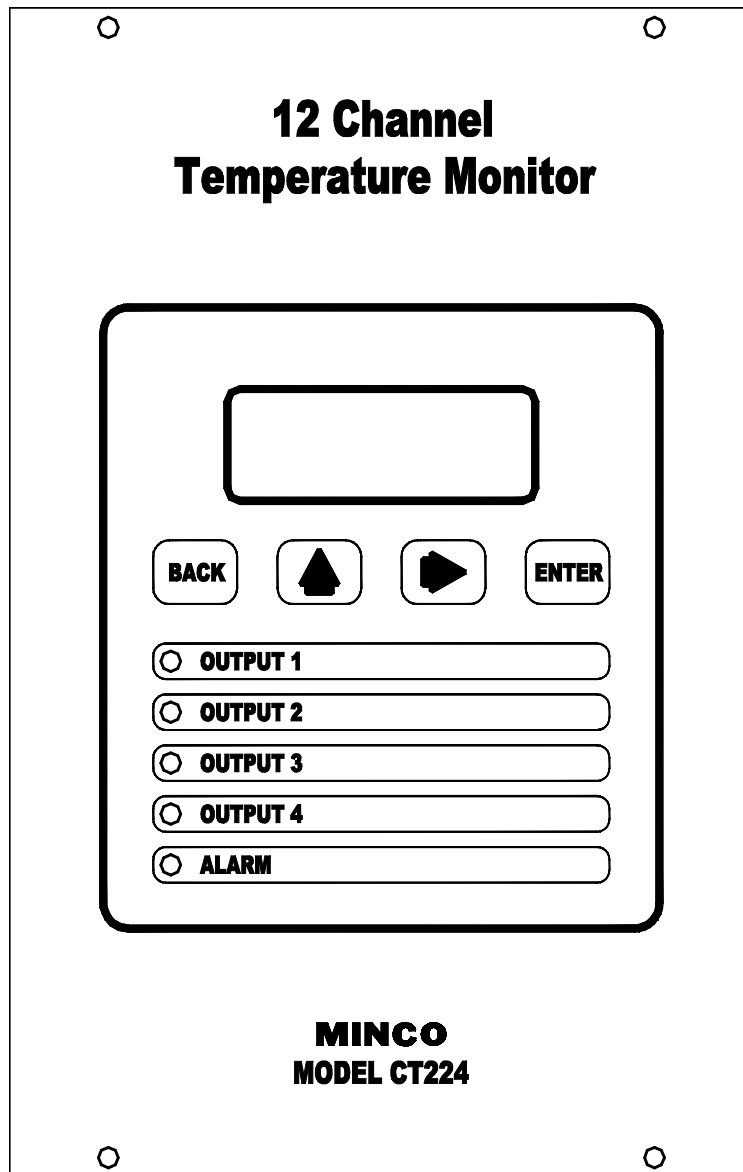




CT224
12-Channel Temperature Monitor
Installation and Operating Instructions



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1. Introduction

The CT224 is a universal 12-channel monitor capable of monitoring inputs for any combination of RTDs, Thermocouples, and 4-20mA loop inputs. The CT224 has 5 outputs, 4 of the outputs can be used for warning or shutdown signals, the other output is dedicated to signaling alarm conditions. One internal audible alarm is also present. RS485 or RS232 Serial Communications is also included on the CT224 and allows use of the Modbus Protocol to communicate data with another device. CT224 Utilities is also provided to allow easy communication with the CT224 by using a computer.

2. Pre-Installation

The first step before installing the CT224 is to determine the input types that will be used. If analog 4-20mA signals will be used as inputs, jumpers under the rear cover will need to be changed. When received, the jumpers are set to allow RTD and thermocouple inputs on all input channels. Analog inputs require that the jumpers be moved to the 4-20mA setting. Follow the simple steps below to allow 4-20mA loop inputs:

1. Remove the 4 screws that hold the rear cover on. (Do not remove the other 4 screws that go directly through the board.)
2. Set the rear cover aside.
3. Look at the top of the CT224. There is one jumper for each channel located next to the corresponding channels terminal block. For all of the channels that will be used for 4-20mA inputs, set the jumper to the position away from the dot. Figure 1 shows a jumper in the position to allow 4-20mA loops. Leave the jumpers for the other channels that will be used for RTDs and thermocouples in the dot position. Figure 2 shows a jumper in the position for RTD and Thermocouple inputs.
4. Replace the rear cover and screws.

The CT224 is now ready to accept 4-20mA inputs on the channels that are set like the jumper shown in Figure 1.

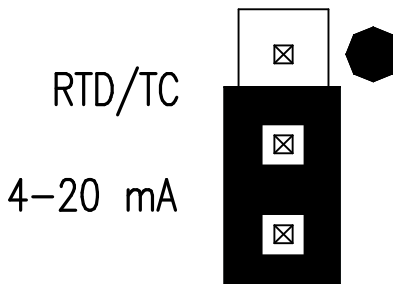


Figure 1 – Jumper in position for 4-20mA Inputs

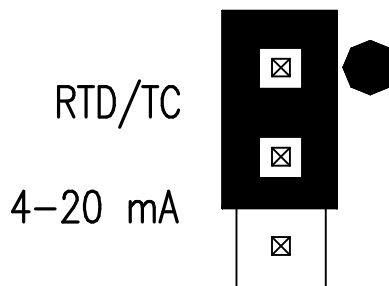


Figure 2 – Jumper in position for RTD or Thermocouple Inputs

3. Installation

A. Mounting

Make a rectangular cut out in the panel where the CT224 will be located. The cutout should be made according to Figure 3.

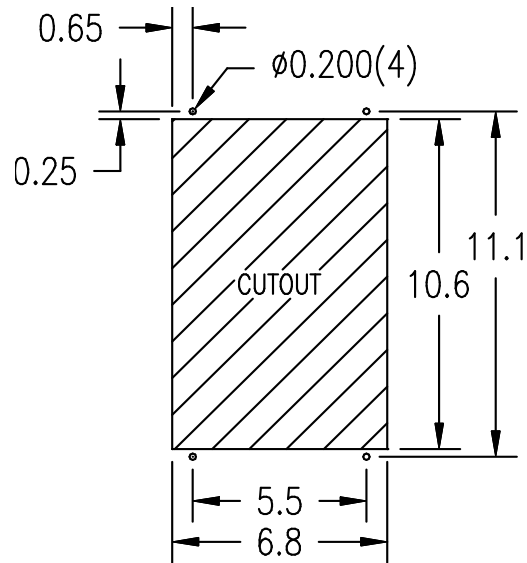


Figure 3 – Panel Cutout

Slide the CT224 into the cut out, drill holes for the screws or bolts that will fasten the unit to the panel. Be sure that the gasket around the CT224 is compressed between the front cover and the panel so that liquid and debris cannot get behind and inside of the panel.

B. Wiring

The locations of the connections on the CT224 are shown in Figure 4. The rear cover of the CT224 also shows the connections for each terminal. More detail for each of the connections is given in the following sections.

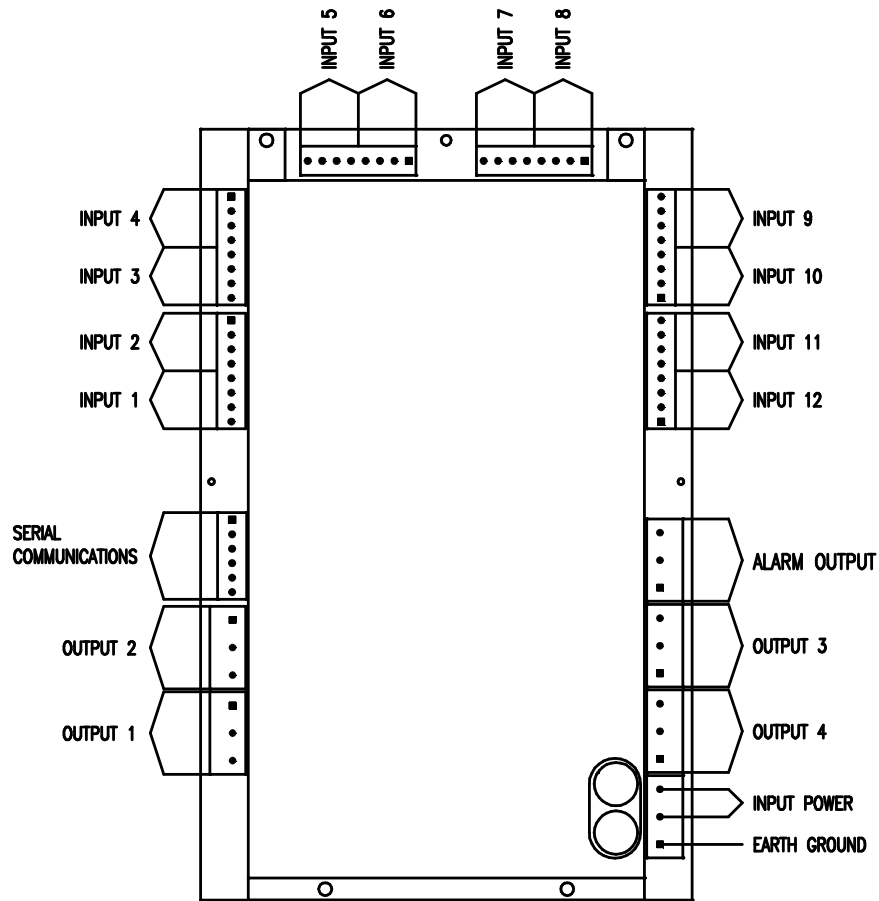


Figure 4 – Wiring Connection Locations

1. Controller Power

The CT224 Power connections will vary depending on which type of power is use.

AC

On AC models, the Line and Neutral will be connected to the terminal block in the lower right hand corner on the rear of the CT224. See Figure 5. The lower terminal on the terminal block is used for ground. It is important to connect earth ground to the lower terminal if shielded cable is used for sensors. This connection is how a grounding connection is made to the shields of the RTDs. Connecting to earth ground also provides a path for current to flow in the event of an electrical failure and helps to protect the operator from possible electrocution in such an event.

