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TMA
Thermomechanical Analyzer



Q Series
Getting Started Guide

Revision D
Issued November 2006

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New Castle, DE 19720

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Notes, Cautions, and Warnings

This manual uses NOTES, CAUTIONS, and WARNINGS to emphasize important and critical instructions.

A NOTE highlights important information about equipment or procedures.



A CAUTION emphasizes a procedure that may damage equipment or cause loss of data if not followed correctly.



A WARNING indicates a procedure that may be hazardous to the operator or to the environment if not followed correctly.

Regulatory Compliance

Safety Standards

For Canada:

CAN/CSA-22.2 No. 1010.1-92 Safety requirements for electrical equipment for measurement, control, and laboratory use, Part 1: General Requirements + Amendments.
CAN/CSA-22.2 No. 1010.2.010-94 Particular requirements for laboratory equipment for the heating of materials + Amendments.

For the European Economic Area: (In accordance with Council Directive 73/23/EEC of 19 February 1973 on the harmonization of the laws of Member States relating to electrical equipment designed for use within certain voltage limits.)

EN61010-1: 1993 Safety requirements for electrical equipment for measurement, control, and laboratory use, Part 1: General Requirements + Amendments.
EN61010-2-010: 1994 Particular requirements for laboratory equipment for the heating of materials + Amendments.

For the United States:

UL61010A-1 Electrical Equipment for Laboratory Use; Part 1: General Requirements.
IEC 1010-2-010: 1992 Particular requirements for laboratory equipment for the heating of materials + Amendments.

Electromagnetic Compatibility Standards

For Australia and New Zealand:

AS/NZS 2064: 1997 Limits and methods of measurement of electronic disturbance characteristics of industrial, scientific and medical (ISM) radiofrequency equipment.

For Canada:

ICES-001 Issue 3 March 7, 1998 Interference-Causing Equipment Standard: Industrial, Scientific, and Medical Radio Frequency Generators.

For the European Economic Area: (In accordance with Council Directive 89/336/EEC of 3 May 1989 on the approximation of the laws of the Member States relating to electromagnetic compatibility.)

EN61326-1: 1997 Electrical equipment for measurement, control, and
laboratory use-EMC requirements-Part 1: General Requirements + Amendments. Emissions: Meets Class A requirements (Table 3). Immunity: Meets performance criteria B for non-continuous operation, minimum requirements (Table 1).

For the United States:

CFR Title 47 Telecommunication Chapter I Federal Communications Commission, Part 15 Radio frequency devices (FCC regulation pertaining to radiofrequency emissions).

Safety

CAUTION: The operator of this instrument is advised that if the equipment is used in a manner not specified in this manual, the protection provided by the equipment may be impaired.

Instrument Symbols

The following labels are displayed on the TMA instrument for your protection:

Symbol	Explanation
	This symbol indicates that a hot surface may be present. Take care not to touch these areas or allow any material that may melt or burn to come in contact with these hot surfaces
	This symbol on the rear access panel indicates that you must unplug the instrument *before* doing any maintenance or repair work; voltages exceeding 120/240 Vac are present in this system. If you are not trained in electrical procedures, do not remove the cabinet covers unless specifically instructed to do so in the manual. Maintenance and repair of internal parts must be performed only by TA Instruments or other qualified service personnel.

Please heed the warning labels and take the necessary precautions when dealing with those parts of the instrument. The *TMA Getting Started Guide* contains cautions and warnings that must be followed for your own safety.

Electrical Safety

You must unplug the instrument before doing any maintenance or repair work; voltages as high as 120/240 Vac are present in this system.

WARNING: High voltages are present in this instrument. Maintenance and repair of internal parts must be performed only by TA Instruments or other qualified service personnel.

WARNING: After transport or storage in humid conditions, this equipment could fail to meet certain aspects of the safety requirements of the safety standards indicated. Refer to the CAUTION on page 24 for the method of drying out the equipment before use.

Sample Decomposition

The TMA is capable of heating samples to 1000°C. Many materials may decompose during the heating, which can generate hazardous byproducts.

WARNING: If you are using samples that may emit harmful gases, vent the gases by placing the instrument near an exhaust.

Samples should not be heated above their decomposition temperatures to prevent the relase of hazardous materials or contamination of the TMA.

Lifting the Instrument

The TMA is a fairly heavy instrument. In order to avoid injury, particularly to the back, please follow this advice:

WARNING: Close the furnace before moving the instrument, even for a short distance. Use two people to lift and/or carry the instrument. The instrument is too heavy for one person to handle safely.

Handling Liquid Nitrogen

The TMA can use the cryogenic (low-temperature) agent, liquid nitrogen, for cooling in subambient experiments. Because of its low temperature [-195°C (-319°F)], liquid nitrogen will burn the skin. When you work with liquid nitrogen, use the following precautions:

WARNING: Liquid nitrogen boils rapidly when exposed to room temperature. Be certain that areas where liquid nitrogen is used are well ventilated to prevent displacement of oxygen in the air.

1. Wear goggles or a face shield, gloves large enough to be removed easily, and a rubber apron. For extra protection, wear high-topped, sturdy shoes, and leave your pant legs outside the tops.

2. Transfer the liquid slowly to prevent thermal shock to the equipment. Use containers that have satisfactory low-temperature properties. Ensure that closed containers have vents to relieve pressure.

3. The purity of liquid nitrogen decreases when exposed to air. If the liquid in a container has been open to the atmosphere for a prolonged period, analyze the remaining liquid before using it for any purpose where high oxygen content could be dangerous.

WARNING:
Potential Asphyxiant

Liquid nitrogen can cause rapid suffocation without warning.

Store and use in an area with adequate ventilation.

Do not enter confined spaces where nitrogen gas may be present unless the area is well ventilated.

The warning above applies to the use of liquid nitrogen. Oxygen depletion sensors are sometimes utilized where liquid nitrogen is in use.

Thermal Safety

During an experiment, the furnace and sample can become very hot or very cold to the touch.

WARNING: Do not use your hands to manually move the furnace and do not put your hands up inside the furnace. It may be hot enough to cause burns.

Cleaning the Instrument

See Chapter 3 for recommended cleaning and maintenance of the TMA instrument.

CAUTION: Before using any cleaning or decontamination method except those recommended by TA Instruments, please check with TA Instruments to make sure that the proposed method will not damage the equipment.

Chapter 1
Introducing the TMA

Overview

The Thermomechanical Analyzer (TMA) is an analytical instrument used to test the physical properties of many different materials.

The TMA instrument works in conjunction with a controller and associated software to make up a thermal analysis system.

Your controller is a computer that performs the following functions:

- Provides an interface between you and the analysis instruments
- Enables you to set up experiments and enter constants
- Stores experimental data
- Runs data analysis programs.

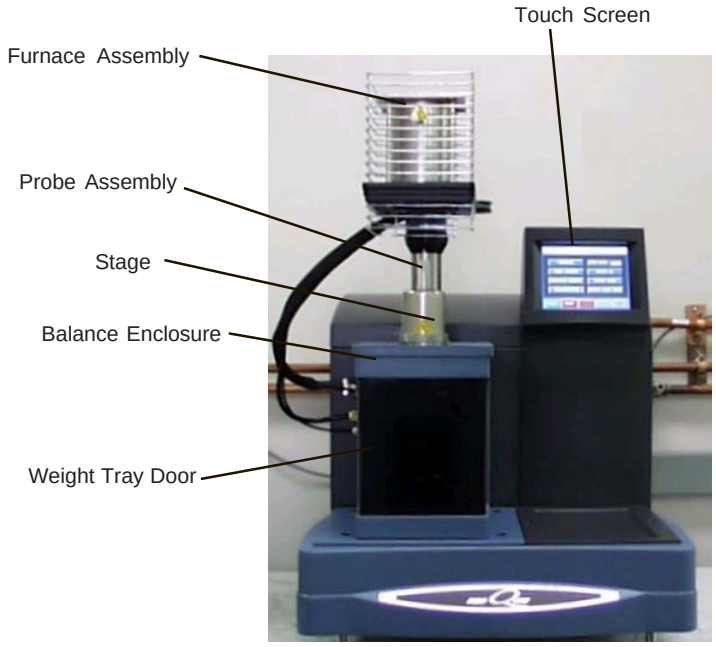


NOTE: For technical reference information, theory of operation, and other information associated with the TMA and not found in this manual, see the online help associated with the instrument control software.

TMA System Components

Your instrument consists of the following components (see the figure here).

- The *balance enclosure* surrounds the TMA balance mechanism, which exerts a specified force on the sample.
- The *probe assembly* is inter-changeable for making several different measurements on various sample materials.
- The *stage* is an interchangeable component that supports the sample during measurement.
- The *furnace assembly* surrounds the stage to heat the sample; it contains the integral cooling container, the furnace monitor thermocouple, and the sample purge line.



- The *weight tray*, located behind the weight tray door, holds the weights to exert an additional known force on the sample.
- The CHROMEL®* / ALUMEL®* *sample thermocouple* senses the temperature of the sample.

