MCT4 4.3 User Manual

MCT4 - 1/4 DIN Controller

A 1/4 DIN multi-loop controller that operates like your favorite smartphone or tablet

EASY TO USE TOUCH SCREEN INTERFACE

Combines multiple control and monitor components into a single, low cost solution

FUTUREDESIGN
CONTROLS

Safety Information in this Manual

Notes, cautions and warnings appear throughout this book to draw your attention to important operational and safety information.

A "**NOTE**" marks a short message to alert you to an important detail.

A "**CAUTION**" appears with information that is important for protecting your equipment and insuring performance.

A "**WARNING**" appears with information that is important for protecting you, others and equipment from damage. Pay very close attention to all warnings that apply to your application.

 This symbol (an exclamation point in a triangle) precedes a general CAUTION or WARNING statement.

 This symbol (a lightning bolt in a lightning bolt in a triangle) precedes an electric shock hazard CAUTION or WARNING safety statement.

Technical Assistance

If you encounter a problem with your MCT4 controller, review all of your configuration information to verify that your selections are consistent with your application: inputs; outputs; alarms; limits; etc. If the problem persists after checking the above, you can get technical assistance by dialing +1 (866) 342-5332 or by faxing your request to +1 (866) 332-8014, Monday thru Friday, 8:00 a.m. to 5:00 p.m. Eastern Standard Time. You can also email your request to support@futuredesigncontrols.com.

An applications engineer will discuss your application with you.

Please have the following information available:

• Complete Model #'s and/or Serial #'s for Component(s) in Question
• Complete Software Version #'s
• All Configuration Information
• All User Manuals

Warranty and return information are on the back cover of this manual.

Comments

Your comments or suggestions on this manual are welcome. Please send them to:
Future Design Controls, P.O. Box 1196, Bridgeview, Illinois, 60455
Telephone: +1 (888) 751-5444; fax: +1 (888) 307-8014
csr@futuredesigncontrols.com

1   What is the MCT4?

The MCT4 system combines all of the features of a loop controller, high-limit control, video/chart recorder and data logging system into a single/intuitive display device. Email (supporting SSL/TLS), SMS (text messaging), FTP, FileWeb, DataWeb (file transfer protocols for automated data backup and web database interface) and remote viewing/control (via Web server/VNC server) are standard with the MCT4 and can be accessed via LAN/WAN using a PC, tablet or smart phone device.

Future Design Controls' MCT4 provides a 4.3" color touch screen interface with standard "Smart Device" user interface features for multi-loop OEM control applications. All loop configuration and runtime user access are configurable at the device with no PC software required. OEM's have the ability to configure runtime features (screen availability, menus, language, etc...) to easily customize the system for their requirements. These configurations can be imported/exported to any other MCT4 device for setup (from scratch) within minutes.

Individual, high performance board level PID loop controls (one for each loop up to a maximum of three) offer up to four control outputs each, powerful profiling capabilities with up to three events each (nine total) and full auto tune functionality with high resolution universal process inputs.

The MCT4 also provides the ability to connect a remote, smart IO module that provides up to an additional eight inputs for process monitoring. The inputs can be configured as any combination of thermocouple, voltage and current, all of which can be viewed from the MCT4 display as well as logged to the MCT4 data file.

1.1   Features

Each of the MCT4 loop control boards provide a single digital input that can be programmed as an automatic program control input, input alarm or input status (visual loop status indication). Each loop control board also provides up to four control outputs which can be used as PID control outputs for heat/cool, direct outputs for controlling external equipment related to the application through software switches called events or be programmed to act as system alarm outputs. When single or dual loop control is used, the HLM high/low limit control board can be installed, providing a single interface for all loop control and limit functions from one display.

The MCT4 can be operated in single set point or automatic program control mode. Program entry is made easy through the use of slide list selections and menu items on a single screen. Programs can be copied to the external USB memory stick and then imported to another MCT4 controller which eliminates the need to enter duplicate programs on multiple systems.

Data file analysis tools make looking at historical data a simple task. Any control variable saved to the data file can be plotted on the historical data chart for any time frame within the data file's total time range. The MCT4 can store over a year's worth of data on its SD memory card. Data logging can be enabled manually or automatically during program operation. Data backup is provided via a USB memory stick for plug and play transfer of files to any PC and through the included FTP back-up utility.

The built in Ethernet functionality includes a Web Server to provides access to all MCT4 data (view only), a VNC interface for remote control and monitoring and an NTS clock, all available via a local Intranet connection (wired or wireless), or the World Wide Web using standard software like Microsoft's Internet Explorer.

The MCT4 provides a rich set of tools for control interaction and process monitoring. The interface provides various loop, chart, alarm, automated program status as well as historical data, alarm log and audit trail views. The menu driven interface eliminates screen "clutter" by providing an easy to use "Smart Device" interface for interaction between the user and MCT4.

The MCT4 protects system access with a four-level security system (user rights based), including audit trail capability that documents all user activity and ensures data integrity by digitally signing all data files and audit trails to meet regulatory requirements.

The MCT4 controller includes the following features:

ACCESSIBILITY
- Touch screen, "Smart Device" user interface (UI) with 30,000-hour LED display
- Built in configuration software; no external software or PC required
- Email, SMS, FTP, FileWeb, DataWeb, VNC and Web functionality standard
- Remote View/Control using PC, Tablet or Smartphone.
- National time server connectivity with daylight savings.

COMMAND BAR ICONS
NAVIGATION, HELP & HOME
The Master Command Bar located on the top of the display provides easy & intuitive 1-touch access from anywhere in the system to Navigation, Help and configured Home view.

Home brings the user back to the system "Home" view. The Home icon can be configured for the following standard views:
- Loop view: includes PV & SP digital display, PV min/max, PID % Output, Auto-Manual, event, profile access and more.
- Overview: all loops, profile and event status
- Chart view: (trend up to the last 24 hours from system RAM) supporting 4 trends with up to 6 values per trend
- Alarm view or Alarm File

Help offers content sensitive text for every view / page in one of 11 supported languages chosen by the user.

Navigation provides access to the configured menu system, traditional drop down or icon.

SECURITY AND AUDIT TRAIL
- Supports up to 30 users over four user groups with access to 40+ functions restricted by user group.
- Supports password aging and verification.
- Operator Audit Trail provides history for all user activity that includes date, time, user name and action; i.e., Loop SP change from 55.2 to 103.5.

PROFILE RAMP/SOAK
- Up to three loops
- Start: via touch screen or Event input
- Profile Name: 16-character naming convention
- Global Profile Configuration:
  - Start from PV or static SP
  - Guaranteed Soak & Ramp band
  - Power Fail / Recovery: Continue from last SP value, PV or static mode.
- Profile Segments: (maximum of 64)
- Guaranteed Soak & Ramp per step
- Events: up to 9 events per step (3 events per loop)
- Jump-To Step: configurable per step
- Profile End Alarm
- Configurable Profile End Logic:
  - Current (Static) Control SP: set point and event status prior to profile start is loaded at end of profile
  - Final SP of profile with all events off
  - Last step of profile SP and events are held when profile stops

ALARMS
- Up to 19 alarms including 10 soft configurable to PCM & HLM, up to 3 alarm outputs per PCM and HLM up to 2 alarm outputs.
- Loop* Alarm Types: Process High & Low, Deviation High & Low, Deviation Band and Event Input.

  * PCM configured as Monitor Input (no PID control) configurable only with process and event input alarms.

  Alarm Mode:
  Normal or Hold (on start-up Hold mode will not activate if in alarm condition and arm once out of alarm condition).

  Silent Alarm, activation does not indicate alarm or write to alarm log file.

  Alarm outputs configurable as latching or non-latching.

DATA ACQUISITION
- Data log PV, SP and PID percent output.
- File name: Free form 16 character appended by time/date or the profile name if started with a profile.
- File Start/Stop: user on-demand, on system boot or profile ramp-soak start/end.
- Data Log interval: configurable 1 second to 31 minutes.
- File Interval: configurable to set time in days (1 to 31) to end and start a new file. This allows syncing files to match product cycles as well as keeping file size manageable.
- ID#1 and ID#2 fields allow user to enter specific information such as a batch and/or lot information that is associated with the data file.
- Operator Comments/Events: Unlimited operator comments/events linked to each file
- File Type: Data Log files are saved in .csv format.
- Digital Signatures: Automatic system as well as user entered signatures.
- Historical Data Viewer: View data log files on the display. Chart is auto-scaled on an X & Y axis for time and units.
- Meets the requirements for:
  - CFR21 Part 11
  - AMS2750E

EVENT INPUTS
- PCM / HLM each have 1 event input configurable for one of the following functions.
  - PCM: Profile Run/Abort, Hold/Resume, Run/Hold, Failure Transfer (Outputs), Alarm Input (indication only) and Loop Status Input
  - HLM: Remote Reset

MATH/LOGIC
- Up to 20 configurable math/logic equations.
  - Math equations allow calculations to be performed on any of the process values. Results are displayed on the Overview screen and can be selected for logging/trending.
  - Logic equations can be assigned to event outputs allowing the output to turn on/off based on user defined conditions.

2   Installation

All MCT4 components are pre-loaded with all operating software and firmware before leaving the factory so it is ready to install when you receive it. Before beginning installation, completely read through this section as well as the following section (3 Power and Wiring) to gain an understanding of the entire installation process. Consider the installation carefully. Plan the power, signal and control wiring before installing the MCT4. Also consider the cabinet space, hardware dimensions, environmental conditions and use good wiring practices to minimize problems that may occur due to electrical interference.

⚠	**WARNING:**	• To avoid potential electric shock and other hazards, all mounting and wiring for the MCT4 must conform to the National Electric Code (NEC) and other locally applicable codes.
		• Special expertise is required to install, wire, configure and operate the MCT4 controller. Personnel without such expertise should not install, wire or operate the MCT4.

⚠	**CAUTION:**	• Prevent metal fragments and pieces of wire from dropping inside the housing of the MCT4. If necessary, place a cover over the unit during installation and wiring. Ingress of such fragments and chips may cause a fire hazard, damage or malfunction of the device.
		• When handling the MCT4 PCM and HLM series control boards, use proper ESD (electro-static discharge) handling procedures to prevent damage to board components.
		• Locate the MCT4 and away from AC power/motor wiring and sources of direct heat output such as transformers, heaters or large capacity resistors.

2.1   Enclosure Guidelines

The MCT4 must be installed correctly for reliable operation. The MCT4 controller is designed for installation within a suitable enclosure. Do not install the MCT4 outside of an enclosure. Care must be taken when locating components to ensure that AC power wiring, contactors, starters, relays and other sources of electrical interference are properly located to minimize their impact on the MCT4.

Particular note should be taken to the position of variable speed drives and switching power supplies. Their input and load cables should be screened and properly grounded to a central equipment grounding point to prevent radiated emissions from affecting MCT4 operation.

2.1.1   Locating the MCT4

It is recommended that the unit be mounted within the front panel of a steel enclosure, through an appropriately sized opening. Proper enclosure depth is required to ensure that there is adequate spacing between the rear of the unit and the front of any high voltage devices mounted in the enclosure when the enclosure door is closed. It is required that a minimum separation of 4" be maintained for proper wiring clearance, so plan a depth to accommodate at least 9" (230mm) behind the front of the panel.

Proper clearance must also be maintained above, below and on both sides of the MCT4 to allow for heat dissipation and to facilitate mounting. A minimum of 2" is recommended.

2.2 Environmental Considerations

Do not subject the MCT4 to operating temperatures below 0°C (32°F) or above 50°C (122°F). Minimum and maximum relative humidity levels are limited between 10% and 90% (non-condensing). The MCT4 touch is to be used indoors only. The unit should not be installed where fast temperature variations may occur as this can cause condensation of water vapor on the device.

The MCT4 should not be exposed to excessive dust, dirt, salt, direct sunlight or shock and vibration. Do not operate the MCT4 controller in an area where chemicals or flammable gases are present. Permitted storage temperature extremes for the MCT4 control system are limited to -10°C (14°F) and 60°C (140°F).

2.3 Mounting Dimensions

The MCT4 is supplied with four mounting clips. All four clips must be installed and properly tightened to insure the IP66 protective rating. Failure to install all mounting clips may also affect touch screen operation. Be sure to tighten each mounting clip evenly so as not to flex the case of the unit. DO NOT over tighten the mounting clips. The clips should be tightened just enough to compress the gasket so that the bezel is parallel with the mounting surface.
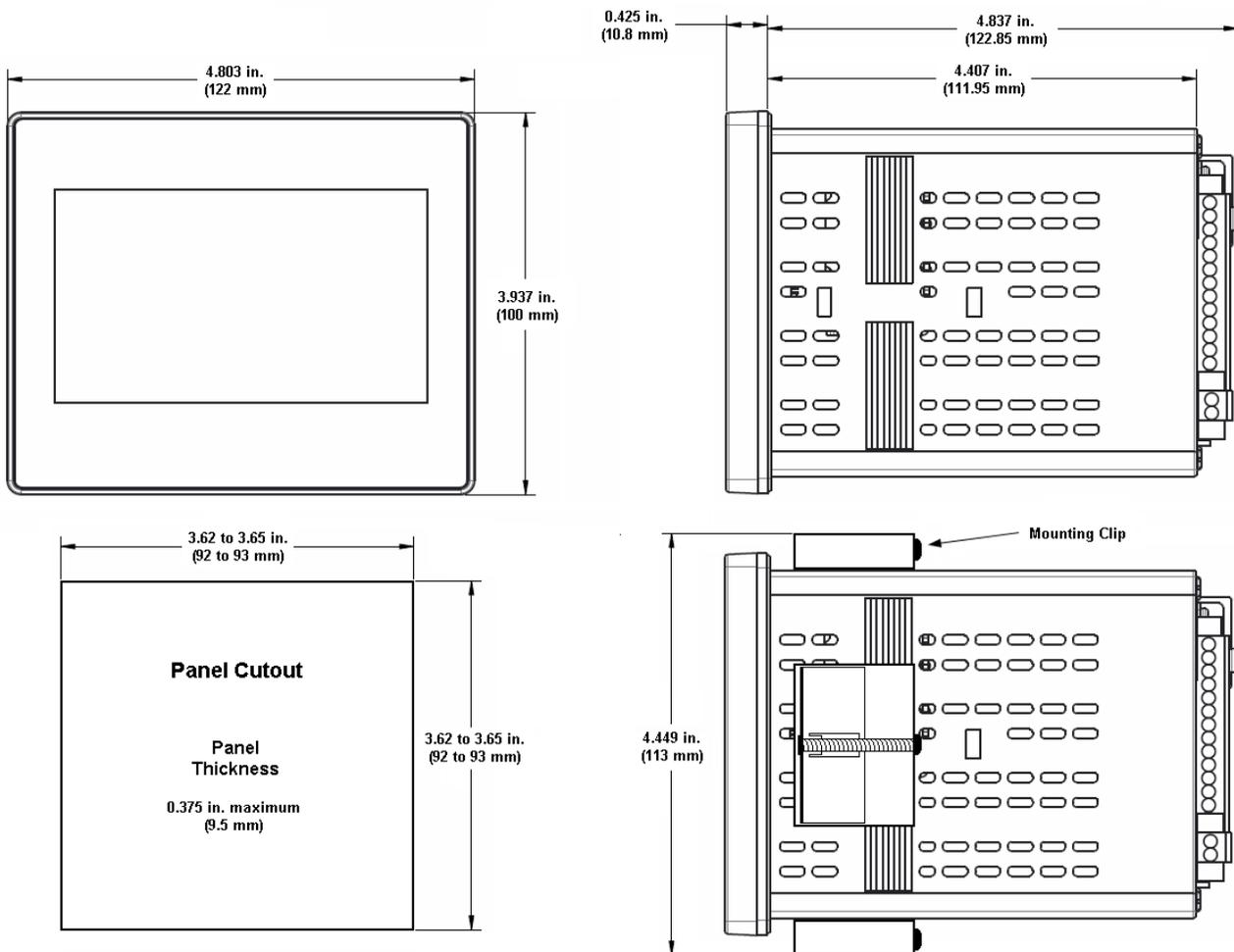
2.3.1   MCT4 Process Loop/Limit Controls

One PCM control board is required for each process control loop. Each PCM must be installed in sequential order beginning with slot 1 up through slot 3. Only one HLM limit board can be installed in the MCT4. The HLM must be installed after all of the PCM cards in the next open slot. For a single loop MCT4, a PCM will be installed in slot 1 and the HLM in slot 2. For a dual loop MCT4, PCM cards will be installed in slots 1 and 2 while the HLM will be installed in slot 3.
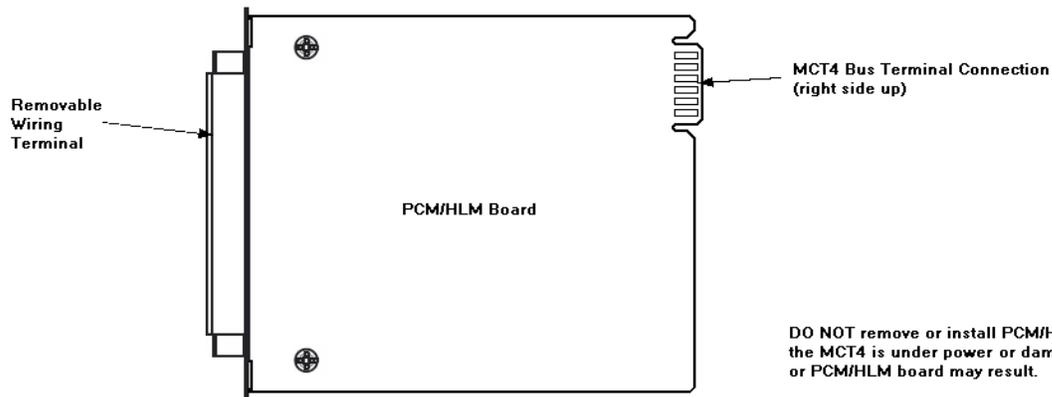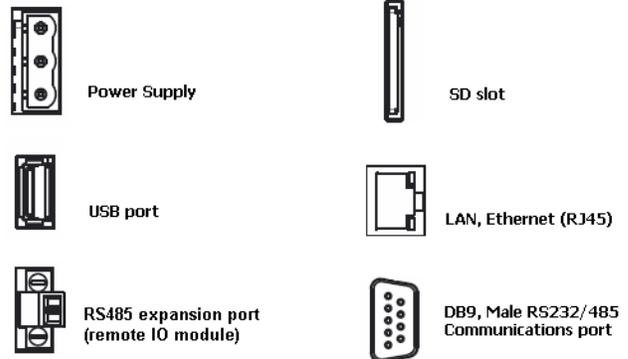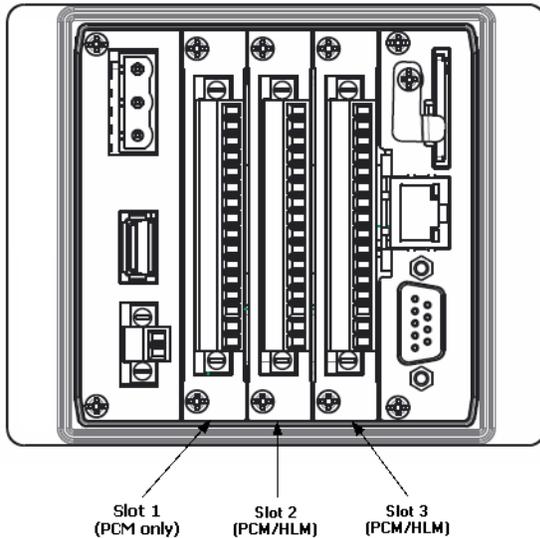
NOTE: The MCT4 will not operate properly without the SD card installed into the SD card slot on the back of the unit. The SD card is preloaded with all software required for 'Auto-Boot' operation. The slot on the back of the interface is 'keyed' so the card can only be installed in one direction. The card is pre-installed for your convenience. If the card is removed, take care when inserting the SD card and DO NOT force it into the slot. The card MUST be installed prior to application of power.

2.4 Smart IO Monitor Module

The Smart series SIO-8AIU(-H) remote I/O module provides the option of adding eight monitor input points to the MCT4. Each input is individually configurable for an array of different thermocouple, voltage and current types. The stand-alone module provides a wide input power range of 10-60VDC and an operating temperature range of -25 to 70°C (-13 to 158°F). Humidity limitations range from 5 to 95% non-condensing.

Unit:mm
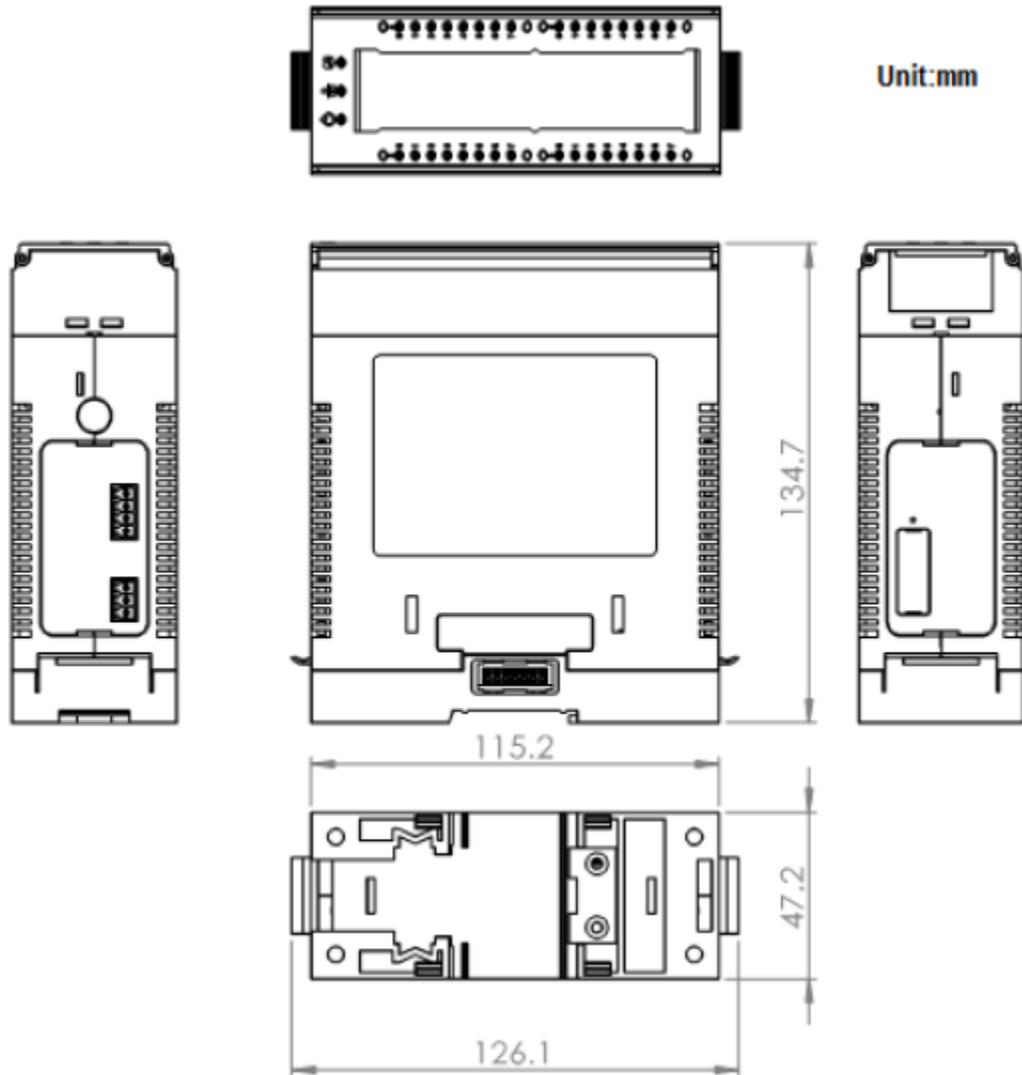
2.5 Expansion IO Module

The expansion I/O module (FDC630TA-DC) provides the option of adding an additional 16 digital inputs and 14 digital outputs to the MCT4. The inputs and outputs can be utilized as alarms, events, or for any number of uses within math/logic functions. The expansion IO module operates on 24VDC power and within an operating temperature range of -30 to 75°C (-22 to 167°F). Humidity limitations range from 10 to 90% non-condensing.

The inputs have a voltage range of 20-28VDC (24VDC nominal). The outputs are transistor (NPN) with an operating range of 5-30VDC with maximum of 0.15A per output (10mA minimum).

NOTE: *The MCT4 supports a maximum of 9 program events and 16 total system events. Any combination of loop outputs and expansion module outputs can be configured as program/manual only events up to the maximums noted. All outputs can be utilized as math/logic only outputs.*

Unit: mm
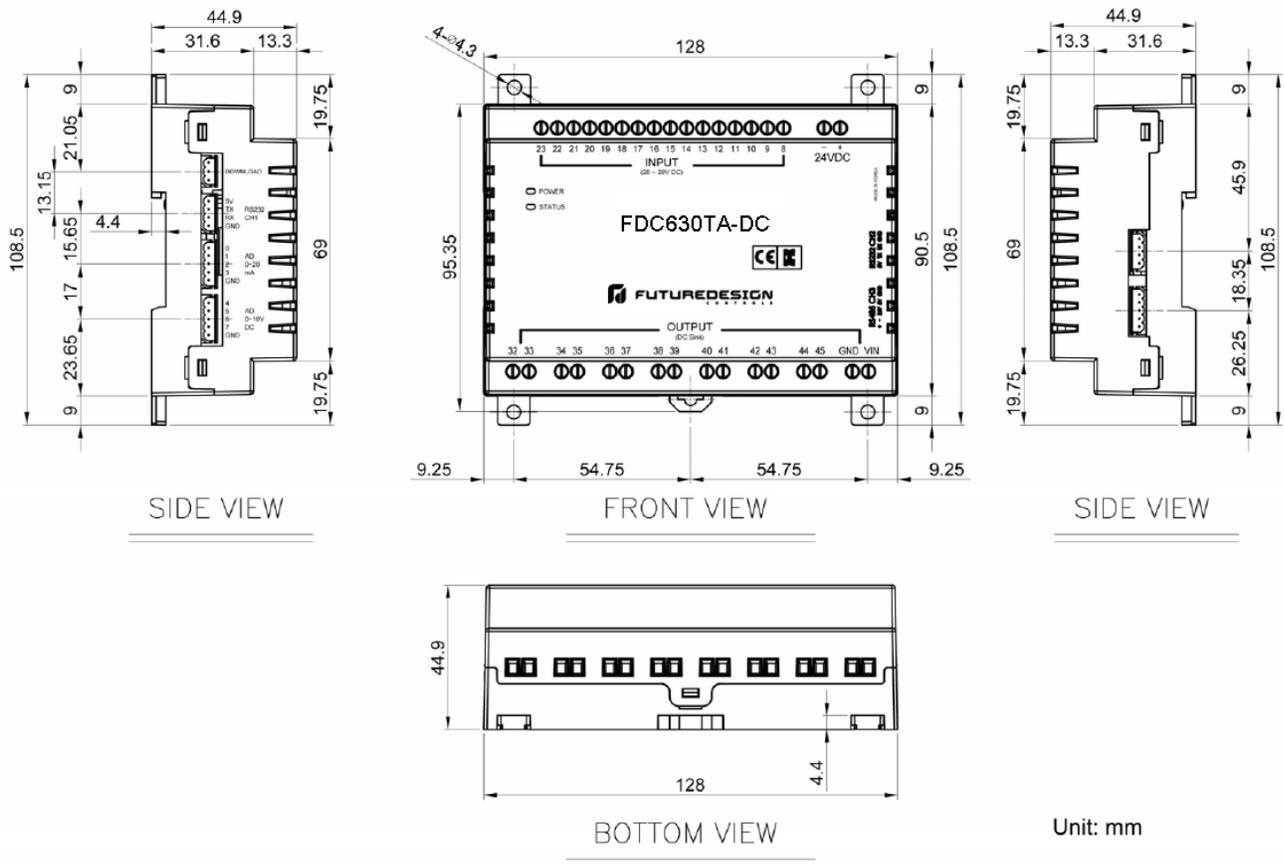
3   Power and Wiring

This section describes the methods and precautions for wiring the MCT4.

| ⚠ | **WARNING:** | • Turn off power before starting installation, removal, wiring, maintenance and inspection of the MCT4 controller. Failure to turn off power may cause electric shock, create a fire hazard or cause damage to the MCT4. |
| | | • Emergency stop and interlocking circuits **MUST** be configured outside of the MCT4. If such circuits are made through the MCT4, failure of the MCT4 may cause uncontrollable operation, damage to equipment or accidents. |

⚠	**CAUTION:**	• This section presents recommended installation practices and procedures. Since no two applications are identical, these recommendations should be considered as guidelines. The system designer should be aware that devices in control systems could fail and thereby create an unsafe condition.
		• Electrical interference in an operator interface can lead to equipment start-up, which could result in property damage and/or physical injury to the equipment operator.
		If the application requires an operator or attendant, you should be aware that this potential safety hazard exists and take appropriate precautions. Consult NEMA ICS 3-304 for more information regarding safety for the installation of solid-state programmable control devices.

3.1   Power Requirements

The MCT4 can be ordered to operate from either 11-26VAC/VDC or 90-250VAC (47-63Hz) supply. Power draws for both power options is 36VA, 15W maximum. Do not power the MCT4 controller and highly inductive loads or input circuitry to other equipment with the same power source used for the MCT4.

For 11-26VAC/VDC models of the MCT4, it is recommended that a time delay-on relay be installed in the power supply wiring to the MCT4. This will prevent rapid on-off cycling of the MCT4 during brown-out or momentary power interruptions. Rapid power cycling to the MCT4 can cause damage to the electronics and/or loss of data. The 90-250VAC model of the MCT4 does not require this power-on delay relay. The internal power supply protects the circuitry from rapid power cycles.

3.1.1   Installing the Power-On Delay Relay

Due to the rate at which AC/DC power supplies reach their nominal supply voltage after application of power, the relay contact of the timer should be installed between the output of the power supply and the power input of the MCT4. This allows the power supply output voltage to reach its nominal value prior to connecting the MCT4 to its output terminals.

In order to properly sense the loss of power, the time delay relay coil should be wired to the AC power source for the DC power supply. This will ensure that the MCT4 is turned off/on at the proper times and prevent malfunction that can be caused by rising or falling voltage at the power supply output during power interruption.

NOTE: *It is recommended that the time delay-on relay be set for a minimum period of 3 seconds.*

GE1A-C

Delayed DPDT
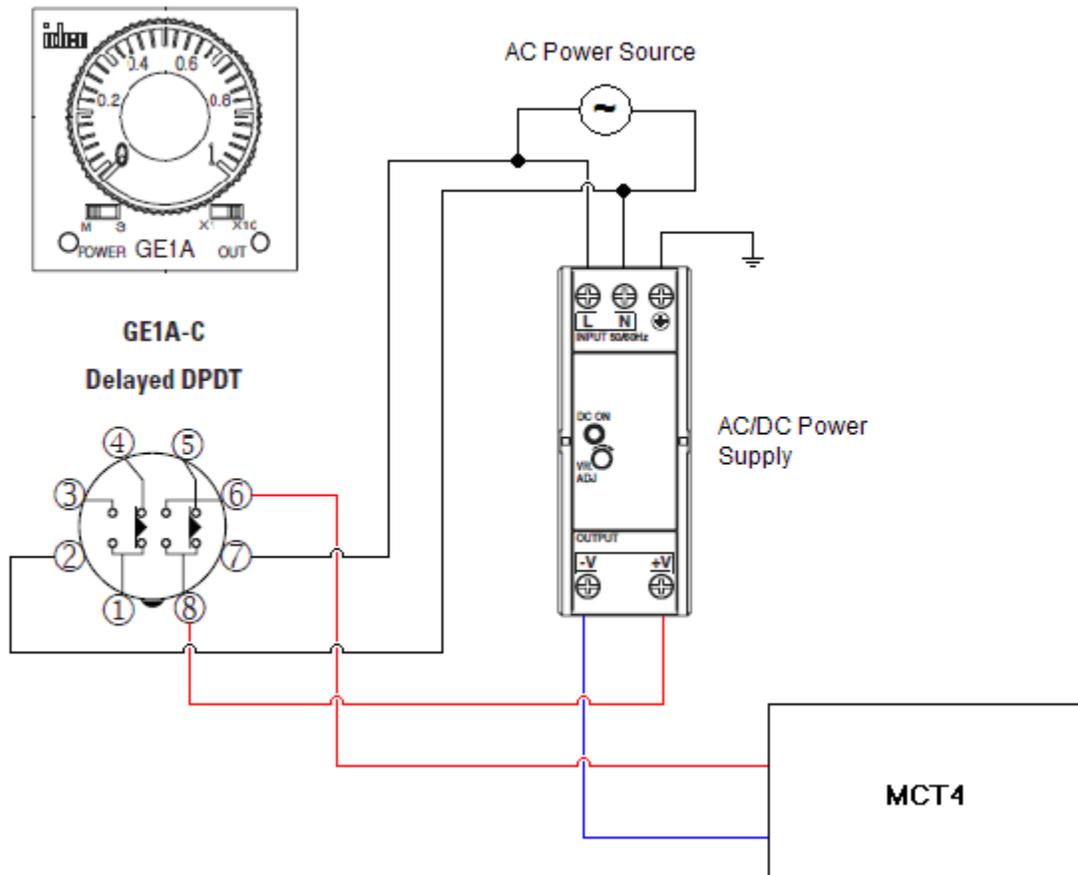
3.2 Connecting to the MCT4

Power connections should be made using 14 AWG copper conductors rated for at least 90°C (maximum wire size = 12 AWG). To make a connection, strip about ¼" of insulation off the end of the wire, turn the connector screw counterclockwise until the gap is wide open, insert the wire all the way in, and turn the screw clockwise until it's tight (maximum torque rating = 0.51 N-m).

NOTE: *Upon application of power, if the MCT4 does not come on within 2 seconds, remove power. Check wiring to ensure proper connections and try to power up again. An Internal fuse will prevent damage for over voltage conditions; however, it isn't guaranteed.*

AC Power, 90-250 V AC, 47~63Hz

Pin		Description
1	⏚	Earth
2		Neutral
3		Line
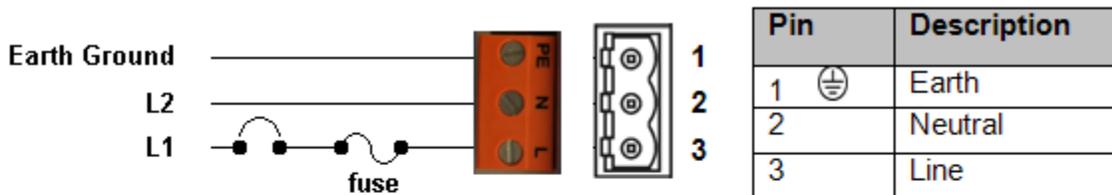
Note: Orange color terminal supplied for AC

DC Power, 11-26 V AC/DC

Pin		Description
1	⏚	Earth
2		DC-
3		DC+

Note: Green color terminal supplied for DC

3.2.1   Process Control Module (PCM) Connections

The MCT4 can have a maximum of three PCM boards installed. The PCM boards must be installed beginning with slot 1 up to slot 3 for the maximum. DO NOT remove or install PCM boards while the MCT4 is under power or damage to the PCM or MCT4 may result.

PCM screw terminals are rated for up to 14 AWG wire and a maximum torque of 0.19 N-m.

3.2.1.1   *Sensor Input*
The PCM provides a universal input via DIP switch and software selections to choose from the available input types. During installation, the DIP switch setting should be verified to ensure that it matches the type of sensor used. The DIP switch is located on the component side of the PCM board.
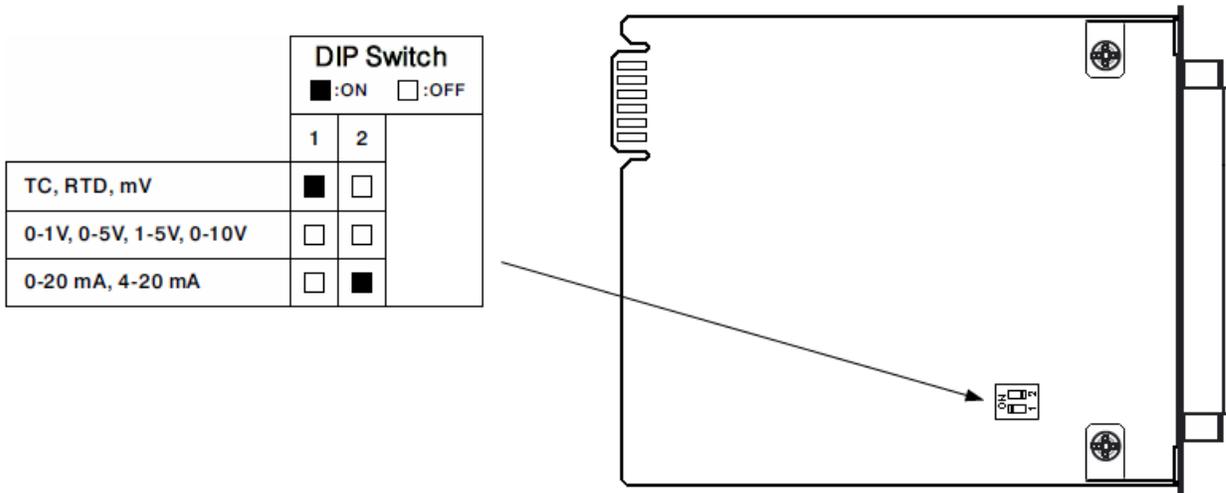
DIP Switch	1	2
TC, RTD, mV	ON	OFF
0-1V, 0-5V, 1-5V, 0-10V	OFF	OFF
0-20 mA, 4-20 mA	OFF	ON

Thermocouple Input: Extension wire must be of the same alloy as the thermocouple to limit errors in reading.

RTD Input: A 2-wire RTD can be used by placing a jumper between terminals 15 and 16 on the PCM. However, for every 1 ohm of lead wire resistance, an error of up to 1.1°C (2°F) can be caused in reading. Therefore, it is recommended that only a 3-wire RTD be used.

Process Input: It is recommended that shielded cable used for process inputs whenever possible to minimize the effects of external electrical interference that can affect accuracy of the reading.

0-1V, 0-5V, 1-5V, 0-10V   0-20 mA, 4-20 mA   TC, mV

RTD: A, B, B (terminals 14, 15, 16)

19
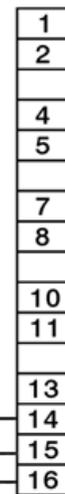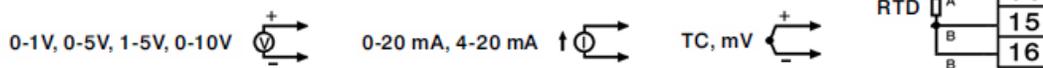
3.2.1.2 Event Input

The Event input accepts a digital type signal via a dry contact (switch/relay) closure. The input can also be activated via an open collector/TTL source.
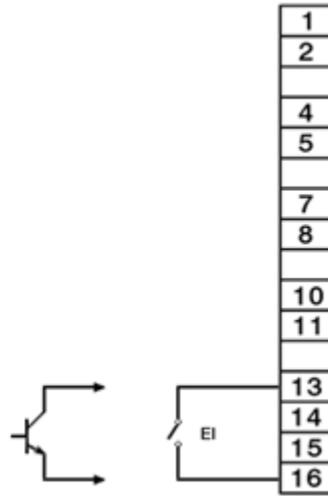
3.2.1.3 Control Outputs

Each PCM can provide up to four outputs. The output type (if present) is based upon the PCM ordering code. Verify that the required output is supplied on the PCM prior to connecting it to the load.

Relay Outputs

Contacts rated 240VAC (30VDC), maximum 2A resistive.
Maximum 1A inductive load cosΦ = 0.4 (L/R = 7ms).
Minimum 100,000 operations at 20 times/minute (resistive load).
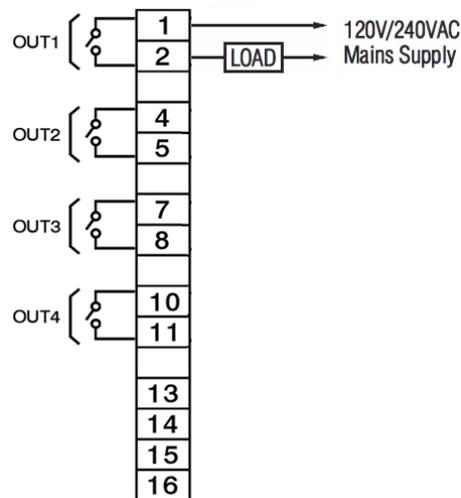
Pulsed Voltage Outputs

Source Voltage: 5V at 30mA, current limiting resistance 66 ohms
14Vat 40mA, current limited at 70mA (recommended for driving 3 phase SSR)
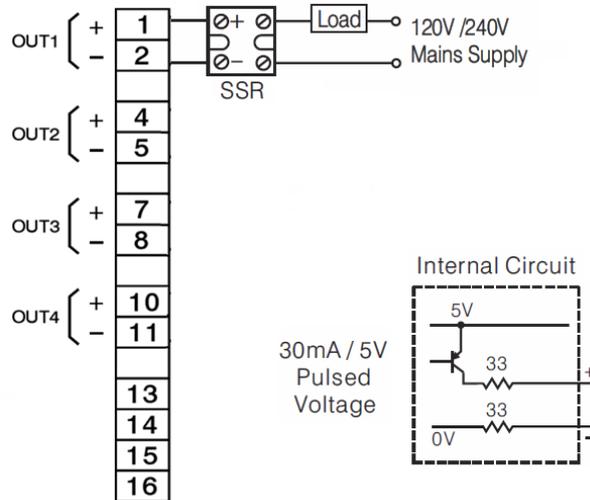
Isolated Linear Outputs

Output 1 and 2 are capable of providing linear outputs for control operation, i.e., heat/cool.
Output 3 does not provide a linear output option.
Output 4 is capable of providing a linear output for process value (PV) or set point (SP) retransmission.
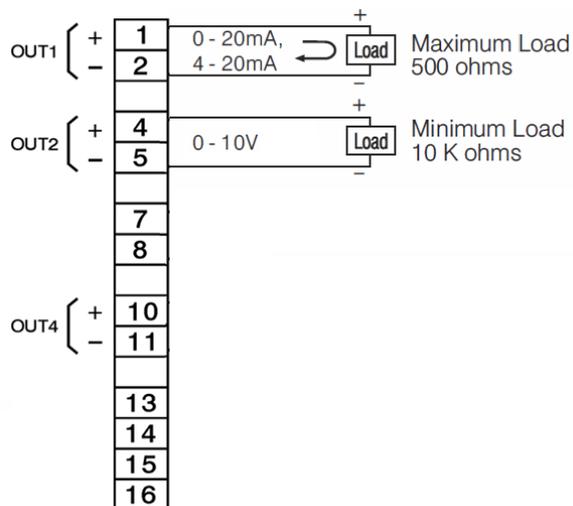
Transmitter Power Supply

Output 1 does not provide a power supply option. It is for control operation only.

Outputs 2, 3 and 4 each provide options for a 5VDC/80mA, 12VDC/40mA or 20VDC/25mA power supply.
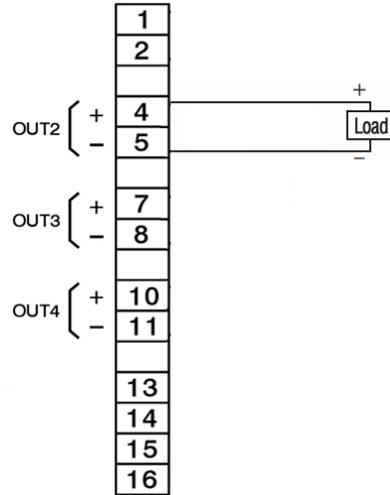
3.2.2   High Limit Module (HLM) Connections

The MCT4 can have a maximum of one HLM board installed. The HLM must be installed after all PCM boards in the next open slot. If only one PCM is installed, the HLM would be installed in slot 2. If a PCM is installed in both slots 1 and 2, the HLM would be installed in slot 3. At least one PCM must be installed in the MCT4 for proper operation.

HLM screw terminals are rated for up to 14 AWG wire and a maximum torque of 0.19 N-m.

3.2.2.1   *Sensor Input*
The HLM provides input type selection via DIP switch and software selections. During installation, the DIP switch setting should be verified to ensure that it matches the type of sensor used. The DIP switch is located on the component side of the HLM board.

DIP Switch		
■:ON □:OFF		
	1	2
TC, RTD, mV	■	□
0-1V, 0-5V, 1-5V, 0-10V *	□	■
0-20 mA, 4-20 mA	■	■

*0-1V and 0-5V/1-5V input types are special order. HLM units ordered with either input type cannot be programmed for any other type.
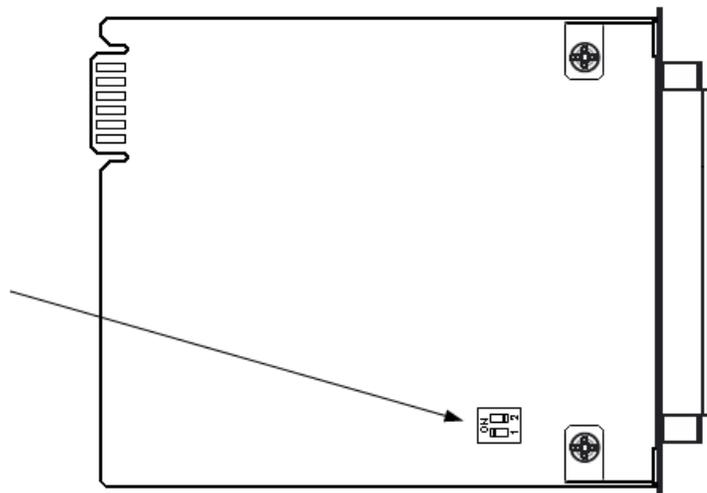
Thermocouple Input: Extension wire must be of the same alloy as the thermocouple to limit errors in reading.

RTD Input: A 2-wire RTD can be used by placing a jumper between terminals 15 and 16 on the PCM. However, for every 1 ohm of lead wire resistance, an error of up to 1.1°C (2°F) can be caused in reading. Therefore, it is recommended that only a 3-wire RTD be used.

Process Input: Linear voltage and current inputs are *NOT* FM approved. It is recommended that shielded cable used for process inputs whenever possible to minimize the effects of external electrical interference that can affect accuracy of the reading.

0-1V, 0-5V, 1-5V, 0-10V   0-20 mA, 4-20 mA   TC, mV

1
2
3
5
6
7
8
9
11
12
13
14
15
16

RTD
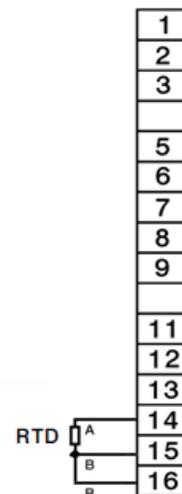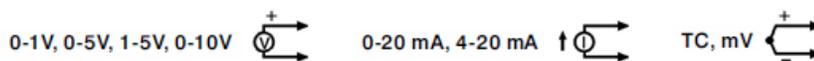
3.2.2.2 Event Input

The Event input accepts a digital type signal via a dry contact (switch/relay) closure. The input can also be activated via an open collector/TTL source.
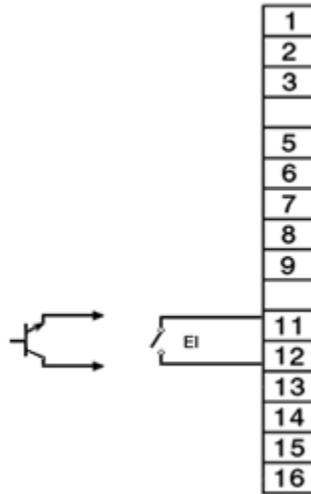
3.2.2.3 Control Outputs

The HLM provides one limit output as well as an optional programmable output. The output type is based upon the HLM ordering code. Verify that the required output is supplied on the HLM prior to connecting it to the load.

Relay Outputs

Contacts rated 240VAC (30VDC), maximum 2A resistive.
Maximum 1A inductive load cosΦ = 0.4 (L/R = 7ms).
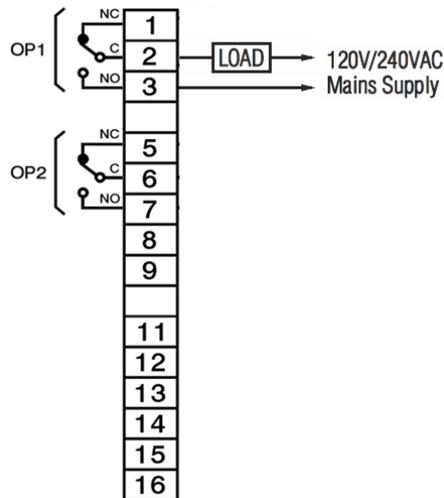
Pulsed Voltage Outputs

Source Voltage: 5V at 30mA, current limiting resistance 66 ohms
14Vat 40mA, current limited at 70mA (recommended for driving 3 phase SSR)
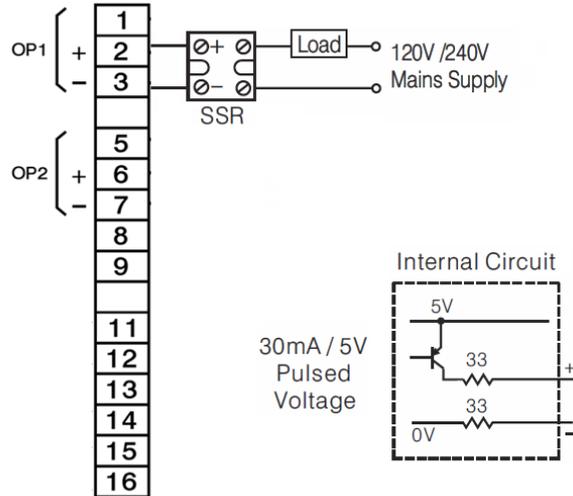
Transmitter Power Supply
Output 1 is for high/low limit operation only. Output 2 provides options for a 5VDC/80mA, 12VDC/40mA or 20VDC/25mA power supply.
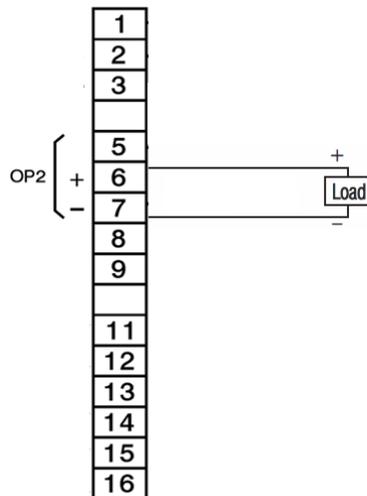
3.2.3   Communication Connections

The MCT4 provides an RS232/485 serial interface, 10/100 base-T Ethernet port and USB port. The serial port and Ethernet port provide user communication options for remote monitoring and control of the MCT4. See section 11 Communications for more information regarding their use.   The USB port provides data file options for copy/backup of internal files (see section 8.4 USB File Transfer) as well as simple import/export configuration utilities (see section 10.7 Configuration).

The MCT4 also provides a "Master" RS485 communication connection. This connection is utilized for the Smart series remote IO module only.

Master RS485 Connector
(*Smart IO Module*)
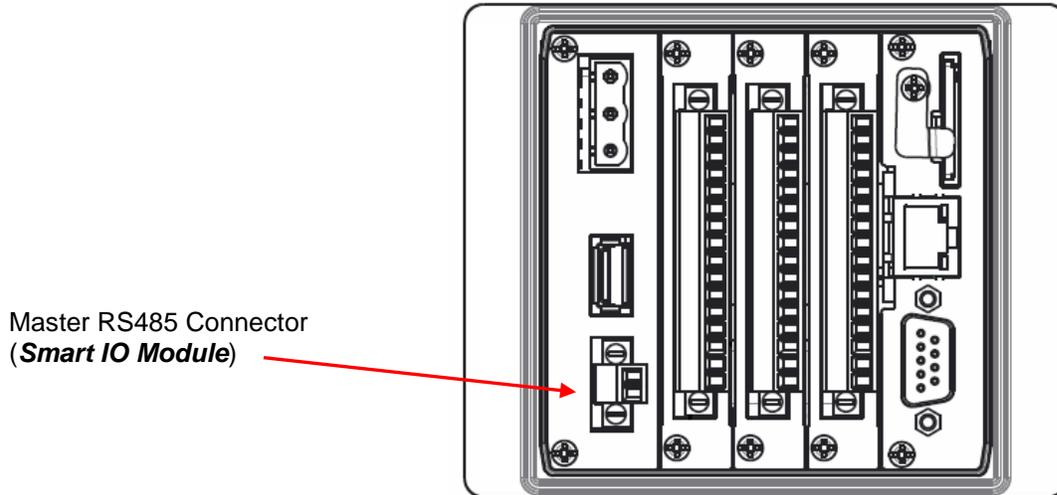
3.2.3.1   *RS232/485 User Serial Communications*
The MCT4 is equipped with a DB9 male serial port that provides both RS232 and RS45 communication options. Only one hardware interface can be used at a time. In order to connect the MCT4 to a PC running software such as Future Design Control's Envision software a cable must be fashioned according to the following diagrams.

RS232
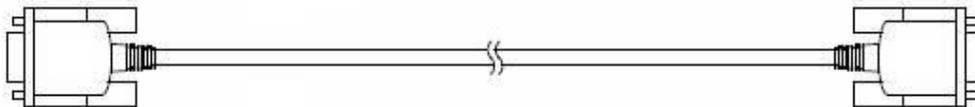
D-sub 9-pin Female Connector Pinouts				Pin	D-sub 9-pin Female Connector Pinouts	
Description		Pin		Pin	Description	
Shield		Cover		Cover	Shield	
RXD	Receive Data	2		2	RXD	Receive Data
TXD	Transmit Data	3		3	TXD	Transmit Data
SG	Signal Ground	5		5	SG	Signal Ground
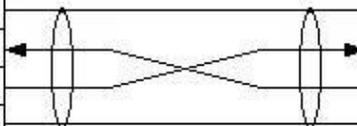
NOTE: DO NOT use a standard null-modem cable to connect the MCT4 to a PC. Most computers do not provide a standard serial port and a USB to serial converter must be used. Incompatibilities may exist between the MCT4 and certain USB to serial adapters which may cause the MCT4 to malfunction when connected using a standard null-modem cable.

RS485

If more than one MCT4 controller is to be placed on the communication link with a PC or the distance between the PC and the MCT4 exceed the recommended maximum of 30 feet for RS232, an RS485 converter is required at the PC in order to utilize the RS485 connection.
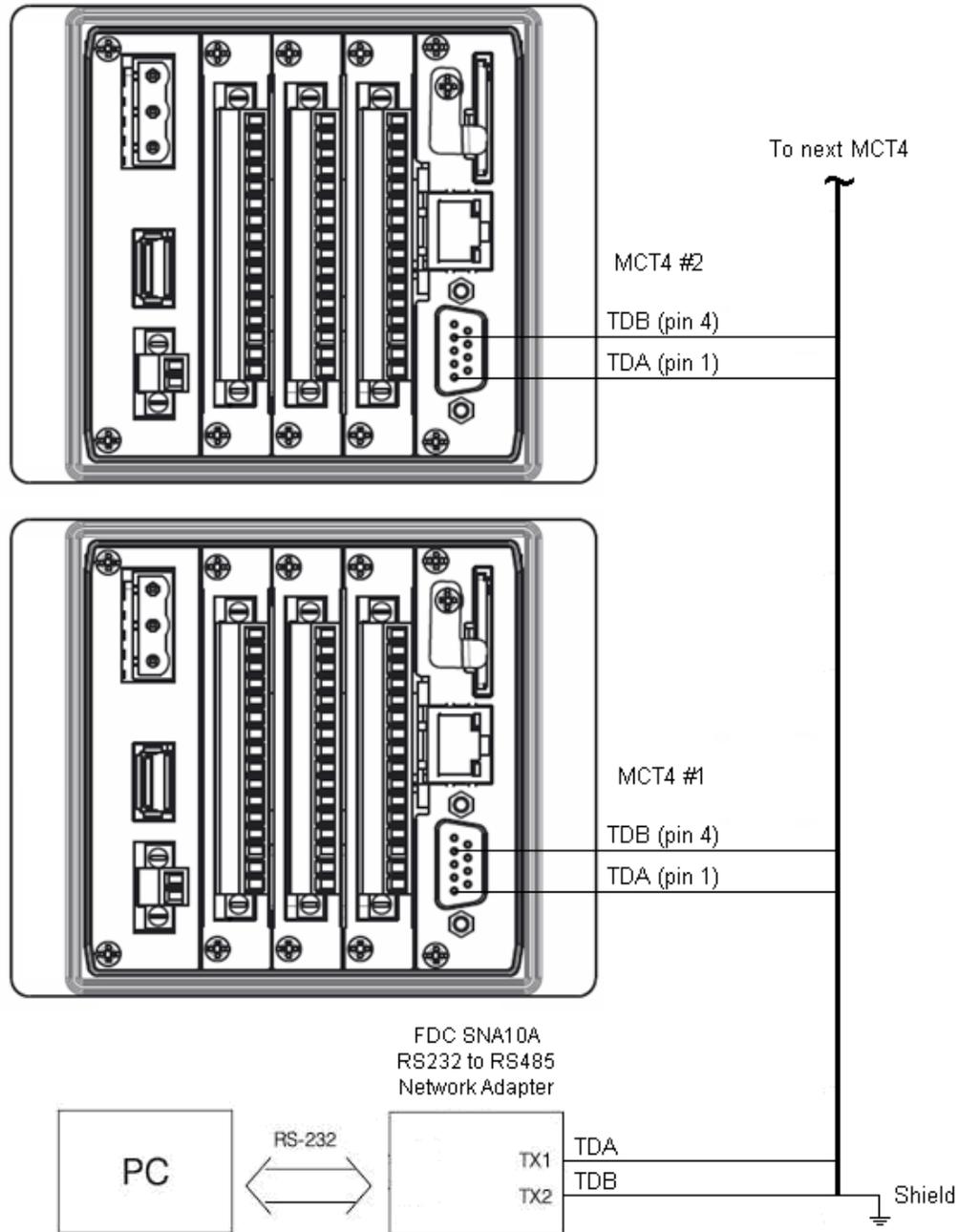
NOTE: The connection requires a single twisted-pair cable that is daisy-chained from one MCT4 to the next. When using shielded twisted-pair cable, be sure to ground only one end of the cable, preferably at the RS232 to RS485 network adapter. Allowing any other portion of the cable shield to come in contact with ground, or grounding both ends, will cause ground loop currents to flow in that section of the cable which can cause communication errors.

3.3   Connecting to the Smart IO Monitor Module

Power connections should be made using minimum 18 AWG copper conductors (maximum wire size = 14 AWG). To make a connection, strip about ¼" of insulation off the end of the wire, turn the connector screw counterclockwise until the gap is wide open, insert the wire all the way in, and turn the screw clockwise until it's tight.
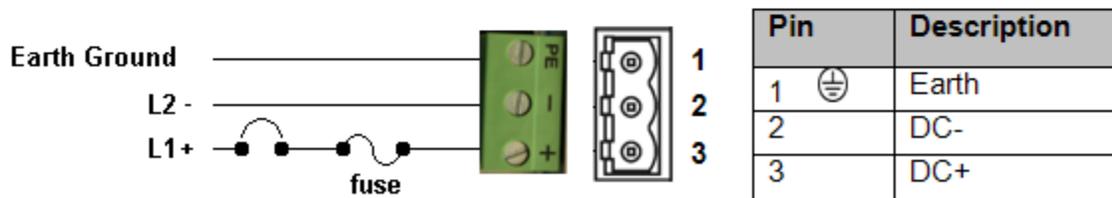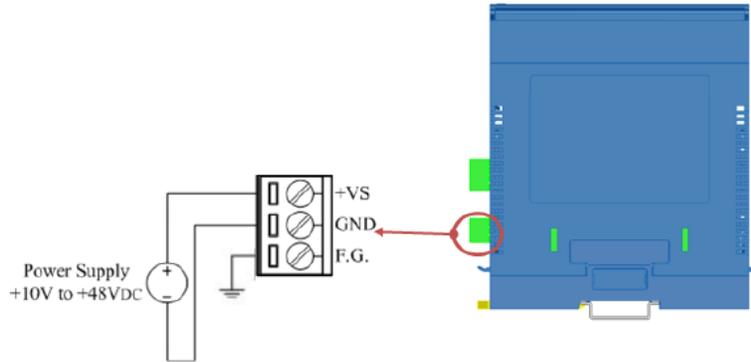

The communication connection to the MCT4 requires a single twisted-pair cable. When using shielded, twisted-pair cable, be sure to ground only one end of the cable, preferably at the module. Allowing any other portion of the cable shield to come in contact with ground, or grounding both ends, will cause ground loop currents to flow in the cable which can cause communication errors.
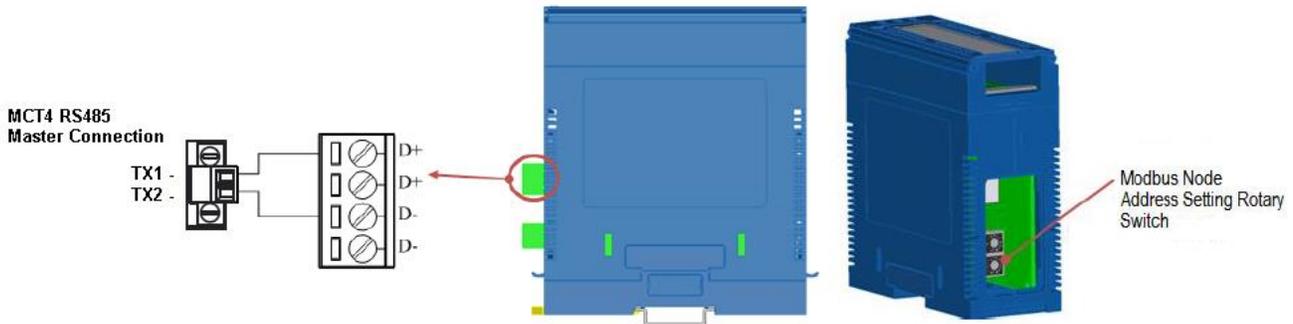
In order for the MCT4 to be able to communicate with the monitor module, the communications address must also be properly set. To do this, remove the cover located on the bottom of the module to access the rotary switches. Adjust both rotatory knobs to a value of 1. Replace the cover after the settings have been made.

IMPORTANT: *See section 4.16 Smart IO Communication Utility to complete the monitor card installation process. This utility must be run in order to set the proper communication parameters in the monitor card prior to use.*

3.3.1   Sensor Wiring

Each input of the Smart series monitor module can be configured for a variety of thermocouples, voltage and current ranges. Thermocouple types include J, K, T, E, R, S, B and N. Voltage ranges include $\pm$100mV, $\pm$500mV, $\pm$1V, $\pm$5V, $\pm$10V, 0~100mV, 0~500mV, 0~1V, 0~5V and 0~10V. Current ranges include $\pm$20mA, 4~20mA and 0~20mA.

NOTE: *When the input is to be used for a current input, the slide switch for the input must be set to current mode. For thermocouple and voltage inputs, the slide switch must be set for voltage mode.*

Channel 0 Mode Switch

Voltage Mode   Current Mode

Channel 7 Mode Switch

Terminal Assignment

00+
00-
01+
01-
02+
02-
03+
03-
04+
04-
05+
05-
06+
06-
07+
07-

Voltage Input

00+
00-   + V
             -
             mV/V

Current Input

00+
00-   + A
             -
             mA

Thermocouple Input

00+
00-   +
             -
             T/C
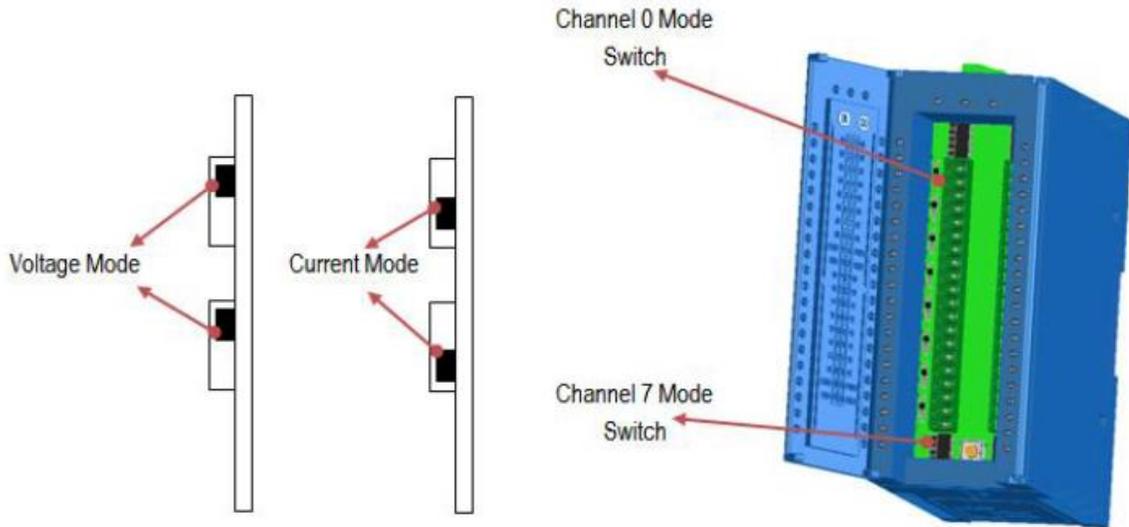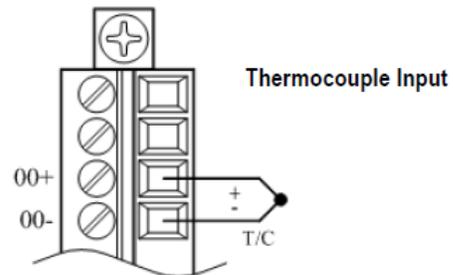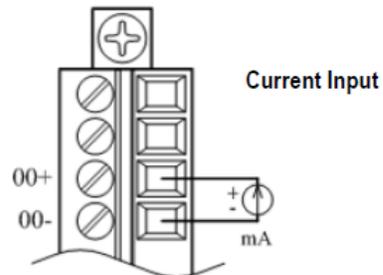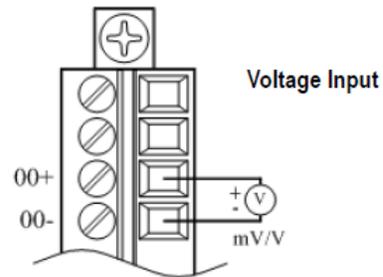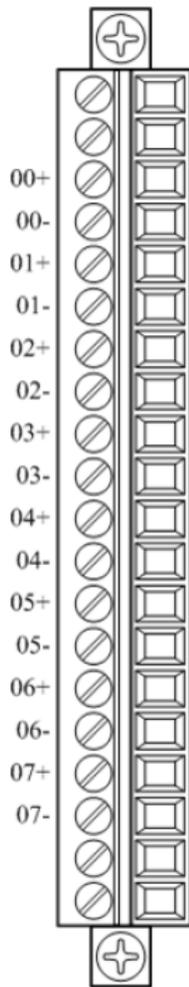
3.4 Connecting to the Expansion IO Module

Power and IO connections should be made using minimum 18 AWG copper conductors (maximum wire size = 14 AWG). To make a connection, strip about ¼" of insulation off the end of the wire, turn the connector screw counterclockwise until the gap is wide open, insert the wire all the way in, and turn the screw clockwise until it's tight.
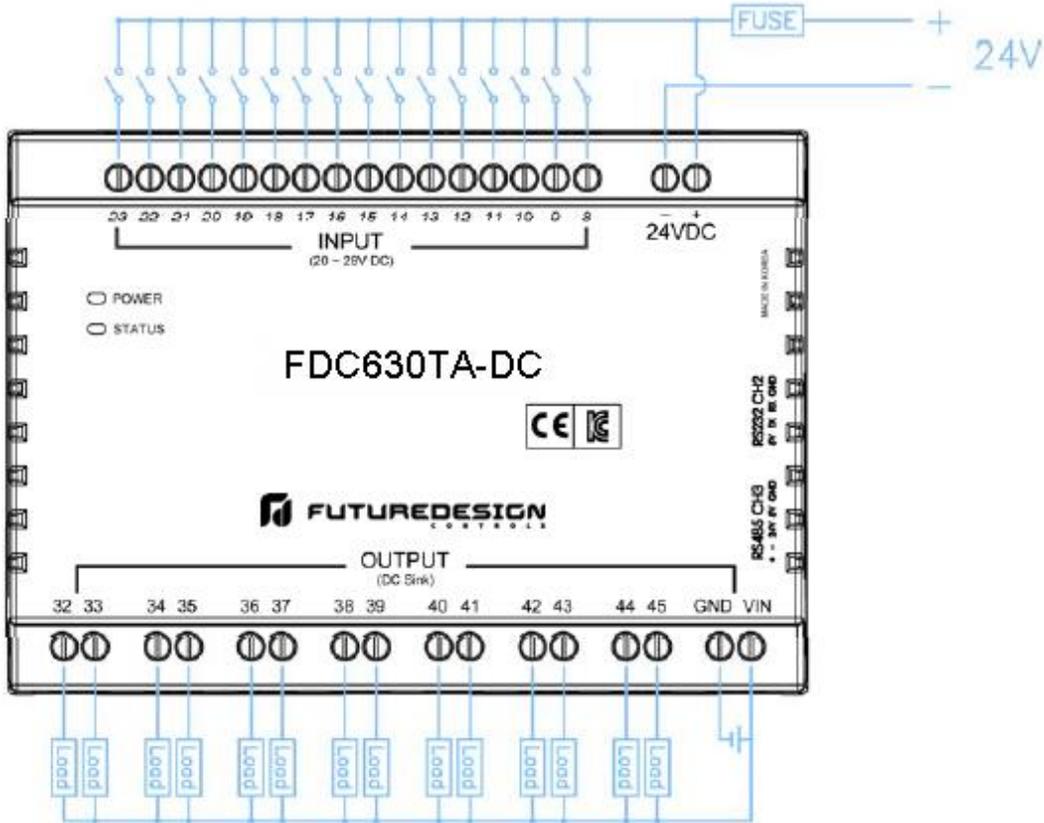
The communication connection to the MCT4 is made via the 5-pin connector on the right side of the expansion module. Connectors are provided with pig-tail leads (TX1=gray, TX2=orange). Lead length is ~18" and can be extended if necessary. When extending the leads, it is recommended that shielded, twisted-pair cable is used.
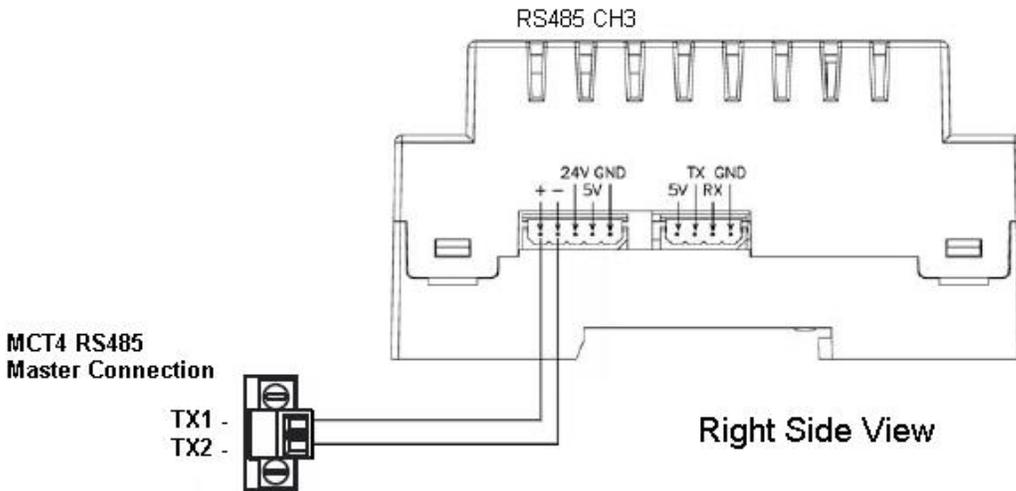
4   Configuring the MCT4

The MCT4 Configurator is a powerful tool that is built in to the system. It is a program that allows the OEM or user to set up control system options for the MCT4 runtime application. This allows for on-the-spot setup of the MCT4 without the need for external hardware and software. The user or OEM must first run the Configurator prior to putting the MCT4 into service in order to properly setup the system for its intended use. The MCT4 Configurator provides the following functionality:

- Set the control type, i.e., single loop, single loop + limit, dual loop, etc.
- Configure the availability of soft alarms
- Configure the availability of monitor points
- Configure the availability and enter math/logic equations
- Provide control loop/limit configuration settings for input type, output function, set point range, etc.
- Provide monitor point configuration settings for input type, zero, span, etc.
- Select the type of user communications for the Modbus slave interface
- 'Splash Screen' name editing for custom OEM or user requirements
- Enable/disable options for runtime menu and screen availability
- Text editing for all system event and alarm names

The Configurator program does not run at the same time as the main runtime software. It can be run by exiting the runtime software via the Offline Setup\Exit Application screen. When the "Exit application (configuration mode startup)" option is selected, on the next power-up, the Configurator application will automatically start.

To access the Configurator:

1. From the runtime application, press the "Home" icon to make sure you are on the main view.

2. Press the "Menu" icon (monitor) and select Device and then Settings.

3. From Settings, press the "Menu" icon (monitor) and select Offline and then Offline.
   Press "Yes" at the prompt to go offline.

4. From Offline, press the "Menu" icon (monitor) and select System and then Exit.

5. On the Exit Application screen, press the "Exit Application (configuration mode startup)" button.
   Press "Yes" at the prompt to exit the application.

6. Once the runtime application quits and the desktop is shown (black screen with the words "System Startup Please Wait…"), cycle power to the MCT4. Once the MCT4 finishes its boot sequence, the Configurator application will be automatically started.
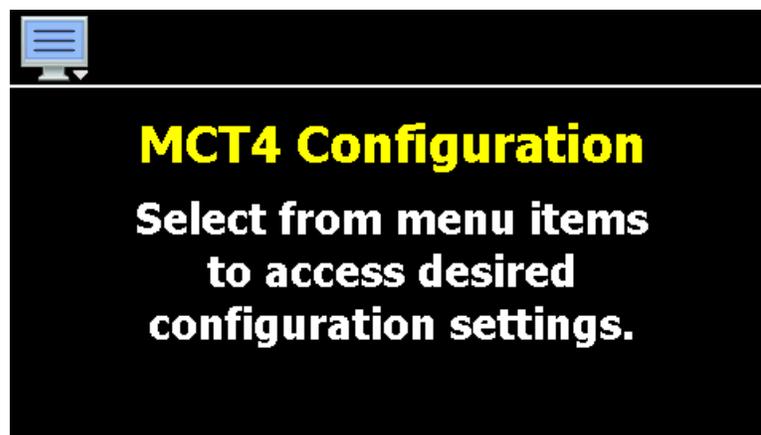
The Configurator menu is accessed by pressing the "Monitor" icon at the top left of the screen.

File	▸	Exit
Setup	▸	About
Options	▸	Loop Address Utility
Startup	▸	Smart IO Comms Utility
Tagnames	▸	
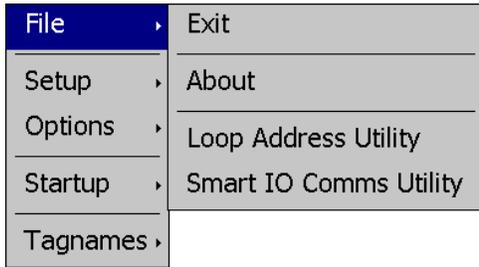
The **File** menu provides selections of "Exit" and "About". The exit function for the Configurator saves all settings and closes the Configurator application. The about selection displays version information for the Configurator application and configured control devices.

It also includes selections for accessing the Loop Address Utility and Smart IO Comms Utility for use in setting up and connecting to B42 loop controls and the remote monitor module.

File	▸	Control Setup
Setup	▸	Loop Configuration
Options	▸	Limit Configuration
		Monitor Configuration
Startup	▸	Soft Alarm Configuration
Tagnames	▸	Math/Logic Configuration
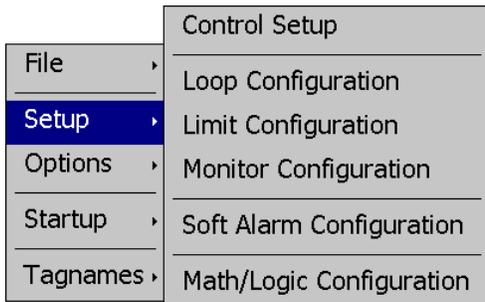
The **Setup** menu provides access to the control setup options. These options include the controller type (single loop, dual loop, cascade, etc.), the process loop and limit settings, soft alarm settings, monitor point settings and math/logic equation entry.

File	▸	
Setup	▸	
Options	▸	Cascade Control
Startup	▸	Expansion IO
Tagnames	▸	Event Timer
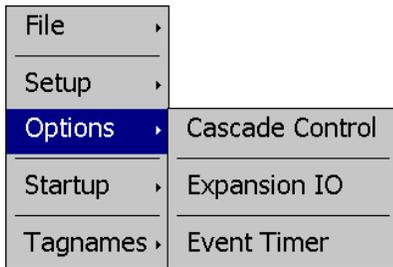
The **Options** menu provides access to Cascade Control, Expansion IO and Event Timer configuration settings.

File	▸	
Setup	▸	
Options	▸	
Startup	▸	Functions
Tagnames	▸	Startup View
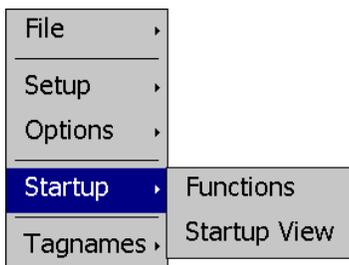
The **Startup** menu provides access to enable and disable MCT4 runtime screens/menus and set the desired startup view selection.

