DISCOVERY DMA 850
DYNAMIC MECHANICAL ANALYZER

Getting Started Guide

Revision A Issued November 2017

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Introduction

Important: TA Instruments Manual Supplement

Please click the TA Manual Supplement link to access the following important information supplemental to this Getting Started Guide:

- TA Instruments Trademarks
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Notes, Cautions, and Warnings

This manual uses NOTES, CAUTIONS, and WARNINGS to emphasize important and critical instructions. In the body of the manual these may be found in the shaded box on the outside of the page.

NOTE: A NOTE highlights important information about equipment or procedures.

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

UNE MISE EN GARDE met l'accent sur une procédure susceptible d'endommager l'équipement ou de causer la perte des données si elle n'est pas correctement suivie.

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

Un AVERTISSEMENT indique une procédure qui peut être dangereuse pour l'opérateur ou l'environnement si elle n'est pas correctement suivie.

Regulatory Compliance

Safety Standards

For Canada

CAN/CSA-C22.2 No. 61010-1-12 Safety requirements for electrical equipment for measurement, control, and laboratory use, Part 1: General Requirements.

CAN/CSA-C22.2 No. 61010-2-010-15 Particular requirements for laboratory equipment for the heating of materials.

For European Economic Area

(In accordance with Council Directive 2014/35/EU of the European Parliament and of the Council of 26 February 2014 on the harmonization of the laws of the Member States relating to the making available on the market of electrical equipment designed for use within certain voltage limits.)

EN 61010-1:2010 Safety requirements for electrical equipment for measurement, control, and laboratory use, Part 1: General Requirements.

EN 61010-2-010:2014 Particular requirements for laboratory equipment for the heating of materials.

For United States

UL61010-1:2015 Electrical Equipment for Laboratory Use; Part 1: General Requirements.

UL61010A-2-010:2015 Particular requirements for laboratory equipment for the heating of materials.

Electromagnetic Compatibility Standards

For Canada

ICES-001 Issue 4 June 2006 Interference-Causing Equipment Standard: Industrial, Scientific, and Medical Radio Frequency Generators.

For the European Economic Area

(In accordance with Council Directive 2014/30/EU of the European Parliament and of the Council of 26 February 2014 on the harmonization of the laws of the Member States relating to electromagnetic compatibility.)

EN61326-1:2013 Electrical equipment for measurement, control, and laboratory use-EMC requirements-Part 1: General Requirements.

For the United States

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

CAUTION: This equipment is not intended for use in residential environments and may not provide adequate protection to radio reception in such environments.

MISE EN GARDE: Cet équipement n'est pas destiné à être utilisé dans des environnements résidentiels et peut ne pas fournir une protection adéquate à la réception radio dans de tels environnements.

Safety

WARNING: 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.

AVERTISSEMENT: L'utilisateur de cet instrument est prévenu qu'en cas d'utilisation contraire aux indications du manuel, la protection offerte par l'équipement peut être altérée.

Instrument Symbols

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

Symbol	Explanation
	This symbol indicates that you should read this Getting Started Guide for important safety information. This guide contains important warnings and cautions related to the installation, operation, and safety of the DMA 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. Ce symbole indique que vous devez lire entièrement ce guide de démarrage pour obtenir d'importantes informations relatives à sécurité. Ce guide contient d'importants avertissements et mises en garde relatifs à l'installation, à l'utilisation et à la sécurité du système DMA. Si vous n'êtes pas formé aux procédures électriques, ne déposez pas les couvercles de l'armoire sauf indications spécifiques contenues dans le manuel. La maintenance et la réparation des pièces internes doivent être effectuées uniquement par TA Instruments ou tout autre personnel d'entretien qualifié.
	This symbol indicates that a hot surface may be present. Take care not to touch this area or allow any material that may melt or burn come in contact with this hot surface. Ce symbole indique la présence possible d'une surface chaude. Prenez soin de ne pas toucher cette zone ou de laisser un matériau susceptible de fondre ou de brûler entrer en contact avec cette surface chaude.

Please heed the warning labels and take the necessary precautions when dealing with those parts of the instrument. The *Discovery DMA 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.

AVERTISSEMENT: Présence de tensions élevées dans cet instrument. La maintenance et la réparation des pièces internes doivent être effectuées uniquement par TA Instruments ou tout autre personnel d'entretien qualifié

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 27 for the method of drying out the equipment before use.

AVERTISSEMENT: Après le transport ou l'entreposage dans des conditions humides, il est possible que cet équipement ne réponde pas à certains aspects des exigences de sécurité relatives aux normes de sécurité indiquées. Reportez-vous à la MISE ENGARDE à la page 27 pour connaître la méthode de séchage de l'équipement avant de l'utiliser.

Handling Liquid Nitrogen

The DMA uses liquid nitrogen as a source of cold gas in the Gas Cooling Accessory (GCA). 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.

AVERTISSEMENT: L'azote liquide bout rapidement lorsqu'il est exposé à la température ambiante. Assurez-vous que les zones où l'azote liquide est utilisé sont bien aérées pour éviter le déplacement de l'oxygène dans l'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.

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

WARNING:
Potential Asphyxiant

Liquid nitrogen can cause rapid suffocation without warning.

Store and use in an area with adequate ventilation.

Do not vent the Gas Cooling Accessory (GCA) in confined spaces.

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

AVERTISSEMENT:
Asphyxiant Potentiel

L'azote liquide peut provoquer un étouffement rapide sans prévenir.

Entreposez-le et utilisez-le dans une zone bien aérée.

N'aérez pas le GCA dans des espaces confinés.

N'entrez pas dans des espaces confinés où l'azote gazeux peut être présent à moins que la zone soit bien aérée.

Thermal Safety

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

WARNING: Allow the clamp to return to room temperature before touching the clamp. Take the proper precautions when removing a hot sample or retorquing a sample.

AVERTISSEMENT: Laissez la bride de serrage revenir à la température ambiante avant de toucher la lampe. Prenez les mesures de précautions appropriées lors du retrait d'un échantillon chaud ou le resserrage d'un échantillon.

WARNING: Do not put your hands inside the furnace. It may be hot enough to cause burns.

AVERTISSEMENT: Ne mettez pas vos mains à l'intérieur du four. Il peut être assez chaud pour causer des brûlures.

Air Pressure Warning

WARNING: The compressed air required to operate the instrument, which is either a house air supply or supplied by the Air Compressor Accessory (ACA), is at high pressures. This high pressure can be dangerous to both personnel and equipment if not handled properly.

• If you are installing the DMA without the ACA, the tubing leading to the air filter regulator must have a pressure rating adequate to handle the source pressure. The pressure going to the air filter regulator must not exceed 1000 kPa gauge (150 psig).

• If you are installing the DMA with the ACA, the tubing supplied by TA Instruments with the accessory must be used to connect it to the air filter regulator. The ACA has a pressure relief valve limiting the pressure supplied by the ACA to 500 kPa gauge (70 psig) maximum.

The tubing supplied with the DMA must be used to connect the instrument to the air filter regulator. Set the pressure on the air filter regulator to 410 to 450 kPa gauge (60 to 65 psig).

AVERTISSEMENT: L'air comprimé requis pour l'utilisation de l'instrument, qui peut être fournipar la source d'approvisionnement en air du bâtiment ou par l'accessoire du compresseur à air (ACA), est à haute pression. Cette haute pression peut être dangereuse pour le personnel et l'équipement si elle
n'est pas manipulée correctement.

• Si vous installez le DMA sans l'ACA, la tuyauterie menant au régulateur du filtre à air doit avoir une pression nominale adéquate pour la manipulation de la pression de la source. La pression qui va vers le régulateur du filtre à air ne doit pas dépasser une pression manométrique de 1000 kPa (150 psig).

• Si vous installez le DMA avec l'ACA, la tuyauterie fournie par TA Instruments avec l'accessoire doit être utilisée pour le raccordement au régulateur du filtre à air. L'ACA est équipé d'une soupape de détente de pression qui limite la pression manométrique fournie par l'ACA à 500 kPa (70 psig) maximum.

La tuyauterie fournie avec le DMA doit être utilisée pour raccorder l'instrument au régulateur du filtre à air. Réglez la pression manométrique sur le régulateur du filtre à air entre 410 et 450 kPa (60 à 65 psig).

DMA Submersion Clamps Warning

Two DMA clamps are available for evaluation of material viscoelastic properties while the material is submerged in a fluid at temperatures up to 80°C. These clamps are designed primarily for isothermal evaluations of polymers in aqueous or buffer solutions.

WARNING: Do not put your hands inside the furnace. It may be hot enough to cause burns.

AVERTISSEMENT: Ne mettez pas vos mains à l'intérieur du four. Il peut être assez chaud pour causer des brûlures.

WARNING: Proper clamp selection within the instrument control software (e.g., submersion film/fiber and submersion compression) is required to ensure that the 80°C upper temperature range cannot be exceeded.

AVERTISSEMENT: La sélection de la bride de serrage appropriée dans le logiciel de commande de l'instrument (p. ex. film/fibre de submersion et compression par submersion) est obligatoire afin de garantir le maintien de la plage de température la plus élevée à 80° C.

Lifting the Instrument

The DMA is a 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.

AVERTISSEMENT: Fermez le four avant de déplacer l'instrument, même pour une courte distance. Demandez à deux personnes de soulever et/ou de porter l'instrument. L'instrument est trop lourd pour qu'une seule personne le manipule en toute sécurité.

Sample Decomposition

The DMA is capable of heating samples to 600°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.

AVERTISSEMENT: Si vous utilisez des échantillons qui émettent des gaz nocifs, ventilez les gaz en plaçant l'instrument près d'un échappement.

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

We recommend that you measure the decomposition temperatures to determine the potential for problems by heating the sample materials in a thermogravimetric analyzer (TGA) or similar instrument, before running the sample on the DMA.

Table of Contents

Chapter 1:

Introducing the DMA 850

Overview

The TA Instruments Discovery Series DMA 850 Dynamic Mechanical Analyzer is an analytical instrument used to measure the mechanical properties of many different materials. These properties are measured as function of temperature, time, and deformation conditions. The DMA 850 is the 4th generation of DMA from TA Instruments and incorporates state-of-the-art technologies in hardware and software. To make measurements, the test specimen is mounted on one of several clamps, all of which have been designed using Finite Element Analysis to minimize mechanical and thermal mass while maximizing instrument and clamp stiffness. The DMA 850 applies a controlled deformation to the specimen to evaluate intrinsic as well as extrinsic mechanical properties of the material.

The DMA instrument works in conjunction with a controller, TA Instruments TRIOS software, and an environmental system to make up a thermal analysis system. The environmental system may be one or more of a controlled temperature chamber (oven) or Relative Humidity chamber.

Figure 1 Discovery DMA 850.

Your controller is a computer that performs the following functions:

- Provides an interface between you and the DMA 850.
- Enables you to set up experiments and enter necessary instrument control information.
- Stores experimental data.
- Allows data to be analyzed.

NOTE: For additional technical reference information, theory of operation, and other information associated with the DMA, see the online help associated with the instrument control software.

DMA System Components

A functional DMA system has several major parts—the DMA assembly, a computer controller for analysis and control of the instrument, and an optional cooling accessory. The following components make up the DMA assembly:

- The mechanical enclosure containing the air bearings, optical encoder, drive motor, and the associated electronics and valves.
- Type N sample and reference thermocouples sense the temperature of the sample and heater and relay the readings to the instrument. The position of the sample and reference thermocouples can be changed to accommodate the various clamp assemblies.
- The user interface allows you to control and monitor some of the DMA functions from the instrument.
- An Environmental Control Accessory, such as the Standard Furnace or DMA-RH, envelops the clamp assembly and provides temperature control. The furnace temperature is monitored by the sample thermocouple.
- The clamp assembly (called the "clamp") is interchangeable for making mechanical measurements in a variety of deformation modes to accommodate a wide array of sample shapes and materials. Several different types of clamps are available for the DMA, see page 23 for a list.
- The Power Control box containing the DMA power supply and furnace heating controller.

