TP03000
ThermoChuck® System

Operator's Guide

Revision D
April 2011

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TP03000 Operator's Guide

Preface

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Notice

Patents have been granted and/or patent applications are pending or are in process of preparation on all our developments.

The material in these instructions is for informational purposes and is subject to change without notice.

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To Our Customers

This Manual

The purpose of this manual is to help obtain the greatest return on your investment. Temptronic suggests that operators, supervisors, and technicians responsible for operating and maintaining this equipment become familiar with the contents of these manuals prior to using the equipment.

Temptronic Support

Introduction   Temptronic is committed to assisting end users and technicians to maintain operational systems which are highly reliable. Temptronic offers the following support services.

Customer Training   Formal technical training courses are available. The training courses cover the theory of operation and the maintenance procedures for the System. For further information, contact the Temptronic Service Department.

Repair Service   Temptronic maintains a fully equipped repair center at the factory plant for warranty and non-warranty repairs. For further information on module and circuit board repairs, our exchange program, and the availability of spare parts, contact the Temptronic Service Department.

Before returning any module or circuit board for repair, contact the Temptronic Service Department to obtain a return authorization (RA) number.

Spare Parts   Electrical and mechanical replaceable parts for the System can be obtained through your local Temptronic representative, or directly from the Temptronic Service Department. When ordering, be sure to specify the:

- Quantity
- Temptronic part number
- Description
- Reference designation (if any)
- Complete model number and serial number of your system

For your convenience, Spare Parts Kits are available for different levels of service activity.

Technical Support   Contact the Temptronic Service Department by one of the following means:

Temptronic Technical Support	
1-800 558-5080	Toll Free Telephone (service calls only)
service@temptronic.com	e-Mail Address
781 688-2302	Service FAX line
781 688-2300	Temptronic Corp. Main Telephone line

ATTENTION

1. Please note that the 1-800 toll free telephone number is dedicated to Service Department calls only. It is not possible to dial this number and to transfer to other departments within Temptronic.

2. The main telephone number, 781 688-2300, should be used for non-service related calls.

Before You Call

Introduction

You can help us support your machine in timely fashion by having on hand specific information when calling in:

- Software Version
- System Model Number

System Model Number

A modular system design allows the customer to select options or features as desired for a given installation or application

The System Model Number Designation, printed on the TP03000 nameplate, reflects the configuration at time of shipment.

System Configuration   TP03000A - ☐ 3 0 0 - ☐

Feature	Code	Description
System Configuration	A	-65°C low temperature capacity; separate controller and refrigeration modules (See Note 1)
High Temperature Limit	1 2	+130°C range +200°C range
I/O Communications	3	IEEE-488 and RS232
Power Configuration*	1 2	115 Volt, 60 Hz 230 Volt, 50 Hz (See Note 2)

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Declaration of Conformity

EC Declaration of Conformity

Manufacturer:

inTEST Thermal Solutions
41 Hampden Road
Mansfield, Massachusetts 02048
United States of America

Product Description:

Product Make: ....ThermoChuck® Thermal Inducing System

Model Number: TP03000A, TP03010A,B, TP03015A,B, TP03020B

Year of Manufacture:...2011

Rating: ....230V~, 50Hz, 10A

Serial Number:............._____

Directives and Standards:

73/23/EEC Low Voltage (LV) Directive
EN 60204-1:1997
EN 61010-1 (relevant aspects)

98/37/EC Machinery Directive, as specified in Annex I
EN ISO 12100-1 & 2 2003
EN 292-2:1991+A1:1995

89/336/EEC Electromagnetic Compatibility (EMC) Directive
EN55011:1998/A1:1999/A2:2002,   EN61000-3-2:2000,   EN61000-3-3:1995/A1:2001,
EN61326:1997/A1:1998/A2:2001
Equipment for Measurement, Control and Laboratory Use – General Use EMC Requirements

This confirmation is based on:

Test Report of: 30671412.002by TUV Rheinland of North America 2006
EG-0570-1 by Curtis-Straus LLC. 2006

Authorized Signature:

Company Seal or Signature of Company Official: _____

Printed Name: James Pelrin

Title: President

Date: March 29, 2011   Place: Mansfield, MA 02048   USA

Document No.: LMS**182440**
ECO 110310 Rev.: D
Sheet 1 of 1

Safety

1

Introduction

This Chapter covers all the safety Warnings and Cautions for the *TP03000 ThermoChuck System* operators.

WARNINGS

⚠ WARNING

WARNING: Operating personnel should perform only the procedures described and recommended in this manual. Only qualified service personnel familiar with the electrical shock hazards present in the equipment should be allowed to perform any disassembly or corrective maintenance of the equipment. Only use the equipment for the intended usages specified by the manufacturer.

⚠ WARNING

WARNING: To avoid shock hazard, the equipment must be grounded with an adequate earth ground per local electrical codes.

⚠ WARNING

WARNING: A ThermoChuck should not be touched at temperatures lower than 10 °C or higher than 40 °C.

⚠ WARNING

WARNING: Dispose of any new or removed coolant fluid in accordance with established polices and procedures for that material.

CAUTIONS

CAUTION

CAUTION: Observe the precautions given on the equipment and within this manual to prevent damage to the equipment. Only use the equipment for the intended usages specified by the manufacturer.

CAUTION

CAUTION: Use proper handling and packaging procedures for static-sensitive circuit boards. Assume that all circuit boards are the static-sensitive type.

CAUTION

CAUTION: Upon initial installation of the equipment, verify that the voltage and frequency on the serial tag at the Controller rear panel match the ratings of the power source to be used for the TP03000A System.

CAUTION

CAUTION: Do not place anything on the ThermoChuck surface that cannot withstand the upper temperature limit of +130 °C (or +200 °C when option).

CAUTION

CAUTION: A ThermoChuck surface is typically gold plated. Do not use any (harsh) abrasive materials for cleaning.

CAUTION

CAUTION: Do not overfill with coolant – the coolant system must have room for expansion of the coolant at high operating temperatures.

CAUTION

CAUTION: Make sure the Controller power cord is disconnected from its power source before replacing the back-up batteries for RAM storage.

Preparation For Use

2

Chapter Overview

Introduction

This chapter provides unpacking and setup information for the *TP03000 ThermoChuck System.*

In this Chapter

This Chapter is divided into the following Sections:

Section	See Page
Unpacking Information	2
Installation Instructions	3
AC Power Input	9
Repackaging	10

Section A: Unpacking Information

. . . .

Introduction

The TP03000 ThermoChuck System is shipped to you in one container. All purchased items are included. When received, examine the container for any signs of mishandling or damage during shipment.

NOTE: If you see any obvious signs of damage to the package, contact the carrier immediately and do not proceed with the installation. Since the shipment is made FOB factory, you should consult your administration concerning claims for shipping damage.

⚠ CAUTION

CAUTION: Packaging materials may be a source for ESD potential. Do not unpack in the vicinity of ESD sensitive components.

When unpacking the system, save all packaging material in the event the system has to be reshipped later. After the system has been unpacked, the following visual inspections should be made:

1. Verify that all items purchased are received.
2. Verify that the indicators and switches are in place and intact.
3. Check that all cable connectors are tightly seated.
4. Verify that all chassis/cabinet mounting hardware is secure.
5. Check that the ThermoChuck Platform (individually packed) is not scratched or damaged.

Section B: Installation Instructions

Section Overview

In this Section

The following topics are covered in this Section:

Placement

The TP03000 System should be located near the test system and a grounded ac power outlet to avoid stressing the electrical cables and coolant lines during operation.

- The Controller requires an 8-inch (203-mm) rear clearance for cables and air flow.
- The Cooler/Circulator requires 12-inch (305-mm) front and rear clearances for cables, hoses, and air flow.

A grounded outlet from the ac power source must be located within 10 feet (2.5 m) of the Controller rear panel for the system input.

If you mount the TP03000 System in a rack, make sure it can support the 160-pound (72.6-kg) Cooler/ Circulator when pulled out on its slides (30-inch, 762-mm, travel) without causing any equipment or personnel hazard.

Also, be sure the equipment slides for mounting the Controller and the Cooler/ Circulator are attached to rear rails in the rack for adequate support. Temptronic provides threaded mounting holes for mounting the TP03000 System components in the following rack slides:

Controller Recommended Slides	
General Devices P/N	Rack Depth
CC 3001-00-0240	24-inch
CC 3001-00-0280	28-Inch
CC 3001-00-0300	30-inch

Cooler/Circulator Recommended Slides	
General Devices P/N	Rack Depth
CC 1501-00-0240	24-inch

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If required and purchased, hardware and installation instructions are provided to interface the ThermoChuck Platform to most standard probers. In some cases, the ThermoChuck Platform (sometimes called chuck) is specially configured to be an integral part of the Z-stage in the prober.

Interconnections

Perform the following before making the system interconnections:

1. Check that MAIN POWER circuit breaker on the Controller rear panel is in the ON position.

2. Check that system power switch on Controller front panel is at the off (0) position.

3. Verify that cable is in place between COOLER connector on Controller rear panel and CONTROL INPUT connector on Cooler/Circulator rear panel.
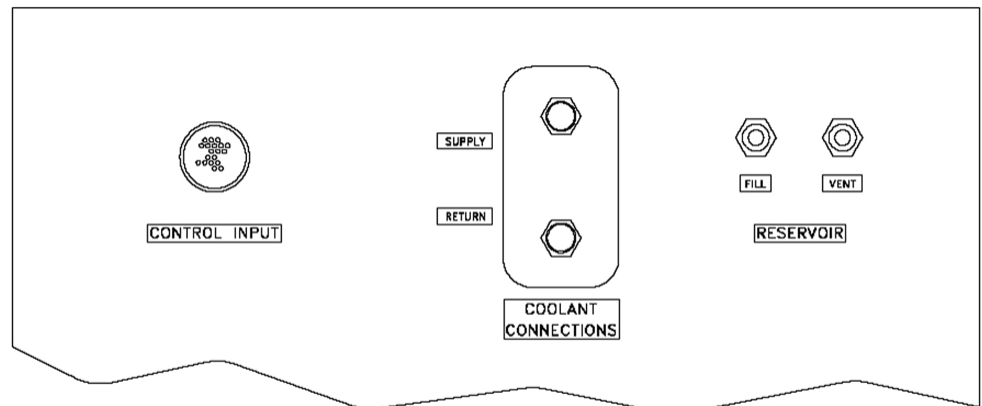
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4. Verify that FILL and VENT ports are covered with caps at Cooler/Circulator rear panel. These caps must be installed to prevent moisture from collecting inside the coolant system and causing the system to malfunction. Remove these caps only during coolant filling or draining.

ThermoChuck Platform Interconnections

1. Mount the ThermoChuck Platform to your prober stage.
2. Connect the supplied coolant lines to the ThermoChuck Platform.

ATTENTION

NOTE: The coolant lines and fittings are Teflon; tighten the ferrule sleeve portion by hand only
do not over tighten. Carefully tighten the pipe thread portion with a wrench.
Refer to Chapter 5: Coolant Fitting Installation Recommendations as needed.

3. Use a CEE (Controlled Environmental Enclosure [dry box]) for continuous ThermoChuck Platform operation below +40 °C.

NOTE: The TP03000 System pumps approximately -50 °C coolant through the ThermoChuck heat sink to dissipate waste heat from the solid-state cooling devices to prevent an overheat condition. USE OF A CEE PREVENTS CONDENSATION AND/OR FROST FROM FORMING ON THE COOLANT LINES, since the fluid inside the coolant lines is below the ambient temperature dew point.
When the system is not being used for temperature testing but left running with the ThermoChuck exposed to ambient it is recommended to set the temperature control to +40°C to turn the pump OFF stopping the coolant flow so frost and condensation will not form on the ThermoChuck and coolant lines.

4. Plug the control cable from the ThermoChuck Platform into the THERMAL DEVICE connector on the Controller rear panel.
5. Connect one coolant line from the ThermoChuck Platform into the SUPPLY port on the Cooler/ Circulator rear panel.
6. Connect the other coolant line from the ThermoChuck Platform into the RETURN port on the Cooler/Circulator rear panel.

ATTENTION

NOTE: The TP03000 is shipped dry without any coolant. The coolant is added as the System is operated for the first time. After the System is placed in operation, inspect the coolant fittings routinely for leaks. Extra fittings are supplied in the event of damage.

CAUTION

CAUTION: Do not operate the TP03000 System without any coolant.

7. Connect the vacuum line (supplied) from the ThermoChuck Platform's port to a vacuum supply.

I/O Bus Interconnections

1. Use the cable connector supplied for the I/O connector (IEEE or RS232) on the Controller rear panel to make interface connections to the remote computer bus.

2. Wire the pin connections for the type interface to be used. Chapter 4 provides greater detail for Remote Interfaces includes pin identifications for the RS-232C and IEEE-488 interface.

ThermoJogger Interconnections

1. For the ThermoJogger option, make sure the ThermoJogger hand controller is the new type (intended for a TP03000A-X300, TP03000A-0301, or TP03020B-2300 Systems).

2. Plug the cable supplied with the ThermoJogger hand control into the JOG connector on the Controller rear panel.

Emergency Off Interconnections

1. For this feature, use the cable connector supplied for the EMO connector on the Controller rear panel to make connections to the external switch in the test system.

2. Remove the wire jumper between pins 1 and 2 and connect the two cable leads from the external switch (must be rated for 24 Vac at 1 A, minimum). (Switch contacts must be closed for TP03000 operation; opened during emergency off.)

ATTENTION

NOTE: Either the wire jumper must be installed in the EMO cable connector or pins 1 and 2 must be a closed circuit through the external switch for operation of the TP03000 system.

Interlock Interconnections

The system rear panel includes a nine-pin connector for the INTERLOCK connections. The mating connector and pins (Interlock plug kit P/N SA73990) are supplied at the time of shipment.

NOTE: The pin extractor tool is AMP Incorporated P/N 91067-2.

The interlock feature can be used to lock an access door/panel on an enclosure that houses the ThermoChuck Platform when its surface temperature exceeds 70 °C. The interlock is a relay closure that is controlled by the system microprocessor. The relay contacts toggle from normally open to normally closed when the ThermoChuck surface temperature goes above 70 °C. The user must supply the interlock signal, which should not exceed 24 volts, 5 amperes.
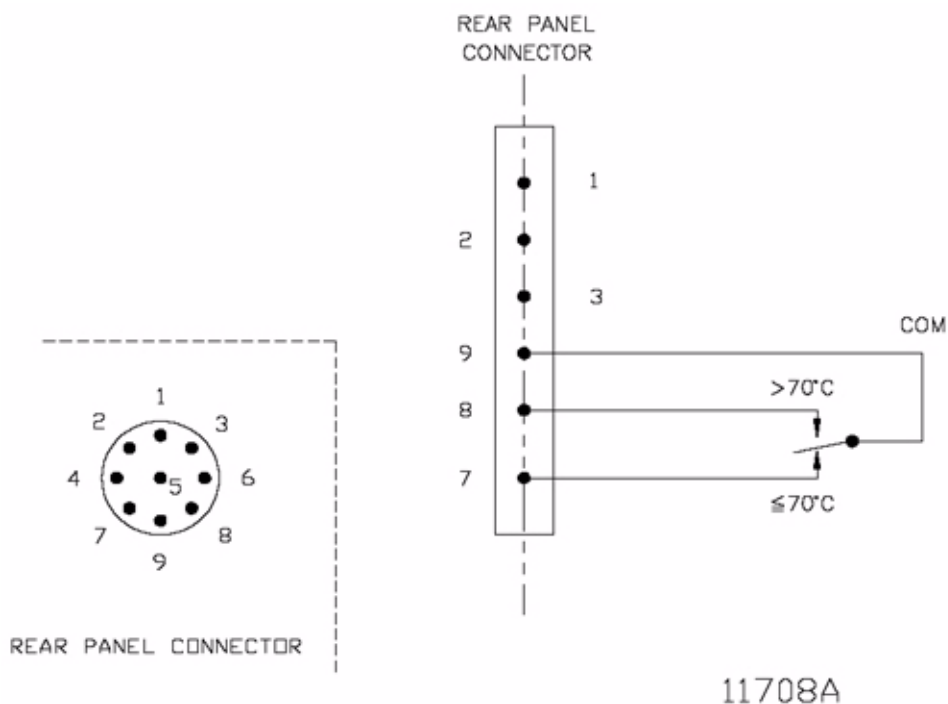
0930_204.jpg

Section C: AC Power Input

The TP03000 Series System will be received with all subassemblies factory set to the input voltage specified at the time of order. Protective circuits and keyed interconnections prevent the interchange of subassemblies from a system with one input voltage (for example 115 Vac nominal, 60 Hz) to be mixed and used on another system with a different input voltage (for example 230 Vac nominal, 50 Hz).

CAUTION: Verify that the voltage and frequency on the serial tag at the Controller rear panel, match the ratings of the power source to be used for the TP03000 System.

For 230-Vac systems, connect the male plug of the 10-foot (2.5-m) service cord to a three-wire grounded supply outlet.

For 115-Vac systems, the controller and chiller have separate service cords. Connect both service cords to a three-wire grounded supply outlet.

The service should be capable of supplying 20 amperes for a 115-Vac system or 10 amperes for a 230-volt system. If possible, the TP03000 System should be supplied from a dedicated ac power circuit. This circuit should not be shared with heavy motor driven equipment. A line filter inside the Controller will enable operation on a power circuit with moderate voltage transients.

Section D: Repackaging

. . . .

If the TP03000 System is to be shipped to another location:

- Drain the coolant from the Cooler/Circulator
- Repackage the system in the original shipping carton and packaging material.
  In the event the original packaging material in not available or reusable, the material used should include:

    - (1) a double-walled carton (check with freight carrier for test strength required)

    - (2) polyfoam, heavy paper, or sheets of cardboard to protect all instrument surfaces, and

    - (3) at least 4 inches (100 mm) of tightly packed, shock absorbing material surrounding the equipment. Close the package securely with heavy paper tape.

Prior approval is required before shipping the system to a Temptronic Sales/Service Office, or to the factory. It is recommended that a tag be attached to the system giving the owner's name, address, telephone number, system model and serial numbers, and the reason for return.

Local Operation

3

Chapter Overview

Introduction

This Chapter contains instructions for front panel (local) operation of the *TP03000 ThermoChuck* System.

In this Chapter

This Chapter is divided into the following Sections:

Section A: Start-Up Instructions

. . . .

The following procedure outlines how to start up the TP03000 System. Once started, you can operate the System in Manual Mode, Program Mode, Automatic Mode, or by Remote Controlled operations (detailed in Chapter 4).

1. Check that the **AC LINE indicator** illuminates, showing that ac power is applied to the Controller and its circuit breaker is in the on position.

2. Power Switch

4. System and Manual indicators illuminate

3. Front Panel Start Up Messages

1. AC Line indicator illuminates
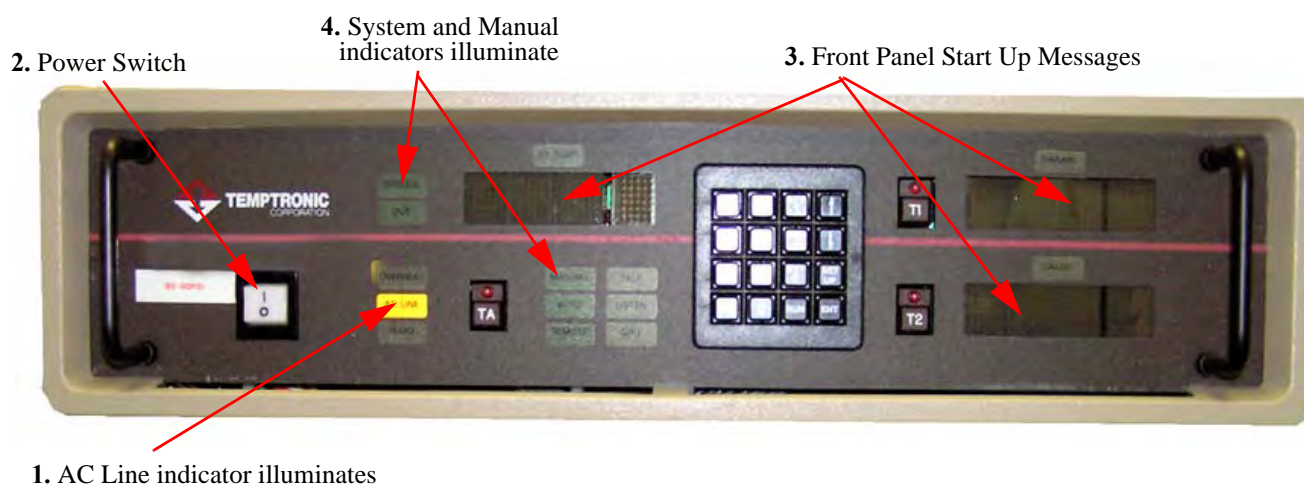
0930_301.jpg

2. Place the system power switch in the on (1) position, making the switch indicator turn on.

3. Observe the front panel displays for the following start up sequence:

   • *Lamp* test - All front panel indicators and display segments turn on at the same time for a short interval.

