FLUKE ®

Hart Scientific ®

9007

Portable Low Temperature Calibrator User's Guide

Rev. 582201 ENG

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Rev. 582201

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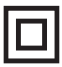
Figures and Tables

1 Before You Start

1.1 Symbols Used

Table 1 lists the International Electrical Symbols. Some or all of these symbols may be used on the instrument or in this manual.

Table1 *International Electrical Symbols*

Symbol	Description
	AC (Alternating Current)
	AC-DC
	Battery
	CE Complies with European Union Directives
	DC
	Double Insulated
	Electric Shock
	Fuse
	PE Ground
	Hot Surface (Burn Hazard)
	Read the User's Manual (Important Information)
	Off
	On

Symbol	Description
	Canadian Standards Association
CAT II	OVERVOLTAGE (Installation) CATEGORY II, Pollution Degree 2 per IEC1010-1 refers to the level of Impulse Withstand Voltage protection provided. Equipment of OVERVOLTAGE CATEGORY II is energy-consuming equipment to be supplied from the fixed installation. Examples include household, office, and laboratory appliances.
	C-TIC Australian EMC Mark
	The European Waste Electrical and Electronic Equipment (WEEE) Directive (2002/96/EC) mark.

1.2 Safety Information

Use this instrument only as specified in this manual. Otherwise, the protection provided by the instrument may be impaired. Refer to the safety information in the Warnings and Cautions sections below.

The following definitions apply to the terms "Warning" and "Caution".

- "Warning" identifies conditions and actions that may pose hazards to the user.
- "Caution" identifies conditions and actions that may damage the instrument being used.

1.2.1 ⚠ Warnings

To avoid personal injury, follow these guidelines.

GENERAL

- **DO NOT** use this instrument in environments other than those listed in the User's Guide.
- Inspect the instrument for damage before each use. **DO NOT** use the instrument if it appears damaged or operates abnormally.
- Follow all safety guidelines listed in the user's manual.
- Calibration Equipment should only be used by Trained Personnel.
- If this equipment is used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired.
- Before initial use, or after transport, or after storage in humid or semi-humid environments, or anytime the dry-well has not been energized for more than 10 days, the instrument needs to be energized for a "dry-out" period of 2 hours before it can be assumed to meet all of the safety re-

quirements of the IEC 1010-1. If the product is wet or has been in a wet environment, take necessary measures to remove moisture prior to applying power such as storage in a low humidity temperature chamber operating at 50°C for 4 hours or more.

- **DO NOT** use this instrument for any application other than calibration work. The instrument was designed for temperature calibration. Any other use of the instrument may cause unknown hazards to the user.
- Completely **unattended operation is not recommended.**
- Overhead clearance is required. **DO NOT** place the instrument under a cabinet or other structure. Always leave enough clearance to allow for safe and easy insertion and removal of probes.
- If the instrument is used in a manner not in accordance with the equipment design, the operation of the dry-well may be impaired or safety hazards may arise.
- This instrument is intended for indoor use only.

BURN HAZARDS

- **DO NOT** turn the instrument upside down with the inserts in place; the inserts will fall out.
- **DO NOT** operate near flammable materials.
- Use of this instrument at **HIGH TEMPERATURES** for extended periods of time requires caution.
- **DO NOT** touch the well access surface of the instrument.
- The block vent may be very hot due to the fan blowing across the heater block of the dry-well.
- The temperature of the well access is the same as the actual display temperature, e.g. if the instrument is set to 140°C and the display reads 140°C, the well is at 140°C.
- For top loading dry-wells, the top sheet metal of the dry-well may exhibit extreme temperatures for areas close to the well access.
- The air over the well can reach temperatures greater that 200°C for high temperature (400°C and higher) dry-wells. **Note:** Probes and inserts may be hot and should only be inserted and removed from the instrument when the instrument is set at temperatures less than 50°C. Use extreme care when removing hot inserts.
- **DO NOT** turn off the instrument at temperatures higher than 100°C. This could create a hazardous situation. Select a set-point less than 100°C and allow the instrument to cool before turning it off.
- The high temperatures present in dry-wells designed for operation at 300°C and higher may result in fires and severe burns if safety precautions are not observed.

ELECTRICAL SHOCK

- These guidelines must be followed to ensure that the safety mechanisms in this instrument will operate properly. This instrument must be plugged into a 115 VAC, 60Hz (230 VAC, 50Hz optional), AC only electric outlet. The power cord of the instrument is equipped with a three-pronged grounding plug for your protection against electrical shock hazards. It must be plugged directly into a properly grounded three-prong receptacle. The receptacle must be installed in accordance with local codes and ordinances. Consult a qualified electrician. **DO NOT** use an extension cord or adapter plug.
- If supplied with user accessible fuses, always replace the fuse with one of the same rating, voltage, and type.
- Always replace the power cord with an approved cord of the correct rating and type.
- **HIGH VOLTAGE** is used in the operation of this equipment. **SEVERE INJURY** or DEATH may result if personnel fail to observe safety precautions. Before working inside the equipment, turn power off and disconnect power cord.

1.2.2 ⚠ Cautions

- Always operate this instrument at room temperature between 41°F and 122°F (5°C to 50°C). Allow sufficient air circulation by leaving at least 6 inches (15 cm) of clearance around the instrument.
- Component lifetime can be shortened by continuous high temperature operation.
- **DO NOT** apply any type of voltage to the display hold terminals. Applying a voltage to the terminals may cause damage to the controller.
- **DO NOT** use fluids to clean out the well. Fluids could leak into electronics and damage the instrument.
- **Never introduce any foreign material** into the probe hole of the insert. Fluids, etc. can leak into the instrument causing damage.
- **DO NOT** change the values of the calibration constants from the factory set values. The correct setting of these parameters is important to the safety and proper operation of the calibrator.
- **DO NOT** slam the probe sheath in to the well. This type of action can cause a shock to the sensor and affect the calibration.
- The instrument and any thermometer probes used with it are sensitive instruments that can be easily damaged. Always handle these devices with care. **DO NOT** allow them to be dropped, struck, stressed, or overheated.
- The Factory Reset Sequence (see Section 11, Troubleshooting) should be performed only by authorized personnel if no other action is successful in correcting a malfunction. You must have a copy of the most recent Report of Calibration to restore the calibration parameters.

- **DO NOT** operate this instrument in an excessively wet, oily, dusty, or dirty environment. Always keep the well and inserts clean and clear of foreign material.
- The dry-well is a precision instrument. Although it has been designed for optimum durability and trouble free operation, it must be handled with care. Always carry the instrument in an upright position to prevent the probe sleeves from dropping out. The convenient handle allows for hand carrying the instrument.
- If a mains supply power fluctuation occurs, immediately turn off the instrument. Power bumps from brown-outs could damage the instrument. Wait until the power has stabilized before re-energizing the instrument.
- Allow for probe expansion inside the well as the block heats.
- Most probes have handle temperature limits. Be sure that the probe handle temperature limit is not exceeded in the air above the instrument.

1.3 Authorized Service Centers

Please contact one of the following authorized Service Centers to coordinate service on your Hart product:

Fluke, Hart Scientific Division

799 E. Utah Valley Drive
American Fork, UT 84003-9775
USA

Phone: +1.801.763.1600
Telefax: +1.801.763.1010
E-mail: support@hartscientific.com

Fluke Nederland B.V.

Customer Support Services
Science Park Eindhoven 5108
5692 EC Son
NETHERLANDS

Phone: +31-402-675300
Telefax: +31-402-675321
E-mail: ServiceDesk@fluke.nl

Fluke Int'l Corporation

Service Center - Instrimpex

Room 2301 Sciteck Tower
22 Jianguomenwai Dajie
Chao Yang District
Beijing 100004, PRC
CHINA

Phone: +86-10-6-512-3436
Telefax: +86-10-6-512-3437
E-mail: xingye.han@fluke.com.cn

Fluke South East Asia Pte Ltd.
Fluke ASEAN Regional Office
Service Center
60 Alexandra Terrace #03-16
The Comtech (Lobby D)
118502
SINGAPORE

Phone: +65 6799-5588
Telefax: +65 6799-5588
E-mail: antng@singa.fluke.com

When contacting these Service Centers for support, please have the following information available:

- Model Number
- Serial Number
- Voltage
- Complete description of the problem

2 Introduction

The Fluke Corporation, Hart Scientific Division 9007 Portable Low Temperature Calibrator (PLTC) contains two calibration zones and may be used as a portable instrument or bench top temperature calibrator for calibration of thermocouples, RTDs, and other temperature devices. The LED display indicates which zone is being used. The 9007 is built into an enclosure designed to meet the requirements of MIL-T-28800. Calibrations may be done over a range of –40 to 140°C. The temperature display and setability resolution are 0.01 degrees.

The PLTC features:

- Rapid heating and cooling
- Interchangeable aluminum probe heat transfer blocks
- Removable lid
- RS-232 and IEEE-488 interface capability

Built in programmable features include:

- Dual zone calibration depth control
- Ramp and soak
- Temperature scan rate control
- Temperature switch hold
- Eight set-point memory
- Adjustable readout in °C or °F

Hart's hybrid analog/digital controller with serial and IEEE-488 ports accurately controls the temperature. The controller uses a precision platinum RTD as a sensor and controls the well temperature with TEDs.

The LED front panel continuously shows the current well temperature. The temperature may be easily set with the control buttons to any desired temperature within the specified range. The calibrator's multiple fault protection devices insure user and instrument safety and protection.

The 9007 PLTC was designed for portability, moderate cost, and ease of operation. Through proper use the instrument should provide continued accurate calibration of temperature sensors and devices. The user should be familiar with the safety guidelines and operating procedures of the calibrator as described in the user's guide.

3 Specifications and Environmental Conditions

3.1 Specifications

Temperature Range	–40°C to 140°C (–40°F to 284°F) with ¼" probe at 25°C ambient
Ambient Range	5–50°C (40–120°F)
Accuracy	±0.15°C (±0.27°F) at 6 inches, ±0.15°C (±0.27°F) at 3 inches
Stability (2-sigma)	±0.02°C (±0.036°F) at 6 inches, ±0.04°C (±0.072°F) at 3 inches
Display Resolution	0.01°C or °F
Heating	Thermoelectric device (TED)
Cooling	Fan, TED
Test Wells	3/4" dia. x 6" deep (various diameter probe heat transfer blocks available)
Controller	Hybrid analog/digital controller with data retention
Power	115 VAC (±10%), 5 A or 230 VAC (±10%), 2.4 A, switchable, 50/60 Hz, 560 Watts
Size	13.8" H x 10.8" W x 16.9" D (351 x 274 x 429 mm)
Weight	36 lb. including heat transfer blocks
Safety	OVER VOLTAGE (Installation) CATEGORY II, Pollution Degree 2 per IEC 1010-1
Fault Protection	Sensor burnout protection, over temperature thermal cut-out, electrical fuse
Fuses	115 V: 4 AT 250 V 230 V:: 3.15 AT 250 V

3.2 Environmental Conditions

Although the instrument has been designed for optimum durability and trouble-free operation, it must be handled with care. The instrument should not be operated in an excessively dusty or dirty environment. Maintenance and cleaning recommendations can be found in the Maintenance Section of this manual.

The instrument operates safely under the following conditions:

- temperature range: 1–50°C (34–122°F)
- pressure: 75kPa–106kPa
- mains voltage within ±10% of nominal
- vibrations in the calibration environment should be minimized
- altitudes less than 2,000 meters

- indoor use only

3.3 Warranty

Hart Scientific, Inc. (Hart) warrants this product to be free from defects in material and workmanship under normal use and service for a period as stated in our current product catalog from the date of shipment. This warranty extends only to the original purchaser and shall not apply to any product which, in Hart's sole opinion, has been subject to misuse, alteration, abuse or abnormal conditions of operation or handling.

Software is warranted to operate in accordance with its programmed instructions on appropriate Hart products. It is not warranted to be error free.

Hart's obligation under this warranty is limited to repair or replacement of a product that is returned to Hart within the warranty period and is determined, upon examination by Hart, to be defective. If Hart determines that the defect or malfunction has been caused by misuse, alteration, abuse or abnormal conditions or operation or handling, Hart will repair the product and bill the purchaser for the reasonable cost of repair.

To exercise this warranty, the purchaser must forward the product after calling or writing a Hart Scientific Authorized Service Center (see Section 1.3) for authorization. The Service Center assumes NO risk for in-transit damage.

THE FOREGOING WARRANTY IS PURCHASER'S SOLE AND EXCLUSIVE REMEDY AND IS IN LIEU OF ALL OTHER WARRANTIES, EXPRESS OR IMPLIED, INCLUDING BUT NOT LIMITED TO ANY IMPLIED WARRANTY OR MERCHANTABILITY, OR FITNESS FOR ANY PARTICULAR PURPOSE OR USE. HART SHALL NOT BE LIABLE FOR ANY SPECIAL, INDIRECT, INCIDENTAL, OR CONSEQUENTIAL DAMAGES OR LOSS WHETHER IN CONTRACT, TORT, OR OTHERWISE.

4 Quick Start

4.1 Unpacking

Unpack the PLTC carefully and inspect it for any damage that may have occurred during shipment. If there is shipping damage, notify the carrier immediately.

Verify that the following components are present:

- 9007 Portable Low Temperature Calibrator
- Heat transfer blocks having the following diameters: 1/4", 3/8", 7/16", 9/16"
- Heat transfer blocks to calibrate thermometers specified in MIL-T-17244 and MIL-T-19646
- Heat transfer block compatible with Rosemount Model 162CE PRT (.219")
- Probe/well insulation having the following diameters: .20", .37", .55" (2 ea.)
- Removable heat transfer block tool (tongs) (2 ea)
- Power Cord
- User’s Guide
- Calibration Procedure Guide
- RS-232 Cable
- Calipers

4.2 Set-up

Place the calibrator on a flat surface with at least 12 inches of free space above the instrument. Depress the breather valve and remove the lid. Plug the power cord into a grounded mains outlet. Observe that the nominal voltage corresponds to that indicated on the top panel of the calibrator.

Carefully insert the probe heat transfer block into the well. Probe heat transfer blocks should be of the smallest hole diameter possible still allowing the probe to slide in and out easily. Heat transfer blocks of various sizes are available from Hart Scientific. The well must be clear of any foreign objects, dirt and grit before the heat transfer block is inserted. The heat transfer block is inserted with the two small tong holes positioned upward.

Turn on the power to the calibrator by toggling the power switch on. The fan should begin quietly blowing air through the instrument and the controller display should illuminate after 3 seconds. After a brief self test the controller should begin normal operation. If the unit fails to operate please check the power connection.

The display begins to show the well temperature and the heater starts operating to bring the temperature of the well to the set-point temperature.

Note: Before turning the power off, set the unit to 25°C and allow the unit to cool below 100°C.

4.3 Power

Remove the lid and plug the PLTC power cord into a mains outlet of the proper voltage, frequency, and current capability. Refer to Section 3.1, Specifications, for power details. Turn the PLTC on using the top panel "POWER" switch. The PLTC begins to heat to the previously programmed temperature set-point. The top panel LED display indicates the actual PLTC temperature.

4.4 Setting the Temperature

Section 6.3 explains in detail how to set the temperature set-point on the calibrator using the front panel keys. The procedure is summarized here.

1. Press "SET" three times to access the set-point value.
2. Press "UP" or "DOWN" to change the set-point value.
3. Press "SET" to program in the new set-point.
4. Press "EXIT" to return to the temperature display.

When the set-point temperature is changed the controller switches the well heater on or off to raise or lower the temperature. The displayed well temperature gradually changes until it reaches the set-point temperature. The well may require 20 minutes to reach the set-point depending on the span. Another 5 to 10 minutes is required to stabilize within ±0.1°C of the set-point. Ultimate stability may take 15 to 20 minutes more of stabilization time.

4.5 Changing Display Units

The 9007 displays temperature in Celsius or Fahrenheit. The temperature units are shipped from the factory set to Celsius. To change to Fahrenheit or back to Celsius perform one of the following set steps:

1. Press the "SET" button four times.
2. Press the "UP" or "DOWN" buttons to change the units.
3. Press the "SET" button to store the change.

Or

1. Press the "SET" and "EXIT" button simultaneously.
2. Press the "SET" button four times.
3. Press the "UP" button.

4. Press the “SET” button to display the units.
5. Press the “SET” button to adjust the units.
6. Press the “UP” or “DOWN” buttons to change the units.
7. Press the “SET” button to store the change.

5 Parts and Controls

The user should become familiar with the PLTC and its parts as discussed in the following sections. A detailed list of subassemblies and parts are located in Appendix A. Refer to Appendix B for component identification and Appendix C for detailed schematics.

5.1 Top Panel

The top panel is shown in Figure 1 on page 16 and consists of the controller display, controller keypad, power switch, power indicator, ready indicator, serial port, IEEE-488 port, display hold terminals, calibration label, serial label, and heat transfer blocks.

1) **Controller Display** - The digital display is an important part of the temperature controller because it not only displays set and actual temperatures but also displays various calibrator functions, settings, and constants. The display shows temperatures in units according to the selected scale °C or °F.

2) **Controller Keypad** - The four button keypad allows easy setting of the set-point temperature. The control buttons (SET, DOWN, UP, and EXIT) are used to set the calibrator temperature set-point, to access and set other operating parameters, and to access and set calibration parameters.

Setting the control temperature is done directly in degrees of the current scale. The control temperature can be set to one-hundredth of a degree C or F.

The functions of the buttons are as follows:

SET - Used to display the next parameter in the menu and to set parameters to the displayed value.

DOWN - Used to decrement the displayed value of parameters.

UP - Used to increment the displayed value.

EXIT - Used to exit from a menu. When EXIT is pressed any changes made to the displayed value will be ignored.

3) **Power Switch** - The power switch is located on the power entry module (PEM) which also houses the fuse and voltage selector.

4) **Power Indicator** - This LED indicator shows that power is being applied to the unit.

5) **Ready Indicator** - This green indicator illuminates when the unit under test (UUT) has stabilized and the probe is ready for a reading to be taken.

6) **Serial Port** - A DB-9 connector is present for interfacing the calibrator to a computer or terminal with serial RS-232 communications.

7) **IEEE-488 Port** - This connector is for interfacing the calibrator to an IEEE-488 (GPIB) bus for control and communications.

8) **Display Hold** - The two terminals may be used to wire a switch or cut-out to the calibrator to trigger the instrument and to freeze the displayed well temperature.

9) **Calibration Label** - The calibration label contains the serial number of the instrument, the date calibrated, and the recalibration date.

10) **Serial Label** - The serial label contains the name of the manufacturer, the manufacturer's address, model number, and serial number.

Note: The warranty label and contract label are on the front of the bottom portion of the instrument. The voltage label and a second contract label are on the back of the bottom portion of the instrument.