The TMA was developed by TA Instruments with the following features:

- Operates over a temperature range of –150 °C to 1000 °C using heating rates up to 200 °C/min
- Determines changes in sample properties resulting from changes in four experimental variables: temperature, force, atmosphere, and time
- Uses samples that can be in solid, film, fiber, or powder form
- Employs interchangeable probes, allowing you to measure the melting point, softening point, tensile modulus, compression modulus, glass transition, stress relaxation, creep, and expansion coefficient.
- Allows additional experiments in parallel plate rheometry, fiber tension, shrinkage force, flexure, and dilatometry with the optional accessories that can be used with the instrument.

Standard Accessories

The accessory kit supplied with the TMA contains weights, a sample holder (stage), a hex wrench, tweezers, samples for calibration, and standard probes.

The standard probes allow you to perform various basic analyses. These probes are as follows:

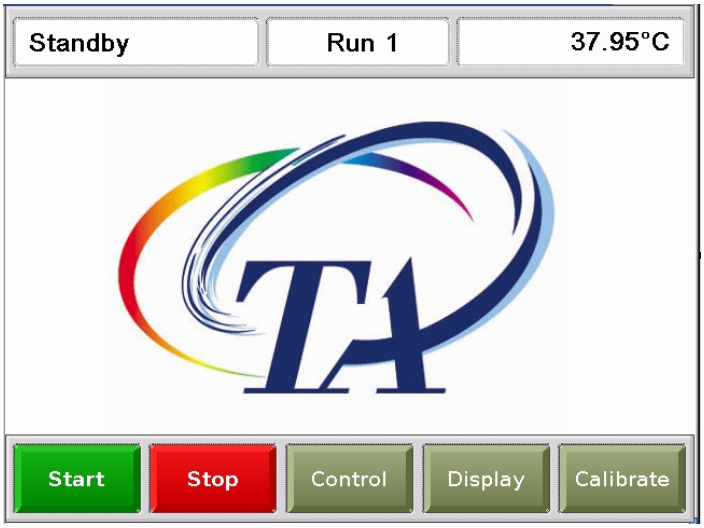
- The *expansion probes* are used to measure the thermal coefficient of expansion and glass transition. The standard expansion probe is used for routine samples. The macro expansion probe covers a larger area of the sample surface and is therefore able to give a more representative reading for samples such as powders, materials with uneven surfaces, frozen liquids, and films.
- The *penetration probe*, which has a small tip that permits it to sink into the material as it is heated, is used to measure softening and melting points.
- Optional probes are also available, see page 21.

Subambient Operation

The TMA can be used to run experiments on cooled samples with a cooling source such as liquid nitrogen contained in the reservoir. In addition, a Mechanical Cooling Accessory is available, see page 21.

The QTMA Touch Screen with QNX/Platinum™

The TMA Q400 instrument has a built-in integrated display and keypad in the form of a touch screen for local operator control. The functions on the screen change depending upon the menu you are using. This section briefly describes the basic layout of these functions when your instrument has QNX and Platinum capabilities installed.



The *status line* along the top of the display shows the current instrument status, run selection, and temperature.

At the bottom of the screen is a set of keys that are used for the primary instrument functions. See the table below for a description of each key.

The functions in the middle of the touch screen will vary depending on the screen displayed.

QNX/Platinum™ Primary Function Keys

Use the following keys for the main functions of the instrument.

Key Name	Description
Start	Begins the experiment. This is the same function as **Start** on the instrument control software. **Start** automatically loads the sample pan and closes the furnace, if necessary, before beginning the experiment.
Stop	If an experiment is running, this key ends the method normally, as though it had run to completion; *i.e.*, the method-end conditions go into effect and the data that has been generated is saved. This is the same function as **Stop** on the instrument control software. If an experiment is not running (the instrument is in a standby or method-end state), the **Stop** key will halt any activity (air cool, all mechanical motion, etc.).
Control	Displays a list of the control command functions. These are used to control the instrument actions such as furnace movement, sample loading/unloading, taring, etc. Items can be selected from the icons or from the drop-down menu. Select **Apply** to initiate the command. See the next page for more details on this screen.

(table continued)

Display	Accesses the display screen, which displays the signals from the instrument such as signal display, real-time plot, instrument information, etc.
Calibrate	Displays the calibration functions available for this instrument.

QNX/Platinum™ Control Menu

The Control Menu (see the figure to the right) is accessed by touching the **Control** key at the bottom of the touch screen. A brief description of each control command is provided in the table below.

NOTE: Most of the commands shown are not available during an active experiment.

Select the desired function either from the drop-down list of Control Commands or by pressing the icon. Then press **Apply** to initiate the action.



Control Command	Description
FURNACE 	Toggles between the furnace closed (up) and furnace open (down) functions, depending on where the furnace is when you press the key. This key can be pressed while the furnace is moving, to reverse the direction of movement.
ZERO LENGTH 	Initializes the automeasure system. This operation should be performed before a sample is loaded and any time the probe or stage is changed.
PROBE UP  *(table continued)*	Used to "open" the probe, this key raises the probe 3 mm, the range of the LVDT, when pressed one time. When the key is pressed a second time, mechanical action occurs, moving the probe and LVDT coil to their maximum upward position. If the probe is moving down and PROBE UP is pushed, the probe will stop and reverse its direction.

Control Command	Description
PROBE DOWN 	Used to "close" the probe, this key lowers the probe 3 mm, the range of the LVDT, when pressed one time. When the key is pressed a second time, mechanical action occurs, centering the LVDT coil. If the probe is moving up and PROBE DOWN is pushed, the probe will stop and reverse its direction.
SHUTDOWN 	Shuts down and resets the instrument.
MEASURE 	Measures your sample's length automatically; use this key before beginning the run. The measured length is transferred to the instrument control software and the value is recorded in the Sample Size field. NOTE: MEASURE is not used with the flexural probe.
AIR COOL	Toggles the air cool function on or off. This is the same function as Air Cool on the instrument control software.
RESET SAVED PARAMETERS	Resets the saved instrument parameters and resets the instrument.

QNX/Platinum™ Display Touch Screen Options

The Display Options are accessed by touching the **Display** key at the bottom of the touch screen. The keys shown in the figure to the right are displayed.



A brief description of the function of each key is provided in the table below.

Key Name	Description
SEGMENTS 	Accesses the experimental method that is currently being used for this experiment.
INFORMATION 	Displays instrument information such as the software version, options, and the IP address.
STATUS 	Displays the three main signals indicating the current status of the experiment.
SIGNALS 	Displays the real-time signal data that comes directly from the instrument. The signals displayed here are customized through the instrument control software by accessing **Tools/Instrument Preferences**.
PLOT 	Displays a time-based plot of data as it is received from the instrument during experiments.
SCREEN SAVER 	Allows you to choose a screen saver for the touch screen.
HOME 	Returns to the opening window.

QNX/Platinum™ Calibration Options

The Calibration Options are accessed by touching the **Calibrate** key at the bottom of the touch screen. The keys shown in the figure below are displayed. A brief description of the function of each key is provided in the table below.



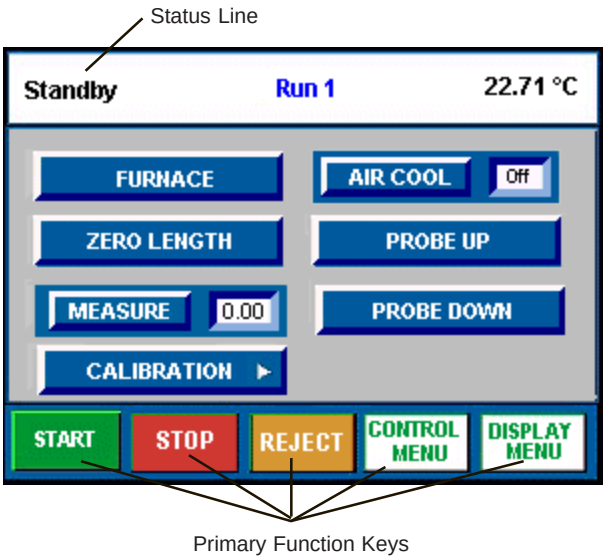
Key Name	Description
TOUCH SCREEN 	Allows you to calibrate the touch screen display.
PROBE 	This procedure, sometimes called "initializing," is used to calibrate zero force, the LVDT, and the probe's compliance. It corrects for any difference in the different probes used on the TMA and should be done every time you change a probe on the TMA.
FORCE 	Force calibration calibrates the force exerted by the probe on the sample during experiments using three different mass values (0, 50, and 100 grams) and can be performed with any probe in place on the instrument. The first calibration point is 0 grams. You may use weights other than the recommended 50 and 100 grams, if desired (up to 100 grams is allowed). For example, you can use 10 grams for force calibration if only low forces will be used in subsequent experiments. This calibration should be performed periodically (approximately once a month).

The TMA Touch Screen (Original)

The TMA Q400 instruments have a built-in integrated display and keypad in the form of a touch screen for local operator control. The functions shown on the screen change depending upon the menu you are using. This section briefly describes the functions of the keys shown on the touch screen displays.

The *status line* along the top of the display (see the figure to the right) shows the current instrument status, current run number, and temperature.

At the bottom of the screen is a set of five keys that are used for the primary instrument functions. These keys are available to you regardless of the menu selected. See the next section for an explanation of the *primary function keys*.



