OPERATION MANUAL

M O D U T E K

MICROTEMP™ SERIES

Process Controller Timers

Model C1115a

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1.0 Warranty Information

Please carefully read the information on the warranty card which you will find packaged with your Modutek product.

Modutek Corp. warrants all its products to be free from defects in materials and workmanship when used under normal operating conditions for a period which is specified on the warranty card.

In the unlikely event that any Modutek product fails while under warranty, Modutek Corp. will, at its option, replace or repair the product.

In the event that repair work is required during the warranty period, contact a Modutek service representative at the appropriate address listed below. **A Return Material Authorization (RMA) number must be obtained prior to shipment.** Returned products and/or parts will NOT be accepted without an RMA number. Purchaser will pay for all shipping charges and said warranty work will be performed at Modutek's place of business.

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1.1 Addendum Notation

In writing this manual we have endeavored to ensure that all the information contained herein is accurate and up to date. Changes made to the product, its options, installation instructions, etc., since the completion of this manual are covered in the form of an addenda section, which is located at the end of this manual. Please read this supplemental information, if included, before proceeding.

2.0 General Information

The MICROTEMP Series of process controller/timers (PCTs) is designed to provide accurate and stable multi-function process control. The MICROTEMP Series PCTs are included as standard equipment with the C, N, Q, Qa, QF, S, Sa, TI, TS, and TSa Series MODUBATHs modules.

Each PCT in the MICROTEMP Series is microprocessor-based and has a built-in timer. The timer performs an automatic countdown with count-through and pre-warn. The countdown time and pre-warn interval are programmable.

The MICROTEMP PCT monitors temperature using a Type "J" thermocouple (T/C) sensor and controls bath temperature with a standard three-mode (P.I.D.) control scheme. It has been optimized to provide maximum flexibility by allowing all of the process settings and adjustments to be performed by the user via the keypad on the front panel. The PCT has two independent thermocouple high-limit controls which provide redundant safety control. The system will shut off automatically should either thermocouple sense an unsafe condition. The POWER switch on the front panel activates and deactivates an internal load carrying relay; when the power is turned off, a mechanical relay deactivates not only the power to the microprocessor section but also the heater.

In addition to the two high-limit controls, there is a third safety switch which is independent of the PCT. This redundant safety is a thermal switch attached directly to the quartz vessel. Should an unsafe temperature occur, the switch will open all power circuits.

SAFETY NOTICE

The self-resetting safety thermal switch opens at 205°C ±10°C. It is physically attached to the process vessel for temperature sensing and is wired in series with the coil of an electromechanical relay which is housed in the PCT. The electromechanical relay contacts open when the unsafe temperature is reached. No further heating can take place until the system returns to a safe temperature. The relay merely resides in the PCT housing for convenience, but is totally independent from the other PCT circuits and interlocks.

MICROTEMP operational parameters are software selectable; all are monitored by status and alarm functions. The alarm functions are fully integrated; the PCT will automatically take appropriate action based on the alarm conditions (see Section 6.0 - Alarms).

Dual displays are provided to allow the temperature and time to be viewed simultaneously. This gives an immediate indication of all pertinent process information. Additionally, discrete light emitting diodes (LEDs) are used to indicate the specific operational modes and conditions of the system.

A solid state power relay is found within the PCT. This eliminates the need for an external relay. This relay carries the heater load directly without any need for external components or wiring. The relay used in model C1115a, C1215a, C1315a, and C1915a has a maximum rating of 15 amps at 208VAC. The relay used in model C1120a, C1220a and C1920a has a maximum rating of 20 amps at 208VAC.

NOTE: The Power switch on the front panel activates and deactivates this mechanical relay. When the power is turned off, the relay has interrupted power to the microprocessor and the heater.

Models C1215a and C1315a each contain the logic and 12 VDC power supply to drive an external solenoid. The C1215a drives a D.I. (deionized) water solenoid. The C1315a drives an H_2O_2 solenoid. There is a corresponding switch on the front panel to manually operate this contact.

A contact switch to actuate a pump has been added to the C1915a. There is a corresponding switch on the front panel to manually operate this contact.

Following is an application chart for the process PCT timers:

Model	Application
C1115a	C, Q, Qa, S, Sa, TI, TS, Tsa Series
C1215a	N Series
C1315a	Q, Qa Series (when used in conjunction with a Chemfeed Series chemical dispensing system
C1915a	QF Series

2.1 Hardware

The MICROTEMP PCT is a self-contained system housed in a chemical resistant Kydex enclosure. The face panel is smooth and made from LEXAN for maximum environmental protection. All printing is on the backside. The keypads and displays are mounted behind the Lexan face (see Figures 3. 1a, b, c, d).

The microprocessor section of the PCT consists of two circuit boards, one for control and one for display. The control board contains two transformers and provides the isolated DC power (+5 and +12 volts) necessary to run the system. It also contains an instrumentation amplifier, an analog/digital, EEPROM memory, and the microprocessor. The display board contains all of the seven segment and LED displays as well as the audio transducer. Models C1215a and C1315a have an auxiliary circuit board added. This board contains the 12 VDC supply, power transistor, and logic for the solenoid drive.

All interconnects are wired via the terminal block on the rear panel of the PCT. The J-type thermocouples are connected with miniature thermocouple jacks.

A solid state power relay is used to control the heater. This allows the microprocessor to maintain the most accurate temperature possible without concern of excess cycling. The power relay contains a zero cross detection scheme which minimizes radio frequency interference (RFI) generation when the load is switched on and off.

An independent high limit circuit is provided. It is powered by an isolation transformer that draws power from the primary side of the master relay. This circuit's sensor is a Type "J" thermocouple. If an over temperature condition occurs, this circuit shuts off the internal master relay and consequently the microprocessor and the heater.

Twelve light emitting diodes[1] (LEDs) are used to indicate and display system status, and to signify any alarm conditions. A 10-key membrane keypad located in the face panel allows system setup adjustment and full timer control.

Two digital displays are used to allow the simultaneous viewing of the process temperature and the timer. Each of the displays has multiple diagnostic and setup functions that are activated by the keyboard during setup or by the microprocessor during alarm conditions.

For liquid Level sensing, an outboard mounted switch is provided. This switch is connected via a tube to a barbed fitting on the rear panel (see Section 4.0 - Installation, for wiring details).

[1] The C1115a MICROTEMP PCT incorporates eleven LEDs.

NOTE: A Liquid Level Sensor is included with every MICROTEMP PCT, except when the PCT is ordered separately.

Incorporated in the power harness is a pair of Teflon breather tubes which should be open to a clean environment which will permit a natural ebb and flow of air as the process module heats and cools. Allowing this to occur will prevent the process module seal from being breached, thereby extending process module life.

2.2 Software

The PCT, being microprocessor based, is actually a dedicated computer. This allows a significant amount of flexibility. The software has been written to allow the user to enter numerous parameters from the keypad to allow customization of the system. Since the hardware incorporates a special non-volatile EEPROM, the system can be easily reconfigured for many applications.

Modifications can be made quickly should the application call for periodic changes. Section 5.0 - Programming, details how this is accomplished. In general, the user steps through a series of setup parameters and selects numeric values for items such as “Setpoint” and “Alarm” levels. Since these settings are digital the system may be set and tuned very accurately. These programmable parameters are significant to the overall operation of the system and are protected by a user-selectable access code. This allows the system supervisor to restrict access to all programmable features.

3.0 Front Panel

3.1 General

The front panel is divided into three parts: (1) digital displays, (2) LED indicators, and (3) keypad. Figure 3.1 is a view of the panel showing the relative position of each part, from top to bottom, respectively.

3.2 Digital Displays

MICROTEMP PCTs have two displays, the Process display and the Timer display. Each is a four digit, seven segment, 0.56 inch high display. They have a normal numeric range of 0.0 to 199.90°C. and 0:00 to 99:59 min./sec., respectively. The displays not only provide the normal temperature and time readouts, but are also used for various program and alarm functions.

In the programming mode, a two-digit alpha prompt (e.g., PS - Process Setpoint) appears in one display to indicate the meaning of the other display. The prompt appears in the left display if the setting is for time, in the right display if the setting is for temperature.

If, during normal operations, an alarm occurs, an alpha code will alternately flash with the process temperature in order to direct attention to the problem. For example, should a liquid level alarm occur, the alpha code LL (liquid level) would alternately flash with the process temperature. Appropriate LED and audio alarms would also be activated.

Hold and Code modes are indicated by the word HOLD or CODE in the timer display. Since the timer might not be active during either of these modes, the display is used to further indicate the current system status.

3.3 LED Displays

Twelve LEDs are incorporated in the face panel. They are divided into two groups: (1) Status and (2) Alarm. Status LEDs provide information about the current operating condition of the system. Alarm LEDs provide information about the specific nature of an alarm when it occurs. As noted previously, other indicators, both audio and visual, are employed when an alarm occurs. These other indicators of the alarm condition may be deactivated by using the SAVE/SIL key (see Section 3.4 - Keypad). However, the Alarm LED indicator may not be overridden and is only cleared when the alarm condition has been corrected.

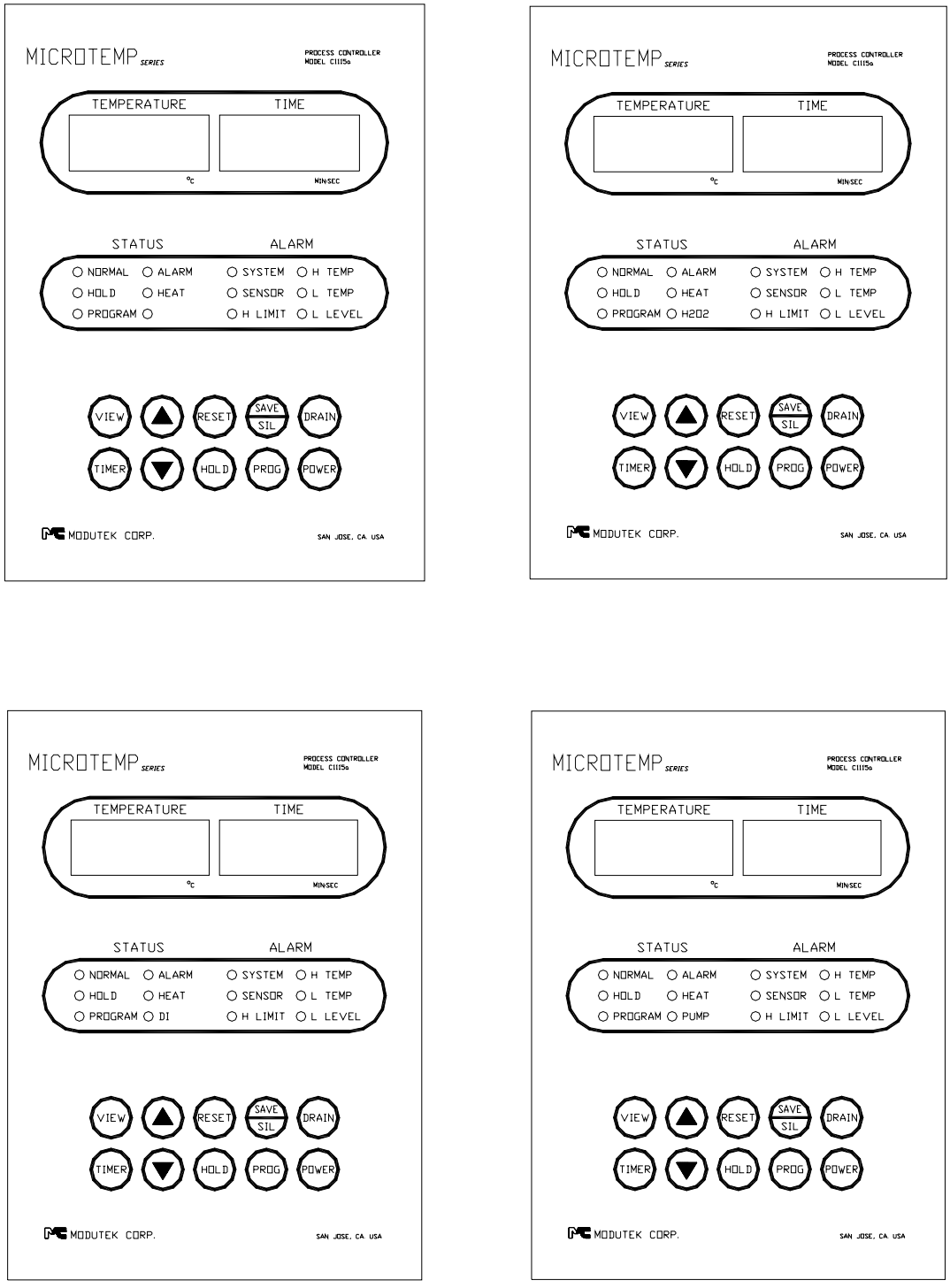


Figure 3.1a, b,c,d - MICROTEMP PCT Front Panel

The following is a list of the individual status LEDs and what they indicate:

NORMAL This LED indicates the normal operating mode for the system. The system is operating within the defined parameters.

HOLD This LED indicates that the PCT is in its standby mode for the system. In this mode all normal monitoring functions are operable, but the heater is non-operable. The only way to exit this mode is by pressing the RESET key.

NOTE: For safety, the unit always starts in this mode either initially or after a power failure. In this mode the process display reads HOLD.

PROGRAM This LED indicates that the PCT is in the program mode. In this mode the user may input tuning and setup parameters (see Section 5.0 - Programming).

ALARM This LED indicates that an alarm condition has occurred and the system is performing under the special conditions required by that alarm. The only way to exit this mode is to clear the alarm. Alarm conditions are activated by numerous sources and are announced by both panel displays and audio tones.

HEAT This LED is illuminated whenever the heater is on.

NOTE: When the system nears the pre-programmed Setpoint this LED will continually cycle on and off.

DI **(C1215a only)** This LED is illuminated whenever the D.I. water solenoid is active. The D.I. water solenoid is active whenever the process temperature is above the D.I. setpoint.

H_2O_2 **(C1315a only)** This LED is illuminated whenever the H_2O_2 solenoid is active. The solenoid is active at the beginning of each timer cycle and at programmed intervals when the process module is on but not in use.

PUMP **(C1915a only)** This LED is illuminated whenever the pump is running. When the LED is on, the contact provided on the rear panel terminal strip should be closed.

The following is a list of the six Alarm LEDs and their activating conditions. For details on each of the alarms see Section 6.0 - Alarms.

SYSTEM The system alarm LED is related to all of the system diagnostics. It indicates an internal malfunction.

SENSOR The sensor alarm LED indicates that a sensor is either open or not connected.

H LIMIT The high limit alarm LED illuminates whenever the High Limit circuit turns the master relay off.

H TEMP The high temperature alarm LED illuminates whenever the process temperature has exceeded the high alarm setpoint.

L TEMP The low temperature alarm illuminates whenever the temperature has fallen below the low temperature alarm setpoint.

NOTE: This alarm will not function until after the system has initially warmed up.

L LEVEL The liquid level alarm LED illuminates when the liquid level switch detects a low fluid condition.

3.4 Keypad

The user interface for the MICROTEMP PCT is the 10-key (12-key for C1915a only) membrane keypad located in the lower portion of the face panel. When a key is pressed, the system will acknowledge with an audio tone and perform the associated action. If an invalid key is pressed, the system will acknowledge with an audio tone but will take no action.

The following is a list of the keys and their varied usages:

POWER This is the master power switch for the PCT. It activates/deactivates an electronic latch which switches the master power relay inside the unit. This in turn switches the power to the microprocessor section on/off.

PROG This is a multi-function key and its action varies with the mode that the system is in which is as follows:

Normal/Hold/Alarm mode - The program key is used to request access to the program mode. Pressing the key once will cause the word “Code” to appear in the timer display. If the access code (AC) is set to 0 the word CODE will be bypassed and the PCT will be in Program mode.

Code mode - After an access code has been entered (see Section 5.2), pressing the key will place the system in the Program mode if the correct access code has been entered, or return to the previous mode if an incorrect code has been entered.

Program mode - When the system is in the program mode, this key is used to step through the various setup parameters (see Section 5.0 - Programming).

HOLD This key places the PCT in the Hold mode. In this mode the heat output is deactivated.

TIMER This is a multi-functional key that is used to start/stop and reset the timer. Its function depends on the current status of the PCT:

Timer start - Starts the countdown timer.

Timer stop - Stops the countdown timer and freezes the display.

Timer reset- Resets the timer, inserts the pre-set time into the display, and continues counting down.

NOTE: If the timer is in the overcount condition the timer display will continue to flash to indicate that it is an overcount.

VIEW This key is used to examine the process setpoint and timer preset. When pressed, the process setpoint is displayed in the process display and the timer preset is displayed in the timer display.

RESET This is a multi-function key that resets a number of functions. Its action is dependent on the current mode of the PCT.

Hold mode - When the system is in the hold mode, pressing the reset key returns the system to the normal mode.

Program mode - When the system is in the program mode, pressing the reset key returns the system to the normal mode.

NOTE: If the system was in the Hold mode prior to entering the program mode, the system would be returned to the Hold mode rather than the normal mode.

SAVE/SIL This is the dual function Save/Silence key.

The **Save** function is active only in the Program mode. It is used to save PCT setup parameters (see Section 7.4 - Save Function).

The **Silence** function is used to silence the audio tone for the timer and any alarm conditions. Flashing alarms in the alphanumeric display are also canceled in this manner.