The DMA Instrument

The DMA 850 Dynamic Mechanical Analyzer is a precision instrument designed to measure viscoelastic properties, such as modulus and damping of rigid and soft solid materials. The sample is mounted on the clamp, which consists of a stationary part connected to the DMA frame, and a moveable part that is connected to the drive motor. Thus, the movement of the motor directly affects the deformation of the sample.

The drive motor is used to apply force or stress on the moving drive block. This motor is non-contact in nature, in that the fixed motor assembly is not physically in contact with the movable drive block. The optical encoder measures the resulting displacement of the moving drive block. For smooth, noise-free and continuous delivery of force, the moving drive block is suspended by an air bearing.

The DMA instrument contains all the necessary electronics and software needed to perform experiments and store the results. The user interface enhances the overall ease of use and displays valuable information during setup, calibrations and experimentation. It has control features such as the ability to set a temperature, move the shaft to help install a sample, control the motor mode, and start or stop an experiment.

The DMA developed by TA Instruments offers the following features:

- operates over a temperature range of –150°C to 600°C, using heating rates up to 20°C/min.
- determines changes in sample properties resulting from changes in seven experimental variables: temperature, time, frequency, stress, force, displacement, and strain.
- uses samples that can be bulk solid bars, cylinders, or tubes, film, fiber, gel, or viscous liquid form.
- employs interchangeable clamps allowing you to measure material properties including: modulus, damping, creep and recoverable compliance, stress relaxation, glass transitions, and softening points.

Air Filter Regulator Assembly

The air filter regulator assembly P/N 986320.901) is used with the instrument to help remove any oil, water, and particulates from the air being supplied to the air bearing.

The air source supplying the air filter regulator can come from a central laboratory supply or from the TA Instruments Air Compressor Accessory (ACA). Inlet pressure should be 80–150 psi from the central laboratory supply, and outlet pressure set for 60 psi.

See "Air Bearing Gas and Air Filter Regulator Connections" on page 32 for information on installing the air filter regulator. Refer to the online help for more details on the air filter regulator assembly.

Figure 2 Air Filter Regulator Assembly.

The DMA 850 User Interface

The DMA 850 instrument has a built-in integrated display and keypad in the form of a user interface 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.

The status line along the top of the display shows the current instrument status 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 user interface (the View panel) will vary depending on the screen displayed.

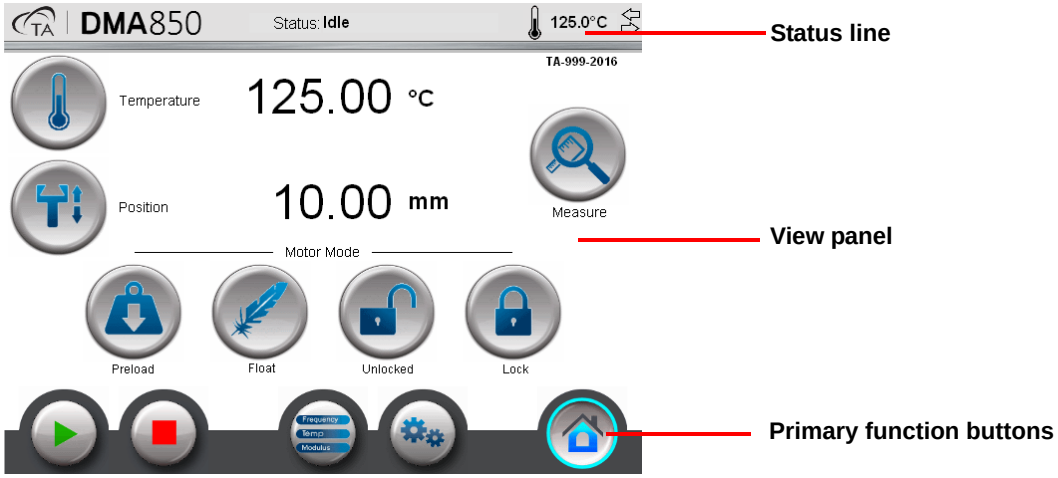


Figure 3 DMA user interface.

Primary Function Buttons

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

Table 1: Primary Function Buttons on the User Interface

Button 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 aborts the test method normally, as though it had run to completion–the data that has been generated is saved and the test end conditions go into effect. If pressed when the instrument is idle, the furnace shuts off and the motor locks. The same function can also be accessed on the instrument control software.

Table 1: Primary Function Buttons on the User Interface

Button Name	Description
Signals 	Displays real-time signal data generated directly from the instrument. Signals can be selected and reordered within the real-time signal section of the TRIOS Control panel.
System 	Allows the selection of cooling accessories, and access to user interface calibration, network settings, system messages, and service information.
Home 	Returns you to the Main screen

View Panel

The View panel provides real-time instrument status and additional functionality pertinent to the selected operation. A list of available functions is described below.

Table 2: View Panel Functions on the User Interface

Button Name	Description
Temperature 	Allows the setting of instrument temperature, and, if applicable, toggle the cooling gas ON/OFF and refill the Gas Cooling Accessory (GCA).
Position 	Specifies the position of the motor, relative to the current zero for the clamp. For example, this feature can be used to directly set a sample length with the film tension clamp.
Measure 	Turns the motor ON and initiates sample measurement based on the test that is currently programmed in TRIOS. In case of oscillation tests, it applies the preload force (if applicable) and then oscillates the motor. Sample properties such as the modulus are calculated and displayed in real time. For non-oscillation tests, this button applies the programmed preload force.

Table 2: View Panel Functions on the User Interface

Button Name	Description
Motor Mode: Preload 	Allows the application of the preload force prior to the start of the test. The applied force value is read from the test currently programmed in TRIOS. This feature is used to establish contact between the moveable clamp and the sample in compression testing, or hold the sample taut in film/tension testing.
Motor Mode: Float 	Releases the clamp, turns on the air-bearing gas, and applies zero force. Use this button to freely move and position the shaft during sample loading.
Motor Mode: Unlocked 	Releases the clamp, turns on the air-bearing gas, and allows for fine control over the positioning of the shaft during sample loading. In this mode, the motor actively controls the velocity of the shaft during movement, but maintains the final shaft position at the end of the movement.
Motor Mode: Lock 	Turns off the air-bearing gas, locking the clamp in its current position.

System View Panel

The **System View Panel** displays the Network connection information for the DMA and the TRIOS host computer connected to the DMA 850. Additional system settings accessible from this screen are listed below..

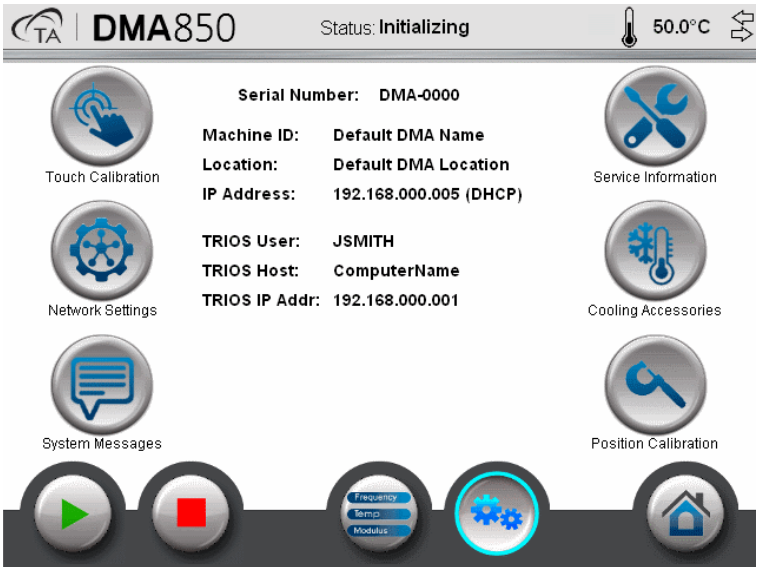


Table 3: System View Panel Functions on the User Interface

Button Name	Description
Touch Calibration 	Use this function to calibrate the user interface.
Network Settings 	The Network Settings button is used to identify the DMA 850 instrument, its location, and network (IP) address information.
System Messages 	The **System Messages** button displays status messages that can be used for troubleshooting
Service Information 	The **Service Information** button displays instrument status information (such as air pressure, temperature sensors, system status, and network communication status). This screen provides easy access to system information that may be used to troubleshoot the instrument.

Table 3: System View Panel Functions on the User Interface

Button Name	Description
Cooling Accessories 	The **Cooling Accessories** button displays a list of available cooling accessories. Once the accessory is installed, use this screen to activate the accessory.
Position Calibration 	Use the **Position Calibration** function to calibrate the DMA 850 position when it is moved or turned off, or the position calibration was unsuccessful during Initialization. The purpose of this calibration is to calibrate the absolute position of the drive shaft (and slide) as read by the optical encoder.

Signal View Panel

The **Signal View Panel** provides updated, real-time information for common test variables. The test variables displayed are identical to the first 10 variables selected for the TRIOS Instrument Control panel.

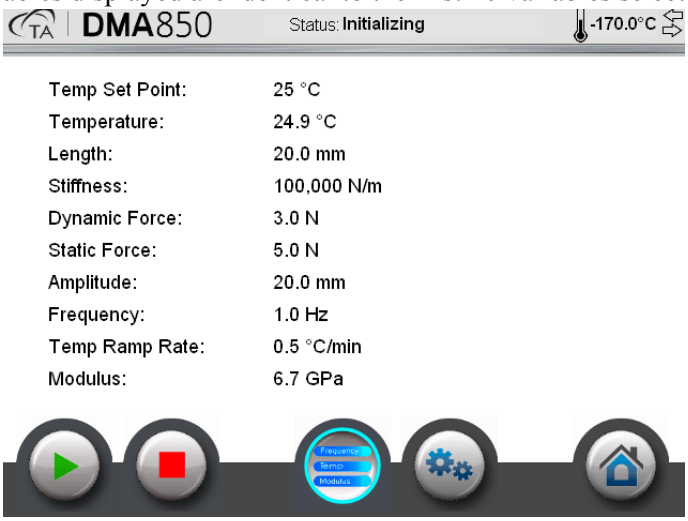


Figure 4

Refer to the online help for additional information regarding the user interface.

Instrument Specifications

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

Table 4: DMA Technical Specifications

Item/Area	Specifications
Dimensions	Depth: 47 cm (18.5 in) Width: 38 cm (15 in) Height: Standard Furnace open: 68.5 cm (27 in) Standard Furnace closed: 53.5 cm (21 in)
Weight with Standard Furnace	34 kg (75 lbs)
Power	100–240 VAC, 47–63 Hz, 14 A Max
Operating Environment Conditions	Temperature: 15 to 30 °C Relative Humidity: 5 to 80% (non-condensing) Installation Category II Pollution Degree 2
Temperature Range	–150[a] to 600°C with standard furnace
Sample Length	50 mm (2 in) maximum
Sample Width	15 mm (0.6 in) maximum
Sample Thickness	5 to 10 mm (depending on clamp)
Displacement Range	up to 25 mm (1.0 in)
Force range	0.001 to 18 N
Atmosphere	Controlled flow with inert gases or air[b]

a. Minimum temperature requires the Gas Cooling Accessory (GCA) or Nitrogen Purge Cooler (NPC) accessory.
b. The use of nitrogen as the air bearing gas is highly recommended when temperatures exceed 400°C.

Table 5: Temperature Control Specifications

Item/Area	Specifications
Temperature Range	–150 to 600°C[a]
Controlled Heating Rate	0.1 to 20°C/min
Cooling Rate	0.1 to 10°C/min
Temperature Reproducibility	± 2°C
Isothermal Stability	± 0.1°C above 50°C; ± 1.0°C below 50°C

a. The use of nitrogen as the air bearing gas is highly recommended when temperatures exceed 400°C.