11) **Heat Transfer Blocks** - The calibrator is supplied with several aluminum heat transfer blocks for insertion into the calibrator well and tongs for removing heat transfer blocks. Heat transfer blocks of various internal hole sizes are available (see Table 2) to allow the user's probe to fit snugly into the well what-

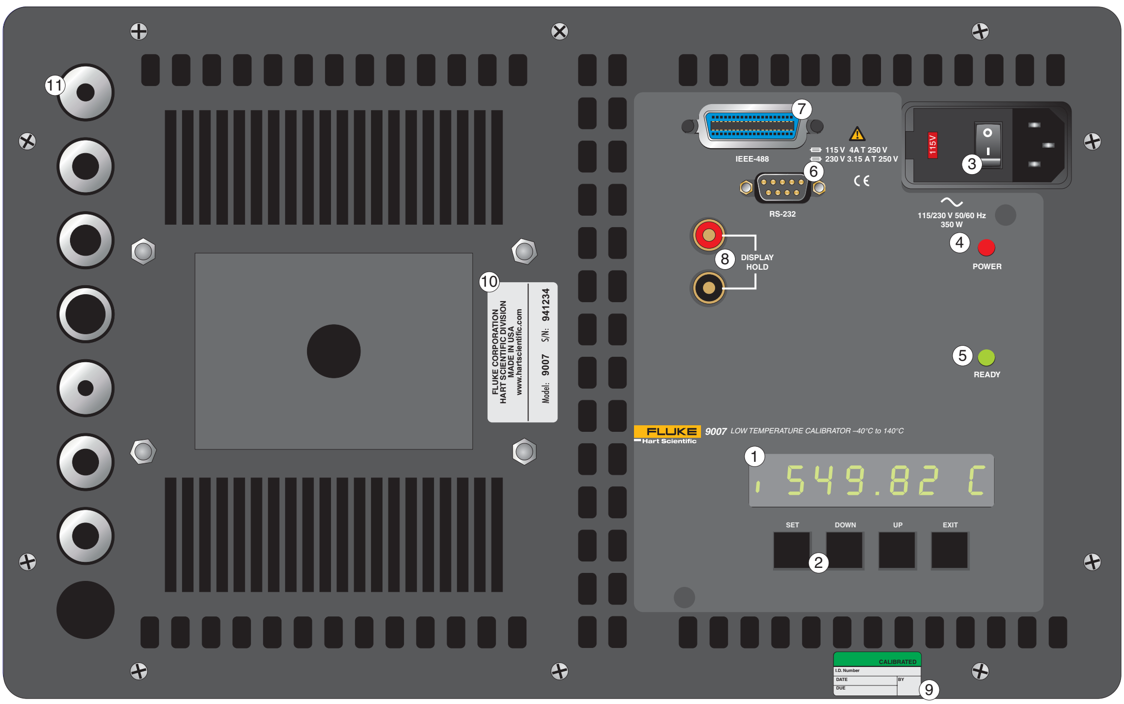


Figure 1 *Top Panel, Lid Removed*

ever the diameter of the probe. **Note:** Use the probe/well insulation of the appropriate size.

Table 2 Probe Heat Transfer Blocks

Model Number	Size
3107-2250	1/4 " heat transfer block
3107-2375	3/8 " heat transfer block
3107-2437	7/16 " heat transfer block
3107-2563	9/16 " heat transfer block
3107-2219	162CE heat transfer block (.219")
3107-2CS3	MIL-T-17244 heat transfer block (3/8" probe x 3")
3107-2CS5	MIL-T-19646 heat transfer block (3/8" probe x 5")

5.2 Lid

The 9007 has a removable lid. The lid contains the manuals, power cord, RS-232 cable, calipers, tongs, probe/well insulation, and rack for heat transfer blocks. Prior to removing the lid, depress the breather valve.

5.3 Internal Parts

5.3.1 Fans

The two fans inside the calibrator run continuously when the unit is being operated to provide cooling for the instrument and heat transfer blocks. Slots at the top of the calibrator are provided for airflow. The air is directed upward.

5.3.2 Constant Temperature Block Assembly

The constant temperature block assembly is made of aluminum and provides a relatively constant and accurate temperature environment in which the sensor to be calibrated is inserted. A 3/4-inch diameter well is provided that may be used for sensors of that size or may be sized down with various sized probe heat transfer blocks. TEDs surround the block and provide even heating and cooling to the sensor. A platinum RTD is imbedded to sense the temperature of the block. The entire assembly is suspended in an air cooled chamber thermally isolated from the chassis and electronics.

6 Controller Operation

This section discusses in detail how to operate the PLTC temperature controller using the front control panel. Using the front panel key switches and LED display the user may monitor the PLTC temperature, set the temperature set-point in degrees C or F, monitor the output power, adjust the controller proportional band, set the cut-out set-point, and program the probe calibration parameters, operating parameters, serial and IEEE-488 interface configuration, and controller calibration parameters. Controller operation is summarized in Figure 2 on page 20.

6.1 Well Temperature

The digital LED display on the top panel allows direct viewing of the actual PLTC temperature. This temperature value is what is normally shown on the display. The units, C or F, of the temperature value are displayed at the right. The bar to the left of the temperature value indicates depth. If the bar is in the lower left corner, the depth is six inches. If the bar is in the upper left corner, the depth is three inches.

35.00 C	*PLTC temperature in degrees Celsius at 6" depth*

The temperature display function may be accessed from any other function by pressing the “EXIT” button.

6.2 Reset Cut-out

If the overtemperature cut-out has been triggered, then the temperature display alternately flashes,

cut-out	*Indicates cut-out condition*

The message continues to flash until the temperature is reduced and the cut-out is reset.

The cut-out has two modes - automatic reset and manual reset. The mode determines how the cut-out is reset which allows the PLTC to heat up again. When in automatic mode, the cut-out resets itself as soon as the temperature is lowered below the cut-out set-point. With manual reset mode the cut-out must be reset by the operator after the temperature falls below the set-point.

When the cut-out is active and the cut-out mode is set to manual (“reset”) then the display flashes “cut-out” until the user resets the cut-out. To access the reset cut-out function press the “SET” button.

SET	*Access cut-out reset function*

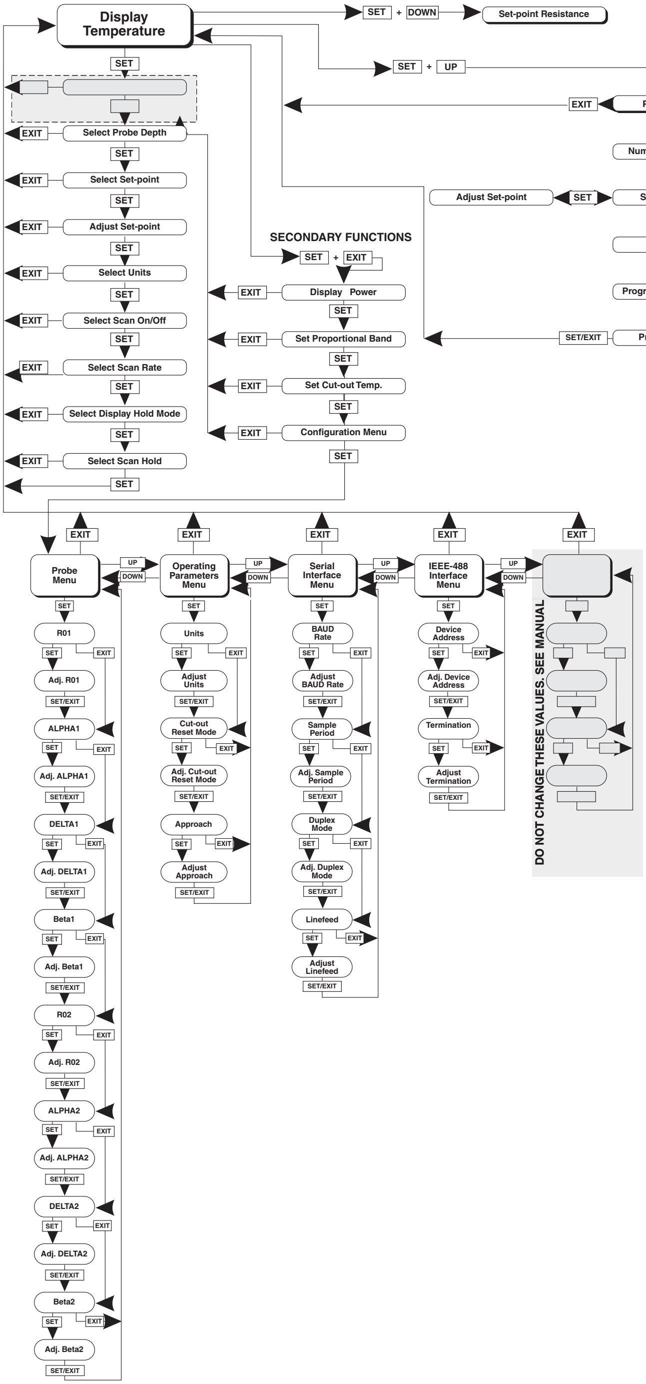


Figure 2 *Controller Operation Flowchart*

The display indicates the reset function.

`rESEt ?` *Cut-out reset function*

Press “SET” once more to reset the cut-out.

[SET] *Reset cut-out*

This also switches the display to the set temperature function. To return to the temperature display, press the “EXIT” button. If the cut-out is still in the over temperature fault condition the display continues to flash “cut-out”. The PLTC temperature must drop a few degrees below the cut-out set-point before the cut-out can be reset.

6.3 Temperature Set-point

The temperature set-point can be set to any value within the range and with resolution as given in the specifications. Be careful not to exceed the safe upper temperature limit of any device inserted into the well. The safety cut-out temperature should be properly adjusted to help prevent this occurrence.

Setting the PLTC temperature involves three steps: (1) selecting the depth of the sensor, (2) selecting the set-point memory, and (3) adjusting the set-point value.

6.3.1 Sensor Depth

The controller has two depths, six inches and three inches. The two depths are provided to reduce the effect of temperature gradients in the heated well. Select the depth that closely matches the length of immersion on the sensor to be calibrated.

To set the temperature, first select the depth of the sensor. This function is accessed from the temperature display function by pressing “SET”. The depth of the sensor is indicated to the left of the display. The six-inch depth is indicated by a small bar on the lower left corner and the three-inch depth is indicated by a small bar on the upper left corner.

`| 35.00 C` *Well temperature in degrees Celsius at 6" depth*

[SET] *Access depth of sensor*

`SnSr=6"` *Sensor is set to 6 inches from the heat transfer block*

To change the sensor depth press “UP” or “DOWN”.

SnSr=3"	*Sensor is set to 3 inches from the heat transfer block*

Press "SET" to accept the new sensor depth and to select the set-point memory.

SET	*Accept selected set-point memory*

6.3.2 Programmable Set-points

The controller stores 8 set-point temperatures in memory. The set-points can be quickly recalled to conveniently set the PLTC to a previously programmed temperature set-point.

The set-point memory may be selected after setting the sensor depth. The number of the set-point memory currently being used is shown at the left on the display followed by the current set-point value.

SnSr=3	*Sensor depth*
SET	*Access set-point memory*
1. 25.0	*Set-point memory 1, 25.00°C currently used*

To change the set-point memory press "UP" or "DOWN".

4. 40.0	*New set-point memory 4, 40.00°C*

Press "SET" to accept the new selection and access the set-point value.

SET	*Accept selected set-point memory*

6.3.3 Set-point Value

The set-point value may be adjusted after selecting the set-point memory and pressing "SET". The set-point value is displayed with the units, C or F, at the left.

C 40.00	*Set-point 4 value in °C*

Press "UP" or "DOWN" to adjust the set-point value.

C 42.50	*New set-point value*

When the desired set-point value is reached press "SET" to accept the new value and access the temperature scale units selection. Press "EXIT" to exit without changing any values.

SET — *Accept new set-point value*

6.3.4 Temperature Scale Units

The temperature scale units of the controller maybe set by the user to degrees Celsius (°C) or Fahrenheit (°F). The units are used in displaying the well temperature, set-point, and proportional band.

Press “SET” after adjusting the set-point value to change display units.

`Un=C` *Scale units currently selected*

Press “UP” or “DOWN” to change the units.

`Un=F` *New units selected*

Press “SET” to accept the present setting and to continue

6.4 Scan

The scan rate can be set and enabled so that when the set-point is changed the PLTC heats or cools at a specified rate (degrees per minute) until it reaches the new set-point. With the scan disabled the PLTC heats or cools at the maximum possible rate.

6.4.1 Scan Control

The scan is controlled with the scan on/off function that appears in the main menu after the set-point function.

`ScAn=OFF` *Scan function off*

Press “UP” or “DOWN” to toggle the scan on or off.

`ScAn=On` *Scan function on*

Press “SET” to accept the present setting and continue.

SET — *Accept scan setting*

6.4.2 Scan Rate

The next function in the main menu is the scan rate. The scan rate can be set from .1 to 100 °C/min. The maximum scan rate, however, is actually limited by the natural heating or cooling rate of the instrument. This is often less than 100 °C/min, especially when cooling.

The scan rate function appears in the main menu after the scan control function. The scan rate units are in degrees C or F per minute, depending on the selected units.

`Sr= 10.0` *Scan rate in °C/min*

Press "UP" or "DOWN" to change the scan rate.

`Sr= 2.0` *New scan rate*

Press "SET" to accept the new scan rate and continue.

[SET] *Accept scan rate*

6.5 Temperature Display Hold

The 9007 has a display hold function which allows action of an external switch to freeze the displayed temperature and stop the set-point from scanning. This feature is useful for testing thermal switches and cut-outs. This section explains the functions available for operating the Temperature Hold feature. An example follows showing how to set up and use the hold feature to test a switch.

6.5.1 Hold Temperature Display

The hold temperature display shows the hold temperature on the right and the switch status on the left. The status "c" means the switch is closed and "o" means the switch is open. The status flashes when the switch is in its active position (opposite the normal position). The hold temperature shows what the temperature of the well was when the switch changed from its normal position to its active position. While the switch is in the normal position the hold temperature follows the well temperature. When the hold feature is enabled you can easily switch the display between the normal temperature display and the hold temperature display by simply pressing the "UP" or "DOWN" buttons.

Operation of the hold temperature requires:

- Scan Control to be on (see Section 6.4.1).
- Hold Mode to be either automatic, normally closed, or normally opened (see Section 6.5.2).
- Scan Hold to be on (see Section 6.5.3).

6.5.2 Mode Setting

The temperature hold feature has three modes of operation; normally closed, normally opened, and automatic. In the normally-closed (n.c.) mode the hold temperature display freezes when the switch opens. In the normally-open (n.o.) mode the hold temperature display freezes when the switch closes. Whenever the switch is in the normal position the hold temperature follows the well temperature.

In automatic mode the normal position is set to whatever the switch position is when the set-point is changed. For example, if the switch is currently open when the set-point is changed, the closed position then becomes the new active position. The normal position is set automatically under any of the following conditions:

- A new set-point number is selected.
- The set-point value is changed.
- A new set-point is set through the communications channels.
- The ramp-and-soak program is running and automatically steps to the next set-point in the sequence.

The automatic mode is useful for repetitive tests of the opening and closing temperatures of a switch.

The operating mode of the temperature hold is set in the primary menu after the scan rate setting.

`HoLd=OFF` *Hold mode set to off*

To change the mode press “UP” or “DOWN”.

`HoLd=Aut` *Automatic mode*

`HoLd=n.c.` *Normally closed mode*

`HoLd=n.o.` *Normally open mode*

Press “SET” to accept the displayed setting.

6.5.3 Scan Hold

In addition to controlling the hold temperature display, a switch can also control set-point scanning by enabling the scan hold function. When the switch changes from normal position to active position scanning stops. For the scan hold to be effective scanning must be enabled and the scan rate should be set to a relatively low value (see Sections 6.4.1 and 6.4.2).

The scan hold is set in the primary menu after the temperature hold mode setting.

`SHoLd=OF` *Scan hold set to off*

To change the mode press “UP” or “DOWN”.

`SHoLd=On` *Scan hold set to on*

Press "SET" to accept the displayed setting.

6.5.4 Switch Wiring

The thermal switch or cut-out is wired to the calibrator at the two terminals on the top panel of the PLTC labeled "DISPLAY HOLD". The switch wires may be connected to the terminals either way. Internally the black terminal connects to ground. The red terminal connects to +5V through a 10 kΩ resistor. The calibrator measures the voltage at the red terminal and interprets +5V as open and 0V as closed.

6.5.5 Switch Test Example

This section describes a possible application for the temperature hold feature and how the instrument is set up and operated.

Suppose you have a thermal switch that is supposed to open at about 75°C and close at about 50°C and you want to test the switch for accuracy and repeatability. You can use the temperature hold feature and the ramp and soak feature (described in detail in the Section 6.7) to test the switch. Measurements can be made by observing the display or, preferably, by collecting data using a printer or computer connected to the RS-232 or IEEE-488 port. To set up the test perform the following steps.

1. Connect the switch wires to the terminals on the top panel of the PLTC and place the switch in the well.
2. Enable set-point scanning by setting the scan to "ON" in the primary menu (see Section 6.4.1).
3. Set the scan rate to a low value, say 1.0°C/min.(see Section 6.4.2). If the scan rate is too high you may lose accuracy because of transient temperature gradients. If the scan rate is too low the duration of the test may be longer than is necessary. You may need to experiment to find the best scan rate.
4. Set the hold mode to automatic (see Section 6.5.2).
5. Set the scan hold to "ON" (see Section 6.5.3).
6. Set the number of program set-points to 2 in the program menu (see Section 6.7.1).
7. Set the first program set-point to a value below the expected lower switch temperature, say 40°C, in the program menu (see Section 6.7.2).
8. Set the second program set-point to a value above the expected upper switch temperature, say 90°C.
9. Set the program soak time to allow enough time to collect a number of data points, say 2 minutes (see Section6.7.3).

10. Set the program function to mode 4 so that the instrument will cycle between the 2 set-points repeatedly. (See Section6.7.4.)
11. Start the program (see Section6.7.5).
12. Collect data on a computer connected to the RS-232 or IEEE-488 port. Refer to Section7 for instructions on configuring the RS-232 and IEEE-488 communications interface. The data may appear as shown in Figure 3. The maxima and minima are the switch temperatures.

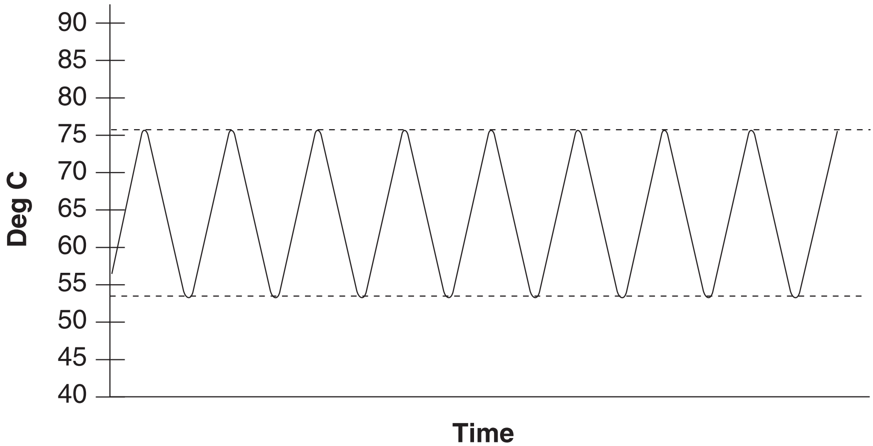


Figure 3 *Switch Test Data*

6.6 Set-point Resistance

The set-point resistance is the resistance the instrument is trying to make the control sensor achieve and is calculated in the firmware using the set-point temperature. This value is not directly adjustable but is recalculated when the set-point temperature is changed. The set-point resistance is used to perform a calibration adjustment using the Callendar-Van Dusen R versus T curve fit. The instrument must be at temperature and stable prior to taking the set-point resistance reading.

To display the Set-point Resistance, press “SET” and “DOWN” simultaneously when the temperature is displayed. When the “SET” and “DOWN” buttons are released the temperature is again displayed.