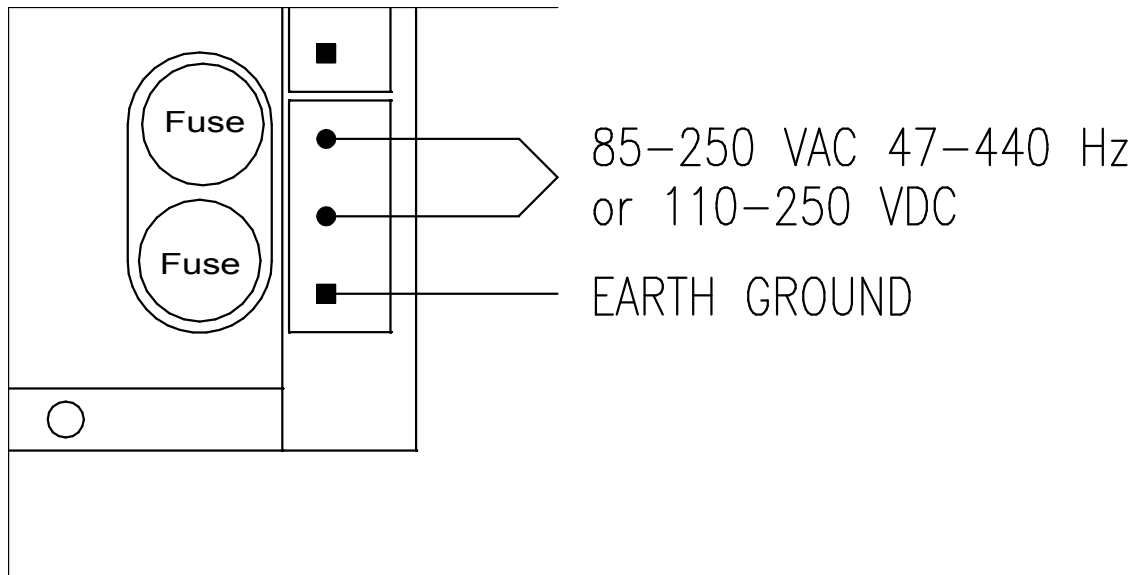


Figure 5 – AC Power Connections

DC

On DC models, the DC voltage is connected to the upper terminals and the terminal block in the lower right corner on the rear of the CT224. See Figure 6. The upper terminal on the control power terminal block is connected to the positive supply voltage, between 18 and 36Vdc. The lower terminal on the terminal block is used for ground. It is important to connect earth ground to the lower terminal if shielded cable is used for sensors. This connection is how a grounding connection is made to the shields of the RTDs. Connecting to earth ground also provides a path for current to flow in the event of an electrical failure and helps to protect the operator from possible electrocution in such an event.

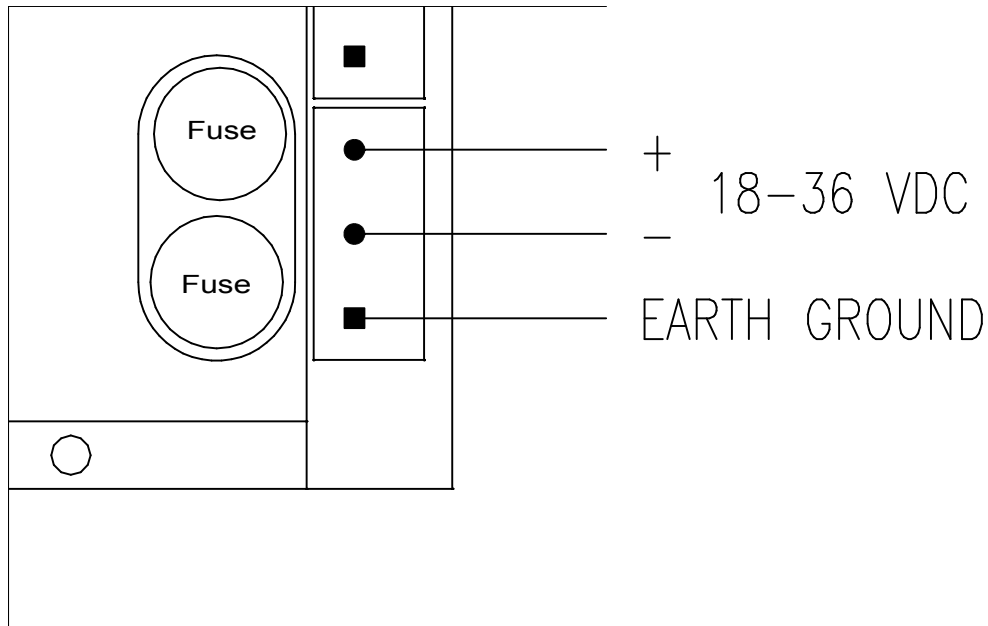


Figure 6 – DC Power Connections

2. Inputs

The CT224 can accept any combination of the input types specified in Section 6 at the end of this document. These may include RTDs, thermocouples, and 4-20mA transmitter loops. However, some care must be taken when using multiple inputs so that a safe environment is created for personnel and equipment. For instance, a CT224 should monitor sensors from only one piece of equipment, especially if high voltage is present. Using this approach, damage to other devices is greatly reduced, if a circuit fault should occur.

The CT224 does not have channel to channel isolation. This means that grounded thermocouples cannot be used directly with the CT224. Ungrounded thermocouples may be used. If grounded thermocouples are used, a device such as a Thermocouple Isolator can be utilized as a means to break ground loops and provide proper inputs to the CT224.

Another consideration due to not having channel to channel isolation is that when using 4-20mA inputs, all loops will share the same return path. Keep this in mind when planning the system to ensure that it is safe to wire all loops together. It is the system designer's responsibility to ensure that good safety measures are used. If unsure about the safety aspects of a system, call Minco for assistance.

Each input channel has 3 input terminals and a common earth ground terminal. The terminals are labeled as A, B, C and D. Terminal D is connected to earth ground, when earth ground is connected to the terminal block as described in Section 1, Controller Power. Input wiring for the different input types is shown in Figures 7, 8, 9, and 10.

RTDs - RTDs Use three terminals per channel. Care should be taken to not exceed 30 ohms of lead wire resistance. Chart 1 shows maximum lead wire length per lead of an RTD so as not to exceed the 30 ohms maximum lead wire resistance. Leadwire for RTDs should be twisted and shielded, this will reduce fluctuations in the readings due to noise.

Leadwire (AWG)	Ohms/Foot at 25°C	Maximum Length for 30 ohms of Resistance
18	.0065	4615
20	.0103	2912
22	.0165	1818
24	.0262	1145
26	.0418	717
28	.0666	450

Chart 1 – Leadwire Resistance per lead

3-wire RTD: The odd colored wire must be connected to terminal A of the input channel. The other two wires can be placed in either order in B and C. If the RTD has a shield, place it into terminal D. When adding leadwire to the RTD, be sure to use the same length and gauge for each lead. The CT224 is able to provide very good compensation for leadwire resistance as

long as each lead has the same resistance. Recommended Extension Leadwire: Belden 1031A or any other wire that is twisted and shielded is a good choice.

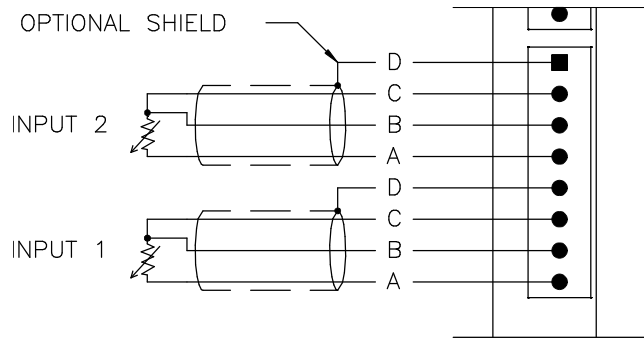


Figure 7 – 3-Wire RTD Wiring

2-wire RTD: One of the leads should be placed in terminal A for the input channel. The other lead should be placed in either B or C. A jumper wire must be placed between B and C in order to complete the input circuit. If the RTD has a shield, connect it to terminal D. Recommended Extension Leadwire: Belden 1030A or any other wire that is twisted and shielded is a good choice.

The 2-wire RTD will exhibit some error due to the inability to compensate for lead wire resistance. This can be partially compensated by using the Zone Offset feature as shown later in the manual under the Programming Configuration section. Chart 2 shows lead wire resistance based on wire gauge. The desired offset value can be calculated using the chart, length of leadwire, and by visiting www.minco.com and using the "Sensor Calc" program to determine the affect of the leadwire. By using this information it is possible to reduce the leadwire error by adjusting the offset.

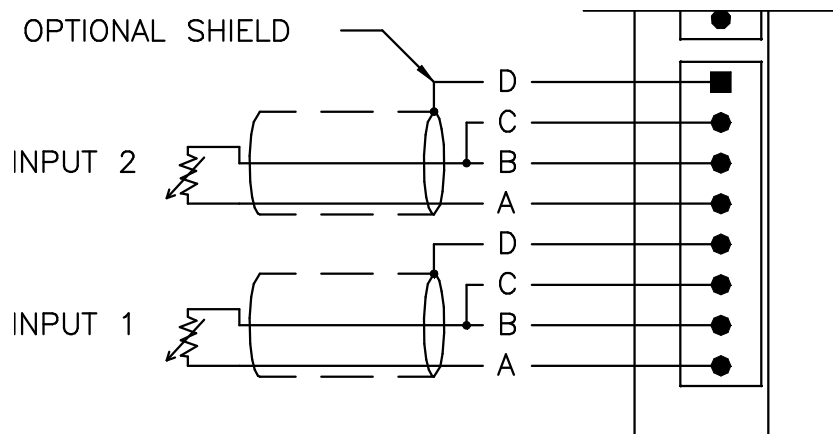


Figure 8 – 2-Wire RTD Wiring

Thermocouples – Thermocouples use terminals B and C. The positive lead on the thermocouple should be connected to the B terminal and the negative lead to the C terminal. On a thermocouple the red lead is usually negative (-) and the other lead is usually positive (+). Figure 9 shows how to wire the Thermocouple to the CT224.

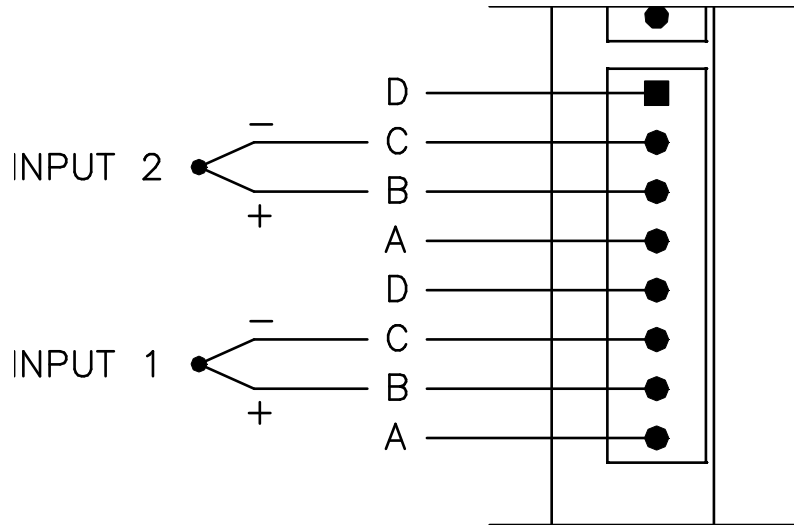


Figure 9 – Thermocouple Wiring

4-20mA – 4-20mA inputs use terminals B and C. The loop positive should be connected to the B terminal and the loop negative should be connected to the C terminal. When configuring the CT224 for 4-20mA loops, you must set the jumpers located on the top part of the PCB to the position with out the dot. This is shown in Figure 1 in the Pre-Installation Instruction section.