NOTE: Experiment information and instrument constants are entered from the controller keyboard, not the instrument touch screen.

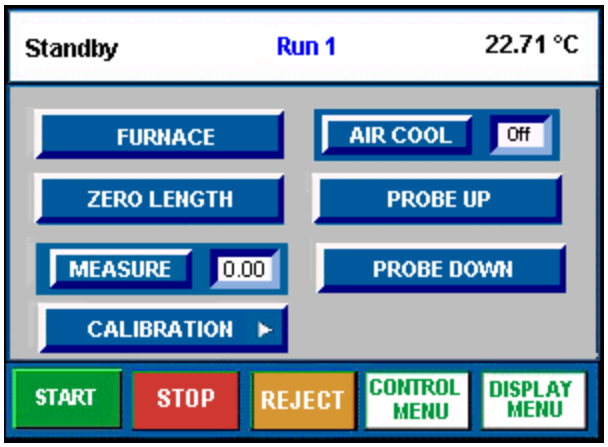
Primary Function Keys

This set of keys, found at the bottom of the touch screen, are used to perform the basic functions of the instrument and to access the two main screens. See the table below for details.

Key Name	Description
START	Begins the experiment. This is the same function as Start on the instrument control software.
STOP	If an experiment is running, this key ends the method normally, as though it had run to completion; *i.e.*, the method-end conditions go into effect and the data that has been generated is saved. This is the same function as Stop on the instrument control software. If an experiment is not running (the instrument is in a standby or method-end state), the Stop key will halt any activity (air cool, all mechanical motion, *etc.*).
REJECT	If an experiment is running, REJECT ends the method. The the method-end conditions go into effect just as if the method had run to completion. However, the data that has been generated is *discarded*. This is the same function as Reject on the instrument control software.
CONTROL MENU	Displays the Control Menu touch screen keys. These are used to control certain instrument actions.
DISPLAY MENU	Accesses the Display Menu screen, which is used to select the desired display option.

TMA Control Menu Keys

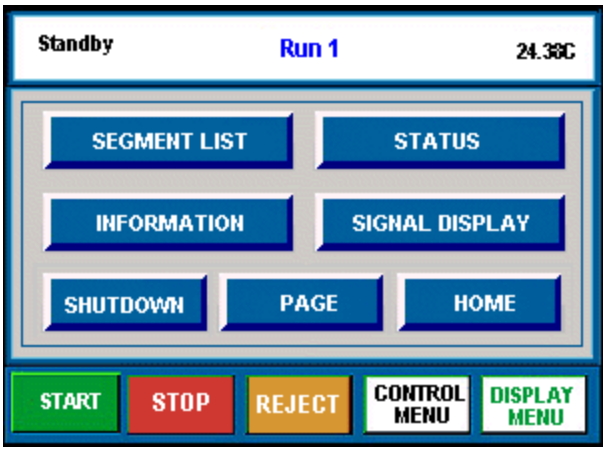
The Control Menu is accessed by touching the Control Menu key at the bottom of the touch screen. The keys shown in the figure here are displayed. A brief description of the function of each key is provided in the table below. The available keys will vary based on the selected coolers and installed accessories.



Key Name	Description
FURNACE	Toggles between raising and lowering the furnace, depending on the state of the furnace when you press the key.
ZERO LENGTH	Initializes the automeasure system. This operation should be performed before a sample is loaded and any time the probe or stage is changed.
MEASURE 0.00	Measures your sample's length automatically; use this key before beginning the run. The measured length is transferred to the instrument control software and the value is recorded in the Sample Size field.
CALIBRATION ▶	Used to advance to the Calibration touch screen, which allows you to select from either Probe Calibration or Force Calibration. Follow the instructions displayed on the screen to perform these calibration procedures.
AIR COOL Off	Toggles the air cool function on or off. This is the same function as Air Cool on the instrument control software.
PROBE UP	Used to "open" the probe, this key raises the probe 3 mm, the range of the LVDT, when pressed one time. When the key is pressed a second time, mechanical action occurs, moving the probe and LVDT coil to their maximum upward position. If the probe is moving down and PROBE UP is pushed, the probe will stop and reverse its direction.
PROBE DOWN	Used to "close" the probe, this key lowers the probe 3 mm, the range of the LVDT, when pressed one time. When the key is pressed a second time, mechanical action occurs, centering the LVDT coil. If the probe is moving up and PROBE DOWN is pushed, the probe will stop and reverse its direction.

Display Menu Keys

The Display Menu is accessed by touching the DISPLAY MENU key at the bottom of the touch screen. The menu shown in the figure here will be displayed. A brief description of the function of each key is provided in the table below.



Key Name	Description
SEGMENT LIST	Accesses the experimental procedure that is currently being used and highlights the active segment.
STATUS	Displays the three main signals indicating the current status of the experiment.
INFORMATION	Displays instrument information such as the software version, options, and the IP (Internet Protocol) address.
SIGNAL DISPLAY	Displays the real-time signal data that comes directly from the instrument. The signals displayed here are customized through the instrument control software.
SHUTDOWN	Ensures proper shutdown of the instrument before turning off the power.
PAGE	Beeps the controller that is connected to the instrument.
HOME	Returns to the opening window.

Options and Accessories

Several optional probes and a cooling accessory are available from TA Instruments to be used with the TMA. A brief description of each one follows. For more information refer to the online documentation.

Probes

- **Film/Fiber Probe**: The TMA film/fiber accessory can be used to measure the physical properties of *fibers or films* as a function of force, temperature, or time.
- **Flexure Accessory**: The Flexure Accessory can be used on the TMA for *three-point bending studies* to measure the flexibility and strength of a variety of materials, such as composites, plastics, and PC boards. It employs a knife-edged probe and either of two types of fixtures, quartz or low-friction aluminum, depending upon the type of experiment desired.
- **Dilatometer Accessory**: The dilatometer accessory kit can be used to determine the volume coefficient of expansion.
- **Parallel Plate Rheometer Accessory**: The parallel plate rheometer accessory can be used to obtain viscosity-temperature or viscosity-time data on substances at low shear rates, over the range of 10 to 10^7 Pa-sec (1 to 10^6 Poise).
- **Hemispherical Probe**: The hemispherical probe is used with the standard quartz stage to obtain softening point data on substances. It is installed, operated, and calibrated using the same procedures as for the standard expansion and penetration probes.

Mechanical Cooling Accessory

The Mechanical Cooling Accessory (MCA) is designed to provide you with a source of continuous cooling for the TMA, while eliminating the need for liquid nitrogen or dry ice. It is a portable, freestanding refrigeration system that can be placed on the floor under a lab bench to conserve counter space. The MCA has a two-stage compressor system that operates in a cascade fashion (first one compressor turns on, then the other compressor joins in). Refrigerant is carried from the unit through an insulated coaxial hose to the cooling head.



When using the MCA it is important to select **Tools/Instrument Preferences/TMA Page** and check the box "MCA attached" to avoid damage to the system.

Instrument Specifications

The tables found on the following pages contain the technical specifications for the TMA.

TMA Instrument Characteristics

Dimensions Furnace Open Furnace Closed	Depth 55.9 cm (22 in.) Width 45.5 cm (18 in.) Height 64.8 cm (25.5 in.) Height 61 cm (24 in.)
Weight (approx.) Weight with Transformer	31.4 kg (69 lb) 39.5 kg (87 lbs)
Power	120 Vac, 47–63 Hz, 1.44 kVA standard 230 Vac, 47–63 Hz, 1.44 kVA if configured with a step-down transformer
Accessory Outlets	Power: 120 V, 47–63 Hz, 400 VA each (used with TA accessories only)
Operating Environment Conditions	Temperature: 15–30 °C Relative Humidity: 5–80 % (non-condensing) Installation Category II Pollution Degree 2 Maximum Altitude: 2000 m
Temperature Range	–150 to 1000°C
Sample Height Sample Thickness for Film/Fiber	25 mm (1 inch) maximum 0.5 mm maximum
Sample Diameter	10 mm (0.39 in) maximum
Sensitivity	15 nanometers
Displacement Range	±2.5 mm (±0.10 inch)
Linearity	±0.5 %
Loading	0.001 to 1.0 Newtons (102 g)
Purge gases	Calibrated for: air, argon, helium, nitrogen, or oxygen
Typical purge flow rate	100 ml/min (-100 °C and above) or 200 ml/min (-150 °C and above).
Programmed Heating Rate	0.01 to 200 °C/min
Temperature Reproducibility	±2 °C

Chapter 2
Installing the TMA

Unpacking/Repacking the TMA

The instructions needed to unpack and repack the instrument are found as separate unpacking instructions in the shipping box and in the online documentation associated with the instrument control software. You may wish to retain all of the shipping hardware, the plywood, and boxes from the instrument in the event you wish to repack and ship your instrument.



WARNING: Have an assistant help you unpack this unit. Do not attempt to do this alone.

Installing the Instrument

Before shipment, the TMA instrument is inspected both electrically and mechanically so that it is ready for operation upon proper installation. Only limited instructions are given in this manual, consult the online documentation for additional information. Installation involves the following procedures:

- Inspecting the system for shipping damage and missing parts
- Installing a voltage configuration unit.
- Connecting the TMA to the TA Instruments controller
- Connecting cables and gas lines.

