



Valco Instruments Co. Inc.

Dynacalibrator Model 230 Instruction Manual

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Symbols used in this document



Attention



Radiant heat warning



Entanglement warning



Electrical warning

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If this equipment is used outside manufacturers' specification the protection provided by the equipment may be impaired.

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 three 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 230 specifications are listed on page 4.

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 230. 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 230 contains two calibrated gas regulating systems – the carrier system and the dilution system. The fixed flow carrier gas system includes a permeation chamber containing the permeation device. The temperature of the chamber, which controls the permeation rate of the calibration gas from the permeation device, is set and monitored at the front panel. The carrier stream is pumped through the chamber to pick up the calibration gas and is then fed on to a mixing tee. The chamber temperature is adjusted from 30°C (or 2°C above ambient, whichever is higher) to 110°C.

In standard models (**Figure 1a**) the dilution gas stream flows through an adjustable valve and a flowmeter to the mixing tee. Front panel access to the valve and flowmeter permits the user to accurately set the dilution stream flow rate to the mixing tee, thereby setting the concentration of calibration gas at the outlet port of the calibrator.

As shown in **Figure 1a**, the carrier stream passes through scrubber #1 and line filter LF1 (30 μ) to differential pressure regulator DPR1. The scrubber contains specially-activated charcoal designed for broad-based scrubbing action, and is particularly effective in removing sulfur dioxide and other sulfur compounds.

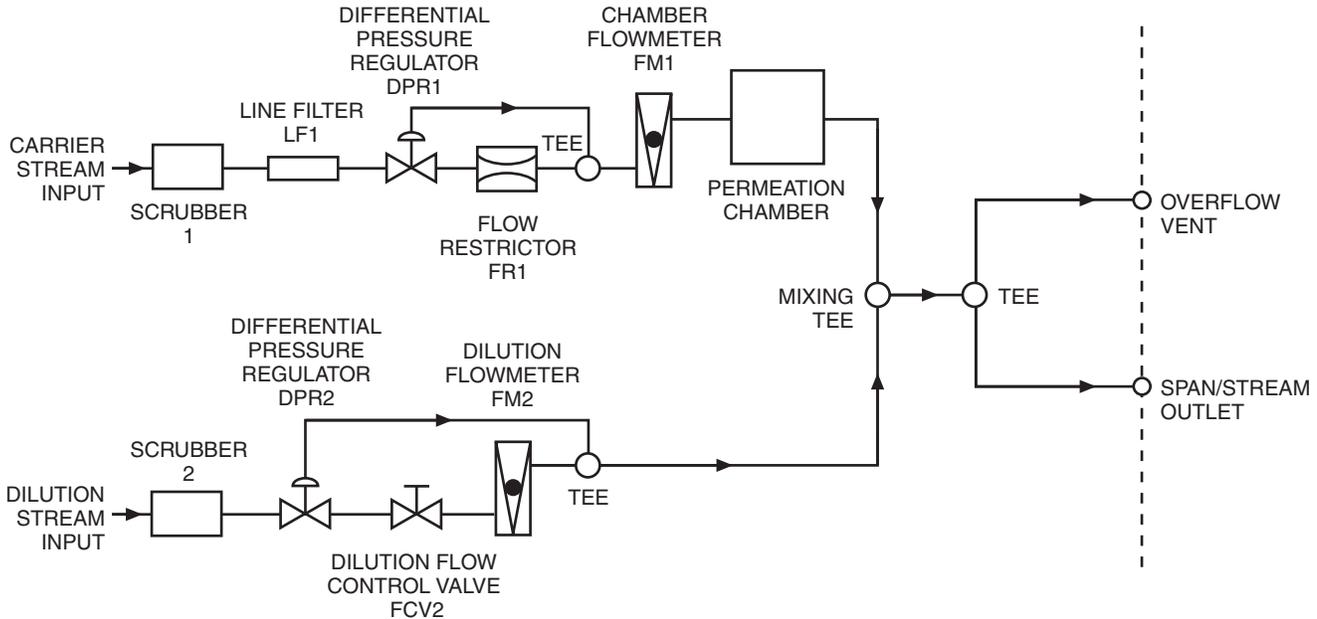


Figure 1a: Model 230 standard plumbing schematic

The differential pressure regulator and carrier flow restrictor FR1 together provide a highly stable carrier stream flow rate to the permeation chamber. The standard carrier flow restrictor consists of a disk with a 0.006" diameter orifice. The flow rate through the orifice is a function of the pressure differential across it, maintained at 3.2 psi by DPR1.

The output of the permeation chamber is fed to a mixing tee, where the calibrated dilution stream is added to set the final concentration. The combined stream is then fed through another tee to the rear panel overflow vent and span outlet.

For those analyzers sensitive to sample feed pressure, the overflow vent dumps excess calibration gas to ensure that the analyzers receive span gas at near atmospheric pressure. The overflow vent is usually left open, but can be plumbed to an external exhaust point. Any exhaust plumbing must be sized so as not to increase pressure into the analyzer under calibration.

Note that the dilution stream passes through scrubber #2 and feeds into differential pressure regulator DPR2. The differential pressure regulator maintains a fixed pressure differential across dilution flow control valve FCV2 and dilution flowmeter FM2.

The flow rate through the flowmeter needle valve is a function of the differential pressure across it and the setting of the dilution flow control valve. This differential is maintained at 3.2 psi by DPR2. The needle valve is adjustable at the front panel. The calibrated output of the dilution flowmeter mixes with the permeation chamber output to provide the final output concentration.