   • *Model number* - Next, for a short interval, the AT TEMP display shows the system series model number (3000) and the PARAM display shows the power frequency (xxHZ).

   • *System Status messages* - Any detected system errors will be displayed. For detailed descriptions of system error messages, refer to Error Message, page 5-20.

The Cooler/Circulator status information is then displayed:

   • **PUMP** (AT TEMP display) **Wait** (PARAM display) - Indicates the timed wait for circulator pump and first stage compressor to reach operational state (approx. 2 minutes). The VALUE alphanumeric display shows countdown to time 0.
   Add coolant at initial start-up or at any other time when FLUID indicator is on (refer to Filling the Reservoir, page 5-11 as needed).

   • **STG2** (AT TEMP display) **Wait** (PARAM display) - Indicates the timed wait for second stage compressor to reach operational state (approx. 1-1/2 minutes).
   The VALUE display shows countdown to time 0.

NOTE: If the system fails to start, consult the *TP03000 Service Manual* or contact the Temptronic Service Department.

4. Confirm that the start-up sequence is complete by observing the following:

- The **SYSTEM** and **MANUAL** indicators illuminate. (The on SYSTEM indicator shows temperature under control with the sensor in ThermoChuck Platform; DUT indicator not used.)
- TA switch indicator turns on and the AT TEMP display shows current temperature of ThermoChuck Platform (approaching ambient setpoint, factory preset to +25.0 °C). The AT TEMP indicator turns on when the ThermoChuck temperature is within the window of the TA setpoint.
- The PARAM and VALUE displays show programmed values for T1 and T2 setpoints, respectively (factory preset T1 & T2 values at +130 °C and -55 °C).
  NOTE: At initial start-up, the setpoint window values are factory preset to ±1.0 °

Section B: Manual Mode Operations

. . . .

Section Overview

At the front panel, three setpoints (T1, T2, and TA) can be selected one at a time for manual temperature control of the ThermoChuck Platform.

- Temperature values for the T1 and T2 setpoints can be changed.
- The temperature value for the TA (ambient) setpoint can be changed
- Window values for the T1, T2, and TA setpoints can be changed.

In this Section

The following topics are covered in this Section:

Changing T1 and T2 Setpoints

Procedure The T1 and T2 setpoint temperature setpoints can be changed to new values by using the 4x4 front-panel keyboard as follows:

3. Press the desired Setpoint Key (T1 or T2)

1. Manual indicator is illuminated

4. Enter a value on the Keypad

5. Press the "ENT" key

2. Press the "Set Up" key
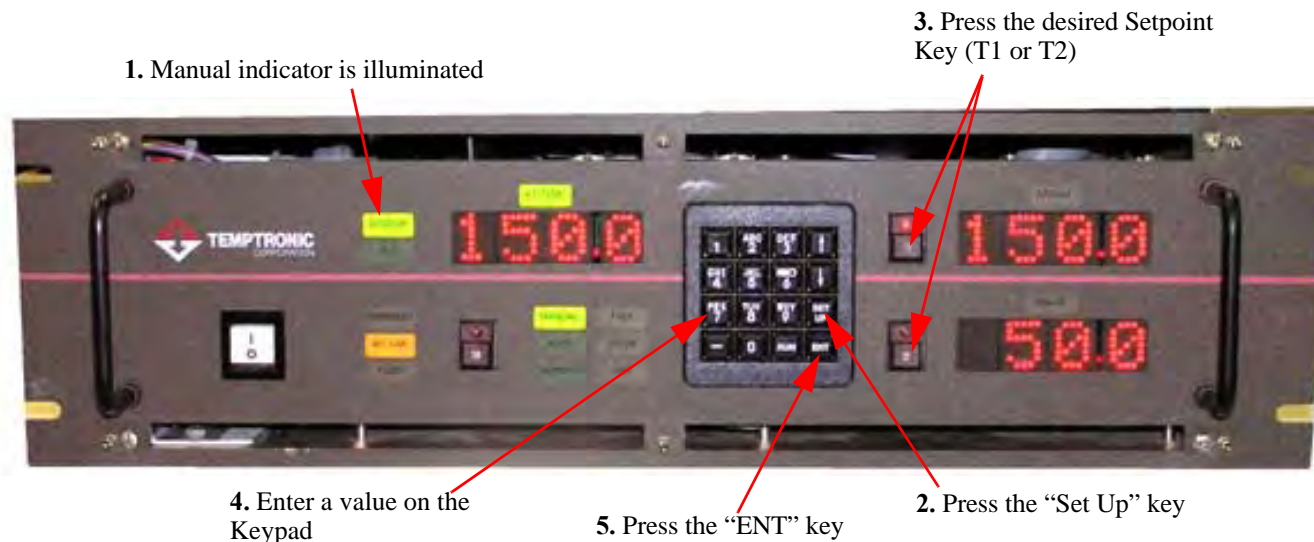
0930_302.jpg

1. Make sure the **MANUAL** indicator is illuminated.

2. Press the **SET UP** key (PARAM, T1, and T2 indicators start flashing; TA indicator turns off.

3. Press the appropriate switch (**T1** or **T2**) to select the desired setpoint.

- Selected switch indicator remains flashing
- Unselected switch indicator turn off
- PARAM indicator turns off.

4. To change a setpoint value with number keys of the 4x4 keypad, enter the new temperature value (values between -99.9 to +999.9 can be entered, but keep within range of your system). Digits of the entered number value enter the display at the right and advance toward the left (to program a setpoint value of 0.0 °C, simply press the **0** key once). If a number is entered in error, you may correct the entry by one of the following ways:

- Make the display overflow by additional key entries until the display restarts from the right. Resume with entry of the desired value.
- Press the **SET UP** key to recall the old temperature value. Resume with entry of the desired value.

NOTE: As an alternate entry method, use the up-arrow and down-arrow keys of the 4x4 keypad to step to the new temperature value.

5. Press the ENTer key to load the new temperature value into memory and exit the programming sequence.

- Selected switch indicator turns off
- TA switch indicator turns back on.

Changing TA Setpoint

The TA setpoint is the Ambient Setpoint. The TA temperature can be changed to any value within the system temperature range. This setpoint is factory preset to 25.0 °C as a default value for safe handling of the ThermoChuck Platform.

If it is necessary to change the TA setpoint, refer to Program Mode Operations, page 3-8.

ATTENTION

TA is the active setpoint at start-up and at the end of Automatic Mode operation. Programming the TA setpoint to an extremely high or low temperature is not recommended.

WARNING

WARNING: A ThermoChuck Platform should not be touched at temperatures lower than 10 °C or higher than 40 °C.

Changing T1, T2, and TA Windows

Window is the range above/below the setpoint, in which the system is "At Temperature."

E*xample: a 50 °C setpoint, with 1.0 °C Window is "At Temp" between 49 to 51 °C.*

The window values of the T1, T2, or TA setpoints cannot be changed while in the Manual Mode. For instructions on changing these values, refer to Program Mode Operations, page 3-8.

Operating at T1, T2, and TA Setpoints

Procedure

Use the following steps to set the temperature of the ThermoChuck Platform at either the T1 or T2 setpoint and then return to the TA setpoint.

1. Make sure the MANUAL indicator is on.

2. Press the appropriate switch (**T1**, **T2**, **TA**) to select the desired setpoint.

3. Check that the indicator on the selected setpoint switch turns on the (indicator on a previously active setpoint switch turns off).

  • the PARAM display shows programmed T1 setpoint temperature

  • the VALUE display shows programmed T2 setpoint temperature.

4. Observe that the ThermoChuck temperature (AT TEMP display) ramps toward and reaches the new setpoint temperature (the AT TEMP indicator turns on as soon as the ThermoChuck temperature is within the setpoint window).

NOTE: While at a T1, T2, or TA setpoint, the operating temperature may be increased or decreased in 0.1 °C steps by using the up-arrow or down-arrow keys of the 4x4 keypad (or by using the two buttons on the hand-held control box of the optional ThermoJogger). This change in operating temperature is temporary — it does not change the programmed setpoint value. Press T1, T2, or TA if you wish to return to its original programmed setpoint value.

5. Press the TA switch to stop operation at a T1 or T2 setpoint or to abort a ramp to one of these setpoints.

Section C: Program Mode Operations
. . . .

Introduction

In addition to the T1, T2, and TA setpoints, operators can program up to five other setpoints (TMP1 through TMP5).

The parameters can be set for each individual setpoint. The parameters include:

- **Window** values (0.1 to 9.9 °C)
  Window is the range above/below the setpoint, in which the system is "At Temperature."
  E*xample: a 50 °C setpoint, with 1.0 °C Window is "At Temp" between 49 to 51 °C.*

- **Ramp** times (0 to 9999)
  Ramp is the rate (in degrees per second) at which the system will "ramp" to the desired setpoint.
  A Ramp rate of "9999" allows the system to "ramp" at the fastest rate possible.
  A Ramp rate of "0" will not allow the system to "ramp" to the desired setpoint. When cycling, a setpoint with a Ramp rate of "0" will be skipped.

- **Soak** values (0 to 9999)
  Soak is the duration (in seconds) that the system will stay (or soak) at the setpoint.

- Number of **Cycles** (0 -999)
  A cycle is completed when the System goes through each of the programmed setpoints (TMP1 through TMP5)
  The number of cycles can be set from 0 to 999.
  A Cycle value of "0" will not allow the system to begin cycling.
  A Cycle value of "999" will allow the system to cycle for an infinite number of times.

Changing Parameters

To change the system parameters:

1. Verify that the front panel's MANUAL indicator is illuminated.

2. Access the Program Menu by pressing the **SET UP** key twice. After the second pressing of the key:

- the PARAM indicator blinks

- the VALUE indicator turns on steady

- the T1 and T2 indicators turn off

- the ARAM display shows mnemonic for last parameter accessed

- the VALUE display shows value for displayed parameter

3. **To view** a particular system parameter, use the up-arrow and down-arrow keys on the 4x4 keypad to scroll the PARAM display to the desired parameter.

4. **To change** a selected parameter value, press the **ENT**er key.

- PARAM indicator turns on steady

- VALUE indicator blinks.

5. Enter the new parameter value with number keys of the 4x4 keypad (temperature values between -99.9 to +999.9 can be entered, but keep within range of your system).
   Digits of the entered number value enter the display at the right and advance toward the left.
   If a number is entered in error, you may correct the entry by one of the following ways:

- Make the display overflow by additional key entries until the display blanks. Resume with entry of the desired value.

- Press the **SET UP** key to recall the old parameter value (returns you to Step 2).

6. As an alternate entry method instead of Step 5, use the up-arrow and down-arrow keys of the 4x4 keypad to step to the new parameter value.

7. Press the **ENT**er key to load the new parameter value into memory.

- PARAM indicator blinks

- VALUE indicator turns off.

8. Return to Step 3 to select another parameter, or press the **SET UP** and **ENT**er keys to exit back to the Manual Mode.

TO VIEW/SELECT A PARAMETER, PRESS CURSOR KEYS ③

② TO ACCESS PROGRAM MODE, PRESS "SET UP" KEY TWICE

TO CHANGE PARAMETERS:

④ PRESS "ENTER" KEY TO LOAD SELECTED PARAMETER

⑤ ENTER NEW VALUE WITH NUMBER OR CURSOR KEYS

⑥ PRESS "ENTER" KEY TO LOAD NEW VALUE

"MANUAL" INDICATOR ON ①
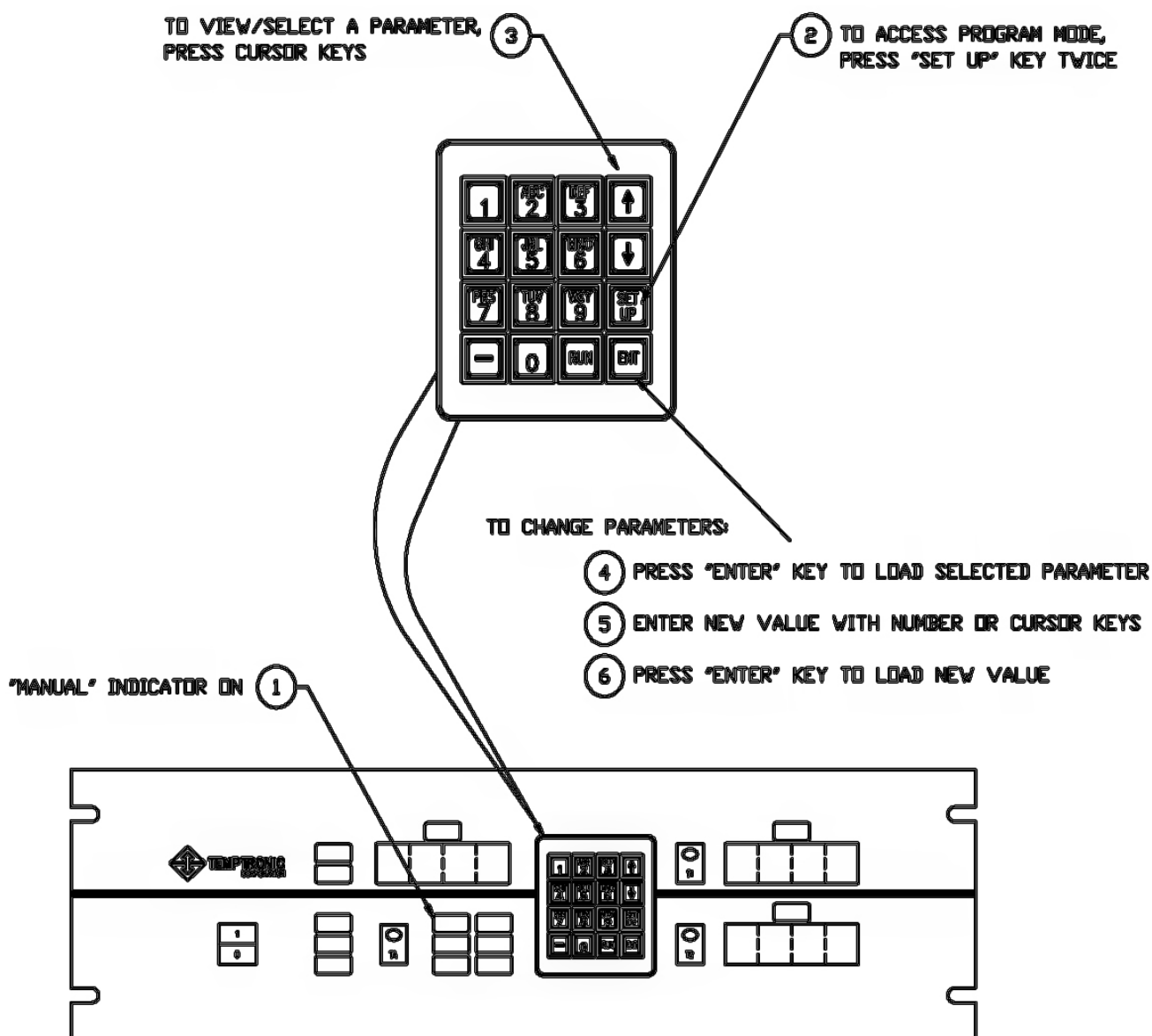
• PRESS "RUN" KEY TO INITIATE TEMPERATURE CONTROL IN AUTOMATIC MODE

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Program Menu (TP0300)

NOTE: for the complete TP03000 Menu, refer to Chapter 5, TP03000 Controller: Complete List of Mnemonic Codes.

Parameter (Mnemonic)**	Description
TMP1	View/Change the Setpoint of TMP1
TMP2	View/Change the Setpoint of TMP2
TMP3	View/Change the Setpoint oft TMP3
TMP4	View/Change the Setpoint of TMP4
TMP5	View/Change the Setpoint of TMP5
TMPA	View/Change the Setpoint oft TMPA
WN1	View/Change the Window of TMP1
WN2	View/Change the Window of TMP2
WN3	View/Change the Window of TMP3
WN4	View/Change the Window of TMP4
WN5	View/Change the Window of TMP5
WNT1	View/Change the Window of T1
WNT2	View/Change the Window of TMP2
WNTA	View/Change the Window of TMPA
RMP1	View/Change the Ramp rate of TMP1
RMP2	View/Change the Ramp rate of TMP2
RMP3	View/Change the Ramp rate of TMP3
RMP4	View/Change the Ramp rate of TMP4
RMP5	View/Change the Ramp rate of TMP5
SK1	View/Change the Soak time of TMP1
SK2	View/Change the Soak time of TMP2
SK3	View/Change the Soak time of TMP3
SK4	View/Change the Soak time of TMP4
SK5	View/Change the Soak time of TMP5
CYCL	View/Change the number of Cycles
PUMP	View/Change the Temperature of the fluid Pump (default value 40 °C; can be set from 35 to 70 °C)
**Press up-arrow key repeatedly to move down the list of mnemonics; press down-arrow key repeatedly to move up the list.	

Section D: Automatic Mode Operations

Introduction

The TP0300 System can be set to run automatically through various temperature setpoints. The parameters for each setpoint (TMP1 through TMP5) must be preset by the operator before the system can operate in Automatic Mode.

Automatic Mode Conditions

Automatic operation is governed by the following factors:

- The CYCL parameter must be set for at least one program cycle to enable the Automatic Mode to start.

- For every programmed setpoint (TMP1 - TMP5) used, a correspondingly numbered window value (WN), soak time (SK), and ramp time (RMP) can be set to a specific value. You must enter a ramp time for each setpoint. The Controller will assign default values for the window and soak time unless you enter a different value.

- With the ramp period set to zero for a particular setpoint, that setpoint will be ignored when the cycle is run.

- If all ramp times are equal to zero, then pressing the RUN key will have no effect and the system remains in the Program Mode.

- If the ramp time selected as a beginning point is set to zero, the system will select the first setpoint with the programmed ramp time as the starting point of the cycle.

- During automatic operation, pressing the RUN key will cause a Halt in the programmed routine with temperature control at the current temperature. Press the RUN key again to continue.

- When a soak time is set to zero for a selected setpoint, the system will ramp to the next programmed setpoint as soon as the system is "AT TEMP".

Procedure

At the front panel, use the following procedure for automatic sequencing of temperature control with the TMP1 - TMP5 setpoints.

1. If not in the Program Mode (Subsection 3-3), press the SET UP key twice to access the Program Mode.

- PARAM indicator blinks
- VALUE indicator turns on steady
- T1 and T2 indicators turn off
- PARAM display shows mnemonic for last parameter accessed
- VALUE display shows value for displayed parameter.

2. Enter the ramp time mnemonic (RMP1 - RMP5) for the setpoint at which you want the programmed cycle to start. Use the up-arrow and down-arrow keys on the 4x4 keypad to select the mnemonic.

NOTE: The PARAM display must show a programmed ramp time before the Automatic Mode can start.

3. Press the **RUN** key to initiate the Automatic Mode routine.

- AUTO indicator turns on.

NOTE: When the number of programmed cycles is completed, the system will stop the routine with temperature control at the TA setpoint (TA indicator blinks). The PARAM display shows CYCL, and the VALUE display shows the number of programmed cycles completed.

4. To exit the Automatic Mode, press the **RUN** key to *Halt*, and then press one of the **T1**, **T2**, or **TA** switches (exits to Manual Mode).

5. To run another cycle, perform Steps 1, 2, and 3 above.

RUN Status Displays

During the Automatic Mode, the PARAM and VALUE displays show the progress of the programmed cycles, alternating back and forth between the temperature status and the cycle status.

While ramping toward a setpoint, first the setpoint is identified by its mnemonic (PARAM display) and temperature value (VALUE display). Next, the cycle is identified by CYCL (PARAM display) and current number (VALUE display).

After reaching a setpoint, first the soak time is identified by its mnemonic (PARAM display) and countdown time remaining for that soak (VALUE display). Next, the cycle is identified by CYCL (PARAM display) and current number (VALUE display).

