI) Wiring for VFD Operation



TCU800 to RIO032 Interconnect (RS485) for VFD Operation



MODBUS Registers for VFD Operation

See the section titled “Pump Control Application by Modbus Register” for a list of the MODBUS registers used in VFD applications. Note that these registers are in addition to the standard TCU pump control application registers in that same section. See the section titled “Pump Control Application by Module Letter and Point” to see the VFD-TCU800’s I/O by DFS Module letter and point, which is needed when configuring the station on the server.

K. Polling the TCU - DFS Point and Modbus Registers

Pump Control Application by Module Letter and Point

The TCU Pump Control template consists of eight individual modules, including one for the integrated radio. The tables on the following pages list the properties of each module contained in the template and provide a description of each point's function.

For those systems using the Modbus protocol, equivalent Modbus registers are also provided.

Note: Alarm states are listed for some but not all of the TCU's I/O points. Those listed are common alarms, but any or all configured telemetry points can be set to alarm in any desired state.

Module A - DMM002

Point #	Point Name	Point Type	Modbus Register	Low State Label	High State Label	Alarm State	Description
1	Pump 1 Status	DI	12545	OFF	RUNNING		Detects the state of Pump 1
2	Pump 2 Status	DI	12546	OFF	RUNNING		Detects the state of Pump 2
3	Pump 3 Status	DI	12547	OFF	RUNNING		Detects the state of Pump 3
4	Phase Monitor Bypass	DI	12548	OFF	ON		Detects if the phase monitor bypass is OFF or ON
5	Low Float Input	DI	12549	OFF	ON		Detects the state of the Low Float
6	Off Float Input*	DI	12550	OFF	ON		Detects the state of the Off float
7	Lead Float Input*	DI	12551	OFF	ON		Detects the state of the Lead float
8	Lag Float Input*	DI	12552	OFF	ON		Detects the state of the Lag float
9	Lag2 Float Input*	DI	12553	OFF	ON		Detects the state of the Lag2 float
10	High Float Input*	DI	12554	OFF	ON		Detects the state of the High float
11	Any Pump	DI	12555	OFF	RUNNING		Detects the status of any pump in the telemetry system
12	Auxiliary Input	DI	12556	OFF	ON		Detects the state of the Auxiliary input

*For VFD operation, these inputs are reserved as spare I/O.

Module B - DCM001

Point #	Point Name	Point Type	Modbus Register	Low State Label	High State Label	Alarm State	Description
1	Starter 1 Out*	DI	12801	OFF	ON		Detects the state of pump starter 1

2	Starter 2 Out*	DI	12802	OFF	ON		Detects the state of pump starter 2
3	Starter 3 Out*	DI	12803	OFF	ON		Detects the state of pump starter 3
4	Auxiliary Out	DI	12804	OFF	ON		Detects the state of the auxiliary output
5	Alarm Light Status	DI	12805	OFF	ON		Detects the state of the alarm light
6	Alarm Horn Status	DI	12806	OFF	ON		Detects the state of the alarm horn
7	Alarm Silence Input	DI	12807	OFF	ON		Indicates the status of the external alarm silence switch
8	Station Disable	DO	520	OFF	ON		In the ON state, allows telemetry to remove power from all pump motors
9	AC Power	DI	12809	NORMAL	FAULT		Allows telemetry to sense AC power failure and activate the alarm.
10	DC Bias	DI	12810	NORMAL	FAULT		Allows telemetry to sense DC bias failure and activate the alarm.

* These points need not be configured when the TCU is running the pump control process, because they are being controlled by the TCU's pump control program. Points A1 (Pump 1), A2 (Pump 2), and A3 (Pump 3) are used to report pump status.

Module C - AMM002

Point #	Point Name	Point Type	Modbus Register	Low State Label*	High State Label**	Resolution/ Units	Alarm State	Description
1	Analog Input 1	AI	33713	4/820	20/4095	0.01/mA		Settings for the primary analog input
2	Analog Input 2	AI	33714	4/820	20/4095	0.01/mA		Settings for the auxiliary analog input
3		AI	33715	0/350	300/3102	1/VAC		Settings for Phase AB voltage (240 option)
		AI	33715	0/350	600/3114	1/VAC		Settings for Phase AB voltage (480 option)
4		AI	33716	0/350	300/3077	1/VAC		Settings for phase AC voltage (240 option)
		AI	33716	0/350	600/3077			Settings for phase AC voltage (480 option)

5		DI	13089	NORMAL	FAULT		FAULT	Allows telemetry to sense float sequence faults and activate the alarm
6		DI	13090	NORMAL	FAULT		FAULT	Detects transducer malfunctions and activates the alarm
7		DI	13091	NORMAL	FAULT		FAULT	Detects the presence of AC Power and activates the alarm when absent
8	Configuration	DI	13092	-	UPDATED			Detects if the local configuration has been updated; activates the alarm for update

* For analog points, the Low State Label column gives the point's Low engineering value followed by its Low raw value.

** For analog points, the High State Label column gives the point's High engineering value followed by its High raw value.