▲ The **UP** arrow key is active only in the Program mode. It is used to increase the numeric value shown in the display. Holding the key down will activate the automatic, rapid decrease of the numeric value.

▼ The **DOWN** arrow key is active only in the Program mode. It is used to decrease the numeric value shown in the display. Holding the key down will activate the automatic, rapid decrease of the numeric value.

DRAIN This key will activate the drain. Pressing this key will empty the process module of its process solution.

NOTE: The DRAIN key is operable only when the process temperature is below the **dr** setting (see Section 5.3 - Parameters)

Caution

Be certain that the plenum and waste system is designed to accept the temperature and concentration of process solution that is to be drained.

PUMP **(C1915a only)** This key is used to activate the pump contact closure.

AUX **(C1915a only)** This key has no function. It is a key that is available for future requirements.

4.0 Installation

The installation procedure for the MICROTEMP PCT is outlined below.

NOTE: All MICROTEMP PCTs are relatively delicate instruments and should not be installed in environments where they will be subjected to corrosive fumes or temperatures outside of the recommended 5-35°C temperature range. It is also recommended that they be installed in areas that offer sufficient heat dissipation clearance (greater than 4 inches) for the rear panel.

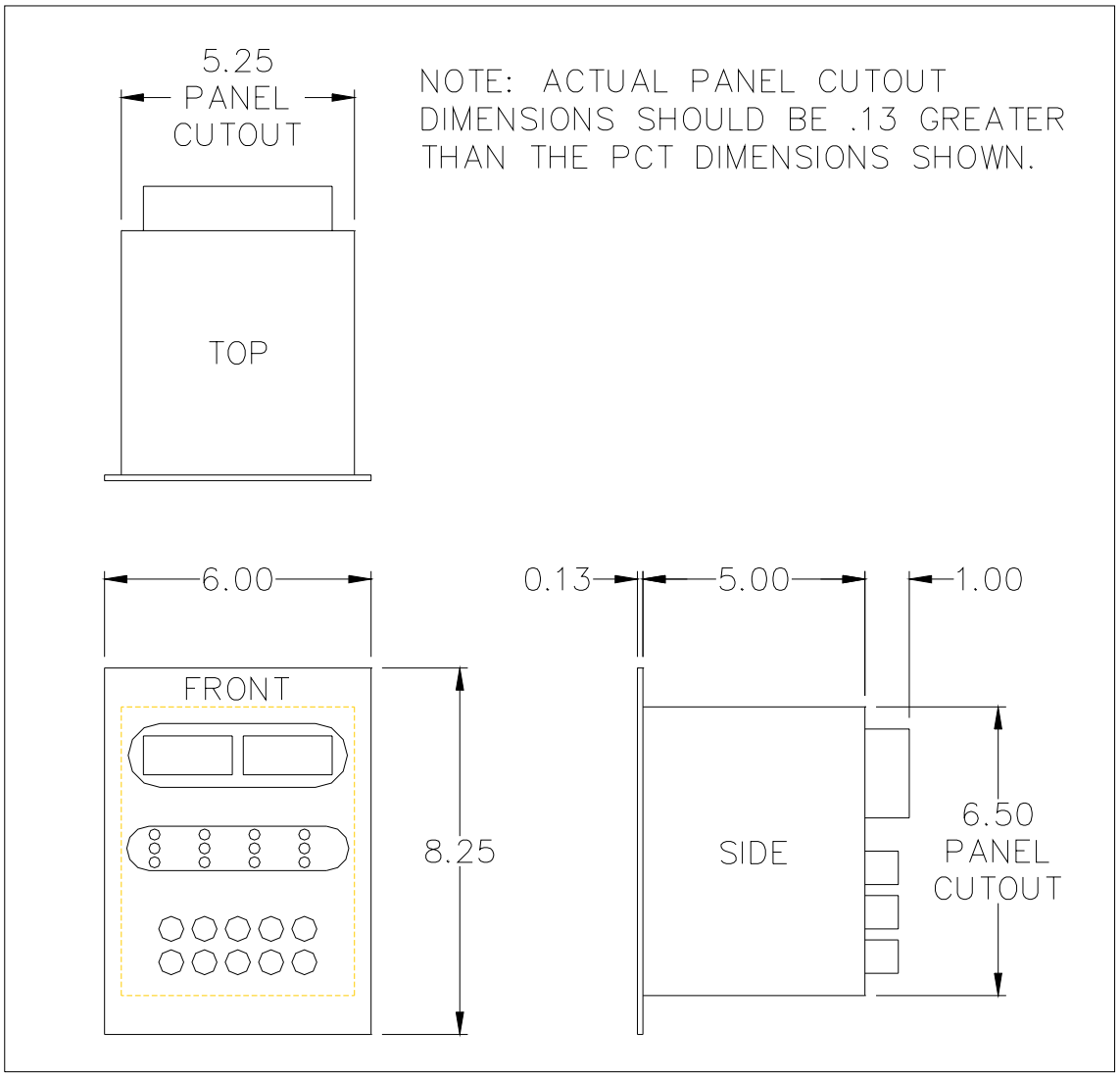


Figure 4.1 MICROTEMP PCT Panel Cutout Dimensions

4.1 Panel Cutout

After determining the location of the PCT, refer to Figure 4.1 for cutout dimensions and Figure 4.2 for installation details.

NOTE: All dimensions noted allow for the minimum clearances for power cords, tubing and wiring, etc.

1. Cut a rectangle, of the proper dimensions, into which the PCT will be fitted.

2. Insert the PCT into the rectangular cutout.

3. Replace two of the four rear cover screws with the provided double ended studs.

4. Secure the PCT in the cutout by binding the cut out panel between the PCT facia and the mounting brackets, as shown in Figure 4.2.

NOTE: Do not over tighten the mounting brackets. Self-tapping screws may be used to secure the brackets to the panel, if desired. (Figure 4.2 “A”)

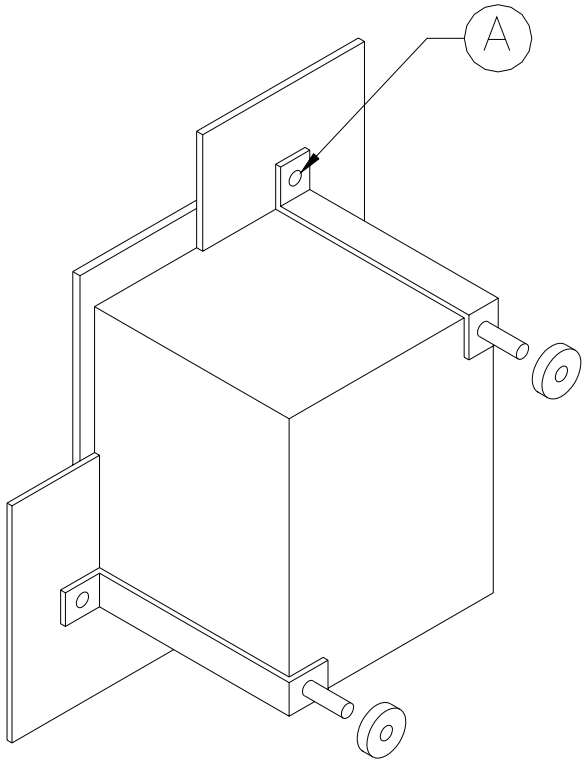


Figure 4.2 MICROTEMP Installation Details

4.2 Electrical Connection

The MICROTEMP PCTs are powered by 208 VAC, 50/60 Hz[2]. Line power is supplied via the main terminal connectors on the rear panel. The heater power connections are also connected via terminal connectors on the rear panel. Additional features such as liquid level, interlocks, and remote Start/Stop may be wired into the terminal block as shown. Refer to the Electrical Schematics in the back of this manual for the particular PCT model and line voltage.

CAUTION

Observe all safety precautions while working electricity.

4.3 Thermocouple Connections

Two thermocouple jacks are provided on the back panel for easy termination of the thermocouple sensors. Both require Type "J" thermocouples terminated in the standard Type "J" miniature connectors.

The process thermocouple is connected to the jack marked PROC. This thermocouple senses the fluid temperature of the process module. It is used by the microprocessor section to perform temperature control functions.

The high limit thermocouple is connected into the jack marked H LIMIT. This thermocouple is used by the high limit circuit to sense excessive temperature conditions and to shut the system off accordingly. It is located such that the system maybe shut down prior to any damaging effects caused by excessive temperature.

NOTE: Proper polarity must be observed in connecting the thermocouple leads. The two thermocouple wires are color coded: (1) white for positive ("+", iron) and (2) red for negative ("J", constantan). These wires should be connected to the appropriately labeled screw thermals on the connector pins.

4.4 Liquid Level Input

A liquid level pressure switch is provided. It is connected with a barbed fitting that accepts a standard 1/4" inside diameter plastic tube. The microprocessor interprets a loss of pressure in the tube as a low liquid level.

[2] Other voltages are available.

4.5 Solenoid Output

Models C1215a and C1315a use 12 VDC solenoids to provide “makeup” D.I. water and H_2O_2 respectively. The logic functions under which these injections take place are discussed in detail in Section 7.7 - Injection.

The solenoid is connected via spade connectors to the terminal board on the rear panel. The solenoid can be any 12 VDC device with a current draw of 500 milliamps or less. The power supply and all switching components are contained internally. Only the solenoid is required to implement this function.

5.0 Programming

NOTE: Each MICROTEMP PCT is pre-programmed at the factory. These default settings insure fail-safe operation after the initial installation. Custom parameter values can be easily selected when process criteria differ from the factory settings. For initial set-up, no access code is needed to gain access to the Program mode.

5.1 Overview

MICROTEMP microprocessor-based PCTs offer the advantage of user-programmable parameters. These parameters determine what the PCT does and how it will respond to various system conditions.

The PROGRAM and the UP and DOWN arrow keys are the only keys used for programming. The PROGRAM key is used to request access to the programming mode. Once access is obtained, it is used to step through the various parameters described below. Once a parameter is selected, the UP, and the DOWN arrow keys are used to set the desired value.

NOTE: The SIL/SAVE key is normally used at the end of this function, but is optional. (see Section 5.4 - Save Function).

Many of the parameters are related to optional features that are available within the MICROTEMP software. If they are not desired, these options may be eliminated by setting their parameters to zero (0). These will be specifically noted in the descriptions which follow in Section 5.3.

5.2 Access Code

Because information contained in the program module controls the behavior of the entire process module/PCT system, it may be desirable to restrict access to this information.

As described in Section 5.3, one programmable parameter is the access code. If this code is set to zero (0), access protection is ignored. The program key will allow unrestricted access to the program mode. If a value greater than zero is entered as the access code parameter, pressing the program key will cause the word CODE to appear in the timer display. This prompt requires that the operator enter the appropriate access code prior to gaining entry to the programming module.

When the word CODE appears in the display, the UP and DOWN arrow keys are used to select the appropriate code number (shown in the timer display). CODE will disappear on the first depression of the UP or DOWN key.

When a code number is selected, the PROGRAM key is pressed to “enter” that number. If the correct code has been selected, the unit will go into the Program mode. If an incorrect code has been selected, or if no action has been taken for 30 seconds, the PCT will revert to the mode it was in prior to the request for access.

5.3 Parameters

The following is the list of parameters in their proper programming sequence. Pressing the “Program” key will cause the listing to advance, in sequence, to the next parameter. After reaching the last item in the sequence the listing will start over from the beginning. The UP and DOWN keys are used to change the numeric value of each parameter.

The following is a list of each parameter code and its function:

Code	Description	Setting Range	Units
CS	Clock Setpoint	00:00 to 99:59	Min:Sec
PA	Prewarn Offset	00:00 to 00:59	Seconds
PS	Process Setpoint	00:00 to 199.9	Degrees C
AI	Auto Injection (C1315a only)	00:00 to 59:99	Min:Sec
HI	High Alarm Setpoint	00:00 to 199.9	Degrees C
LO	Low Alarm Setpoint	00:00 to 199.9	Degrees C
DI	D.I. Injection (C1215a only)	00:00 to 199.9	Degrees C
dr	Drain Setpoint	00:00 to 199.9	Degrees C
AC1	Access Code	0 to 1999	
Cr	Cycle Rate	1 to 19	Seconds
Pb	Proportional Band	0.0 to 19.9	Degrees C
rE	Reset	0.0 to 19.9	Minutes
rA	Rate	0.0 to 19.9	Minutes
CA/OF	Calibration/Offset	+ or -9.9	Degrees C
IP	Injection Period	0 to 9:59	Min:Sec

CS **The Clock Setpoint** is the preset value for the countdown timer. The value chosen for this parameter will be inserted automatically into the countdown timer when the timer is reset.

PA **The Pre-warn Offset** is the time at which the audio warning will begin, prior to the countdown timer reaching zero. Its purpose is to signify that the countdown period has almost elapsed. The tone will cycle on and off until the timer reaches 0:00.

PS **The Process Setpoint** is the temperature at which the PCT will maintain the process module.

AI **(Model C1315a only)** This parameter dictates the accumulated time period after which an Automatic Injection will occur. If set to zero this function will not be active.

HI **The High Alarm Setpoint** is the temperature above which the high alarm will be activated. If the process temperature reaches or exceeds this limit, the high alarm is activated (see Section 6.0 - Alarms).

LO **The Low Alarm Setpoint** is the temperature below which the low alarm will be activated. If the process temperature reaches or drops below this limit the low alarm is activated (see Section 6.0 - Alarms).

DI **(Model C1215a only)** This parameter is the temperature setting at which the D.I. water solenoid will activate. The D.I. solenoid is active anytime the process temperature is above this setting.

dr **The Drain Setpoint** is a feature through which a specific temperature can be set for system draining. The system will drain once the solution temperature is below the preset value.

AC1 **The Access Code** is the number that must be matched to gain entry into the programming mode. This number may be changed at any time, but a note should be kept of its value. If set to "0" this function is non-operational.

NOTE: If the access code is changed but not saved, it reverts to the last saved value upon subsequent powerup.

Cr This parameter sets the **Cycle Rate** for the injection system. Cycle rate is the rate at which the output will cycle on and off.

NOTE: The length of the "on" output cycle is controlled to match the heat requirements of the system.

Pb **The Proportional Band** is the parameter that determines the cycling range for the PCT in degrees C. This band indicates the range over which the PCT will proportion (see Section 8.0 - Tuning).

rE **The Reset parameter** sets the integration time for the second mode of the three-mode control scheme (P.I.D.). If this parameter is set to 0.0, the reset function is eliminated (see Section 8.0 - Tuning).

rA **The Rate function** sets the differentiation constant for the third mode of the three-mode control scheme (P.I.D.). If this parameter is set to 0:0, the rate function is eliminated (see Section 8.0 -Tuning).

CA/OF **The Calibration/Offset** parameter is used to offset the cumulative error resulting from the true bath temperature and the temperature signal generated by the thermocouple. This is a fixed offset that is either added to or subtracted from the thermocouple reading prior to its use by the microprocessor. This adjustment is an automatic internal compensation and will affect all readings from the process thermocouple.

IP **Injection Period** setting pertains to Model C1315a only. This parameter controls the injection period for both the auto injection and timer injection. Every time the timer is used, or if the auto-injection period accumulates, the solenoid is activated for the period set in IP. If set to 0:00 both the automatic and timer injections are eliminated (see Section 7.7 - Injection).

5.4 Save Function

The parameters discussed in the previous section are saved in duplicate by the PCT. The first set of parameters is stored in RAM (Random Access Memory). This set is the one used by the operator when stepping through the parameter setup mode as described above. It is the set of parameters that may be changed in the Program mode. Additionally, this is the set of parameters that is read by the PCT in running its program.

The second set of these parameters is maintained in a special EEPROM (Erasable Programmable Read Only Memory) chip. This is a permanent (10 year minimum life) memory that does not require battery backup. When the PCT is first turned on, it automatically reads the parameters from the EEPROM and loads them into the RAM.

The user may change any of the parameters during an operation and then recall the original parameters by simply turning the PCT off and on. If new parameters are to be permanently maintained, it is necessary to store them in the EEPROM memory. This is done by simply pressing the SAVE key while in the Program mode. A series of dashes will appear across the displays to indicate that the unit is in the SAVE mode. This process will take approximately one second.

6.0 Alarms

6.1 Overview

As mentioned previously, there is a series of Alarm LEDs on the face of the MICROTEMP PCT. These alarm LEDs are related to the set of software programmable parameters that define the limits of operation (e.g. high alarm setpoint). This section will discuss the particular response that the PCT will make to each alarm condition.

The basic principle of the alarm function is to alert the operator to any conditions that are outside the normal operating conditions, as prescribed by both the programmable parameters and certain overriding system parameters. Additionally, the alarms are presented in such a way as to: (1) draw maximum attention to the errant condition, (2) allow the user maximum flexibility in investigating the cause of the condition, and (3) maintain an indication of the original cause of the alarm.

A combination of audio and visual alarms is used. In all alarm conditions the Alarm LED in the Status section of the front panel will begin to flash. Coincident with this, the LED in the alarm section will illuminate, indicating the type of alarm that has been activated. In most cases, an alpha code will begin to flash in the process display, alternating with the process temperature to call further attention to the specific problem. Additionally, an audio tone that has a 50/50 duty cycle on a one second period will sound.

After the alarm has sounded, pressing the SAVE/SIL key will silence the audio portion of the alarm. At this point, normal control is returned to the operator.