Remote Interfaces

4

Chapter Overview

In this Chapter

This Chapter is divided into the following Sections:

Section A: Remote Interfaces Introduction

....

Remote Interfaces Overview

The *TP03000* System has two different remote communications interfaces:

GPIB (IEEE-488.2)

Serial (RS-232C)

- The *TP03000* GPIB host interface was designed to be in substantial compliance with IEEE Standard 488.2. Please refer to the IEEE-488.2 standard for command syntax and general programming information.
- The Serial interface uses the software protocols of the IEEE-488.2 standard. Additional software commands were added to emulate the functionality normally provided by dedicated GPIB control lines.
- The GPIB and Serial interfaces feature complete IEEE-488 service request and serial polling capabilities. The system can be programmed to generate service requests for temperature events (reaching the desired temperature, completing cycling, etc.), System-specific errors (overheat, low fluid).
- This manual provides information specific to the *TP03000* System and identifies which instructions the System supports.
- For the System to be controlled by a remote Host, the System must first be initialized and be in an operating mode capable of temperature control.
- When the System is being controlled by a remote Host, the controller front panel "Remote" indicator will illuminate.

Syntax Overview

For both GPIB (IEEE-488.2) and Serial (RS-232C):

- All message strings to and from the TP03000 consist of ASCII characters.
- Numerical arguments are always sent/received in decimal format as a string of ASCII characters.
- Some numerical arguments consist of a series of binary flags. They are sent as a decimal number equal to the sum of the binary weights of each flag bit that is a "one."
- Commands with arguments must have a space between the command and the argument.
- Serial (RS-232C) program messages (strings) must be terminated with a line feed. GPIB program messages (strings) may be terminated with a line feed, by setting the EOI line, or both.
- In GPIB mode, response messages from the TP03000 are terminated with a line feed character with the EOI line set. In Serial mode, response messages are terminated with a carriage return followed by a line feed.
- Program message unit separators ";" (semicolons) are required to delimit multiple commands or queries in a single program message (string).

Section B: Serial Interface (RS-232C)

Section Overview

In this Section
The following topics are covered in this Section:

Serial Interface Pin-Outs and Handshaking (RS-232C)

Interface Connector Pin Allocations

The TP03000 Controller interfaces to the RS-232C communications lines through a standard 25-pin female connector on the Controller rear panel. The Controller can operate in a three-wire (transmit, receive, ground) configuration. Besides the minimum requirements for communication, four more lines are connected as given below. These lines are required to carry out the hardwired handshake mode.

Pin Number	RS-232C	Function/Signal Level
1	AA	Protective Ground
2	BA (TDATA)	Data line from TP03000 Controller
		High = ON = logic 0 = +12V = SPACE
		Low = OFF = logic 1 = -12V = MARK
3	BB (RDATA)	Data line to TP03000 Controller
		High = ON = logic 0 = +3 to +25 V
		Low = OFF = logic 1 = -3 to -25 V
4	CA	"Request to Send" from TP03000 Controller
		High = ON = logic 0 = +12 V = SPACE
		Low = OFF = logic 1 = -12 V = MARK
5	CB	"Clear to Send" to TP03000 Controller
		High = ON = logic 0 = +3 to +25 V
		Low = OFF = logic 1 = -3 to -25 V
7	AB (SGND)	Signal ground (return line)

BUSY Considerations

Messages sent to the TP03000 Controller can contain single or multiple commands.
The TP03000 Controller reads these commands into a buffer until a <CR> or <LF> is received. After the <CR> or <LF> is received, the Controller begins to process the commands, and will not perform any further communication (transmit data or receive commands) until all of the present commands are processed. All commands in multiple-command messages are processed together. A time period of up to 0.5 second should be allowed for commands to take effect in the actual instrument

Example:

Message from Remote Computer:

RS25;RW0.5;RM32;SS;SW;SM; <LF>

Response from TP03000 Controller:

25.0;0.5;32; <CR> <LF>

The Remote Computer should not send another message until the TP03000 Controller is through processing the previous one, because any message sent while the Controller is busy, will be lost.
One way to control the data exchange is for the Remote Computer's application program to set a timer and wait an appropriate period before sending another message.
A better way to control the communications is to use handshaking.
The TP03000 Controller can use one of two handshaking methods to prevent loss of data.

Using a Hardwire Handshake

In hardwired handshake operation, the TP03000 Controller regulates the data exchange sequence by setting the electrical voltage on the CA line (pin 4 of I/O connector) high to the Remote Computer. This state signals the computer to send another group of commands. If the TP03000 Controller is busy processing a command and cannot input another, it sets the CA line (Request to Send) to a low state. If all commands are processed and it is ready for another group of commands, it sets the line high. By monitoring this line, the Remote Computer knows when it can or cannot safely transmit another set of commands.

In the hardwired handshake mode, the TP03000 Controller will only transmit data when the voltage on the CB line (pin 5 of I/O connector) is high.

NOTE: If the Remote Computer being used does not set the CB line (Clear to Send) to a high, this can be handled by disconnecting pin 5 and tying it to the CD line (at pin 20 of I/O connector) which is always high.

Using an Enquire/Acknowledge Handshake

Choose the 488.1 command option at the front panel
The enquire/acknowledge handshake, which uses the ASCII characters ENQ (05H) and ACK (06H) to control the data transfer, is a form of software handshaking initiated by the Remote Computer. With this handshake, the computer's application program controls the data exchange process by asking (ENQ) the TP03000 Controller to respond (ACK) when it is ready to receive another set of commands.

Example:

Message from Remote Computer:
RS25;RW0.5; <ENQ> <CR> <LF>
Response from TP03000 Controller:
<ACK> <CR> <LF>
NOTE: <ENQ> must come before <CR> in the command line for proper operation.

Another Example:

Message from Remote Computer:
RS25;RW0.5; <CR> <LF> <ENQ>

When the TP03000 Controller receives a <CR> in its input buffer, it will not input any more characters until it processes the two commands (RS25 and RW0.5 in the above example).

During this time the <ENQ>Q will be lost. Therefore, this line will get no response, <ACK>, from the TP03000 Controller.

Serial Interface Parameters (RS-232C)

RS-232C Parameters Menu

The following Serial Interface parameters are available in the TP0300 Controller Menu:

Mnemonic	Description	Options
BRT	View/Change RS-232C Baud Rate	300, 600, 1200, 4800, or 9600 baud
DBT	View/Change RS-232C Data Bits	7 or 8
PAR	View/Change RS-232C Parity	Even (2), odd (1), or no (0) parity
STP	STP View/Change RS-232C Stop Bits	One or two
MSK	View/Change RS-232C Mask	0 - 255
LNER	View RS-232C Line Errors	Viewing clears errors
HHS	View/Change Hardware Handshaking	Enabled (1), disabled (0)
CMDS	View/Change 488.1/488.2 Style Option	488.1 or488.2 **NOTE:** The CMDS should be set to 488.1 for RS-232C control.

Setting the RS-232C Parameters

The table above identifies the RS-232C communications parameters that can be viewed or changed in the TP03000 Controller menu.

The PARAM display shows the mnemonic for the last parameter accessed.

The VALUE display shows the option selected for the displayed parameter.

At the Controller front panel, use the following procedure to view or change any of the RS-232C communications parameters:

1. Check that the MANUAL indicator is on.
2. Access the Program Mode by pressing the **SET UP** key twice.
3. To view a particular communications parameter, use the up-arrow and down-arrow keys to scroll the PARAM display to the desired parameter.
4. To change a selected parameter option, press the **ENT**er key.
   - PARAM indicator turns on steady
   - VALUE indicator blink
5. Enter the new option on the 4x4 keypad, starting with the Most Significant (MS) digit first to the Least Significant (LS) digit.
6. Press the **ENT**er key to load the new option into memory.
7. Repeat Steps 3 through 6 to change any parameter needing a new value.
8. Verify that the CMDS parameter is set to: 488.1
   The CMDS should be set to 488.1 for RS-232C control.
9. When completed with viewing/changing the communications parameters, select the LER mnemonic to view the RS-232C line error status. If an error should occur during RS-232C

Remote Controlled operation, it will be identified on the VALUE display. The hexadecimal value of any line errors will be displayed in the following format:

- Bit 0 - overrun error
- Bit 1 - parity error
- Bit 2 - framing error
- Bit 3 - break interrupt

After correction of the error, pressing any Controller keypad key will clear the error display.

NOTE: The syntax for the receive and send commands is given in Syntax Overview, page 4-2.

Serial Interface Control (RS-232C)

Check that the TP03000 System completes a successful power start-up.
For convenience if possible, locate the Remote Computer within viewing range of the
Controller front panel. The illustration below shows the LED status indicators involved with
RS-232C Remote Controlled operation.Controller Indicator Group for RS-232C Operation

**Controller Indicator
Group for RS-232
Operation**

Illuminates when
the Controller
Transmits

Illuminates when
the Controller
Receives (or listens)

Illuminates when the
System is under
Remote Control

Illuminates when
the TP03000
Requests Service
from the Remote
Computer
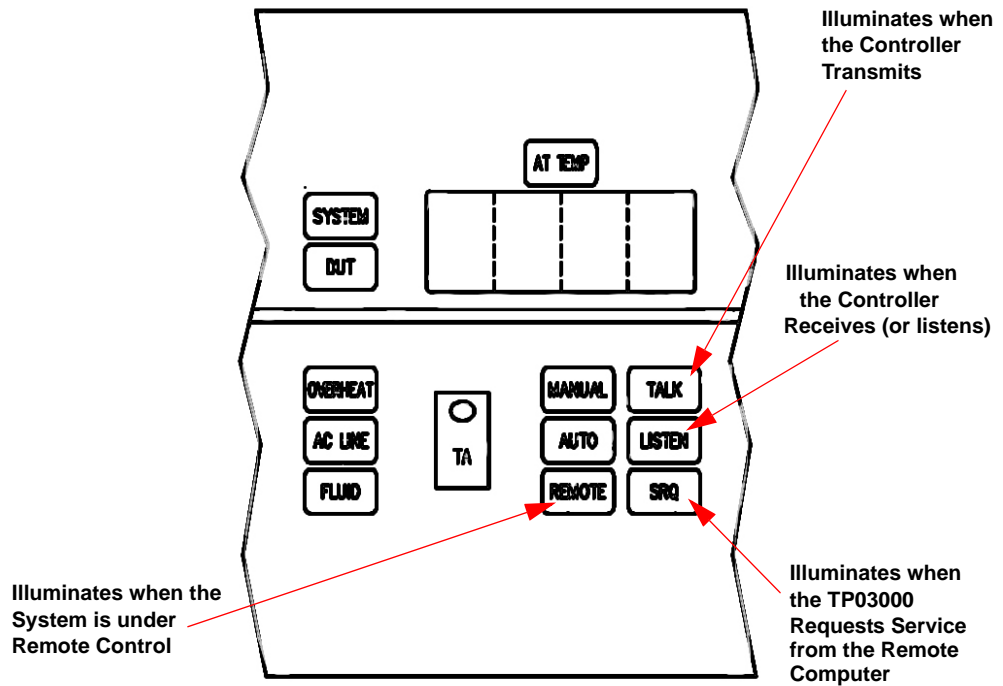
0930_401.jpg

Serial Interface Commands (RS-232C)

Remote control of the TP03000 System is started, stopped, or queried by one of the following six commands (these commands emulate an IEEE-488 interface and all begin with an asterisk [*]:

- ***GL (Go to Local)** Usually, the TP03000 Controller will go remote whenever it receives a message and will remain remote until the ENTer key is pressed. However, after receiving the *GL command, the TP03000 Controller will go to local and remain local until a *RM or a *LL command is received.

- ***RM (Go Remote)** After receiving this command, the TP03000 Controller will go remote and remain remoted until either the **ENTer** key is pressed or a ***GL** command is received.

- ***LL (Local Lockout)** After receiving this command, the **ENTer** key is locked out and the TP03000 Controller will go remote and remain remote until a ***GL** command is received.

- ***CL (Device Clear)** This command clears bit 6 of the Service Request Interface (SRQ), and resets any overheat, open loop, or message not executed error condition.

- ***ST (Send Status)** After receiving this command, the TP03000 Controller clears the SRQ flag, and sends the ASCII representation of the status byte to the Remote Computer.

- ***OSx** Argument "x" is a 0 - 8 character string that the TP03000 Controller will send to the Remote Computer when an SRQ is generated.

Service Request, SRQ (RS-232C)

The TP03000 Controller requests service similar to the SR1 function of the IEEE-488 interface. Any one or combination of events can initiate an SRQ. A single byte of information is allowed for an instrument's response. The TP03000's response (the **Status Byte**) has the following format:

Bit Function:

0 Arriving AT TEMP

1 Leaving AT TEMP

2 Always 0

3 Always 0

4 System error

5 Message not executed (message not understood)

6 RSV (indicates this device generated SRQ)

7 Power up

The SRQ Mask (RM and SM messages) has the same format as the Status Byte. If one or more of bits 0 through 7, excluding the 3 and 6 bits, of the Status Byte makes a transition from 0 to 1, and the corresponding bit in the SRQ mask is also 1, then bit 6 of the Status Byte will go to 1 and an SRQ will be generated. The SRQ will remain pending until a serial poll (*ST) of the TP03000 Controller is performed. The Status Byte will not change while an SRQ is pending. The serial poll clears bit 6 of the Status Byte.

At power on, bits 0 to 5 of the SRQ mask are set to 0. Bit 7 is set to 1 if it was 1 at power down and if it is 1 generates a power up SRQ.

Bit 5 of the Status Byte (message not executed) is valid after a message is received. Bit 5 is set if a syntax error was detected or if an RS or RW command was received while the system was local (interface states LOCS or LWLS). If multiple commands are sent in a single message, commands prior to the error are executed and the remainder of the message is ignored. Bit 5 remains set until another message is received.

Section C: GPIB Interface (IEEE-488)

Section Overview

In this Section   The following topics are covered in this Section:

Topic	See Page
GPIB Specifications (IEEE-488)	
GPIB Data Exchange Protocol (IEEE-488)	
GPIB Interface Parameters (IEEE-488)	
GPIB Control (IEEE-488)	
IEEE-488.1 Commands and Queries	
IEEE-488.2 Commands and Queries	
Service Request, SRQ (IEEE-488)	

GPIB Specifications (IEEE-488)

The following is the specification for the Temptronic Corporation IEEE-488 function of this device.

These function subsets fully describe the interaction of the instrument with the bus. They do not define the syntax of transmitted messages and the way the instrument generates service requests and responds to serial polls. These areas that are of concern to the user in terms of writing Temptronic device dependent software are defined in the next paragraphs.

SH1: Complete Source Handshake Interface Function.

AH1: Complete Acceptor Handshake Interface Function.

T6: A subset of the Talker Functions which includes Basic Talker, Serial Poll and Unaddress if MLA.

TE0: The extended talker functions are not supported.

L4: A subset of the Listener Functions which includes Basic Listener and Unaddress

if MTA.

LE0: The extended listener functions are not supported.

SR1: Complete Service Request Interface Capability.

RL1: Complete Remote Local Function Capability.

PP0 No Parallel Poll Capability.

DC1: Complete Device Clear Function Capability (the device clear state for the

Temptronic device is the power up state).

DT0: No Device Trigger Capability.

C0: No Controller function.

GPIB Data Exchange Protocol (IEEE-488)

Messages to the TP03000 Controller may be one or more commands. When a message is received, the Temptronic device goes BUSY while it handles each command of a message. While busy, the Temptronic device will not respond and could "hang up" the bus. To avoid tying up the bus, use the SRQ function's Not Busy bit so the Remote Computer can tell when to send another message.

Example:

<u>Message from Remote Computer:</u>

RS100;SS;ST;<CR> <LF>

<u>Response from TP03000:</u>

100.0;45;0;<NL>

NOTE: (NL = New Line, formerly known as Line Feed)

GPIB Interface Parameters (IEEE-488)

IEEE-488 Parameters Menu

The following GPIB Interface parameters can be viewed and changed in the TP0300 Controller Menu:

The controller's PARAM display shows the mnemonic for the last parameter accessed.

The controller's VALUE display shows the value of the displayed parameter.

Mnemonic	Description	Options
MSK	View/Change IEEE-488 Mask	0 - 255
ADR	View/Change IEEE-488 Address	0 - 30
CMD	View/Change 488.1/488.2 Style Option	488.1 or 488.2

- The IEEE-488 Mask (SRQ Mask) permits the TP03000 Controller to generate an SRQ message ONLY for the interrupt condition specified. Use the MSK mnemonic to view or change these interrupt conditions. For greater detail, refer to Service Request, SRQ (IEEE-488), page 4-22.

- Like any device installed on an IEEE-488 bus, the TP03000 Controller must have its own unique address. Use the ADR mnemonic to view the current address (initially set by the factory) or to change to a new address.

Setting the GPIB Parameters

At the Controller front panel, use the following procedure to view or change one of the IEEE-488 communications parameters:

1. Check that the MANUAL indicator is on.
2. Access the Program Mode by pressing the SET UP key twice.
3. To view a particular communications parameter, use the up-arrow and down-arrow keys to scroll the PARAM display to the desired parameter.
4. To change a selected parameter value, press the ENTer key.
- PARAM indicator turns on steady
- VALUE indicator blinks.
5. Enter the new value on the 4x4 keypad, starting with the Most Significant (MS) digit first to the Least Significant (LS) digit.
6. Press the ENTer key to load the new value into memory.
7. Repeat Steps 3 through 6 to change any parameter needing a new value.

GPIB Control (IEEE-488)

Check that the TP03000 System completes a successful power start-up.

For convenience (if possible), locate the Remote Computer within viewing range of the Controller front panel. The illustration below shows the LED status indicators involved with RS-232C Remote Controlled operation

When the TP03000 System is under the control of the Remote Computer, the REMOTE indicator will be on. At frequent intervals, the TALK and LISTEN indicators will turn on alternately, indicating communication between the Remote Computer and the TP03000.

Controller Indicator Group for IEEE-488 Operation

Illuminates when the Controller Transmits

Illuminates when the Controller Receives (or listens)

Illuminates when the System is under Remote Control

Illuminates when the TP03000 Requests Service from the Remote Computer
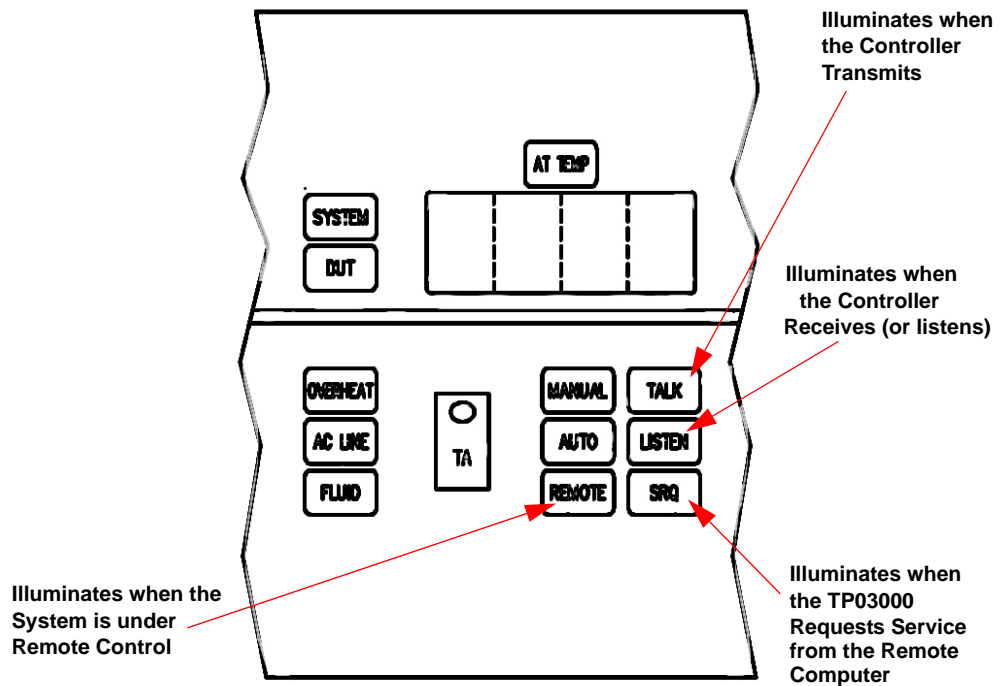
0930_401.jpg

IEEE-488.1 Commands and Queries

Receive Commands (488.1)

NOTE: The 488.2 format should be used for new applications for compatibility with future product designs.