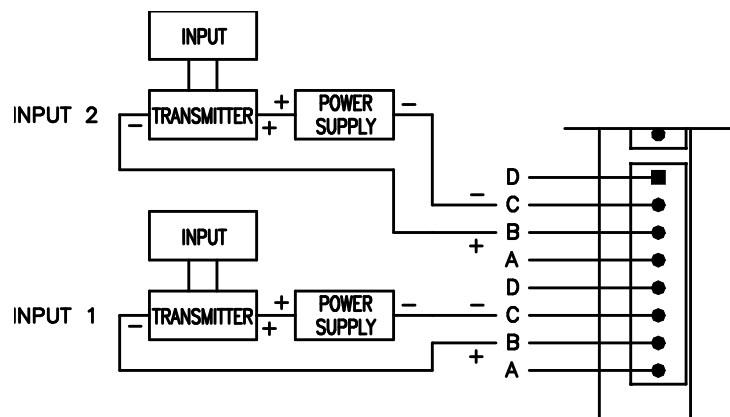


Figure 10 – 4-20mA Wiring Diagram

3. Outputs

Two types of outputs are available on the CT224, relays or logic. The output type is determined by the options that were ordered.

There are three terminals for each output. All three terminals are used when relays are the output type. When logic outputs are installed, only two of the terminals are used. The terminals are labeled as A, B, C. **Caution:** The terminal positions are A, B, C on the left side of the unit reading from top to bottom, but they are labeled as C, B, A on the right side of the unit.

The CT224 has 5 outputs. Four of the outputs are used for signals and can be configured to trip and untrip in several different ways. The different methods are covered in section **4. Program Configuration part B) Entering The Program Settings**. The Alarm Output differs from the other 4 outputs in several ways. The Alarm Output will use the hysteresis value for the channel that caused it to trip as its untrip value. If the alarm is configured to sound with a channel that is set to latch another output on a trip, the alarm will continue to sound until a key is pressed. The Alarm Output cannot be configured for reverse acting, it is always direct acting.

Relay outputs: Relays are SPDT, they have terminals for both normally open (NO) and normally closed (NC) contacts. The NO contact is between terminals B and C and the NC contacts are between terminals A and B.

Logic outputs: Logic outputs use terminals A and B, with B as the reference ground. Logic outputs are **not** isolated from the controller supply. Caution must be taken when using logic outputs since several devices may be sharing the same reference ground when they are connected.

4. **Serial Communications**

Modbus protocol is used to communicate between the CT224 and other device (PC or PLC). Two physical interface options are available for serial communications. They are RS232 and RS485. The CT224 is always a slave device.

RS485

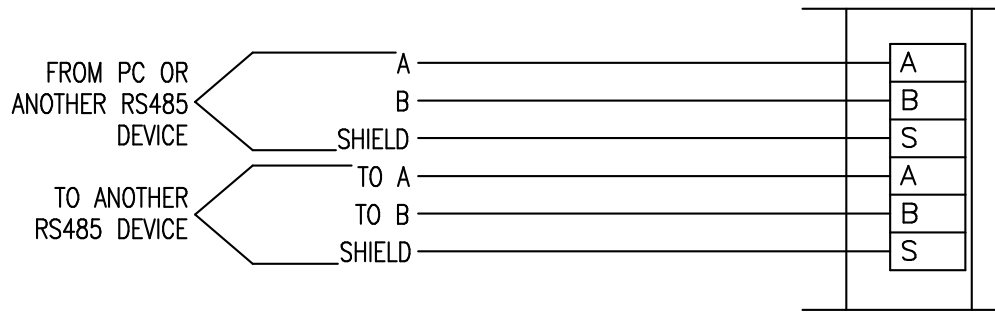
RS485 allows for multiple devices to be connected to one network. Up to 128 CT224 can be connected to a network. The RS485 standard allows up to 32 nodes to be connected on a half-duplex network. However, each CT224 accounts for only $\frac{1}{4}$ of a node, so 128 CT224 can be connected to the network when RS485 is used as the medium.

The connections on the CT224 are labeled as A, B, and S. The two signal wires are A and B. The A terminal should be connected to the A terminal on the RS232 to RS485 converter. The B terminal should be connected to the B terminal on the RS232 to RS485 converter. The S terminal should be connected to the shield. The shield wire should be connected to ground in **one location only**, to avoid ground loops, which can cause erratic communications. Refer to Figure 11 for a wiring diagram.

RS232

Terminal A is the Transmit Data (TD) connection, terminal B is the Receive Data (RD) connection, and terminal S is the Signal Ground (SG) connection on the CT224. RS232 devices require Terminal A connected to Receive Data from the master device, Terminal B to Transmit Data from the master device, and terminal S to Signal Ground. For a 9-pin D-Sub connector on a PC, connect A to pin 2, B to pin 3, and S to pin 5. Caution should be taken when using RS232, as it is not isolated. This could cause ground loops through devices, which could cause damage to the CT224 and / or other devices. Refer to Figure 11 for a wiring diagram.

RS485



RS232

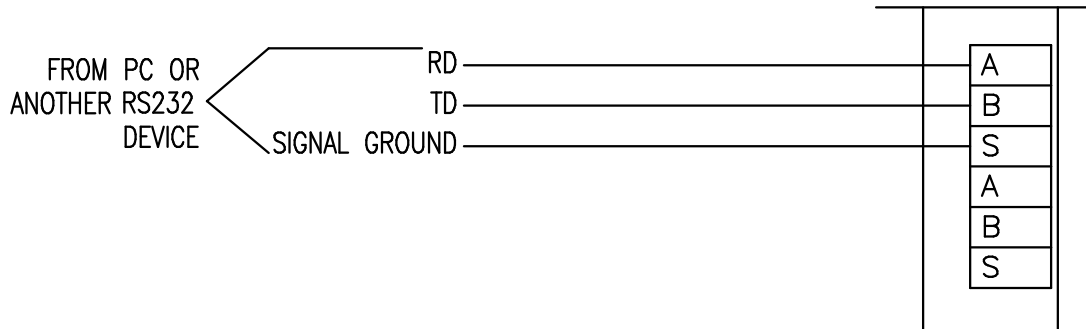


Figure 11 – Wiring diagrams for RS232 and RS485

Connecting Multiple CT224

A network of CT224's should be wired so that the CT224's are in a chain. However, only devices using RS485 can be connected in this manner. RS232 will only allow one (1) device to be connected to a port, so RS232 devices cannot be used in a network. A star or ring configuration is **not** appropriate for RS485. Each CT224 should only be connected to at most 2 other CT224. Figure 12 shows the basic wiring for a chain configuration. Like terminals on the CT224's should be connected together in the chain, A to A, B to B, S to S.

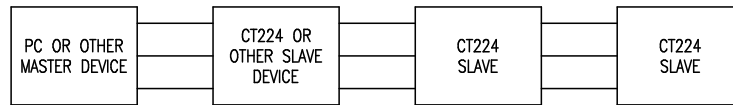


Figure 12 – Master Slave Chain

End devices (Master and last Slave) on an RS485 network should be terminated to achieve error-free communications. The termination should match the characteristic impedance of the network. Normally this value is about 120ohms. Figure 13 shows how to easily apply a termination resistor to the last CT224 in a chain. Do not use more than 2 termination resistors on the network. There are many other methods for terminating an RS485 network. If interested in trying a different termination approach, consult the Internet for various other configurations. In most applications, terminating with 120ohm resistors will provide error-free communications.

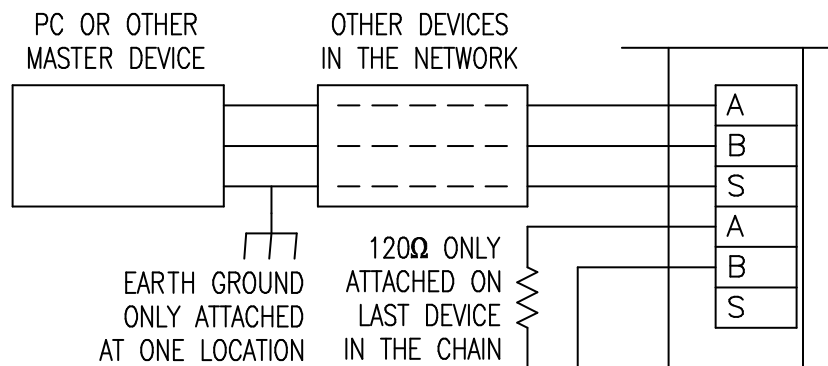


Figure 13 – Termination of RS485 Network

4. Program Configuration

A. Using the CT224

The CT224 has two main modes of operation, Monitoring Mode and Menu Mode. When the CT224 is powered up it will enter Monitoring Mode. Initially the message "Initializing Inputs" will be shown on the display. The CT224 is evaluating the inputs and initializing the outputs based on the program configuration that has been stored in the device. After a few seconds the screen will change and display an input reading.

1. Modes / Buttons

The CT224 has 4 buttons. The user interface has been designed to offer quick modifications to many parameters in an easy to use manner. Buttons have different purposes depending on the Mode of the CT224.

Monitoring Mode

Most of the time the unit will be in Monitoring Mode. In Monitoring Mode, all zones that are configured for input (including the Cold Junction Compensation value), are scanned and the program settings are used to adjust the outputs.

When in Monitoring Mode, the Back and Right arrow buttons display the next lower input zone while the Enter and Up arrow buttons move to the next higher input zone. When customized zone names are used, they will be displayed. The name given to input zone 1 will be displayed in place of the default name "ZONE 1". Entering a custom zone name can be done by entering Menu Mode, selecting Options, Rename Zones.

Menu Mode

To enter Menu Mode from Monitoring Mode, press and hold any key for 3 seconds. A beep will sound and the main menu will be shown. There are many different menus that can be accessed in the Menu Mode. While in Menu Mode, the inputs are not read and outputs are not adjusted. A 60-second countdown is started each time a key is pressed when in Menu Mode. If 60 seconds passes without pressing a key, the CT224 will reset and enter Monitoring Mode and continue to evaluate inputs and outputs.

The buttons in Menu Mode are used for different purposes based on which area is entered. The Back and Right arrow buttons move the cursor up one line and the Enter and Up arrow move the cursor down one line when making a selection from a list. When a selection is made which prompts the user for input, then the buttons take on different tasks. When prompted to enter a value, the Up arrow is used to change the value of the character or the selection where the cursor is located. Once the desired character has been set at the current cursor position, pressing the right arrow will move the cursor to the next position and the Up arrow can be used to adjust that character. Pressing Enter will accept (and save) the current setting and advance to the next step in the configuration process. The Back button is used to move back to the previous step in the configuration process or exit the section that is currently being

modified. To quickly exit an area where configuration is being done, hold the Enter Key for 3 seconds and the mode will be exited. All parameters that were modified and saved by pressing Enter will be saved.

The first menu shown when Menu Mode is entered is the Main Menu. It allows the following choices:

1. *Monitor Zones*
2. *Setup*
3. *Manual Reset*
4. *Options*

1. Monitor Zones

Select this option to return to Monitoring Mode to read and evaluate the inputs and outputs.