99.222	*Current set-point resistance setting is displayed*

6.7 Ramp and Soak Program

The ramp and soak program feature of the 9007 allows the user to program a number of set-points and have the PLTC automatically cycle between the temperatures, holding at each for a determined length of time. The user can select one of four different cycle functions.

The program parameter menu is accessed by pressing "SET" and then "UP".

`I 100.00 C` *Well temperature at 6" depth*

SET + UP *Access program menu*

`ProG` *Program menu*

Press "SET" to enter the program menu

SET *Enter program menu*

6.7.1 Number of Program Set-points

The first parameter in the program menu is the number of set-points to cycle through. Up to 8 set-points can be used in a ramp and soak program.

`Pn=8` *Number of program set-points*

Use the "UP" or "DOWN" buttons to change the number from 2 to 8.

`Pn=3` *New number of program set-points*

Press "SET" to continue. Press "EXIT" to ignore any changes and to continue.

SET *Save new setting*

6.7.2 Set-points

The next parameters are the program set-points.

`1 50.0` *First set-point*

Use the "UP" or "DOWN" buttons to select any of the set-points.

`3 30.0` *Third set-point*

Press "SET" to be able to change the set-point.

`C 30.00` *Set-point value*

Use “UP” and “DOWN” to change the set-point value.

`C 40.00` *New set-point value*

Press “SET” to save the new set-point value.

The other set-points can also be set in the same manner. Once the set-points are programmed as desired press “EXIT” to continue.

[EXIT] *Continue to next menu function*

6.7.3 Program Soak Time

The next parameter in the program menu is the soak time. This is the time, in minutes, that each program set-point is maintained after settling before proceeding to the next set-point. The duration is counted from the time the temperature settles to within a specified stability.

`Pt=15` *Soak time in minutes*

Use the “UP” or “DOWN” buttons to change the time.

`Pt=5` *New soak time*

Press “SET” to continue.

[SET] *Save new setting*

6.7.4 Program Function Mode

The next parameter is the program function or cycle mode. There are four possible modes which determine whether the program scans up (from set-point 1 to n) only or both up and down (from set-point n to 1), and also whether the program stops after one cycle or repeats the cycle indefinitely. Table 3 below shows the action of each of the four program mode settings.

Table 3 *Program Mode Setting Actions*

Function	Action
1	up-stop
2	up-down-stop
3	up-repeat
4	up-down-repeat

PF=1 *Program mode*

Use the "UP" or "DOWN" buttons to change the mode.

PF=4 *New mode*

Press "SET" to continue.

SET *Enter program menu*

6.7.5 Program Control

The final parameter in the program menu is the control parameter. You may choose between three options to either start the program from the beginning, continue the program from where it was when it was stopped, or stop the program.

Pr=OFF *Program presently off*

Use the "UP" or "DOWN" buttons to change the status.

Pr=StArt *Start cycle from beginning*

Press "SET" to activate the new program control command and return to the temperature display.

SET *Activate new command*

6.8 Secondary Menu

Functions, which are used less often, are accessed within the secondary menu. The secondary menu is accessed by pressing “SET” and “EXIT” simultaneously and then releasing. The first function in the secondary menu is the heater power display.

6.9 Heating/Cooling Power

The temperature controller controls the temperature of the well by sending a linear DC voltage to the TEDs. The total power being applied to the TEDs is determined by the duty cycle or the ratio of TED on time to the pulse cycle time. By knowing the amount of heating the user can tell if the calibrator is heating up to the set-point, cooling down, or controlling at a constant temperature. Monitoring the percent heater power lets the user know the stability of the well temperature.

The heating/cooling power display is accessed in the secondary menu. Press “SET” and “EXIT” simultaneously and release. The heating/cooling power is displayed as a percentage of full power.

100.00C	*Well temperature at 6" depth*
SET + EXIT	*Access heating/cooling power in secondary menu*
SEC	*Flaches "SEC" for secondary menu*
12 Pct	*Heating/cooling power in percent*

To exit out of the secondary menu press “EXIT”. To continue on to the proportional band setting function press “SET”.

6.10 Proportional Band

In a proportional controller such as this the heater output power is proportional to the well temperature over a limited range of temperatures around the set-point. This range of temperature is called the proportional band. At the bottom of the proportional band the heater output is 100%. At the top of the proportional band the heater output is 0. Thus as the temperature rises the heater power is reduced, which consequently tends to lower the temperature back down. In this way the temperature is maintained at a fairly constant temperature.

The temperature stability of the well and response time depends on the width of the proportional band. See Figure 4. If the band is too wide the well temperature will deviate excessively from the set-point due to varying external conditions. This is because the power output changes very little with temperature and the controller cannot respond very well to changing conditions or noise in the system. If the proportional band is too narrow the temperature may swing back and forth because the controller overreacts to temperature variations. For best control stability the proportional band must be set for the optimum width.

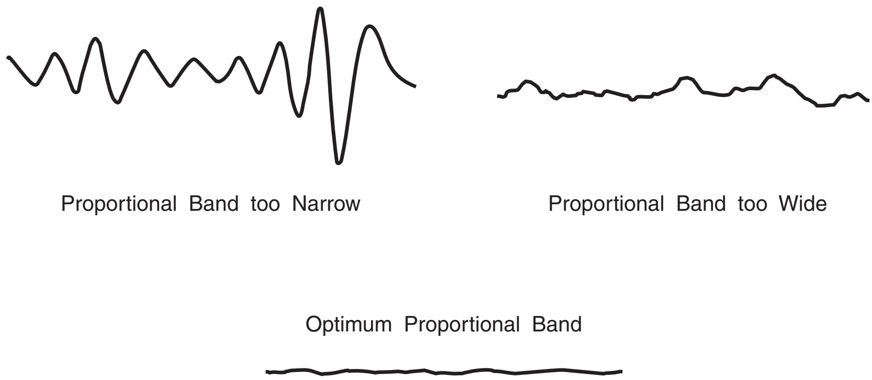


Figure 4 *Well Temperature Fluctuation at Various Proportional Band Settings*

The proportional bandwidth is set at the factory to about 8.0°C. The proportional band width may be altered by the user if he desires to optimize the control characteristics for a particular application.

The proportional bandwidth is easily adjusted from the front panel. The width may be set to discrete values in degrees C or F depending on the selected units. The proportional band adjustment is be accessed within the secondary menu. Press "SET" and "EXIT" to enter the secondary menu and show the heater power. Then press "SET" to access the proportional band.

SET + EXIT *Access heating/cooling power in secondary menu*

12 Pct *Heating/cooling power in percent*

SET *Access proportional band*

Pb= 14.1 C *Proportional band setting*

To change the proportional band press "UP" or "DOWN".

Pb=13.1 C *New proportional band setting*

To accept the new setting and access the cut-out set-point press “SET”. Press “EXIT” to exit the secondary menu ignoring any changes just made to the proportional band value.

SET *Accept the new proportional band setting*

6.11 Cut-out

As a protection against software or hardware fault, shorted transistor, or user error, the calibrator is equipped with an adjustable heater cut-out device that shuts off power to the thermoelectric devices if the well temperature exceeds a set value. This protects the instrument and probes from excessive temperatures. The cut-out temperature is programmable by the operator from the front panel of the controller.

If the cut-out is activated because of excessive well temperature, power to the heater is shut off and the instrument cools. The well cools until it reaches a few degrees below the cut-out set-point temperature. At this point the action of the cut-out is determined by the setting of the cut-out mode parameter. The cut-out has two modes - automatic reset or manual reset. If the mode is set to automatic, the cut-out automatically resets itself when the temperature falls below the reset temperature allowing the well to heat up again. If the mode is set to manual, the heater remains disabled until the user manually resets the cut-out.

The cut-out set-point may be accessed within the secondary menu. Press “SET” and “EXIT” to enter the secondary menu and show the heater power. Then press “SET” twice to access the cut-out set- point.

SET + EXIT *Access heating/cooling power in secondary menu*

`12 Pct` *Heating/cooling power in percent*

SET *Access proportional band*

`Pb= 14.1 C` *Proportional band setting*

SET *Access cut-out set-point*

`CO= 127C` *Cut-out set-point*

To change the cut-out set-point press “UP” or “DOWN”.

`CO= 122C` *New cut-out set-point*

To accept the new cut-out set-point press "SET".

SET *Accept cut-out set-point*

The next function is the configuration menu. Press "EXIT" to resume displaying the well temperature.

6.12 Controller Configuration

The controller has a number of configuration and operating options and calibration parameters, which are programmable via the front panel. These are accessed from the secondary menu after the cut-out set-point function by pressing "SET". There are 5 sets of configuration parameters - probe parameters, operating parameters, serial interface parameters, IEEE-488 interface parameters, and controller calibration parameters. The menus are selected using the "UP" and "DOWN" keys and then pressing "SET".

6.13 Probe Parameters

The probe parameter menu is indicated by,

PrObE *Probe parameters menu*

Press "SET" to enter the menu. The probe parameters menu contains the parameters, R0x, ALPHAx, DELTAx, and BETAx (where x=1 for six-inch sensor depth or 2 for three-inch sensor depth) which characterize the resistance-temperature relationship of the platinum control sensor. The first set of parameters, R01, ALPHA1, DELTA1, and BETA1 are for the six-inch sensor depth and the second set are for the three-inch sensor depth. These parameters may be adjusted to improve the accuracy of the calibrator. This procedure is explained in detail in the 9007 Portable High Temperature Calibrator Calibration Procedure Manual.

The probe parameters are accessed by pressing "SET" after the name of the parameter is displayed. The value of the parameter may be changed using the "UP" and "DOWN" buttons. After the desired value is reached press "SET" to set the parameter to the new value. Pressing "EXIT" causes the parameter to be skipped ignoring any changes that may have been made.

6.13.1 R0x

This probe parameter refers to the resistance of the control probe at 0°C. The value of this parameter is set at the factory for best instrument accuracy.

6.13.2 ALPHAx

This probe parameter refers to the average sensitivity of the probe between 0 and 100°C. The value of this parameter is set at the factory for best instrument accuracy.

6.13.3 DELTAx

This probe parameter characterizes the curvature of the relationship of the sensor. The value of this parameter is set at the factory for best instrument accuracy.

6.13.4 BETAx

This parameter relates to the higher order nonlinearity of the sensor below 0°C. The value is set at the factory for best instrument accuracy.

6.14 Operating Parameters

The operating parameters menu is indicated by,

PAr	*Operating parameters menu*

Press “UP” to enter the menu. The operating parameters menu contains the units scale setting, cut-out reset mode setting and approach setting.

6.14.1 Temperature Scale Units

The temperature scale units selection is the first function in the operating parameters menu.

The temperature scale units of the controller may be set by the user to degrees Celsius (°C) or Fahrenheit (°F). The units are used in displaying the well temperature, set-point, proportional band, and cut-out set-point.

Press "SET" to access the units.

SET	*Access units*

UnitS	*Units menu*

Press "SET" to change the units.

Un= C	*Scale units currently selected*

Press “UP” or “DOWN” to change the units.

Un= F	*New units selected*

Press "SET" to accept the new selection and resume displaying the well temperature.

6.14.2 Cut-out Reset Mode

The cut-out reset mode determines whether the cut-out resets automatically when the well temperature drops to a safe value or must be manually reset by the operator.

The parameter is indicated by,

CtorSt	*Cut-out reset mode parameter*

Press "SET" to access the parameter setting. Normally the cut-out is set for automatic mode.

Cto=Auto	*Cut-out set for automatic reset*

To change to manual reset mode press "UP" and then "SET".

Cto=rSt	*Cut-out set for manual reset*

6.14.3 Approach

The approach parameter can be used to reduce overshoot. The larger the value the less overshoot there will be. However, if the value is too large it may take too long for the temperature to settle to a new set-point. The default value is 5.

The parameter is indicated by,

APPr	*Approach parameter*

Press "SET" to access the parameter setting.

APP= 5	*Approach set to 5*

Press "UP" or "DOWN" to change the value.

APP= 7	*New approach value*

Press "SET to accept the new value.

6.15 Serial Interface Parameters

The serial RS-232 interface parameters menu is indicated by,

SErIAL	*Serial RS-232 interface parameters menu*

The serial interface parameters menu contains parameters which determine the operation of the serial interface. The parameters in the menu are BAUD rate, sample period, duplex mode, and linefeed.

6.15.1 BAUD Rate

The BAUD rate is the first parameter in the menu. The BAUD rate setting determines the serial communications transmission rate.

The BAUD rate parameter is indicated by,

`BAUd` *Serial BAUD rate parameter*

Press “SET” to choose to set the BAUD rate. The current BAUD rate value is displayed.

`1200 b` *Current BAUD rate*

The BAUD rate of the serial communications may be programmed to 300, 600, 1200, or 2400 BAUD. The default BAUD rate is 1200. Use “UP” or “DOWN” to change the BAUD rate value.

`2400 b` *New BAUD rate*

Press “SET” to set the BAUD rate to the new value or “EXIT” to abort the operation and skip to the next parameter in the menu.

6.15.2 Sample Period

The sample period is the next parameter in the serial interface parameter menu. The sample period is the time period in seconds between temperature measurements transmitted from the serial interface. For example, if the sample rate is set to 5, the instrument transmits the current measurement over the serial interface approximately every five seconds. The automatic sampling is disabled with a sample period of 0. The sample period is indicated by,

`SAnPLE` *Serial sample period parameter*

Press “SET” to choose to set the sample period. The current sample period value will be displayed.

`SA= 1` *Current sample period(seconds)*

Adjust the value with “UP” or “DOWN” and then use “SET” to set the sample rate to the displayed value.

`SA= 60` *New sample period*

6.15.3 Duplex Mode

The next parameter is the duplex mode. The duplex mode may be set to full duplex or half duplex. With full duplex any commands received by the calibrator via the serial interface are immediately echoed or transmitted back to the device of origin. With half duplex the commands are executed but not echoed.

The duplex mode parameter is indicated by,

dUPL	*Serial duplex mode parameter*

Press "SET" to access the mode setting.

dUP=FULL	*Current duplex mode setting*

The mode may be changed using "UP" or "DOWN" and pressing "SET".

dUP=HALF	*New duplex mode setting*

6.15.4 Linefeed

The final parameter in the serial interface menu is the linefeed mode. This parameter enables (on) or disables (off) transmission of a linefeed character (LF, ASCII 10) after transmission of any carriage-return.

The linefeed parameter is indicated by,

LF	*Serial linefeed parameter*

Press "SET" to access the linefeed parameter.

LF= On	*Current linefeed setting*

The mode may be changed using "UP" or "DOWN" and pressing "SET".

LF= OFF	*New linefeed setting*

6.16 IEEE-488 Parameters

The calibrator is fitted with an IEEE-488 GPIB interface. The user may set the interface address and termination within the IEEE-488 parameter menu. The menu is indicated by,

IEEE	*IEEE-488 parameters menu*

Press "SET" to enter the menu.

6.16.1 IEEE-488 Address

The IEEE-488 interface must be configured to use the same address as the external communicating device.

The address is indicated by,

AddrESS	*IEEE-488 interface address*

Press “SET” to access the address setting.

Add= 22	*Current IEEE-488 interface address*

Adjust the value with “UP” or “DOWN” and then use “SET” to set the address to the displayed value.

Add= 15	*New IEEE-488 interface ad-dress*

6.16.2 Termination

The transmission termination character can be set to carriage return only, linefeed only, or carriage return and linefeed. Regardless of the option selected the instrument interprets either a carriage return or linefeed as a command termination during reception.

The termination parameter is indicated with,

EOS	*IEEE-488 termination*

Press “SET” to access the termination setting.

E= Cr	*Present IEEE-488 termination*

Use “UP” or “DOWN” to change the selection.

E= LF	*New termination selection*

Use “SET” to save the new selection.

6.17 Calibration Parameters

The user has access to the instrument calibration constants. These values are set at the factory and must not be altered. The correct values are important to the accuracy and proper and safe operation of the calibrator. Access to these parameters is available to the user only so that in the event that the controller’s memory fails the user may restore these values to the factory settings. The user should have a list of these constants and their settings on the Report of Calibration that shipped with the instrument.

Caution: *DO NOT change the values of the calibration constants from the factory set values. The correct setting of these parameters is important to the safety and proper operation of the calibrator.*

The calibration parameters menu is indicated by,

CAL	*Calibration parameters menu*

Press "SET" five times to enter the menu.

6.17.1 CTO

This parameter sets the calibration of the over-temperature cut-out. This is not adjustable by software but is adjusted with an internal potentiometer. For the 9007 PLTC this parameter should read between 145 and 150.

6.17.2 SCO

This parameter is used at the factory for testing purposes and **SHOULD NOT** be altered by the user.

7 Digital Communication Interface

The PLTC is capable of communicating with and being controlled by other equipment through the digital interface. Two types of digital interface are available - the RS-232 serial interface and the optional IEEE-488 GPIB interface.

With a digital interface the instrument may be connected to a computer or other equipment. This allows the user to set the set-point temperature, monitor the temperature, and access any of the other controller functions, all using remote communications equipment.

7.1 Serial Communications

The calibrator is equipped with an RS-232 serial interface that allows serial digital communications over fairly long distances. With the serial interface the user may access any of the functions, parameters and settings discussed in Section 6 with the exception of the BAUD rate setting.

7.1.1 Wiring

The serial communications cable attaches to the calibrator through the DB-9 connector at the back of the instrument. Figure 5 shows the pin-out of this connector and suggested cable wiring. To eliminate noise, the serial cable should be shielded with low resistance between the connector (DB-9) and the shield.

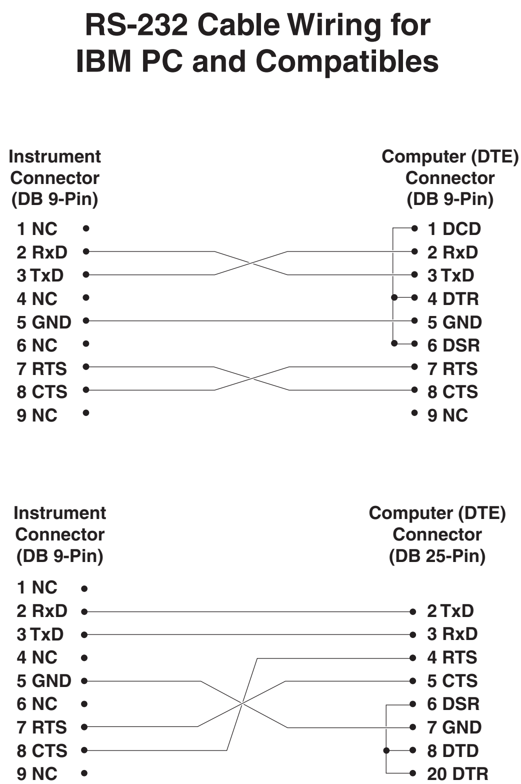


Figure 5 *Serial Cable Wiring*

7.1.2 Setup

Before operation the serial interface must first be set up by programming the BAUD rate and other configuration parameters. These parameters are programmed within the serial interface menu.

To enter the serial parameter programming mode first press “EXIT” while pressing "SET" and release to enter the secondary menu. Press "SET" repeatedly until the display reads "ProbE". This is the menu selection. Press "UP" repeatedly until the serial interface menu is indicated with "SErIAL". Finally press "SET" to enter the serial parameter menu. In the serial interface parameters menu are the BAUD rate, the sample rate, the duplex mode, and the linefeed parameter.