NOTE: (1) Several of the alarms automatically turn off the heater output. The output may not be turned on until the errant condition is remedied and the alarm is cleared.

(2) Even though the alarm has been silenced, the status alarm LED will continue to flash and the LED in the alarm section will continue to indicate the source of the alarm.

6.2 Alarm Listing

The following is a list of the alarms and the appropriate responses that the system will take:

SYSTEM The system alarm indicates abnormal conditions within various system diagnostics as detected by the PCT. An example would be the malfunction of the EEPROM's "save" routine. In this case the alarm would indicate that an error has been detected; the command should be re-entered or the unit reset. If a system malfunction persists, the unit should be shut off and returned to Modutek Corp. for repair.

SENSOR The microprocessor continually monitors the thermocouples for open circuits. If an open circuit is detected, the heater will be shut off and the alarm will be activated. The process display will alternately flash the temperature and **OP** for open sensor.

H LIMIT This is a special alarm for the high limit thermocouple which is secured to the outside of the process vessel. Because the alarm is connected to the 12 VDC power supply (see section 7.6 - High Limit) prior to the master relay, the thermocouple is continually monitored for an excessive temperature condition even when the PCT is off.

If the system is shut down by the High Limit alarm circuitry, this LED will remain illuminated, to indicate the reason for the off status. When the high limit condition is cleared, the LED indicator is deactivated.

L TEMP This is a low temperature alarm. It monitors the process temperature being read by the process thermocouple and activates whenever the process temperature drops beneath the low alarm setpoint (after the system has come out of the Warm-up mode). When activated, the process display alternately shows the process temperature and the code **LO**.

NOTE: The Warm-up mode is a special condition in which, upon initial start-up of the system, the low temperature alarm remains inactive until the system has exceeded the low alarm temperature. Any subsequent drop below the low temperature setting will activate the alarm.

L LEVEL The microprocessor monitors the liquid level sensing switch and activates the liquid level alarm when a low level is detected. This condition exists when the pressure on the liquid level sensing switch drops too low. The code **LL** is alternately flashed with the process temperature. The heat is turned off.

7.0 Operation

7.1 Overview

Each MICROTEMP PCT possesses many powerful, independent control functions which are incorporated into a single enclosure system. The microprocessor allows each control section to operate independently unless a conflict occurs between operations. The microprocessor's program polls all of the control sections, communicates appropriate parameters to them and provides a functional interface between each of the sections. For example, the temperature control section is allowed to maintain a temperature unless the alarm monitor section determines that it is potentially unsafe.

7.2 General Control

The MICROTEMP PCT is turned on by pressing the POWER key on the face panel. After a short delay, during which the unit performs self-diagnostic checks, the displays will activate and the system will begin monitoring and displaying the process thermocouple temperature. For safety reasons, the system always initiates into the Hold mode. During this period the word HOLD will appear in the timer display and the active Status LED will be the HOLD LED. In this condition the heater output is inactive. Pressing the reset key will change the PCT mode from Hold to Normal unless an alarm condition has occurred, in which case the PCT will be in the alarm mode.

Assuming no alarms have occurred and the Normal mode is active, the temperature control function is enabled and will begin performing the standard three mode control sequence that will bring the bath temperature up to the pre-programmed process setpoint.

Anytime the unit is in the Normal mode, the countdown timer may be activated using the TIMER key. Additionally, the Program mode may be entered and any of the parameters may be set or adjusted.

The operation of each of these individual control segments is discussed in the following sections.

7.3 Timer

The timer function is operated using the timer display and timer key. The timer key is used to start, stop and reset the timer. When first pressed, the Timer key starts the timer. The timer functions by counting down from the preset value to 0:00; prior to reaching 0:00, a pre-warn alarm is sounded. This alerts the operator to the impending completion of the countdown period. After reaching the 10:00 value the timer counts back to the preset value in order to track the elapsed time since the countdown started.

The pre-warn is programmable from 0 to 59 seconds. When the countdown has reached the pre-warn time, an audio tone (50% duty cycle on a one second period) begins to sound. When the count reaches 0:00 the tone becomes continuous and the timer display begins to flash, indicating an overcount.

The Timer key is used to start, stop, and reset the timer. When first pressed, the Timer key starts the timer. The sequence will then proceed as described above. When pressed a second time it will stop the timer. This will freeze the display and cancel the audio tone (when applicable). If the unit is in the overcount condition, the value will be frozen but the display will continue to flash to indicate overcount.

Pressing the key for a third time will reset the timer. This cancels the flashing (when applicable), and inserts the preset CS (Clock Setpoint) in the timer display. The timer will then begin its next cycle.

The Timer key also actuates the H_2O_2 injection (Model C1315a only - See Section 7.7 - Injection).

7.4 Temperature Control

The temperature control section provides direct control of the electric heating element. This section consists of a standard three mode (P.I.D.) PCT with built-in load carrying solid-state switching. The heater is connected directly to the PCT.

The process temperature and associated tuning constants are selected in the programming mode; the PCT will automatically bring the process solution temperature to the process setpoint and maintain it at that level.

The heater output can be disabled by pressing the HOLD key or through the various alarm conditions (high temperature, high limit, bath limit, open sensor and liquid level alarms).

The Heat LED in the Status indicator is illuminated whenever power is being applied to the heater.

The temperature control scheme is a standard time proportioning system (see Section 8.0 - Tuning) wherein the process module temperature is controlled by the application of heat, D.I. water, or H_2O_2 (depending on the particular model of MICROTEMP PCT) for precise time periods. The process thermocouple that is connected to the PROC input jack on the rear of the PCT detects the temperature in the bath. The signal generated by the thermocouple is then processed through a special instrumentation amplifier that provides noise rejection, a reference junction and cold junction compensation. The signal is then filtered and sent to an analog/digital converter and then to the microprocessor. The pre-programmed digital calibration parameter (CA or OF, depending on the particular PCT, in the programming mode) is either added to, or subtracted from, this digital reading of the process temperature. This new value is the process temperature and is displayed on in process display.

The microprocessor program then uses the other control parameters to determine the proper amount of heat that is to be applied to the module in order to reach and maintain the setpoint temperature.

7.5 Alarm Monitor

In the software, there is a series of checks that is continuously made to ensure that the system is operating within the parameters programmed by the user.

The process temperature is first compared to the High and Low Alarm Setpoints. If the process temperature exceeds the High or drops below the Low Alarm Setpoints, an alarm condition is signaled. A high alarm will turn the heat off.

Special hardware is incorporated to monitor the two thermocouples that are used with the system. The circuitry is used to ensure that a sensor is connected to the system and that the thermocouple wire is not broken. If for any reason an open circuit is detected on a sensor, the circuit will relay this information to the program. An open sensor alarm will be triggered and the heat shut off.

The system continually monitors itself for internal malfunctions. If such a malfunction should occur, the System alarm is triggered.

Additionally, the liquid level input is monitored and if a low pressure condition is detected, the internal liquid level switch will cause the program to indicate a low liquid alarm. The heat is shut off.

7.6 High Limit

Another section incorporated in each PCT is the High Limit circuitry, which contains a redundant single setpoint temperature monitor. This section is powered by a separate isolation transformer and uses a totally independent high limit thermocouple. Its purpose is to monitor the bath for excessive temperature and should such a condition occur, the PCT will be automatically turned off.

The High Limit circuit is a redundant hardware function that is capable of turning the PCT off, independent of the basic control system. It is different from the high alarm setpoint, which is a software function under microprocessor control.

The High Limit thermocouple is processed through an instrumentation amplifier that also provides the reference and cold junction compensation. This signal, which is a measure of the thermocouple temperature, is compared to a pre-calibrated mechanical setpoint (see Section 9.0 - High Limit). If the temperature at the thermocouple exceeds the preset value, the circuit turns off the internal load carrying master relay. It also lights the “High Limit” LED alarm light.

If the PCT is experiencing one of these conditions, it will shut itself off. It cannot be turned on until this High Limit condition has been cleared. Again, it should be noted that the High Limit circuit is powered by its own transformer and thus remains on at

all times, even when the power switch is in the “off” position. The heater and microprocessor sections are electrically connected to the master relay output and thus disabled by either of these alarms.

7.7 Injection

Models C1215a and C1315a both have an additional circuit board which contains the logic and 12 VDC power to run an external injection solenoid. These injection solenoids inject D.I. water or H_2O_2 into the process solution for precise time periods.

The Model C1215a uses the solenoid to inject D.I. water. The program continually compares the process temperature to the D.I. setpoint. When the process temperature is above the D.I. setpoint and the PCT is in the Normal mode, the solenoid will be active. Under all other conditions the solenoid will be off.

The Model C1315a injects H_2O_2. This injection is also controlled by the program, but is performed in either a manual or automatic mode. When the timer is operated, the solenoid is opened for a period of time (IP - Injection Period) that the user selected in the Program mode.

The solenoid will remain open for this injection period if the user timer is running. It will terminate at the end of the injection period or if the user timer is stopped.

An automatic injection period (AP) is also available to the user in the programming mode. This AP is an accumulative period. The program automatically tracks the amount of time that has elapsed since the timer was last used. Once this accumulated time reaches the programmed value, an automatic injection is triggered. The solenoid is then opened for the injection period (IP).

After the automatic injection, the solenoid is turned off and the accumulative timer is reset to zero. This process continues as long as the PCT is in the normal mode and the timer is not used. Whenever the timer is operated, the accumulative timer is re-zeroed.

8.0 Tuning

8.1 Review

The control scheme used in this PCT is a standard P.I.D. system with anti-reset windup. This section will briefly review P.I.D. control as it relates to this system. It should be noted that this section is related specifically to the MICROTEMP series of PCTs, and may differ from other products. Refer all compatibility and service questions to the Modutek service department.

The terms P.I.D. and three-mode are interchangeable. This first mode of control, “P” (Proportional), refers to the basic control scheme. The concept is that the PCT will determine the percentage of heat required by the system and will adjust the average power input to balance the system. The power to the heater is either fully on or fully off. Thus, proportional control in this application is more correctly termed “time proportioning”.

The Cycle Rate (Cr) setting is used to determine the rate at which the heater power is turned on and off. The proportioning of the output power is accomplished by varying the percentage of the time that the PCT is on during the period.

For example, if Cr = 10, then the PCT will cycle on/off once every ten seconds. If the process has determined that the system requires only half of the full power output of the heater to maintain a specific temperature, the output will be on for five seconds and off for five seconds in a continuous cycle. As the heat requirement varies, this percentage will increase to slightly longer periods on, such as 5.1 seconds on, 4.9 seconds off. The opposite is true for decreasing heat load requirements. Thus, when the PCT is at or near the setpoint, the Heat LED in the status box will continually flash to indicate the time proportioning of the heater.

To compute the required percentage of on time, the PCT uses the Proportional Band (Pb) as set in the programming mode. It is over this band that the output will vary from 0 to 100%. If, for example, the process setpoint is at 100°C and the proportional band is set at ten degrees C, the PCT will time proportion the heater output from 100% to 0% when the process temperature varies from 90° to 100°C. When the process temperature is at 90°C and less, the heater output will be fully on. Between 90°C and 100°C the output will time proportion from 100% down to 0%. At any temperatures above 100°C, the output will be completely off.

The above example is relative to situations in which the rate and reset functions are not used. If used, rate and reset will cause a shifting in the proportional band, which will vary the percentages just discussed. However, rate and reset do not affect the basic function, only the position of the proportional band at a given time.

If proportional band and cycle rate are factored into the above example, the shift is revealed: The cycle rate was ten seconds with a proportional band of 10°C and a setpoint of 100°C. When the process temperature is 96°C, it is 40% into the proportional band. Based on this, a heater output of 40% is required. Given the ten second cycle rate, the heater would be on for four seconds and off for six seconds.

A proportional control scheme requires a certain degree of error to have the heat on. Therefore, in the example above, only 10% of the heat is required to maintain the desired temperature. The PCT will cycle on for one second and off for nine seconds; the temperature will stabilize at 99°C, rather than desired 100°C. The difference between the two is termed “droop”. Droop is the difference between the setpoint and the control point in a proportional system.

To remove this droop, the 2nd mode (I, Integral) of the P.I.D. scheme is required. This “I” mode, commonly termed “automatic reset” mode, calculates the difference between the current process temperature and the desired setpoint. It then mathematically corrects the system to compensate for this error. How often this is done, is based on the rE (reset adjustment) parameter that is selected in the program mode.

Anti-Reset Windup is a special software feature that locks out the Reset function when the system is outside of the proportional band. If the system automatically adjusted the droop before the system was nearing stability, large errors would occur. Anti-reset windup is used to eliminate such potential errors.

The third mode in the P.I.D. scheme is the “D” (Derivative) mode, commonly referred to as “rate”. When a system has large step changes in D.I. water requirements, this mode compensates for possible temperature overshoots of the setpoint by controlling the D.I. water solenoid’s ratio of on/off times. As the bath temperature gets closer to the setpoint the amount of on time decreases and the amount of off time increases. The temperature stabilizes when the on and off times are equal. This equilibrium occurs just below the setpoint, with the associated droop, as discussed above.

When a PCT has large step changes in heat requirements, it may require this feature to compensate for such changes. Its primary function is to eliminate overshoots as the temperature is stabilizing. It controls the rate of change of the temperature when large temperature fluctuations occur. Overshoot is common during the initial warm-up of a process module and on those process modules that experience fluctuating work loads. When overshoot is not a problem, the rate function may be eliminated for simplicity.

In general, the PCT must be reset whenever process parameters have been changed.

9.0 High Limit

9.1 Setting High Limit

As previously noted, the High Limit is an independent circuit that monitors the High Limit thermocouple and turns off the PCT if the pre-set temperature is exceeded. For safety purposes, this is a totally independent circuit from the microprocessor; it cannot be set or adjusted from the front panel. Setting or adjusting the circuit requires a mechanical adjustment of a potentiometer on the circuit board as detailed below:

NOTE: Over-adjusting of the potentiometer can cause damage. Do not turn more than 25 turns in either direction.

CAUTION

THIS IS A SAFETY ADJUSTMENT THAT HAS BEEN FACTORY SET. DO NOT RE-ADJUST WITHOUT SPECIFICALLY KNOWING THE SAFETY CONSEQUENCES

1. The adjustment of the High Limit Setpoint requires the use of a thermocouple calibration instrument such as a Doric Trend-Cal 466 or equivalent (this instrument applies the necessary signal to the PCT and displays the equivalent temperature). Connect this instrument to the MICROTEMP PCT as illustrated in Figure 9.1.

2. Adjust the potentiometer by inserting a screwdriver into the access hole provided on the left side of the PCT enclosure.

   Turning the potentiometer clockwise increases the setpoint; turning counter-clockwise decreases the setpoint.

   The PCT should be off, but line power must be applied.

   Adjust the setting on the thermocouple calibrator to the desired trip point. If this is above the current HI parameter setting, the H LIMIT alarm will activate. This will be indicated by the H LIMIT LED illuminating.

3. Adjust the potentiometer in a **clockwise** direction until the tone stops. If the setting is below the current high limit setpoint, the previous step will not have been necessary.

4. Adjust the potentiometer slowly in a **counter-clockwise** direction until the tone stops. If the setting is below the current high limit setpoint, the previous step will not have been necessary.

5. Check the setting by lowering the calibrator temperature and slowly increasing it to the desired trip point. Repeat the previous steps, if necessary, to achieve as accurate a result as required.

