TEMPERATURE CONTROLLED
CHAMBER
MODEL 9300A

OPERATOR MANUAL

9300A.OM Rev.7

2018-01-31

Approved By:

QA:

S/N:

Form MI 65, Rev. 1, dated 09-01-27 (QAP 19,App.”M”)

The 9300A is an Electrostatic Sensitive Device (ESD). Failure to observe standard, antistatic practices can result in degradation of performance or improper measurement results, even when an actual failure does not occur. Do not touch the terminals during measurement and avoid any electrostatic discharge, namely when the measurement is running.

To ensure CE power line pulse rejection compliance, the 9300A must be operated using the power cord supplied by the manufacturer (MIL).

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LIST OF FIGURES

1 INTRODUCTION

This manual contains Operating instructions and Service information for Model 9300A Temperature Controlled Chamber. The model possesses a remote control capability through the GPIB bus (optional with the related software).

The model has high accuracy, high stability, easy manipulation and low competition cost. These features make it suitable to be used in a wide variety of applications from laboratory measurements to industrial processes. The features of the 9300A model include:

- Temperature Protection in the selectable range
- LCD display
- IEEE-488 interface
- Wide range of AC power
- Two thermistors as thermal sensors
- Alternation between °C and °F
- Easy operation
- Measurement automation with remote option

1.1 General Description

The 9300A model has been designed in order to provide a very stable, high accuracy performance and a flexible setting environment for thermal applications.

The model is a plug-in run unit that instantly measures the current temperature in the chamber using the previous setting value when the power is turned on.
The 9300A unit can be operated in the local mode by using the keyboard and the LCD display or in the remote mode by using the GPIB bus.

Two internal thermistors are used for sensing the chamber temperature and reflecting the temperature variations to the controller. By detecting thermal information, a firmware program on the microprocessor controller manipulates

the relevant control algorithm and determines a control process. A combination of the thermoelectric cooling device (Peltier) and heating elements gives the chamber the required setting temperature.

1.2 Physical Inspection

The Model 9300A is thoroughly inspected and tested before shipment. However, damage could result from shipping. Do a visual check of the equipment and packaging materials, both should be free of marks or dents. The shipping case should be kept until the instrument can be thoroughly checked for mechanical and electrical damage. It is also recommended that the shipping case is kept for future use such as sending the instrument for calibration or service.

1.2.1 Contents

The following items should be included in the box upon delivery:

Item	Quantity
9300A	1
Fuse (installed in instrument) + spare	2 + 2
Operator Manual	1
Power Cord	1
Shelves	2
Insulator	1

1.2.2 Front Panel Description

A photo of the front panel is found in Figure 1.

Figure 1 9300A Front Panel

The push button keys are used in order to enter measurement values and to select different functions. Refer to Figure 2 below for a photo of the display area and the push button keys. Push the ‘decimal key’ button ‘•’ in order to enter the options menu where different settings can be made (refer to chapter 5.3). Press ‘**ENTER**’ in order to set a new temperature for the Chamber.

The ‘**REM**’ key is the LOCAL/REMOTE indicator LED and the return to LOCAL switch. The LED is lit when the 9300A is under remote control.