Module D - DCM001

Point #	Point Name	Point Type	Modbus Register	Low State Label	High State Label	Alarm State	Description
1	Pump 1 Disable	DO	1025	OFF	ON		Allows telemetry to turn off Pump 1 regardless of pump's TCU state
2	Pump 2 Disable	DO	1026	OFF	ON		Allows telemetry to turn off Pump 2 regardless of pump's TCU state
3	Pump 3 Disable	DO	1027	OFF	ON		Allows telemetry to turn off Pump 3 regardless of pump's TCU state
4	Pump 1 Override	DO	1028	OFF	ON		Allows telemetry to turn on Pump 1 regardless of pump's TCU state
5	Pump 2 Override	DO	1029	OFF	ON		Allows telemetry to turn on Pump 2 regardless of pump's TCU state
6	Pump 3 Override	DO	1030	OFF	ON		Allows telemetry to turn on Pump 3 regardless of pump's TCU state
7	Pump 1 Starter	DI	13319	NORMAL	FAULT	FAULT	Allows telemetry to sense a Pump 1 starter failure and activate the alarm

8	Pump 2 Starter	DI	13320	NORMAL	FAULT	FAULT	Allows telemetry to sense a Pump 2 starter failure and activate the alarm
9	Pump 3 Starter	DI	13321	NORMAL	FAULT	FAULT	Allows telemetry to sense a Pump 3 starter failure and activate the alarm
10	Pump 1 Stop	DI	13322	NORMAL	FAULT	FAULT	Allows telemetry to sense a Pump 1 stop failure and activate the alarm
11	Pump 2 Stop	DI	13323	NORMAL	FAULT	FAULT	Allows telemetry to sense a Pump 2 stop failure and activate the alarm
12	Pump 3 Stop	DI	13324	NORMAL	FAULT	FAULT	Allows telemetry to sense a Pump 3 stop failure and activate the alarm

Module E - ACM001

Point #	Point Name	Point Type	Modbus Register	Low State Label*	High State Label**	Alarm State	Description
1	Remote Level	AO	42273	4/820	20/4095	0.01/mA	Calibration point for displaying level for a remote input
2	Unused						
3	Unused						
4	Well Level	AO	42276	0/0	60/600	0.1/FT	Calibration point for displaying well level

* For analog points, the Low State Label column gives the point's Low engineering value followed by its Low raw value.

** For analog points, the High State Label column gives the point's High engineering value followed by its High raw value.

Module F - DCM001

Point #	Point Name	Point Type	Modbus Register	Low State Label	High State Label	Alarm State	Description
1	RESERVED	DO	1537	OFF	ON		RESERVED
2	Low Well Level	DI	13826	NORMAL	ALARM	ALARM	Detects state of Low level sensor
3	High Well Level	DI	13827	NORMAL	ALARM	ALARM	Detects state of High level sensor
4	HOA 1	DI	13828	-	HAND	HAND	Detects position of HOA 1 switch and activates alarm for "Hand" position
5	HOA 1	DI	13829	-	OFF	OFF	Detects position of HOA 1 switch and activates alarm for "Off" position

6	HOA 1	DI	13830	-	AUTO		Detects position of HOA 1 switch and activates alarm for “Auto” position
7	HOA 2	DI	13831	-	HAND	HAND	Detects position of HOA 2 switch and activates alarm for “Hand” position
8	HOA 2	DI	13832	-	OFF	OFF	Detects position of HOA 2 switch and activates alarm for “Off” position
9	HOA 2	DI	13833	-	AUTO		Detects position of HOA 2 switch and activates alarm for “Auto” position
10	HOA 3	DI	13834	-	HAND	HAND	Detects position of HOA 3 switch and activates alarm for “Hand” position
11	HOA 3	DI	13835	-	OFF	OFF	Detects position of HOA 3 switch and activates alarm for “Off” position
12	HOA 3	DI	13836	-	AUTO		Detects position of HOA 3 switch and activates alarm for “Auto” position

Module G - DCM001

Point #	Point Name	Point Type	Modbus Register	Low State Label	High State Label	Alarm State	Description
1	Aux Out Override On	DO	1793	OFF	ON		OFF=Normal Operation; ON=Override Aux Output to ON state
2	Alarm Light Override	DO	1794	OFF	ON		OFF=Normal Operation; ON=Override Alarm Light Output to ON state
3	Alarm Horn Override	DO	1795	OFF	ON		OFF=Normal Operation; ON=Override Alarm Horn Output to ON state
4	Aux Out Disable	DO	1796	OFF	ON		OFF=Normal Operation; ON=Disable Aux Output
5	Alarm Light Disable	DO	1797	OFF	ON		OFF=Normal Operation; ON=Disable Alarm Light Output
6	Alarm Horn Disable	DO	1798	OFF	ON		OFF=Normal Operation; ON=Disable Horn Light Output
7	Pump Override Reset	DO	1799	OFF	ON		OFF=Normal Operations; ON=Turn OFF any Pump Overrides when OFF level reached

8	Analog Updating	DO	1800	OFF	ON		Legacy PCU function. Only applies to a TCU being used as a PCU. Has no application in a standard TCU installation. This setting is an on/off switch for logging analog values. It enables the TCU to respond with full analog status each time it is polled. This setting should be used judiciously as it will have a large impact on the radio-polling rate.

Module R - RIM006

Point #	Point Name	Point Type	Modbus Register	Low State Label*	High State Label**	Resolution/ Units	Alarm State	Description
1		DO	1	OFF	ON		ON	Control point used to turn off the TCU's AC power and go to battery power
2-10	Unused							
11		DI	12299	OFF	ON		OFF	Detects the presence of isolated DC bias and activates the Alarm when absent
12		DI	12300	OFF	ON		OFF	Detects the presence of AC Power and activates the Alarm when absent
13		AI	32945	0/0	255/100	0.1/%		Detects the amount of current drawn when the radio is keyed
14		AI	32946	0/0	255/100	0.1/%		Detects the average receive signal strength
15		AI	32947	0/32	100/212	0.1/F		Detects the TCU's internal temperature

* For analog points, the Low State Label column gives the point's Low raw value followed by its Low Engineering value.