2. Setup Menu

The Configuration Menu may require a password to enter, by default no password is required. The Configuration Menu contains the following options.

1. *Change Passwords*
2. *Change Settings*
3. *Modify Offsets*
4. *Comm Settings*

1. Change Passwords - Select the password to change. A message asking if you would like to change a password will be shown. Choose 'Yes' to change a password or 'No' to exit the Change Passwords option. By setting a password to 0000, the password will be deactivated. The valid range for a password is 0000 to 9999. If a password is already entered, the user will be required to enter the existing password in order to change it. If you forget your password, the master password can be used, it is found on the last page of this manual. Available selections are:

1. *Program Password*
2. *Unlatch Password*

1. **Program Password** – Changes the password that is used to protect the Change Program option.
2. **Unlatch Password** – Changes the password that is used to protect Manual Reset of the Outputs.

2. Change Settings - This section is used to configure all inputs and outputs. (May be password protected.) When this section is exited, either due to the 60-second timeout or exited by the user, the CT224 will automatically reset and start scanning with the new program settings. The CT224 will also reset when program settings are changed via the communications link using CT224 Utilities. This is the main section of the CT224 configuration process and

has a full section below covering its use. See section 4B, Entering the Program Settings, for more information.

3. Modify Offsets - Adjust the offset for each input zone. The offsets are used to improve accuracy of the readings. This could be useful if a 2-wire RTD is used or a particular value is crucial in a process. The offset can be used so that less error is present. The units for the offset are Tenths. So, if the reading is off by -1 degree (or 1 unit in any other measurement), the number that should be entered for the offset value is 10, because this will raise the value by 10 tenths or +1 degree.

4. Comm Settings – This selection steps through setting the monitor address and the baud rate for the serial communications. The settings chosen must match the settings selected by the master device that will be communicating with the CT224. The first screen requests the user to enter the Modbus address. The valid range of addresses is from 1 to 247. If 0 is selected, the CT224 will not monitor the communication lines. Each CT224 is factory set to a default Modbus address of 1. If communications are not used, it is acceptable to leave the default address at 1. If multiple CT224 are to be used, the addresses should be changed to prevent communication errors. The next screen will request setting the baud rate. Valid baud rates are: 600, 1200, 2400, 4800, 9600, and 19200.

3. Manual Reset - Use this option to reset the outputs if a trip has occurred and Manual Reset Only was selected when configuring the outputs. (May be password protected.)

4. Options – Options Menu allows the user to personalize the zone names and exercise the relays.

1. *Rename Zones*
2. *Exercise Relays*
3. *Freeze Outputs*

1. Rename Zones – This option is used to personalize the display. Up to 16 characters can be entered to describe the input location. Capital letters (A-Z), numbers (0-9), and spaces are allowed.

2. Exercise Relays – This option can be used to trip the outputs for test purposes. This can be helpful to verify that wiring is correct and that connections are secure. When selected and relays are in tripped condition, the unit will keep the outputs tripped until another key is pressed.

3. Freeze Outputs – Selecting this option will disable the program from changing the state of any output. The message “Outputs are Frozen” is displayed on the screen when this selection is active and the CT224 is in Monitor Mode. To unfreeze the outputs, choose this option again and the Freeze Outputs option will be disabled.

B) Entering the Program Settings

The first step to take when configuring the CT224 is to decide how you would like the device configured. Configuration is best performed using CT224 Utilities. If you do not have a computer available for configuration you may also use the keypad on the CT224 to enter the settings. If using the keypad to configure the CT224, use the Setup Worksheet to speed up the process and reduce errors. Due to the 60-second timeout in the CT224, it is best to fill out the Setup Worksheet before configuring the unit. This will also allow you to have record of the settings that are programmed into the unit for future reference.

A description for each of the configuration options is give on the following pages.

Reverse acting outputs? - Choose the outputs you would like to configure for reverse action.

N – Relay: Normally Open (NO) contact will be open and the Normally Closed (NC) contact will be closed.

Logic: Output will be low (0V) in untripped state.

Y – Relay: NO contact will be closed and the NC contact will be open in the untripped state. The Logic: Output will be high (+5V) in untripped state.

Temperature Scale: Choose the temperature scale that the CT224 should use. RTDs and thermocouples will use this temperature scale for display. Options are F, Fahrenheit and C, Celsius.

Zone to be displayed during normal operation: Choose how the input readings should be displayed.

The user can always adjust the displayed reading by pressing keys, after 5 seconds the CT224 will resume it's process of displaying the High, Low or Scanning through inputs.

High – Highest input reading is displayed, regardless of input type.

Low – Lowest input reading is displayed, regardless of input type.

Any – Display will stay on the zone that the user has set it to.

Minutes of alarm silence when a key is pressed: Set the amount of time to wait until the alarm will resound, if the alarm condition is still present. Valid range is 1 to 100 minutes or Stays Off. This setting only resounds the alarm, it will not re-trip an output. It is designed to remind personnel that there is still a trip condition in affect.

If an input fails: This setting allows the user to determine what action the CT224 should take if a broken sensor is detected.

Sound alarm – Alarm will sound if input fails. Alarm will resound according to the "Minutes of alarm silence when a key is pressed" set in the previous step.

Trip output(s) associated with failed input – All outputs configured to trip on the channel that has a failed input will trip.

Ignore – Continue operating like the input is still functioning properly.

Choose input type: Select the input type for this zone. Options are:

RTD Inputs

Material	Resistance at 0°C in ohms	TCR	Sensor Range
Platinum (PA)	100	.00392	-200 to 700°C (-328 to 1292°F)
Platinum (PB)	100	.00391	-200 to 700°C (-328 to 1292°F)
Platinum (PD or PE)	100	.00385	-200 to 850°C (-328 to 1562°F)
Platinum (PF)	1000	.00385	-200 to 600°C (-328 to 1112°F)
Nickel (NA)	120	.00672	-80 to 260°C (-112 to 500°F)
Copper (CA)	9.035 (10 Ω at 25°C)	.00427	-100 to 260°C (-148 to 500°F)

Thermocouple Inputs

Type	Sensor Range
E	-270 to 1000°C (-454 to 1832°F)
J	-200 to 1200°C (-328 to 2192°F)
K	-270 to 1150°C (-454 to 2102°F)
T	-270 to 400°C (-454 to 752°F)

4-20mA Transmitters: Output proportional to process variable for Pressure PSI, Pressure Bar, % Relative Humidity, Process Variable mA, Process Variable Vdc, Vibration G, Temperature °C, Temperature °F.

Enter Low End of Transmitter Range: This setting will only be displayed if a 4-20mA input is selected in the previous step. All ranges for RTDs and thermocouples are fixed. The valid input range is between -999 and 9999.

Enter High End of Transmitter Range: This setting is also only available when a 4-20mA input is selected. The valid input range is between -999 and 9999. The high end of the transmitter range must be higher than the low end.

No Input Connected: This setting disables this zone (turn zone off).

Zone X Trip 1: Set the trip value for this zone. When Trip 2 is displayed it will correspond to the second trip value for the zone. Valid temperature ranges are shown in the charts found under "Choose input type:". If a value not within the range for the sensor is entered, a warning will be displayed and a new, valid setting should be entered.

Trip Over or Under? – This setting determines when the outputs will trip.

Over – Outputs for the zone will trip when the reading is higher than the trip value.

Under – Outputs for the zone will trip when the reading is lower than the trip value.

Sound Alarm on Trip? –Yes will cause the alarm to sound and alarm output to trip when the reading passes the trip value. Selecting No will not sound the alarm when the outputs are tripped.

Outputs to trip:

Output1__ Output2__

Output3__ Output4__ - A Y after the output indicates to trip the output when the reading passed the trip value. An N after the output indicates the output should not be tripped.

Untrip Outputs by: - This setting will determine how the outputs associated with this trip will be untripped.

Manual Reset Only – This setting causes the outputs to latch. In addition, temperature display will show highest reading since the trip event. The outputs can only be reset by entering the Main Menu and selecting Manual Reset. This will also return temperature display to normal operation. (A password may be necessary to reset the relays.)

Pressing Enter – The outputs will untrip when Enter is pressed.

Using Hysteresis – The outputs will untrip when the input value exits the hysteresis (deadband) limit.

Note: The order of precedence for the methods of untrip is Manual Reset Only, Pressing Enter, and then Using Hysteresis. This means that if at any time an output is tripped and configured by an zone to untrip using Manual Reset Only, the only way to untrip that zone is using the Manual Reset.

Note: When any zone causes a trip for an output, all zones that have caused a trip on that output will be refreshed. This means that if an output has been tripped and then cleared by pressing Enter and another zone causes that output to retrip, the output will act as though both trips have reoccurred at the same time to cause the output to trip. So, if the second trip were to reset by dropping below the programmed hysteresis value, the output will still be tripped, due to the first zone, which caused the trip. To reset the output again, Enter would need to be pressed.

Set Hysteresis: - Hysteresis is the amount that the reading must move past the trip value before the outputs will reset. For example, the system is configured to trip at 100°F, has a 10°F hysteresis and will trip Output 1 on an over temperature reading. The reading increases to 100°F, so Output 1 trips. The reading will need to go below 90°F before Output 1 will reset.

C. Setup Worksheet

Prompt	Description	Selection
Reverse acting outputs?	Choose which outputs should be in an active state, before a trip condition occurs.	Output 1__ Output 2__ Output 3__ Output 4__
Temperature Scale:	Choose the temperature scale to which the CT224 should be configured.	Degrees _____
Zone to be displayed during normal operation:	Choose how input readings should be displayed.	High Low Any
Minutes of alarm silence when a key is pressed:	Set the amount of time that should pass before the alarm will resound due to an alarm condition.	_____ Minutes
If an input fails:	Choose action to take if input fails.	Sound Alarm Trip Output(s) Ignore
Zone X Trip 1: Choose input type:	Choose the type of input that is attached.	Zone 1 _____ Zone 6 _____ Zone 2 _____ Zone 7 _____ Zone 3 _____ Zone 8 _____ Zone 4 _____ Zone 9 _____ Zone 5 _____ Zone 10 _____ Zone 6 _____ Zone 11 _____ Zone 7 _____ Zone 12 _____
Zone X Trip 1: Enter Low End of Transmitter Range:	For 4-20mA current loops, enter the low end of the range of the input. These settings will not be used for RTD and Thermocouple inputs. The range for RTD and Thermocouples are not changeable. See Specifications in the rear of the manual for the range of RTD and Thermocouples.	Zone 1 _____ Zone 6 _____ Zone 2 _____ Zone 7 _____ Zone 3 _____ Zone 8 _____ Zone 4 _____ Zone 9 _____ Zone 5 _____ Zone 10 _____ Zone 6 _____ Zone 11 _____ Zone 7 _____ Zone 12 _____