It is recommended that you have your TMA installed by a TA Instruments Service Representative, call for an installation appointment when you receive your instrument.



CAUTION: To avoid mistakes, read this entire chapter before you begin installation.

NOTE: If you plan to ship your TMA by commercial carrier, you will need to remove the voltage configuration unit first. Please refer to the online help accessed through the Help menu for detailed instructions on transporting the TMA.

Inspecting the System

When you receive your TMA, look over the instrument and shipping container carefully for signs of shipping damage, and check the parts received against the enclosed shipping list.

- If the instrument is damaged, notify the carrier and TA Instruments immediately.
- If the instrument is intact but parts are missing, contact TA Instruments.

Choosing a Location

Because of the sensitivity of TMA experiments, it is important to choose a location for the instrument using the following guidelines. The TMA should be:

In ... a temperature-controlled area.
... a clean, vibration-free environment.
... an area with ample working and ventilation space.

On ... a stable work surface.

NOTE: Placing the TMA on a stable, vibration-free work surface is very important to instrument performance.

Near ... a power outlet (120 Vac, 50 or 60 Hz, 15 amps, or 230 Vac, 50 or 60 Hz, 10 amps if configured with a step down transformer).
...your TA Instruments thermal analysis controller.
...sources of compressed lab air and purge gas supplies with suitable regulators.



CAUTION: Your air source must be clean, dry, and oil-free to ensure proper operation of the TMA.

Away from ... any flammable materials.
... dusty environments.
... exposure to direct sunlight.
... direct air drafts (fans, room air ducts).
... poorly ventilated areas.
... noisy or mechanical vibrations.



CAUTION: Drying out the instrument may be needed, if it has been exposed to humid conditions. Certain ceramic materials used in this equipment may absorb moisture, causing leakage currents to exceed those specified in the applicable standards until moisture is eliminated. It is important to be certain that the instrument ground is adequately connected to the facilities ground for safe operation.

Run the following method to dry out the TMA:
1 Ramp at 10°C/min to 400°C
2 Isothermal for 30 min.

Voltage Configuration Unit

A voltage configuration/safety isolation unit is required for 230 Vac or 120 Vac. It is shipped in a separate container from the instrument. Obtain the unit and follow these steps to install it in the Power Control Unit (PCU):

WARNING: High voltages are present in this instrument as indicated by the label.

Be sure to unplug the instrument before performing these instructions. See the WARNING on page 8.

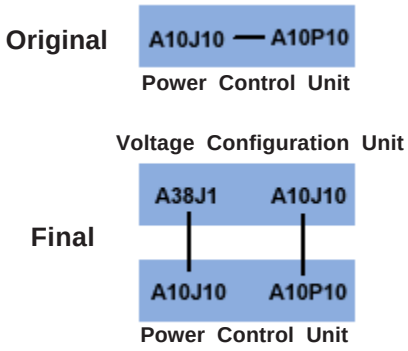
WARNING: Use of the voltage configuration/safety isolation unit is required to protect against hazardous leakage current from the furnace assembly.

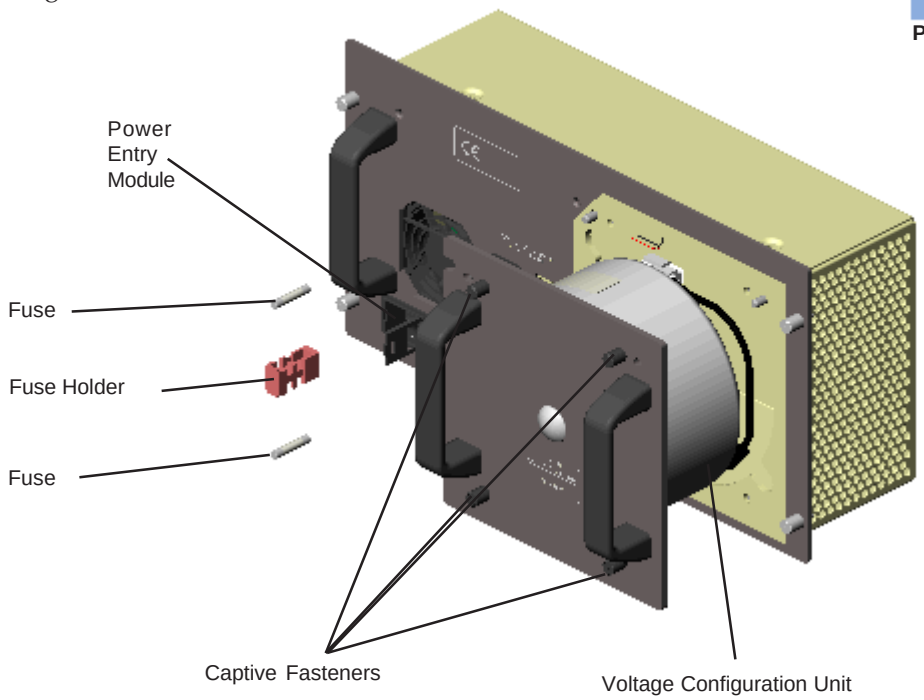
1. Disconnect the A10J10 connector from A10P10 located inside the PCU. Now connect the A10J10 connector on the voltage configuration unit to A10P10 located inside the PCU.

2. Connect A10J10 located inside the PCU to A38J1 on the anti-surge subassembly. See the diagram to the right.

3. Install the subassembly into the PCU and tighten the four (4) captive fasteners to secure it.

4. *For 230 Vac only:* Remove the fuse holder from the power entry module and replace the 10 amp fuses with 6.3 amp fuses, which are supplied in the voltage configuration kit. Discard the 10 amp fuses. See the figure below.





Replace Fuses for 230 Vac Only

Connecting Cables and Lines

To connect the cables and gas lines, you will need access to the TMA instrument's rear panel. All directional descriptions are written on the assumption that you are facing the back of the instrument.

NOTE: Connect all cables before connecting the power cords to outlets. Tighten the thumb-screws on all computer cables.

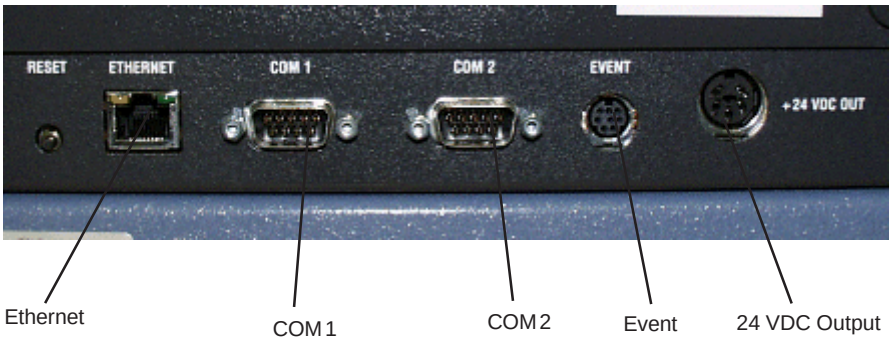
CAUTION: Whenever plugging or unplugging power cords, handle them by the plugs, not by the cords.

WARNING: Protect power and communications cable paths. Do not create tripping hazards by laying the cables across accessways.

WARNING: DO NOT position the instrument so that it is difficult to turn off the power switch or to unplug the power cord.

Ports

The TMA has nine ports that are located on the back of the instrument. The following table provides a description of function of each port. Refer to this list when connecting cables and lines.

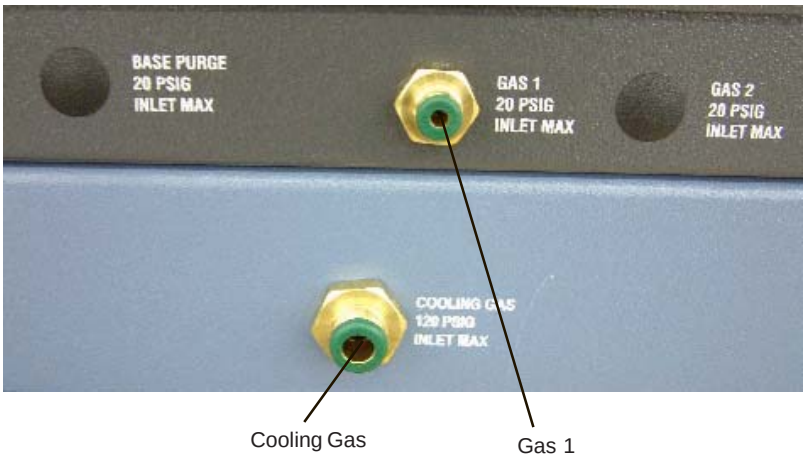


Five Ports on Left Rear of TMA

Port	Function
Ethernet	Provides communication capabilities.
Com 1	Diagnostic port (factory use only).
Com 2	Accessory port.
Event	Capable of the following functions: general purpose relay contact closure, or general purpose input 4 – 24 Vdc for external syncing. This port is not used for standard operation.
24 VDC output	This port is not used with the TMA.