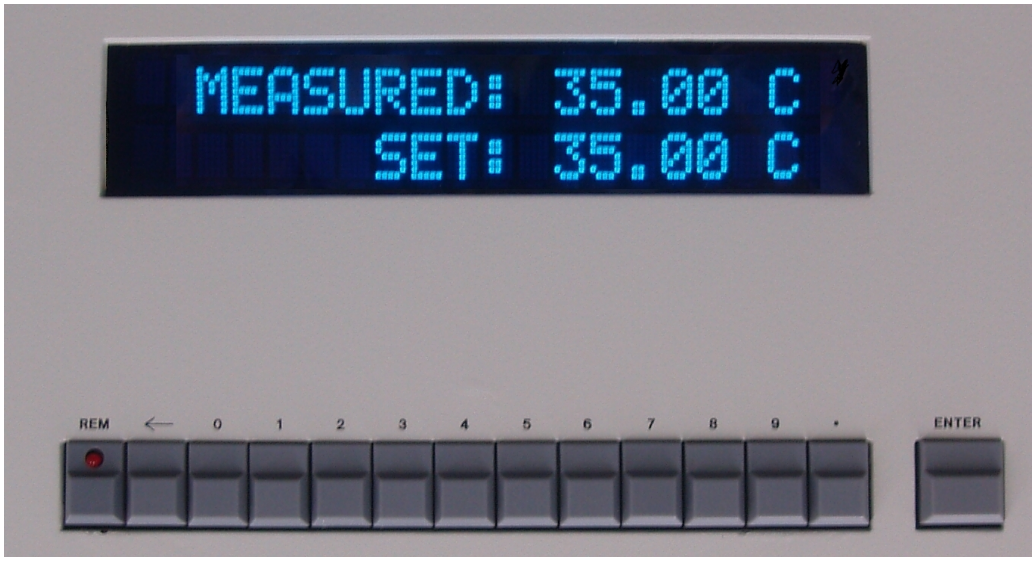


Figure 2 Display area and push button keys

1.2.3 Rear Panel Description

A photo of the rear panel is found in Figure 3. The name and the function of the different switches and connectors are described in Table 1.