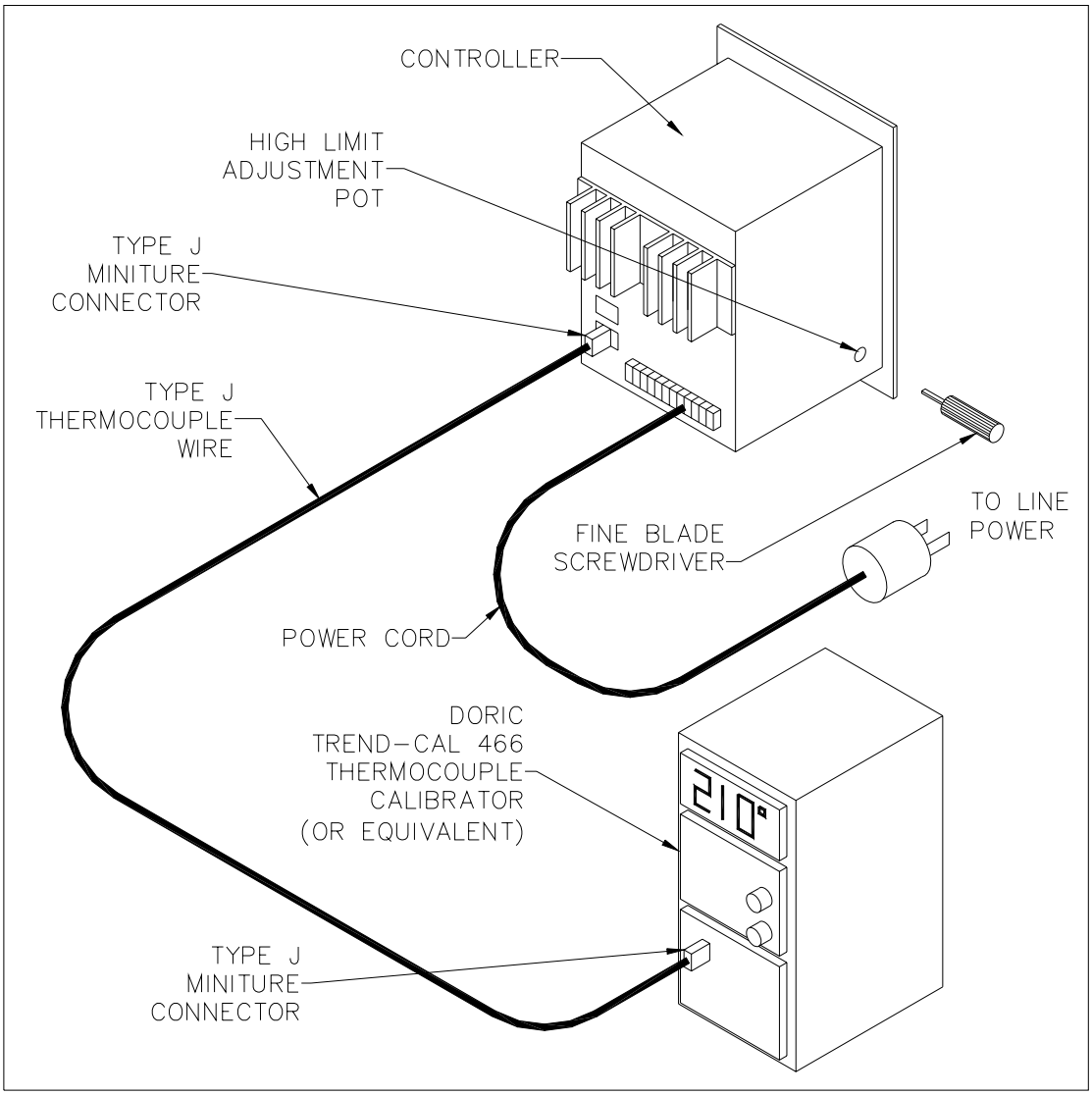


Figure 9.1 Adjusting the High Limit Setpoint

10.0 Calibration

10.1 System

Once the PCT has been installed, it may be desirable to calibrate the overall system for maximum accuracy. The PCT has been factory calibrated; however, after installation or system modification (such as the replacement of a thermocouple) it may be desirable to re-calibrate the system for maximum accuracy.

NOTE: Thermocouples are manufactured to specific tolerances, any given thermocouple may generate a basic error in the system. Additionally, thermocouples are sheathed in Teflon, which tends to degrade the accuracy of the readings. The location of the thermocouple in the process module and any stratification of the liquid in the process module can also cause minor errors in the actual reading.

The OF (offset) parameter is a calibration adjustment in the programming section that is used to offset such cumulative errors in the system. This fixed offset parameter is either added to or subtracted from the thermocouple reading prior to its use by the microprocessor. This adjustment is an automatic internal compensation and will affect all readings from the process thermocouple. The adjustment has a range of +/-9.9°C.

For optimum performance in a fixed condition, the following procedure is suggested:

1. The process temperature should be brought up to its standard operating temperature and allowed to stabilize.

2. A precision laboratory thermometer should be placed in the process solution next to the sensor.

3. Read the exact process solution temperature on the thermometer.

4. Determine the difference between the actual process solution temperature and the temperature displayed on the process display.

5. Enter the Program mode and set the OF parameter to the value that should be added to or subtracted from the process temperature reading to make it agree with the actual process solution temperature (see Section 5.0 - Programming for details).

6. Return to the normal mode. The process temperature should read the same as the precision thermometer.

7. If there are any discrepancies, repeat steps 3 through 6.

8. Once an appropriate value has been obtained, re-enter the program mode and press the SAVE key to permanently save this calibration value.

9. If operating temperatures are to exceed 165°C, in most, cases it is recommended that the system be left on 24 hours a day for the production period (typically a week). This will avoid long heat-up times of approximately 4 to 5 hours.

CAUTION

IF THE HIGH LIMIT OR BATH LIMIT ALARM IS ACTUATED AND POWERS DOWN THE PCT, CONTACT A MODUTEK SERVICE REPRESENTATIVE IMMEDIATELY.

10. After satisfying the preceding, enter the Program mode and change the HI TEMP parameter to 10°C above the process temperature.

11.0 Troubleshooting

Problem 1 The PCT will not turn on.

Remedy a) Connect the green and black wires from the power cable or install a jumper between X1 and X2.

Remedy b) Ensure that the main circuit breaker is closed.

Problem 2 The process solution does not heat.

Remedy a) Press the RESET key once (from the Hold mode).

Remedy b) Check the PCT output (circuit HH & HN 208V) with the heat on.

Remedy c) Return the bath for repair.

Problem 3 Alarm LED and audio tone are activated intermittently.

Remedy a) Check to ensure that all thermocouples are properly grounded.

Problem 4 SYSTEM alarm LED is ON; display flashes "OP".

Remedy a) Re-enter the command.

Remedy b) Reset the PCT.

Remedy c) Return the PCT for repair.

Problem 5 SENSOR alarm LED is ON; display flashes "OP".

Remedy a) Check for open thermocouple circuits.

Problem 6 H LIMIT alarm LED is on; High Limit thermocouple has detected excessive temperature - system is shut OFF.

Remedy a) Contact a Modutek Service Representative.

Problem 7 H TEMP alarm LED is on; display flashes "HI" and the process temperature exceeds the High Alarm Setpoint - heater output and injection control are turned OFF.

Remedy a) Re-program the Proportional Band (Pb) and Cycle Rate (Cr) parameters.

Remedy b) Contact a Modutek Service Representative.

Problem 8 L TEMP alarm LED is on. Display flashes "LO"; process temperature has dropped below the Low Alarm Setpoint.

Remedy a) Re-program the Low Temperature setpoint (LO)

Remedy b) Refer to Problem 2.

Problem 9 **L LEVEL alarm LED is on. Display flashes “LL”. Liquid level of process vessel has dropped below the defined parameter. Heater is turned OFF.**

Remedy a) Check the level of solution in the Liquid Level Sensor tube. The liquid level must be at the gray line (minimum).

12.0 Service

The MICROTEMP PTCs are self contained and do not incorporate any parts which are replaceable by the user. Should you experience a failure, please return the PCT to the Modutek Service Dept. using the procedure outlined in Section 1.0.

13.0 Specifications

Type:	Multi-function microprocessor based
Memory:	EEPROM (minimum 10 year life, no battery backup required)
Dimensions:	See Figure 4.1
Power requirements:	208 VAC, single phase, 50/60 Hz, 15 amps (Other voltages are available)
Housing material:	Black P.V.C.
Facia material:	Lexan
Power cord length:	6 ft.

14.0 Notes

15.0 Controller Schematics & Wiring

SAFETY NOTICE

The self-resetting safety thermal switch opens at 205° +/- 10°C. It is physically attached to the process vessel for temperature sensing, and is wired in series with the coil of an electromechanical relay which is housed in the PCT. The electromechanical relay contacts open when the unsafe temperature is reached and no further heating can take place until the system returns to a safe temperature. This safety switch merely resides in the PCT housing for convenience, but is totally independent as far as the safety circuit.

LEGEND

Power Harness from Process Module	**PCT Connections**
Yellow, Thermal Switch	X1
Blue, Thermal Switch	X2
Black, Heater	HH
Red, Heater	HN
Silver, Over-temperature Thermocouple	H LIMIT
Process Thermocouple from Process Module	
Brown	PROC
Liquid Level Sensor	
Black	C
Black	LL
Power Cord from Supply Voltage	
Black, 208	208H
White, 208	208N
Green, Chassis Ground	G
Aspirator Valve Solenoid in Headcase	
Gray (either)	D2
Drain Valve Solenoid in Headcase	
Gray (either)	D2

Legend, Cont.

Solenoid Harness from Process Module

Red	S1
White	S2

Process Station Power

120 Hot	P1

Remote Mount Audio Alarm	**PCT Connections**
Black, 12 VDC	+
White, 12 VDC	BUZ

Remote Mount Operation Switch (Timer)

Yellow	TC
Purple	TMR

Ancillary Devices

Aspirator Valve Solenoid

Gray (either)	Station Power, common

Drain Solenoid

Gray (either)	Station Power, common

Remote Mount Operation Switch (Timer)

Black (either)	Station Power 120
Black (either)	Station Power 120

ADDENDUM 1

MODUTEK CORPORATION
C1315a PROCESS CONTROLLER/TIMER SPECIAL PROGRAM

This is a special model of the standard C1315a Process Controller/Timer (PCT). It contains all of the standard features of the C1315a PCT and is modified only in that the injection process has been expanded.

The PCT now has two injection modes, which are selected by utilizing the new “PN” (Program Number) in the stack. When PN = 1, the system will operate as a standard C1315a PCT. When PN = 0, the special injection sequence is activated.

The special injection sequence (PN = 0) allows the user to program a maximum of five sets of delay and injection periods. These injection periods are activated during the normal timer run, just as the single injection is in the standard model.

The order of the parameters has been revised for clarity. The following is a listing of the initial parameters. NOTE: Items not listed are identical to the standard C1315a PCT.

CODE	SETTING RANGE	DESCRIPTION
CS	0:00 to 99:59 min:sec	Clock Setpoint
PA	0:00 to 00:59 sec	Pre-Alarm
IP	0:00 to 10:00 min:sec	Injection Period
AI	0:00 to 99:59 min:sec	Auto. Inj. Period
PN	0 or 1	Program Number
D1	0:00 to 10:00 min:sec	Delay Number 1
I1	0:00 to 10:00 min:sec	Inject Number 1
D2	0:00 to 10:00 min:sec	Delay Number 2
I2	0:00 to 10:00 min:sec	Inject Number 2
D3	0:00 to 10:00 min:sec	Delay Number 3
I3	0:00 to 10:00 min:sec	Inject Number 3
D4	0:00 to 10:00 min:sec	Delay Number 4
I4	0:00 to 10:00 min:sec	Inject Number 4
D5	0:00 to 10:00 min:sec	Delay Number 5
I5	0:00 to 10:00 min:sec	Inject Number 5

NOTE: When PN = 1, parameters D1 through I5 are eliminated from the programming stack.

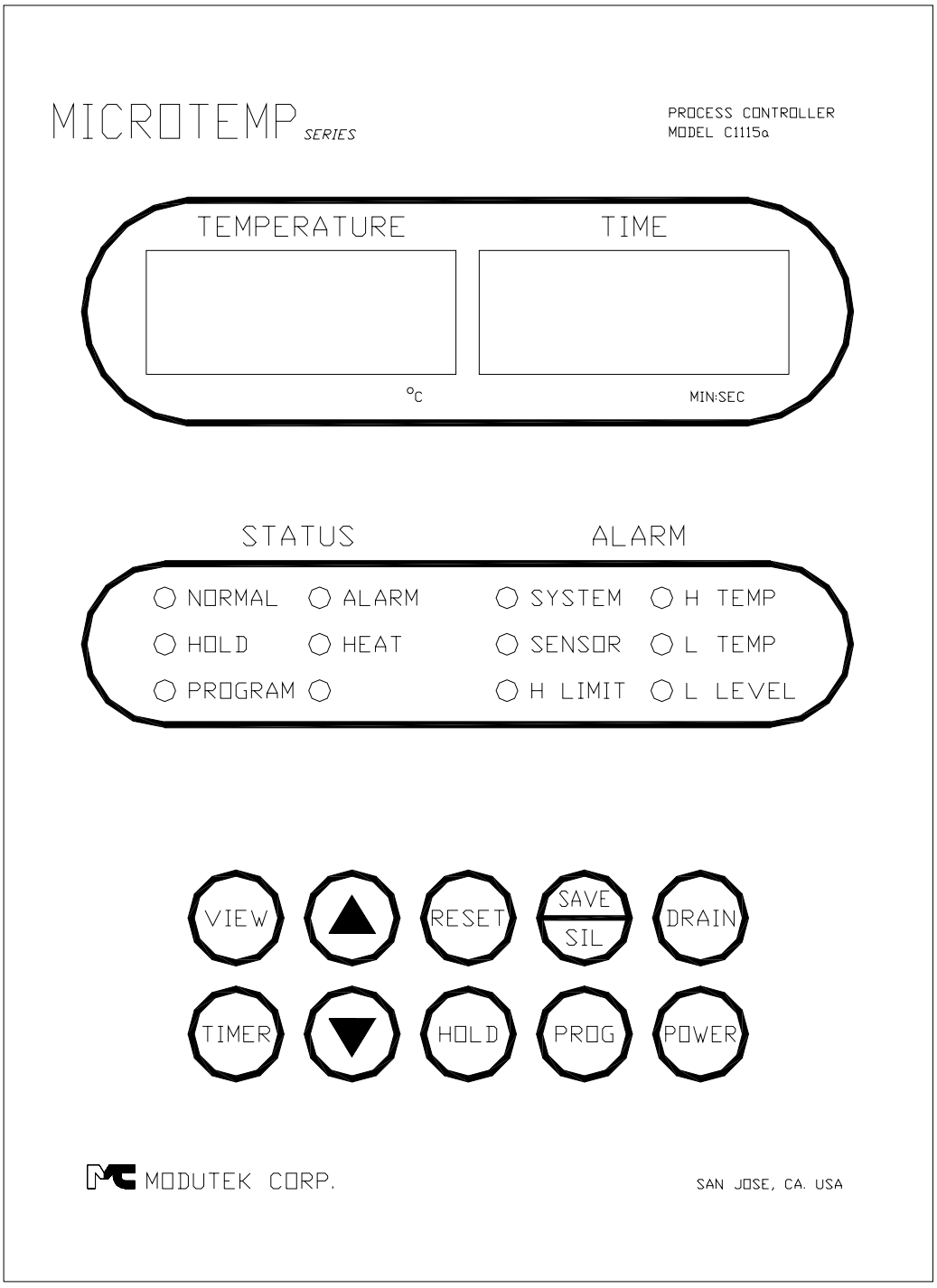
The ‘IP’ and ‘AI’ parameters are utilized with both PN = 0 and PN = 1. In both cases, the Automatic Injection functions as described in the standard C1315a PCT manual. If no operation occurs for the period programmed into ‘AI’, an Automatic Injection of duration ‘IP’ will be initiated.

When PN = 1, the ‘IP’ parameter is utilized as the Injection Period that occurs when the Timer is started. The parameters ‘D1’ through ‘I5’ are ignored. This is the standard C1315a function.

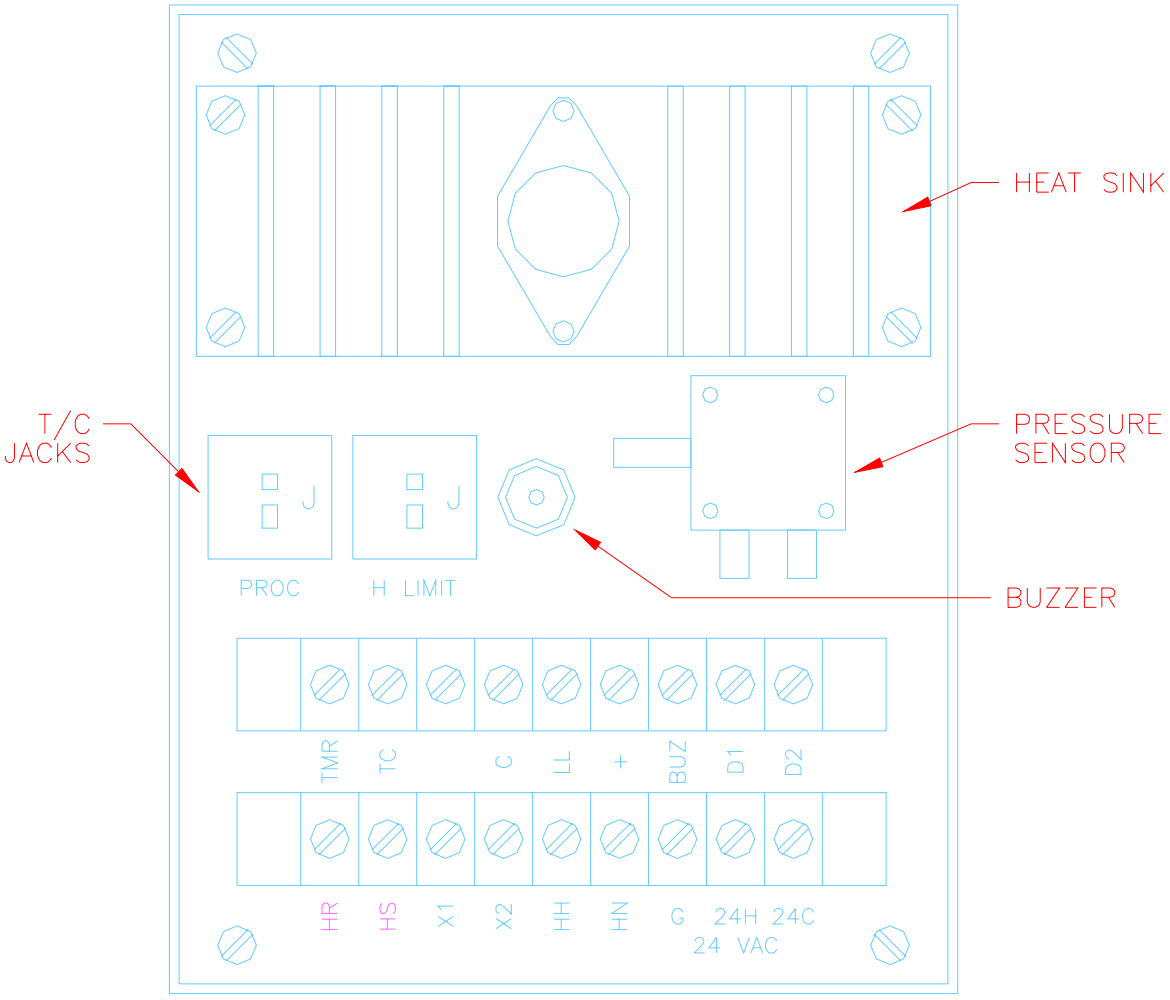
When ‘PN’ = 0, the Injection sequence described by the new parameters ‘D1’ through ‘I5’ are utilized to control the injection during the Timer countdown. When the Timer key is depressed, the countdown Timer will activate and be displayed in the Timer display. At the same instant, the injection timer sequence will begin. The ‘D1’ delay will be counted down and the injection solenoid will be off. When this interval has elapsed, the injection solenoid will activate and the ‘I1’ period will be counted down. This sequence will continue until the completion of the ‘I5’ count at which time the injection solenoid will be turned off.