Each Receive command has two letters with numeric arguments. These commands prompt the TP03000 Controller to listen and establish internal conditions and accept new control parameters.

Receive commands have the syntax as listed below with an additional argument as follows:

n is an integer 1 to 5 w is a number 0.1 to 9.9

j is an integer 0 to 9999 t is a number -99.9 to +999.9

k is an integer 0 to 999 b is an integer 0 or 1

y is an integer 0 to 255

is an integer 1 to 3

- 1 = T1
- 2 = T2
- 3 = TA

All the above arguments are to be transmitted as ASCII characters. For example, the byte 127 would be sent as three ASCII numbers (a 1, a 2, and a 7). Type t and w arguments are rounded to tenths when received. All space characters in messages to the TP03000 Controller are ignored. Separators are not required between multiple commands; however, either a comma (,) or a semicolon (;) are permitted.

RSt Receive remote Setpoint (error if local) RWw Receive remote Window (error if local)

RMy Receive service request Mask (see section on Service Requests)

RPb Receive Power state (0 = power inhibited, 1 = power enabled)

R n S t Receive set #n Setpoint temperature (error if not remote)

R n W w Receive set #n Window value (error if not remote)

R n R j Receive set #n Ramp time (0-9999 seconds) (error if not remote)

R n K j Receive set #n soaK time (0-9999 seconds) (error if not remote)

RN k Receive cycle couNt (0-999) (error if not remote)

RA n Receive beginning RAmp number

RX b Receive eXcitation (1=ramp & soak on) (0=ramp & soak off) (error if not remote)

RG n Receive toGgle ramp #n (0=halt, 1=restart)

RB n Receive local setpoint numBer n (error if not remote)

R#Lt Receive Local setpoint number temperature

Messages from the Remote Computer should be terminated with a Carriage Return <CR> and a Line Feed <LF>.

SD Receive the status of power reduction. (1= power reduced, 0= power not reduced)

Send Commands (488.1)

The Send commands have at least two letters for identification. Some of these commands add a numeric argument to specify a control parameter. These commands cause the TP0300 Controller to talk and send specific requested data to the Remote Controller.
Send commands have the syntax as listed below.

ST Send current Temperature (t format)

SS Send current Setpoint (t format)

SW Send current Window (w format)

SM Send service request Mask (y format, see section on Service Requests)

SF Send condition Flags (y format, detailed below)

SE Send system Error type (y format, detailed below)

S n S Send set #n Setpoint temperature

S n W Send set #n Window value

S n R Send set #n Ramp time

S n K Send set #n soaK time

SN Send cycle couNt

SB Send current local setpoint numBer (1 = T1, 2 = T2, 3 = TA)

SH Send option status cHeck byte (y format, detailed below)

SI Send cycles remaining

SA Send beginning ramp

S#L Send Local setpoint temperature

Messages when sent by the Remote Computer should have the formats indicated above which correspond to the Receive command format. The transmitted message from the TP03000 Controller will be followed by a Carriage Return <CR>, a Line Feed <LF> for RS-232C and <NL> New Line for IEEE-488.

Condition flag byte (SF):

Returns an ASCII string that is a decimal number between 0 and 255 which converted to a binary number indicates the register bit(s) that is (are) positive,

BIT	FUNCTION
0	AT TEMP
1	Calibration Enabled
2	Power inhibited
3	Remote
4	Lockout
5	System error
6	0 1 0 1
7	0 0 1 1 0- System in default calibration 0- Calibrated state 1 1- Calibrated state 2 1- System Calibrated

Examples: If the system returns the following decimal numbers in response to an SF query and they are converted to their binary equivalents, they would indicate the following:

SF0	Binary	0	0	0	0	0	0	0	0
	Bits	7	6	5	4	3	2	1	0

The ASCII string SF 0 gives:
Binary 0 = no status register bits positive

SF0	Binary	0	0	0	0	0	1	1	1
	Bits	7	6	5	4	3	2	1	0

The ASCII string SF 7 gives:
Binary 111
= status register bits 2, 1, 0 are positive
= Power inhibited, Calibration enabled, AT TEMP

SF0	Binary	0	0	0	1	0	0	0	0
	Bits	7	6	5	4	3	2	1	0

The ASCII string SF 16 gives:
Binary 10000
= status register bit 4 is positive = Lockout (enabled)

System Error type byte (SE):

Returns an ASCII string that is a decimal number between 0 and 255, which converted to a binary number indicates the register bit(s) that is (are) positive:

BIT	FUNCTION
0	Overheat
1	Open Loop
2	Always 0
3	Always 0
4	Always 0
5	Always 0
6	Always 0
7	Always 0

Option Status Check byte (SH):

Returns an ASCII string that is a decimal number between 0 and 255, which converted to binary number indicates the register bit(s) that is (are) positive:

Bit	Decimal Condition	Description
0	1	Option is active
1	2	Option is stopped
2	4	Option is ramping
3	8	Option is soaking
4	16	Setpoint number coding (see below)
5	32	Setpoint number coding (see below)
6	64	Setpoint number coding (see below)
7	128	Not used = 0

Setpoint Coding:

Byte (bit)	Binary Weight	Setpoint Number				
		1	2	3	4	5
4 (bit 0)	1	1	0	1	0	1
5 (bit 1)	2	0	1	1	0	0
6 (bit 2)	3	0	0	0	1	1

Example: Status check byte is decimal 85,
64 - (bit 2) = 4
16 - (bit 0) = 1 (4 + 1 = setpoint 5)
4 - option is ramping
+ 1 - option is active
85

IEEE-488.2 Commands and Queries

At the front panel, the CMDS option can be set to either 488.1 or 488.2. Next follows a list of commands and queries for use in the 488.2 command style mode. The numeric formats (n, j, k, y, #) are the same as for the 488.1 format, and the responses to queries are the same in both cases. However, in commands with numeric arguments, there must be a space between the command and the numeric string.

Interface Commands and Queries

*CLS - Clear the status data registers

*ESE - Set standard event status enable register; *ESE nnn-- where nnn is 0-255

*ESE? - Read standard event status enable (mask) register

*ESR? - Read standard event status register
bit 7--power on--NOT USED
bit 6--user request--NOT USED
bit 5--command error (cme)
bit 4--execution error (exe)
bit 3--device dependant error (dde)
bit 2--query error (qye)
bit 1--request control--NOT USED
bit 0--operation complete-- NOT IMPLEMENTED
NOTE: The above bits are latched and are automatically cleared when the register is read.

*IDN? - Send instrument identification

*SRE y - Set service request enable register

*SRE? - Send service request enable register

*STB? - Read the status byte:
bit 7 - ready
bit 6 - master status summary bit (SRQ)
bit 5 - standard event (esr) summary bit
bit 4 - message available (IEEE only, serial always 0)
bit 3 - temperature event (tesr) summary bit
bit 2 - device specific error (eror) summary bit
bit 1 - not used
bit 0 - not used

TECR

bit 0 at temp
bit 1 not at temp

TECR? - Read temperature event condition register

TESR
bit 0 arriving at temp
bit 1 leaving at temp

TESR? - Read temperature event status register (clears register)

TESE? - Read temperature event status enable register

TESE y - Set temperature event status enable register

Receive Commands

SETN n Receive setpoint number, as follows:

SETN Value
0 - TA Setpoint and window
1 - #1 Ramp/Cycle Setpoint,Window,Ramp Time,and Soak Time
2 - #2 Ramp/Cycle Setpoint,Window,Ramp Time,and Soak Time
3 - #3 Ramp/Cycle Setpoint,Window,Ramp Time,and Soak Time
4 - #4 Ramp/Cycle Setpoint,Window,Ramp Time,and Soak Time
5 - #5 Ramp/Cycle Setpoint,Window,Ramp Time,and Soak Time
6 - T1 Setpoint and window
7 - T2 Setpoint and window
8 - Remote Setpoint and window

Example(s):

To change the T2 setpoint to 125.0 send the following:

SETN 7
SETL 125.0

To change the #3 setpoint to 25.0 send the following:

SETN 3
SETP 25.0

To change the Remote setpoint to 55.0 send the following:

SETN 8
SETP 55.0

Notes:
While remote the system will control from the Remote setpoint unless Ramp/Cycle is active. After changing SETN to a value other then 8 it should be returned to 8 to ensure proper remote operation.

SETP t Receive temperature setpoint

WNDW t Receive temperature window

SOAK j Receive soak time in seconds

RAMP j Receive ramp rate in seconds

MASK y Receive SRQ mask

POWR b Receive power state. (0=power inhibited, 1=enabled)

CYCC k Receive cycle count

STRT n Receive starting ramp number

EXCT b Ramp/soak excitation. (1=start ramp/soak. 0=halt)

TOGL n Switch ramp/soak #n on or off

SETB n Receive local setpoint number (where local is TA, T1, T2, and no cycling is active)

SETL t Receive local setpoint temperature (where local is TA, T1, T2, and no cycling is active)

Send queries

TEMP? Send current chuck temperature

FLAG? Send ASCII representation of flags byte

SETP? Send current chuck temperature setpoint

EROR? Send ASCII representation of error byte

WNDW? Send current temperature window

CYCC? Send cycle count

CYCN? Send cycle number

SOAK? Send soak time

RAMP ? Send ramp rate in seconds

OPTN? Send option check byte

STRT? Send starting setpoint number

SETB? Send local setpoint number (where local is TA, T1, T2, and no cycling is active)

SETL? Send local setpoint temperature (where local is TA, T1, T2, and no cycling is active)

PWRH? read heating power limit

PWRL? read cooling power limit

PWRC? read current power

NOTE: The following commands are now RS232 serial only (not part of IEEE-488.2 command set):

- *GL Go to Local
- *RM Go Remote
- *LL Local Lockout

Service Request, SRQ (IEEE-488)

The TP03000 Controller can request service by the Remote Controller. Any one or combination of events can cause a service request (SRQ). Then, the Remote Controller typically conducts a Serial Poll to discover which instrument on the bus requested service and the reason for the request. A single byte of information is called for this response.

The SRQ mask is a decimal number between 0 and 255 that represents an ignored bit 6 when received (always a logic 0 when sent) followed by a New Line (with END asserted during the New Line). All of the SRQ Mask is cleared at power up except the MSB (Power up SRQ) which has been retained by the TP03000 Controller back-up battery during power down.

Bit	Condition	Mask (binary)
0	Arriving at AT TEMP	1
1	Leaving AT TEMP	2
2	Not busy	4
3	Always = 0	8
4	System Error 16	16
5	Message not executed (message not understood)	32
6	RSV (indicates this device generated SRQ)	64
7	Power up	128

Bit 2 is cleared when the first character of a message is received. It is set when all commands in that message are executed.

Bit 5 is valid when bit 2 is set after a message is received. Bit 5 is set if a syntax error was detected or if an RS or RW command was received while the system was local (interface states LOCS or LWLS).
If multiple commands are sent in a single message, commands prior to the error are executed and the remainder of the message is ignored. Bit 5 remains set until another message is received.

If one or more of the bits 0 through 7, excluding the 6 bit, of the status byte makes a transition from 0 to 1 and the corresponding bit in the interrupt mask is also 1, then bit 6 of the status byte will go to 1 generating an SRQ. The SRQ will remain pending until a serial poll is performed which will clear bit 6. The status byte will not change while an SRQ is pending.

All other SRQ mask bits are changed to 0 at power up except bit 7 which is set to the state at power down.

Messages to the TP03000 Controller may be terminated by asserting END with last data byte or by sending New Line or both. All special characters (ASCII 0-31) are ignored except New Line (hex 0AH).

Messages from the TP03000 Controller are terminated by the sequence New Line with END asserted.

Routine Maintenance

5

Chapter Overview

In this Chapter

The TP03000 Systems have been designed and manufactured to withstand the rigors of constant use in most manufacturing environments. To ensure many hours of trouble free service from your system, a routine of preventive maintenance should be performed on a regular basis.

This Chapter is divided into the following Sections:

Section A: Inspection and Cleaning

. . . .

Inspection

Weekly inspection is recommended for frequently used systems to ensure normal operation with no deterioration of performance. Verify that the system reaches a selected setpoint in normal time, maintains the temperature without change, and the LED indicators and 4-digit displays all function reliably. Check the integrity of the ThermoChuck Platform cabling and hoses.

Cleaning

Keep the system clean for reliable operation. In particular, clean the working surface of the ThermoChuck Platform frequently (depending on operating environment) for good thermal and electrical contact with the test specimens. Clean the ThermoChuck Platform in the same manner commonly used for cleaning printed circuit board contacts. Take care not to plug the vacuum holes.

CAUTION

CAUTION: The ThermoChuck Platform surface is typically gold plated. Do not use any (harsh) abrasive materials for cleaning.

Clean the condenser inlet of the Cooler/Circulator every 3 months or sooner if needed. Pull off the front grill of the Cooler/Circulator for access. Clean the condenser inlet with a vacuum cleaner to remove any dust. A dirty condenser inlet will reduce the air flow and degrade the cooling performance of the Cooler/ Circulator.

Clean the Controller front panel every 6 months or sooner if needed. Use a soft, lint-free cloth or a ball of absorbent cotton, moistened with a mild glass cleaner. Use caution when cleaning the display lenses; be careful not to scratch them or to get cleaning liquids into the Controller. *Do not* use a paper towel; *do not* use enough liquid to drip or run.

Section B: Calibration

Section Overview

In this Section   The following topics are covered in this Section:

Topic	See Page
Verification Procedure	4
Calibration Procedure	6
Calibration Table	9

Verification Procedure

Before the TP03000 System is calibrated or at any time the system calibration for a thermal device is questioned, perform the verification procedure as outlined below.

To ensure an accurate system calibration, follow proper temperature sensing techniques (contact your Sales/Service representative if you have any questions). Verify that the instrumentation (external precision temperature monitor and thermocouple sensor) used to sense the working surface temperature is in calibration. This instrumentation must be calibrated against a primary or transfer standard.

Checking Previous Calibration Values

By scrolling through the controller menu to **HCAL** and **LCAL**, the operator can view information about the previous system calibration. The controller front panel will display the following information when **HCAL** or **LCAL** is displayed:

- the **PARAM** window will display either **HCAL** or **LCAL**
- the **AT TEMP** window will display the Calibration Setpoint used in the previous calibration
- the **VALUE** window will display the reading of the external sensor during the previous calibration

Procedure

⚠ CAUTION

CAUTION: Do not place anything on the ThermoChuck Platform surface that cannot withstand the upper temperature limit of the ThermoChuck Platform.

1. Switch off power to the TP03000 Controller.
2. Wait for the ThermoChuck Platform surface to reach ambient temperature for safe handling.
3. Install the sensor of the external temperature monitor in the calibration hole at the circumference of the ThermoChuck Platform. *Do not use the vacuum hole.*
   NOTE: Remove the socket-head set screw for access to the calibration hole, and make sure the measurement sensor is in good thermal contact with the Platform.
4. Switch on power to the Controller, and allow 15 minutes for warm-up (MANUAL indicator will turn on).
   NOTE: Place the ThermoChuck Platform in a suitable enclosure if necessary to prevent its surface from being exposed to air currents.
5. Press the appropriate switch (T1 or T2) to select a setpoint near the desired low temperature to be verified.
6. At the 4x4 keypad, enter the desired temperature (current low calibration value or factory default value, or a frequently used low test temperature).
7. After the AT TEMP indicator comes on, wait 2 minutes for the external temperature monitor to stabilize. Verify that the measured temperature is within ±0.5 °C of the temperature entered in Step 6.
8. Press the appropriate switch (T1 or T2) to select a setpoint near the desired high temperature to be verified.
9. At the 4x4 keypad, enter the desired temperature (current high calibration value or factory default value, or a frequently used high test temperature).

10. After the AT TEMP indicator comes on, wait 2 minutes for the external temperature monitor to stabilize. Verify that the measured temperature is within ±0.5 °C of the temperature entered in Step 9.

11. If desired, verify the system calibration at intermediate temperatures between those used in Steps 6 and 9 or at other test temperatures.

12. Evaluate the deviations in entered and measured temperature values to determine if a recalibration is needed and what the interval should be between re-calibrations.

Calibration Procedure

Introduction

Check the temperature calibration of the TP03000 System every 1000 hours of operation or every 6 months to verify the temperature control accuracy of the system. After 1 year, calibrate only as necessary based on the previous calibration performance. Because of the stable and reliable characteristics of the platinum RTD sensor used in the ThermoChuck Platform, a two-point calibration assures accurate operation over the system temperature range. This calibration ends with an automatic tune routine that checks and compensates for changes in DUT thermal mass load on the ThermoChuck Platform surface.

If the system defaulted to its "dCAL" condition previously during operation and an external temperature monitor is not available, the system can be calibrated using previous calibration measurements. Use either the factory calibration values or your latest user-calibration values as recorded in the Calibration Table to substitute in Steps 12 and 16 of this procedure (the previous values should be stored in memory under the LCAL and HCAL mnemonics).

Since the TP03000 Systems will accept different thermal devices (not at the same time) with the same power requirements, it is likely that some users will switch back and forth. This may require the calibration procedure to be performed each time a device is changed because the system retains one set of calibration values at a time. Therefore, it is recommended that a set of calibration values be recorded for each thermal device.

Acceptable Calibration Ranges (TP030xx Systems)

The System may be calibrated using the Default calibration setpoints or using User Defined calibration setpoints. The following table details the acceptable calibration setpoint ranges.

System Model	Acceptable Low Calibration Values	Acceptable High Calibration Values
TP03000	-55°C to150°C (default: -40°C)	-5.0°C to 200°C (default: 150°C)
TP03010A	20°C to 150°C (default:30°C)	70°C to200°C) (default: 150°C)
TP03010B	0°C to 150°C (default: 20°C)	50°C to 200°C (default: 150°C)
TP03015A	30°C to 150°C (default: 35°C)	80°C to 200°C (default: 150°C)
TP03015B *w/ 200°C Chuck*	0°C to 150°C (default: 35°C)	50°C to 200°C (default: 150°C)
TP03015B *w/ 300°C Chuck*	0°C to 250°C (default: 35°C)	50°C to 300°C (default: 250°C)
TP03020B	20°C to 150°C) (default: 35°C)	70 to 200°C) (default: 150°C)

ATTENTION

The Low Calibration Value and High Calibration Value MUST have a 50°C *Delta*.
Temptronic Corporation DOES NOT guarantee complete temperature accuracy IF the system's default calibration setpoints are not used.

CAUTION

CAUTION: Do not place anything on the ThermoChuck Platform surface that cannot withstand the upper temperature limit of the ThermoChuck Platform.

Procedure

1. Switch off power to the TP03000 Controller.

2. Wait for the ThermoChuck Platform surface to reach ambient temperature for safe handling.

3. Install the sensor of the external temperature monitor in the calibration hole at the circumference of the ThermoChuck Platform. *Do not use the vacuum hole.*
   NOTE: Remove the socket-head set screw for access to the calibration hole, and make sure the measurement sensor is in good thermal contact with the Platform.

4. Remove the calibration label on the Controller rear panel for access to the CALIBRATE selector switch. Slide the CALIBRATE selector switch to the opposite position to enable the calibration procedure.

5. Switch on power to the Controller, and allow 15 minutes for warm-up (MANUAL indicator will turn on).
   NOTE: Place the ThermoChuck Platform in a suitable enclosure if necessary to prevent its surface from being exposed to air currents.

6. Press the **SET UP** key twice to access the Program Mode.

7. Use the cursor keys on the 4x4 keypad to scroll the PARAM display until the mnemonic CAL appears.

8. If you would like to use the system's Default calibration setpoints, press the **RUN** key (and proceed to step 9).
   If you would like to use User Defined calibration setpoints, press the **ENT** key.
   • Use the numeric keypad (0 - 9) to set new calibration setpoints
   • Use the **ENT** key to enter the new calibration setpoints
   • Use the **Setup** key to escape and exit.
   • Once the new calibration setpoints have been set and entered, press the **RUN** key (and proceed to step 9).

9. The Controller will start temperature control for the low calibration setpoint with LCAL displayed in the PARAM display. (The current low-calibration value will show in the VALUE display.)

10. Wait for the ThermoChuck Platform temperature to get within the setpoint window (the AT TEMP indicator turns on and the VALUE indicator starts blinking, indicating that the calibration value can be entered).