(table continued)

Port	Function
Base Purge	This port is not used with the TMA.
Gas 1	Gas inlet port controlled by the Mass Flow Controller. Used for the sample purge gas.
Gas 2	This port is not used with the TMA.
Cooling Gas	Provides the furnace with air for cooling (830 kPa gauge [120 psig] maximum pressure).



Ports on the Back of the TMA Q400

Purge Line

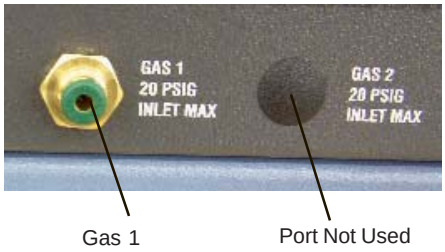
You can control the sample atmosphere during experiments by connecting a purge gas to the system. The TMA is equipped with a mass flow controller (MFC) to control the flow rate of the gas. Follow these instructions to connect the purge line. Refer to the figure below to locate the purge lines.

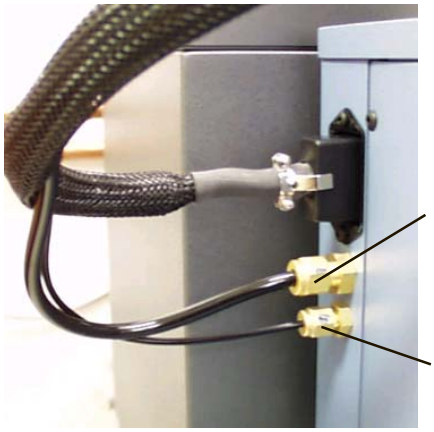
CAUTION: Do not use any liquid in the purge lines. Use of corrosive gases will shorten the life of the instrument.

WARNING: Use of an explosive gas as a purge gas is dangerous and is not recommended for the TMA instrument. See Chapter 1 for a list of recommended purge gases.

1. Locate the Gas 1 port; this port is used to purge the sample area.

2. Connect the primary gas line to the Gas 1 port using 1/8-inch O.D. tubing. Teflon® TFE tubing is recommended and is supplied in the instrument shipping accessory kit. The flow rate is controlled through the Mass Flow Controller settings chosen using the instrument control software.





The purge gas flows through the instrument and is channeled internally to the sample purge line shown in the figure to the left.

3. Make sure that the pressure of your purge gas source is regulated between 100 and 140 kPa gauge (15 and 20 psig).

Connecting the Cooling Gas Line

Air cooling is used to cool the TMA furnace to room temperature.

Follow the procedure below to install the cooling gas line for air cool:

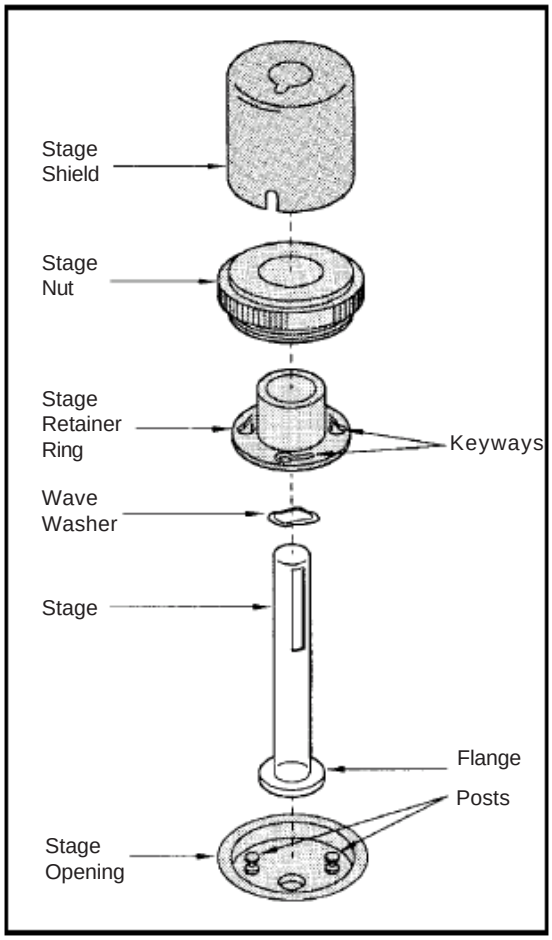
1. Locate the Cooling Gas fitting, a 1/4-inch Legris fitting on the right side of the TMA cabinet back, marked with an 830 kPa gauge (120 psig) maximum warning label (see the figure to the right).

2. Make sure your compressed air source is dry, filtered, and regulated to between 170 and 830 kPa gauge (25 and 120 psig).

3. Connect the compressed air line to the Cooling Gas fitting.



Installing the Stage

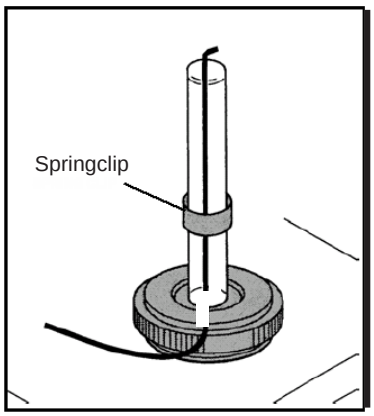


To install the stage on the TMA, check to make sure the furnace is raised and off to the side. Then follow these steps (refer to the figure here for illustration of the parts):

1. Remove the stage shield by lifting it straight up. (This is a friction fit.)
2. Turn the large stage nut counterclockwise to remove it.
3. Twist the stage retainer ring (with key slots) counter-clockwise, and pull it up off the three posts.
4. Remove the stage from the accessory kit.
5. Slide the wave washer (washer with rippled edges) down over the top of the stage so that it fits on the flange.
6. Slide the stage retainer ring down over the top of the stage so that it rests on top of the wave washer.
7. Insert the whole assembly (stage, wave washer, and retainer ring) into the stage opening, aligning the key slots in the retainer ring with the posts.
8. Press down and turn the retainer ring clockwise to lock the assembly in position.
9. Replace the large stage nut, turning it clockwise to install it.
10. Attach the thermocouple to the stage as follows:

    a. Position the tip of the thermocouple so that it bends at a 90° angle and lies flat against the platform. It should be close to, but not touching the sample.

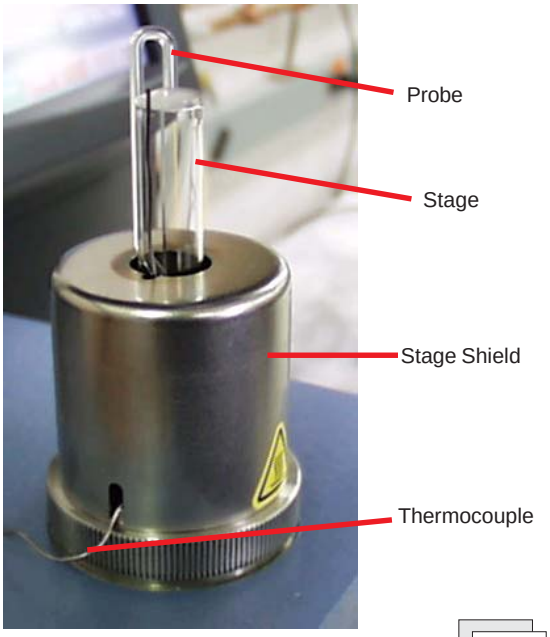
    b. Hold the thermocouple against the stage assembly, and put on the spring clip to keep the thermocouple in place (see the figure below).



11. Place the stage shield on the stage, aligning the slot in the bottom over the thermocouple (see the figure to the right).

12. Install one of the probes as directed in the next section. (Refer to Chapter 3 for guidelines to use when selecting a probe.)

13. Rotate the furnace into position over the stage.



Installing the Expansion/Penetration Probes

When you first receive the TMA, you will need to install a probe. Later, if a different sample form is used, you can change to the appropriate probe for the experiment. (Refer to Chapter 3 for details on probe selection.) The procedures that follow explain the installation and removal of the expansion, macro expansion, penetration, flexure, dilatometer, and hemispherical probes.

Installing a Probe

1. Raise the furnace and rotate it clockwise to move it off to the side.

2. Insert the core end of the probe carefully into the opening in the TMA stage.

3. Loosen the probe-locking lever, which is the knurled post found behind the weight tray door, by turning it counterclockwise. Hold the probe-locking lever in the up position and continue lowering the probe into the stage until you can feel it seat in the locking mechanism.

4. Tighten the probe-locking lever by turning it clockwise.

5. Calibrate the newly installed probe as directed in the online help found in the instrument control software.

Removing a Probe

1. Raise the furnace, and rotate it clockwise to move it off to the side.

2. Grasp the top of the probe with one hand. Using the other hand, locate and hold the probe-locking lever, found behind the door that covers the weight tray.

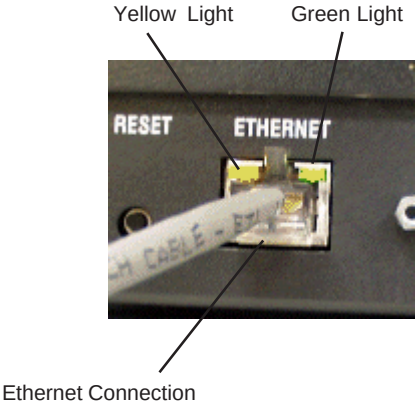
3. Unscrew the locking lever by turning it counterclockwise approximately one turn.