** For analog points, the High State Label column gives the point's High raw value followed by its High Engineering value.

Additional Modules Used for VFD Operation

These settings are automatically configured in the TCU800 when VFD Mode is enabled. They still must be matched on the server as well, however, to ensure proper communication via telemetry.

Module H - ACM002

Point #	Point Name	Point Type	Modbus Register	Low State Label*	High State Label**	Resolution/ Units	Alarm State	Description
1	Pump 1 Speed Control Signal	AI	43041	0/819	100/4095	0%		
2	Pump 2 Speed Control Signal	AI	43042	0/819	100/4095	0%		
3	Pump 3 Speed Control Signal	AI	43043	0/819	100/4095	0%		

* For analog points, the Low State Label column gives the point's Low engineering value followed by its Low raw value.

** For analog points, the High State Label column gives the point's High engineering value followed by its High raw value.

Module I - AMM002

Point #	Point Name	Point Type	Modbus Register	Low State Label*	High State Label**	Resolution/ Units	Alarm State	Description
1	Pump 1 Speed Feedback	AI	35249	0/819	100/4095	0%		
2	Pump 2 Speed Feedback	AI	35240	0/819	100/4095	0%		
3	Pump 3 Speed Feedback	AI	35251	0/819	100/4095	0%		

Module J - DMM002

Point #	Point Name	Point Type	Modbus Register	Low State Label	High State Label	Alarm State	Description
1-8	Spares	DI	14849-14856	OFF	ON		Spares for connecting any required additional I/O

Module K - DCM003-1

Point #	Point Name	Point Type	Modbus Register	Low State Label	High State Label	Alarm State	Description
1-8	Spares	DI	2817-2824	OFF	ON		Spares for connecting any required additional I/O

Pump Control Application by Modbus Register

The information on the following pages lists the properties of each of the TCU's equivalent Modbus registers and provides a description of each register's function.

Notes:

The information is sorted by register number in ascending order.

Labels in italics indicate differences between the standard TCU and the VFD-TCU (specifically registers 12550-12554). Additional Modbus registers are used in the VFD-TCU and are listed at the end of the table.

Alarm states are listed for some but not all of the TCU's I/O points. Those listed are common alarms, but any or all configured telemetry points can be set to alarm in any desired state.

For analog input (AI) and output (AO) points, the Low State Label column gives the point's Low Engineering value followed by its Low Raw value; the High State Label column gives the point's High Engineering value followed by its High Raw value.

Register	Label	Type	Low State Label	High State Label	Resolution/ Units	Alarm State	Description
1	Battery Test	DO	OFF	ON		ON	Control point used to turn off the TCU's AC power and go to battery power
520	Station Disable	DO	OFF	ON			In the ON state, allows telemetry to remove power from all pump motors
1025	Pump 1 Disable	DO	OFF	ON			In the ON state, allows telemetry to cut power to Pump 1
1026	Pump 2 Disable	DO	OFF	ON			In the ON state, allows telemetry to cut power to Pump 2
1027	Pump 3 Disable	DO	OFF	ON			In the ON state, allows telemetry to cut power to Pump 3
1028	Pump 1 Override	DO	OFF	ON			In the ON state, allows telemetry to control Pump 1 and bypass the TCU
1029	Pump 2 Override	DO	OFF	ON			In the ON state, allows telemetry to control Pump 2 and bypass the TCU
1030	Pump 3 Override	DO	OFF	ON			In the ON state, allows telemetry to control Pump 3 and bypass the TCU
1537	Reserved	DO					Factory use only. Do not use.

1793	Aux Out Override On	DO	OFF	ON			In the ON state, allows telemetry to control the auxiliary output
1794	Alarm Light Override	DO	OFF	ON			In the ON state, allows telemetry to control the alarm light
1795	Alarm Horn Override	DO	OFF	ON			In the ON state, allows telemetry to control the alarm horn
1796	Aux Out Disable	DO	OFF	ON			Detects if the auxiliary output is in the auto or disabled state
1797	Alarm Light Disable	DO	OFF	ON			Detects if the alarm light is in the auto or disabled state
1798	Alarm Horn Disable	DO	OFF	ON			Detects if the alarm horn is in the auto or disabled state
1799	Pump Override Reset	DO	OFF	ON			When set, allows the Off level input to reset pump overrides
1800	Analog Updating	DO	OFF	ON			This is a legacy PCU function, and only applies to a TCU being used as a PCU. It has no application in a standard TCU installation. This setting is an on/off switch for logging analog values. It enables the TCU to respond with full analog status each time it is polled. This setting should be used judiciously as it will have a large impact on the radio polling rate.
12299	Bias Voltage	DI	OFF	ON		OFF	Detects the presence of isolated DC bias and activates the alarm when absent.
12300	TCU Power	DI	OFF	ON		OFF	Detects the presence of AC power and activates the alarm when absent.
12545	Pump 1 Status	DI	OFF	RUNNING			Detects the state of pump 1
12546	Pump 2 Status	DI	OFF	RUNNING			Detects the state of pump 2
12547	Pump 3 Status	DI	OFF	RUNNING			Detects the state of pump 3
12548	Phase Monitor Bypass	DI	OFF	ON			Detects if the phase monitor bypass is OFF or ON
12549	Low Float Input	DI	OFF	ON			Detects the state of the Low float