File	▸	
Setup	▸	
Startup	▸	Alarm Names
Tagnames	▸	Event Names
		Custom Name\Address
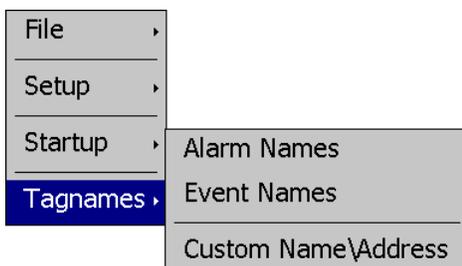
The **Tagnames** menu provides access to the text editing functions of the Configurator which allow the event and alarm names to be changed to match their use in the system. The menu also provides access to edit the splash screen information that is shown when the runtime application starts.

From the Configurator, the user or OEM can then set up all process loop/limit controls, monitor points (if installed) as well as choose from a long list of standard features to provide in the runtime application. During setup, the output control functions of each device can be changed, so any equipment being controlled by the outputs should be placed in an "off" state, so that any modifications to output functions will not cause an unsafe condition or damage to equipment.

IMPORTANT: *Once all configuration settings are made, you must select "Exit" from the File menu to exit the Configurator prior to cycling power to the MCT4. All configuration files are written upon exiting the Configurator. Do not cycle power prior to exiting the Configurator or settings will be lost and the MCT4 will not operate properly once the runtime application starts.*

Upon exiting the Configurator application and cycling power to the MCT4, the runtime application will be automatically started on the next boot sequence.

4.1 Control Setup

The Control Setup screen is accessed from the Setup menu. It allows the user or OEM to select the control type, and set the number of soft alarms, monitor points and math/logic equations.
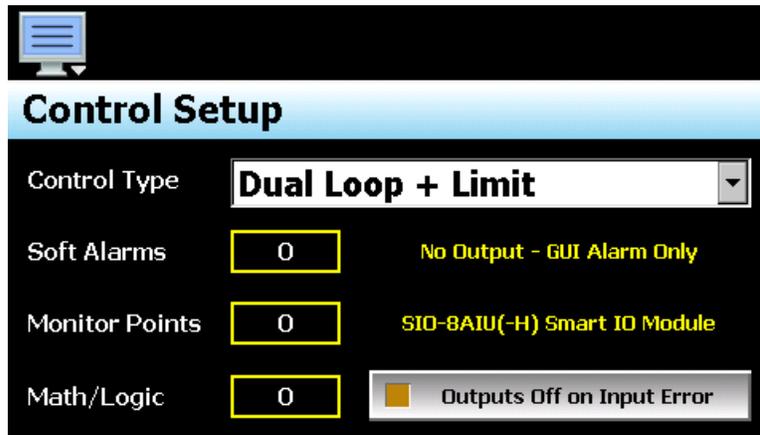
The **Control Type** drop down menu is used to define the mode of operation for the MCT4. The number of PCM process loop boards and HLM limit board (if required) are set automatically and dependent upon the control type selected. The selections include:

Single Loop   When single loop is selected, the MCT4 will be configured as a single loop controller. A PCM process loop control must be inserted into slot 1 for proper operation.

Single Loop + Limit   When single loop + limit is selected, the MCT4 will be configured as a single loop controller with limit. A PCM process loop control must be inserted into slot 1 and an HLM limit board must be inserted into slot 2.

Dual Loop   When dual loop is selected, the MCT4 will be configured as a dual loop controller. Two PCM process loop controls are required and must be inserted into slots 1 and 2 for proper operation.

Dual Loop + Limit   When dual loop is selected, the MCT4 will be configured as a dual loop controller with a limit. Two PCM process loop controls are required and must be inserted in slots 1 and 2 with an HLM limit board inserted into slot 3 for proper operation.

Three Loop   When three loop is selected, the MCT4 will be configured as a three loop controller. Three PCM process loop controls are required and must be inserted into slots 1, 2 and 3 for proper operation.

The **Soft Alarms** field is used to enter the number of soft alarms that will be provided on the system. A soft alarm is an alarm without a physical control output. It is a software-based alarm that can be used to alert an operator that a process has exceeded desired operating conditions. The MCT4 is capable of providing up to ten soft alarms. When at least one soft alarm is entered, the Soft Alarm Configuration menu item is enabled and the mode of operation for the soft alarm(s) can be specified. See section 4.5 Soft Alarm Configuration for more information.

The **Monitor Points** field is used to enter the number of monitor points that will be provided on the system. The MCT4 is capable of providing up to eight monitor points via the external Smart IO module. When at least one monitor point is entered, the Monitor Configuration menu item is enabled and the input(s) can be defined. See section 0

Monitor Configuration for more information.

The **Math/Logic** field is used to enter the number of math/logic equations that are to be used. The MCT4 is capable of providing up to 20 user configurable equations. When at least one math/logic equation is entered, the Math/Logic Configuration menu item is enabled and the equations can be entered. See section 4.6 Math/Logic Configuration for more information.

The **Outputs Off on Input Error** selection button is used to disable logic outputs of all configured logic equations if any input to the system is in a fault condition. This includes all loops, limits and monitor points. The selection is a global selection, meaning it affects all logic equations even if they do not use the specific input that is in an error condition.

4.2   Loop Configuration

The Loop Configuration screen is accessed from the Setup menu. The screen provides access to all loop control board settings. When the selected control type requires more than one loop control, the left/right scroll buttons will be provided at the top right of the screen. These buttons can be used to scroll through all available loop controls in order to view/edit settings for each.
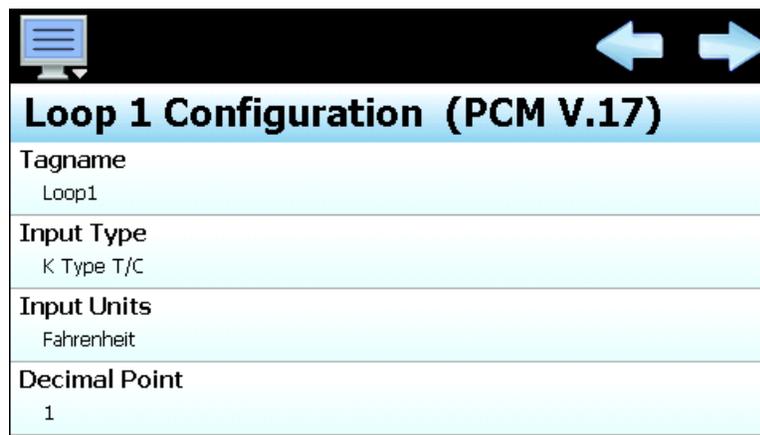
The model and version of the PCM installed will be shown in the scroll list header. To view all of the available settings, simply swipe up or down on the screen to scroll through the list items. To edit a value, tap the row for the desired item. If the entry is a simple numeric value, the number entry pad will be shown. If the item has multiple selections to choose from, a list of individual selections for the item will be shown. For a comprehensive list of all loop control board settings, their ranges and factory default values see appendix section A.5.1 PCM Parameter Description.

4.2.1 Tagname

The Tagname entry allows the user or OEM to assign a specific name for each control loop, up to 11 characters in length. This name will be used throughout the MCT4 runtime application and can be used to provide a more detailed description as to the function the loop provides. Default tag names are Loop1, Loop2 and Loop3.

4.2.2 Input Type

The Input Type entry is used to select the type of sensor that will be connected to the loop control. The input type can be a temperature input (thermocouple or RTD) or a linear input type (VDC or mA).

The input type selections are mutually exclusive, i.e., selecting one input will turn all other selections off. Once the desired input type has been selected, press the "Done" button to set the input type for the loop control board and return to the main Loop Configuration screen.

NOTE: *The PCM is equipped with DIP switches on the component side of the board. The DIP switches must be set properly according to the input type selection made. See section 3.2.1.1 Sensor Input for details on sensor wiring and DIP switch settings according to selected sensor type.*

4.2.3 Input Units

The Input Units entry is used to select the temperature units for temperature input types (thermocouple or RTD). If the selected input type for the loop is a linear input (VDC or mA), the Input Units entry will display the text entry keypad allowing the user or OEM to enter specific engineering units up to four characters.

The input unit selections for temperature are mutually exclusive, i.e., selecting one will turn off the other. Once the desired temperature units have been selected, press the "Done" button to set the input units for the loop control board and return to the main Loop Configuration screen.

4.2.4 Decimal Point

The Decimal Point entry allows the input precision to be adjusted between zero and one decimal digits for temperature input types, between zero and two for a 0-60mV input and from zero to three for VDC and mA input types.

IMPORTANT: *Once the loop control board has been configured with a specific decimal point, changing the decimal point will require the loop control board to be reconfigured in order to maintain previous control settings. Automatic programs, alarm set points, set point limits, input low/high scale, etc., DO NOT automatically scale. An entry of 100.0 becomes 1000 when changing the decimal point to zero (not 100) and must be re-entered to set the proper value.*

4.2.5 Input Low/High Scale

The Input Low Scale and Input High Scale entries are used to set the input range for linear input types (VDC or mA). The entries are not available for temperature input types since they utilize a fixed range based on the sensor type. The input low scale value can be set from -32768 up to the high scale value minus 50. The high scale value can be set from the low scale value plus 50 up to 32767.

NOTE: *The minimum and maximum scale values are limited by the decimal point selection. For a decimal of 0, the values are -32768 and 32767 respectively. For one decimal point, the values are -3276.8 and 3276.7. For two decimal digits, the values are -327.68 and 327.67 and for three decimal digits the values are -32.768 and 37.767.*

4.2.6 Input Filter

The Input Filter entry is used to select the time constant used for filtering the process input.
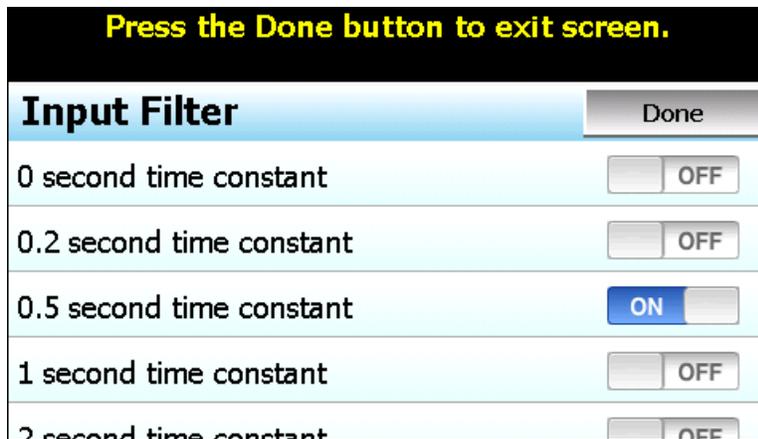
The time constant selections are mutually exclusive, i.e., selecting one will turn off the others. Once the desired filter constant has been selected, press the "Done" button to set the input filter for the loop control board and return to the main Loop Configuration screen.

4.2.7   Event Input Function

The Event Input Function is used to select the desired mode of operation for the digital input of the loop control board. The event input selections are mutually exclusive, i.e., selecting one will turn off the others. Once the desired function has been selected, press the "Done" button to set the event input function for the loop control board and return to the main Loop Configuration screen.

The **Automatic program run/abort** function will start the currently loaded program from step 1 if not already running, upon activation of the input (an off to on transition). Deactivating the input (an on to off transition) will stop the program if it is currently running.

The **Automatic program hold/resume** function will place a currently running program into hold when the event input is activated (an off to on transition). The program will resume operation and return to the run mode when the input is deactivated (an on to off transition).

The **Failure transfer** function puts the loop control outputs into failure transfer mode when the input is activated. The output will then go to the percent output value set for failure transfer. The loop control outputs will return to normal PID control when the input is deactivated.

NOTE: *If an automatic ramp/soak program is in operation and the loop is under program control, placing it in failure transfer via the event input will cause the program to be placed into hold. When the event input is then turned off and failure transfer is disabled, the program will have to be manually resumed by either a separate event input or by selecting "Run" from the Program Operation window.*

The **Automatic program run/hold** function will start the currently loaded program from step 1 if not already running, upon first activation of the input (an off to on transition). Deactivating the input (an on to off transition) will then cause the program to go into hold. The input must then be reactivated in order for the program to resume operation.

The **Loop status input** function provides a visual indication on the Loop View screen in the runtime application. When the input is activated, the border around the loop is highlighted blue. When the input is deactivated, the border around the loop returns to the default dark gray color. This can be used as a means for alerting the user of an operating condition, such as the equipment the loop is controlling is in operation.

The **Alarm input** function allows the event input to be used for alarm indication. When the input is activated, the Event Input Alarm Message/Annotation (see following section 4.2.8) is displayed on the alarm screen in the runtime application and the audible alarm sounds.

The **Data logging annotation** functions allows the event input to be used to write an annotation (operator event) to the running data log file. When the input is activated, the Event Input Alarm Message/Annotation (see following section 4.2.8) is written to the data file.

The **Math/logic input only** function allows the event input to be used as an input for math/logic equations only. See section 4.6 Math/Logic Configuration for more information.

NOTE: *In order for the alarm and annotation input functions to operate properly, the input must be activated for at least five seconds. If the input is not activated for the minimum time period, the input status may not be captured and the alarm or annotation will not be posted. In order for the input to reset and capture the next input status, the input must also remain off for at least five seconds.*

The **Initialize ramp rate setpoint to PV** function is utilized in conjunction with the loop ramp rate option (see section 4.2.36 Ramp Rate Operation). When ramp rate operation is enabled for the loop, activating the input (off to on transition) will reset the current loop set point to the PV value. The loop set point will then continue ramping from the current PV value to the ramp rate target set point according to the programmed ramp rate.

The **Ramp rate hold** function utilized in conjunction with the loop ramp rate option (see section 4.2.36 Ramp Rate Operation). When ramp rate operation is enabled for the loop, activating the input will pause the set point ramp and hold the loop set point at its current value. Deactivating the input will allow the loop set point to continue ramping from its current value to the ramp rate target set point according to the programmed ramp rate.

The **Activate SP2** function enables a secondary set point for the loop (see section 4.2.40 Setpoint 2). When activated, the current loop set point is overridden and the configured SP2 value is used as the loop set point. When the input is deactivated, the loop set point returns to the previous user entered set point

NOTE: *When SP2 is activated, it will override the loop set point even if an automatic ramp/soak program I in operation. When the input is deactivated, the loop set point will return to the set point as determined by the running program at the time the input is deactivated.*

4.2.8   Event Input Alarm Message/Annotation

When the event input function is set to alarm input or data logging annotation, the Event Input Alarm Message/Annotation entry allows the user or OEM to assign the message that will be shown on the alarm screen in the runtime application for alarm operation, or the operator event that will be written to the data log file for annotation operation. The message can be up to 25 characters long.

4.2.9   Low/High Limit Setpoint

The low and high limit set points are used to set the minimum and maximum allowed set points that can be entered for the loop control. These are typically set by the OEM to limit the control range to within the safe operating range of the equipment.

NOTE: *The runtime application provides additional user low and high set point limits (see section 9.3 Setpoint Limits). These can be adjusted to further limit the allowable set point range within the band set by the OEM low and high limit set points. By default, the user set point limits are zero. The user set points must also be adjusted in the runtime application in order to allow proper set point entry.*

4.2.10   Output 1 Function

The Output 1 Function is used to set the mode of operation for the primary control output of the loop control board. The output can be set for heating or cooling on/off control, time proportioning or linear control. The output selections are mutually exclusive, i.e., selecting one will turn off the others. Once the desired function has been selected, press the "Done" button to set the output function for the loop control board and return to the main Loop Configuration screen.

NOTE: The output function must be set to match the type of output ordered on the loop control board. Relay and SSRD output types are used for on/off and time proportioning control. The isolated VDC and mA output types are used for linear control.

Press the Done button to exit screen.

Output 1 Function	Done
None	OFF
Heating on-off control	OFF
Heating time proportioning	ON
Heating linear control	OFF
Cooling on-off control	OFF
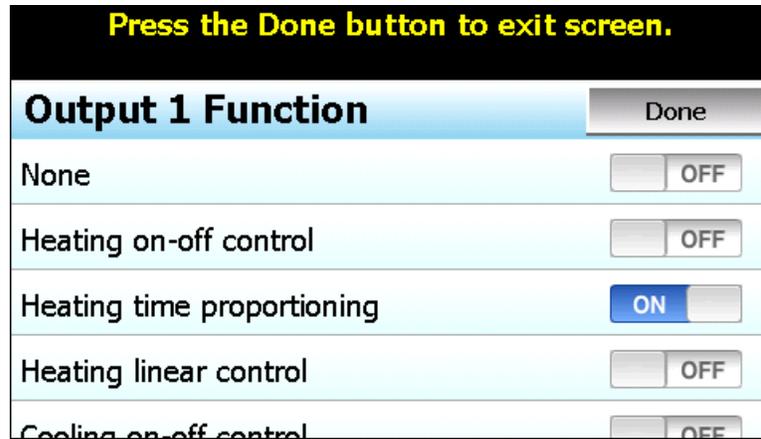
The **Heating on-off control** function will turn on the output when the process value is below set point. When the process value rises above the set point plus the on-off control hysteresis, the output will turn off.

The **Heating time proportioning** function uses the PID settings to cycle the output on and off according to the percentage of heating required using the cycle time configured for output 1. For example, if the percentage of output is 50% and the cycle time is 18 seconds, the output will repeat on/off cycles of 9 seconds each. If the output was only 25%, the output would be on for 4.5 seconds and off for 13.5 seconds of the 18 second cycle time.

The **Heating linear control** function uses the PID settings to vary the VDC or mA output from the minimum to the maximum range of the output as a direct percentage of the heating output.

The **Cooling on-off control** function will turn on the output when the process value is above set point. When the process value falls below the set point minus the on-off control hysteresis, the output will turn off.

The **Cooling time proportioning** function uses the PID settings to cycle the output on and off according to the percentage of cooling required using the cycle time configured for output 1. For example, if the percentage of output is 50% and the cycle time is 6 seconds, the output will repeat on/off cycles of 3 seconds each. If the output was only 25%, the output would be on for 0.75 seconds and off for 5.25 seconds of the 6 second cycle time.

The **Cooling linear control** function uses the PID settings to vary the VDC or mA output from the minimum to the maximum range of the output as a direct percentage of the cooling output.

NOTE: Linear heating and cooling outputs are either 0-20mA or 0-10VDC. If a non-zero based or less than the maximum value output is required i.e. 4-20mA or 1-5VDC, the output low/high limit values must be set accordingly; refer to section 4.2.14 Output 1 Low/High Limit Values.

4.2.11   Output 1 Failure Transfer

The output 1 failure transfer setting is used to set the value the output should go to if there is an input failure, i.e., sensor break. The output can be set for bumpless (-1) operation or a fixed percentage of output (from 0 to 100%) if proportioning or linear control is selected for the output function. When failure transfer is set to bumpless, the output will remain at its previous percentage of output until the input condition is corrected. Note that this should not be used for extended periods of time as a runaway condition could occur if separate limit devices are not installed to ensure safe limits of operation by turning off the system should a limit be exceeded.

If the output function is set for on-off control, the failure transfer can be set to have the output turn on (1) or turn off (0) when a sensor break occurs.

4.2.12   Output 1 ON-OFF Control Hysteresis

The output 1 on-off control hysteresis can be set when the output 1 function is set for heating or cooling on-off control. It is used to eliminate rapid cycling of the control output by applying a safe-sided dead band to the control output. When the control set point is exceeded, the output will turn on. The output will not turn off until the process rises above (for heating) or falls below (for cooling) the set point by the hysteresis value.

The hysteresis can be set from a minimum of 0.1 to a maximum of 50.0 for units of degrees Centigrade and to a maximum of 90.0 for units of degrees Fahrenheit and when a linear input type is used.

4.2.13   Output 1 Cycle Time

The output 1 cycle time can be set when the output 1 function is set for heating or cooling time proportioning control. The cycle time can be adjusted from 0.1 to 90.0 seconds. For cycle times less than 18 seconds, it is recommended that the loop control board be ordered with the SSRD drive output for output 1 to extend the life of the control output.

4.2.14   Output 1 Low/High Limit Values

The output low and high limit values can be set when the output 1 function is set for heating or cooling time proportioning or linear control. They are used to set the minimum and maximum percentage of the output range for the installed output type.

For example, the standard range of the mA output is 0-20mA. In order to use the output as a 4-20mA output, the low limit value would need to be set to 20% (20% of 20ma = 4ma). For the voltage output, the default range is 0-10VDC. In order to achieve a 1-5VDC output, the low limit would have to be set to 10% (10% of 10VDC is 1VDC). The high limit would then have to be set to 50% in order cut the output span in half to get a maximum output of 5VDC.

It is recommended that the output low limit be set for 0% when time proportioning is selected as the output function. Otherwise, the output would continue to cycle on and off even if the control output required by the PID value is 0%. In the case of time proportioning outputs, the cycle time is used as the range of the output. If the cycle time were set to 18 seconds, a low limit setting of 10% would equate to a 1.8 second minimum on time. Thus, even with the PID value calling for 0% output, the output would still cycle 1.8 seconds on and 16.2 seconds off.

4.2.15   Output 2 Function

The Output 2 Function is used to set the mode of operation for the secondary control output of the loop control board.

NOTE: *The output function must be set to match the type of output ordered on the loop control board. Relay and SSRD output types are used for proportioning control, alarm or event outputs. The isolated VDC and mA output types are used for linear control.*
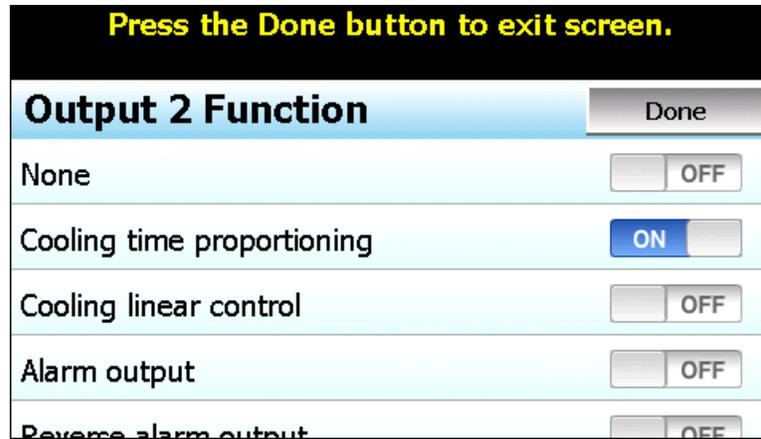
The output can be set for cooling time proportioning or linear control, an alarm or an event. The output selections are mutually exclusive, i.e., selecting one will turn off the others. Once the desired function has been selected, press the "Done" button to set the output function for the loop control board and return to the main Loop Configuration screen.

The **Cooling time proportioning** function uses the PID settings to cycle the output on and off according to the percentage of cooling required using the cycle time configured for output 1. For example, if the percentage of output is 50% and the cycle time is 6 seconds, the output will repeat on/off cycles of 3 seconds each. If the output was only 25%, the output would be on for 0.75 seconds and off for 5.25 seconds of the 6 second cycle time.

The **Cooling linear control** function uses the PID settings to vary the VDC or mA output from the minimum to the maximum range of the output as a direct percentage of the cooling output.

NOTE: *The linear cooling output is either 0-20mA or 0-10VDC. If a non-zero based or less than the maximum value output is required i.e. 4-20mA or 1-5VDC, the output low/high limit values must be set accordingly; refer to section 4.2.17 Output 2 Cycle Time.*

The **Alarm output** function activates the Alarm 1 configuration settings for assigning the type of alarm logic to apply to output 2. When the alarm condition is active, the output will turn on.

The **Reverse alarm output** function activates the Alarm 1 configuration settings for assigning the type of alarm logic to apply to output 2. The output will be normally "on" when this function is selected. When the alarm condition is active, the output will turn off.

The **Event output** function allows the output to be turned on and off via an automatic program or manually through the MCT4 runtime application to act as a "soft" switch to turn system components on and off.

The **DC power supply output** function must be selected when the output type ordered for the loop control board output 2 is a transmitter power supply.

The **Manual event output only** function is similar to the Event output function above as it allows the output to be turned on manually through the MCT4 runtime application to act as a "soft" switch to turn system components on and off. However, the output cannot be controlled via an automatic program which allows the output to be controlled separately regardless of program operation.

The **Math/Logic event output only** function allows the output to be controlled only by a logic equation (See section 4.6 Math/Logic Configuration). The output will not be accessible through the runtime application as a "soft" switch like the event/manual event only selections.

4.2.16 Output 2 Failure Transfer

The output 2 failure transfer setting is used to set the value the output should go to if there is an input failure, i.e., sensor break. The output can be set for bumpless (-1) operation or a fixed percentage of output (from 0 to 100%) if proportioning or linear control is selected for the output function.

When failure transfer is set to bumpless, the output will remain at its previous percentage of output until the input condition is corrected. Note that this should not be used for extended periods of time as a runaway condition could occur if separate limit devices are not installed to ensure safe limits of operation by turning off the system should a limit be exceeded.

If the output function is set as an alarm, the failure transfer can be set to have the output turn on (1) or turn off (0) when a sensor break occurs.

NOTE: *The failure transfer setting is not applicable when the output 2 function is set for event or DC power supply and does not affect output operation.*

4.2.17 Output 2 Cycle Time

The output 2 cycle time can be set when the output 2 function is set for cooling time proportioning control. The cycle time can be adjusted from 0.1 to 90.0 seconds. For cycle times less than 18 seconds, it is recommended that the loop control board be ordered with the SSRD drive output for output 2 to extend the life of the control output.

4.2.18 Output 2 Low/High Limit Values

The output low and high limit values can be set when the output 2 function is set for cooling time proportioning or linear control. They are used to set the minimum and maximum percentage of the output range for the installed output type.

For example, the standard range of the mA output is 0-20mA. In order to use the output as a 4-20mA output, the low limit value would need to be set to 20% (20% of 20ma = 4ma). For the voltage output, the default range is 0-10VDC. In order to achieve a 1-5VDC output, the low limit would have to be set to 10% (10% of 10VDC is 1VDC). The high limit would then have to be set to 50% in order cut the output span in half to get a maximum output of 5VDC.

It is recommended that the output low limit be set for 0% when time proportioning is selected as the output function. Otherwise, the output would continue to cycle on and off even if the control output required by the PID value is 0%. In the case of time proportioning outputs, the cycle time is used as the range of the output. If the cycle time were set to 18 seconds, a low limit setting of 10% would equate to a 1.8 second minimum on time. Thus, even with the PID value calling for 0% output, the output would still cycle 1.8 seconds on and 16.2 seconds off.

4.2.19 Output 3 Function

The Output 3 Function selection is used to configure the loop control board output as an alarm or an event. The output selections are mutually exclusive, i.e., selecting one will turn off the others. Once the desired function has been selected, press the "Done" button to set the output function and return to the main Loop Configuration screen.

Press the Done button to exit screen.

Output 3 Function	Done
None	OFF
Alarm output	OFF
Reverse alarm output	OFF
Event output	ON
DC power supply output	OFF

The **Alarm output** function activates the Alarm 2 configuration settings for assigning the type of alarm logic to apply to output 3. When the alarm condition is active, the output will turn on.

The **Reverse alarm output** function activates the Alarm 2 configuration settings for assigning the type of alarm logic to apply to output 3. The output will be normally "on" when this function is selected. When the alarm condition is active, the output will turn off.

The **Event output** function allows the output to be turned on and off via an automatic program or manually through the MCT4 runtime application to act as a "soft" switch to turn system components on and off.

The **DC power supply output** function must be selected when the output type ordered for the loop control board output 3 is a transmitter power supply.

The **Manual event output only** function is similar to the Event output function above as it allows the output to be turned on manually through the MCT4 runtime application to act as a "soft" switch to turn system components on and off. However, the output cannot be controlled via an automatic program which allows the output to be controlled separately regardless of program operation.

The **Math/Logic event output only** function allows the output to be controlled only by a logic equation (See section 4.6 Math/Logic Configuration). The output will not be accessible through the runtime application as a "soft" switch like the event/manual event only selections.

4.2.20   Output 3 Failure Transfer

The output 3 failure transfer setting is used to set whether the output should be on (1) or off (0) when there is an input failure, i.e., sensor break. The setting applies to alarm output functions only.

4.2.21   Output 4 Function

The Output 4 Function selection is used to configure the loop control board output as an alarm, event or retransmit output. The output selections are mutually exclusive, i.e., selecting one will turn off the others. Once the desired function has been selected, press the "Done" button to set the output function and return to the main Loop Configuration screen.

NOTE: *The output function must be set to match the type of output ordered on the loop control board. Relay and SSRD output types are used for alarm or event outputs. The retransmission VDC and mA output types are used for process value or set point retransmit.*

Press the Done button to exit screen.

Output 4 Function	Done
None	OFF
Alarm output	ON
Reverse alarm output	OFF
Event output	OFF
Retransmit process value	OFF

The **Alarm output** function activates the Alarm 3 configuration settings for assigning the type of alarm logic to apply to output 4. When the alarm condition is active, the output will turn on.

The **Reverse alarm output** function activates the Alarm 3 configuration settings for assigning the type of alarm logic to apply to output 4. The output will be normally "on" when this function is selected. When the alarm condition is active, the output will turn off.

The **Event output** function allows the output to be turned on and off via an automatic program or manually through the MCT4 runtime application to act as a "soft" switch to turn system components on and off.

The **Retransmit process value** and **Retransmit setpoint value** functions allow the loop control board output to retransmit the current input value or control set point to remote devices such as a chart recorder.

The **DC power supply output** function must be selected when the output type ordered for the loop control board output 4 is a transmitter power supply.

The **Manual event output only** function is similar to the Event output function above as it allows the output to be turned on manually through the MCT4 runtime application to act as a "soft" switch to turn system components on and off. However, the output cannot be controlled via an automatic program which allows the output to be controlled separately regardless of program operation.

The **Math/Logic event output only** function allows the output to be controlled only by a logic equation (See section 4.6 Math/Logic Configuration). The output will not be accessible through the runtime application as a "soft" switch like the event/manual event only selections.

4.2.22 Output 4 Failure Transfer

The output 4 failure transfer setting is used to set whether the output should be on (1) or off (0) when there is an input failure, i.e., sensor break. The setting applies to alarm output functions only.

4.2.23 Output 4 Low/High Limit Values

The output low and high limit values can be set when the output 4 function is set for retransmit process or setpoint value. They are used to set the minimum and maximum percentage of the output range for the installed output type.

For example, the standard range of the mA output is 0-20mA. In order to use the output as a 4-20mA output, the low limit value would need to be set to 20% (20% of 20ma = 4ma). For the voltage output, the default range is 0-10VDC. In order to achieve a 1-5VDC output, the low limit would have to be set to 10% (10% of 10VDC is 1VDC). The high limit would then have to be set to 50% in order cut the output span in half to get a maximum output of 5VDC.

4.2.24 Output 4 Retransmit Low/High Scale

The output retransmit low and high scale can be set when the output 4 function is set for retransmit process or setpoint value. They are used to set the retransmit range of the output. The low scale value corresponds to the output low limit value and the high scale value corresponds with the output high limit value.

For example, if the output function is set for "Retransmit process value", setting the low scale to -100 and the high scale to 100, would produce a linear output between the output low limit and output high limit as the process value varies between -100 and 100. If the output low and high limit values scaled the output to a 4-20mA signal, as the process value varied between -100 and 100, the output would vary linearly between 4ma and 20mA.

4.2.25 Alarm (1-3) Function

The Alarm 1, 2 and 3 Functions are used to select the alarm type for outputs 2, 3 and 4 respectively if the output function is configured as alarm or reverse alarm. The alarm selections are mutually exclusive, i.e., selecting one will turn off the others. Once the desired alarm type has been selected, press the "Done" button to set the alarm function for the loop control board output and return to the main Loop Configuration screen.

NOTE: *For the following alarm descriptions, PV = process value, SV = the control set point value, ASP is the alarm set point and AHY is the alarm hysteresis.*
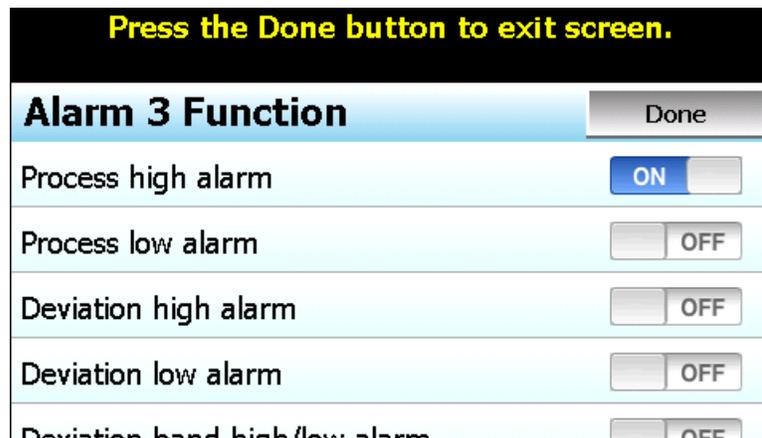
A **Process high alarm** is independent of set point. When the process value is higher than the alarm set point (PV > ASP), a process high alarm occurs. When the process value is lower than the alarm set point minus the alarm hysteresis (PV < ASP–AHY), the alarm is off.

A **Process low alarm** is independent of set point. When the process value is lower than the alarm set point (PV < ASP), a process low alarm occurs. When the process value is above the alarm set point plus the alarm hysteresis (PV > ASP+AHY), the alarm is off.

A **Deviation high alarm** is dependent upon the control set point and alerts the operator when the process value deviates too high over the set point value. For deviation high alarms, the alarm set point is entered as a positive value. When the process is higher than the control set point plus the alarm set point (PV > SV+ASP), a deviation high alarm occurs. When the process value falls below the control set point plus alarm set point minus the alarm hysteresis (PV < SV+ASP-AHY), the alarm is off.

A **Deviation low alarm** is dependent upon the control set point and alerts the operator when the process deviates too far below the set point value. For deviation low alarms, the alarm set point is entered as a negative value. When the process is lower than the control set point plus the alarm set point (PV < SV+ASP), a deviation low alarm occurs. When the process value rises above the control set point plus alarm set point plus the alarm hysteresis (PV < SV+ASP+AHY), the alarm is off.

A **Deviation band high/low alarm** sets two trigger levels relative to the control set point value. For deviation band alarms, the alarm set point is entered as a positive value. The two alarm trigger levels are then defined as SV+ASP and SV-ASP for the high and low alarm values. When the process value is greater than the high alarm value (PV > SV+ASP) or less than the low alarm value (PV < SV-ASP), a deviation band alarm occurs. When the process value is within the high and low trigger levels by the value of the alarm hysteresis (PV < SV+ASP-AHY and PV > SV-ASP+AHY), the deviation band alarm is off.

4.2.26 Alarm (1-3) Mode

The Alarm 1, 2 and 3 Modes are used to select the mode of operation for outputs 2, 3 and 4 respectively if the output function is configured as an alarm or reverse alarm. The mode selections are mutually exclusive, i.e., selecting one will turn off the others. Once the desired alarm mode has been selected, press the "Done" button to set the alarm operation for the loop control board output and return to the main Loop Configuration screen.
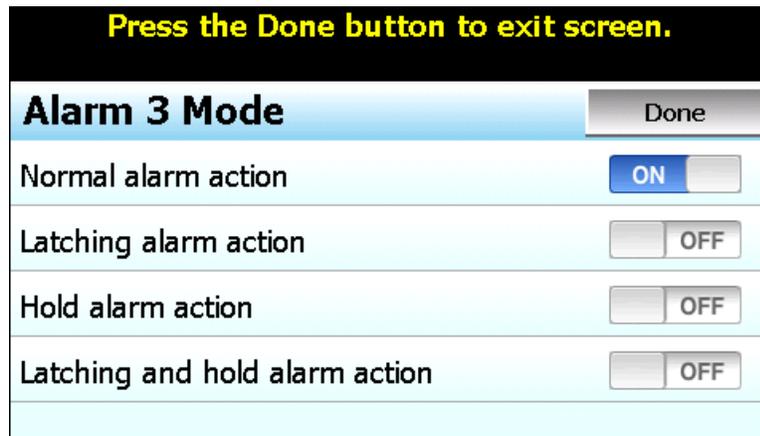
Normal alarm action has the alarm output off in the non-alarm condition and on in the alarm condition. The output state is inverted for a reverse alarm output.

Latching alarm action will keep the alarm output on even if the alarm condition has cleared until the alarm is reset by the user. The output state is inverted for a reverse alarm output.

Hold alarm action prevents the alarm from activating on power up even when an alarm condition is present. The alarm will be blocked until the alarm condition clears. Once cleared, the alarm will then operate normally and activate when an alarm condition occurs.

The **Latching and hold alarm action** combines both the latching and hold alarm actions listed above.

4.2.27 Alarm (1-3) Indication

The Alarm 1, 2 and 3 Indication settings are used to select whether the alarm will be shown in the MCT4 runtime application or be hidden from the user. This allows the OEM to configure an alarm to perform a specific control function while preventing the user from adjusting the set point or seeing the activation state of the alarm.

Press the Done button to exit screen.

Alarm 3 Indication   Done

Hide alarm status/settings   OFF

Show alarm status/settings   ON

When the alarm indication is set for **Hide alarm status/settings**, the alarm will be removed from the MCT4 runtime application. The user will not be able to edit the alarm message or adjust the alarm set point. When the alarm activates, there will be no indication or message on the alarm screen and the audible alarm will not sound. The alarm operates as a "silent" alarm with no indication to the user.

When the alarm indication is set for **Show alarm status/settings**, the user will be able to access and change the alarm set point and alarm message under the device settings. When the alarm occurs, the alarm message will be displayed on the Alarm screen and the audible alarm will sound.

The indication selections are mutually exclusive, i.e., selecting one will turn off the other. Once the desired alarm indication has been selected, press the "Done" button to set the alarm operation and return to the main Loop Configuration screen.

NOTE: *If the alarm is hidden but its mode is set for latching, the user will not have any indication that the alarm requires manual reset.   When an alarm is hidden, it is recommended that the normal or hold mode be used so that the alarm output automatically resets when the alarm condition is no longer present.*

4.2.28   Alarm (1-3) Setpoint

The alarm set points can be set when the alarm function is set for a process or deviation type of alarm. If the alarm indication is set to "show" the alarm status and settings, the set point will also be available in the MCT4 runtime application. If the alarm indication is set for "hide" alarm status and settings, the alarm set point will not be available in the MCT4 runtime application and can only be changed in the Configurator.

4.2.29   Alarm (1-3) Hysteresis

The alarm hysteresis can be set when the alarm function is set for a process or deviation type of alarm. It is used to eliminate rapid on/off cycling of the alarm output by applying a safe-sided dead band to the alarm. When the alarm set point is exceeded, the alarm will activate. The alarm will not deactivate until the process rises above (for low alarm) or falls below (for high alarm) the alarm set point by the hysteresis value. The hysteresis can be set from a minimum of 0.1 to a maximum of 50.0 for units of degrees Centigrade and to a maximum of 90.0 for units of degrees Fahrenheit and linear input types.

4.2.30   Alarm (1-3) Delay

The alarm delay is used to delay the activation of the alarm for a specified period of time. The delay is entered in minutes and seconds and can be set with a minimum of zero (00.00) to a maximum of 99 minutes and 59 seconds (99.59).

For non-latching alarms (normal or hold mode), the programmed time delay is activated (timing begins) when the alarm setpoint is exceeded. The alarm delay will stop timing (and reset) if the PV = (Alarm SP – HY) (hysteresis). If the time delay times out and alarm setpoint is still exceeded, the output associated with the alarm will actuate.

For latching alarms (latching or latching and hold mode), the programmed time delay is activated (timing begins) when the alarm setpoint is exceeded. When the time delay starts, the internal alarm circuit is latched (not output but internal time circuit). After the delay expires, the output associated with the alarm will actuate. The alarm delay does not stop timing when PV = (Alarm SP-HY). This means programming an alarm delay when using the latching type of alarm acts as a "delay on" contact since the latching circuit is set immediately when the alarm setpoint is exceeded, but the output is not actuated until the delay times out.

4.2.31   Setpoint at Start of Automatic Program

The Setpoint at Start of Automatic Program entry is used to select the set point that will be used by the loop control at the start of a ramp/soak program. The start set point selections are mutually exclusive, i.e., selecting one will turn off the other. Once the desired starting set point has been selected, press the "Done" button to return to the main Loop Configuration screen.
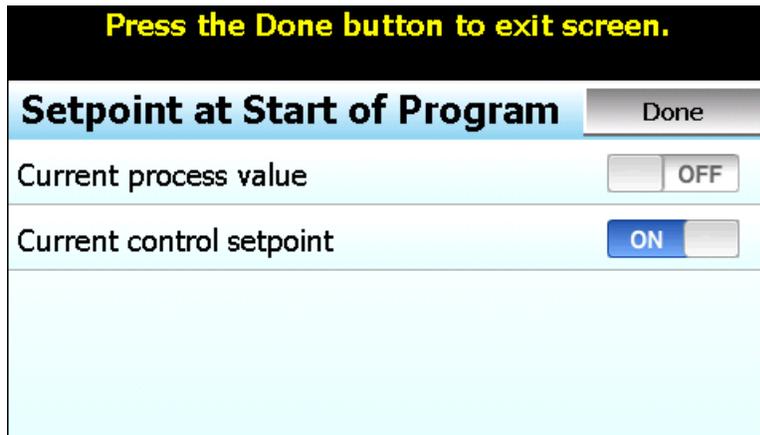
The **Current process value** selection will cause the loop control to immediately assume the current process value as the set point when the program is started. If the program is started on a ramp step, the program will begin ramping the set point from the current process value to the target set point of the step. If the program is started on a soak step, the program will hold the set point at the process value for the duration of the soak step.

The **Current control setpoint** selection will cause the loop control to use the current static set point when the program is started. If the program is started on a ramp step, the program will begin ramping from the static set point to the target set point of the step. If the program is started on a soak step, the program will hold the static set point for the duration of the soak step.

4.2.32   Setpoint at End of Automatic Program

The Setpoint at End of Automatic Program entry is used to select the set point (and event status) that will be used by the loop control at the end of a program. The end set point selections are mutually exclusive, i.e., selecting one will turn off the other. Once the desired end set point has been selected, press the "Done" button to return to the main Loop Configuration screen.
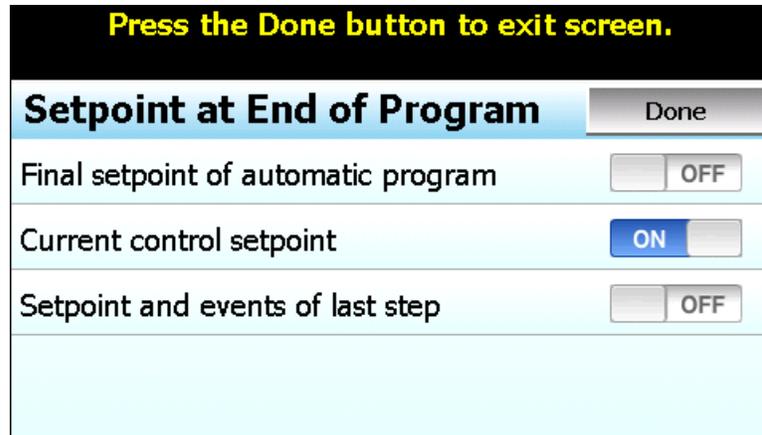
The **Final setpoint of automatic program** selection will use the final set point value programmed on the end step of the program as the control set point when the program ends. The event status will be set to the previous static event selections that were used prior to program operation. If the program is stopped prior to reaching the end step, the control set point and event status will both be set to the previous static set point and event selections that were used prior to program operation.

The **Current control setpoint** selection will return the control set point and event status to the previous static set point and event selections that were used prior to program operation. If the program is stopped prior to completing normally, the control set point and event status will also return to the previous static values.

The **Setpoint and events of last step** selection will leave the control set point and event status at the values set in the last step of the program prior to the end step. If the program is stopped prior to completing normally, the control set point and event status will remain at the current values of the step the program was stopped on.

4.2.33   Power Fail Recovery

The Power Fail Recovery entry is used to select the desired mode of operation of the loop control when power is restored if an automatic ramp/soak program was running at the time power was lost. The recovery selections are mutually exclusive, i.e., selecting one will turn off the others. Once the desired recovery mode has been selected, press the "Done" button to set the power recovery mode and return to the main Loop Configuration screen.

NOTE: *This selection is common to all loops and can also be made via the runtime application on the "Recovery" screen in offline settings. For additional information regarding the manner in which program recovery is achieved, see the Appendix section A.3 Program Recovery Detail.*
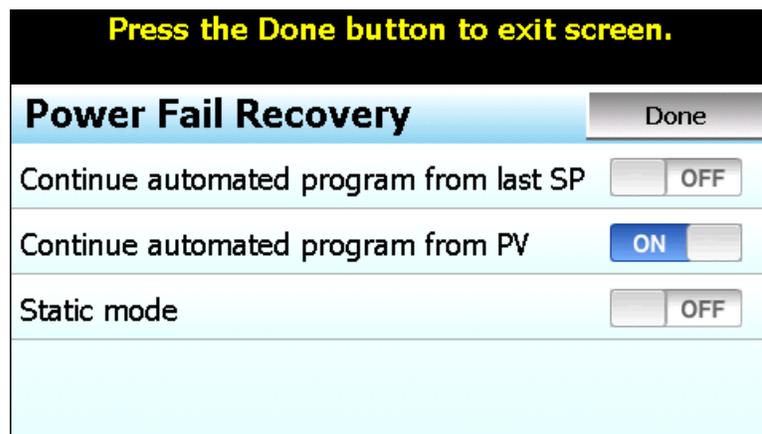
The **Continue automated program from last SP** selection will resume the program from where it left off with the last set point set by the program at the time of power failure.

The **Continue automated program from PV** selection will resume the program using the current process value at the time power is restored as the set point.

NOTE: *If continue from PV is selected and the recovery occurs on a ramp step, the ramp rate can be affected. If only one loop is under program control, the time remaining in the step will be recalculated in order to maintain the ramp rate that was programmed for the step based on the current PV value and the target set point of the step. However, if two or three loops are under program control, all loops operate under a common time base. Since the PV and target set point of each loop vary, the time is not recalculated and each loop will continue ramping from its current PV value to its target set point in the time remaining. This could result in a significant change in ramp rate for the remainder of the step.*

The **Static mode** selection will terminate the automated program and return the loop control to the single set point mode of operation based on the "Setpoint at end of program" selection for the loop.

4.2.34 Communication Mode

The Communication Mode selection is used to specify how the loop control responds to a loss of communications with the MCT4 base unit. The communication mode selections are mutually exclusive, i.e., selecting one will turn off the other. Once the desired mode has been selected, press the "Done" button to set the communication mode for the loop control board and return to the main Loop Configuration screen.
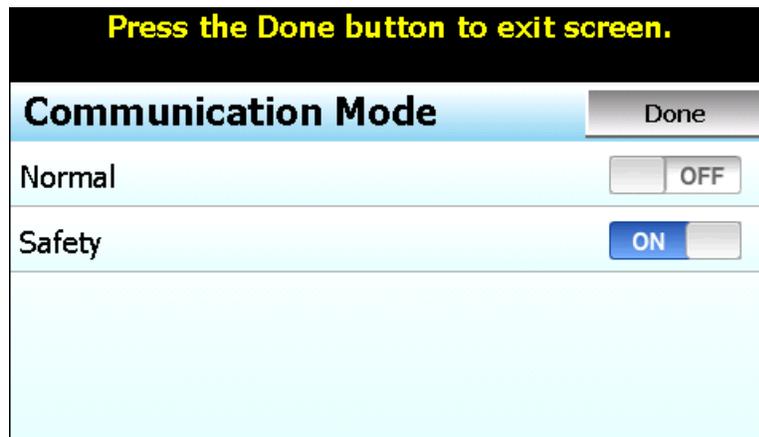
With the **Normal** mode selection, the loop control will continue operation according to the last command given. When power is first applied to the MCT4, the loop control outputs will activate immediately according to the last commands given prior to power loss.

With the **Safety** mode selection, all loop control outputs will be set to their minimum output state (according to the value set in the output low limit setting) with event/alarm outputs turning off if there is a loss in communications with the MCT4 base unit that exceeds 60 seconds. Since the MCT4 base unit touch screen interface provides the means for control and monitoring of loop operation, this ensures that any devices connected to the loop control outputs will be shut down/turned off until corrections can be made to restore normal operation.

It also prevents the loop control outputs from activating when power is first applied to the MCT4 until proper communication is established with the base unit. This prevents any devices connected to the loop control outputs from being activated until the runtime application has started which provides the user with access to the system through the touch screen interface.

4.2.35 Loop Mode

The Loop Mode selection is used to set the behavior of the loop and how the operator can interact with it. Once the desired mode has been selected, press the "Done" button to return to the main Loop Configuration screen.

IMPORTANT: *Loops that are to be used under program control (Program Ramp/Soak mode) must be set in order, i.e., 1…2…3. If a loop is set to Monitor Only or Static Only all following loops must also be set to either Monitor Only or Static Only.*
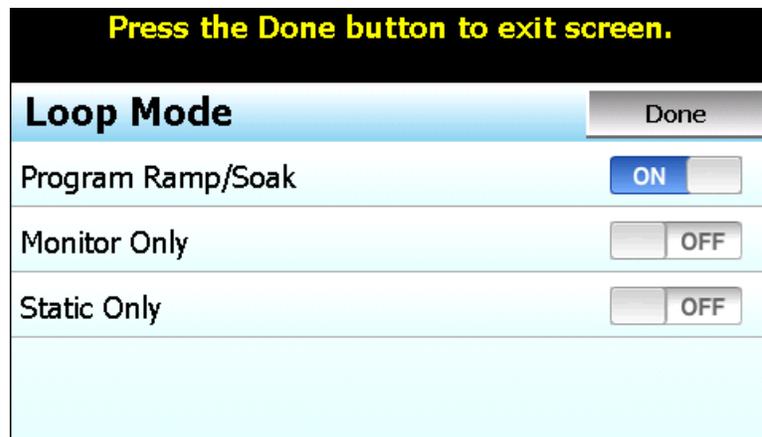
The **Program Ramp/Soak** mode is the default selection. It allows the loop to be controlled by an automatic ramp/soak program as well as by the operator in the static (single set point) mode when a program is not running.

The **Monitor Only** selection turn the loop into a monitor point in which the loop set point and percentage of output in the MCT4 runtime are hidden so only the process value is shown. This provides an easy method for adding another input to the system for monitoring the value of a process, while also providing additional outputs that could be used as events, sensor power supply, etc. The loop will not appear under the time/set point entry list when entering a ramp/soak program; however, any outputs of the loop programmed as events will be able to be selected in the program and/or controlled manually by the operator.

The **Static Only** selection turns the loop into a single set point control only. It will appear as a standard control loop; however, it will not appear under the time/set point entry list when entering a ramp/soak program; however, any outputs of the loop programmed as events will be able to be selected in the program and/or controlled manually by the operator.

The **Hidden** selection hides the loop values (PV, SP and %Out) in the runtime. It will appear as if the loop is not installed. However, the event input and event outputs can be configured to provide additional IO for the system. The loop event outputs (outputs 2, 3 and 4) will be able to be selected in the program and/or controlled manually by the operator and the event input can be used for program control, as an alarm input or for data log annotation.

NOTE: *When the loop is hidden, a jumper must be installed across the process input terminals to prevent the input from being in an alarm condition. Even though the loop is not shown in the runtime, the input of the loop control is still functional. It is also recommended that the input type be set to the linear 0-10V. This will ensure that an input error will not occur.*

4.2.36 Ramp Rate Operation

The Ramp Rate Operation selection is used to enable single set point ramping for the loop. This allows the user to adjust the rate at which the system responds to a set point change. It can be used to reduce thermal shock to a product by controlling the rate of change in temperature for example, when going from one set point to another. Once the desired mode has been selected, press the "Done" button to return to the main Loop Configuration screen.
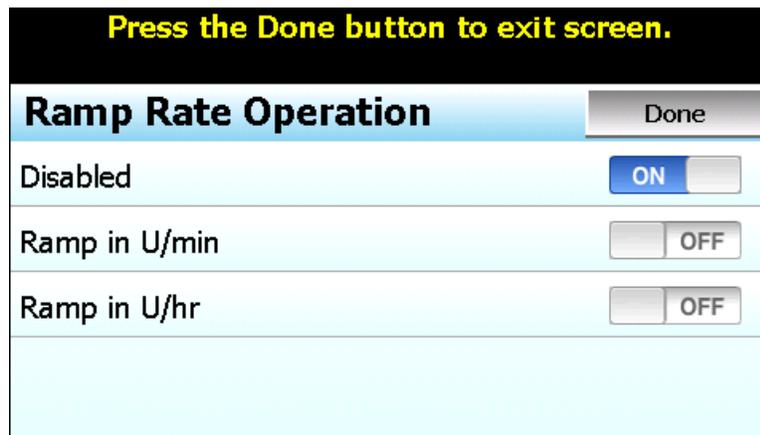
The **Disabled** selection turns ramp rate operation off. When ramp rate is not enabled, the loop act as a single set point control, meaning that as each set point is entered, the system will attempt to achieve and control to that set point as quickly as possible.

The **Ramp in U/min** selection enables ramp rate operation. When enabled, limits of entry can then be configured (see following sections) for the minimum and maximum rate of change the set point is permitted to make in units per minute. The user is then provided fields of entry on the set point Limits screen (see section 9.3 Setpoint Limits) in the runtime. This allows the user to adjust the rate at which the set point will ramp from the current process value to each set point entered.

The **Ramp in U/hr** selection enables ramp rate operation. When enabled, limits of entry can then be configured (see following sections) for the minimum and maximum rate of change the set point is permitted to make in units per hour. The user is then provided fields of entry on the set point Limits screen (see section 9.3 Setpoint Limits) in the runtime. This allows the user to adjust the rate at which the set point will ramp from the current process value to each set point entered.

4.2.37 Ramp Rate Down Low/Upper Limit

The ramp rate down low and upper limit entries are used to define the minimum and maximum ramp rate the user can set for the rate of change of the loop set point under ramp rate operation when the set point is below the current process value. The low limit can be set from 0 up to the upper limit. The upper limit can be set from the low limit value up to 5000 for units of degrees Centigrade or 9000 for units of degrees Fahrenheit or linear inputs.

NOTE: *The minimum and maximum scale values are limited by the decimal point selection. For a decimal of 0, the values are 0-5000°C (0-9000°F). For one decimal point, the values are 0.0 and 500.0°C (0.0 and 900.0°F). For two decimal digits (liner inputs), the values are 0.00 and 90.00 and for three decimal digits the values are 0.000 and 9.000.*

4.2.38   Ramp Rate Up Low/Upper Limit

The ramp rate up low and upper limit entries are used to define the minimum and maximum ramp rate the user can set for the rate of change of the loop set point under ramp rate operation when the set point is above the current process value. The low limit can be set from 0 up to the upper limit. The upper limit can be set from the low limit value up to 5000 for units of degrees Centigrade or 9000 for units of degrees Fahrenheit or linear inputs.

NOTE: *The minimum and maximum scale values are limited by the decimal point selection. For a decimal of 0, the values are 0-5000°C (0-9000°F). For one decimal point, the values are 0.0 and 500.0°C (0.0 and 900.0°F). For two decimal digits (liner inputs), the values are 0.00 and 90.00 and for three decimal digits the values are 0.000 and 9.000.*

4.2.39   Setpoint 2 Format

When the evet input of the loop is set for the "Activate SP2" function (see section 4.2.7 Event Input Function) the set point 2 format selection will be active. This selection allows the user to choose the format of set point 2 and how the value is applied. Once the desired format has been selected, press the "Done" button to return to the main Loop Configuration screen.
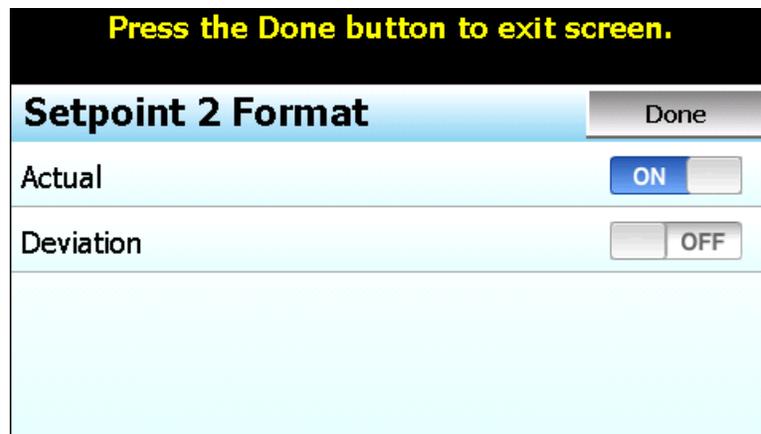
The **Actual** selection means that set point 2 will be an actual set point value, i.e., temperature for example. When the event input is then activated, the value entered for set point 2 (see following section) will be used as the loop set point, overriding the current user entered or operating program set point. When the event input is deactivated, the loop set point will then revert back to the user entered or operating program set point.

The **Deviation** selection means that set point 2 will be an offset to the current loop set point. When the event input is activated, the value entered for set point 2 (see following section) will be added to the current user entered or operating program set point. Thus, if the user enters a new set point, or the set point defined by the operating program changes, the loop set point will also change while maintaining the offset defined by the value of set point 2. When the event input is deactivated, the loop set point will revert back to the actual user entered or operating program set point.

4.2.40   Setpoint 2

When the evet input of the loop is set for the "Activate SP2" function (see section 4.2.7 Event Input Function) the set point 2 entry will be active. If the set point 2 format is set for "Actual" (see previous section), set point 2 can be entered with lower and upper limits matching the loop's low and high limit set points.

If the set point 2 format is set for "Deviation" (see previous section), the minimum and maximum entry values are limited by the decimal point selection. For temperature in degrees Centigrade and, a decimal of 0, the values are -18000 and 18000 respectively. For one decimal point, the values are -1800.0 and 1800.0.

For temperature in degrees Fahrenheit or linear input types, with a decimal of 0 the values are -32767 and 32767. For one decimal point, the values are -3276.7 and 3276.7. For two decimal digits, the values are -327.67 and 327.67 and for three decimal digits the values are -32.767 and 37.767.

4.3   Limit Configuration

The Limit Configuration screen is accessed from the Setup menu. The screen provides access to all limit control settings.
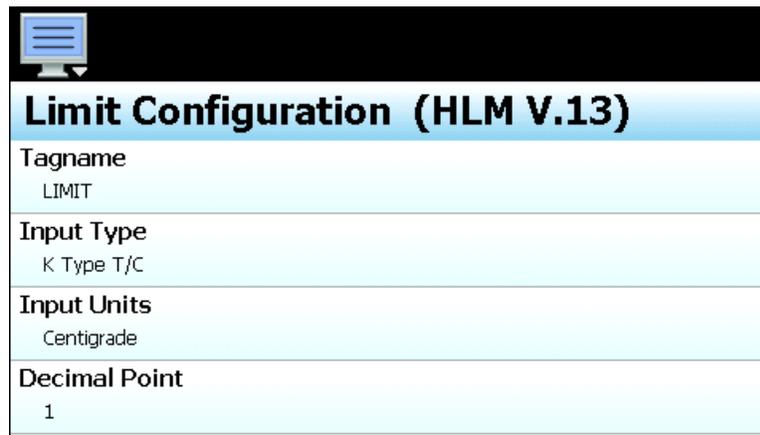
The model and version of the limit control attached will be shown in the scroll list header. To view all of the available settings, simply swipe up or down on the screen to scroll through the list items. To edit a value, tap the row for the desired item. If the entry is a simple numeric value, the number entry pad will be shown. If the item has multiple selections to choose from, a list of individual selections for the item will be shown. For a comprehensive list of all limit board settings, their ranges and factory default values see appendix section A.5.2 HLM Parameter Description.

4.3.1   Tagname

The Tagname entry allows the user or OEM to assign a specific name for each control loop, up to 11 characters in length. This name will be used throughout the MCT4 runtime application. The default tag name is LIMIT.

4.3.2   Input Type

The Input Type entry is used to select the type of sensor that will be connected to the limit control. The input type can be a temperature input (thermocouple or RTD) or a linear input type (VDC or mA).
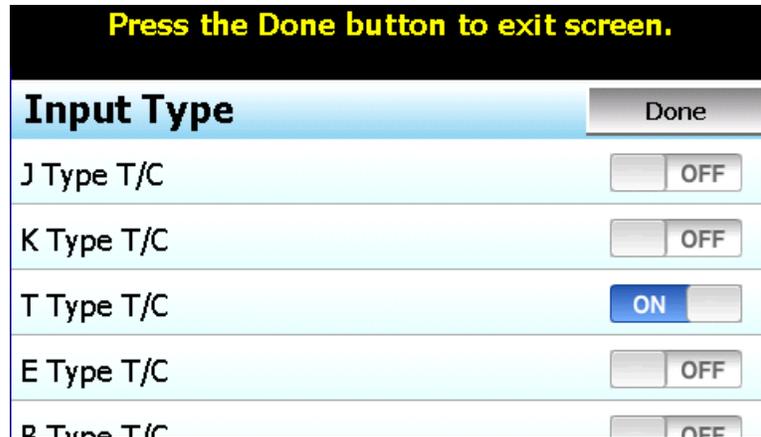
The input type selections are mutually exclusive, i.e., selecting one input will turn all other selections off. Once the desired input type has been selected, press the "Done" button to set the input type for the limit control and return to the main Limit Configuration screen.

NOTE: *The HLM limit control is equipped with DIP switches on the component side of the board. The DIP switches must be set properly according to the input type selection made. See section 3.2.2.1 Sensor Input for details on sensor wiring and DIP switch settings according to selected sensor type.*

Input type selections of 0-1V, 0-5V and 1-5V require special order HLM boards. Only the 0-10V input selection is compatible with standard HLM units. If a 0-1V, 0-5 or 1-5V input is required, it must be ordered accordingly. Linear inputs, current and voltage, are not FM approved.

4.3.3   Input Units

The Input Units entry is used to select the temperature units for temperature input types (thermocouple or RTD). If the selected input type for the limit is a linear input (VDC or mA), the Input Units entry will display the text entry keypad allowing the user or OEM to enter specific engineering units up to 4 characters.
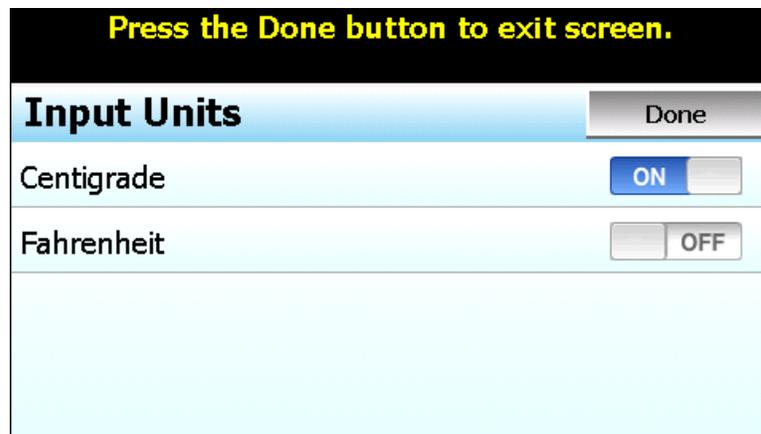
The input unit selections for temperature are mutually exclusive, i.e., selecting one will turn off the other. Once the desired temperature units have been selected, press the "Done" button to set the input units for the limit control and return to the main Limit Configuration screen.

4.3.4   Decimal Point

The Decimal Point entry allows the input precision to be adjusted between 0 and 1 decimal digits for temperature input types and between 0 and 3 for a 0-60mV input and VDC and mA input types.

IMPORTANT: *Once the limit control has been configured with a specific decimal point, changing the decimal point will require the limit control to be reconfigured in order to maintain previous control settings. Alarm set points, input low/high scale, etc., DO NOT automatically scale. An entry of 100.0 becomes 1000 when changing the decimal point to zero (not 100) and must be re-entered to set the proper value.*

4.3.5   Input Low/High Scale

The Input Low Scale and Input High Scale entries are used to set the input range for linear input types (VDC or mA). The entries are not available for temperature input types since they utilize a fixed range based on the sensor type. The input low scale value can be set from -19999 up to the high scale value. The high scale value can be set from the low scale value up to 45536.

NOTE: *The minimum and maximum scale values are limited by the decimal point selection. For a decimal of 0, the values are -19999 and 45536 respectively. For one decimal point, the values are -1999.9 and 4553.6. For two decimal digits, the values are -199.99 and 455.36 and for three decimal digits the values are -19.999 and 45.536.*

4.3.6   Input Filter

The Input Filter entry is used to select the time constant used for filtering the process input.
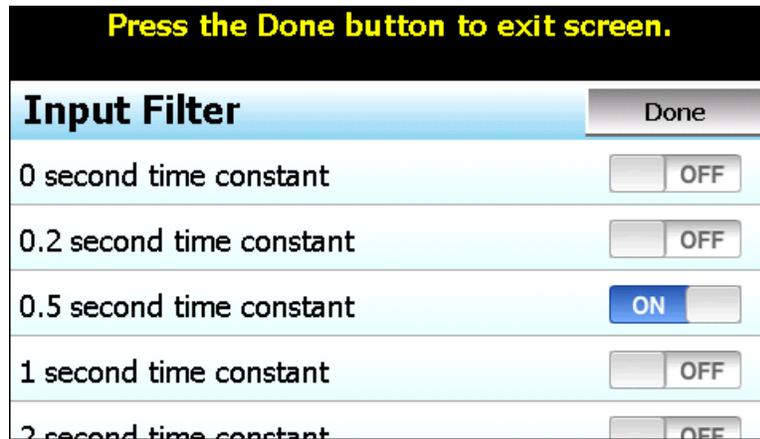
The time constant selections are mutually exclusive, i.e., selecting one will turn off the others. Once the desired filter constant has been selected, press the "Done" button to set the input filter for the limit control and return to the main Limit Configuration screen.

4.3.7   Output 1 Function

The Output 1 Function is used to set the mode of operation of the limit control output. The output can be set for high limit control, low limit control or high/low limit control. The output selections are mutually exclusive, i.e., selecting one will turn off the others. Once the desired function has been selected, press the "Done" button to set the limit output function and return to the main Limit Configuration screen.

Press the Done button to exit screen.

Output 1 Function	Done
High limit control	OFF
Low limit control	OFF
High/Low limit control	ON

The **High limit control** function will turn off the output when the process value exceeds the high limit set point. Once the process value is below the high limit set point and the alarm is reset, the output will turn on.

The **Low limit control** function will turn off the output when the process value exceeds the low limit set point. Once the process value is above the low limit set point and the alarm is reset, the output will turn on.

The **High/Low limit control** function will turn off the output when the process value exceeds the high or low limit set point. Once the process value is within the high and low set point and the alarm is reset, the output will turn on.

NOTE: *If a sensor break occurs, the PV value is driven to a value above the maximum of the selected input type. Therefore, the limit will not go into alarm if configured for "Low limit control". If this circumstance creates a safety issue, it is recommended that the output be configured as a "High/Low limit control".*

4.3.8 Output 1 Hysteresis

The output 1 hysteresis is used to create a safe-sided dead band around the high/low limit set point to prevent the alarm from being reset and then immediately reactivating if the process is hovering around the alarm set point. In order to reset the high or low limit alarm, the process value must fall below the high limit set point or rise above the low limit set point by the hysteresis value.

4.3.9 Lower/Upper Limit of High Setpoint

The lower and upper limits of high set point are used to set the minimum and maximum allowed value that can be entered for the high limit alarm set point. These entry fields are active when the output 1 function of the limit control is set to high limit control or high/low limit control. These values are typically set by the OEM to ensure that the user can not adjust the high limit set point beyond the maximum safe operating limits of the process.

4.3.10 Lower/Upper Limit of Low Setpoint

The lower and upper limits of low set point are used to set the minimum and maximum allowed value that can be entered for the low limit alarm set point. These entry fields are active when the output 1 function of the limit control is set to low limit control or high/low limit control. These values are typically set by the OEM to ensure that the user can not adjust the low limit set point beyond the maximum safe operating limits of the process.

4.3.11 High/Low Limit Setpoint

The high and low limit set points are the alarm points at which output 1 of the limit control will open when the process value exceeds the entry. The high set point entry is available when the output 1 function of the limit control is set to high limit control or high/low limit control and the low set point entry is available when the output

1 function of the limit control is set to low limit control or high/low limit control. The set points are also available on the Alarm screen in the MCT4 runtime application.

4.3.12 Output 2 Function

The Output 2 Function is used to set the mode of operation for the secondary control output of the limit control. The output selections are mutually exclusive, i.e., selecting one will turn off the others. Once the desired function has been selected, press the "Done" button to set the output function for the limit control and return to the main Limit Configuration screen.

NOTE: *The output function must be set to match the type of output ordered on the limit control.*
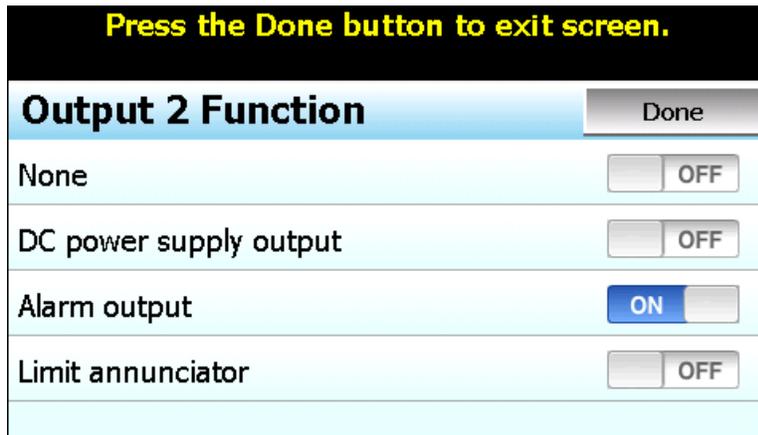
The **DC power supply output** function must be selected when the output type ordered for the limit control is a transmitter power supply.

The **Alarm output** function activates the alarm configuration settings for assigning the type of alarm logic to apply to output 2. When the alarm condition is active, the output will turn on.

The **Limit annunciator** function uses output 2 as a means for activating an external audible alarm. When the limit output deactivates due to the process value exceeding the high or low limit set point, output 2 will also activate. The output will remain activate until the reset button is pressed on the Alarm screen in the runtime application or the remote reset is activated.

4.3.13 Alarm Function

The Alarm Function is used to select the alarm type for output 2 if the output function is configured as an alarm output. The alarm selections are mutually exclusive, i.e., selecting one will turn off the other. Once the desired alarm type has been selected, press the "Done" button to set the alarm function for the limit control output and return to the main Limit Configuration screen.

Press the Done button to exit screen.

Alarm Function	Done
Process value high alarm	ON
Process value low alarm	OFF

NOTE: *For the following alarm descriptions, PV = process value, ASP is the alarm set point and AHY is the alarm hysteresis.*

When **Process value high alarm** is selected and the process value is higher than the alarm set point (PV > ASP), a process high alarm occurs. When the process value is lower than the alarm set point minus the alarm hysteresis (PV < ASP–AHY), the alarm is off.

When **Process value low alarm** is selected and the process value is lower than the alarm set point (PV < ASP), a process low alarm occurs. When the process value is above the alarm set point plus the alarm hysteresis (PV > ASP+AHY), the alarm is off.

4.3.14 Alarm Mode

The Alarm Mode is used to select the mode of operation for output 2 if the output function is configured as an alarm output. The mode selections are mutually exclusive, i.e., selecting one will turn off the other. Once the desired alarm mode has been selected, press the "Done" button to set the alarm operation for the limit control output and return to the main Limit Configuration screen.

Press the Done button to exit screen.

Alarm Mode	Done
Normal alarm action	ON
Latching alarm action	OFF

Normal alarm action has the alarm output off in the non-alarm condition and on in the alarm condition.

Latching alarm action will keep the alarm output on even if the alarm condition has cleared until the alarm is reset by the user.

4.3.15   Alarm Indication

The Alarm Indication entry is used to select whether the alarm will be shown in the MCT4 runtime application or be hidden from the user. This allows the OEM to configure the alarm to perform a specific control function while preventing the user from adjusting the set point or seeing the activation state of the alarm.

The indication selections are mutually exclusive, i.e., selecting one will turn off the other. Once the desired alarm indication has been selected, press the "Done" button to set the alarm operation and return to the main Limit Configuration screen.

NOTE: *If the alarm is hidden but its mode is set for latching, the user will not have any indication that the alarm requires manual reset. When an alarm is hidden, it is recommended that the normal or hold mode be used so that the alarm output automatically resets when the alarm condition is no longer present.*

When the alarm indication is set for **Hide alarm status/settings**, the alarm will be removed from the MCT4 runtime application. The user will not be able to edit the alarm message or adjust the alarm set point. When the alarm activates, there will be no indication or message on the alarm screen and the audible alarm will not sound. The alarm operates as a "silent" alarm with no indication to the user.

When the alarm indication is set for **Show alarm status/settings**, the user will be able to access and change the alarm set point and alarm message under the device settings. When the alarm occurs, the alarm message will be displayed on the Alarm screen and the audible alarm will sound.

4.3.16   Alarm Setpoint

The alarm set point can be set when output 2 is configured as an alarm output. If the alarm indication is set to "show" the alarm status and settings, the set point will also be available in the MCT4 runtime application. If the alarm indication is set for "hide" alarm status and settings, the alarm set point will not be available in the MCT4 runtime application and can only be changed in the Configurator.

4.3.17   Alarm Hysteresis

The alarm hysteresis can be set when output 2 is configured as an alarm output. It is used to eliminate rapid on/off cycling of the alarm output by applying a safe-sided dead band to the alarm. When the alarm set point is exceeded, the alarm will activate. The alarm will not deactivate until the process rises above (for low alarm) or falls below (for high alarm) the alarm set point by the hysteresis value.

The hysteresis can be set from a minimum of 0.1 to a maximum of 10.0 for units of degrees Centigrade and to a maximum of 18.0 for units of degrees Fahrenheit and linear input types.

4.3.18 Alarm Failure Transfer

The Alarm Failure Transfer is used to set the state of output 2 if there is an input failure, i.e., sensor break. The selections are mutually exclusive, i.e., selecting one will turn off the other. Once the desired alarm failure transfer selection has been made, press the "Done" button to return to the main Limit Configuration screen.

The **Output goes off as unit fails** selection will force the output off during failure regardless of the alarm activation status.

The **Output goes on as unit fails** selection will force the output on during failure regardless of the alarm activation status.

4.3.19 Event Input Function

The Event Input Function is used to select the desired mode of operation for the digital input of the limit control board. The event input selections are mutually exclusive, i.e., selecting one will turn off the others. Once the desired function has been selected, press the "Done" button to set the event input function for the limit control and return to the main Limit Configuration screen.

When **Remote reset** is selected for the event input function, the event input will perform an alarm reset each time the input terminals go from open to closed.

4.3.20   Display Format

The Display Format entry is used to select the normal display mode for the limit control in a non-limit condition. The display format selections are mutually exclusive, i.e., selecting one will turn off the others. Once the desired display format has been chosen, press the "Done" button to return to the main Limit Configuration screen.
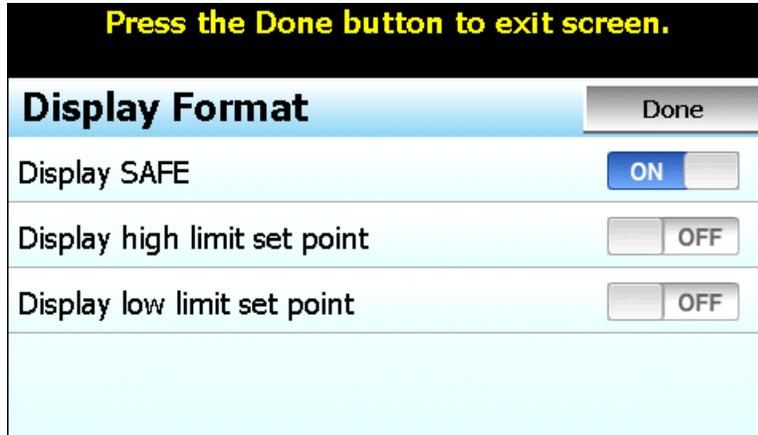
When **Display SAFE** is selected, the Loop View and All View screens in the runtime application will display the word "SAFE" when the limit alarm is not active. When a limit alarm is activated, the word "SAFE" will be replaced with either the high limit set point (if the high limit alarm is tripped) or the low limit set point (if the low limit alarm is tripped).

When **Display high limit set point** is selected, the Loop View and All View screens in the runtime application will display the high limit set point regardless of the limit alarm condition.

When **Display low limit set point** is selected, the Loop View and All View screens in the runtime application will display the low limit set point regardless of the limit alarm condition.

4.3.21   Restart Mode

The Restart Mode entry is used to select the limit control state on power up. Once the desired mode has been chosen, press the "Done" button to return to the main Limit Configuration screen.

NOTE: *Available on limit control with V.16 firmware or later. Limit controls prior to V.16 operate according to the "Normal" mode described below.*
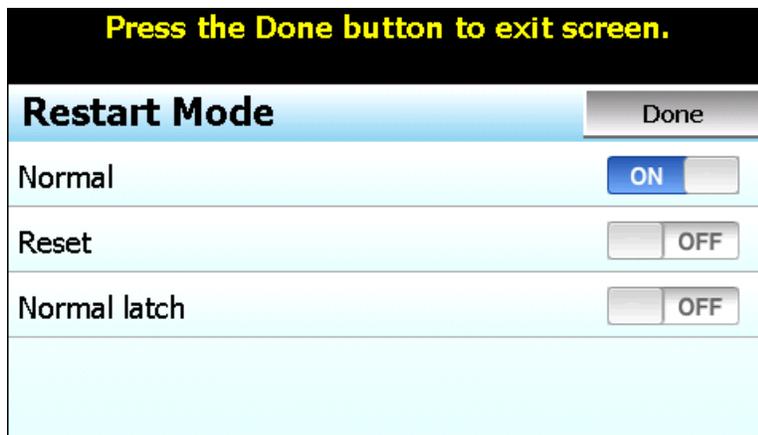
When **Normal** is selected (default mode) and power is applied, as long as the process value is not exceeding either the high or low limit set point, the limit output (OUT1) will be energized. If upon application of power, the process value is exceeding either the high or low limit set point, the limit output will not be energized. If output 2 is configured as a limit annunciator (see section 4.3.12 Output 2 Function), it will be energized to indicate the alarm condition.

