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VICI®

Valco Instruments Co. Inc.

Dynacalibrator
Model 500
Instruction Manual

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9/13

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Symbols used in this document



Attention



Radiant heat warning



Entanglement warning



Electrical warning

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Introduction

General Description

VICI Metronics Dynacalibrators® use Dynacal® permeation devices to generate the precise gas concentrations necessary for calibrating air pollution analyzers, monitors, and other instruments that measure gas concentrations in the parts-per-million range and lower.

Dynacalibrators are available in four models, each with a large variety of optional features to fit a wide range of calibration requirements. All critical factors, such as permeation rates, gas flow rates, and permeation chamber temperatures are calibrated against standards traceable to the National Institute of Standards and Technologies.

Model 500 specifications are listed on page 5.

Dynacal Permeation Devices

Metronics Dynacal permeation devices are the simplest and most reliable method for supplying a source of trace quantities of various gases. They can accommodate virtually any requirement for generating low concentrations of gases. Permeation rates from thousands of ng/min down to fractional parts of a ng/min are possible. The devices can be supplied filled with any one of hundreds of different compounds, both organic and inorganic.

How to Use This Manual

This manual provides installation, operation, and maintenance information for all configurations of the Model 500. The identification tag on the rear panel of every Dynacalibrator is stamped with the unit's complete model number, which reflects the exact unit configuration. A chart on the last page of the manual explains the model numbers.

Basic Design

The Model 500 contains three calibrated gas regulating systems – two carrier systems and one dilution system. Each fixed flow carrier system includes a permeation chamber containing the permeation device. The temperature of each chamber controls the permeation rate of the calibration gas from the permeation device. Each chamber temperature is set and monitored at the front panel, or remotely by serial communication. Each chamber temperature is adjustable from 30°C (or 2°C above ambient, whichever is higher) to 110°C.

Each carrier stream can be selected independently, or both carriers can be added together with the dilution stream. The dilution gas stream is pumped through an adjustable valve and a flowmeter to the mixing tee for each carrier stream. Front panel access to the valve and flowmeter permits the user to accurately set the dilution stream flow rate that will be mixed with the selected carrier stream(s), thereby controlling the concentration of the calibration gas available at the outlet port of the calibrator

As indicated in **Figure 1**, the carrier stream passes through scrubber #1 and micron line filter LF1 to the differential pressure regulator DPR1. The scrubber contains specially-activated charcoal designed for broad-based scrubbing action. This scrubbing medium is particularly effective in removing sulfur dioxide and other sulfur compounds.

The differential pressure regulator and carrier flow restrictor FR1 together provide a highly stable carrier stream flow rate to the permeation chamber. The flow rate through the orifice is a function of the pressure differential across it; this differential is maintained at 3.2 psi by DPR1.

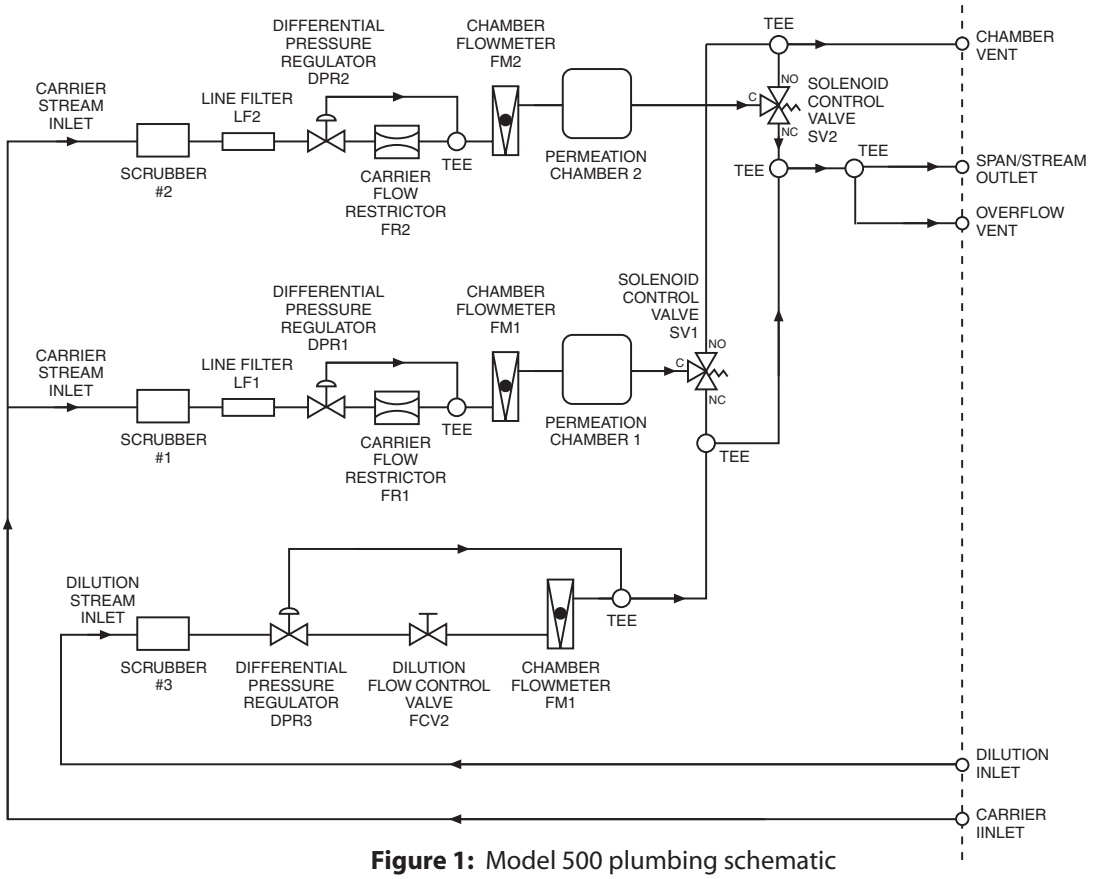


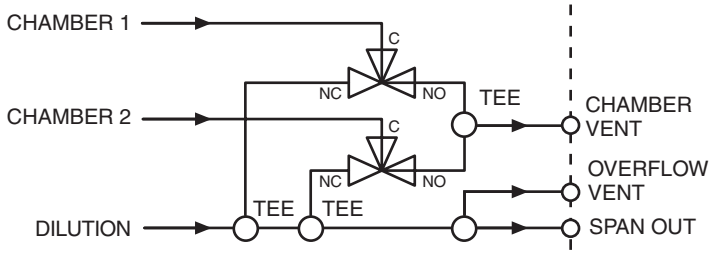
Figure 1: Model 500 plumbing schematic

The output of the permeation chambers is fed forward to SV1 and SV2, respectively. When the front panel switches are ON for SPAN 1 and/or SPAN 2, then the respective carrier flows are routed through the valves' C and NC ports and to the mixing tee, where the calibrated dilution stream is added and mixed into it to set the final concentration. When neither SPAN 1 nor SPAN 2 are selected, both SV1 and SV2 are de-energized, and the chamber output passes through its C and NO ports to the chamber vent. The dilution stream alone then passes through the mixing tee. The output of the mixing tee is split by another tee and fed to the overflow vent and solenoid control valve SV3.

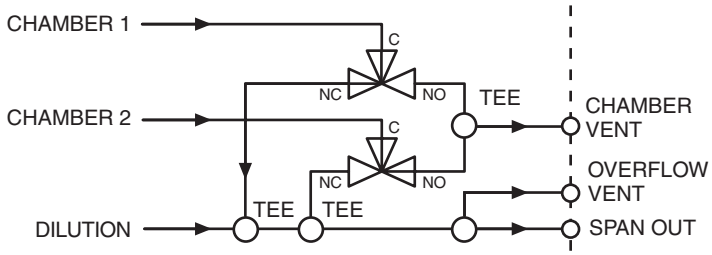
The overflow vent is usually left open, but can be plumbed to an external exhaust port. Any exhaust plumbing must be sized so that it doesn't cause any increased pressure into the analyzer under calibration.

Referring again to **Figure 1**, note that the dilution stream passes through scrubber #3 and feeds into differential pressure regulator DPR3. The Model 500 contains a dilution flow control valve and rotometer, plus a rotometer for SPAN 1 and SPAN 2 carrier flows. When energized, solenoid control valve SV1 opens to route carrier 1 flow to the mixing tee. Differential pressure regulator DPR1 maintains a fixed 3.2 psi pressure differential across the selected flow control valve and meter. The flow rate through the selected flowmeter is then a function of this fixed pressure differential and the carrier flow control orifice FR1. The desired dilution flow, set using FCV2, is mixed with any selected permeation chamber output to provide a final output concentration.