12550	Off Float Input Spare I/O (VFD)	DI	OFF	ON			Detects the state of the Off float (Spare I/O in VFDTCU application).
12551	Lead Float Input Spare I/O (VFD)	DI	OFF	ON			Detects the state of the Lead float (Spare I/O in VFD-TCU application).
12552	Lag Float Input Spare I/O (VFD)	DI	OFF	ON			Detects the state of the Lag float (Spare I/O in VFDTCU application)
12553	Lag2 Float Input Spare I/O (VFD)	DI	OFF	ON			Detects the state of the Lag2 float (Spare I/O in VFD-TCU application)
12554	High Float Input Spare I/O (VFD)	DI	OFF	ON			Detects the state of the High float (Spare I/O in VFD-TCU application)
12555	Any Pump	DI	OFF	RUNNING			Detects the status of any pump in the telemetry system
12556	Auxiliary Input	DI	OFF	ON			Detects the state of the Auxiliary input
12801	Starter 1 Out	DI	OFF	ON			Detects the state of pump starter 1
12802	Starter 2 Out	DI	OFF	ON			Detects the state of pump starter 2
12803	Starter 3 Out	DI	OFF	ON			Detects the state of pump starter 3
12804	Auxiliary Out	DI	OFF	ON			Detects the state of the auxiliary output
12805	Alarm Status Status	DI	OFF	ON			Detects the state of the alarm light
12806	Alarm Horn Status	DI	OFF	ON			Detects the state of the alarm horn
12807	Alarm Silence Input	DI	OFF	ON			Indicates the status of the external alarm silence switch
12809	AC Power	DI	NORMAL	FAULT			Allows telemetry to sense AC power failure and activate the alarm
12810	DC Bias	DI	NORMAL	FAULT			Allows telemetry to sense DC bias failure and activate the alarm
12811	Phase Sequence	DI	NORMAL	FAULT			Allows telemetry to sense phase sequence failure and activate the alarm
12812	Process	DI	RUNNING	STOPPED			Allows telemetry to sense if the TCU's BASIC program is running

13089	Float Sequence	DI	NORMAL	FAULT			Allows telemetry to sense float sequence faults and activate the alarm
13090	Level Transducer	DI	NORMAL	FAULT			Detects transducer malfunctions and activates the alarm
13091	Phase Voltage	DI	NORMAL	FAULT			Detects the presence of AC power and activates the alarm when absent
13092	Configuration	DI	-	UPDATED			Detects if the local configuration has been updated and activates the alarm for update
13319	Pump 1 Starter	DI	NORMAL	FAULT		FAULT	Allows telemetry to sense a Pump 1 starter failure and activate the alarm
13320	Pump 2 Starter	DI	NORMAL	FAULT		FAULT	Allows telemetry to sense a Pump 2 starter failure and activate the alarm
13321	Pump 3 Starter	DI	NORMAL	FAULT		FAULT	Allows telemetry to sense a Pump 3 starter failure and activate the alarm
13322	Pump 1 Stop	DI	NORMAL	FAULT		FAULT	Allows telemetry to sense a Pump 1 stop failure and activate the alarm
13323	Pump 2 Stop	DI	NORMAL	FAULT		FAULT	Allows telemetry to sense a Pump 2 stop failure and activate the alarm
13324	Pump 3 Stop	DI	NORMAL	FAULT		FAULT	Allows telemetry to sense a Pump 3 stop failure and activate the alarm
13826	Low Well Level	DI	NORMAL	ALARM		ALARM	Detects the state of the Low level sensor
13827	High Well Level	DI	NORMAL	ALARM		ALARM	Detects the state of the High level sensor
13828	HOA 1	DI	-	HAND		HAND	Detects position of HOA 1 switch and activates alarm for “Hand” position
13829	HOA 1	DI	-	OFF		OFF	Detects position of HOA 1 switch and activates alarm for “Off” position
13830	HOA 1	DI	-	AUTO			Detects position of HOA 1 switch and activates alarm for “Auto” position
13831	HOA 2	DI	-	HAND		HAND	Detects position of HOA 2 switch and activates alarm for “Hand” position

13832	HOA 2	DI	-	OFF		OFF	Detects position of HOA 2 switch and activates alarm for “Off” position
13833	HOA 2	DI	-	AUTO			Detects position of HOA 2 switch and activates alarm for “Auto” position
13834	HOA 3	DI	-	HAND		HAND	Detects position of HOA 3 switch and activates alarm for “Hand” position
13835	HOA 3	DI	-	OFF		OFF	Detects position of HOA 3 switch and activates alarm for “Off” position
13836	HOA 3	DI	-	AUTO			Detects position of HOA 3 switch and activates alarm for “Auto” position
32945	Reserved	AI					Factory use only. Do not use.
32946	Reserved	AI					Factory use only. Do not use.
32947	Internal Temperature	AI	0/32	100/212		0.1/F	Detects the TCU’s internal temperature
33713	Analog Input 1	AI	4/820	20/4095	0.01/mA		Settings for the primary analog input
33714	Analog Input 2	AI	4/820	20/4095	0.01/mA		Settings for the auxiliary analog input
33715	Phase AB Voltage (240 VAC)	AI	0/350	300/3102	1/VAC		Settings for Phase AB voltage for 240 VAC 1- or 3-phase monitor
33715	Phase AB Voltage (480 VAC 3-phase)	AI	0/350	600/3114	1/VAC		Settings for Phase AB voltage for 480 VAC 3-phase monitor
33716	Phase AC Voltage (240 VAC)	AI	0/350	300/3077	1/VAC		Settings for phase AC voltage for 240 VAC 1- or 3-phase monitor
33716	Phase AC Voltage (480 VAC 3-phase)	AI	0/350	600/3077	1/VAC		Settings for phase AC voltage for 480 VAC 3-phase monitor
42273	Remote Level	AO	4/820	20/4095	0.01/mA		Calibration point for displaying the level for a remote input
42276	Well Level	AO	0/0	60/600	0.1/FT		Calibration point for displaying well level