11. Wait 5 minutes minimum at the low calibration setpoint for the external temperature monitor to stabilize. The AT TEMP indicator should stay on at this setpoint.

12. Read the actual temperature from the external temperature monitor, and enter that value on the Controller keypad. (For example: if monitor reads -50.6 °C, enter that value on the keypad.) *Be sure to record the measured low-calibration value in the* Calibration Table.

13. Press the **ENT**er key to enter the measured low-calibration value into memory. The Controller now will start temperature control for the high calibration setpoint with HCAL displayed in the PARAM display. (The current high-calibration value will show in VALUE display.)

14. Wait for the ThermoChuck Platform temperature to get within the window of the high calibration setpoint (the AT TEMP indicator turns on and the VALUE indicator starts blinking, indicating that the calibration value can be entered).

15. Wait 5 minutes minimum at the high calibration setpoint for the external temperature monitor to stabilize. The AT TEMP indicator should stay on at this setpoint.

16. Read the actual temperature from the external temperature monitor, and enter that value on the Controller keypad. (For example: if monitor reads +99.8 °C (or +149.8 °C for 200 °C option), enter that value on the keypad.) *Be sure to record the measured high-calibration value in the* Calibration Table.

17. Press the **ENT**er key to enter the measured high-calibration value into memory.

18. Slide the CALIBRATE selector switch back to the opposite position (before turning off the system).

19. Cover the access hole with a new calibration label. This completes the system calibration procedure.

Calibration Table

	Calibration Default Values	Factory Calibration	User Calibration		
			6 mo	1 year	2 years
No. 1 Thermal Device Type and SN:					
Low Calibration Value	°C	°C	°C	°C	°C
High Calibration Value	°C	°C	°C	°C	°C
Date and Initials					
No. 2 Thermal Device Type and SN:					
Low Calibration Value	°C	°C	°C	°C	°C
High Calibration Value	°C	°C	°C	°C	°C
Date and Initials					
No. 3 Thermal Device Type and SN:					
Low Calibration Value	°C	°C	°C	°C	°C
High Calibration Value	°C	°C	°C	°C	°C
Date and Initials:					
No. 4 Thermal Device Type and SN:					
Low Calibration Value	°C	°C	°C	°C	°C
High Calibration Value	°C	°C	°C	°C	°C
Date and Initials					

0930_501.jpg

Section C: Filling and Draining the Coolant Reservoir

Section Overview

In this Section

The following topics are covered in this Section:

Topic	See Page
Filling the Reservoir	11
Draining the Reservoir	11
Flushing the Coolant	12

Introduction

The following procedures for filling or draining the coolant reservoir of the Cooler/Circulator should be carefully followed to ensure proper system operation.

Prior to shipment, the coolant reservoir is drained. You will need to purchase a supply of coolant for your use. The closed loop system requires approximately 25 fluid ounces (750 ml) of either Fluorinert FC-77[2] or Galden[3] HT 110 coolant. Follow the manufacturer's recommended procedure for storing, handling, and disposing of the coolant fluid (see the "Materials Safety Data Sheets" in Appendix A).

You may obtain either coolant fluid from:

FC-77
3M Corporation Headquarters
3M Center, 223-6S-04
St. Paul, MN 55144-1000
Telephone: (612) 733-1710 (ordering product and pricing)
(612) 733-3735 (literature)
(612) 733-7424 (technical assistance)

HT 110
Ausimont USA, Incorporated
10 Leonards Lane
Thorofare, NJ 08086
Telephone: (609) 853-8119 (main number)
(609) 853-6405 FAX
(800) 221-0553 (ordering product and pricing)

Filling the Reservoir

Add coolant to the reservoir in the Cooler/Circulator, any time the FLUID indicator turns on at the Controller front panel.

1. Remove caps from the FILL and VENT ports at rear of the Cooler/Circulator.

2. Attach the hose and funnel (supplied) to the FILL port.

3. Gradually fill the reservoir with coolant through the funnel and hose until the FLUID indicator turns off at the Controller front panel. Then add 6 fluid ounces (180 ml) more. Note that indicator will turn on momentarily when the pump starts after an initial filling.

CAUTION

CAUTION: Do not overfill - the system must have room for expansion of the coolant at high operating temperatures.

4. Remove hose and funnel, and reinstall the caps on the FILL and VENT ports for proper system operation. The system is now ready for operation.

Draining the Reservoir

1. Turn off ac power to the TP03000 Controller.

2. Disconnect the coolant hose from the CHUCK RETURN port at rear of the Cooler/Circulator.

3. Remove cap from VENT port; save the cap.

4. Position the coolant hose to empty coolant into a suitable container.

5. Apply power to the Controller and start temperature control of the ThermoChuck Platform at a setpoint of +25.0 °C. Allow the system to operate until all coolant is pumped from the hose (until STG2 Wait is displayed).

6. Turn off ac power to the Controller.

7. Reinstall cap (previously saved) on the VENT port to prevent spillage of any coolant remaining in the Coolant/Reservoir.

WARNING

WARNING: Dispose of any new or removed coolant fluid in accordance with the established policies and procedures for that material.

Flushing the Coolant

1. Follow the Draining the Reservoir procedure above.

2. Install, if not already in place, the VENT cap and leave the FILL port capped

3. Attach a dry air or dry nitrogen (-70 °C) source at low pressure (3 - 4 psig, 21 - 28 kPa) to the CHUCK RETURN port at rear of the Cooler/Circulator.

4. Allow at least 2 hours of air purge to remove the residue coolant from the reservoir and

ThermoChuck Platform system.

5. Disconnect the dry gas source and reconnect the coolant hose from the ThermoChuck Platform to the CHUCK RETURN port.

6. Follow the Filling the Reservoir procedure above.

7. Dispose of the removed coolant fluid properly (see **WARNING** above).

Section D: Back-Up Battery Replacement

Section Overview

In this Section

If the System has displayed an **ERR0** error message, the back-up battery probably needs replacement. First remove the enclosure cover and top cover for access to the battery as outlined in the next paragraph. Prior to replacement, check the battery voltage.

The following topics are covered in this Section:

Topic	See Page
Battery Access	14
Battery Check	16
Battery Replacement	16

Battery Access

**Controller Access
Covers**

Top Cover

Heat Sink
Safety Cover
(4)

Capacitors
Safety Cover
(1)

(2)
Captive
to
Cover

(4)

Bottom Cover

Enclosure Cover
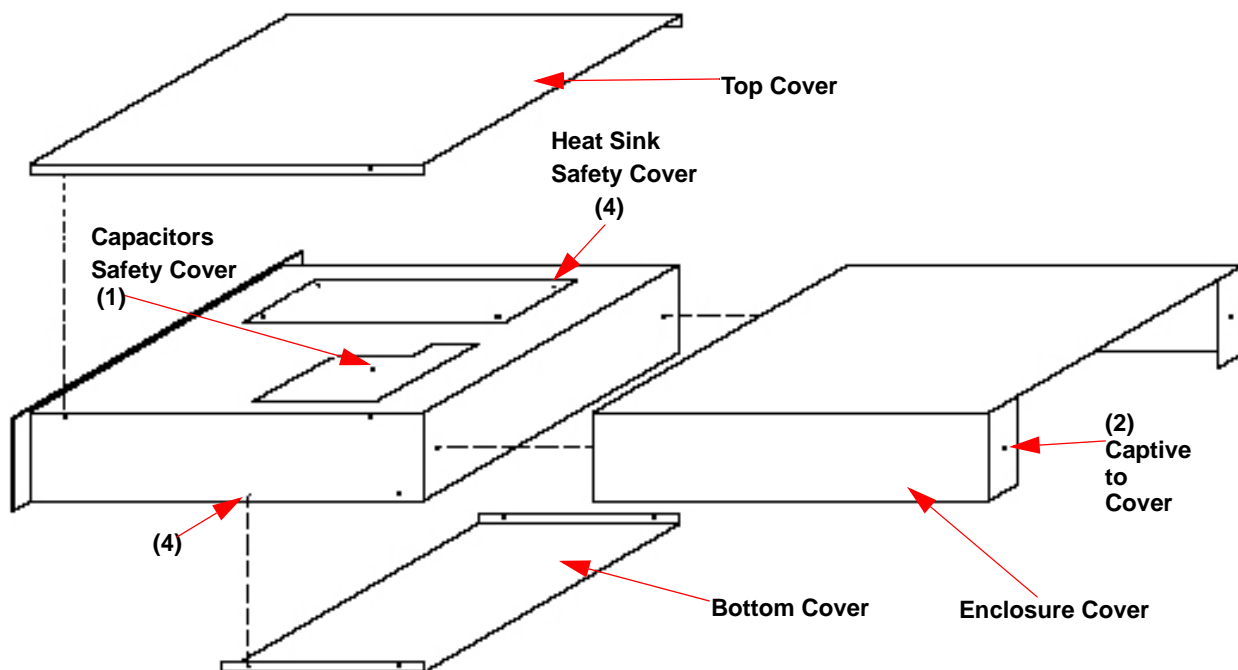
0930_502.jpg

To remove the covers necessary to access the battery inside the Controller,

1. Switch off power to the TP03000 System, and unplug the system's power cord(s) from the service outlet.

2. Disconnect all cables at the rear of the Controller.

3. Remove the enclosure cover by loosening (2) slotted knurled screws at the rear corners of the Controller. Slide the enclosure cover off the rear of the Controller.

4. To access the top interior, remove the top cover by loosening four screws in slotted holes of the cover and then lifting the cover free.

5. Locate the main board in the Controller.

MAIN CONTROLLER BOARD

Controller Front Panel
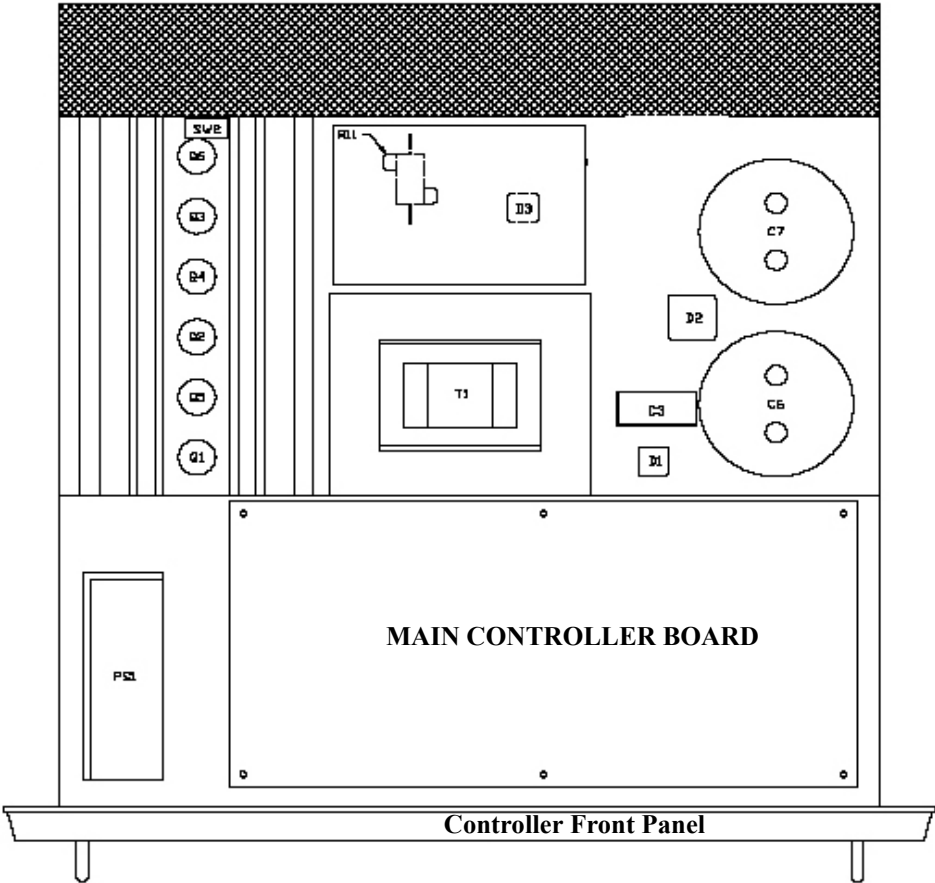
0930_503.jpg

6. Locate the back-up batteries (B1) on the main board.

Back-up Batteries (B1)
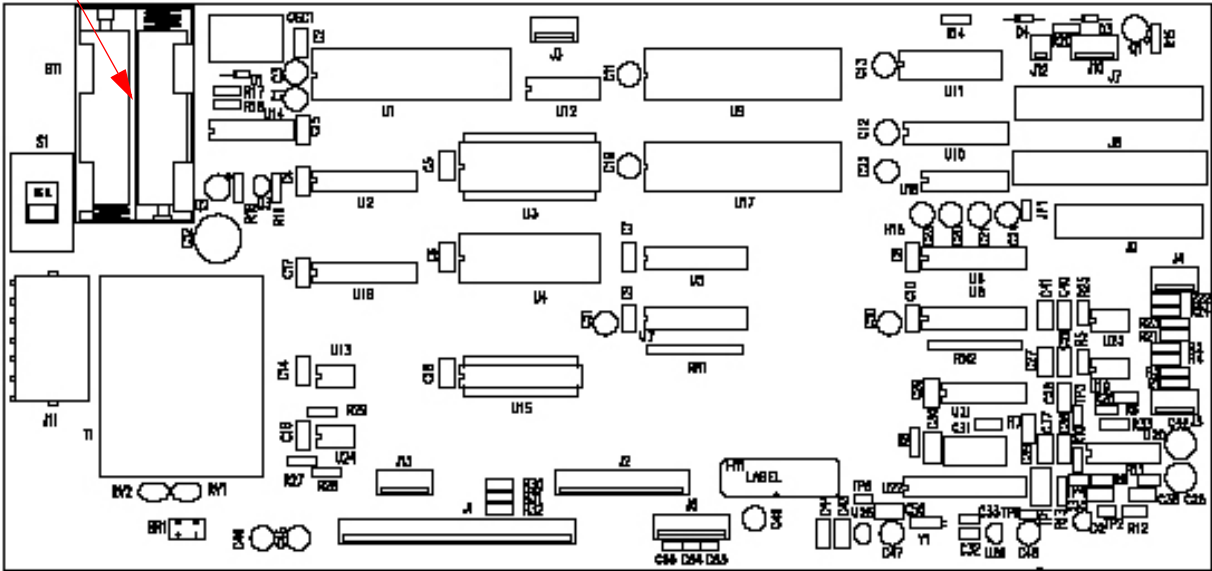
0930_504.jpg

Battery Check

⚠️ **CAUTION**

CAUTION: Make sure the system power cord is disconnected from its power source before making the following measurement.

1. Measure the battery voltage with a digital voltmeter connected between the battery (+) and (-) ends nearest the front panel. An acceptable voltage is between 2.4 and 3.5 volts.
2. If the battery voltage is unacceptable, replace as outlined in the next paragraph.

Battery Replacement

1. Carefully pull both batteries from their battery holder on the main board, noting the polarity position of each battery.
2. Replace the old batteries with two new, size AA alkaline batteries. Make sure the new batteries are positioned with their polarities the same as the old batteries.
3. Reassemble the Controller and restart its operation.
   You will have to re-enter the values for any mnemonic parameters programmed. Refer to Chapter 3: Program Mode Operations.
   However, calibration values are retained during battery replacement because they are stored in non-volatile memory.

Section E: Operating Diagnostics

Section Overview

In this Section   The following topics are covered in this Section:

Topic	See Page
System Parameters	18
OVERHEAT Indications	18
No AC Power	19
Error Message	20
TP03000 Controller: Complete List of Mnemonic Codes	21

System Parameters

Important system parameters that may be viewed by selection of the identifying mnemonic while in the Program Mode.

- **LCAL** View low calibration default
- **HCAL** View high calibration default
- **CHUK** View ThermoChuck code
- **ROM** View PROM revision level

OVERHEAT Indications

The system software monitors the ThermoChuck temperature to check if it agrees with a programmed setpoint or temperature change. An unexpected ThermoChuck temperature is shown to the operator as a steady or flashing indication of the OVERHEAT lamp on the front panel.

Steady A steady indication of the OVERHEAT lamp warns that the ThermoChuck temperature has exceeded its upper temperature limit (5 °C higher than the 130 °C or 200 °C upper limit).

In the event of an overheated condition,

1. Determine cause for the condition (for example, programmed setpoint above upper temperature limit).
2. After the ThermoChuck has cooled below its upper limit, press the **SET UP** key twice, and use the up-arrow and down-arrow keys on the 4x4 keypad to display the **EROR** mnemonic (the number 1 will appear in VALUE display to identify the type of error). Press the **ENTer** key to clear the error.

Flashing A flashing indication of the OVERHEAT lamp warns that the system software does not sense a temperature change for some interval when the temperature should be changing. This loss of temperature control (OPEN LOOP condition) may result from two sources: hardware or software.

In the hardware type, check for an open circuit in the ThermoChuck cable connections, the ThermoChuck sensor, or the control feedback loop.

In the software type, a heat safety check by the software has failed. The heat safety check requires that the ThermoChuck surface temperature increases at a ramp rate of at least 2 °C per every minute until the setpoint is reached. Usually, a heat safety failure is caused by too large a thermal load on the ThermoChuck. Check that a fan is not blowing too much cool air across the ThermoChuck or that its load does not act too much as a large heat sink.

After correcting the trouble that caused a flashing OVERHEAT condition, reset the system to normal operation as given above for a steady OVERHEAT condition.

No AC Power

In the event the AC LINE indicator on the Controller front panel is not on, make the following checks:

1. MAIN POWER circuit breaker on Controller rear panel is in on position.

2. EMO circuit is closed (see Emergency Off Connections, Par. 2-2.2).

3. Power cord of Controller is plugged into the output receptacle of the appropriate ac power source.

The ac power source is delivering the proper voltage at its output receptacle.

Error Message

Error messages that may occur at system start-up have the following explanations:

ERRO — CHEK — BATT indicates that the back-up batteries BT1 (refer to Back-Up Battery Replacement, page 5-13) probably need replacement. Check their output voltage; if low, replace both batteries.

ERR1 — CHEK — CHUK indicates that the ThermoChuck Platform is not sensed. Check that the ThermoChuck Platform is plugged into the rear of the Controller. Check that the interconnecting cable or the Platform itself does not have an open circuit. Measure for continuity between pins 34 and 35 or 35 and 37 of cable connector.

ERR2 — CHEK — SENS indicates that the ThermoChuck temperature sensor is open. Check that the interconnecting cable or the ThermoChuck Platform RTD sensor does not have an open circuit.

ERR3 — OVER — LOAD indicates that the driver circuit for the ThermoChuck Platform is overloaded. Check that the interconnecting cable or the Platform itself does not have a short circuit. Substitute another ThermoChuck Platform if possible.

ERR4 — WRNG — CHUK indicates that the wrong ThermoChuck Platform is connected to the Controller. This Platform is not recognized or supported by the system software (PROM) installed in the Controller.

ERR5 — COMM — FAIL indicates that an interrupt occurred in the communications link. Try to clear the interrupt by entering either a *CLR or *CLS command (refer to Chapter 4).

dCAL — RUN — CAL indicates that the Controller is using default calibration values. This message will occur if the main PROM has been replaced with one of a different revision, or the system calibration values have changed during normal operation to cause the default. Re-calibrate the Controller as outlined in Calibration, page 5-3.

ERR7 — LINE — FRQ? indicates an internal line frequency sensing fault within the Controller. Its processor is not receiving any line frequency (possibly a main board fault). Contact your technical service representative for assistance.

xxxx— POWR— REDU? indicates a power reduction by the system.The power reduction is a result of chuck aging or chuck overload. Verify that the ThermoChuck Platform is not overloaded. Replace the ThermoChuck Platform if it shows signs of aging.
This error message can be cleared by pressing the Enter key.