Table 6: Experimental Specifications

Item/Area	Specifications
Modulus Range	1 kPa to 1000 GPa
Modulus Precision	± 1%
Frequency Range	0.001 to 200 Hz
Maximum Force	18 N
Minimum Preload Force	0.001 N
tan δ Range	0.0001 to 10
tan δ Resolution	0.00001
tan δ Sensitivity	0.0001
Dynamic Deformation	± 0.01 to 10,000 µm
Strain Resolution	1 nm

Table 7: ACA Specifications

Item/Area	Specifications
Dimensions	Depth: 38 cm (15 in) Width: 38 cm (15 in) Height: 23 cm (9 in)
Weight (approx.)	10 kg (22 lbs)
Power Inlet Power Outlet	120 VAC 50/60 Hz 120 VAC 50/60 Hz
Fuse	2 A Slo-Blo

Options and Accessories

Several optional clamps and accessories are available from TA Instruments to be used with the DMA 850. A brief description of each one follows. For more information refer to the online documentation.

Clamps

The DMA 850 utilizes several different types of clamps. These clamps can be classified as either tensioning or non-tensioning clamps. Tensioning clamps require the application of a positive force (preload force) on the sample at all times.

Tensioning clamps are:

- 3-point bending
- film tension
- fiber tension
- compression
- penetration
- submersion compression
- submersion film/fiber.

Non-tensioning clamps are:

- single cantilever
- dual cantilever
- shear sandwich.

All clamps have two basic parts—a moveable clamp and a fixed clamp (also sometimes called a stage). Additional information about the clamps can be found in the online help topic, “Available DMA Clamps.”

The single/dual cantilever clamp is included with the DMA 850. For the directions on installing and removing this clamp, refer to “Installing the Single/Dual Cantilever Clamp” on page 45.

Gas Cooling Accessory (GCA)

The GCA (P/N 991400.902) is used to perform subambient DMA experiments. The GCA utilizes liquid nitrogen, stored in a holding tank, to provide cooling. It has been designed for automatic refilling from a low pressure [170 kPa gauge (25 psig) maximum] bulk storage tank that can be located within 1.8 meters (6 feet) of the GCA. The GCA is also capable of being filled manually by disconnecting it from the instrument and moving it to a bulk storage source. The minimum temperature that can be reached with a GCA is –150°C. Refer to the GCA Getting Started Guide or online help for more details on this accessory.

Figure 5 Gas Cooling Accessory.

Air Chiller System (ACS) Accessory

The ACS is a unique multi-stage air chiller system for subambient temperature control and general cooling of select instrumentation from TA, including the DMA 850. The ACS units feature durable compressors, small footprint, uninterrupted operation, are CFC-free, and for specified temperature ranges, eliminate the recurring cost and safety concerns associated with handling and use of liquid nitrogen. The Air Chiller Systems require an air supply at pressure of 7 bar (100 psi), flow rate of 200 L/min, and dew point of at least –40°C (–40°F) or better, and appropriate instrument-specific Chiller Panel. Note that the dew point is to be measured at the operating pressure of 7 bar (100 psi). The minimum temperature for the ACS-3 is –100°C and –50°C for the ACS-2. Refer to the ACS Getting Started Guide or online help for more details on this accessory.

Figure 6 ACS Accessory (ACS-3 shown).

Nitrogen Purge Cooler Accessory (NPC)

The Nitrogen Purge Cooler (P/N 986310.901), is an optional accessory for extending the temperature range of the DMA 850 standard furnace to –160°C. The NPC consists of a 2.5 L Dewar flask that contains a copper coil tube. The furnace is cooled by purging nitrogen gas through the copper coil immersed in the liquid nitrogen-filled Dewar flask. The NPC requires a nitrogen gas supply (25 to 120 psi) at a flow rate of 30 L/min, and access to a supply of liquid nitrogen and equipment necessary for safe handling, transportation, and pouring of the liquid.

NOTE: The NPC is for crash cooling and controlled heating only. Controlled cooling rates are possible using the Gas Cooling Accessory (GCA), or Air Chiller Systems (ACS-2, ACS-3).

Refer to the Nitrogen Purge Cooler Accessory Getting Started Guide or online help for more details on this accessory.

Figure 7 Nitrogen Purge Cooler Accessory.

DMA-RH Accessory

The DMA-RH Accessory (P/N 985700.901) allows mechanical properties of a sample to be analyzed under controlled and/or varying conditions of both relative humidity and temperature. The DMA-RH Accessory is compatible with most DMA 850 clamps, with the specific exception of the submersion clamp. However, for best results, ensure that the sample has sufficient exposed surface area so that water vapor adsorption and desorption are not impeded. As such, the film/fiber, specialty fiber, cantilever, and three-point bend clamps are most appropriate for use with this accessory

Refer to the DMA-RH Accessory Getting Started Guide or online help for more details on this accessory.

Figure 8 DMA-RH Accessory.

Air Compressor Accessory (ACA)

The Air Compressor Accessory P/N 986350.901) is a compact unit that connects directly to the air filter regulator. It supplies compressed air to the air filter regulator for the DMA air bearing gas supply when a compressed air source is not available. (This gas also serves as the furnace purge.)

See "Air Bearing Gas and Air Filter Regulator Connections" on page 32 for ACA installation instructions.
Refer to the online help for more details on this accessory.

Figure 9 Air Compressor Accessory.

Chapter 2:

Installing the DMA

Unpacking/Repacking the DMA

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.

AVERTISSEMENT: Faites-vous aider par une personne pour dépoter cet appareil. N'essayez pas de le faire tout seul.

CAUTION: Follow the directions on the unpacking instructions enclosed with your instrument, PN 985730.000, "Unpacking the Discovery DMA 850 Instrument," carefully when removing the shipping material.

MISE EN GARDE: Suivez attentivement les instructions figurant sur les instructions de déballage jointes à votre instrument, réf. 985730.000, "Déballage de l'instrument Discovery DMA 850," lors du retrait du matériel d'expédition.

Installing the Instrument

Before shipment, the DMA 850 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 TRIOS online Help for additional information. Installation involves the following procedures:

- Inspecting the system for shipping damage and missing parts.
- Choosing a location for instrument installation.
- Connecting the DMA to the TA Instruments controller.
- Connecting cables and gas lines.

It is recommended that you have your DMA 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.

MISE EN GARDE: Pour éviter de commettre des erreurs, lisez tout le chapitre avant de commencer l'installation.

Inspecting the System

When you receive your DMA 850, 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 DMA experiments, it is important to choose a location for the instrument using the following guidelines. The DMA 850 system should be:

In

- A temperature-controlled area.
- A clean, vibration-free environment.
- An area with ample working and ventilation space.

On

- A stable, non-flammable work surface.

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

Near

- A power outlet (100–240 VAC, 47–63 Hz, 14 A max.)
- Your TA Instruments controller (computer).
- 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 DMA 850.

MISE EN GARDE: Votre source d'air doit être propre, sèche et dépourvu d'huile afin d'assurer le fonctionnement approprié du DMA 850.

Away from

- 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.

After installing the instrument, run the following method to dry out the DMA:
1 Select the DMA Express mode in TRIOS.
2 Choose “Oscillation” test mode and “Temperature ramp” test type. Use the 0.0030” steel shim supplied with the accessory kit for this test.
3 Ramp from current temperature to 400°C at 10°C/min, soak for 30 min. at End Temperature.

MISE EN GARDE: Le séchage de l'instrument peut s'avérer nécessaire, s'il a été exposé à l'humidité. Certains matériels en céramique utilisés dans cet équipement peuvent absorber la moisissure, faisant en sorte que les courants de fuite dépassent ceux indiqués dans les normes applicables jusqu'à l'élimination de la moisissure. Il est important de s'assurer que la mise à la terre de l'instrument est correctement connectée à la mise à la terre des installations pour une utilisation sécurisée.

Après avoir installé l'instrument, exécutez la méthode suivante pour assécher le DMA:
1 Sélectionnez le mode DMA Express dans TRIOS.
2 Choisissez le mode de test "Oscillation" et le type de test "Rampe de température". Utilisez la cale en acier 0,0030 "fournie avec le kit d'accessoires pour ce test.
3 Rampe de la température actuelle à 400 ° C à 10 ° C / min, tremper pendant 30 minutes à la température finale.

Connecting Cables and Lines

To connect the cables and gas lines, you will need access to the DMA 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 thumbscrews on all computer cables.

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

MISE EN GARDE: Chaque fois que vous branchez ou débranchez les cordons d'alimentation, tenez-les par les fiches et non par les cordons.

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

AVERTISSEMENT: Protégez les chemins de câble électriques et de câbles de télécommunication. Ne créez pas de risques de déclenchement en posant des câbles sur les voies d'accès.

Ports

The DMA has nine ports that are located on the back of the instrument. The below table provides a description of function of each port. Figures 8–10 show the position of these ports on the back of the instrument. Refer to this list when connecting cables and lines.

Table 8: Port Functions

Port	Function
COOLING GAS INLET	Inlet for cooling the furnace through air cooling and the NPC (830 kPa gauge [120 psig] maximum pressure)
EXT INPUT	TA Instruments Internal Use only.
EVENT	Capable of the following functions: general purpose relay contact closure, or general purpose input 4 – 24 VDC for external syncing. This port is used for ACS operation.
ETHERNET	Communication port to the controller (computer) or network.
COM1	Accessory port. Used for DMA-RH communications.
MAIN POWER	Provides power to the instrument from the Power Box.
CAN BUS	Used for GCA communications.
COOLING GAS OUTLET	Provides cooling gas to the furnace for use with air cooling or the Nitrogen Purge Cooler accessory.
AIR BEARING GAS INLET	Gas inlet port for the air bearing. Requires a clean, dry source of air or inert gas (410 to 450 kPa gauge [60 to 65 psig]).

Figure 10 Cooling gas port on the left rear of the instrument.

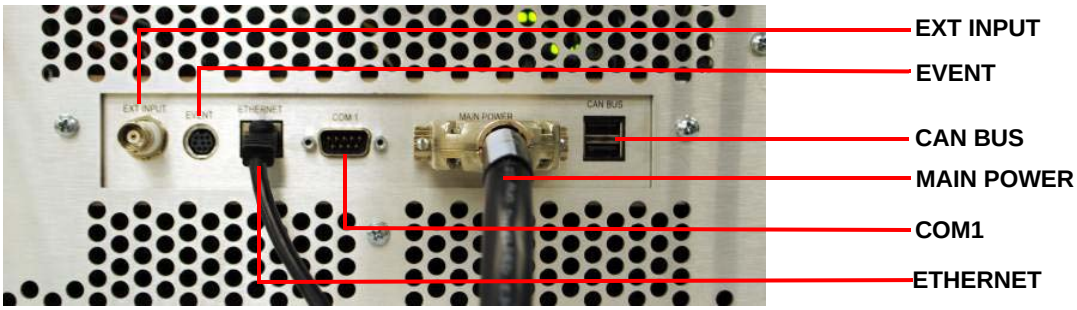


Figure 11 Back panel.

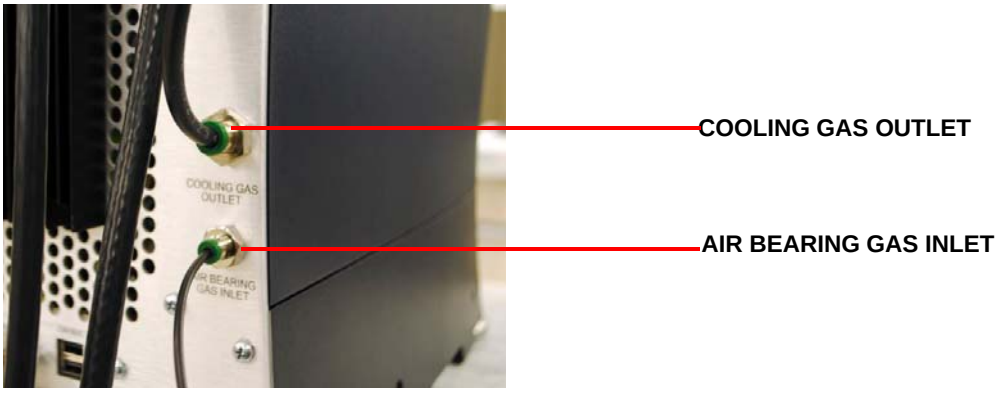


Figure 12 Ports on the right rear of the instrument.