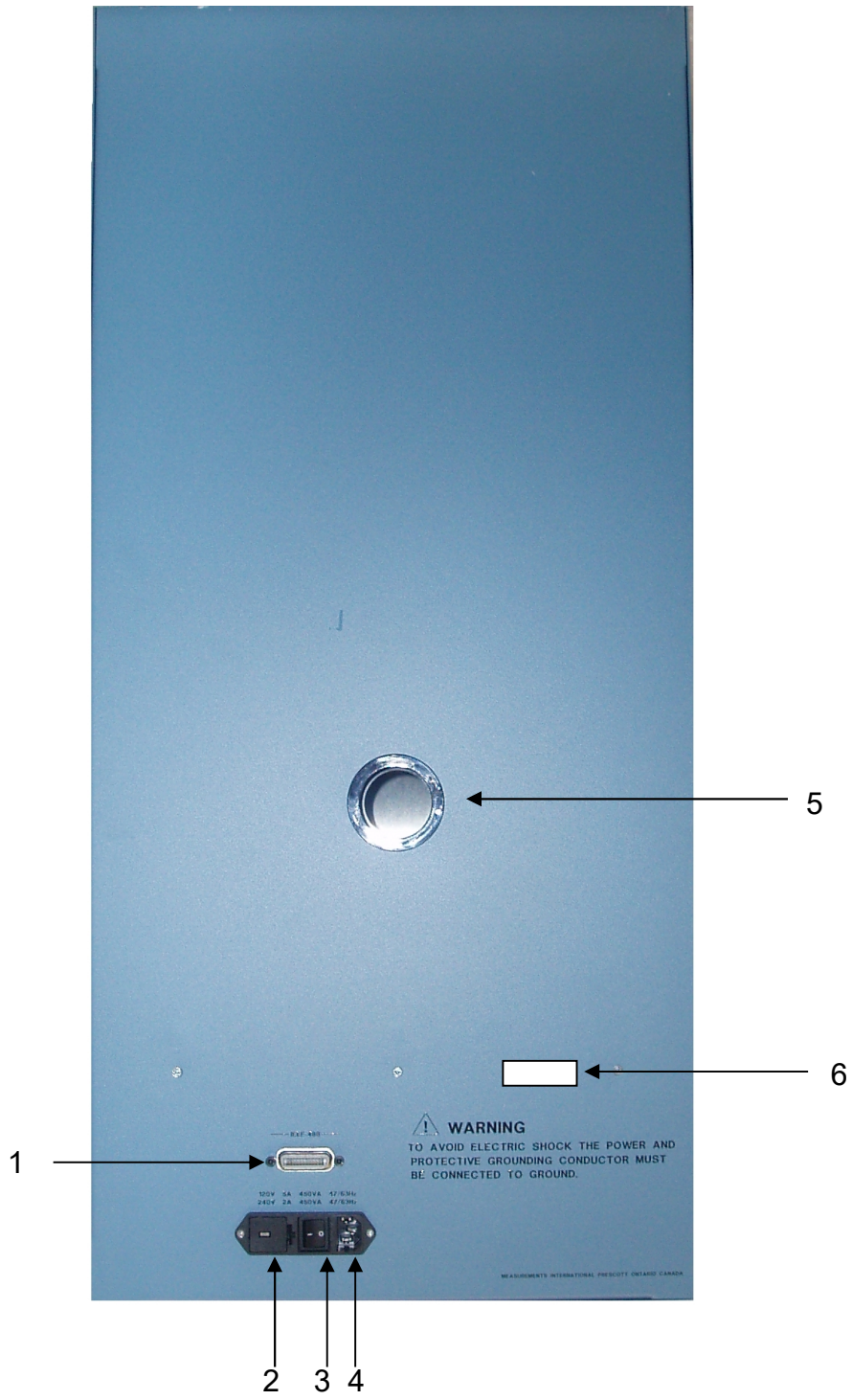


Figure 3 9300A Rear Panel

REFERENCE NUMBER	TYPE	FUNCTION
1	24 pin connector	IEEE-488 Interface
2		Fuse Cover / Line Voltage Selector
3	Rocker Switch	POWER ON/OFF
4	3-prong Receptacle	AC Power Connection
5	Opening	Cable entry
6	8-Pos Dip Switch	Set a Temperature Protection Range (4-options in Table 2)

Table 1: Rear Panel Connectors

Protection Ranges	Dip Switch POS				Trig-Min Value	Trig-Max Value
	1	2	3	4		
No Protection		On		On	N/A	N/A
17C ~ 31C		On	On		17±0.5 C	31±0.5 C
18C ~ 28C	On			On	18±0.5 C	28±0.5 C
14C ~ 41C	On		On		14±0.5 C	41±0.5 C

Table 2 Protection Range Settings

Note: It is recommended to switch all POS to the off position, before setting a new range.

1.3 Electrical Inspection

1.3.1 Line Voltage

The Model 9300A is tested and shipped with the AC voltage selected for the destination country. However, the selections should be verified to insure that the voltage selections are correct. AC voltage settings are on the back of the system in the power entry module (Figure 4). Detailed instructions for setting them are in the following section of this manual.

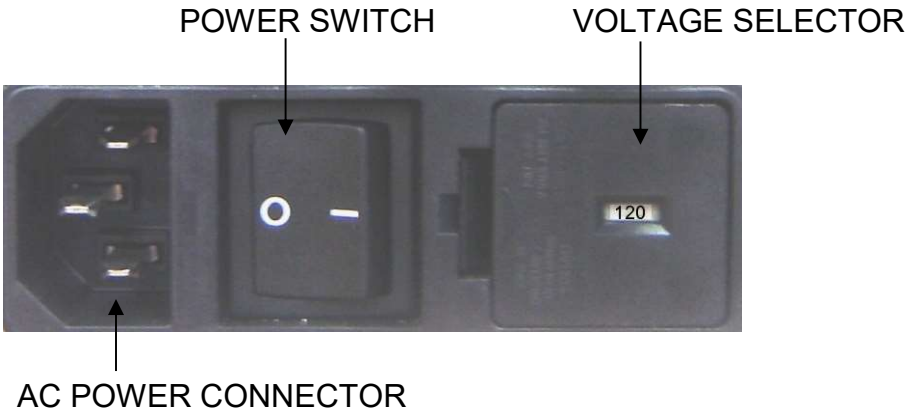


Figure 4 Power entry module

1.3.2 Input Voltage Selector

Remove the power cord before attempting to change the AC input selection. Locate the small square notch in the side of the voltage selector cover (Figure 4). Use a small screw driver to gently pry the fuse cover off. The input voltage selector is located at the right end of the power entry module. Use a small pair of pliers in order to remove the voltage selector from the module. Reinstall the voltage selector into the power entry module with the new voltage value to the outside.

WARNING:

If the voltage selection was incorrect then the **FUSES** should be checked for correct rating. Refer to the **FUSE REPLACEMENT** section for replacement instructions and specifications.

1.3.3 Fuse Inspection/Replacement

The fuses (2) are located inside the power entry module located in the rear panel. Refer to Figure 4 and the **INPUT VOLTAGE SELECTOR** section for instructions on how to remove the cover.

WARNING:

Remove the power cord from the unit before attempting to change the fuses.

1.3.4 Fuse Requirements

AC LINE VOLTAGE	SLOW BLOW FUSE
100	5 AMP. 250 VOLT
120	5 AMP. 250 VOLT
220	2 AMP. 250 VOLT
240	2 AMP. 250 VOLT

2 SPECIFICATIONS (INSERT DATA SHEETS)

3 INSTALLATION

3.1 Environmental

Although the unit has been designed for optimum durability and trouble-free operation, it is not recommended to operate the unit in an excessively dusty, dirty, or wet environment.