Additional Modbus Registers Used in VFD-TCU

Register	Label	Module Letter	Module Type	Point Type	Low State Label	High State Label	Resolution /Units	Notes
43041	Pump 1 Speed Control Signal	H	ACM002	AI	0/819	100/4095	0/%	
43042	Pump 2 Speed Control Signal	H	ACM002	AI	0/819	100/4095	0/%	
43043	Pump 3 Speed Control Signal	H	ACM002	AI	0/819	100/4095	0/%	
35249	Pump 1 Speed Feedack	I	ACM002	AI	0/819	100/4095	0/%	
35250	Pump 2 Speed Feedback	I	ACM002	AI	0/819	100/4095	0/%	
35251	Pump 3 Speed Feedback	I	AMM002	AI	0/819	100/4095	0/%	
14849-14856	Spares	J	DMM002	DO	OFF	ON		Spares for connecting any required additional I/O
2817-2824	Spares	K	DCM003-1	DI	OFF	ON		Spares for connecting any required additional I/O

DFS Module to MODBUS Register Maps

If you are using an HMI other than HT3, you will need to configure that software with the correct Modbus register information in order to poll a Modbus slave device connected to the TCU. Modules H-O can be used to store data from Modbus slave devices connected to the TCU on its RS-485 interface. (A typical application would be adding a RIO032/ RIO128. See "Appendix G: Adding a RIO to the TCU.")

On the next pages, find the module type that corresponds to the type of Modbus slave I/O you added to the TCU.

- digital inputs = DMM
- digital outputs = DCM
- analog inputs = AMM
- analog outputs = ACM

Then, find the column for the module letter the I/O was added to. Each of the modules (H-O) can accomodate:

- Twelve (12) digital status registers, or
- Eight (8) digital control registers, or
- Four (4) analog status registers, or
- Four (4) analog control registers

For example, if you added 4 (four) digital inputs to module H, you would select the first four registers listed in the module H column of the DMM Module Type table (14337, 14338, 14339, 14340).

DMM Module Type

Point #	Modbus Register by Module Letter							
	H	I	J	K	L	M	N	O
1	14337	14593	14849	15105	15361	15617	15873	16129
2	14338	14594	15850	15106	15362	15618	15874	16130
3	14339	14595	14851	15107	15363	15619	15875	16131
4	14340	14596	14852	15108	15364	15620	15876	16132
5	14341	14597	14853	15109	15365	15621	15877	16133
6	14342	14598	14854	15110	15366	15622	15878	16134
7	14343	14599	14855	15111	15367	15623	15879	16135
8	14344	14600	14856	15112	15368	15624	15880	16136
9	14345	14601	14857	15113	15369	15625	15881	16137
10	14346	14602	14858	15114	15370	15626	15882	16138
11	14347	14603	14859	15115	15371	15627	15883	16139
12	14348	14604	14860	15116	15372	15628	15884	16140

DCM Module Type

Point #	Modbus Register by Module Letter							
	H	I	J	K	L	M	N	O
1	2049	2305	2561	2817	3073	3329	3585	3841
2	2050	2306	2562	2818	3074	3330	3586	3842
3	2051	2307	2563	2819	3075	3331	3587	3843
4	2052	2308	2564	2820	3076	3332	3588	3844
5	2053	2309	2565	2821	3077	3333	3589	3845
6	2054	2310	2566	2822	3078	3334	3590	3846
7	2055	2311	2567	2823	3079	3335	3591	3847
8	2056	2312	2568	2824	3080	3336	3592	3848

AMM Module Type

See note (below ACM Module Type table) on resolution of DFS analog modules.

Point #	Modbus Register by Module Letter							
	H	I	J	K	L	M	N	O
1	34993	35249	35505	35761	36017	36273	36529	36785
2	34994	35250	35506	35762	36018	36274	36530	36786
3	34995	35251	35507	35763	36019	36275	36531	36787
4	34996	35252	35508	35764	36020	36276	36532	36788

ACM Module Type

See note (below) on resolution of DFS analog modules.

Point #	Modbus Register by Module Letter							
	H	I	J	K	L	M	N	O
1	43041	43297	43553	43809	44065	44321	44577	44833
2	43042	43298	43554	43810	44066	44322	44578	44834
3	43043	43299	43555	43811	44067	44323	44579	44835
4	43044	43300	43556	43812	44068	44324	44580	44836

Note: DFS analog modules have 12 bit resolution (0 - 4095). If the Modbus slave device being configured has a higher resolution, the number of bits (typically 15) will need to be configured in the TCU's ModX Lth field (where X represents the module letter being configured) in order for the value to read correctly.