7.1.2.1 BAUD Rate

The BAUD rate is the first parameter in the menu. The display prompts with the BAUD rate parameter by showing "BAUd". Press "SET" to choose to set the BAUD rate. The current BAUD rate value is displayed. The BAUD rate of the 9007 serial communications may be programmed to 300, 600, 1200, or 2400 BAUD. The BAUD rate is pre-programmed to 2400 BAUD. Use "UP" or "DOWN" to change the BAUD rate value. Press "SET" to set the BAUD rate to the new value or "EXIT" to abort the operation and skip to the next parameter in the menu.

7.1.2.2 Sample Period

The sample period is the next parameter in the menu and prompted with "SAnPLE". The sample period is the time period in seconds between temperature measurements transmitted from the serial interface. If the sample rate is set to 5, the instrument transmits the current measurement over the serial interface approximately every five seconds. The automatic sampling is disabled with a sample period of 0. Press "SET" to choose to set the sample period. Adjust the period with "UP" or "DOWN" and then use "SET" to set the sample rate to the displayed value.

7.1.2.3 Duplex Mode

The next parameter is the duplex mode indicated with "dUPL". The duplex mode may be set to half duplex ("HALF") or full duplex ("FULL"). With full duplex any commands received by the thermometer via the serial interface are immediately echoed or transmitted back to the device of origin. With half duplex the commands are executed but not echoed. The default setting is full duplex. The mode may be changed using "UP" or "DOWN" and pressing "SET".

7.1.2.4 Linefeed

The final parameter in the serial interface menu is the linefeed mode. This parameter enables ("On") or disables ("OFF") transmission of a linefeed character (LF, ASCII 10) after transmission of any carriage-return. The default setting is with linefeed on. The mode may be changed using "UP" or "DOWN" and pressing "SET".

7.2 Serial Operation

Once the cable has been attached and the interface set up properly the controller immediately begins transmitting temperature readings at the programmed rate. The serial communications uses 8 data bits, one stop bit, and no parity. The set-point and other commands may be sent via the serial interface to set the temperature set-point and view or program the various parameters. The interface commands are discussed in Section7.4. All commands are ASCII character strings terminated with a carriage-return character (CR, ASCII 13).

7.3 IEEE-488 Communication

The IEEE-488 interface is standard on the PLTC. Instruments supplied with this option may be connected to a GPIB type communication bus that allows many instruments to be connected and controlled simultaneously. To eliminate noise, the GPIB cable should be shielded.

7.3.1 Setup

To use the IEEE-488 interface first connect an IEEE-488 standard cable to the back of the calibrator. Next set the device address. This parameter is programmed within the IEEE-488 interface menu.

To enter the IEEE-488 parameter programming menu first press “EXIT” while pressing “SET” and release to enter the secondary menu. Press “SET” repeatedly until the display reaches “PrObE”. This is the menu selection. Press “UP” repeatedly until the IEEE-488 interface menu is indicated with “IEEE”. Press “SET” to enter the IEEE-488 parameter menu. The IEEE-488 menu contains the IEEE-488 address parameter.

7.3.1.1 IEEE-488 Interface Address

The IEEE-488 address is prompted with “AddrESS”. Press “SET” to program the address. The default address is 22. Change the device address of the calibrator if necessary to match the address used by the communication equipment by pressing “UP” or “DOWN” and then “SET”.

7.3.1.2 IEEE-488 Operation

Commands may now be sent via the IEEE-488 interface to read or set the temperature or access other controller functions. All commands are ASCII character strings and are terminated with a carriage-return (CR, ASCII 13). Interface commands are listed below.

7.4 Interface Commands

The various commands for accessing the calibrator functions via the digital interfaces are listed in this section (see Table 4). These commands are used with both the RS-232 serial interface and the IEEE-488 GPIB interface. In either case the commands are terminated with a carriage-return character. The interface makes no distinction between upper and lower case letters, hence either may be used. Commands may be abbreviated to the minimum number of letters that determines a unique command. A command may be used to either set a parameter or display a parameter depending on whether or not a value is sent with the command following a "=" character. For example "s" returns the current set-point and "s=130.00" sets the set-point to 130.00 degrees.

In the list of commands, characters or data within brackets, "[" and "]", are optional for the command. A slash, "/", denotes alternate characters or data. Numeric data, denoted by "n", may be entered in decimal or exponential notation. Characters are shown in lower case although upper case may be used. Spaces may be added within command strings and will simply be ignored. Backspace (BS, ASCII 8) may be used to erase the previous character. A terminating CR is implied with all commands.

Table 4 *Interface Commands*

Command Description	Command Format	Command Example	Returned	Returned Example	Acceptable Values
Display Temperature					
Read sensor depth	sens	sens	sens:9 {(6") or (3")}	sens:1 (6")	
Set sensor depth to 6" (1) or 3" (2) depth	sens=1/2	sens=2			1 or 2
Read current set-point	s[etpoint]	s	set: 9999.99 {C or F}	set: 130.00 C	
Set current set-point to n	s[etpoint]=n	s=120			Instrument Range
Read scan function	sc[an]	sc	scan: {ON or OFF}	scan: ON	
Set scan function:	**sc[an]=on/of[f]**				ON or OFF
Turn scan function on	sc[an]=on	sc=on			
Turn scan function off	sc[an]=of[f]	sc-of			
Read scan rate	sr[ate]	sr	srat: 999.99 {C or F}/min	srat: 10.0 C/min	
Set scan rate to *n* degrees per minute	sr[ate]=*n*	sr=5			.1 to 100°C
Read display temperature hold status	hm[ode]	hm	hmode: {OFF or AUTO or NO or NC}	hmode: AUTO	
Set display temperature hold mode:	**hm[ode]=OF[F]/AU[TO]/NO/NC**				OFF or AUTO or NO or NC
Set hold mode to off	hm[ode]=OF[F]	hm=of			
Set hold mode to automatic	hm[ode]=AU[TO]	hm=auto			
Set hold mode to normally open	hm[ode]=NO	hm=no			
Set hold mode to normally closed	hm[ode]=NC	hm=nc			
Read temperature	t[emperature]	t	t: 999.99 {C or F}	t: 55.69 C	
Read hold status	ho[ld]	ho	ho:{Closed or Open}, 999.99 {C or F}	ho: Open, 75.0 C	
Secondary Menu					
Read proportional band setting	pr[op-band]	pr	pb: 999.99	pb: 15.9	
Set proportional band to *n*	pr[op-band]=n	pr=8.83			Depends on Configuration
Read cut-out setting	c[utout]	c	c: 9999 {C or F}	c: 145 C	
Set cut-out setting:	**c[utout]=n/r[eset]**				
Set cut-out to *n* degrees	c[utout]=n	c=145			Temperature Range
Reset cut-out now	c[utout]=r[eset]	c=r			
Read heater power (duty cycle)	po[wer]	po	p%: 9999	p%: 100	
Ramp and Soak Menu					
Read number of programmable set-points	pn	pn	pn: 9	pn: 2	

Interface Commands continued

Command Description	Command Format	Command Example	Returned	Returned Example	Acceptable Values
Set number of programmable set-points to *n*	pn=*n*	pn=4			1 to 8
Read programmable set-point number *n*	ps*n*	ps3	ps*n*: 9999.99 {C or F}	ps1: 50.00 C	
Set programmable set-point number *n* to *n*	ps*n*=*n*	ps3=50			1 to 8, Instrument Range
Read program set-point soak time	pt	pt	ti: 999	ti: 5	
Set program set-point soak time to *n* minutes	pt=*n*	pt=5			0 to 500
Read program control mode	pc	pc	prog: {OFF or ON}	prog: OFF	
Set program control mode:	**pc=g[o]/s[top]/c[ont]**				GO or STOP or CONT
Start program	pc=g[o]	pc=g			
Stop program	pc=s[top]	pc=s			
Continue program	pc=c[ont]	pc=c			
Read program function	pf	pf	pf: 9	pf: 3	
Set program function to *n*	pf=*n*	pf=2			1 to 4
Configuration Menu					
Probe Menu					
Read R01 calibration parameter	r01	r01	r01: 999.999	r01: 100.578	
Set R01 calibration parameter to *n*	r01=*n*	r01=100.324			98.0 to 104.9
Read ALPHA1 calibration parameter	al1	al1	al1: 9.9999999	al1: 0.0038573	
Set ALPHA1 calibration parameter to *n*	al1=n	al1=0.0038433			0.00370 to 0.00399
Read DELTA1 calibration parameter	de1	de1	de1: 9.99999	de1: 1.46126	
Set DELTA1 calibration parameter to *n*	de1=*n*	de1=1.45			0.0 to 2.9
Read BETA1 calibration parameter	be1	be1	be1: 9.999	be1: 0.342	
Set BETA1 calibration parameter to *n*	be1=n	be1=0.342			–100 to 100
Read R02 calibration parameter	r02	r02	r02: 999.999	r02: 100.578	
Set R02 calibration parameter to *n*	r02=*n*	r02=100.324			98.0 to 104.9
Read ALPHA2 calibration parameter	al2	al2	al2: 9.9999999	al2: 0.0038573	
Set ALPHA2 calibration parameter to *n*	al2=n	al2=0.0038433			0.00370 to 0.00399
Read DELTA2 calibration parameter	de2	de2	de2: 9.99999	de2: 1.46126	
Set DELTA2 calibration parameter to *n*	de2=*n*	de2=1.45			0.0 to 2.9
Read BETA2 calibration parameter	be2	be2	be2: 9.999	be2: 0.342	
Set BETA2 calibration parameter to *n*	be2=n	be2=0.342			–100 to 100

Interface Commands continued

Command Description	Command Format	Command Example	Returned	Returned Example	Acceptable Values
Operating Parameters Menu					
Set temperature units:	**u[nits]=c/f**				C or F
Set temperature units to Celsius	u[nits]=c	u=c			
Set temperature units to Fahrenheit	u[nits]=f	u=f			
Read cut-out mode	cm[ode]	cm	m: {xxxx}	m: AUTO	
Set cut-out mode:	cm[ode]=r[eset]/a[uto]				RESET or AUTO
Set cut-out to be reset manually	cm[ode]=r[eset]	cm=r			
Set cut-out to be reset automatically	cm[ode]=a[uto]	cm=a			
Read approach setting	ap[proach]	ap	ap: 9	ap: 5	
Set approach setting to *n* degrees	ap[proach]=*n*	ap=15			0 to 20°C
Serial Interface Menu					
Read serial sample setting	sa[mple]	sa	sa: 9	sa: 1	
Set serial sampling setting to *n* seconds	sa[mple]=*n*	sa=0			0 to 4000
Set serial duplex mode:	**du[plex]=f[ull]/h[alf]**				FULL or HALF
Set serial duplex mode to full	du[plex]=f[ull]	du=f			
Set serial duplex mode to half	du[plex]=h[alf]	du=h			
Set serial linefeed mode:	**lf[eed]=on/of[f]**				ON or OFF
Set serial linefeed mode to on	lf[eed]=on	lf=on			
Set serial linefeed mode to off	lf[eed]=of[f]	lf=of			
Calibration Menu (WARNING – changing the following calibration values may change the accuracy of the instrument.)					

Interface Commands continuted

Command Description	Command Format	Command Example	Returned	Returned Example	Acceptable Values
These commands are only used for factory testing.					
Read software cut-out mode	*sco	*sco	sco: {ON or OFF}	sco: ON	
Set software cut-out mode:	***sco=ON/OF[F]**				ON or OFF
Set software cut-out mode on	*sco=ON	*sco=on			
Set software cut-out mode off	*sco=OF[F]	*sco=off			
Miscellaneous (not on menus)					
Read firmware version number	*ver[sion]	*ver	ver.9999,9.99	ver.9007,4.00	
Read structure of all commands	h[elp]	h	list of commands		
Legend:	[] Optional Command data				
	/ Alternate characters or data				
	{} Returns either information				
	n Numeric data supplied by user–may be entered in decimal or exponential notation				
	9 Numeric data returned to user				
	x Character data returned to user				
Note:	When DUPLEX is set to FULL and a command is sent to READ, the command is returned followed by a carriage return and linefeed. Then the value is returned as indicated in the RETURNED column.				

8 Test Probe Calibration

For optimum accuracy and stability, allow the calibrator to warm up for 30 minutes after power-up and then allow adequate stabilization time after reaching the set-point temperature. After completing calibration, allow the block to cool by setting the temperature to 100°C or less before switching the power off. Actual use of this instrument should be determined by your applicable Quality Assurance requirements. The following procedure is provided for information only.

8.1 Calibration Methods

8.1.1 Direct Calibration

Direct calibration involves testing a probe directly against the PLTC temperature display. The advantage of this method is that it is quick and easy.

Insert the probe to be calibrated into the well of the PLTC. The probe should fit snugly into the calibrator probe heat transfer block yet should not be so tight that it cannot be easily removed. Avoid any dirt or grit that may cause the probe to jam into the heat transfer block. Best results are obtained with the probe inserted to the full depth of the well. Once the probe is inserted into the well, allow adequate stabilization time to allow the test probe temperature to settle as described. Once the probe has settled to the temperature of the well, it may be compared to the calibrator display temperature. The display temperature should be stable to within 0.1°C for best results.

Caution: *Never introduce any foreign material into the probe hole of the insert. Fluids, etc., can leak into the calibrator causing damage to the calibrator or binding and damage to your probe.*

8.2 PLTC Characteristics

Understanding the thermal characteristics of the PLTC can help you achieve the best accuracy and efficiency possible.

8.2.1 Vertical Gradient

There is a temperature gradient vertically in the test well. The TED has been applied to the block in such a way as to compensate for nominal heat losses out of the top of the PLTC and minimize vertical temperature gradients. However, actual heat losses will vary depending on the number and types of probes inserted into the calibrator and the block temperature. For best results, insert probes the full depth of well.

The unit has been calibrated for both an upper (3") and lower (6") depth. Ensure that your probe is inserted to the depth indicated on the display.

8.2.2 Stabilization and Accuracy

The stabilization time of the PLTC depends on the conditions and temperatures involved. Typically the test well is stable to 0.1°C within 5 minutes of reaching the set-point temperature as indicated by the display. Ultimate stability is achieved 10 to 20 minutes after reaching the set temperature.

Inserting a cold probe into a well requires another period of stabilizing depending on the magnitude of the disturbance and the required accuracy. For example, inserting a .25 inch diameter room temperature probe into a heat transfer block at 140°C takes five minutes to be within 0.1°C of its settled point and takes 30 minutes to achieve maximum stability.

Decreasing the time required for the calibration process can be accomplished by knowing how soon to make the measurement. It is recommended that typical measurements be made at the desired temperatures with the desired test probes to establish these times.

9 Calibration Procedure

See the manual entitled 9007 Portable Low Temperature Calibrator Calibration Procedure Manual.

10 Maintenance

- The calibration instrument has been designed with the utmost care. Ease of operation and simplicity of maintenance have been a central theme in the product development. Therefore, with proper care the instrument should require very little maintenance. Avoid operating the instrument in an oily, wet, dirty, or dusty environment.
- If the outside of the instrument becomes soiled, it may be wiped clean with a damp cloth and mild detergent. Do not use harsh chemicals on the surface that may damage the paint.
- It is important to keep the well of the calibrator clean and clear of any foreign matter. Do not use fluid to clean out the well.
- The PLTC should be handled with care. Avoid knocking or dropping the calibrator.
- For PLTCs with removable probe heat transfer blocks, the heat transfer blocks can become covered with dust and carbon material. If the buildup becomes too thick, it could cause the heat transfer blocks to become jammed in the wells. Avoid this build up by periodically buffing the heat transfer blocks clean.
- If a heat transfer block should be dropped, examine the heat transfer block for deformities before inserting it in the well. If there is any chance of jamming the heat transfer block in the well, file or grind off the protuberance.
- Do not slam or drop the probe stem into the well. This type of action can cause a shock to the sensor in the probe or instrument.
- If a hazardous material is spilt on or inside the equipment, the user is responsible for taking the appropriate decontamination steps as outlined by the national safety council with respect to the material.
- If the mains supply cord becomes damaged, replace it with a cord with the appropriate gauge wire for the current of the instrument. If there are any questions, call a Hart Scientific Authorized Service Center (see Section 1.3) for more information.
- Before using any cleaning or decontamination method except those recommended by Hart, users should check with Hart Scientific Customer Service to be sure that the proposed method will not damage the equipment.
- If the instrument is used in a manner not in accordance with the equipment design, the operation of the PLTC may be impaired or safety hazards may arise.
- The overtemperature cut-out should be checked every 6 months to see that it is working properly. In order to check the user selected cut-out, follow the controller directions (Section 6.11) for setting the cut-out. Both the manual and the auto reset option of the cut-out should be checked. Set the

instrument temperature higher than the cut-out. Check to see if the display flashes cut-out and the temperature is decreasing.

11 Troubleshooting

If problems arise while operating the 9007, this section includes information necessary to inspect, troubleshoot, repair and verify operation after report or operational faults with the 9007 PLTC. The depth of the troubleshooting is to the subassembly level with regards to circuit boards. Special tools or equipment are not required, other than those normally found in maintenance shops, except when determing PLTC stability. Refer to Table 6 on page 55 for a troubleshooting guide.

To test the stability, test equipment capable of a resolution to 0.01 is required. Typically, a digital thermometer or bridge and a strip chart recorder are used. Adequate digital thermometers include Hart models 1560/2560, 1575, and 1590.

11.1 Troubleshooting

The following table lists several problems that may arise followed by suggested actions to take to fix the problem. PCB designates the term Printed Circuit Board. If the listed solutions do not work, call a Hart Scientific Authorized Service Center (see Section 1.3).

Table 6 *Troubleshooting Table*

Symptom	Possible Cause	Possible Solution
No display.	Poor power connection.	Check that the AC power cord is plugged in to an AC outlet and connected to the unit.
	Blown fuse on analog PCB.	Replace the fuse on the analog PCB (refer to Figure 8 on page 67).
Display is missing segments or unintelligible.	Faulty display PCB.	Replace the display control PCB (refer to Figure 8 on page 67).
	Faulty digital PCB.	Replace the digital PCB (item 8 on Figure 7 on page 66).
Display not reading correct temperature.	Incorrect parameters.	Power the unit on and watch the display. Verify that R01, ALPHA1, DELTA1, BETA1, R02, ALPHA2, DELTA2, and BETA2 in memory, match those on the Report of Calibration.
	Analog PCB Switch set wrong.	Set Probe Switch (SW1) on the analog PCB to the “PT” position (refer to Figure 8 on page 67).
	Faulty control probe.	The probe connector (refer to Figure 8 on page 67) should read 0.1 to 2.0 ohms between pins 1 and 2 and between pins 3 and 4. The probe conector should read between 100Ω and 200Ω between pins 1 and 4 with the block cool. Replace the cooling block assembly (refer to Section 11.2.9, Cooling Block Replacement Procedure).