3.2 Location

The unit should be placed in such a way that the clearance (measured from the sides of the unit) to any walls or other obstacles is at least 7 cm. The vents located on the sides and bottom of the unit must not be blocked in order to ensure proper ventilation. Where applicable, try and minimize the unit's exposure to vibrations.

When the unit is mounted in a rack, we recommend to place the unit at the bottom or to have at least 2.5 cm of free space between the bottom of the Chamber and other instruments. Avoid placing heat generating instruments directly below the unit as this may affect the performance of the unit.

3.3 Ground

GROUND THE INSTRUMENT

Always ensure that the instrument chassis and cabinet are connected to an electrical ground. The instrument is supplied with a 3-conductor AC cord that plugs into the AC power module at the rear of the instrument. To minimize shock hazard, always ensure that this cable is plugged into an approved three-contact electrical outlet.

3.4 Interface Connections

Interface connection is made via a 24 pin D type connector located on the rear panel (refer to Figure 4). One end of the IEEE-488 bus cable plugs into this and the other into the interface connector on the remote control computer.

3.5 Power Switch

The power on/off switch is in the power entry module on the back panel. See Figure 4. Illumination of the front panel LCD display is the power on indication.

3.6 Safety Information

1) Clearance to any walls or other obstacles must be at least 7 cm.
2) Empty the contents in the unit before lifting or moving the unit.
3) Avoid contact with enclosed metal parts while the 9300A is in use.
4) Always unplug the unit before cleaning it.
5) Use cleaning solvents that are appropriate for cleaning polypropylene.
6) Do not block the vents aside of the unit to ensure proper ventilation.
7) Do not spray liquid cleaners, water or any other substance into the air vents.
8) Do not place heavy items (>20 kg) on top of the unit.

4 SYSTEM AND FUNCTION DESCRIPTION

The 9300A unit is designed to provide a very stable performance and a flexible settings environment for the thermal applications. The system block diagram is shown in Figure 5.

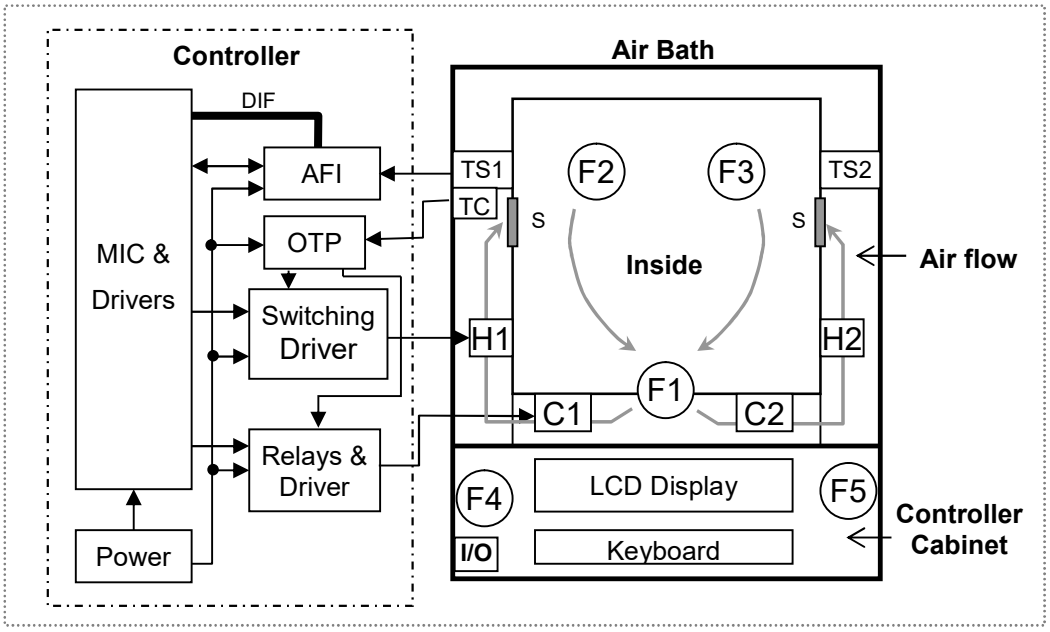


Figure 5 9300A System Block Diagram

4.1 System Description

Each section (element) of the system is illustrated above (refer to Figure 5).