Legacy PCU

The table below, "Point Values for Legacy PCU," lists the properties of the legacy PCU template. Point 49 has two possible configurations (labeled 49a and 49b), depending on the device's type (4-20 mA or 0-5 V). The template defaults to a 4-20 mA device. If necessary, edit the point to fit your system.

Point Values for Legacy PCU

Point #	Point Name	Point Type	Low State Label*	High State Label**	Alarm State	Resolution/ Units †
1	Low Float Input	DI	OFF	ON		
2	Off Float Input	DI	OFF	ON		
3	Lead Float Input	DI	OFF	ON		
4	Lag 1 Float Input	DI	OFF	ON		
5	Lag 2 Float Input	DI	OFF	ON		
6	High Float Input	DI	OFF	ON	ON	
7	Auxiliary Input	DI	OFF	ON		
8	Alarm Horn Cond.	DI	ENABLED	SILENCED		
9	Pump #1 Status	DI	OFF	RUNNING		
10	Pump #2 Status	DI	OFF	RUNNING		
11	Pump #3 Status	DI	OFF	RUNNING		
12	Phase Monitor Bypass	DI	OFF	ON		
13	Phase Voltage	DI	OK	FAULT	FAULT	
14	Phase Sequence	DI	OK	FAULT	FAULT	
15	Pump #1 Starter	DI	OK	FAULT	FAULT	
16	Pump #2 Starter	DI	OK	FAULT	FAULT	
17	Pump #3 Starter	DI	OK	FAULT	FAULT	
18	Pump #1 Stop	DI	OK	FAULT	FAULT	
19	Pump #2 Stop	DI	OK	FAULT	FAULT	
20	Pump #3 Stop	DI	OK	FAULT	FAULT	
21	Float Sequence	DI	OK	FAULT	FAULT	
22	Level Transducer	DI	OK	FAULT	FAULT	
23	Backup Memory	DI	OK	FAULT	FAULT	
24	AC Power	DI	OK	FAULT	FAULT	
25	DC Bias	DI	OK	FAULT	FAULT	
26	Low Well Level	DI	OK	ALARM	ALARM	
27	High Well Level	DI	OK	ALARM	ALARM	
31	HOA Switch 1	DI	-	HAND	HAND	
32	HOA Switch 1	DI	-	OFF	OFF	
33	HOA Switch 1	DI	-	AUTO		
34	HOA Switch 2		-	HAND	HAND	
35	HOA Switch 2	DI	-	OFF	OFF	
36	HOA Switch 2	DI	-	AUTO		
37	HOA Switch 3	DI	-	HAND	HAND	

38	HOA Switch 3	DI	-	OFF	OFF	
39	HOA Switch 3	DI	-	AUTO		
40	Auxiliary Output	DI	OFF	ON		
41	Alarm Horn Status	DI	OFF	RINGING		
42	Alarm Light Status	DI	FLASHING	OFF		
43	Any Pump	DI	OFF	RUNNING		
44	PCU Configuration	DI	-	UPDATED	UPDATED	
49a	Analog Input	AI	0/0	20/255		1 / mA
49b	Analog Input	AI	0/0	5/255		.1 / VAC
50	Phase AB Voltage	AI	151/0	300/255		5 / VAC
51	Phase AC Voltage	AI	151/0	300/255		5 / VAC
52	Well Level	AI	0/0	60/600		0.5 / ft
58	Pump #1 Override	DO	OFF	ON		
59	Pump #2 Override	DO	OFF	ON		
60	Pump #3 Override	DO	OFF	ON		
61	Aux. Output Override	DO	OFF	ON		
62	Alarm Horn Override	DO	OFF	ON		
63	Alarm Light Disable	DO	OFF	ON		
64	Station Disable	DO	OFF	ON		
65	Pump #1 Disable	DO	OFF	ON		
66	Pump #2 Disable	DO	OFF	ON		
67	Pump #3 Disable	DO	OFF	ON		
68	Aux. Output Disable	DO	OFF	ON		
69	Alarm Horn Disable	DO	OFF	ON		
70	Alarm Light Override	DO	OFF	ON		
71	RESERVED	DO	OFF	ON		
72	Override Reset	DO	DISABLE	ENABLE		
73	Analog Updating	DO	OFF	OFF		

* For analog points, the Low State Label column gives the point's Low engineering value followed by its Low raw value.

** For analog points, the High State Label column gives the point's High engineering value followed by its High raw value.

† Resolution and units apply to analog points only.

Point Descriptions for Legacy PCU

Point #	Point Name	Description
1	Low Float Input	Detects if the Low Level sensor is in the OFF state or the ON state
2	Off Float Input	Detects if the Off Level sensor is in the OFF state or the ON state
3	Lead Float Input	Detects if the Lead Level sensor is in the OFF state or the ON state
4	Lag 1 Float Input	Detects if the Lag Level sensor is in the OFF state or the ON stat.
5	Lag 2 Float Input	Detects if the Lag2 Level sensor is in the OFF state or the ON state
6	High Float Input	Detects if the High Level sensor is in the OFF state or the ON stat.
7	Auxiliary Input	Detects if the Auxiliary Input is in the OFF state or the ON state
8	Alarm Horn Cond.	Gives status of external alarm-silence switch
9	Pump #1 Status	Detects whether pump 1 is in the OFF state or the RUNNING state