Air Bearing Gas and Air Filter Regulator Connections

The DMA requires a 410 to 450 kPa gauge (60 to 65 psig) source of air or inert gas (e.g., nitrogen) for its air bearing system. The air source supplying the Air Filter Regulator can come from a central laboratory supply or from the TA Instruments Air Compressor Accessory (ACA).

An Air Filter Regulator (P/N 986320.901), shown in the figure below, is used with the instrument to supply clean, dry and oil-free gas to the air bearings. The air filter helps to remove any oil, water, and particulates from the air supply source.

Figure 13 Air Filter Regulator.

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

MISE EN GARDE: Votre source d'air doit être propre, sèche et dépourvu d'huile afin d'assurer le fonctionnement approprié du DMA.

This gas also serves as the furnace purge. If an inert atmosphere is needed, you must use inert gas for the air bearings. The air bearings use gas at the rate of approximately 2 liters per minute. The air bearing gas flows through the instrument and is channeled internally to the sample.

NOTE: The use of nitrogen as the air bearing gas is highly recommended when temperatures exceed 400°C.

Proper installation and maintenance of the air filter regulator is important for the performance and life of the DMA 850's air bearings. (See the online help for information on maintaining the air filter regulator.) An efficient system ensures minimum pressure loss and removal of contaminants such as water, oil, dirt, rust, and other foreign materials. TA Instruments recommends the following minimum criteria for the air being supplied to the Air Filter Regulator:

- Oil and liquid water = < 2 mg /m^3

- Water vapor dew point at 690 kPa gauge (100 psig) = 0°C (32°F)

NOTE: If you are using a desiccant dryer, it is best to install it after the Air Filter Regulator.

Connecting the Air Filter Regulator (Lab air source only)

To connect the air filter regulator to the instrument, refer to Figure 13 above and follow the instructions below. If you are using an ACA, use the instructions "Connecting the Air Filter Regulator to the Air Compressor Accessory (ACA)" on page 34.

1 Connect 1/4-inch tubing from the air supply source to the quick connect fitting on the left side of the air filter regulator.

2 Push one end of the thin 1/8-inch tubing into the air filter regulator fitting. Insert the tubing into the fitting until it cannot go in any further.

WARNING: Use of an explosive or corrosive gas as an air bearing gas is dangerous and will damage the DMA instrument. Use air or an inert gas (such as nitrogen) only, for the air bearing gas.

AVERTISSEMENT: L'utilisation d'un gaz explosif ou corrosif comme du gaz contenant de l'air est dangereuse et peut endommager l'instrument DMA. Utilisez uniquement de l'air ou un gaz inerte (tel que l'azote) pour le gaz contenant de l'air.

3 Locate the Air Bearing Gas Inlet on the right rear of the DMA instrument (see the figure below).

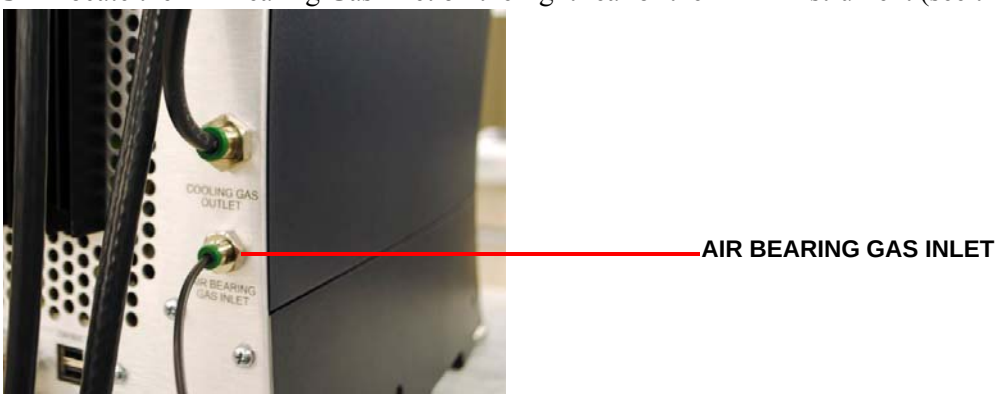


Figure 14 Air Bearing Gas Inlet.

4 Push the opposite end of the thin 1/8-inch tubing, which is connected to the air filter regulator, into the Legris fitting on the right side of the back of the DMA. Insert the tubing into the fitting until it cannot go in any further.

5 Turn the air source on. Set the filter outlet pressure to 410 to 450 kPa gauge (60 to 65 psig). A solenoid valve inside the DMA controls the flow to the air bearings.

Connecting the Air Filter Regulator to the Air Compressor Accessory (ACA)

Certain precautions must be observed to prevent humidity from entering and damaging the DMA's air bearing. When installing the ACA for use with the DMA follow these guidelines:

- Do not locate the ACA on the same benchtop or tabletop as the DMA. The vibrations from the ACA will affect the DMA's performance.
- Position the ACA, leaving approximately 12 to 15 cm (5 to 6 inches) clear around the fan vents to allow air to circulate freely.
- Place the four rubber feet flat on the benchtop. Do not stand the ACA on end.
- Connect the air tubing, supplied with the ACA, by pushing it into the connection shown in the figure on the previous page. Then connect the other end of the tubing to the air filter regulator.

CAUTION: The full length (3 m [10 feet]) of the tubing supplied with the ACA should be used between the outlet on the ACA and the inlet to the air filter regulator. This will aid in condensing any moisture in the air and improve the effectiveness of the air filter regulator.

MISE EN GARDE: La longueur totale (3 m [10 pieds]) de la tuyauterie fournie avec l'ACA doit être utilisée entre la sortie de l'ACA et l'arrivée du régulateur du filtre à air. Cela permet de condenser toute la moisissure contenue dans l'air et d'améliorer l'efficacité du régulateur du filtre à air.

CAUTION: Do not attempt to open the ACA; there are no customer-serviceable parts. Contact TA Instruments for service.

MISE EN GARDE: N'essayez pas d'ouvrir l'ACA car il ne contient aucune pièce réparable par l'utilisateur. Contactez TA Instruments pour l'entretien.

To connect the air filter regulator to the instrument, refer to Figure 13 above and follow the instructions below.

1. The air filter regulator is pre-assembled with a Parker quick-connect fitting in the left side of the regulator. This fitting is used with the tubing supplied with the DMA. When using the ACA, unscrew the quick-connect fitting on the left side of the filter/regulator. Then install the 1/8-inch quick-connect fitting included with the ACA.
2. Push the 1/8-inch tubing from the ACA (see the figure below) into the Parker fitting. Insert the tubing into the fitting until it cannot go in any further.

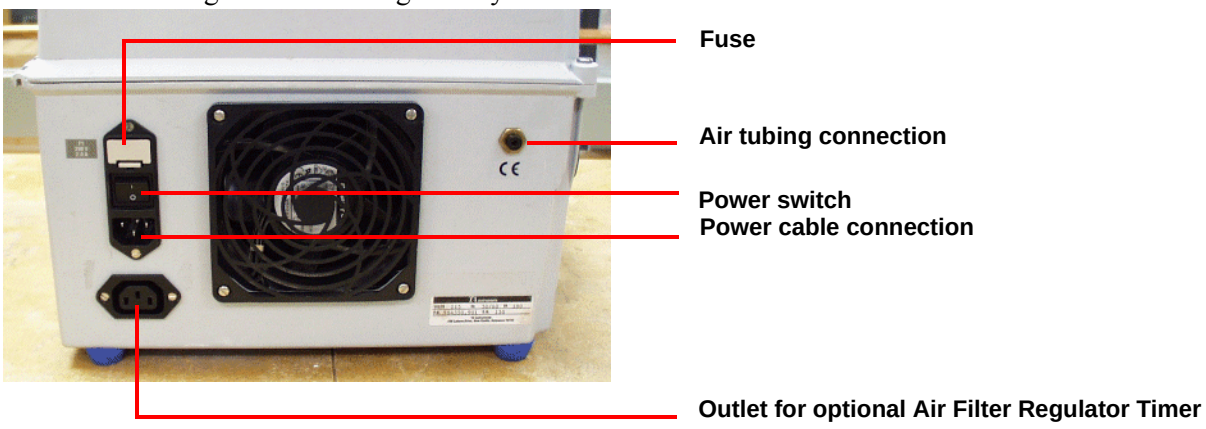


Figure 15 Air Compressor Accessory.

3 Push one end of the thin 1/8-inch tubing into the air filter regulator fitting. Insert the tubing into the fitting until it cannot go in any further. The full ten feet of tubing supplied with the ACA must be used to connect the ACA to the air filter regulator. Do not cut the tubing short; however, the tubing may be coiled to save space.

WARNING: Use of an explosive or corrosive gas as an air bearing gas is dangerous and will damage the DMA 850 instrument. Use air or an inert gas (such as nitrogen) only, for the air bearing gas.

AVERTISSEMENT: L'utilisation d'un gaz explosif ou corrosif comme du gaz contenant de l'air est dangereuse et peut endommager l'instrument DMA 850. Utilisez uniquement de l'air ou un gaz inerte (tel que l'azote) pour le gaz contenant de l'air.

4 Locate the Air Bearing Gas Inlet on the right rear of the DMA 850 instrument (see the figure below).

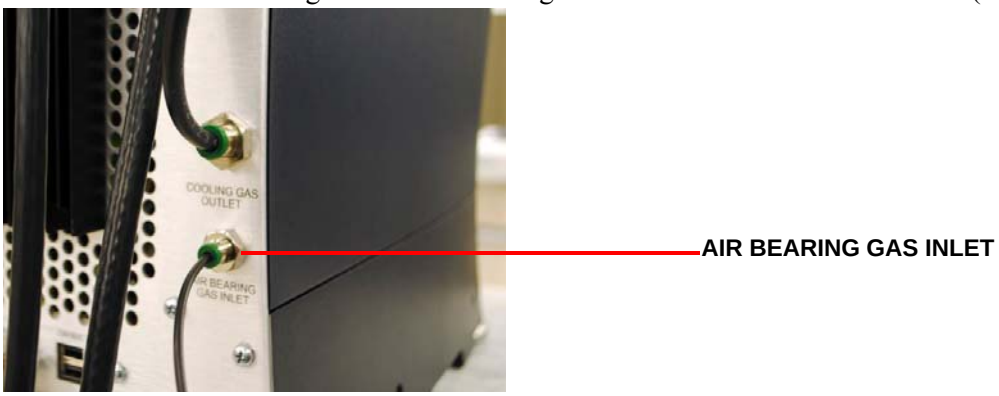


Figure 16 Air Bearing Gas Inlet.

5 Push the opposite end of the thin 1/8-inch tubing, which is connected to the air filter regulator, into the Legris fitting on the right side of the back of the DMA 850. Insert the tubing into the fitting until it cannot go in any further.

6 Connect the ACA to a 120 V power source and turn it on.

NOTE: A step-down transformer (P/N 573050.001) is required for operating the ACA in 240 V regions. See below for installation instructions.

7 Set the filter outlet pressure to 410 to 450 kPa gauge (60 to 65 psig). A solenoid valve inside the DMA controls the flow to the air bearings.

NOTE: Check the pressure gauge on the regulator before turning on the ACA. If the pressure gauge on the air filter regulator reads more than 70 kPa gauge (10 psig), release the pressure. If you try to turn on the ACA with more than 70 kPa gauge (10 psig) pressure in the system, the ACA will draw an excessive amount of current and may overload its fuse.

Installing the Step-Down Transformer for the ACA (240 V regions only)

Every ACA unit is shipped with a step-down transformer and converter. To install the transformer:

1 Plug the ACA power cable into the front of the transformer.

Figure 17 ACA connected to the step-down transformer.