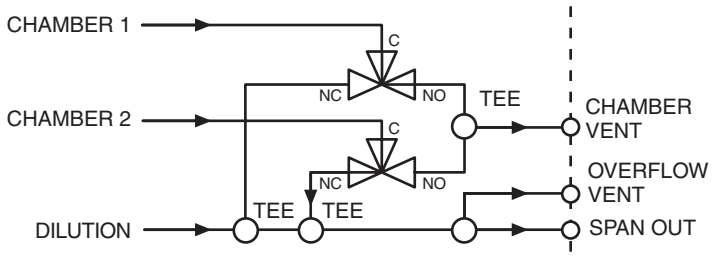
Zero mode



Span 1



Span 2



Span 1 + Span 2

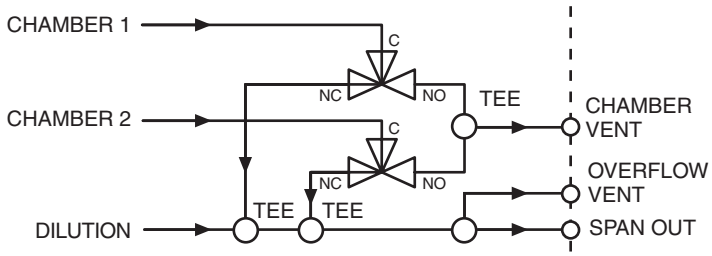


Figure 2: Model 500 output flow configurations

The Model 500 has four modes of operation – ZERO, SPAN 1, SPAN 2, and Both SPAN 1 and SPAN 2. When the calibrator mode is changed to ZERO, SPAN 1, or SPAN 2, a two position valve in the calibrator interrupts the sample input and substitutes the calibrator output to the analyzer.

ZERO (neither SPAN 1 nor SPAN 2 on), SPAN 1, SPAN 2, and SPAN 1 + SPAN 2 can provide three points of calibration along with a zero reference. The ZERO mode vents the outputs from the permeation chamber through an exhaust port so that only the dilution stream passes through the mixing tee to the stream outlet port and into the analyzer for zero point calibration.

The SPAN 1 mode mixes the carrier stream with the dilution stream from a high-flow control valve and flowmeter for low output concentrations of the trace gas. In the SPAN 2 mode, a low-flow control valve and flowmeter are substituted for the high flow components in the dilution stream to produce high output concentrations of the trace gas. Front panel access to the control valves for each of the two dilution flow-meters permits the user to accurately set both a low and high output concentration and switch between them and zero air for the three-point check.

Options

The following paragraphs provide general information on each, with more detailed information found in “Advanced Theory of Operation” on page 24.

Input Configurations

The Dynacal 500 series is available with either single or dual gas supply. Both plumbing configurations rely on external feed gas supplies and regulators. The two gas inlet system allows for different gases to be used for carrier and dilutent. Both systems are available with nominal maximum flow capacities from 1 to 20 liters per minute.

Rack Mount Options

The standard Dynacalibrator is packaged in a free-standing case with carrying handles, for bench use. The units may also be packaged for mounting in a standard 19" equipment rack.

Special Customer Options

Special options, identified by the “S” at the end of the model number, are not covered in this basic manual. If your Dynacalibrator is equipped with a special option, the required additional information will be found on the Special Option Sheets in the back of this manual. The Special Option Sheets carry the serial number of the Dynacalibrator to which they apply.

Specifications

Operational

Output concentration range	Fractional ppb to hundreds of ppm
Carrier flow rate (nominal)	76, 180, or 375 cc/min, factory set and specified per unit
Dilution flow rate (nominal)	1,2,5,10,15, and 20 L/min full scale
Dilution flowmeter accuracy	+1% at each major flow setting above 3 +3% at 1,2, and 3 at 25°C ambient,
Permeation chamber	50% relative humidity and 760 mm Hg
Temperature range	30°C* to 110°C *or 2°C above ambient, whichever is higher
Temperature setpoint accuracy	+0.1°C (N.I.S.T. traceable) at any integral temperature setting at or above 30°C
Temperature setpoint repeatability	+0.05°C at any fixed ambient temperature
Temperature equilibrium time (nominal)	1.5 hour maximum
Size	Accepts devices up to 23.5 cm (9.25") long x 1.6 cm (0.62") diameter
Operational modes	Zero, span 1, span 2, and span 1 + span 2
Remote mode of oven temps	Serial RS-232
Operating Duty Cycle	Continuous

Environmental

Operating noise emission (at 3 feet)	45 to 50 dBa
Ambient operating temperature	20°C to 35°C
Operating humidity	0 - 95% relative humidity
Storage temperature	10°C to 40°C
Storage humidity	0 - 50% relative humidity
Operating altitude	10,000' MSL

Physical characteristics

Dimensions (standard case)	43.2 cm (17") wide x 60.3 cm (23.75") deep x 26.7 cm (10.5") high
Weight	21.3 kg (47 ibs)

Power requirements

Voltage and frequency	100-240 VAC, 50/60 Hz
Power consumption	150 W maximum
Power cord	6' power cord, standard 3-prong, U-ground plug

Options

Basic plumbing	Second gas supply inlet
Gas flow capacity	0.4 - 1 liter/min 0.4 - 2 liters/min 0.4 - 5 liters/min 0.4 - 10 liters/min 0.4 - 15 liters/min 0.4 - 20 liters/min

Getting Started

Every Dynacalibrator is completely calibrated, thoroughly tested and inspected, and carefully packed prior to shipment. The carrier has assumed responsibility for its safe delivery upon acceptance of the shipment.

Initial Receiving Inspection/Check

On receipt of your unit, before signing the waybill and releasing the carrier's agent, inspect the shipment for the following:

1. The number of cartons received tallies with that on the waybill.
2. The weight of the shipment agrees with that on the waybill.
3. There is no visible evidence of damage to the shipment or its containers.
4. Check the condition of the shock sensors on the sides of the box. If any indicator is tripped please note this with the carrier immediately.

Any discrepancies to the above must be clearly described on the waybill and signed by the carrier's agent. Failure to adequately describe such external evidence of loss or damage may result in the carrier refusing to honor any subsequent claim.

Unpacking the Dynacalibrator

After the initial receiving inspection and check, the Dynacalibrator may be unpacked. A carefully sized and mated pair of shipping cartons have been designed to ensure against any damage to the Dynacalibrator while it is in transit. Use the following procedures to remove the instrument from the packaging, referring to **Figure 3** as necessary.



Save all the packing materials – both cartons, the eight corner blocks, and the two inner carton supports – for any future shipment of the Dynacalibrator.

1. Neatly slit the shipping tape along the edges of the flaps on the top of the carton with a knife. Do not try to pull or tear the tape.
2. Open the outer carton and remove the four corner blocks on top of the inner carton.
3. Neatly slit the shipping tape along the edges of the flaps on the top of the inner carton with a knife. Take care to penetrate the tape with the knife only far enough to cut it. The Dynacalibrator is directly beneath the flaps.
4. Carefully lift the Dynacalibrator out of the inner carton.

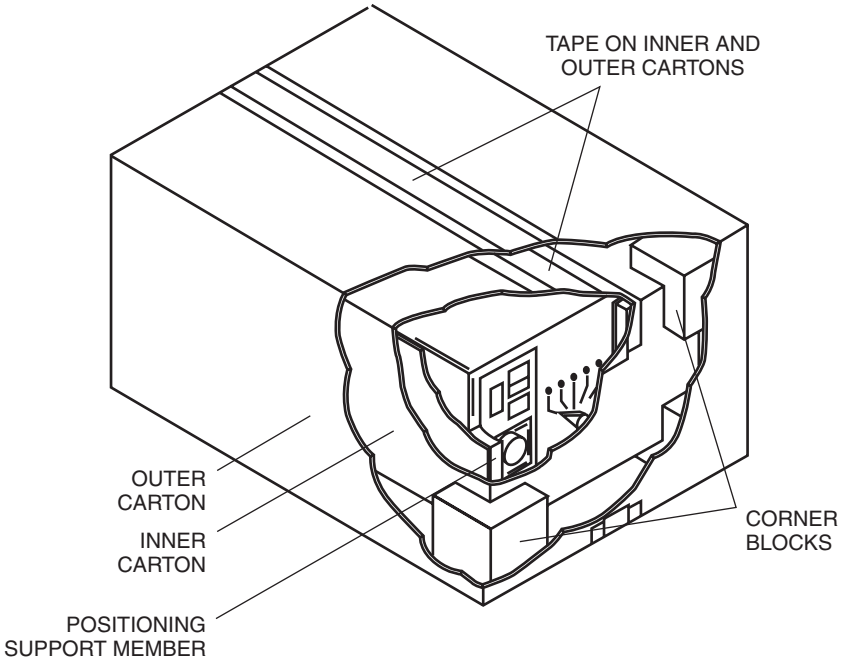


Figure 3: Dynacalibrator packaging

Concealed Damage

Concealed damage is damage which is not apparent until after the equipment has been unpacked and examined or tested. In the event that concealed damage is discovered, a written request for inspection must be forwarded to the carrier's agent within 15 days of the delivery date. All cartons and packing materials must be kept intact for the inspection. Delay in submitting the inspection request or destroying the packing materials may give grounds for refusal of any claim.

After inspection, the carrier's agent will usually request the return of the equipment to VICI for inspection and repair. When this work is completed, the equipment will be returned to you with an invoice itemizing charges for all repairs. This invoice will become part of your claim to the carrier.

In the case of shipments made F.O.B. destination, VICI will, at your request, handle the filing of damage claims with the carrier provided an acceptable inspection report from the carrier is furnished to VICI. If, however, the claim is disallowed through no fault of VICI, repair charges will be billed directly to you.



You must unpack and fully inspect the equipment and file a written request for inspection with the carrier within 15 days of delivery to ensure claim satisfaction in the event of concealed damage.