4. Raise the probe gently and twist slightly to aid its removal from the stage opening.

Ethernet Switch Setup

In order to connect the instrument to a network, you will need to make the necessary cable connections as described below. The instrument and controller will be connected to an Ethernet switch. In addition, there are instructions for connecting the controller to a LAN.

Connecting the Instrument to the Switch



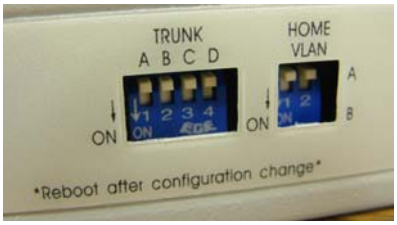
1. Locate the Ethernet port on the left rear of the instrument (shown in the figure to the right).

2. Connect one end of the Ethernet cable into the instrument's Ethernet port.

3. Connect the other end of the Ethernet cable to one of the network ports on the Ethernet switch (shown in the figure below).



Ethernet Switch



Configuration Switches

4. Check the configuration switches, located on the back panel. They must be set to off, or the up position, for the controller to communicate to the instruments.

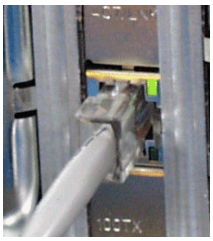
5. Check the Ethernet port on the rear of the instrument. If communication between the instrument and the switch has been properly established, a solid green light and flashing yellow light will appear at the port.

6. Follow the directions in the next section to connect the controller to the Ethernet switch.

Connecting the Controller to the Switch

1. Locate the Ethernet port on the back of the computer.

2. Plug one end of the Ethernet cable into the computer's Ethernet port (shown in the figure to the right).



Computer Ethernet Port

3. Connect the other end of the cable to one of the network ports on the switch.

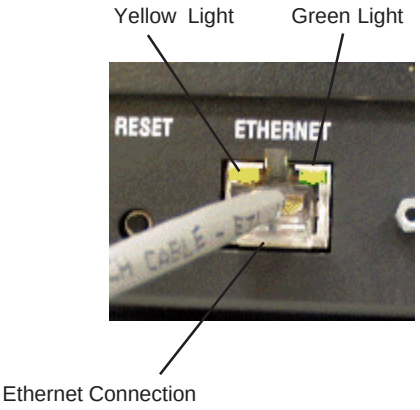
4. Check the Ethernet port on the rear of the computer. If communication between the computer and the switch has been properly established, a solid green light and flashing yellow light will appear at the port.

5. Follow the directions in the next section to connect the controller to a LAN for networking capabilities.

Connecting the Controller to a LAN

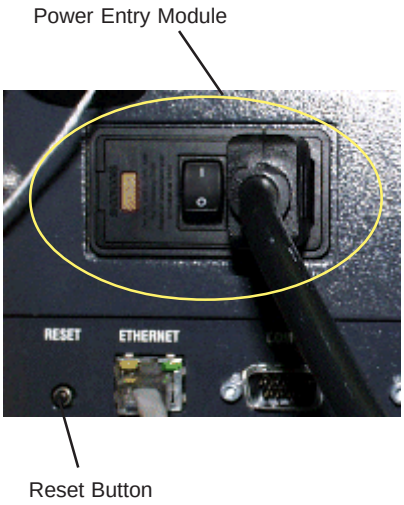
Before you can connect the controller to a LAN, you will need to have already installed a network interface card into the computer.

1. Locate the second Ethernet port on the back of the computer.
2. Plug one end of the Ethernet cable into the computer's Ethernet port.
3. Plug the other end into the LAN.
4. Check the Ethernet port on the rear of the computer. If communication between the computer and the LAN has been properly established, a solid green light and flashing yellow light will appear at the port.



Power Switch

The power switch is located at the rear of the instrument. It is part of the assembly called the *power entry module*, which also contains the power cable connection and fuses. The power switch is used to turn the instrument on and off.



Power Cable

NOTE: A <HAR>-marked (harmonized) power cable meeting the standards of the country of installation is required for the European Economic Area.

Install the power cable as follows:

1. Make sure the TMA POWER switch is in the Off (0) position.
2. Plug the power cable into the TMA power entry module.

CAUTION: Before plugging the TMA power cable into the wall outlet, make sure the instrument is compatible with the line voltage. Check the label on the voltage configuration unit panel to verify the voltage.

3. Plug the power cable into the wall outlet.

Starting the TMA

1. Check all connections between the TMA and the controller. Make sure each component is plugged into the correct connector.

2. Set the instrument power switch to the ON (1) position.

After the proper power up sequence, the TA Instruments logo will be displayed on the touch screen, this indicates that the instrument is ready for use.

NOTE: Allow the TMA to warm up for at least 30 minutes before performing an experiment.

Shutting Down the TMA

Before you decide to power down your instrument, consider the following:

- All of the components of your thermal analysis system are designed to be powered on for long periods.

- The electronics of the TMA and the controller perform more reliably if power fluctuations caused by turning units on and off are minimized.

For these reasons, turning the system and its components on and off frequently is discouraged. Therefore, when you finish running an experiment on your instrument and wish to use the thermal analysis system for some other task, it is recommended that you leave the instrument on.

To ensure proper shutdown of the instrument, it is recommended that you initiate the "Shutdown Instrument" function before turning off or resetting your instrument. This function is available on the instrument touch screen or through the Instrument Control software.

To power down your instrument set the power switch to the OFF (0) position.

Chapter 3
Use, Maintenance, & Diagnostics

Using the TMA

All of your TMA experiments will have the following general outline. In some cases, not all of these steps will be performed. The majority of these steps are performed using the instrument control software. The instructions needed to perform these actions can be found in the online help in the instrument control program; therefore, they will not all be covered in detail here.

- Calibrating the instrument
- Selecting, calibrating, and zeroing the probe
- Selecting the desired mode (standard or calibration) through the TA instrument control software
- Preparing and loading the sample
- Adjusting the thermocouple position and closing the furnace
- Creating or choosing the test procedure and entering sample and instrument information through the TA instrument control software
- Setting the purge gas flow rate
- Adding coolant to the furnace reservoir for subambient operation, if applicable
- Starting the experiment.

To obtain accurate results, follow procedures carefully.

Before You Begin

Before you set up an experiment, ensure that the TMA and the controller have been installed properly. Make sure you have:

- Made all necessary cable connections from the TMA to the computer
- Connected all gas lines
- Powered up the unit
- Connected any desired accessories
- Connected the instrument with the controller
- Become familiar with controller operations
- Calibrated the TMA, if necessary.

Calibrating the TMA

To obtain accurate experimental results, calibrate the TMA when you first install it. To keep your TMA working to the highest level of performance possible, you should calibrate periodically thereafter. A brief description of each calibration is outlined below. For details on how to perform that calibration, refer to the online help documentation accessed through the instrument control software.

Force Calibration

Force calibration calibrates the force exerted by the probe on the sample during experiments using three different mass values (0, 50, and 100 grams) and can be performed with any probe in place on the instrument. The first calibration point is 0 grams. You may use weights other than the recommended 50 and 100 grams, if desired (up to 100 grams is allowed). For example, you can use 10 grams for force calibration if only low forces will be used in subsequent experiments.

This calibration should be performed periodically (approximately once a month) and can be performed from the TA instrument control program or the instrument's touch screen.

> NOTE: A force calibration performs the functions of a probe calibration (see the next section). Therefore, it is not necessary to perform a probe calibration immediately following a force calibration.

Probe Calibration

This procedure, sometimes called "initializing," is used to calibrate zero force, the LVDT, and the probe's compliance. It corrects for any difference in the different probes used on the TMA and should be done every time you change a probe on the TMA. This calibration can be performed from the TA instrument control program or the instrument's touch screen.

Temperature Calibration

Temperature calibration is based on a run, conducted in the calibration mode, in which a temperature standard (*e.g.*, indium) is heated through its melting point. The recorded melting point of this standard is compared to the known melting point, and the difference is calculated for temperature calibration.

In addition, you can use up to four other standards to calibrate temperature. If you use one pair of known and observed points, the entire curve is offset, or shifted, to the actual melting point. If you use multiple standards, the temperature is corrected by a cubic spline fit between the points with fixed offset values beyond the calibration window. This can create a small discontinuity in the heating rate. The multiple-point temperature calibration is more accurate than the one-point calibration.

For all probe types except the film/fiber accessory, small flattened pieces of standard metals are placed on the stage. To protect the stage from amalgamation with the metal, it is recommended that aluminum or platinum be placed between the stage and the metal standard. The end of the probe can also be wrapped with foil for added protection.

For the film/fiber probe, metal wires can be crimped into the aluminum balls and used for calibration.

When to Calibrate:

The sample thermocouple should be calibrated in the following situations:

- When the TMA is first installed
- When the sample thermocouple is changed
- When the TMA is serviced or repaired
- Periodically (approximately once a month)
- If you are changing the temperature range of interest
- If the run data obtained seems to be inaccurate
- When the purge gas is changed.