2 Attach the converter to the plug on the back of the transformer.

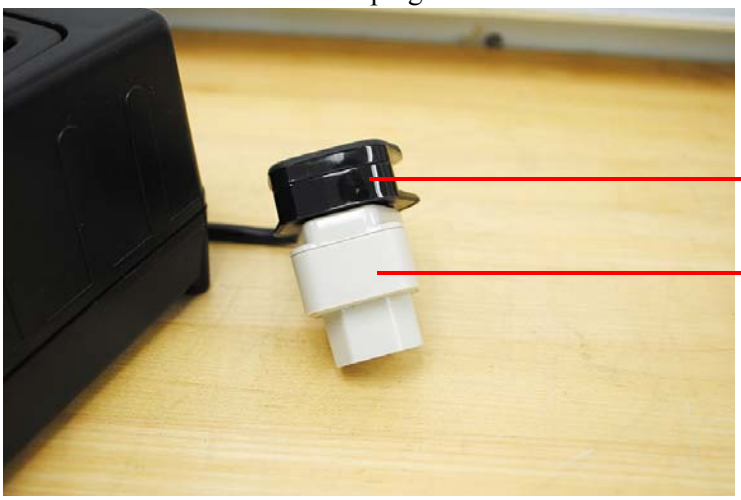


Figure 18

3 Plug one end of the appropriate power cable (not supplied) into the converter and the other end into a 240 V power source.

Connecting the Cooling Gas Line

The cooling gas connection supplies the DMA furnace with gas to cool the furnace to room temperature and heat the submersion clamp fluid only when the Gas Cooling Accessory (GCA) or Air Cooling System (ACS) is not connected to the DMA. (See the GCA Getting Started Guide, ACS Getting Started Guide, or the online help for further information on the GCA or ACS.)

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 left side of the DMA cabinet back, marked COOLING GAS 120 PSIG INLET MAX.

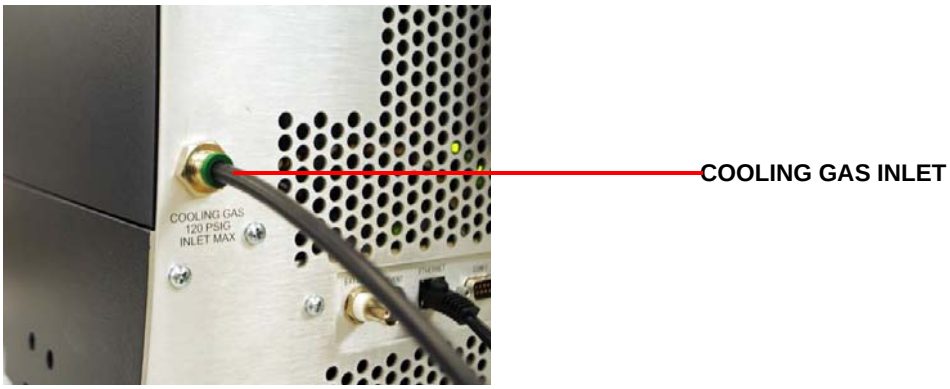


Figure 19 Cooling Gas fitting.

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.

Cooling Gas Connections

The Cooling Gas tube will be assembled on the DMA 850 at the factory. If you are using the Cooling Gas function to cool your DMA and/or heat the submersion clamp fluid and you must reinstall the Cooling Gas tube, then follow these instructions:

1 Locate the Cooling Gas tubing assembly.

2 Attach the Swagelok fitting to the Cooling Gas inlet fitting on the side of the DMA 850. Use a wrench to tighten the fitting.

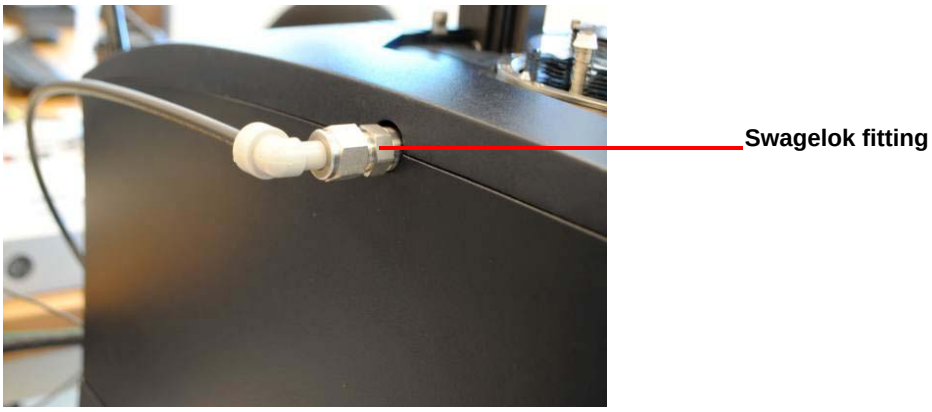


Figure 20 Swagelok fitting and tubing on the Cooling Gas inlet.

3 Locate the 1/4-inch Cooling Gas outlet fitting on the rear of the instrument.

4 Insert the 1/4-inch tubing into the Cooling Gas outlet fitting.

Figure 21 Cooling gas outlet tubing.

Setting Up System Communication

The instrument and controller must connect to a router, switch, or LAN. Refer to TRIOS Software Installation Instructions for more details.

Power Switch

The main power switch is located at the rear of the Power Control Box. The power switch is used to turn off power to the instrument. The DMA 850 is placed in standby mode when the main power switch is on.

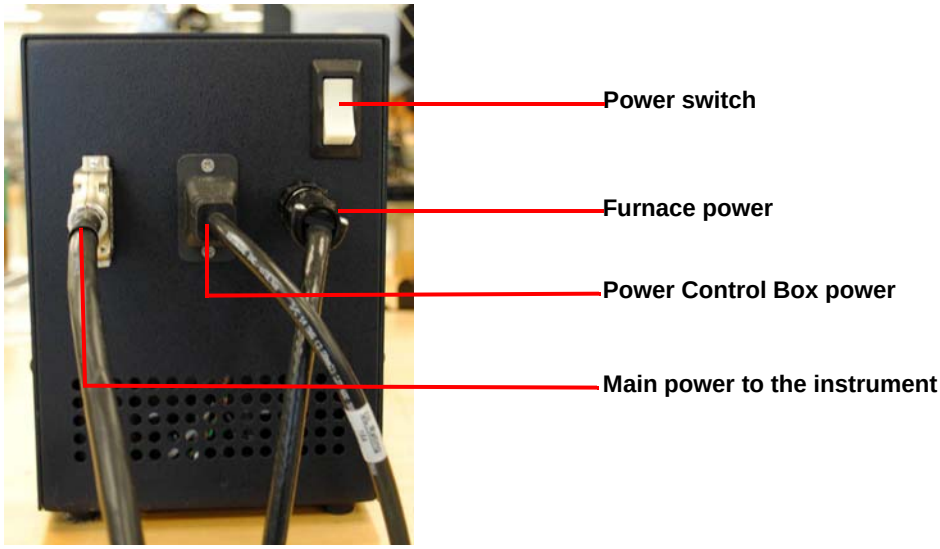


Figure 22 Power Control Box.

Connecting the Power Cables

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

Refer to Figure 22 above for power ports on the back of the Power Control Box.

1 Make sure the DMA Power Control Box switch is in the Off (0) position.

2 Plug the power cable into the DMA Power Control Box power entry module and then plug the other end of the power cable into the wall outlet.

3 Plug one end of the power interconnect cable into the back of the Power Control Box and the other end into the back of the instrument.

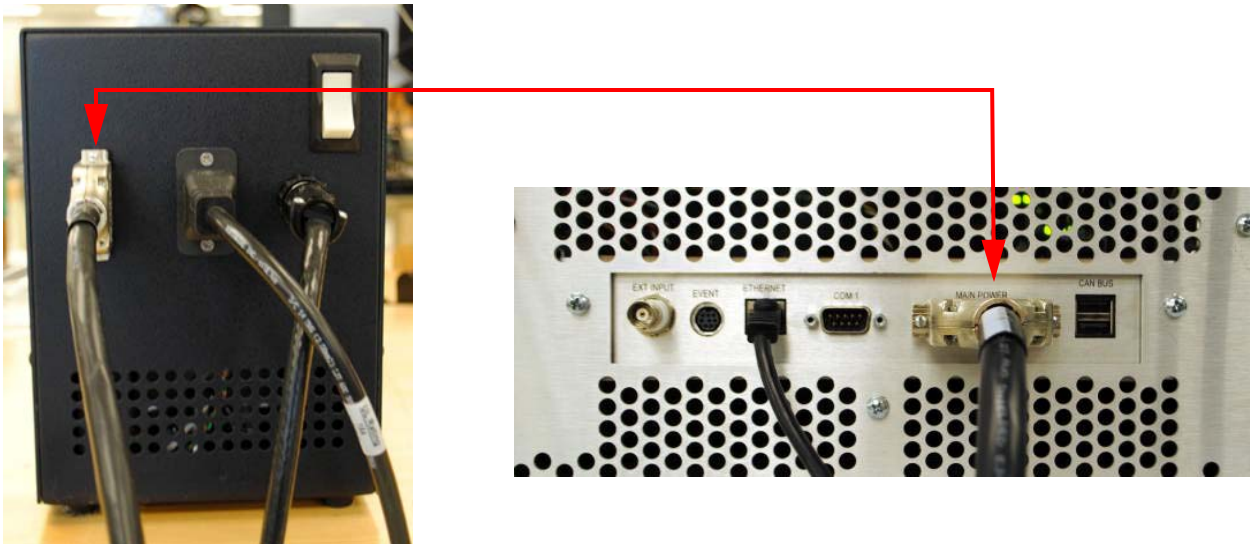


Figure 23 Power interconnect cable.

4 If a furnace is installed, plug the furnace power cable into the furnace power port on the back of the Power Control Box.

Starting the DMA

1 Check all connections between the DMA 850, the Power Control Box, and the controller. Make sure each component is plugged into the correct connector.

2 Verify that the pressure into the Air Bearings is set for 60 psi.

3 Set the power switch on the Power Control Box to the **ON** (**I**) position. The power button on the DMA 850 instrument flashes red, indicating that the instrument is in Standby mode.

4 Press the power button on the side of the instrument.

After the proper power up sequence, the DMA 850 home screen displays on the user interface, and indicates the temperature. If the instrument has been off for a significant amount of time, it will not be ready for use until the Upper and Lower Frame temperatures reach 40°C. This may take up to 30 minutes and the instrument status displays, “Warming up” during this period.

Once the frames reach the necessary temperatures, the motor will come on and attempt to do a position calibration. If a sample or shipping clamp is installed, the calibration will fail and the status on the user interface will indicate an error state. To redo the calibration, simply remove the sample or the shipping clamp and do the calibration from the user interface through the System View Panel  .

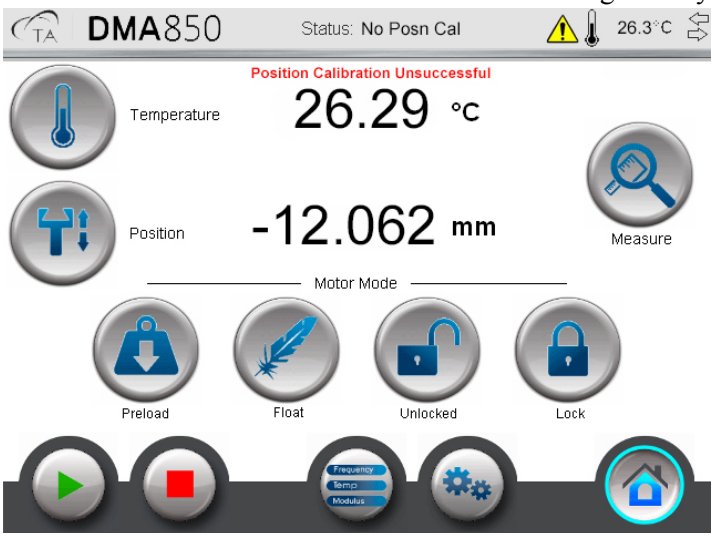


Figure 24 Position Calibration message at startup.

5 Remove the shipping bracket from the instrument (refer to the Unpacking Instructions included with the instrument).

The instrument is now ready for use.