If the timer is manually terminated or the ‘CS’ parameter is selected such that the countdown time period is shorter than the total elapse time for the injection sequence, the sequence will be automatically terminated and the solenoid turned off.

If any of the timing periods are set to zero, they will be skipped. Thus, if no initial delay is required, simply setting the ‘D1’ parameter to 0:00 will begin the sequence with an immediate injection when the timer is started.

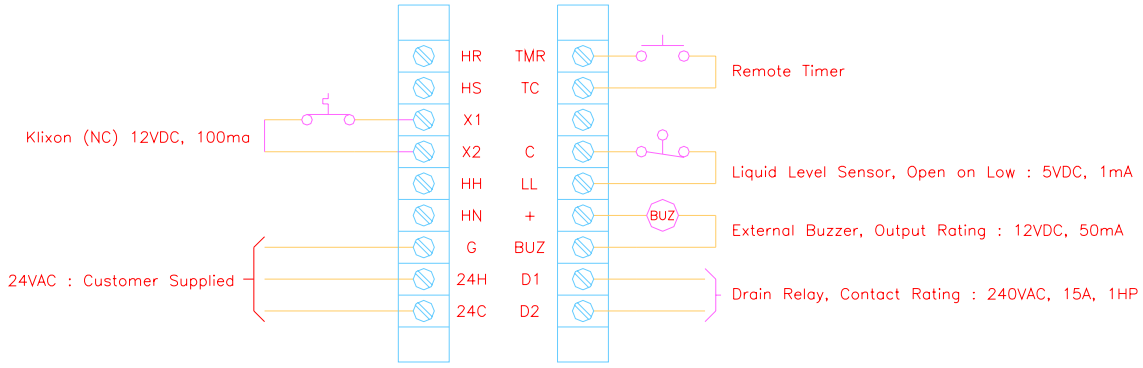


C1115a Front Panel

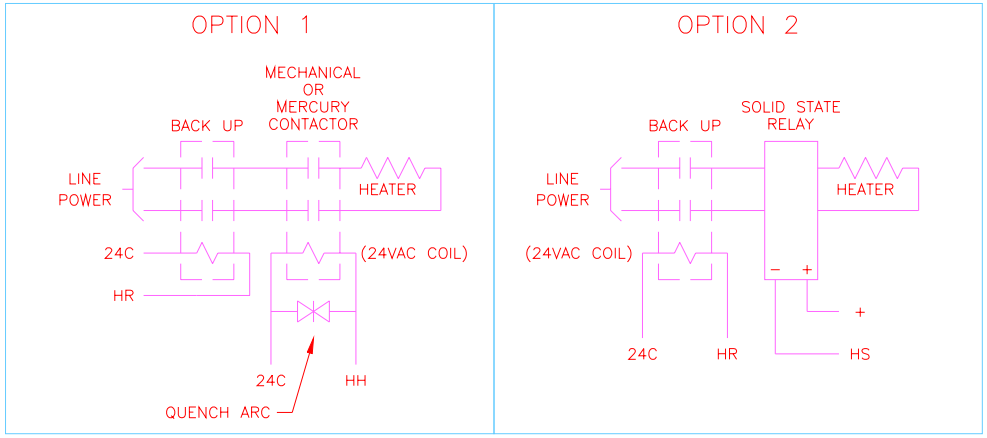


C1115a–24VAC Rear View

ZONE	REV	DESCRIPTION	DATE	APPR'D

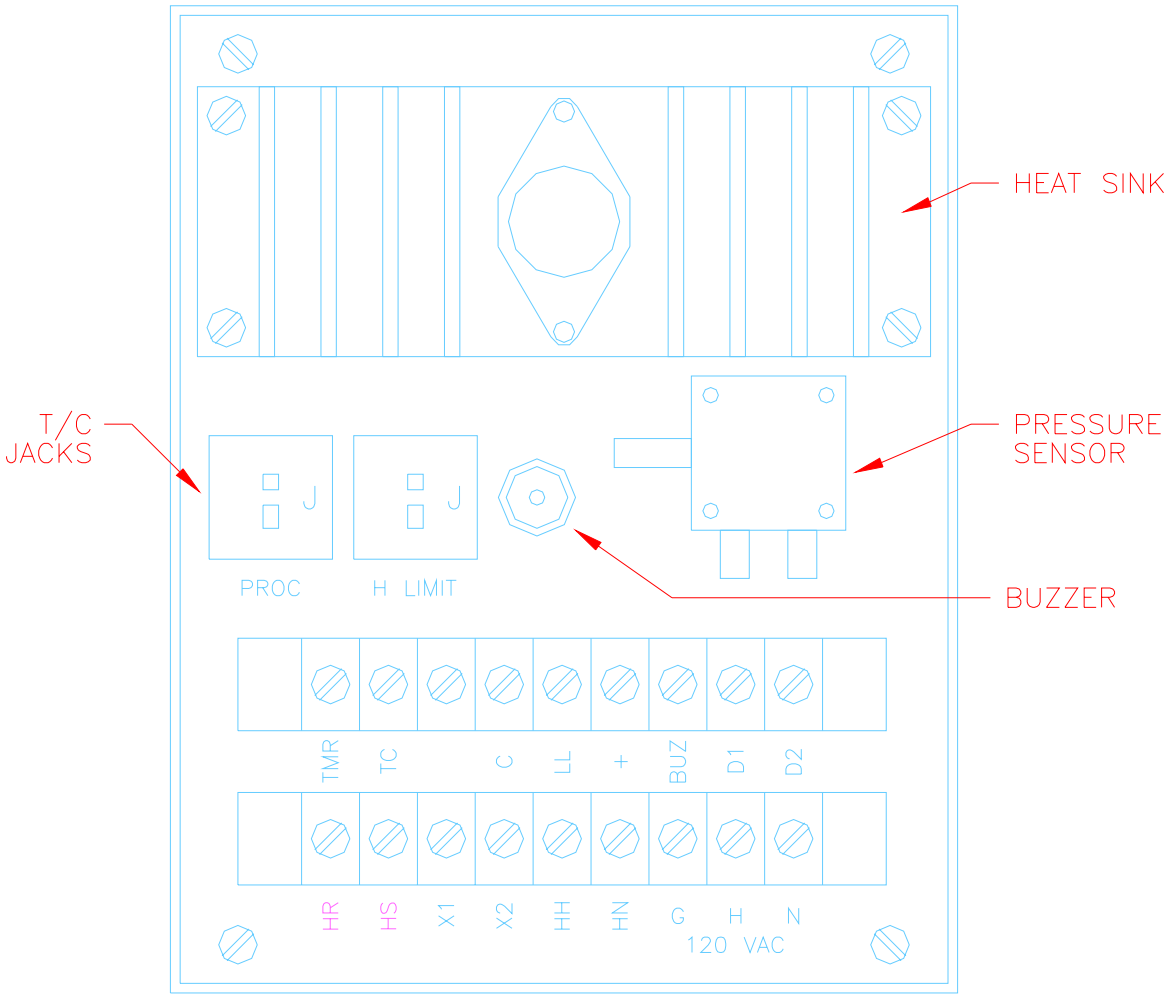


NOTE: Connected devices are supplied by others.
'+' terminal rated at 12-20VDC (unregulated), 100mA



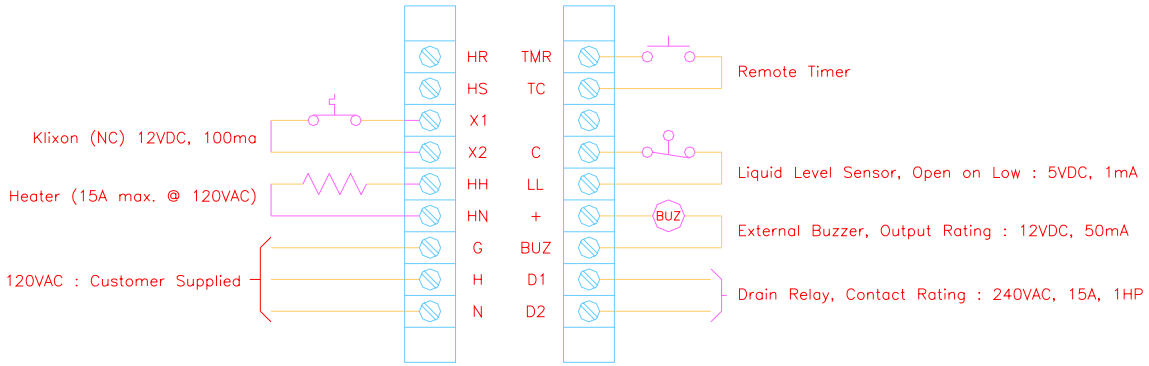
NOTE: The use of a Quench Arc on every mechanical relay and solenoid in the system is highly recommended. Use Paktron p/n 104M06QC100 or equivalent.

UNLESS OTHERWISE SPECIFIED ALL DIMENSIONS ARE IN INCHES TOLERANCES ARE: FRACTIONS ± 1/32 DECIMALS .XX ±.010 .XXX ±.005 .XXXX ±.001 ANGLES ± 1°	CONTRACT NO.	MODUTEK CORP. 6367 SAN IGNACIO AVENUE SAN JOSE, CA. 95119 (408)362-2000
MATERIAL	NAME / DATE	C1115a 24VAC Controller Connection Diagram
FINISH	DRAWN BY: J. Atkin 5/29/97	FSCM NO. / DWG NO. C1115sch-24VAC / REV A
DO NOT SCALE DRAWING	DESIGNED BY:	SCALE: n/a c1115sch SHT 1 OF 4
	APPROVED BY:	
	CHECKED BY:	

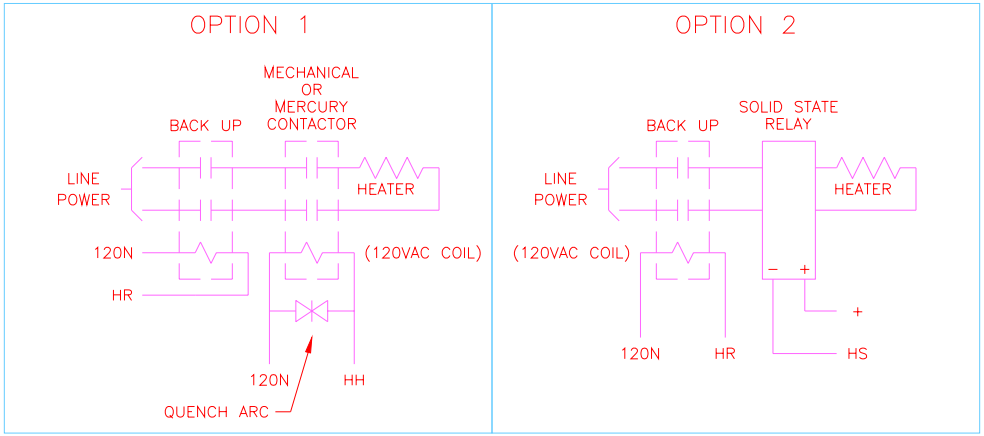


C1115a–120VAC Rear View

ZONE	REV	DESCRIPTION	DATE	APPR'D



NOTE: Connected devices are supplied by others.
'+' terminal rated at 12-20VDC (unregulated), 100mA



NOTE: The use of a Quench Arc on every mechanical relay and solenoid in the system is highly recommended. Use Paktron p/n 104M06QC100 or equivalent.

UNLESS OTHERWISE SPECIFIED ALL DIMENSIONS ARE IN INCHES TOLERANCES ARE: FRACTIONS ± 1/32 DECIMALS .XX ±.010 .XXX ±.005 .XXXX ±.001 ANGLES ± 1°
MATERIAL
FINISH
DO NOT SCALE DRAWING

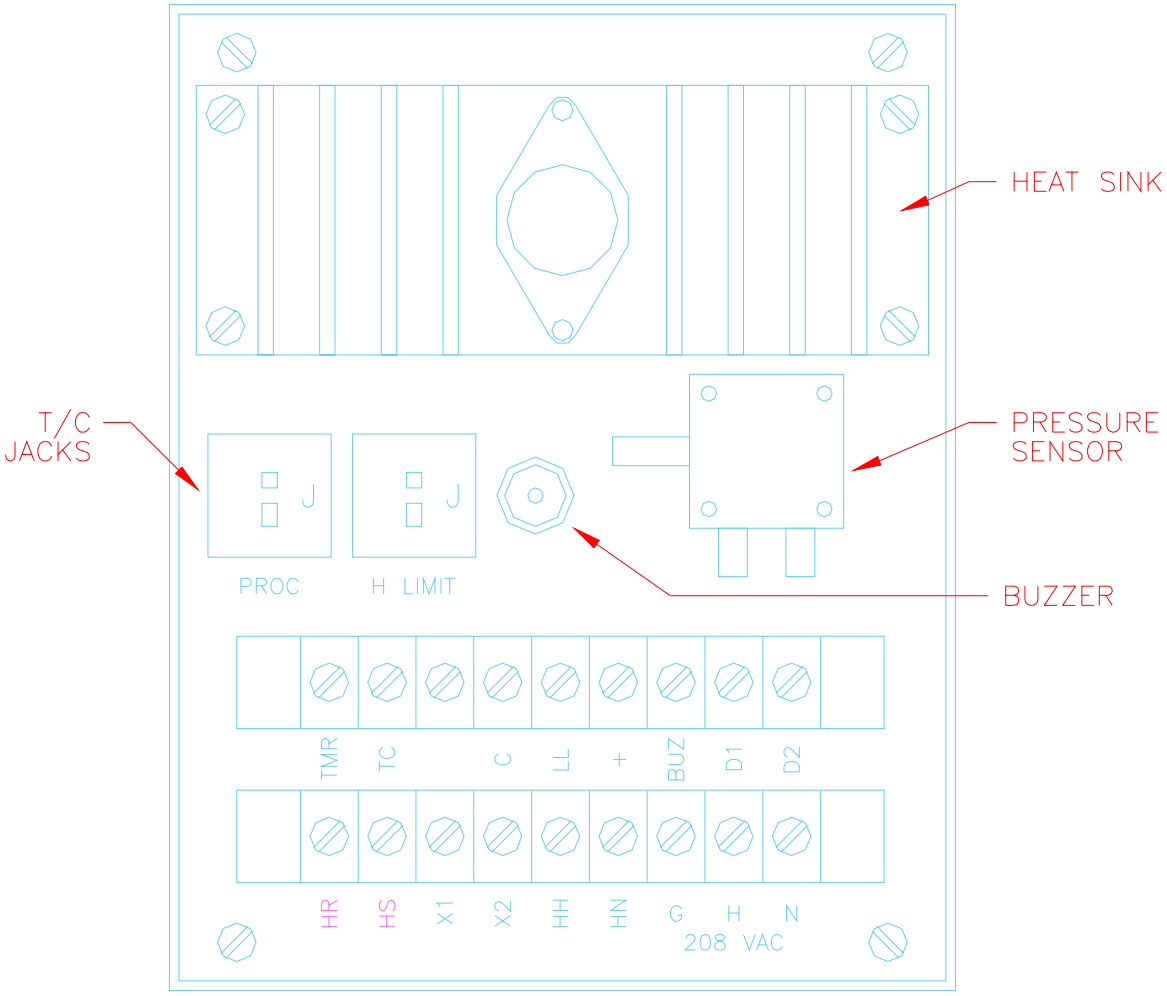
CONTRACT NO.