Unit Location

In general, the Dynacalibrator should be as close as possible to the analyzer to be calibrated, as long as:

- the ambient temperature is at least 2°C below the selected operating temperature of the permeation chamber.
- ambient temperature variations are minimal.
- exposure to precipitation and condensation is minimized.
- air flow around the unit's cooling vents and rear panel fan intake is not blocked or restricted, particularly for the rack-mounted units.
- it is on a level surface, to prevent errors in flow determination caused by a non-vertical flowmeter



When the Dynacalibrator is installed in an instrument rack, the user must make certain that the overall rack ventilation/ cooling is adequate.

A bench-mounted Dynacalibrator should be placed on a firm horizontal surface – preferably the same surface as the analyzer to be calibrated. A rack-mounted enclosure in a mobile installation (van, aircraft, etc.) requires additional mechanical support between the rack and the rear of the enclosure. This additional support is not needed for slide-mounted enclosures.

Once the Dynacalibrator has been unpacked and a location selected, check the packing slip included with the shipment to verify that all the ancillary parts (forceps, etc.) are available. In the event of a discrepancy, please notify VICI immediately.

Permeation Device Conditioning

Dynacal permeation devices must be conditioned prior to their use in the Dynacalibrator. Proper conditioning ensures that the device performs at its specified mass permeation rate and accuracy.

Conditioning is accomplished primarily by heating the device for a specified time period in a temperature-controlled environment (at the intended operating temperature ±1°C) through which there is a steady purge of dry gas at a minimum of 80 cc/min.

Since conditioning for each specific device is a function of a variety of factors, inflexible rules or recommendations cannot be included here. Contact VICI Metronics for conditioning information for your permeation devices.

Rear Panel Connections

Remove all shipping caps and shipping plugs from the rear panel bulkhead fittings. All these hardware items should be saved for reuse if the Dynacalibrator must be stored or returned to VICI.

The connections available on the rear panel of the different models and configurations are listed in **Table 1**. If a plumbing connection is required, the block under the fitting heading is marked with an "X"; if there is no connection, the block is blank.

Fitting locations are identical for all configurations. Fitting holes which are not used are equipped with blank caps. All connections are clearly marked and easily identified.

Model	Inlets				Outlets			Bypasses		Vents	
	Sample	Supply	Carrier	Dilution	Stream	Span	Zero	Carrier	Dilution	Overflow	Chamber
500-0			X			X				X	X
500-1			X	X		X				X	X

X = Required connection
blank = No connection

Table 1: Dynacalibrator Model 500 rear panel connections

Supply Inlet

All Dynacalibrators except those with -1X input configurations (separate carrier and dilution inlet ports) are equipped with a supply inlet fitting. The supply inlet must be connected to an external pressurized source of carrier and dilution gas such as an external pump, a cylinder of compressed gas, etc. The most commonly used gas is dry air; however, dry nitrogen or any other comparably inert gas including ambient air may also be used.



The pressure of the external gas source connected to the supply inlet must be at least 10 psig but no more than 25 psig. High pressure pumps and gas cylinders are potentially very dangerous. Extreme care must be exercised when making or breaking connections between the Dynacalibrator and external gas sources. A suitable relief valve and/or regulator must be employed on all external sources.

If there is a need to condition the incoming external source of gas (external pump or pressurized cylinder), the conditioning filters, scrubbers, dehydrators, *etc.* should be placed on the supply stream before it is connected to the Dynacalibrator inlet.

Carrier/Dilution Inlets

All 500 Series Dynacalibrators are configured with either a single inlet (500-0-***) or a dual inlet (500-1-***) and therefore require an external source of pressurized gas. On dual inlet systems two different types of gas can be used – one for dilution and one for carrier. The most commonly used gas is dry air; however, dry nitrogen or any other comparably inert gas including ambient air may also be used.



CAUTION: Externally supplied pressurized gas sources MUST be limited to a pressure range of 10 psig minimum to 25 psig maximum at these inlets.

Span and Zero Outlets

The primary outlet on the Model 500 is labeled SPAN OUTLET. The span outlet may be either permanently plumbed to the calibrate input port of an analyzer or temporarily connected to its sample input for calibration, depending on the capabilities of the analyzer.



NOTE: The span outlet port should be directly connected to the analyzer input with a minimum length of tubing. Altering the output stream in any manner may affect the concentration of calibration gas in the stream.

Overflow Vent

All Dynacalibrators include an overflow vent to dump excess calibration gas, ensuring that analyzers sensitive to sample feed pressure receive a supply from the Dynacalibrator at near atmospheric pressure. The overflow vent is therefore usually left open, or plumbed to an external exhaust point with large diameter tubing. External devices (filters, etc.) or tubing with too small a diameter on the overflow vent may cause an undesirable increase of pressure at the analyzer's input.

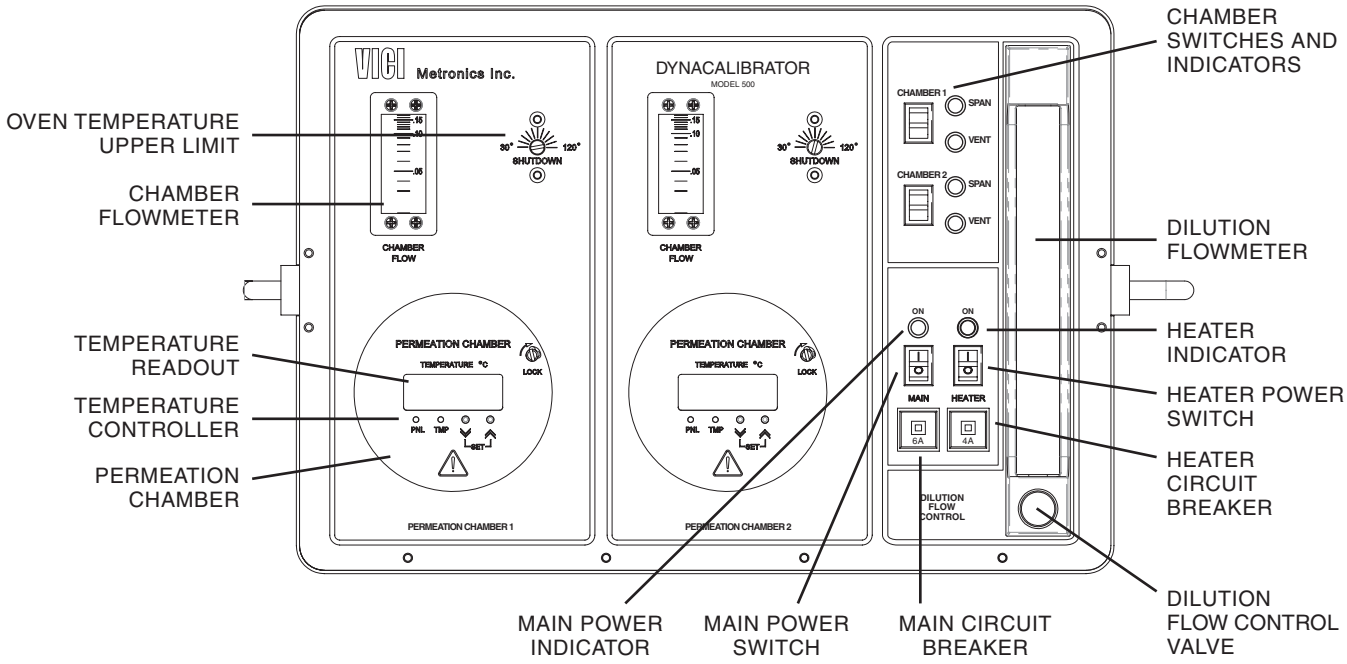


Figure 4: Model 500 front panel controls and indicators

Front Panel Controls and Indicators

The section entitled "Advanced Theory of Operation" beginning on page 24 includes more detailed information on the interrelation of the front-panel controls and indicators with the internal pneumatic and electrical flow of the units.

MAIN POWER switch, indicator, and circuit breaker
The push-button switch provides primary power to all circuits. The LED indicator lights when main power is on. A 6 amp circuit breaker is installed in the main primary power input line to all circuits.

HEATER POWER switch, indicator, and circuit breaker
The push-button switch provides primary power to the heater circuits when the main power switch is on. The LED indicator lights when heater power is on. A 4 amp circuit breaker is installed in the primary power line to the permeation chamber heater circuits.

PERMEATION CHAMBER
This is the chamber which holds the permeation devices. A tool is provided to rotate the panel lock screw 90° counterclockwise to unlock the cap.

CHAMBER FLOWMETER
A ball float and gauge in the carrier stream immediately preceding the chamber indicates relative carrier flow. The actual carrier flow is set at the factory. Refer to the calibration sheet at the back of the manual.

TEMPERATURE readout and controller
The front panel displays the current chamber temperature and the control status of the instrument, indicated by the PNL and TMP lights. The chamber

temperature can be set manually through the controls on the front panel or remotely through RS-232 communication. *(Refer to the chapter entitled "Serial Port Communications on page 17)*. After a temperature set point is entered by either method, it is written to memory so that after a power failure the unit will return to the condition previously established.

DILUTION FLOW CONTROL VALVE
Turning the knob on the Dilution Flow Control Valve clockwise will increase the diluent flow that will mix with any selected carrier flow. If neither Span 1 nor Span 2 are selected, this flow will act as a Zero gas at the SPAN OUTLET.

DILUTION FLOWMETER
The ball floats and gauge indicate the dilution stream flow rate, and are controlled by the dilution flow control knob. Factory calibrated flow rates at integral float settings are provided at the rear of the manual.