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

Shutting Down the DMA

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

- All of the components of the DMA 850 system are designed to be powered on for long periods.
- The electronics of the DMA 850 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 DMA 850 system for some other task, it is recommended that you leave the instrument on.

Should you decide to power down or reset your instrument follow these steps:

1 Remove the sample and verify that the shaft is able to travel the full range of displacement (25 mm). In case of compression and submersion clamps, the clamp will have to be removed to access the full range of motion. Ensuring that the motor has access to the 25 mm of displacement before powering down the instrument allows the position calibration to automatically complete during instrument initialization. If a "Position Calibration Unsuccessful" (see Figure 24) displays at startup, remove the clamp and redo the position calibration from the instrument user interface.

2 Shutdown the instrument as follows:

a To ensure proper shutdown of the instrument, press the power button on the side of the instrument. This will initiate the shutdown sequence. The instrument is kept in standby mode, shutting off the main instrument power supply and furnace, but preventing the instrument from being affected by power line fluctuations.

b After the instrument has completed its shutdown sequence, set the power switch on the Power Control Box to the **OFF** (**0**) position.

Installing and Removing the Standard Furnace

Installing the Furnace

1 Remove the 4 screws from the instrument cover plate and set aside the screws and plate for reinstallation later on in the procedure

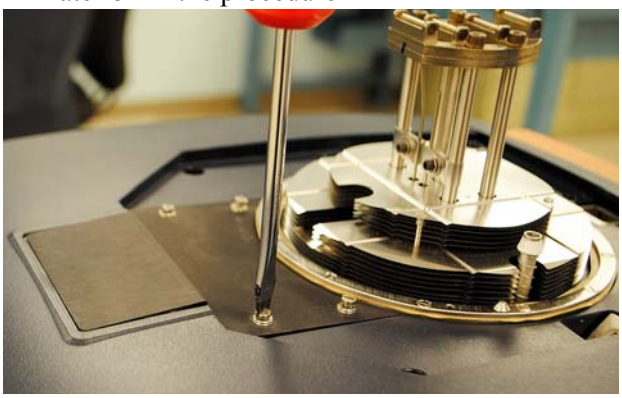


Figure 25 Removing the instrument cover plate.

2 Insert the furnace mechanism housing into the opening.

Figure 26 Insert furnace mechanism housing.

3 Secure the furnace mechanism housing with 4 screws.

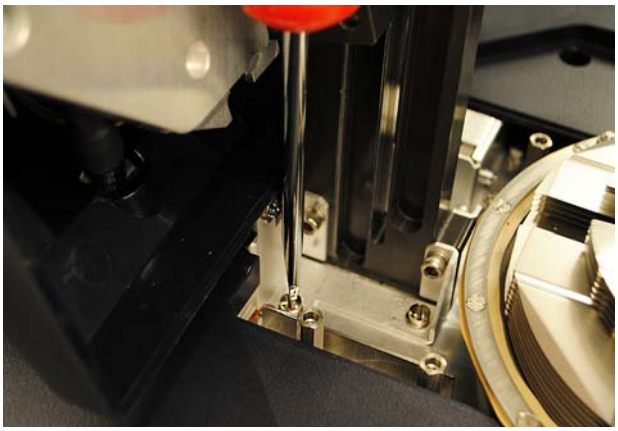


Figure 27

4 Install the furnace cable harness clamping screw on the back of the instrument.

5 Install the filler plate supplied with the furnace accessory.

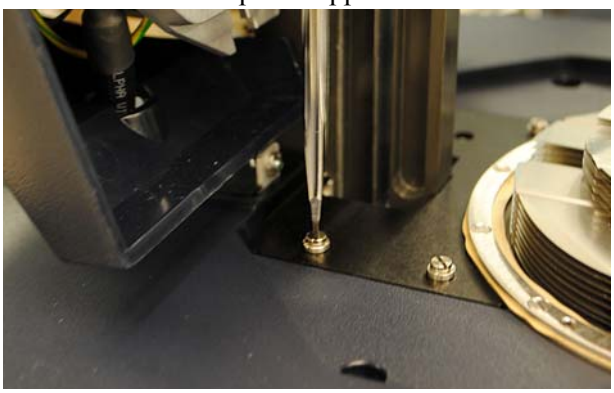


Figure 28 Install filler plate.

WARNING: If prolonged low temperature tests are being performed frost/moisture may form on some areas of furnace cover. If frost/moisture is observed on the top of the furnace, then ensure this is removed to the side of the DMA before lifting furnace. When removing do not push toward the rear of the instrument where cabling is situated.

AVERTISSEMENT: Si des tests prolongés à basse température sont effectués, du givre ou de l'humidité peut se former sur certaines zones du couvercle de la fournaise. Si du givre ou de l'humidité est observé sur le dessus de la fournaise, assurez-vous de l'enlever sur le côté du DMA avant de lever le four. Lors du retrait, ne poussez pas vers l'arrière de l'instrument où le câblage est situé.

Removing the Furnace

To remove the furnace, follow the installation instructions in reverse.

CAUTION: The spring mechanism may try to close on removal. Make sure it is held in position when lifting the furnace from the instrument.

MISE EN GARDE: Le mécanisme à ressort peut essayer de se fermer lors du retrait. Assurez-vous qu'il est maintenu en position lorsque vous le soulevez de l'instrument.

Figure 29 Removing the furnace.

Installing the Single/Dual Cantilever Clamp

When you initially receive the DMA 850, a clamp will need to be installed. The procedures that follow explain the installation and removal of the single/dual cantilever clamp, which is the standard clamp used on the DMA. Later, if a different sample geometry is required, you can install the appropriate clamp for the experiment.

The single/dual cantilever clamps are used to analyze weak to moderately stiff samples. The samples are rigidly clamped using the cantilever clamps.

To install the single/dual cantilever clamp on the DMA, follow these steps:

1 Slide the dovetail of the moveable clamp into the dovetail holder of the drive shaft. Align the dovetail with the edge of the holder.

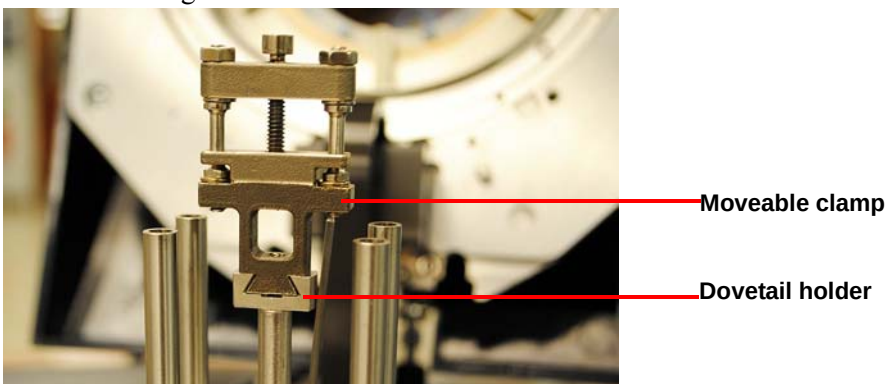


Figure 30 Inserting the moveable clamp.

2 Insert the 1/16” hex key (included in the kit) to tighten the setscrew in the center of the moveable clamp. Do not overtighten the setscrew.

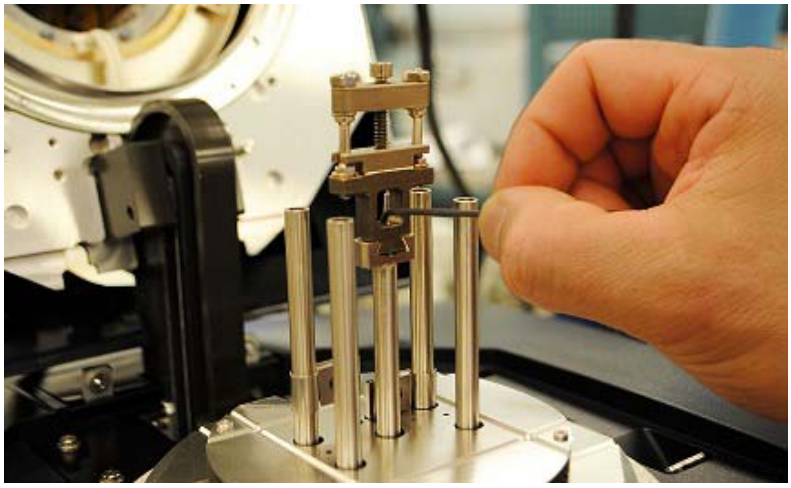


Figure 31 Tightening the moveable clamp setscrew.

3 Lower the fixed clamp carefully over the moveable clamp. (You may need to reposition the thermocouple. See “Aligning the Thermocouples” on page 50, if needed.)

4 Line up the fixed clamp with the mounting posts and tighten the four hex screws using the torque wrench with 9/64”bit.

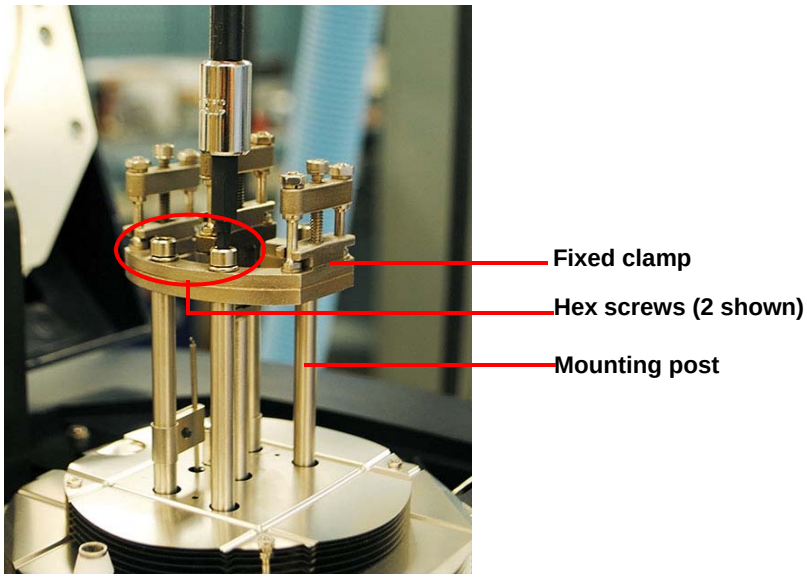


Figure 32 Installing the fixed clamp.

CAUTION: The fixed clamp should be installed with the torque wrench set to 10 in.lb. Over torquing the fixed clamp can twist the mounting posts and may damage the instrument.

MISE EN GARDE: La pince fixe doit être installé avec la clé dynamométrique réglée à 10 lb.po Plus de torque la pince fixe peut tordre les postes de montage et peut endommager l'appareil.

5 Ensure that the moveable clamp is aligned so that it is parallel to and equally spaced between the fixed clamps. You may need to loosen the setscrew again to adjust the moveable clamp’s position. Be sure to retighten the setscrew again, if you have loosened it.

6 Make sure the appropriate clamp type and mode are selected in TRIOS, or set up a new cantilever clamp using the clamp wizard in TRIOS.

7 Follow the instructions in TRIOS.

8 Position the thermocouple so that it is close to, but not touching, the sample.

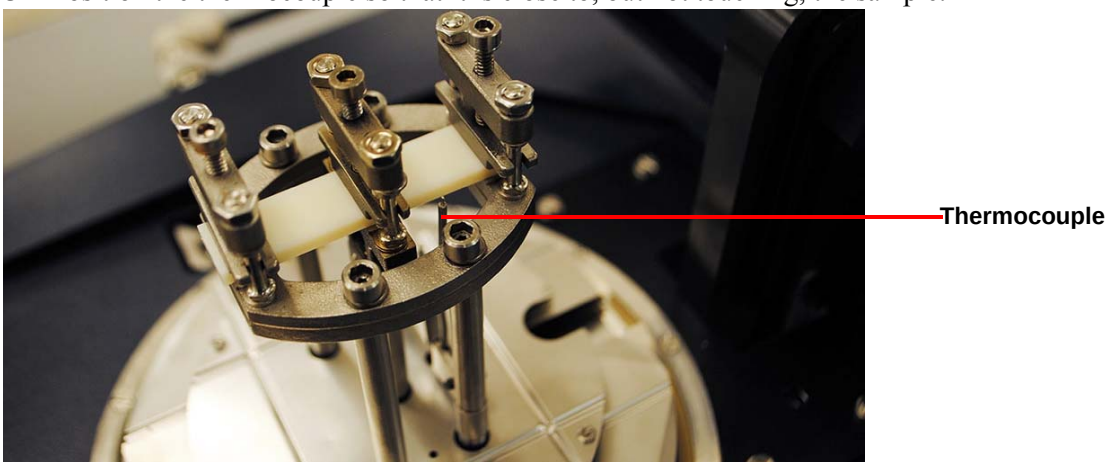


Figure 33 Thermocouple close to sample.