TP03000 Controller: Complete List of Mnemonic Codes

Parameter (Mnemonic)**	Description
TMP1	View/Change the Setpoint of TMP1
TMP2	View/Change the Setpoint of TMP2
TMP3	View/Change the Setpoint oft TMP3
TMP4	View/Change the Setpoint of TMP4
TMP5	View/Change the Setpoint of TMP5
TMPA	View/Change the Setpoint oft TMPA
WN1	View/Change the Window of TMP1
WN2	View/Change the Window of TMP2
WN3	View/Change the Window of TMP3
WN4	View/Change the Window of TMP4
WN5	View/Change the Window of TMP5
WNT1	View/Change the Window of T1
WNT2	View/Change the Window of TMP2
WNTA	View/Change the Window of TMPA
RMP1	View/Change the Ramp rate of TMP1
RMP2	View/Change the Ramp rate of TMP2
RMP3	View/Change the Ramp rate of TMP3
RMP4	View/Change the Ramp rate of TMP4
RMP5	View/Change the Ramp rate of TMP5
SK1	View/Change the Soak time of TMP1
SK2	View/Change the Soak time of TMP2
SK3	View/Change the Soak time of TMP3
SK4	View/Change the Soak time of TMP4
SK5	View/Change the Soak time of TMP5
CYCL	View/Change the number of Cycles
ADR	View/Change IEEE-488 Address 0 - 30
MSK	View/Change RS-232C or IEEE-488 Mask 0 - 255
BRT	View/Change RS-232C Baud Rate 300, 600, 1200, 4800, or 9600 baud
DBT	View/Change RS-232C Data Bits 7 or 8
PAR	View/Change RS-232C Parity Even (2), odd (1), or no (0) parity
STP	STP View/Change RS-232C Stop Bits One or two

Parameter (Mnemonic)**	Description
LNER	View RS-232C Line Errors
CMDS	View/Change 488.1 or 488.2 Style Option **NOTE:** The CMDS should be set to 488.1 for RS-232C control.
LCAL	View Low Calibration Default
HCAL	View High Calibration Default
CHUK	View ThermoChuck Code
ROM	View PROM Revision level
EROR	Indicates Error Condition (0 = no error)
CAL	Indicates System is in Calibration Mode
PUMP	View/Change the Temperature of the fluid Pump (default value 40 °C; can be set from 35 to 70 °C)

**Press up-arrow key repeatedly to move down the list of mnemonics; press down-arrow key repeatedly to move up the list.

Section F: Coolant Fitting Installation Recommendations

Internal "Teflon" ferrule type fittings

Carefully tighten "Swagelok" fittings which have Teflon ferrules (such as ThermoChuck internal ferrules fitted to flexible Teflon hoses) as follows:

1) To properly tighten the coolant tube nut, first assemble and turn it until only hand tight.
2) Then turn an additional 1/2 turn only.
3) Measurements indicate the additional 1/2 turn requires approximately 2.0 pound-force inch (2.0 lbf/in) or 0.23 Kilogram-force meter (kgf/m).
NOTE: If over-torqued, then tubing or ferrules can be damaged, which can cause leaking. Check to insure fittings are tight (not leaking) after several temperature transitions.

Teflon will "cold work", with temperature transitions, so these connections need to be checked frequently especially when the system is first installed. After the first few transitions the retainer nut needs to be checked for tightness. Also, over tightening can be a problem in that it can collapse the ferrules and actually cause them to leak more. The additional 1/2 turn after hand tight is usually all that is required.

FRONT TEFLON FERRULE (TEMPTRONIC P/N FG01000)

REAR TEFLON FERRULE (TEMPTRONIC P/N FG01020)

KNURLED NUT (TEMPTRONIC P/N FG01030)

TEFLON COOLANT LINE (PER ORDER)

TEFLON FERRULE TYPE FITTING
NOTE PART ARRANGEMENT
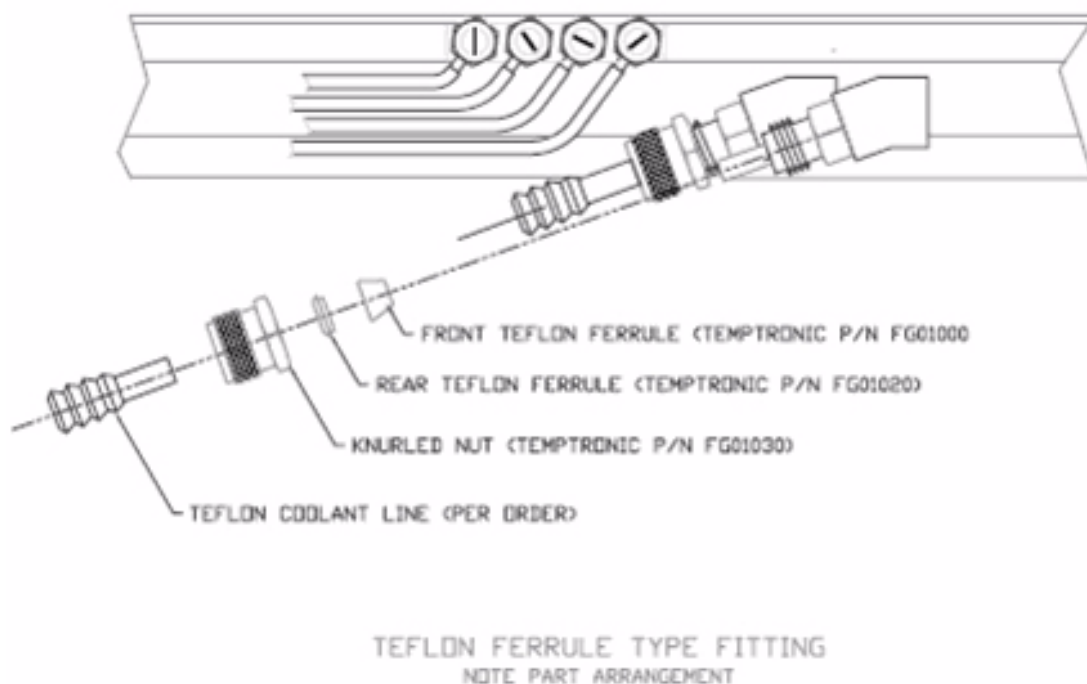
2350_505.jpg

External "Flare" type fittings

Carefully tighten "flare" type fittings (such as external coolant line from chiller to prober) as follows:

1) Lubricate threads and assemble to fitting body. Turn nut until hand tight.
2) Use a wrench to further tighten assembly until tightness feels "solid." Then apply a 1/6th turn.
NOTE: If over-torqued, then fitting can be damaged, and/or tubing can be split at the flare. Check if fitting is tight (not leaking) after several temperature transitions.
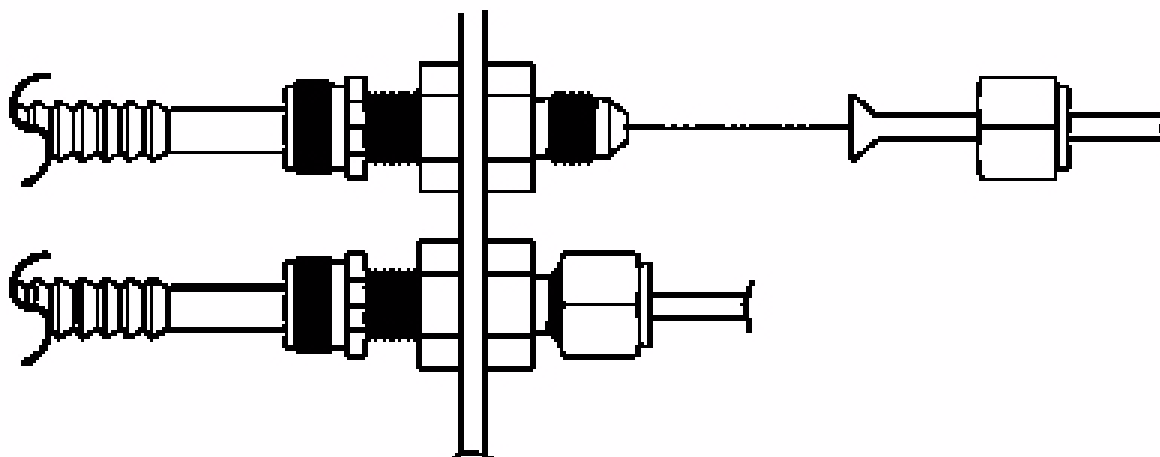
FLARE TYPE FITTING

2350_506.jpg

Section G: Identifying Damaged Flare Fittings

**The Flare
("Swagelok") Fitting
Detailed**

Swagelok
Body

Swagelok
Front Ferrule

Swagelok
Back Ferrule

Swagelok
Nut

Identifying Damaged Ferrules

Properly tightened Ferrules:
- the front ferrule has retained its shape
- the back ferrule is not driven under the front ferrule.

Over tightened Ferrules:
- the front ferrule has collapsed. A "lip" has formed on the ferrule.
- the rear ferrule is driven under the front ferrule.

"lip" on front ferrule

Materials Safety Data Sheets

A

MSDS Overview

Introduction

The Materials Safety Data Sheets (MSDS) for storing, handling, or disposing the following fluids used in the System are presented in this Appendix:

Material Safety Data Sheet

SECTION 1: PRODUCT AND COMPANY IDENTIFICATION

PRODUCT NAME: FC-77 FLUORINERT Brand Electronic Liquid
MANUFACTURER: 3M
DIVISION: Electronics Markets Materials Division

ADDRESS: 3M Center
St. Paul, MN 55144-1000

EMERGENCY PHONE: 1-800-364-3577 or (651) 737-6501 (24 hours)

Issue Date: 07/26/2004
Supercedes Date: 07/26/2004

Document Group: 10-3791-0

Product Use:
Intended Use: For industrial use only. Not intended for use as a medical device or drug.
Specific Use: Testing Fluid or Heat Transfer Fluid for Electronics

SECTION 2: INGREDIENTS

Ingredient	C.A.S. No.	% by Wt
PERFLUORO COMPOUNDS, (PRIMARILY COMPOUNDS WITH 8 CARBONS)	86508-42-1	100

SECTION 3: HAZARDS IDENTIFICATION

3.1 EMERGENCY OVERVIEW

Specific Physical Form: Liquid
Odor, Color, Grade: Colorless, odorless liquid.
General Physical Form: Liquid
Immediate health, physical, and environmental hazards:

3.2 POTENTIAL HEALTH EFFECTS

Eye Contact:
Contact with the eyes during product use is not expected to result in significant irritation.

Skin Contact:
Contact with the skin during product use is not expected to result in significant irritation.

Inhalation:
No health effects are expected.

Ingestion:
No health effects are expected.

3.3   POTENTIAL ENVIRONMENTAL EFFECTS

This compound is completely fluorinated (perfluorinated), or it contains perfluorinated portions. Perfluoroalkyl groups resist degradation in most natural environments. This low-solubility substance has insignificant toxicity to aquatic organisms (Lowest LL50 or EL50 is >1000 mg/L). LL50 (Lethal Level) and EL50 are similar to LC50 and EC50, but tests the water phase from incompletely-miscible mixtures. Take precautions to prevent direct release of this substance to the environment.   ATMOSPHERIC FATE: Perfluoro compounds (PFCs) are photochemically stable and expected to persist in the atmosphere for more than 1000 years. PFCs have high global warming potentials (GWP), exceeding 5000 (100-yr-ITH). The Ozone Depletion Potential (ODP) is Zero.

SECTION 4: FIRST AID MEASURES

4.1 FIRST AID PROCEDURES

The following first aid recommendations are based on an assumption that appropriate personal and industrial hygiene practices are followed.

Eye Contact: Flush eyes with large amounts of water.   If signs/symptoms persist, get medical attention.

Skin Contact: Wash affected area with soap and water.   If signs/symptoms develop, get medical attention.

Inhalation: If signs/symptoms develop, remove person to fresh air.   If signs/symptoms develop, get medical attention.

If Swallowed: No need for first aid is anticipated.

SECTION 5: FIRE FIGHTING MEASURES

5.1 FLAMMABLE PROPERTIES

Autoignition temperature   *Not Applicable*
Flash Point   *Not Applicable*
Flammable Limits - LEL   [*Details:* Nonflammable]
Flammable Limits - UEL   [*Details:* Nonflammable]

5.2 EXTINGUISHING MEDIA
Material will not burn.

5.3 PROTECTION OF FIRE FIGHTERS

Special Fire Fighting Procedures: Wear full protective equipment (Bunker Gear) and a self-contained breathing apparatus

(SCBA). Water may be used to blanket the fire. Exposure to extreme heat can give rise to thermal decomposition.

Unusual Fire and Explosion Hazards: No unusual fire or explosion hazards are anticipated. No unusual effects are anticipated during fire extinguishing operations. Avoid breathing the products and substances that may result from the thermal decomposition of the product or the other substances in the fire zone. Keep containers cool with water spray when exposed to fire to avoid rupture.

> **Note: See STABILITY AND REACTIVITY (SECTION 10) for hazardous combustion and thermal decomposition information.**

SECTION 6: ACCIDENTAL RELEASE MEASURES

Accidental Release Measures: Observe precautions from other sections. Call 3M- HELPS line (1-800-364-3577) for more information on handling and managing the spill. Evacuate unprotected and untrained personnel from hazard area. The spill should be cleaned up by qualified personnel. Ventilate the area with fresh air. Contain spill. Working from around the edges of the spill inward, cover with bentonite, vermiculite, or commercially available inorganic absorbent material. Mix in sufficient absorbent until it appears dry. Collect as much of the spilled material as possible. Clean up residue with an appropriate organic solvent. Read and follow safety precautions on the solvent label and MSDS. Place in a metal container approved for transportation by appropriate authorities. Seal the container. Dispose of collected material as soon as possible.

> **In the event of a release of this material, the user should determine if the release qualifies as reportable according to local, state, and federal regulations.**

SECTION 7: HANDLING AND STORAGE

7.1 HANDLING
Avoid skin contact with hot material. For industrial or professional use only. No smoking: Smoking while using this product can result in contamination of the tobacco and/or smoke and lead to the formation of the hazardous decomposition products mentioned in the Reactivity Data section of this MSDS. Store work clothes separately from other clothing, food and tobacco products. Use general dilution ventilation and/or local exhaust ventilation to control airborne exposures to below Occupational Exposure Limits. If ventilation is not adequate, use respiratory protection equipment.

7.2 STORAGE
Store away from heat. Keep container tightly closed. Keep container in well-ventilated area.

SECTION 8: EXPOSURE CONTROLS/PERSONAL PROTECTION

8.1 ENGINEERING CONTROLS
Provide appropriate local exhaust when product is heated. Provide appropriate local exhaust ventilation on open containers. For those situations where the fluid might be exposed to extreme overheating due to misuse or equipment failure, use with appropriate local exhaust ventilation sufficient to maintain levels of thermal decomposition products below their exposure guidelines.

8.2 PERSONAL PROTECTIVE EQUIPMENT (PPE)

8.2.1 Eye/Face Protection
Avoid eye contact.
The following eye protection(s) are recommended: Safety Glasses with side shields.

8.2.2 Skin Protection
Avoid skin contact with hot material. Wear appropriate gloves, such as Nomex, when handling this material to prevent thermal burns. Avoid skin contact.

Select and use gloves and/or protective clothing to prevent skin contact based on the results of an exposure assessment. Consult with your glove and/or protective clothing manufacturer for selection of appropriate compatible materials.
Gloves made from the following material(s) are recommended: Nitrile Rubber.

8.2.3 Respiratory Protection
Under normal use conditions, airborne exposures are not expected to be significant enough to require respiratory protection. Avoid breathing of vapors, mists or spray.
Select one of the following NIOSH approved respirators based on airborne concentration of contaminants and in accordance with OSHA regulations: Half facepiece or fullface air-purifying respirator with organic vapor cartridges.   Consult the current 3M Respiratory Selection Guide for additional information or call 1-800-243-4630 for 3M technical assistance. If thermal degradation products are expected, use fullface supplied air respirator.

8.2.4 Prevention of Swallowing
Do not eat, drink or smoke when using this product. Wash exposed areas thoroughly with soap and water.

8.3 EXPOSURE GUIDELINES

None Established

SECTION 9: PHYSICAL AND CHEMICAL PROPERTIES

Specific Physical Form:	Liquid
Odor, Color, Grade:	Colorless, odorless liquid.
General Physical Form:	Liquid
Autoignition temperature	*Not Applicable*
Flash Point	*Not Applicable*
Flammable Limits - LEL	[*Details:* Nonflammable]
Flammable Limits - UEL	[*Details:* Nonflammable]
Boiling point	90 - 107 ℃
Density	1.8 g/ml
Vapor Density	Approximately 14 [@ 20 ℃] [*Ref Std:* AIR=1]
Vapor Pressure	Approximately 42 mmHg [@ 20 ℃]
Specific Gravity	Approximately 1.8 [*Ref Std:* WATER=1]
pH	*Not Applicable*
Melting point	*Not Applicable*
Solubility in Water	Nil
Evaporation rate	> 1 [*Ref Std:* BUOAC=1]
Volatile Organic Compounds	[*Details:* Exempt]
Percent volatile	Approximately 100 %
VOC Less H2O & Exempt Solvents	[*Details:* Exempt]
Viscosity	0.8 centistoke [@ 20 ℃]

SECTION 10: STABILITY AND REACTIVITY

Stability: Stable.

Materials and Conditions to Avoid: Finely divided active metals; Alkali and alkaline earth metals; Heat(greater than 200 ℃)

Hazardous Polymerization: Hazardous polymerization will not occur.

Hazardous Decomposition or By-Products

Substance   **Condition**
  Hydrogen Fluoride   At Elevated Temperatures - greater than 200 ºC
  Perfluoroisobutylene (PFIB)   At Elevated Temperatures - greater than 200 ºC

Hazardous Decomposition: If the product is exposed to extreme condition of heat from misuse or equipment failure, toxic decomposition products that include hydrogen fluoride and perfluoroisobutylene can occur.

Hydrogen fluoride (CAS No. 7664-39-3) has an ACGIH Threshold Limit Value - Ceiling of 3 ppm (as fluoride), an OSHA Permissible Exposure Limit - Time Weighted Average of 3 ppm (as fluoride) and a revoked OSHA Permissible Exposure Limit - Short Term Exposure Limit (which is enforced by some State Right-To-Know programs) of 6 ppm (as fluoride). Hydrogen fluoride may cause respiratory tract irritation, dental or skeletal fluorosis and irritation or burns to the eyes or skin, particularly when dissolved in water (hydrofluoric acid). The odor threshold for HF is 0.04 ppm, providing good warning properties for exposure.

Perfluoroisobutylene(CAS No. 382-21-8) has an ACGIH Threshold Limit Value - Ceiling of 0.01 ppm. Perfluoroisobutylene may cause respiratory tract irritation, pulmonary edema, cyanosis, and effect on the hematopoietic system.

SECTION 11: TOXICOLOGICAL INFORMATION

Product-Based Toxicology Information:

 A Material Toxicity Summary Sheet (MTSS) has been developed for this product. Please contact the address listed on the first page of this MSDS to obtain a copy of the MTSS for this product.

Please contact the address listed on the first page of the MSDS for Toxicological Information on this material and/or its components.

SECTION 12: ECOLOGICAL INFORMATION

ECOTOXICOLOGICAL INFORMATION

Test Organism	**Test Type**	**Result**
Water flea, Daphnia magna	48 hours Effect Concentration 50%	>1500 mg/l
Fathead Minnow, Pimephales promelas	96 hours Lethal Concentration 50%	>1000 mg/l

CHEMICAL FATE INFORMATION

Test Type	**Result**	**Protocol**
20 days Biological Oxygen Demand	Nil	
Chemical Oxygen Demand	Nil	

SECTION 13: DISPOSAL CONSIDERATIONS

Waste Disposal Method: Reclaim if feasible. As a disposal alternative, incinerate in an industrial or commercial facility in the presence of a combustible material. Combustion products will include HF. Facility must be capable of handling halogenated materials.

   To reclaim or return, check product label for contact.

EPA Hazardous Waste Number (RCRA): Not regulated

Since regulations vary, consult applicable regulations or authorities before disposal.

SECTION 14:TRANSPORT INFORMATION

ID Number(s):
98-0204-0701-5, 98-0204-0703-1, 98-0204-0704-9, 98-0211-1773-8, 98-0211-1774-6, 98-0211-3998-9, 98-0211-3999-7, 98-0211-6447-4, 98-0211-8800-2, 98-0211-8807-7, 98-0211-8875-4, 98-0211-8882-0, 98-0211-9371-3, 98-0212-3123-2, 98-0212-3124-0, 98-0212-3183-6, ZF-0002-0105-1, ZF-0002-0106-9, ZF-0002-0320-6, ZF-0002-0389-1, ZF-0002-1139-9, ZF-0002-1164-7, ZF-0002-1445-0, ZF-0002-4132-1

Please contact the emergency numbers listed on the first page of the MSDS for Transportation Information for this material.