Prompt	Description	Selection
Zone X Trip 1: Enter High End of Transmitter Range:	For 4-20mA current loops, enter the high end of the range of the input.	Zone 1 _____ Zone 6 _____ Zone 2 _____ Zone 7 _____ Zone 3 _____ Zone 8 _____ Zone 4 _____ Zone 9 _____ Zone 5 _____ Zone 10 _____ Zone 6 _____ Zone 11 _____ Zone 7 _____ Zone 12 _____
Zone X Trip 1:	Set the trip value.	Zone 1 _____ Zone 6 _____ Zone 2 _____ Zone 7 _____ Zone 3 _____ Zone 8 _____ Zone 4 _____ Zone 9 _____ Zone 5 _____ Zone 10 _____ Zone 6 _____ Zone 11 _____ Zone 7 _____ Zone 12 _____
Zone X Trip 1: Trip Over or Under?	Set the input condition for when the output(s) should trip.	Zone 1 _____ Zone 6 _____ Zone 2 _____ Zone 7 _____ Zone 3 _____ Zone 8 _____ Zone 4 _____ Zone 9 _____ Zone 5 _____ Zone 10 _____ Zone 6 _____ Zone 11 _____ Zone 7 _____ Zone 12 _____
Zone X Trip 1: Sound Alarm on Trip?	Set to alarm when an output is tripped.	Zone 1 _____ Zone 6 _____ Zone 2 _____ Zone 7 _____ Zone 3 _____ Zone 8 _____ Zone 4 _____ Zone 9 _____ Zone 5 _____ Zone 10 _____

Prompt	Description	Selection
		Zone 6 _____ Zone 11 _____ Zone 7 _____ Zone 12 _____
Zone X Trip 1: Outputs to trip: Output1__ Output2__ Output3__ Output4__	Choose outputs to trip when trip value is observed.	Zone 1 Trip 1: Zone 7 Trip 1: Output1__ Output2__ Output1__ Output2__ Output3__ Output4__ Output3__ Output4__ Zone 2 Trip 1: Zone 8 Trip 1: Output1__ Output2__ Output1__ Output2__ Output3__ Output4__ Output3__ Output4__ Zone 3 Trip 1: Zone 9 Trip 1: Output1__ Output2__ Output1__ Output2__ Output3__ Output4__ Output3__ Output4__ Zone 4 Trip 1: Zone 10 Trip 1: Output1__ Output2__ Output1__ Output2__ Output3__ Output4__ Output3__ Output4__ Zone 5 Trip 1: Zone 11 Trip 1: Output1__ Output2__ Output1__ Output2__ Output3__ Output4__ Output3__ Output4__ Zone 6 Trip 1: Zone 12 Trip 1: Output1__ Output2__ Output1__ Output2__ Output3__ Output4__ Output3__ Output4__
Zone X Trip 1: Untrip Outputs by:	Choose the preferred method to untrip the outputs.	Zone 1 _____ Zone 6 _____ Zone 2 _____ Zone 7 _____ Zone 3 _____ Zone 8 _____ Zone 4 _____ Zone 9 _____ Zone 5 _____ Zone 10 _____ Zone 6 _____ Zone 11 _____ Zone 7 _____ Zone 12 _____

Prompt	Description	Selection
Zone X Trip 1: Set Hysteresis:	Set the hysteresis (deadband) value. Hysteresis is the amount that the input value must pass beyond the trip value before the output will untrip.	Zone 1 _____ Zone 6 _____ Zone 2 _____ Zone 7 _____ Zone 3 _____ Zone 8 _____ Zone 4 _____ Zone 9 _____ Zone 5 _____ Zone 10 _____ Zone 6 _____ Zone 11 _____ Zone 7 _____ Zone 12 _____
Zone X Trip 2: Choose input type:	Choose the type of input that is attached.	Zone 1 _____ Zone 6 _____ Zone 2 _____ Zone 7 _____ Zone 3 _____ Zone 8 _____ Zone 4 _____ Zone 9 _____ Zone 5 _____ Zone 10 _____ Zone 6 _____ Zone 11 _____ Zone 7 _____ Zone 12 _____
Zone X Trip 2: Enter Low End of Transmitter Range: (4-20mA inputs only, if another input type is selected, this option will not be displayed.)	Enter the low end of the range of the input.	Zone 1 _____ Zone 6 _____ Zone 2 _____ Zone 7 _____ Zone 3 _____ Zone 8 _____ Zone 4 _____ Zone 9 _____ Zone 5 _____ Zone 10 _____ Zone 6 _____ Zone 11 _____ Zone 7 _____ Zone 12 _____
Zone X Trip 2: Enter High End of Transmitter Range: (4-20mA inputs only, if another input type is selected, this option will not be displayed.)	Enter the high end of the range of the input.	Zone 1 _____ Zone 6 _____ Zone 2 _____ Zone 7 _____ Zone 3 _____ Zone 8 _____ Zone 4 _____ Zone 9 _____ Zone 5 _____ Zone 10 _____

Prompt	Description	Selection
		Zone 6 _____ Zone 11 _____ Zone 7 _____ Zone 12 _____
Zone X Trip 2:	Set the trip value.	Zone 1 _____ Zone 6 _____ Zone 2 _____ Zone 7 _____ Zone 3 _____ Zone 8 _____ Zone 4 _____ Zone 9 _____ Zone 5 _____ Zone 10 _____ Zone 6 _____ Zone 11 _____ Zone 7 _____ Zone 12 _____
Zone X Trip 2: Trip Over or Under?	Set the condition when the outputs should trip.	Zone 1 _____ Zone 6 _____ Zone 2 _____ Zone 7 _____ Zone 3 _____ Zone 8 _____ Zone 4 _____ Zone 9 _____ Zone 5 _____ Zone 10 _____ Zone 6 _____ Zone 11 _____ Zone 7 _____ Zone 12 _____
Zone X Trip 2: Sound Alarm on Trip?	Set to alarm when an output is tripped.	Zone 1 _____ Zone 6 _____ Zone 2 _____ Zone 7 _____ Zone 3 _____ Zone 8 _____ Zone 4 _____ Zone 9 _____ Zone 5 _____ Zone 10 _____ Zone 6 _____ Zone 11 _____ Zone 7 _____ Zone 12 _____

Prompt	Description	Selection
Zone X Trip 2: Outputs to trip: Output1__ Output2__ Output3__ Output4__	Choose outputs to trip when trip value is observed.	Zone 1 Trip 1: Zone 7 Trip 1: Output1__ Output2__ Output1__ Output2__ Output3__ Output4__ Output3__ Output4__ Zone 2 Trip 1: Zone 8 Trip 1: Output1__ Output2__ Output1__ Output2__ Output3__ Output4__ Output3__ Output4__ Zone 3 Trip 1: Zone 9 Trip 1: Output1__ Output2__ Output1__ Output2__ Output3__ Output4__ Output3__ Output4__ Zone 4 Trip 1: Zone 10 Trip 1: Output1__ Output2__ Output1__ Output2__ Output3__ Output4__ Output3__ Output4__ Zone 5 Trip 1: Zone 11 Trip 1: Output1__ Output2__ Output1__ Output2__ Output3__ Output4__ Output3__ Output4__ Zone 6 Trip 1: Zone 12 Trip 1: Output1__ Output2__ Output1__ Output2__ Output3__ Output4__ Output3__ Output4__

Zone X Trip 2: Untrip Outputs by:	Choose the preferred method to untrip the outputs.	Zone 1 _____ Zone 2 _____ Zone 3 _____ Zone 4 _____ Zone 5 _____ Zone 6 _____ Zone 7 _____	Zone 6 _____ Zone 7 _____ Zone 8 _____ Zone 9 _____ Zone 10 _____ Zone 11 _____ Zone 12 _____
Zone X Trip 2: Set Hysteresis:	Set the hysteresis (deadband) value. Hysteresis is the amount that the input value must pass beyond the trip value before the output will untrip.	Zone 1 _____ Zone 2 _____ Zone 3 _____ Zone 4 _____ Zone 5 _____ Zone 6 _____ Zone 7 _____	Zone 6 _____ Zone 7 _____ Zone 8 _____ Zone 9 _____ Zone 10 _____ Zone 11 _____ Zone 12 _____

5. Communications

The CT224 uses Modbus protocol to communicate over an RS485 bus. RTU transmission mode is supported by the CT224. ASCII transmission mode is not supported. Data transfer must adhere to the following data format: 1 start bit, 8 data bits, 1 stop bit and no parity. Supported data rates are: 600, 1200, 2400, 4800, 9600, and 19200 baud. Supported function codes are 0x03, 0x04, and 0x10. These instructions allow the program settings to be read and modified and access to the input readings on the monitor. The communications are limited to 41 characters per transmission, including header information and checksum. A character is defined as hexadecimal 0 ... 9, A ... F. Modbus addresses are allowed in the range from 1 to 247. If the CT224 is set to a Modbus address of 0, the unit will ignore all signals on the communication inputs. Command responses may take one second or more in some cases, so be aware of this when designing third-party communication systems.

The CT224 supports half-duplex operation. This means that only two signal wires are required to send and receive signals. Using half-duplex operation helps to minimize wiring and still provides the long distance communications allowed while using RS485. Wire lengths up to 4000 ft. are allowed with RS485 as compared to only 50 ft. using RS232.

Using a PC for RS485 Communications

Minco offers an accessory package (AC102734) that contains an isolated RS232 to RS485 converter, power supply to power the converter, and a DB25 to DB9 adapter. These parts have been thoroughly tested and have been found to work properly with the CT224 and CT224 Utilities. CT224 Utilities software is configured to use a converter that requires DTR to be active all of the time and RTS to be active when transmitting and inactive when receiving. Other converters that have the same requirements will work with the CT224 Utilities. Minco does not guarantee that any other RS232 to RS485 converter will work with the CT224.

A) Function Codes

Function Code 0x03 – Read program settings

The 0x03 function code is used to read the program settings in the CT224. Program settings are shown in the memory map later in this section. The maximum number of data bytes that can be sent from the CT224 is 32. This is due to the 41 byte limit set for communications. Therefore, the maximum value that can be used as the number of memory locations to read is 16.

To request data from 3 memory locations starting at location 0x20, the proper data string to use, assuming the monitor address is 1, would be:

0103002000030104

01	Monitor Address
03	Function Code
00	High byte of starting memory location
20	Low byte of starting memory location
00	High byte of the number of memory locations to read
03	Low byte of the number of memory locations to read
0104	The checksum for the string that is being sent

The response from the CT224 would look like the following:

01030600010002000374FD

01	Monitor Address
03	Function Code
06	Number of data bytes returned
000100020003	Data bytes returned starting at memory location 0x20
74FD	The checksum for the string that was sent

Function Code 0x04 – Read current inputs

The 0x04 function code is used to retrieve the current input readings.

To request data from 4 memory locations starting at location 0x10, the proper data string to use, assuming the monitor address is 1, would be:

010400100003CEB1

01	Monitor Address
04	Function Code
00	High byte of starting memory location
10	Low byte of starting memory location
00	High byte of the number of memory locations to read
04	Low byte of the number of memory locations to read
0CF0	The checksum for the string that was sent

The response from the CT224 would look something like the following: (Returned data bytes will obviously vary, depending on the values at those locations.)