When **Reset** is selected and power is applied, the limit output (OUT1) will always remain off. This is a "fail-safe" mode that always requires the user to manually reset the limit control when power is cycled. Note that if output 2 is configured as a limit annunciator (see section 4.3.12 Output 2 Function), it will also remain off when power is applied regardless of whether or not the process value is exceeding either the high or low limit set point.

The **Normal latch** mode is a combination of the normal and reset modes. The operation of the limit control on power up is dependent upon the limit condition prior to power loss. If the control was not in a limit condition on power down, when power is applied, it will follow the rules of the normal restart mode. However, if a limit condition exists on power down, the limit will remember this state on power up.

Thus, the limit output (OUT1) will remain off when power is applied due to the previous limit condition at power down regardless of the current process value. Even if the process value is within the safe operating limits, the limit control will require manual reset at power up. If output 2 is configured as a limit annunciator, and it was active when power was removed, it will be energized when power is restored. If the limit annunciator was silenced prior to power down, meaning the user pressed the Reset button on the alarm screen, the output will remain off when power is restored.

4.4 Monitor Configuration

The Monitor Configuration screen is accessed from the Setup menu. The screen provides access to all monitor points as entered on the Control Setup screen. When more than one monitor point is configured, the left/right scroll buttons will be provided at the top right of the screen. These buttons can be used to scroll through all available monitor points in order to view/edit settings for each.
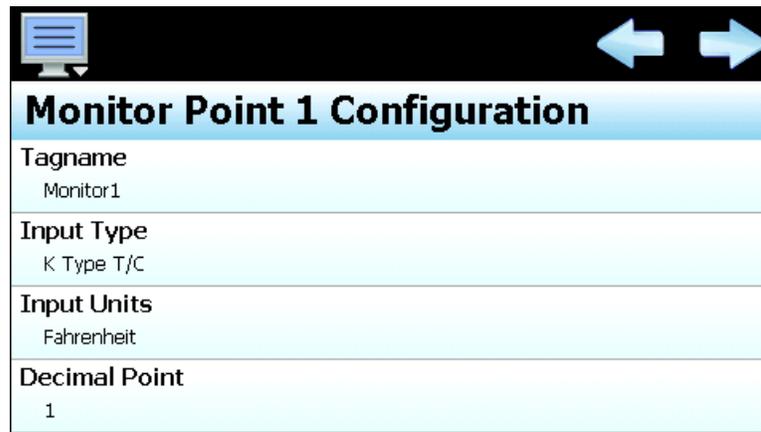
To view all of the available settings for a monitor point, simply swipe up or down on the screen to scroll through the list items. To edit a value, tap the row for the desired item. If the entry is a simple numeric value, the number entry pad will be shown. If the item has multiple selections to choose from, a list of individual selections for the item will be shown.

4.4.1 Tagname

The Tagname entry allows the user or OEM to assign a specific name for each monitor point, up to 11 characters in length. This name will be used throughout the MCT4 runtime application. The default tag names are Monitor1 to Monitor8.

4.4.2 Input Type

The Input Type entry is used to select the type of sensor that will be connected to the monitor point input. The input type can be a temperature input (thermocouple) or a linear input type (VDC or mA).
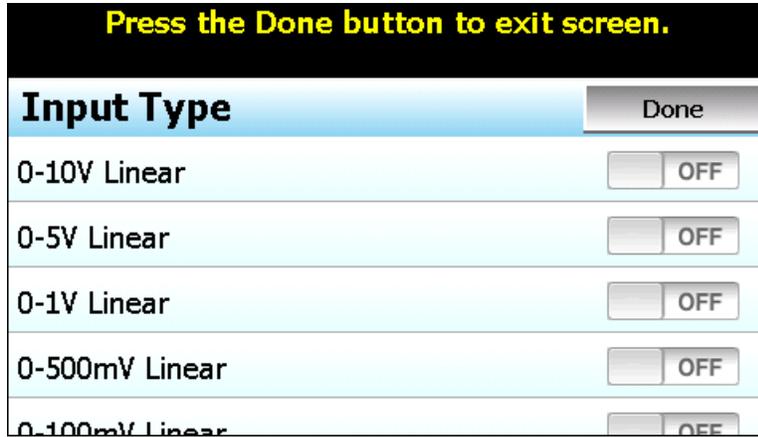
The input type selections are mutually exclusive, i.e., selecting one input will turn all other selections off. Once the desired input type has been selected, press the "Done" button to set the input type for the monitor point and return to the main Monitor Configuration screen.

NOTE: *Each input is equipped with a slide switch for selecting voltage or current input type. The switch must be set properly according to the input type selection made. See section 3.3.1 Sensor Wiring for details on sensor wiring and switch settings according to selected sensor type.*

4.4.3 Input Units

The Input Units entry is used to select the temperature units for thermocouple input types. If the selected input type for the monitor point is a linear input (VDC or mA), the Input Units entry will display the text entry keypad allowing the user or OEM to enter specific engineering units up to 4 characters.
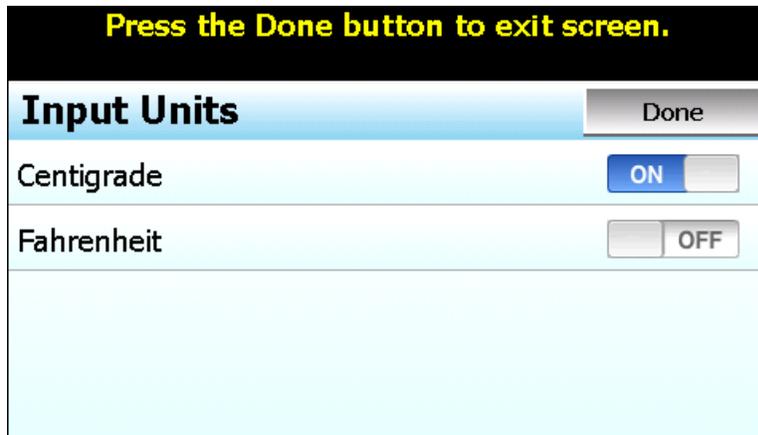
The input unit selections for temperature are mutually exclusive, i.e., selecting one will turn off the other. Once the desired temperature units have been selected, press the "Done" button to set the input units for the monitor point and return to the main Monitor Configuration screen.

4.4.4   Decimal Point

The Decimal Point entry allows the input precision to be adjusted between 0 and 1 decimal digits for temperature input types (thermocouple) and between 0 and 3 for linear input types (VDC and mA).

IMPORTANT: *Once the monitor point has been configured with a specific decimal point, changing the decimal point will require the low/high scale to be reconfigured for linear input types in order to maintain the previous input span. An entry of 100.0 becomes 1000 when changing the decimal point to zero (not 100) and must be re-entered to set the proper value.*

4.4.5   Input Low/High Scale

The Input Low Scale and Input High Scale entries are used to set the input range for linear input types (VDC or mA). The entries are not available for thermocouple inputs since they utilize a fixed range based on the sensor type. The input low scale value can be set from -32768 up to the high scale value. The high scale value can be set from the low scale value up to 32767.

NOTE: *The minimum and maximum scale values are limited by the decimal point selection. For a decimal of 0, the values are -32768 and 32767 respectively. For one decimal point, the values are -3276.8 and 3276.7. For two decimal digits, the values are -327.68 and 327.67 and for three decimal digits the values are -32.768 and 32.767.*

4.5   Soft Alarm Configuration

The Soft Alarm Configuration screen is accessed from the Setup menu. The screen allows the user or OEM to program each soft alarm up to the total number entered on the Control Setup screen. When more than one soft alarm is programmed, the left/right scroll buttons will be provided at the top right of the screen in order to view/edit settings for each alarm.
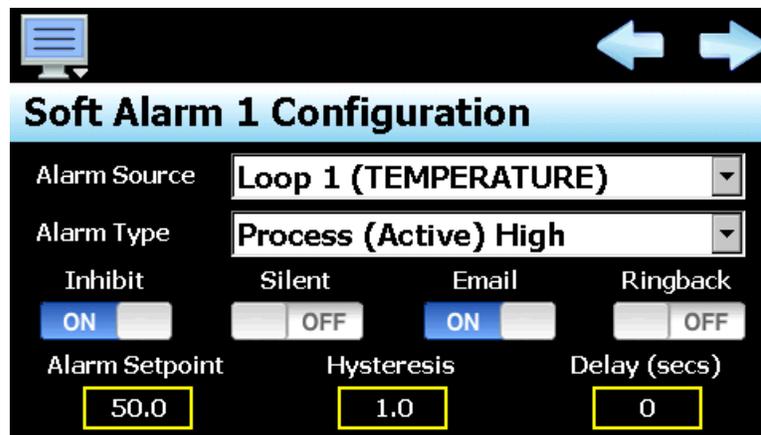
The **Alarm Source** drop down menu selection lists all loops, limits, monitor points and math equations (if configured) to be chosen for the process value to be monitored by the alarm. Any configured logic equations are also included as alarm source selections in which the true/false state of the equation is utilized to activate the alarm.

The **Alarm Type** drop down menu selection is used to choose the type of alarm. Alarm choices include process (active) high, process (active) low, deviation high, deviation low, deviation band and end of program. The

deviation alarms can only be chosen for control loops. For the limit, monitor points, math/logic equations and loops programmed for monitor only, there is no set point to associate with the alarm.

For the following alarm descriptions, PV = process value, SV = the control set point value, ASP is the alarm set point and AHY is the alarm hysteresis.

Process (Active) High   The alarm is independent of set point. When the process value is higher than the alarm set point (PV > ASP), a process high alarm occurs. When the process value is lower than the alarm set point minus the alarm hysteresis (PV < ASP–AHY), the alarm is off.

When the alarm source is a logic equation, the alarm will activate when the result of the logic equation is true. The alarm will deactivate when the result of the logic equation is false.

Process (Active) Low   The alarm is independent of set point. When the process value is lower than the alarm set point (PV < ASP), a process low alarm occurs. When the process value is above the alarm set point plus the alarm hysteresis (PV > ASP+AHY), the alarm is off.

When the alarm source is a logic equation, the alarm will activate when the result of the logic equation is false. The alarm will deactivate when the result of the logic equation is true.

Deviation High   The alarm is dependent upon the control set point and alerts the operator when the process value deviates too high over the set point value. For deviation high alarms, the alarm set point is entered as a positive value. When the process is higher than the control set point plus the alarm set point (PV > SV+ASP), a deviation high alarm occurs. When the process value falls below the control set point plus alarm set point minus the alarm hysteresis (PV < SV+ASP-AHY), the alarm is off.

Deviation Low   The alarm is dependent upon the control set point and alerts the operator when the process deviates too far below the set point value. For deviation low alarms, the alarm set point is entered as a negative value. When the process is lower than the control set point plus the alarm set point (PV < SV+ASP), a deviation low alarm occurs. When the process value rises above the control set point plus alarm set point plus the alarm hysteresis (PV < SV+ASP+AHY), the alarm is off.

Deviation Band   The alarm sets two trigger levels relative to the control set point value. For deviation band alarms, the alarm set point is entered as a positive value. The two alarm trigger levels are then defined as SV+ASP and SV-ASP for the high and low alarm values. When the process value is greater than the high alarm value (PV > SV+ASP) or less than the low alarm value (PV < SV-ASP), a deviation band alarm occurs. When the process value is within the high and low trigger levels by the value of the alarm hysteresis (PV < SV+ASP-AHY and PV > SV-ASP+AHY), the deviation band alarm is off.

End of Program   The alarm is not associated with the process value or set point. The alarm is turned on upon completion of an automatic ramp/soak program. Once the alarm has occurred it must be manually cleared from the Alarm screen of the runtime application.

The **Inhibit** selection is used to enable the hold mode of operation for the alarm. When on, this setting prevents the alarm from activating on power up even when an alarm condition is present. The alarm will be blocked until the alarm condition clears. Once cleared, the alarm will then operate normally and activate when an alarm condition occurs.

The **Silent** selection is used to disable annunciation of the alarm in the runtime application. When on, this setting prevents the alarm from being displayed on the alarm screen and also prevents it from being recording in alarm history. It also prevents the alarm icon from being shown and the audible alarm from sounding when

the alarm occurs. Note that the alarm will still be accessible from the Alarm settings screen in the runtime application (see section 9.2 Alarms) so that the alarm set point, delay and alarm message can still be edited.

The **Email** selection is used to enable email/SMS capability for the alarm. When on, if the email client of the MCT4 has been properly configured and email addresses have been entered into the system to receive email and/or SMS messages on alarm (see section 9.8 Email), the alarm message will be sent to the applicable email addresses when the alarm occurs. If this setting is off, no email/SMS message will be sent regardless of the email client settings.

The **Ringback** selection is used in conjunction with the alarm delay. When on, this setting allows the alarm to be reset and cleared from the Alarm screen in the runtime application even if the alarm is still active by resetting the alarm delay. The alarm will then reactivate after the alarm delay period expires as long as the alarm condition remains active.

The **Alarm Setpoint** can be entered when the alarm function is set for a process or deviation type of alarm. The alarm set point will also be available in the MCT4 runtime application.

The alarm **Hysteresis** can be entered when the alarm function is set for a process or deviation type of alarm. It is used to eliminate rapid on/off cycling of the alarm output by applying a safe-sided dead band to the alarm. When the alarm set point is exceeded, the alarm will activate. The alarm will not deactivate until the process rises above (for low alarm) or falls below (for high alarm) the alarm set point by the hysteresis value.

The alarm **Delay** can be entered when the alarm function is set for a process or deviation type of alarm. The alarm delay will also be available in the MCT4 runtime application. The alarm delay is used to delay the activation of the alarm for a specified period of time. The delay is entered in seconds and can be set with a minimum of zero to a maximum 5999 seconds (99 minutes and 59 seconds).

The programmed time delay is activated (timing begins) when the alarm setpoint is exceeded. The alarm delay will stop timing (and reset) once the process value returns to non-alarm level. If the time delay times out and the alarm setpoint is still exceeded, the alarm will activate.

4.6 Math/Logic Configuration

The Math/Logic Configuration screen is accessed from the Setup menu. The screen provides access to all math/logic equations as entered on the Control Setup screen. When more than one equation is configured, the left/right scroll buttons will be provided at the top right of the screen. These buttons can be used to scroll through all available equations in order to view/edit settings for each.
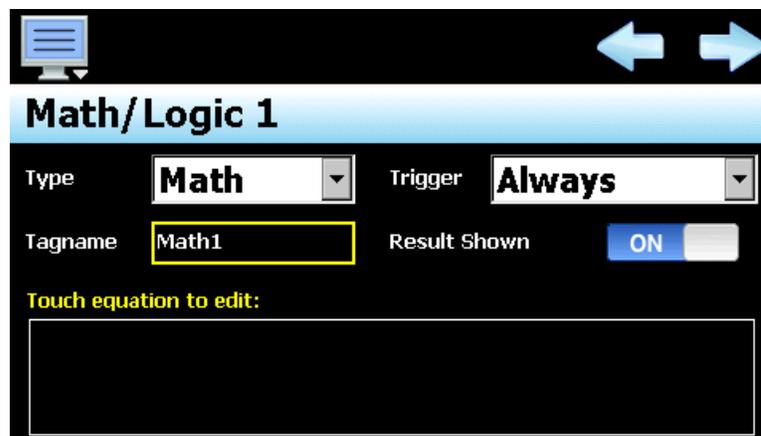
Math Type

The **Type** drop down menu is used to select what the equation will be used for. Selections include Math, Logic and timer. When Math is selected, the result of the equation can be shown on the Overview screen in the

runtime application if the Result Shown selection is turned on. The result of the calculation would then also be selectable for plotting on each of the four user configurable trends as well as a selectable point for data logging.
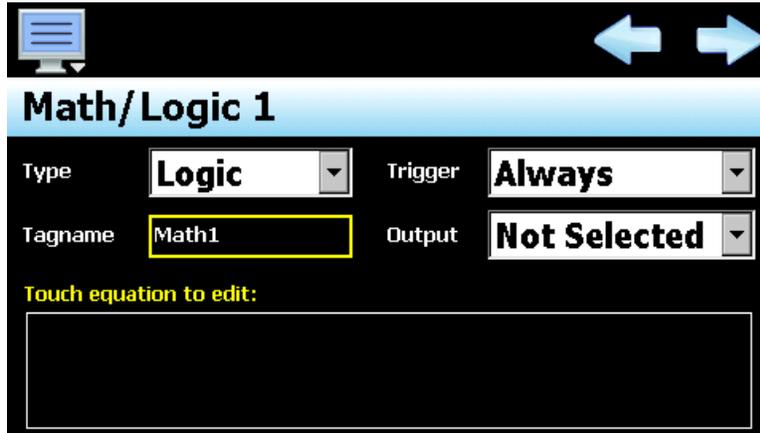
Logic Type

When Logic is selected, the equation will be utilized to obtain a true/false result which will then be set to the selected output. The output will be activated when the result of the equation is true and turned off when the result of the equation is false.
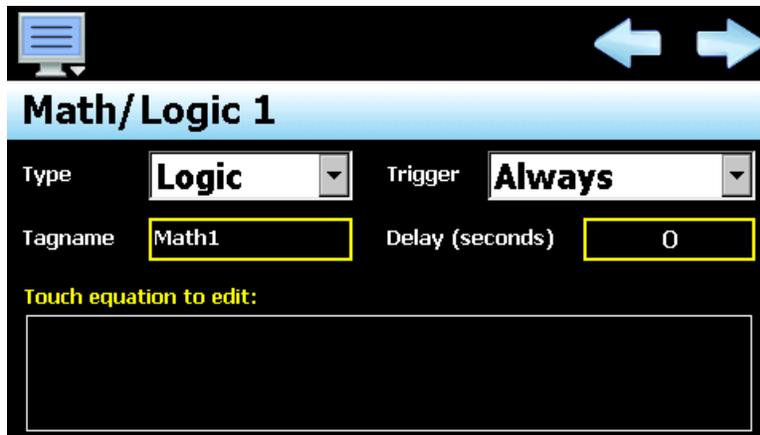
Timer Type

When Timer is selected, the equation will be utilized to obtain a true/false result to activate a time delay. The equation can then be selected as a timer input on another Logic equation as T1-T20 corresponding to the number of the math/logic equation 1-20.

The **Tagname** entry allows the user or OEM to assign a specific name for each equation, up to 11 characters in length. This name will be used throughout the MCT4 runtime application to identify the calculated value on the Overview screen and in the trend and data logging point selection lists. The default tag names are Math1 to Math20. The tagname will also be shown in the Inputs drop-down menus on the equation entry screen for reference when selecting math or timer equations as inputs to other equations.

The **Trigger** selection is used to determine what condition must be met in order for the equation to be solved. If the condition is not met, the runtime application will skip the equation and not evaluate it. The default selection of "Always" means that the equation is constantly evaluated and a new result determined every scan. Depending upon the configuration of the MCT4, the following additional trigger selections are available:

S1_EventIn   Loop 1 (slot 1) event input. If selected, the equation will be evaluated when the event input is activated. This selection is available when the event input function of the PCM in slot 1 is configured for any of the functions except for failure transfer.

S2_EventIn   Loop 2 (slot 2) event input. If selected, the equation will be evaluated when the event input is activated. This selection is available when the event input function of the PCM in slot 2 is configured for any of the functions except for failure transfer.

S3_EventIn   Loop 3 (slot 3) event input. If selected, the equation will be evaluated when the event input is activated. This selection is available when the event input function of the PCM in slot 3 is configured for any of the functions except for failure transfer.

S1_EvOut2   Loop 1 (slot 1) event output 2. If selected, the equation will be evaluated when the event output is activated. This selection is available when the output 2 function the PCM in slot 1 is configured for event, manual event only or math/logic event output only.

S1_EvOut3   Loop 1 (slot 1) event output 3. If selected, the equation will be evaluated when the event output is activated. This selection is available when the output 3 function the PCM in slot 1 is configured for event, manual event only or math/logic event output only.

S1_EvOut4   Loop 1 (slot 1) event output 4. If selected, the equation will be evaluated when the event output is activated. This selection is available when the output 4 function the PCM in slot 1 is configured for event, manual event only or math/logic event output only.

S2_EvOut2   Loop 2 (slot 2) event output 2. If selected, the equation will be evaluated when the event output is activated. This selection is available when the output 2 function the PCM in slot 2 is configured for event, manual event only or math/logic event output only.

S2_EvOut3   Loop 2 (slot 2) event output 3. If selected, the equation will be evaluated when the event output is activated. This selection is available when the output 3 function the PCM in slot 2 is configured for event, manual event only or math/logic event output only.

S2_EvOut4   Loop 2 (slot 2) event output 4. If selected, the equation will be evaluated when the event output is activated. This selection is available when the output 4 function the PCM in slot 2 is configured for event, manual event only or math/logic event output only.

S3_EvOut2   Loop 3 (slot 3) event output 2. If selected, the equation will be evaluated when the event output is activated. This selection is available when the output 2 function the PCM in slot 3 is configured for event, manual event only or math/logic event output only.

S3_EvOut3   Loop 3 (slot 3) event output 3. If selected, the equation will be evaluated when the event output is activated. This selection is available when the output 3 function the PCM in slot 3 is configured for event, manual event only or math/logic event output only.

S3_EvOut4   Loop 3 (slot 3) event output 4. If selected, the equation will be evaluated when the event output is activated. This selection is available when the output 4 function the PCM in slot 3 is configured for event, manual event only or math/logic event output only.

ExpIn8-23   Expansion IO module inputs 8 to 23. If selected, the equation will be evaluated when the input is activated. The selections are available when the expansion IO module is enabled and the input function is set to any of the available functions except for "None".

ExpOut32-45   Expansion IO module outputs 32 to 45. If selected, the equation will be evaluated when the output is activated. The selections are available when the expansion IO module is enabled and the output function is set to any of the available functions except for "None".

NOTE: *When a trigger selection other than "Always" is made and the condition is no longer met, the previous result of the equation will be maintained until the trigger condition is again met and a new result is calculated. For math equations, the calculated value will be maintained. For logic and timer equations, the previous output and timer state will be maintained. Thus, if the output is on when the*

trigger condition changes to false, the output controlled by the logic equation will remain on until the trigger condition is again met and a new output state can be determined.

The **Output** selection is provided for Logic equations and is used to select the output for the equation. The available output selections depend upon the number of loops available and the number of outputs configured as events as well as expansion IO module configuration. The available selections can include S1_EvOut2, S1_EvOut3, S1_EvOut4, S2_EvOut2, S2_EvOut3, S2_EvOut4, S3_EvOut2, S3_EvOut3, S3_EvOut4 and ExpOut32 to 45 which correspond to the trigger selections above.

IMPORTANT: *The output selections are common to all logic equations; therefore, multiple equations can be assigned to the same output. If multiple equations are required for various conditions to control a single output, make sure to configure the proper trigger for each equation so that only one equation is active at a time. If more than one equation is active at a time, the output may toggle on and off according to different results coming from multiple equations.*

If a logic equation is set to an event output and an automatic ramp/soak program is in operation, the event state is continuously set by the running program. If the program state and equation result are different, the output will continuously toggle on and off. Therefore, it is recommended that logic equations not be tied to event outputs that can also be under program control.

The **Result Shown** selection is provided for Math equations. When on, the result of the equation is displayed on the Overview screen in the runtime and the value is also selectable for data logging and trending. When off, the value is not displayed in the runtime. The off selection is typically chosen if a derived value is required for a soft alarm, but is not something that needs to be displayed to the user.

The **Delay** entry is provided for Timer equations. The delay is entered in seconds and can be set with a minimum of zero to a maximum 86400 seconds (24 hours). When the equation result is true for the time period entered, the internal timer output will activate. When the equation result is false, the time will be reset to zero and the internal timer output will deactivate.

4.6.1   Entering a Math/Logic Equation

To enter an equation, first select the equation type desired. Once the type has been selected, touch the equation field on the Math/Logic Configuration screen. This will display the equation entry screen.
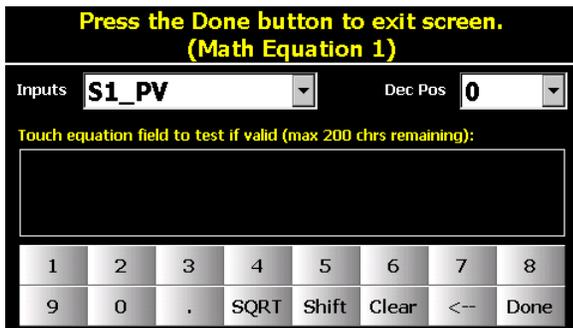
Math Equation Entry
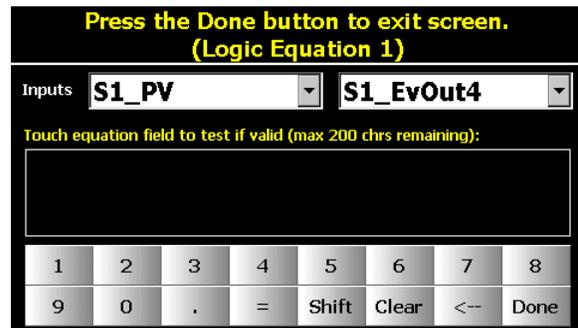
Logic Equation Entry

The entry screen provides a keypad with access to all available operators for equation entry. Math type equations provide a SQRT (square root) key while logic/timer equations replace the square root function with the equals (=) comparator. Pressing the "Shift" key toggles between the numeric and comparison operators as shown below.

Equations follow the standard order of operations for mathematics. Multiplication and division operators are evaluated first, followed by addition and subtraction. It is recommended that you determine what your equation should be prior to entry, so that parenthesis can be added in the proper locations in order to ensure that operations are carried out in the proper order. New entries are always appended to the current equation. You cannot go back and insert values or operators into an existing equation that may have been missed. You must either backspace to the location (<--) or clear the equation and start over. By planning and/or writing down the equation first, it will prevent you from having to start over.

The **Inputs** drop-down menu(s) provide the means for adding system process values to the equation. Simply select the desired value from the menu, and the value will be appended to the equation. For math equations, only process values are available. These include the loop/limit PV, loop SP, loop %Out and the results of other math equations. The available process input selections can include:

S1_PV   Loop 1 (slot 1) process value.

S1_SP   Loop 1 (slot 1) set point value.

S1_%Out   Loop 1 (slot 1) percentage of output.

S2_PV   Loop 2/Limit (slot 2) process value.

S2_SP   Loop 2 (slot 2) set point value. Only available a PCM is installed in slot 2.

S2_%Out   Loop 2 (slot 2) percentage of output. Only available a PCM is installed in slot 2.

S3_PV   Loop 3/Limit (slot 3) process value.

S3_SP   Loop 3 (slot 3) set point value. Only available a PCM is installed in slot 3.

S3_%Out   Loop 3 (slot 3) percentage of output. Only available a PCM is installed in slot 3.

M1-M20   Math equation 1-20 result. The tagname entered for the math block will also be shown in parenthesis to assist in identification of each math result, i.e., M1 (*Tagname*).

For logic equations, an additional menu is provided that allows you to select from the available loop event inputs and event outputs which correspond to the items listed under the Trigger selections above. If any equations are configured as the Timer type, they will also be provided as T1 to T20. The tagname of the equation will appear after the "T" designator for reference. If equation 5 was configured with the tagname "Cool Dly" the menu item would be displayed as "T5 (Cool Dly)". When selected as an input, the value would be displayed in the equation as simply "T5". Additionally, if any soft alarms have been configured, they will also be available for selection in a logic equation. They will be provided in the drop-down menu as SA1 to SA10 corresponding to soft alarms 1 through 10.

The **Dec Pos** entry field is available for math equations only. It allows precision of the math equation result to be adjusted between 0 and 3 decimal digits for display on the Overview screen in the runtime application and is also reflected in the value written to the data log file if the point if chosen for logging.

Any time during equation entry, you can test the validity of the equation by touching the entry field. The equation is also automatically tested when the "Done" button is pressed.
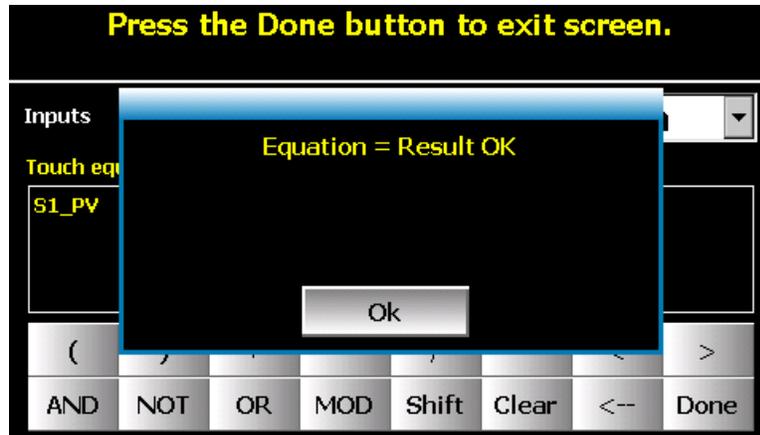
Only a valid equation can be saved. If the equation cannot be properly solved, you will not be able to exit the screen until the equation is corrected or cleared.
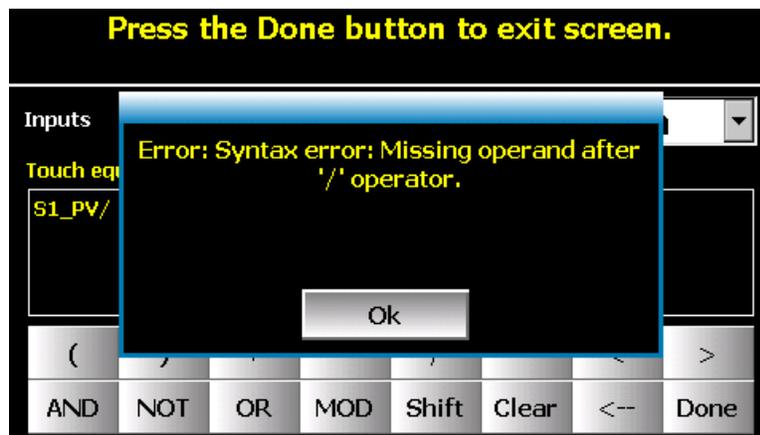
The error message will provide help in determining what is wrong with the equation; however, due to the number of possible combinations it is up to the user to ultimately evaluate the equation and verify its validity. Once the equation can be properly solved, pressing the "Done" button will return to the Math/Logic Configuration screen.

4.6.2   Math/Logic Equation Examples

The MCT4 equation module is not designed for high-speed calculation or logic purposes. The equation module is not deterministic, i.e., does not operate on a fixed interrupt. The equations are scanned approximately once every two seconds; however, file IO operations or remote communications, VNC activity, etc., could extend the evaluation interval.

If your desired output control logic requires timing resolution better than the above scan rate, use separate external device(s) to perform the required logic that are capable of the timing resolution needed.

4.6.2.1   *Order of Operations*

The MCT4 supports standard math operators including addition (+), subtraction (-), multiplication (*) and division (/). The power of the MCT4 math/logic block, is that it allows free-form entry of any equation including any combination of variables the system provides. Due to this however, when entering equations, it is important to understand the standard order of operations or the result may not be what is expected. The standard order of operations is a collection of rules that reflect conventions about which procedures to perform first in order to evaluate a given mathematical expression.

For example, in mathematics and most computer languages (including the MCT4), multiplication is granted a higher precedence than addition, and it has been this way since the introduction of modern algebraic notation. Thus, the expression 2 + 3 × 4 is interpreted to have the value 2 + (3 × 4) = 14, not (2 + 3) × 4 = 20. Where it is desired to override the precedence conventions, or even simply to emphasize them, parentheses ( ) can be added to indicate an alternative order or reinforce the default order to avoid confusion. For example, by adding parenthesis to the original expression, (2 + 3) × 4 forces addition to precede multiplication providing the result of 20.

The same holds true for division and subtraction in which division is given a higher precedence than subtraction. Therefore, when an equation is evaluated by the MCT4, multiplication and division are executed first from left to right, and then addition and subtraction are performed from left to right. If parenthesis are included in the equation, the expression(s) within the parenthesis are evaluated first.

Parentheses First

    4 x (5 + 3) – (4 / 2)   (5 + 3) = 8 and (4 / 2) = 2 are evaluated first

    4 x 8 – 2   4 x 8 = 32 is evaluated first since multiplication before addition

    32 – 2   subtraction is performed last to get result of 30

Else Multiply or Divide before Add or Subtract

    4 x 5 + 3 – 4 / 2   4 x 5 = 20 and 4 / 2 = 2 are evaluated first

    20 + 3 – 2   addition and subtraction performed last to get result of 21

With the introduction of exponents in the 16th and 17th centuries, they were given precedence over both addition and multiplication and could be placed only as a superscript to the right of their base. For example, $3 + 5^2 = 28$ and $3 \times 5^2 = 75$. The MCT4 does not provide the exponent operator; however, it can be accomplished by multiplying the number by itself the same number of times as the value of the exponent, i.e., $5^2 = 5 \times 5 = 25$.

If you require a value raised to a power, you must multiply the value by itself in the equation remembering to ensure proper order of operation using parenthesis. If you do not use parenthesis to prioritize the operation, you will not get the desired result.

Exponent

    Example: $75 / 5^2$

    Correct: 75 / (5 * 5)   (5 * 5) = 25   evaluated first since it is in parenthesis

                  75 / 25   division performed last to get proper result of 3

    Incorrect: 75 / 5 * 5   75 / 5 = 15 evaluated first since multiply/divide performed from left to right

                  15 * 5   multiplication performed last results in incorrect value of 75

In order to calculate the average of several values, you simply add each of the variables together, and then divide by the number of variables. Again, the parenthesis are required in order for the calculation to be proper evaluated.

Averaging Example:

Average monitor points 1 to 4 where Mon1=72, Mon2=74, Mon3=78 and Mon4=77.

Correct entry: (Mon1 + Mon2 + Mon3 + Mon4) / 4
                       (72 + 74 + 78 + 77) / 4 = 75.25

Incorrect entry: Mon1 + Mon2 + Mon3 + Mon4 / 4
                       72 + 74 + 78 + (77 / 4) = 243.25

Without the parenthesis, the equation would incorrectly divide the process value of monitor point 4 by 4 and then add that to the sum total of monitor points 1, 2 and 3. By utilizing the parenthesis, the sum total of all monitor points will be determined first, and that value will then be divided by 4 to get the proper average of all four points.

4.6.2.2   Square Root (SQRT) Implementation

To obtain the square root of a value or expression, you first activate the square root function by pressing the SQRT key. This appends the square root function "SQRT[" to the current equation. The SQRT key will "lock" on as indicated by changing color. All variable selections following the activation of the SQRT function will be part of the square root expression. Pressing the SQRT key again will end the square root entry by appending the closing bracket "]" to the equation and the key will unlock. Equation entry can then continue as normal.

4.6.2.3   Sample and Hold

To implement sample and hold, simply assign a trigger to the math equation instead of using the default "Always" selection. When the trigger is on, sampling will occur, i.e., the equation will be continuously evaluated. When the trigger is off, the MCT4 will stop evaluating the equation, but the previous value will be maintained. This provides a simple means for performing sample and hold.

For example, at the end of a cycle we want to capture the average temperature of loops 1 and 2 and hold that value until the next cycle is started. The event input of loop 1 is already used as a status input to indicate that the cycle is active, so we can it as our trigger. Our math/logic block would then be as follows:
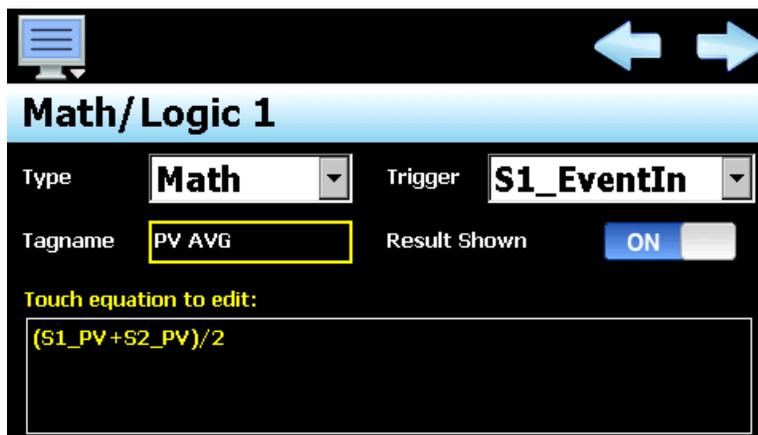
Since the trigger is active during the cycle, the average of loop 1 and loop 2 will be calculated and displayed on the Overview screen. When the cycle completes and the input turns off, the trigger for the equation will also turn off. The average of loop 1 and loop 2 will no longer be calculated; however, the previous value calculated will be held and displayed on the Overview screen until the next cycle is started, at which the trigger is again activated when the input turns on and a new average is calculated.

4.6.2.4   Basic Logic Operators

The MCT4 provides standard logic operators (AND, OR, NOT) as well comparison operators of less than (<), greater than (>) and equals (=). Couples with the free-form entry of the MCT4 math/logic blocks, it permits the operators to be used in any combination with any available system variable to create the custom logic required for any application.

AND   If either input is false, the output is false. If both inputs are true, the output is true.
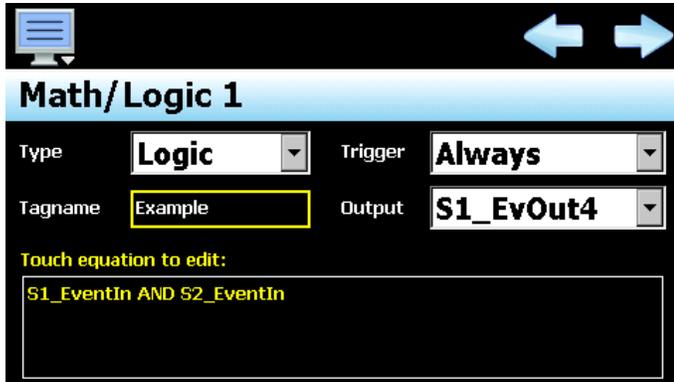
Inputs		Output
F	F	F
F	T	F
T	F	F
T	T	T
F = False (off) T = True (on)		

Nand   If either input is false, the output is true. If both inputs are true, the output is false.

Note: NAND is just what it implies, i.e., NOT AND.
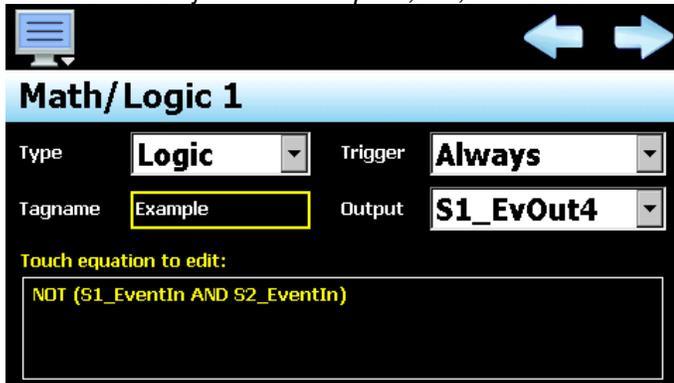
Inputs		Output
F	F	T
F	T	T
T	F	T
T	T	F
F = False (off) T = True (on)		

OR   If either input is true, the output is true. If both inputs are false, the output is false.
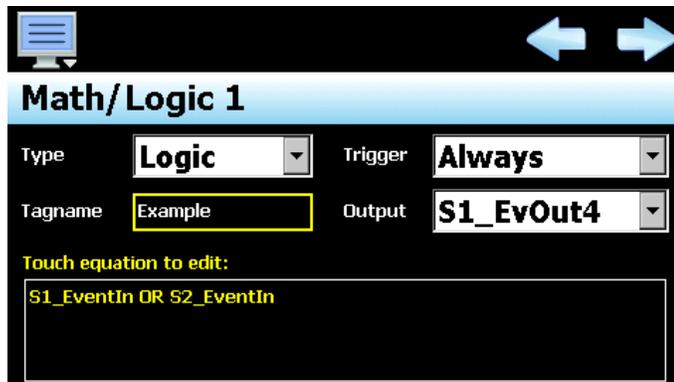
Inputs		Output
F	F	F
F	T	T
T	F	T
T	T	T
F = False (off) T = True (on)		

Nor   If either input is true, the output is false. If both inputs are false, the output is true.

Note: NOR is just what it implies, i.e., NOT OR.
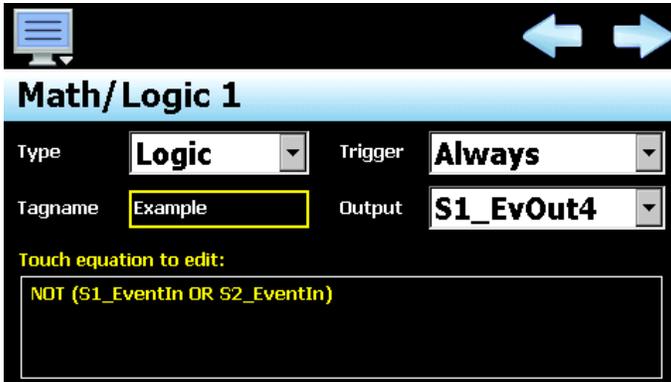
Inputs		Output
F	F	T
F	T	F
T	F	F
T	T	F
F = False (off) T = True (on)		

Latch   When the trigger is active, the output follows the input. When the trigger is off, the output is held (latched) at the value it had when the trigger was lost.
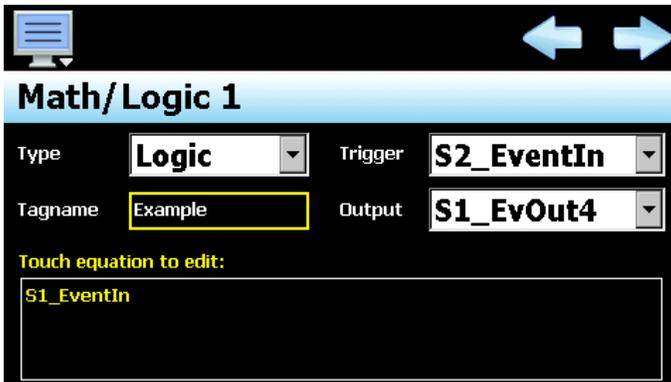
As long as loop 2 event input is true (on), the equation will be evaluated. Thus, the loop 1 event output 4 will be on when the loop 1 event input is on and off when it is off.

When the loop 2 event input is false (off), the equation will no longer be evaluated and the previous output state will be held.

RS Flip Flop   One input sets the output true; another sets it false.
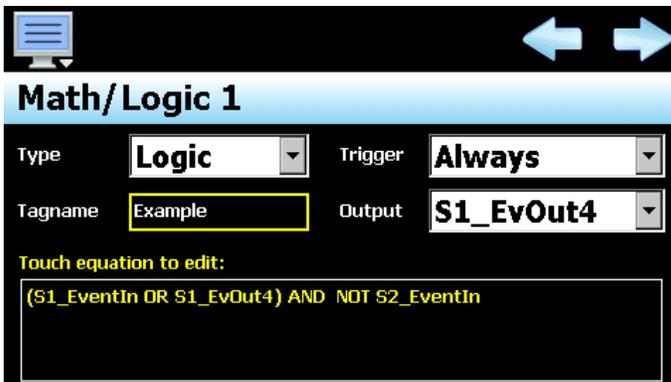
If the loop 1 event input is on and the loop 2 event input is off, the output will be true. Since the output is logically OR'd with the loop 1 event input, even if the input is turned off, the expression within the parenthesis is still true so the output holds itself on.

If the loop 2 event input is then turned on, it will result in a false outcome, and the output will be turned off.

Comparison (Equals)   If two values are the same, the output is true.
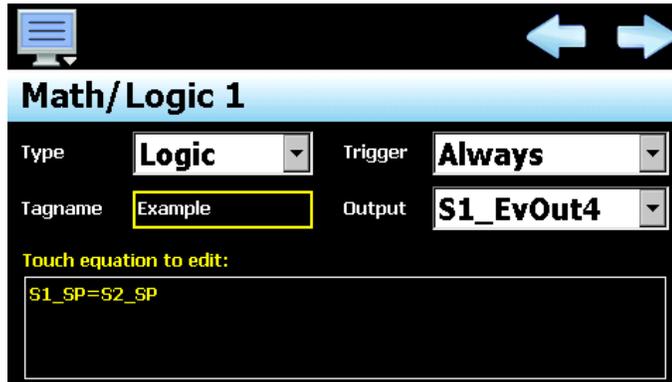
Comparing values…

As long as the set point of both loop 1 and 2 are equal, the output will be on.
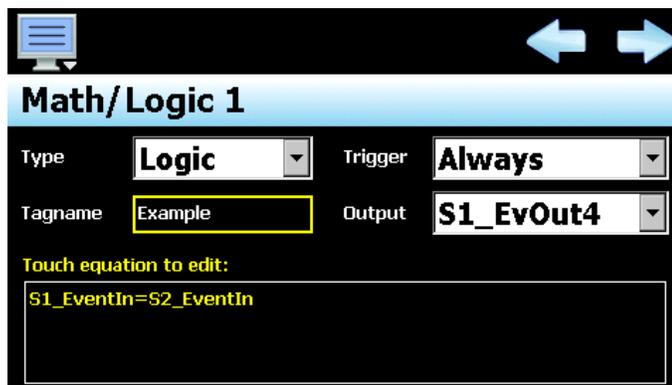
Comparing logic states…

As long as the loop 1 and 2 event input states are equal, the output will be on, i.e., if both inputs are on or both inputs are off, the output is on.

4.6.2.5   *Advanced Boost Heat/Cool Logic Example*

Boost heat and boost cool applications typically involve two-stage heating and cooling where the low capacity stage is normally used to maintain set point condition. When a large set point change then occurs, the low capacity stage would require too long of a period in time to achieve set point, so a second stage is then necessary to increase the rate of change until set point is again reached. The boost stage is then disabled and the low stage can again maintain set point.

This type of operation can be programmed into the MCT4 using a logic type equation to activate a digital output which would enable the boost heating or cooling stage. Take the following example:

Loop 1 (temperature control)
- Output 1 configured for heating
- Output 2 configured for cooling
- Output 3 configured as math/logic event output only (for boost heat)
- Output 4 configured as math/logic event output only (for boost cool)

The application requires that the boost heat output is activated when the heating output is greater than 80% and the boost cool output is activated when the cooling output is greater than 50%. This can be done utilizing two logic equations. We can begin by navigating to the Control Setup screen and entering a value of 2 for the number of Math/Logic equations. Next, we will navigate to the Math/Logic Configuration screen to enter the equations.

Math/Logic 1 will be used for boost heat, so first we select "Logic" for the equation Type. For reference, the Tagname will be set to "Boost Heat". The Trigger will be left at the default of "Always" since the output should activate any time the heating percentage of output is above 80%. The Output selection must then be set to

output 3 of loop 1. This corresponds to the "S1_EvOut3" selection. To enter the equation, press the equation display field. Select the output value of loop 1 (S1_%Out) and using the keypad buttons, enter the greater than symbol (>) and the value of 80. Finally, press the "Done" button and your screen should be as shown below.
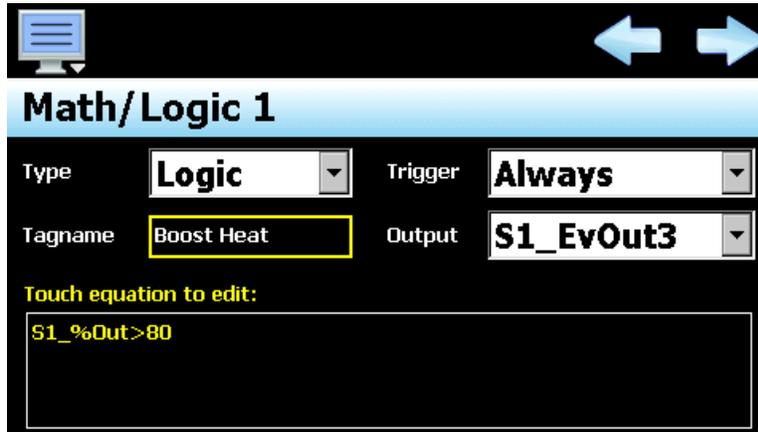
When the temperature percentage of output is greater than 80, event output 3 of loop 1 will activate. When the percentage of output is below 80, the output will turn off. The equation for boost cool will be entered in the same manner. First, press the "next" navigation arrow at the top right of the screen to access equation 2.

Like the boost cool equation, set the equation Type to logic. The Trigger will be left at the default of "Always". For the Tagname, enter "Boost Cool" in order to provide a reference for what the equation is used for. For the Output selection, choose "S1_EvOut4" which corresponds to output 4 of loop 1. For the equation, elect the loop 1 percentage of output (S1_%Out), but unlike boost heat, we will select the less than symbol for the comparison.

This is necessary because the loop percentage of output is represented as a negative number in heat/cool applications. Thus, in order to have the output activate when the cooling percentage is greater than 50%, we need to specify less than -50 which corresponds to a cooling output of 50% to 100% (full cooling). When complete, the equation will appear as in the image below.
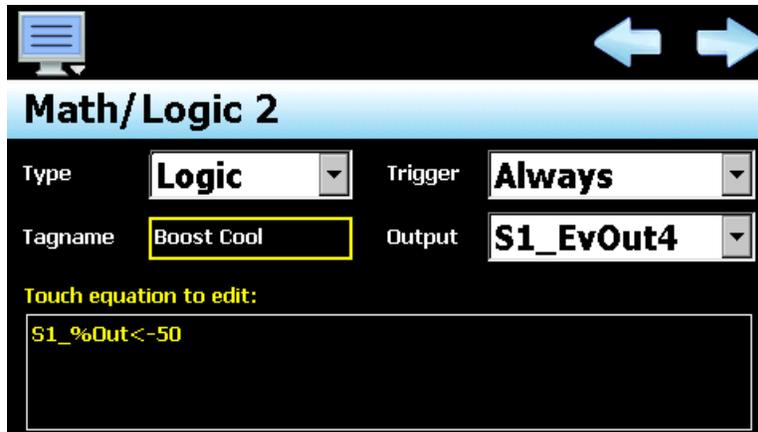
When the temperature percentage of output is less than -50, event output 4 of loop 1 will activate. When the percentage of output is above -50, the output will turn off. The two equations now provide the boost heat and cool functions required. However, what happens if the percentage of output is varying around the desired set point. If the heating output is varying between 79% and 81% for example, this can cause the boost heat output to constantly turn on and off. This could cause a control issue since the second stage of heat would by cycling on and off which may cause oscillation in temperature when the set point is first reached.

In order to prevent that, we could add delays that require the percentage of output for to exceed the required activation point for a period of time. This would prevent the output from cycling on and off when the heating output varies from 79% to 81% by requiring it to be above 80 for a period of 10 seconds for example. In order to do this, we need to implement a Timer equation. To do this, we first need to increase the number of Math/Logic equation on the Control Setup screen. Do this by setting the number of equations to 3. Next, navigate to the Math/Logic Configuration screen and select equation 3.

Set the Type of equation to "Timer". The Trigger can be left at the default of "Always" so that the timer is activated/deactivated based on the percentage of output. For the Tagname, enter "Heat Delay" to describe the function of the timer. Next, enter the required delay period in seconds (10 for this example). The timer is activated based on the result of the equation entered. Like the previous logic equation for boost heat, we want the timer to activate when the percentage of output is greater than 80%. Thus, for the equation, enter "S1_%Out>80".

This will result in the time delay being started when the percentage of output is greater than 80%. If at any time the percentage of output falls below 80%, the time will be reset and the delay will start again when the output exceeds 80%. If the output remains above 80% for the 10 second delay period, the internal timer output will be activated. To implement the delay on the output, we must now change the equation for the boost heat output. Do this by pressing the "Next" navigation arrow at the top right of the screen to access Math/Logic 1 equation.

To use the timer in the equation, touch the equation to edit it. Press the "Clear" button to delete the current equation, and then select the timer from the logic item drop-down menu. It will be displayed as "T3 (Heat Delay)". Press the "Done" button to complete the modification. You should now have Math/Logic 1 and Math/Logic 3 equations as depicted below.

With the above two equations, the timer will begin counting down when the heat percentage of output is greater than 80. Once the 10 second delay period expires, the internal timer output will be on. When the timer output is on, equation one will be evaluated as true since the timer (T3) is expired. This results in event output 3 of loop 1 activating and enabling boost heat. The same thing can be accomplished with boost cool by using a fourth math equation to create another timer to delay the boost cool output.

4.6.2.6 Advanced Compressor Control Logic Example

Compressor control applications typically involve single or dual stage refrigeration systems. Dual stage systems are utilized in ultra-low temperature situations such as environmental test chambers or even heat treat applications where temperatures below -100°F (-73°C) are required. Typically, control schemes for environmental chambers tend to be more complex. Take the following example in which an environmental chamber controls both temperature and humidity. For heat/cool operation only, a dual stage refrigeration system is used to get to ultra-low temperatures. However, when in the temperature/humidity mode of operation in which the chamber is controlling both temperature and humidity, only the first cooling stage is utilized.

Since humidity can only be controlled between temperatures of 32°F (0°C) and 212°F (100°C), the second stage refrigeration system is not used for cooling since it operates at too low of a temperature. Also, stage 1 is

required for dehumidification by using what is referred to as a "wet coil" which is used to strip moisture out of the air within the chamber, much like a home dehumidifier unit strips moisture from the air in damp locations such as a basement. All of this requires the controls system to know when to use stage 1 compressor vs. stage 1 and 2 compressors as well as when to turn them on and off based on cooling and dehumidification demand. This can all be accomplished using several logic/timer equations in the MCT4. Let's begin with a typical temperature/humidity system configuration as follows:

Loop 1 (temperature control)
- Output 1 = heating
- Output 2 = cooling
- Output 3 = event output for chamber on/off (enables/disables fans for circulating air)
- Output 4 = stage 1 compressor (for cooling and dehumidification when humidity control active)

Loop 1 (Humidity control)
- Output 1 = heating (humidification)
- Output 2 = cooling (dehumidification)
- Output 3 = event output for humidity system on/off
- Output 4 = stage 2 cooling (for cooling when humidity control is not active)

We only require the refrigeration compressors to operate when cooling or dehumidification is required. We also do not want the compressors turning on and off rapidly, so start and stop delays should be used to prevent them from turning on and off quickly when the temperature or humidity is hovering around set point. We will begin by creating an on-delay timer that can be used as the requirement for the compressor(s) to run. We will define equation 1 and a Timer type. The Trigger will be "Always" as we want it to evaluate the systems operation at all times. By providing it with a Tagname of "CMP ON DLY" we will know it is for delaying the start of the compressors.
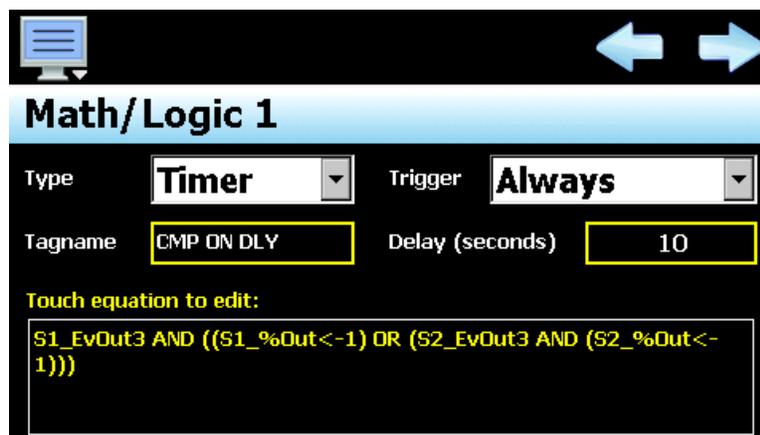
We do not want to delay the start of the compressor too long, so as shown above s short delay of 10 second is used. The equation shown above defines the condition at which the time delay begins. Since we do not want the compressors activating unless the chamber is on, we begin with the chamber event (S1_EvOut3) having to be on which is loop 1 event output 3. As long as that event is on, we require the compressor to run if cooling is required. Thus, we add the condition of loop 1 output being less than -1% which is a cooling demand of 1% (S1_%Out < -1). We also need the compressor to activate if the humidity system is on and dehumidification is called for. This is loop 2 event output 3 active and loop 2 output being less than -1% which is a dehumidification demand of 1% (S2_EvOut3 AND (S2_%Out < -1)).

Note that the two conditions for cooling and dehumidification have to be combined with a logical OR in parenthesis so that if the chamber event is on AND cooling OR dehumidification are required the timer will be activated. The position of parenthesis is important so that the evaluation is carried out properly. As can be

seen, the equation can become complicated when multiple evaluations are required so it is best to write out the equation first and then enter it into the MCT4. Now that we have the start delay, we need the stop delay. We will advance to math/logic equation 2 and define it as a Timer type also.

Like the start delay, we need the MCT4 to continuously monitor system operation so the Trigger is "Always". The Tagname can be "CMP OFF DLY" so we know it determines when the compressors are to turn off. We also want to extend the off delay so that once set point is reached, they will be available for a small bump of cooling or dehumidification should it be needed frequently to maintain set point, so in this example we will use 90 seconds. The off delay is essentially the opposite of the on-delay equation. We want the compressors to turn off when both cooling AND dehumidification are not required.

As shown in the image below, we begin by evaluating the loop 1 percentage of output and when greater than 1%, we want to signal that the compressors are not required (S1_%Out > 1). However, we must also perform a logical AND with the dehumidification requirement because we do not want the compressors turning off unless both cooling and dehumidification are not required. The dehumidification requirement is also only a valid condition if the humidity system is on. If it is turned off, the dehumidification requirement does not matter as the humidity system is not enabled. Thus, our off delay can time down if the humidity event is not active OR the loop 2 is actually calling for humidity (NOT S_2EvOut3 OR (S2_%Out > 1)).

Again, note the importance of the parenthesis in evaluating the cooling requirement, the dehumidification requirement, and then evaluating the two together to determine if the off-delay timer can count down.
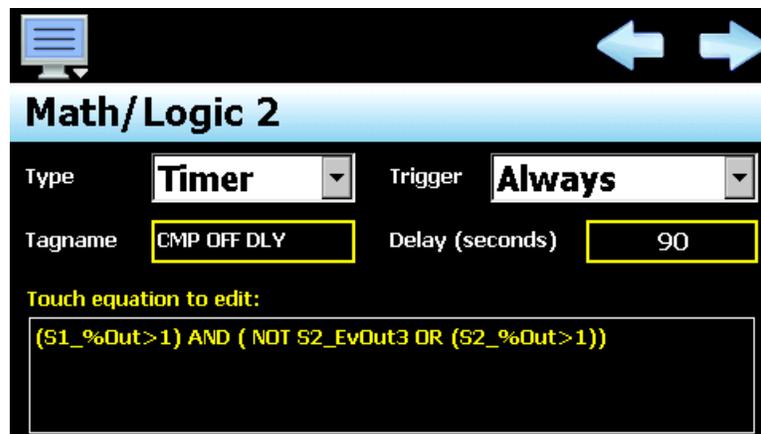
Before utilizing the on and off delay timers in logic equations to active the compressor outputs, one more timer is required. In the case of dual stage refrigeration systems, a delay is required between the start of stage 1 and the start of stage 2. This is necessary in order for the first stage to be ready for the load placed on it when the second stage starts, so that it can remove the heat from the second stage. Thus, we require one more timer which will create in math/logic equation 3.

This equation is relatively simple (as shown below). First, we need to verify that the stage 1 output is activated (S1_EvOut4) which is loop 1 event output 4. Next, we only want stage 2 to activate if the humidity system is not on which is loop 2 event output 3 (NOT S2_EvOut3). We will give it a 30 second delay and the Tagname of "SYS2 DLY" for reference. Now that all of the required time delays have been created, we can create the two logic equations to active the outputs for the stage 1 and stage 2 compressors.

Math/Logic 3

Type	**Timer**	**Trigger**	**Always**
Tagname	SYS2 DLY	**Delay (seconds)**	30

Touch equation to edit:

S1_EvOut4 AND NOT S2_EvOut3

Advancing to math/logic equation 4, we will enter the logic equation for activating the stage 1 compressor. With the equation set for the "Logic" type, we will enter a Tagname of "Stage 1" for identification purposes. The Trigger will be left at the default of "Always" so that it evaluates the compressor output control at all times. Since this equation is to control the stage 1 compressor output which is loop 1 event output 4, we set the Output to "S1_EvOut4".

For the compressor output to activate, we require the chamber event to be active (S1_EvOut3) and the on-delay timer to be expired, which was the math/logic equation 1 (represented as T1). However, we require the compressor to remain on until the off-delay timer expires which was math/logic equation 2 (represented as T2). In order to do this, we can utilize the same output the equation is to control, as the "latch" to hold itself on. This is done by the logic comparison of T1 OR S1_EvOut4. When combined with the chamber event, we then have a result of when the chamber event is on AND the on delay is expired or the compressor is on, turn on the compressor. Since the compressor output is off at system start, the event must be on and the time delay expired for the compressor output to activate.

Math/Logic 4

Type	**Logic**	**Trigger**	**Always**
Tagname	STAGE 1	**Output**	**S1_EvOut4**

Touch equation to edit:

S1_EvOut3 AND (T1 OR S1_EvOut4) AND NOT T2
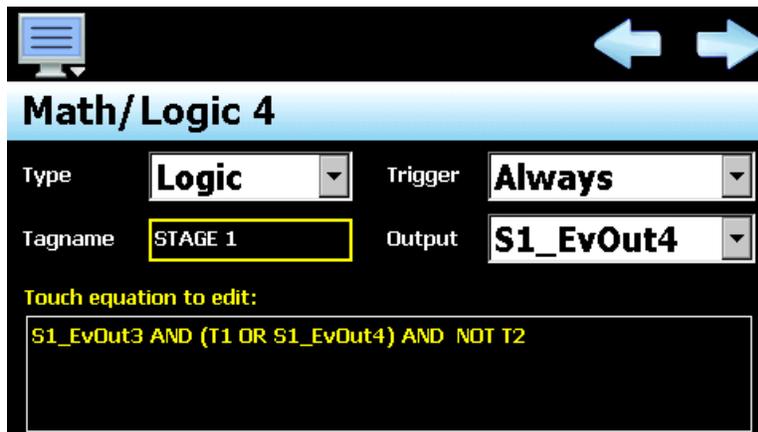
However, once the compressor activates, it would remain on unless the chamber event turns off. In order to get it to turn off based on the off-delay timer expiring, we add the final portion of the equation which is the off-delay timer NOT being expired. Thus, even once the compressor is activated and it latches itself in, the result of the equation only remains true when the off-delay timer (T2) is not expired. Once the off-delay timer expires, the result of the equation is false and the stage 1 compressor output turns off.

The final equation, Math/Logic 5, is for the stage 2 compressor output. It will essentially a duplicate of the stage 1 equation, but with one additional condition, i.e., the delay timer (math/logic equation 3) must also be expired.

Math/Logic 5

Type	Logic	Trigger	Always
Tagname	STAGE 2	Output	S2_EvOut4

Touch equation to edit:

S1_EvOut3 AND (T1 OR S1_EvOut4) AND NOT T2 AND T5
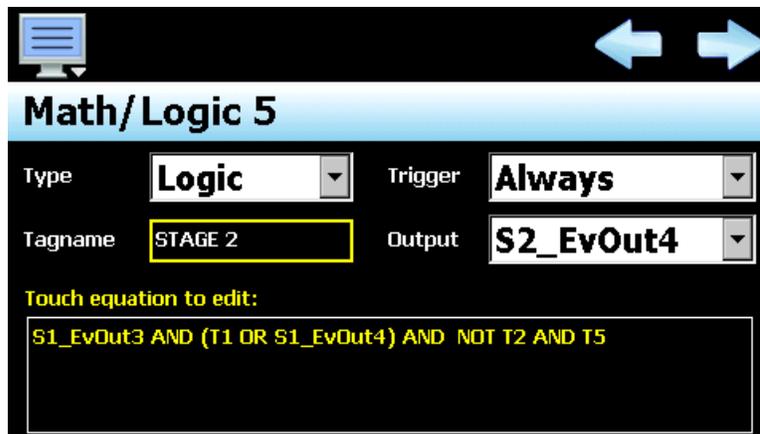
By duplicating the stage 1 equation and appending the requirement that the system 2 delay time has expired (represented as T5), the stage 2 compressor output will activate and deactivate under the same conditions as the stage 1 compressor, but also require the system 2 delay to be expired. Since the system 2 delay timer is only enabled if stage 1 is active and the humidity system is not active, the permits stage 2 operation only when in heat/cool operation and not humidity operation as required.

Note that this is only an example on how the MCT4 and the math/logic module can be utilized to perform more complex control scenarios such as compressor control. The free-form logic entry provides you with numerous options and possibilities to implement various logic tasks that your application may require.

4.7   Cascade Control Option

Cascade control can be utilized when the control type is set for Dual Loop (+ Limit) or Three Loop. For the Single Loop (+ Limit) control type selections, the cascade control function selections are not accessible since cascade control requires two loops in order to operate.

4.7.1   What is Cascade Control?

In single-loop control, the loop controller's set point is set by an operator and its output drives a final control element. For example, a temperature controller driving a heating element which regulates the temperature of a jacket surrounding a reactor vessel.

In this example, the ability to ultimately control the product temperature is dependent upon the thermal conductivity of the reactor vessel material, the thermal conductivity of the oil as well as that of the product itself. Since the loop control (LC) is only monitoring product temperature, as long as it is below set point the output will be on and the heating element will be heating the oil.

If thermal conduction to the product is slow, the heating oil could reach temperatures well above the desired safe operating range, causing a catastrophic failure of the reactor vessel. Or, it could cause a large overshoot once the product reaches set point since the oil is already heated well above the desired temperature and thus destroying the product.
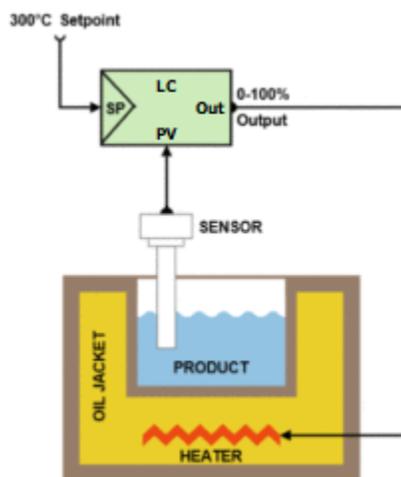
A solution for the problems that are inherent to this system is cascade control. Cascade control is a concept in which one control loop (a.k.a. primary, outer or master) is used to drive a second control loop (a.k.a. secondary, inner or slave). Cascade control is typically used to improve control of systems that are subject to significant lag, like this example. In a cascade control arrangement, there are two controllers of which one controller's output drives the set point of another controller. Here, the outer product temperature controller (master) is driving the set point of the inner oil temperature controller (slave) in order to keep the product at its set point.

The maximum oil temperature is limited to a safe operating range since it is now controlled directly. The product temperature control generates a set point of 0 to 400°C based on a 0 to 100% output. Thus, the oil temperature will not exceed 400°C.

This also limits possible overshoot of the product once it reaches set point. As the product approaches set point, the control output decreases causing a drop in the oil temperature set point. The oil temperature control loop then immediately responds by reducing its output to decrease oil temperature.

Ideally, as the product reaches its set point, the oil temperature will also have decreased to a minimal value over the product (in order to account for thermal losses in the system) and thus hold the product at its set point.
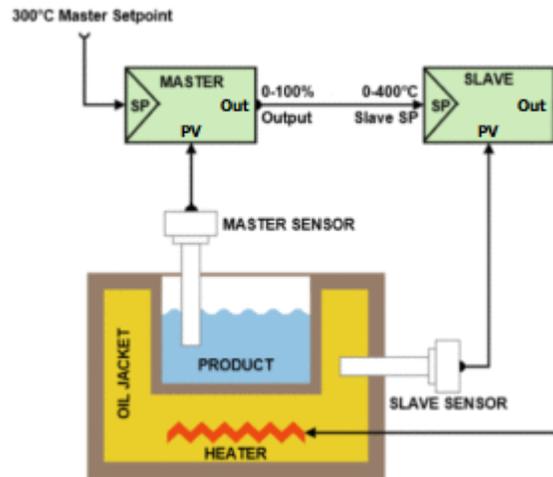
The advantage of cascade control, like in the example above, comes down to isolating a process with relatively slow dynamics (like temperature, level, humidity) from some other relatively-fast process that has to be manipulated to control the slow process. If the heating elements were directly immersed in the product, then cascade control would most likely not be necessary as the heating elements would directly affect the product temperature. Since the heating element affects oil temperature, and that in turn affects product temperature, cascade control is necessary in order to properly control the system.

Cascade control does have disadvantages. One, it requires an additional measurement in order to work. Two, there is an additional controller that has to be tuned. And three, the control strategy is more complex, for engineers and operators alike. These disadvantages have to be weighed up against the benefits of the expected improvement in control to decide if cascade control should be implemented.

Cascade control is beneficial only if the dynamics of the inner loop are fast compared to those of the outer loop. Cascade control should generally only be used if the inner loop is at least three times faster than the outer loop, because the improved performance may not justify the added complexity. In addition to the diminished benefits of cascade control when the inner loop is not significantly faster than the outer loop, there is also a risk of interaction between the two loops that could result in instability. This is especially true if the inner loop is tuned very aggressively.

4.7.2   Cascade Settings

The Cascade Control screen is accessed from the Options menu. The function selections are provided via three, drop down menus. These menus allow the mode of operation to be set as well as select which loops are to be the inner and outer.
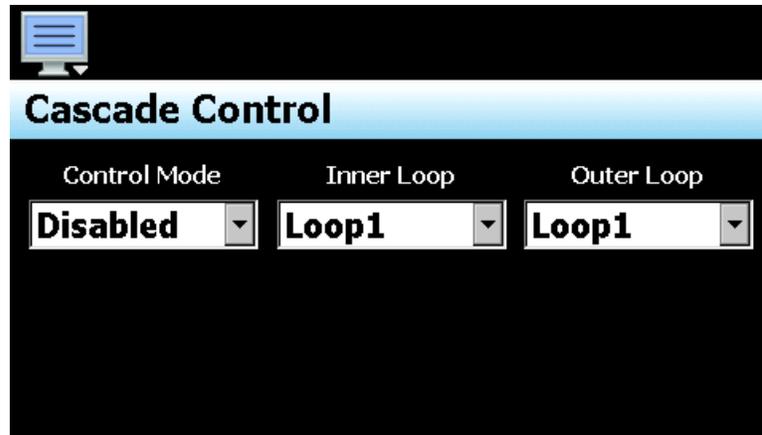
The **Cascade Control Mode** drop down menu provides the following selections:

Disabled   Cascade control is not implemented and all loops run independently of one another.

Process   This mode allows the lower and upper set point range of the inner loop to be defined relative to the outer loop's percentage of output. When selected, entry fields (on the Cascade screen in the runtime application) are provided and used to set the lower and upper set point range of the inner loop. The output of the primary loop is used to calculate a linear set point between these lower and upper values in order to generate the set point for the inner loop.

For example, if the outer loop is configured for heat only or cool only, it will have an output of 0 to 100%. If the lower and upper limits entered in the runtime on the Cascade screen are 0 and 50, an output of 0 to 100% on the outer loop will generate a set point of 0 to 50 on the inner loop. So, an output of 50% would be a set point of 25 on the inner loop.

If the outer loop is configured for heat/cool operation, it will have an output of -100 to 100% where -100% is full cooling and 100% is full heating. If the lower and upper limits entered in the runtime on the Cascade screen are 0 and 50, an output of -100 to 100% on the outer loop will generate a set point of 0 to 50 on the inner loop. So, an output of 0% (no heating or cooling) would be a set point of 25 on the inner loop.

Note: *This mode is recommended for heat only or cool only applications where the inner loop must exceed the outer loop set point in order to account for losses in the system in order to get the outer loop to reach set point.*

To utilize this mode of operation, the control outputs of the inner loop must be wired to the final control elements. The outer loop is not used to directly control the process. It is used to generate the set point for the inner loop.

Deviation   This mode allows the lower and upper set point range of the inner loop to be defined as an offset from the outer loop set point. When selected, entry fields (on the Cascade screen in the runtime application) are provided and used to set the lower and upper deviation from the outer loop set point. The lower and upper range of the inner loop set point is calculated by adding and/or subtracting these values as offsets from the outer loop set point. As the outer loop set point changes, the window defined by the lower and upper limits automatically changes with it.

For example, if the outer loop is configured for heat/cool operation, it will have an output of -100 to 100% where -100% is full cooling and 100% is full heating. The cooling output of 0 to -100% will apply an offset of 0 up to the lower limit value and the heating output of 0 to 100%

will apply an offset of 0 up to the upper limit value. With an output of 0% on the outer loop and an outer loop set point of 25, the inner loop set point would also be 25 (no offset).

However, if the lower limit value is -10 for example, the inner loop set point will vary from 25 to 15 as the outer loop cooling output goes from 0 to -100%. Likewise, if the upper limit value is 10, the inner loop set point will vary from 25 to 35 as the outer loop heating output goes from 0 to 100%. As the outer loop set point is changed, to 80 for example, the inner loop set point window then varies with it and becomes 70 to 90. This limits the range of the inner loop set point to a small band around the outer loop set point.

Note: This mode is recommended for heat/cool applications to limit the difference between the outer and inner loop process values to minimize the amount of overshoot/undershoot that could occur once set point is reached.

To utilize this mode of operation, the control outputs of the inner loop must be wired to the final control elements. The outer loop is not used to directly control the process. It is used to generate the set point for the inner loop.

Ratio   This mode of operation allows the inner loop set point to be defined according to the outer loop's process value. When selected, a single entry field (on the Cascade screen in the runtime application) is provided and used to enter a ratio for the inner loop. The value entered is multiplied to the outer loop's process value and the result is used as the inner loop set point.

For example, if the ratio is set to 0.2, with an outer loop process value of 0, the inner loop set point will also be 0. As the process value of the outer loop increases, the inner loop set point will also increase proportionally to the outer loop's process value. So, with an outer loop process value of 10, the inner loop set point would be 2 (10 multiplied by 0.2).

Note: This mode is typically used in mixing applications (flow) where the outer loop is directly controlling flow of water for example, and the inner loop would be controlling the flow of an additive that is required to be mixed at a certain percentage.

To utilize this mode of operation, typically both the control outputs of the outer loop and inner loop are wired to the final control elements. The outer loop would control the valve for water flow, while the inner loop would control the valve for additive flow. This allows the operator to adjust the water flow as required for downstream processes and the inner loop will automatically adjust the required additive flow based on the actual water flow rate.

If in this example the water flow rate is controlled by another process, the outer loop would not be wired and its set point value would not be utilized. The inner loop set point is determined solely by the actual process value of the outer loop.

The **Cascade Control Inner Loop** and **Cascade Control Outer Loop** drop down menus provide a current list of all configured loops (by tagname). This allows the inner and outer loops to be selected according to the desired loop order. Note that both inner and outer loop cannot be set to the same loop. If the same loop is selected, cascade control will not operate. Once loop must be selected as the outer loop to drive the set point of the inner loop.

4.8   Expansion IO Module Option

The Expansion IO Configuration screen is accessed from the Options menu. The screen allows the option to be enabled/disabled and also provides access to all input and output function settings for the expansion IO module.
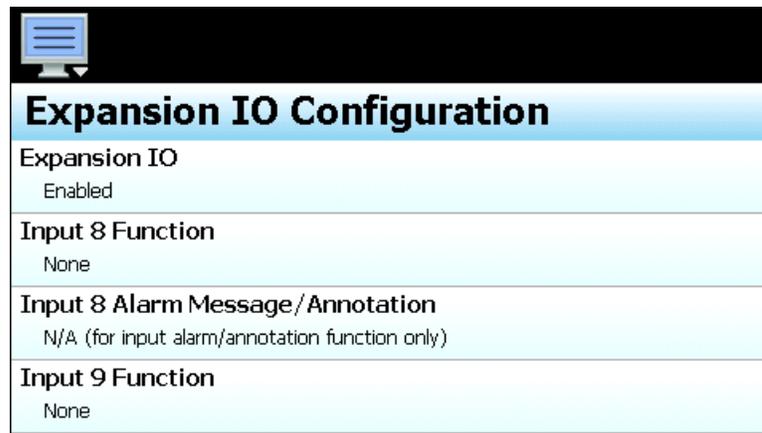
To view all of the available settings, the Expansion IO must be set to "Enabled". When enabled, the configuration items for each input and output will then be provided in the list. Simply swipe up or down on the screen to scroll through the list items. To edit a value, tap the row for the desired item.