Cell Constant

Cell constant calibration is based on a run conducted in the calibration mode in which a known standard (*e.g.*, aluminum or copper) is heated through its transition temperature and data is gathered for analysis. The cell constant is calculated by dividing the actual coefficient of expansion of the standard by the measured coefficient of expansion. The cell constant is then entered in the instrument control software for calibration of the instrument.

Using the default cell constant value of 1.000 is usually adequate; however, for greatest accuracy, calibration should be performed.

It is recommended that you follow the procedures of ASTM Standard Test Method E831 to perform the cell constant calibration.

Running a TMA Experiment

CAUTION: Drying out the instrument may be needed, if it has been exposed to humid conditions. Certain ceramic materials used in this equipment may absorb moisture, causing leakage currents to exceed those specified in the applicable standards until moisture is eliminated. It is important to be certain that the instrument ground is adequately connected to the facilities ground for safe operation.

Run the following method to dry out the TMA:

1 Ramp at 10°C/min to 400°C
2 Isothermal for 30 min.

All of your TMA experiments will follow the same general outline (see page 35). In some cases, not all of these steps will be performed. The following sections provide more information on these steps. See the instrument control software online help for anything not covered in this manual.

Selecting a Probe

The type of probe that you use is dependent upon the kind of testing information desired. The table below lists the probes available, their specifications, and the type of testing yielded.

When choosing a probe to use for an experiment, follow these steps:

1. Select and install the appropriate probe for the analysis desired. See the table on the next page for a brief description of the various probes available.

2. Perform a Probe Calibration for a newly installed probe or "zero" an already installed probe. (The zeroing instructions are found in the next section.)

TMA Probe Types

Probe Type	Contact Diameter mm (in.)	Pressure Exerted by 0.01 N Load	Types of Tests Yielded
Penetration	0.89 (0.035)	16 kPa	Softening point Melting point
Expansion	2.54 (0.100)	1.9 kPa	Expansion coefficient Compression modulus Tensile modulus Glass transition
Macro Expansion	6.07 (0.239)	0.34 kPa	Expansion coefficient Compression modulus Tensile modulus Glass transition
Film/Fiber	Not applicable	Not applicable	Tensile stress

(table continued)

Probe Type	Contact Diameter mm (in.)	Pressure Exerted by 0.01 N Load	Types of Tests Yielded
Flexure	5.08 (0.2)	0.49 kPa	Deflection temperature Flexibility
Dilatometer	6.07 (0.239)	0.34 kPa	Expansion coefficient
Parallel Plate	9.52 (0.375)	0.14 kPa	Viscosity-temperature Viscosity-time Wall shear rate
Hemispherical	~2.54 (0.1)	~1.9 kPa	Softening point

NOTE: Refer to online help for details regarding the probes.

Zeroing the Auto Measure System

This procedure is used to initialize the auto-length measure system. It should be performed before each experiment to ensure accurate sample length measurements. To zero the TMA auto measure system, simply press the ZERO LENGTH key on the touch screen.

Guidelines for Handling Samples

Sample Preparation

Sample preparation will vary based on the selected probe type. Guidelines for samples used for penetration and expansion studies are detailed below:

- They should be as flat as possible, with parallel ends, to ensure stable placement on the stage.
- Samples should be long enough (5 to 10 mm for most materials) for adequate resolution, keeping in mind that large samples may experience temperature gradients during high heating rates.
- Thermoplastic samples can be heated and formed into suitable specimens and then cooled; however, this process may change important thermal history.
- If you plan to run samples that may melt and adhere to the stage, it is best to use the quartz protective wafers under the sample. See the next section for information.

Sample Loading

After your sample has been prepared, follow these steps to load it on the TMA:

1. Raise the furnace and rotate it clockwise to move it off to the side.
2. Remove any previously run samples from the stage and ensure that no residue remains.

   NOTE: It is recommended that you place a quartz wafer or a piece of thin aluminum foil between the stage and any thermoplastic samples to prevent damage to the stage. See step 3.

3. *For samples that may melt and adhere to the stage:* Place the protective quartz wafer onto the stage and center it.
4. Access the Control Menu on the touch screen. Press ZERO LENGTH on the touch screen to provide a zero reference point.
5. Open (raise) the probe. (Press PROBE UP on the touch screen).
6. Place the sample on the stage under the probe tip (see the figure to the right).
7. Adjust the sample thermocouple, if needed. Regardless of the size or shape of the sample that you are running on the TMA, position the tip of the thermocouple so that it bends at a gentle 90° angle and lies flat against the platform. It should be close to, but not touching the sample (as shown here). Note that a sharp bend could damage the thermocouple.
8. Measure the sample length as follows: Before you begin the experiment, it is important to take an initial measurement of the sample. To do this, simply press the MEASURE key on the instrument touch screen. This automatically applies the preload force that you have specified through the instrument control program, then measures and stores the sample length.



Starting an Experiment

Before you start the experiment, ensure that the TMA is connected with the controller, the sample is loaded, the furnace is closed, and you have entered all necessary information through the instrument control software.

> NOTE: Once the experiment is started, operations are best performed at the computer keyboard. The TMA is very sensitive to motion and might pick up the vibration caused by touching a key on the instrument touch screen.

Stopping an Experiment

If for some reason you need to discontinue the experiment, you can stop it at any point by selecting **Stop** through the instrument control software or by pressing the STOP key on the touch screen.

Another function that stops the experiment is REJECT. However, the Reject function discards all of the data from the experiment while the Stop function saves any data collected up to the point at which the experiment was stopped.

Maintaining the Instrument

The primary maintenance procedures described in this section are the customer's responsibility. Any further maintenance should be performed by a representative of TA Instruments or other qualified service personnel. Consult the online documentation installed with the instrument control software for further information.

WARNING: Because of the high voltages in this instrument, untrained personnel must not attempt to test or repair any electrical circuits.

CAUTION: Before using any cleaning or decontamination method except those recommended by TA Instruments in this chapter, please check with TA Instruments to make sure that the proposed method will not damage the equipment.

Cleaning the Touch Screen

You can clean the TMA touch screen as often as you like. The touch screen should be cleaned with a household liquid glass cleaner and soft cloth. Wet the cloth, not the touch screen with the glass cleaner, and then wipe off the touch screen and surrounding surfaces.

WARNING: Do not use harsh chemicals, abrasive cleansers, steel wool, or any rough materials to clean the touch screen as you may scratch the surface and degrade its properties.

Cleaning the Probe Assembly

After each experiment, check the probe assembly. If the probe is dirty, remove it using the procedures found in Chapter 2 and the online help, then clean the probe as follows:

1. Use contact cleaner or acetone applied with a soft brush or cloth to clean the LVDT core and the upper probe.

2. Heat the end of the quartz probe with a Bunsen burner until the residue evaporates and the probe is clean. Heat the probe very slowly if the sample contains a large amount of glass or mineral filler.

NOTE: Probes may also be cleaned in a nitric acid solution.

Cleaning the Stage

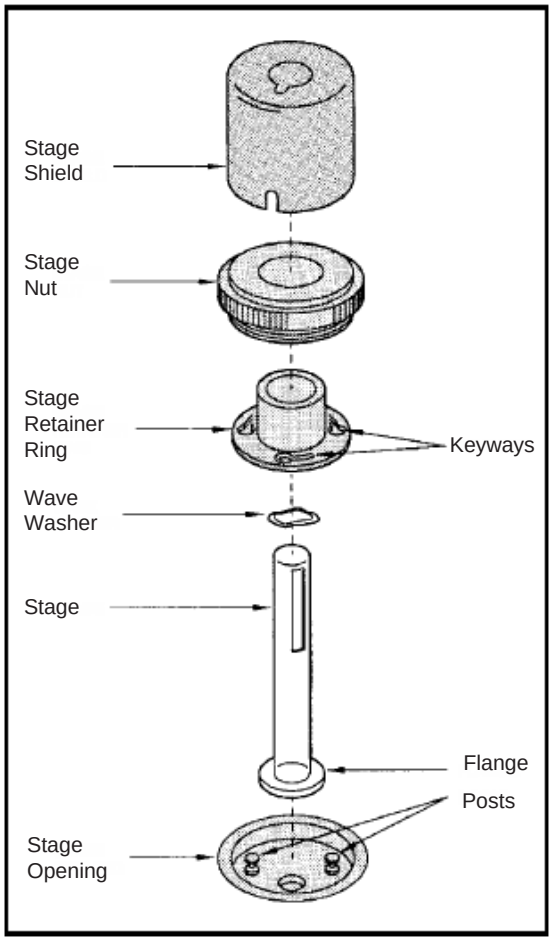
Dirt or sample residue left on the top of the stage may interfere with the next sample placed on the stage. To maintain proper experimental conditions, clean the stage as follows:

For small amounts of residue:

1. Use industrial cleaner or acetone on a soft cloth to wipe the top of the stage.

For thorough cleaning:

Refer to the figure to the right when needed.