4.1.1 Chamber Air Flow

There are a total of five fans in the 9300A system. Fan F1 transports air out of the chamber into the chamber walls where it is heated/cooled before it is transported back into the chamber by fans F2, F3 and the louver slots (S). The fans circulates the air in order to eliminate the gradient in the chamber temperature in order to obtain an even temperature distribution inside the chamber.

The two fans located in the control cabinet (F4, F5) are used in order to cool the heat sinks on the Peltier devices and power supplies.

4.1.2 Cooling and Heating Units

The temperature in the unit changes with operation of the thermoelectric devices (C1, C2) and heating elements (H1, H2).

The thermoelectric Peltier devices are used as the cooling source which operates with two relays and a temperature-controlled window. The Peltier module has a 200-220 BTU/hr capacity of generating cooling air.

Two heating elements are used in order to generate heating air and also to handle the actions of the temperature control. The heating elements are turned on or off by a switching power transistor that is controlled by a microprocessor. It has a capability of 90 W and it can rapidly generate an increase in the temperature.

The control strategy for the cooling and heating units is described in section 4.2.

4.1.3 Thermal Sensors

Two thermistors (TS1, TS2) placed on both sides of the chamber (refer to Figure 5) are used in order to obtain more thermal information in different areas. The temperature of the unit is measured by the two sensors whose change in resistance value reflects changes in the temperature. An ADC and a bridge circuit are used to acquire the relevant temperature data in real time.

4.1.4 Controller

A microprocessor (MIC) is used as a main controller to handle the Analog Front Interface (AFI), digital (DIF) interfaces and drivers. It implements the control processing algorithm and manipulates the LCD display and keyboard.

A medium-speed analog to digital converter (ADC) located on the AFI board acquires the thermal signal from the thermistors and transfers the data to the microprocessor. The microprocessor manages the control procedures for the temperature operating with a specific algorithm.

4.1.5 Temperature Protection

The purpose of the protection is used to avoid the bath temperature over the range of the specific temperature when the microcontroller is out of controlling the bath.

The Over-Temperature-Protection (OTP) controller is to detect the bath temperature using a Thermocouple (TC) and to determine the control processing for controlling the cooling powers or heating power off when the current temperature is out of the regular temperature range. There are four options to be able to select one specified range.

4.1.6 Control Drivers

Two relays are used to switch the cooling controller and a switching power transistor is used in order to control the heating.

4.1.7 Power Supply

The three individual powers are used to supply the cooling unit (Peltier module), the heating elements and control circuitry with the drivers. One DC power supply provides a higher stable voltage (+12V DC) as a reference voltage used in the firmware.

4.2 Control Strategy

A simple and efficient method is used to control the thermoelectric (Peltier) cooling devices and the heating elements in order to make the chamber temperature measurement more accurate and stable. An algorithm has also been developed for controlling the temperature in order to be able to reach the desired chamber temperature rapidly and smoothly (less overshoot).

The thermoelectric devices (Peltier elements) are used as the cooling source that is classified into two groups. Two relays are used for controlling the operations. The control procedure has a good performance with an optimized control window by ±2 °C that allows the temperature to reach a set point with a low overshoot and a fast response.

The heating elements generate the heating air and also manage the actions of the temperature control. The heating elements are turned on or off by a switching power transistor controlled by the microprocessor.

Refer to Appendix A1 for the details of the control strategy.

4.3 Operation Modes

Two operation modes, local and remote are provided for system operations.

The local operation mode, also called manual mode is managed with the keyboard and LCD display. Refer to Chapter 5 MANUAL OPERATION.

The remote operation mode operates through the GPIB cable and a PC. Refer to Appendix A3 “IEEE-488 COMMANDS” for a list of commands that can be sent via the GPIB interface. A graphical user interface (GUI) program provides an easy and flexible powerful tool in order to manage the control procedures. The GUI instructions are given in the Software User Guide manual.

4.4 Performance and Features

The stability of the temperature is maintained by the status of the cooling devices and finely controlled by the heating elements that are switched on and off around the setting point. The stability is also related to the deviation of the reference voltage.

The Temperature Controlled Chamber is guaranteed to perform according to the specifications without any objects located inside the chamber. The accuracy of the Chamber might deviate slightly from the specifications when objects are

present inside the unit. This is due to the change in the airflow. Although the chamber is designed to eliminate effects of the temperature gradient, the temperature in some areas like the corners may be deviated from the specifications.