4.8.1 Input (8-23) Function

The input function is used to select the desired mode of operation for each digital input. Each input is provided with its own function selection. The input numbers correspond to the markings on the expansion IO module. The input selections are mutually exclusive, i.e., selecting one will turn off the others. Once the desired function has been selected, press the "Done" button to set the input function for the selected expansion module input and return to the main Expansion IO Configuration screen.
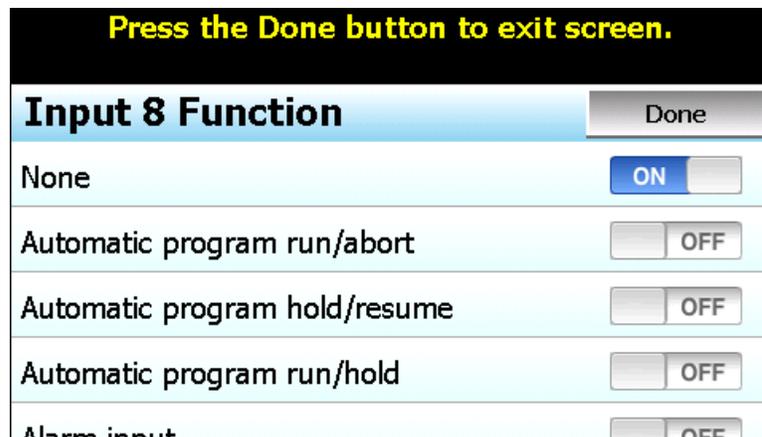
The **Automatic program run/abort** function will start the currently loaded program from step 1 if not already running, upon activation of the input (an off to on transition). Deactivating the input (an on to off transition) will stop the program if it is currently running.

The **Automatic program hold/resume** function will place a currently running program into hold when the input is activated (an off to on transition). The program will resume operation and return to the run mode when the input is deactivated (an on to off transition).

The **Automatic program run/hold** function will start the currently loaded program from step 1 if not already running, upon first activation of the input (an off to on transition). Deactivating the input (an on to off transition) will then cause the program to go into hold. The input must then be reactivated in order for the program to resume operation.

The **Alarm input** function allows the input to be used for alarm indication. When the input is activated, the Input Alarm Message/Annotation (see following section 4.8.2) is displayed on the alarm screen in the runtime application and the audible alarm sounds.

The **Data logging annotation** functions allows the input to be used to write an annotation (operator event) to the running data log file. When the input is activated, the Input Alarm Message/Annotation (see following section 4.8.2) is written to the data file.

The **Math/logic input only** function allows the input to be used as an input for math/logic equations only. See section 4.6 Math/Logic Configuration for more information.

NOTE: *In order for the alarm and annotation input functions to operate properly, the input must be activated for at least five seconds. If the input is not activated for the minimum time period, the input status may not be captured and the alarm or annotation will not be posted. In order for the input to reset and capture the next input status, the input must also remain off for at least five seconds.*

4.8.2   Input (8-23) Alarm Message/Annotation

When the input function is set to alarm input or data logging annotation, the Input Alarm Message/Annotation entry (for the corresponding numbered input) allows the user or OEM to assign the message that will be shown on the alarm screen in the runtime application for alarm operation, or the operator event that will be written to the data log file for annotation operation. The message can be up to 25 characters long.

4.8.3   Output (32-45) Function

The output function selection is used to select the desired mode of operation for each digital output. Each output is provided with its own function selection. The output numbers correspond to the markings on the expansion IO module. The output selections are mutually exclusive, i.e., selecting one will turn off the others. Once the desired function has been selected, press the "Done" button to set the output function for the selected output and return to the main Expansion IO Configuration screen.
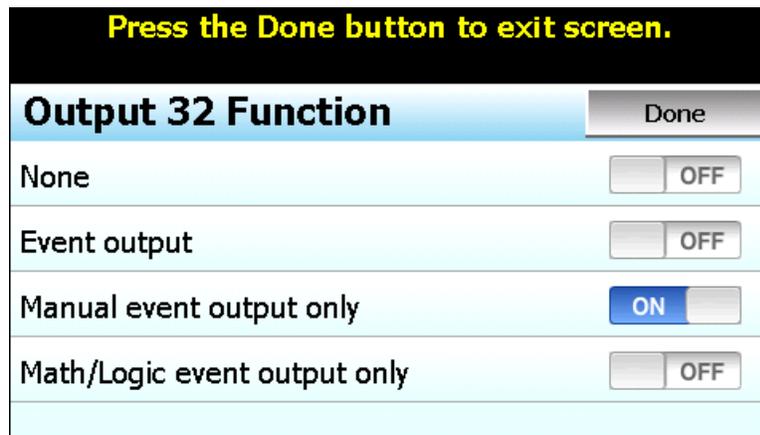
The **Event output** function allows the output to be turned on and off via an automatic program or manually through the MCT4 runtime application to act as a "soft" switch to turn system components on and off.

The **Manual event output only** function is similar to the Event output function above as it allows the output to be turned on manually through the MCT4 runtime application to act as a "soft" switch to turn system components on and off. However, the output cannot be controlled via an automatic program which allows the output to be controlled separately regardless of program operation.

The **Math/Logic event output only** function allows the output to be controlled only by a logic equation (See section 4.6 Math/Logic Configuration). The output will not be accessible through the runtime application as a "soft" switch like the event/manual event only selections.

IMPORTANT: *The expansion IO module is equipped with a communications safety interrupt.   If communications are lost between the MCT4 and the expansion module for more than 60 seconds, all outputs of the expansion module will be turned off. When communications to the expansion module is restored, the outputs will immediately return to their previous state.*

Therefore, it is recommended that the system is set to an "off" state and power is cycled to the MCT4 prior to troubleshooting any communication failures in order to reboot the system from the off state. This ensures that any logic associated with output operation can resume from a known state when communications are restored in order to maintain any programmed sequence of events that must occur in order according to existing logic blocks.

4.9   Event Timer Option

The event timer option provides a countdown timer coinciding with the event 1 output. This provides simple, timed operation of the system for a preset period when more complex automatic program operation is not required.
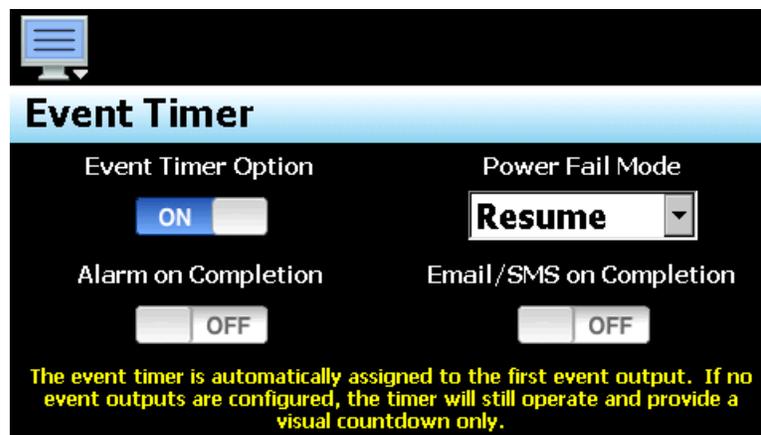
The **Event Timer Option** button toggles the option on and off. When enabled, the timer is automatically associated with event 1 and its corresponding output. Thus, when the timer is started, event 1 will be turned on. When the timer is stopped and/or completes its cycle, event 1 will be turned off. Access to the timer is provided by a "Stopwatch" icon on the Loop View and Overview screens in the runtime application.

The **Power Fail Mode** selection is used to set the desired mode of operation of the timer when power is restored if it was running at the moment power was lost.

Terminate: *When power is restored, event 1 and the timer will be off.*

Resume: *When power is restored, event 1 will be on and the timer will continue operation from the time remaining at the moment power was lost (within 1 minute accuracy).*

Restart: *When power is restored, event 1 will be on and the timer will reset and begins its countdown from the specified time entry.*

When **Alarm on Completion** is turned on, the MCT4 will activate an alarm upon completion of the timed cycle. Once the alarm has occurred it must be manually cleared from the Alarm screen of the runtime application.

The **Email/SMS on Completion** selection is used to enable email/SMS capability for the timer. When on, if the email client of the MCT4 has been properly configured and email addresses have been entered into the system to receive email and/or SMS messages on alarm (see section 9.8 Email), a timer completion message will be sent to the applicable email addresses at the end of the timing cycle. If this setting is off, no email/SMS message will be sent regardless of the email client settings.

4.10 Functions

The MCT4 functions are accessed from the Startup menu and allow the user or OEM to select which screens/menu items will be enabled (shown) in the MCT4 runtime application. These functions can be used to customize the system to meet specific requirements.

When functions are disabled at the Configurator level from the functions list, it will be disabled in the runtime software by removing the menu item or disabling the field so the operator cannot select the function or edit any corresponding settings related to the function. The following list provides the available MCT4 functions, where to find the menu item(s) applicable to the function and a description of what it applies to.

IMPORTANT: *Disabling MCT4 functions that are not required for the application results in a system that is clean and easy to use for the operator; however, be careful when disabling certain items. Without access to them, there may be no way to determine if the system is operating as required.*

MCT4 Function	Runtime Menu Location	Description
Loop View	View\Loop	View loop PV, %Out, set loop set point and set fixed percentage of output **NOTE:** Without access to the loop view screen, the user will be unable to set a fixed percentage of output for the loop. If access to All View is also removed, user will be unable to turn manual event outputs on and off.
All View	View\Overview	view loop PV, %Out, set loop set point **NOTE:** If access to the Loop View is also removed, the user will be unable to monitor or adjust loop operation.
Chart View	View\Chart	view and set up real time trends for loops and monitors

MCT4 Function	Runtime Menu Location	Description
Alarm View	View\Alarm Notifications	view and reset current alarms current alarm status **NOTE:** With the function disabled, the user will only be able to access the alarm screen to reset an alarm when the alarm occurs by pressing the flashing alarm icon. If the alarm is latching and does not reset, the user will be unable to return to the screen to try and clear the alarm unless another alarm occurs to again display the flashing alarm icon.
Alarm Log	View\Alarm File	view and email alarm history files
Security Settings	Security Notifications	view/set security rights, view audit trails, user log on view security and audit status **NOTE:** If security is enabled, but system security is then disabled through this item, the user will be unable to log on. Default security (operator level) access will be used. This allows audit trails to be active while hiding all user security features. With security menu disabled, audit trail files are accessible via Log/USB File Utilities or temporarily re-enable security menu to gain access to the audit files.
Automatic Program Control/Recovery	Program Device\Settings\Offline\Set\Recovery Notifications	view, create, edit and run automatic ramp/soak programs set power recovery mode view program status **NOTE:** When disabled, all program items and menus will be removed from the runtime application. The user will be unable to access or start programs via the interface.
Data Logging	Data\Data Notifications	enable/disable data logging, select points for logging, access to historical viewer, FTP and USB File utilities view data log status, length and interval **NOTE:** If data logging is set to log on program operation or when the MCT4 starts and this menu is then disabled, data logging will be disabled. This menu item must remain visible in order for the built-in data logging of the MCT4 to function. The USB File utilities will not be accessible to copy or delete data, alarm, audit or program files.
Data Log Viewer	Data\Chart	access to view historical data log files
Annotations	Data\View\Annotation	access to add and view operator annotations to data files
Digital Signatures	Data\View\Signature	access to view and add digital signature to data log file
File Utilities	Data\Utilities\USB	access to copy/delete alarm, audit, program and data log files **Note:** Alarm, audit and data files may be transferred via FTP if unit is so configured.

MCT4 Function	Runtime Menu Location	Description
FTP/WAN Settings	Data\Utilities\FTP/WAN	access to view/configure FTP file transfer settings **NOTE:** Once the FTP is configured for Auto Backup in the runtime application, this menu item can be disabled and hidden from the operator so that OEM configuration is preserved and cannot be accessed or altered. The Auto Backup to the FTP Server would occur as configured.
Loop Manual Mode	View\Loop	access to placing the loop in manual and setting a fixed percentage of output
Loop PID Tuning	Device\Settings\View\Tuning	access loop tuning screen **NOTE:** With loop PID tuning disabled, the user will also lose the ability to place the loop in auto tune.
Loop Cascade Settings	Device\Settings\Set\Cascade	access cascade settings screen
Alarm Settings	Device\Settings\Set\Alarm	access alarm settings **NOTE:** Alarms can be fully programmed in the Configurator and hidden in the runtime by disabling this function. The alarms will operate as programmed in the background removing all access by the operator.
Email/SMTP Settings	Device\Settings\Email\Email	access to view/configure email settings
Communication Settings	Device\Settings\Set\Comms Notifications	access to web server, Modbus and VNC settings view web server and VNC status
Edit Event Names	Device\Settings\Set \Event	access to view/edit system event names **NOTE:** Event names can be assigned in the runtime and then this item disabled to prevent changes to event names.
Temperature Units	Device\Settings\Offline\Set\Units	access to set temperature units
Input Calibration	Device\Settings\Offline\Calibrate\Inputs	access to input calibration for all loops and limit control if installed
Import/Export Setup	Device\Settings\Offline\System\ Configuration	access import/export utility to back up current Orion-M configuration or restore configuration from back-up file
Setpoint Limits	Device\Settings\Set\Limit	access loop set point high and low entry limits as well as ramp rate up/down and deviation hold settings if ramp rate operation configured for loop
Language	Device\Settings\Offline\Set\Language	access to set the MCT4 display language selection for menus and online help
Exit Application	Device\Settings\Offline\System\Exit	access to the exit application screen
Loop view Manual Operation	View\Loop – Manual Operation button	access for turning manual events on and off
Loop View Program Operation	View\Loop – Program Operation button	access to program selection and run/hold control

4.11 Startup View

The Startup View screen is accessed from the Startup menu and allows the user or OEM to define which of the main view screens the runtime application will display when it first starts and when the "Home" icon is pressed.

Startup View

Loop View	ON
All View	OFF
Chart View	OFF
Alarm View	OFF
Alarm Log	OFF
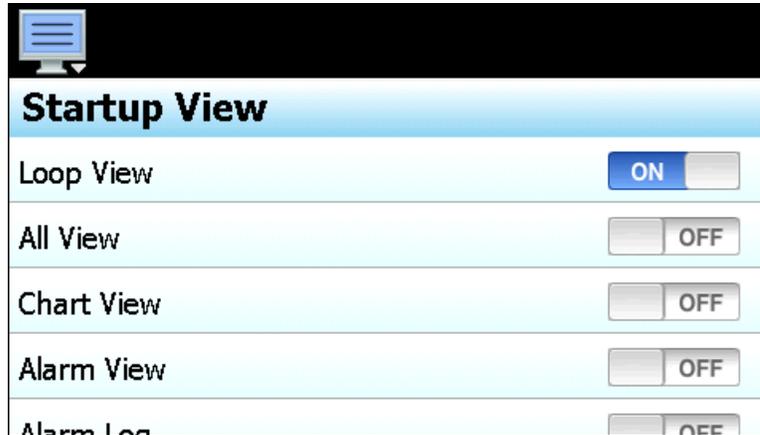
The available selections are Loop View, All View, Chart View, Alarm View and Alarm Log.

NOTE: *If the selected screen to view on startup is disabled in the MCT4 functions list, the screen will only be available when the "Home" icon is pressed.*

4.12 Alarm Names

The Alarm Names screen is accessed from the Tagnames menu and allows the user or OEM to edit the name (alarm message) of all configured alarms. In order to access the screen, there must be at least one loop control output configured as an alarm, one soft alarm programmed or the limit control installed.

Alarm Names

ALM#1
(Loop 1 Output 4)
ALM#2
(Loop 1 Soft Alarm)
ALM#3
(Loop 1 Soft Alarm)
ALM#4
(Loop 1 Soft Alarm)

The alarms will be listed in sequential order starting with any outputs programmed as an alarm on loop 1 through loop 3 and/or the limit, and then soft alarms. The default alarm names are ALM#1, 2, 3, etc. To assist in identifying which device/output the alarm is assigned to, the list includes the alarm source. The alarm names will be displayed in the runtime application as the alarm description on the Alarm screen. To change the name of an alarm, select the alarm from the list and enter the desired text up to 25 characters.

4.13 Event Names

The Event Names screen accessed from the Tagnames menu and allows the user or OEM to edit the names of all configured event outputs. In order to access the screen, there must be at least one loop control output configured as an event.

Event Names

EV1
(Loop 1 Output 3)

EV2
(Loop 2 Output 3)

EV3
(Loop 2 Output 4)

The events will be listed in sequential order starting with any outputs programmed as an event on loop 1 through loop 3. The default event names are EV1, 2, 3, etc. To assist in identifying which device/output the event is assigned to, the list includes the event source. The event names will be displayed in the runtime application on the Manual Operation slide out, All View and program Entry screens. To change the name of an event, select the event from the list and enter the desired text up to 9 characters.

4.14 Custom Name\Address

The Custom Name\Address screen is accessed from the Tagnames menu and is typically used by the OEM to configure the main splash screen when the MCT4 runtime application starts. It allows the company name and contact information to be entered and shown each time the MCT4 controller is powered up. It also allows the name of the controller to be changed in order to adapt it to a specific product or market.

Custom Name\Address

Company	FUTURE DESIGN CONTROLS
Address	BRIDGEVIEW, IL
Phone	888-751-5444
Prod Name	MCT4

Enter startup screen and about information.

To edit the company, address, phone number or controller (product) name, press the field and enter the desired text. Each field can be entered with a maximum of 24 characters that will be displayed on the splash screen when the MCT4 starts.

4.15 Loop Address Utility

The Loop Address Utility is a common MCT utility that is utilized on the MCTB hardware platform. It is accessed from the File menu. It is not for use with the MCT4 unless external loop control boards are used (custom application). The PCM and HLM cards of the MCT4 do not require address assignment. However, external loop control boards (the B42 on the MCTB hardware platform) must have their individual communication address set to properly communicate with the user interface.
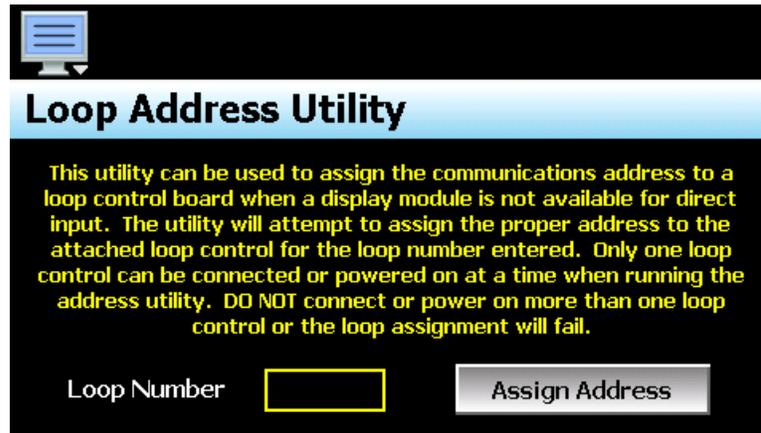
In order to use the utility, only one loop control board can be connected to the master RS485 serial interface of the MCT4 at a time. All PCM and HLM cards must also be removed (if installed). With only one loop control board powered on or connected, press the Loop Number field and enter the address to assign to the attached loop control. Once entered, press the "Assign Address" button and the utility will begin scanning for the loop control board and set its address to the one entered once found. If the utility fails to set the address, check the wiring to insure it is properly connected.

If the loop control board has been previously used for another application, it may be possible that the address or other communications settings have been changed, which prevent the utility from working. In this case, a display module must be connected to the loop control board to set the proper communications settings:

    Address: 1, 2 or 3 (for loop 1, 2 or 3)
    Baud rate: 9600
    Parity: Even

IMPORTANT: *The loop input number corresponds to the communications address that must be set in the loop control board for the MCTB to access it properly. If the communications address is not set properly in the loop control, the MCT4 will not be able to communicate with it or may communicate with the wrong loop control and assign the incorrect set points and control parameters to it.*

4.16 Smart IO Communication Utility

The default communication parameters of the monitor module (new module or one that has factory reset applied) do not match the proper settings required to communicate with the MCT4. The Smart IO Communication Utility (accessed from the File menu) provides quick, easy method to configure the monitor module parameters via the touch of a button.

Smart IO Communication Utility

This utility can be used to detect and set the the proper communication parameters in the Smart IO monitor point card for use with the MCT. In order to use this utility, be sure that the monitor card address is properly set (both rotary knobs set to 1). Cycle power to the monitor card after setting the proper address. With the monitor card properly connected to the RS485 serial link, press the "Detect Monitor Point Card" button (See manual if connect attempt fails).

Detect Monitor Point Card

In order to use the utility, the monitor module must be connected to the RS485 master interface of the MCT4 and have its communication address properly set via the two rotary dials (see section 3.3 Connecting to the Smart IO Monitor Module). Press the "Detect Monitor Point Card" button and the utility will attempt to set the communication parameters. On success, a prompt will be shown to cycle power to the monitor module. Once power is cycled, the MCT4 will then be able to communicate with the monitor module and the inputs can be configured.

If the utility is unable to set the monitor module communication parameters, verify that the communication wiring is properly connected and the address is properly set (both rotary dials to one). If the monitor module has been previously used in another application, it may be possible that the default communication parameters are not in use. To reset the monitor module to default values, press and hold the initialization button for approximately 3 seconds. The three LED indicators at the top of the module will blink once the reset has been performed.

INIT Push button
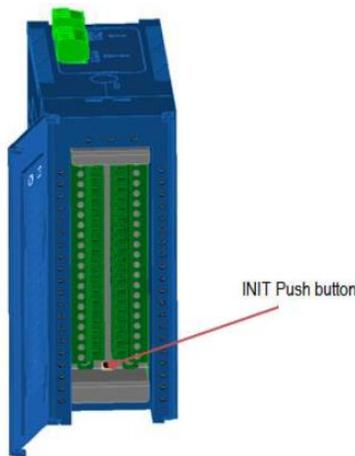
Cycle power to the monitor module after the reset is performed and again press the "Detect Monitor Point Card" button on the MCT4. The MCT4 should then be able to set the proper communication settings. Upon success, be sure to cycle power to the monitor module so that it will begin using the new communication settings.

NOTE: *When the initialization is performed, all input type selections will be returned to the factory default of ±10VDC. Input types will have to be reconfigured any time a factory reset is performed.*

5 Basic Operation

This section is designed to help guide the user through the MCT4 touch screen interface and menu structure in order to navigate through the various operation, monitor and setup screens and gain an understanding of how to use them. Subsequent sections of this manual are tailored to the special features and functions of MCT4. Consult those sections of the manual for further information and specifics on how to set up and operate them.

5.1 OEM Configuration Options

The availability of certain menu items, screens and the functionality of MCT4 are determined by the configuration of the loop control(s). This manual covers all available options, some of which may not be available on your system.

If there are questions or concerns about the operation and available options on your MCT4 controller, contact your OEM for further information. Only your OEM can address equipment related issues.

5.1.1 Loop Control Monitor Only Mode

The loop control "Monitor Only" mode selection in the Configurator provides an OEM with a low-cost video recorder option to use in place of a standard circle/strip/paperless recorder. When the loop monitor only mode is enabled in the Configurator for a loop, the MCT4 automatically configures itself to remove all set point fields, automatic ramp/soak program control options, loop tuning and set point limit access so that only the loop process value (PV) is available for the monitor only loop.
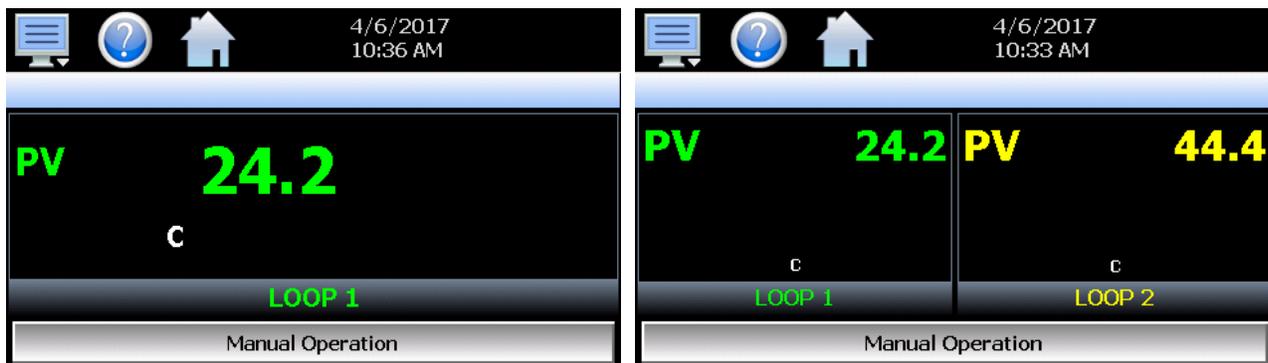
| - Loop View on single loop system - | - Loop View on dual loop system - |

Unlike your basic chart recorder; however, the loop controls are still functional. They can be used to control a process if there is the need for fixed, single set point control. A loop can be programmed with a fixed set point by the OEM, and it will then control the process in the background without the need for any user access.

The OEM can also provide events for the user to turn equipment on or off, and alarms can be configured to alert the user to process changes.

If one control loop is required while another point is for recording only, enabling the monitor only mode on loop 2 in the Configurator for example, will remove the set point fields, program operation, tuning and set point limit access for loop 2 only. Loop 1 will maintain all control functions including the automatic ramp/soak program operation, while loop 2 will be shown as a monitor only point for recording purposes.

If additional program events are required, even though loop 2 is a monitor only loop, any of its outputs can be programmed as events. The events will then be accessible under ramp/soak program entry and can be controlled by the program.

5.1.2 Event Timer Operation

The event timer option in the MCT4 configuration provides the OEM with a countdown timer connected to event 1 output. This provides simple, timed operation of the system for a preset period when more complex automatic program operation is not required. When the option is enabled, a "Stopwatch" icon is provided in the menu bar at the upper right of the Loop View and Overview screens.
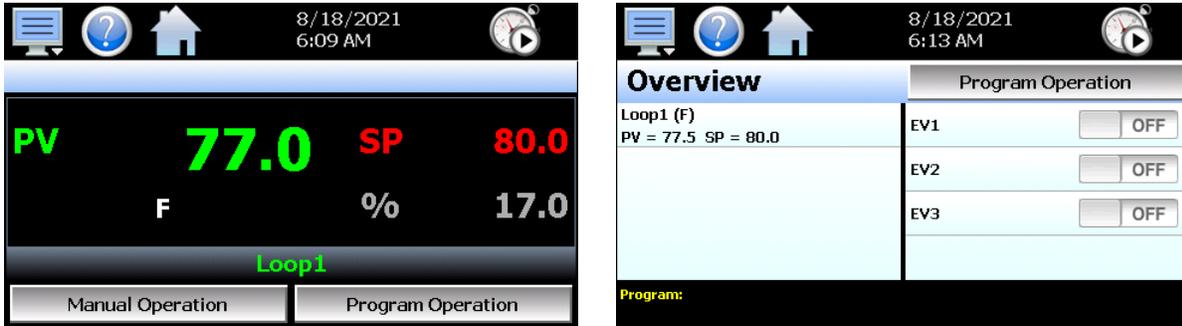
While the timer is not in operation, event 1 can be turned on and off manually by the user. When the timer is running, the event is forced on by the timer. Once the timer completes its cycle, the event will be forced off. To start the timer, simply press the "Stopwatch" icon and the numeric keypad will be displayed. Enter the desired time and press the Start button to begin timer operation (see section 5.1.2.1 Entering the Time and Starting the Timer below).

Once the timer is in operation, the blue program status bar on the Loop View screen and the program status field at the bottom of the Overview screen will indicate that the timer is active with the total time the timer was set for along with the time remaining (i.e., Timer Active (HH:MM:SS) - HH:MM:SS remaining).
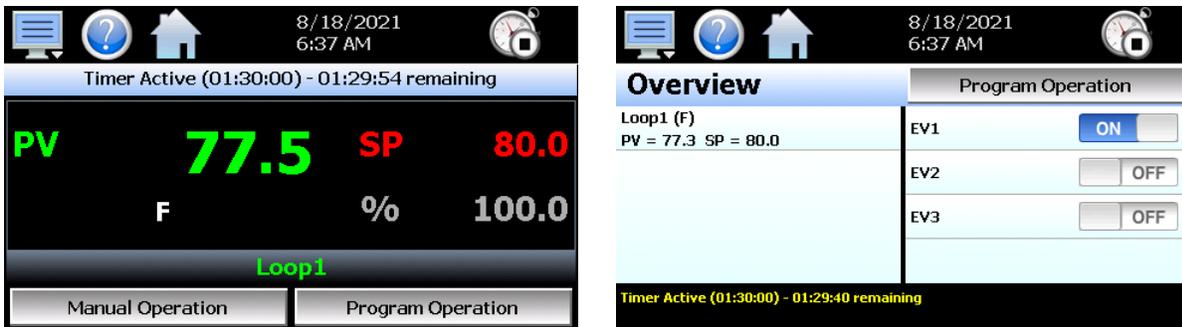
To stop the timer, press the "Stopwatch" icon. This will display a dialog with a "Yes" and "No" prompt to stop the timer. Selecting "Yes" will turn event 1 output off and the timer will be stopped.

NOTE: *Timer operation and automatic program operation cannot be performed at the same time. If the timer is active, an automatic ramp/soak program cannot be started. Likewise, if an automatic ramp/soak program is in operation, the timer cannot be activated.*

5.1.2.1   *Entering the Time and Starting the Timer*

Upon pressing the "Stopwatch" icon when the timer is not in operation, the numeric entry keypad will be shown. The run time is entered as a period of time in hours, minutes and seconds. To make time entry easy, the entry will automatically be formatted into time as the number keys are pressed. For example, if the run time is to be thirty seconds long, just enter a value of 30. If the run time is one minute and thirty seconds, enter a value of 130 for 1 minute, 30 seconds.

If the run time is one hour and thirty minutes, enter a value of 13000 for 1 hour, 30 minutes and 00 seconds. One hour and thirty minutes can also be interpreted as a total time of 90 minutes; therefore, you can also enter a value of 9000 for 90 minutes, 00 seconds. Upon pressing the 'Start' button, the timer will begin operation and the countdown will be displayed and begin as 1:30:00.

After the time is entered, pressing the "Start" button on the keypad will activate the timer. The operator can also exit by pressing the "Cancel" button without starting the timer. Once the timer is started, the current time value will be saved. This allows the timer to be used repeatedly without having to re-enter the time each use. Every subsequent time the "Stopwatch" icon is pressed to activate the timer, the previous time value will be automatically entered on the keypad. The timer can then be activated by simply pressing the "Start" button on the keypad. The operator can also begin entering a new time if desired which will automatically overwrite the previous value.

5.2 Touch Screen Interface

The MCT4 display is split into two sections; the icon bar and main display area.

Icon Bar →

Main Display →
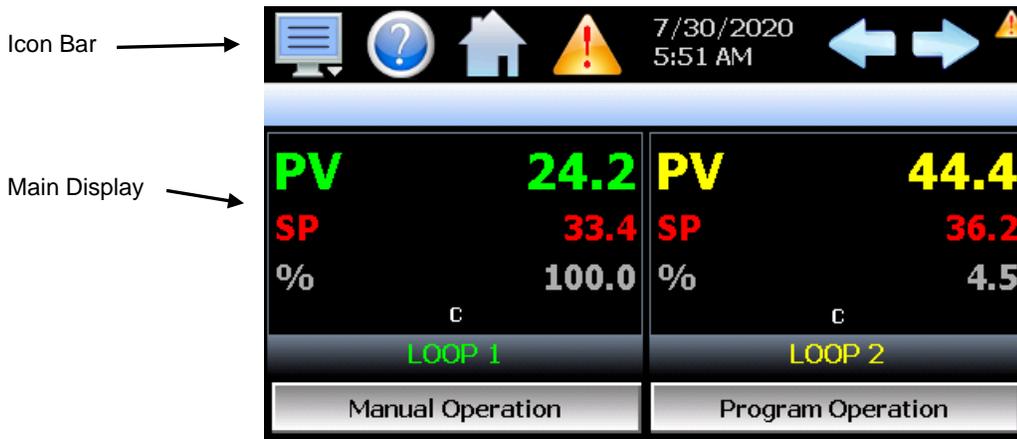
Loop View Screen

IMPORTANT: *Do not use any sharp or metal objects on the touch screen as they may damage the surface. Also, be sure that hands and fingers are free from oils or chemicals which may mar the surface of the touch screen.*

The menu icon will open the main menu for navigating to the different control and monitoring screens. Menu items will dynamically appear providing available options based on the system area the user is in, i.e., security, data logging, setup, etc.

The information (help) icon will display text-based help associated with the current screen. Help is available in 10 languages based on the user selection in the offline setup of section of MCT4.

The home icon will return the user to the main view from anywhere in the MCT4 application. The main view is set by the user/OEM in the MCT4 configuration and can be the single or dual loop, chart, alarm, alarm history, event or digital IO view.

The main alarm icon will appear and flash on each new alarm occurrence. Pressing the alarm icon will take the user directly to the alarm monitor screen in order to view and/or reset the active alarm condition(s).

Once new alarms have been acknowledged the main alarm icon will be hidden. If any of the alarm conditions are still active, the alarm notification icon will appear in the upper right of the screen to remind the user that alarm condition(s) still exist even after they have been acknowledged. Once all alarm conditions have cleared, the icon will no longer be shown.

The left and right navigation arrows will only appear on screens that provide additional information that the user can scroll to such as charts or the program entry screen in order to cycle through each step of a ramp/soak program.

NOTE: *A single press of the left or right arrows will scroll program steps to the next step or screens to the next available screen option (i.e., chart number). Pressing and holding the arrow keys will continue the item scrolling until the last step of the program is reached or the button is released.*

5.3 Menu Navigation

The MCT4 provides the user with the ability to select text-based menu navigation, much like the typical file menu system of a PC, as well as an icon-based navigation system like that of a "smart" device. The user can switch back and forth between the two from the Setup menu.
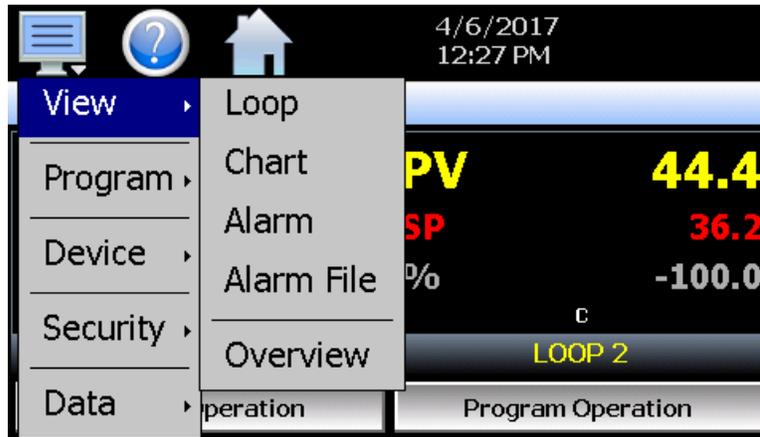
Text Based Navigation
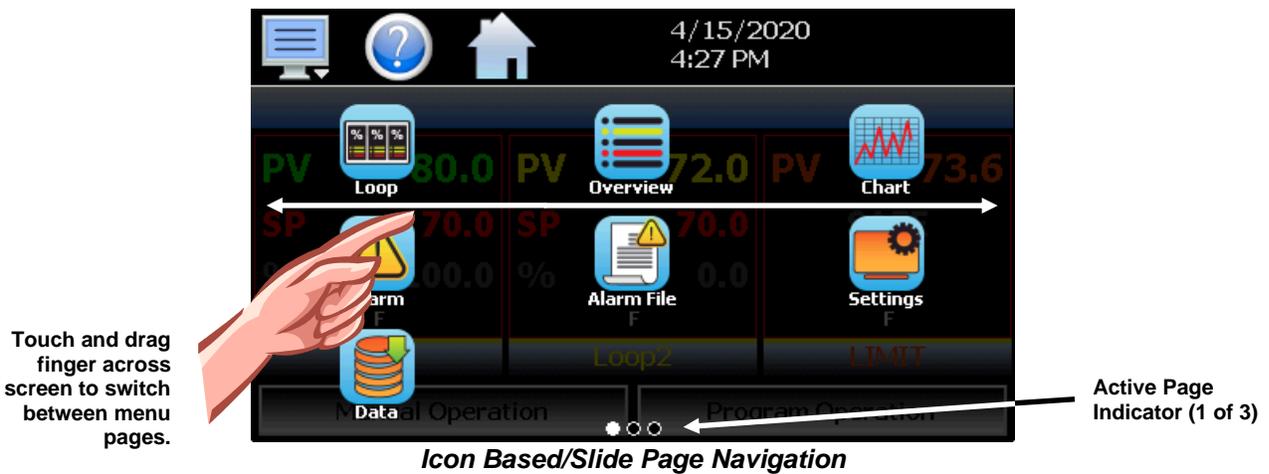
Touch and drag finger across screen to switch between menu pages.

Active Page Indicator (1 of 3)

Icon Based/Slide Page Navigation

The available menu items are dependent upon the OEM configuration of MCT4. Not all of the menu items shown may be available on your system. The following information is provided as an overview of the full navigational menus for the MCT4.

5.3.1   Home Menu

The home menu is the top level, default menu provided when MCT4 first powers on. Pressing the menu (monitor) icon will display the main menu offering the selections shown below.

5.3.1.1   Text Based Home Menu

The **View** menu provides navigation to all standard view screens. These include the Loop view, real time Chart, Alarm monitor, Alarm File and Overview control screens.

The **Program** menu provides access to the automatic ramp/soak program actions, Entry and Status views.

The **Device** menu provides access to the MCT4 controller settings. These include, loop set point entry limits, alarm set points, communication settings, email setup as well as access to offline settings for date/time, etc.

The **Security** menu provides access for user login, security settings and audit trail viewing if the security system is enabled.

The **Data** menu provides access to data log functions, file utilities, FTP\WAN back-up settings as well as the historical data viewer.

5.3.1.2   Icon/Slide Page Based Home Menu

Slide page 1 provides navigation to all standard view screens. These include the Loop and Overview, Chart, Alarm monitor, and Alarm File.

It also provides quick access to the MCT4 Settings and Data file functions which include file utilities, FTP\WAN back-up settings as well as the historical data viewer.

Slide page 2 provides access to program Entry and Status views.

Slide page 3 provides access to Configure security settings, Audit trail viewing, current User information, user Password editing and user Login and Log Off functions.

5.3.2   Device Settings Menu

The device settings menu is provided when the user selects "Settings" from the main "Device" menu. See section 9 Device Settings for detailed information on these settings and their use.

5.3.2.1   Text Based System Setup Menu
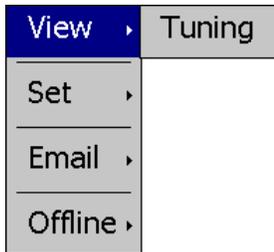
The **View** menu provides navigation to the manual loop Tuning screen.
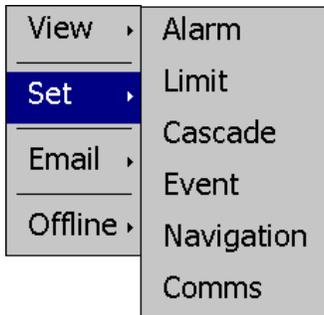
The **Set** menu provides access to settings Alarm set points, control loop set point Limits, Cascade control settings, Event tagnames, Navigation type selection and Communications options.
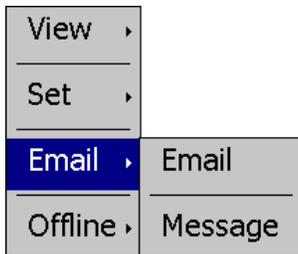
The **Email** menu provides settings for the email server to send SMS text messages and/or emails on alarm and allows the user to compose and send a Message to any user configured in the system.
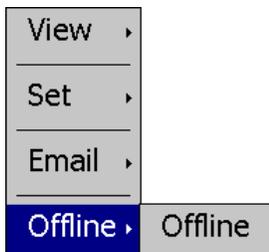
The **Offline** menu provides access to the MCT4 offline setup which provides the user with the ability to adjust the date/time, calibrate the touch screen, configure profile power recovery options, etc.

5.3.2.2 *Icon/Slide Page Based Device Settings Menu*
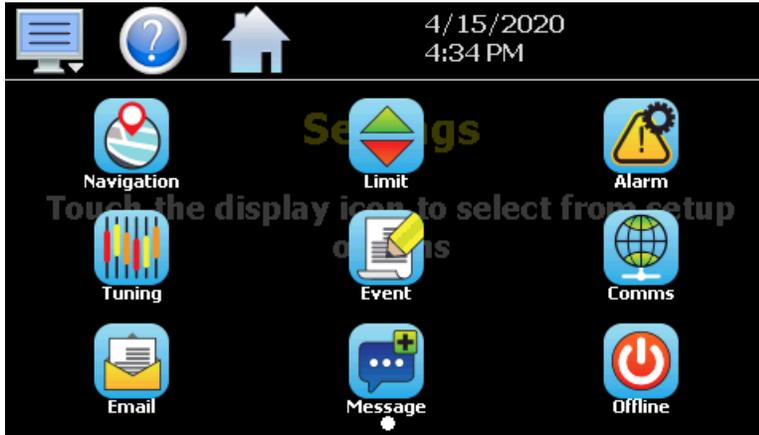
Slide page 1 provides access to Navigation type, control loop set point Limits, Alarm set points, loop Tuning, Event tagname entry and Email server settings and Messaging.

It also includes access to the communications settings for the web page, VNC server and Modbus user communications.
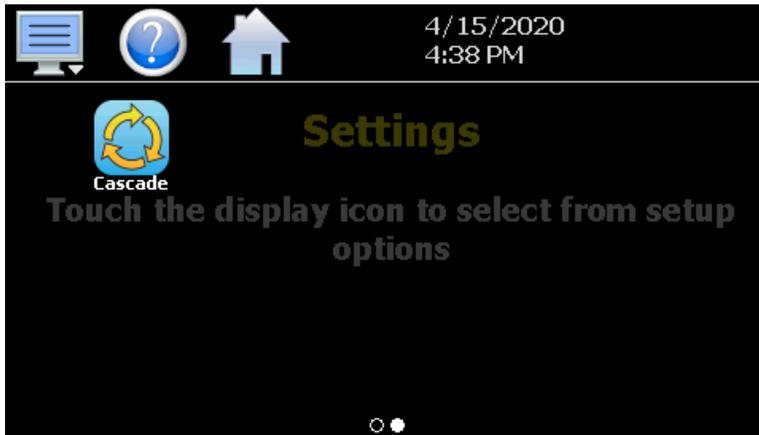
Slide page 2 provides access to Cascade control settings.

5.3.3   Offline Menu

The offline menu is provided when the user selects "Offline" from the device settings "Offline" menu. See section 10 Offline for information on these settings and their use.

NOTE: *Offline settings can only be accessed when an automatic ramp/soak program is not running and data logging is turned off.*

5.3.3.1   *Text Based Offline Setup Menu*
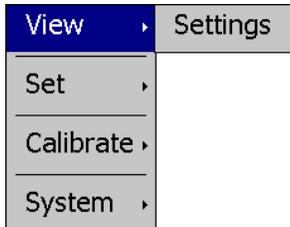
The **View** menu provides navigation back to the MCT4 device settings menu.
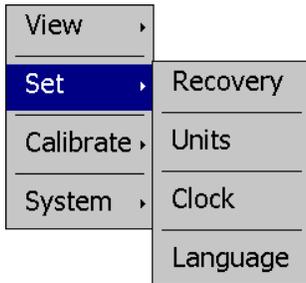
The **Set** menu provides access to the profile power Recovery options, temperature Units selection, NTS Clock, and Language settings.
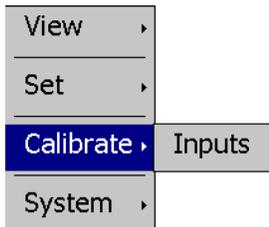
The **Calibrate** menu provides access to the user input calibration for the control loop/limit inputs.
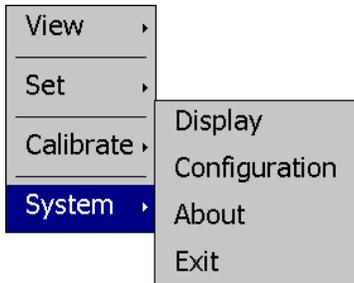
The **System** menu provides access to the MCT4 Display settings, import/export Configuration utility, About screen and Exit application screen.

5.3.3.2   *Icon/Slide Page Based Offline Menu*
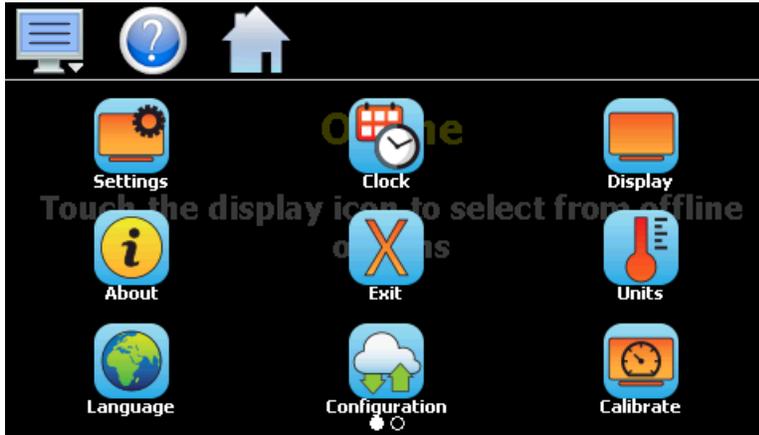
Slide page 1 provides navigation back to the device Settings menu, Clock, Display settings, About MCT4 and Exit application screens, temperature Units selection, Language, import/export Configuration utility and input Offset calibration.
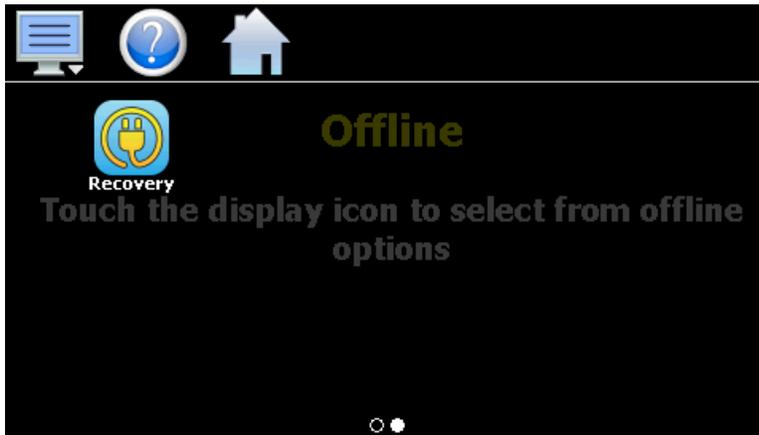
Slide page 2 provides access to the automated program power Recovery options.

5.3.4   Data Menu

The data log menu is provided when the user selects "Data" from the main "Data" menu. See section <u>8</u> Data Logging for information on these settings and their use.

5.3.4.1   Text Based Data Logging Menu
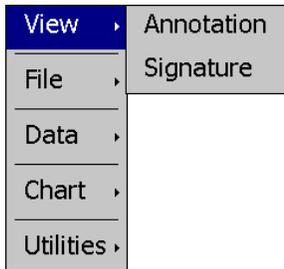
The **View** menu provides access to the data file Annotation and digital Signature screens.
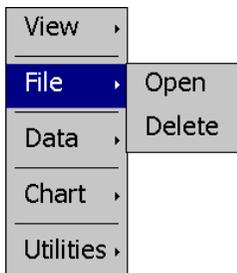
The **File** menu provides functions for opening and deleting historical data log files.
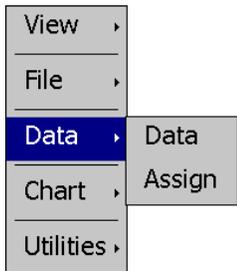
The **Data** menu provides access to the main Data screen for starting and stopping data logging and to the log point Assignment screen where the user can select which items are to be logged to the history file.
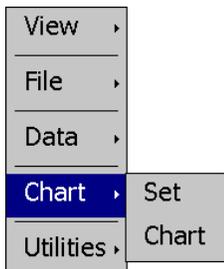
The **Chart** menu provides functions for viewing historical data files in graphical format.
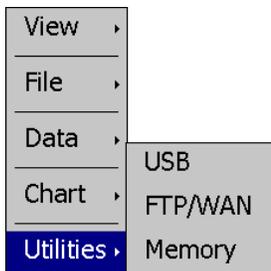
The **Utilities** menu provides access to the MCT4 file management utilities including USB file transfer and FTP/WAN back-up.

5.3.4.2   Icon/Slide Page Based Log Menu
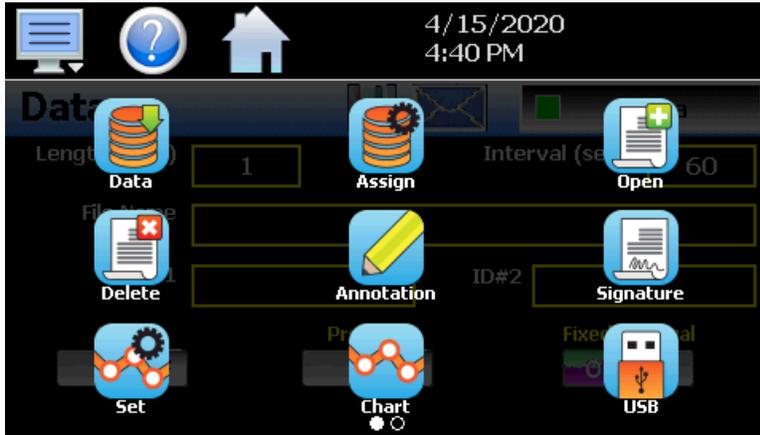
Slide page 1 provides access to the main Data log screen and to the log point Assignment screen where the user can select which items are to be logged.

Historical data file functions are provided for Opening and Deleting historical files and viewing/setting data file Annotations and digital Signatures.

The plot Set and Chart icons provide access to the historical data viewer options.

Slide page 2 provides access to the FTP/WAN back-up settings and the memory check utility for viewing available system/storage memory space.

5.4   Notifications

The notification window is a feature that can be accessed by pressing the date/time field in the icon bar. This window provides a snapshot of current MCT4 activity. The notification window can be closed by pressing the date/time field again, or is automatically closed if the Menu, Home or a navigation arrow icon is pressed.

A user can view all notifications by touching the screen and dragging their finger up or down on the list to scroll through all items like other lists in MCT4. The notifications include the following:

- Loop PV and SP for each loop configured.
- Automatic program status including name of running profile.
- Active alarm status including the most recent alarm.
- Data logging status including active file name and the length and logging rate set.
- Security status active/inactive status.
- Current user.
- Audit trail active/inactive status.
- Web server active/inactive status.
- VNC server active/inactive status.
- MCT4 IP address.
- Available SD storage memory remaining.

The appearance of the items is based on the configuration of the MCT4. If data logging or security functions are disabled in the Configurator for example, their status items will be removed from the list as well. If navigation from the notifications list is enabled (see section 0

Navigation), pressing a single row in the list will display the screen associated with the item. This provides an easy way to quickly access the desired item if user action is required.

NOTE: *The notification items do not update while the list is shown. The information shown in the list is a snapshot of the data at the time the window was shown. Therefore, the PV or SP shown for a loop may not be the actual values for the loop if the notification window is left open for extended periods of time. The notification window is not available in the offline setup.*

5.5 Control Loops (Single Set point Operation)

The Loop view screen provide direct viewing options for the control and monitoring of the MCT4 control loops and limit control (if configured). The Loop screen allows the user to adjust the current loop set point (SP) and view the process variables (PV) and percentages of output (%) for each loop.

5.5.1 Loop View

The Loop screen is accessed from the home "View" menu. It automatically configures itself to display from one to three loops or up to two loops and limit control based on the configuration of the MCT4.
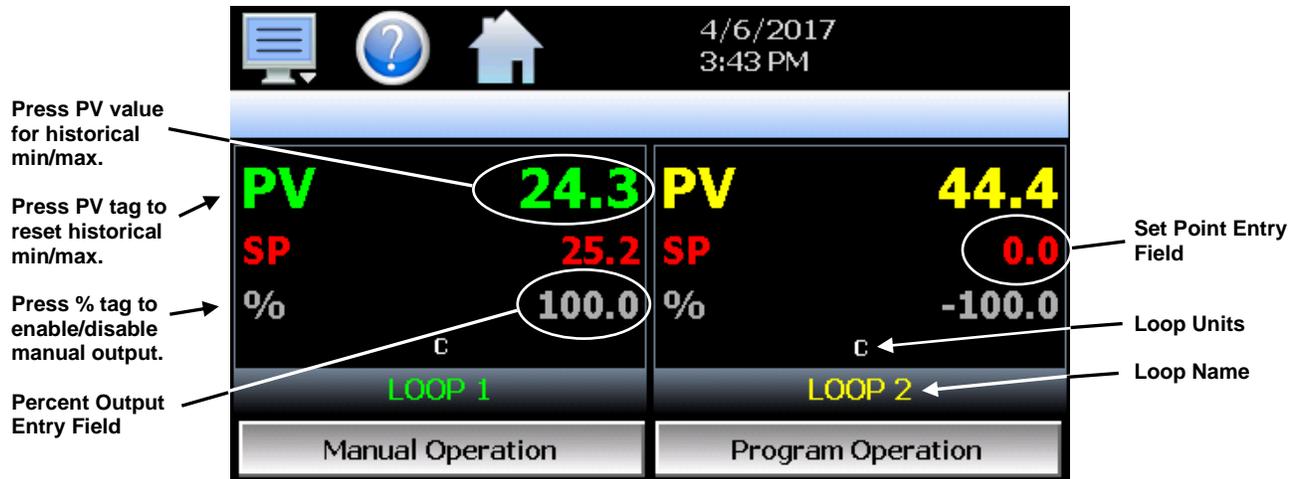
The **set point entry field** is the area where the screen can be touched in order to bring up the keypad entry window. Using the numeric entry keypad, a new set point can be entered. Once entered, the new set point will be shown in the set point entry field. Adjustment of the set point is locked out if an automated ramp/soak program is running.

IMPORTANT: *When operating in single set point mode, the set point and event selections are saved 15 seconds after the last entry is made. If the set point or event selections are changed and power is removed prior to the 15 second time period, when power is re-applied, the loop set point and event selections will return to the previous value. Ensure that power remains on for 15 second interval after an entry is made in order to have it power-up with the desired set point and event selections the next time power is applied.*

The **percent output entry field** is the area where the screen can be touched in order to bring up the keypad entry window. Using the numeric keypad, a new fixed percentage of output can be set for the loop. In order to be able to enter a fixed output percentage, the loop must first be placed in manual output mode. This is done by pressing the "%" tag on the screen. This feature can be removed by turning off the "Loop Manual Mode" function in the Configurator.

The **loop name and loop units**, shown at the bottom of each loop (or limit), will display the tagname and units as entered in the Configurator.

5.5.1.1 *Ramp Rate Operation*

When a loop is configured for ramp rate operation, the "SP" label will provide additional status for the loop in regards to whether the set point is ramping up, down, or is stable at the target set point. This is accomplished by providing a direction arrow (up or down) to indicate which direction the set point is ramping. Once the set point has reached its target, a bidirectional arrow will be shown to indicate the set point has reached its target.

Press SP tag to view ramp rate settings.

Under ramp rate operation, when a set point is entered, the loop starts the ramp from the current process value and then continues to the target set point according to the rate up or rate down entry made on the set point Limits screen (see section 9.3 Setpoint Limits). The target set point, ramp rate and deviation hold entries can be viewed at any time by pressing the SP tag for the loop.

Pressing the "OK" button will close the dialog window and return to the Loop view screen. The Overview screen indicates a loop under ramp conditions by displaying the target set point in parenthesis after the actual loop set point.
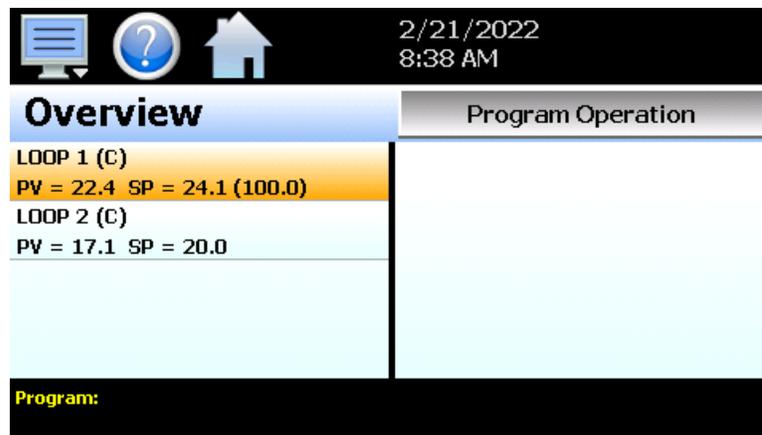
Once the loop is at its target set point, the target set point will be removed and only the normal PV/SP information will be provided. Thus, the only indication a loop is configured for ramp rate operation on the Overview screen, is when it is actively ramping to a set point.

IMPORTANT: *On power up, and each time the user transitions from offline settings to online operation, each loop that is configured for ramp rate will restart ramping operation from the current process value to the last target set point provided regardless as to whether it had reached set point prior to entering offline mode. This ensures that the user entered rate of change is maintained when the MCT4 resumes control of the system.*

If automatic ramp/soak program operation is utilized with loops configured for ramp rate operation, the program will override the user entered rate up/down limits. The loop set points will be defined by the program. Thus, it is up to the user to ensure that the program is written properly so that it does not exceed the maximum desired rate of change for the loop set point.

5.5.1.2 *Setpoint 2 Operation*

A secondary set point can be configured for a loop and activated via the loop's event input. The secondary set point can be either an actual set point value, or a deviation offset from the current user or program defined set point the loop is currently operating under (see section 4.2.39 Setpoint 2 Format). When set point 2 is activated, the "SP" tag label on the main Loop View screen will indicate that set point 2 is active by displaying "S2".
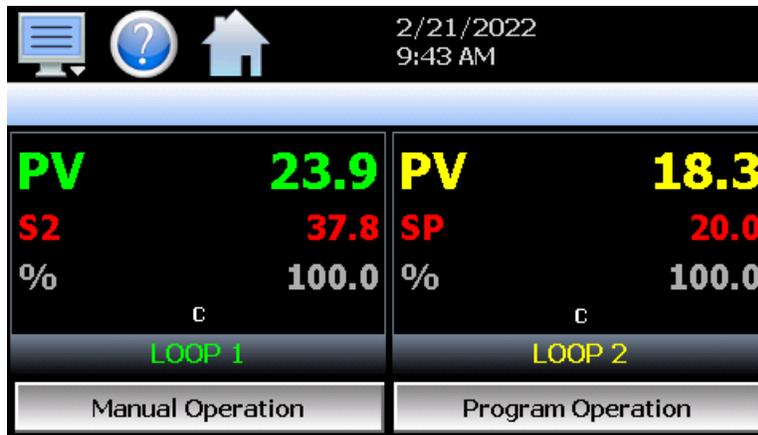
Pressing the SP tag label will display a dialog indicating the current user (or program) set point shown as "S1". The Overview screen will also indicate that the loop is under set point 2 operation and via the "S2" tag designation for the set point while displaying the user (or program) set point S1 in parenthesis.
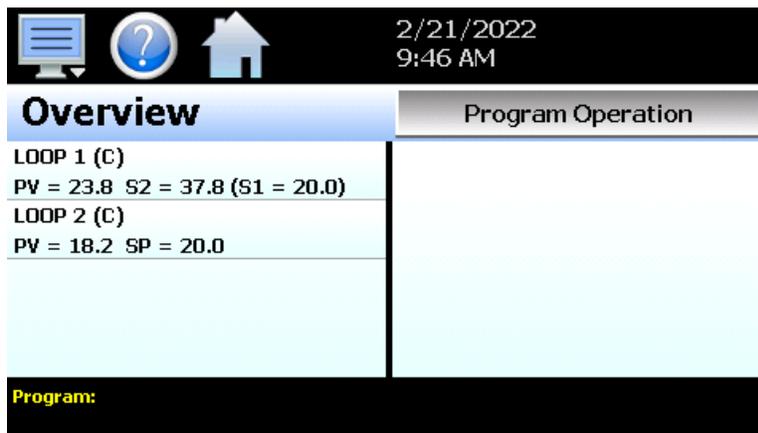
IMPORTANT: *If set point 2 is configured as an actual set point, it will override the set point defined by the operating ramp/soak program. If set point 2 is defined as a deviation, the offset will be continuously applied to the set point defined by the operating program.*

If the loop is not under program control, the offset will be applied to each user set point entry. Once the event input is deactivated, disabling set point 2, the loop would then operate under the value of the last user set point entered (or the actual set point defined by the operating program).

5.5.1.3   Historical Minimum and Maximum

The MCT4 monitors and stores the minimum and maximum process value reached during operation for each loop in the system as well as the limit if configured. The current historical values can be viewed by pressing the process value display field for the desired loop or limit.

Pressing the "OK" button will close the dialog window and return to the Loop view screen. The historical values are reset each time the runtime application is started and can also be manually cleared by pressing the "PV" tag on the Loop view screen.

Pressing the "Yes" button in the dialog window will reset historical minimum and maximum values and default them both to the current process value. Pressing "No" will simply close the dialog.

5.5.1.4   Manual Operation

The Manual Operation button displays a "slide out" window providing access to all events programmed for the system. To turn each event and its corresponding output on or off, simply press the button associated with the event. Slide the list up or down as necessary to view additional events if more are programmed than can be displayed in the window at one time.

NOTE: The MCT4 loop controls can provide up to 3 event outputs each (for a total of 9 events). Depending upon the configuration of MCT4, some outputs may perform specific control or alarm functions. The use of each output, and what it controls, is determined by the system designer. If there are questions or concerns about the configuration and operation of your MCT4 controller, contact your OEM for further information. Only your OEM can address equipment related issues.

The names of events are also determined by the system designer. The screen shot above is an example. Consult section 9.5 Event Names on how to change the names of events.

5.5.1.5   Program Operation

The Program Operation button displays a "slide out" window with all automated program operations included. Press the desired icon for quick access to any program operation. The "Select" icon can be used to select any program stored for quick run operations. The "TOD Start" icon allows the current loaded program, or newly selected program, to be started at a specific time and date.
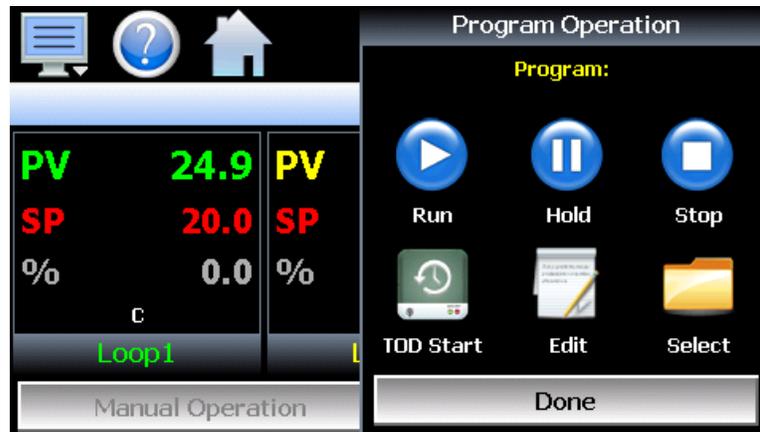
5.5.2   Overview Screen

The Overview screen displays all loops, the limit and events on a single screen for quick access to all system parameters. Press any loop to access the "slide out" keypad for set point entry. Press an event button to turn the output on and off. The Program Operation button displays the "slide out" window to access all automated program operations. Fields located at the bottom of the Overview screen will display the current program loaded as well as a scrolling alarm field which will cycle through any and all alarms that are active in the system.
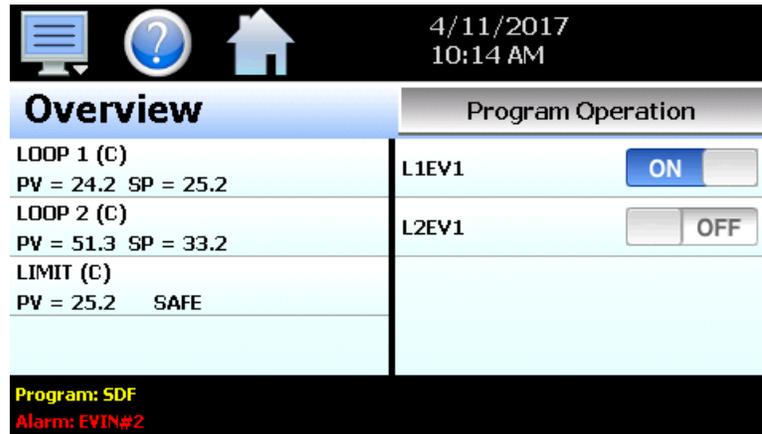
5.6   Process Monitoring

The Loop and Overview screens provide the current process values of the MCT4. In order to view the process inputs over time, the MCT4 provides real-time charts. Four user configurable charts are provided with up to six plot points per chart.

5.6.1   Charts

The Chart screen is accessed from the home "View" menu. The real-time charts can be configured to display the process variable (PV), set point (SP) and percentage of output (%) of each control loop over a selectable period of time. The vertical axis determines the range of displayed data while the horizontal axis determines the history period. The maximum time period that can be shown in a chart is 24 hours. The MCT4 comes standard with 4 configurable charts. Each chart includes up to 6 trend lines configurable by the user.
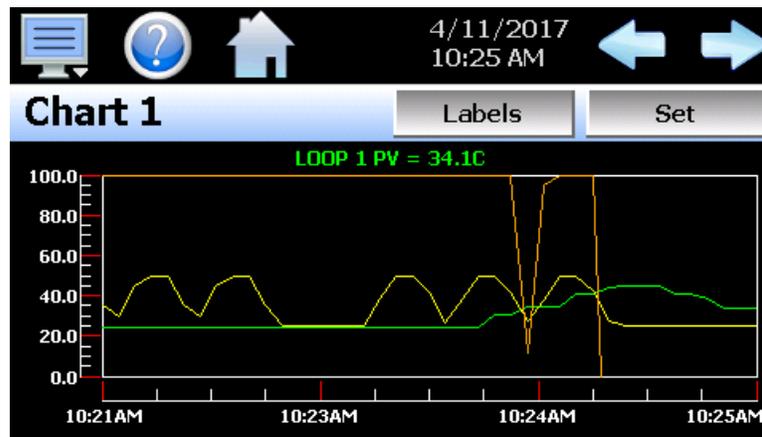
The rate at which the chart plots a new point is based on the time period to be shown. Each buffer can hold a total of 720 readings for each of the selected channels to plot. The update rate can be calculated by the formula: time period (in minutes) * 60 / 720. Note that for time periods less than 72 minutes, the update rate will be held

to a minimum of 6 seconds. Thus, the update rate will vary from a minimum of 6 seconds (for time periods of 72 minutes or less) up to a maximum of 120 seconds for 1440 minutes (24 hours).

The **Labels** button allows the user to cycle through each of the configured plot channels to determine what each colored plot represents as well as view the current value without having to return to the Loop or Overview screens. When both left and right vertical axis are shown on the trend, the label will append a left axis indicator "<" or right axis indicator ">" to point to the axis the plot point is assigned to.

The left and right scroll buttons at the upper right of the screen allow the user to cycle through each of the four available charts. The charts also allow you to "zoom in" on a particular area to have a more detailed look at current data. By using your finger to select an area on the screen, the chart will zoom in on that area. To select a portion of the plot, touch and hold the screen with your finger. Drag your finger across the graph and a box will be drawn around the selected area. Removing your finger from the screen will cause the chart to redraw with only the selected plot area. To return to the normal view, touch the 'X' or 'Y' axis and select zoom out to return to the previous zoom setting or zoom normal to return to the full display.

NOTE: *When a chart is zoomed in, it will not update with new information. The chart must be in normal view mode in order to update at each time interval. The chart will return to normal automatically when selecting a different screen to view.*

5.6.1.1   Chart Setup

To configure a chart, press the "Set" button in the upper right corner of the display. The setup screen will be shown. To assign channels to the chart, simply touch the on/off button for the desired items in the list to select them. Select the left or right vertical axis for each item by selecting the item in the list and press the button for the desired "Left" or "Right" axis. The left axis is the default axis selection. If none of the channels are assigned to the right axis, the axis will not be shown on the chart.
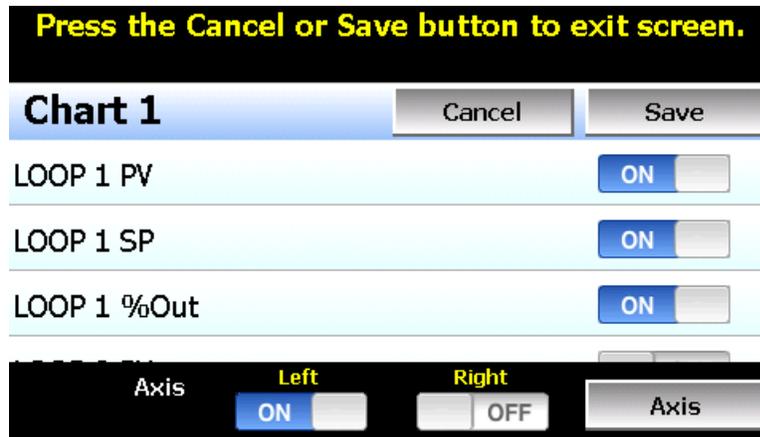
Once the channel selections have been made, press the "Axis" button to adjust the time period and vertical axis ranges of the graph.

Press the Return button to exit screen.

Axis 1   Return

Time Period (minutes)   4

Left	Right
Maximum 100	Maximum 100
Minimum 0	Minimum 0
Automatic Scale OFF	Automatic Scale OFF
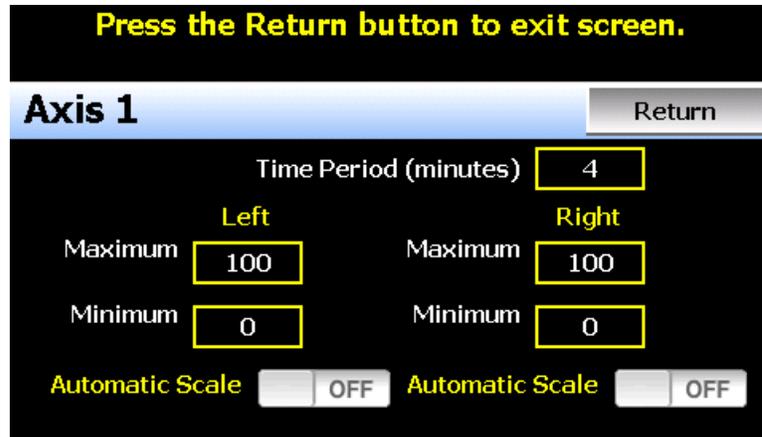
Time Period   Adjusts the displayed time period for the graph. The allowable range is from 4 to 1440 minutes (24 hours).

Maximum   The maximum value sets the maximum range of the vertical access with a minimum value of -32,760 and a maximum of 32,760.

Minimum   The minimum value sets the minimum range of the vertical access with a minimum value of -32,760 and a maximum of 32,760.

Automatic Scale   When on, the vertical axis will automatically adjust its zero and span as needed to display the selected plot channels.

Once all settings have been made, press the "Return" button to return to the channel selection screen. Press the "Save" button to store the current channel and axis entries or the "Cancel" button to exit chart setup without altering the current chart settings. If channel selections or the time period for the chart has changed, all current chart data will be cleared when the new entries are saved. The chart will then begin plotting new data according to the new settings.

5.7   System Alarms

When an alarm condition occurs, the alarm icon flashes in the MCT4 icon bar to provide a visual indication of an alarm condition. An audible alarm will also sound if the alarm requires immediate operator attention such as a loop communications failure or a process alarm set point has been exceeded. For more information on adjusting the audible alarm volume, see section 10.6 Display Settings.

NOTE: *The MCT4 loop controls can provide up to 3 alarm outputs each (for a total of 9 alarms). Depending upon the configuration of the MCT4, some outputs may perform specific control or event functions. The use of each output, and what it controls, is determined by the system designer. If there are questions or concerns about the configuration and operation of your MCT4 controller, contact your OEM for further information. Only your OEM can address equipment related issues.*

For information on alarm operation, see section 9.2 Alarms.

5.7.1   Alarm Monitor

The Alarm screen is accessed from the home "View" menu. It can also be displayed by pressing the alarm icon whenever a new alarm occurs. It displays all current and/or previously acknowledged alarms according to time and date of occurrence. Once the alarm is reset, the alarm icon will be hidden; however, the alarm condition may still be present.

The alarm will be removed from the list when cleared by the operator by pressing the "Clear" button. Only alarms that are not currently active in the system can be cleared from the alarm list.

IMPORTANT: *If a loop control is in manual mode or in automatic tune and the reset button is preset, the alarm reset will terminate automatic tune or manual mode and place the loop back into normal operation.*

Upon alarm reset, if the process no longer exceeds the alarm set point, but the loop control alarm output has not yet reset due to the alarm hysteresis, the alarm reset will ignore the alarm hysteresis and the alarm output will immediately go to the non-alarm output state.

5.7.2   Alarm File

The Alarm File screen is accessed from the home "View" menu. It displays all alarms for any given day. The MCT4 can store daily alarm files for a period of a year or longer (time based on storage usage for data history). Each time an alarm occurs on the MCT4, the alarm is written to a file. Alarm file names are listed as MMDDYYYY (where MM = month, DD = day, YYYY = year. The "Open" file button will display a dialog box where the user can select any alarm file to view.
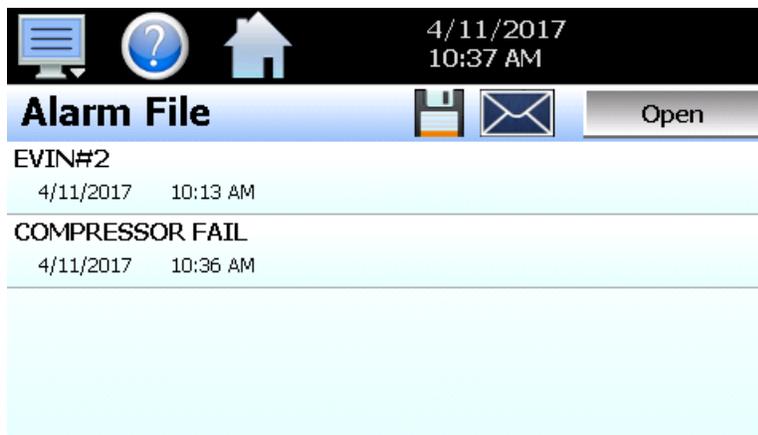
The send email icon ✉ allows the user to send a copy of the currently opened alarm file to any user configured in MCT4. When the email icon is pressed, an "Add Recipients" window will be displayed where the user can select recipients for the file from any of the email addresses configured under the MCT4 email settings. For information on how to add email recipients to MCT4, see section 9.8 Email.

The **Disk** icon next to the **Email** icon allows the user to save the currently opened data file to a USB memory device connected to the MCT4.

.
NOTE: If no alarms occurred on a given day, an alarm file will not be created for that day. The alarm list will display up to 650 alarm files. If more than 650 alarm files are present, the alarm files cannot be shown in the list and the files will have to be exported from the MCT4 in order to view them. This can be done either via USB file utilities (see section 8.4 USB File Transfer) or FTP (see section 8.5 FTP/FileWeb/DataWeb Interface).

6 Automatic Ramp/Soak Program Operation

A ramp/soak program is a set of instructions (set points and events) programmed as a timed sequence of steps. When a program is run, the MCT4 executes each step of the program automatically, in sequence, based on the time duration and settings for each step. The MCT4 can store hundreds of programs (depending on storage usage for data history) with up to 64 steps in each. All program step entry is located on a single screen so even the most complex program is easy to create and edit.

Program Entry Screen

The pop-up "File" icon menu provides the following functions:

New   Clears all current program entries.

Open   Provides file open dialog to select a program from memory.

Save   Saves the current program being edited.

Save As   Saves the program being edited under a new name.

Delete   Deletes the current program from internal memory.

Export   Export the current program to USB memory device.

The pop-up "Edit" icon menu provides the following functions:
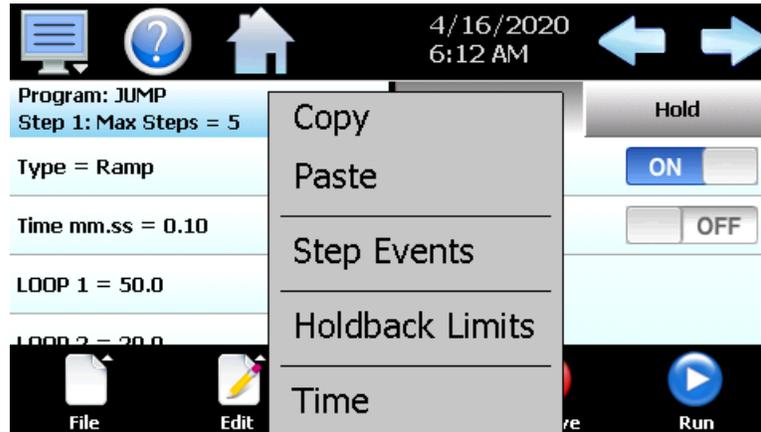
Copy   Copies current step data including events.

Paste   Pastes previously copied step data to the current step.

Step Events   Copies and pastes current step events to all following steps.

Holdback Limits Sets holdback limit values for each loop (set once only per program).

Time   Sets time for program in hh:mm or mm:ss (set once only per program).

6.1   Entering a Ramp/Soak Program

Ramp/Soak programs are created and edited from the program Entry screen. The program Entry screen can also be accessed directly from the "Program" menu or "Program Operation" button on Loop and Overview screens. To create an automatic ramp/soak program:

1.) From the File pop-up menu, select "New" to create a new program.

2.) Enter or delete steps by pressing the "Insert" or "Remove" icons. Steps can be added or deleted "on the fly" as required. Inserting steps anywhere within the program will not affect steps already programmed.

3.) For each step, press any row in the loop list view to set the step type, time or loop set point. Entry is dynamic and the interface will display a pop-up menu or slide out numeric keypad to match the type of entry pressed in the list. Slide the list up or down to view more data like any standard smart device. Press any button in the "Event" list to turn the event output on or off for the program step. If holdback for any loop step is required (and programmed in holdback screen), press the "Hold" button and select the loop the step holdback.

4.) From the File menu, select "Save" to save the program.