Removing the Single/Dual Cantilever Clamp

The following procedure is used to remove the clamp. If a sample is installed, remove it before proceeding.

1 Press the **Lock** button to lock the clamp in place.

2 Loosen, but do not remove, the four hex screws holding the fixed clamp on the mounting posts. See Figure 32.

3 Lift the fixed clamp off the four supports.Take care not to damage the thermocouple.

4 Loosen the setscrew on the moveable clamp and then remove the clamp by sliding it out of the dovetail holder. See Figure 31.

Chapter 3:

Use, Maintenance, & Diagnostics

Using the DMA 850

All of your DMA 850 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; therefore, they will not all be covered in detail here.

- Calibrating the instrument
- Selecting and preparing the sample
- Creating or choosing the test procedure and entering sample and instrument information through TRIOS software
- Loading the prepared sample and closing the furnace
- Starting the experiment

To obtain accurate results, follow these procedures carefully.

Before You Begin

Before you set up an experiment, ensure that the DMA 850 and the controller have been installed properly. Make sure you have:

- Made all necessary cable connections from the DMA 850 to the controller
- Connected all gas lines (air bearing and air cool)
- Connected any desired accessories (furnace, GCA, ACS)
- Powered up the unit (waiting at least 30 minutes before starting an experiment)
- Become familiar with controller operations
- Calibrate the DMA 850, if necessary

Calibrating the DMA 850

To obtain accurate experimental results, you should calibrate the DMA 850 when you first install it. For the best results, you should recalibrate periodically. A brief description of each of the calibrations is outlined below. For details on how to perform each calibration, refer to the online help accessed through the instrument control software.

Position Calibration

This is used to calibrate the absolute position of the drive shaft (and slide) as read by the optical encoder. The DMA 850 automatically performs the position calibration during the Initialization procedure at instrument startup. It can also be accessed from the touchscreen through the **System**  button.

The position calibration verifies the motor travel over the full range (25 mm). For successful calibration, remove all samples. For certain clamps such as compression and all submersion clamps, it is necessary to remove the clamp before starting the calibration.

Force Calibration (Balance and Weight)

The Force calibration procedure is used to adjust the force exerted by the clamp on the sample and the force registered by the instrument during experiments. The fixtures needed to perform the force calibration are provided in the accessory kit, including a precision 1 kg weight and a platform to place the weight on the drive shaft. This calibration can be accessed through the Instrument Calibration in TRIOS and must be performed when the DMA 850 is moved or at least once a month.

Installation Stability Verification

The Installation Stability Verification performs a time sweep test at a fixed oscillation displacement and high frequency. This test provides a quantitative measure of the stability of the DMA 850's installation and ensures that all four feet are in contact with the table on which the instrument is placed. A real time readout of the residual phase angle is displayed in TRIOS and on the instrument's touchscreen and will reach a maximum value at the optimum position.

This calibration should be performed when the DMA 850 is moved or at least once in six months.

Phase Calibration

Phase calibration is used to compensate for phase shift caused by inertia, electronics, and mechanical characteristics of installation. Phase calibration should be performed whenever the instrument is moved.

Clamp Calibration

This procedure calibrates the properties of the installed DMA 850 sample clamp. This calibration is performed each time you install a clamp for the first time. Clamp calibrations may involve up to three steps (mass, zero, and compliance), depending on the clamp installed.

Running a DMA 850 Experiment

All of your DMA 850 experiments will have the following general outline. In some cases, not all of these steps will be performed. See the instrument control software online help for anything not covered in this manual.

Basic Experimental Steps

1. Choose, install, and calibrate the clamp appropriate for the sample shape and modulus range. Refer to TRIOS online help for information.
2. Position the thermocouple near the sample.
3. Select the mode of operation needed to perform the desired type of experiment.
4. Create a procedure that is appropriate to the operating mode, including force, frequency, heating rate, etc., as defined by the mode and the clamp type.
5. Mount the properly prepared sample on the DMA 850. Then press **Measure** to start the motor, preview the desired measurement, and confirm that conditions are acceptable before continuing with the experiment.
6. Close the furnace and start the experiment.

These steps are explained in detail in TRIOS online help.

Single/Dual Cantilever Clamps

The single/dual cantilever clamps can be used for relatively weak to moderately stiff materials. The samples can range from supported thermosetting resins, to elastomers, amorphous, or lightly-filled thermoplastic materials. Dual cantilever clamps are good for testing weak elastomers and for curing supported resins. The single cantilever clamps should always be used for measuring the properties of amorphous polymers and elastomers through the glass transition, and for analyzing materials with high thermal expansions. Refer to the TRIOS online help topic, “Single/Dual Cantilever Clamp” for more information.

Aligning the Thermocouples

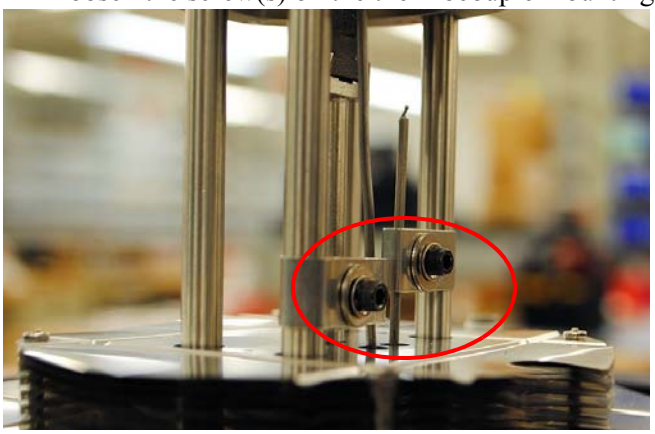
Two thermocouples are present in the DMA 850 furnace cavity. The right-side thermocouple provides the sample temperature reading for all clamps except the submersion compression, submersion three point bending, and submersion film/fiber. Those three submersion clamps use an extended left-side thermocouple to measure the temperature of the fluid and sample.

When using any non-submersion clamp, the right-side (sample) thermocouple should be close to, but not touching the sample when it is loaded on the clamp. The left-side (reference) thermocouple need not be close to the sample and may be repositioned as necessary to clear the sample and clamp.

When using a submersion clamp, the left-side (sample) thermocouple should be bent over and the tip submerged in the fluid, close to, but not touching the bottom of the tank. Ensure that the slide can move freely without interference from the thermocouple. The right-side (reference) thermocouple need not be close to the sample and may be repositioned as necessary to clear the sample, clamp, and tank.

You may find it necessary to realign one or both of the thermocouples when a new clamp is installed, or if the thermocouples are bent or misaligned.

1 Loosen the screw(s) on the thermocouple mounting bracket(s).



2 Move the thermocouple(s) up or down, as needed, or bend to the desired angle.

3 Retighten the screw in the bracket(s).

4 If needed, adjust the angle of the thermocouple tip so that it is close to, but not touching, the sample. You may need to bend the thermocouple in order to get it closer to the sample. Do not introduce a sharp bend, a gradual bend is preferred. Take care when you bend the thermocouple that it does not break.

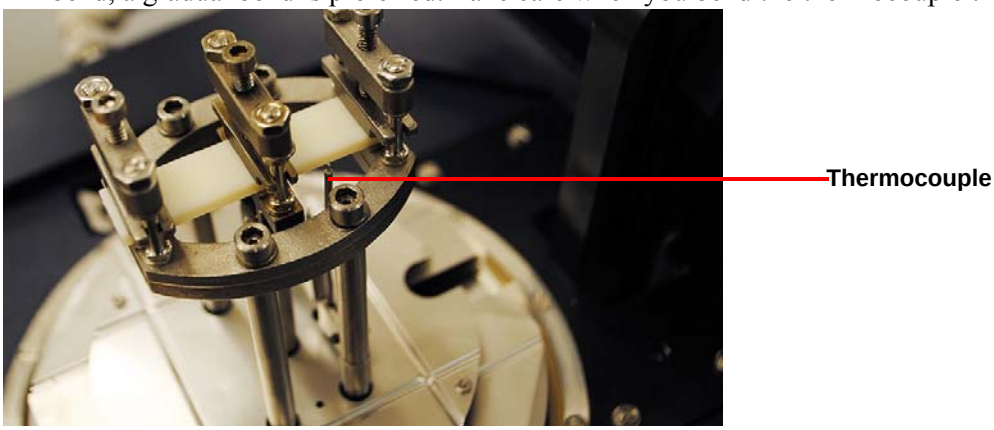


Figure 34 Thermocouple near sample.

Selecting the Operating Mode

There are multiple operating modes available for the DMA 850. Each mode listed in the table below reflects a different class of experiment that can be performed. Before you can begin an experiment, you need to select an operating mode using the instrument control software.

If you are upgrading to Discovery from Q Series™, use the Equivalent column of the table to help you determine the mode for DMA 850 that is equivalent to the mode used for Q800.

Table 9: Operating Mode

Q800 Test		Equivalent DMA 850 Test		
Mode	**Name**	**Mode**	**Name**	**Test Setting**
DMA Multi-Strain	Strain Sweep	Oscillation	Strain Sweep	Amplitude
DMA Multi-Stress	Stress Sweep	Oscillation	Stress Sweep	Force
DMA Multi-Frequency Strain	Isothermal Temperature Frequency Sweep	Oscillation	Frequency Sweep	Amplitude
DMA Multi-Frequency Strain	Temperature Ramp Frequency Sweep	Oscillation	Temperature Ramp (Multifrequency)	Amplitude
DMA Multi-Frequency Strain	Temperature Ramp	Oscillation	Temperature Ramp	Amplitude
DMA Multi-Frequency Strain	Temperature Step Frequency Sweep	Oscillation	Temperature Sweep (Multifrequency)	Amplitude
DMA Multi-Frequency Strain	Temperature Step	Oscillation	Temperature Sweep	Amplitude
DMA Multi-Frequency Stress	Isothermal Temperature Frequency Sweep	Oscillation	Frequency Sweep	Force
DMA Multi-Frequency Stress	Temperature Ramp Frequency Sweep	Oscillation	Temperature Ramp (Multifrequency)	Force
DMA Multi-Frequency Stress	Temperature Ramp	Oscillation	Temperature Sweep (Multifrequency)	Force
DMA Multi-Frequency Stress	Temperature Step Frequency Sweep	Oscillation	Temperature Sweep (Multifrequency	Force
DMA Multi-Frequency Stress	Temperature Step	Oscillation	Temperature Sweep	Force

Table 9: Operating Mode

Q800 Test		Equivalent DMA 850 Test		
N/A		Oscillation	Temperature Ramp (Multifrequency)	N/A
		Oscillation	Temperature Sweep (Multifrequency)	N/A
		Oscillation	Temperature Sweep (Multifrequency)	N/A
		Oscillation	Time Sweep	N/A
		Oscillation	Fatigue Tests	N/A
DMA Creep	Creep TTS	Stress Control	Creep TTS	Force
DMA Creep	Creep	Stress Control	Creep Recovery	Force
DMA IsoStrain	IsoStrain	Strain Control	IsoStrain	Strain %
DMA Stress Relaxation	Stress Relaxation	Strain Control	Stress Relaxation	Strain %
DMA Stress Relaxation	Stress Relaxation TTS	Strain Control	Stress Relaxation TTS	Strain %
DMA Strain Rate	Strain Ramp	Rate Control	Strain Ramp	Strain %
DMA Strain Rate	Displacement Ramp	Rate Control	Strain Ramp	Displacement
DMA Controlled Force	Stress/Strain	Rate Control	Stress Ramp	Stress
DMA Controlled Force	Temperature Ramp/ Controlled Force	Rate Control	Stress Ramp	Force

Performing Experiments

Once you have set the appropriate instrument and experimental parameters and have mounted a sample on the DMA 850, you are ready to run the experiment.