0104060001000200030004AEF0

01	Monitor Address
04	Function Code
06	Number of data bytes returned
0001000200030004	Data returned, 4 – 16 bit words
AEF0	The checksum for the string that was sent

Function Code 0x10 – Write program settings

The 0x10 function code is used to write program settings to the CT224. When sending the Write Program Settings command, the hexadecimal number 10 will be used. Program settings are shown in the memory map later in this section. The maximum number of data bytes that can be sent to the CT224 is 32. This is due to the 41 byte limit set for communications. Therefore, the maximum value that can be used as the number of memory locations to write is 16.

To store settings to 3 memory locations starting at location 0x20, the proper data string to use, assuming the monitor address is 1, would be:

011000200003AABBCCDDEEFF5B39

01	Monitor Address
10	Function Code
00	High byte of starting memory location
20	Low byte of starting memory location
00	High byte of the number of memory locations to write
03	Low byte of the number of memory locations to write
AABB	First word of data to send
CCDD	Second word of data to send
EEFF	Third word of data to send
5B39	The checksum for the string that was sent

The response from the CT224 would look something like the following:

011006C2AD

01	Monitor Address
10	Function Code
06	Number of data bytes received
C2AD	The checksum for the string that was sent

B) Memory Map

Explanation of the Value Format can be found after the chart **Current Values for Inputs and Outputs**.

Program Settings are stored according to the chart below:

Register Address	Description	Value Format
0000	Reverse Acting Relays / Temperature Scale	A
0001	Zone to be displayed	B
0002	Length of Silence	C
0003	Action to take on failed input	D
0004	Zone 1 Trip 1 – Input Type	E
0005	- Low end of input range	F
0006	- High end of input range	G
0007	- Trip Value	H
0008	- Trip Over or Under	I
0009	- Sound Alarm / Outputs to trip	J
000A	- Output Reset / Hysteresis Value	K
000B	Zone 1 Trip 2 – Trip Value	H
000C	- Trip Over or Under	I
000D	- Sound Alarm / Outputs to trip	J
000E	- Output Reset / Hysteresis Value	K
000F	Zone 2 Trip 1 – Input Type	E
0010	- Low end of input range	F
0011	- High end of input range	G
0012	- Trip Value	H
0013	- Trip Over or Under	I
0014	- Sound Alarm / Outputs to trip	J
0015	- Output Reset / Hysteresis Value	K
0016	Zone 2 Trip 2 – Trip Value	H
0017	- Trip Over or Under	I
0018	- Sound Alarm / Outputs to trip	J
0019	- Output Reset / Hysteresis Value	K
001A	Zone 3 Trip 1 – Input Type	E
001B	- Low end of input range	F
001C	- High end of input range	G
001D	- Trip Value	H
001E	- Trip Over or Under	I
001F	- Sound Alarm / Outputs to trip	J

Register Address	Description	Value Format
0020	- Output Reset / Hysteresis Value	K

0021	Zone 3 Trip 2 – Trip Value	H
0022	- Trip Over or Under	I
0023	- Sound Alarm / Outputs to trip	J
0024	- Output Reset / Hysteresis Value	K
0025	Zone 4 Trip 1 – Input Type	E
0026	- Low end of input range	F
0027	- High end of input range	G
0028	- Trip Value	H
0029	- Trip Over or Under	I
002A	- Sound Alarm / Outputs to trip	J
002B	- Output Reset / Hysteresis Value	K
002C	Zone 4 Trip 2 – Trip Value	H
002D	- Trip Over or Under	I
002E	- Sound Alarm / Outputs to trip	J
002F	- Output Reset / Hysteresis Value	K
0030	Zone 5 Trip 1 – Input Type	E
0031	- Low end of input range	F
0032	- High end of input range	G
0033	- Trip Value	H
0034	- Trip Over or Under	I
0035	- Sound Alarm / Outputs to trip	J
0036	- Output Reset / Hysteresis Value	K
0037	Zone 5 Trip 2 – Trip Value	H
0038	- Trip Over or Under	I
0039	- Sound Alarm / Outputs to trip	J
003A	- Output Reset / Hysteresis Value	K
003B	Zone 6 Trip 1 – Input Type	E
003C	- Low end of input range	F
003D	- High end of input range	G
003E	- Trip Value	H
003F	- Trip Over or Under	I
0040	- Sound Alarm / Outputs to trip	J
0041	- Output Reset / Hysteresis Value	K
0042	Zone 6 Trip 2 – Trip Value	H
0043	- Trip Over or Under	I
0044	- Sound Alarm / Outputs to trip	J

0045	- Output Reset / Hysteresis Value	K
0046	Zone 7 Trip 1 – Input Type	E
0047	- Low end of input range	F
0048	- High end of input range	G
0049	- Trip Value	H
004A	- Trip Over or Under	I
004B	- Sound Alarm / Outputs to trip	J
004C	- Output Reset / Hysteresis Value	K
004D	Zone 7 Trip 2 – Trip Value	H
004E	- Trip Over or Under	I
004F	- Sound Alarm / Outputs to trip	J
0050	- Output Reset / Hysteresis Value	K
0051	Zone 8 Trip 1 – Input Type	E
0052	- Low end of input range	F
0053	- High end of input range	G
0054	- Trip Value	H
0055	- Trip Over or Under	I
0056	- Sound Alarm / Outputs to trip	J
0057	- Output Reset / Hysteresis Value	K
0058	Zone 8 Trip 2 – Trip Value	H
0059	- Trip Over or Under	I
005A	- Sound Alarm / Outputs to trip	J
005B	- Output Reset / Hysteresis Value	K
005C	Zone 9 Trip 1 – Input Type	E
005D	- Low end of input range	F
005E	- High end of input range	G
005F	- Trip Value	H
0060	- Trip Over or Under	I
0061	- Sound Alarm / Outputs to trip	J
0062	- Output Reset / Hysteresis Value	K
0063	Zone 9 Trip 2 – Trip Value	H
0064	- Trip Over or Under	I
0065	- Sound Alarm / Outputs to trip	J
0066	- Output Reset / Hysteresis Value	K
0067	Zone 10 Trip 1 – Input Type	E
0068	- Low end of input range	F
0069	- High end of input range	G

006A	- Trip Value	H
006B	- Trip Over or Under	I
006C	- Sound Alarm / Outputs to trip	J
006D	- Output Reset / Hysteresis Value	K
006E	Zone 10 Trip 2 – Trip Value	H
006F	- Trip Over or Under	I
0070	- Sound Alarm / Outputs to trip	J
0071	- Output Reset / Hysteresis Value	K
0072	Zone 11 Trip 1 – Input Type	E
0073	- Low end of input range	F
0074	- High end of input range	G
0075	- Trip Value	H
0076	- Trip Over or Under	I
0077	- Sound Alarm / Outputs to trip	J
0078	- Output Reset / Hysteresis Value	K
0079	Zone 11 Trip 2 – Trip Value	H
007A	- Trip Over or Under	I
007B	- Sound Alarm / Outputs to trip	J
007C	- Output Reset / Hysteresis Value	K
007D	Zone 12 Trip 1 – Input Type	E
007E	- Low end of input range	F
007F	- High end of input range	G
0080	- Trip Value	H
0081	- Trip Over or Under	I
0082	- Sound Alarm / Outputs to trip	J
0083	- Output Reset / Hysteresis Value	K
0084	Zone 12 Trip 2 – Trip Value	H
0085	- Trip Over or Under	I
0086	- Sound Alarm / Outputs to trip	J
0087	- Output Reset / Hysteresis Value	K
0088	Input Offset – Zone 1	L
0089	- Zone 2	L
008A	- Zone 3	L
008B	- Zone 4	L
008C	- Zone 5	L
008D	- Zone 6	L
008E	- Zone 7	L

008F	- Zone 8	L
0090	- Zone 9	L
0091	- Zone 10	L
0092	- Zone 11	L
0093	- Zone 12	L
0094	Reserved	
0095	Reserved	
0096	Reserved	
0097	Reserved	
0098	Zone 1 Name - Characters 1, 2	M
0099	- Characters 3, 4	M
009A	- Characters 5, 6	M
009B	- Characters 7, 8	M
009C	- Characters 9, 10	M
009D	- Characters 11, 12	M
009E	- Characters 13, 14	M
009F	- Characters 15, 16	M
00A0	Zone 2 Name - Characters 1, 2	M
00A1	- Characters 3, 4	M
00A2	- Characters 5, 6	M
00A3	- Characters 7, 8	M
00A4	- Characters 9, 10	M
00A5	- Characters 11, 12	M
00A6	- Characters 13, 14	M
00A7	- Characters 15, 16	M
00A8	Zone 3 Name - Characters 1, 2	M
00A9	- Characters 3, 4	M
00AA	- Characters 5, 6	M
00AB	- Characters 7, 8	M
00AC	- Characters 9, 10	M
00AD	- Characters 11, 12	M
00AE	- Characters 13, 14	M
00AF	- Characters 15, 16	M
00B0	Zone 4 Name - Characters 1, 2	M
00B1	- Characters 3, 4	M
00B2	- Characters 5, 6	M
00B3	- Characters 7, 8	M

ooB4	- Characters 9, 10	M
ooB5	- Characters 11, 12	M
ooB6	- Characters 13, 14	M
ooB7	- Characters 15, 16	M
ooB8	Zone 5 Name - Characters 1, 2	M
ooB9	- Characters 3, 4	M
ooBA	- Characters 5, 6	M
ooBB	- Characters 7, 8	M
ooBC	- Characters 9, 10	M
ooBD	- Characters 11, 12	M
ooBE	- Characters 13, 14	M
ooBF	- Characters 15, 16	M
ooC0	Zone 6 Name - Characters 1, 2	M
ooC1	- Characters 3, 4	M
ooC2	- Characters 5, 6	M
ooC3	- Characters 7, 8	M
ooC4	- Characters 9, 10	M
ooC5	- Characters 11, 12	M
ooC6	- Characters 13, 14	M
ooC7	- Characters 15, 16	M
ooC8	Zone 7 Name - Characters 1, 2	M
ooC9	- Characters 3, 4	M
ooCA	- Characters 5, 6	M
ooCB	- Characters 7, 8	M
ooCC	- Characters 9, 10	M
ooCD	- Characters 11, 12	M
ooCE	- Characters 13, 14	M
ooCF	- Characters 15, 16	M
ooD0	Zone 8 Name - Characters 1, 2	M
ooD1	- Characters 3, 4	M
ooD2	- Characters 5, 6	M
ooD3	- Characters 7, 8	M
ooD4	- Characters 9, 10	M
ooD5	- Characters 11, 12	M
ooD6	- Characters 13, 14	M
ooD7	- Characters 15, 16	M
ooD8	Zone 9 Name - Characters 1, 2	M