Symptom	Possible Cause	Possible Solution
Display flashes any error code.	Corrupted controller memory.	**Factory Reset Sequence:** Hold the "SET" and "EXIT" keys down at the same time while powering up the unit. The screen will display "-init-", "9007" and the version of the software. The unit will need to be reprogrammed for R01, ALPHA1, DELTA1, BETA1, R02, ALPHA2, DELTA2 and BETA2. These numbers are found on the Report of Calibration.
	Faulty digital PCB.	Replace the digital PCB (item 8 on Figure 6 on page 65).
	Faulty analog PCB.	Replace the analog PCB (item 7 on Figure 6 on page 65).
Unit heats or cools slowly.	Scan may be on with a low scan rate.	Refer to the Scan Control and Scan Rate settings in Sections 6.4.1 and 6.4.2 on page 23.
Input power indicator not illuminated.	Blown fuse.	Replace the fuses in the PEM (item 16 on on page 65) on top panel.
	LED burned out	Replace the power and ready indicator PCB (see Section11.2.6 on page 59).
Unit not heating or cooling.	Faulty TED.	Replace the cooling block assembly (see Section11.2.9 on page 60).
	Faulty power supply.	Refer to the power supply verification Section11.2.11 on page 61.
	Unit is "Cut-out".	Refer to Section 6.11 on page 33.
Display flashes "cut-out".	Software cut-out is set too low.	Refer to the Cut-out setting in Section6.11 on page 33.
	Faulty or disconnected thermocouple.	Replace the cooling block assembly (see Section 11.2.9 on page 60).
	Corrupted controller memory.	Perform the **Factory Reset Sequence** as described in the symptom "Display flashes any error code" on page 56.
Display flashes "-276°C" or "-459°F".	Corrupted controller memory.	Perform the **Factory Reset Sequence** as described in the symptom "Display flashes any error code" on page 56.
	Sensor is disconnected, open or shorted.	The probe connector (refer to Figure 8 on page 67) should read 0.1 or 2.0 ohms between pins 1 and 2 and between pins 3 and 4. The probe connector should read between 100 ohms and 200 ohms between pins 1 and 4 with the block cool. Replace the cooling block assembly (refer to Section 11.2.9, Cooling Block Replacement Procedure).
Unit is out of specification.	Incorrect parameters.	Make sure the parameters in the unit match those on the Report of Calibration.
	Operator not using probe insulation.	Use the proper probe/well insulation around the probe.
Unit does not hold parameters.	Faulty battery.	Replace the controller battery (refer to Section11.2.3 on page 58).
Controller remains in cooling or heating state at any set-point.	Corrupt controller memory.	Perform the **Factory Reset Sequence** as described in the symptom "Display flashes any error code" on page 56.
	Faulty digital, analog, or output PCB.	Replace digital, analog, or output PCB. (Refer to Figure 6 on page 65, items 7 and 8.)
Unit is unstable.	Proportional band is set improperly.	Refer to Section6.10 on page 31.

Symptom	Possible Cause	Possible Solution
Unable to communicate using IEEE-488.	Incorrect address.	Set address (refer to Section 6.16.1 on page 39).
	Incorrect EOS.	Send linefeed (LF) at the end of each command. Set PLTC to send LF (refer to Section6.15.4 on page 38).
	EOI expected.	PLTC will not send EOI. Disable EOI detection on GPIB controller.
Unable to communicate using RS-232.	Incorrect BAUD rate.	Set BAUD rates to match.
	Incorrect termination.	Send Linefeed (LF) after command (refer to Section 6.15.4 on page 38).
	Faulty cable.	Replace with a new cable.

11.2 Replacement and Verification Procedures

⚠ **Warning:** *High voltage present. Danger of ELECTRICAL SHOCK. Follow the Preparation for Service Procedure (Section 11.2.2) prior to disassembly of PLTC components.*

Generally, replacing parts on the 9007 is not difficult. Most components can be replaced by evaluating the situation of the bad component, noting electrical connection, and then replacing the bad component. Installation of the new component is accomplished by reversing the process. The following procedures are more involved and have been included for your convenience. Refer to Figures 6, 7, 8, and 9 for component placement.

11.2.1 Fuse Replacement Procedure

1. Remove the power cord from the power entry module (PEM).
2. Using a small straight slot screwdriver, pry up on the PEM fuse lid.
3. Using the same small straight slot screwdriver pry up on the tab on the red fuse holder and remove and replace the bad fuse(s) with the correct amperage fuses(s). **Always replace the fuses with ones of the same voltage and current rating.**
4. Reverse this process to reassemble the PEM.
5. Make sure the voltage matches input power.

11.2.2 Preparation for Service Procedure

1. Let the instrument cool prior to disassembly. Prepare a clean surface to lay the internal assembly on.
2. Wear a grounding strap to protect components against electrostatic discharge (ESD).

3. Find the PLTC Report of Calibration with the constants R01, ALPHA1, DELTA1, BETA1, R02, ALPHA2, DELTA2, and BETA2 (refer to Section 6.12), prior to disconnecting the power.
4. Remove all inserts from the well block.
5. Disconnect all cords and cables from the instrument.
6. Remove the internal assembly by removing the ten Phillips screws around the top panel perimeter (refer to Figure 1 on page 16).
7. Gently turn the unit upside down and slide the encasement off (refer to Figure 8 on page 67).

11.2.3 Battery Replacement Procedure

1. Follow the Preparation for Service procedure (refer to Section 11.2.2).
2. Remove the Phillips screw from the IEEE PCB (refer to Figure 8 on page 67).
3. Pull the IEEE PCB straight out, off of the connector.
4. Remove the battery by positioning a small straight slot screwdriver in the tab on the battery holder.
5. Install a new battery with the '+' sign showing.
6. Reverse this process to reassemble the IEEE PCB making sure that the connector is aligned. Inspect all connections.
7. Use the constants from the Report of Calibration to reprogram the PLTC constants.

11.2.4 Analog and Digital PCBs Replacement Procedure

1. Follow the Preparation for Service procedure (refer to Section 11.2.2).
2. Remove the Phillips screw from the IEEE PCB (refer to Figure 8 on page 67).
3. Pull the IEEE PCB straight out, off of the connector.
4. Disconcert the serial cable (J3), the power and ready indicator cable (J5), the display cable (J2), and the switch hold cable (J6) from the digital PCB.
5. Remove the two Phillips screws and one #6x5/16" standoff on the digital PCB.
6. Pull the digital PCB straight out, off of the connector.
7. Disconnect the cable connectors from the analog PCB, noting where the connections are located.
8. Remove the three Phillips screws and one #6x3/4" standoff on the analog PCB.

9. Reverse this process to install the new controller PCBs. Ensure all connections are made properly. The yellow-white thermocouple connector goes to the positive, (+), of J7 on the Analog PCB (refer to Figure 8 on page 67).

11.2.5 Display Control PCB Replacement Procedure

1. Follow the Preparation for Service procedure (refer to Section 11.2.2).
2. Disconnect the display cable (J2) from the digital PCB (refer to Figure 8 on page 67).
3. Cut the wire tie holding the display cable.
4. Using a right angle Phillips screwdriver, remove the 3 Phillips screws from the display control PCB and remove the PCB.
5. Reverse this process to install the new display control PCB. Two wire ties are required to secure the display cable.

11.2.6 Power and Ready Indicator PCB Replacement Procedure

1. Follow the Preparation for Service procedure (refer to Section 11.2.2).
2. Disconnect the power and ready indicator cable (J1) from the power and ready indicator PCB (refer to Figure 8 on page 67).
3. Remove the two Phillips screws from the power and ready indicator PCB and remove the PCB (refer to Figure 8 on page 67).
4. Reverse this process to install the new power and ready indicator PCB.

11.2.7 DC Fan Verification and Replacement Procedure

1. Follow the Preparation for Service procedure (refer to Section 11.2.2).
2. DC Fan Verification
   a. Plug the PLTC in and turn the unit on.
   b. Observe the two fans on the cooling block assembly and determine which one is not functioning (see Figure 9 on page 68 and Figure 7 on page 66, item 11).
   c. If both fans are not functioning, turn the power off and disconnect the fan cable (J5) on the output PCB. Verify that 48 volts are present. If 48 volts are present, the fans are bad (refer to Figure 9 on page 68).
3. DC Fan Replacement
   a. Disconnect the fan cable (J5) from the output PCB (refer to Figure 9 on page 68).
   b. Cut the fan wires.
   c. Remove the four Phillips screws from each fan.

d. Reverse this process to install the new DC fans. Ensure that airflow is directed inward (see arrows on the fans). Crimp the wires using 18 gauge splicers.

11.2.8 Disassembly of PCB Mounting Panel and Cooling Block Assembly Procedure

Refer to Figures 8 and 9 on pages 67 and 68 when performing this procedure.

1. Disconnect the IEEE cable (J3) from the IEEE PCB.
2. Disconnect the display cable (J2) and the switch hold cable (J6) from the digital PCB.
3. Disconnect the probe cable (J2) and thermocouple cut-out wires (J7) from the analog PCB.
4. Disconnect the cooling block assembly from the PCB mounting panel by removing the 6/32” screw (Figure 9) on the top left corner of the PCB mounting panel.
5. Disconnect the AC connector (CN1) from the switching power supplies.
6. Disconnect the PCB ground cable from the PCB mounting panel.
7. Turn the internal assembly (PCB mounting panel, cooling block assembly, and top panel) so the top panel is facing up.
8. Remove the six hex screws from the block on the top panel and lift the top panel off.

11.2.9 Cooling Block Assembly Replacement Procedure

1. Follow the Preparation for Service procedure (refer to Section 11.2.2).
2. Follow the Disassembly of PCB Mounting Panel and Cooling Block Assembly procedure (refer to Section 11.2.8). Refer to Figure 9 on page 68 for the block assembly placement.
3. Remove the four screws from each fan.
4. Pull the thermocouple cut-out wires through the hole on the PCB Mounting Panel.
5. Remove or cut the pins from the probe connector noting the color placement. Pull the probe cable through the hole on the PCB Mounting Panel.
6. Remove the cut-out relay (refer to Figure 9 on page 68).
7. Disconnect the block wires to the cut-out relay, noting placement. The cooling block assembly can now free from all other components.
8. Reverse this process to install the new cooling block assembly. Make sure none of the wires are pinched.

11.2.10 Output PCB Replacement Procedure

1. Follow the Preparation for Service procedure (refer to Section 11.2.2).
2. Follow the Disassembly of PCB Mounting Panel and Cooling Block Assembly (refer to Section 11.2.8).
3. Remove the four #6 x 6/32" screws from the output PCB.
4. Reverse this process to install the new output PCB.

11.2.11 Power Supply Verification and Replacement Procedure

1. Follow the Preparation for Service procedure (refer to Section 11.2.2).
2. Power Supply Verification
   a. Using a voltmeter, verify that line voltage is present on both CN1 connectors between the 2 wires (see Figure 9 on page 68).
   b. Disconnect the DC input cable (J2) from the output PCB.
   c. Insert the meter leads into the DC input (J2) connectors. The voltmeter should measure 48VDC between the purple and the white wires and between the purble and gray wires. If 48VDC is not present, check for continuity between DC input wires (J2) and CN2 and CN3 on both power supplies. If continuity is good, replace one or both of the power supplies.
4. Power Supply Replacement
   a. Turn the instrument off and disconnect the power cord from the PEM.
   b. Follow the Disassembly of PCB Mounting Panel and Cooling Block Assembly procedure (refer to Section 11.2.8).
   c. Remove the four screws on the bad power supply and slide it out.
   d. Reverse this process to install the new power supply.

11.2.12 Relay Replacement Procedure

1. Follow the Preparation for Service procedure (refer to Section 11.2.2).
2. Remove the two #8 x 8/32" screws from the cooling block assembly.
3. Do a direct replacement of the wires and mount the new relay onto the cooling block assembly.

11.3 Comments

11.3.1 EMC Directive

Hart Scientific's equipment has been tested to meet the European Electromagnetic Compatibility Directive (EMC Directive, 89/336/EEC). The Declaration of Conformity for your instrument lists the specific standards to which the unit was tested.

11.3.2 Low Voltage Directive (Safety)

In order to comply with European Low Voltage Directive (73/23/EEC), Hart Scientific equipment has been designed to meet the IEC 1010-1 (EN 61010-1) and IEC 1010-2-010 (EN 61010-2-010) standards.

12 Appendix A - Subassemblies and Parts List

Refer to Figures 6 and 7 on pages 65 and 66 when referencing the following subassemblies and parts.

Table 7 *Parts List*

Ref. Des.	Part Number	Qty	Description	FSCM	Manufacturer	MFR. Part Number
1	00002134	1	Chassis Assembly	64841	Hart Scientific	00002134
2	02182133	1	Display Label	64841	Anagraphica	02182133
3	00002431	1	Cooling Block Assembly	64841	Hart Scientific	00002431
4	00002132	1	Top Panel Assembly	64841	Hart Scientific	00002132
5	70103116	10	10-32x1" PPH, SST Screw	08226	Reliable Industries	70103116
6	40003120	1	Display Control PCB	64841	Mt. Tech	40003120
7	40003110	1	Analog PCB	64841	Mt. Tech	40003110
7	28002510	2	.25A 250V SB Fuse	03614	Buss	MDL-1/4
8	40003115	1	Digital PCB	64841	Mt. Tech	40003115
8	28051188	1	3V Coin Cell BR2325 Battery	43744	Panasonic	BR2325 P135
9	40004490	1	IEEE-488 PCB	64841	Mt. Tech	40004490
10	02150120	1	Tongs	64841	Hart Scientific	02150120
11	85104349 23300002	2 1	Fan Assembly (2-115V 50/60 Hz Fans with connectors part #23300002)	——— 27264	Nidec Molex	TA450DC 09-50-3021
12	90031052	2	48 VDC Power Supply	———	Cosel	LDA150W-48
13	40002418	1	Output PCB	64841	Mt. Tech	40002418
14	25231057	1	2P2T 10A 24V Relay	89265	P&B	KUIP11D55-24
15	10251000	1	10A 250V 2 Pole Filter-Fuse Switch	7793	Corcom	PS0SXSSXB
16	28020500	2	5A 250V Fuse	03614	Buss	AGC-5
17	40002393	2	Connector Body Assembly	64841	DWF	40002393
18	02180730	1	Warranty Label	64841	Anagraphica	021-8073-0
19	02180690	1	Calibration Label	64841	Anagraphica	021-8069-0
20	40002136	1	Indicator PCB	64841	Hart Scientific	40002136
21	70069106-B	2	#6/32" hex screws	08226	Reliable Industries	70069106-B
22	70089106-B	4	#8/32" hex screws	08226	Reliable Industries	70089106-B
NS	03150291	2	Probe/well insulation .20"	64841	Hart Scientific	03150291
NS	03150292	2	Probe/well insulation .37"	64841	Hart Scientific	03150292
NS	03150293	2	Probe/well insulation .55"	64841	Hart Scientific	03150293

Ref. Des.	Part Number	Qty	Description	FSCM	Manufacturer	MFR. Part Number
NS - Not Shown						
Note: Part number 40003292 (IEEE-488) has been replaced with a new part number 40004490 (IEEE-488). Part number 40003292 is no longer available. If this part is replaced, you must also replace the firmware. (See the table below.)						

Part Number	Board Identifier	Firmware
40003292	009-2B13	3.72 or less
40004490	009-2B58	4.XX

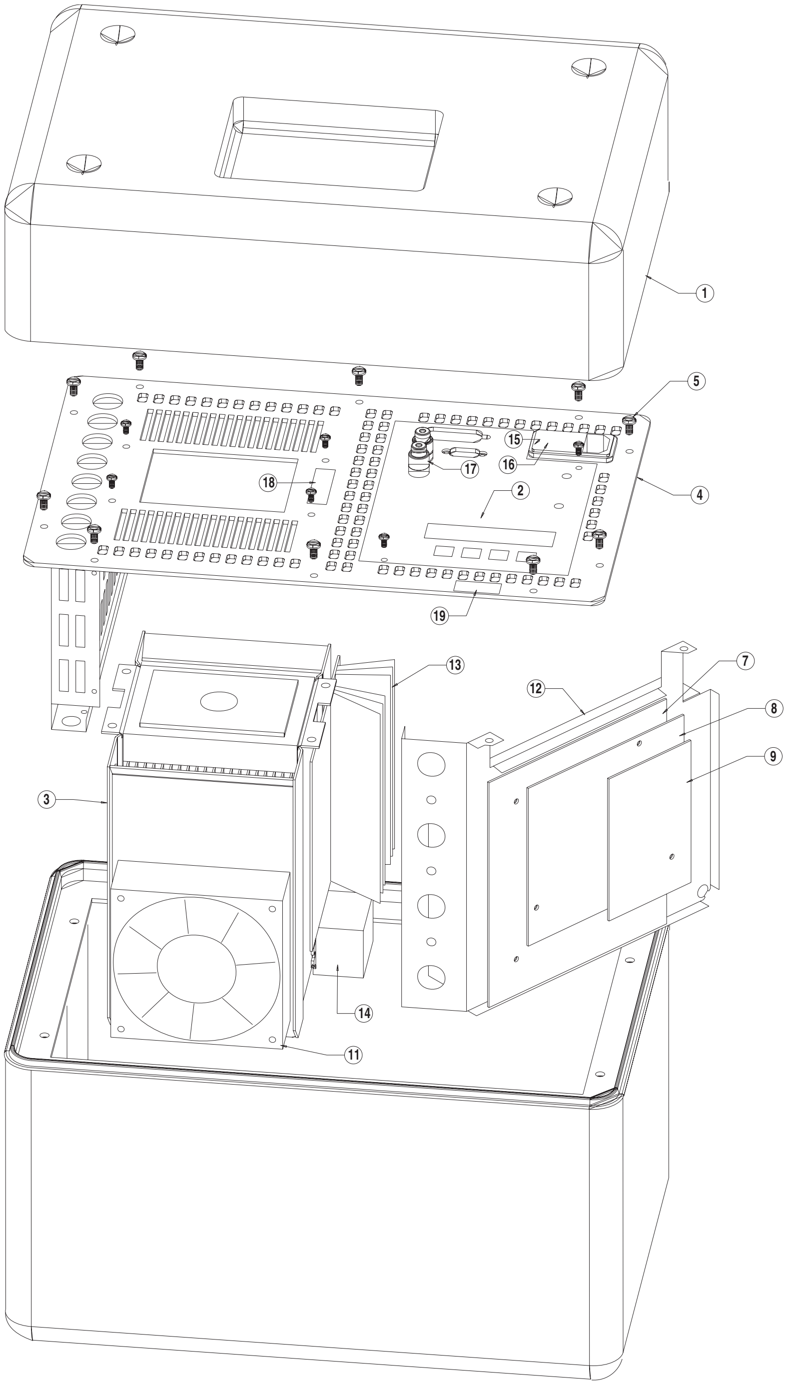


Figure 6 *Top View of Top Panel and Cooling Block Assembly*

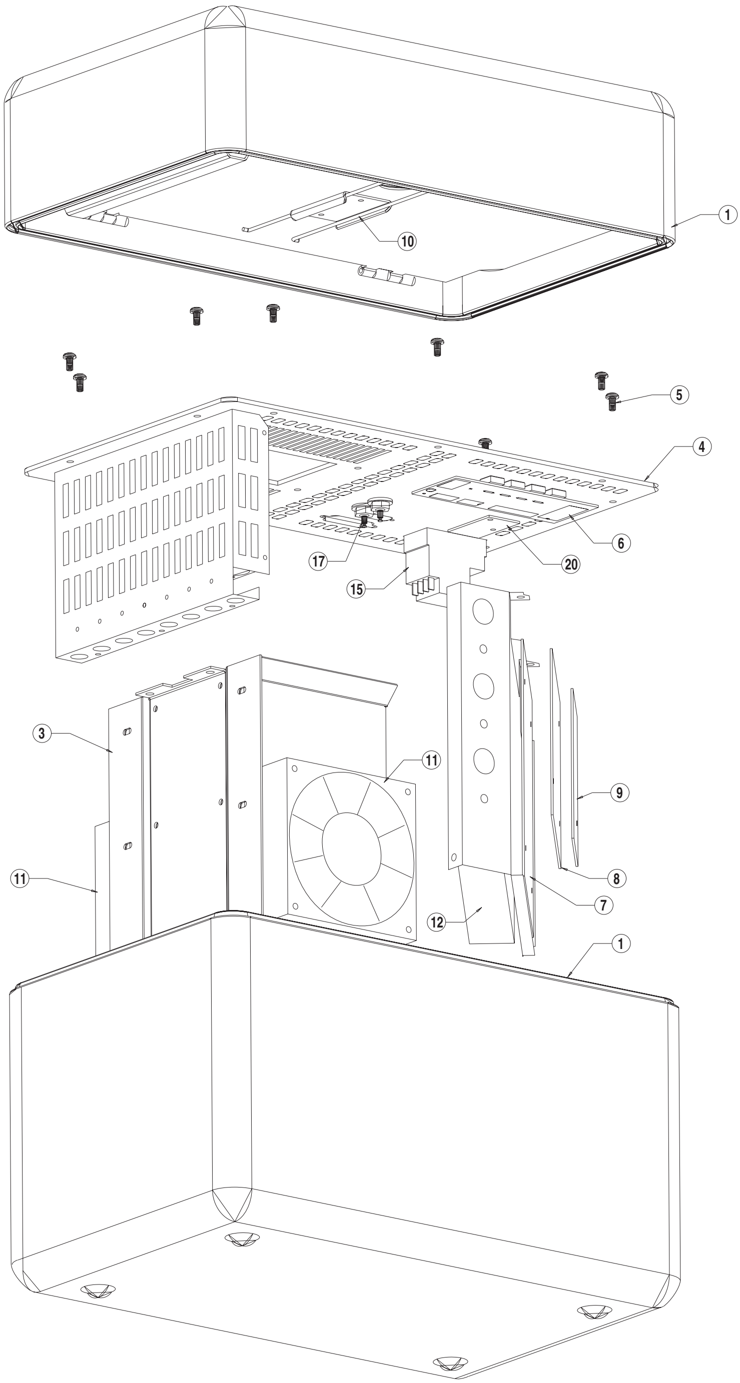


Figure 7 *Side View of Cooling Block Assembly and Internal Assembly*

13 Appendix B - Component Identification

Warning: *High Voltage Present. Remove power cord before removing the top panel.*

To remove the Top Panel, remove the 10 Phillips screws around the perimeter.