OVEN TEMPERATURE UPPER LIMIT
A thermostat provides a safety shutoff at this user-defined setpoint, usually 5 - 10 degrees above the normal run temperature of the permeation device in use. If the oven runs out of control and the temperature goes above this setting, power to the oven heater is shut down and a "PFAIL" indication appears in the temperature display window.

CHAMBER switches and indicators
Series 500 Dynacalibrators have two permeation chambers. Each chamber has a switch which places the chamber in line with the diluent stream, and two indicators to provide visual confirmation of the switch setting. Each chamber is functionally independent, so that the user can select either, both, or neither chamber to be in line with the diluent stream. These options allow four possible settings:

- ZERO, or CHAMBER 1 VENT/CHAMBER 2 VENT: Zero is effectively enabled when neither chamber is selected; only the diluent stream passes through the SPAN OUTLET. Use this setting to make sure there are no residuals in the output stream.
- CHAMBER 1 SPAN/CHAMBER 2 VENT: With Chamber 1 set to SPAN, the carrier flow from Chamber 1 is mixed with the diluent flow set by the Dilution Flow Control Valve. This combined flow is dispensed through the SPAN OUTLET port on the back panel. Increasing diluent flow decreases the concentration delivered; decreasing diluent flow increases the delivered concentration. In this setting, Chamber 2 carrier is vented and does not mix with the diluent.
- CHAMBER 2 SPAN/CHAMBER 1 VENT: With Chamber 2 set to SPAN, the carrier flow from Chamber 2 is mixed with the diluent flow set by the Dilution Flow Control Valve. This combined flow is dispensed through the SPAN OUTLET port on the back panel. Increasing diluent flow decreases the concentration delivered; decreasing diluent flow increases the delivered concentration. In this setting, chamber 1 carrier is vented and does not mix with the diluent.
- CHAMBER 1 SPAN/CHAMBER 2 SPAN: With Chambers 1 and 2 both set to SPAN, Carrier 1 and Carrier 2 are both mixed with the diluent flow controlled by the Dilution Flow Control Valve. The combined total flows of Carrier 1, Carrier 2, and Dilution Flow are distributed to the SPAN OUTLET port on the rear panel. The total flows of all three streams must be used for an accurate calculation of the delivered concentration.

Calculations

Concentration of the permeant compound in the span outlet stream is inversely proportional to the carrier flow rate through the chamber. It is determined using the following equation:

$$\text{Concentration (ppm)} = \frac{K * P}{F}$$

Where: K = 24.45 / molecular weight of gas
P = permeation rate in ng/min (information included with the permeation device documentation)
F = Chamber carrier flow (ml/min)

If the permeation rate is known for some reference temperature, the rate at a second temperature can be estimated as follows:

$$\log P = \log P_O + 0.034 (T - T_O)$$

Where: P_O = Permeation rate at reference temperature T_O
P = New permeation rate at temperature T



Certified devices should be used only at the temperature specified on the certificate.

Using any permeation device beyond its recommended temperature range could result in the destruction of the device by explosion and/or changes in the membrane characteristics. If in doubt, contact VICI Metronics with the part number of the device to determine its maximum temperature limit.

Sample Calculation

Given:
Permeation rate: 21,000 ng/min Cl_2 @ 30°C
Carrier flow: 500 ml/min

Then:

$$\text{Concentration (ppm)} = \frac{K * P}{F}$$

$$= \frac{(0.346)(21,000)}{500} = \mathbf{14.5\ ppm}$$

For zero reference measurement, remove the permeation device from the chamber.

Initial Power-Up

Connections

1. Plug the supplied power cord into the rear mounted power supply. Ensure that the power supply output cable is plugged into the interface board power connector.
2. Connect the carrier gas source (25 psi maximum pressure) to the carrier inlet on the rear panel.
   If this is a dual inlet system:
   Connect appropriate source gases to the carrier inlet and dilution gas inlet. The source must be of sufficient capacity to flow the maximum LPM of the sum of dilution and carrier combined on a single inlet system. The carrier inlet source must be able to provide at least 500 SCCM, and the dilution inlet must be able to source the maximum dilution flow, which may be as high as 20 SLPM.
3. Turn on the calibrator with the main power switch on the front panel. This supplies the fans, the control valves, and the pump, if so equipped.
4. Turn on the heater switch on the front panel. The display on the permeation chamber cover will display a boot sequence, followed by a display of the actual temperature.
5. Connect the span outlet to your instrument.



Always leak check the entire instrument and all flow connections, particularly if toxic, corrosive, or flammable gas mixes will be generated.

Use clean/dry air or N_2 to perform a pressure/decay test to verify the leak integrity of the system before putting it into service.

Chamber Temperature

- If the chamber temperature exceeds the value set by the mechanical temperature limit switch, the heater will automatically shut down and a warning screen will appear on the touch screen controller.
- When the front panel door is removed, the heater automatically shuts down.
- Always refer to the separate instructions accompanying the permeation tube(s) to make sure that the selected temperature is compatible with the permeation tube(s) being used.

The front panel displays the current chamber temperature and the control status of the instrument, indicated by the PNL and TMP lights. *(Refer to Figure 4 on page 11.)* The chamber temperature can be set manually through the controls on the front panel or remotely through RS-232 communication. *(Refer to the chapter entitled "Serial Port Communications" on page 17)*. After a temperature set point is entered by either method, it is written to memory so that after a power failure the unit will return to the condition previously established.

Setting the Chamber Temperature Manually

To read the current set point: press and hold the ⩓ button.
To read the chassis environment temperature: press and hold the ⩔ button.

1. To set the desired temperature, simultaneously press the ⩓ and ⩔ buttons, then release them. The PNL light will start flashing, indicating the controller is in the temperature set mode.
2. Use the ⩓ and ⩔ buttons to reach the desired temperature set point. NOTE: Maximum temperature set point is 110°C; minimum is 30°C.
3. To enter or register the desired temperature set point, simultaneously press the ⩓ and ⩔ buttons, then release them. The PNL light will stop flashing. If the set point is not entered, after two minutes the controller will ignore the temperature in Step 2 and revert to its previous status.

To prevent the set point from being accidentally changed, the front panel controls can be disabled with a serial command. Refer to the section titled "Serial Port Communications" on page 17.

Setting the Oven Temperature Limit

A mechanical thermostat is integrated with the temperature control circuit for fail-safe temperature control. This thermostat should be used to prevent accidental overheating of low temperature permeation devices or permeation devices containing toxic or hazardous chemicals. Overheating can rupture the device or cause an unintended release of chemicals.

The temperature markings on the front panel are approximate (±10°C). For a more accurate setting:

1. Using a flat-tipped screw driver or the tool provided, adjust the setting all the way clockwise.
2. Turn on the Dynacalibrator main power and heater power. Do not install any permeation devices yet.
3. Set the chamber temperature 5°C higher than the desired operating temperature, and wait for temperature equilibrium.
4. After equilibrium, slowly rotate the limit switch counterclockwise until the display reads "PFAIL". (You may hear a faint click.)
5. Turn off the heater power switch and wait 15-20 minutes for the chamber to cool.
6. Turn on the heater power switch and set the chamber operating temperature.



When PFAIL occurs, the Dynacalibrator must be turned off long enough for the chamber to cool before the power is turned back on.

Setting the Chamber Temperature via Serial Port (RS-232)

Refer to the section titled "Serial Port Communications" on the next page.

Installing the Permeation Device(s)

1. With the tool provided, rotate the panel lock screw 90° counterclockwise.
2. Remove the front panel oven cover to access the chamber cap.



CAUTION: The permeation chamber cap may be warm to touch.
If the calibrator has been in use, avoid exposure to gas vapors while opening the chamber cap by using appropriate mitigation and personal protection equipment.

3. Unscrew the chamber cap with the tool provided.
4. Add or remove the permeation device(s) with the supplied forceps or other tool appropriate to the job..
5. Secure the chamber cap with the tool provided.
6. Run a pressure/decay test to make sure that the chamber cap is leak tight.
7. Reinstall the front panel assembly and rotate the panel lock screw 90° clockwise.
8. Allow one hour for equilibration. Refer to the separate instructions accompanying the permeation tube to make sure that the selected temperature is compatible with the permeation tube being used.

The Dynacalibrator is ready to be put into service.

Important Permeation Device Considerations

- If more than one tube is to be used in the oven at the same time, order all the tubes with permeation rates given at the same temperature.
- Certified permeation devices should be used only at the temperature specified on the certificate.
- Using any permeation device beyond its recommended temperature range could result in the destruction of the device by explosion and/or changes in the membrane characteristics. If in doubt, contact VICI Metronics or their authorized representative with the part number of the device to determine its maximum temperature limit.

Serial Port Communication

The Dynacalibrator Model 500 can be monitored and controlled remotely by means of a serial port connection and a terminal emulation program such as HyperTerminal®.