10	Pump #2 Status	Detects whether pump 2 is in the OFF state or the RUNNING state
11	Pump #3 Status	Detects whether pump 3 is in the OFF state or the RUNNING state
12	Phase Monitor Bypass	Detects whether the phase monitor is ENABLED or BYPASSED
13	Phase Voltage	Allows telemetry to sense phase voltage failure and activate the alarm
14	Phase Sequence	Allows telemetry to sense phase sequence failure and activate the alarm
15	Pump #1 Starter	Allows telemetry to sense Pump 1 Starter failure and activate the alarm
16	Pump #2 Starter	Allows telemetry to sense Pump 2 Starter failure and activate the alarm
17	Pump #3 Starter	Allows telemetry to sense Pump 3 Starter failure and activate the alarm
18	Pump #1 Stop	Activates the alarm any time Pump 1 is running and stops without control by the PCU
19	Pump #2 Stop	Activates the alarm any time Pump 2 is running and stops without control by the PCU
20	Pump #3 Stop	Activates the alarm any time Pump 3 is running and stops without control by the PCU
21	Float Sequence	Allows telemetry to sense float sequence fault and activate the alarm
22	Level Transducer	Detects malfunction of a Transducer and activates the alarm
23	Backup Memory	Detects failure of the EEPROM backup memory and activates the alarm
24	AC Power	Detects the presence of AC Power and activates the Alarm when absent
25	DC Bias	Detects the presence of isolated DC bias and activates the alarm when absent
26	Low Well Level	Detects whether the Low Level sensor is OK or in the FAULT (Emergency Low) state
27	High Well Level	Detects whether the High Level sensor is OK or in the HIGH state
31	HOA Switch 1	Detects position of HOA switch 1 and activates alarm for “Hand” position
32	HOA Switch 1	Detects position of HOA switch 1 and activates alarm for “Off” position
33	HOA Switch 1	Detects position of HOA switch 1 and indicates the “Auto” position
34	HOA Switch 2	Detects position of HOA switch 2 and activates alarm for “Hand” position
35	HOA Switch 2	Detects position of HOA switch 2 and activates alarm for “Off” position
36	HOA Switch 2	Detects position of HOA switch 2 and indicates the “Auto” position
37	HOA Switch 3	Detects position of HOA switch 3 and activates alarm for “Hand” position
38	HOA Switch 3	Detects position of HOA switch 3 and activates alarm for “Off” position
39	HOA Switch 3	Detects position of HOA switch 3 and indicates the “Auto” position
40	Auxiliary Output	Detects whether the auxiliary output is in the OFF or ON state
41	Alarm Horn Status	Detects whether the alarm horn is in the OFF or RINGING state
42	Alarm Light Status	Detects whether the alarm light is in the FLASHING or OFF state
43	Any Pump	Indicates the run status of any pump
44	PCU Configuration	Detects if the Local Configuration has been updated and activates the alarm for UPDATE.
49a	Analog Input	Settings for Analog Input when used with analog-current type transducer
49b	Analog Input	Settings for Analog Input when used with analog-voltage type transducer
50	Phase AB Voltage	Settings for Phase AB Voltage for phase monitor
51	Phase AC Voltage	Settings for phase AC voltage for phase monitor
52	Well Level	Calibration points for displaying Well Level

58	Pump #1 Override	In the OVERRIDE state, allows telemetry to control Pump 1 and bypass the TCU
59	Pump #2 Override	In the OVERRIDE state, allows telemetry to control Pump 2 and bypass the TCU
60	Pump #3 Override	In the OVERRIDE state, allows telemetry to control Pump 3 and bypass the TCU
61	Aux. Output Override	In the OVERRIDE state, allows telemetry to control the Auxiliary Output
62	Alarm Horn Override	In the OVERRIDE state, allows telemetry to control the Alarm Horn
63	Alarm Light Disable	In the OVERRIDE state, allows telemetry to control the Alarm Light
64	Station Disable	In the DISABLED state, allows telemetry to cut power to all pump motors
65	Pump #1 Disable	In the DISABLED state, allows telemetry to cut power to Pump 1
66	Pump #2 Disable	In the DISABLED state, allows telemetry to cut power to Pump 2
67	Pump #3 Disable	In the DISABLED state, allows telemetry to cut power to Pump 3
68	Aux. Output Disable	Detects if the auxiliary output is in the AUTO or DISABLED state
69	Alarm Horn Disable	Detects if the alarm horn is in the AUTO or DISABLED state
70	Alarm Light Override	Allows telemetry to override the Alarm Light and activate the alarm at the central site
71	RESERVED	RESERVED
72	Override Reset	When set, allows the Off Level input to reset pump overrides
73	Analog Updating	Enables Analog readings

L. Support, Service, and Warranty

Support and Service

Data Flow Systems offers support services nationwide from its home office and through authorized Value Added Resellers (VARs) and System Integrators. Contact your local Data Flow Systems representative for:

- Sales and order support
- Product technical training
- Warranty support
- Support service agreements

If you are unsure of whom to contact, call DFS' Melbourne headquarters at 321-259-5009 and ask for the Sales Department. Alternatively, send an email to service@dataflowsys.com.

Technical Product Assistance

Please review the information in "Appendix C: Maintenance and Troubleshooting," before contacting Data Flow Systems If you need further assistance, contact your local Data Flow Systems representative. If you are unsure of whom to contact, call DFS' Melbourne headquarters at 321-259-5009 and ask for the Service Department. Alternatively, send email to service@dataflowsys.com.