NAME	DATE
DRAWN BY: J. Atkin	5/29/97
DESIGNED BY:	
APPROVED BY:	
CHECKED BY:	

MODUTEK CORP.
6387 SAN IGNACIO AVENUE
SAN JOSE, CA. 95119 (408)362-2000

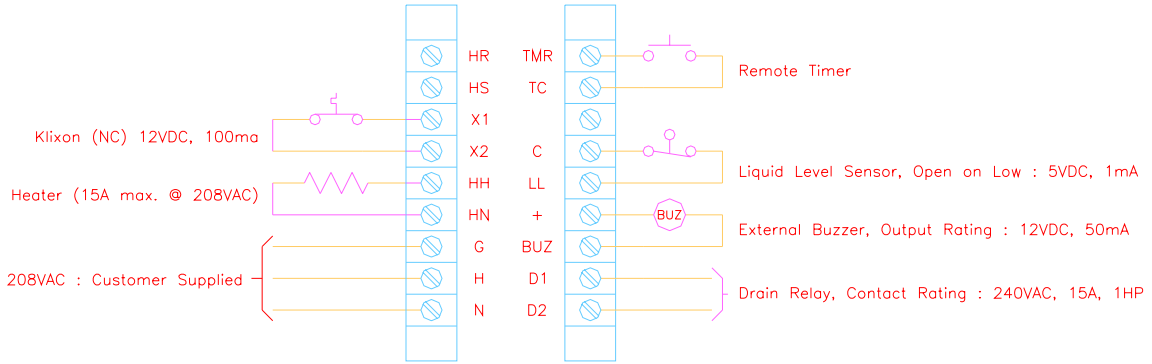
C1115a 120VAC Controller
Connection Diagram

FSCM NO. | DWG NO. C1115sch-120VAC | REV A
SCALE: n/a | c1115sch | SHT 2 OF 4

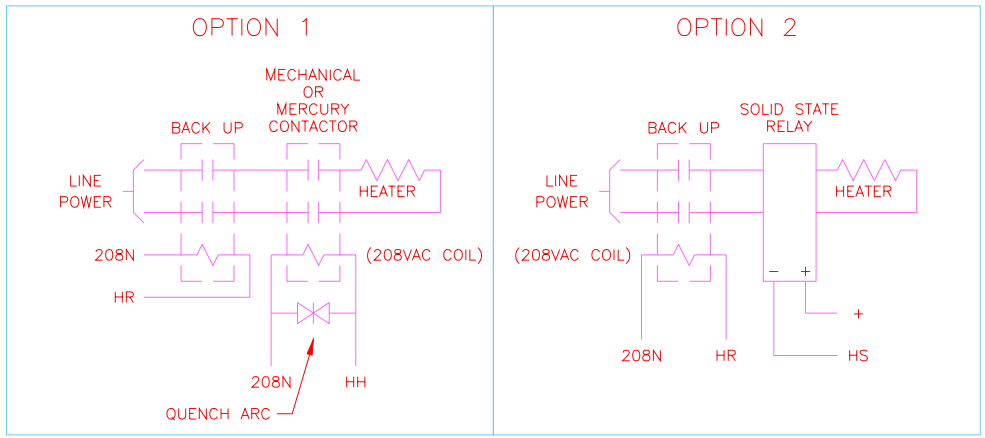


C1115a–208VAC Rear View

ZONE	REV	DESCRIPTION	DATE	APPR'D



NOTE: Connected devices are supplied by others.
'+' terminal rated at 12-20VDC (unregulated), 100mA



NOTE: The use of a Quench Arc on every mechanical relay and solenoid in the system is highly recommended. Use Paktron p/n 104M06QC100 or equivalent.

UNLESS OTHERWISE SPECIFIED ALL DIMENSIONS ARE IN INCHES TOLERANCES ARE: FRACTIONS ± 1/32 DECIMALS .XX ±.010 .XXX ±.005 .XXXX ±.001 ANGLES ± 1°
MATERIAL
FINISH
DO NOT SCALE DRAWING

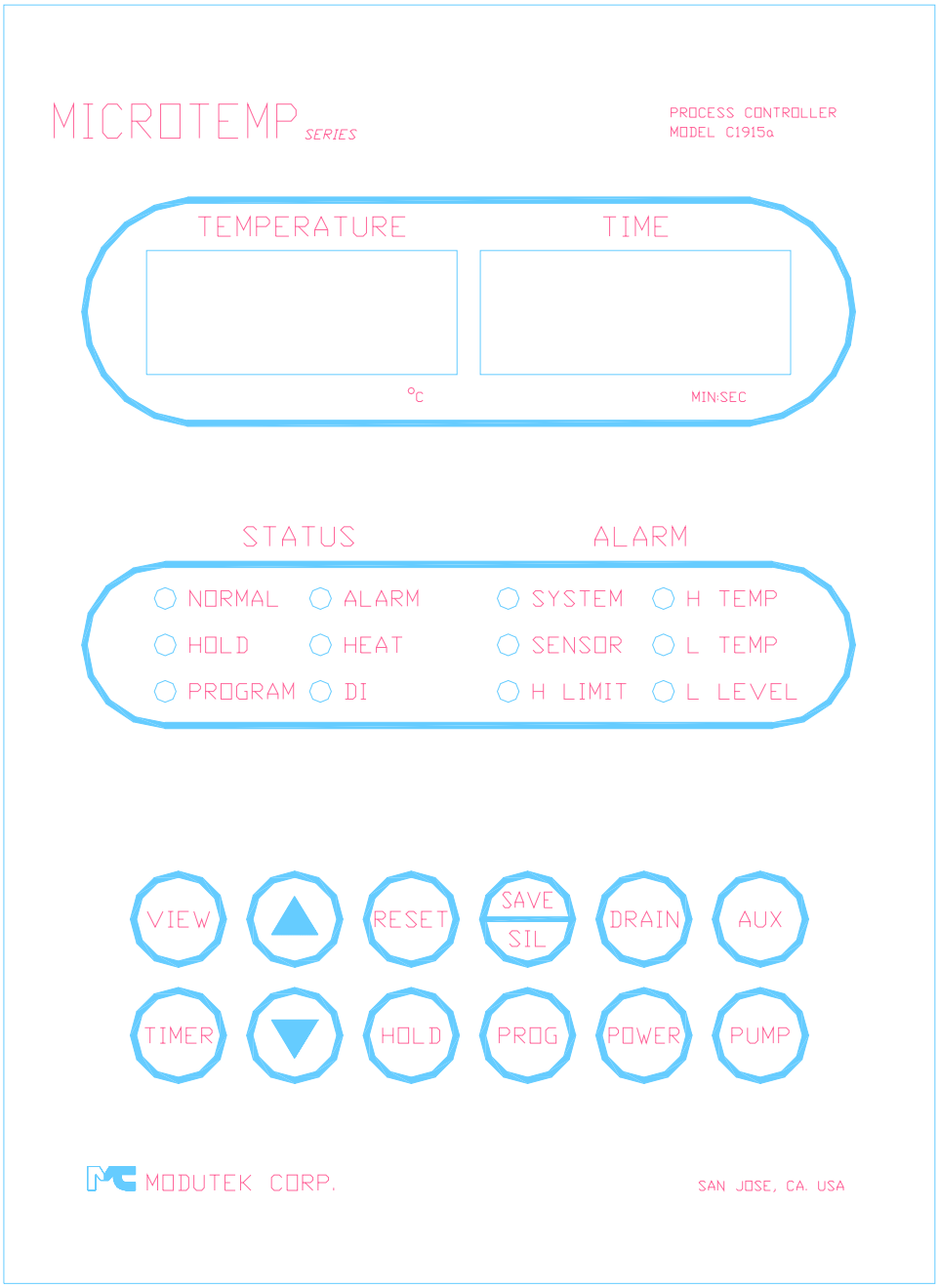
CONTRACT NO.

NAME	DATE
DRAWN BY: J. Atkin	5/29/97
DESIGNED BY:	
APPROVED BY:	
CHECKED BY:	

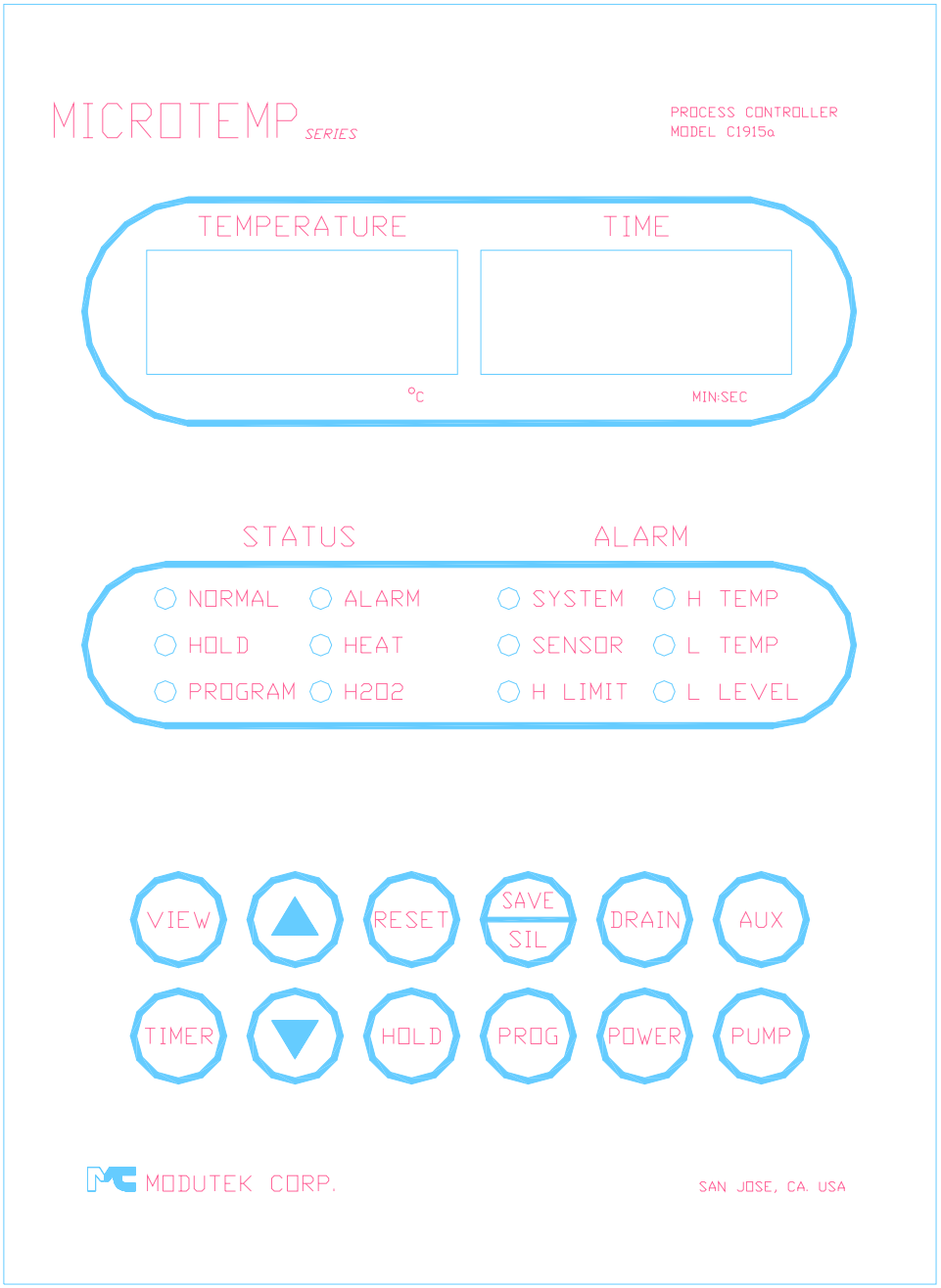
MODUTEK CORP.
6387 SAN IGNACIO AVENUE
SAN JOSE, CA. 95119 (408)362-2000

C1115a 208VAC Controller
Connection Diagram

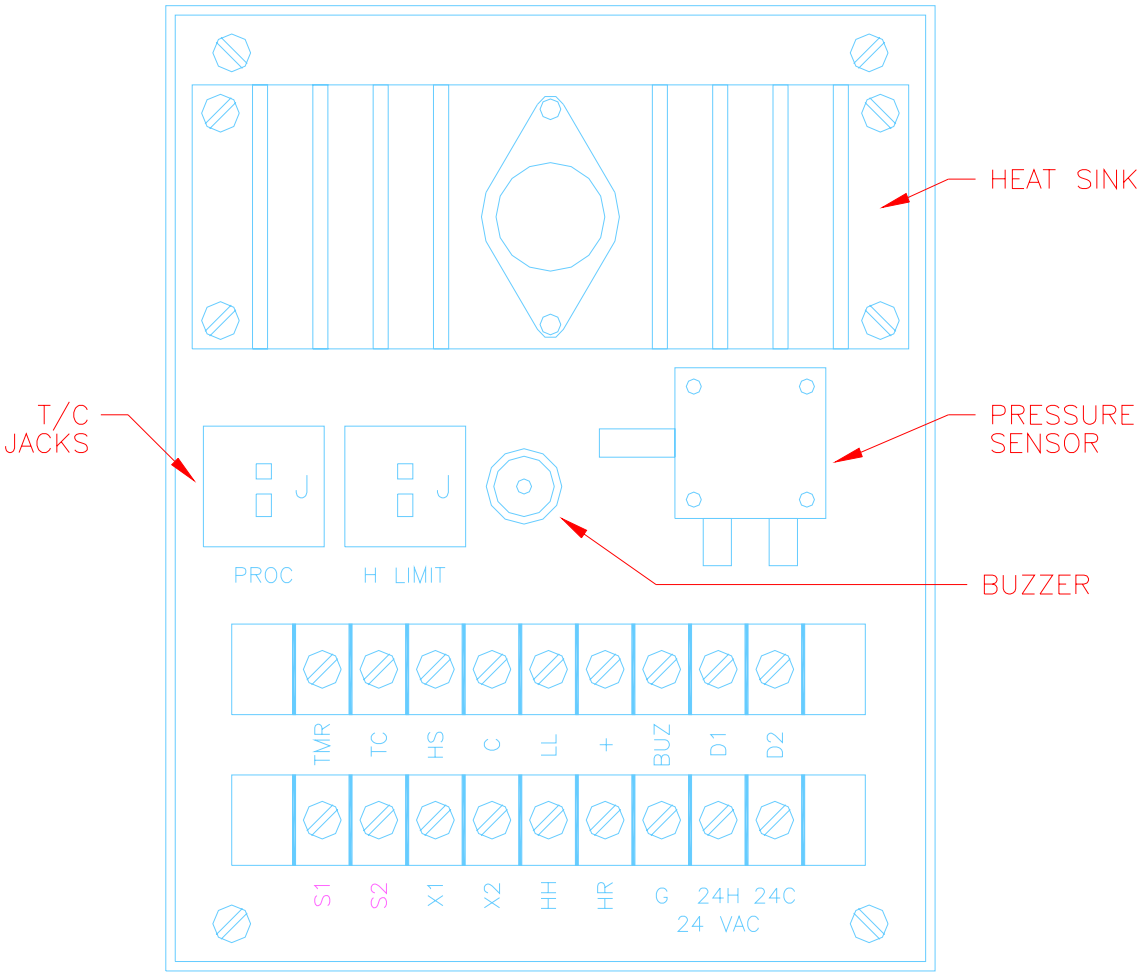
FSCM NO.	DWG NO.	REV
	C1115sch-208VAC	A
SCALE: n/a	c1115sch	SHT 3 OF 4



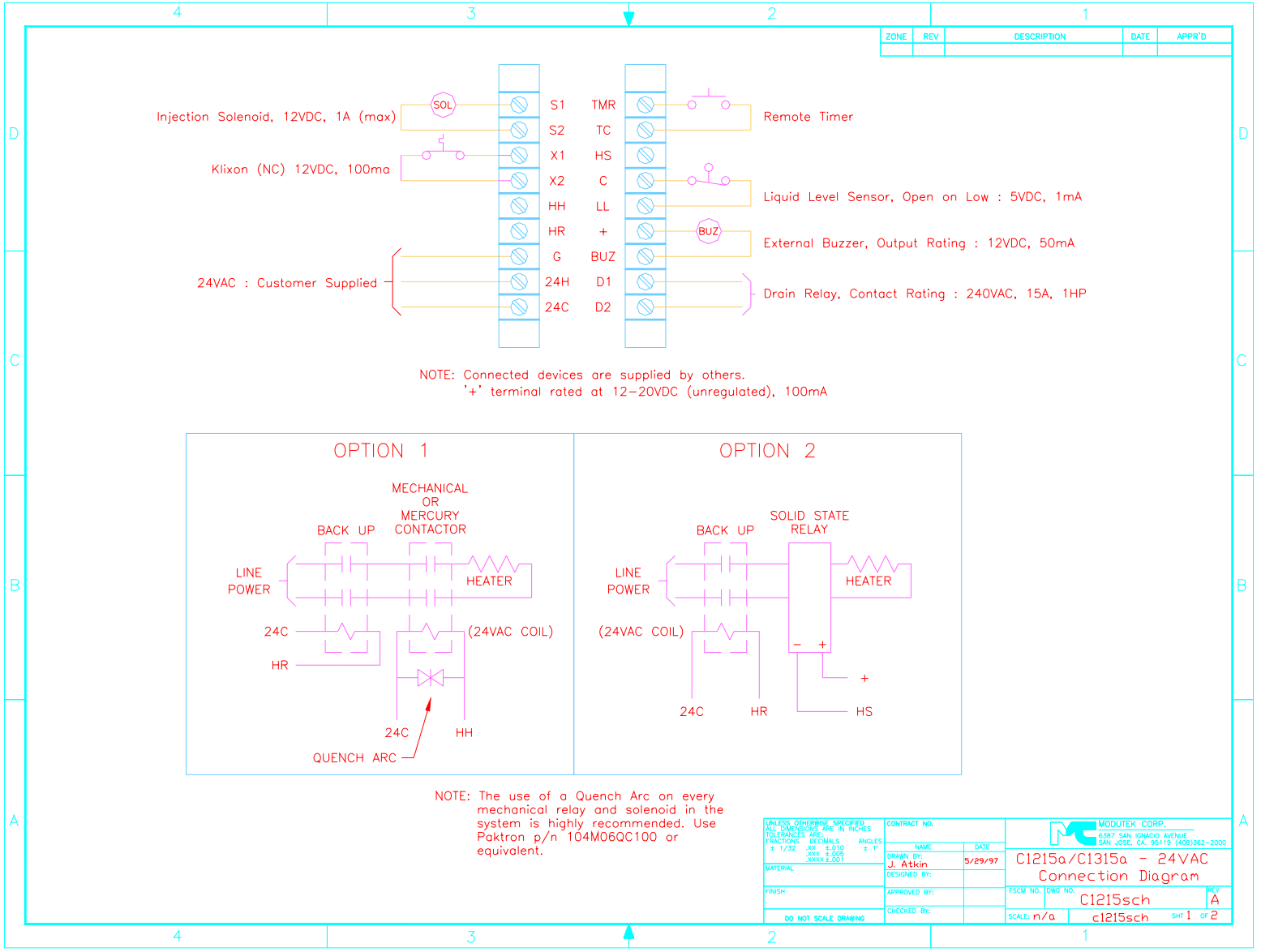
C1215a Front Panel

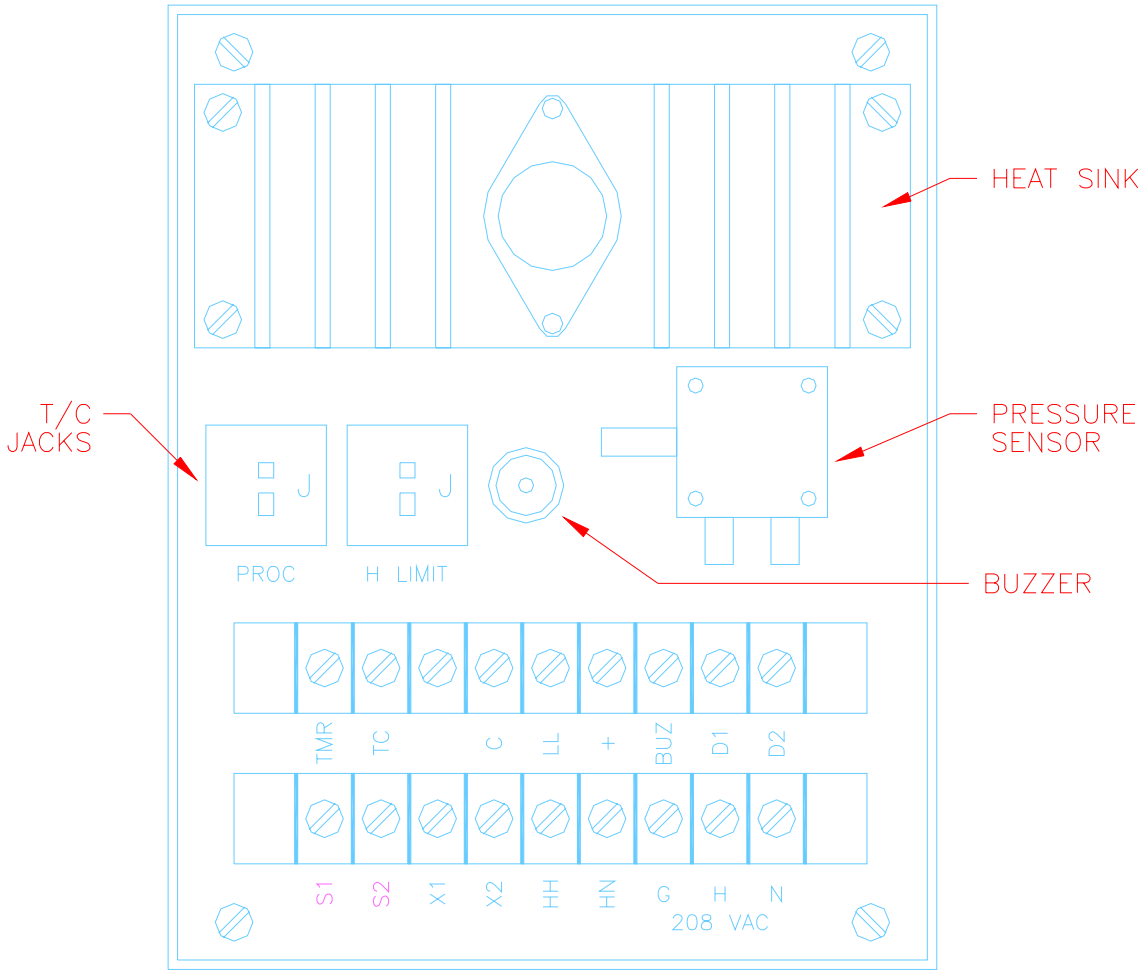


C1315a Front Panel



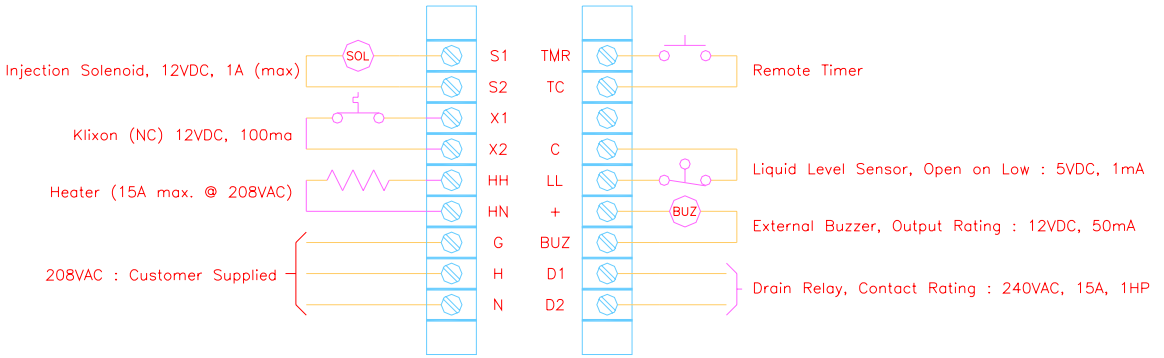
C1215a–24VAC Rear View
C1315a–24VAC Rear View


ZONE
REV
DESCRIPTION
DATE
APPR'D
Injection Solenoid, 12VDC, 1A (max)
SOL
Klixon (NC) 12VDC, 100ma
24VAC : Customer Supplied
S1
S2
X1
X2
HH
HR
G
24H
24C
TMR
TC
HS
C
LL
+
BUZ
D1
D2
Remote Timer
Liquid Level Sensor, Open on Low : 5VDC, 1mA
External Buzzer, Output Rating : 12VDC, 50mA
Drain Relay, Contact Rating : 240VAC, 15A, 1HP
NOTE: Connected devices are supplied by others.
'+' terminal rated at 12-20VDC (unregulated), 100mA
OPTION 1
MECHANICAL
OR
MERCURY
CONTACTOR
BACK UP
LINE
POWER
HEATER
24C
HR
(24VAC COIL)
24C
HH
QUENCH ARC
OPTION 2
SOLID STATE
RELAY
BACK UP
LINE
POWER
HEATER
(24VAC COIL)
24C
HR
HS
NOTE: The use of a Quench Arc on every mechanical relay and solenoid in the system is highly recommended. Use Paktron p/n 104M06QC100 or equivalent.
UNLESS OTHERWISE SPECIFIED ALL DIMENSIONS ARE IN INCHES
TOLERANCES ARE:
FRACTIONS ± 1/32
DECIMALS .XX ±.010 .XXX ±.005 .XXXX ±.001
ANGLES ± 1°
DO NOT SCALE DRAWING
MATERIAL
FINISH
CONTRACT NO.
NAME
DATE
DRAWN BY: J. Atkin 5/29/97
DESIGNED BY:
APPROVED BY:
CHECKED BY:
MODUTEK CORP.
6387 SAN IGNACIO AVENUE
SAN JOSE, CA. 95119 (408)362-2000
C1215a/C1315a - 24VAC
Connection Diagram
FSCM NO.
DWG NO. C1215sch
REV A
SCALE: n/a
c1215sch
SHT 1 OF 2



C1215a–208VAC Rear View

ZONE	REV	DESCRIPTION	DATE	APPR'D



NOTE: Connected devices are supplied by others.
'+' terminal rated at 12-20VDC (unregulated), 100mA

UNLESS OTHERWISE SPECIFIED
ALL DIMENSIONS ARE IN INCHES
TOLERANCES ARE:
FRACTIONS ± 1/32 DECIMALS .XX ±.010 .XXX ±.005 .XXXX ±.001 ANGLES ± 1°
MATERIAL
FINISH
DO NOT SCALE DRAWING

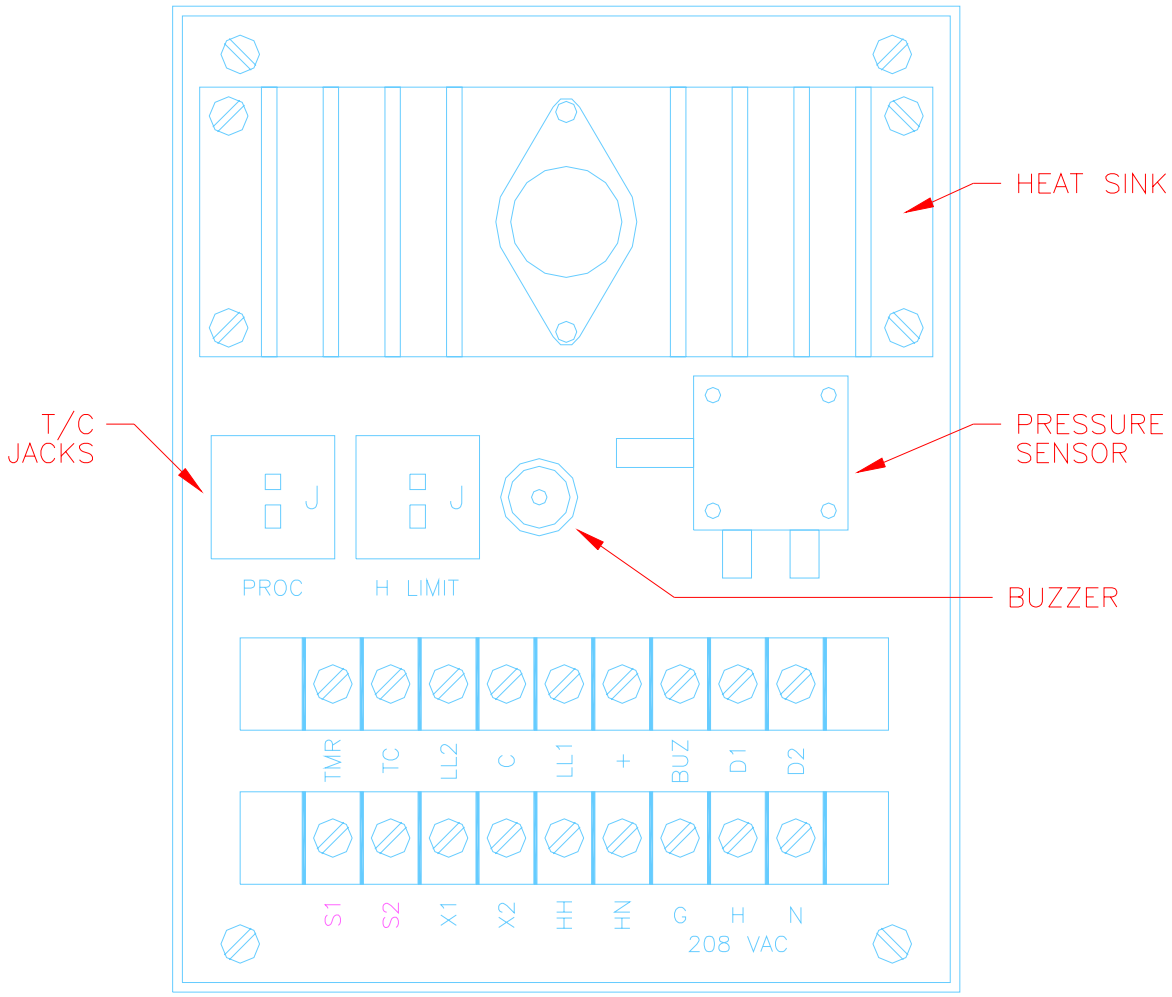
CONTRACT NO.

	NAME	DATE
DRAWN BY:	J. Atkin	5/29/97
DESIGNED BY:		
APPROVED BY:		
CHECKED BY:		

MODUTEK CORP.
6387 SAN IGNACIO AVENUE
SAN JOSE, CA. 95119 (408)362-2000

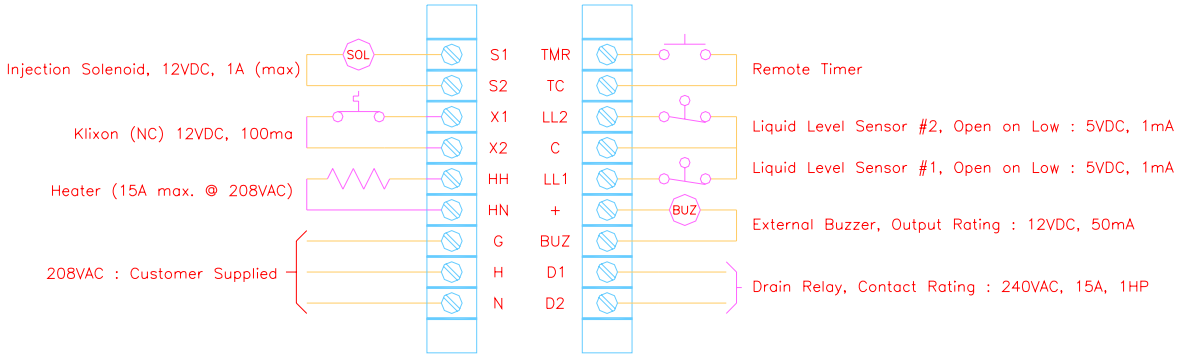
C1215a - 208VAC
Connection Diagram

FSCM NO. | DWG NO. C1215sch | REV A
SCALE: n/a | c1215sch | SHT 2 OF 2



C1315a–208VAC Rear View

ZONE	REV	DESCRIPTION	DATE	APPR'D



NOTE: Connected devices are supplied by others.
'+' terminal rated at 12-20VDC (unregulated), 100mA

UNLESS OTHERWISE SPECIFIED
ALL DIMENSIONS ARE IN INCHES
TOLERANCES ARE:
FRACTIONS ± 1/32 DECIMALS .XX ±.010 .XXX ±.005 .XXXX ±.001 ANGLES ± 1°
MATERIAL
FINISH
DO NOT SCALE DRAWING

CONTRACT NO.

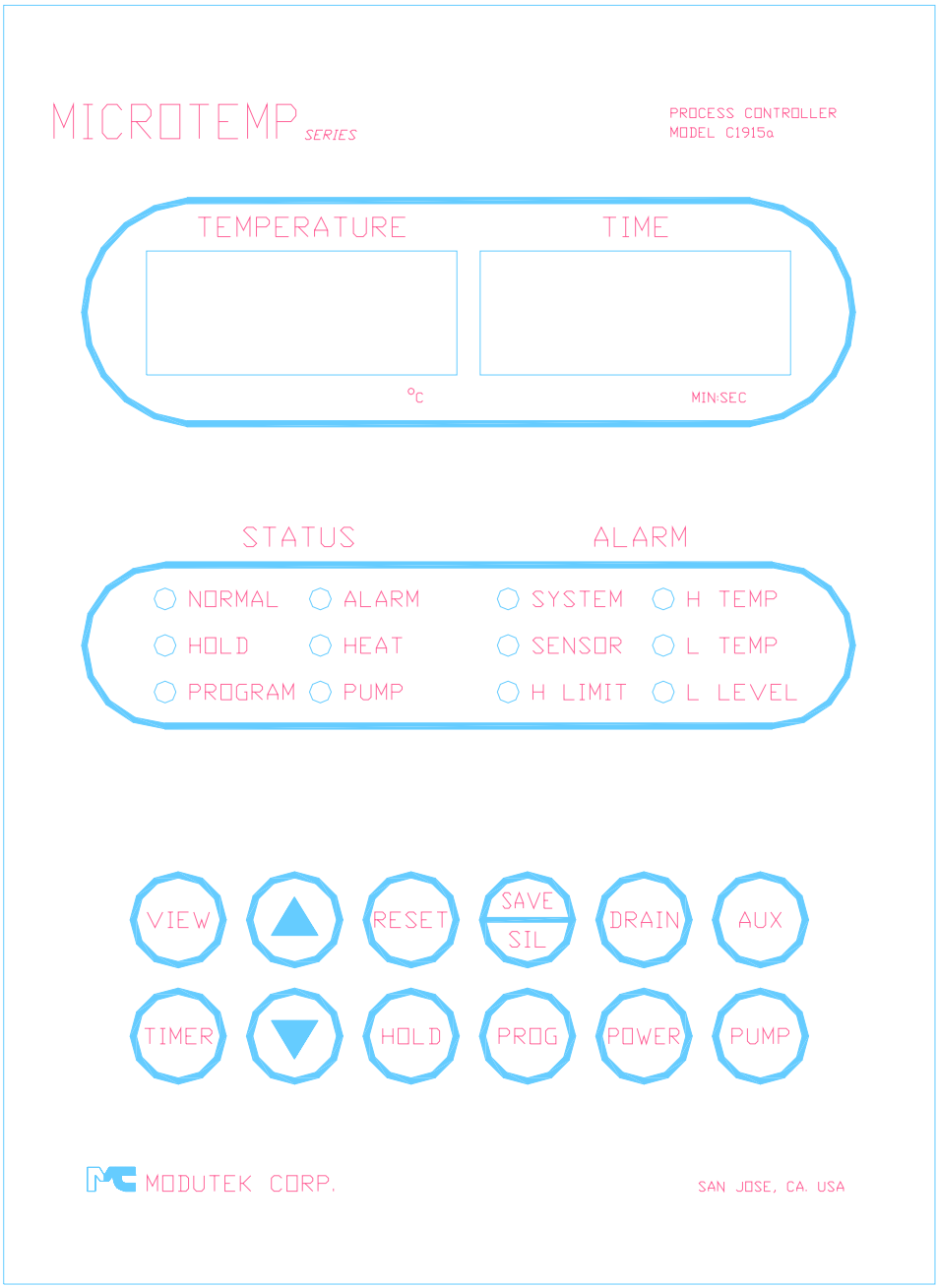
	NAME	DATE
DRAWN BY:	J. Atkin	5/29/97
DESIGNED BY:		
APPROVED BY:		
CHECKED BY:		