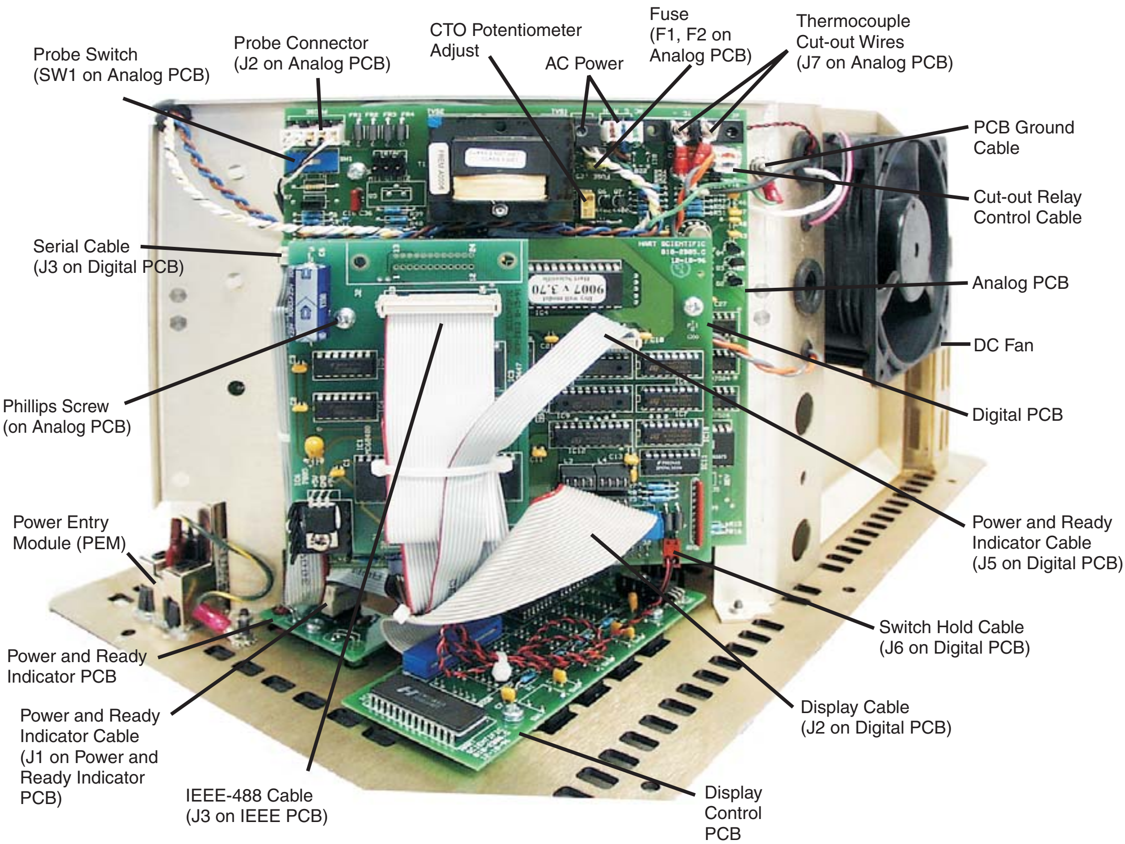


Figure 8 *PCB Mounting Panel, Enclosure Removed*

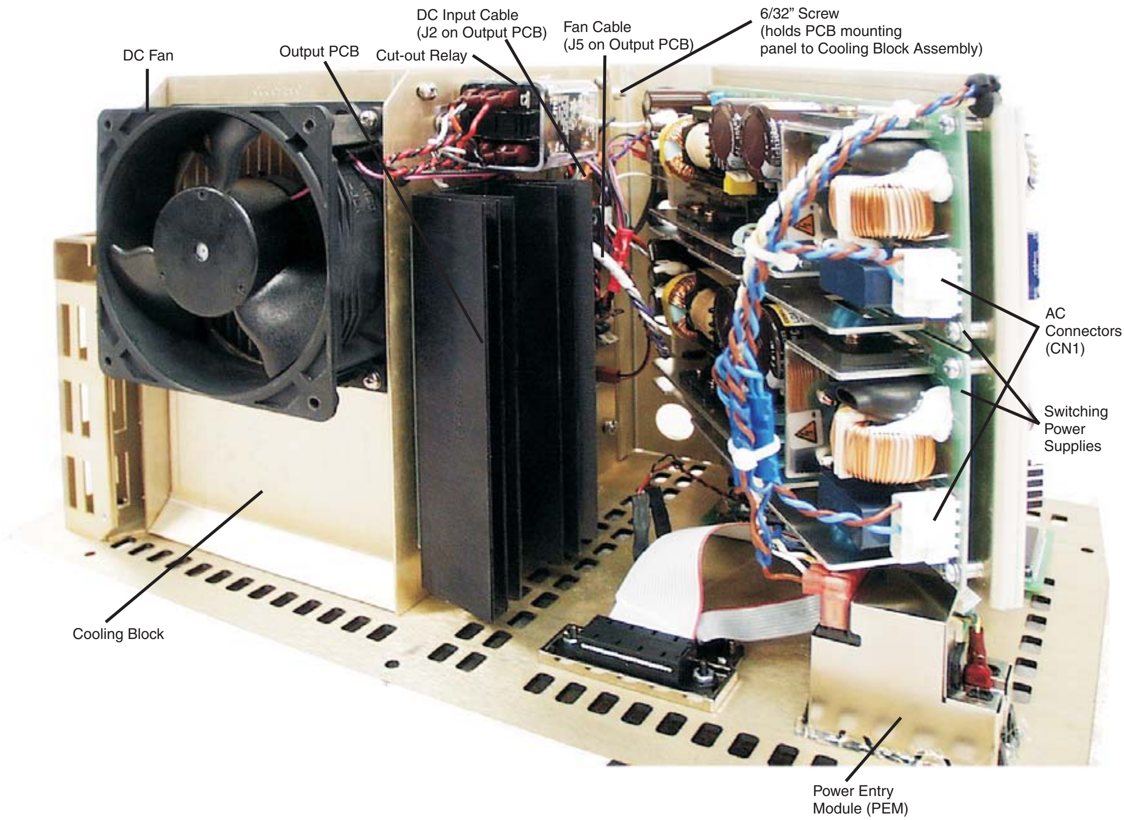


***Figure 9** Cooling Block Assembly, Enclosure Removed*

14 Appendix C - Detailed Schematics

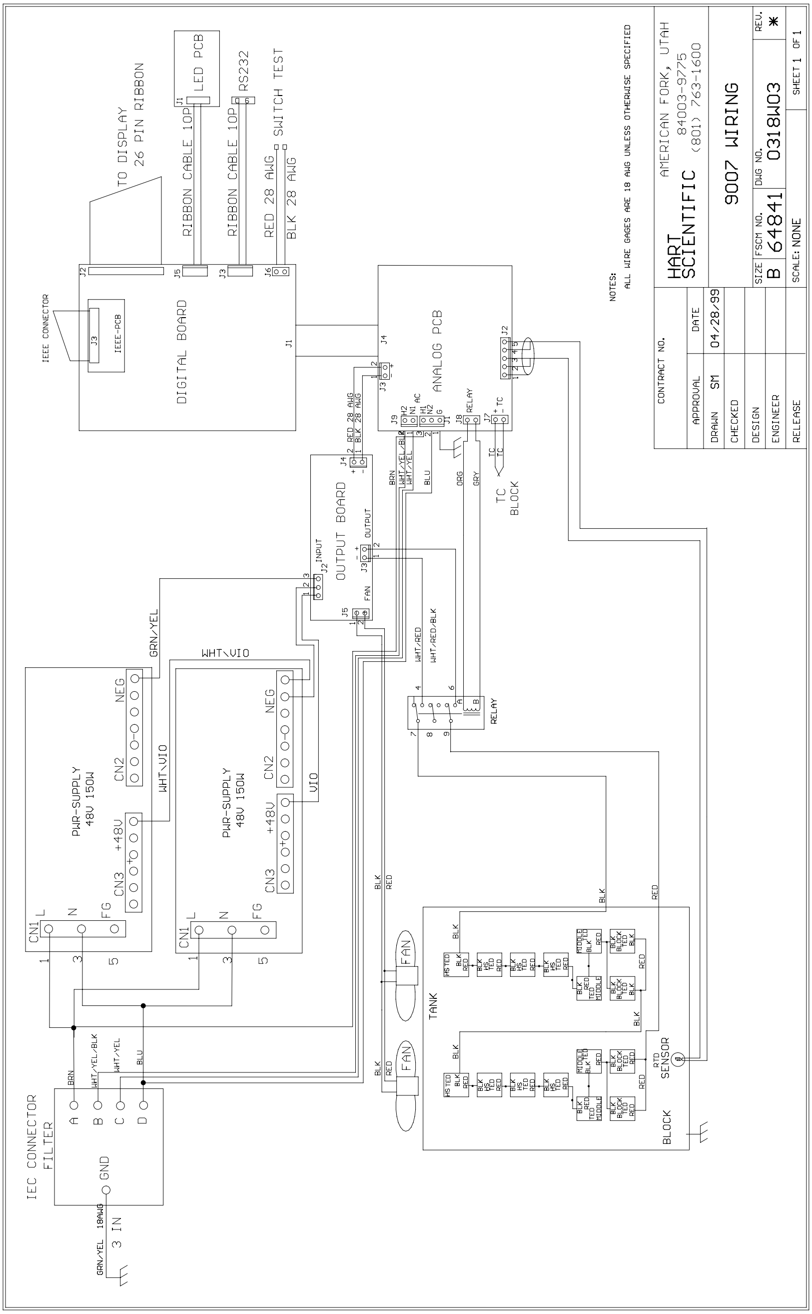


Figure 10 *System Schematic Diagram—1 of 1*

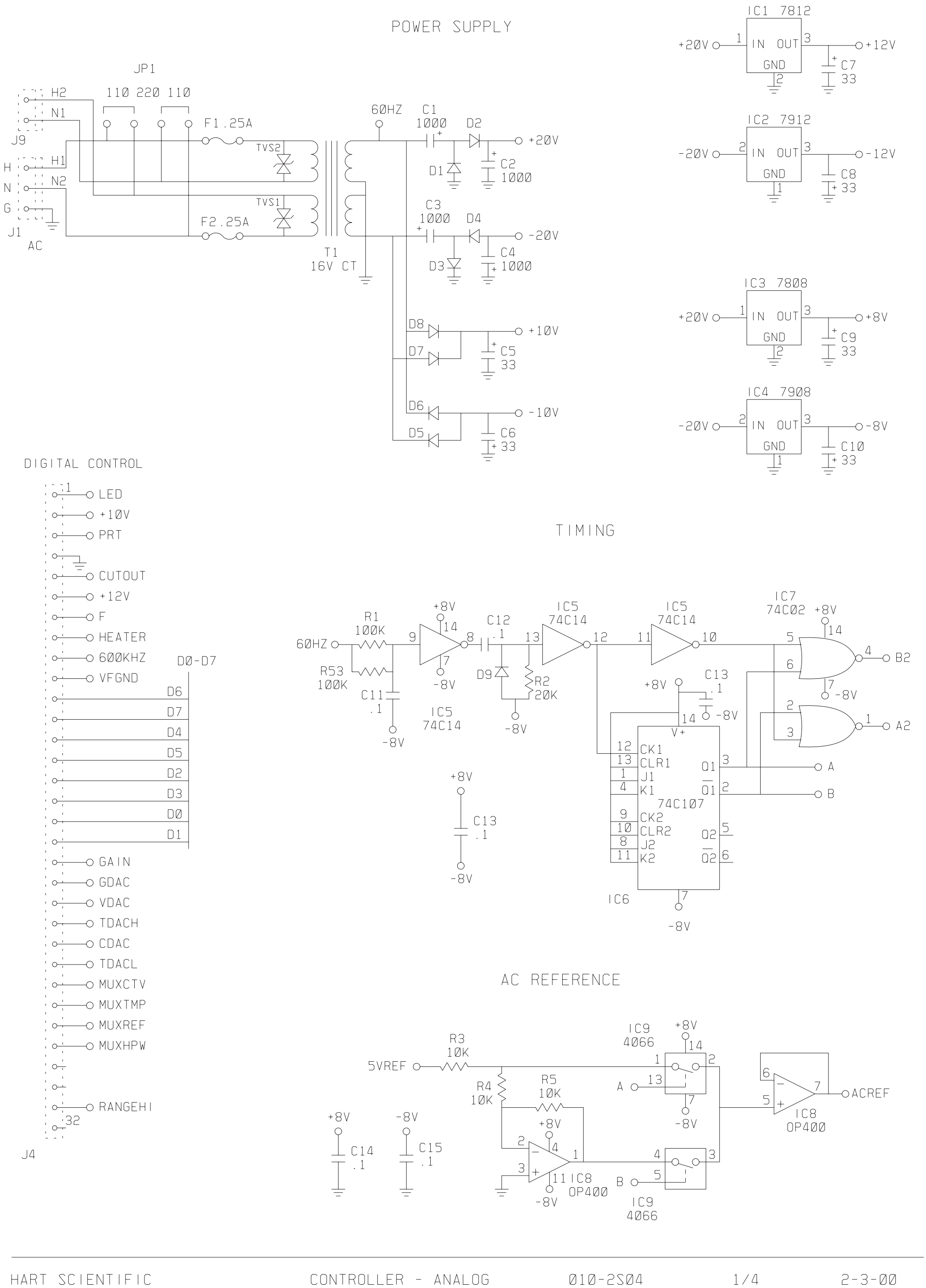


Figure 11 *Analog PCB Schematic Diagram Part No. 40003110 — 1 of 4*

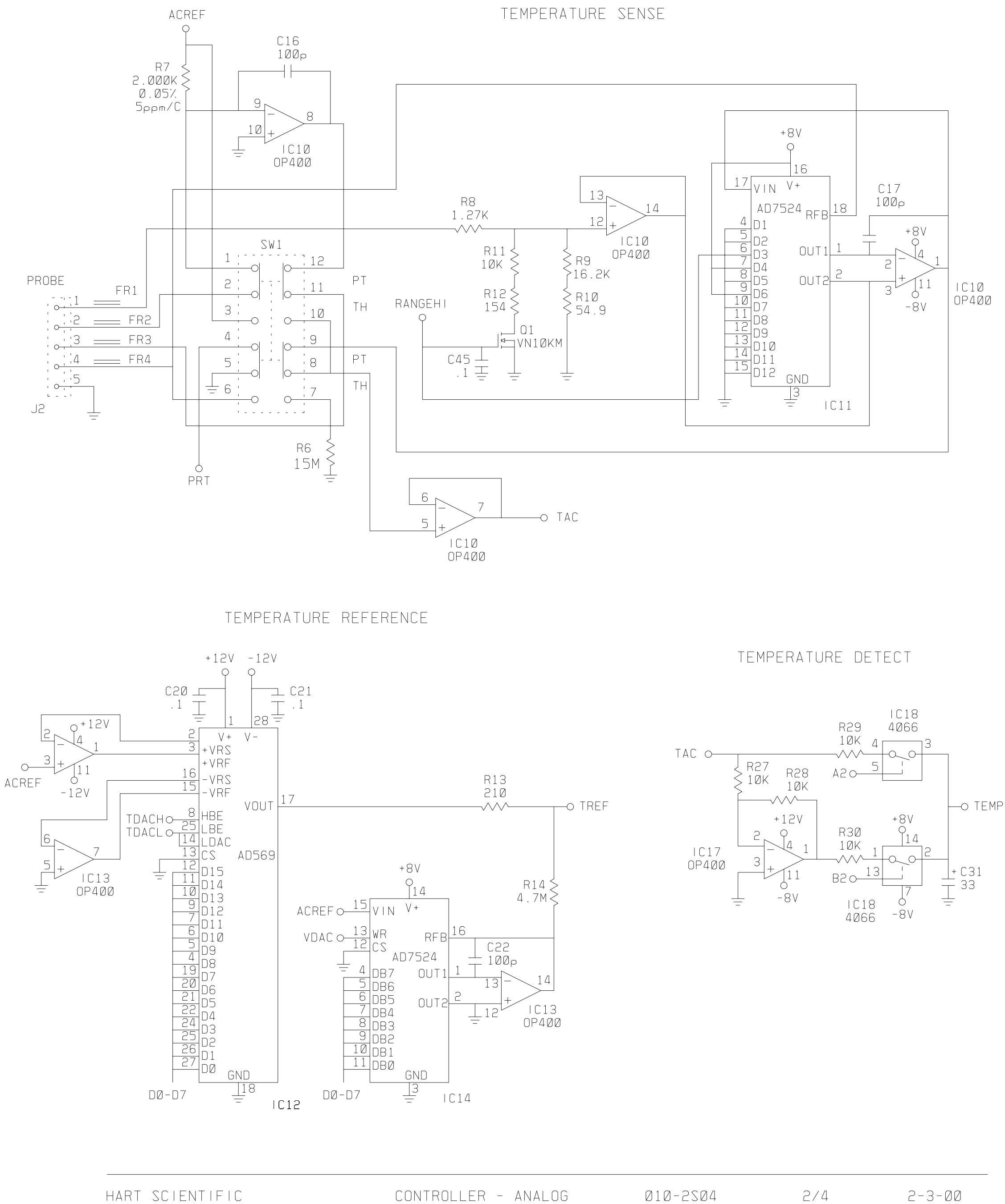


Figure 12 *Analog PCB Schematic Diagram Part No. 40003110 — 2 of 4*

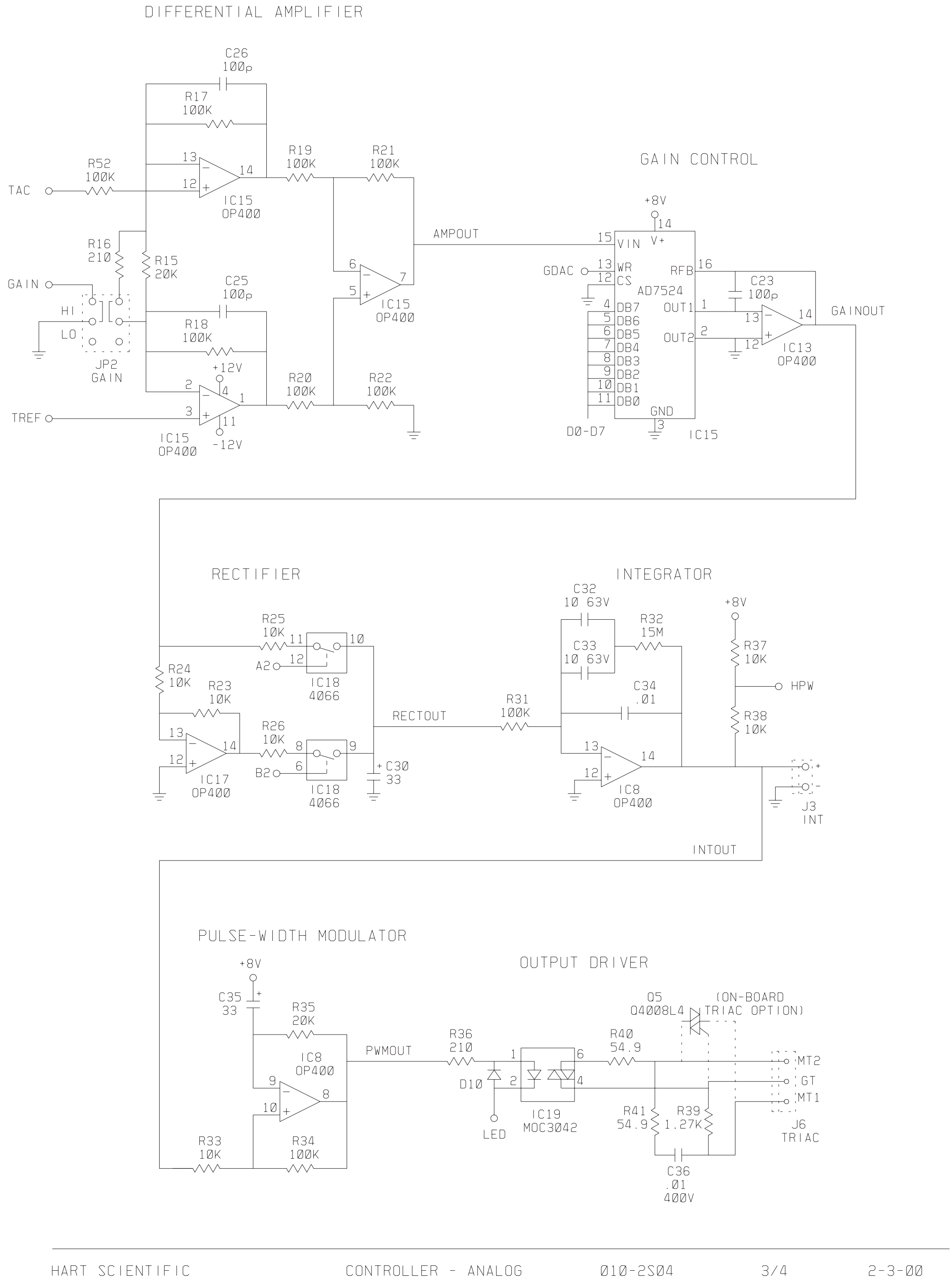