5 MANUAL OPERATION

The controller consists of a keyboard and a LCD screen, which allows the user to manually set the chamber.

When the power is switched on, the 9300A unit displays the MIL firmware revision number (Figure 6) and current GPIB address as shown in Figure 7. Then the system starts to initialize and load the stored parameters for a stable operation using the 9300A firmware. Refer to chapter 5.2 for information on how to set a temperature.

Figure 6 Air Bath Information Panel

Figure 7 Current GPIB address

After several seconds the unit is ready to measure the temperature of the chamber. The chamber temperature will be displayed on the front LED panel, as shown in Figure 8. The first line displays the current chamber temperature and the second line shows the setting temperature.

Figure 8 Temperature display (operation status)

The following sections describe how to configure and set the operational functions and parameters. Refer to Appendix A2 for a description of the 9300A menus.

5.1 Keyboard Symbols and Functions

The functions of the buttons on the keyboard are described below.

- **REM** - when the indicator light on this button is on, it indicates that the remote operation is activated. Pressing the button will stop the remote operation and then the LED light will be off.
- "←" (backspace key). Used to change data.
- "**0**" through "**9**" plus "•" buttons are used to enter the setting values and to select options for menu operation to configure the system.
- "•" button is used for entering the submenu. Refer to chapter 5.3.
- **ENTER** - the ENTER button is used in order to access the "Enter New Bath Temperature" menu. It is also used in order to apply other settings and to return back to an upper level menu option or to return to the normal operation mode.

5.2 Set a New Temperature

Press the '**ENTER**' button in order to access the "Enter New Bath Temperature (C):" screen (Figure 9). Enter the new temperature. The setting resolution is 0.01. After having entered the new Bath Temperature, press the '**ENTER**' button in order to apply the new value and return to the operation status mode screen.

Figure 9 Set New Temperature

5.3 Select Temperature Scale

Press the '•' button, a submenu is displayed in Figure 10. Press '**ENTER**' in order to return to normal operating status.

Figure 10 Configuration menu

The temperature unit can be presented in either degrees Celsius (°C) or Fahrenheit (°F) and it can be set from the front panel. Press '**2**' in order to change the temperature scale. Press '**1**' for degrees Celsius or press '**2**' for degrees Fahrenheit. Refer to Figure 11.

Figure 11 Select temperature scale

After the selection has been made, the screen displays the Configuration menu (Figure 10). Press '**ENTER**' in order to return to normal operating status (Figure 8).

5.4 Communication Setting

From the configuration menu in Figure 10, press the '**1**' button in order to set a proper GPIB address for the Chamber. Refer to Figure 12. The top line shows the current GPIB address and the new address (1 to 31) can be entered by using the push button keys. Press the '**ENTER**' button in order to apply the selection and return to the submenu.

Figure 12 Set GPIB address

5.5 System Reset

From the Configuration menu (refer to Figure 10), the system reset option can be selected by pressing the '**3**' button. The setting window is shown in Figure 13.

Figure 13 System Reset

Pressing the '**1**' button will allow the user to reset the system. The following settings are default:

- Temperature is set to 25 °C
- GPIB address is 15
- Temperature unit is given in degrees Celsius

It takes a couple of seconds in order to process a system reset. The 'Processing' message is shown on the display during processing system reset. After the procedure, the system goes back to normal operation status.

Press '**2**' (the "Cancel" button) in order to keep the current settings without making any changes.

A1 CHART OF THE 9300A CONTROL PROCEDURE

The temperature control algorithm is implemented in the firmware. The algorithm performs the following strategies and steps: two cooling groups (C1 & C2) and one group of heating units (H1 & H2) can be controlled individually to turn ON or OFF in the combined operations.