MODUTEK CORP.
6387 SAN IGNACIO AVENUE
SAN JOSE, CA. 95119 (408)362-2000

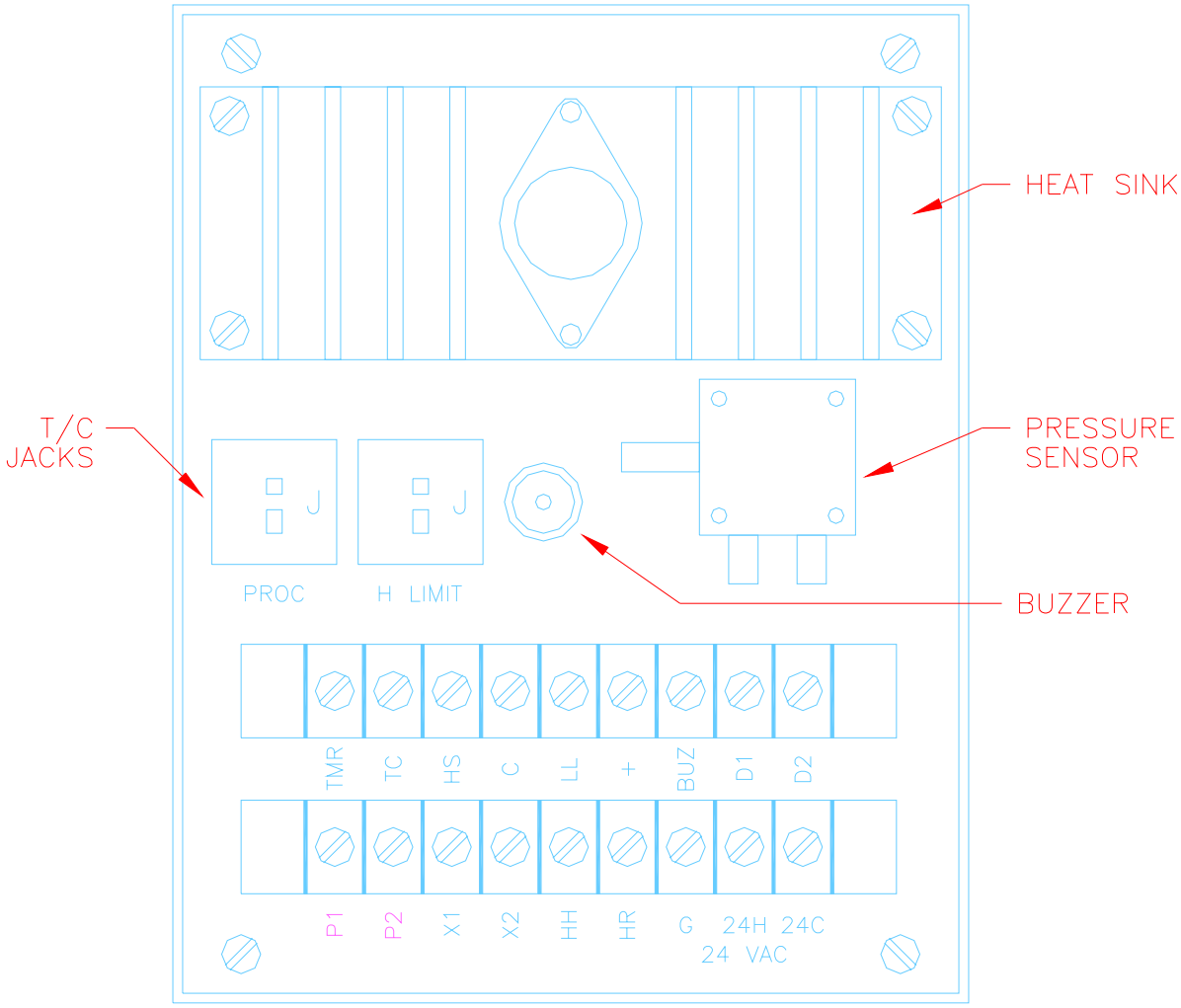
C1315a - 208VAC
Connection Diagram

FSCM NO.	DWG NO.	REV
	C1315sch	A

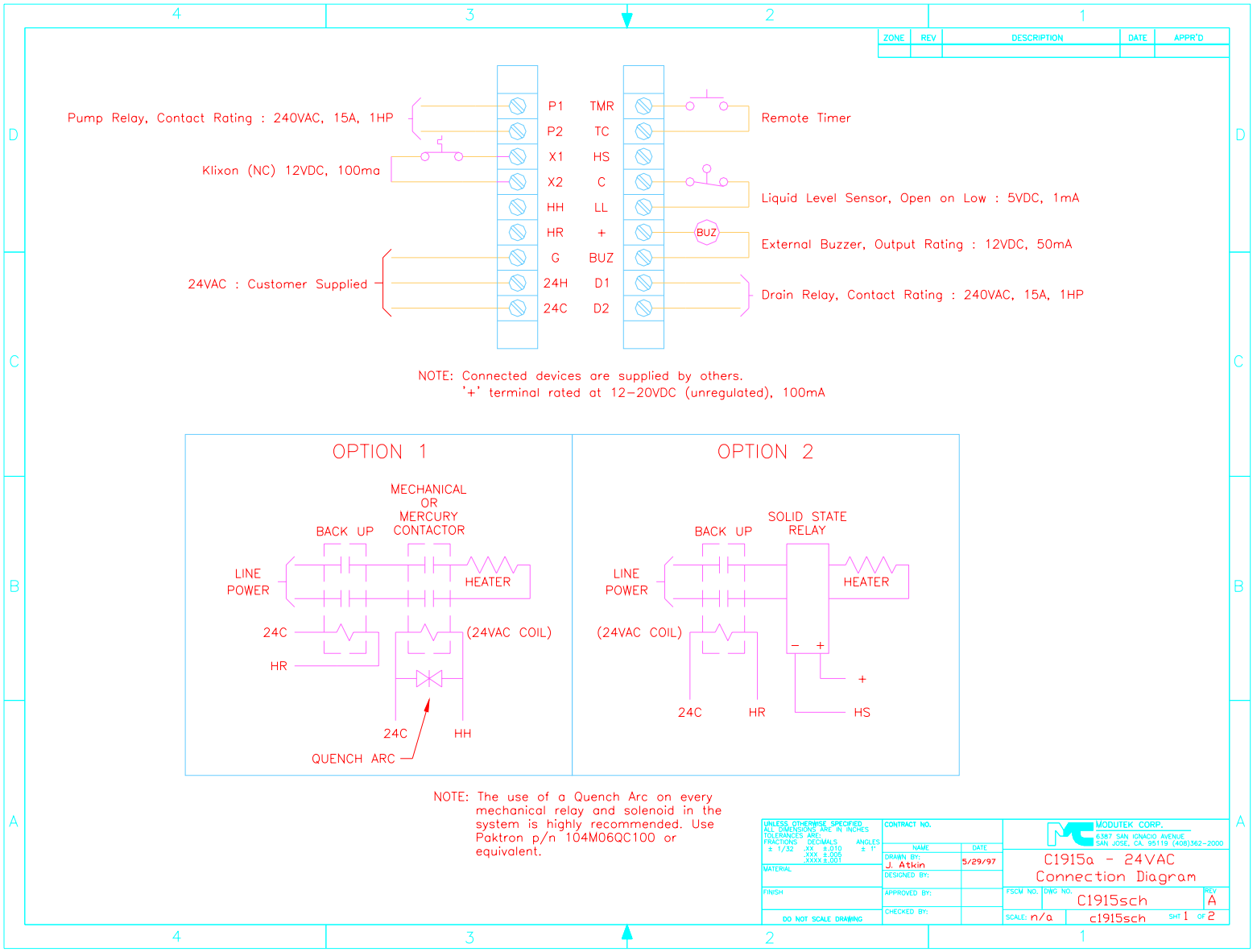
SCALE: n/a | c1315sch | SHT 1 OF 1

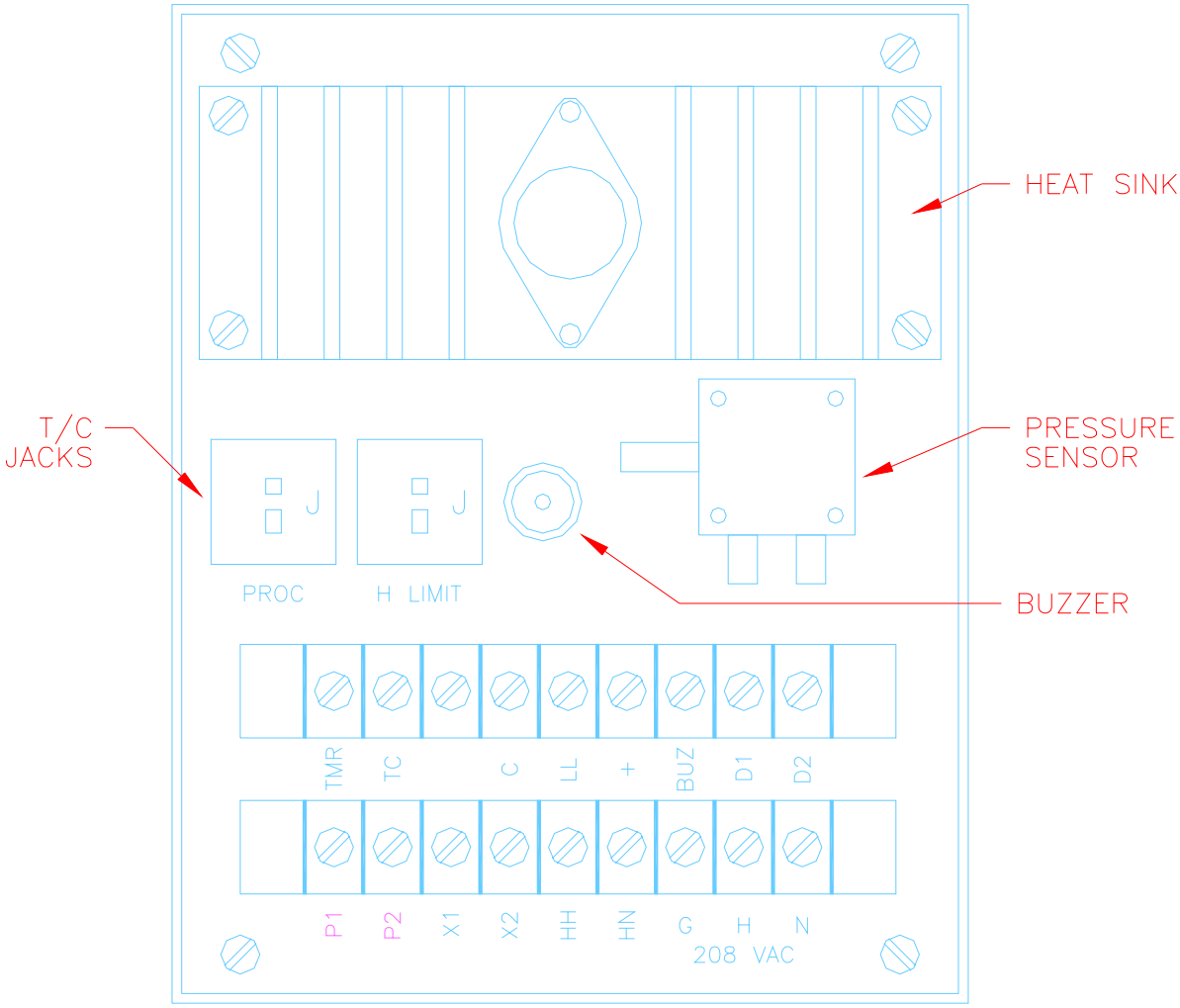


C1915a Front Panel



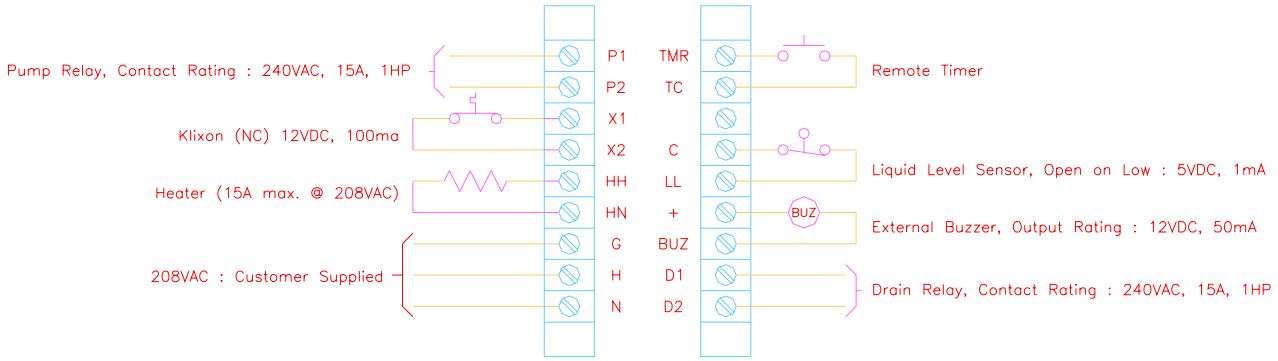
C1915a–24VAC Rear View


ZONE
REV
DESCRIPTION
DATE
APPR'D
Pump Relay, Contact Rating : 240VAC, 15A, 1HP
Klixon (NC) 12VDC, 100ma
24VAC : Customer Supplied
P1
P2
X1
X2
HH
HR
G
24H
24C
TMR
TC
HS
C
LL
+
BUZ
D1
D2
Remote Timer
Liquid Level Sensor, Open on Low : 5VDC, 1mA
External Buzzer, Output Rating : 12VDC, 50mA
Drain Relay, Contact Rating : 240VAC, 15A, 1HP
NOTE: Connected devices are supplied by others.
'+' terminal rated at 12-20VDC (unregulated), 100mA
OPTION 1
MECHANICAL OR MERCURY CONTACTOR
BACK UP
LINE POWER
HEATER
24C
HR
(24VAC COIL)
24C
HH
QUENCH ARC
OPTION 2
SOLID STATE RELAY
BACK UP
LINE POWER
HEATER
(24VAC COIL)
24C
HR
HS
NOTE: The use of a Quench Arc on every mechanical relay and solenoid in the system is highly recommended. Use Paktron p/n 104M06QC100 or equivalent.
UNLESS OTHERWISE SPECIFIED, ALL DIMENSIONS ARE IN INCHES
TOLERANCES ARE:
FRACTIONS ± 1/32
DECIMALS .XX ±.010 .XXX ±.005 .XXXX ±.001
ANGLES ± 1°
MATERIAL
FINISH
DO NOT SCALE DRAWING
CONTRACT NO.
NAME
DATE
DRAWN BY: J. Atkin 5/29/97
DESIGNED BY:
APPROVED BY:
CHECKED BY:
MODUTEK CORP.
6367 SAN IGNACIO AVENUE
SAN JOSE, CA. 95119 (408)362-2000
C1915a - 24VAC
Connection Diagram
FSCM NO.
DWG NO. C1915sch
REV. A
SCALE: n/a
c1915sch
SHT 1 OF 2



C1915a–208VAC Rear View

ZONE	REV	DESCRIPTION	DATE	APPR'D



NOTE: Connected devices are supplied by others.
'+' terminal rated at 12-20VDC (unregulated), 100mA

UNLESS OTHERWISE SPECIFIED
ALL DIMENSIONS ARE IN INCHES
TOLERANCES ARE:
FRACTIONS ± 1/32 DECIMALS .XX ±.010 .XXX ±.005 .XXXX ±.001 ANGLES ± 1°
MATERIAL
FINISH
DO NOT SCALE DRAWING

CONTRACT NO.

NAME	DATE
DRAWN BY: J. Atkin	5/29/97
DESIGNED BY:	
APPROVED BY:	
CHECKED BY:	

MODUTEK CORP.
6387 SAN IGNACIO AVENUE
SAN JOSE, CA. 95119 (408)362-2000

C1915a - 208VAC
Connection Diagram

FSCM NO. | DWG NO. C1915sch | REV A
SCALE: n/a | c1915sch | SHT 2 OF 2