SECTION 15: REGULATORY INFORMATION

US FEDERAL REGULATIONS
 Contact 3M for more information.

311/312 Hazard Categories:
  Fire Hazard - No   Pressure Hazard - No   Reactivity Hazard - No   Immediate Hazard - No   Delayed Hazard - No

STATE REGULATIONS
 Contact 3M for more information.

CHEMICAL INVENTORIES
The components of this product are in compliance with the chemical notification requirements of TSCA.

All applicable chemical ingredients in this material are listed on the European Inventory of Existing Chemical Substances (EINECS), or are exempt polymers whose monomers are listed on EINECS.

The components of this product are listed on the Canadian Domestic Substances List.

The components of this product are listed on the Australian Inventory of Chemical Substances.

The components of this product are listed on Japan's Chemical Substance Control Law List (also known as the Existing and New Chemical Substances List.)

Contact 3M for more information.

INTERNATIONAL REGULATIONS

Contact 3M for more information.

This MSDS has been prepared to meet the U.S. OSHA Hazard Communication Standard, 29 CFR 1910.1200.

SECTION 16: OTHER INFORMATION

NFPA Hazard Classification
    Health: 3   **Flammability:** 0   **Reactivity:** 0   **Special Hazards:** None

National Fire Protection Association (NFPA) hazard ratings are designed for use by emergency response personnel to address the hazards that are presented by short-term, acute exposure to a material under conditions of fire, spill, or similar emergencies. Hazard ratings are primarily based on the inherent physical and toxic properties of the material but also include the toxic properties of combustion or decomposition products that are known to be generated in significant quantities.

HMIS Hazard Classification
    Health: 0   **Flammability:** 0   **Reactivity:** 0   **Protection:** X - See PPE section.

Hazardous Material Identification System (HMIS(r)) hazard ratings are designed to inform employees of chemical hazards in the workplace. These ratings are based on the inherent properties of the material under expected conditions of normal use and are not intended for use in emergency situations. HMIS(r) ratings are to be used with a fully implemented HMIS(r) program. HMIS(r) is a registered mark of the National Paint and Coatings Association (NPCA).

Revision Changes:
Section 14: ID Number(s) was modified.

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    3M MSDSs are available at www.3M.com

Galden HT 110

SOLVAY SOLEXIS, Inc.
10 Leonards Lane
Thorofare, NJ 08086
856-853-8119

Section 1 - Chemical product and Company information

Date Revised: December 30, 2002
Product Name: Galden HT 110
Chemical Name: Propene, 1,1,2,3,3,3-hexafluoro, oxidized, polymerized
Chemical Family: Fluorocarbons, Perfluorinated polyethers
Synonyms: None
Emergency Telephone: 800-424-9300 (CHEMTREC, 24 hours)
856-853-8119

Emergency Overview:

Clear, colorless liquid. Thermal decomposition will generate hydrogen fluoride (HF), which is corrosive.

Section 2 - Compositional information

Name:	CAS#	Approximate Weight (% wt.):
Propene, 1,1,2,3,3,3-hexa-fluoro, oxidized, polymerized	69991-67-9	100

Section 3 - Potential Health Effects

Effects of Overexposure:

Eye Contact
Eye contact may cause slight irritation.

Skin Contact
Skin contact may cause slight irritation.

Inhalation
Inhalation of vapors or mists may cause respiratory tract irritation.

Ingestion
No ill effects are expected.

Section 4 - First Aid Measures

Eye Contact:
Flush eyes for 15 minutes with copious amounts of water, retracting eyelids often. Seek medical attention if irritation persists.

Skin Contact:
Wash skin thoroughly with mild soap and water. Flush with lukewarm water for 15 minutes.

Inhalation:
If symptoms of irritation, discomfort or overcome by exposure, remove affected person to fresh air. Give oxygen or artificial respiration as needed.

Ingestion:
If conscious, drink three to four 8 ounce glasses of water or milk. Call a physician. If unconscious, immediately take affected person to a hospital. Do not give anything by mouth to an unconscious person.

Section 5 - Fire Fighting Measures

Flash Point: Not Applicable
Lower Explosive Limit: Not Applicable
Upper Explosive Limit: Not Applicable
Autoignition Temperature: Not Applicable
Extinguishing Media: Water (spray or fog), foam, dry chemical or carbon dioxide (CO2).

Unusual Fire Hazards:

Fluoropolymers will degrade upon prolonged heating or in a fire, liberating carbonyl fluoride and hydrogen fluoride (HF). This gas is toxic if inhaled or it comes into contact with moist skin. HF has an ACGIH TLV ceiling limit of 3 ppm (2.6 mg/m3) and an OSHA PEL TWA of 3 ppm. Carbonyl fluoride has an ACGIH TLV TWA and OSHA PEL TWA of 2 ppm (5 mg/m3).

Fire Fighting Procedures:

Use self contained breathing apparatus (SCBA) and skin protection for acid gas exposure. Do not enter fire area without proper protection. Fight fire from safe distance. If possible, air monitoring should be performed.

Section 6 - Accidental Release Measures

Releases:

In case of a release or spill, absorb material onto vermiculite or similar inert absorbent. Use Perfluorosolv0 PFS-1 as an aid in cleaning. Place spilled material into covered container for disposal. Dispose of according to applicable local, state and federal regulations. Extinguish all ignition sources and evacuate the area. Exercise caution; spill area may be slippery.

Section 7 - Handling and Storage

Wash hands after use and before handling food or applying cosmetics. Do not use tobacco products in the immediate area. Keep containers closed. Keep away from heat, sparks and flames. Do not store near combustible materials.

Section 8 - Exposure Controls/Personal Protection

ACGIH Threshold Limit Value (8 hr. time weighted average):
None established

OSHA Permissible Exposure Limit Value (8 hr. time weighted average):
None established

Engineering Controls:

Ventilation Requirements:
Local Exhaust: Vent vapors or mists generated by processing away from operating personnel. Local exhaust ventilation at a rate of 50 feet per minute.

Personal Protective Equipment:

Respiratory Protection:
No occupational exposure standards have been developed for this material. In situations where exposure to vapors or mists is likely, NIOSH/MSHA approved respirators are recommended. Respirator use limitations made by NIOSH/MSHA or the manufacturer must be observed. Respiratory protection programs must be in accordance with 29 CFR 1910.134.

Eye Protection:
Eye/Face Protection: ANSI Z87.1 approved safety glasses with side shields or equivalent.

Skin Protection:
Rubber or latex recommended but not necessary.

Section 9 - Physical and Chemical Properties

Appearance: Clear liquid
Color: Colorless
Odor: Odorless
Vapor Pressure: Not available
Vapor Density (Air=1): Not available
Boiling Point: Not available
Melting Point: Not available
Specific Gravity: 1.7-1.9
Solubility in Water: Insoluble
Molecular Formula: $CF_3-[(O-CF-CF_3-CF_2)n-(O-CF_2)m]-O-CF_3$
Molecular Weight: Not available
% Volatile by Volume: 0

Section 10 - Stability and Reactivity

Stability:

This material is stable.

Reactivity:

This material is not reactive.

Conditions to Avoid:

Heat, sparks, flames, and other ignition sources; avoid heating above 290 C/554 F.

Materials to Avoid:

Strong or non-aqueous alkali and Lewis acids above 100 C/212 F.

Hazardous Decomposition Products:

Thermal decomposition of this product will generate hydrogen fluoride (HF), which is corrosive, causing burns on contact with skin and other tissue.

Incompatibility (Materials to Avoid):

Alkali metals and halogenated compounds.

Section 11 - Toxicological Information

Rat oral LD50: greater than 25.65 g/kg
Rat intraperitoneal LD50: greater than 25 g/kg
Rat dermal LD50: greater than 2 g/kg
Rabbit skin irritation: not irritating
Rabbit eye irritation: not irritating
Guinea pig sensitization: not a sensitizer

Section 12 - Ecotoxicological Information

No ecotoxicological information is available for this material.

Section 13 - Disposal Considerations

Waste Disposal: Material, as supplied, is not a hazardous waste. Landfill according to current federal, state and local regulations, or incinerate in a high-temperature incinerator designed to burn fluorine-containing materials. Processing, use or contamination may make this information inaccurate or incomplete.

Section 14 - Transportation information

Shipping Class: Not regulated by DOT.

Section 15 - Regulatory information

All components of this product are listed on the Toxic Substances Control Act (TSCA) Section 8(b) Chemical Inventory and the Canadian Environmental Protection Act (CEPA) provisional domestic substances list (DSL). This product is not a "hazardous substance" as defined by OSHA Hazard Communication Standard (29 CFR 1910.1200). This product is not a "controlled product" as defined by the Canadian Workplace Hazardous Materials Information System (WHMIS).

SARA Section 302 Extremely Hazardous Substances:
Not listed

SARA 311/312:
Acute: No
Chronic: No
Fire: No
Reactivity: No
Sudden Release of Pressure: No

SARA Section 313 Toxic Chemicals:
Not listed

Section 16 - Additional Information

NFPA Ratings (Scale of 0-4):

Health=1

Fire=0

Reactivity=0

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"SUVA" 507

6123FR   Revised 24-MAR-1999

CHEMICAL PRODUCT/COMPANY IDENTIFICATION

Material Identification

   "SUVA" is a registered trademark of DuPont.

   Corporate MSDS Number   : DU007297

Company Identification

   MANUFACTURER/DISTRIBUTOR

```
                    DuPont Chemical Solutions Enterprise
                    1007 Market Street
                    Wilmington, DE 19898
```

```
PHONE NUMBERS
   Product Information  : 1-800-441-7515
   Transport Emergency  : CHEMTREC 1-800-424-9300
   Medical Emergency    : 1-800-441-3637
```

COMPOSITION/INFORMATION ON INGREDIENTS

```
Components
```

```
Material                                  CAS Number    %
HFC-125                                    354-33-6    50
HFC-143a                                   420-46-2    50
```

HAZARDS IDENTIFICATION

```
Potential Health Effects

   Potential Health Effects

   SKIN CONTACT

   Immediate effects of overexposure may include: Frostbite, if
   liquid or escaping vapor contacts the skin.  Significant
   skin permeation, and systemic toxicity, after contact
   appears unlikely.

   INHALATION
```

Gross overexposure may cause: Central nervous system depression with dizziness, headache, confusion, incoordination, drowsiness or unconsciousness. Suffocation, if air is displaced by vapors. Based on animal data, this material may cause: Irregular heart beat with a strange sensation in the chest, "heart thumping", cardiac arrhythmias, apprehension, lightheadedness, feeling of fainting, dizziness, inadequate circulation, weakness, sometimes progressing to loss of consciousness and death.

At flame temperatures, this material can decompose to hydrogen fluoride which can be lethal at much lower concentrations.

ADDITIONAL HEALTH EFFECTS

Increased susceptibility to the effects of this material may be observed in persons with pre-existing disease of the: cardiovascular system.

Carcinogenicity Information

None of the components present in this material at concentrations equal to or greater than 0.1% are listed by IARC, NTP, OSHA or ACGIH as a carcinogen.

FIRST AID MEASURES

First Aid

INHALATION

If inhaled, immediately remove to fresh air. Keep person calm. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Call a physician.

SKIN CONTACT

In case of contact, immediately flush skin with plenty of water

for at least 15 minutes while removing contaminated clothing and
shoes. Call a physician. Wash contaminated clothing before
reuse. Treat for frostbite if necessary by gently warming
affected area.

EYE CONTACT

In case of contact, immediately flush eyes with plenty of water
for at least 15 minutes. Call a physician.

INGESTION

Ingestion is not considered a potential route of exposure.

 Notes to Physicians

Because of possible disturbances of cardiac rhythm, catecholamine
drugs, such as epinephrine, should only be used with special
caution in situations of emergency life support.

FIRE FIGHTING MEASURES

Flammable Properties

    Flash Point   : Will not burn
    Flammable limits in Air, % by Volume
    LEL   : Not applicable
    UEL   : Not applicable
    Autoignition   : Not determined

    Fire and Explosion Hazards:

    Cylinders may rupture under fire conditions. Decomposition
    may occur.

    Contact of welding or soldering torch flame with high
    concentrations of refrigerant can result in visible changes
    in the size and color of torch flames. This flame effect
    will only occur in concentrations of product well above the

recommended exposure limit, therefore stop all work and
ventilate to disperse refrigerant vapors from the work area
before using any open flames.

Potential combustibility:

"Suva" 507 is not flammable at temperatures up to 100 deg C
(212 deg F) at atmospheric pressure. However, mixtures of
"Suva" 507 with high concentrations of air at elevated
pressure can become combustible at ambient temperature. As
the temperature of the mixture is increased, lower pressure
(but still greater than atmospheric pressure) can create the
same effect. Therefore, "Suva" 507 should not be mixed with
air under pressure for leak testing or other purposes. In
general, "Suva" 507 should not be used or allowed to exist
with high concentrations of air above atmospheric pressure.

Extinguishing Media

As appropriate for combustibles in area.

Fire Fighting Instructions

Cool cylinder with water spray or fog. Self-contained
breathing apparatus (SCBA) is required if cylinders rupture
and contents are released under fire conditions. Water
runoff should be contained and neutralized prior to release.

ACCIDENTAL RELEASE MEASURES

Safeguards (Personnel)

NOTE: Review FIRE FIGHTING MEASURES and HANDLING (PERSONNEL)
sections before proceeding with clean-up. Use appropriate
PERSONAL PROTECTIVE EQUIPMENT during clean-up.

Accidental Release Measures

Ventilate area (using forced ventilation), especially low or

enclosed places where heavy vapors might collect. Remove
open flames. Use self-contained breathing apparatus (SCBA)
for large spills or releases.

HANDLING AND STORAGE

Handling (Personnel)

  Avoid breathing high concentrations of vapor. Avoid contact of
  liquid with eyes and prolonged skin exposure. Use with sufficient
  ventilation to keep employee exposure below recommended limits.

  Contact with chlorine or other strong oxidizing agents
  should also be avoided. See Fire and Explosion Data
  section.

Storage

  Do not heat above 52 C (126 F). Store in a clean, dry place.

EXPOSURE CONTROLS/PERSONAL PROTECTION

Engineering Controls

  Refrigerant concentration monitors may be necessary to
  determine vapor concentrations in work areas prior to use of
  torches or other open flames, or if employees are entering
  enclosed areas.

Exposure Guidelines

 Applicable Exposure Limits

```
HFC-125
PEL   (OSHA)              : None Established
TLV   (ACGIH)            : None Established
AEL * (DuPont)           : 1000 ppm, 8 & 12 Hr. TWA
WEEL  (AIHA)             : 1000 ppm, 4900 mg/m3, 8 Hr. TWA

HFC-143a
PEL   (OSHA)              : None Established
TLV   (ACGIH)            : None Established
AEL * (DuPont)           : 1000 ppm, 8 & 12 Hr. TWA
WEEL  (AIHA)             : 1000 ppm, 8 Hr. TWA
```

* AEL is DuPont's Acceptable Exposure Limit. Where governmentally
imposed occupational exposure limits which are lower than the AEL
are in effect, such limits shall take precedence.

PHYSICAL AND CHEMICAL PROPERTIES

```
Physical Data

   % Volatiles             : 100 %
   Evaporation Rate        : >1
   Solubility in Water     : Not Determined
   Odor                    : Ethereal (slight).
   Form                    : Liquified Gas.
   Color                   : Clear, Colorless.
   Boiling Point           : -46.9 C (-52.4 F) @ 1 atm
   Vapor Pressure          : 184.9 psia @ 25 C (77 F)
   Specific Gravity        : 1.079 @ 25 C (77 F)
```

STABILITY AND REACTIVITY

Chemical Stability

   Stable at normal temperatures and storage conditions.

   However, avoid open flames and high temperatures.

 Incompatibility with Other Materials

   Incompatible with active metals, alkali or alkaline earth
   metals--powdered Al, Zn, Be, etc.

 Decomposition

   Decomposition products are hazardous. This material can be
   decomposed by high temperatures (open flames, glowing metal
   surfaces, etc.) forming hydrofluoric acid and possibly
   carbonyl fluoride. These materials are toxic and
   irritating. Contact should be avoided.

 Polymerization

   Polymerization will not occur.

TOXICOLOGICAL INFORMATION

Animal Data

   HFC-125

   INHALATION:

   4 hour, ALC, rat: > 709,000 ppm (Very low toxicity).

   Single exposure to high doses caused: Lethargy. Labored
   breathing. Weak cardiac sensitization, a potentially fatal
   disturbance of heart rhythm caused by a heightened
   sensitivity to the action of epinephrine. Repeated exposure
   caused: No significant toxicological effects.
   No-Observed-Adverse-Effect-Level (NOAEL): 50,000 ppm

ADDITIONAL TOXICOLOGICAL EFFECTS:

No animal data are available to define the following effects of this material: carcinogenicity, reproductive toxicity. In animal testing this material has not caused developmental toxicity. Tests have shown that this material does not cause genetic damage in bacterial or mammalian cell cultures, or in animals. This material has not been tested for its ability to cause permanent genetic damage in reproductive cells of mammals (not tested for heritable genetic damage).

HFC-143a

   Inhalation 4 hour LC50: > 540,000 ppm in rats (Very low toxicity by inhalation)

INHALATION: Single exposure to 500,000 ppm caused anaesthesia, but no mortality at 540,000 ppm. Cardiac sensitization occurred in dogs at 300,000 ppm from the action of exogenous epinephrine. Two, 4-week inhalation studies have been conducted. In the first study, pathological changes in the testes were observed at all exposures concentrations; no effects were observed in females. The testicular effect was considered related to the method used to expose the rats to HFC-143a. In the second study using the same exposure concentrations, no effects were noted in males at any concentration. Data from a 90-day study revealed no effects in male or female rats at exposures up to 40,000 ppm.

INGESTION: Long-term exposure caused significantly decreased body weights in male rats fed 300 mg/kg for 52 weeks, but there was no effect on mortality. During this long-term exposure study, tests in rats demonstrated no carcinogenic activity when HFC-143a was administered orally in corn oil at 300 mg/kg/day, five days a week, for 52 weeks and observed for an additional 73 weeks. Tests in animals demonstrate no developmental toxicity. No animal test reports are available to define reproductive hazards. Tests in bacterial cell cultures demonstrate mutagenic activity, but the compound did not induce oncogenic transformation of mammalian cells in culture. HFC-143a was not mutagenic in animals.

ECOLOGICAL INFORMATION

Ecotoxicological Information

   AQUATIC TOXICITY:

HFC-143a

     The compound is very low to slightly toxic.
     96 hr. LC50, rainbow trout: > 40 mg/L.

DISPOSAL CONSIDERATIONS

Waste Disposal

   Comply with Federal, State, and local regulations. Reclaim
   by distillation or remove to a permitted waste disposal
   facility.

TRANSPORTATION INFORMATION

Shipping Information

   DOT/IMO/IATA
   Proper Shipping Name   : LIQUEFIED GAS, N.O.S.

```
                              (PENTAFLUOROETHANE AND TRIFLUOROETHANE)
Hazard Class             : 2.2
UN No.                   : 3163
DOT/IMO Label            : NONFLAMMABLE GAS

Shipping Containers

Tank Trucks.
Cylinders.
```

REGULATORY INFORMATION

```
U.S. Federal Regulations

   TSCA Inventory Status    : Listed.

   TITLE III HAZARD CLASSIFICATIONS SECTIONS 311, 312

   Acute      : No
   Chronic    : No
   Fire       : No
   Reactivity : No
   Pressure   : Yes

   HAZARDOUS CHEMICAL LISTS

   SARA Extremely
   Hazardous Substance        - No
   CERCLA Hazardous Substance - No
   SARA Toxic Chemical        - No
```

OTHER INFORMATION

NFPA, NPCA-HMIS

    NPCA-HMIS Rating
    Health   : 1
    Flammability   : 0
    Reactivity   : 1

    Personal Protection rating to be supplied by user depending on use
    conditions.

    The data in this Material Safety Data Sheet relates only to the
    specific material designated herein and does not relate to use in
    combination with any other material or in any process.