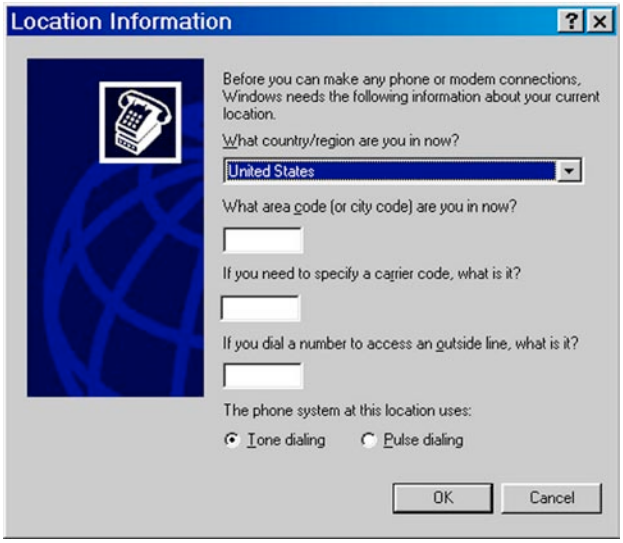
The unit is controlled by entering two-character commands, shown in the table below. Commands may be either upper case or lower case. Parameters enclosed in brackets ([ ]) are optional. Note that for enable/disable commands, the states indicated by an "*" are the defaults at power-up. Only the altered set point temperature and function coefficients are retained when power is off and restored at power-up.

Command	Meaning
DC[[=] n]	Show/set decimation count *(Data logging rate, in seconds)*
L+	Start data logging *(Log data at the interval set by the decimation count: DC=1 sets a one second interval)*
L-	Stop data logging*
P+	Enable front panel control*
P-	Disable front panel control *(Prevent set point from being changed with panel controls)*
SC	Show coeffecients
TE	Read environment temperature
TR	Read controlled temperature
TS[[=] n]	Show/set temperature setpoint
VR	Show firmware version
??	Display the list of available commands

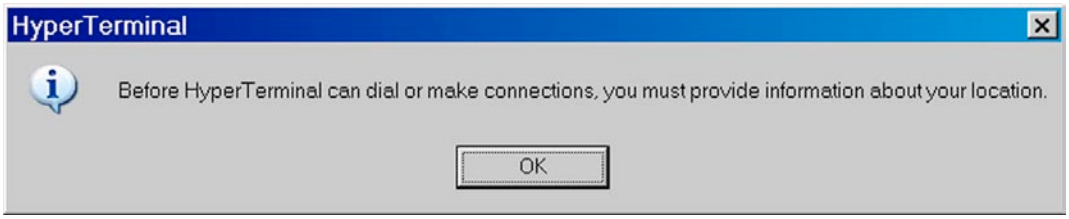
* Factory defaults, reset at start-up

Setting Up Serial Communication via HyperTerminal®

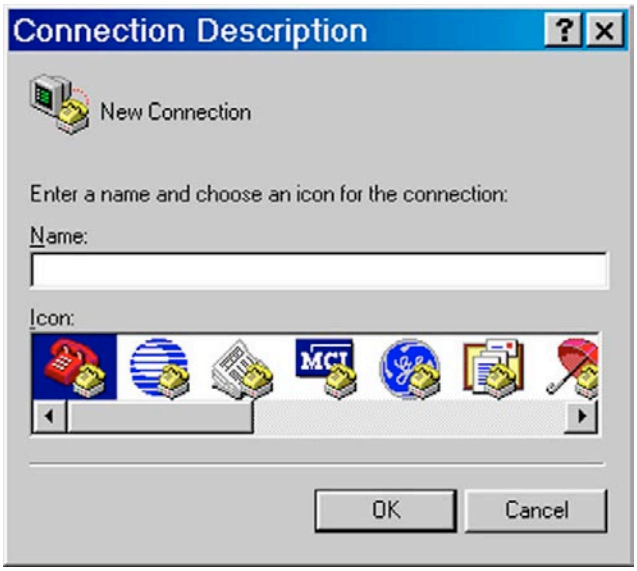
1. To open HyperTerminal in Windows®, click Start > Programs > Accessories > Communications > HyperTerminal. The following screen will appear:



2. Click "Cancel". Since no modem is involved, this information is not necessary. The following screen will appear:



3. Click "OK", which reveals the next screen:

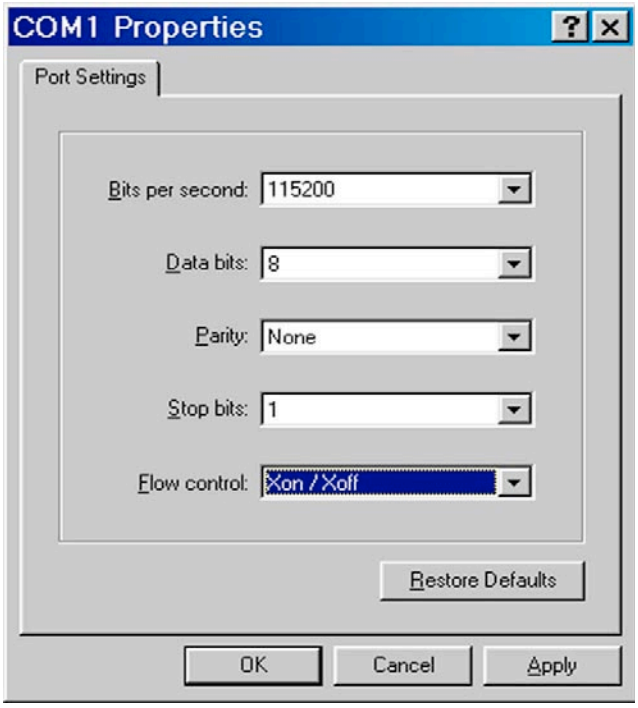


4. Enter a name, such as "dyna500", and select an icon to associate with the file. Then click "OK".

5. If necessary, click through the warning screens again to get to this screen:

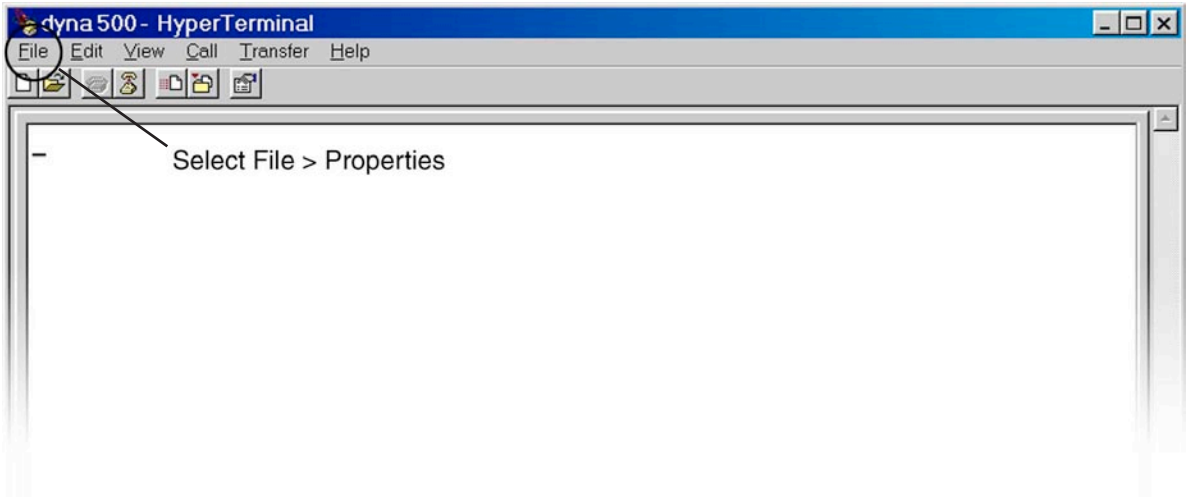


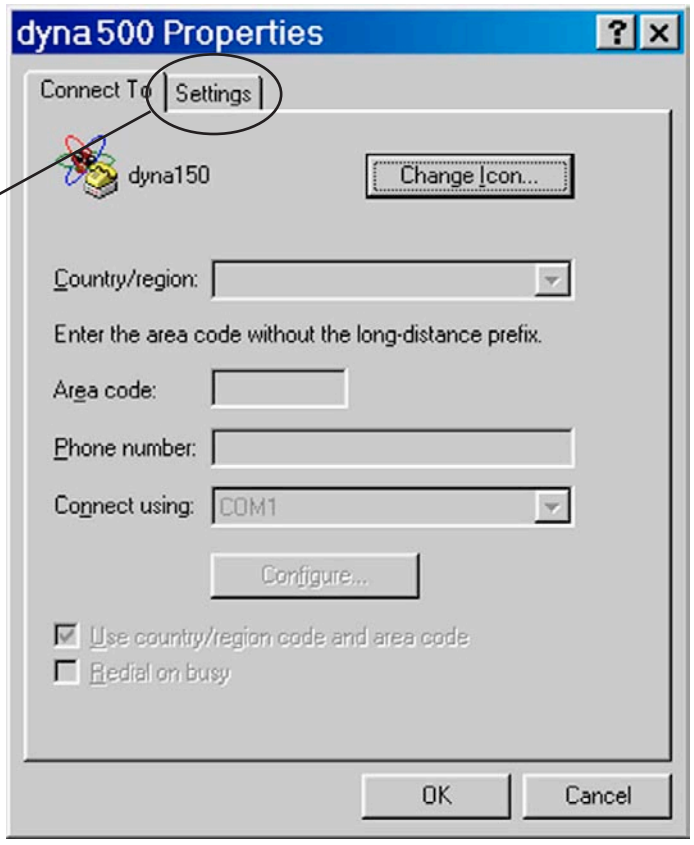
6. Select the appropriate COM port and click "OK" to bring up this screen:



7. Set the port parameters as indicated above, and click "OK".

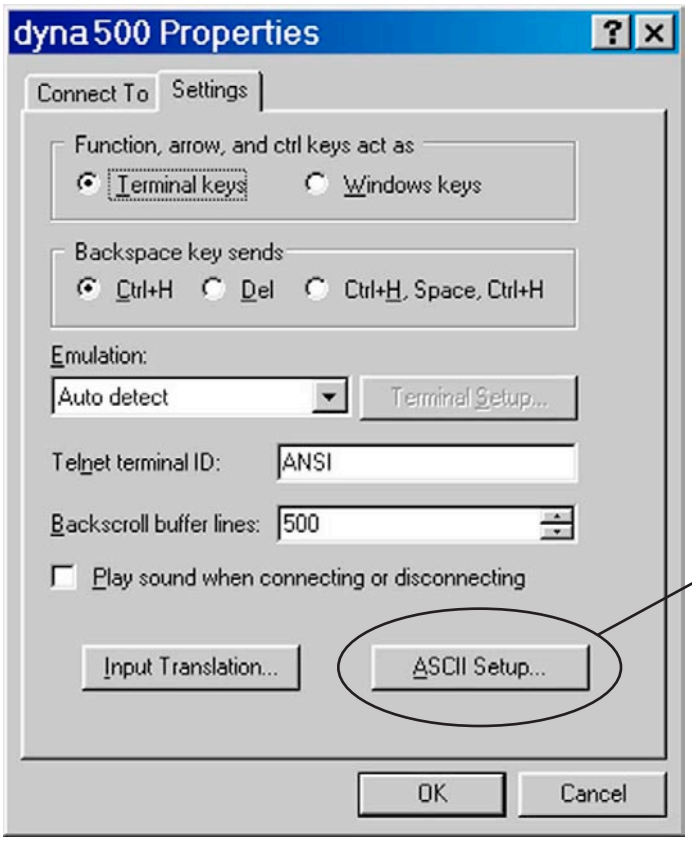
8. Now we are at the dyna500 HyperTerminal screen (below). Select "File", then "Properties:





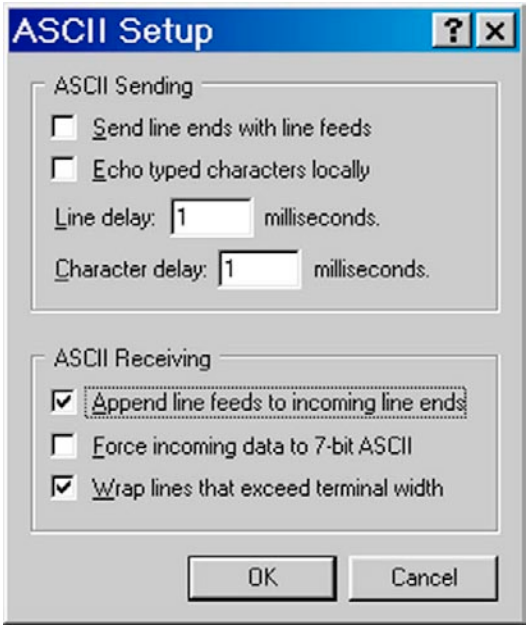
Click "Settings"

9. On the dyna500 Properties screen (above), click "Settings" to bring up the screen below.



Click "ASCII Setup..."

10. Click "ASCII Setup" and set the parameters as indicated below. Click "OK".



11. When the screen returns to Dyna500 HyperTerminal *(page 19, bottom illustration)*, click "File", then "Save" to save this Dynacalibrator Model 500 communications setup.

The following text will be displayed in the HyperTerminal window when communication is first established with the Dynacalibrator Model 500:

Parameters recovered.
Program checksums ok.
Initializing SPI . . . ok
Initializing A/D . . . ok
Initializing IIC . . . DS1624 started
Valco Dynacalibrator online.

A simple processor test can be performed by opening HyperTerminal before powering up the Dynacalibrator. If the processor has some defects, the message "Bad checksum in Block xxx" is displayed instead of line 2 above. If this occurs, please consult VICI.

Entering Commands

Each command must be followed by the <ENTER> key.

Examples:

To set the chamber temperature to 50°C, type "TS=50" and press <ENTER>.
To read the set point, type "TS" and press <ENTER>.
To read the current chamber temperature, type "TR" and press <ENTER>.
To start data logging, type "L+" and press <ENTER>. To stop data logging, type "L-" and press <ENTER>.

Analyzer Calibration

After the power-up procedure has been completed and the chamber temperature and permeation device have reached equilibrium, the Dynacalibrator is ready to be connected to the analyzer being calibrated. Use a minimum length of tubing for the connection, and make sure none of the calibrator's vents are blocked.

1. Place the Dynacalibrator in the ZERO mode.

2. Connect its stream outlet to the input of the analyzer. Make sure that the total flow of zero air (as indicated by the dilution flowmeter alone) exceeds the suction rate of (all) the analyzer(s) being calibrated.

3. Adjust both dilution flow control valves to the pre-calculated span points, making sure as always that the total calibrator output flow exceeds the suction rate (total of the suction rates) of the analyzer(s) being calibrated. Align the centers of the floats in the flowmeters to the selected scale readings. Allow the analyzer reading to stabilize at the zero point (usually about ten minutes) before calibrating or recording the reading.

4. Switch to the SPAN 1 and SPAN 2 modes, checking the dilution flow setting and allowing the analyzer sufficient stabilization time at each point.

If the Dynacalibrator will be operated remotely, perform the above procedure one time manually before switching to the REMOTE mode. Also, a remote timer-sequencer must be adjusted for sufficient analyzer stabilization time at each calibration point.

Shutdown Procedure

Dynacalibrators are designed to operate continuously; however, if it is necessary to turn the unit off, use the following procedures:

1. With the tool provided, rotate the panel lock screw 90° counterclockwise.
2. Gently pull the front panel assembly out.



CAUTION: The permeation chamber cap may be hot. If the calibrator has been in use, avoid exposure to gas vapors while opening the chamber cap.

3. Unscrew the chamber cap with the tool provided.
4. Remove and contain permeation devices in an appropriate manner as described in permeation device literature..
5. Secure the chamber cap with the tool provided,
6. Reinstall the front panel assembly and rotate the panel lock screw 90° clockwise.
7. Place devices in the containers provided and store them in an appropriate place until further use is required. (A refrigerator or freezer is recommended.)
8. Allow the carrier flow to purge the chamber for about five minutes
9. If the unit will be left unpowered for an extended length of time, disconnect all the plumbing from the rear panel inlets and outlets and cap them.

When repowering the unit, always perform the start-up procedures starting on page 14.

Advanced Theory of Operation

Dynacalibrator operation is based on the principle of mixing a known mass flow of gas derived from a permeation device with a metered stream of clean carrier/dilution gas to generate a precise concentration of span gas.

User-selectable calibration gases originate from Dynacal permeation devices which are maintained at a user-selectable constant temperature within the Dynacalibrator's permeation chamber. Permeation rates can be precisely determined gravimetrically as a function of temperature.

An internal flow regulating system ensures a stable gas flow over extended periods of time for both the carrier air and dilution air streams. The carrier stream continuously sweeps the permeation gas from the permeation chamber. This stream then mixes with the dilution stream to provide the final calibration as supply.

Different span gas concentrations can be generated by changing one or a combination of the following parameters: (1) the dilution stream flow rate, (2) the permeation chamber temperature, or (3) the number and/or type of permeation devices. The fastest, simplest, and most common method is to change only the dilution flow rate.

The carrier flows at a fixed rate, maintained at a constant value by a sapphire orifice plate and a differential pressure regulator. Orifice sizes are available for rates of 80-376 sccm.

The dilution flow is user-adjustable from approximately 100 cc/min to over 20 liters/min, depending on the capacity option selected. Model 500 Dynacalibrators contain a single dilution flow control valve and rotameter. Since the Model 500 can provide a wide dynamic range of span gas calibrations simply by changing the flow rate of the dilution gas, it is considered to be a multi-point calibrator of exceptional range, accuracy, and precision.

Each Dynacalibrator model contains basic pneumatic plumbing, with several configuration options. The plumbing configuration selected (see the simple diagram below) processes the input gas supply into a carrier stream and a dilution stream. The carrier stream picks up the calibrated trace gas and is subsequently mixed with the dilution stream for the desired output concentration.

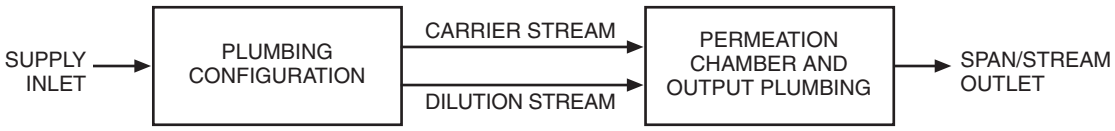


Figure 5: Basic block diagram

Plumbing Configurations

There are two plumbing configurations available for Model 500 Dynacalibrators. The plumbing configuration is defined by the first digit of the 2-digit numerical suffix to the basic model number, *e.g.*, Model 500-12 is equipped with plumbing configuration 1. The second digit of the 2-digit suffix defines the overall instrument gas flow capacity. A lower case letter is added to this number to indicate the carrier flow (and the orifice used). Refer to page 4 for information about the available flow capacity ranges.

Many of the plumbing components of the Dynacalibrator, such as the dilution flowmeter, are rated for the different flow capacities. The following discussion disregards these differences and describes the basic flow through the unit in relative terms.