> **NOTE:**   *Programs can be saved with names of up to 16 characters long. However, the MCT4 only uses the first 14 characters of the program name for display updates and record keeping. When naming programs, try to keep the name limited to 14 characters in order to have the full program name shown, or use the first 14 characters as a means of more clearly identifying the program when more than 14 characters are used.*

6.1.1   Setting Step Type

Programs are entered as a sequence of steps which define the set point and length of time that a loop should take to reach the set point (ramp) or remain at a set point (soak). The ramp and soak units can both be set for hours/minutes or minutes/seconds or one can be set for hours/minutes while the other is set for minutes/seconds. To begin editing a program step, first select the type of step by pressing the first row in the list and make the desired selection from the step type pop-up menu.

NOTE: *As the step type selection is changed, the list will update to include only the items specific to the selected step type. This simplifies step entry by only requesting user entry for the items necessary for proper step operation.*

The **Ramp** selection allows the user to program each loop to ramp to a set point in a specific period of time. Simply select ramp from the pop-up menu and then enter the loop set point(s) and time.

The **Soak** selection allows the user to program each loop to maintain its set point for a specific period of time. Simply select soak from the pop-up menu and then enter the time desired to maintain the set point.

The **Jump** selection allows the user to jump to a previous step in the program and set the number of times the program should execute the jump before continuing to the following step of the program.

The **End** selection allows the user to program the last step of the program. The end step type includes final set points (if configured) and a cycle count entry to allow the user to enter the number of cycles the program should repeat itself if desired.

6.1.2   Setting Step Set Points and Time

Set point entry is only provided when entering a ramp step. If "soak" is selected for the step type, the loop(s) will remain at the previous set point for the amount of time entered for the step. The set point entered for each control loop is used as the target set point for the step, i.e., the set point the loop control will arrive at by the end of the step. Each set point will change independently of the other in order to arrive at the target set point when the time left in the step reaches zero.

To enter the set point for a loop, touch the set point field for the loop and enter the desired set point. To enter the step time, touch the time field to enter in the desired time duration. Time is entered as HH.MM or MM.SS depending upon the selection made on the Time setup screen under the Edit icon pop-up menu. Thus, to enter a time of 1 hour for example, you would enter a value of 1.00 for one hour and zero minutes. To enter a step time of 30 minutes, the time entry would be made as 0.30 for 30 minutes. If the time selection was in minutes and seconds, an entry of 1 minute and 30 seconds would be made as 1.30.

NOTE: A step time of zero can be entered for a step to implement an immediate set point change when programmed for ramp. If holdback is enabled on a step, a minimum step time of 10 seconds 0.10 (mm:ss) or 1 minute 0.01 (hh:mm) is required to ensure that the holdback condition can recognize the process change in order for holdback to operate.

6.1.2.1   _Ramp/Soak Time Units Selection_

The Time selection screen is accessed by selecting the "Time" menu item from the Edit pop-up menu.
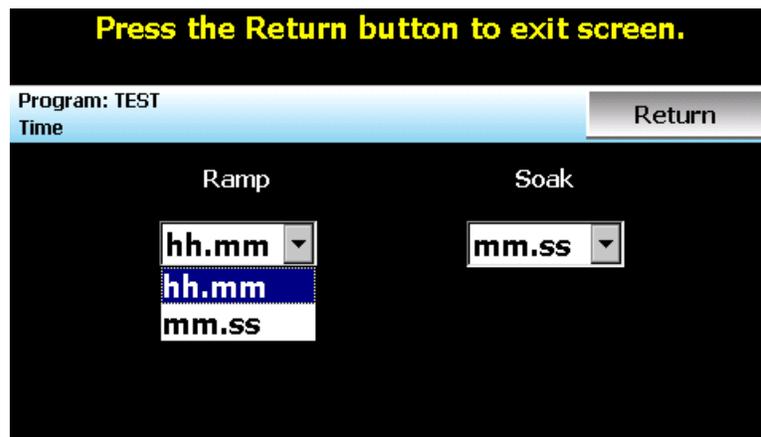
For dual loop and three loop systems, the ramp and soak time selections both provide the option of hours and minutes (hh.mm) and minutes and seconds (mm.ss). The selections apply to all steps of the program. The time units can be changed at any time during program entry; however, the time entry of each step is not scaled to the new unit selection when the change is made.

If program steps were entered in the previous selection of "mm.ss" for example, a time of one minute and thirty seconds (1.30) will become a time entry of one hour and thirty minutes (1.30). If the time unit selection is changed, all steps must be reviewed in order to make sure the actual time length for each step is set to the desired length.

6.1.3   Setting Step Set Point and Ramp Rate (single loop only)

For single loop systems, the time units for ramp steps on the Time setup screen under the Edit icon pop-up menu can be set for units/hour or units/minute. If the ramp units are set for units/hour or units/minute, ramp steps are entered as a rate of change in process units/time period. If a set point is entered for the step that matches the set point of the previous step, the step will be skipped since the loop is already at set point.

NOTE: *A ramp rate entry is only available for single loop MCT4 systems because the length of time for the step to complete is based upon the change in set point and the rate at which the set point is to ramp. Ramp units of time are still available for selection on single loop systems if time entry is preferred over rate.*

6.1.3.1   *Ramp Rate/Soak Time Units Selection*

The Time selection screen is accessed by selecting the "Time" menu item from the Edit pop-up menu.
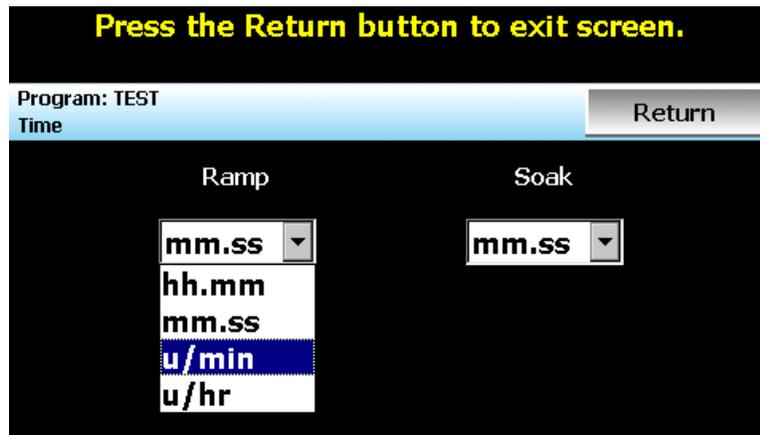
For single loop systems, the ramp and soak time selections both provide the option of hours and minutes (hh.mm) and minutes and seconds (mm.ss). In addition, the ramp time selections include units/minute (u/min) and units/hour (u/hr). The selections apply to all steps of the program. The time units can be changed at any time during program entry; however, the time entry of each step is not scaled to the new unit selection when the change is made.

If a ramp step was entered in the previous selection of "u/hr" for example, a ramp rate entry of 10 degrees per hour will become 10 degrees per minute if the ramp selection is changes to "u/min". When time unit selections are changed, all steps must be reviewed in order to make sure the actual ramp rate or time length for each step is set to the desired length.

6.1.4   Setting Step Events

For each step of the program, the user can select which events are to be on during the step. To edit step events, press the "Event" button on the program Entry screen. This will display the Event list for the program step.

When at least one event is turned on in a step, an asterisk '*' will appear before the word "Event" on the list selection button.

This indicates that at least one event is turned on without having to press the "Event" button, or if the events that are turned on are not currently shown in the list due to the scroll position of the list.

The desired event state for the step can then be set by pressing the on/off button for each event to toggle them on and off. Sliding the list up or down will display additional events if more events are program than can be shown in the list at one time.

Events cannot be set for the End step. During program operation, when the End step is reached, the event outputs will return to their previous static setting (prior to starting program operation). If the loop controls are configured for "Setpoints and events of last step" at end of program operation, the events will maintain their current state.

NOTE: *The step events must be set individually for each step. Even though a ramp/soak program may be in operation, if the events are not set, the associated loop control output will not turn on. To make setting step events quick and easy, the MCT4 provides the "Step Events" function from the "Edit" menu. When selected, all event selections of the current step will be copied to all following steps.*

This requires the user to only enter event selections for one step (step 1 for example), and if all following steps use the same event selections, selecting "Step Events" from the "Edit" icon pop-up menu will then copy the selections to all other steps of the program.   This feature can be used on any step of the program, so if event selections then change on step 5, the function can be used again and all steps after step 5 will then have event selections of step 5 copied to them leaving steps 1-4 with the previous selections.

6.1.5   Setting Hold Conditions

The available hold conditions consist of holdback and wait for. For each loop under program control, either option can be selected. For loops not controlled by the program (monitor/static only) or monitor inputs, only the wait for selection is available. To edit hold conditions for each input, touch the row for the input you wish to set. A pop-up menu will be displayed offering the selections of Off, Hold and Wait For.

When Hold is selected, the program will automatically enter a hold condition any time during the step if the loop's process value deviates from its set point by more than the holdback limit setting for the loop. When Wait For is selected for one or more inputs, the program will automatically enter a hold condition upon entering the step. The program will not resume operation until all selected inputs reach the wait set point. Thus, the holdback selection operates throughout the step to pause the step time countdown when the loop process value deviates too far from the set point. The wait selection acts as a single-shot hold upon entering a step, so once

all inputs reach the wait set point, the step time countdown will resume and not be held up again for the remainder of the step.

When at least one hold condition set in a step, an asterisk '*' will appear before the word "Hold" on the list selection button.

This indicates that holdback or wait for is enabled on at least one input without having to press the "Hold" button to view the list selections.

NOTE: *For proper holdback and wait for operation, a minimum step time of 1 seconds 0.01 (mm:ss) or 1 minute 0.01 (hh:mm) is required. If the step time is zero, the hold condition will not be activated and the program will proceed to the next step.*

6.1.5.1   HoldBack Limits

The holdback limit settings are used to set the control tolerance for each loop during steps that have holdback enabled. When the loop process value deviates from its set point by more than the band value (above or below set point), the program timer will stop until the process value re-enters the holdback band. The Holdback Limits are accessed from the Edit pop-up menu. The entries apply to every step in the program and only need to be entered once for the program.
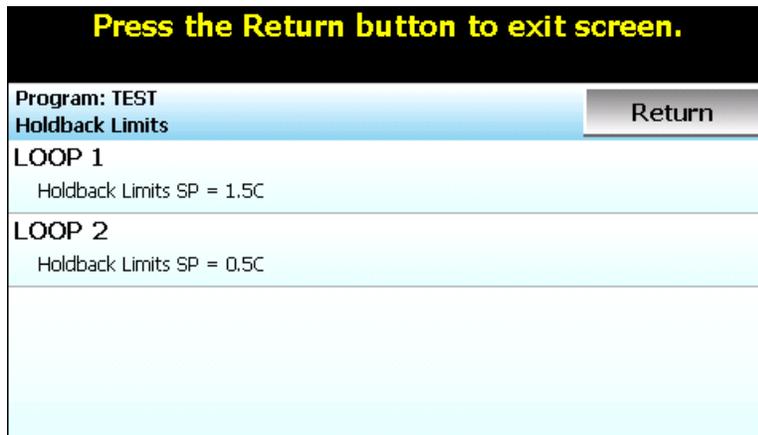
The MCT4 uses "band" type holdback operations. This means the MCT4 will be in hold mode when the loop process value is above or below the loop set point by the entered holdback limit value during step operation. Holdback steps must have a minimum value of 0.01 (mm:ss) or 0.01 (hh:mm) for holdback to engage during the step. A time value of 0 in a holdback step will cause the program to continue to the next step and skip holdback operation.

6.1.5.2   Wait For Set Point

When the wait for condition is selected for one or more inputs, an additional entry for the wait set point (Wait SP) will be provided at the bottom of the hold selection list. This set point is common for all inputs chosen to wait for.

The set point entry is critical in order for the step to operate correctly. During the wait state, each selected loop and/or monitor input must arrive at or cross the wait set point in order for the program to resume operation. Thus, the previous step must ensure that all selected process values will be moving towards the target wait set point prior to the step with the wait selections beginning. If all selected loops and/or monitors do not cross the wait set point after the wait step has started, the program will pause indefinitely on the step until the user takes action.
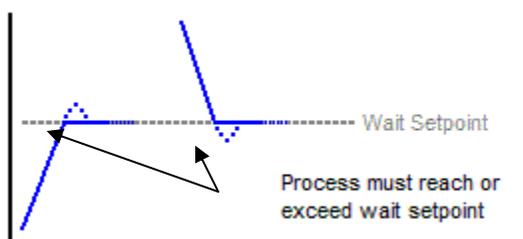
6.1.6   Setting Jump Steps

This feature allows the program to jump back to a previous step in order to repeat certain sections of a program. When a jump step is entered, the program will jump to the specified "jump step" rather than continuing on to the next step in the program. After all of the programmed jump cycles have been completed, the program will then continue to the following step without making any further jumps.

NOTE: *The MCT4 has the ability to do nested looping, i.e., allowing multiple jump steps to be programmed throughout a program in which one jump cycle is repeated within another jump cycle. The program Status screen will display the current cycle count; however, this is for the outer most jump step. If nested jump loops are programmed, the cycle count of the inner jump loops is not displayed.*

To program a jump step, select jump for the step type and enter the step number that you want the program to jump back to along with the total number of times the jump is to be made (by pressing each row in the list). A cycle count of one indicates that no jump will be made since one cycle is completed upon reaching the jump step.

6.1.7   Setting the End Step

All programs require that the last step is entered as an "End" step type regardless of the length (2 to 64 steps) of the program. The end step type provides a cycle count entry which makes it easy for the operator to repeat an entire program without having to enter a jump step. The end step cycle count can be set from 1 to 9999 cycles. An entry of 10,000 can also be made which signifies infinite looping, i.e., the program will keep repeating itself until manually stopped by the user. Press each row in the list to make the desired entry.
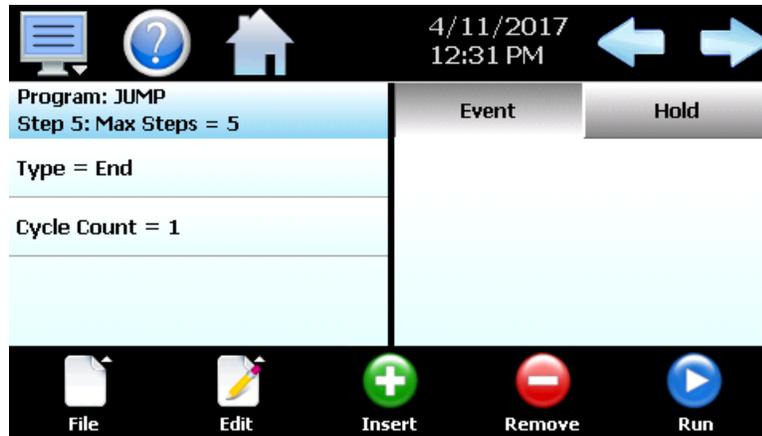
If the loop controls are configured for "Final setpoint of automatic program" at end of program operation, the loop set point for each loop also will be displayed in the list. When the program ends, the set point entered on the end step will be used as the loop set point.

The MCT4 configuration also provides the options for having the loop controls maintain their current set point of the last step or return to the static mode of operation when the program is completed. When configured to maintain the set point of the last step, the loop set points will maintain their current value. When configured to use the last control set point, the loop controls will automatically return to the previous static set point (prior to the start of the program) when the program ends. If there are questions or concerns about the configuration and operation of your MCT4 controller, contact your OEM for further information. Only your OEM can address equipment related issues.

6.2   Starting an Automatic Ramp/Soak Program

All automated program operating functions are accessed via the Program Operation screen. This screen can be accessed by pressing the "Program Operation" button on the Loop view or Overview screens or by pressing the "Run" button on the program Entry screen.
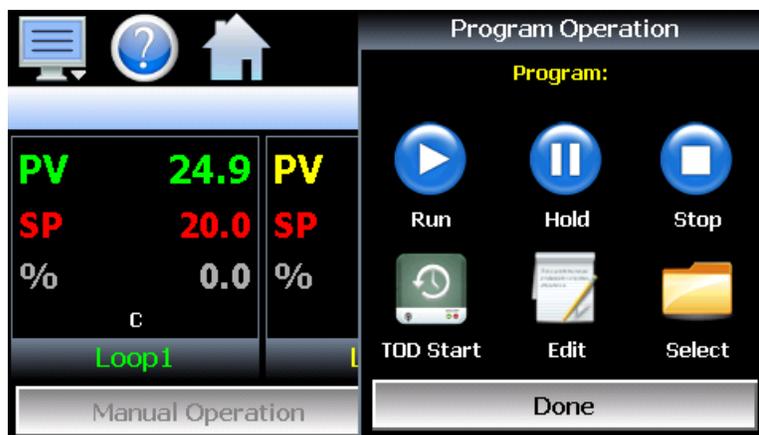
The program operation allows an operator to run, hold, stop, edit and select automatic programs. The Program operation window will display the program loaded in the MCT4 which is ready for operation by pressing the Run, Hold or Stop buttons. If a program is already loaded, the user can start the program without entering a start step. This offers a quick start/stop of programs for repetitive test operations. In this case, the program will always start from step 1.

If entering a Start Step is required (to start the program on a specific step), press the "Select" button and choose the program from the list, then press the run button. This will display the **Start Step** entry.

The **start step** can be adjusted up and down by pressing the right/left arrow buttons or by pressing the step number field and directly entering the desired start step via the numeric keypad. Once the desired start step number is entered, press the "Start" button. The program will then be transferred to the loop control(s) and started once the transfer is complete.

To stop a program, select "Stop" from the Program Operation window. When a program is stopped, the loop set points and events will revert back to the single set point (static mode) values that were entered prior to the program being started. The Edit button will navigate directly to the program Entry screen so a program can be created, edited and stored.

6.2.1   Starting a Ramp/Soak Program at a Specific Time

A program can be set to start at a specific date/time by pressing the TOD Start icon. Similar to pressing the Run icon, if a program is already loaded, the user will be able to set the date/time for current program to start without entering a start step. If there is the need to set the step for the program to start from, or a specific program was selected to run, the user will be able to enter the start step after setting the date/time for the program to start.

The date and time fields will automatically populate with the current date and time (within the next half-hour increment). Each field can then be set to the specific date and time desired for the program to begin. When the Start button is pressed and a start step entry is required, the Start Step entry will be shown; otherwise, the program will be placed into TOD start from step 1.

NOTE: Time is entered in a 24-hour time format. To convert time from a 12-hour format (AM/PM) into 24-hour format, add 12 to the hours for PM time. For example, 2pm will be a value of 14 (2 + 12) for hours. A time of 5:30pm will be 17 hours, 30 minutes.

The program status will then indicate that the program is in TOD Start and include the date and time at which the program is to start. Once the start time is reached, the program will then begin operation.
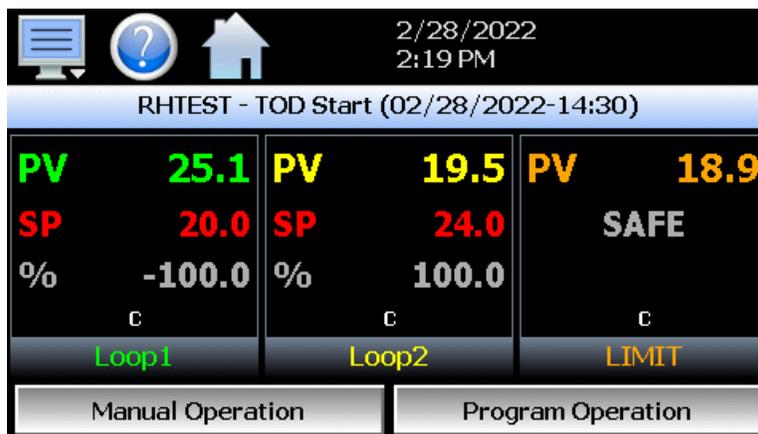
IMPORTANT: When a program is in TOD Start, any loops and events that are under program control will be locked out from user adjustment. Even though the program is not yet executing its programmed steps, the program is technically active. This means that any loop set points and/or events should be set to the desired state prior to starting the program.

If power is lost to the system while a program is in TOD start, and then returns after the scheduled date/time at which the program was to start, the program will begin operation from the moment power is restored.

6.2.2 Hold/Resume Ramp/Soak Program Operation

At any time during the operation of a program, it can be manually placed into hold. This stops the program timer; however, the MCT4 continues operation under the current step settings at the time the program was put into hold. To pause a program, select "Hold" from the Program menu. To resume the program from the point in which it was paused, select "Start" from the Program menu.

NOTE: *The program will automatically be placed in hold if holdback is enabled for the step and the process value of the selected loop deviates from set point by more than the holdback band. When the program is in holdback, it cannot be resumed by pressing the Run button. The program will automatically resume once the process value of the selected "hold loop(s)" is within the holdback band from set point.*

6.3 Monitoring Automated Ramp/Soak Program Operation

The program Status view provides all information regarding the operation of the current program.

The **Status** field indicates the current operating mode of the program, i.e., On, In Hold and Off.

The **Cycles** field indicates the number of cycles left to be completed for the current jump loop.

The **Steps** field indicates the total number of steps in the current program.

The **Step** field indicates the step number currently being executed.

The **Time** field indicates the total length of time programmed for the current step in hours, minutes and seconds.

Time Remaining is the time remaining in the current step.

The set points for each loop are shown dynamically based on the number of loops programmed for automatic ramp/soak operation. They indicate the programmed set point that will be achieved by the end of the step. The fields will also indicate the current ramp or soak status for the loop based on the set point of the step. If the target set point of the step is greater than the loop set point, "ramp up to" will be displayed. If the set point is lower than the current loop set point, "ramping down to" will be displayed. If the step is a soak step or the target set point is the same as the current loop set point, "soak at" will be displayed.

The name of the running program, or current program loaded to the MCT4 loop controls, will be shown at the bottom center of the screen. If no program has been loaded, the field will be empty.

IMPORTANT: *If the set point does not match the set point programmed for the step, check the set point limits for the loop (see section 9.3 Setpoint Limits). The lower and upper limits define the allowed operating range. If a step set point exceeds a limit, it will be coerced to the lower or upper limit that it exceeds. This is done automatically without altering the original program.*

6.4 Common Questions About Ramp/Soak Program Operation

1. How do I start or run a ramp/soak program?

To select and start a program, use the Program Operation window which can be accessed from the Loop, Overview or program Entry screens. All start, stop, hold, edit and program select operations are available from this window.

2. How do I know which program is running?

When a program is running, the name is displayed on program Status view screen as well as the Loop and Overview screens. It is also shown on the Program Operation window. The MCT4 will indicate that the program is running when it is in operation. If a program is not running, the MCT4 will display the name of the currently loaded program, i.e., present in memory and ready to be run.

3 Why is the program not running to the set point entered for the step?

Automatic ramp/soak program operation is limited by the lower and upper set point limits (*see section 9.3 Setpoint Limits*). If a program step has a set point that exceeds the lower or upper limit, the set point will be automatically coerced to the limit it exceeds. This prevents damage to equipment or product by ensuring that the system only operates to the range entered by the user. If a program step has a set point of 100 for example, but the upper limit is 90, when the program is run the set point will be coerced to the maximum allowed upper limit of 90 during operation of the step.

The original program remains unaltered, so if the user then changes the lower and upper limits to match the range of set points within the program, the program will then operate to the programmed set points. This ensures that the operating range of the system cannot be exceeded even if a user accidentally copies a program from another system with a greater operating range.

4 Why is the program not coming out of a Wait For hold condition?

When a wait condition is applied to a step, the step will not begin until the wait condition is met. When using a wait condition to initiate a soak step, be sure to place the wait condition on the soak step. If the wait is applied to the ramp step, the program will not continue because the set point will not change until the wait condition is met, i.e., the ramp cannot take place until the step is executed. Since the set point does not change, the input will not change to meet the wait set point and the program will wait indefinitely.
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7 Security

The MCT4 security model provides an administrator with the tools to add up to 30 users to the system. Each user must have a unique ID, full name and password. Four user levels are provided which include system, user, supervisor and administrator levels. Specific access rights can be assigned to each user level and password aging can be implemented. Verification is provided (if enabled) for any parameters that will change a control parameter, which could upset the process (i.e., loop set point, start/stop automated ramp/soak programs, etc.).

Verification requires that the logged in user must log in again before the process value (at the controller) will actually be changed. This feature is provided for extra security. The following example will make re-authentication clearer:

A supervisor logs on the system. The supervisor then steps away from the system to take a phone call but does not log out before leaving. If another user tries to change the control set point on any loop, the system will require another login (by an authorized user for that level) before the control set point is actually changed. This provides an extra level of protection to make the system more "tamper proof".

The Security menu is accessed from the home menu and provides access to the security section of the MCT4.

Configure
Login
Log Off
Audit
User
Password

The Security menu provides the following functions:

Configure   Provides access to security setup to add users, set rights and options.

Login   Log on a user if security is enabled.

Log Off   Log off a user if security is enabled.

Audit   Allows the user to view any of the saved audit trail files.

User   Shows the current user logged into the system.

Password   Allows the current user to change their password.

7.1 Adding Users

The "New" user tab provides the ability to add up to 30 users to the system. To add a user, first select the type of user from the drop-down list (System, User, Supervisor or Administrator).

NOTE: *At least one administrator must be added to the system (and maintained) in order to enable security.*

Press each field to add the user ID, full name and password (no spaces allowed, 5 characters minimum and 16 characters maximum). If two-factor authentication is enabled (see section 7.4 Setting Security Options), a valid SMS number must be entered in the 2FA SMS Number field for the user. This allows the system to send a security code to the user's personal device during the log in process.

If two-factor authentication is not enabled, users can be added without filling in the 2FA SMS Number field. However, if the 2FA security option is later enabled, users without an entry for the 2FA SMS Number, will not be held to the two-factor authentication login process. They will be able to log in by simply entering their user ID and password.

NOTE: *The SMS address is specific to the service provider. Each service provider has their own unique address; however, the phone number is always the "name" for the address entry. There are internet sites with this information that cover most of the providers, or when in doubt, contact your service provider for the proper address format.*

Once all entries are made, press the "Create" button to add the user to the system. If the passwords do not match or the user ID is already used, the MCT4 will alert the user and not accept the entry.

7.2   Viewing Users

The "Users" tab provides the administrator with the ability to view information on each user entered into the system. Password information is not available. The user can be deleted from this tab and a new password for each user can also be entered from this area.

To delete a user, select the user from the list and press the "Delete" button. Likewise, to change the password for a user, select the user from the list and press the "Password" button.

7.2.1   New Password Entry

To change a password, select the desired user by touching the User ID in the list box and press the 'New Password' button. Enter the new password and confirm the password. Press the "Accept" button to change the password (no spaces allowed, 5 characters minimum and 16 characters maximum).
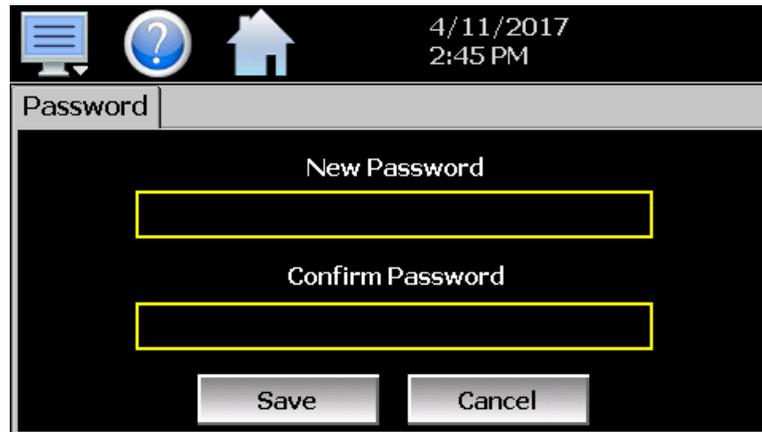
7.3   Setting User Access

The "Access" tab provides the administrator the ability to assign rights to each user level (System, User, Supervisor and Administrator). To enable or disable specific program functions (user rights) for each user level, select the user right from the list and press the corresponding on/off button for the user level you want to change access rights for. If the button is set to on, user access will be enabled for the user group.

User access for "Security" cannot be disabled for the administrator group. This is a safety feature to make sure that any administrator with the proper user ID and password can access security. If the administrator losses his/her ID or password, there is no "back door" to the system and it will have to be reset and reprogrammed in order to return to normal operation.

7.3.1 Security System User Access

Shown below is a list of the available user rights, where to find the menu item(s) applicable to the user right and a description of what it applies to. Note that the OEM configuration allows many menu items to be disabled; in which case the menu for a specific user right may not be shown.

User Right	Menu Location	Description
Setpoint Edit	View/Loop, Overview	applies to loop controls when not running an automatic ramp/soak program (does not apply to loop alarms)
	Device/Settings/Set/Limit	applies to loop controls with ramp rate operation enabled allowing rate up/down and deviation hold entry
Events	View/Events	applies to enable or disable manual events
Manual Mode	View/Single	enable or disable loop control Manual mode button
Automatic Tune	View/Single	enable or disable loop control Automatic Tune button
Program Operate	Program/Run, Hold, Stop actions	applies to all program control menu selections; does not affect digital Inputs configured for same action
Recovery	Device/Settings/Offline/Set/Recovery	logic when running an automated ramp/soak program when power lost & recovery:
Reset Alarms	View/Alarm	alarm Reset button
Clear Alarms	View/Alarm; Clear button	prevents alarm list view from being cleared
Chart Settings	View/Chart	configure plot channels, scale & time for charts
Data	Data/Data	applies to all data logging actions & settings
Annotation	Data/View/Annotation	access to add operator messages to active log file
Signature	Data/View/Signature	access to add digital signature to active historical data file
Open	see description	alarm, automatic program, audit & data files
Save	see description	program "save" and "save as"; note files may be copied from system with USB file transfer utilities
Delete	see description	data files & automatic programs; note files may be deleted with File Utilities
Program Edit	Program/Entry	no data entry or access to Events or Step SP/Time fields; can't insert/delete/copy/paste step.
USB	Data/Utilities/USB	allows USB memory stick to copy/delete data, alarm, program & audit trail files & to import programs
FTP/WAN	Data/Utilities/FTP/WAN	configure FTP client settings
Communications	Device/Settings/Set/Comms	configure web page, Modbus address & VNC settings
Tuning	Device/Settings/View/Tuning	manual adjustment of loop tuning parameters
Setpoint Limits	Device/Settings/Set/Limit	applies to loop controls (does not apply to loop/monitor alarms)
Adjust Alarms	Device/Settings/Set/Alarm	applies to all loop and monitor point alarms
Event Names	Device/Settings/Set/Event	configure event tagnames (seen in manual Events & program step Events)
Email Settings	Device/Settings/Email/Email Settings	configure email settings and addresses
Email Message	Device/Settings/Email/Message	access to compose & send email message
Offline	Device/Settings/Offline	access to Off-Line menu system: Units, set Clock, Calibrate Touch, Language, Exit To Application, input Offset, Configuration
Calibrate Touch	Device/Settings/Offline/System/Display	access to the touch screen calibration utility
Backlight	Device/Settings/Offline/System/Display	access to edit backlight settings for brightness and off delay time
Alarm Volume	Device/Settings/Offline/System/Display	allows edit of MCT4 alarm beeper volume
Units	Device/Settings//Offline/Set/Units	loop/monitor point temperature unit configuration - C\F
Clock	Device/Settings/Offline/Set/Clock	Set Date/Time, Time Zone, DST and NTS connection
NTP	Device/Settings/Offline/Set/Clock	enable & choose National Time Server location
Daylight Savings	Device/Settings/Offline/Set/Clock	enable Daylight Savings Time (DST)
Language	Device/Settings/Offline/Set/Language	Select help language
Security	View/Security/Configure	applies to Security Setup
Configuration	Device/Settings/Offline/System/ Configuration	access to import/export setup files of MCT4

User Right	Menu Location	Description
Default Configuration	Device/Settings/Offline/System/ Configuration; Reset Default Configuration button	function to clear system configuration and reset all to blank (default) state for reconfiguring
Exit (run mode)	Device/Settings /Offline/System/Exit; "Exit application. (automatic mode startup)." button	prevents MCT4 application from being stopped
Exit to Configurator	Device/Settings/Offline/System/Exit; "Exit Application. (configuration mode startup)." button	prevents MCT4 application from being stopped and access to the MCT4 configurator application
Cascade	Device/Settings //Cascade	Set cascade settings when cascade control enabled.
Calibrate Inputs	Device/Settings /Offline/Calibrate	Provides user offset calibration or full calibration of all MCT4 inputs.

7.4 Setting Security Options

The security "Options" tab provides the administrator the ability to set the global security options.
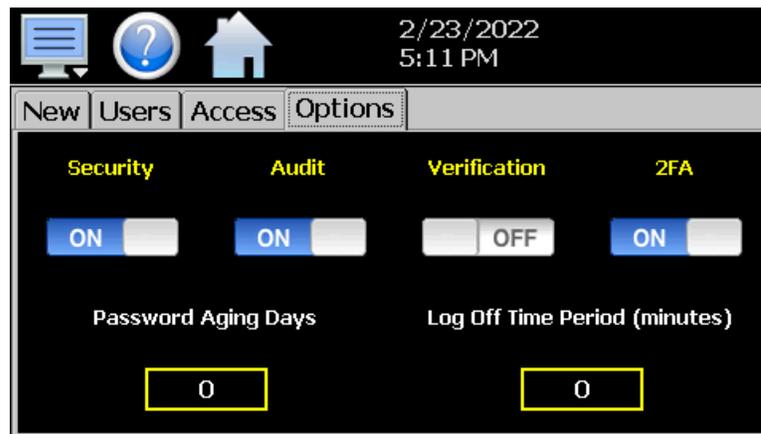
Security is the global setting that turns the MCT4 security system on or off. The security system must be enabled for the audit trail to be enabled.

Audit is a global setting that turns the audit trail on or off. When the audit trail is turned on, all user actions are written to a daily log.

When enabled, **Verification** requires that the logged in user must log in again before the entry value will actually be changed. This option is mutually exclusive with 2FA, i.e., only one can be enabled at a time.

Two-factor authentication (**2FA**) requires users to be added to the system with valid SMS numbers associated to their personal devices. During log in, when 2FA is enabled, the system will send the user a verification code that they must then enter to complete the log in process. See the following section regarding two-factor authentication and its use.

IMPORTANT: *In order for 2FA to function, the system must be connected to the internet and valid email server settings must be entered (see section 9.8.3 Email Settings). If the system does not have internet access and/or email settings are not properly entered, the system will be unable to send log in verification codes and users will not be able to log in to the system.*

The **Password Aging Days** field is a global for all users. Password aging starts from the day the user is entered into the system. The value can be set from 0 to 365 days. A value of zero disables password aging.

NOTE: *When using password aging and the password expires for a user, the user will be required to change their password before access to the system is permitted. A user can change their password at any time (even if aging is not used) by selecting "Password" from the main security menu.*

The **Log Off Time Period (minutes)** field is a global for all users. The log off time begins once a user logs into the system. If the user does not perform any actions within the specified time, the system will automatically log the user out. User actions are defined as any action that requires a process change, i.e., changing a SP, changing an alarm description, etc. Any field protected by security settings of the MCT4 are user action fields. The log off time can be set from 0 to 1440 minutes (24 hours). A value of zero disables the auto log off feature.

NOTE: *If a user begins an action such as changing a set point, but does not complete the task and leaves the numeric keypad shown, the system will log the user out if the log off time elapses. However, since the keypad is still shown, the set point change can still be completed as the task had already begun. In this case, if a user then enters a new set point, the audit trail will record the change under the user that was previously logged in, but since the user was automatically logged out while the keypad was shown, the user will be required to log in to access the set point again.*

7.4.1 Two-Factor Authentication (2FA)

2FA is an extra layer of security used to make sure that the person trying to gain access to the system is who they say they are. When enabled, the log in process will begin as normal with the user entering their user ID and password. Then, instead of immediately gaining access, they will be required to enter a one-time passcode (OTP) sent to their personal device via text message. Once the code is entered, access will be granted.
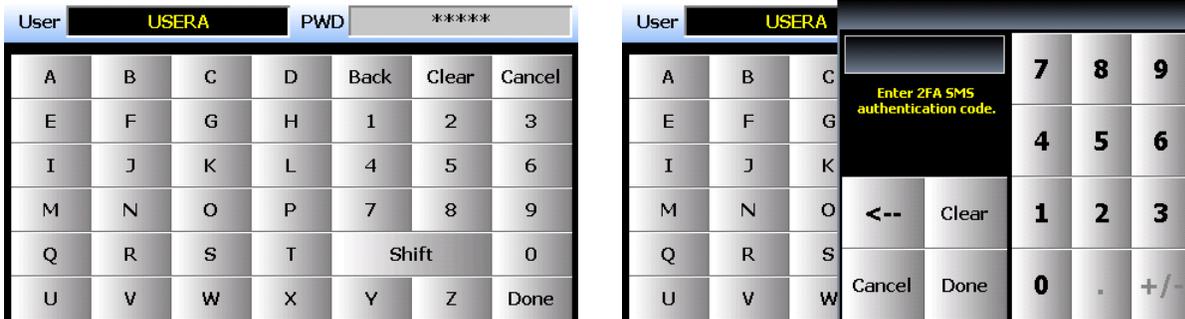
In order to enable 2FA, a USB memory device must first be inserted into the USB port of the MCT4. This USB device then becomes a "security key" for the unit that allows 2FA to be bypassed should internet access be lost. Without internet access, users will be unable to receive the OTP needed to log in. However, by inserting the USB security key into the MCT4's USB port, the OTP is bypassed and the user is able to log in by simply entering their user ID and password.

This USB security key can be used for multiple MCT4's by inserting it into each MCT4 and enabling 2FA from the Security Options screen. If 2FA is already enabled on the MCT4, turning 2FA off and then back on will add the unit's encrypted security key to the USB device. Additional USB security keys can be created, if necessary, by inserting each USB device one at a time, and then turning 2FA off and then back on again.

The USB security key is not associated with any particular user in the system, but with the MCT4 itself. Thus, any user in the system can bypass 2FA when the USB security key is inserted in the MCT4. Therefore, it is recommended that the system administrator retains access to any USB security key created.

NOTE: *Any users entered into the system without a 2FA SMS Number (see section 7.1 Adding Users) will not be required to enter an OTP even if 2FA is enabled. Therefore, users previously entered into the system without the 2FA SMS Number will have to be deleted and re-entered in order to hold them to the 2FA log in requirement.*

7.5 Audit Trail

The audit trail viewer is accessed by selecting "Audit" from the Security menu. It displays all user actions that affected the system for any given day. The MCT4 can store daily audit files for a period of a year or longer (time based on storage usage for data history).

Each time a user takes an action that affect the operation of the system (changing a set point, start/stop data logging, changes an alarm set point, etc.), the action is written to a file. Audit trail file names are listed as MMDDYYYY (where MM = month, DD = day, YYYY = year. The "Open" file button will display a dialog box where the user can select any audit file to view.

NOTE: *If no actions occurred on a given day, an audit file will not be created for that day.*

Each action recorded to the file includes the date/time it occurred as well as the user (if logged in) that made the change. If no user is logged in, the user will be listed as "Device Manager", which is the default user account for the MCT4 system.

The send email icon ✉ allows the user to send a copy of the currently opened audit trail file to any user configured in the MCT4. When the email icon is pressed, an "Add Recipients" window will be displayed where the user can select recipients for the file from any of the email addresses configured under the MCT4 email settings. For information on how to add email recipients to the MCT4, see section 9.8 Email.

The **Disk** icon next to the **Email** icon allows the user to save the currently opened data file to a USB memory device connected to the MCTB.

8   Data Logging

The MCT4 data logging features are accessed via the home 'Data" menu item. The system data logging provides the ability to select individual points for logging, view data log files and start/stop logging operations. The logging ability of MCT4 provides an easy-to-use, convenient method to obtain electronic data without the need for additional data acquisition equipment.

The Data Log menu provides navigation to the following functions:
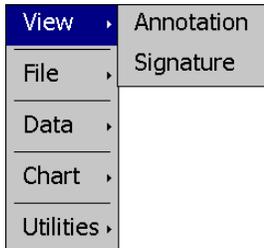
***View** menu*

Annotation: Allows the user to insert a notification into the currently
                        running log file or view all annotations associated with the
                        currently loaded historical data file.
Signature: Allows the user to digitally sign a file to prevent data
                        tampering and view all digital signatures associated with the
                        currently loaded historical data file.
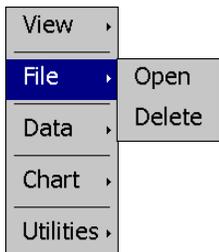
***File** menu*

Open: Opens a history file for review.
Delete: Allows the user to delete the currently loaded history file.

    NOTE: *The "Delete" log file function does not affect data from a
                        file that is running, only the current data log file loaded
                        for review.*
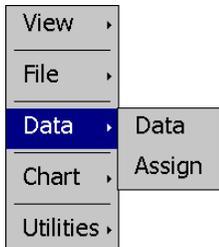
***Data** menu*

Data: Displays main data log screen with status of logger.
Assign: Allows the user to select what variables are to be logged.
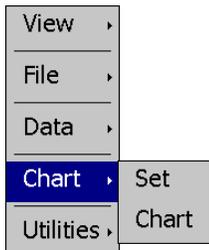
***Chart** menu*

Set: Selection of data file points and time period for history review.
Chart: Plots historical data after time and points are selected.
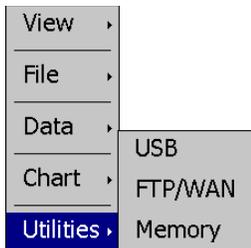
***Utilities** menu*

USB: Allows the user to access file utility functions.
FTP/WAN: Provides access to the automatic file back-up settings.
Memory: Displays memory capacity remaining on MCT4.

8.1 Selecting Points for Logging

In order for the data logging function of the MCT4 to operate, the user must first select what variables are to be logged to the data file. To choose which points are to be logged, select "Assign" from the Data menu.
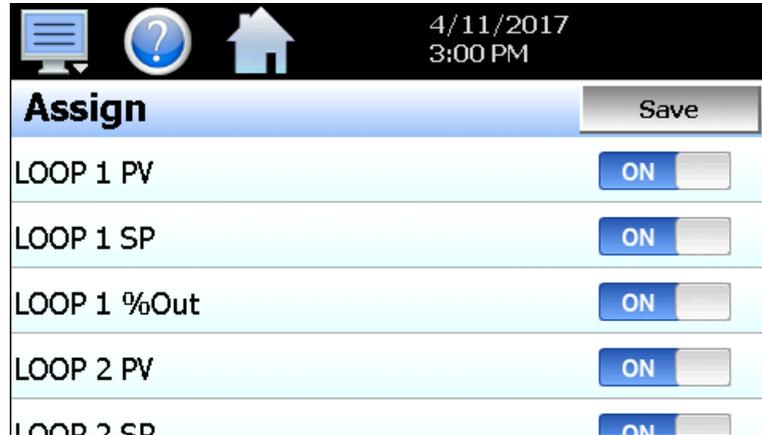
Press the on/off button for each item to toggle it on/off. When on, the variable will be logged to the data file. When selections are completed, press the "Save" button to save the point selection to memory. New selections will not take effect until the Save button is pressed.

8.2 Starting/Stopping Data Logging

The MCT4 logs data to its SD card. Current data for each variable is written to the log at a fixed interval based on the settings entered in the "Length" and "Interval" fields. File names are automatically generated using MMDDYYYY-HHMMSS format (where MM = month, DD= day, YYYY = year, HH = hour, MM = minutes, SS = seconds). To use a specific file name, touch the "File Name" field and enter the desired name (up to 16 characters). When a file name is entered, the file will be saved as FileName_MMDDYYYY-HHMMSS.
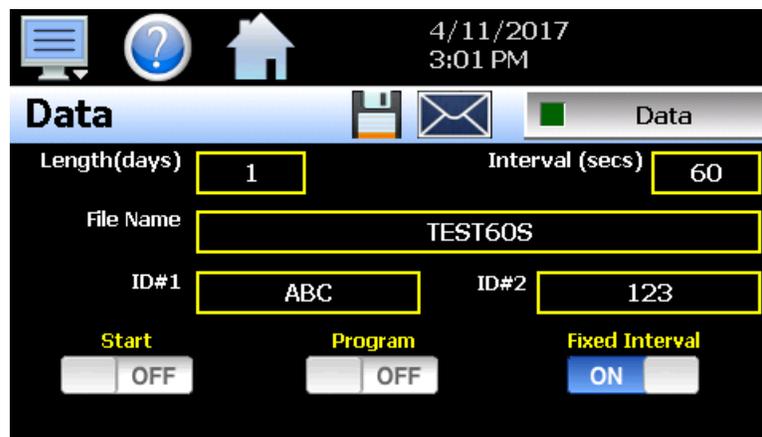
The data logger also provides two entry fields, **ID#1** and **ID#2**, which allow the user to enter in information specific to the file such as a batch and/or lot number to identify product that may be associated with the new data file. These entries will be saved with the data log file for later identification.

The ID#1 and ID#2 fields are also used to identify the MCT4 when DataWeb is active (see section 8.5 FTP/FileWeb/DataWeb Interface). When the DataWeb feature is in use, the ID#1 and/or ID#2 entries are used to identify a specific MCT4 from many units that may be sending data to the same database. The ID#1 and ID#2 fields also allow the user to search for only the data specific to a single unit in the remote database. The entries in these fields should be unique to each MCT4 connected to the server.

If more than one MCT4 utilizes the same entries, the data from all units with the same ID's will be combined under the one ID in the database. This will render the data unusable as there will be no way to split the data between the different units and know which data points are from each unit. If this does occur; however, the MCT4 will still have a local copy of the data stored to the local data log file(s). This provides a backup copy of the data just in case the ID numbers of more than one unit are identical.

The **Length (days)** field sets the length of a data file in number of days. It can be set for 1 to 31 days. Once the selected number of days has elapsed, a new data file will be created and logging will continue in the new file.

The **Interval (secs)** field is used to set the rate at which points are written to the log file which equates to the sample rate in seconds. When the "Fixed Interval" option is turned on, the logging interval will be automatically set to record at minute intervals based on the number of days set for the file. If the file is set for 1 day in length, the logging rate will be at 1-minute intervals. If the file is set for 7 days, then the logging rate will be every 7 minutes. This keeps the data file size manageable and able to be viewed by the MCT4 data viewer.

The log interval can be manually set to any rate between 1 and 1860 seconds in any combination with the number of days before a new file is started. To do this, turn off the "Fixed Interval" option and enter in the desired logging rate in seconds.

NOTE: *Logging at shorter intervals allows the MCT4 to capture fast changing processes, but the data files can become extremely large. Files that exceed the capability of the MCT4 data viewer (>520KB in size) will have to be extracted from the MCT4 using a USB memory stick or FTP file transfer in order to be viewed remotely on a PC.*

Files larger than the 520KB limit will not be automatically, digitally signed by the MCT4. If the files are to be digitally signed, this must be done manually by extracting the files and using the FDC data viewer program running on a remote PC.

To manually start data logging, press the "Data" button. Any time logging is enabled, the indicator on the Data button will be illuminated. To stop data logging, press the Data button again. Data logging can also be started automatically by turning on the "Start" or "Program" option.

The **Start** option automatically turns data logging on whenever the MCT4 is first powered on. This action simulates that of a standard chart recorder.

The **Program** option is a convenient method for gathering information that pertains only to the operation of an automatic ramp/soak program. When selected, the MCT4 will turn the data logger on at the beginning of a program and off once the program is completed. This eliminates the need to scan through extensive data records to find the specific information you are looking for from a particular time period.

NOTE: *The MCT4 will automatically use the program name as the filename for the log file (up to 14 characters). This provides a simple identifier for log files that pertain only to automatic program operation. Any entry made in the File Name field will be ignored.*

The **Email** icon next to the data log on/off button allows the user to select the currently open data file and email the file to any user that has been setup to receive emails from the MCT4.

The **Disk** icon next to the **Email** icon allows the user to save the currently opened data file to a USB memory device connected to the MCT4.

8.2.1   Calculating Log File Size

The MCT4 saves the log file in a text-based format (.csv), so the amount of memory consumed for each reading is dependent upon the number of digits required to accurately display the value (1 byte per character). This optimizes memory usage but also makes calculating an exact file size difficult. To obtain a worst-case approximation of the resultant file size, use the following formula:

   File Size (Bytes) = (64 + LD) * number of readings in the file

      Where:
         LD (loop data) = 7 * number of points selected for logging

Example
MCT4 with three loops of controller data (PV, SP, %Out selected) for each loop (total of nine points). Logging set at one second interval running for a duration of one day.

      LD: 7 * 9 = 63
      number of readings in file: 60 secs/min * 60 mins/hr * 24 hrs/day = 86400

      File Size (Bytes) = (64 + 63) * 86400 = 10,972,800

An MCT4 logging nine points of data at a one second interval will consume a maximum of 11MB of memory per day. With an SD memory card size of 8GB, the MCT4 can log data for approximately two years before the SD memory card is full.

      8GB = 8,000MB (total memory card space) / 11MB (per day) = 727 days (1.9 years)

NOTE: *Available memory space on the SD card is also affected by the number of ramp/soak programs, alarm files and audit trail files that are stored. The quantity and size of these files will reduce the memory space available for logging. Regular file maintenance is recommended in order to ensure adequate space remains available for the logging of data.*

8.3   Reviewing Historical Data

Historical files can be opened and viewed using the historical viewer. In order to view a historical data file, it must first be opened by selecting "Open" from the File menu. Once the file has been opened, the MCT4 can automatically plot the first eight channels of the historical data file or the user can choose to cancel the plot and select which channels should be plotted as well as adjust the specific time period to plot.

NOTE: *The open historical data file list will display up to 650 files. If more than 650 log files are present, the files cannot be shown in the list and the files will have to be exported from the MCT4 in order to view them. This can be done either via USB file utilities (see section 8.4 USB File Transfer) or FTP (see section 8.5 FTP/FileWeb/DataWeb Interface).*

8.3.1   History Plot Setup

The history plot setup allows the user to select any time frame (zoom in/out) from the historical data file as well as select up to six channels of data to plot. To edit the settings for the historical plot, select "Set" from the Chart menu.

Any point from the data file can be selected along with the vertical axis to be used for each channel to be plotted. Select channels from the list by turning them on or off and use the "Left" and "Right" axis buttons to assign the selected item to the left or right axis for the plot range. To adjust the period of time to plot from the data file, press the "Time" button.
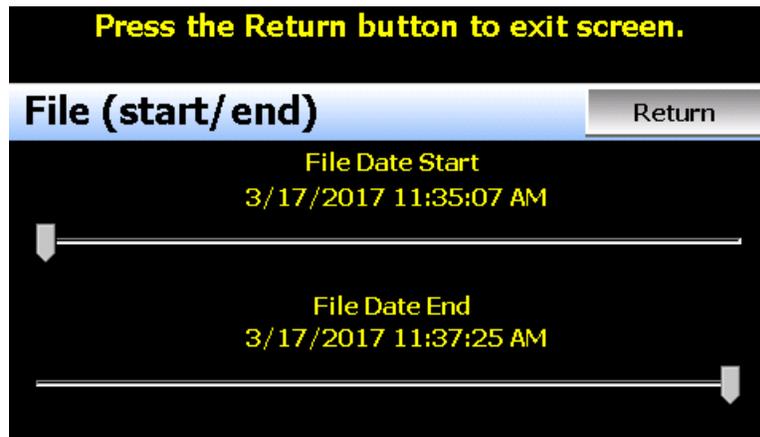
The start and end dates for the currently loaded file will be shown with time in hours, minutes and seconds. The "File Date Start" and "File Date End" sliders are used to select a time span for historical viewing. Once the desired start and end times have been set, press the "Return" button to return to the Chart Settings screen.

8.3.2   Plotting Historical Data

The history Chart plots the data from the currently opened history file according to the selections made under chart setup. If a file has not been opened or data points have not been assigned to a plot, the MCT4 will alert the user to correct the problem. The 'X' and 'Y' axis scales are set to auto scale based on current values for each plot channel so no user action is required.

The historical graph provides the same zoom feature as the real-time charts so the user can zoom in on a particular area of the historical plot by dragging their finger across the screen to draw a rectangle around the desired plot area.
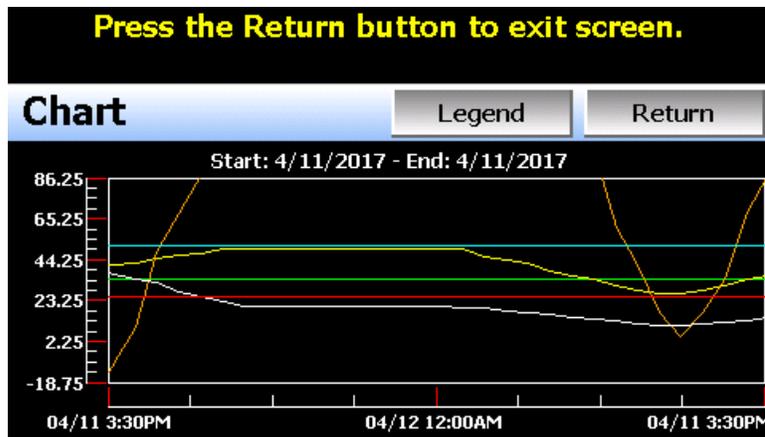
Pressing the "Legend" button will provide the user with channel information by displaying the names of the selected plot channels, which axis they are associated with and the color used to display the plot channel. Pressing the button again will toggle the display back to the historical chart.

NOTE: When pressing the Legend button to toggle between the historical chart and the legend screen, it may take several seconds for the chart to become visible depending on the size of the data file and number of channels selected to plot.

When finished viewing the historical chart, you must press the "Return" button to exit the historical data viewer and return to the main data log screen.

8.4   USB File Transfer

The "Utilities" section of the MCT4 interface provides all the functionality required for retrieving files and maintaining the internal SD memory card. The internal SD card should not be removed from the MCT4 interface. Any change to SD directory structure (moving or deleting files with a PC) may cause the MCT4 interface to stop operating and a new SD card will need to be ordered. Never move or delete the directories unless using the provided MCT4 file utilities functions.

NOTE: *The data log files, programs, alarm log and audit trail directories are saved to the internal SD card (not the USB memory stick device) plugged into the MCT4 interface. Never unplug the SD card when MCT4 is powered up or loss of data may result.*

The USB file transfer screen allows the user to copy or erase files from the internal SD card. Complete file directories for all MCT4 file types can be copied to the USB memory stick and erased from the internal SD card. The current status for file functions is displayed for the operator during copy/delete operations. The MCT4 also allows automatic programs to be imported from the USB memory stick. Programs must be exported from another MCT4 device to the memory stick first, before this function can be used. The MCT4 will look for "Program" directories on the memory stick for import and alert the user if none exist.

NOTE: *All file transfer functions can be used while data logging is running. If the operator needs to back up or delete files from the system, a large number of files could take considerable time to backup and delete from memory. The file transfer screen will be locked during file transfer so plan the timing appropriately when access to other screen functions is not required.*

When data logging is running, the current data log file will not be copied or deleted while using the file transfer functions. This protects the current file and makes sure that the data file is complete before being copied and cannot be deleted from memory while it is still in operation.
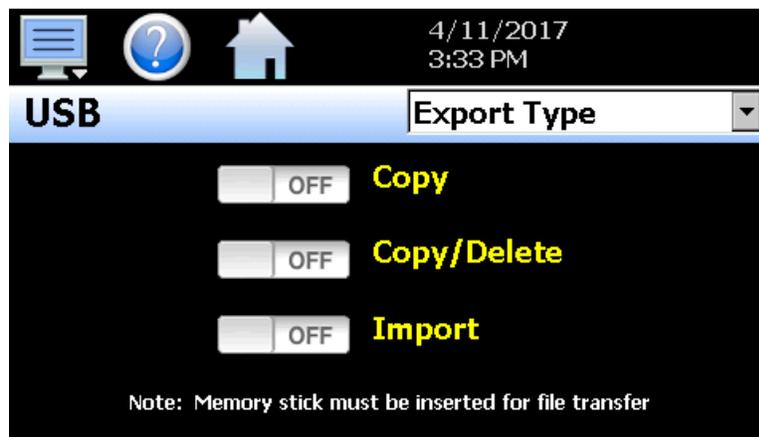
To **Copy** files, insert the USB memory stick into the USB port. Select the file type you wish to copy from the "Export Type" drop down menu. Available file selections are Program, Alarm, Audit and Data files. Once the selection is made, press the "Copy" button. All related files will be copied to the USB memory stick with progress status displayed to user.

To **Copy/Delete** files from internal memory, insert the USB memory stick into the USB port. Select the file type you wish to copy and erase from the MCT4 internal memory by selecting it from the "Export Type" drop down menu. Available file selections are Program files, Alarm files, Audit trail files and Data files. Once the selection is made, press the "Copy/Delete" button. All related files will be copied to the USB memory stick and then deleted from the MCT4 with progress status displayed to user.

The **Import** file function allows automatic ramp/soak program files to be copied from the USB memory device to the MCT4. A dialog box will appear listing the available program directories on the USB memory stick. Program directory names exported from the MCT4 are in the format 'Programs_mm-dd-yyyy-hh-mm-ss'.

NOTE: *The USB memory stick must be inserted into the USB port for any of the file utility operations to function. It is recommended to only use memory sticks certified by Future Design Controls for use with the MCT4. Future Design Controls has tested and validated these memory devices for proper operation and performance.*

Due to manufacturing variations in the USB memory sticks, it may take a few seconds up to 30 seconds for the MCT4 to recognize the device when it is plugged in. Allow sufficient time for the device to be recognized before attempting any file utility operations or the MCT4 will indicate a file transfer/memory stick error.

When files are being copied to the USB storage device, a directory for each file type will be created to store the copied files. The directory structure is as follows:

Program files directory: Programs_mm-dd-yyyy-hh-mm-ss
Alarm files directory: Alarm Files_mm-dd-yyyy-hh-mm-ss
Audit files directory: Audit Files_mm-dd-yyyy-hh-mm-ss
Data files directory   Data Files_mm-dd-yyyy-hh-mm-ss

The purpose for using the date and time as part of the directory name, is to make sure the user can track the date and time of the file transfer. If a user transfers a file type more than once in a single day, the files will be grouped logically by time.

When accessing the data files saved to the USB memory stick, the data files will be in ".csv" format. These files can be opened directly with Microsoft Excel or any program that opens a comma separated file format. You can copy or empty the "Data Files"' directory by simply plugging the USB device into a PC's USB port. The device then becomes like any removable disk attached to the computer and can be manipulated once plugged into the PC.

The FDC Data Viewer program is a free Windows accessory program that allows users to view, plot and print data files and is available from Future Design Controls or any manufacturer that markets the MCT4 product. It is required when using the digital signature feature of MCT4.

IMPORTANT: *Once files are deleted from the MCT4 storage devices, they are gone and cannot be retrieved. DO NOT edit, move or delete any other files from the internal SD memory card unless using the MCT4 file utilities. The MCT4 will not operate properly if the file/directory structure is altered.*

8.4.1   Recommend File Maintenance

A quick note about file storage; data and setup files (programs, data files, alarm log and audit trail files) need some maintenance every now and then. After a period of time, storage devices fill up and files require backup or file deletion when no longer needed. The Microsoft WinCE platform allows for a maximum of 999 files per directory when all the files begin with the same 8 characters. Alarm and audit files are recorded by date (one per day) with the format of MMDDYYYY (where MM = month, DD = day, YYYY = year) so there is essentially no limit to the number of files other than available storage area.

Data log files however, could reach the maximum based on the number of files created per day and if the logging on Program is enabled or a file name is specified by the user. If data logging is manually started or activated on system Startup and only 1 file is created per day, there will be no effective file limit since the first 8 characters of the file name are the date, like that of alarm and audit files.

If a file name is specified or logging on Program operation is enabled, each file will begin with the same prefix. Thus, multiple files can begin with the same 8 characters this limiting the maximum number of files that can be stored. At a frequency of 3 per day, 7 days a week for example, the maximum 999 files would be reached within one year. It is recommended that a quarterly maintenance schedule be adopted to copy and delete all data files from the MCT4 through either the USB file transfer or FTP backup utilities to prevent the maximum file number from being reached.

If the maximum number of files is reached, the MCT4 will display the alarm message "Data file error. SD card full or missing." and data logging will be disabled. Note that there is still sufficient memory space on the SD card; however, due to the maximum number of files being reached, no more files can be placed in the data log folder. Regular backup and removal of files from the MCT4 will prevent this from occurring.

It is also highly recommended to backup and delete alarm and audit files as well. While it is possible to store years of files, the time it will take to copy the files once the time has come, could take hours due to the large number of files. The MCT4 file browser is also limited to a total of 650 files. If the number of alarm files or audit files exceeds the 650 file limit, you will be unable to open and view alarm or audit files on the MCT4. They will have to be exported via USB or FTP in order to be viewed.

More frequent backups will also require less time to perform. The speed at which files can be transferred is more dependent on the number of files than the size of the files. A fewer number of large files takes less time than a large number of small files.

8.5 FTP/FileWeb/DataWeb Interface

The FTP/WAN screen allows the user to configure automatic back-up of all data files contained in the MCT4 memory to a user designated FTP or secure FileWeb site (https://). When enabled, the MCT4 will automatically back up all data log files, alarm files and audit trail files at 2:00AM each day. With the optional delete files selection, the MCT4 will then automatically delete the files from its internal memory after back up. This will maintain MCT4 memory automatically, so that continuous data logging can be performed without filling up the available memory space.

The MCT4 also offers a DataWeb LAN/WAN/Cloud interface. This allows the MCT4 to transfer data directly into a server's data base rather than using file-based data solutions. The DataWeb interface provides the transfer of secure (https://), real time data which can be shared and viewed across networks for real time manufacturing data systems interface.

NOTE: *Setting up an FTP site on your network may require authorization and/or assistance from your network administrator. Contact your network administrator for proper settings and authorization from your network server (if required) to allow the MCT4 to connect to the designated FTP site.*
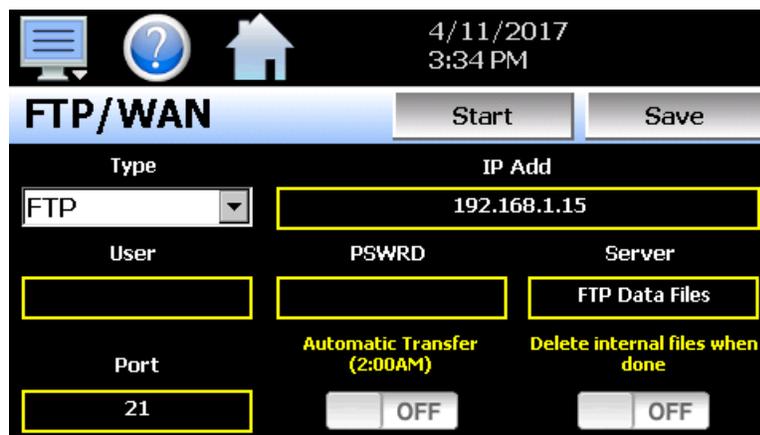
The **Type** drop down is used to select the FTP/WAN interface. Choices are FTP, FileWeb and DataWeb.

The **IP Add** field is used to enter the IP address of the FTP/FileWeb/DataWeb site that MCT4 is to interface with.

The **User** field allows you to enter a user name for site access. When the MCT4 connects to the FTP/FileWeb/DataWeb site, the user name will be used to identify the connection. If a security login is required (FileWeb/DataWeb always require security credentials), the proper user name will have to be entered in this field. If security is not used (FTP only), this field can be left blank (blank for anonymous login using FTP only).

The **PSWRD** (password) field is used in conjunction with the User name field and is for entering a password so the MCT4 can access the site. If security is not used (FTP only), this field can be left blank (blank for anonymous login using FTP only).

The **Server** field is used to enter the directory information where the files are to be backed during FTP/FileWeb operation. This field is not used during DataWeb interface selection. When the connection occurs, the MCT4 will place the historical data files in the "Sever" field directory structure when using FTP/FileWeb interfaces. The MCT4 will automatically create an "Alarms" directory and an "Audit" directory within the specified server directory for backup of the alarm files and audit trail files. The "Sever" field for FTP and FileWeb must match the directory structure setup at the server.

For example, if FTP is used and the "root" path at the server is "Files", in order for the MCT4 files to be transferred to this directory, the "Sever" field must contain the text "Files". If there is a directory inside of the server root "Files" directory named "unit1775" and the files are to be transferred to this directory, the "Server field must contain the text "Files/unit1775". The FTP operation will error and the transfer will not be completed if the "Server" field is not entered properly or does not match the FTP server configuration.

NOTE: *For FileWeb operation, the Server field is optional and can be left blank. It can be used to enter additional directory information (if desired) on where the files are to be stored. By default, the MCT4 is hard coded to store files on the specified server in the "\Files\user name\" directory. If an entry is made in the Server field, the resulting path would be "\Files\user name\server\".*

When the **Automatic Transfer (2:00AM)** option is turned on, the MCT4 will perform an automatic backup of all historical data files, alarm files and audit trail files contained in its internal memory to the designated FTP/FileWeb site. Note that if data logging is currently active, the active file will not be copied. When the **DataWeb** interface is used, real time data is transferred to a database rather than transferring actual files so this option is not used and is disabled.

When the **Delete internal files when done** option is turned on, the MCT4 will delete all data log files, alarm files and audit trail files within its memory after completing the backup to the FTP site. Note that if data logging is currently active, the active file will not be deleted. When the DataWeb interface is used, real time data is transferred to a database rather than transferring actual files so this option is not used and is disabled.

Once all settings have been made, press the "Save" button to save the settings so that on the next power-up, the entries will be maintained. The "Start" button can be used at any time to perform a manual data backup using FTP or FileWeb interfaces. If the files already exist on the FTP/FileWeb site, they will be overwritten on each subsequent backup. If the FTP/FileWeb site is down, or the MCT4 is not connected to the network, a local alarm message on the Alarm screen will indicate a transmission failure.

NOTE: *Typically, FTP/FileWeb Server connections use case sensitive alpha-numeric characters for the User name, Password and Server directory. Contact your network administrator for proper settings.*

8.5.1   More About FTP, FileWeb and DataWeb Interfaces

FTP servers (File Transfer Protocol) have been around for many years and can be installed on local or network machines. The FTP server allows a client (MCT4) to transfer files to the FTP server once installed. This allows for manual and automatic backup of data from the MCT4.

MCT4 Field Setup	FTP Server Setup
Type = FTP	FTP server setup for passive operation (see Appendix section A.2 FTP, FileWeb, DataWeb Requirements/Installation for additional information).
IP Add = xxx.xxx.xxx.xxx	Actual IP address of FTP server
User = userName	Actual user name for login if authentication used.
Password = userPassword	Actual password for login if authentication used.
Server = myFTP	FTP server setup with a root directory named "myFTP". The FTP server directory path must exist and match the MCT4 setup for proper operation. If there is an additional directory within the "myFTP" root directory, its name would be appended to the path. (i.e., myFTP/Files if a "Files" directory inside the myFTP server root directory is the target for transfer).
Port = 21	Port used at MCT4 and open at FTP server.

NOTE: *Make sure proper permissions are set at the FTP server for access/creation of directories and read/write access. Also check root directory structure at Server to identify the actual root that was created for the files since there can be additional layers created by the server and displayed in the path.*

The FileWeb interface allows the MCT4 to transfer its files to a web site for download which can then be viewed using a standard web browser. This interface provides the user the ability to setup a web site to store files for local or global access without installing an FTP server. The MCT4 supports https:// (secure) transfer of files.

MCT4 Field Setup	FileWeb Server Setup
Type = FileWeb	FileWeb server setup (see Appendix section A.2 FTP, FileWeb, DataWeb Requirements/Installation for additional information).
IP Add = https://fdcutil.com/FDDataService.svc	Actual named address of FileWeb server/service.
User = userName	Actual user name for login at FileWeb server (required).
Password = userPassword	Actual password for login at FileWeb server (required).
Server = *optional path*	The FileWeb server/service must be configured with a root "\files\" directory in order to use the MCT4 FileWeb feature. The MCT4 is hard coded to transfer files to the "files" directory in the root of the server. If the Server field also contains an entry (i.e., optionalPath), the resulting path would be "\files*optionalPath*\". If the directory does not exist, it will be created at the server by the MCT4 based on the permissions settings at the server.
Port = not used	

NOTE: *Make sure proper permissions are set at the FileWeb server for access/creation of directories and read/write access. Also check root directory structure at Server to identify the actual root that was created for the files since there can be additional layers created by the server and displayed in the path.*

The DataWeb interface allows the MCT4 to transfer data to a web data base service using MySQL and Microsoft IIS as a web platform. The MCT4 can interface directly to a local or Web data base (Cloud) thereby allowing access to any system globally without any special "client" applications required to view the data. This allows the MCT4 to share data with local or global manufacturing systems by storing data directly to a manufacturing database. The MCT4 supports https:// (secure) transfer of data.

MCT4 Field Setup	DataWeb Server Setup
Type = DataWeb	FileWeb server setup (see Appendix section A.2 FTP, FileWeb, DataWeb Requirements/Installation for additional information).
IP Add = https://fdcutil.com/FDDataService.svc	Actual named address of DataWeb server/service.
User = userName	Actual user name for login at FileWeb server (required). This is the directory where the database structure will reside on the server. The MCT4 will use this directory path for sending data to the database.
Password = userPassword	Actual password for login at DataWeb server (required).
Server = not used	The directory where the database exists uses the userName as the default location for data storage.
Port = not used	
Data logging screen entries: ID#1 = unit specific identifier ID#2 = unit specific identifier (see section 8.2 Starting/Stopping Data Logging)	Used as the unit identifiers by the remote database in order to store the data sent from the MCT4. At least one field must contain an entry and should be unique to any other MCT4's that connect to the same server database.

NOTE: *An IT professional with experience is required for DataWeb server setup. Future Design Controls does not support server-side programming or setup but can offer 3rd party resources to assist with or handle complete server-side projects.*

The DataWeb interface does not transfer complete files for backup like the FTP and FileWeb interfaces. The DataWeb interface transfers records in real time based on the log setup interval at the MCT4. When logging is started at the MCT4, data will begin transfer to the server-side site. Data will be transferred to the server at the beginning of logging (one record) with additional records transferred based on the rate that the MCT4 data log interval is set for.

If the data log interval rate is set for 60 seconds, the MCT4 will populate the database with a single set of records (PV, SP, %Out determined by data log/server setup) once every 60 seconds. If the data log interval rate is set for 120 seconds, the MCT4 will populate the database with a single set of records (PV, SP, %Out determined by data log/server setup) once every 120 seconds. Data log intervals can be set as fast a 1 second since buffering is used at the MCT4 for faster data log rates, but in this case the database would receive a total of 60 records once per minute (one record per second). Buffering for rates faster than 1 minute is used to reduce access/overhead at the server side while still maintaining 1 second date/time stamps for database record keeping.

8.5.2   FileWeb/DataWeb Server Components and Requirements.

While the actual server-side development is more involved than this manual will cover, component overview and installation is covered in section A.2 of the Appendix.

Web Development Support:

Future Design Controls does not support or develop custom server-side web solutions. We can offer 3rd party resources to assist customers in these development requirements.

8.6   FDCUtil.com Web site for FTP, FileWeb and DataWeb Testing

The FDCUtil web site is a Future Design Controls http/https site that allows customers to create a free account and test the FTP, FileWeb and DataWeb interfaces offered on the MCT4. The site automatically deletes files every hour since this is a test site only and cannot be used for permanent web storage of files or data. The site allows customers to fully test and verify that data is being transferred properly from the MCT4 device to the FDCutil site, thereby providing everything needed to test the MCT4 and the Internet connection without requiring additional software or development. This allows the customer to test the interface and pick which type of data transfer is the best for operations.

Access the Web Site and Create an Account:

To create a free account, go to the following link: https://fdcutil.com/FDDataWeb/
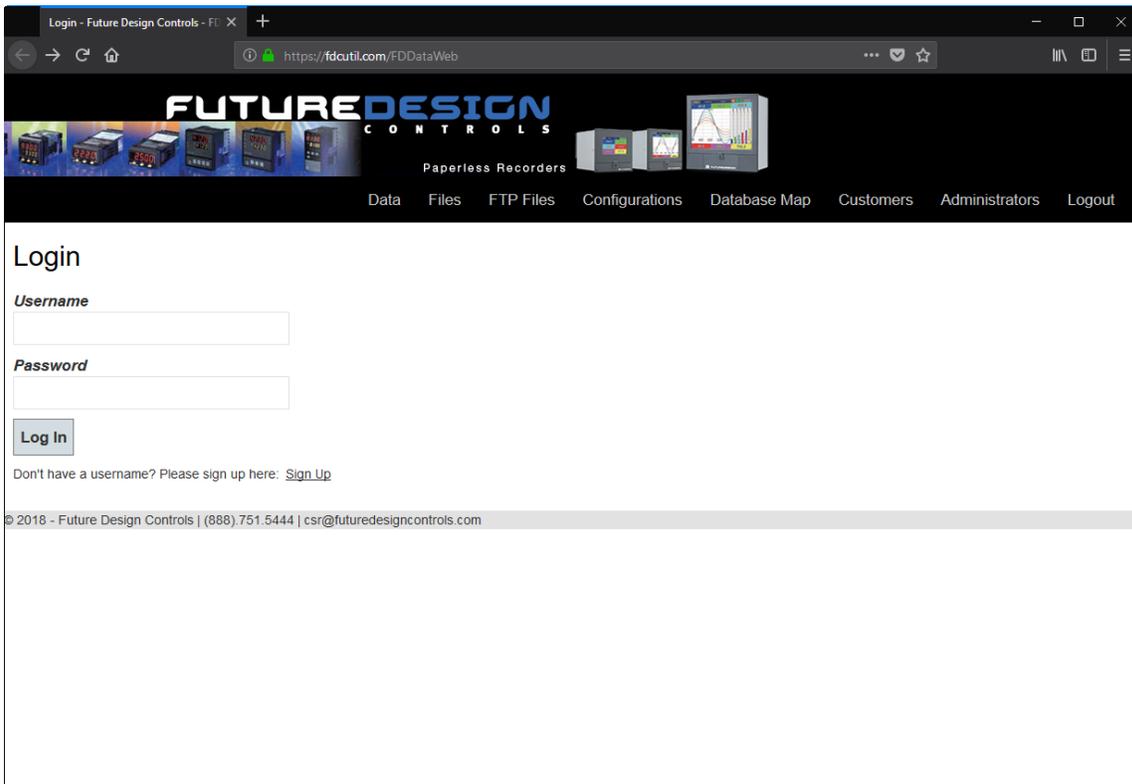
Click on the "Sign Up" link. Enter your name, company name, email address and password. Note that your email address will not be used for solicitation purposes. It is used to send an account verification email. The email sent requires no confirming information; it only verifies that a real user got the email before activating the account. Although FdcUtil.com is a no-charge site, important user data is encrypted for additional protection.
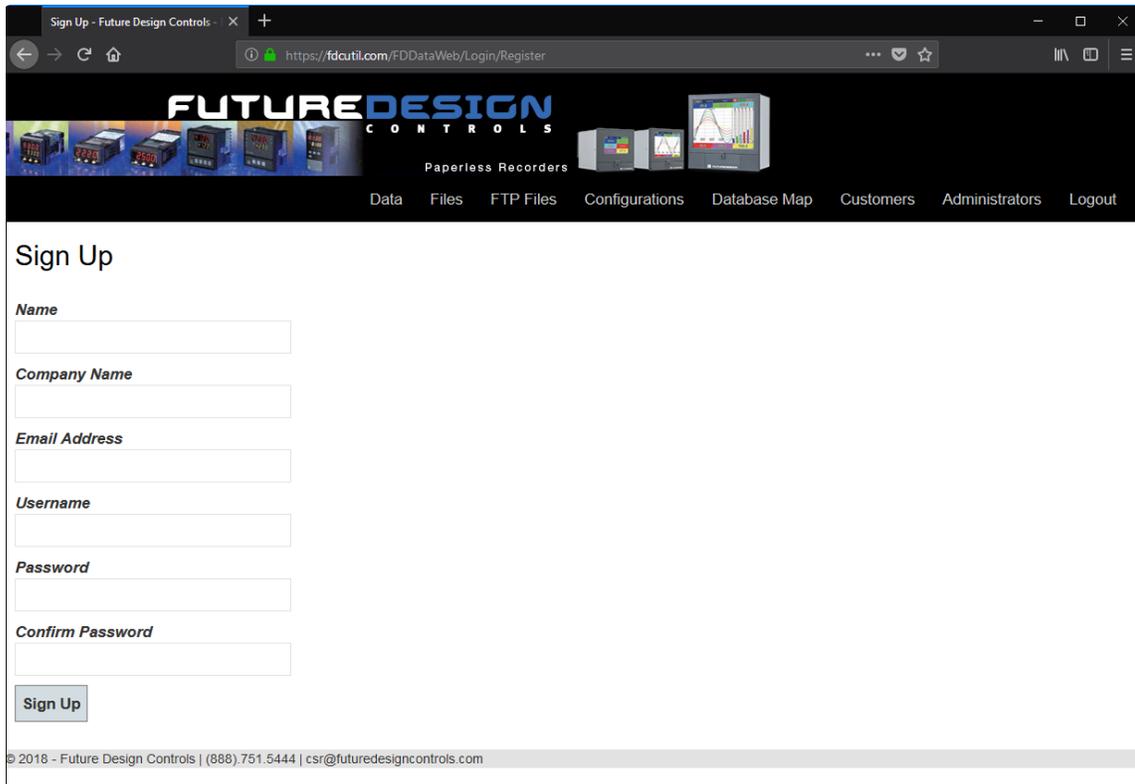
Once you have created and verified your account, you can log in to the website. Once logged in, the main FDCUtil website will be displayed with tabs for Data (DataWeb), Files (FileWeb), FTP Files (FTP) and Configurations. These tabs can be clicked on and will display data after transfer from the MCT device. Every hour, the data will be deleted from each section (except for Configurations) or the data can be manually deleted using the "Delete" link on each page.