    Responsibility for MSDS : MSDS Coordinator
    >   : DuPont Fluoroproducts
    Address   : Wilmington, DE 19898
    Telephone   : (800) 441-7515

    # Indicates updated section.

                            End of MSDS

"SUVA" 95 (R-508B)

6087FR   Revised 10-JUL-1997

CHEMICAL PRODUCT/COMPANY IDENTIFICATION

Material Identification

    Corporate MSDS Number   : DU008080

Company Identification

    MANUFACTURER/DISTRIBUTOR
                DuPont
                Fluoroproducts
                1007 Market Street
                Wilmington, DE 19898

    PHONE NUMBERS

```
Product Information  : 1-800-441-7515
Transport Emergency  : CHEMTREC 1-800-424-9300
Medical Emergency    : 1-800-441-3637
```

COMPOSITION/INFORMATION ON INGREDIENTS

Components

Material	CAS Number	%
TRIFLUOROMETHANE	75-46-7	30-50
HEXAFLUOROETHANE	76-16-4	50-70

HAZARDS IDENTIFICATION

Potential Health Effects

Inhalation of high concentrations of vapor is harmful and may cause heart irregularities, unconsciousness, or death. Intentional misuse can be fatal. Vapor reduces oxygen available for breathing and is heavier than air. Liquid contact can cause frostbite.

HUMAN HEALTH EFFECTS:

Human health effects of overexposure by inhalation may include nonspecific discomfort such as nausea, headache, or weakness; temporary nervous system depression with anaesthetic effects such as dizziness, headache, confusion, incoordination, and loss of consciousness; or with gross overexposure, possibly temporary alteration of the heart's electrical activity with irregular pulse, palpitations, or inadequate circulation. Individuals with preexisting diseases of the central nervous or cardiovascular system may have increased susceptibility to the toxicity of excessive exposures. Eye or skin contact with the liquid may cause

frostbite.

Carcinogenicity Information

None of the components present in this material at concentrations
equal to or greater than 0.1% are listed by IARC, NTP, OSHA or ACGIH
as a carcinogen.

FIRST AID MEASURES

First Aid

IF HIGH CONCENTRATIONS ARE INHALED: Immediately remove to
fresh air. Keep persons calm. Call a physician. If not
breathing, give artificial respiration. If breathing is
difficult, give oxygen.

IN CASE OF SKIN CONTACT: Flush with water. Treat for
frostbite if necessary.

IN CASE OF EYE CONTACT: Flush with water. Call a physician
if frostbite occurs.

IF SWALLOWED: Ingestion is not considered a potential route
of exposure.

Notes to Physicians

Because of possible disturbances of cardiac rhythm,
catecholamine drugs, such a epinephrine, should be
considered only as a last resort in life-threatening
emergencies.

FIRE FIGHTING MEASURES

Flammable Properties

    Flash Point   : Will not burn

    Flammable limits in Air, % by Volume
    LEL   : Not applicable.
    UEL   : Not applicable.

    Fire and Explosion Hazards:

    Use water spray or fog to cool containers. Cylinders are
    equipped with temperature and pressure relief devices but
    may still rupture under fire conditions. Decomposition
    may occur, producing HF, CO and possibly COF_2.

Extinguishing Media

    Use media appropriate for surrounding material.

Fire Fighting Instructions

    Self-contained breathing apparatus (SCBA) is required if
    cylinders rupture or release under fire conditions. Water
    runoff should be contained and neutralized prior to release.

ACCIDENTAL RELEASE MEASURES

Safeguards (Personnel)

    NOTE: Review FIRE FIGHTING MEASURES and HANDLING (PERSONNEL)
    sections before proceeding with clean-up. Use appropriate
    PERSONAL PROTECTIVE EQUIPMENT during clean-up.

Accidental Release Measures

    Material evaporates at atmospheric pressure (vaporizes).
    Ventilate area - especially low places where heavy vapors
    might collect. Remove open flames.

HANDLING AND STORAGE

Handling (Personnel)

   Avoid contact of liquid with eyes and prolonged skin
   exposure. Use with sufficient ventilation to keep employee
   exposure below recommended limits.

Storage

   Clean, dry area. Do not heat above 51.7 deg. C (125 deg. F)

EXPOSURE CONTROLS/PERSONAL PROTECTION

Engineering Controls

   Normal ventilation for standard manufacturing procedures is
   generally adequate. Local exhaust should be used when large
   amounts are released. Mechanical ventilation should be used
   in low places.

Personal Protective Equipment

   Neoprene rubber or leather gloves should be used when
   handling liquid. Chemical splash goggles should be worn
   when handling liquid. Under normal manufacturing
   conditions, no respiratory protection is required when using
   this product. Self-contained breathing apparatus (SCBA) is
   required if a large spill or release occurs.

Exposure Guidelines

 Applicable Exposure Limits
   TRIFLUOROMETHANE
   PEL   (OSHA)   : None Established
   TLV   (ACGIH)   : None Established
   AEL * (DuPont)   : 1000 ppm, 8 & 12 Hr. TWA

   HEXAFLUOROETHANE

```
     PEL   (OSHA)                  : None Established
     TLV   (ACGIH)                 : None Established
     AEL * (DuPont)                : 1000 ppm, 8 & 12 Hr. TWA
```

     * AEL is DuPont's Acceptable Exposure Limit. Where governmentally
     imposed occupational exposure limits which are lower than the AEL
     are in effect, such limits shall take precedence.

PHYSICAL AND CHEMICAL PROPERTIES

     Physical Data

```
        Boiling Point             : -88 C (-126 F)
        Vapor Density             : (Air = 1)
        % Volatiles               : 100 WT%
        Odor                      : Slight ethereal
        Form                      : Compressed Gas
        Color                     : Clear, colorless
```

STABILITY AND REACTIVITY

     Chemical Stability

        Material is stable. However, avoid open flames and high
        temperatures.

     Decomposition

        This product can be decomposed by high temperatures (open
        flames, glowing metal surfaces, etc.) forming HF, COF2 or
        CO. These materials are toxic and irritating. Contact
        should be avoided.

     Polymerization

Polymerization will not occur.

TOXICOLOGICAL INFORMATION

Animal Data

TRIFLUOROMETHANE:

   Inhalation 4-hr LC50 : >663,000 ppm in rats

Material is untested for skin and eye irritancy, and for animal sensitization.

Effects from single high inhalation exposure to Trifluoromethane include anaesthetic effects, and nonspecific effects such as weight loss were observed at concentrations >22%. No cardiac sensitization was observed in dogs after breathing 800,000 ppm for periods of 5-10 minutes following epinephrine challenge. In another test, dogs exposed to up to 30% or up to 50% (with aditional oxygen), had no positive responses. No cardiac sensitization occurred in baboons exposed by inhalation to 10%, 30%, 50%, or 70% Trifluoromethane before or after an epinephrine challenge; there was a dose-related decrease in heart rates and differences in respiratory rates during exposure.

No animal tests are available to define the carcinogenic hazards of Trifluoromethane. The maternal and developmental NOAEL was 50,000 ppm. Trifluoromethane is not considered a unique developmental hazard to the conceptus. There were no developmental or reproductive effects.

Tests have shown that Trifluoromethane does not produce genetic damage in bacterial or mammalian cell cultures. It has not produced genetic damage in tests on animals.

HEXAFLUOROETHANE:

   Inhalation 4-hour LC50: >800,000 ppm in rats

Effects observed in animals by inhalation include decreased

growth rate, pulmonary changes, irregular respiration, increased urine volume and creatinine, reversible pathological changes in the kidneys, and increased urinary fluoride concentration. One study showed no arrhythmogenic effects in dogs at a concentration of 20%, while another study did show some arrhythmogenic effects in both guinea pigs and dogs. Long-term inhalation exposures resulted in an initial decrease in growth rate, but no other adverse changes were noted. No animal test reports are available to define carcinogenic, developmental, or reproductive hazards. The compound does not produce genetic damage in bacterial cell cultures but has not been tested in animals.

DISPOSAL CONSIDERATIONS

Waste Disposal

Reclaim by distillation or remove to a permitted waste disposal facility. Dispose in accordance with all Federal, State and local regulations.

TRANSPORTATION INFORMATION

Shipping Information

    DOT/IMO
    Proper Shipping Name   : COMPRESSED GAS, N.O.S.
                                (FLUORINATED HYDROCARBONS)
    Hazard Class   : 2.2
    UN No.   : 1956
    DOT/IMO Label   : Nonflammable Gas

    Shipping Containers

    Cylinders and ton tanks.

REGULATORY INFORMATION

U.S. Federal Regulations

    TSCA Inventory Status   : Reported/Included.

    TITLE III HAZARD CLASSIFICATIONS SECTIONS 311, 312

    Acute   : Yes
    Chronic   : No
    Fire   : No
    Reactivity : No
    Pressure   : Yes

    LISTS:

      SARA Extremely Hazardous Substance - No
      CERCLA Hazardous Substance   - No
      SARA Toxic Chemicals   - No

OTHER INFORMATION

NFPA, NPCA-HMIS

    NPCA-HMIS Rating
    Health   : 1
    Flammability   : 0
    Reactivity   : 1

    Personal Protection rating to be supplied by user depending on use
    conditions.

The data in this Material Safety Data Sheet relates only to the
specific material designated herein and does not relate to use in
combination with any other material or in any process.

Responsibility for MSDS : MSDS Coordinator
>   : DuPont Fluoroproducts
Address   : Wilmington, DE 19898
Telephone   : (800) 441-7515

# Indicates updated section.

                          End of MSDS

Model TP03000 Series ThermoChuck® Systems

for probing, characterization and failure analysis of wafers, chips & hybrids at high and low temperatures

TP03000 Series ThermoChuck® Systems

System:

- **-65ºC to +200ºC** extended temperature range with a low noise, DC control system.

- Up to five temperatures and ramp/soak/cycle thermal cycling sets can be programmed at the front panel.

- **IEEE-488 and RS232** included.

- Self-contained system requires no liquid nitrogen or CO_2 for cooling.

- Highly efficient cooling systems for reliable, low temperature testing of hybrids and other high power devices.

ThermoChuck:

- Temperature controlled vacuum chucks accommodate wafers of various sizes to **200mm**.

- High precision: Excellent temperature control, stability and uniformity.

- **Standard, high isolation and guarded configurations** available.

- Advanced chuck design provides low stray capacitance and high electrical resistance to ground. DC power minimizes electrical noise.

- May be interfaced to manual or automatic probing stations, laser trimmers or inspection stations.

THERMOCHUCK SYSTEMS are essential for probing, characterization and failure analysis of wafers, individual chips and hybrids at temperatures required for commercial or MilSpec testing.

TP03000 Systems consist of a controller, a stand-alone self-contained cooler/circulator and a temperature controlled vacuum chuck assembly. **TP03010 Systems** consist of a single rackmountable controller/heat exchanger unit and a temperature controlled vacuum chuck assembly.

ThermoChuck

The ThermoChuck vacuum chuck assembly is a high precision thermal platform with the ability to shut off outer vacuum rings for better "hold down" of smaller wafers. The chuck surface is electrically isolated and gold plated for electrical contact to the substrate. **Other chuck surface treatments (nickel, hard anodized)** are available on request.

ThermoChucks are also available in **high isolation and guarded** configurations for application requirements including **high electrical isolation, low stray capacitance, femptoamp level wafer probing and other sensitive measurements**. For noise-sensitive test applications, the DC power controller also minimizes electrical noise.

The **CHUCK DIAMETER** is selected by the user depending on the wafer diameter. Four inch is standard for wafers up to 100mm size. 5, 6 and 8 inch chucks are optional for wafers with sizes up to 125mm, 150mm and 200mm respectively. All chucks are supplied with a set of vacuum adapters in order to select the appropriate vacuum rings for probing smaller diameter wafers, hybrid modules or chips.

Optional Mechanical Interface Kits and dedicated chuck configurations are available in order to adapt the ThermoChuck assembly to any major wafer probing station.

Controller

Large alphanumeric displays and an intuitive front panel make the TP03000 and TP03010 Systems easy to use in any mode. The micro-processor-based controller features three selectable operating modes:

Manual-Front panel control, **three easily programmed and selectable temperature setpoints**.

Auto-Permits fully programmed operation without the need for an external computer, allows user to **program and run up to 5 temperatures with ramp times, soak times and number of cycles**. All user selected and programmed parameters and status information are displayed continuously during this operating mode.

Remote-Permits programming and operation for external computer using either **IEEE-488 or RS232 interface**.

- Non-volatile memory retains all programmed parameters.
- **Built-in protection** against excessive high temperature prevents damage to both the DUT and the system.
- The controller has a simple, **automated calibration procedure** and several self-diagnostic routines. A relay closure is available to provide visual indication or an interlock when the chuck surface is set above +70ºC.
- **Modular construction** of the controller assures easy access, serviceability and added safety while the compact size permits set up in the many lab areas where space is at a premium.

SYSTEM

Temperature Range[2] (C)

	TP03000	TP03010A	TP03010B
Standard Temperature Range	-65° to +130°C	+20° to +130°C[1]	0° to +130°C
Optional Extended Temperature Range	-65° to +200°C	+20° to +200°C[1]	0° to +200°C

[1]Ultimate low temperature is dependent on type and temperature of coolant used. With air at +25ºC, low temperature = +20ºC; with water at +25ºC, low temperature = +5ºC.

[2]Ultimate low temperature is specified at no load with the chuck maintained in a still air ambient at +25ºC maximum. Some degradation of ultimate low temperature may occur over time with larger chuck diameters. Ultimate low temperature may degrade up to 5ºC for 200mm diameter ThermoChuck configuration. Coolant line integration, routing and length will affect low temperature performance.

The compact TP03010 system controller and cooler/circulator are combined in one chassis, shown with optional cabinet. The TP03010 is supplied in rackmount configuration.

Computer Interface

The TP03000 and TP03010 systems are supplied with both **IEEE-488 and RS232 interfaces**. This feature permits computer control of all user selectable parameters including set temperatures, control windows, ramp and soak times, number of cycles and "inhibit power".

The system also provides the interface bus with system status, condition and service request information. The programming protocols are consistent with IEEE-488 specifications.

Installation Option

Both the controller and the separate cooler/circulator for the TP03000 systems are available in a 19 inch EIA rackmount configuration. The TP03010 systems are supplied as an integrated system consisting of both the controller and heat exchanger assembly in a single chassis. The TP03010 systems are supplied in rackmount configuration with cabinets available as an option.

SERIES
ThermoChuck® Systems

Specifications - ThermoChuck Platform

Diameter	103.1 mm, (4.06 inch) diameter ThermoChuck	(wafers to 100 mm)
	128.5 mm, (5.06 inch) diameter ThermoChuck	(wafers to 125 mm)
	154 mm, (6.06 inch) diameter ThermoChuck	(wafers to 150 mm)
	203 mm, (8.0 inch) diameter ThermoChuck	(wafers to 200 mm)
Temperature Uniformity	±0.5°C or ±0.5% of set temperature (whichever is greater)	
Surface	Gold, nickel plated or anodized aluminum with provisions for grounding or biasing	
Surface Electrical Isolation	>10^9 ohms at 500 V DC between surface and ground at 25°C - higher resistance construction is optional.	
Surface to Ground Capacitance	103.1 mm, (4.06 inch) diameter ThermoChuck:	<275 pf
	128.5 mm, (5.06 inch) diameter ThermoChuck:	<375 pf
	154 mm, (6.06 inch) diameter ThermoChuck:	<525 pf
	203 mm, (8.0 inch) diameter ThermoChuck:	<950 pf
Height	25.4 mm (1.0 inch) nominal	
Weight (approximate)	103.1 mm, (4.06 inch) diameter ThermoChuck:	0.6 kg (1 lb., 5 oz)
	128.5 mm, (5.06 inch) diameter ThermoChuck:	0.8 kg (1 lb., 10 oz)
	154 mm, (6.06 inch) diameter ThermoChuck:	1.0 kg (2 lbs., 3 oz)
	203 mm, (8.0 inch) diameter ThermoChuck:	1.8 kg (4 lbs.)
Surface Flatness	.001 inch TIR up to +130°C	
	.002 inch TIR up to +200°C	
Surface Base Parallelism	.001 inch TIR at +25°C	

System Specifications

Control Method	Bi-Polar DC Proportional, Integral, Derivative (PID)
Temperature Accuracy	±0.5°C (when calibrated against a primary or transfer standard)
Temperature Stability	±0.1°C
Temperature Resolution	Set: 0.1°C Indicate: 0.1°C
Ambient Operating Temperature	+10°C to +30°C
Humidity Operating Range	0 to 90% non-condensing
Overheat Protect Temperature	For all systems, high temperature in system range +5°C +135°C (high temperature in range: +130°C) +205°C (high temperature in range: +200°C)
Temperature Display	Four digits, 0.1°C resolution
Remote Control	IEEE-488 and RS232 I/O
Local Control	3 pushbuttons for the selection of two operating temperatures and one "ambient" preset temperature. 4 x 4 keypad for the setting of temperatures and all other system control parameters.
Status Indicators	Seventeen LED lamps to indicate operating, pde, selected set point and operating state of IEEE-488 interface.
Non-volatile Memory	Back-up retention of set up parameters

WEIGHTS AND DIMENSIONS

Model TP03000 Series ThermoChuck® Systems

Rackmount Configuration

	TP03000 Controller	TP03000 Cooler/Circulator Unit	TP03010 Single Chassis; requires user-supplied coolant	TP03010B Single Chassis, requires self-contained coolant
panel	13.3H x 48.3W (cm) 5.25H x 19.0W (inches)	53.4H x 48.26 (cm) 21.0H x 19.0W (inches)	13.33H x 48.25W (cm) 5.25H x 19.0W (in.)	
chassis	3.25H x 42.5W x 44.5D**(cm) 5.2H x 16.75W x 17.5D**(in.)	51.8H x 42.5W x 61.6D**(cm) 20.4H x 16.75 x 24.25D**(in.)	13.25H x 42.5W x 61D**(cm) 5.22H x 16.75W x 24D**(in.)	13.25H x 42.5W x 69D**(cm) 5.22H x 16.75W x 27.1D**(in.)
weight	16.80 kg (37 lbs.)	72.64 kg (160 lbs.)	19.52 kg (43 lbs.)	24.06 kg (53 lbs.)

Cabinet Configuration

	TP03000 Controller with Cabinet	TP03000 Cooler/Circulator with Cabinet	TP03010A System with Cabinet	TP03010B System with Cabinet
dimension	15.24H x 48.9W x 47.6D** (cm) 6.0H x 19.25W x 18.75D** (in.)	71.75H x 52.1W x 68.6D** (cm) 28.25H x 20.5W x 27.0D** (in.)	15.24H x 48.9W x 64.14D** (cm) 6.0H x 19.25W x 25.25D** (in.)	15.24H x 48.9W x 64.14D** (cm) 6.0H x 19.25W x 28.5D** (in.)
weight	19.98 kg (44 lbs.)	95.4 kg (210 lbs.)	25 kg (55 lbs.)	29.5 kg (65 lbs.)

*Note: Controller requires 6 inches clearance for cables and airflow. **Depth is measured from back of front panel to face of rear panel.

SYSTEM OPTIONS AND ACCESSORIES

Rackmount / Cabinets

TP03000	The separate controller and cooler/circulator are supplied with cabinets. Units may be configured to fit a 19" EIA rack.
TP03010	The single controller/circulator unit is configured to fit a 19" EIA rack. Cabinet is optional.
Controlled Environment Enclosure (CEE)[3]	Recommended by ThermoChuck operation at temperatures below the dew point. Provides a dry, clean test environment. Optional light-tight and EMI shielded configurations are also available. Consult the factory.

[3]Below ambient temperatures are always present during normal operation of the TPO3000A System. The CEE is always recommended for use with this system.

FACILITIES REQUIREMENTS

	TP03000A	TP03010A	TP03010B
power[4]	115 VAC, 60 Hz (100 to 130V Range), 20 Amps 220 VAC, 50/60 Hz (210 to 230V Range), 10 Amps	115 VAC, 50/60 Hz (100 to 130V Range), 10 Amps 220 VAC, 50/60 Hz (210 to 230V Range), 5 Amps	
compressed air or water	Not Applicable	3 SCFM at 30 PSIG	Not Applicable
	Not Applicable	1 liter/minute, 30 PSIG maximum	Not Applicable

[4]Contact factory to confirm for TP03000 Series Systems to be operated beyond the continental US. A buck/boost transformer is available to condition power input.

inTEST
www.intest.com
Positioner & Docking Solutions
www.intest.com

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an inTEST Company
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TEL: +1.781.688.2300
www.inTESTthermal.com

TestDesign
an inTEST Company
Interface Solutions
www.intest.com