1. Raise the furnace, and rotate it clockwise to move it off to the side.
2. Remove the stage shield by lifting it straight up. (This is a friction fit.)
3. Take off the spring clip that holds the sample thermocouple, and move the thermocouple off to the side of the stage.
4. Turn the stage nut counterclockwise to remove it.
5. Twist the stage retainer ring (with key slots) counterclockwise, pull it up off the posts, and slide it up off the stage.
6. Take the wave washer up off the stage flange, and remove it.
7. Remove the stage from the stage opening.
8. Use industrial cleaner or acetone applied with a soft brush or cloth to clean the stage surface.
9. Heat the stage surface with a Bunsen burner until the residue evaporates and the stage is clean. Heat the stage very slowly if the sample contains a large amount of mineral or glass filler.

   The stage may also be cleaned in a nitric acid solution.
10. Reassemble the stage, stage shield, etc. by reversing steps 6 through 2.

Cleaning the Thermocouple

Sample residue and dirt may interfere with the accuracy of the thermocouple readings. To clean the thermocouple:

1. Raise the furnace and rotate it clockwise to move it off to the side.
2. Remove the stage shield by lifting it straight up. (This is a friction fit.)
3. Remove the spring clip holding the thermocouple in place.
4. Hold the thermocouple away from the probe assembly, and clean it gently with a low flame using a hand-held burner.
5. Reposition the thermocouple so that the tip of the thermocouple bends at a gentle 90° angle and lies flat against the platform. It should be close to, but not touching the sample as seen in the figure here. Note that a sharp bend could damage the thermocouple.
6. Replace the spring clip to hold the thermocouple in place.
7. Replace the stage shield.



Replacements

Occasionally, you may need to replace a broken or worn-out part of the TMA. Any replacements needed, other than those discussed in this manual, must be supplied and installed by qualified TA Instruments service personnel. Call (302) 427-4050 for service.

Replacing the Thermocouple

You may find that the need arises for a new thermocouple (PN 944344.902) as a result of normal wear and tear, accidental breakage, contamination of the thermocouple, etc.

Removing the Existing Thermocouple

To remove the thermocouple, you will need to perform the following steps:

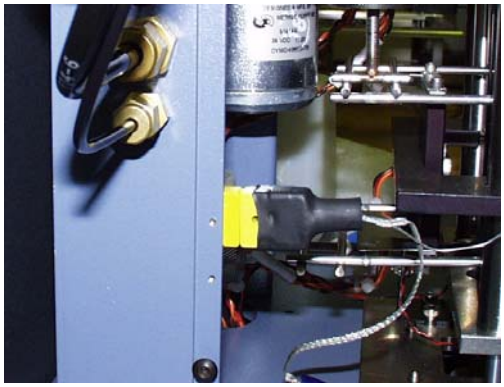
WARNING: Whenever you remove the balance enclosure, make sure that the power is off and the instrument is unplugged.

1. Raise the furnace and rotate it clockwise to move it off to the side.
2. Remove the stage shield by lifting it straight up. (This is a friction fit.)
3. Remove the spring clip holding the thermocouple in place.
4. Obtain the hex wrench from the accessory kit and remove the screws, two on each side that hold the balance enclosure in place.
5. Slide the balance enclosure out and remove it.
6. Thread the thermocouple carefully down through the opening in the platform, and unplug it.

Installing a New Thermocouple

Replace the sample thermocouple, following the remainder of the instructions.

1. Insert the two-pin thermocouple connector into the fitting as shown in the figure to the right.
2. Carefully route the thermocouple through the guide to prevent interference with the balance mechanism. (See the yellow lined route in the figure on the next page.) A service loop is recommended to take up excess length.
3. Carefully thread the thermocouple, tip first, up through the hole in the top of the balance enclosure.



Plugging in the TMA Thermocouple

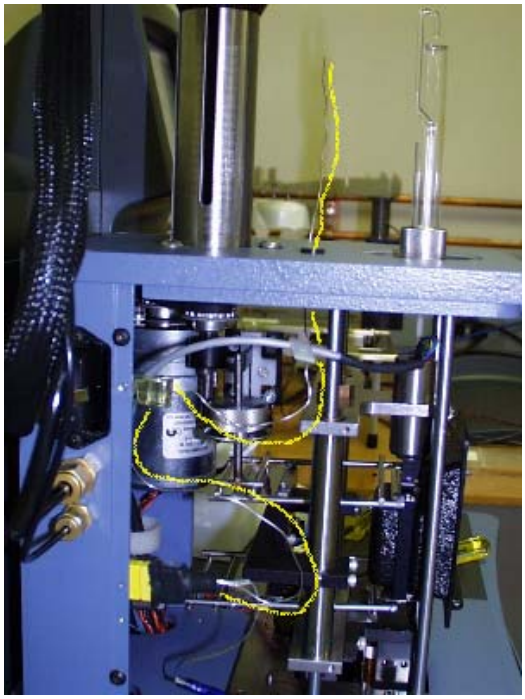
4. Slide the balance enclosure into position.

5. Replace the screws, two on each side, that hold the balance enclosure in place.

6. Reposition the thermocouple so that the tip of the thermocouple bends at a 90° angle and lies flat against the sample platform. It should be close to, but not touching the sample.

7. Replace the spring clip to hold the thermocouple in place.

8. Place the stage shield on the stage, aligning the slot in the bottom over the thermocouple wire.



Threading the Thermocouple

Replacing Fuses

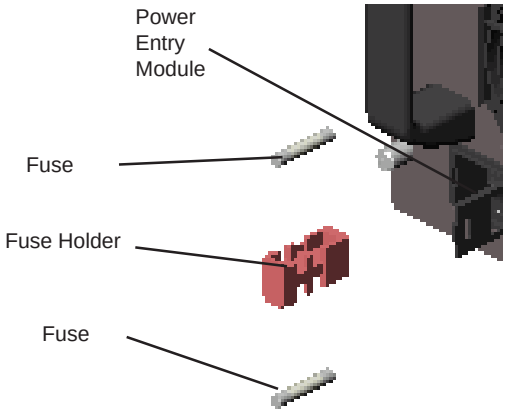
WARNING: Always unplug the instrument before you examine or replace the fuses.

Replacing the TMA Fuses

The TMA contains internal fuses that are not user serviceable. If any of the internal fuses blows, a hazard may exist. Call your TA Instruments service representative.

The only fuses that you can replace yourself are the fuses located in the power entry module located at the rear of the instrument. To check or change these fuses:

1. Turn the instrument off and remove the power cord.
2. Insert a small screwdriver at the edge of the power entry module door and pry it open.
3. Insert the screwdriver on the edge of the fuse holder to pull it out of the instrument.
4. Remove old fuses and replace the fuses only with the type and rating indicated on the instrument's rear panel.
5. Place fuse holder back into opening and push the door shut.



Replacement Parts

Replacement parts for the TMA that are available from TA Instruments. See the table below when ordering parts.

Part Number	Description
944200.901	**Standard TMA Accessory Kit consisting of:**
944122.901	Expansion Probe Assembly
944126.901	Penetration Probe Assembly
944123.901	Macro-Expansion Probe Assembly
944120.901	Sample Stage
900902.901	Indium Calibration Standard
940070.000	Aluminum Calibration Standard
942057.000	Teflon® Demonstration Sample
259537.000	Forceps
259522.000	Set Weights
203947.005	3/32 Hex Wrench
269792.001	Wave Washers
944205.001	Thermocouple Retainer
	Optional Accessory Kits
944201.901	**Film/Fiber Accessory Kit consisting of:**
944121.901	Film/Fiber Sample Stage
944128.901	Film/Fiber Probe Assembly
941038.901	Vial Cleaved Aluminum Balls
944047.901	Film Clamp Assemblies
944144.001	Film Clamp Fixture
269789.001	Jeweler's Screwdriver (0.080 inch)
269793.001	Film Clamp Screws (#0 - 80)
944014.001	Automeasure Gauge
944202.901	**Dilatometer Accessory Kit consisting of:**
944124.901	Dilatometer Probe Assembly
941143.000	Dilatometer Sample Vials
941148.901	Vials Filling Medium
941022.901	Vial Aluminum Calibration Standards
944203.901	**Flexure Accessory Kit consisting of:**
944127.901	Flexure Probe Assembly
941054.000	Flexure Sample Platform

(table continued)

Part Number	Description
944203.902	**TMA Q400 EM Accessory Kit consisting of:**
944127.901	Flexure Probe Assembly
941054.000	Flexure Sample Platform
945045.901	3-Point Bend Calibration Jig
944204.901	**Parallel Plate Rheometer Accessory Kit consisting of:**
943125.000	Rheometer Alignment Cages
943126.000	Rheometer Parallel Plates
900902.901	Indium Sample Kit
943121.000	Pellet Press Base Screw
943122.000	Pellet Press Cylinder head
943123.000	Pellet Press Piston
943124.000	Pellet Press Cylinder
944125.901	Hemispherical Probe Assembly
945025.901	Heater Assembly for use with the TMA Q400
205221.001	6.3 A Fuse
205221.002	10 A Fuse
944341.901	Protective Quartz Wafers for the TMA Stage
944073.001	Washer disc silicon
944072.001	Reservoir mass aluminum

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