FTP Files Page:

The FTP files page, accessible from the "FTP Files" menu item, lists the files in the customer's FTP data directory. These are only the files in the customer's directory, not all uploads. The user can delete the files from this page.
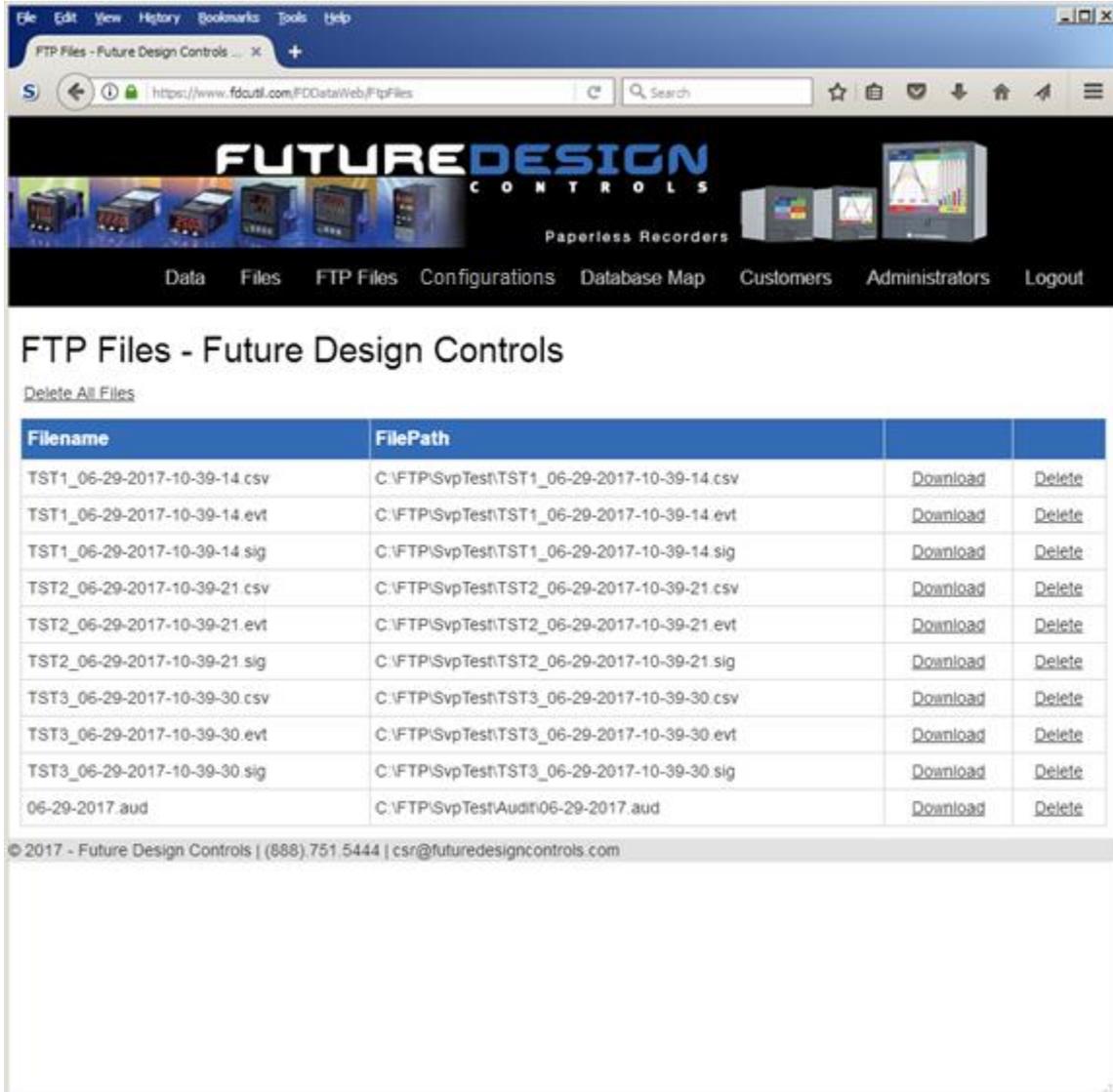
FTP sample setup using FDCutil.com:

To setup the MCT for use with the FDCutil.com FTP server, contact Future Design Controls technical support for FTP access. The FTP section of FDCutil.com is used for tech support (pass/fail) testing only when validation if required at a customer site (customer site not working for some reason). This is due to the user-based security in the FileWeb/DataWeb interfaces not included in the FTP services.

After FTP access is given by FDC technical support, press the "Save" button to complete the setup on the MCT FTP/WAN screen. Press the "Start" button to begin a manual transfer of files from the MCT to the FDCutil.com site. Login to the FDCutil.com site to view the FTP files by pressing on the FTP files link on the page (or press FTP link if already logged into FDCutil.com).

Data Files Page (FileWeb):

The data files page, accessible from the "Files" menu item, lists the files in the customer's data directory. These are only the files in the customer's directory, not all uploads. The user can delete the files from this page.
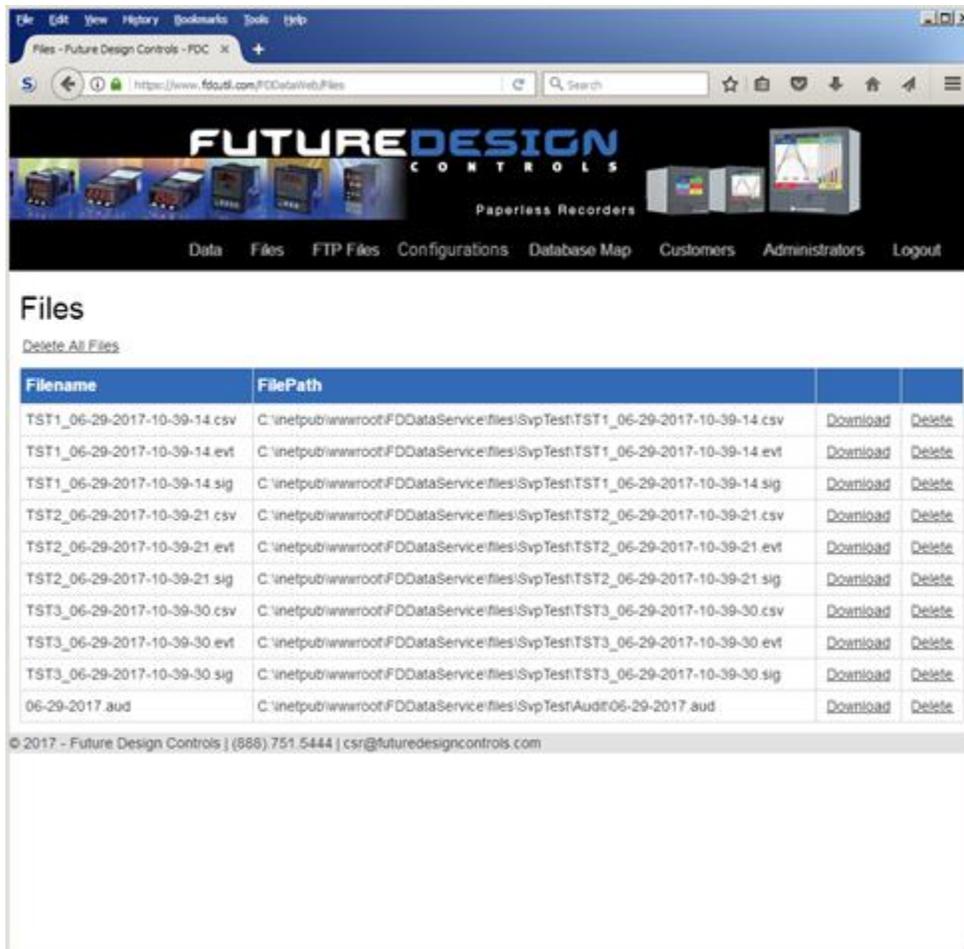
FileWeb sample setup using FDCutil.com:

To setup the MCT4 for use with the FDCutil.com FileWeb server, go to the FTP/WAN screen on the MCT4 and enter the following data into the screen fields. Make sure to replace the "custName" and "custPassword" text below with the actual user name/password entered during the FDCutil.com signup process.

Type = FileWeb
IP Add = https://fdcutil.com/FDDataService.svc
User = custName
Password = custPassword
Server = optional
Port = not used

Press the "Save" button to complete the setup on the MCT4 FTP/WAN screen. Press the "Start" button to begin a manual transfer of files from the MCT4 to the FDCutil.com site. Login to the FDCutil.com site to view the FTP files by pressing on the Files link on the page (or press Files link if already logged into FDCutil.com)

Database Data Page (DataWeb):

Once logged in, the customer will be shown the Data page. If data has been uploaded to the database, the "Device ID" drop-down menu will contain the list of units (according to the ID#1 and/or ID#2 entries as made on the Data logging screen).
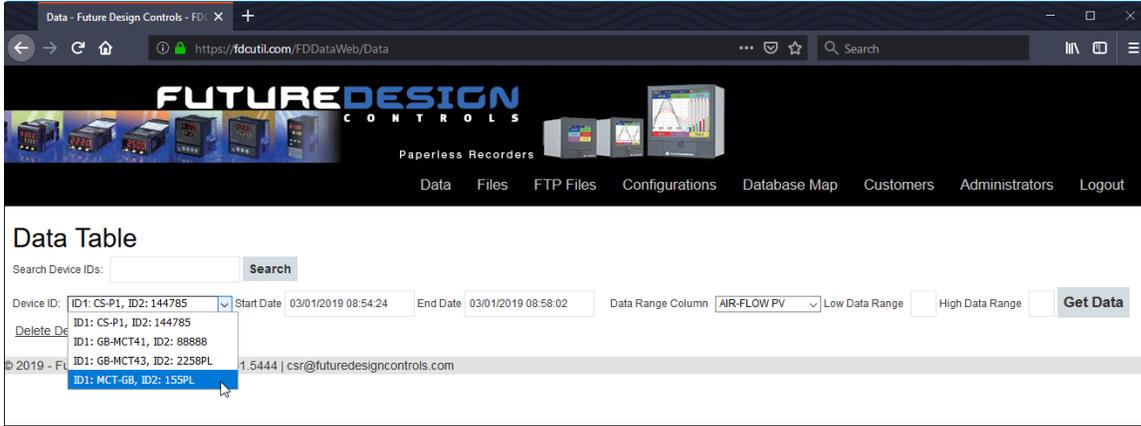
To view the data, select the desired unit from the list and click the "Get Data" button below the Device ID menu. The data available between the Start Date and End Date will be displayed.
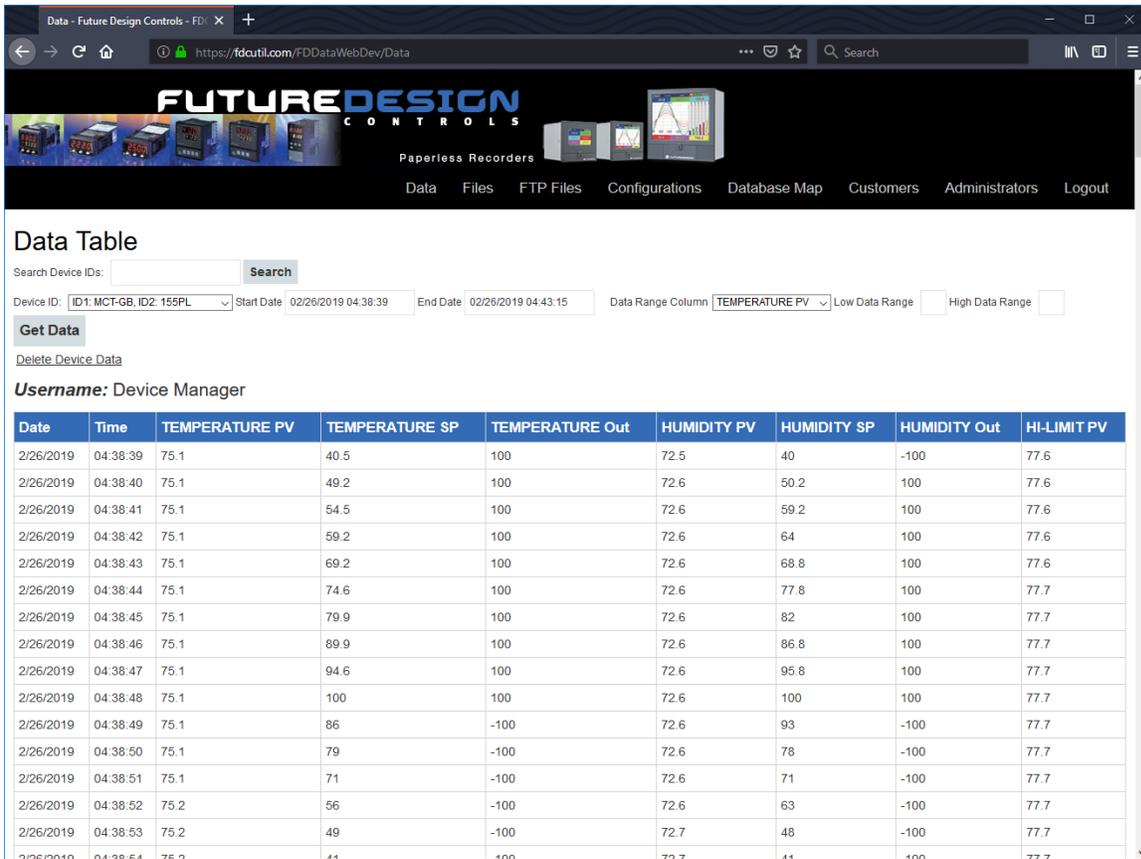
The start and end dates can be altered by simply clicking on the fields to display only data from a specific time frame. When the specified time period is entered, press the Get Data button to refresh the data table. The Data Range Column selection and Low/High Data Range fields can also be used to search for data points that fit within the specified range.

The available data can also be viewed in graph format. Hover the mouse over the Data tab and selections for Trend and Table will be provided.
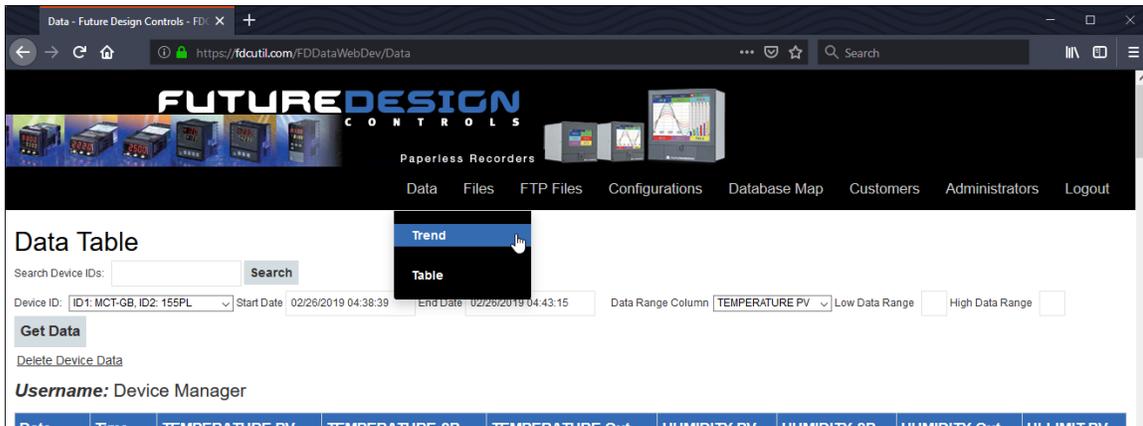
Once Trend is selected, choose the desired unit from the Device ID menu. Place a check next to each available point you want to plot and click the Update Chart button. A trend plot according to the chosen plot points and time range will be displayed along with the corresponding data table below.
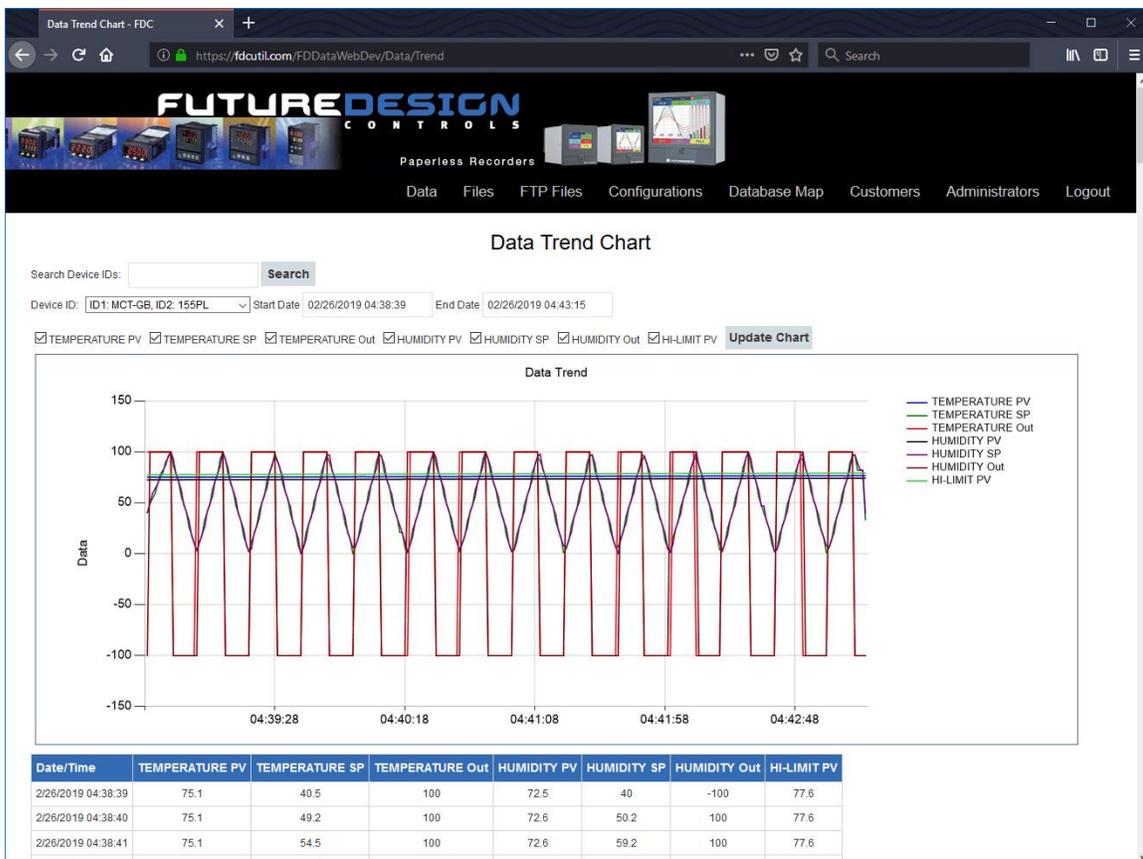
NOTE: *Once you access the Data Table or Data Trend Chart page, the default start and end times are based on the available data at the server. If an MCT4 is actively sending data, you must manually set the end time to a future date so that each time you refresh the page via the Get Data or Update Chart buttons, the page is updated with the latest data sent from the MCT4.*

DataWeb sample setup using FDCutil.com:

To setup the MCT4 for use with the FDCutil.com DataWeb server, go to the FTP/WAN screen on the MCT4 and enter the following data into the screen fields. Make sure to replace the "custName" and "custPassword" text below with the actual user name/password entered during the FDCutil.com signup process.

Type = DataWeb
IP Add = https://fdcutil.com/FDDataService.svc
User = custName
Password = custPassword
Server = empty (no characters)
Port = not used
ID#1 = unique identifier of your choice
ID#2 = unique identifier of your choice

Press the "Save" button to complete the setup on the MCT4 FTP/WAN screen. Next, navigate to the Data logging screen. Make entries in the ID#1 and/or ID#2 fields. These entries should be unique to the MCT4 and not duplicates of any other MCT4 you may have connected to the site. Once logging is started at the MCT4, data will begin transfer to the "Data" section of the server-side site. Data will be transferred to the server at the beginning of logging (one record) with additional records transferred based on the rate that the MCT4 data log interval is set for.

If the data log interval rate is set for 60 seconds, the MCT4 will populate the database with a single set of records (PV, SP, %Out determined by data log/server setup) once every 60 seconds. If the data log interval rate is set for 120 seconds, the MCT4 will populate the database with a single set of records (PV, SP, %Out determined by data log/server setup) once every 120 seconds. Data log intervals can be set as fast a 1 second since buffering is used at the MCT4 for faster data log rates, but in this case the database would receive a total of 60 records in 1 minute (one record per second). Buffering for rates faster than 1 minute is used to reduce access/overhead at the server side while still maintaining 1 second date/time stamps for database record keeping.

8.7 Annotation

The Annotation screen allows the user to add messages to the running data file and view any messages currently associated with a loaded historical data file.
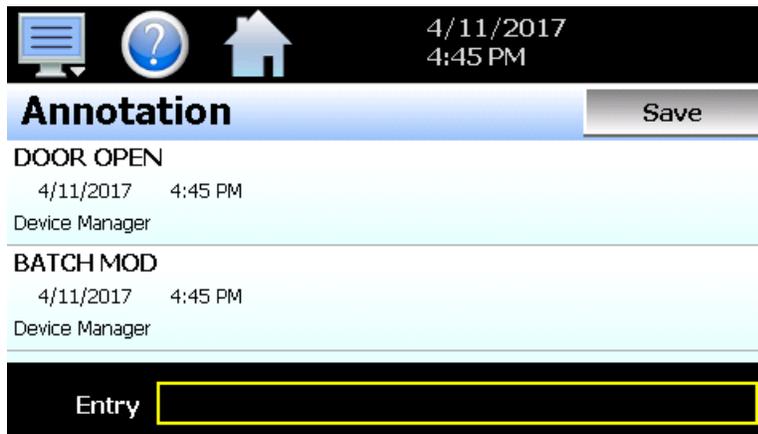
When a historical data file is loaded, the Annotation screen will display any messages that were written to the file. The date, time, user name and description of the data file annotation is shown. Note that the currently running data log file can be opened as a historical data file, and the current annotations for the running file will be shown.

To add an annotation to the running log file, touch the "Entry" field at the bottom of the screen and enter the message (up to 16 characters maximum). Press the "Add" button and the message will be added to the current log file. If the running log file was opened as the historical log file, the annotation will be shown immediately on the screen as it is added. If logging is not currently running, the entry field will be disabled.

8.8   Add\View Digital Signatures

The Signature screen allows the user to add digital signatures to historical data log files and view any digital signatures currently associated with the loaded historical log file.
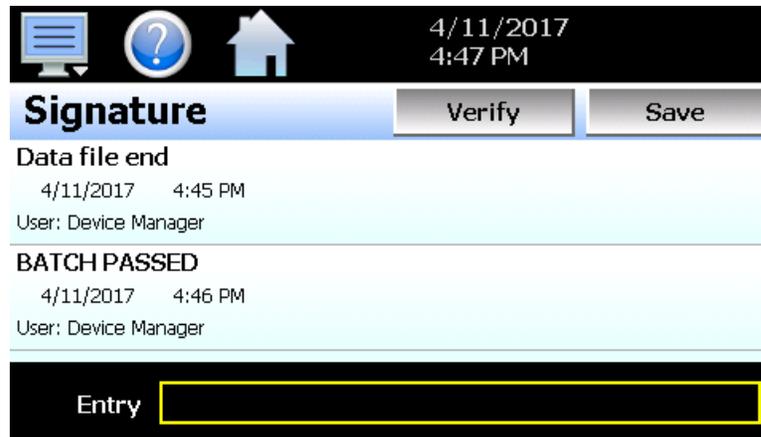
When a historical data file is loaded, the Signature screen will display any signatures currently associated with the file. To verify a digital signature and ensure that the data file has not been altered, touch the signature in the list box and press the "Verify" button. The MCT4 will compare the signature to the log file to see if any alterations to the data have been made. The MCT4 will then indicate if the signature is valid or not.

If the signature is valid, the historical data file is intact and has not been altered. If the signature is invalid, the data has been altered at some time after the signature was assigned to the file. For data integrity, the MCT4 automatically signs a data file when logging is stopped; however, this only occurs if the "Auto Interval" is selected on the Log screen. If a different logging interval is used, the MCT4 will not automatically sign the file and it must be signed by a user.

To add a digital signature to the historical log file, touch the "Entry" field at the bottom of the screen and enter in the comment line for the signature (up to 16 characters maximum). Press the "Add" button and the signature will be added to the log file. The signature includes the date and time of the signature, the user name and comment line. If a user is not logged into the system, the default user name "Device Manager" will be entered as the user.

NOTE: *The Signature screen is not available if security is disabled. The MCT4 security module must be enabled in order to digitally sign data log files (see section 7 Security).*

9   Device Settings

This section covers the use of extended controller features that enhance the functionality of the system. To gain access to the MCT4 setup options, select "Settings" from the home Device menu.

The Device Settings menu provides navigation to the following functions:
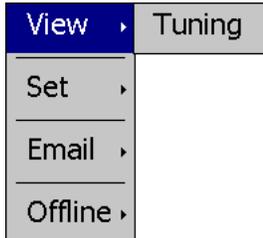
View *menu*
Tuning: Provides access to manual loop tuning.
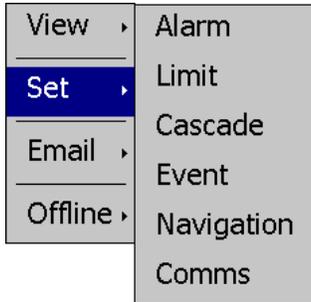
Setup *menu*
Alarm: Provides access to the alarm set points/message entry.
Limit: Sets minimum/maximum set points allowed for each loop.
Cascade: Provides access to the cascade control set points.
Event: Allows the user to edit names used to describe events.
Navigation: Allows the user to choose text based or icon based/slide page navigation menus.
Comms: Allows user to set MCT4 communication settings.
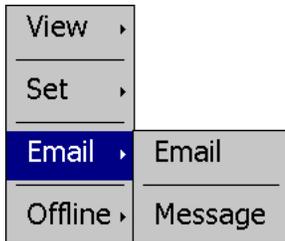
Email *menu*
Email: Provides access to the MCT4 email system manager.
Message: Allows the user to send an email message to users entered in the system.
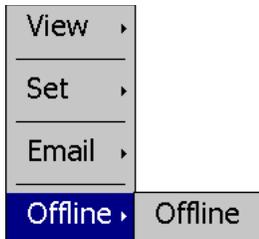
Offline *menu*
Offline: Provides access to offline system settings.

9.1 Tuning

The loop Tuning screen allows for manual and automatic tuning of the MCT4 control loops. Tuning parameters should only be manually adjusted by skilled users familiar with proportional control. Improper settings can result in control loop instability and equipment damage. The loop automatic tune function is the recommended method of loop tuning. If the control response achieved after performing an auto tune does not provide the desired control response, then minor adjustment of the tuning parameters may be done manually to obtain the desired response.
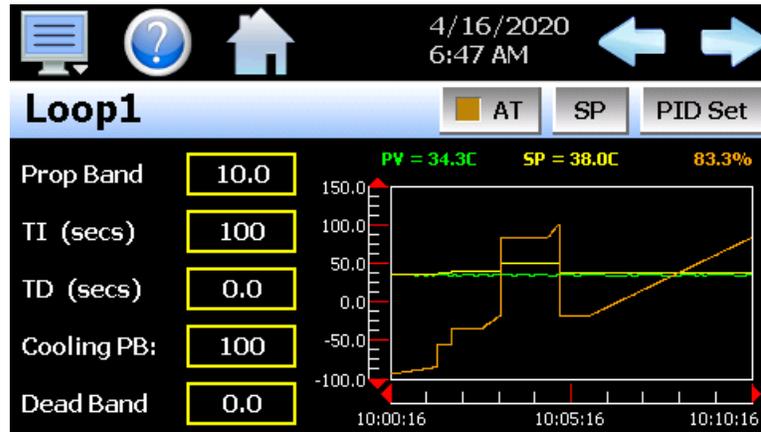
The available tuning parameters are dependent upon the loop configuration. If programmed for heat or cool only control, then the available parameters will be PB (proportional band), TI (integral time period) and TD (derivative time period). If the loop is configured for heat/cool operation then two additional parameters for Cooling PB (cooling proportional band) and Dead Band (heat/cool dead band) will be provided.

The tune screen also provides a live real time chart for monitoring the control response of the control loop while adjusting tuning parameters. The chart is fixed at a 10-minute time period and updates once per second.

Pressing the **SP** button allows the user to adjust the loop set point without having to leave the tuning screen in order to observe the control response.

Pressing the **AT** button allows the user to activate/deactivate the loop auto tuning feature. When auto tune is active, the indicator on the button will be illuminated. In addition, the process value of the loop on the Loop view screen will flash while auto tune is active. This allows the user to activate auto tune and then return to the main Loop view screen to observe system operation while being informed of the loop auto tune status.

NOTE: *The auto tune function does not affect any of the configured PID sets. The auto tune only updates the current PID values currently used in the loop control. If auto tune is being used to determine PID set values for a specific operating range, the values determined by the auto tune function must be manually entered into the proper PID set. They will not be transferred automatically when the auto tune is complete.*

Pressing the **PID Set** button provides access to the loop PID Set Configuration screen that allows multiple PID values to be utilized by the loop at varying process ranges. See section 9.1.3 Configuring PID Sets for more information.

9.1.1 Heat or Cool only P (or PD) Control

When a loop is programmed for heat or cool only control, it is possible to set the integral time to zero in order to eliminate reset action. A "PB Offset" field will then be shown for entering a manual reset value to correct for the control offset that will occur once the loop has stabilized. The offset entry is measured in percent with a range of 0-100%.

Once the process has stabilized, if the process value is lower than the set point by 5° for example, and 20.0 is used for the proportional band, that is equal to an offset of 25%. Thus, the PB offset would be increased by 25% to compensate for the set point offset in the process. Note that automatic tune is disabled for P or PD control. In order to perform an auto tune, the integral time would have to be set to a value greater than zero. P or PD control is not precise for processes with changing load conditions and will require frequent adjustments of the offset. The PID control mode should be used because it automatically does this.

9.1.2   Heat/Cool (Bimodal) Control

When a loop is programmed for heat/cool operation, the values of the Cooling PB and Dead Band affect the way the heat and cool outputs work together to control the process.

The **Cooling PB** is measured in % of the proportional band with a range 50-300. Set cooling PB to 100% to begin and examine the cooling effect. If cooling action should be enhanced then decrease the cooling band. If cooling action is too strong then increase the cooling band. The value of the cooling proportional band is related to the heating proportional band and its value remains unchanged throughout any auto tuning procedures.

NOTE: *The adjustment of the Cooling PB is also related to the cooling media used. When air is used as the cooling media, it is recommended that the Cooling PB be set to 100%. For oil, a typical setting to use for the Cooling PB is 125%. If water is used as the cooling media then adjust the Cooling PB to 250%.*

The adjustment of **Dead Band** is more dependent upon system requirements. If more positive values of dead band (greater dead band) are used, an unwanted cooling action can be avoided but an excessive overshoot may occur. If more negative values of dead band (greater overlap) are used, an excessive overshoot can be minimized but an unwanted cooling action may occur.

Dead band is adjustable in the range of -36.0% to 36.0 % of the heating proportional band. A negative dead band value provides an overlap between heating and cooling action in which both outputs can be active at the same time. A positive dead band value provides a dead band area in which neither output is active around set point.

9.1.3   Configuring PID Sets

The PID Set screen allows the user to assign multiple PID sets to the control loop. Each loop can have up to five PID sets assigned. The default is one PID set. When only one PID set is assigned, the PID entries and activation set point fields are hidden. At least two PID sets must be enabled in order to enter specific PID values and the process value at which they will be used.
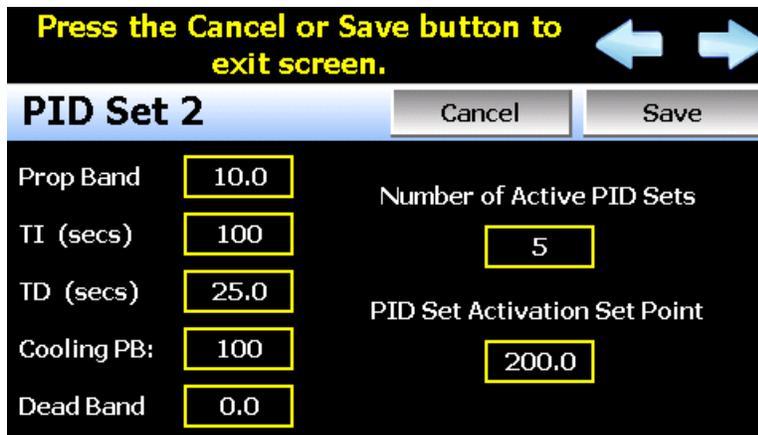
The **Number of Active PID Sets** allows the user to specify how many PID sets to use. When set to a value of one, only the PID values currently set to the loop are used (the values displayed on the Tuning screen). When

set between two and five, the PID set entries are then written to the loop control according to the activation set point and current process value.

The **PID Set Activation Set Point** is the process value above which the PID set is utilized. PID sets two through five have an activation set point. PID set one is the default PID set, so an activation set point is not utilized. Each PID set activation set point must be greater than the previous set point. Thus, as the process value increases, the PID set utilized will increase.

For example, a temperature control loop having the Number of Active PID Sets at a value of three, will result in the loop control using one of three PID sets based on the current temperature. The PID sets will switch according to the activation set points entered for PID set two and PID set three. For this example, PID set two will have an activation set point of 100 degrees and PID set three will have an activation set point of 200 degrees.

Starting with a loop control set point (SP) and process value (PV) of 70 degrees, the loop will use PID set one as both SP and PV are below the activation set points for PID set one and PID set two. In order for the PID set to change to PID set two, both the SP and PV have to rise above the 100 degree activation set point. If the user were to then change the loop SP to 150, the loop continue operation using PID set 1. As the temperature starts to rise, PID set two values will then be written to the loop control once the PV rises above 100 degrees.

The loop will then continue to use PID set two until the SP is changed to a value within another PID set range and the PV also enters that same range. If the user then changes the SP to 200 which matches the activation set point of PID set three, the loop will use PID set two until the PV rises above 200. If the PV does not reach the 200 activation set point, the PID set will not be activated. This prevents PID sets from actively toggling back and forth at the activation point and causing control instability. Once the PV reaches the 200 degree activation point, the PID set would switch to set three. PID set three would then remain in use even if the PV were to drop below 200. Only when both SP and PV are below 200 would the PID set switch back to set two.

During operation, should the set point change span multiple PID sets, the PID sets will be activated as the PV enters each activation range. Continuing from the example above, if the set point is changed back to 70 degrees, it is then in the PID set one range. However, with the PV at 200 degrees, PID set 3 is active. As the temperature starts to decrease and the PV falls below 200 degrees, this will then activate PID set two. The loop will then operate under PID set two. As the temperature continues to fall and drops below the PID set two activation set point of 100 degrees, the loop will then begin operating under PID set one.

NOTE: *As different PID sets are activating, the tuning constants shown on the Tuning screen will change to the active PID set. The tuning constants on the Tuning screen are the actual PID values used by the loop control. Thus, at any time during operation, the user is able to view the values currently in use. Changing any of the values on the tuning screen will result in the loop control using the new value, but will not affect the PID set. The manually entered value will remain in use until another PID set is activated when the corresponding activation set point is met.*

9.2   Alarms

The alarm screen allows the user to edit the alarm set points and alarm messages that will be displayed on the alarm screen should the alarm be activated.
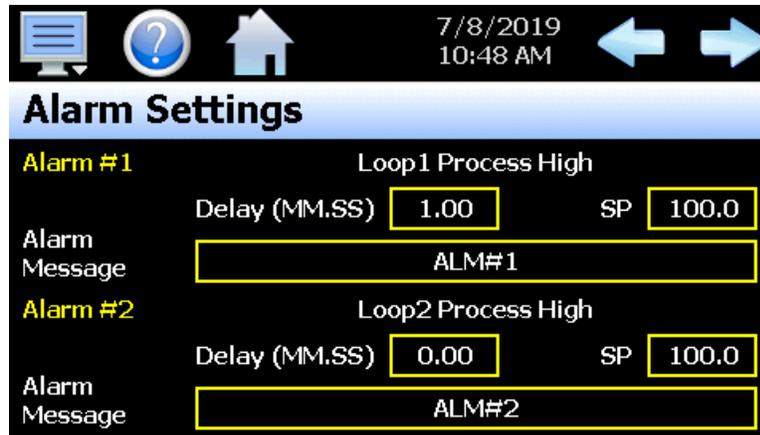
The alarm numbers, **Alarm #**, identify the alarms currently shown on the screen along with the alarm description which contains the loop name that the alarm is assigned to as well as the alarm type. The left and right scroll buttons at the upper right of the screen will be shown if more than two alarms are available so that the user can access each alarm by pressing left or right to go to the previous or next alarm.

The alarm **Delay (MM.SS)** and **SP** (set point) fields allow the user to enter the alarm delay (in minutes and seconds) and the set point at which the alarm is to activate. The alarm type and alarm hysteresis are defined by the OEM in the MCT4 configuration and cannot be changed. Only the alarm delay and set point can be changed by the user.

NOTE: *The End of Program alarm type does not have a set point or alarm delay.*

The **Alarm Message** is the text notification that appears on the Alarm screen when the alarm activates. This message can be edited (up to 25 characters maximum) so that the alarm message more accurately describes what the alarm means.

NOTE: *The MCT4 supports a total of 9 hardware + 10 software alarms for a total of 19 alarms. The MCT4 loop control boards can provide up to 3 alarm outputs each for a total of 9 alarms (when three PCM's used or two PCM's and HLM limit control). Software alarms activate no hardware electrical outputs when energized and are for display only including audible alarm and email operation.*

Depending upon the configuration of the MCT4, some PCM board outputs may perform specific control or event functions. The use of each output, and what it controls, is determined by the system designer. If there are questions or concerns about the configuration and operation of your MCT4 controller, contact your OEM for further information. Only your OEM can address equipment related issues.

9.2.1   Limit Alarms

If the limit option is installed, the high and low limit alarm set points and alarm (output 2) set point will be provided depending upon the configuration of the limit control. All limit alarm set points are locked in addition to system security settings if configured. In order to change a limit-alarm set point, the field must first be unlocked.
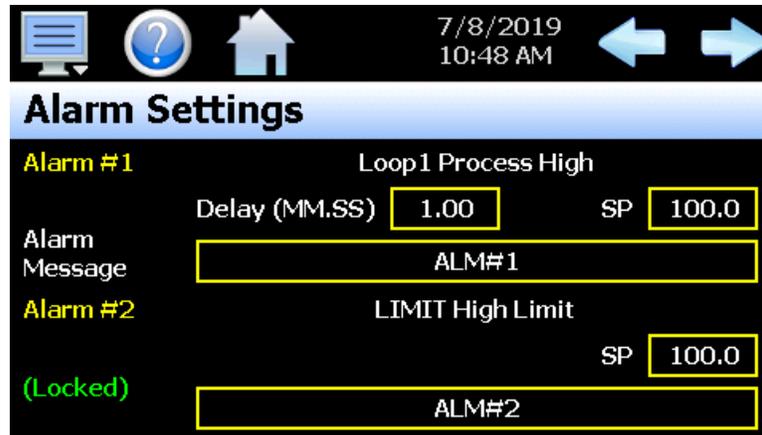
When the alarm is locked, the "Alarm Message" description will be replaced with "(Locked)". Pressing alarm set point entry field will display a dialog indicating that the field is locked. In order to unlock a limit-alarm set point, press and hold the alarm set point field. After approximately 4 seconds, the "(Locked)" descriptor will be replaced with the standard "Alarm Message" text. When this occurs, stop pressing on the screen and the numeric keypad will be shown. A new alarm set point can then be entered.

After a period of 1 minute (if no further edits are made to limit alarm set points) or upon leaving the Alarm screen, the limit set points will automatically be relocked. The process will then have to be repeated to make another change.

9.3 Setpoint Limits

The set point Limit screen allows for the adjustment of the minimum and maximum operating set points allowed to be entered for the control loops. These limits can be used to prevent operators from entering a value that exceeds the survivability limits of equipment or product being manufactured, reducing the risk of property damage.
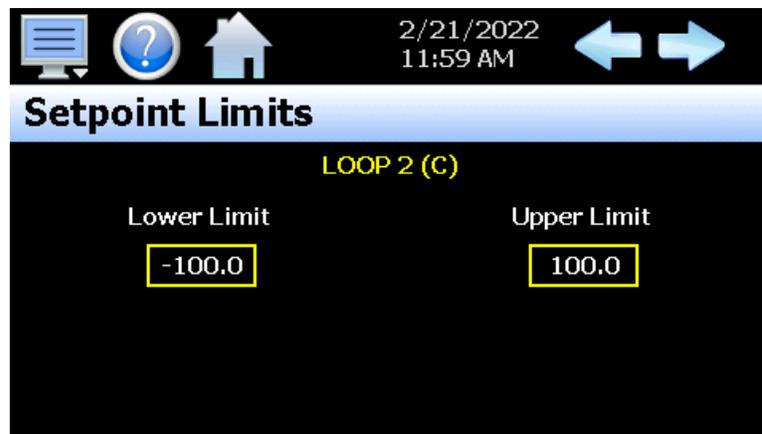
Enter the desired set point limits by touching the "Lower Limit" and "Upper Limit" entry fields and enter the desired values using the numeric keypad.

IMPORTANT: *The operation of automatic ramp/soak programs is limited by the lower and upper limits. If a program was created or imported from another MCT4 system with set points that exceed the current lower and/or upper limits, when the program is run, the program step set points will be coerced to the lower or upper limit that it exceeds. This protects the equipment or product being manufactured from being subjected to values that exceed current set point limits.*

The minimum and maximum values for the lower and upper limits are defined by the OEM limits set in the MCT4 configuration. The MCT4 prevents the user from entering set point limits outside of these configuration values. Consult your OEM or equipment installer regarding the maximum set point limits permitted for your system.

9.3.1   Ramp Rate Limits

When the loop is configured for ramp rate operation, the set point Limit screen will provide fields for the adjustment of the set point rate of change as well as the deviation hold. These limits are used to define the rate at which the set point increases or decreases towards the target set point, as well as when to pause the set point ramp should the process not be able to keep up.
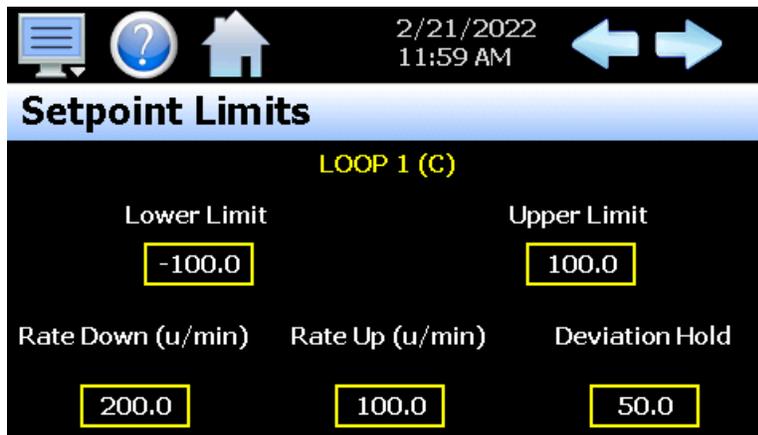
The Rate Down and Rate Up entries allow the user to define the rate at which the set point ramps towards the target set point entered by the user from the current process value. When a new set point is entered, if the set point is below the current process value, the set point will utilize the rate down. When the new set point entered is above the current process value, the set point will ramp according to the rate up entry. The minimum and maximum values allowed to be entered for rate down and rate up are defined for the loop in the Configuration. This allows the user or OEM to define the minimum/maximum rate of change allowed during normal operation.

NOTE: *If a rate down/up entry of 0 is made, the set point change will be made immediate. For example, if the rate down is 0 and a new set point of 10 is entered for the loop and the current process value is 90, the set point will immediately change to 10 with no ramp rate. This allows a loop to be configured for ramp rate operation in the configuration, but also allows the user to bypass ramp rate operation when not required by setting the rate of change to 0.*

The Deviation Hold entry is used to temporarily pause the set point ramp should the process not be able to keep up with the rate of change in set point. When the difference between the set point and process value exceeds the deviation hold entry, the set point will be held at its current value until the process falls back within the band. The set point would then continue ramping according to the corresponding rate of change entry.

9.4   Cascade

The Cascade settings screen allows for the adjustment of the cascade low and high or ratio set point. It is available on systems programmed for the Cascade or Dual Loop + Cascade control type in the Configurator.

NOTE: *The implementation of cascade control and its mode of operation is application specific and determined by the system designer. The MCT4 provides process, deviation and ratio control modes. The cascade control mode is defined by the OEM in the MCT4 configuration. If there are questions or concerns about the configuration and operation of your MCT4 controller, contact your OEM for further information. Only your OEM can address equipment related issues.*

9.4.1 Process Cascade Mode

This mode uses the low and high set points as the upper and lower range for the secondary loop set point. The percentage of output of the primary loop is converted to calculate a linear set point between these two values. The Process Low and Process High values are limited to the minimum and maximum values for the lower and upper set point limits of the secondary loop as defined by the OEM in the MCT4 configuration.

The process mode has the benefit of maximum change rates by allowing the secondary loop set point to go to absolute limits. This allows the process to achieve set point as quickly as possible but does so at the cost of stability. If the process has a large lag time, the control may oscillate uncontrollably once the process reaches set point because of the large overshoot. In most cases, deviation is the recommended selection.

9.4.2 Deviation Cascade Mode

This mode uses the low and high set points as the upper and lower range to generate a set point offset for the secondary loop set point relative to the primary loop set point. The secondary loop set point is calculated by adding these values as offsets from the primary loop set point. As the primary loop set point changes so does the window defined by the set points.

The deviation mode has the benefit of limiting the maximum and minimum overshoot that the secondary loop can exhibit relative to the desired primary loop set point. This allows the system to be fine-tuned to the minimum amount of overshoot required to obtain the desired set point.

9.4.3 Ratio Cascade Mode

This mode provides a single set point which is used to calculate the secondary loop set point according to the primary loop process value. This is typically use din blending applications where the flow rate of the primary fluid is monitored and controlled via the primary loop, and the secondary loop is to add a fractional amount of another substance to the mix.

As the primary flow changes, the secondary loop set point will adjust according to the ratio multiplier in order to maintain the proper mixture.

9.5 Event Names

The Event names screen allows the user to change the names of the system events in order to describe what function they perform. The event names are limited to nine alphanumeric characters.
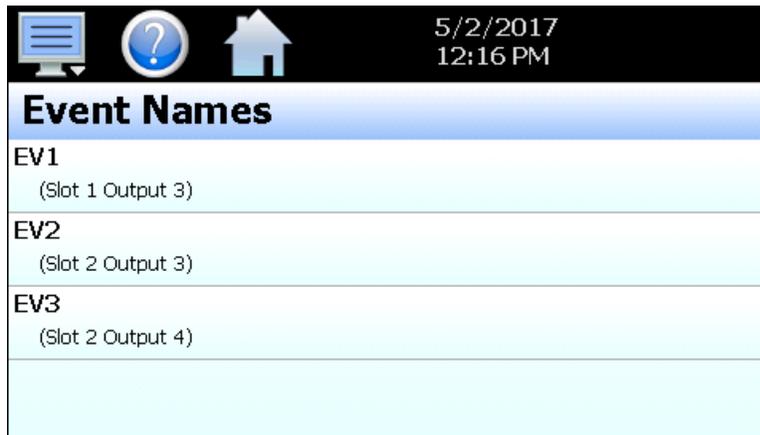
To change the name of the event, select the event by touching its current tag name in the list. Press the "Edit" button and enter the new tag name using the alpha-numeric keypad and press "Done" when finished. The new name will then appear in the event name list box and will be used throughout all MCT4 screens wherever the event is shown.

9.6 Navigation

The MCT4 provides both text-based PC style menus and icon-based slide page navigation menus similar to today's "smart" devices. The user can select either type at any time from the Navigation screen. Press the button for the desired menu type to make the selection. The choices are mutually exclusive, so when one selection is made, the other will be de-selected. The button indicator for the active selection will illuminate to show the current selection.
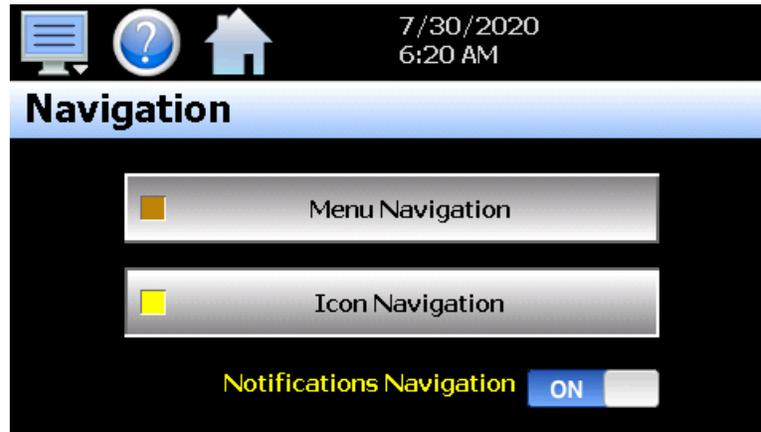
The **Notifications Navigation** selection allows the user to enable/disable navigation from the notifications window. When enabled and the user presses a row in the notifications window, the screen associated with the item in the selected row will be shown.

Depending upon the system configuration, selections can include:

- Loop, limit, monitor point and math results display the Startup screen selected in the configuration.
- Automatic program status including name of running program displays the program Entry screen.
- Active alarm status including the most recent alarm displays the main Alarm screen.
- Data logging status including active file name, length and logging rate display the Data Log screen.
- Security status will display the Security settings screen if the current user has access.
- The current User displays the Log In screen or Log Off prompt if security is active.
- Audit trail active/inactive status displays the Audit Trail screen.
- Web server active/inactive status displays the Communication settings screen.
- VNC server active/inactive status displays the Communication settings screen.
- MCT4 IP address displays the Communication settings screen if enabled in the configuration.
- Available SD storage memory remaining displays the current memory status.

9.7   Communication Settings

The "Comms" screen provides settings for the Modbus serial and TCP interfaces as well as the web server and VNC interfaces. It also provides the MCT4 IP address, which is required for using the Modbus TCP, VNC and web server interfaces. For more information regarding the use of the MCT4 data communications interfaces, see section 11 Communications.

The **Modbus Address and Parity** settings are used to configure the serial interface for user communications. Valid addresses are 1 to 247. The parity setting allows the serial port to be set for Even, Odd or no parity (None).

The Modbus Address is also used to specify the unit ID for Modbus TCP communications. Modbus TCP communications is provided over the Ethernet interface on port 502.

The **VNC Address and Password** set access rights to the MCT4 VNC server. Valid addresses are from 0 to 255. The VNC password selection defines the connection mode for the server. The selections are "None" and "VncAuth" which requires users to enter the password when connecting to the MCT4 over the VNC interface.

IMPORTANT: *When multiple MCT4 controllers are connected to a single router (DHCP server), it is imperative that each MCT4 have a different VNC address. If multiple MCT4 controllers have the same VNC address, network errors may result causing the VNC server to shut down or cause the MCT4 to "lock-up" and become non-responsive requiring the unit to be power cycled in order to return to normal operation.*

The **VNC Device Name** field is used to enter a name (up to 35 characters) that can better identify the MCT4 to users logged into the VNC interface. The name entered here will be used on the VNC header window on a PC, so that if multiple VNC clients are open to different systems, each one can be identified.

The **VNC Password** field is used to enter the password (up to 20 characters) that a user must enter for the VNC interface to connect to MCT4 if the VNC password is enabled.

The **IP Address** field is a static field that provides the IP address of the MCT4 which is required for connecting over the VNC, web and Modbus TCP server interfaces. See the following section 9.7.1 Ethernet Settings for more information on how to adjust the device IP and other LAN information.

The **Www.** (web server) pushbutton is used to enable or disable the web server interface.

The **VNC** server pushbutton is used to enable or disable the VNC server interface.

The **Ethernet** button is used to access the Ethernet settings screen.

NOTE: *Any changes made to the above settings must be saved in order for them to take effect. When changes are completed, press the "Save" button. In order for any changes to the VNC server to take effect, power must also be cycled to the MCT4. The new VNC settings will only take effect when MCT4 first boots up. Serial communication and web server settings take effect immediately upon save.*

9.7.1   Ethernet Settings

The "Ethernet" screen provides settings for the network interface of the MCT4. It is accessed by pressing the Ethernet button on the Communications screen.
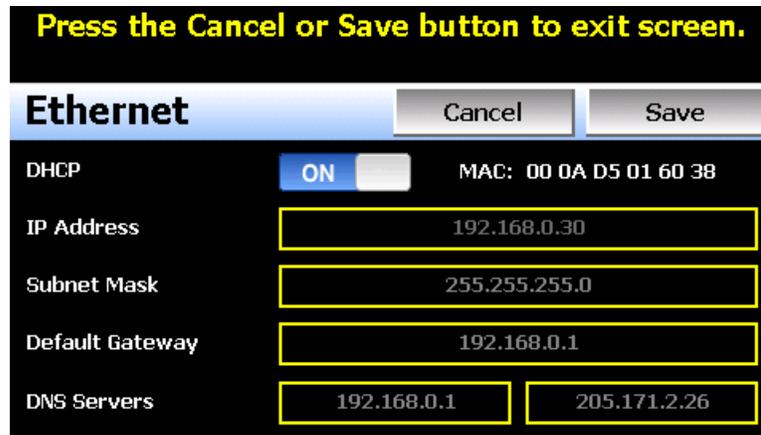
The **MAC** address field displays the media access control address (physical address) of the MCT4. This is a unique identifier for the network hardware of the MCT4 and cannot be changed. It is for informational purposes and may be required by your network administrator when connecting the MCT4 to your network.

The **DHCP** button is used to turn automatic addressing on and off. By default, the MCT4 is shipped with the DHCP setting on. This means the MCT4 will be assigned an IP address by the network router. When on, the entry fields will be disabled, but will display current connection information used by the MCT4. In order to enter a static address, press the button to turn it off.

To set the static network address, enter a valid **IP Address**, **Subnet Mask** and **Default Gateway**. The **DNS Servers** are not required, but typically the IP address of the network router is entered to provide one. Consult your network administrator for the proper values. The IP address must not be a duplicate of any other address on the network or the interface will not operate correctly. The entry fields except IPV4 addressing format only. The MCT4 does not except IPV6 addressing.

NOTE: *When DHCP is on and the MCT4 is disconnected from the network, the entry fields on the Ethernet screen will continue to display connection information based on its last valid connection for diagnostic purposes. The IP address on the main Communications screen (or shown in the notifications list) always displays the current address used by the MCT4. If the IP address on the Communications screen displays the loop-back address of "127.0.0.1" then no connection is present.*

When DHCP is off, the IP address on the Communications screen will always display the user entered static IP address regardless of connection status. It does not indicate whether a valid network connection is present or not.

9.8 Email

The MCT4 email server has the ability to send alarm messages to email and SMS addresses. Up to 30 addresses can be programmed into the system. Each one can be configured to receive emails, SMS text messages or both. When an alarm occurs, MCT4 will send an alert to the specified address for each user in the list. The email settings are accessed by selecting "Email" from the setup "Email" menu.

9.8.1 Email Address Entry

Select the "New" tab to add new email addresses to the system. For each entry, enter the recipient's Name, Email Address and/or SMS Number (up to 50 characters each). Turn on the Email Alarm and/or SMS Alarm options to specify which addresses the alarm messages are to be sent to. Press the "Create" button to add the user to the list.
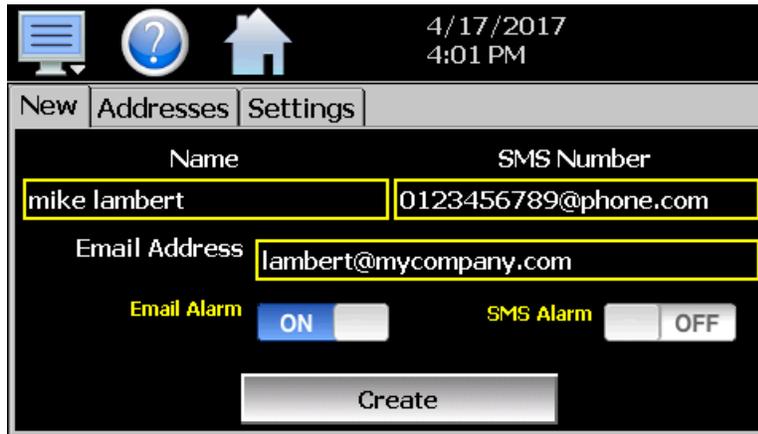
NOTE: *The SMS address is specific to the service provider. Each service provider has their own unique address; however, the phone number is always the "name" for the address entry. There are internet sites with this information that cover most of the providers, or when in doubt, contact your service provider for the proper address format.*

9.8.2 Email Addresses

Selecting the "Addresses" tab allows the user to view the list of email addresses entered in the MCT4. Each entry will be shown with the notification method and address associated with it (email/SMS). To delete a user, touch the name of the user in the list box and press the "Delete" button. This will permanently remove the user from the list.
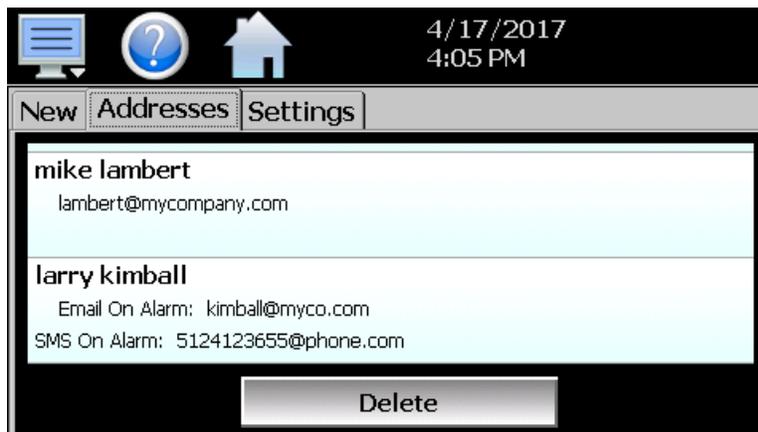
9.8.3 Email Settings

The "Settings" tab provides access to the email server configuration, which is how the MCT4 is able to connect and send email messages over its Ethernet connection. Each field may have up to 50 characters.
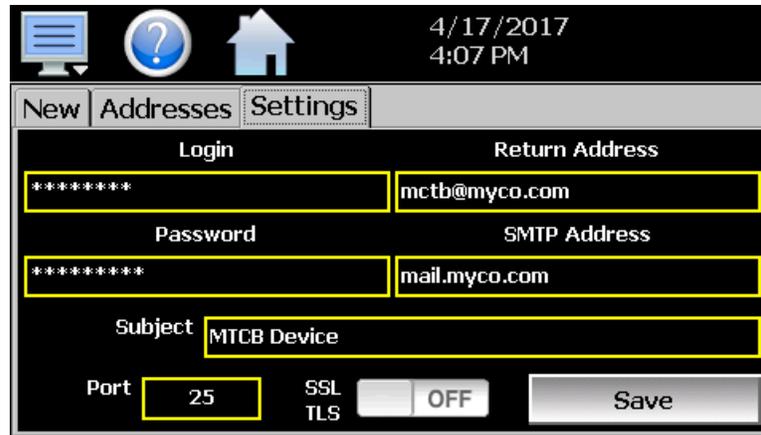
The **Login** field is used to enter the login name required by the MCT4 to log in to your company's mail server. You can use your login if one is not set up specifically for the MCT4 on your network. Contact your network administrator for assistance.

The **Return Address** is the address given for the MCT4 on your company's mail server. The MCT4 does not accept email messages; however, this field is required for proper email delivery for security/anti-spam purposes. If using your personal login name, you can also use your personal email address if one is not set up specifically for the MCT4 on your network. Contact your network administrator for assistance.

The **Password** field is used for entering a password, if required by your network server, to send email. Contact your system administrator for assistance.

This **SMTP Address** field is for entering the address of the email server used for sending emails. This must be a valid mail server for which the above settings allow MCT4 access. Contact your system administrator for assistance.

This **Subject** field is used to enter a subject line for emails and/or SMS text messages. It can be used to provide an identifier to the recipients of the alarm message to know which chamber it is coming from.

NOTE: *It is recommended to put some form of entry in this field. It can be left blank; however, many firewalls and spam filters will filter out messages without subject lines. That may prevent recipients from receiving the email. It can also be useful for identifying a particular unit on the factory floor.*

The **Port** field is used to set the port number that will be used on the device for email operations. For non-secure connections (no SSL/TLS) port 25 is the default. If SSL/TLS is used, port 587 is usually the standard port selected.

The **SSL/TLS** button is used to enable or disable Secure Socket Layer (SSL) and Transport Security Layer (TLS) functionality. These protocols are used to provide an authenticated connection between servers and clients as well as encrypt information between the two. This provides a more secure environment for email information with many public email services only allowing SSL/TLS connectivity.

NOTE: *The MCT4 (client) uses the explicit mode of securing the connection to the mail server. This typically uses the same port as clear text (unsecured) which is usually port 25 or port 587. In this mode, the*

MCT4 will connect to the mail server, then request a secure connection. Once the secure connection has been established, the MCT4 will transmit the email over the secured connection.

The MCT4 does not support the implicit mode of securing the connection which is typically done over port 465. Common services (Gmail for example), by default use the implicit mode of securing the connection. This model assumes that the link is secure from the start, and all communication is done using secure protocols.

The MCT4 can connect to the Gmail SMTP server, but in order to do so you must specify port 587 instead of port 465. You must also adjust the security settings of the Google account to which the login/password is associated with to allow "less secure app access". This does not make the account less secure. It simply allows the MCT4 to connect to the Gmail server over an open connection, and then establish a secure connection.

Once all settings have been made, be sure to press the "Save" button to begin using the new values and store them, so that on the next power up, the settings will be retained. The body of the email/SMS text message will contain the description of the alarm condition as it would appear on the alarm screen. If the mail server is down, or the MCT4 is not connected to the network, the message will not be sent and a local alarm message on the Alarm screen will indicate a transmission failure.

9.8.4   Email Message

MCT4 provides the user with the ability to send short email messages to users configured in the MCT4 email server. To send a message, select "Message" from the device settings, Email menu.

Press the "Compose" button to create a brief message using the keypad (up to 100 characters). When you are finished entering the message, press the "Done" button. The completed message will then be shown in the message window. Press the "Send" button to select the email recipients you wish to receive the message and send the message.

10 Offline

The Offline settings do not include the OEM setup of the MCT4. Refer to the documentation provided by your OEM regarding the MCT4 configuration. In order to enter offline setup, automated ramp/soak program operation and data logging must be manually stopped.

NOTE: Upon entering offline setup, all loop control outputs, event outputs and alarm outputs will be set to their corresponding OFF state. Power supply and retransmission outputs will continue to operate normally. Upon returning to the online mode, the outputs will be returned to normal operation. Limit outputs are not affected.

The offline menu provides navigation to the following functions:
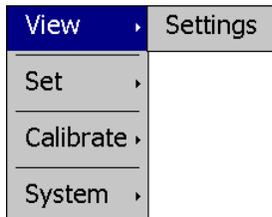
View *menu*
Settings: Navigation back to the device settings menu.
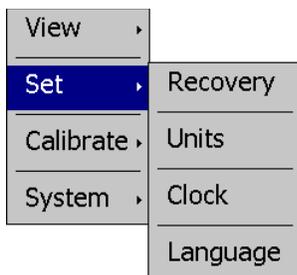
Set *menu*
Recovery: Settings for profile power recovery action.
Units: Setting for temperature units.
Clock: Settings for system date and time
Language: Settings for menu and help language text.
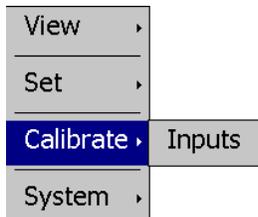
Calibrate *menu*
Offset: Settings for loop input offset calibration.
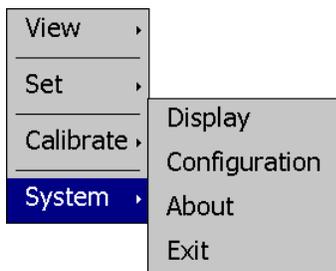
System *menu*
Display: Access to display calibration and backlight settings.
Configuration: Access to MCT4 import/export utility.
About: View current firmware/software version numbers.
Exit: Exit MCT4 application and access to the
                        MCT4 configurator.

10.1 Power Recovery

The Power Recovery setting allows the user to select how the system should restart in the event of a power failure while an automatic ramp/soak program was running. When power is restored, the MCT4 will perform the selected recovery action. To set the power recovery action, push the recovery mode button for the desired setting to select it as the power-up state. The selections are mutually exclusive to one another, i.e., only one can be selected at a time. As a new selection is made, the previous setting will be automatically turned off.
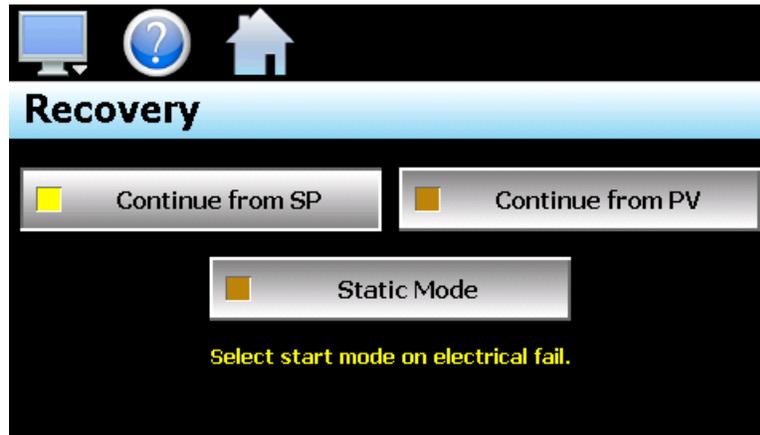
Select **Continue from SP** to have the MCT4 resume the program from where it left off on loss of power. The set point ramp will continue from the set point value at the time of power interruption.

Select **Continue from PV** to have the MCT4 resume the program from where it left off on loss of power. The set point ramp will continue from the current process value of the loop and not the last set point value.

Select **Static Mode** to have the MCT4 default to single set point operation on power-up. The program will be stopped and the loops will control to the last static set point entry.

NOTE: *When a program is NOT running and a power down/up sequence occurs, the MCT4 will return with the same set points and system events active as when the power was lost.*

   See Appendix section A.3 Profile Recovery Detail for a more detailed explanation and examples of program recovery operation.

10.1.1   Recovery Interval

During program operation, the current program progress is stored in memory on each step change and at 5-minute intervals during step operation. During static set point operation, the current control set point and events are stored to memory within 15 seconds after a change is made.

For program operation, this results in a possible recovery error of up to 5 minutes. For example, a program is running and enters step 2 which is a ramp step from 0 to 100 degrees in 10 minutes. If power is lost at 4 minutes into the step and "Continue from SP" is the selected recovery mode, when power is restored the program will begin operation from the beginning of step 2 with a set point of 0. It will not resume operation from 50 degrees at 4 minutes into the step.

If the power is lost at 8 minutes into the step (2 minutes remaining), the program will continue from the last save point which was 5 minutes into the step (5 minutes remaining) with a set point of 50 degrees. For soak steps the set point remains a constant and time remaining is the only variable. So as with the ramp step, the time remaining in the step will continue from the last save point.

10.2 Degrees C/F Units Selection

The MCT4 can display temperatures in either degrees Centigrade or Fahrenheit. To change the temperature display units, select "Units" from the offline Set menu.
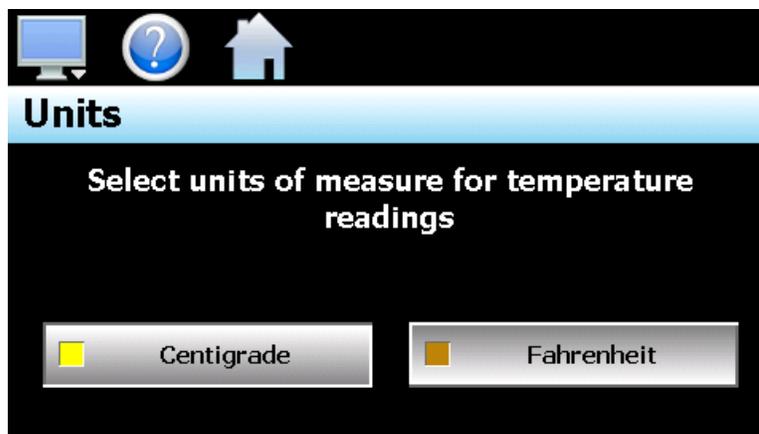
Press the button for the desired temperature units to make the selection. The choices are mutually exclusive so when one selection is made, the other will be de-selected.

NOTE: *When changing display units, ramp/soak program set points will not be converted between units. Separate programs are required for each temperature range. Operating the MCT4 with programs that have been written using alternate units could cause property damage or personal injury.*

10.3 Clock Settings

The system date and time is adjusted from the "Adjust Time" tab under the Set/Clock menu. The current date and time will be displayed in the thumb wheels as shown below.

To make adjustments, scroll each time wheel to adjust the month, day, year, hour, minutes, seconds and AM/PM selection. Once all adjustments have been made, press the "Save" button to set the system clock to the date and time entered.

10.3.1 Time Options

Select the "Time Options" tab to configure the time zone and national time server clock settings. If the MCT4 is connected to the internet, these settings can be used to have the MCT4 automatically synchronize its time with one of the nationally provided time servers.
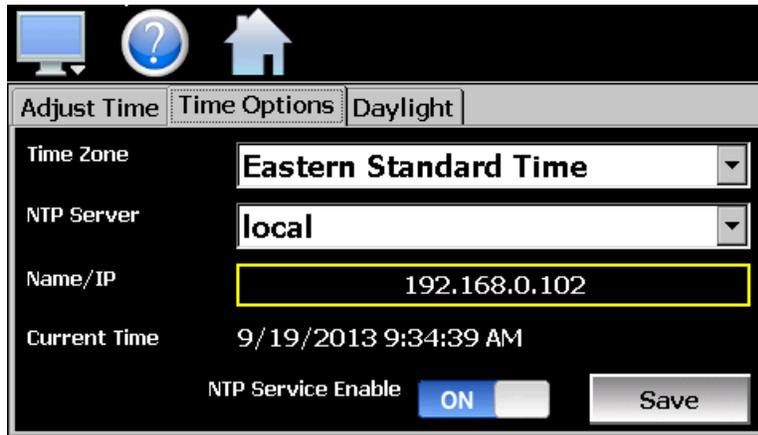
To enable the national time server, select your time zone and which time server you wish to use from the drop-down menu selections. Turn on the "NTP Service Enable" option and press the "Save" button. The MCT4 will then synchronize its time with the selected national time server at 2:00AM each day.

If the MCT4 is not connected to the internet, a local alarm message will be shown on the alarm screen; "*NTP Failure. Check cable and server*" to indicate that the time server could not be located.

10.3.1.1 Local Time Server Settings

If an active internet connection is not available, or company policy prohibits internet access, the MCT4 can be configured to use a local time server instead of one of the national time servers. To configure the use of a local time server, select "local" from the NTP server list. When selected, the "Name/IP" entry field will be shown. The computer name or IP address of the computer running the local timer server on the LAN can then be entered. The MCT4 will then contact the local computer in order to synchronize time.

NOTE: *The steps required to configure and provide NTP service from a computer on the LAN is outside the scope of this manual. Contact your network administrator for assistance.*

10.3.2 Daylight Savings

Select the "Daylight" tab to configure daylight saving time options. The daylight savings time options allow the user to set the start date and end date for daylight savings time.

If your locale utilizes daylight savings time, set the start and stop dates for daylight savings and turn on the "Daylight Savings Enable" option. Press the "Save" button to store the settings. MCT4 will then automatically update its clock for daylight savings time.

NOTE: If the NTS time server setting is enabled, and the selected time zone uses daylight savings time, daylight savings must be properly configured and enabled or the clock will not show the correct time.

10.4 Language

The Language screen is used to select the language for all of the online help, menus and most static display fields. Note that the keypad will remain in English, so all user text entry will still be in the English language.

Available language selections include:
- ✓ Chinese Simplified
- ✓ Chinese Traditional
- ✓ English
- ✓ French
- ✓ German
- ✓ Italian
- ✓ Japanese
- ✓ Korean
- ✓ Portuguese
- ✓ Russian
- ✓ Spanish

DISCLAIMER: English is the default language for the MCT4 control system. All other language selections provided through translation from the English language. FDC does not guarantee the accuracy or validity of alternative language selections and shall not be liable for any damages or losses, whether direct, indirect, incidental, special, consequential or any other damages for misinterpretation of other languages. FDC offers a free, PC based application which allows the end user or OEM to create the translation files for the desired language selection. The translation files can then be copied to the MCT4 control system in order to provide a more accurate or desired translation.

10.5 Calibration

Each MCT4 loop control and limit control is calibrated at the factory before shipment; however, they can be recalibrated in the field with the use of proper calibration equipment. The user calibration offset provides the means for the end user or OEM to simply apply an offset to the factory calibration. Typical reasons for applying this offset may include the need to match a particular reference standard, to match the calibration to a particular transducer or sensor or to remove long term drift in the factory set calibration.

To access calibration, select "Inputs" from the Calibrate menu. When more than one loop and/or the limit control is installed, the left/right navigation arrows will be provided at the top right of the screen. This allows the user to scroll through each available loop and limit if installed.
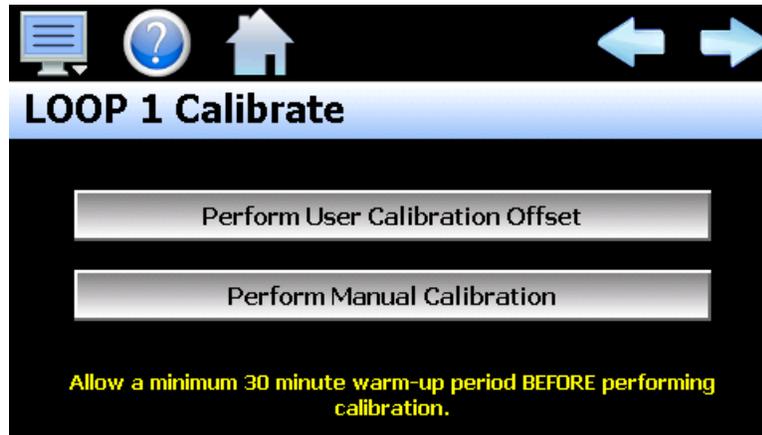
Press the **Perform User Calibration Offset** button to access the settings for applying an offset to the loop or limit factory calibration. This is the recommended method of calibrating the inputs for users without special calibration equipment and is suitable for most applications.

Press the **Perform Manual Calibration** button to begin the factory calibration procedure for the selected loop or limit input. This option is NOT recommended for users with limited calibration experience. Special high accuracy equipment is required to properly calibrate the inputs to factory standards. Improper calibration could render the device inoperable and require it to be sent back to the factory for repair.

Prior to performing any calibration procedure, read the documentation carefully and understand the steps required to perform calibration. The loop and limit controls must be powered for a minimum of 30 minutes prior to performing calibration in order to ensure that they have warmed up and are at normal operating temperature.

Required calibration sources:

Thermocouple Input:	0 – 100mV and K-Type source $\pm$ 0.005% accuracy
RTD Input:	0 – 300ohm source $\pm$ 0.005% accuracy
Voltage Input:	0 – 10VDC source $\pm$ 0.005% accuracy
Milliamp Input:	0 – 20mA source $\pm$ 0.005% accuracy

10.5.1 Loop Calibration Offset

The calibration offset provides a two-point offset; a low point offset and a high point offset. The two-point offset constructs a straight line (linear calibration) between the two points. To insure greatest accuracy, it is best to calibrate with the two points at the minimum and maximum operating ranges for the system.
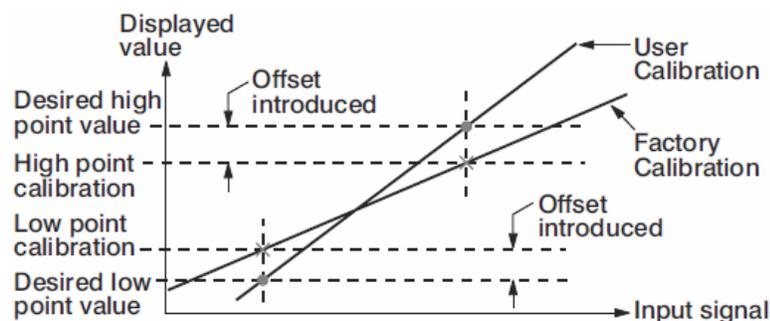
To begin calibration, send the low signal input to the loop control. If the process value does not match the reference signal, adjust the low point offset so that the process value matches the reference input signal. Press the button to switch to the high point offset and then apply the high signal input to the loop control. Adjust the high point offset if necessary in order to make the process value match the reference signal.

Press the Done button to exit screen.

LOOP 1 Calibrate

Process Value   20.2

Low Point Offset   0.0

Apply low scale input signal. Adjust low point offset until the process value is equal to the desired value.

Press to Display/Adjust High Point Offset

Done
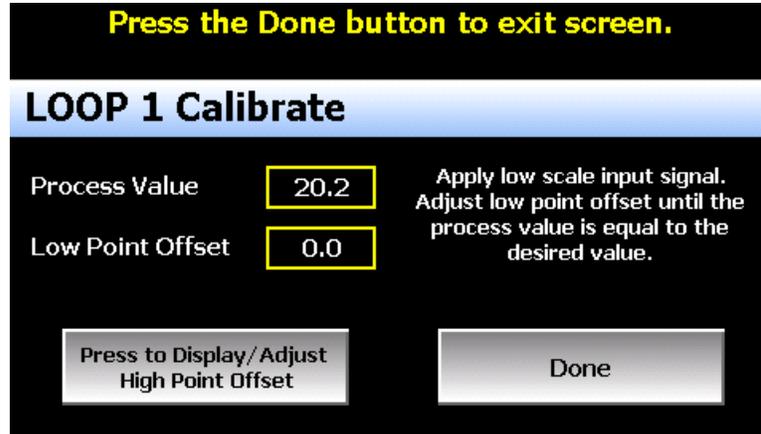
Once the high point offset has been adjusted, press the button to switch to the low point offset and again apply the low signal input to the loop control input. If the process value does not match the reference signal, adjust the low point offset again so that the process value matches the reference input signal. Again, press the button to return to the high point offset and apply the high signal input to the loop control. Adjust the high point offset if necessary in order to get the process value to match the high reference signal. This process may have to be repeated several times depending upon the amount of offset applied. Each time the low or high offset is adjusted, it can affect the opposite end of the calibration curve.