Return Authorization (RA) Procedure

Data Flow Systems' function modules are designed to be robust and highly reliable. We back this performance with a 3-year full warranty (see our warranty statement for details). In the event that a function module fails, during or after the warranty period, it may be returned to Data Flow Systems to be repaired or replaced.

All RA's will be subject to standard shipping and handling charges. Minimum handling charge will be assessed, in most cases, for work such as Radio Tuning, Backplanes, "No Problem Found," and other minor repairs. Handling charges will be waved on warranty equipment. Standard shipping and charges will be based on UPS ground, please advise if other arrangements are needed (UPS Red, FedEx, Pickup, Freight…). Standard cost of repairs and shipping charges can be obtained by contacting our RA Department by phone or e-mail.

STEP 1: Replace the failed module with a spare module of the same type, if one is available.

STEP 2: Contact Data Flow Systems Inc. in one of the following ways to receive an RA number. To recieve an RA number, the following information will be needed:

Customer/Utility Name and Ship to Address
Contact Name and Phone Number
Products to be returned and Serial Numbers
Detailed description of failure
PO#

Email - An RA# can be obtained by e-mailing DFS at rma@dataflowsys.com.

Phone - RA# will be issued over the phone by calling DFS at 321-259-5009 during normal operating hours.

Note: The lack of a detailed description of could result in the return of equipment due to the inability to properly determine the nature of the failure or testing resulting in “no problem found.”

STEP 3: Place the function module(s) individually in an electrostatic discharge bag and then wrap with foam and bubble wrap. Pack the wrapped module(s) in a sturdy box with Styrofoam popcorn or bubble wrap. Include a packing slip with the following information:

1. Module model, serial number, the probable cause of failure, and the RA number
2. Shipping address
3. Shipping instructions (shipping costs greater than UPS ground are charged to the customer)

STEP 4: Address the box to:

RA Department # [the RA number you received here]

Data Flow Systems

605 N John Rodes Blvd.

Melbourne, FL 32934-9105

STEP 5: Ship the box to DFS using any typical shipping carrier (e.g. UPS or FedEx). If circumstances permit, have a DFS employee hand-carry the package to the headquarters for you. Please note that DFS employees are not permitted to hand-carry an unpacked module.

Modules are typically repaired and shipped back to the customer within a two-week period starting at the time the module reaches the RA department. If additional information is required during the repair of the module(s), the DFS service department will contact you.

To get information on the progress of your equipment in for repair, contact the DFS RA Department at rma@dataflowsys.com or 321-259-5009.

Replacement of equipment may be in the event that the equipment and/or parts are unrepairable. Warranty equipment will be replaced without prior notification as a warranty replacement. The customer will be notified by phone, if equipment not under warranty cannot be repaired, with information of available options.

DFS reserves the right to return any material received without an RA# or not conforming to the requirements of this RAprocess.

Notice

The intended purpose of the TCU is telemetry control. Using the TCU for purposes other than telemetry control is not recommended and will void the warranty.

Warranty

DFS products carry a one-year warranty against defects in the material and workmanship. All Plug-in Function Models, Telemetry Control Units, Power Supply Modules and Radio Interface Modules carry an extended two-year return-to-factory warranty. Products that carry an extended warranty are covered against damage due to lighting and surge for the entire three-year period when installed per factory-approved requirements.

Questions or Comments on this Manual

If you find a problem with any of the information in this manual or have suggestions on how it could be improved, please contact us at the following address:

Data Flow Systems
Documentation Department
605 N. John Rodes Blvd.
Melbourne, FL 32934

Alternatively, e-mail us at:
documentation@dataflowsys.com

Glossary

alternation	Pumps configured for alternation take turns acting as lead. This shares the work of pumping over time.
bias voltage	Voltage used to bias (or hold) an input in the ON state. Absence of the voltage forces the input in the OFF state.
configure	Choosing the operating conditions of the station from a menu.
external	External equipment, devices, etc. outside of the TCU.
failure mode	Failure conditions displayed in the Alarm display mode of the TAC Pack TCU's LCD.
flow volume	Well or tank volume between the Off level and the Lead level configured in the TCU. This setting is used in the derived flow calculation.
ground	Zero-voltage reference point of a circuit. May be connected to earth ground or used as a common connection point.
Input	Inputs to the TCU consist of 3 phase monitor inputs, 6 telemetry inputs, and 12 digital monitor inputs.
input common	Point where multiple input circuits are terminated.
LCD	Liquid-crystal display used to display messages.
LED	Light-emitting diode used to indicate an on/off condition.
line	Input side of switch or relay contacts.
load	Output side of switch or relay contacts.
neutral	Zero reference point of an AC voltage.
output	Digital control output of the TCU.
override	Control output logic is ignored and the output is set to a specific state.
pump mode	Selected method of pumping for either a well (pump down) or storage tank (pump up).
return	The circuit wire or terminal that completes the circuit path back to ground or neutral.
set points	Those points configured in a station using an analog transducer to simulate the the function of float switches. Pseudo levels corresponding to the desired levels for starting or stopping pumps and for turning on level alarms are set in the user interface.
source	Electric power supply. Provides voltage, AC or dc, for use in input/output circuits.
staging levels	Levels in a well or tank at which an action (pump start or stop, or alarm activation) occurs.
telemetry	Communication system used to monitor and control a remote unit or units from a central site.
total flow	The Total Flow value is based on the time it takes to fill the flow volume (above). This derived flow is used to meter the calculate the flow rate and total flow volume.

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