Configuration 0

The plumbing configuration designated "0" (**Figure 6**) consists of a single input port, an integral micron filter/pressure regulator assembly, and a tee. Dry gas (air, nitrogen, etc.) at the appropriate pressure is supplied by the user to the supply inlet on the back panel. Particulates larger than 30 microns are removed by filter F1. Line regulator PR1 is set at the factory to deliver 10 psig gas to the working parts of the instruments. The output of PR1 is split by the tee into the carrier and dilution stream paths.

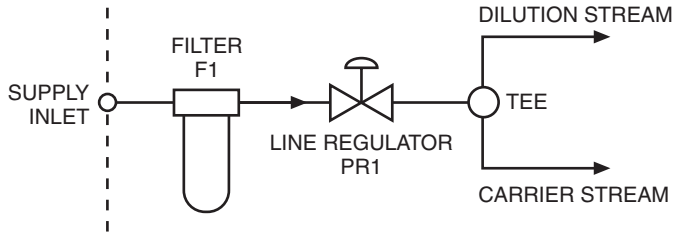


Figure 6: Diagram of configuration 0

Configuration 1

Figure 7 shows plumbing configuration "1". Each line – carrier and dilution – contains its own input port and an integral micron filter/pressure regulator assembly. User-supplied gas is filtered and regulated down to 10 psig by the factory-set line regulator for the carrier and dilution stream paths.

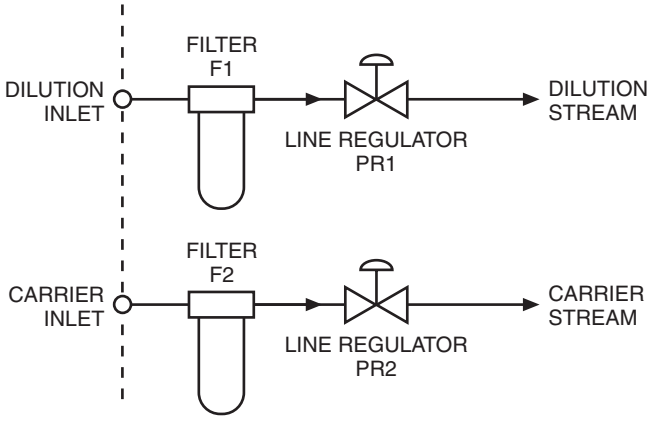


Figure 7: Diagram of configuration 1

Electrical Description

The basic wiring of the Model 500 is shown schematically in **Figure 8**. Dynacalibrators are powered from a benchtop style transformer on the rear panel. This is a switcher-style supply that allows a range of input voltage and frequency from 100 to 240 VAC at 50-60 Hz. The power supply steps the voltage down and regulates the output to 24 VDC. If the cord end type is inappropriate for your locale, please contact Vici Metronics for a replacement cord.

The main power switch S1 is on the front panel, along with the main fuse F1. When the main power switch is on, 24 VDC energizes the main power indicator on the front panel, as well as the fan and stream switching solenoids.

Power to the permeation chamber heater is controlled by switch S2 on the front panel. There is a separate fuse F2 and indicator for power to the permeation chamber heater.

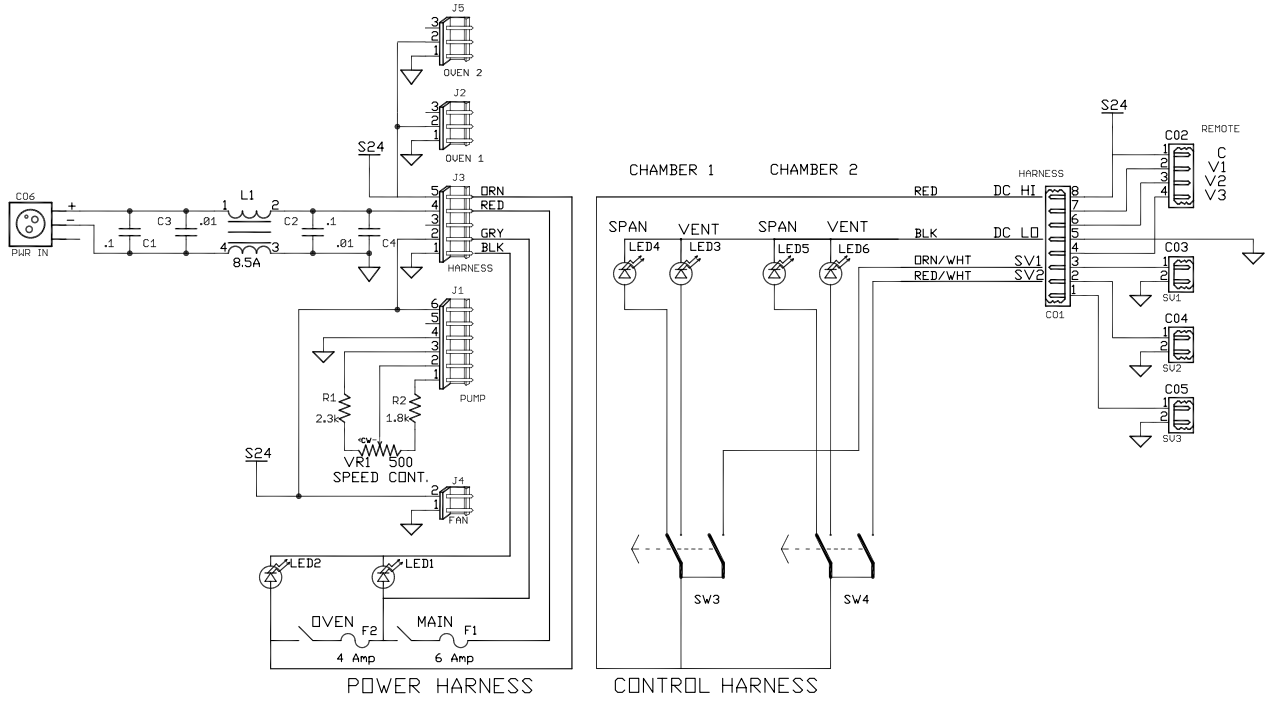


Figure 8: Model 500 electrical schematic

Maintenance

Since Dynacalibrators are designed for and generally used in applications that require continuous service, a planned routine maintenance program is highly recommended. Routine maintenance consists of inspection, cleaning, calibration, and leak checks. The table below lists the recommended checks and maintenance frequencies for continuous and non-continuous use. The recommendations are provided to help you keep your unit in peak operating condition and avoid catastrophic failures at inopportune times.

Use the shut-down procedures on page 23 to remove the unit from service and the turn-on procedures on page 14 to return it to service.

Maintenance action	Recommended schedule	
	Continuous use	Periodic use
Instrument inspection and cleaning	Quarterly	1000 hours
Leak check	Quarterly	1000 hours
Carrier flow rate verification	Quarterly	1000 hours
Filter inspection and cleaning	Quarterly	1000 hours
Dilution flowmeter calibration	Annually	4000 hours
Chamber temperature calibration	Annually	4000 hours

Instrument Inspection and Cleaning

The following procedure should be performed quarterly for units in continuous service or at least after every 1000 hours of service. For the steps which call for disassembly, see the appropriate paragraph in this section.

1. Remove the unit from service according to the shut down procedures on page 26. Disconnect all power and plumbing.

2. Remove the top cover of the unit by unscrewing the six allen screws on each side of the instrument, above the side bars..

3. Snap the black fan screen off the rear and soak it in warm water with a mild detergent. Do not use a solvent.

4. Remove the four screws, hex nuts, and lockwashers that attach the fan to the rear panel. Remove the fan filter and soak it with the fan screen in warm water and a detergent.

5. Blow out the interior of the unit thoroughly with dry, low-velocity air. Remove any dirt that remains with a soft paint brush.

6. Clean the fan blades with a soft paint brush or a soft cloth dampened in the water and detergent solution.

7. Clean the exterior surfaces of the unit with a soft cloth dampened in the water and detergent solution. Do not use an abrasive.

8. Inspect all wiring for any loose connections or broken insulation.

9. Inspect all assembly mountings for loose hardware, and tighten as necessary.
10. Rinse the fan screen and fan filter in clean water and blow dry with low-velocity air.
11. Reinstall the fan, fan filter, fan screen brackets, and fan screen using the four screws, lockwashers, and hex nuts.
12. Replace the top cover of the unit and return it to service according to the procedures on page 14.

Carrier Flow Rate Verification

The carrier flow rate is maintained at a constant value through use of a differential pressure regulator which keeps a constant 3 psi pressure drop through a sapphire orifice plate. The actual carrier flow rate of each unit is determined at the factory prior to shipment and noted on the Flowmeter Calibration Data sheet provided with each unit. The front panel carrier flowmeter provides only a relative indication of the flow; however, changes in its reading can indicate the need for flow verification. To verify the flow rate, a one liter N.I.S.T. traceable flowmeter is recommended. After using the appropriate leak checking procedures to determine that the calibrator has no leaks, proceed as follows:

1. Remove power from the unit.
2. Remove the top cover of the unit by unscrewing the six allen screws on each side of the instrument, above the side bars..
3. Close the dilution flow control valve(s) all the way (fully clockwise).
4. Plug the overflow vent securely.
5. Connect the flowmeter to the span outlet.
6. Connect main power to the unit and depress the main power switch. If the unit does not have an internal main pump, connect a gas source to the supply or carrier inlet.
7. Measure the flow rate to an accuracy of ±1% per the instructions in the flowmeter manual.
8. Record the flow rate on the current Flowmeter Calibration Data sheet for the Dynacalibrator.