If the known calibration error of the loop input is the same at both the minimum and maximum operating range of the system, i.e., a linear offset, you can simply enter the difference between the reference signal and process value for both the low point offset value and high point offset value. If both the low and high point offsets match, it shifts the calibration curve thus applying the value of the low/high point offset equally across the entire range.

For example, if the range of operation is -50.0 to 350.0 degrees and the error between the reference signal and the process value is 0.7 at both the low and high range resulting in process values of -49.3 and 350.7, simply enter the value of -0.7 for both the low and high point offset. This will shift the curve equally at both ends of the curve so the resulting process values will be -50.0 and 350.0.

Once the calibration offset is complete, press the "Done" button to return to the main Calibration screen.

10.5.2 Limit Calibration Offset

The calibration offset provides a single point shift. If the limit control is used for high/low operation and the error differs from one end of the calibration curve to the other, the shift value can be used to split the difference between the two. This will make the error equal at both ends of the curve or it can be used to shift it to reduce error at one end of the curve; however, it will also increase the error at the opposite end of the curve.

Press the Done button to exit screen.

LIMIT Calibrate

Process Value	31
PV Shift (offset)	0

Apply desired input signal and adjust the PV Shift (offset) until the process value is equal to the desired value.
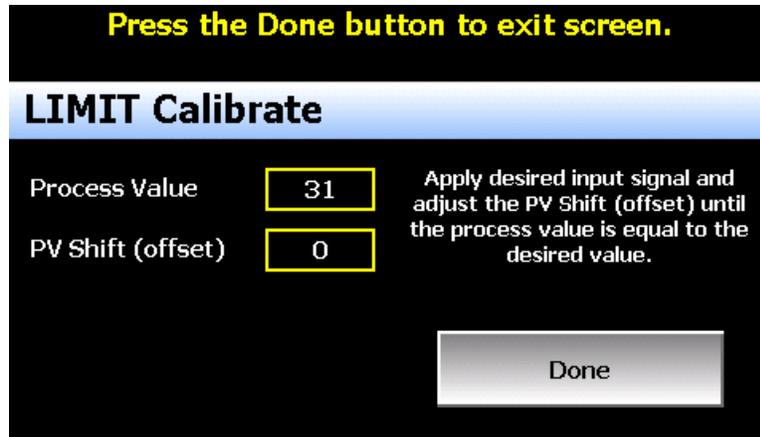
Done

To begin calibration, apply the desired reference signal to the limit control input. Adjust the PV Shift value to achieve the desired process value. Once the calibration offset is complete, press the "Done" button to return to the main Calibration screen.

10.5.3   Monitor Point Calibration Offset

The calibration offset provides a single point shift. If the input error differs from one end of the calibration curve to the other, the shift value can be used to split the difference between the two. This will make the error equal at both ends of the curve or it can be used to shift it to reduce error at one end of the curve; however, it will also increase the error at the opposite end of the curve.

Press the Done button to exit screen.

Monitor1 Calibrate

Process Value	25.2
PV Shift (offset)	0.2

Apply desired input signal and adjust the PV Shift (offset) until the process value is equal to the desired value.
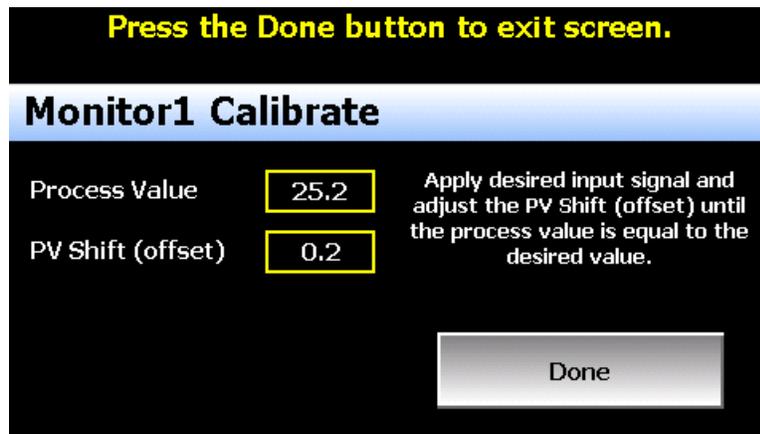
Done

To begin calibration, apply the desired reference signal to the monitor point input. Adjust the PV Shift value to achieve the desired process value. Once the calibration offset is complete, press the "Done" button to return to the main Calibration screen.

10.5.4   Manual (Factory) Calibration

The manual calibration procedure is a two-step process for RTD and linear inputs and a three-step process for thermocouple inputs. Each step of the calibration procedure can be skipped which provides the user with a means to exit manual calibration without actually altering the calibration coefficients of the loop or limit control.

CAUTION: *Performing manual calibration will replace the factory calibration coefficients with new values. If calibration is performed incorrectly, it could introduce a large input error resulting in dangerous operating conditions if not detected or render the device inoperable requiring that it be sent back to the factory for repair. Prior to calibrating each coefficient, it is recommended that the current value be recorded.*

The calibration coefficients can be manually entered so if the calibration process fails, the previous values can be re-entered returning the unit to its previous operational state.

10.5.4.1 Thermocouple Input Calibration

When the loop or limit control input is configured as a thermocouple input, pressing the "Perform Manual Calibration" button on the main Calibration screen will begin the thermocouple calibration procedure. The procedure is a three-step process and begins by calibrating the zero of the A to D converter.

To calibrate the input low coefficient, connect the millivolt source to the input terminals of the loop or limit control. Adjust the source signal to 0mV and allow several seconds for the source signal to stabilize. Record the current calibration coefficient value. Press the "Calibrate" button to calibrate the input low coefficient. A dialog will be shown indicating the new coefficient is being calculated. DO NOT alter the source signal during the process. Once complete, the dialog will close and the new coefficient value will be shown.

If the new coefficient value is -1999 or 1999, the calibration failed. Check the source connections and insure the proper signal is applied. Press the Calibrate button to repeat the process or press the coefficient display/entry field and enter the previous coefficient value recorded to return the loop/limit back to its previous state. To skip the input low coefficient calibration or to proceed to the next step after calibration has been performed, press the "Next" button.

Step 2 of the procedure is calibrating the span of the A to D converter. To calibrate the input high coefficient, connect the millivolt source to the input terminals of the loop or limit control. Adjust the source signal to 60mV and allow several seconds for the source signal to stabilize. Record the current calibration coefficient value. Press the "Calibrate" button to calibrate the input high coefficient. A dialog will be shown indicating the new coefficient is being calculated. DO NOT alter the source signal during the process. Once complete, the dialog will close and the new coefficient value will be shown.

If the new coefficient value is -1999 or 1999, the calibration failed. Check the source connections and insure the proper signal is applied. Press the Calibrate button to repeat the process or press the coefficient display/entry field and enter the previous coefficient value recorded to return the loop/limit back to its previous state. To skip the input high coefficient calibration or to proceed to the next step after calibration has been performed, press the "Next" button. The final step of the procedure is calibrating the cold junction.

To calibrate the cold junction, a K-Type thermocouple is required. Connect the K-Type thermocouple source to the input terminals of the loop or limit control using K-Type thermocouple wire. Adjust the source signal to 0C and allow several seconds for the source signal to stabilize. Record the current calibration coefficient value. Press the "Calibrate" button to calibrate the cold junction. A dialog will be shown indicating the new coefficient is being calculated. DO NOT alter the source signal during the process. Once complete, the dialog will close and the new coefficient value will be shown.
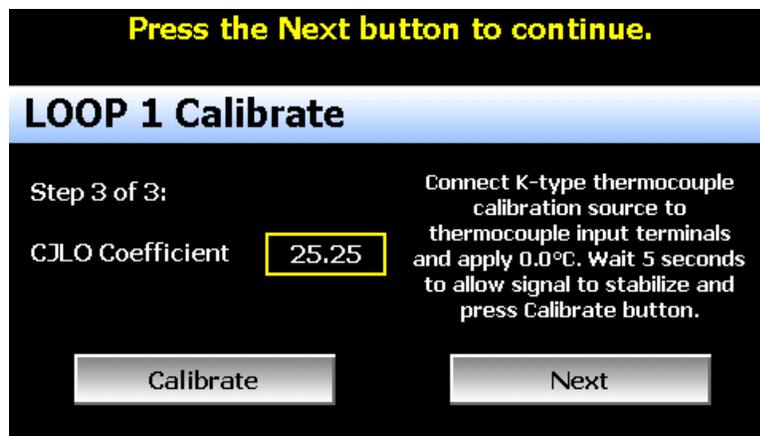
If the new coefficient value is -5.00 or 40.00, the calibration failed. Check the source connections and insure the proper signal is applied. Press the Calibrate button to repeat the process or press the coefficient display/entry field and enter the previous coefficient value recorded to return the loop/limit back to its previous state. To skip the cold junction calibration or to complete the calibration procedure, press the "Next" button.

Once the calibration steps have been completed, connect a calibration source matching the type of input configured for the loop/limit control. Adjust the reference signal to the low and high end of the operational range to verify that the process value matches the reference signal within the accuracy limits for the input type.

Press the Done button to exit screen.

LOOP 1 Calibrate

Process Value   24.9   Calibration complete. Apply configured input type and verify process value is reading correctly within limits of accuracy.
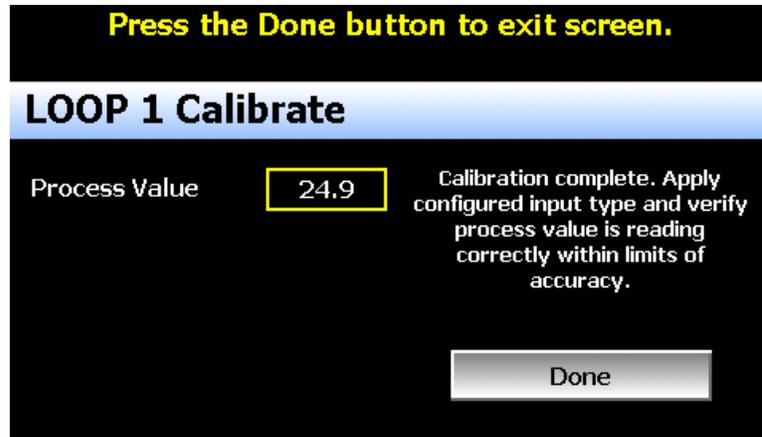
Done

Once the input has been verified to display the proper value according to the input reference signal, reconnect the control sensor to the loop/limit control and press the "Done" button. This will return to the main Calibration screen.

10.5.4.2 *RTD and Linear Input Calibration*

When the loop or limit control input is configured with an RTD or linear input, pressing the "Perform Manual Calibration" button on the main Calibration screen will begin the calibration procedure for the configured input type. The procedure is a two-step process and begins by calibrating the zero of the A to D converter.

To calibrate the input low coefficient, connect the resistance source (for RTD input), voltage source (for voltage input) or milliamp source (for current input) to the input terminals of the loop or limit control. Adjust the source signal to 100 ohms (for RTD input), 0VDC (for linear voltage input) or 0mA (for current input) and allow several seconds for the source signal to stabilize. Record the current calibration coefficient value.

Press the "Calibrate" button to calibrate the input low coefficient. A dialog will be shown indicating the new coefficient is being calculated. DO NOT alter the source signal during the process. Once complete, the dialog will close and the new coefficient value will be shown.

Press the Next button to continue.

LOOP 2 Calibrate

Step 1 of 2:

RTDL Coefficient   -64   Connect resistance calibration source to RTD input terminals and apply 100 ohms. Wait 5 seconds to allow signal to stabilize and press Calibrate button.

Calibrate   Next

If the new coefficient value is -1999 or 1999, the calibration failed. Check the source connections and insure the proper signal is applied. Press the Calibrate button to repeat the process or press the coefficient display/entry field and enter the previous coefficient value recorded to return the loop/limit back to its previous state. To skip the input low coefficient calibration or to proceed to the next step after calibration has been performed, press the "Next" button.

Step 2 of the procedure is calibrating the span of the A to D converter. To calibrate the input high coefficient, adjust the resistance source to 300 ohms (for RTD input) or 20mA (for current input). If calibrating a voltage input, adjust the voltage source to 60mV for 0-60mV input, 1VDC for 0-1VDC input, 5VDC for 0-5/1-5VDC input or 10VDC for 0-10VDC input. Allow several seconds for the source signal to stabilize. Record the current calibration coefficient value and press the "Calibrate" button. A dialog will be shown indicating the new coefficient is being calculated. DO NOT alter the source signal during the process. Once complete, the dialog will close and the new coefficient value will be shown.

If the new coefficient value is -1999 or 1999, the calibration failed. Check the source connections and insure the proper signal is applied. Press the Calibrate button to repeat the process or press the coefficient display/entry field and enter the previous coefficient value recorded to return the loop/limit back to its previous state. To skip the input high coefficient calibration or to complete the calibration procedure, press the "Next" button.

Once the calibration steps have been completed, adjust the reference signal to the low and high end of the operational range to verify that the process value matches the reference signal within the accuracy limits for the input type.
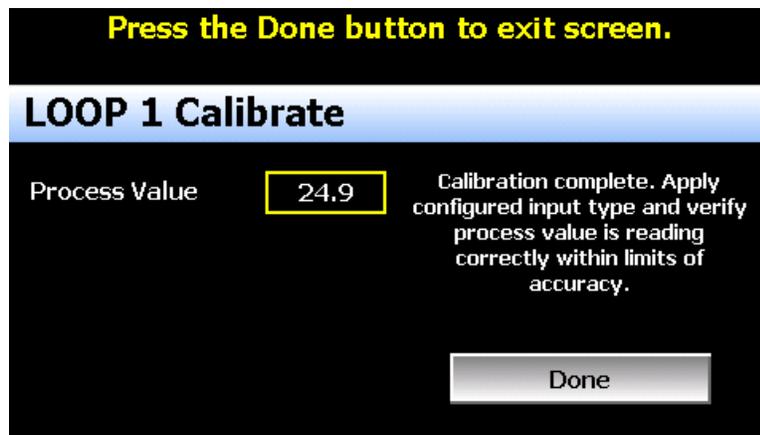
Once the input has been verified to display the proper value according to the input reference signal, reconnect the control sensor to the loop/limit control and press the "Done" button. This will return to the main Calibration screen.

10.6 Display Settings

The Display screen provides access to the touch screen calibration utility, back light settings and alarm volume adjustment.
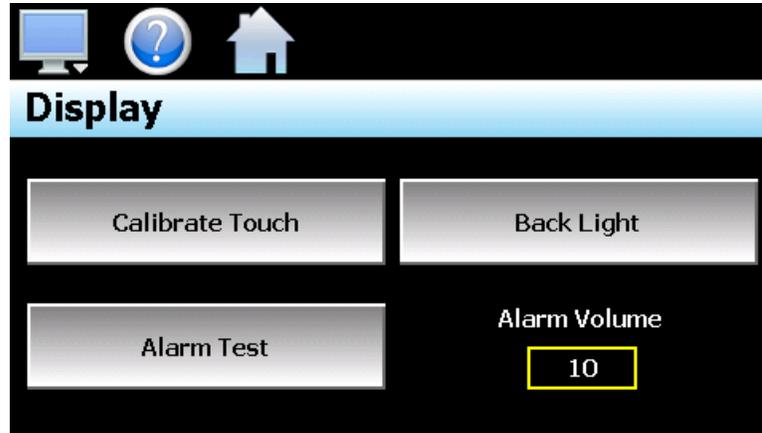
The **Alarm Volume** adjusts how loud the internal alarm buzzer of the MCT4 will be when activated under an alarm condition. The volume can be set from 0 (off) to 100. To edit the alarm volume, touch the entry field and enter the desired volume level. To test the buzzer, press the "Alarm Test" button.

10.6.1 Calibrate Touch

After extended use and many hours of operation, it may be necessary to recalibrate the touch screen of the MCT4. A typical sign that the screen may be out of adjustment, is inaccurate responses when attempting to press buttons, check boxes or adjust fields on the display. The calibration utility is provided in order to re-adjust the screen when this happens.

To begin the calibration process, press the "Calibrate Touch" button. An alert message will appear stating that the application will be disabled to perform the calibration procedure. Press "Yes" to continue.
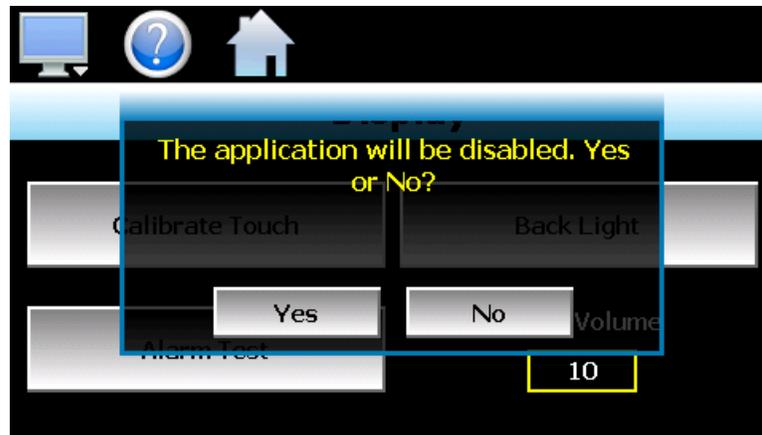
The calibration utility will start and crosshairs will appear on the screen. At each crosshair position, touch the screen at the center of the crosshairs. Repeat this for each position in order to set the calibration. The calibration requires five points, the center and four corners.

NOTE: *It is recommended that you use your finger rather than a stylus when calibrating the screen. The touch response will be more fluid after calibrating it with your finger.*

Carefully press and briefly hold stylus on the center of the target.
Repeat as the target moves around the screen.
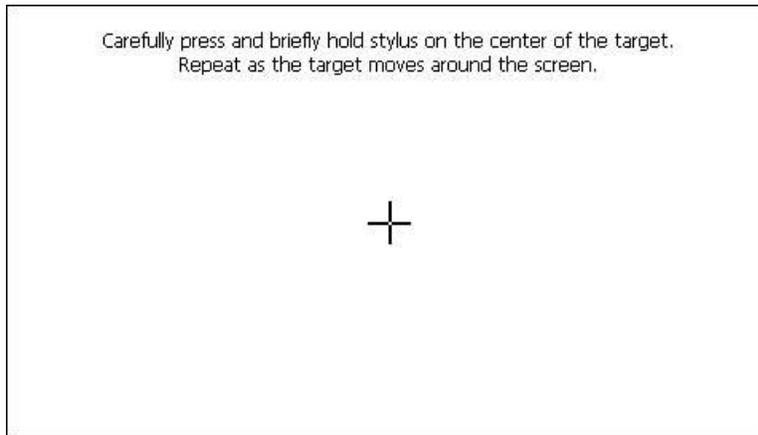
Once complete, the calibration utility will provide a notification message that the new calibration settings have been measured and to touch the screen to register the new calibration data; just touch anywhere on the screen to close the window and return to the MCT4 application to resume normal operation.

New calibration settings have been measured.
Touch the screen to register saved data.
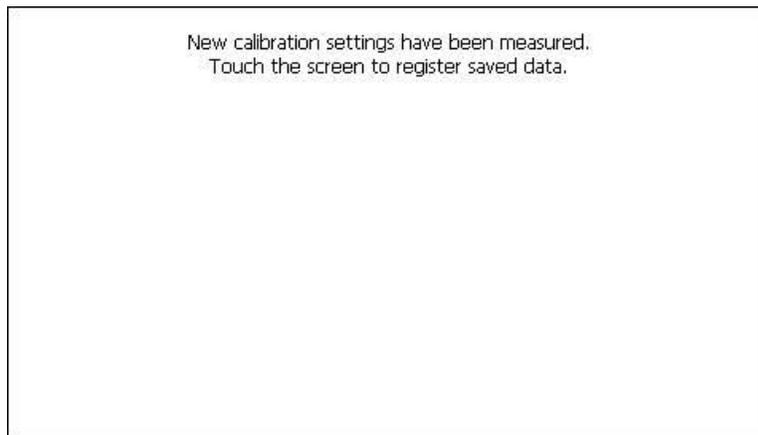
10.6.2 Backlight Settings

The backlight settings allow the user to adjust the screen brightness as well as set a time period for dimming the backlight after a period of inactivity which can extend the life of the display. To adjust the backlight settings, press the "Back Light" button. An alert message will appear stating that the application will be disabled to enter the backlight settings, press "Yes" to continue.

Select the "Backlight" tab from on the Display Properties window. Press the "Advanced…" button to access the settings for the backlight.

NOTE: *The checkboxes on the Backlight tab for "Automatically turn off backlight while on battery power" and "Automatically turn off backlight while on external power" have no effect on backlight operation and should be left unchecked.*
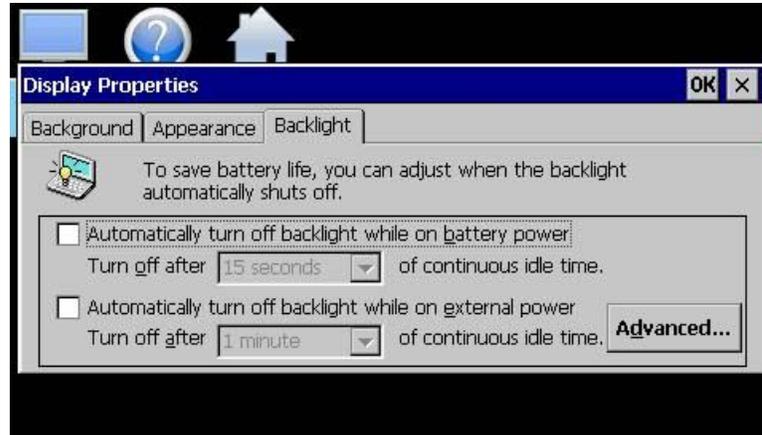
The brightness of the display during operation is set by adjusting the "Run" slider. The default setting is 100. The "User Idle" slider is used to adjust the brightness of the display during periods of inactivity. The default setting is 5. Use caution when adjusting the "Run" slider. It is possible to set the brightness to zero (0), in which case the screen will go black and you will be no longer able to see the settings. Should this occur, it is possible to tap the screen in the general area of the run slider. If you tap the screen in the proper position of the slider, it can set the slider to make the screen visible again. It is recommended that the slider not be adjusted below 20.

When adjusting the "User Idle" slider, the screen will temporarily adjust to the setting of the slider as you move it. If you choose a value of zero (0), the screen will go black. However, once you lift your finger, the screen will return to the "run" brightness level after a couple seconds.
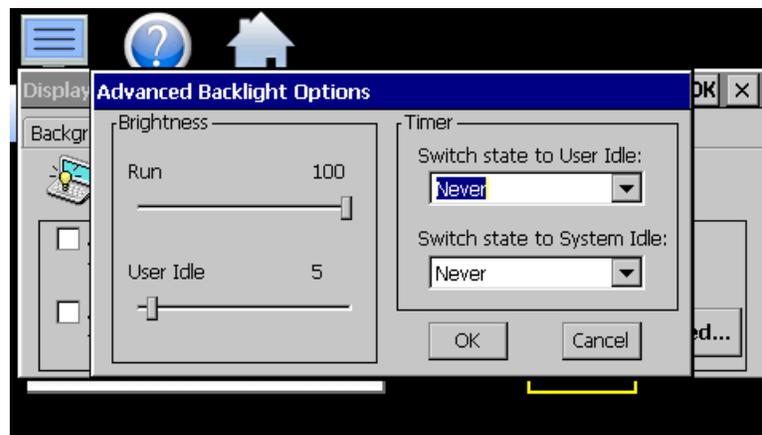
To enable the backlight dimming function, use the "Switch state to User Idle" drop-down menu and select a time period for no activity at which the screen should dim. The delay time can be set at fixed intervals from 1 minute up to 30 minutes. To disable the dimming feature, select "Never".

Once all settings are complete, press the "OK" button and then press the "OK" button at the top right of the "Display Properties" window to return to the MCT4 application and begin normal operation.

10.7 Configuration

The Configuration utility allows the user to back up the entire configuration of the MCT4 and save it to a file for "safe keeping" in case of system damage due to a lightning strike, etc. The utility also allows the MCT4 to be configured with a push of a button by selecting from a list of preconfigured setups that could be created and saved on a USB memory device or remote server for loading a configuration to a new MCT4 system.

IMPORTANT: ***Do not import configuration files that are not intended for use with the current hardware configuration of the MCT4 as unexpected operation may result.***
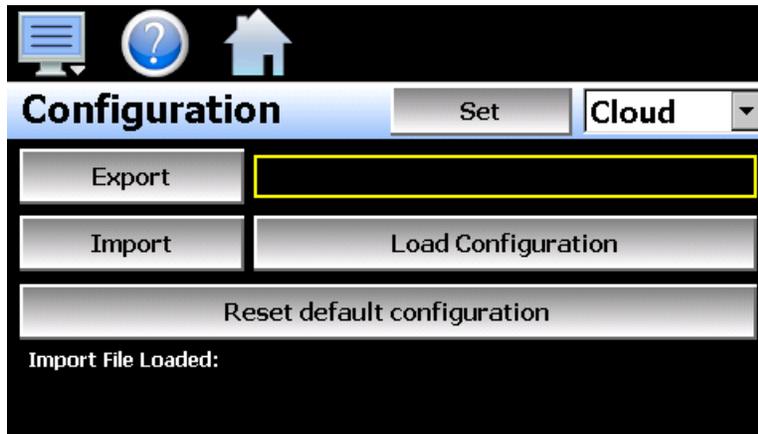
By default, the import/export procedure is set to operate via USB. To perform import/export operations from a remote server, use the drop-down menu to select "Cloud". When "Cloud" is selected, a "Set" button will appear to the left of the drop-down menu. Pressing the button will display the Cloud setup screen where the remote server settings can be entered (see section 10.7.1 Cloud Server Settings). The settings only need to be entered once as they can be saved and used for any future import/export operations.

When the **Export** button is pressed, the MCT4 configuration data will be written to the USB memory device or remote server. The export file function will use the name entered in the text field to the right of the export button and create a directory on the memory stick with that name, to contain the configuration data. The filename can be entered with up to 10 characters which permits multiple configurations to be identified and saved for later retrieval. The export files will be saved to a directory with a name format of "MCTA_*filename*_mm-dd-yyyy-hh-mm-ss" to identify the configuration according to the date and time it was created. This prevents multiple configuration files with the same name from overwriting previous files. It also allows the user to identify a backup of the MCT4 so that it could be reconfigured to a previous date if multiple back-ups are created.

If the export is being sent to a remote server, a single file is created with the format of "MCTA_*filename*_mm-dd-yyyy-hh-mm-ss.ccg". The file is encrypted and automatically signed with a digital signature in order to protect it and prevent alteration of the file. Should a file be tampered with, it would fail the import, thus protecting the MCT4 from accepting a bad configuration file.

The **Import** button is used to configure the MCT4 according to the currently loaded configuration file. To load a configuration file, the USB memory device must first be inserted into the USB port (or the remote server has to be properly configured and the MCT4 connected to the internet when Cloud is selected). When the **Load Configuration** button is pressed, a list of available configuration files from the memory stick (or remote server) will be shown. Select the desired file from the list and press "Open" to load the file. Once the file is loaded, the import process can be started. Pressing the "Import" button will begin the process. When the import is complete, you must cycle power to the MCT4 in order for the new configuration data to be loaded into runtime memory for proper operation.

The **Reset default configuration** button can be used to clear the current MCT4 configuration and reset the system back to default values. This function clears all user and/or OEM configuration values and returns the system to an "as new" factory state allowing the system to be configured from scratch. This function is provided as a means to start over in the event that the system configuration has been altered to an unknown state and is not operating properly, and a known good configuration is not available to import. Rather than go through every setting of every feature to try and determine where the configuration error exists, this allows the system to be cleared so that it can be reconfigured from a clean slate.

NOTE: *The configuration functions do not affect the VNC server configuration. The enable state, VNC address, device name and password fields must be manually changed as these settings are specific to each device and must be set independently for proper VNC server operation over a network.*

The network settings, i.e., DHCP/ Static IP address settings and control loop set points are also not saved to the configuration file. These settings must be done manually.

10.7.1 Cloud Server Settings

The "Cloud" screen provides settings for the remote configuration FileWeb server. The screen is accessed by pressing the "Set" button on the Configuration screen. Note that the "Set" button is only shown when "Cloud" is selected for the import/export configuration location.

The **IP Address** field is used to enter the IP address of the remote server site that MCT4 is to interface with.

The **User Name** field allows you to enter a user name for site access. When the MCT4 connects to the site, the user name will be used to identify the connection. The user name is required for FileWeb access.

The **Password** field is used in conjunction with the user name field and is for entering a password, so the MCT4 can access the site. A password is required for FileWeb access.

The **Server** field is used to enter additional directory information for the server (if desired) where the files are to be stored during import/export operation. The field can be left blank. By default, the MCT4 is hard coded to store files on the specified server in the "\configs*user name*\" directory. If an entry is made in the Server field, the path would be "\configs*user name**server*\".

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MCT4 Field Setup	FileWeb Server Setup
IP Address = https://fdcutil.com/FDDataService.svc	Actual named address of FileWeb server/service.
Server = *optional path*	The FileWeb server/service must be configured with a root "\configs\" directory in order to use the MCT4 cloud import/export feature. The MCT4 is hard coded to transfer configuration files to the "configs" directory in the root of the server. This results in a typical file path of "\configs*userName*\". If the Server field also contains an entry, the resulting path would be "\configs*userName**Server*\".

	It is recommended that this field be left blank for the majority of users to insure all configuration files are stored in the base "configs" directory. When loading a configuration for import, only the files in the specified directory will be available for selection. If a configuration file was stored to a location specified by the Server field and the proper entry is not known, the user will be unable to select the proper configuration file for import.
User Name = *userName*	Actual user name for login at FileWeb server (required).
Password = *userPassword*	Actual password for login at FileWeb server (required).

NOTE: *Make sure proper permissions are set at the server for access/creation of directories and read/write access. Also check root directory structure at the server to identify the actual root that was created for the files since there can be additional layers created by the server field and displayed in the path (see Appendix section A.2 FTP, FileWeb, DataWeb Requirements/Installation for additional information).*

10.7.2 Importing an OEM Default Configuration

The "Reset default configuration" button loads a predefined configuration stored in memory on the MCT4. The factory configuration is "blank" meaning it will reset all attached loop control boards and limit control to the FDC factory defaults. All user and/or EOM configuration settings will be cleared which will require the user to reconfigure the entire device for the intended application.

For OEM manufacturers, the MCT4 provides a means of importing a default factory configuration. If an end user happens to make configuration changes that affect operation, or to insure the system is configured properly to OEM specifications while providing customer support, the OEM configuration can be stored in the MCT4 and will be installed when the "Reset default configuration" button is pressed.

Hidden Import Factory Defaults Button
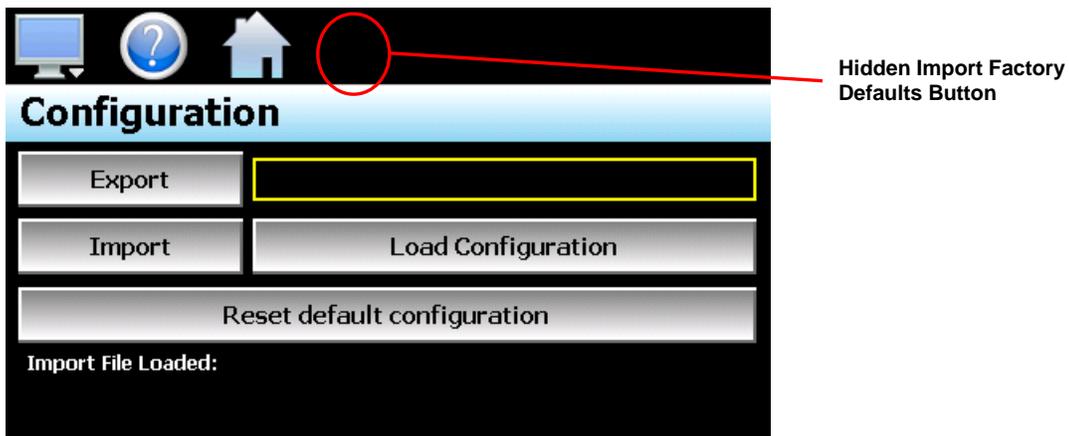
To import a factory default configuration, insert the USB memory device containing the desired configuration file. Next to the "Home" icon is a hidden button. Tap the location repeatedly 10 times within a period of 4 seconds. A dialog will be shown prompting to copy a configuration as factory defaults. When "Yes" is selected, the open file screen will be shown. Select the desired configuration file and press the "Open" button to import the file as factory defaults.

NOTE: *Importing a factory defaults file does not affect the current configuration of the unit. This only imports a configuration file as the factory defaults file.*

10.8 About MCT4

The "About" MCT4 screen provides operating system version numbers for the currently installed firmware and software of both the MCT4 HMI and loop control boards and limit device. This information should be recorded prior to any service request so that proper assistance can be provided for your control model.

10.9 Exit Application

The "Exit" Application screen allows the user to quit the MCT4 runtime software and return to the CE.Net operating system. This operation is NOT recommended with the exception of users who are in charge of system configuration due to the danger of editing or removing files by accident.
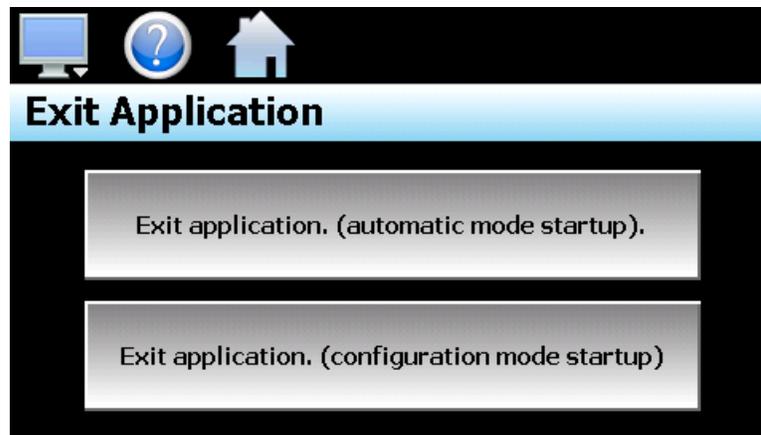
The **automatic mode startup** option will return the MCT4 to normal operation on the next power up.

The **configuration mode startup** option will start the MCT4 Configurator program on the next power up so that the user can access control loop and MCT4 configuration settings.

11 Communications

This section provides instructions on how to use the MCT4 communication interfaces. As a standard, the MCT4 is equipped with both an Ethernet interface and an RS232/485 serial interface for user communications.

11.1 Ethernet Communications

The MCT4 provides several options for remote control and monitoring over the Ethernet communications interface. The web server interface provides a monitor only connection, while the VNC server and Modbus TCP interfaces allow a user to manipulate and control the MCT4 remotely. The VNC interface allows the user to view and observe operation of the MCT4 display directly on their PC screen while the Modbus TCP interface allows the user to manipulate MCT4 operation via other devices and/or software capable of Modbus TCP communications.

NOTE: *In order to use Ethernet communications, the MCT4 must be properly connected to a network. To connect the MCT4 to a network, connect the touch screen's Ethernet port to your network using a standard CAT5 cable connection. Note that after connecting the network cable, it may be necessary to cycle power to the MCT4 in order for it to obtain a valid IP address.*

11.1.1 Guide to Smart Networking Practices

The expansion of Ethernet onto the industrial floor has brought forth a new realm of possibilities from the gathering of information to the inherent control of equipment from anywhere around the world. The flexibility and convenience that this provides makes it a very desirable feature for new equipment. The MCT4 provides this ability, but there are considerations that must be taken by the end user to protect their equipment and investment.

Just like placing a personal computer on the internet opens it up to outside attack, placing your MCT4 on a network poses the same risk. The first thing to remember is this: The most likely cause of problems is not a hacker trying to sabotage your equipment, but more often to be related to the ubiquity of PCs with Ethernet cards, the ease with which your own co-workers can "hang stuff on the network", and careless or nonexistent internal security measures. Accidental problems are more common than deliberate ones.

Allowing anyone access to the MCT4 by placing it on the office LAN, also opens the door for accidental shutdown, damage to equipment, loss of data, lost time, etc. This is possible even by the most well-intentioned co-workers. Thus, there are several steps that should be taken to minimize this risk.

The first is to never mix your office LAN with your control LAN. The control LAN should be a separate network that consists of your MCT4 controller(s) and possibly any other equipment that you may have that is related to the operation of the system. It should be separated from your office LAN by a firewall, or at minimum, a bridge or router. A control network and a business network have two entirely different purposes and their interaction should be closely controlled.

It is also unwise to assume that any Ethernet capable devices themselves have any security features at all. The MCT4 VNC server only provides minimal single-password based security access. Separating the control LAN from the office LAN using a firewall would increase security and only allow control access that is based on a combination of IP source address, destination address, and port number. This is by no means completely "hacker-proof", but it should keep the well-meaning co-workers out.

Another hazard is connecting consumer "plug and play" devices to your control LAN. A printer for example, might flood the network with traffic in a "broadcast storm" as it tries to self-configure or advertise its presence to all nodes on the network. Faulty devices, for example defective NIC cards, can transmit large amounts of bad packets (i.e., runts, which are abnormally short Ethernet frames) into your network. Using switches instead of hubs will limit the effect of such problems.

The most commonly overlooked source of problems is cabling. Not all cables are created equal. Electrical noise generated by factory equipment or other electrical equipment in the area, could easily corrupt transmitted data over the network and cause devices to "lock up" or shut down the VNC server, both of which then require the MCT4 to be shut down and restarted to clear the problem.

Select the right cable for the environment. Shielded twisted pair (STP) cable is naturally more noise immune and is preferable to unshielded twisted pair or UTP in noisy situations. STP should have at least 40dB CMRR and less than 0.1pF capacitance unbalance per foot. Ground STP cable, making sure the ground is connected only at one end. CAT5 STP patch panels normally provide a grounding strip or bar. Hubs and switches don't provide grounding, use cables.

It's wise to be pessimistic about a cable's ability to reject noise from 230 VAC and 460 VAC power lines and electrically "noisy" equipment in the area. Capacitance imbalance in cables greater than 70pF per 100m can introduce harmonic distortion resulting in bit errors. The cost of cable is quite small compared to total equipment cost, so if you're looking to save money, this is not a place to do it. Choose a well-designed cable to minimize bit-error rate after installation, and that will give faster throughput with fewer glitches.

11.1.1.1 *The MCT4 and Network Security*

When most people think of security, they think of anti-virus programs and continuous operating system updates to insure their system is running with the "latest-and-greatest" software. For consumer devices, this is well and good, but when it comes to industrial devices not so much. How many times has an update to the OS caused an issue with an existing program that for now some reason is not working correctly or crashes inexplicably. How about an anti-virus program updating its threat definitions and now sees an application as a potential threat and blocking it from operating? To have this occur on a control device could be catastrophic to a process. So how does the MCT4 address these concerns while still providing threat protection?

The MCT4 software validation uses a specific OS version and revision number as part of the validation process. WinCE is not the same as Win7, 10, etc. and does not support automatic updates since the OS must be installed in a specific portion of memory using a cable or SD with the device present. The OS layout is also specific to the hardware on the device. FDC has never had an update to the OS unless the hardware changed on our units which required a driver (mostly third party) for the new hardware. This also provides stability since this is an industrial device that provides specific functionality without most of the "overhead" of the OS's that full PC's run.

Most security issues arise from browsing or opening an email attachment that carries harmful code. The MCT4 dos not support the addition of anti-virus software: however, the MCT4 does not have a browser or an email server to receive emails or attachments. The FTP, FileWeb and DataWeb interfaces are also client based only. They transmit files and data to remote servers, but do not receive.

The MCT4 writes data to a web page in memory that can be accessed by an external browser. This is a read only web page (from the remote browser) that contains process values, set points, event and current program data only. The internal web page data is written over with real time data every 30 seconds. The MCT4 does not read any data from its internal web page so any corruption of the web page would not affect MCT4 display/control operations.   There are no passwords or sensitive data sent from the remote browser to the "read only" web page.

A virus to attack Windows CE would be difficult, but not impossible. Every Windows CE device is different (by manufacturer), so not an easy standard to write the virus against. The virus would need to be built for Windows CE and the CPU that the MCT4 runs, and the storage device doesn't have a standard name. There might be industrial devices that run anti-virus on their CE devices; however, FDC is not aware of any. As the saying goes, the best defense is a good offense. It is best to design a "smart network" to prevent intruders from gaining access in the first place than to try and fend them off once they are already in the door.

11.1.2 Using the Web Server

The MCT4 web server allows a user to remotely monitor operations anywhere via a PC's standard web browser. When enabled, the web server provides a detailed status page of the current operating conditions. The web server can be enabled and disabled by pressing the web server (Www.) button on the communications screen (select "Comms" from the Device\Settings\Set menu).
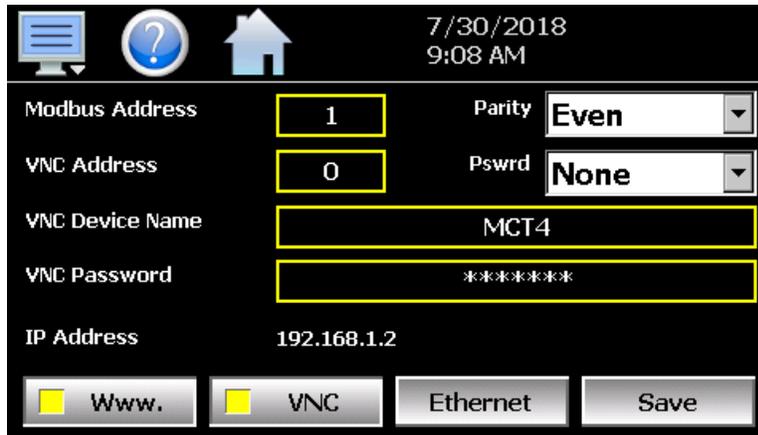
You must use the assigned IP address to access the MCT4. The IP address is shown on the communications screen and is also included in the notifications list. Write down the IP address so you will have it later to enter into your web browser.

NOTE: *Contact your network administrator prior to enabling the web server of the MCT4. Company policy may prohibit the use of web servers for security reasons. Future Design Controls is not responsible for the use of, nor makes any claims as to the security of the web server interface over your network. The use of the web server is the responsibility of the end user.*

To access and view the MCT4 web page, enter the following link in your PC's browser address window: http://"IPaddress"/MCT.html.   Using the IP address from the sample screen, the entry would be: http://192.168.1.2/MCT.html. The following example is typical of the MCT4 web page appearance. The web page updates automatically every 30 seconds and provides information on each individual control loop, ramp/soak program status, alarm status and system event status.

FUTURE DESIGN CONTROLS - MCT4

BRIDGEVIEW, IL - 888-751-5444

CONTROL DATA

LOOP 1	PV = 26.9	SP = 24.0
LOOP 2	PV = 7.6	SP = 5.4
LIMIT	PV = 32	SAFE

AUTOMATED PROGRAM

Program Name	TEST2
Program Status	Inactive
Cycles Remaining	2
Total Steps	4
Current Step	1
Step Time Running	1.00
Remaining Step Time	1.00
LOOP 1 Target SP	24.0
LOOP 2 Target SP	5.4

SYSTEM ALARMS

SYSTEM EVENTS

EV1	OFF
EV2	OFF
EV3	OFF

11.1.3 Using the VNC Server

The MCT4 VNC server allows a user to remotely monitor and control MCT4 by directly viewing and manipulating the touch screen over the network. You must use the assigned IP address and VNC port number to access MCT4. The IP address is shown on the communications screen and is also included in the notifications list. Write down the IP address and port number so you will have it to enter into your VNC viewer.

There are many VNC viewers available for both PC and tablet use. Due to the ever-changing market and availability of such applications, it is not possible to test them all for compatibility or provide assistance for their use with the MCT4. It is the responsibility of the end user to test the chosen VNC client for compatibility with the MCT4 prior to putting the unit into service. If the VNC client viewer has compatibility issues with the MCT4, it can cause the VNC server to stop responding and/or shut down requiring power to be cycled to the MCT4 in order to reboot the system and restart the server.

Future Design Controls has tested and recommends the use of RealVNC's viewer. It has been tested for compatibility with the MCT4 and a free version can be obtained from http://www.realvnc.com/ for PC/MAC use. RealVNC does offer a version for the iPad that can be obtained through the App Store for a small fee. The App Store also offers a free VNC client called Remotix for the iPad. It has also been tested for compatibility with the MCT4.

NOTE: *Contact your network administrator prior to enabling the VNC server of the MCT4. Company policy may prohibit the use of VNC servers and/or viewers for security reasons. Future Design Controls is not responsible for the use of, nor makes any claims as to the security of the VNC server interface over your network. The use of the VNC server is the responsibility of the end user.*

11.1.3.1 Recommended VNC Viewer Settings (PC/MAC)

This section applies to setup of the recommended RealVNC viewer for PC/MAC. These settings have been tested and evaluated in order to provide the best performance and quickest response to user input when using the VNC viewer with the MCT4. After installing the VNC viewer software, it is recommended that the following changes be made to the default viewer settings.

To begin, start the VNC viewer. Click on the "Options" button in order to open the VNC Viewer - Options window. Click on the "Advanced" button at the bottom left of the window in order to show the advanced setup options.
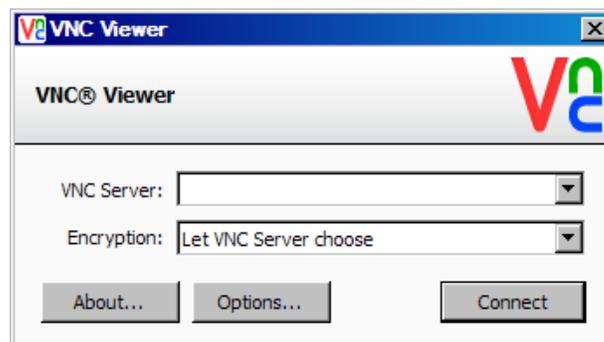
On the Display tab, make sure the scaling is set to "No scaling" and the checkbox for "Adapt to network speed (recommended)" is checked.
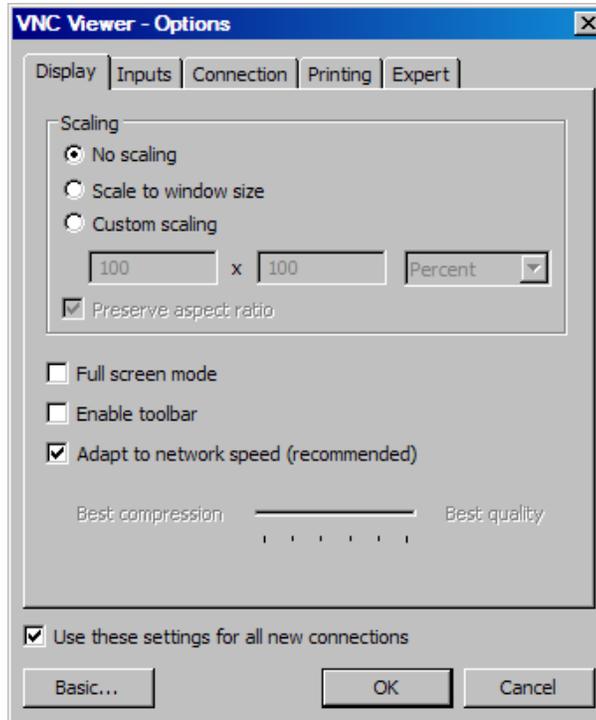
Next, select the Inputs tab and deselect all entries except for "Enable mouse input" and "Rate-limit mouse move events". The "Inputs:" drop down selection box will automatically change to "Custom" when the settings are made.
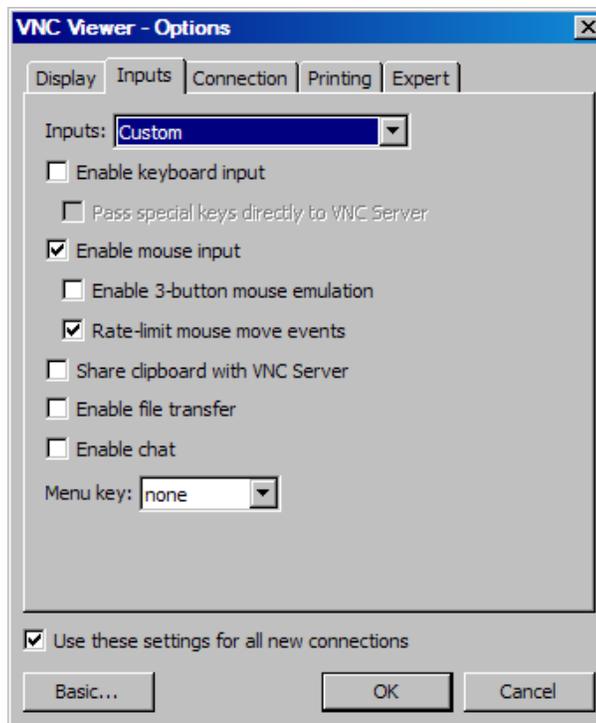
Proceed to the Expert tab. Scroll down the list of settings until you find the "PreferredEncoding" and "Protocol3.3" options. Set the preferred encoding to Hextile and the Protocol 3.3 option to true. Verify that the "Use these settings for all new connections" checkbox at the bottom of the window is checked and click the OK button. This will set the selections to the default start settings for the VNC viewer.
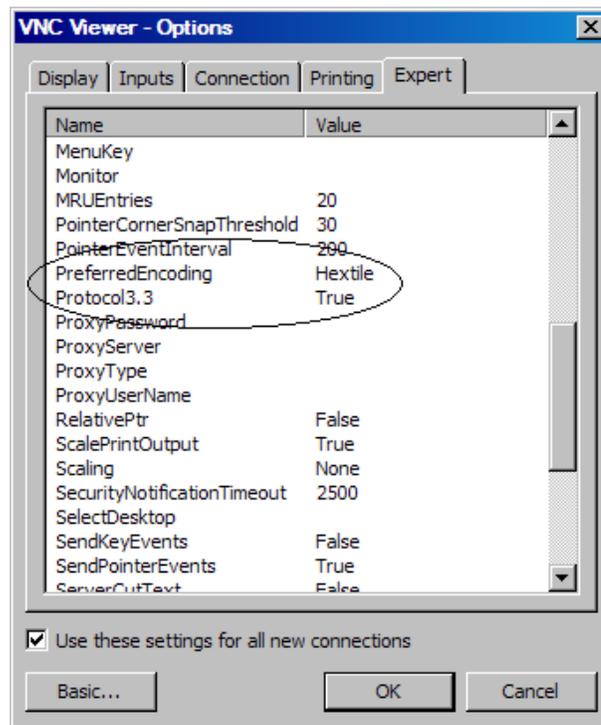
11.1.3.2 _Recommended VNC Viewer Settings for Tablets_

The VNC clients for tablets have been found to offer limited flexibility for use with the MCT4. Most clients have default settings requiring security to be enabled on the server in order to connect. If you have trouble connecting with a VNC viewer through an iPad, iPhone or even an Android based phone, start by enabling the security on the MCT4 VNC server and be sure to enter those settings in the client viewer.

Color and encoding options can also affect the connectivity. If the client offers the option, leave color and encoding options to "automatically detect" or "server decides". If the client is still unable to connect, try default encoding of Hextile and set the color option to limited colors such as 256-bit color. Future Design Controls does not write or create VNC clients (3rd party software), so final selection of client and testing is the end user responsibility. The following settings are provided as an example for the Remotix client for the iPad. When adding an MCT4 server to the Remotix client, use the following settings. Note that the VNC server in the MCT4 must have security enabled in order for this client to connect.

Connection Type: VNC
Host/IP: _IP address of MCT4_
Port: _VNC address of MCT4 (5900 = 0, 5901 = 1, etc…)_
Use SSH Tunnel: Off
VNC Authentication: VNC Password
VNC Password: _VNC password of MCT4_
VNC Server Type: AutoDetect
Operating System: Windows
Preferred Encodings: Hextile
Color Depth: 16 bits

11.1.3.3 Accessing the MCT4 through a VNC Viewer

The following examples are based on the use of the RealVNC viewer for PC/MAC. Once the default settings have been entered, just enter the IP address and port number for the MCT4 and click the "Connect" button to access the MCT4 over the network.

Intranet Example: If the IP address assigned is 192.168.3.5 and the configured VNC Address is 1, from the PC's VNC Viewer address field, enter '192.168.3.5:1' to access the device (address 1 relates to port 5901, address 2 to port 5902, etc., which is the port opened by the VNC server in order to allow communications with the MCT4 over the network).
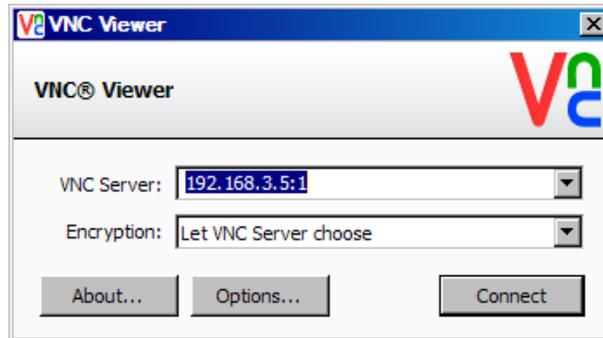
Internet Example: Internet connection usually requires a qualified network System Administrator. Typically, a permanent IP address and specific port address are assigned to the MCT4; support on this action is beyond the scope of this guide. *Consult your network system administrator for assistance in setting up an Internet connection.*

If the IP address of the LAN is 69.216.64.69 and the configured VNC Address is 1 (port 5901 has been opened and assigned to this specific MCT4 controller), from the remote PC (outside of the site Servers LAN), in the VNC Viewer address field enter '69.216.64.69::5901' to access the device (5901 relates to address 1, 5902 to address 2, 5903 to address 3, etc., note the double colon).
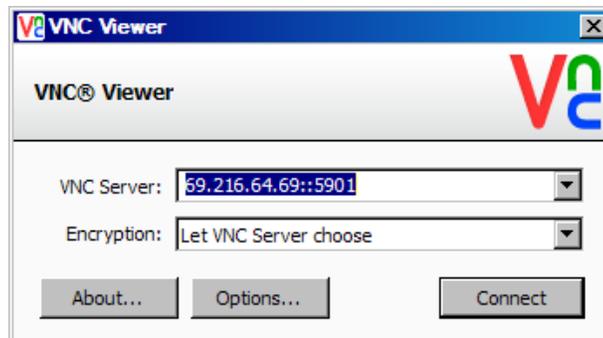
NOTE: The IP address shown on the communications screen of the MCT4 is the local LAN address and would not typically be used for an Internet connection.

Security Example: If the VNC server password is enabled on the MCT4 for either example above, upon pressing the "Connect" button to make the connection, the VNC viewer will prompt for the proper password. The connection will only be established once a valid password is entered.
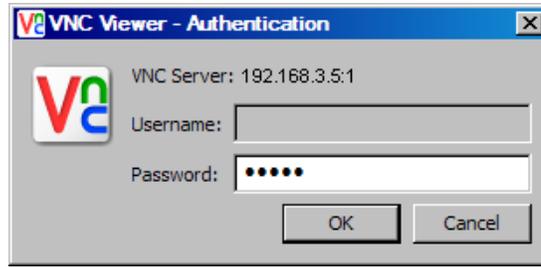
Once the connection is established, the current MCT4 display will be shown on your desktop. The image will be a duplicate of what is on the MCT4. As you manipulate the screen, the display of the MCT4 will also be manipulated so that any local operator will be able to see what is happening and vice versa.
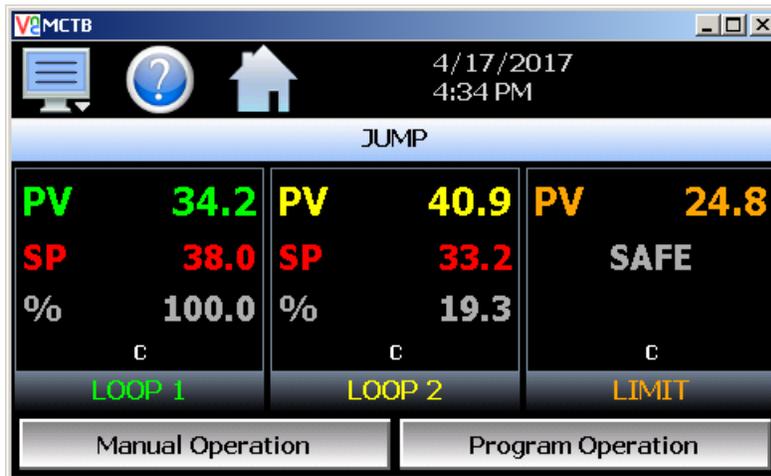
Multiple instances of the VNC viewer can be started on your PC. By running multiple viewers, you can have access to multiple MCT4 controllers right from your desktop. The heading of each VNC viewer window will use the "VNC Device Name" entry for the header. By entering a unique name for each MCT4, you can identify each VNC connection and know which system you are accessing.

The VNC viewer is meant to be used for short term control access to the MCT4. It is not meant for long term monitoring of system operation. If long term monitoring access is desired, use the built-in web server of the MCT4 or a PC with FDC software to monitor and control the MCT4 over its serial communications port. The web server interface and PC software is designed for long term monitoring and status updates.

Due to the nature of VNC operation, and for security reasons, the VNC viewer connection should not be left open on your desktop. The viewer connection should be opened in order to perform the necessary control and/or status check of system operation, and then closed once the task is complete. Accidental manipulation of the control or erroneous network activity could cause connection problems over the VNC interface and result in the VNC server shutting down and requiring the MCT4 to be restarted in order to regain access.

NOTE: *Some viewers may also contain additional features for file transfer and other high-level functions. These functions are NOT compatible with the MCT4. Any attempt to use them may cause the MCT4 VNC server to malfunction and require power to be cycled in order to reboot the system. All viewers should be used ONLY to monitor and manipulate the MCT4 as if you were standing directly in front of the unit and touching the screen.*

11.1.4 Using Modbus TCP/IP Communications

The MCT4 Modbus TCP server interface allows a user to remotely monitor and control the MCT4 via another device or software application compatible with Modbus TCP/IP protocol. The acronym TCP stands for Transmission Control Protocol while IP stands for Internet Protocol. These protocols are used together and handle the transfer of data over the internet. When Modbus information is sent using these protocols, the data is passed to the TCP layer where additional information is attached and then passed to the IP layer. The IP layer then places the data in a packet (or datagram) and transmits it.

Like the MCT4 Modbus serial interface, the TCP interface is always active; however, rather than using the Modbus Address on the communications screen as the slave address, the MCT4 IP address is used as the slave address. In order for Modbus TCP communications to function, the Master (or Client in Modbus TCP) establishes a connection with the Slave (or Server) using the IP address. In this case, the server is the MCT4. The MCT4 waits for an incoming connection from the client, and once a connection is established, the MCT4 then responds to queries from the client until the client closes the connection.

In order for a client to establish a connection with the MCT4, the following settings must be used by the client:

IP address (of slave) =   MCT4 IP address as displayed on the Communications screen
Unit Identifier =   MCT4 Modbus Address as displayed on the Communications screen.
Port Number =   502

NOTE: *The implementation and/or use of a Modbus TCP client is outside the scope of this manual. For additional information regarding Modbus TCP/IP protocol there are many resources available online (http://www.modbus.org/specs.php) or consult the documentation provided with your client software application.*

For a list of supported functions and data available over the Modbus TCP interface, see Appendix section A.1 Modbus Communications.

11.2 Serial Communications

The MCT4 serial interface uses Modbus RTU protocol. Any device used to communicate with the MCT4 over the serial interface must use this protocol.
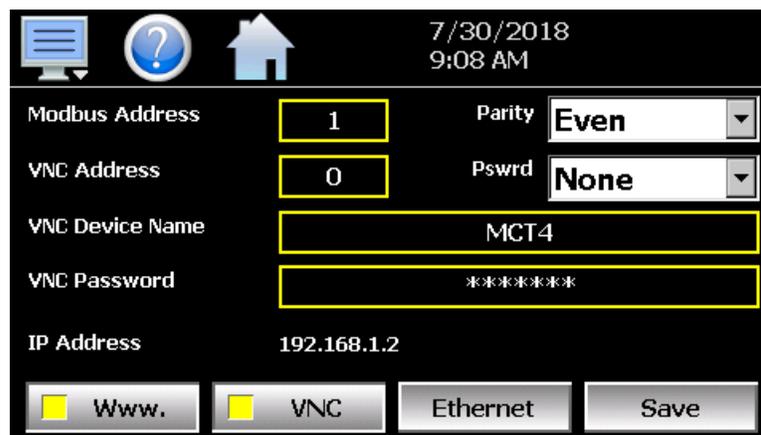
The communication address and parity can be set on the Web/Modbus/VNC screen. All other communication settings are fixed. The port settings of the device used to communicate with MCT4 must be set to match in order for the communications to take place.

Address: 1-247 (user selectable)
Baud Rate: 9600
Data Bits: 8
Stop Bits: 1
Parity: None, Odd, Even (user selectable)

The Modbus address is used to identify the MCT4 on the serial link. When a multi-drop connection is used, each controller on the link must have a different address so that each one can be identified separately. If two or more MCT4 controllers have duplicate addresses, communications with those controllers will fail because they will each try to respond to the same message. For single MCT4 connections, the address only needs to match that of the commands being sent from the host device.

IMPORTANT: *See Appendix section A.1 Modbus Communications for details on the available data and functions supported.*

12 Alarm Codes and Troubleshooting

This section provides explanations of standard MCT4 alarms to help in diagnosing and resolving the alarm conditions. Note that the information provided here covers standard alarms only, and not alarms configured by the OEM. If you are unable to diagnose a problem through the use of this guide, contact your OEM for further assistance.

Some of the troubleshooting procedures may require access to live circuitry. Dangerous accidental contact with line voltage may be possible. Only qualified service personnel should be allowed to perform these procedures.

Alarm Monitor Description	Explanation/Corrective Action
"*tagname*" A to D converter failure	(error code 40) Indicates that the analog to digital converter in the loop or limit control indicated by "*tagname*" has failed. Return to factory for repair or replace. *If the MCT4 is running a ramp/soak program when this alarm occurs, the program will be terminated if it occurs on either loop 1 or loop 2. If the alarm occurs on loop 3, the program will continue operation.*
Auto tune failed for "*tagname*".	(error code 26) Indicates that auto tune was unable to execute properly for the loop control indicated by "*tagname*". Verify that PB >0 and TI>0 before starting auto tune. Try manual tuning instead of auto tuning if the process has a very slow response.
"*tagname*" cold junction failure	(error code 30) Indicates that the cold junction compensation in the loop or limit control indicated by "*tagname*" has failed. Return to factory for repair or replace.
Communications error with "*tagname*". Check cable.	Communication error occurred between the MCT4 base unit and installed PCM/HLM indicated by *"tagname"*. Verify that the PCM/HLM is properly installed in the base unit. Replace PCM/HLM card.
Data file error. SD card full or missing.	Indicates that data logging could not be started or has been stopped due to an issue in accessing the SD memory card. This will occur if the memory card does not have any remaining memory space available or the maximum number of files has been reached in the data log directory. Use the USB file utilities or FTP to backup (copy) and delete data files from the MCT4 in order to free up memory. Verify that an SD card is properly inserted into the MCT4. Replace SD card.
"*tagname*" EEPROM failure	(error code 29) Indicates that the memory in the loop or limit control indicated by "*tagname*" has failed. Return to factory for repair or replace.
Email Error! Check cable or server down.	Indicates that the MCT4 was unable to send an alarm message through the mail server. Verify that the MCT4 is properly connected to the network and that the email settings and addresses are valid. *This alarm will also occur if the email server limit has been reached for the number of allowed emails. The hourly/daily limits for allowed email messages is dependent upon the service provider. If the email limit is reached, the server will terminate the connection and prevent the MCT4 from sending the email resulting in the alarm.*

Alarm Monitor Description	Explanation/Corrective Action
FTP! Check cable or server down.	Indicates that the FTP back-up attempt of the data files failed. Verify that the MCT4 is properly connected to the network and that the FTP settings are valid. *If the MCT4 is not connected to a network, disable the FTP data back-up to prevent this alarm from occurring.*
Main System Error: "*message*"	Indicates that an internal failure occurred in the module indicated in *"message"*. All system functions associated with the module are disabled. Unit must be rebooted in order to restore operation. If problem persists, contact your OEM for assistance. Modules include: *CommsThread* – communications with loops/limit/monitor disabled *ModbusTCP* – user ModbusTCP communications disabled *DataLog* – data logging and automatic program operation disabled *GraphTrend* – real time trends disabled *Email* – email disabled *Network* – all Dataweb, Fileweb and FTP disabled *NtsServer* – national time server clock synchronization disabled *MathLogic* – all math/logic functions disabled
Memory Error Please check SD card.	Indicates that the SD card cannot be accessed when checking available memory space. Verify that an SD card is properly inserted into the MCT4. Replace SD card.
NTP Ping Failed. Check Cable.	Indicates that the MCT4 was unable to synchronize its clock with the selected time server. Verify that the MCT4 is properly connected to the network and the selected time server is accessible. *If the MCT4 is not connected to a network, disable the NTS clock to prevent this alarm from occurring.*
"tagname" outputs 1 and 2 incorrectly configured.	(error code 4) Indicates that the control loop configuration for the loop control indicated by "tagname" is not valid and must be corrected to clear the alarm. Check and correct setup values of output 2, PB, TI and output 1. If output 2 is required for cooling control, the control should use PID mode (PB > 0, TI > 0) and output 1 should use reverse mode (heat action), otherwise, don't use output 2 for cooling control.
SD card damaged or missing.	Indicates that the SD card cannot be accessed for USB file transfer. Verify that an SD card is properly inserted into the MCT4. Replace SD card.
SD card filled. Please use USB file transfer.	Indicates that a file was unable to be written due to lack of available free space on the memory card. Use the USB file utilities or FTP to backup (copy) and delete alarm, audit and data files from the MCT4 in order to free up memory. Can also occur if the SD card is missing/not properly inserted.
"tagname" sensor break	Check sensor wiring for the loop or limit control indicated by *"tagname"*. Verify lead connections. If sensor requires power, verify power to sensor. *If the MCT4 is running a ramp/soak program when this alarm occurs, the program will be placed in hold if the sensor break occurs on a loop that is controlled by the program and must be manually resumed. If the sensor break occurs on a loop not controlled by the program, the program will remain running.*

Appendix

A.1 Modbus Communications

The MCT4 utilizes Modbus as its standard protocol and offers both Modbus RTU serial and Modbus TCP forms. This section provides information on the supported functions and data available over the Modbus interface. It is assumed that the user is already familiar with Modbus protocol and has a basic understanding of its implementation and use. For additional information and support, modbus.org (http://modbus.org/tech.php) provides an abundance of technical documents, standards and support applications.

Listed below are a few of the more common software packages that claim to support Modbus protocol. This list is provided as informational only. Contact the software manufacturer for more information on applying their software.

LabView by National Instruments
11500 N Mopac Expwy
Austin, TX 78759-3504
Phone 800-683-8411
http://www.natinst.com

Wonderware by Wonderware
26561 Rancho Pkwy. South
Lake Forest, CA 92630
Phone 949-727-3200
http://www.wonderware.com

SpecView by SpecView Corporation
13409 53rd Ave NW
Gig Harbor, WA 98332
Phone 253-853-3199
http://www.specview.com

A.1.1 Supported Function Codes

Modbus bases its data model on a series of tables, each of which defines a particular range of values. In the case of the MCT4, all data is contained within the Holding Register data table. This means that all communication transactions between the MCT4 and the master (client) are performed using three command types. These include Read Holding Registers, Write Single Register and Write Multiple Registers.

		Function Codes	
		code	(hex)
16 bits access (word)	Read Holding Registers	03	03
	Write Single Register	06	06
	Write Multiple Registers	16	10

Function code 03 (read holding registers) is used to read the contents of a contiguous block of data registers from the MCT4. The request from the master specifies the starting register address and the number of registers. The response message from the MCT4 contains the value of each register requested (two bytes per register).

Function code 06 (write holding register) is used to write to a single data register in the MCT4. The request from the master specifies the address of the register to be written and the value. The response message from the MCT4 is an exact duplicate of the sent message (if completed successfully).

Function code 16 (write multiple registers) is used to write to a contiguous block of data registers in the MCT4. The request from the master specifies the starting register address to be written, the number of registers to write and two bytes of data for each register. The normal response message from the MCT4 returns the function code, starting address and quantity of data registers written.

A.1.2 MCT4 Data Registers

Some of the values contained in the MCT4 register base contain bit-oriented values. This means that each bit of the word indicates an on/off status for a specific setting or condition. In handling these values, it is recommended that the word be converted to its binary equivalent.

By converting the value to its binary equivalent, it produces a Boolean array of true [bit on (1)] and false [bit off (0)] values. This allows each bit to be examined individually. In the same manner, creating a Boolean array of 16 bits produces an equivalent hexadecimal value that can be sent to the MCT4 in order to set a control register.

For the purpose of this manual, parameters defined as bit oriented will have the function of each bit associated with the bit's index number in the data word. The index number is equal to that of a typical array function. Thus, an index number of zero, selects the first bit in the word (LSB). An index number of 1 selects the second bit in the word, and so on. This helps eliminate offset selection errors that may occur when coding software and using array functions to select which bit in the word that is required for examination.

Data Register (1 word = 16 bits)

MSB 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 LSB

Index
Bit15
Bit14
Bit13
Bit12
Bit11
Bit10
Bit9
Bit8
Bit7
Bit6
Bit5
Bit4
Bit3
Bit2
Bit1
Bit0
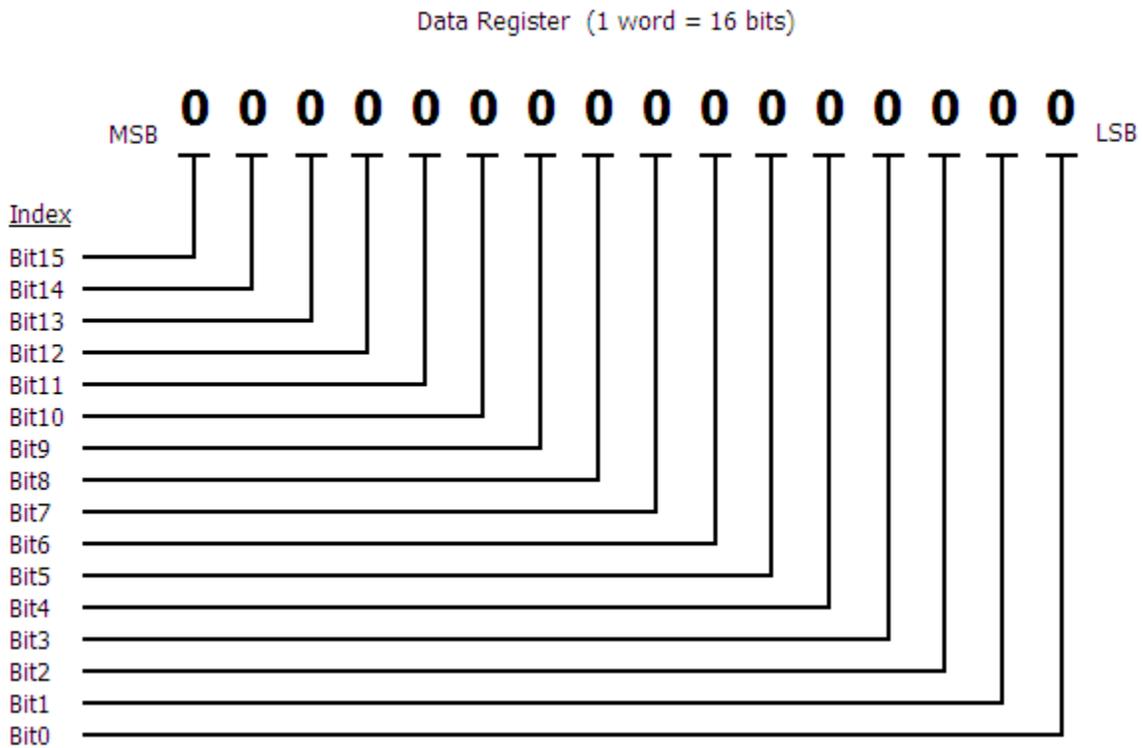
Adhere to the following lists of registers and their allowable data ranges. DO NOT attempt to write to any other register number than those listed. DO NOT write to registers that are for options your controller does not have. Failure to adhere to this requirement can result in erratic control and/or damage to equipment.

A.1.2.1   _Control Registers_

Modbus Address	Register Number		Parameter Description	Data *A Type	Range *B Low	High	*C Unit
400001	0	**(0x0000)**	System Offline/Busy Status	R	*B1	*B1	-
400002	1	**(0x0001)**	Alarm Reset	R/W	0	1	-
400003	2	**(0x0002)**	Automatic Program Out of Sync Alarm	R	0	1	-
400004	3	**(0x0003)**	Loop Communication Alarm Status	R	*B2	*B2	-
400005	4	**(0x0004)**	Loop Control Error Status	R	*B3	*B3	-
400006	5	**(0x0005)**	Process Alarm Status	R	*B4	*B4	-
400007	6	**(0x0006)**	Process Alarm Status	R	*B4	*B4	-
400008	7	**(0x0007)**					
400009	8	**(0x0008)**					
400010	9	**(0x0009)**	Control Loop Manual Override	R/W	*B5	*B5	-
400011	10	**(0x000A)**	Control Loop Autotune Activation	R/W	*B6	*B6	-
400012	11	**(0x000B)**	**RESERVED** – DO NOT write to register				
400013	12	**(0x000C)**	System Events	R/W	*B7	*B7	-
400014	13	**(0x000D)**					
400015	14	**(0x000E)**	Automatic Program Start Step Number	R/W	1	64	-
400016	15	**(0x000F)**	Automatic Program Operating Status	R/W	*B8	*B8	-
400017	16	**(0x0010)**	Program Name Characters 1 & 2	R	*B9	*B9	-
400018	17	**(0x0011)**	Program Name Characters 3 & 4	R	*B9	*B9	-
400019	18	**(0x0012)**	Program Name Characters 5 & 6	R	*B9	*B9	-
400020	19	**(0x0013)**	Program Name Characters 7 & 8	R	*B9	*B9	-
400021	20	**(0x0014)**	Program Name Characters 9 & 10	R	*B9	*B9	-
400022	21	**(0x0015)**	Program Name Characters 11 & 12	R	*B9	*B9	-
400023	22	**(0x0016)**	Program Name Characters 13 & 14	R	*B9	*B9	-
400024	23	**(0x0017)**	Current Program Step	R	1	64	-
400025	24	**(0x0018)**	Total Number of Steps	R	1	64	-
400026	25	**(0x0019)**	Total Time of Step	R	0	99.59	-
400027	26	**(0x001A)**	Time Remaining in Step	R	0	99.59	-
400028	27	**(0x001B)**	Cycles Remaining for Current Jump Loop	R	1	10000	-
400029	28	**(0x001C)**	Program TOD Start Month/Day	R/W	*B15	*B15	-
400030	29	**(0x001D)**	Program TOD Start Year	R/W	0	99	-
400031	30	**(0x001E)**	Program TOD Start Hour/Minute	R/W	*B16	*B16	-
400032	31	**(0x001F)**	Loop 1 Target SP Current Step/Ramp Rate	R	-32768	32767	*C1
400033	32	**(0x0020)**	Loop 2 Target SP Current Step/Ramp Rate	R	-32768	32767	*C1
400034	33	**(0x0021)**	Loop 2 Target SP Current Step/Ramp Rate	R	-32768	32767	*C1
400035	34	**(0x0022)**					
400036	35	**(0x0023)**	Loop 1 Process Variable (PV)	R	-32768	32767	*C1
400037	36	**(0x0024)**	Loop 1 Setpoint (SP)	R/W	-32768	32767	*C1

Modbus Address	Register Number		Parameter Description	Data *A Type	Range *B Low	High	*C Unit
400038	37	**(0x0025)**	Loop 1 Percent Output (%Out)	R/W	-100.00	100.00	%
400039	38	**(0x0026)**	Loop 1 Operational Status	R	*B10	*B10	-
400040	39	**(0x0027)**	Loop 1 Error Code	R	*B11	*B11	-
400041	40	**(0x0028)**	Loop 2 / Limit Process Variable (PV)	R	*B12	*B12	*C1
400042	41	**(0x0029)**	Loop 2 Setpoint (SP)	R/W	-32768	32767	*C1
400043	42	**(0x002A)**	Loop 2 Percent Output (%Out)	R/W	-100.00	100.00	%
400044	43	**(0x002B)**	Loop 2 / Limit Operational Status	R	*B10	*B10	-
400045	44	**(0x002C)**	Loop 2 / Limit Error Code	R	*B11	*B11	-
400046	45	**(0x002D)**	Loop 3 / Limit Process Variable (PV)	R	*B12	*B12	*C1
400047	46	**(0x002E)**	Loop 3 Setpoint (SP)	R/W	-32768	32767	*C1
400048	47	**(0x002F)**	Loop 3 Percent Output (%Out)	R/W	-100.00	100.00	%
400049	48	**(0x0030)**	Loop 3 / Limit Operational Status	R	*B10	*B10	-
400050	49	**(0x0031)**	Loop 3 / Limit Error Code	R	*B11	*B11	-
400051	50	**(0x0032)**					
400052	51	**(0x0033)**	Alarm 1 Setpoint	R/W	*B13	*B13	*C1
400053	52	**(0x0034)**	Alarm 2 Setpoint	R/W	*B13	*B13	*C1
400054	53	**(0x0035)**	Alarm 3 Setpoint	R/W	*B13	*B13	*C1
400055	54	**(0x0036)**	Alarm 4 Setpoint	R/W	*B13	*B13	*C1
400056	55	**(0x0037)**	Alarm 5 Setpoint	R/W	*B13	*B13	*C1
400057	56	**(0x0038)**	Alarm 6 Setpoint	R/W	*B13	*B13	*C1
400058	57	**(0x0039)**	Alarm 7 Setpoint	R/W	*B13	*B13	*C1
400059	58	**(0x003A)**	Alarm 8 Setpoint	R/W	*B13	*B13	*C1
400060	59	**(0x003B)**	Alarm 9 Setpoint	R/W	*B13	*B13	*C1
400061	60	**(0x003C)**	Alarm 10 Setpoint	R/W	*B13	*B13	*C1
400062	61	**(0x003D)**	Alarm 11 Setpoint	R/W	*B13	*B13	*C1
400063	62	**(0x003E)**	Alarm 12 Setpoint	R/W	*B13	*B13	*C1
400064	63	**(0x003F)**	Alarm 13 Setpoint	R/W	*B13	*B13	*C1
400065	64	**(0x0040)**	Alarm 14 Setpoint	R/W	*B13	*B13	*C1
400066	65	**(0x0041)**	Alarm 15 Setpoint	R/W	*B13	*B13	*C1
400067	66	**(0x0042)**	Alarm 16 Setpoint	R/W	*B13	*B13	*C1
400068	67	**(0x0043)**	Alarm 17 Setpoint	R/W	*B13	*B13	*C1
400069	68	**(0x0044)**	Alarm 18 Setpoint	R/W	*B13	*B13	*C1
400070	69	**(0x0045)**	Alarm 19 Setpoint	R/W	*B13	*B13	*C1
400071	70	**(0x0046)**					
400072	71	**(0x0047)**	Input 1 Units	R	*B14	*B14	-
400073	72	**(0x0048)**	Input 2 Units	R	*B14	*B14	-
400074	73	**(0x0049)**	Input 3 Units	R	*B14	*B14	-
400075	74	**(0x004A)**	Input 4 Units	R	*B14	*B14	-
400076	75	**(0x004B)**	Input 5 Units	R	*B14	*B14	-

Modbus Address	Register Number	Parameter Description	Data *A Type	Range *B		*C Unit
				Low	High	
400077	76 (0x004C)	Input 6 Units	R	*B14	*B14	-
400078	77 (0x004D)	Input 7 Units	R	*B14	*B14	-
400079	78 (0x004E)	Input 8 Units	R	*B14	*B14	-
400080	79 (0x004F)	Input 9 Units	R	*B14	*B14	-
400081	80 (0x0050)	Input 10 Units	R	*B14	*B14	-
400082	81 (0x0051)	Input 11 Units	R	*B14	*B14	-
400083	82 (0x0052)					
400084	83 (0x0053)					
400085	84 (0x0054)					
400086	85 (0x0055)					
400087	86 (0x0056)					
400088	87 (0x0057)					
400089	88 (0x0058)					
400090	89 (0x0059)					
400091	90 (0x005A)	Monitor Point 1 Process variable (PV)	R	-32768	32767	*C1
400092	91 (0x005B)	Monitor Point 2 Process variable (PV)	R	-32768	32767	*C1
400093	92 (0x005C)	Monitor Point 3 Process variable (PV)	R	-32768	32767	*C1
400094	93 (0x005D)	Monitor Point 4 Process variable (PV)	R	-32768	32767	*C1
400095	94 (0x005E)	Monitor Point 5 Process variable (PV)	R	-32768	32767	*C1
400096	95 (0x005F)	Monitor Point 6 Process variable (PV)	R	-32768	32767	*C1
400097	96 (0x0060)	Monitor Point 7 Process variable (PV)	R	-32768	32767	*C1
400098	97 (0x0061)	Monitor Point 8 Process variable (PV)	R	-32768	32767	*C1
400099	98 (0x0062)	Expansion Module Input Status	R	*B17	*B17	-
400100	99 (0x0063)	Expansion Module Output Status	R	*B18	*B18	-

Notes:

*A   R/W Specifies readable / writable data, R specifies read only data and W specifies a write only control value.