(A) Heater operates based on

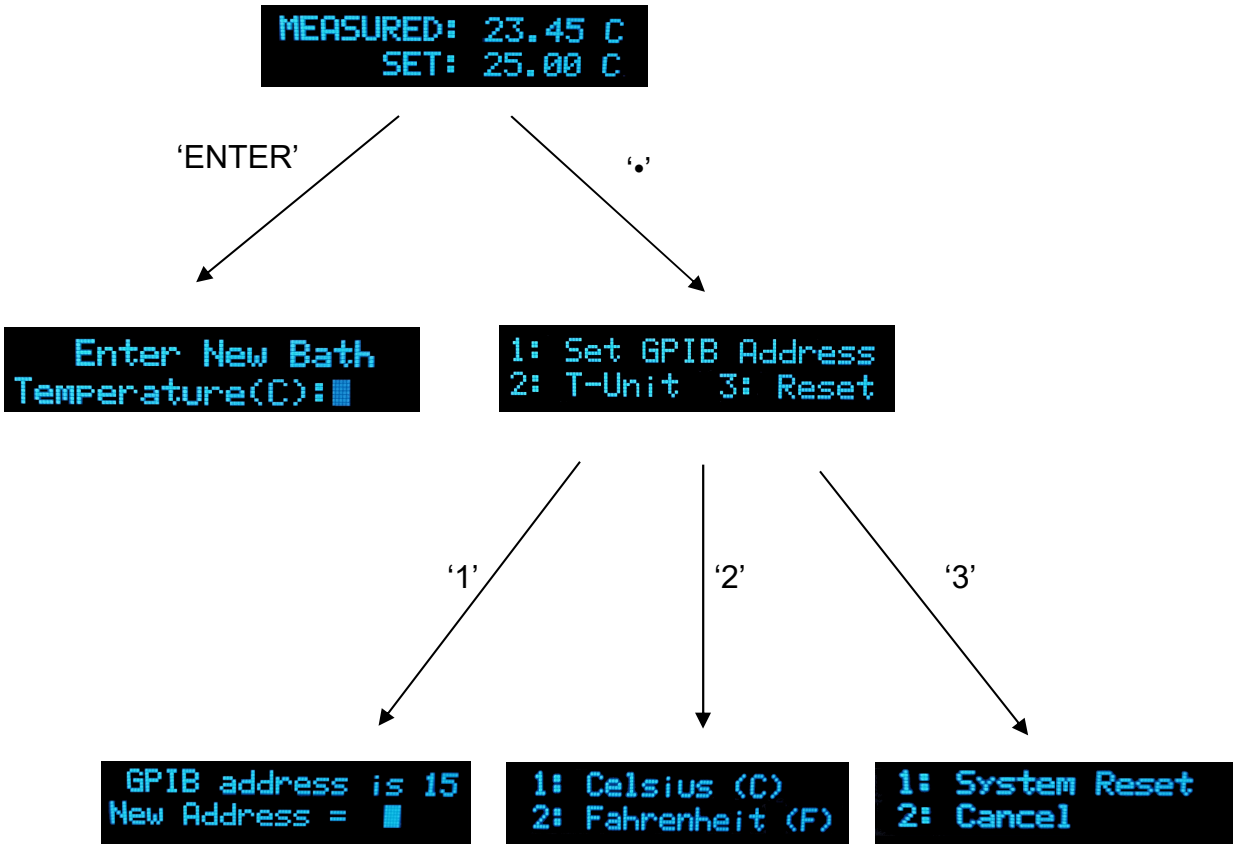
- If the measured (actual) temperature < setting point
  Heater (H1 & H2) is ON
- Otherwise :
  Heater (H1 & H2) is OFF

(B) Cooler operates based on

- If the measured (actual) temperature value > setting point + 2.0 °C
  C1 & C2 ON (Heater OFF)
- If the measured (actual) temperature value < setting value - 2.0 °C
  C1 & C2 OFF (Heater ON)
- If the measured (actual) temperature value $\leq$ | setting value $\pm$ 2.0 °C |

1. when temperature setting point in 15 °C to < 20 °C,
   C1 & C2 ON
2. when temperature setting point in 20 °C to < 30 °C,
   C1 ON, C2 OFF
3. when temperature setting point in 30 °C to 40 °C,
   C1 & C2 OFF

A2 9300A MENU DESCRIPTION



A3 IEEE-488 COMMANDS

COMMAND NAME	FORMAT	ACTION
°F → °C	C	Change temperature unit from Fahrenheit to Celsius.
°C → °F	F	Change temperature unit from Celsius to Fahrenheit.
Remote	K	Set the 9300A to Remote mode. This command sets the Local Lockout flag true. It locks the keyboard.
Local	L	Set the 9300A to local mode. It also sets the Local Lockout flag false.
Receive measured temperature	m	Receive the value of the measured temperature from 9300A to PC.
Check temperature setting	s	Receive a temperature setting from 9300A to PC.
Set Temperature Value	T	Set a temperature value (“T15.00” to “T40.00”).
Local Unlock	U	This command sets the Local Lockout flag false.