Dilution Flowmeter Calibration

VICI recommends that Dynacalibrators be returned to the factory for N.I.S.T. traceable dilution flowmeter calibrations, unless you have access to sophisticated flow measuring equipment

Chamber Temperature Calibration

Prior to shipment, the permeation chamber digital temperature control is calibrated against the temperature of the gas in the permeation chamber using an NIST-traceable PRT, (platinum resistance thermometer). The results of this calibration have been supplied with your instrument.

At this point, it is helpful to give an overview of the total calibration process. A multiple point measurement is made with excursions to the extremes of range. The values logged during this process allow a calculation of correction that gives very tight agreement between the measured and the setpoint values. This calibration equation is downloaded into the control board, correcting the front panel display values to be within the tolerances of the controller.

In point of definition, measured temperatures are the equilibrium temperatures that result at specific temperature setpoints. Calibration is done by running multiple setpoints to characterize the response of the controller and oven. This characterization is then modeled and corrections are calculated based on the model response. The corrections are input and then the multiple setpoints are again run with the PRT, and must fall within the specification in order to move to final assembly. To define this process further is outside of the scope of this document and the range of work that is done by field services.

Calibration temperatures are integral Celsius temperatures (±0.1°C) that will exist in the permeation chamber at specific digital settings. These temperatures are always expressed in integers, since all permeation device calibrations are performed at integral Celsius temperatures. Dynacalibrator calibration temperatures are NIST-traceable to match permeation device calibrations which are also NIST-traceable.

Recalibration of all points is normally not required nor indicated. Recertification on an annual basis is recommended at the temperature setpoints where permeation devices will be used. Example: If an H2S permeation device is going to be used at 55°C, and a COS tube is being used at 40°C, then the recertification should be done at 2 points, 55°C and 40°C. This reduces the cost of recertification and cuts down considerably on the time in test.

Troubleshooting

If you intend to perform detailed troubleshooting on your Dynacalibrator, please first read the section entitled "Advanced Theory of Operation" which starts on page 24. The flow diagrams included there will provide significant help. Most gas flow problems can be isolated to a particular component using a low-pressure air source and a magnihelic pressure gauge.

Electrical Troubleshooting

Since electrical components are incorporated into circuit boards, there is little that can be done by the user other than resetting tripped circuit breakers. If the breakers continue to trip, the unit must be returned to the factory for repair.



Always completely disconnect main power from the Dynacalibrator before reaching inside the unit. Use clip-on probes installed while main power is disconnected to make all test point connections for hot checks. Reconnect power only after test connections are properly made and hands are withdrawn from inside the unit. Failure to observe this warning can result in severe electrical shock and serious injury to personnel.

Pneumatic Troubleshooting

There are two reasonably direct methods that can be used to troubleshoot leaks in a Dynacalibrator, each with its advantages and disadvantages. The first method, using leak detection fluid, (Leak-Tek, Snoop, soap solution, etc.) is relatively fast but is somewhat messy and requires careful cleanup after the leak is located and repaired. The second method, isolating components by breaking connections, can consume more time but does not require cleanup.

Leak Detection Fluid Method

1. Remove the top cover of the unit by unscrewing the six allen screws on each side of the instrument, above the side bars..
2. Trace out the internal plumbing loop that has been found to be leaking, starting at the point where the leak checker gauge has been connected and ending at the point where the air source has been connected. Be sure you have not overlooked any fitting, joint, or other possible point of leak in this loop. (The loop is the entire set of internal plumbing that was subjected to the leak checking charging pressure of 20 inches of water.)
3. Open the valve on the air source and slowly charge the unit until the gauge reads 20 inches of water. Close the valve on the air source.
4. Isolate the leak by using a small quantity of leak detection fluid on each possible leak point in the suspect loop. Watch carefully for the bubbling or foaming effect that characterizes a leak.



Most leaks that arise under internal pressures of 20 inches of water will be small. Because of this, be sure to watch carefully for a full 30 seconds before concluding that the point being tested does not leak.

5. Repeat steps 3 and 4 for each potential leak point in the suspect loop.
6. Tighten or remake any connection or joint that has been found to be leaking. Replace any component whose leak cannot be stopped by the tightening or remaking process.
7. Rerun the overall system leak checking procedure called out earlier in this section to ensure that all the leaks in the loop have been identified and repaired.
8. Using clean, lint-free rags, carefully wipe up any residual leak detection fluid from the interior of the Dynacalibrator cabinet.

Component Isolation Method

1. Remove the top cover of the unit by unscrewing the six allen screws on each side of the instrument, above the side bars..
2. Trace out the internal plumbing loop that has been found to be leaking, starting at the point where the leak checker gauge has been connected and ending at the point where the air source has been connected. Be sure you have not overlooked any fitting, joint, or other possible point of leak in this loop. (The loop is the entire set of internal plumbing that was subjected to the leak checking charging pressure of 20 inches of water.)
3. Starting at the air source end of the suspect loop, break a fitting and, using an appropriate adapter, connect the leak checker gauge to the upstream side of the disconnected joint.
4. Open the valve on the air source and slowly charge the unit until the gauge reads 20 inches of water. Close the valve on the air source.
5. Monitor the gauge for at least 30 seconds. If the reading does not change, there are no leaks in this path to this point. Proceed to Step 7. If the reading drops, then a leak between the air source and the leak checker gauge can be inferred.
6. Tighten or remake any connection or joint that is upstream of the leak checker gauge. Repeat steps 4, 5, and 6 until no further leaks are indicated, then proceed to step 7.
7. Once a section of the loop has been determined to be leak free, go to the next fitting downstream of the point of the previous check and repeat the previous procedure starting at step 3 above. When the end of the loop has been reached by the previous sequential troubleshooting procedure, this check can be considered completed. For reference, the end of the loop is the point where, in the initial leak checking procedure, the Leak Checker gauge was placed.
8. Once the task has been completed and all leaks eliminated, close the instrument up and return it to use.

Model Number Breakdown

Model ___ - _ _ - ___ - _

Instrument Model
230 - Basic
340 - Intermediate
450 - Most versatile
500 - Dual chamber*

Basic Plumbing Configuration
0 - No pump, single gas supply inlet
1 - No pump, dual gas supply inlets (carrier & dilution)
2 - Internal pump, no gas stream bypasses*
3 - Internal pump, single gas stream bypass (carrier)*
4 - Internal pump, single gas stream bypass (dilution)*
5 - Internal pump, dual gas stream bypasses (carrier & dilution)*

Dilution Gas Flow Capacity
3 - 1 L/min
4 - 2 L/min
5 - 5 L/min
6 - 10 L/min
7 - 15 L/min
8 - 20 L/min
9 - special flow

Carrier Gas Flow Capacity
a - 80 cc/min
b - 175 cc/min
c - 350 cc/min

Rack Mount
T - Slide-mount package with pull handles (19")

Additional Options
C - 220V/50Hz operation
D - Flowmeter with fully calibrated dual floats; second float gives full scale reading at ~50% capacity
M - Constructed for use with moisture and moisture-sensitive compounds
S - Any non-standard option (contact factory for quote)

Chamber Material
I - 150 Inertium
N - HC-276 (for HCl, HF, and Cl)

* Internal pump options (2 through 5) not available on Model 500

Accessories

Name	Description	Product No.
PFA	Low-pressure-drop particulate filter assembly for Dynacalibrators with an internal pump which will be operated in dusty environments	50-02-102
FC	Replacement filter cartridge for PFA	07-10-016
CSU	Replacement charcoal scrubber unit	50-02-041
PD	Replacement pump diaphragm	07-05-001
LF	Replacement 5 micron line filter element, with gaskets	07-13-005

Warranty

This Limited Warranty gives the Buyer specific legal rights, and a Buyer may also have other rights that vary from state to state. For a period of 90 calendar days from the date of shipment, VICI Metronics Inc. (hereinafter Seller) warrants the goods to be free from defect in material and workmanship to the original purchaser. During the warranty period, Seller agrees to repair or replace at Seller's option defective and/or nonconforming goods or parts (exclusions noted below) without charge for material or labor, subject to inspection FOB VICI Metronics Inc. factory. Buyer's exclusive remedy is repair or replacement of defective and nonconforming goods.

Seller excludes and disclaims any liability for lost profits, personal injury, interruption of service, or for consequential incidental or special damages arising out of, resuiting from, or relating in any manner to these goods

This Limited Warranty does not cover:

lamps or fuses
damage due to improper shipping
damage due to improper use
damage due to modifications or alterations
damage due to improper maintenance.

This Limited Warranty does not cover defects, damage, or nonconformity resulting from abuse, misuse, neglect, lack of reasonable care, modification, or the attachment of improper devices to the goods. This Limited Warranty does not cover expendable items. This warranty is VOID when repairs are performed by a nonauthorized service center or representative.

The warranties contained in this agreement are in lieu of all other warranties expressed or implied, including the warranties of merchantability and fitness for a particular purpose.

This Limited Warranty supercedes all prior proposals or representations oral or written and constitutes the entire understanding regarding the warranties made by Seller to Buyer. This Limited Warranty may not be expanded or modified except in writing signed by the parties hereto.

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