When you run experiments using the single or dual cantilever clamps, follow the instructions given below. For other clamps, refer to TRIOS online help. Please note the following conditions pertaining to single/ dual cantilever clamp experiments:

- If the thermal expansion of a material is high—such as for thermoplastics and rigid elastomers—use the single cantilever clamp, rather than the dual cantilever clamp, to obtain the most accurate results.
- You may need to tighten the clamps at the minimum temperature, when you run elastomer samples at subambient temperatures. To do this, follow the suggested method below:

1 Install and calibrate the desired clamp.

2 Program the desired test method, including an Equilibrate segment as your first segment.

NOTE: Use the Measure Again After Method Equilibration option on the Advanced Parameters window to adjust for dimension changes in the sample after the sample temperature equilibrates at the lower temperature setting. This option is applicable to film/fiber tension, compression, and penetration clamps only.

3 Load the desired sample.

4 Tighten the clamp and close and lock the furnace.

5 Enter the desired low starting temperature. This will bring your sample to the starting temperature without applying forces to it that might distort it. Observe the temperature of the sample and wait until the sample has reached the set temperature.

- In the Control panel in TRIOS: Enter the desired low starting temperature and then click the return arrow.

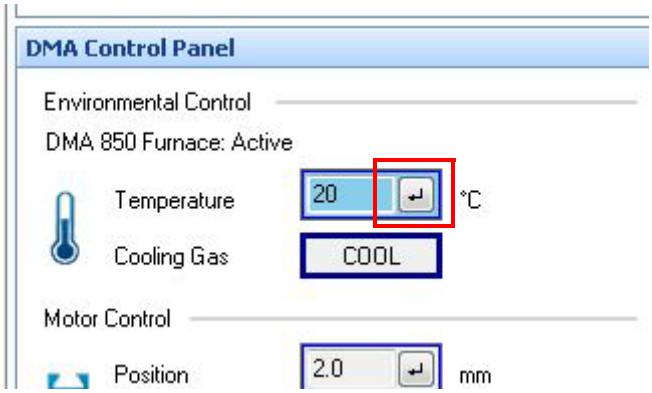


Figure 35 Return arrow to set the entered temperature.

- On the instrument user interface: Press **Temperature** on the main screen. Enter the desired low starting temperature and then press **Set Temp**.

6 Open the furnace. The GCA or ACS will automatically stop and switch to a vent state and the furnace heaters will be turned off while the furnace is open.

7 Quickly and carefully tighten the clamp again using the torque wrench set to the appropriate value for you sample. Refer to TRIOS online help for guidelines.

CAUTION: Use the appropriate tools and safety precautions if you need to handle the sample or clamps. They can be hot or cold enough to cause injury.

MISE EN GARDE: Utilisez les outils et les précautions de sécurité appropriés si vous devez manipuler l'échantillon ou les brides de serrage. Ils peuvent être assez chauds ou froids pour provoquer des blessures.

8 Close and lock the furnace.

9 Press **Start** to begin your programmed experiment.

Starting an Experiment

Before you start the experiment, ensure that the DMA 850 is connected with the controller 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 DMA 850 is very sensitive to motion and may pick up the vibration caused by touching a key on the instrument user interface.

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 **Stop** on the user interface. The DMA 850 will follow its end of test conditions for temperature and motor control.

Removing Samples

When the experiment has run to completion, remove the sample from the single/dual cantilever clamp as follows:

1 Wait for the sample to return to room temperature before you attempt to remove it.

2 Unlock and open the furnace.

3 Press the **Lock** button to lock the moveable clamp in position.

4 Loosen the three clamping center screws that are holding the sample between the moveable jaws and remove the sample. If any sample residue remains stuck to the clamp, remove it by scraping it off with a razor blade or similar tool.

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.

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

DANGER: À cause de la présence de tensions élevées dans cet instrument, le personnel non formé ne doit pas essayer de tester ou de réparer les circuits électriques.

Cleaning the User Interface

You can clean the DMA 850 user interface as often as you like. The user interface should be cleaned with a household liquid glass cleaner and soft cloth. Wet the cloth, not the user interface, with the glass cleaner and then wipe off the screen and surrounding surfaces.

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

AVERTISSEMENT: N'utilisez pas de produits chimiques agressifs, de nettoyants abrasifs, de la laine d'acier ou tout autre matériau rugueux pour nettoyer l'écran de l'interface utilisateur, car vous pourriez égratigner sa surface et dégrader ses propriétés.

Cleaning the Furnace

After extended use, the inside of the furnace may become coated with sample and therefore require cleaning. Periodic cleaning is recommended for optimum operation and performance.

See TRIOS software online help for furnace cleaning instructions.

Replacement Parts

Replacement parts for the DMA 850 that are available from TA Instruments are listed below. Refer to the tables below when ordering parts.

Table 10: DMA 850 Accessory Kit (986018.901) Items (see Appendix A)

Part Number	Description
986018.901	DMA 850 Accessory Kit (includes all items below)
280037.000	Tool, wrench torque drive
982161.902	Sample, ABS (Acrylonitrile Butadiene Styrene) 6 cm (2.35 inch) (5)
982161.903	Sample, ABS (Acrylonitrile Butadiene Styrene) 3.5 cm (1.4 inch) (5)
982165.902	Sample, polycarbonate 6 cm (2.35 inch) (5)
982165.903	Sample, polycarbonate 3.5 cm (1.4 inch) (5)
984308.004	Sample, 0.030 inch calibration
984308.005	Sample, 0.030 inch x.75 calibration
982166.003	Sample, .125 compliance, 6 cm (2.35 inch) long
982166.004	Sample, .125 compliance, 3.5 cm (1.4 inch) long
986308.901	Platform 1 kg weight
983169.001	Digital caliper B&S
270339.003	1 kg weight
205221.002	Fuse, 10 Amp, 250 V
259508.000	Brass tweezers
280038.000	Tool, .25 hex head wrench, 3/32 bit
280039.000	Tool, 7/64 hex wrench, .25 bit
984347.001	Tool, 1/16 L hex wrench (mod)
280255.002	Tool, 9/64 L hex wrench, balldriver
280257.001	Tool, 3/32 L hex wrench, balldriver
984015.902	Dual cantilever bending stage
984015.903	Dual cantilever dovetail
270871.001	Socket setscrew, steel, .25 long cup point
204578.000	Lubricating spray
280041.001	Adapter, hex shank, 2-inch long with friction ball

Table 11: Additional Replacement Parts

Part Number	Description
251470.025	Ethernet cable (7.7m [25 foot], shielded)
573046.001	Power cord 120 V
985724.901	Control thermocouple (88.9 mm length)
985724.902	Sample thermocouple (127 mm length)
980228.902	Glass support cloth (0.205 mm thick, 32.92 m length)
984309.901	PET film samples 3.5 cm (1.5 inch) long (10)
984310.901	Indium wire samples 3.5 cm (1.5 inch) long (10)
984313.901	PET string sample 36" long
982165.904	Polycarbonate sample (0.794 mm thick, 35.56 mm long, pkg of 5)
984309.901	Polyethylene terephthalate (PET) film (pkg of 10 pieces, 38.1 mm long)
984313.901	PET fiber (914.4 mm long)
984054.001	Drive shaft
986012.901	DMA 850 Standard Furnace
983164.001	Calibration sample thin film clamp
280257.001	Tool, wrench hex 3/32 L ball driver
280039.000	Hex wrench 7/64 0.25 bit
984347.001	Hex wrench 1/16 L
270962.001	Telescoping gauge (for 10 mm single cantilever clamps)
270962.002	Telescoping gauge (for 17 mm single cantilever clamps)
986320.901	Filter/regulator
270975.001	Filter element
613.06404	Replacement coalescing filter element
613.06406	Replacement particle filter element
613.02001	90 µ Nupro filter element
573050.001	Transformer Step-Down 230V–115V

Table 12: Clamp Kits

Part Number	Description
984048.901	8 mm single/dual cantilever clamp kit
984047.901	20 mm single/dual cantilever clamp kit
984015.901	35 mm single/dual cantilever clamp kit
984026.901	Three-point bending clamp kit (5, 10, and 15 mm lengths)
984014.901	Three-point bending clamp kit (20 and 50 mm lengths)
984018.901	Parallel plate compression clamp kit (includes 15 and 40 mm plates)
984022.901	Penetration kit
984016.901	Film/fiber tension clamp kit
985016.901	Dual surface film tension clamp
984023.901	Specialty fiber tension clamp kit
984017.901	Shear sandwich clamp kit
985067.901	Submersion compression clamp kit
985068.901	Submersion film/fiber clamp kit
985178.901	Three-point bending submersion clamp kit
986252.901	DMA 850 Film/Fiber clamp kit
986270.901	DMA 850 Compression Clamp Kit

Table 13: DMA 850 Accessories

Part Number	Description
986350.901	Air Compressor Accessory
991400.902	Gas Cooling Accessory (GCA) - auto tank fill
985700.901	DMA-RH Accessory
986310.901	Nitrogen Purge Cooler
405001.901	ACS-2 Air Chiller System 220–230 VAC, 60 Hz
405001.902	ACS-2 Air Chiller System 220–230 VAC, 50 Hz
405000.901	ACS-3 Chiller System 220–230 VAC, 60 Hz

Table 13: DMA 850 Accessories

Part Number	Description
405000.902	ACS-3 Chiller System 220–230 VAC, 50 Hz
986300.901	DMA 850 Air Chiller Panel (for use with the ACS-2 and ACS-3 Air Chiller Systems)

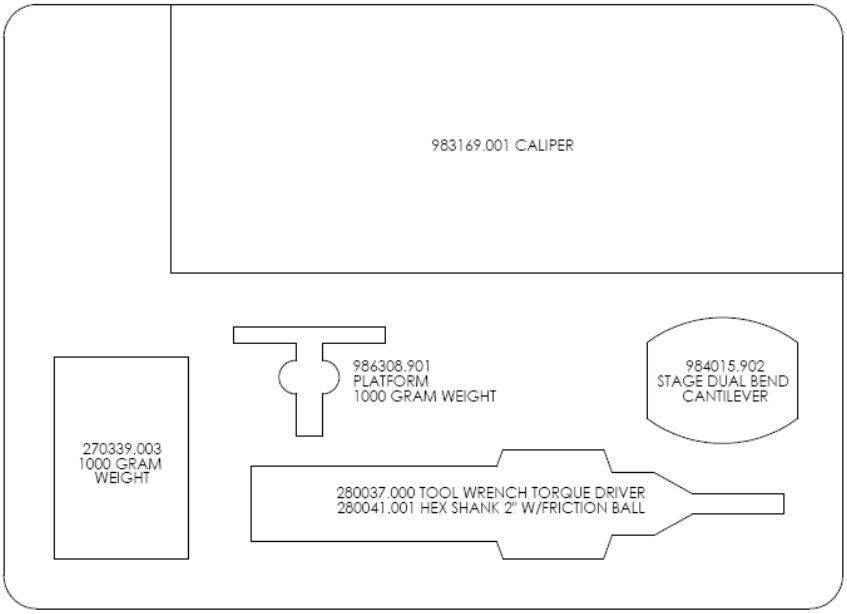
Appendix A:

DMA 850 Accessory Case Contents

Accessory Case Contents

Top Layer

The following items are stored in the top layer DMA 850 accessory case:



TOP LAYER

Bottom Layer

The following items are stored in the bottom layer DMA 850 accessory case: