

Model 9113
Portable Furnace
User Manual

HART
SCIENTIFIC



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WARNING

To ensure the safety of operating personnel, and to avoid damage to this equipment:

DO NOT operate this unit without a properly grounded, properly polarized power cord.
DO NOT connect this unit to a non-grounded, non-polarized outlet.

DO USE a ground fault interrupt device.

WARNING

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.

WARNING

HIGH TEMPERATURES PRESENT

in this equipment

FIRES AND SEVERE BURNS

may result if personnel fail to observe safety precautions.

WARNING

To ensure the safety of personnel, and to avoid damage to equipment:

DO NOT use this unit for any application other than calibration work.
DO NOT use this unit in environments other than those listed in the user's manual.

Continuous use of this equipment at high temperatures for extended periods of time
requires caution.

Completely **unattended high temperature operation is not recommended** for
safety reasons.

Components and heater lifetimes can be shortened by continuous high temperature operation.

Follow all safety guidelines listed in the user's manual.

WARNING

THIS EQUIPMENT SHOULD ONLY BE USED BY TRAINED PERSONNEL.

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1 Introduction

The model 9113 Portable Calibration Furnace was designed specifically for calibrating PRT's, fiber optic sensors and thermocouples at the higher temperature ranges up to 1100°C. The furnace utilizes an equilibrium block capable of making comparison measurements. Temperature stability is better than $\pm 0.75^\circ\text{C}$ throughout the range and the gradient between wells at full insertion is less than 1.0°C ($\pm 0.25^\circ\text{C}$).

The temperature control system utilizes a digital controller with a type K thermocouple control sensor. An RS-232 interface is optional. The controller displays

the set temperature and the actual temperature simultaneously. The displays show temperature to the nearest degree in $^\circ\text{C}$ or $^\circ\text{F}$ (normally shipped in $^\circ\text{C}$, may be changed to $^\circ\text{F}$). The temperature is set with convenient up and down buttons on the front panel.

The furnace is protected from excessive temperature with an over-temperature cut-out. The cut-out is relay operated and independent from the temperature controller to protect against the possibility of thermal runaway due to a shorted solid state relay which controls the heater.

2 Specifications and Environmental Conditions

2.1 Specifications

See [Table 1](#).

2.2 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: 5–50°C (41–122°F)
- ambient relative humidity: 15–50%
- pressure: 75kPa–106kPa
- mains voltage within $\pm 10\%$ of nominal
- vibrations in the calibration environment should be minimized
- altitude does not effect the performance or safety of the unit

2.3 Warranty

The 9113 calibration furnace is covered by a 1 year warranty that takes effect 10 days after the product is

Table 1 Specifications

Operating Range:	200°C to 1100°C
Stability:	$\pm 0.75^\circ\text{C}$
Test Well:	1.3" Dia. X 10.5" Deep. Available inserts size the well for best thermal contact with the probe.
Inserts:	Special high temperature alloy. Standard inserts include a reference and a test hole. One insert is included with the 9113 with 1 hole for 0.25" dia. probes and one for 0.28" dia. standard. Additional custom drilled inserts are available with holes sizes starting at 3/16" (probe size fit). Insert block dimension is 1.25" dia. X 6" long.
Interface:	Optional, RS-232 serial interface for computer controlled operation
Cooling:	Built in fan keeps enclosure cool and assists cool down after high temperature use
Size:	17.5 H X 13" W X 7" D
Weight:	22 lb.

shipped. This warranty excludes breakage of the quartz tube. The manufacturer will provide parts and labor without charge for repair or replacement of the instrument due to defects in material or workmanship. The warranty will not apply if the product has not been used according to the instruction manual or has been

tampered with by the user. For service or assistance, please contact the manufacturer.

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3 Safety Guidelines

- Operate the instrument in room temperatures between 5-50°C (41-122°F). Allow sufficient air circulation by leaving at least 6 inches of space between the furnace and nearby objects. Overhead clearance needs to allow for safe and easy insertion and removal of probes for calibration. If the furnace is equipped with cooling coils, use cold water circulation when the furnace is used above 600°C.
- The furnace is a precision instrument. Although it has been designed for optimum durability and trouble free operation, it must be handled with care. The instrument should not be operated in wet, oily, dusty or dirty environments. It is important to keep the well of the instrument free of any foreign matter. Do not operate near flammable materials.
- Do not use fluids to clean out the well.
- The furnace generates extreme temperatures. Precautions must be taken to prevent personal injury or damage to objects. Probes may be extremely hot when removed from the furnace. Cautiously handle probes to prevent personal injury. Carefully place probes on a heat resistant surface or rack until they are at room temperature.
- Use only a grounded AC mains supply of the appropriate voltage to power the instrument. The furnace requires 8 amps at 115 VAC ($\pm 10\%$), single phase, 50/60 Hz. (optional 230 VAC ($\pm 10\%$))
- Before initial use, after transport, and anytime the furnace has not been energized for more than 10 days, the instrument needs to be energized for a "dry-out" period of 1-2 hours before it can be assumed to meet all of the safety requirements of the IEC 1010-1.
- The instrument is equipped with operator accessible fuses. If a fuse blows, it may be due to a power surge or failure of a component. Replace the fuse once. If the fuse blows a second time, it is likely caused by failure of a component part. If this occurs, contact Hart Scientific Customer Service. Always replace the fuse with one of the same rating, voltage, and type. Never replace the fuse with one of a higher current rating.
- If a mains supply power fluctuation occurs, immediately turn off the furnace. Power bumps from brown-outs and black-outs can damage the instrument. Wait until the power has stabilized before re-energizing the furnace.

4 Quick Start

4.1 Unpacking

Unpack the furnace 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:

- 9113 Furnace
- Model 3189, Equilibration Block Assembly
- Equilibration Block Assembly Removal Tool
- Power Cord
- Manual

The equilibration block assembly is packed separately in order to protect the quartz tube from breakage during shipment. The equilibration block assembly should not be installed into the furnace until it has been placed in location.

4.2 Set-up

Place the furnace on a flat surface with at least 6 inches of free space around the instrument. Plug the power cord into a grounded mains outlet. Observe that

the nominal voltage corresponds to that indicated on the back of the furnace.

Carefully insert the equilibration block into the well using the removal tool to lower the block in place. The well must be clear of any foreign objects, dirt, and grit before the equilibration block is inserted.

Turn on the power to the furnace by toggling the power switch on. 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 well heater starts operating to bring the temperature of the well to the set-point temperature.

4.3 Power

Plug the furnace power cord into a mains outlet of the proper voltage, frequency, and current capability. Typically this outlet is 115 VAC ($\pm 10\%$), 50/60 Hz or 230 VAC ($\pm 10\%$), 50/60 Hz. Turn the furnace on using the front panel on/off switch. The furnace turns on and begins to heat to the previously programmed temperature set-point. The front panel LED display indicates the actual furnace temperature.

5 Installation

5.1 Location

The furnace is intended to be used in any environment which is clean, safe and reasonably free from drafts. The best results from the furnace will be realized if the temperature fluctuations in the room are not excessive. A minimum of 6 inches free air space around the furnace must be allowed. This will allow air exchange to safely remove excess heat from the furnace.

DANGER

This furnace is intended for high temperature use and consequently a fire danger exists. Keep away from flammable materials and keep fire extinguishing equipment near by.

5.2 Power

The furnace's nominal voltage is 115 VAC ($\pm 10\%$), 8 amps, single phase, 50/60 Hz. A six foot 16 AWG, 2 conductor with ground, removable power cord is provided. Be sure an adequate ground is provided.

5.3 "Dry-out" Period

Before initial use, after transport, and any time the instrument has not been energized for more than 10 days, the instrument will need to be energized for a "dry-out" period of 1–2 hours before it can be assumed to meet all of the safety requirements of the IEC 1010-1.

5.4 Equilibration Block Installation

After the furnace has generally been installed, the equilibration block may be inserted. Carefully insert the block into the quartz tube. See [Figure 1](#) on page 13. Extreme care should be taken installing the Equilibration Block since it is very heavy and the quartz tube is very fragile. Care must be taken to prevent dirt, insulation, or other foreign materials from getting between the block and the quartz tube or it might break during heat up due to thermal expansion differences. The fit between the block and the tube is typically loose in order to accommodate this expansion. A handle is provided to insert the block. It consists of a stainless steel rod with a 1/4-20 threaded end which is screwed into the top of the block. The block is then lowered down over the control and cut-out sensors using the handle and allowed to rest on the ceramic fiber insulation on the bottom of the well. You will notice that there are grooves on either side of the block for the sensors to slide into. The grooves have a tapered opening at the bottom to facilitate entry of the sensors.

WARNING

When the furnace must be moved for any reason, remove the block assembly to prevent breakage of the quartz tube.

6 Parts and Controls

6.1 Top Panel

See [Figure 1](#).

The heater is made of a fiber ceramic insulating material with the heating element imbedded. The heater is cylindrical in shape and is enclosed in an aluminum case with additional ceramic fiber insulation surrounding it. The heater provides about 850 watts of heating power. The heater is primarily a radiating device and is rated for a maximum furnace operating temperature of 1100°C. Realize, however, that the higher the operating temperature the lower the lifetime of any high temperature heater. Limiting the number of hours at the extreme high end of the temperature range to only the time required for calibrations will increase the longevity of your furnace heating element.

6.1.1 Temperature Controller

The temperature controller (see [Figure 2](#) for detail) is a full PID micro-processor based instrument as indicated. It is set to cover the range of 0 to 1100°C. It features two LED type displays. The upper display normally indicates the actual temperature while the lower display indicates the set temperature. The displays are also utilized in setup and alarm functions. Other indicators include the OP1 and OP2 indicator lights. The OP1 indicator lights when the heater is on. The "M" indicator flashes if the sensor fails. If the sensor opens, the heaters will shut off.

The OP2 and "R" are not functional in this unit.

6.1.1.1 Temperature Adjustment Up/Down Keys

See [Figure 2](#). The up and down arrow keys are used to increase and decrease the set temperature, select

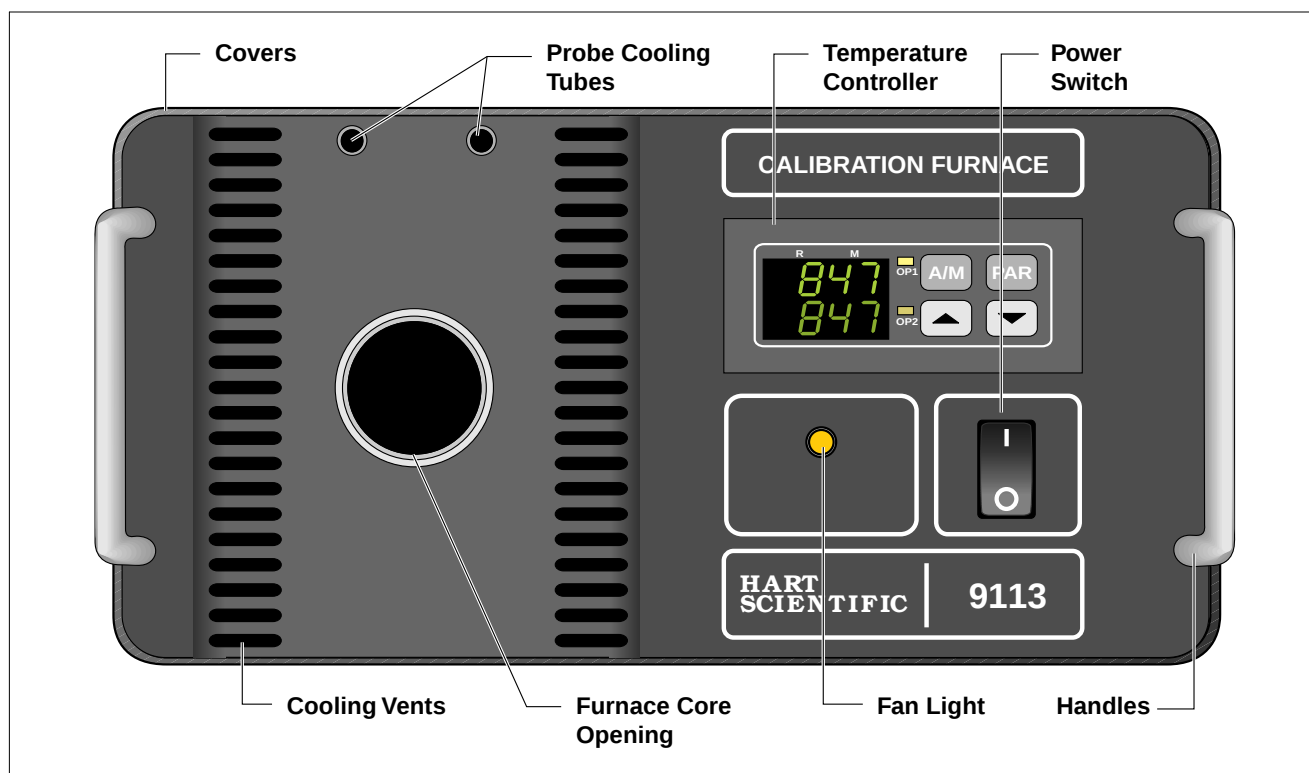


Figure 1 Top Panel

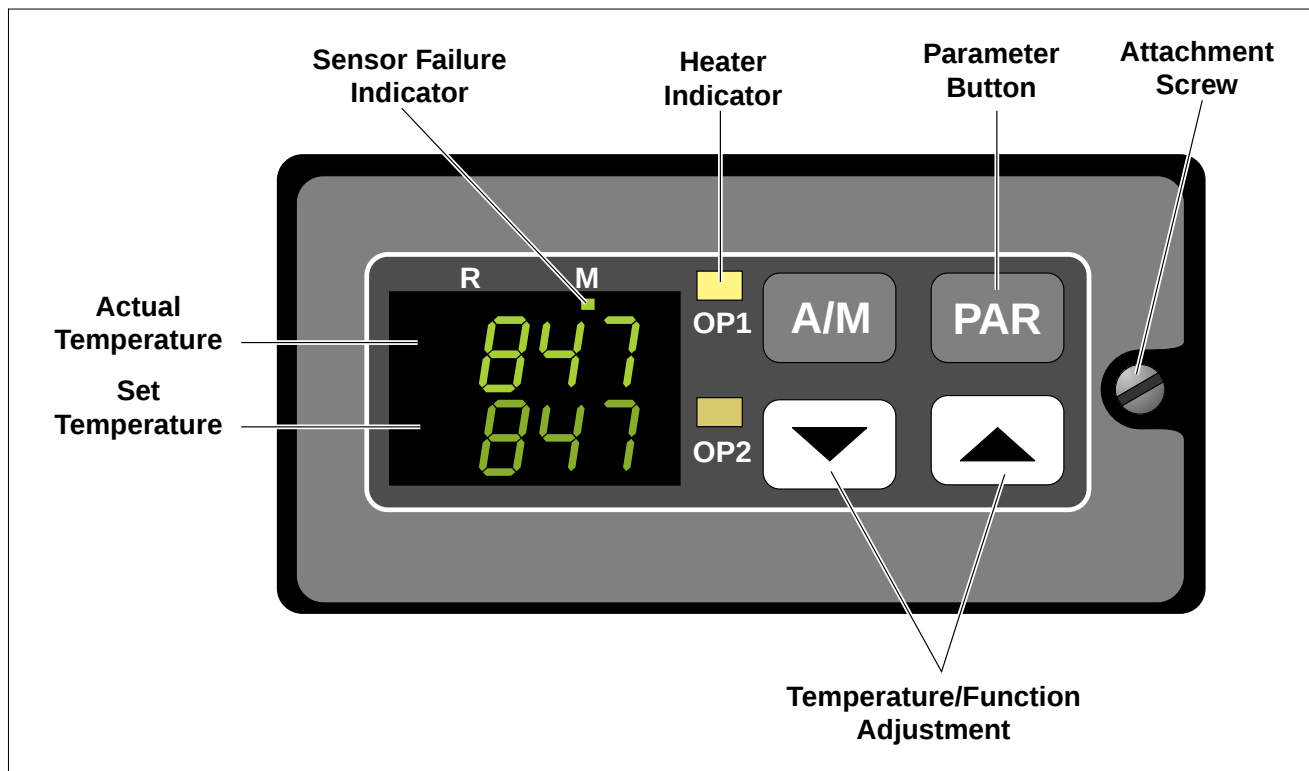


Figure 2 Temperature Controller (enlarged view)

between °C and °F, and other functions. A quick single stroke will increment or decrement the temperature setting. Holding the buttons down causes a gradual acceleration of the temperature setting. When these buttons are used to adjust other functions or “parameters”, they are used in conjunction with the “PAR” button.

6.1.2 Power Switch

The power switch is located on the right side of the furnace just under the temperature controller. The bottom is pressed inward revealing the bright reddish colored portion indicating the switch is actuated on. Note that the internal fan is wired ahead of the power switch so that it will stay on until the fan thermostat determines that the unit is cooled even though the main power may have been turned off. This way the outer surfaces of the enclosure will not be heated to dangerous levels from stored heat. The fan does not come on until the internal temperature rises adequately to actuate the thermostat.

6.1.3 Fan Light Indicator

The fan light indicator comes on when the fan thermostat reaches about 40°C inside the chassis and actuates. This light will stay on as a reminder to leave the power connected until the unit has sufficiently cooled.

6.1.4 Probe Cooling Tubes

Two probe cooling tubes are built into the model 9113 furnace. They have the capacity of cooling up to two 3/8 inch diameter probes with out any danger to the furnace, facility or other equipment in the area. Avoid laying hot probes on surfaces which are flammable or may be damaged by high heat.

6.1.5 Handles

Handles are provided on each end of the furnace to allow transport of the unit as needed. Remove the equilibration block before moving any distance as a precaution against breakage.

6.1.6 Cooling Vents

The cooling vents in the top and in the front and rear covers provide inlets for air to circulate through the chassis and keep it cool. The air is expelled through the rear of the chassis at the fan exit.

6.2 Equilibration Block Assembly

See [Figure 3](#).

The equilibration block is intended to stabilize the temperature fluctuations and to conduct heat between the test wells in order to equalize them. The whole assembly is supported by a quartz tube and fiber ceramic insulation. Two grooves along the sides of the block provide contact with the control thermocouple and the over-temperature cut-out thermocouple. All heated materials are quartz, ceramic fiber, or INCONEL (alloy 600 or other related high oxidation resistant metals).

The top view of the block reveals 3 holes; the test probe hole, the reference thermometer hole, and the removal tool hole. The standard equilibration block is sized for .25 and .28 inch diameter probes, however, custom options are possible. The block removal tool hole is a 1/4-20 threaded hole to allow a similarly threaded tool to be inserted for the ease of insertion and removal of the block.

6.2.1 Temperature Control and Cut-out Sensors

The temperature control sensor is a type K as indicated. It is grounded to the INCONEL sheath. The probe is normally inserted as shown in [Figure 3](#). It fits in a slot along the thermal equilibration block as indicated.

The cut-out sensor is the same as the control sensor. It is inserted along the groove on the opposite side from the control thermocouple. It helps prevent the heater elements from overheating thus prolonging their life.

6.3 Back Panel

See [Figure 4](#).

The nomenclature on the rear panel of the furnace provides important information to the user in case service is required. Note that the manufacturer (Hart Scientific, Inc.), manufacturers location (American Fork, Utah 84003, USA) and model number data specific to this unit are provided. Refer to the Model and Serial numbers whenever service is required.

6.3.1 Power Cable

The furnace is provided with a 16 gauge two conductor with ground molded cordset. The cordset is removable for convenience in moving the unit.

6.3.2 Fuse

The fuses used are 10 amp fuses. They protect the system 115 VAC power and are easily accessed from the rear of the furnace. If the furnace fails to operate, check these first.

6.3.3 RS-232 Port (Optional)

An RS-232 serial port is available as an option for computer control of the furnace. It is located on the rear panel of the unit as shown. See Digital Communications Interface, [Section 8](#).

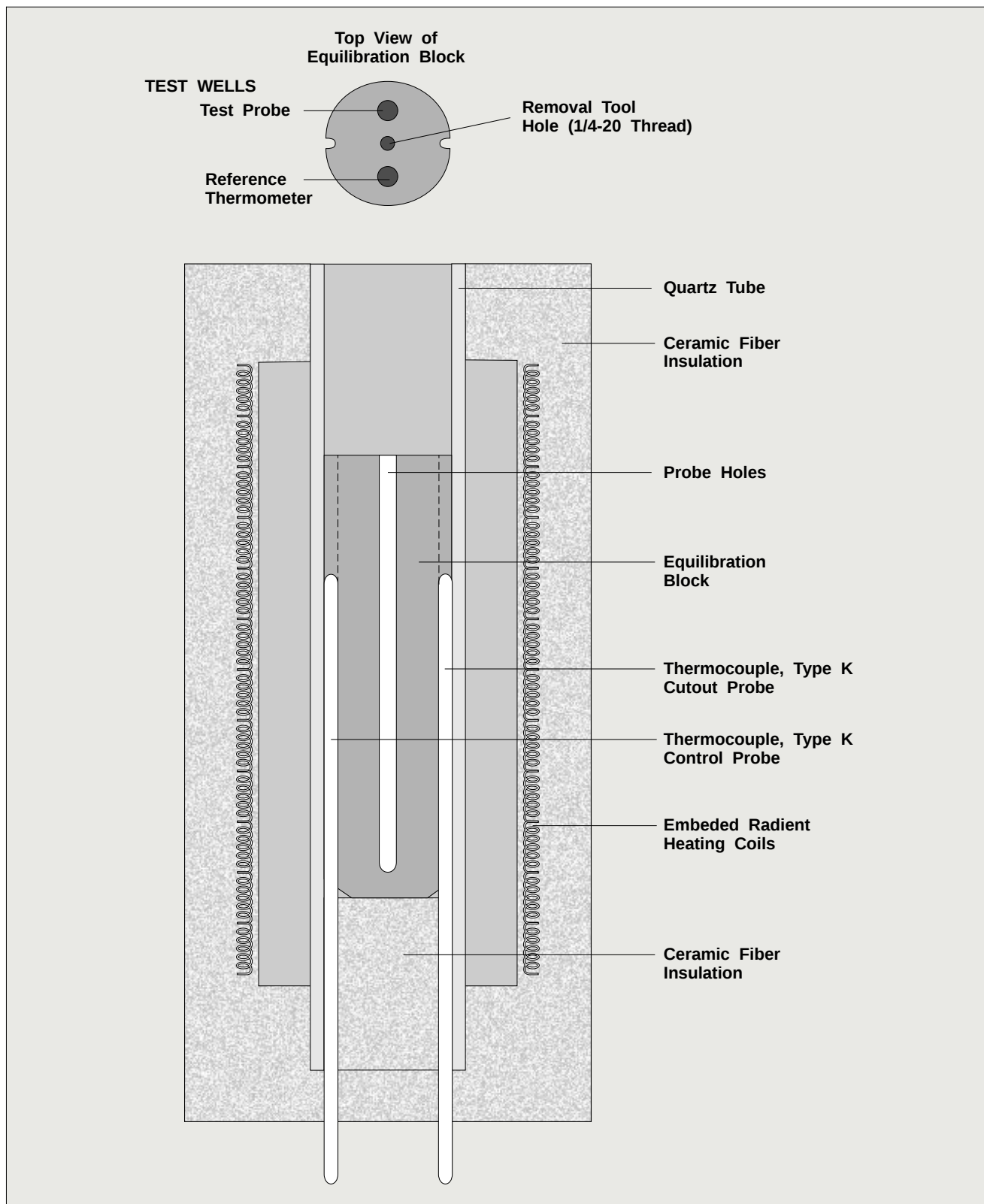


Figure 3 Equilibration Block Assembly

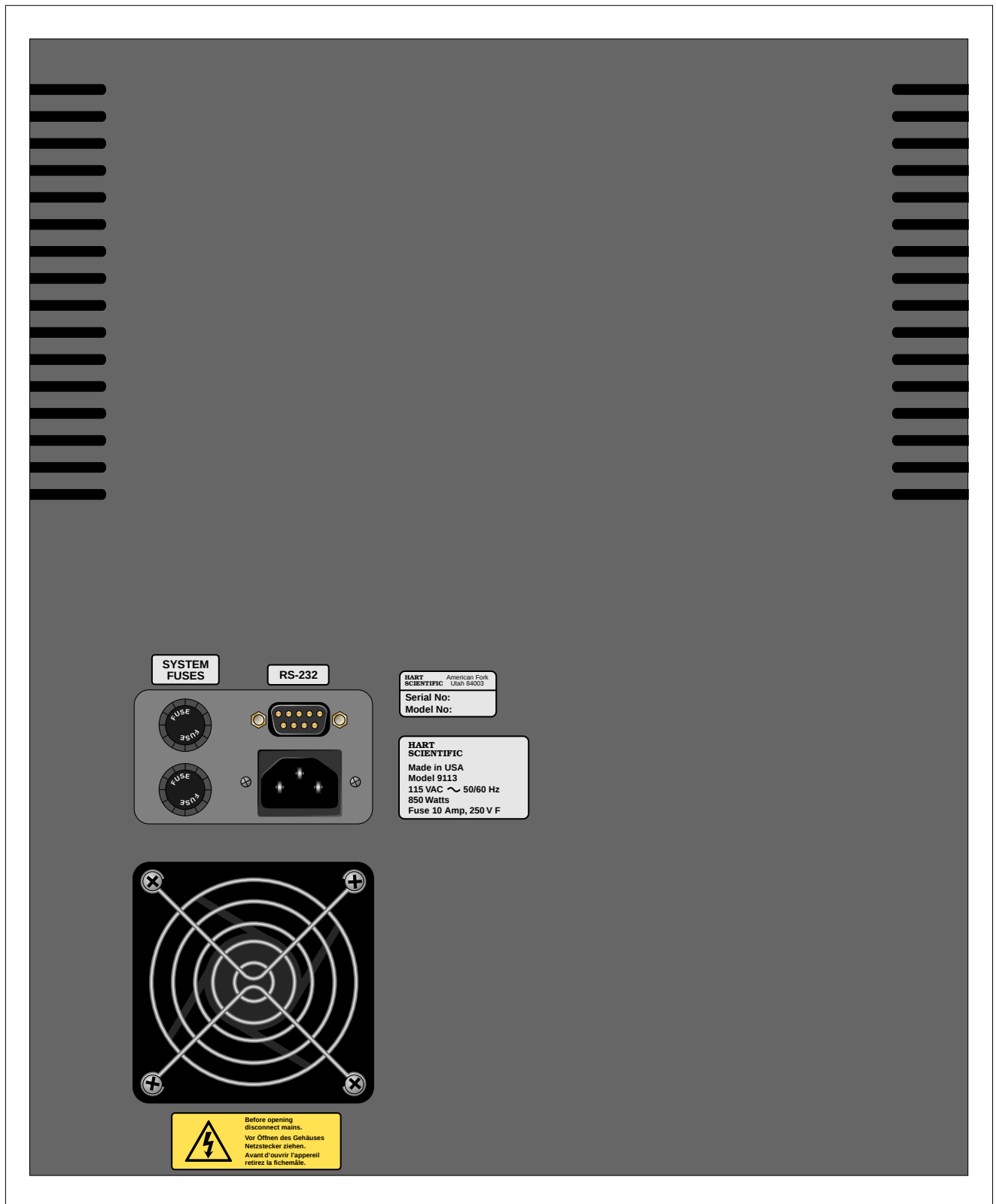


Figure 4 Back Panel

7 General Operation

7.1 Overview

The model 9113 is a temperature controlled furnace utilizing a full PID micro-processor based temperature controller with a type K thermocouple temperature sensor. The temperature controller sends a time proportional signal to the solid state relay (triac) which regulates the current to the heater. The object of temperature control is the equilibration block with test wells containing the reference probe and the test sensor to be calibrated inside. This block provides a thermal mass which tends to stabilize the temperature and reduce the gradients between the test wells. The furnace cabinet contains ventilation holes as well as a fan controlled by a thermostat. This cooling capability prevents the surface of the enclosure from getting hot. In the event that the fans should fail, a second thermostat is installed in the cabinet which will shut down the furnace heaters if the cabinet exceeds a safe temperature.

7.2 Operating the Temperature Controller

Operating the model 9113 is straight forward once you have grasped all the basic principles.

Temperature selection accomplished by using the up and down arrow keys on the front of the temperature controller. The lower display will indicate the new temperature setting while the upper display shows the actual temperature. When scanning from one temperature to another you will notice that the temperature controller seems to be ahead of the temperature of the equilibration block. This is because the temperature control sensor is near the outside of the block for rapid control response and it takes some time for the heat to conduct into the center. Depend on your external temperature monitor to establish when the equilibration block has reached the desired temperature and achieved stability.

The actual temperature indication made by the temperature controller is not intended to be a calibration reference, but to merely provide a general indication of the furnace temperature. NIST traceable standard thermometers are available and should be used in

making comparison measurements. For less stringent measurements, you may make a calibration of the controller and control probe at particular temperature points and use that with reasonable accuracy for a time.

WARNING

Take care that all sensors used as references or being calibrated in the furnace are capable of withstanding the desired temperature range to be used.

For best results, all reference or sample probes should be inserted into the full depth of the well. At this position, the stability is the highest and the gradients are the lowest. Hart Scientific recommends that each user satisfy themselves as to what the uncertainties are in terms of stability and gradients between the test wells. Variations in equipment, probe size and configuration, etc. will have effects on these important factors. A solid (unstirred) mass such as in a furnace is subject to heat losses from the probe stem which varies from probe to probe and temperature to temperature. Typically, stabilities are better than $\pm 0.75^{\circ}\text{C}$. For calibrations that must be less than full insertion into the test well, make your own comparisons between the reference and test cell at that depth to establish the uncertainties.

The furnace can be used throughout the temperature range of 100 to 1100°C. Lower temperatures are sluggish however. High integrating values are required to maintain controller stability (1200 sec) at the lower temperatures.

WARNING

Take extreme care in handling hot probes. The extreme temperatures generated in a furnace of this type can cause serious personal injury. Do not touch them on external surfaces of the furnace or set them on any other surfaces unable to withstand those temperatures. A fire hazard exists.

7.2.1 Over Temperature Cut-out

The over temperature cut-out protects the furnace from exceeding its own safe operating range. The cut-out is factory set to about 1125°C. The cut-out

controls a relay which is wired in series with the heater circuit. The cut-out is provided as a safety backup in case the temperature controller or the triac circuit driven by the temperature controller fails causing thermal runaway.

8 Digital Communications Interface (optional)

If supplied with the option, the 9113 furnace is capable of being controlled by other equipment through the digital interface.

8.1 Wiring

The serial communications cable attaches to the furnace through the DB-9 connector at the back of the instrument. [Figure 5](#) shows the pin-out of the 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.

8.2 Example

First, make the appropriate cable assembly for your computer system. Connect the appropriate connectors to your computer and to the furnace. Load GWBASIC. Then load the program TC847.BAS. Run the program. Set the Baud Rate on the Controller of the 9113 to 9600. Next set the address of your furnace, it must be 10 or greater. Now you can set the temperature or if needed the furnace parameters. A listing of the parameters and their meaning are in the following table.

PV	process value (temperature)
SL	setpoint
OP	output power
XP	proportional band
TI	integration time
TD	derivative time
CH	Cycle time

To set a parameter, simply type in the parameter and the value. Example, SL=800. This sets the control temperature to 800°C.

The program supplied is a demo program and may be altered by you for your specific needs.

For details of controller operation, see the controller manual supplied. (The controller manual is supplied only with the RS-232 option.)

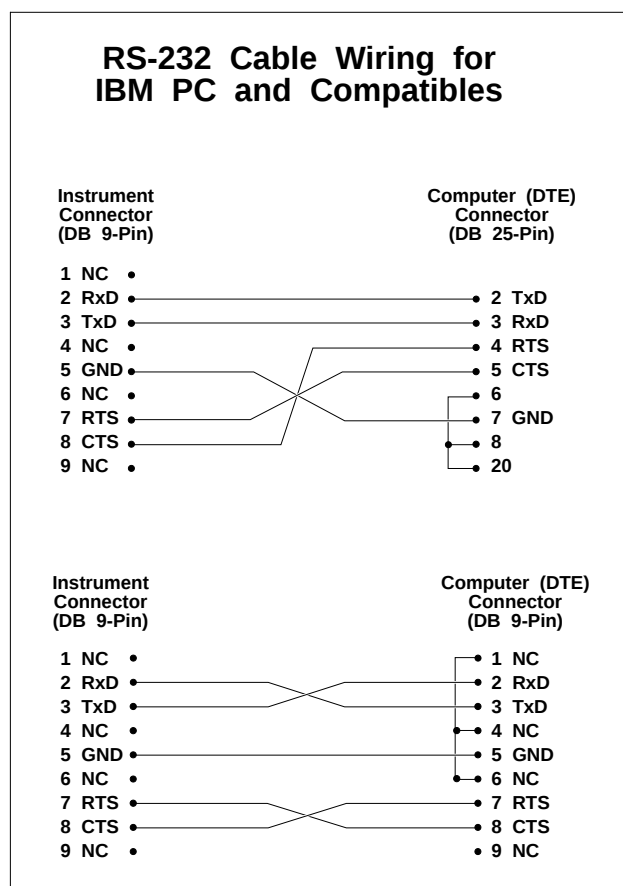


Figure 5 Serial Communications Wiring Diagram

9 Test Probe Calibration

For optimum accuracy and stability, allow the calibrator to warm up for 10 minutes after power-up and then allow adequate stabilization time after reaching the set-point temperature. After completing calibration, allow the block to cool before switching the power off. After the power is turned off, the fan continues to run and the “Fan Light Indicator” stays on until the unit is safely cooled .

9.1 Calibration Methods

9.1.1 Direct Calibration

Direct calibration involves testing a thermocouple probe directly against the furnace's 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 furnace calibrator. The probe should fit snugly into the equilibration 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 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 0.75°C for best results.

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.

9.1.2 Comparison Calibration

Comparison calibration involves testing a probe against a similar reference probe. The advantage to this method is that better accuracy can be achieved since errors due to furnace inaccuracy, stem effect, and drift can be reduced.

After inserting the probes to be calibrated, allow sufficient time for the probes to settle and the temperature of the furnace to stabilize.

It is best if both the reference probe and the probe under test are the same size and construction. Using probes with different lengths, diameters and materials results in different stem effects causing an unknown temperature difference. All furnaces have horizontal and vertical gradients that change with temperature . This is an unknown variable which can be factored out if probes are the same type, length, diameter, and material. Probes should be inserted to the same depth in the well.

The following procedure can be used to calibrate a probe against a reference while eliminating error due to temperature gradients between wells.

- Place the reference probe in one well.
- Place the probe to be calibrated, the unit under test (UUT), in another well.
- With the reference inserted into one well and the probe under test inserted into a second well, make measurements of each.
- Swap the locations of the reference probe and probe under test. Allow plenty of time for thermal settling.
- Make another set of measurements of the reference probe and the probe under test.
- Average the two measurements of the reference probe. Average the two measurements of the probe under test. Averaging the two measurements in this way eliminates error due to temperature gradients between the two wells.
- You may now compare the averaged measurement of the probe under test with the averaged measurement of the reference probe.
- For best results repeat the test several times at the same temperature and at different temperatures.

This method can be used with different types of probes but the user must determine the uncertainty of the measurement.

9.1.3 Calibration of Multiple Probes

Fully loading the calibrator with probes increases the time required for the temperature to stabilize after inserting the probes. Be sure that the temperature has stabilized before starting the calibration.

Multiple probes may be calibrated simultaneously using either the direct or comparison calibration method. Stem effect causes less error in the comparison calibration method than with the direct calibration method.

9.2 Furnace Characteristics

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

9.2.1 Vertical Gradient

There is a temperature gradient vertically in the test well. The heater has been applied to the block in such a way as to compensate for nominal heat losses out of the top of the furnace and minimize vertical temperature gradients. However, actual heat losses 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.

9.2.2 Stabilization and Accuracy

The stabilization time of the furnace calibrator depends on the conditions and temperatures involved. Typically, the furnace stabilizes to 0.75°C within 10 minutes of reaching the set-point temperature as indicated by the display. Ultimate stability is achieved 20 to 30 minutes after reaching the set temperature.

Inserting a cold probe into a well requires another period of stabilization depending on the magnitude of the disturbance and the required accuracy. For example, inserting a ¼ inch diameter probe at room temperature into a block at 300°C takes approximately 5 minutes to be within 0.75°C of its set-point and takes 10 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.

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 which may damage the paint.
- Be sure that the well of the furnace is kept clean and clear of any foreign matter. Do not use fluids to clean out the well.
- 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 Hart Scientific Customer Service 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 furnace may be impaired or safety hazards may arise.

WARNING

This unit contains ceramic fiber components. Service personnel coming into contact with these materials should take proper precautions when handling them.

11 Trouble Shooting

If problems arise while operating the 9113, this section provides some suggestions that may help you solve the problem. A wiring diagram is also included. Opening the unit without contacting Hart Scientific Customer Service may void the warranty.

The controllers without RS-232 capabilities are shipped with the calibration parameters "locked". Therefore, the user does not have access to these parameters. We do not recommend that the user unlock these parameters without contacting Hart Scientific Customer Service.

11.1 Troubleshooting

No Power, no display on controller

- Check that the power cord is plugged in
- Check that the power cord is seated securely in socket on rear of the unit.
- Check the system fuses. They may be blown.

Unit does not heat correctly

- Possible triac or relay problems. Contact Hart Scientific Customer Service.

Display shows extremely high temperatures even when unit is cool

- If the calibration parameters in the controller are unlocked, the type of thermocouple could

be wrong. Check to see that the controller is set for a Type K thermocouple.

- The Type K thermocouple may be disconnected or damaged. Contact Hart Scientific Customer Service.

Unit heats but does not achieve set point and an audible click or chatter is heard

- The electric cut-out board is either damaged or out of calibration. Contact Hart Scientific Customer Service.
- The nominal voltage is less than 100 VAC. Check the voltage at the wall socket. If this is a "brown out," turn the unit off until the power is restored. If the voltage is continuously less than 100 VAC, check with the local utility company. If the unit was ordered specifically for a nominal voltage of 100 VAC or less (Japan), Hart has compensated for this before shipping the furnace.

Unit heats but does not achieve set point and the display shows alarm messages

- "Hi alarm" and/or "D alarm" parameters in the controller are not set properly or the thermocouple may be damaged. Contact Hart Scientific Customer Service to check all parameters in the controller. The controllers without RS-232 capabilities are shipped with the calibration parameters "locked". Therefore, the user does not have access to these parameters.

11.2 Wiring Diagram

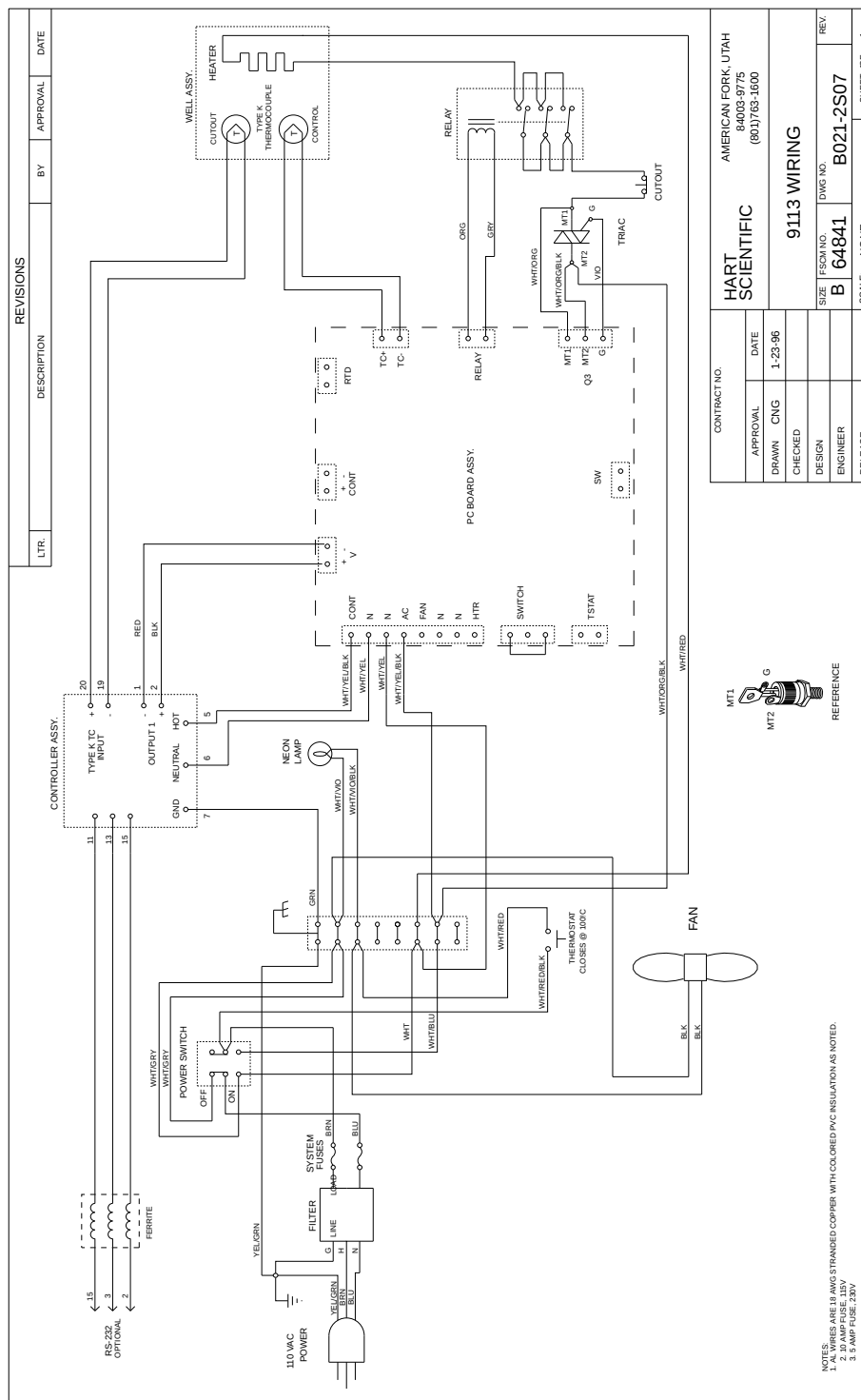


Figure 6 Wiring Diagram