00D9	- Characters 3, 4	M
00DA	- Characters 5, 6	M
00DB	- Characters 7, 8	M
00DC	- Characters 9, 10	M
00DD	- Characters 11, 12	M
00DE	- Characters 13, 14	M
00DF	- Characters 15, 16	M
00E0	Zone 10 Name - Characters 1, 2	M
00E1	- Characters 3, 4	M
00E2	- Characters 5, 6	M
00E3	- Characters 7, 8	M
00E4	- Characters 9, 10	M
00E5	- Characters 11, 12	M
00E6	- Characters 13, 14	M
00E7	- Characters 15, 16	M
00E8	Zone 11 Name - Characters 1, 2	M
00E9	- Characters 3, 4	M
00EA	- Characters 5, 6	M
00EB	- Characters 7, 8	M
00EC	- Characters 9, 10	M
00ED	- Characters 11, 12	M
00EE	- Characters 13, 14	M
00EF	- Characters 15, 16	M
00F0	Zone 12 Name - Characters 1, 2	M
00F1	- Characters 3, 4	M
00F2	- Characters 5, 6	M
00F3	- Characters 7, 8	M
00F4	- Characters 9, 10	M
00F5	- Characters 11, 12	M
00F6	- Characters 13, 14	M
00F7	- Characters 15, 16	M
00F8	Modbus Address	N
00F9	Baud Rate Indicator	O
00FA	Reserved	
00FB	Reserved	
00FC	Simulation Mode / Wait Mode / Reset	P
00FD	Password for entering programming menu	Q

ooFE	Password for allowing manual reset	R
ooFF	Reserved	

Current Values for Inputs and Outputs:

Register Address	Description	Value Format
0000	Input Reading for Zone 1 – Upper 16 bits	S
0001	– Lower 16 bits	S
0002	Input Reading for Zone 2 – Upper 16 bits	S
0003	– Lower 16 bits	S
0004	Input Reading for Zone 3 – Upper 16 bits	S
0005	– Lower 16 bits	S
0006	Input Reading for Zone 4 – Upper 16 bits	S
0007	– Lower 16 bits	S
0008	Input Reading for Zone 5 – Upper 16 bits	S
0009	– Lower 16 bits	S
000A	Input Reading for Zone 6 – Upper 16 bits	S
000B	– Lower 16 bits	S
000C	Input Reading for Zone 7 – Upper 16 bits	S
000D	– Lower 16 bits	S
000E	Input Reading for Zone 8 – Upper 16 bits	S
000F	– Lower 16 bits	S
0010	Input Reading for Zone 9 – Upper 16 bits	S
0011	– Lower 16 bits	S
0012	Input Reading for Zone 10 – Upper 16 bits	S
0013	– Lower 16 bits	S
0014	Input Reading for Zone 11 – Upper 16 bits	S
0015	– Lower 16 bits	S
0016	Input Reading for Zone 12 – Upper 16 bits	S
0017	– Lower 16 bits	S
0018	Input Reading for CJC – Upper 16 bits	S
0019	– Lower 16 bits	S
001A	Output Status	T

Value Format Chart:

Value Format	Explanation
A	<p>This 16 bit word is used for two parameters. The upper 8 bits set which outputs are used as reverse acting or direct acting. The lower 8 bits set the temperature scale.</p> <p>Reverse or Direct acting outputs: A 0 indicates Normal output operation and a 1 indicates Reverse acting. The format is as follows: 0000 4321, where bit location 4 represents output 4, bit location 3 represents output 3, etc.</p> <p>Temperature Scale: 0 indicates using degrees C and a 1 indicates using degrees F The format is as follows: 0000 000X, where X will be a 0 or 1 indicating the scale</p> <p>Example: Set Output 1 and 2 as reverse acting and the temperature scale to F: The 16 bits to send would be: 0000 0011 0000 0001 = 0x0301</p>
B	<p>This 16 bit word sets the zone to be displayed.</p> <p>0000 0000 0000 00XX, where XX is 00 for High zone, 01 for Low zone, or 10 for 'Any'. The 'Any' option will stay on the zone that was last viewed by the user.</p> <p>Example: Set option 'Any': The 16 bits to send would be: 0000 0000 0000 0010 = 0x0002</p>
C	<p>This 16 bit word sets the length of silence before the alarm will resound if a trip condition still exists after the alarm has been silenced. To set the alarm so that it will not resound, a value greater than 100 should be.</p> <p>Example: Set the silence time to 5 minutes: The 16 bits to send would be: 0000 0000 0000 0101 = 0x0005</p> <p>To disable the alarm from resounding, set the value to 101: The 16 bits to send would be: 0000 0000 01101 0101 = 0x0065 (101 decimal)</p>

D	<p>This 16 bit word sets the zone to be displayed.</p> <p>0000 0000 0000 00XX, where XX is 00 for Sound Alarm, 01 for Trip Outputs, or 10 for Ignore.</p> <p>Example: Set option Trip Outputs: The 16 bits to send would be: 0000 0000 0000 0001 = 0x0001</p>																																								
E	<p>This 16 bit word sets the input type.</p> <p>0000 0000 000X XXXX, where X XXXX is assigned in the chart below.</p> <table border="1" data-bbox="444 667 1097 1472"> <thead> <tr> <th>Hex value</th> <th>Input Type</th> </tr> </thead> <tbody> <tr><td>0x00</td><td>Input Off</td></tr> <tr><td>0x01</td><td>PA</td></tr> <tr><td>0x02</td><td>PB</td></tr> <tr><td>0x03</td><td>PD or PE</td></tr> <tr><td>0x04</td><td>PF</td></tr> <tr><td>0x05</td><td>NA</td></tr> <tr><td>0x06</td><td>CA</td></tr> <tr><td>0x07</td><td>E Thermocouple</td></tr> <tr><td>0x08</td><td>J Thermocouple</td></tr> <tr><td>0x09</td><td>K Thermocouple</td></tr> <tr><td>0x0A</td><td>T Thermocouple</td></tr> <tr><td>0x0B</td><td>4-20mA Pressure, PSI</td></tr> <tr><td>0x0C</td><td>4-20mA Pressure, Bar</td></tr> <tr><td>0x0D</td><td>4-20mA % Humidity</td></tr> <tr><td>0x0E</td><td>4-20mA Process Variable, mA</td></tr> <tr><td>0x0F</td><td>4-20mA Process Variable, Vdc</td></tr> <tr><td>0x10</td><td>4-20mA Vibration, G</td></tr> <tr><td>0x11</td><td>4-20mA Temperature, C</td></tr> <tr><td>0x12</td><td>4-20mA Temperature, F</td></tr> </tbody> </table> <p>Example: Set the input to a PF (1000 ohm platinum) RTD. The 16 bits to send would be: 0000 0000 0000 0100 = 0x0004</p>	Hex value	Input Type	0x00	Input Off	0x01	PA	0x02	PB	0x03	PD or PE	0x04	PF	0x05	NA	0x06	CA	0x07	E Thermocouple	0x08	J Thermocouple	0x09	K Thermocouple	0x0A	T Thermocouple	0x0B	4-20mA Pressure, PSI	0x0C	4-20mA Pressure, Bar	0x0D	4-20mA % Humidity	0x0E	4-20mA Process Variable, mA	0x0F	4-20mA Process Variable, Vdc	0x10	4-20mA Vibration, G	0x11	4-20mA Temperature, C	0x12	4-20mA Temperature, F
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F This 16 bit word sets the low end of the input range. The valid input range is between -999 and 9999. If using a temperature input, the low end of the range is shown in the following chart, choose the low end for °F, if the temperature scale is set to °F or choose the low end for °C, if the temperature scale is set to °C. The low and high end of the range must be entered for the given sensor input or errant operation may result. The low end of the range must also be lower than the high end of the range.

Input Type	Low End , °F	Low End, °C
PA	-328	-200
PB	-328	-200
PD or PE	-328	-200
PF	-328	-200
NA	-112	-80
CA	-148	-100
E Thermocouple	-470	-279
J Thermocouple	-346	-210
K Thermocouple	-454	-270
T Thermocouple	-454	-270
4-20mA (All)	-999 to 9999	-999 to 9999

Example:

Set the low end of the range for a PF sensor when the temperature scale is set to F.

The 16 bits to send would be: 1111 1110 1011 1000 = 0xFEB8 (-328 decimal)

G This 16 bit word sets the high end of the input range. The valid input range is between -999 and 9999. If using a temperature input, the low end of the range is shown in the following chart, choose the low end for °F, if the temperature scale is set to °F or choose the low end for °C, if the temperature scale is set to °C. The low and high end of the range must be entered for the given sensor input or errant operation may result. The high end of the range must also be higher than the low end of the range.

Input Type	High End , °F	High End, °C
PA	1292	700
PB	1292	700
PD or PE	1562	850
PF	1166	630
NA	500	260
CA	500	260
E Thermocouple	1832	1000
J Thermocouple	2192	1200
K Thermocouple	2500	1370
T Thermocouple	752	400

	4-20mA (All)	-999 to 9999	-999 to 9999
	<p>Example: Set the high end of the range for a PF sensor when the temperature scale is set to F. The 16 bits to send would be: 0000 0100 1000 1110 = 0x048E (1166 decimal)</p>		
H	<p>This 16 bit word sets the Trip Value. The value must be set between the low and high end of the range for proper operation. If the value is set higher than the high end of the range, the input will be turned Off. If the second trip point is used for an input, the first trip point must also be used. The second trip point cannot be set and used without setting the first trip point, it will be ignored.</p> <p>Example: Set the Trip Value to 100. The 16 bits to send would be: 0000 0000 0110 0100 = 0x0064 (100 decimal)</p> <p>Set the input to Off for an input using a PF sensor with temperature scale set to F. The 16 bits to send would be: 0000 0100 1000 1111 = 0x048F (1167 decimal)</p>		
I	<p>This 16 bit word sets whether to trip on an input reading that is Over or Under the trip point.</p> <p>0000 0000 0000 000X, where X is 0 for Over or 1 for Under.</p> <p>Example: Set the outputs to trip on an Over reading: The 16 bits to send would be: 0000 0000 0000 0000 = 0x0000</p>		
J	<p>This 16 bit word is used for two parameters. The upper 8 bits set whether to trip the alarm output and sound the alarm. The lower 8 bits set the outputs to trip.</p> <p>Trip alarm output and sound alarm: A 0 indicates that the alarm output and alarm buzzer will not be activated when a trip condition occurs on the specified input. A 1 indicates that the alarm output and alarm buzzer will be activated when a trip condition occurs on the specified input. The format is as follows: 0000 000X, where X will be a 0 or 1</p> <p>Outputs to Trip: A 0 indicates not to trip and a 1 indicates to trip when a trip condition occurs. The format is as follows: 0000 4321, where bit location 4 represents output 4, bit location 3 represents output 3, etc.</p> <p>Example: Set the alarm to trip when a trip condition occurs and trip output 2 and 3: The 16 bits to send would be: 0000 0001 0000 0110 = 0x0106</p>		