*B   The range of certain parameters are dependent upon system options. Consult the following range tables for information regarding the use of these parameters.

Reading bit-oriented parameters
The value contained in these parameters is dependent upon the combination of "on" bits (1). Therefore, only the individual status of each bit has meaning, not the value of the parameter.

Setting bit-oriented parameters
The value that must be written to these parameters is dependent upon the combination of "on" bits. Therefore, it is necessary to know the current value of the parameter before setting it so that only the bit status you want to update is changed. Otherwise, sending a value derived from only the bit you wish to set will turn off all other functions related to the other bits in the parameter.

*B1

Parameter Value	Description
0	MCT4 is Online
1	Offline/Program Download in Progress

The status of this register should be used for information only, as a means of determining if the system is ready for operation.

*B2

Parameter Value	Description
Bit0	Loop 1 Communications Error
Bit1	Loop 2 / Limit / Monitor Card Communications Error
Bit2	Loop 3 / Limit / Monitor Card Communications Error
Bit3	Monitor Card Communication Error
Bit4 – Bit15	Not Assigned

Note: If a bit is on, check the corresponding loop / limit communication wiring/settings to determine the cause for the alarm.

For Bit1 and Bit2, the device associated with the error is dependent upon the system configuration. If the MCT4 is a single loop control with the limit installed, Bit1 will represent an error code on the limit control. If the MCT4 has two control loops configured with monitor points and no limit, Bit1 will represent an error on loop 2 while Bit2 represents an error on the monitor card.

*B3

Parameter Value	Description
Bit0	In1 Sensor Break (loop control error)
Bit1	In2 (loop/limit control error)
Bit2	In3 (loop/limit control error)
Bit3	In4 Sensor Break
Bit4	In5 Sensor Break
Bit5	In6 Sensor Break
Bit6	In7 Sensor Break
Bit7	In8 Sensor Break
Bit8	In9 Sensor Break
Bit9	In10 Sensor Break
Bit10	In11 Sensor Break
Bit11–Bit15	Not Assigned

Note: If a bit is on, it indicates a problem with the associated device. If the input is associated with a loop or limit control, check the corresponding loop or limit operational status register to determine the cause for the alarm.

For monitor points, check input wiring to determine if the signal is within the proper range for the input configuration.

*B4

Parameter Value	Description
Bit0	Alarm 1 Active
Bit1	Alarm 2 Active
Bit2	Alarm 3 Active
Bit3	Alarm 4 Active
Bit4	Alarm 5 Active
Bit5	Alarm 6 Active
Bit6	Alarm 7 Active
Bit7	Alarm 8 Active
Bit8	Alarm 9 Active
Bit9	Alarm 10 Active
Bit10	Alarm 11 Active
Bit11	Alarm 12 Active
Bit12	Alarm 13 Active
Bit13	Alarm 14 Active
Bit14	Alarm 15 Active
Bit15	Alarm 16 Active

Note: Alarms 1 through 16 are indicated in register 5. The number of alarms available in the system is dependent upon the configuration.

Parameter Value	Description
Bit0	Alarm 17 Active
Bit1	Alarm 18 Active
Bit2	Alarm 19 Active
Bit3 – Bit15	Not Assigned

Note: Alarms 17 through 19 are indicated in register 6. The register will be used to indicate alarm active status only when more than 16 alarms are configured.

*B5

Parameter Value	Description
Bit0	Loop 1 Manual Mode
Bit1	Loop 2 Manual Mode
Bit2	Loop 3 Manual Mode
Bit3 – Bit15	Not Assigned

Note: When loop is in manual mode, the loop percentage of output can be set by writing to the corresponding loop percent output register.

*B6

Parameter Value	Description
Bit0	Loop 1 in Auto Tune
Bit1	Loop 2 in Auto Tune
Bit2	Loop 3 in Auto Tune
Bit3 – Bit15	Not Assigned

Note: Auto tune may not be available depending upon the loop configuration. If auto tune operation is not available, the bit for the loop will automatically turn off after being set.

When auto tune completes normally, the bit for the loop will automatically turn off indicating that tune is complete. To terminate an auto tune in progress, turn off the bit for the desired loop.

*B7

Parameter Value	Description
Bit0	Event 1
Bit1	Event 2
Bit2	Event 3
Bit3	Event 4
Bit4	Event 5
Bit5	Event 6
Bit6	Event 7
Bit7	Event 8
Bit8	Event 9
Bit9	Event 10
Bit10	Event 11
Bit11	Event 12
Bit12	Event 13
Bit13	Event 14
Bit14	Event 15
Bit15	Event 16

Note: Not all system events may be available on your system. Event names and functions are defined by system configuration. Consult your system documentation or contact your OEM for information on event use.

*B8

Parameter Value	Description
0	Automatic Program Start (On)
1	Automatic Program Hold
2	Automatic Program Halt (Off)
3	Holdback (read only)
4	TOD Start

*B9

Parameter Value	High Order Byte	Low Order Byte	Description
Range Low	32	32	Program Name Character (ASCII Table)
Range High	126	126	Program Name Character (ASCII Table)

See the ASCII character chart in Section 3.1 for the character representation of these values.

Example
Read command of registers 16 to 22 from the MCT4 returns the following values:

Register Values:	0x74 53	0x72 6F	0x20 65	0x65 54	0x74 73	0x20 20	0x20 20
ASCII Equivalent:	t S	r o	e	e T	t s		

Assemble the ASCII characters in order from low to high byte starting with register 16 in order to assemble the automatic program name: "Store Test". Note that null characters are not used in the program name. A space (0x20) will be used is used in place of a null character to maintain the 14-character name length if the program name is not 14 characters long.

*B10

Parameter Value	Description
Bit0	Program Run Mode / Limit Ou1
Bit1	Program Hold Mode / Limit Out2
Bit2	Static Mode
Bit3	Auto Tune Mode
Bit4	Manual Mode
Bit5	Off Mode
Bit6	Failure Transfer
Bit7	Automatic Program Ramp Up
Bit8	Automatic Program Ramp Down
Bit9	Automatic Program Soak
Bit10	Alarm 1 Active
Bit11	Alarm 2 Active
Bit12	Alarm 3 Active
Bit13	Event 1 On
Bit14	Event 2 On
Bit15	Event 3 On

Note: The "alarm active" and "event on" status bits cannot be used for determining alarm or event status. The alarm and event activation are based upon loop configuration. To monitor alarm and event status, use registers 5 and 12 respectively.

For **limit controls**, only Bit0 and Bit1 are used. The bits represent the active state of the limit output. When the bit is on (1), the output is on. When the bit is off (0), the output is off. Under normal conditions Bit0 will be on indicating a non-limit condition. The status of Bit1 is dependent upon the alarm configuration of output 2.

*B11

Parameter Value	Description
0	No Error
4	Illegal Setup Values
10	Comm Error – Bad Function Code
11	Comm Error – Register Out of Range
14	Comm Error – Write Read Only Data
15	Comm Error – Out of Range Data
25	Holdback Time Out
26	Auto Tune Error
27	Input Type Requires Calibration
29	EEPROM Error
30	Cold Junction Failure
39	Sensor Break
40	A to D Failure

*B12

Parameter Value	Range Low	Range High
Loop PV Monitor PV	-32768	32767
Limit PV	-19999	45536

Note: The process value for loop controls and monitor points are read directly as a short, i.e., a 16-bit signed integer with the range of -32768 to 32767.

For the **limit control**, the process value is read as an unsigned integer, i.e., a 16-bit unsigned integer with a range of 0 to 65535. In order to convert the value read to the actual process value, subtract 19999 from the value read from the limit control. This results in a value of -19999 to 45536.

*B13

Parameter Value	Input Units	Range Low	Range High
Loop Alarm SP	Deg C	-18000	18000
	Deg F	-32768	32767
	Process	-32768	32767
Limit Alarm SP	Deg C	-11280	25120
	Deg F	-19999	45536
	Process	-19999	45536

Note: The alarm set point value for loop controls is read/written directly as a short, i.e., a 16-bit signed integer with the range of -32768 to 32767.

For the **limit control**, the alarm set point value is read/written as an unsigned integer, i.e., a 16-bit unsigned integer with a range of 0 to 65535. In order to convert the value read/written to the limit control to the proper display value, subtract 19999 from the value read or add 19999 to the value prior to writing it. This results in a value within the overall range of -19999 to 45536.

*B14

Parameter Value	Description
0	Centigrade
1	Fahrenheit
2	Process Units

Note: When the loop, limit or monitor point input type is linear (process units), the units of measure are based on the OEM configuration.

*B15

Parameter Value	Range Low	Range High	Description
High Byte	1	12	Month
Low Byte	1	31	Day

*B16

Parameter Value	Range Low	Range High	Description
High Byte	0	23	Hour
Low Byte	0	59	Minute

*B17

Parameter Value	Description
Bit0	Input 8
Bit1	Input 9
Bit2	Input 10
Bit3	Input 11
Bit4	Input 12
Bit5	Input 13
Bit6	Input 14
Bit7	Input 15
Bit8	Input 16
Bit9	Input 17
Bit10	Input 18
Bit11	Input 19
Bit12	Input 20
Bit13	Input 21
Bit14	Input 22
Bit15	Input 23

*B18

Parameter Value	Description
Bit0	Output 32
Bit1	Output 33
Bit2	Output 34
Bit3	Output 35
Bit4	Output 36
Bit5	Output 37
Bit6	Output 38
Bit7	Output 39
Bit8	Output 40
Bit9	Output 41
Bit10	Output 42
Bit11	Output 43
Bit12	Output 44
Bit13	Output 45
Bit14-15	Not Assigned

*C1   The units of measure and range of a loop or limit control is dependent upon the configuration of the input and/or the units of temperature selection (Celsius or Fahrenheit) of the MCT4. The decimal point position for the loop or limit input is an implied value based on the configuration of the input. Thus, a register value of 345 can represent an actual process value of 345, 34.5, 3.45 or 0.345 depending upon the decimal point configuration of the loop or monitor input.

A.1.2.2   *Automatic Program Registers*

The automatic program parameters are a separate group of registers that are used to load programs into the MCT4. The manner in which the program steps are configured and sent to the MCT4 is specific and must be followed exactly.

Each program step consists of 20 data registers. The program must be written one step at a time, using a multiple write command (0x10) to write the data for all 18 registers at once. This allows programs to be stored as two-dimensional arrays, of which code can be written to simply index through the array step-by-step and transmit the program file to the MCT4.

IMPORTANT: *When downloading programs to the MCT4, the program will be saved with the name contained in the program header. If no name is specified (register values of 0), the default name of "PC_Download" will be used. The program can then be accessed and/or edited from the front of the MCT4.*

If program already exists within the MCT4 memory with the same name, it will be overwritten. However, if the program with the same name is currently running, the program downloaded will not overwrite the existing program. It will instead be saved as "PC_Download". After the current program is stopped, the operator can then choose to save the program under its intended name, or rename it to something else.

The first 20 registers (the program header) of the program contain specific settings related to the program. These include hold back limits, ramp units, dwell units, the program name and the length of the program (number of steps).

Modbus Address	Register Number		Parameter Description	Data *D Type	Range *E Low	High	*F Unit
401101	1100	**(0x044C)**	Hold Back Limit Loop 1	W	*E1	*E1	PV
401102	1101	**(0x044D)**					
401103	1102	**(0x044E)**	Ramp Units	W	*E2	*E2	-
401104	1103	**(0x044F)**	Dwell Units	W	*E3	*E3	-
401105	1104	**(0x0450)**	Hold Back Limit Loop 2	W	*E1	*E1	PV
401106	1105	**(0x0451)**					
401107	1106	**(0x0452)**	Total Number of Steps	W	1	64	-
401108	1107	**(0x0453)**	Program Name (Chars 1 & 2)	W	*E4	*E4	-
401109	1108	**(0x0454)**	Program Name (Chars 3 & 4)	W	*E4	*E4	-
401110	1109	**(0x0455)**	Program Name (Chars 5 & 6)	W	*E4	*E4	-
401111	1110	**(0x0456)**	Program Name (Chars 7 & 8)	W	*E4	*E4	-
401112	1111	**(0x0457)**	Program Name (Chars 9 & 10)	W	*E4	*E4	-
401113	1112	**(0x0458)**	Program Name (Chars 11 & 12)	W	*E4	*E4	-
401114	1113	**(0x0459)**	Program Name (Chars 13 & 14)	W	*E4	*E4	-
401115	1114	**(0x045A)**	Program Name (Chars 15 & 16)	W	*E4	*E4	-
401116	1115	**(0x045B)**					
401117	1116	**(0x045C)**	Hold Back Limit Loop 3	W	*E1	*E1	PV
401118	1117	**(0x045D)**					
401119	1118	**(0x045E)**					
401120	1119	**(0x045F)**					

The following 20 registers of the automatic program contain the data for step 1 of the program.

Modbus Address	Register Number		Parameter Description	Data *D Type	Range *E Low	High	*F Unit
401121	1120	**(0x0460)**	Step Number*	W	0	63	-
401122	1121	**(0x0461)**	Step Type	W	*E5	*E5	-
401123	1122	**(0x0462)**	Ramp Target Setpoint Loop 1	W	-32768	32767	PV
401124	1123	**(0x0463)**	Ramp Time or Ramp Rate	W	0	5999	-
401125	1124	**(0x0464)**	Event Selections 1, 2, 3	W	*E6	*E6	-
401126	1125	**(0x0465)**	Holdback Type Loop 1	W	*E7	*E7	-
401127	1126	**(0x0466)**	Dwell Time	W	0	9999	-
401128	1127	**(0x0467)**	Jump Step	W	0	63	-
401129	1128	**(0x0468)**	Jump Cycles	W	1	9999	-
401130	1129	**(0x0469)**	Final Setpoint Loop 1	W	-32768	32767	PV
401131	1130	**(0x046A)**	Ramp Target Setpoint Loop 2	W	-32768	32767	PV
401132	1131	**(0x046B)**	Event Selections 4, 5, 6	W	*E8	*E8	-
401133	1132	**(0x046C)**	Holdback Type Loop 2	W	*E7	*E7	-
401134	1133	**(0x046D)**	Final Setpoint Loop 2	W	-32768	32767	PV
401135	1134	**(0x046E)**	Ramp Target Setpoint Loop 3	W	-32768	32767	PV
401136	1135	**(0x046F)**	Event Selections 7, 8, 9	W	*E9	*E9	-
401137	1136	**(0x0470)**	Holdback Type Loop 3	W	*E7	*E7	-
401138	1137	**(0x0471)**	Final Setpoint Loop 3	W	-32768	32767	PV
401139	1138	**(0x0472)**	Wait Selections	W	*E10	*E10	-
401140	1139	**(0x0473)**	Wait Setpoint	W	-32768	32767	-

*The **Step Number** must be offset by -1 when writing step data to the MCT4. Steps 1-64 will be sent with the step number as a value of 0-63 (-1 offset).

All remaining steps of the program follow the same format and data structure as is represented for step one above. Up to the following 1260 registers are used to contain the additional step data of the program as required for steps 2 through 64. Since few if any programs will contain the maximum of 64 steps, it is only necessary to write the step data for the number steps used in the program.

Modbus Addresses	Register Numbers	
401141 – 401160	1140 (0x0474) – 1159 (0x0487)	Program Step 2 Data Registers
401161 – 401180	1160 (0x0488) – 1179 (0x049B)	Program Step 3 Data Registers
401181 – 401200	1180 (0x049C) – 1199 (0x04AF)	Program Step 4 Data Registers
401201 – 401220	1200 (0x04B0) – 1219 (0x04C3)	Program Step 5 Data Registers
401222 – 401240	1220 (0x04C4) – 1239 (0x04D7)	Program Step 6 Data Registers
401241 – 401260	1240 (0x04D8) – 1259 (0x04EB)	Program Step 7 Data Registers
401261 – 401280	1260 (0x04EC) – 1279 (0x04FF)	Program Step 8 Data Registers
401281 – 401300	1280 (0x0500) – 1299 (0x0513)	Program Step 9 Data Registers

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through

| 402381 - 402400 | 2380 (0x094C) – 2399 (0x095F) | Program Step 64 Data Registers |

Notes:

*D   W Specifies write only data.

*E1

Parameter Value	Temperature Units °C	Temperature Units °F	Process Units
Range Low	0	0	0
Range High	555	999	999

*E2

Parameter Value	Description
0	Hours and Minutes
1	Minutes and Seconds
2	Units/Minute
3	Units/Hour

Note: DO NOT use ramp units of units/minute or units/hour on a dual loop system. Since step time is defined by the ramp rate and the change in set point, the program will get out of sync between each loop causing an automatic program run error.

*E3

Parameter Value	Description
0	Hours and Minutes
1	Minutes and Seconds

*E4   See note *B9 in Section 5.1 for information on the range of this parameters.

*E5

Parameter Value	Description
0	Ramp
1	Soak
2	Jump
3	End

Note: The last step of an automatic program must be an end step. If the last step is not an end step, the program will not run correctly and/or a program download error will occur and the program will not operate.

*E6

Parameter Value	Description
Bit0	Event 1
Bit1	Event 2
Bit2	Event 3
Bit3 – Bit15	Not Assigned

Note: The available system events are based on the configuration of the MCT4. Event outputs configured as manual event outputs only cannot be controlled by the program.

*E7

Parameter Value	Description
0	Holdback Disabled
3	Deviation Band Holdback

*E8

Parameter Value	Description
Bit0	Event 4
Bit1	Event 5
Bit2	Event 6
Bit3 – Bit15	Not Assigned

Note: The available system events are based on the configuration of the MCT4. Event outputs configured as manual event outputs only cannot be controlled by the program.

*E9

Parameter Value	Description
Bit0	Event 7
Bit1	Event 8
Bit2	Event 9
Bit3 – Bit15	Not Assigned

Note: The available system events are based on the configuration of the MCT4. Event outputs configured as manual event outputs only cannot be controlled by the program.

*E10

Parameter Value	Description
Bit0	Loop 1 Wait For
Bit1	Loop 2 Wait For
Bit2	Loop 3 Wait For
Bit3	Monitor Point 1 Wait For
Bit4	Monitor Point 2 Wait For
Bit5	Monitor Point 3 Wait For
Bit6	Monitor Point 4 Wait For
Bit7	Monitor Point 5 Wait For
Bit8	Monitor Point 6 Wait For
Bit9	Monitor Point 7 Wait For
Bit10	Monitor Point 8 Wait For
Bit11-Bit15	Not Assigned

Note: The available wait selections are based on the configuration of the MCTB. Wait selections for loops or monitor points that are not configured will not function.

*F   The unit PV means that the unit of the parameter is the same as the unit of PV (the loop configuration).

Use caution when loading an automatic program to the MCT4. You must ensure that the decimal point scaling and units of measurement in the program match the loop configuration. Loading a program with a temperature set point of 80 will result in a control temperature of 8.0°F if the MCT4 control is in degrees Fahrenheit with a decimal resolution of 1 for the loop control. However, if the MCT4 is set for degrees Centigrade with a decimal resolution of 0 for the loop control, it will result in a control temperature of 80°C (176°F).

A.1.2.3   Starting an Automatic Program

Automatic programs are sent to the MCT4 in a step-by-step process. The download sequence must be followed in proper order and must complete without errors to be valid. The MCT4 automatically detects when a program transfer is started when the first group of registers containing the program specific data is sent (registers 1100-1119). The MCT4 then begins looking for the total number of steps to be sent in sequential order as was set in register 1106. Once the last step has been received, the MCT4 then saves the program to memory based on the name provided in registers 1107-1114 and sets it as the current program.

During the program transfer, register 0 will be set to 1 to indicate that the process is taking place. Once the register value returns to zero, the program is ready to be started. If register 0 does not return to zero, then the last step of the program was either not received, or the total number steps sent do not match the value set in register 1106. Should this occur, the program transfer should be restarted at the PC and the entire program sent again.

If any other write command is sent during a program transfer, the program transfer will be aborted and register 0 will return to a value of 0. The program download will then have to begin again. Program downloads must be performed as a continuous transfer from start to finish with no interruptions.

Starting a Program

Is the program already loaded?

NO →

Send program to the MCT4 one step at a time always starting with the program header data:

Send program data – 1100 thru 1119

Send step 1 data – 1120 thru 1139

Send step 2 data – 1140 thru 1159
…..
…..
…..
Send last step data

Is MCT4 online? 0=0

NO

YES

YES

Set program start step. 14=(1-64)

Set program to run. 15=0

Done
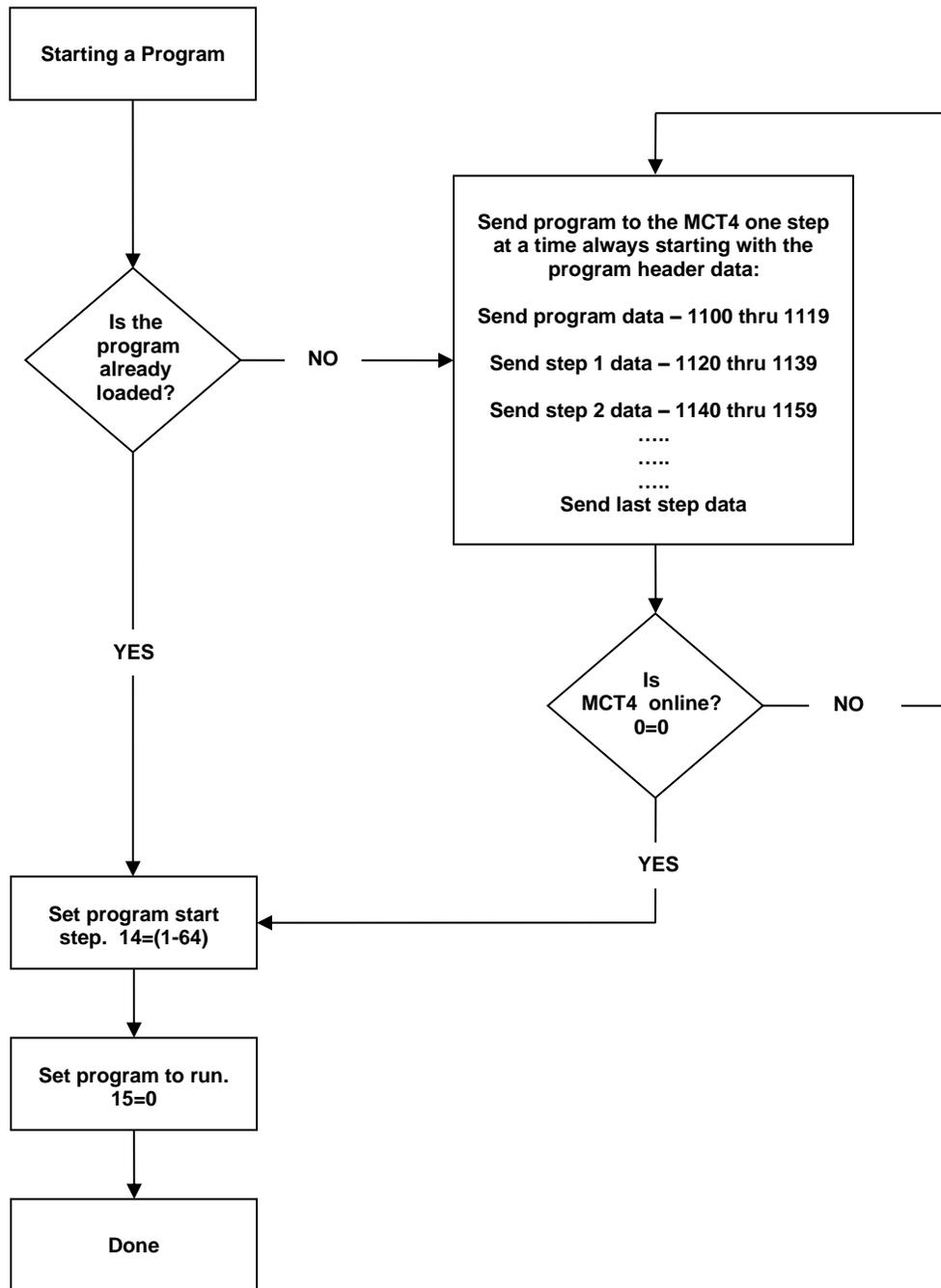
A.2   FTP, FileWeb, DataWeb Requirements/Installation

A.2.1   Introduction

The following describes the system requirements and components for the FDC Cloud service and website. The FDC cloud service provides the ability to upload data from FDC devices to cloud storage for backup and/or further analysis. The website provides the ability to verify data, uploads, and to manage users.

A.2.2   System Overview

There are four server components; the data transfer service (FDDataService), the website (FDDataWeb), the FTP server, and a MySQL database. FDDataService and FDDataWeb are Microsoft .Net services, and use Microsoft Internet Information Services (IIS) as a web platform. The MySQL (Can be SQL, Oracle, etc.) database stores user configuration information as well as providing cloud data storage if desired.

A.2.3   System Requirements

A Microsoft Windows server is required, with the following minimum capabilities:
- Windows Server 2008 or greater
- 2 GB RAM or greater
- 2 Cores or greater
- 40GB Storage or greater (this will vary depending on the user's expected uploads)
- .Net framework version 4.5 or greater
- MySQL 5.6 or greater

The server should be setup to provide the web server role.

A.2.4   FDC Cloud "Server" Services

Future Design Controls does not provide direct support or hosting services; however, third party support is available from our partner *Mooseworks Software* which can provide:

1. Complete site and installation without hosting charges (includes FDC site with custom banner, site setup, all code/data model definitions and manual). User provides the server and hosting credentials including domain name and https certificate.

2. Purchase of #1 above with hosting using Amazon Web Services (AWS). AWS T2 small server with 30GB storage. User provides the domain name and https certificate. Support cost on a yearly basis.

3. Purchase of #1 above with no hosting but support of client server at customer facility or customer selected location. Support cost on a yearly basis for web service and application.

4. DIY documentation – interface/data model definitions and server setup directions. DIY experience recommendations include installation and configuration of web servers, web services, SQL language and HTML/.NET code. Support packages for DIY documentation can be purchased in 5, 10 and 25 hour increments.

- Custom development services:
  - Fixed pricing available for well-defined systems.
  - Time and material options available for less defined, continuous engagements.

For more information please see the MCT Cloud Services document or contact FDC support for assistance.

A.3 Program Recovery Detail

The following will provide a detailed explanation of program recovery operation for the MCT4.

Program Power Recovery

1. **Static Mode**

   When power is cycled the program will be terminated. The control set point and events will return to the previous static set point and event activation or remain at their current settings if the loop is configured to use the set points and events of the last step.

2. **Continue From SP**

   When power is cycled the program will resume operation in the same step with the same event activation and step time that were present at the time of power interruption. The accuracy of time recovery will be from the beginning of each step and every 5 minutes into the step.

   a. When recovery occurs on a ramp step, the set point and time remaining in the step will return to the values at the last save interval. If less than 5 minutes into the step, the step will resume from the beginning of the step. If more than 5 minutes into the step, the step will return to the last 5 minute interval that elapsed (from the beginning of the step) and resume from the set point and time remaining at that moment the save occurred.

   b. When recovery occurs on a soak step, the set point and time remaining in the step will return to the last save interval. If less than 5 minutes into the step, the step will resume from the beginning of the step. If more than 5 minutes into the step, the step will return to the last 5 minute interval that elapsed (from the beginning of the step) and resume from the time remaining at that moment the save occurred.

3. **Continue From PV**

   When power is cycled the program will resume operation in the same step with the same event activation that was present at the time of power interruption. The set point and time remaining; however, are dependent upon step type.

   a. When recovery occurs on a ramp step, the program will resume with the control set point equal to the current process value.

      i. If ramp rate units are used (u/min, u/hr), the time remaining will be dependent upon the programmed ramp rate and the difference between the process value and the target set point of the step. The time remaining will be recalculated in order to ramp from the current PV value to the target set point of the step at the programmed ramp rate.

      ii. If ramp time units are used (MM.SS or HH.MM), the step will continue ramping from the current PV value to the target set point of the step in the time remaining at the point power was lost. This will in effect, alter the ramp rate for the remainder of the step in order to reach the same set point with what time is left in the step.

   b. When recovery occurs on a soak step, the set point and time remaining in the step will return to the last save interval. If less than 5 minutes into the step, the step will resume from the beginning of the step. If more than 5 minutes into the step, the step will return to the last 5 minute interval that elapsed (from the beginning of the step) and resume from the time remaining at that moment the save occurred.

A.4 MCT4 Base Unit Specifications

Technical Specifications

Description	Details
Size	4.3"
Resolution (W X H in pixels)	480 x 272
Display type	TFT, Wide touch Screen
Colors	65,536
Touch screen Type	Resistive analog
Active display area (W X H mm)	95 X 54
MTBF back light at 25 0C	30,000 hrs.
Backlight	LED
Brightness Adjustment	Yes
Screen Saver	Yes
Language Fonts	Yes

Main Hardware

Description	Details
Processor, CPU speed	ARM Cortex-A8, 1Ghz
Flash Memory(ROM)	128 MB
SDRAM(RAM)	256 MB
Operating system	WinCE 6.0
Real Time Clock	Yes
Buzzer	Yes
SD card slot	Yes

Communication Ports/Interfaces

Description	Details
RS232C / RS485, DB9 Male	1
Ethernet 10/100 Mbps, RJ45	1
USB Host	1
RS485, screw terminal	1

General Specifications

Description	Details
Rated Voltage	110/220 VAC (24 VDC)
Power supply	90-250 VAC (11-26 VDC)
Rated Current	0.8A AC (3.27A DC)
Power Consumption	36VA (15W)
Outer dimensions (W X H X D mm)	122 X 100 X 134
Mounting depth (mm)	123
Panel cut (W X H mm)	91^{+1} X 91^{+1}
Protection	IP66/NEMA 4X front, IP20 housing and terminals
Front bezel, housing	Plastic, plastic
Installation	Panel Mount
Net Weight (Kg)	0.65

Standards, Certificates and Approvals

Description	Details
UL approval	UL 61010-1 and CSA C22.2 No.61010-1-12
Low Voltage Directive	2014/35/EU
EMC Directive	2014/30/EU
Requirements for Emission	EN 61326-1:2013
Tick mark for Australia	AS/NZS CISPR 11:2004
FCC	FCC Part 15, Subpart B, Class A

NOTE: *The table above shows the approvals that may be available.*

Base Standards for EMC & Safety

Description	Details
Electrostatic discharge	IEC 61000-4-2: 2008
Radiated radio-frequency electromagnetic fields	IEC 61000-4-3: 2006 + A1:2007 + A2:2010
Electrical fast transient/burst	IEC 61000-4-4: 2012
Surge	IEC 61000-4-5: 2014
Conducted disturbances induced by radio-frequency fields	IEC 61000-4-6: 2014
Power frequency magnetic field	IEC 61000-4-8: 2009
Voltage dips, short interruptions and voltage variations	IEC 61000-4-11: 2004
Emission from Electromagnetic fields	CISPR 11:2009 + A1:2010 Class A
Harmonics Current	IEC61000-3-2:2014
Voltage Fluctuation and Flicks	IEC61000-3-3:2013
Requirements for Safety	EN61010-1:2013

Protective class

Description	Details
Standard enclosures	IP 66/NEMA 4X (Front), IP20 housing and terminals

Operating conditions

Description	Details
Temperature	0C to + 50C
Relative Humidity	10% to 90%, no condensation
Altitude	2000 meters maximum
Pollution	Degree 2
Sinusoidal vibration conforming to IEC 60068-2-6	10 to 58Hz: 0.75mm amplitude 58 to 150Hz: 1g 1oct/min. 10 sweeps
Shock conforming to IEC 60068-2-29	3 shocks per direction 11ms 10g

NOTE: *In temperatures below 0°C, the response time of liquid crystal display becomes slower and color of the display will be darker than normal. Do not operate in ambient temperature less than 0°C.*

LCD specifications

Description	Details
Touch operations	1,000,000 times using R 0.8 Polyacetal stylus with force 250g
Vibration test	10-55 Hz, Stroke: 1.5mm, 2 hrs. for each direction of X, Y, Z
Shock test	100G, 6ms, +/- X, +/- Y, +/- Z, 3 times for each direction
Typical viewing angle	Vertical (up/down), 50° / 70° Horizontal (left/right), 70° / 70°

Transport & Storage conditions

Description	Details
Temperature	-20C to + 60C
Relative Humidity	10% to 90%, no condensation
Altitude	2000 meters maximum
Sinusoidal vibration conforming to IEC 60068-2-6	5 to 16.8 Hz: 3.5 mm amplitude 16.8 to 150 Hz: 2g 1oct/min. 40 sweeps
Shock conforming to IEC 60068-2-29	3 shocks per direction 11ms 15g

WARNING*:* ***Cancer and Reproductive Harm:*** *This warning is intended to address certain Prop 65 chemicals that may be found in Future Design Controls products. These products can expose you to chemicals including lead and lead compounds which are known to the State of California to cause cancer, birth defects or other reproductive harm.*

A.5   PCM/HLM Module Specifications

* INPUT SPECIFICATIONS:

Type	Range	Accuracy @ 24 C	Input Impedance
J	-120 C 1000 C (-184 F 1832 F)	+/-2 C	2.2 Mohms
K	-200 C 1370 C (-328 F 2498 F)	+/-2 C	2.2 Mohms
T	-250 C 400 C (-418 F 752 F)	+/-2 C	2.2 Mohms
E	-100 C 900 C (-148 F 1652 F)	+/-2 C	2.2 Mohms
B	0 C 1820 C (-32 F 3308 F)	+/-2 C (200-1820 c)	2.2 Mohms
R	0 C 1767.8 C (-32 F 3214 F)	+/-2 C	2.2 Mohms
S	0 C 1767.8 C (-32 F 3214 F)	+/-2 C	2.2 Mohms
N	-250 C 1300 C (-418 F 2372 F)	+/-2 C	2.2 Mohms
L	-200 C 900 C (-328 F 1652 F)	+/-2 C	2.2 Mohms
C	0 C 2315 C (32 F 4199 F)	+/-2 C	2.2 Mohms
P	0 C 1395 C (32 F 2543 F)	+/-2 C	2.2 Mohms
PT100 (DIN)	-210 C 700 C (-346 F 1292 F)	+/-0.4 C	1.3 Kohms
PT100 (JIS)	-200 C 600 C (-328 F 1112 F)	+/-0.4 C	1.3 Kohms
MV	-8mV 70mV	+/-0.05%	2.2 Mohms
MV	-3mV 27mA	+/-0.05%	70.5 ?ohms
V	-1.3V 11.5V	+/-0.05%	302 Kohms

Resolution: 18 bits
Sampling Rate: 5 times / second
Maximum Rating: -2VDC minimum, 12VDC maximum (1 minute for mA input)
Temperature Effect: A1.5uV/ C for all inputs except mA input
A3.0uV/ C for mA input
Sensor Lead Resistance Effect:
T/C: 0.2uV/ohm
3-wire RTD: 2.6 C/ohm of resistance difference of two leads
2-wire RTD: 2.6 C/ohm of resistance sum of two leads
Sensor Break Responding Time:
Within 4 seconds for TC, RTD and mV inputs, 0.1 second for 4-20 mA and 1 - 5VDC inputs.
Burn-out Current: 200 nA
Common Mode Rejection Ratio (CMRR): 120dB
Normal Mode Rejection Ratio (NMRR): 55dB
Sensor Break Detection: Sensor open for TC, RTD and mV inputs, Sensor short for RTD input below 1 mA for 4-20 mA input, below 0.25VDC for 1 - 5VDC input, unavailable for other inputs.
Electrical Isolation: Optical isolation; 1500V~ (ac) minimum, between input signals and power supply circuit.

OUTPUT SPECIFICATIONS:
Relay Rating: 2A/240 VAC, life cycles 200,000 for resistive load
Pulsed Voltage: Source Voltage 5V @30mA, current limiting resistance 66 ohms
Source Voltage 14V@40mA, current limited at 70mA
Linear Output (PCM):

Resolution:	15 bits
Output Regulation:	0.02% for full load change
Output Settling Time:	0.1 sec. (stable to 99.9%) Isolation
Breakdown Voltage:	1000 VAC
Temperature Effect:	+/- 0.01% of span per degree C

Analog Retransmission (PCM):

Output Signal:	4-20 mA, 0-20 mA, 0 - 5VDC, 1 - 5VDC, 0 - 10VDC
Resolution:	15 bits
Accuracy:	+/-0.05% of span +/-0.0025%/ C Load
Resistance:	0 - 500 ohms (for current output) 10K ohms minimum (for voltage output)
Output Regulation:	0.01% for full load change
Output Settling Time:	0.1 sec. (stable to 99.9%)
Isolation Breakdown Voltage:	1000 VAC min. Integral
Linearity Error:	+/-0.005% of span
Temperature Effect:	+/-0.0025% of span per degree C
Saturation Low:	0 mA (or 0 VDC)
Saturation High:	22.2 mA (or 5.55VDC, 11.1VDC min)
Linear Output Range:	0-22.2mA (0-20mA or 4-20mA)
Volts DC:	0 - 5.55VDC (0 - 5VDC, 1 - 5VDC) 0 - 11.1VDC (0 - 10VDC)

CONTROL FUNCTION (PCM):
Control Action: Direct and reverse
Proportional Band:

Temperature:	0.1 to 500C (0.1 to 900F)
Linear Input:	0.1 to 900.0

Reset (Auto): 0 to 3600 seconds
Rate (Derivative): 0 to 900.0 seconds
PB Offset: 0 to 100%
Dual PID Heat/Cool (bimodal):

Cool Proportional Band	50 to 300% of heat PB
Proportional Deadband	-36.0% to +36.0% of heat PB

Time Proportioning Cycle Time:
0.1 to 90 seconds
On-Off / Alarm Hysteresis (PCM/HLM):
0.1 to 50C (0.1 to 90.0F)

EVENT INPUT SPECIFICATIONS:

Logic Low:	-10V minimum, 0.8V maximum
Logic High:	2V minimum, 10V maximum

APPROVAL STANDARDS:

UL / cUL:	UL 61010C-1
EN:	EN 61010-1 (IRC-1010-1)
EMC:	EMC 61326
RoHS:	RoHS 2.0 Compliant, W.E.E.E.
FM (HLM):	FM temperature limit switch - indicating

*   *When subject to the necessary field calibration, the MCT4 is suitable for use in Nadcap applications in all furnace classes as defined in AMS2750E clause 3.3.1.*

A.5.1 PCM Parameter Description

Parameter Notation	Parameter Description	Range	Default Value
SP	Controller (Static Mode) Set point value	Low: SPLO High: SPHI	77 F
ASP1	Set point for alarm 1	Low: -32768 High: 32767	18 F
ASP2	Set point for alarm 2	Low: -32768 High: 32767	18 F
ASP3	Set point for alarm 3	Low: -32768 High: 32767	18 F
INPT	Input sensor selection	J type T/C K type T/C E type T/C B type T/C R type T/C S type T/C N type T/C L type T/C C type T/C P type T/C PT 100 ohms DIN curve PT 100 ohms JIS curve 4-20 mA linear current input 0-20 mA linear current input 0-60 mV linear millivolt input 0-1V linear voltage input 0-5V linear voltage input 1-5V linear voltage input 0-10V linear voltage input	J
UNIT	Input unit selection	Degree C Degree F Process	Fahrenheit
DP	Decimal point selection	No decimal point 1 decimal digit 2 decimal digits 3 decimal digits	No decimal point
INLO	Input low scale value *(linear inputs only)*	Low: -32768 High: INHI - 50	0
INHI	Input high scale value *(linear inputs only)*	Low: INLO + 50 High: 32767	100

Parameter Notation	Parameter Description	Range	Default Value
FILT	Input filter	0 second time constant 0.2 second time constant 0.5 second time constant 1 second time constant 2 second time constant 5 second time constant 10 second time constant 20 second time constant 30 second time constant 60 second time constant	0.5 second
EIFN	Event input function	None Automatic program run Automatic program hold Automatic program abort Failure transfer Automatic program advance next step Automatic program run/hold Loop status input Alarm input	None
SPLO	Low Limit of Set Point	Low: -32768 High: SPHI	0 F
SPHI	High Limit of Set Point	Low: SPLO High: 32767	1000 F
OUT1	Output 1 Function	None Heating on-off control Heating time proportioning Heating linear control Colling on-off control Cooling time proportioning Cooling linear control	None
O1FT	Out 1 Failure Transfer	BPLS (bumpless transfer) 0.0 ~ 100.0% to continue output 1 control function as the unit fails OFF (0) or ON (1) for alarm or event output.	0
O1HY	Output 1 ON-OFF Control Hysteresis	Low: 0.1 High: 90.0 F (50.0 C)	0.2 F
CYC1	Output 1 cycle time	Low: 0.1 High: 90.0 sec.	18.0
OP1L	Low Limit Value for Output 1	Low: 0 High: 100.0%	**0**
OP1H	High Limit Value for Output 1	Low: 0 High: 120.0%	100
PB	Proportional Band #1	Low: 0.0 High: 900.0 F (500.0 C)	18 F

Parameter Notation	Parameter Description	Range	Default Value
TI	Integral Time #1	Low: 0 High: 3600 sec.	100
TD	Derivative Time #1	Low: 0.0 High: 900.0 sec	25.0
OFST	Offset value for proportional control (TI must = 0)	Low: 0 High: 100.0 %	25.0
OUT2	Output Function 2	None Cooling time proportioning Cooling linear control Alarm output Reverses alarm output Event output DC power supply output	None
O2FT	Output 2 Failure Transfer	BPLS (bumpless transfer) 0.0 ~ 100.0 % to continue output 1 control function as the unit fails OFF (0) or ON (1) for alarm or event output.	0
CYC2	Output 2 Cycle Time	Low: 0.1 High: 90.0 sec.	18.0
CPB	Cooling Proportional Band	Low: 50 High: 300%	100
DB	Heating - Cooling Deadband	Low: -36.0 High: 36.0%	0
OP2L	Low Limit Value for Output 2	Low: 0 High: 100.0 %	0
OP2H	High Limit Value for Output 2	Low: 0 High: 120.0 %	100
OUT3	Output 3 Function	None Alarm output Reverse alarm output Event output DC power supply output	None
O3FT	Output 3 Failure Transfer	OFF: Output off as unit fails ON: Output on as unit fails	OFF
OUT4	Output 4 Function	None Alarm output Reverse alarm output Event output Retransmit process value Retransmit setpoint value DC power supply output	None
O4FT	Output 4 Failure Transfer	OFF: Output off as unit fails ON: Output on as unit fails	OFF

Parameter Notation	Parameter Description	Range	Default Value
OP4L	Low Limit Value for	Low: 0 High: 100.0 %	0
OP4H	High Limit Value for	Low: 0 High: 120.0 %	100
REL4	Retransmission Low Scale Value for Output 4	Low: -32768 High:32767	0 F
REH4	Retransmission High Scale Value for Output 4	Low: -32768 High:32767	100 F
ALF1	Alarm 1 Function *(when alarm is selected under OUT1 Function)*	Process high alarm Process low alarm Deviation high alarm Deviation low alarm Deviation band high/low alarm End of automated program Hold mode Static mode	Deviation high alarm
A1MD	Alarm 1 Operation Mode	Normal Alarm action Latching alarm action Hold alarm action Latching and hold alarm action	Normal alarm action
A1HY	Alarm 1 Hysteresis	Low: 0.1 High: 90.0 F (50.0 C)	0.2 F
ALF2	Alarm 2 Function *(when alarm is selected under OUT2 Function)*	Process high alarm Process low alarm Deviation high alarm Deviation low alarm Deviation band high/low alarm End of automated program Hold mode Static mode	Deviation high alarm
A2MD	Alarm 2 Operation Mode	Normal Alarm action Latching alarm action Hold alarm action Latching and hold alarm action	Normal alarm action
A2HY	Alarm 2 Hysteresis	Low: 0.1 High: 90.0 F (50.0 C)	0.2 F
ALF3	Alarm 3 Function *(when alarm is selected under OUT3 Function)*	Process high alarm Process low alarm Deviation high alarm Deviation low alarm Deviation band high/low alarm End of automated program Hold mode Static mode	Deviation high alarm
A3MD	Alarm 3 Operation Mode	Normal Alarm action Latching alarm action Hold alarm action Latching and hold alarm action	Normal alarm action

Parameter Notation	Parameter Description	Range	Default Value
A3HY	Alarm 3 Hysteresis	Low: 0.1 High: 90.0 F (50.0 C)	0.2 F
STAR	Set Point Value at Start of Program	Current process value (PV) Controller set point (SP)	Current control setpoint
END	Set Point Value at End of Program	Final set point of program Current control setpoint	Current control setpoint
PFR	Power Fail Recovery	Continue program from last SP Continue program from PV Static mode	Static mode

A.5.2   HLM Parameter Description

Parameter Notation	Parameter Description	Range	Default Value
HSP1	High Limit Setpoint 1	Low: HSPL High: HSPH	110 F
LSP1	Low Limit Setpoint 1	Low: LSPL High: LSPH	0 F
SP2	Setpoint 2 value for output 2	Low: -19999 High: 45536	110 F
INPT	Input sensor selection	J type T/C K type T/C E type T/C B type T/C R type T/C S type T/C N type T/C L type T/C C type T/C P type T/C PT 100 ohms DIN curve PT 100 ohms JIS curve 4-20 mA linear current input 0-20 mA linear current input 0-60 mV linear millivolt input 0-1V linear voltage input 0-5V linear voltage input 1-5V linear voltage input 0-10V linear voltage input	J
UNIT	Input unit selection	Degree C Degree F Process	Fahrenheit

Parameter Notation	Parameter Description	Range	Default Value
RESO	Decimal point selection	No decimal point 1 decimal digit 2 decimal digits 3 decimal digits	No decimal point
INLO	Input low scale value *(linear inputs only)*	Low: -19999 High: INHI	0
INHI	Input high scale value *(linear inputs only)*	Low: INLO High: 45536	100
SHIF	PV shift (offset) value	Low: -360.0 F (-200.0 C) High: 360.0 F (200.0 C)	0.0
FILT	Input filter	0 second time constant 0.2 second time constant 0.5 second time constant 1 second time constant 2 second time constant 5 second time constant 10 second time constant 20 second time constant 30 second time constant 60 second time constant	0.5 second
OUT1	Output 1 Function	High limit control Low limit control High/Low limit control	High limit control
O1HY	Output 1 Hysteresis	Low: 0.1 High: 18.0 F (10.0 C)	0.2 F
HSPL	Lower Limit of High Limit SP	Low: -19999 High: HSPH	0 F
HSPH	Upper Limit of High Limit SP	Low: HSPL High: 45536	1000 F
LSPL	Lower Limit of Low Limit SP	Low: -19999 High: LSPH	0 F
LSPH	Upper Limit of Low Limit SP	Low: LSPL High: 45536	1000 F
OUT2	Output Function 2	None DC power supply output Alarm output Limit annunciator	None
ALFN	Alarm Function *(when alarm output is selected under OUT2 Function)*	Process value high alarm Process value low alarm	Process value high alarm
ALMD	Alarm Operation Mode	Normal Alarm action Latching alarm action	Normal alarm action

Parameter Notation	Parameter Description	Range	Default Value
ALHY	Alarm Hysteresis	Low: 0.1 High: 18.0 F (10.0 C)	0.2 F
ALFT	Alarm Failure Transfer	Output off as unit fails Output on as unit fails	Output on as unit fails
A2MD	Alarm 2 Operation Mode	Normal Alarm action Latching alarm action Hold alarm action Latching and hold alarm action	Normal alarm action
EIFN	Event Input Function	None Remote Reset	None
DISP	Display Format	Display SAFE Display high limit setpoint Display low limit setpoint	Display SAFE

A.6 SmartIO Monitor Module Specifications

Parameter	Specification
Channels	8 channels
Voltage Range	±100mV, ±500mV, ±1V, ±5V, ±10V, 0~100mV, 0~500mV, 0 ~ 1V, 0 ~ 5V, 0 ~ 10V
Current Input	±20mA, 4~20mA, 0~20mA (Slide switch select)
Direct Sensor Input	J, K, T, E, R, S, B, N
Burn-out Detection	Yes (all V, 4 ~ 20 mA & all T/C)
Channel Independent Configuration	Each channel
Sampling Rates	2.5 samples/second per channel
Resolution	16-bit
Accuracy	±0.1% FSR
Input Impedance	Voltage: 2MΩ Current: 120 Ω
Span Drift	±25 ppm/°C
Zero Drift	±6 μV/°C
CMR @ 50/60 Hz	120 dB
NMR @ 50/60 Hz	100 dB
Input Voltage Protection	±240V
Common Mode Voltage	240V
Power Consumption	1.6W @ 24V

Thermocouple Input
Type J Thermocouple -210 ~ 1200 °C
Type K Thermocouple -270 ~ 1372 °C
Type T Thermocouple -270 ~ 400 °C
Type E Thermocouple -270 ~ 1000 °C
Type R Thermocouple -50 ~ 1768 °C
Type S Thermocouple -50 ~ 1768 °C
Type B Thermocouple 0 ~ 1820 °C
Type N Thermocouple -270 ~ 1300 °C

A.7 Expansion IO Module Specifications

Input Specifications	
Input Voltage Range	20VDC ~ 28VDC
Recommended Operating Voltage	24VDC
Input Impedance	2.2kΩ @ 24VDC (Do not connect)

Output Specifications	
Input Voltage Range	5 ~ 30VDC
Recommended Operating Voltage	6 ~ 27VDC
Maximum Current	0.15A per point
Minimum Current	10mA per point

A.8 Power Supply Specifications

DIN Rail Mount Power Supply Specifications

| Model	24V DC output	PS5R-VD24		
Output Capacity		60W		
Input	Rated Input Voltage (Single-phase two-wire)[1]		100 to 240V AC (Voltage range: 85 to 264V AC/100 to 370V DC) (Load ≤ 80% at 100-105V DC)	
	Frequency		50/60 Hz	
	Input Current (Typ.)	100V AC	1.3A	
		230V AC	0.8A	
	Inrush Current (Typ.) (Ta=25°C, cold start)	100V AC	18A	
		230V AC	45A	
	Leakage Current	120V AC	0.5mA max.	
		230V AC	1.0mA max.	
	Efficiency (Typ.) (at rated output)[2]	100V AC	86%	
		230V AC	86%	
	Power Factor (Typ.)	100V AC	—	
		230V AC	—	
Output	Rated Voltage/Current		24V/2.5A	
	Adjustable Voltage Range		±10%	
	Output Holding Time (Typ.) (at rated output)	100V AC	13ms	
		230V AC	105ms	
	Start Time (at rated input and output)		800 ms max.	
	Rise Time (at rated input and output)		200ms max.	
	Regulation	Input Fluctuation	0.4% max.	
		Load Fluctuation	1.0% max.	
		Temperature Change	0.05%/°C max. (-10 to +55°C)	
		Ripple (including noise)	4% p-p max. (-25 to -10°C)	
			1.5% p-p max. (-10 to +0°C)	
			1% p-p max. (0 to +55°C)	
Overcurrent Protection		105% min. (auto reset)		
Operation Indicator		LED (green)		
Dielectric Strength	Between input and output terminals		3,000V AC, 1 minute	
	Between input and ground terminals		2,000V AC, 1 minute	
	Between output and ground terminals		500V AC, 1 minute	
Insulation Resistance		Between input and output terminals: 100MΩ min. (500V DC megger) Between input and ground terminals: 100MΩ min. (500V DC megger)		
Operating Temperature[4] (No freezing)		−25 to +70°C		
Operating Humidity (no condensation)		20 to 90% RH		
Storage Temperature (No freezing)		-25 to +75°C		
Storage Humidity (no condensation)		20 to 90% RH		
Vibration Resistance		10 to 55Hz, amplitude 0.375mm, 2 hours each in 3 axes (when used with BNL6 end clips)		
Shock Resistance		300 m/s² (30G), 3 times each in 6 directions		
Expected Life[5]		8 years minimum (at the rated input, 50% load, operating temperature +40°C, standard mounting direction)		
EMC	EMI		EN61204-3 (Class B)	
	EMS		EN61204-3 (industrial)	
Safety Standards		UL508 (Listing), UL1310 Class 2, ANSI/ISA-12.12.01 CSA C22.2 No. 107.1, 213, 223 EN60950-1, EN50178		

Other Standard	SEMI F47 (at 208V AC input only)
Degree of Protection	IP20 (EN60529)
Dimensions (mm)	95H × 36W × 108D
Weight (approx.)	260g
Terminal Screw	M3.5

*At normal temperature and humidity unless otherwise specified.
Note 1: DC input voltage is not subject to safety standards. When using on DC input, connect a fuse to the input terminal for DC input protection.
Note 2: Under stable state.
Note 3: PS5R-VB05 (5V DC/2.0A) is 10W (Up to 3.0A at Ta = 0 to 40°C. Not subject to safety standards above 2.0A.)
Note 4: See the output derating curves.
Note 5: Calculation of the expected life is based on the actual life of the aluminum electrolytic capacitor. The expected life depends on operating conditions.
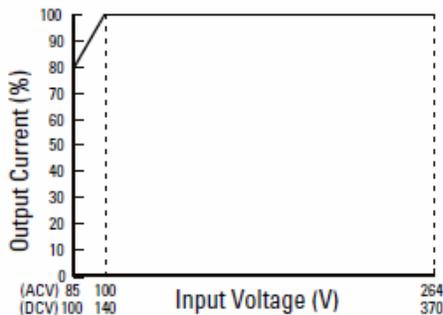
Operating Temperature vs. Output Current

Conditions: Natural air cooling (Operating temperature is the temperature around the switching power supply.)
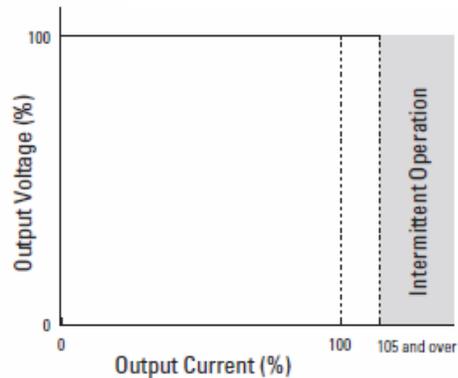
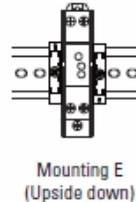### PS5R-VD24
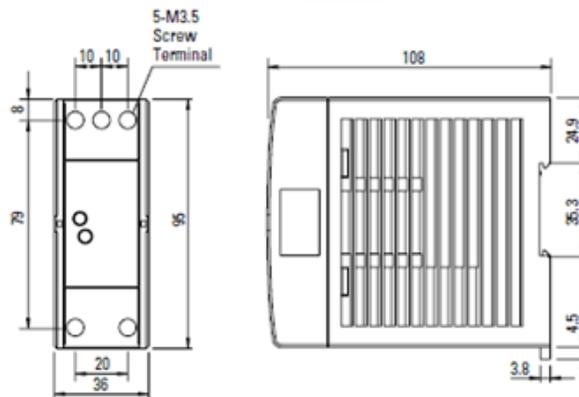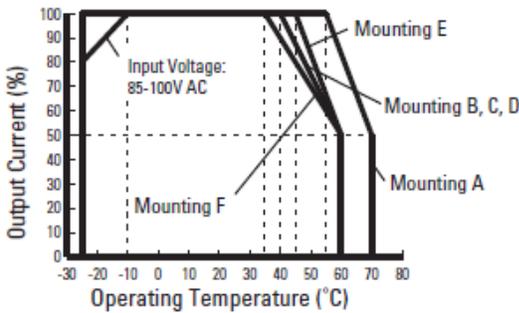
Input Voltage vs. Output Current Ta=25°C

Overcurrent Protection Characteristics

Operating Temperature Approved by Safety Standards

UL508, CSA C22.2 No.107.1, ANSI/ISA12.12.01, EN60950-1, EN50178					
Mounting A	Mounting B	Mounting C	Mounting D	Mounting E	Mounting F
55	40	40	40	45	35

Mounting A (Vertical, standard) | Mounting B (Upright) | Mounting C (Right side up) | Mounting D (Left side up) | Mounting E (Upside down) | Mounting F (Downward)
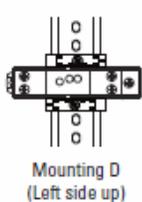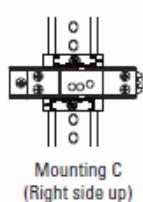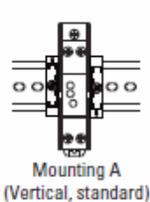
Open Frame Power Supply Specifications

Description			Power Supplies	[50W] PS3X-D24
Input	Rated Input Voltage			100 to 240V AC
	Voltage Range (Note 1)			88 to 264V AC / 125 to 375V DC
	Frequency			47 to 63 Hz
	Input Current			1.3A max.
	Inrush Current (Ta = −25°C, ACV cold start)		at 115V AC	30A max.
			at 230V AC	50A max.
	Leakage Current			1.5mA max.
	Efficiency (Typ.) (230V AC at input/rated output)		5V	—
			12V	81%
			24V	84%
Output	Rated Voltage/Current			24V, 2.2A
	Adjustable Voltage Range			±10%
	Output Holding Time			23 ms typ. (100V AC) 60 ms minimum (230V AC)
	Start Time			1000 ms max. (230V AC input, rated output)
	Rise Time			30 ms max. (230V AC input, rated output)
	Regulation	Input Fluctuation		0.5% max.
		Overvoltage Fluctuation		5V: ±2% max. 12V, 24V: ±1% max.
		Temperature Fluctuation		0.04% / °C max. (−10 to +45°C)
		Ripple (including noise)	−20 to −10°C	–
			−10 to 0°C	24V: 300mV max.
			PS3X-B, C: 0 to +50°C PS3X-D, Q, E: 0 to +45°C	24V: 150mV max.
Supplementary Functions	Overcurrent Protection			105% min. (auto reset) (Note 2)
	Overvoltage Protection			Intermittent operation or output off at 115% min. (Note 3)
	Operation Indicator			green LED
Dielectric Strength	Between input and output terminals			3000V AC, 1 minute
	Between input and ground terminals			2000V AC, 1 minute
	Between output and ground terminals			500V DC, 1 minute
Insulation Resistance				100MΩ minimum, 500V DC megger (between input and output terminals, between input and ground terminals)
Operating Temperature				−10 to +70°C (no freezing, see output derating)
Operating Humidity				20 to 85% RH (no condensation)
Storage Temperature				−40 to +85°C (no freezing)
Storage Humidity				10 to 95% RH (no condensation)
Vibration Resistance				10 to 55 Hz, 20m/s² constant, 2 hours each in 3 axes
Shock Resistance				200m/s², 1 shock each in 3 axes
EMC	EMI			EN55022 Class B
	EMS			EN55024
Safety Standards				IEC/EN60950-1, UL60950-1, CSA C22.2 No. 60950-1
Dimensions (H × W × D) (mm)				82H × 35W × 99D
Weight (approx.)				340g
Terminal Screw				M3.5

Note 1: See "Output Current vs. Input Voltage" characteristics next page. Not subject to safety standards. When using DC input, connect a fuse to the input terminal for DC input protection.
Note 2: Overload for 30 seconds or longer may damage the internal elements.
Note 3: One minute after the output has been turned off, turn on the AC input again.

Operating Temperature vs. Output Current (Derating Curves)

Conditions: Natural air cooling (operating temperature is the temperature around the power supply)

PS3X-D

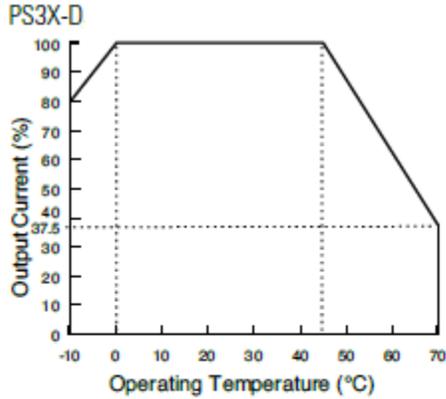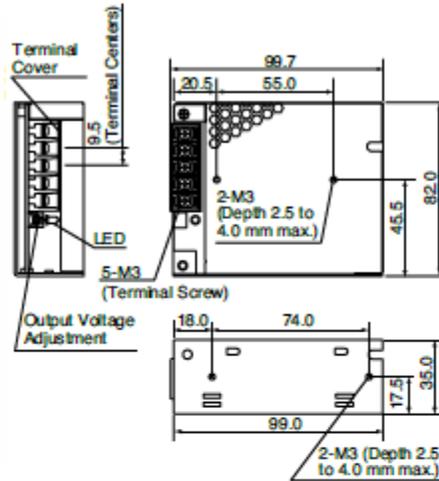| PS3X-D12, -D24 | |
| PS3X-Q05, -Q12, -Q24 | |

Dimensions (mm)

Output Current vs. Input Voltage (TA = 25°C)
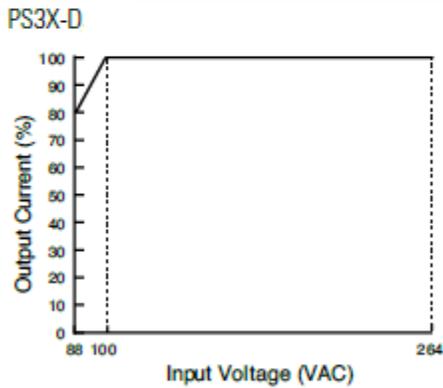
PS3X-D
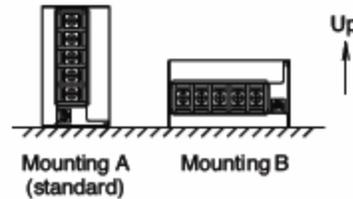

Overcurrent Protection Characteristics
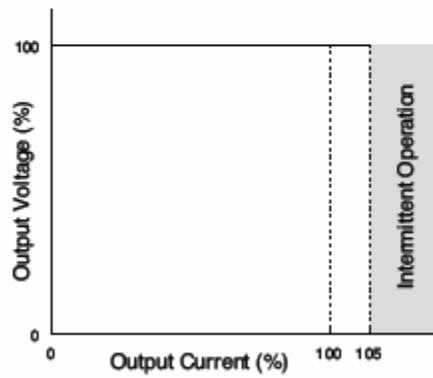
Operating Temperature by Safety Standards

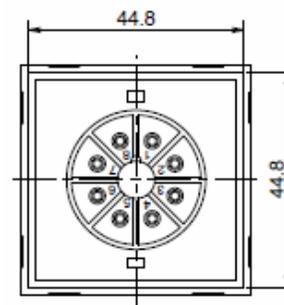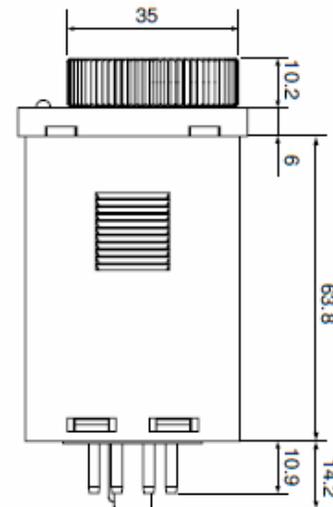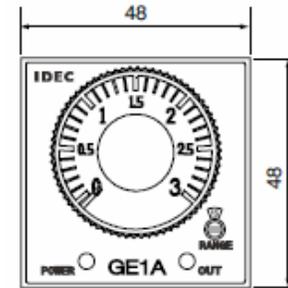| Power Supplies	UL/EN60950-1
	Mounting A, B
PS3X-D24	45°C

Mounting A (standard)   Mounting B

A.9   Power-On Delay Relay Specifications

[GE1A-C10HA110]

CE   cULus UL, c-UL Listed
File No. E55996

TÜV Rheinland

Specifications

Rated Operating Voltage	24V AC/DC 100 to 120V AC 220 to 240V AC	
Voltage Tolerance	AC: 85 to 110% DC: 90 to 110%	
Contact Rating	240V AC/5A 24V DC/5A	
Contact Form	DPDT or SPDT+ instantaneous SPDT	
Repeat Error	±0.2% ±10msec maximum	
Voltage Error	±0.5% ±10msec maximum	
Temperature Error	±3% maximum	
Setting Error	±10% maximum	
Reset Time	0.1 sec maximum	
Insulation Resistance	100MΩ minimum (500V DC megger)	
Dielectric Strength	Between power and output terminals: 1,500V AC, 1 minute Between contact circuits: 750V AC, 1 minute	
Vibration Resistance	Damage limits: Amplitude 0.75mm, 10 to 55 Hz Operating extremes: Amplitude 0.5mm, 10 to 55 Hz	
Shock Resistance	Damage limits: 500m/s² (Approx. 50G)	
Power Consumption	GE1A-B	24V AC type: 1.6 VA
		24V DC type: 1.0W
		110V AC type: 3.8 VA
		220V AC type: 7.7 VA
	GE1A-C	24V AC type: 2.0 VA
		24V DC type: 0.8W
		110V AC type: 3.5 VA
		220V AC type: 8.0 VA
Electrical Life	100,000 operations minimum (at full rated load)	
Mechanical Life	10,000,000 operations minimum	
Operating Temperature	−10 to +55°C (without freezing)	
Operating Humidity	35 to 85% RH (without freezing)	

Item	Terminal Number		Operation
Set Time			
Power	2 - 7 (8p)		
Delayed Contact	5 - 8 (8p)	(NC)	
	6 - 8 (8p)	(NO)	
Indicator	POWER		
	OUT		

8-Pin Screw Terminal (SR2P-06)

A.10 Ordering Specifications

Enter a number in each box which corresponds to the specifications desired when ordering the MCT4 with PCM and/or HLM modules.

MCT4 - ☐☐ **-** ☐ **-** ☐ **-** ☐ **-** ☐☐

Software Type
01:    MCT4
XX: Special Order Code

Power Input
4:    90-250VAC 50/60Hz
5:    11-26VAC/DC

Module Type Slot 1
0:    None
Pxxxx: Process Control Module (PCM Matrix)

Module Type Slot 2
0:    None
Pxxxx: Process Control Module (PCM Matrix)
Hxxx: High Limit Module (HLM Matrix)

Module Type Slot 3
0:    None
Pxxxx: Process Control Module (PCM Matrix)
Hxxx: High Limit Module (HLM Matrix)

Documentation
0:    None
C: CD
U: USB Memory Stick

Special Order Code
00:    None
XX: Special Order Code

Part number examples:

MCT4-014-P1111-P1111-H111-000

MCT4 with 2 process control modules and a high limit module. Standard software. 90-250VAC 50/60HZ. Each process control module (slot #1 and #2) is equipped with 4 relay outputs. Slot 3 has a high-limit module installed equipped with 2 relay outputs. No special order code.

MCT4-AB5-P3311-H111-0-000

MCT4 with 1 process control module and a high limit module. Special software code "AB". 11-26VAC/VDC. PCM#1 module equipped with 4-20mA in outputs 1 and 2 and relays in outputs 3 and 4. Slot 2 has a high limit module installed with 2 relay outputs. Slot 3 is empty and not used. No special order code.

MCT4-014-P1111-0-0-0AN

MCT4 with 1 process control module. Standard software. 90-250VAC 50/60 HZ. Process control module (slot #1) is equipped with 4 relay outputs. Slot 2 and 3 are empty and not used. "AN" special order code.

PCM MATRIX

Enter a number in each box which corresponds to the hardware required when ordering the Process Control Module (PCM).

P ☐ ☐ ☐ ☐

PCM Modules can be
Installed in slots 1, 2 or 3

OUTPUT 1

0: None
1: Relay 2A/240VAC (Form A)
2: Pulsed voltage to drive SSR, 5V/30mA
3: 0-20mA/4-20mA isolated output (OM99-3)
4: 0-10V isolated output (OM99-5)
C: Pulse voltage to drive SSR, 14V/40mA (OM99-7)

OUTPUT 2

0: None
1: Relay 2A/240VAC (Form A)
2: Pulsed voltage to drive SSR, 5V/30mA
3: 0-20mA/4-20mA isolated output (OM99-3)
4: 0-10V isolated output (OM99-5)
7: Transmitter power supply 20VDC/25mA (DC99-1)
8: Transmitter power supply 12VDC/40mA (DC99-2)
A: Transmitter power supply 5VDC/80mA (DC99-3)
C: Pulse voltage to drive SSR, 14V/40mA (OM99-7)

OUTPUT 3

0: None
1: Relay 2A/240VAC (Form A)
2: Pulsed voltage to drive SSR, 5V/30mA
7: Transmitter power supply 20VDC/25mA (DC99-1)
8: Transmitter power supply 12VDC/40mA (DC99-2)
A: Transmitter power supply 5VDC/80mA (DC99-3)
C: Pulse voltage to drive SSR, 14V/40mA (OM99-7)

OUTPUT 4

0: None
1: Relay 2A/240VAC (Form A)
2: Pulsed voltage to drive SSR, 5V/30mA
3: Retransmit 0-20mA/4-20mA (OM99-3)
4: Retransmit 0-10VDC (OM99-5)
7: Transmitter power supply 20VDC/25mA (DC99-1)
8: Transmitter power supply 12VDC/40mA (DC99-2)
A: Transmitter power supply 5VDC/80mA (DC99-3)
C: Pulse voltage to drive SSR, 14V/40mA (OM99-7)

PCM Modules support Universal Analog Signal Inputs T/C-RTD, mA and VDC.
Hardware configuration is via board DIP switch.
Default hardware configuration is T/C-RTD

HLM MATRIX

Enter a number in each box which corresponds to the hardware required when ordering the High Limit Module (HLM).

H ☐ ☐ ☐

HLM Modules can be installed in:
- Slot 2 for 1 loop system
- Slot 3 for 2 loop system

Signal Input*
1: Thermocouple: J, K, T, E, B, R, S, N, L, C, P,
   PT100 DIN, PT100 JIS, 0-60mV
2: Voltage 0-1VDC
3: Voltage 0-10VDC
4: Current 0-20mA (4-20mA)
5: Voltage 0-5VDC (1-5VDC)

OUTPUT 1
0: None
1: Relay 2A/240VAC (Form C)
2: Pulsed voltage to drive SSR, 5V/30mA
C: Pulse voltage to drive SSR, 14V/40mA (OM99-7)

OUTPUT 2
0: None
1: Relay 2A/240VAC (Form C)
2: Pulsed voltage to drive SSR, 5V/30mA
7: Transmitter power supply 20VDC/25mA (DC99-1)
8: Transmitter power supply 12VDC/40mA (DC99-2)
A: Transmitter power supply 5VDC/80mA (DC99-3)
C: Pulse voltage to drive SSR, 14V/40mA (OM99-7)

HLM signal input order codes #1, #3 and #4 are hardware configurable via DIP switch. Recalibration is required when switching between signal input types. HLM modules ordered with signal input order code #2 or #5 cannot be reconfigured.

* HLM configured with Signal Inputs 0-60mV, 0-1VDC, 0-5V/1-5DC, 0-10VDC or 0-20/4-20mA are NOT FM approved.

Control System Options *(ordered separately as needed)*

Smart IO Monitor Module
Monitor Module   SIO-8AIU-H   (8 universal inputs; thermocouple, VDC, mA)

Power Supply (input 100-240VAC / Output 24VDC)
DIN Rail Mount: PS5R-VD24   60W power supply (2.5A)
Open Frame: PS3X-D24AFG   50W power supply (2.2A)

Note: Either of the above will power the MCT4 (24VDC power option)

System Reset Timer
GE1A-C10HA110/SR2P-06   Reset Timer and socket (DIN RAIL)

Note: Timer is recommended for proper restart on 24VDC powered units due to power fluctuations in power supply outputs that can occur during momentary power interruptions (<500ms).

USB Memory Stick
UDF115-8GB   8GB High Capacity USB Memory Stick (3VDC)

Replacement SD Memory Card
SD-4MA   8GB High Capacity SD Memory Card (preloaded with MCT application software)

Printed Operators Manual (*available online at* www.futuredesigncontrols.com/MCT4)
Part Number
MCT4 4.3 User Manual

USB Cables & Accessories
WPUS-BAX-05M   USB panel mount adapter
WPCVR-USB   USB waterproof IP67 cover (for above)

Replacement Terminal Blocks
Power Input   Part #: 10343-1203A-01-10
COM2   Part #: 10343-1202B-10-00
PCM   Part #: 10343-1216B-03-00
HLM   Part #: 10343-1216B-10-00

Retaining Screws (used to secure PCM/HLM in MCT4 base unit)
Part #: 10483-00300400701, M3 x 4 screw (package of 4)

A.11 Support and Warranty Information

SOFTWARE VERSIONS FOR FDC- MCT4 Control System

The software version levels for the MCT4 Control system can be viewed in the offline system setup, from the System menu; select "About". Both the HMI (Human Machine Interface – color touch screen) and loop/limit control firmware and software versions will be displayed.

When obtaining replacement parts or to get assistance for setup and/or troubleshooting purposes, it is important to have this information available to insure that your request is processed properly and in a timely manner. It is recommended that this information be written down and kept in a readily accessible location along with this manual, so that it is available when required.

CE Net Version: _____   CE Image Version: _____

HMI Version: _____   CE BSP Version: _____

Loop 1 Version: _____   Loop2 /Limit Version: _____   Loop3 /Limit Version: _____

SmartIO Monitor Module Version: _____

⚠️ **The CE Net version of the HMI, and firmware versions of the loop and limit controls of the MCT4 control system are proprietary and only available directly from Future Design Controls.**

Using similar or like components obtained from a source other than Future Design Controls will cause unexpected operation and/or malfunction of the MCT4 control system. Any attempts to do so will be at the user's own risk and void any and all claims or warranties with Future Design Controls.

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Return Material Authorization:

Contact Future Design Controls for Return Material Authorization Number prior to returning any product to our facility:

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