Figure 13 *Analog PCB Schematic Diagram Part No. 40003110 — 3 of 4*

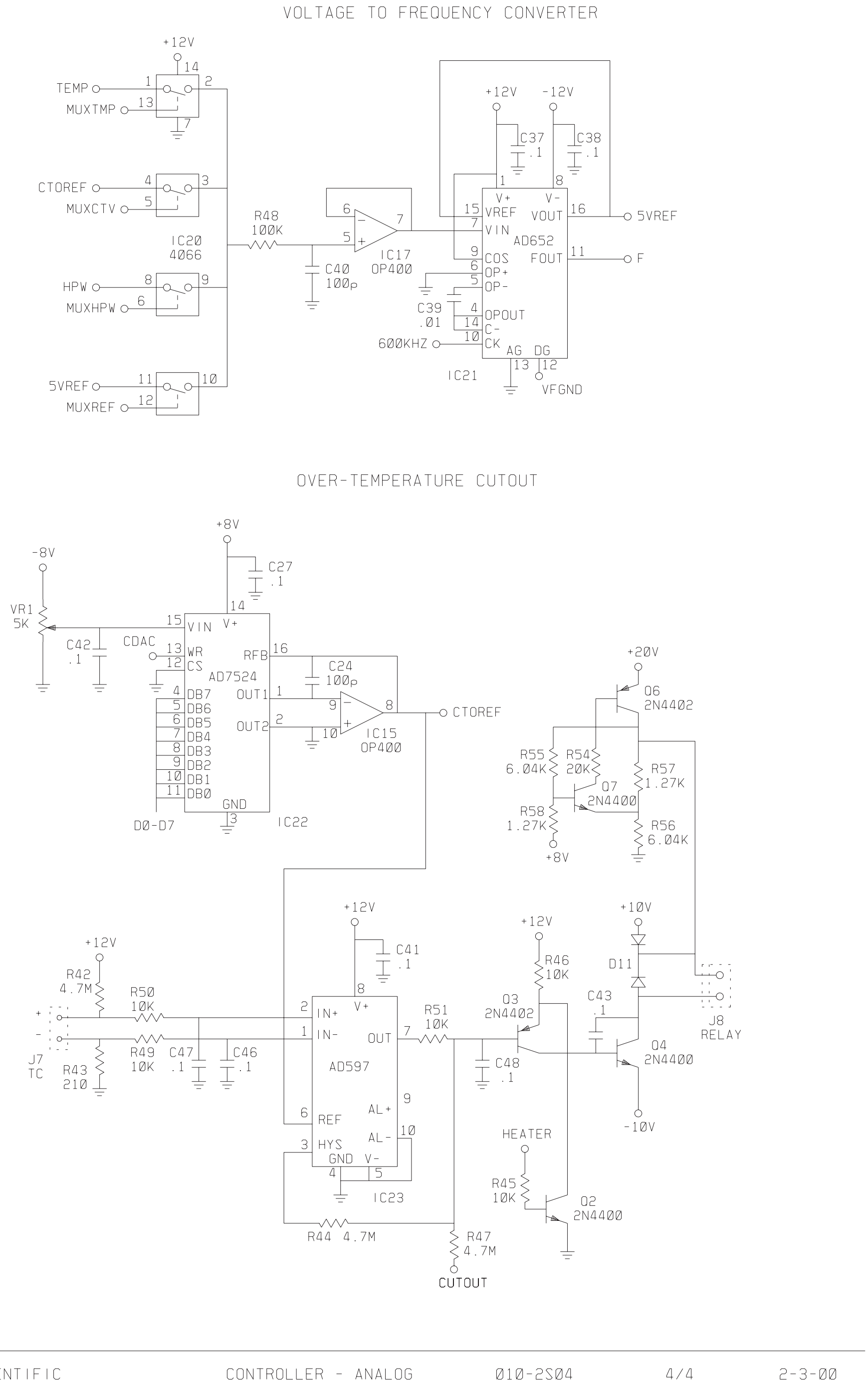


Figure 14 *Analog PCB Schematic Diagram Part No. 40003110 — 4 of 4*

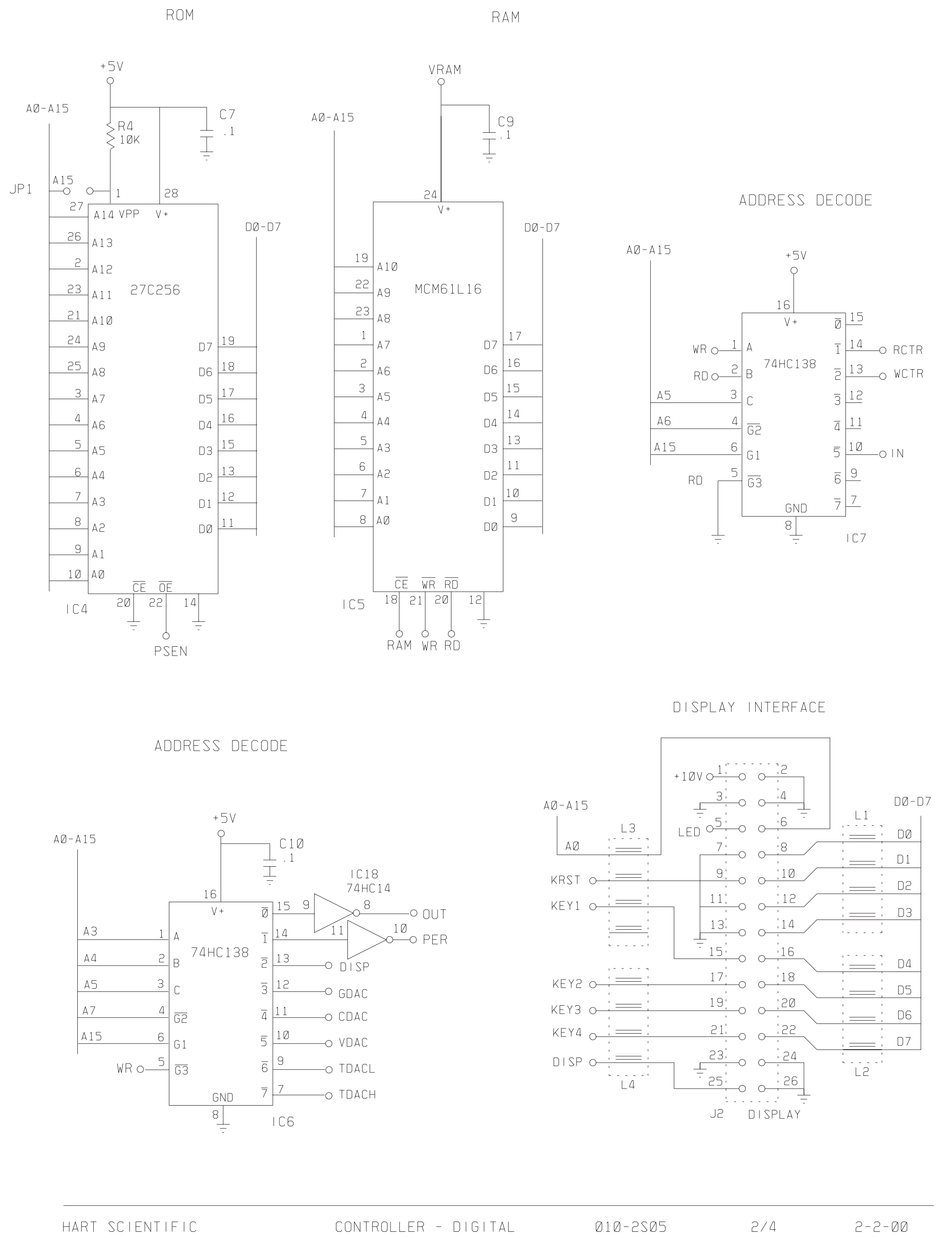


Figure 15 *Digital PCB Schematic Diagram, Part No. 40003115 — 1 of 4*

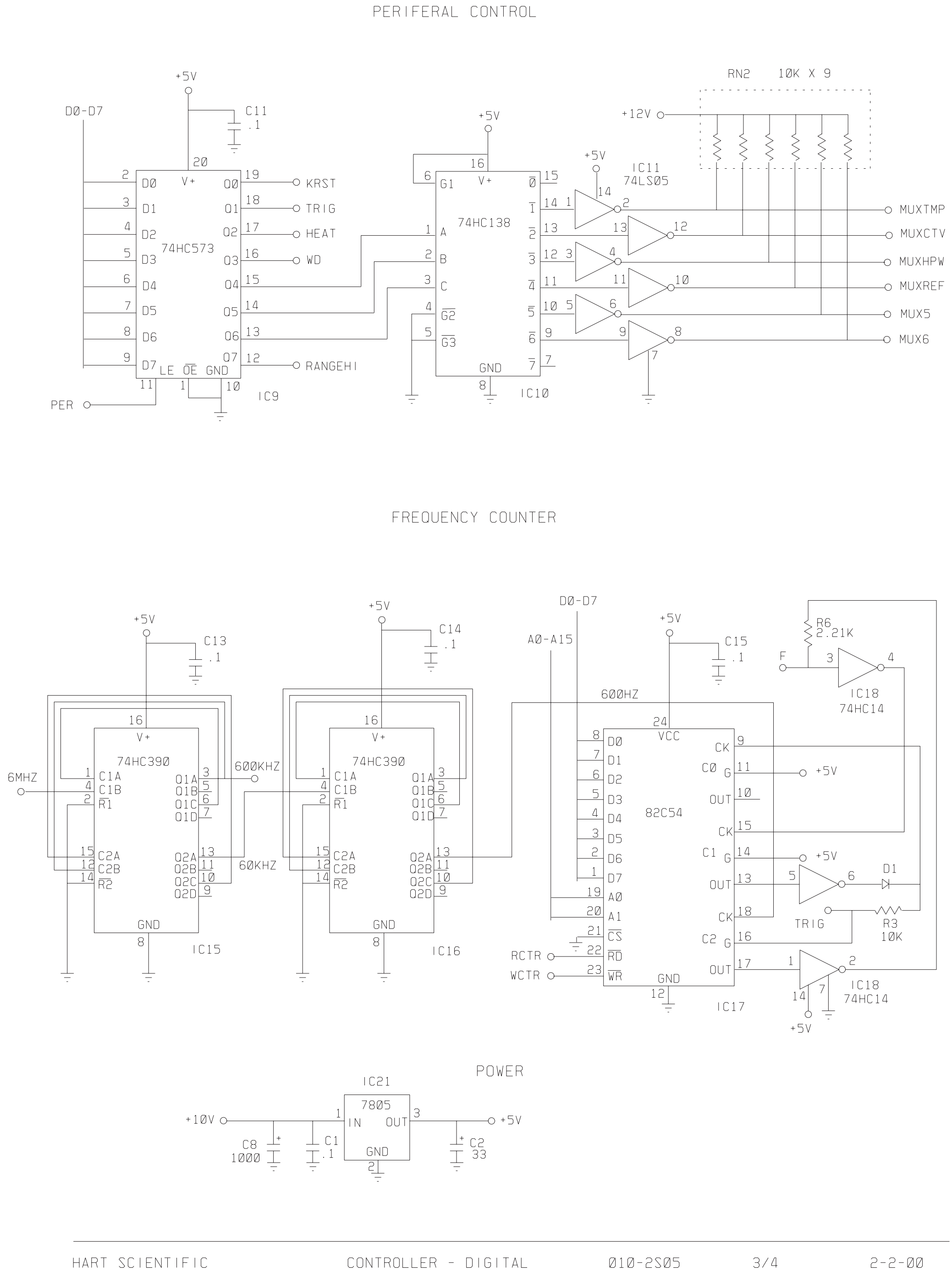


Figure 16 *Digital PCB Schematic Diagram, Part No. 40003115 — 2 of 4*

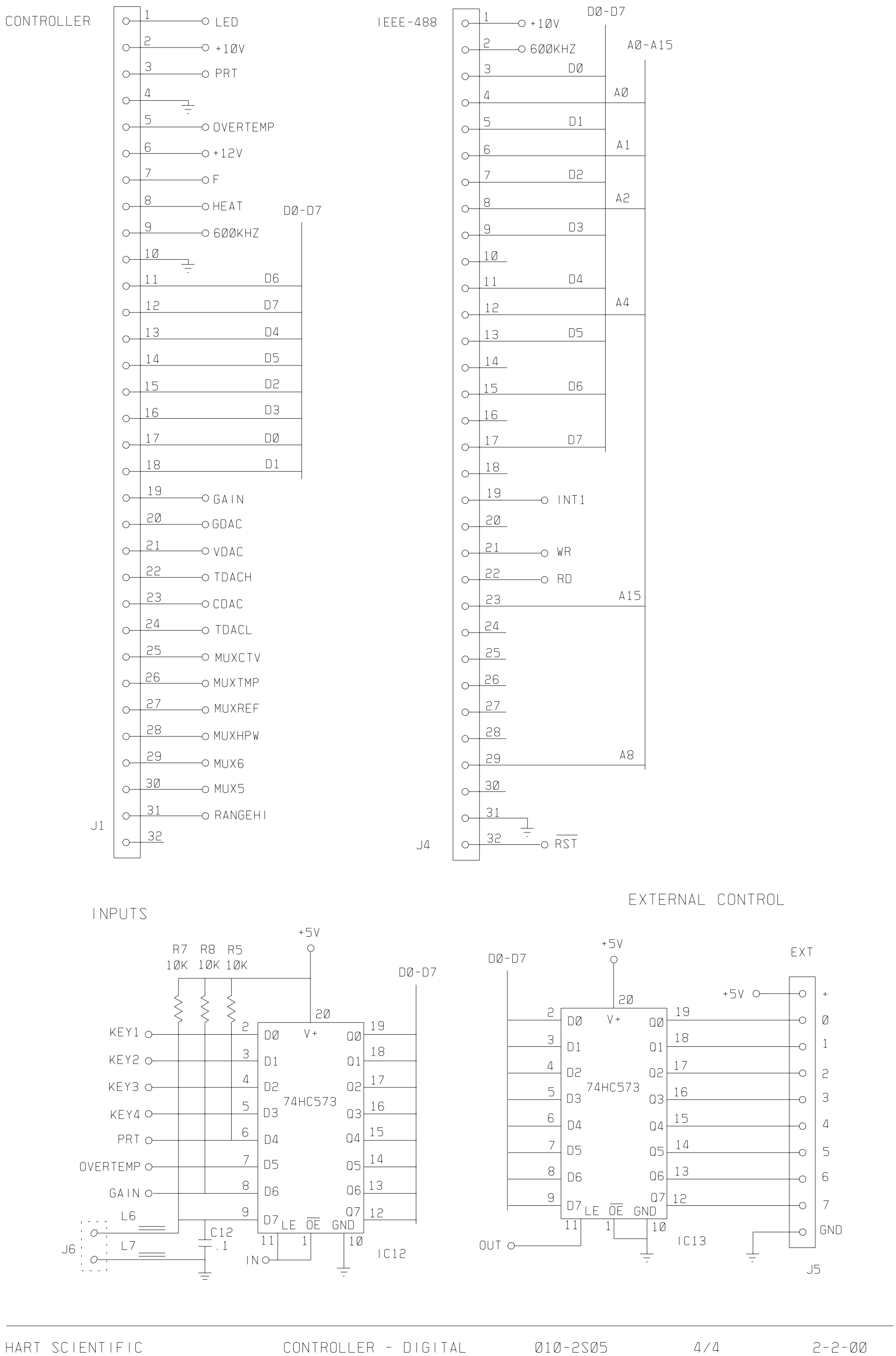


Figure 17 *Digital PCB Schematic Diagram, Part No. 40003115 — 3 of 4*

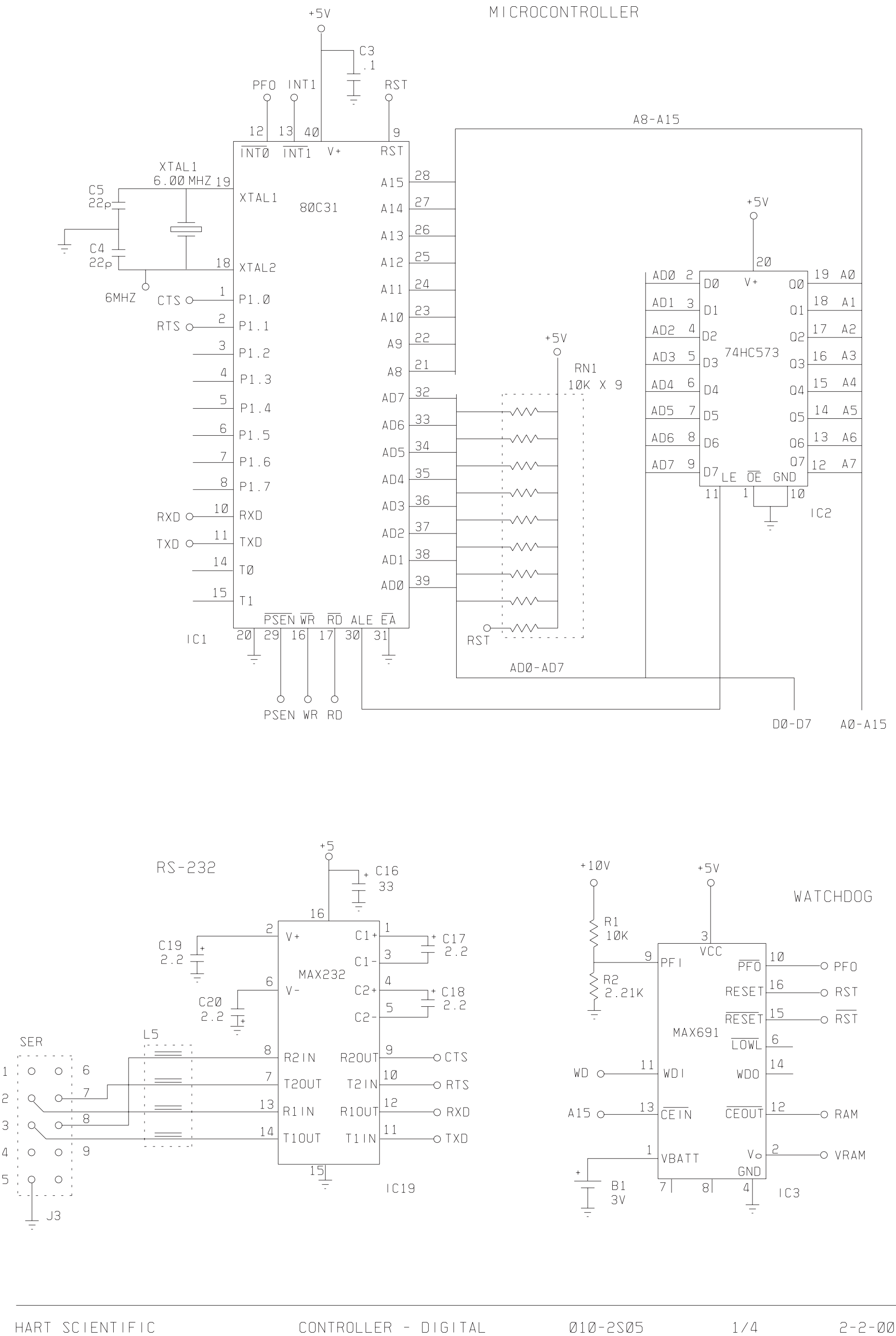