K	<p>This 16 bit word is used for two parameters. The upper 8 bits set the type of action that will be taken to untrip the output(s) when a trip has occurred. The lower 8 bits set the hysteresis value that will be used, if applicable.</p> <p>Action to take to untrip the output(s): 0 indicates that a Manual Reset will be used to untrip the output(s). 1 indicates that Hysteresis will be used to untrip the output(s). 2 indicates that the output(s) can be untripped by pressing Enter. The format is as follows: 0000 00XX, where XX will be a 00, 01, or 10</p> <p>Hysteresis: Hysteresis can be any value between 0 and 20. The units for the hysteresis are determined by the units used for the input type.</p> <p>Example: Set the output(s) to untrip using Manual Reset: The 16 bits to send would be: 0000 0000 0000 0000 = 0x0000</p> <p>Se the output(s) top untrip using the hysteresis value. Set the hysteresis value to 10. The 16 bits to send would be: 0000 0001 0000 1010 = 0x010A</p>														
L	<p>This 16 bit word is used to set the offset to add to the input reading to compensate for some error in the sensor input. The offset is .1 x value. This means that if the decimal number 10 is stored for the offset, the actual offset is 1 unit (units are the same as the unit for the input type for the given input). The valid range for offsets is -999 to 9999.</p> <p>Example: Set the offset to 1.2 units. The 16 bits to send would be: 0000 0000 0000 1100 = 0x000C (12 decimal)</p>														
M	<p>This 16 bit word holds 2 ASCII character codes. The characters are used in the name for the input.</p> <p>The ASCII character code chart for characters understood by the CT224 is shown below.</p> <table border="1" data-bbox="443 1612 787 1934"> <thead> <tr> <th>Hex Code</th> <th>ASCII Character</th> </tr> </thead> <tbody> <tr> <td>0x20</td> <td></td> </tr> <tr> <td>0x30</td> <td>0</td> </tr> <tr> <td>0x31</td> <td>1</td> </tr> <tr> <td>0x32</td> <td>2</td> </tr> <tr> <td>0x33</td> <td>3</td> </tr> <tr> <td>0x34</td> <td>4</td> </tr> </tbody> </table>	Hex Code	ASCII Character	0x20		0x30	0	0x31	1	0x32	2	0x33	3	0x34	4
Hex Code	ASCII Character														
0x20															
0x30	0														
0x31	1														
0x32	2														
0x33	3														
0x34	4														

	0x35	5
	0x36	6
	0x37	7
	0x38	8
	0x39	9
	0x41	A
	0x42	B
	0x43	C
	0x44	D
	0x45	E
	0x46	F
	0x47	G
	0x48	H
	0x49	I
	0x4A	J
	0x4B	K
	0x4C	L
	0x4D	M
	0x4E	N
	0x4F	O
	0x50	P
	0x51	Q
	0x52	R
	0x53	S
	0x54	T
	0x55	U
	0x56	V
	0x57	W
	0x58	X
	0x59	Y
	0x5A	Z
	<p>Example: Set two characters to be 'R5' in the name for a zone. The 16 bits to send would be: 0101 0010 0011 0101 = 0x5235</p>	
N	<p>This 16 bit word sets the Modbus Address for the controller. The valid range for addresses is 1 to 247.</p> <p>Example: Set the address to 20: The 16 bits to send would be: 0000 0000 0001 0100 = 0x0014 (20 decimal)</p>	

O	<p>This 16 bit word sets the Baud Rate for the CT224 according to the chart below.</p> <table border="1" data-bbox="443 289 857 573"> <thead> <tr> <th>Hex Code</th> <th>Baud Rate</th> </tr> </thead> <tbody> <tr> <td>0</td> <td>600</td> </tr> <tr> <td>1</td> <td>1200</td> </tr> <tr> <td>2</td> <td>2400</td> </tr> <tr> <td>3</td> <td>4800</td> </tr> <tr> <td>4</td> <td>9600</td> </tr> <tr> <td>5</td> <td>19200</td> </tr> </tbody> </table> <p>Example: Set the Baud Rate to 4800: The 16 bits to send would be: 0000 0000 0000 0011 = 0x0003</p>	Hex Code	Baud Rate	0	600	1	1200	2	2400	3	4800	4	9600	5	19200
Hex Code	Baud Rate														
0	600														
1	1200														
2	2400														
3	4800														
4	9600														
5	19200														
P	<p>This 16 bit word sets the mode of operation for the CT224.</p> <p>0x0000 - Normal Operation. The CT224 will have 0x0000 in this location when it is operating in a normal fashion.</p> <p>0x0001 – Reset. If 0x0001 is placed in this register, the CT224 will reset itself.</p> <p>0x0505 – Wait Mode. If 0x0505 is placed into this register, the CT224 will not read any inputs and will not trip any outputs. It is recommended that Wait Mode be entered before updating any program settings. This will prevent erratic trips caused by only partially configured inputs. If Wait Mode is not existed within 2 minutes, the CT224 will automatically exit Wait Mode and return to Normal Operation. Wait Mode is normally exited by writing 0x0001 (Reset) to the register. This will cause the CT224 to reset and begin using the new settings.</p> <p>Example: Unit is reading inputs and updating the outputs (operating in Normal Mode). Update the program settings and return to normal operation.</p> <p>The first step should be to enter Wait Mode. Do this by sending 0x0505 to the register. Then, update the settings that are to be updated. After updates have been made, send 0x0001 to the register. The CT224 will reset and clear any trips that may have been in place due to the old settings. The CT224 will monitor inputs after reset and use the new settings.</p>														
Q	<p>This 16 bit word is used to store the password needed to enter the Configuration Menu. Valid range for inputs is from 0 to 9999. 0 is used to disable the password.</p> <p>Example: Set the password for entering the Configuration Menu to 3456.</p>														

	The 16 bits to send would be: 0000 1101 1000 0000 = 0x0D80 (3456 decimal)
R	<p>This 16 bit word is used to store the password needed to Manual Reset the CT224. Valid range for inputs is from 0 to 9999. 0 is used to disable the password.</p> <p>Example: Set the password for entering the Configuration Menu to 1234. The 16 bits to send would be: 0000 0100 1101 0010 = 0x04D2 (1234 decimal)</p>
S	<p>This 16 bit word contains part of an input reading. The Input Reading is comprised of 2, 16 bit words. When the upper and lower words are combined into one 32 bit word, the result will yield the true reading for the input x .1 . This means that if the input reads 1234, the true input reading is 123.4 .</p> <p>If the upper 16 bit word is 0x7FFF, this indicates that the input is Off. If the upper 16 bit word is 0x0001, this indicates that the input has Failed.</p> <p>The valid range for inputs is determined by the low and high input ranges.</p> <p>Example: If the full 32 bit reading is 0x00000800, the true input is 204.8 If the full 32 bit reading is 0xFFFFFFFF0, the true input is -1.6 If the full 32 bit reading is 0x7FFFFFFF, the input is Off If the full 32 bit reading is 0x000186A0 (100,000 decimal), the input has Failed.</p>
T	<p>This 16 bit word contains the current status of the outputs. The upper 8 bits hold the status of the outputs. The lower 8 bits are undetermined.</p> <p>The upper 8 bits have the format 00054321. Where bit number 5 indicates the status of the alarm, 0 not tripped or 1 tripped. Bit number 4 indicates the status of output 4, 0 not tripped or 1 tripped. Bit number 3 indicates the status for output 3, etc.</p> <p>Example: The 16 bit value read in was 0000 0101 1000 1000 The lower 8 bits can be discarded. Use the upper 8 bits 0000 0101. 1's indicate that outputs 1 and 3 are tripped and 0's indicate that outputs 2, 4 and the alarm output are not tripped.</p>

Important Message Regarding Communications: The memory in the CT224 should not be used in a way that parameters are being changed often. All settings are stored in EEPROM. Repeated programming of EEPROM will cause the memory to fail. Under normal use, reprogramming of memory will not be a problem. However, if an automated routine is used to constantly change the settings, the limit of programming cycles can be quickly overcome.

Specifications:

Input: 1 to 12 RTDs (2 or 3-wire), Thermocouples, or 4-20 mA current loop.
Standard Input Types:

RTD:

- 200 to 700°C: PA (100 Ω /0.00392 $\Omega/\Omega/^\circ\text{C}$)
- 200 to 700°C: PB (100 Ω /0.00391 $\Omega/\Omega/^\circ\text{C}$)
- 200 to 850°C: PD/PE (100 Ω /0.00385 $\Omega/\Omega/^\circ\text{C}$)
- 200 to 600°C: PF (1000 Ω /0.00385 $\Omega/\Omega/^\circ\text{C}$)
- 80 to 260°C: NA (120 Ω /0.00672 $\Omega/\Omega/^\circ\text{C}$)
- 100 to 260°C: CA (10 Ω /0.00427 $\Omega/\Omega/^\circ\text{C}$)

Thermocouple: (Ungrounded only)

- 270 to 1000°C: Type E
- 200 to 1200°C: Type J
- 270 to 1150°C: Type K
- 270 to 400°C: Type T

4-20 mA current loop:

Pressure (PSI, Bar), Humidity (%), Temperature ($^\circ\text{F}$, $^\circ\text{C}$),
Process Variable (mA, Vdc), and Vibration G. Must be linear
with respect to process variable to be measured.

Input Scan Rate: Less than 1.5 seconds.

Outputs Relays: Form C, SPDT 10 A @250 VAC/24 VDC resistive load; 10 A
make current; 2500 VA breaking capacity, 1/4 HP at 120 VAC
motor load.

Logic: 5V DC output, 20 mA.

Display: 20x4 line backlit LCD. 0.1 $^\circ\text{F}$ or 0.1 $^\circ\text{C}$.

Keyboard: 4 membrane type keys with audible and tactile feedback.

Accuracy: 2 $^\circ\text{C}$ (3 $^\circ\text{F}$) in 0 to 60 $^\circ\text{C}$ (32 to 158 $^\circ\text{F}$) ambient, over entire input range.

Power Supply: Option A: 85 to 240 VAC @ 50/60 Hz. Or 110 to 250 VDC, 5 Watts
max.

Option B: 18 to 36 VDC, 6 Watts max.

Replacement Fuses: 5x20mm, 250V, 500 mA.

Communication Interface: RS485 or RS232 (Modbus protocol).

Enclosure: Steel case; NEMA 4 front panel.

Ambient Temperature Rating: 0 to 60 $^\circ\text{C}$ (32 to 158 $^\circ\text{F}$).

Connections: Terminal blocks at rear accept wires to AWG 12.

Dimensions: 7.5" x 11.5" x 2".

Mounting: Panel mount enclosure. See cutout drawing.

Weight: 3.8 lbs.

Approvals: UL 508, CSA C22.2 No. 14-M91

UL File No: E252736

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How to Order

CT224	Model Number: CT224
A	Power Supply: A = 85-240 VAC @ 50/60 HZ / 110-250 VDC B = 18-36 VDC
1	Output: 1 = Relays 2 = Logic (5V)
A	Communication Interface: A = RS232 B = RS485
CT224A1A ← Sample Part Number	

CT224 Master Password is: 9821

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