Figure 18 *Digital PCB Schematic Diagram, Part No. 40003115 — 4 of 4*

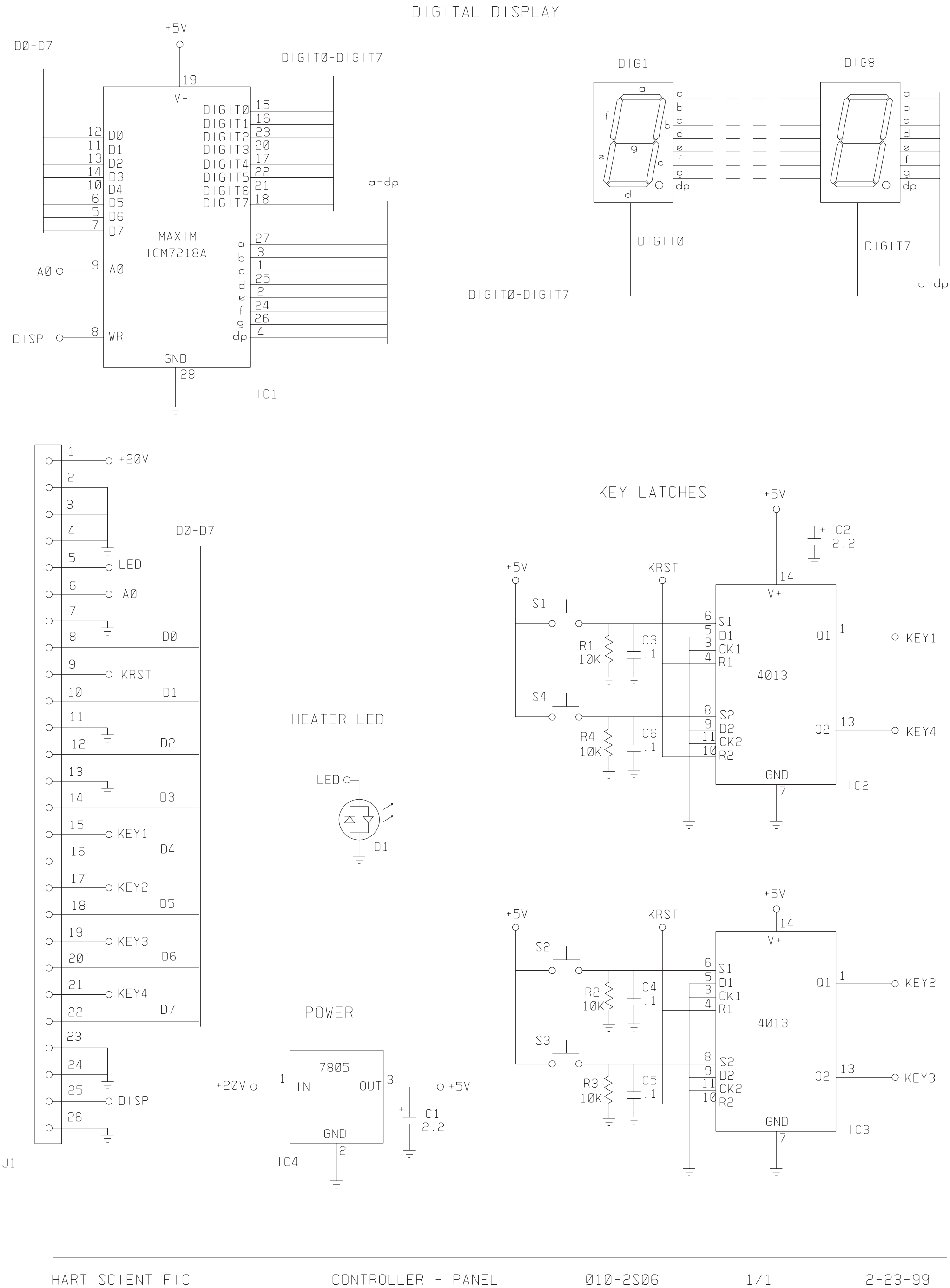


Figure 19 *Display Control PCB Schematic Diagram, Part No. 40003120 — 1 of 1*

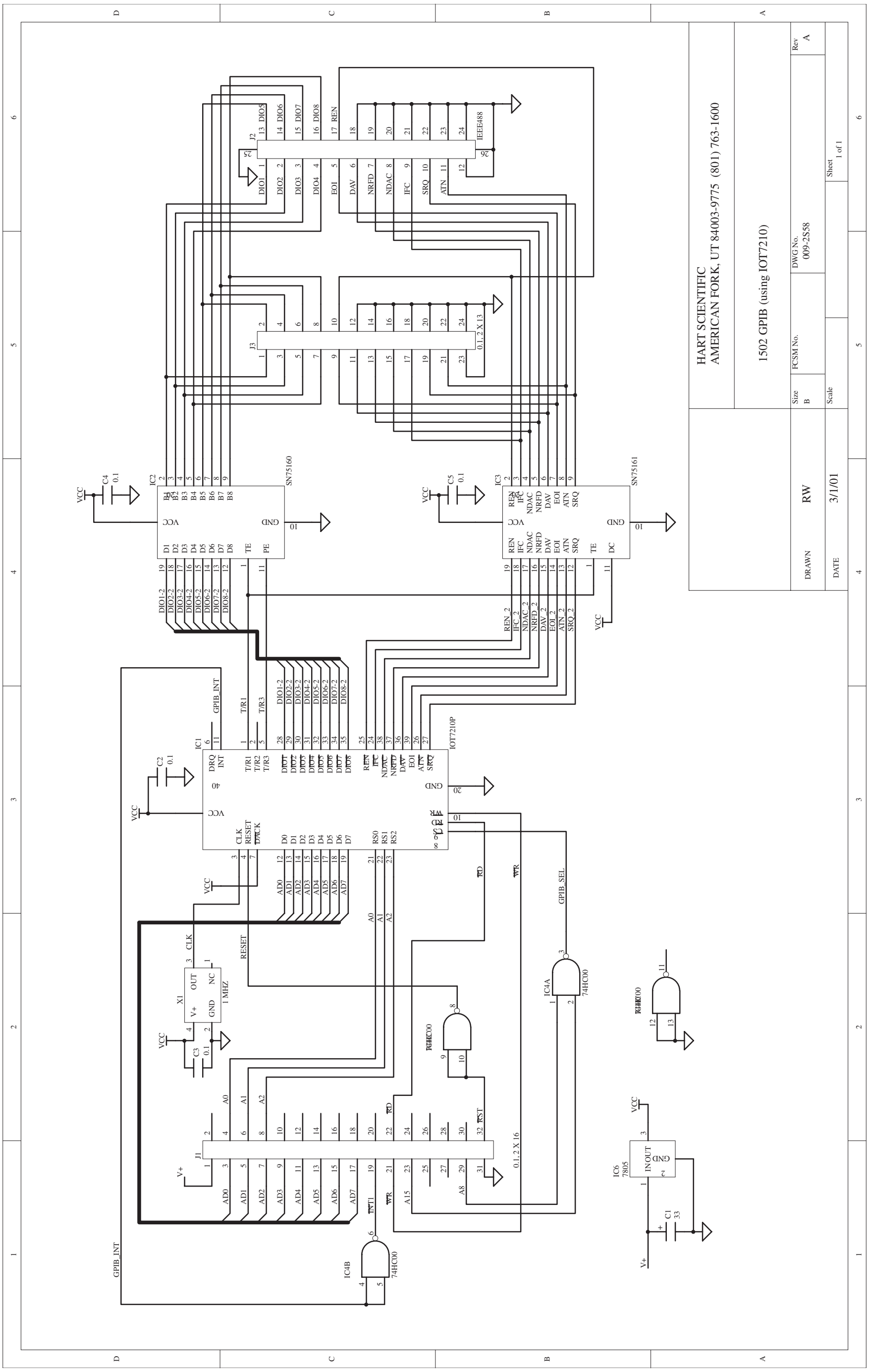


Figure 20 *IEEE-488 PCB Schematic Diagram, Part No. 40004490— 1 of 1*

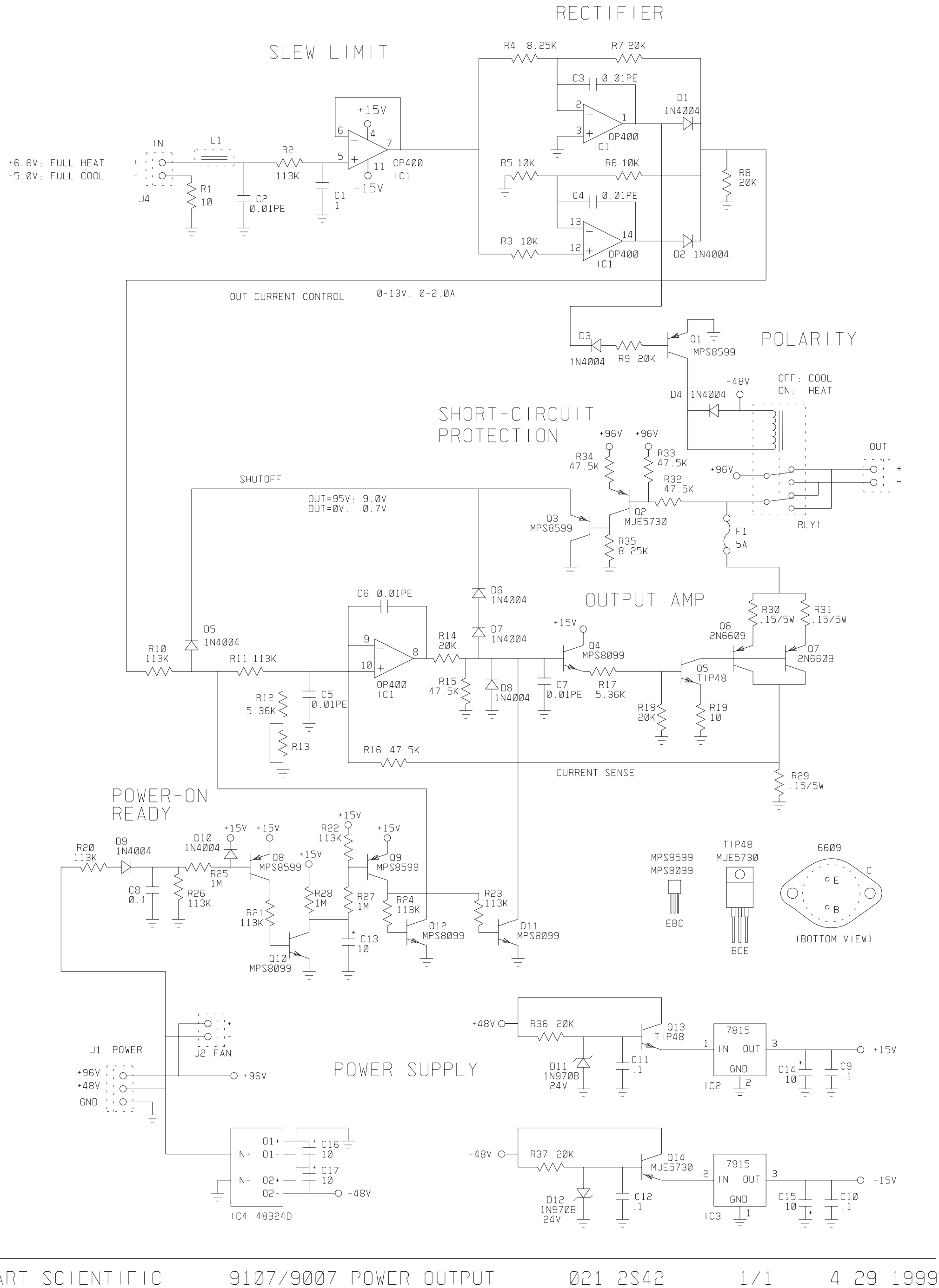


Figure 21 Output PCB Schematic Diagram, Part No. 40002418— 1 of 1

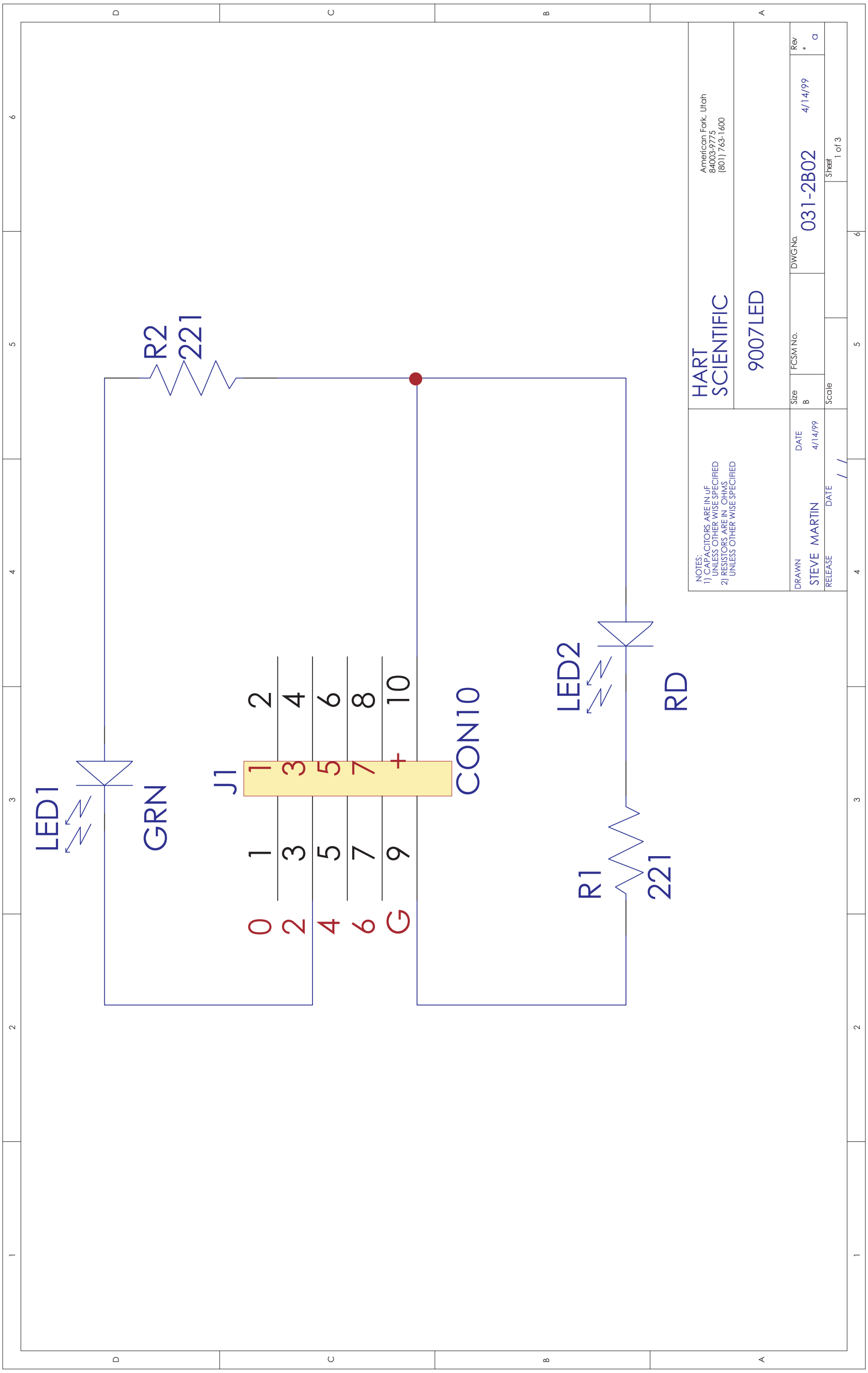


Figure 22 Power and Ready Indicator PCB Schemmatic Diagram, Part No. 40002136 - 1 of 1