When the non-pressurized internal pump option is included, the rear-panel zero outlet port is internally connected to a passive scrubber which functions identically to those previously described. In operation, the zero outlet is plumbed either to the analyzer sample intake port or to the zero air intake port, so that analyzer suction provides flow through the scrubber.

Options

More detailed information found in “Advanced Theory of Operation” on page 22.

Input Configurations

There are six different input plumbing configurations available. The units may be equipped with or without an internal pump. Units without internal pumps can be supplied with one or two gas supply inlet ports (carrier and dilution). Models with pumps are available with gas stream bypasses for either the dilution or carrier stream or both. (Units without internal pumps do not require gas stream bypasses.) Those with internal pumps have a single inlet port supplying the pump, the outlet of which is split into carrier and dilution streams. The gas stream bypasses on these units are also downstream from the pump, permitting the user to connect external scrubbers, driers, separate gas supplies, etc. in either or both streams. All models 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.

Electronic Flow Control

Many of the flow components can be replaced by a mass flow controller for simplified operation. (**Figure 1b**)

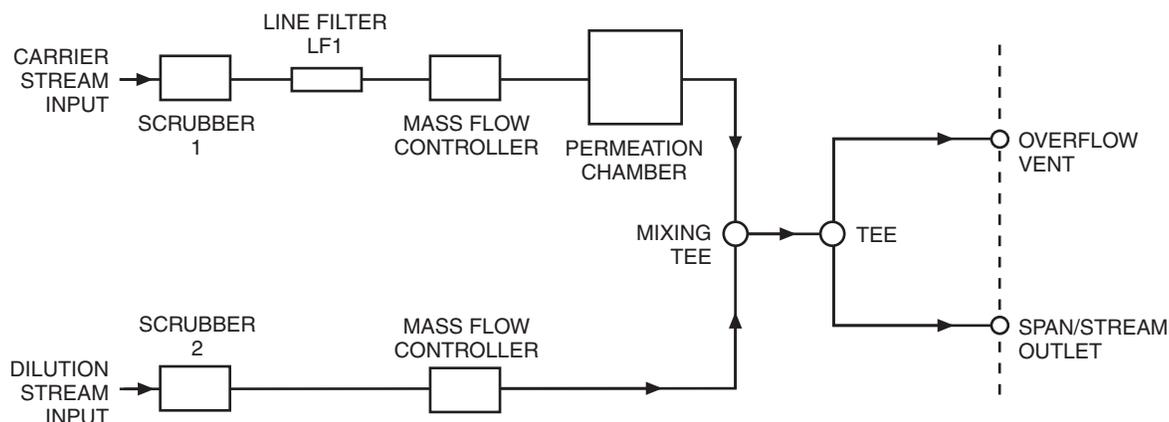


Figure 1b: Model 230 optional plumbing schematic

Specifications

Refer to page 35 for additional data on units with the electronic flow control option.

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 100°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
Operating Duty Cycle	Continuous

Environmental

Operating noise emission (at 3 feet)	55 to 60 dBA for units with internal pumps 45 to 50 dBA for units without
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	
Without internal pump	19.1 kg (42 lbs)
With internal pump	24.5 kg (54 lbs)

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	Internal pump Second gas supply inlet Carrier stream bypass Dilution stream bypass
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.

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 2** 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.

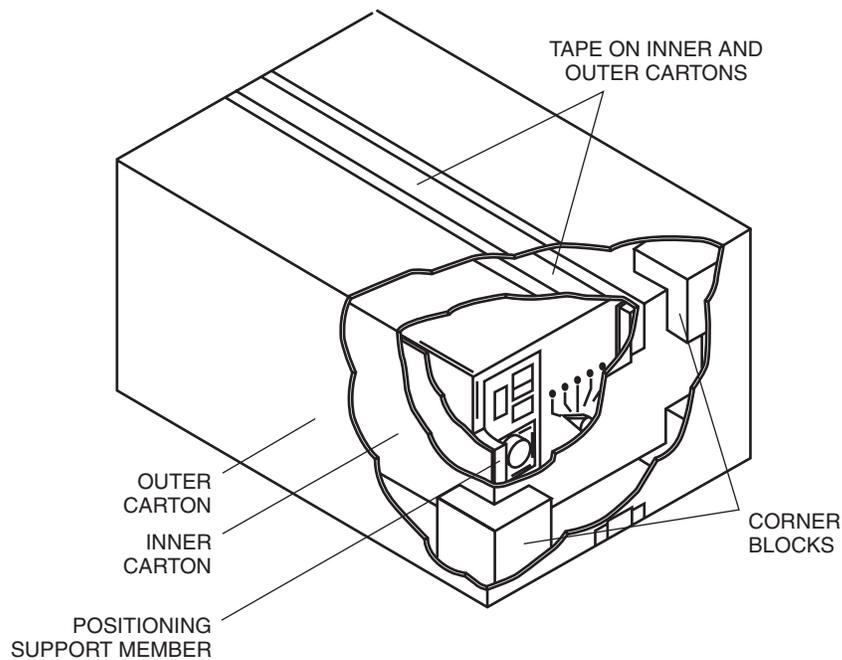


Figure 2: Dynacalibrator packaging

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.
- ambient particulate levels are minimal.
(In the event that dust is prevalent, the unit should be equipped with a Metronics Particulate Filter Assembly.)
- 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 $\pm 1^\circ\text{C}$) 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 the connection is optional, the block is marked with an "O"; 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
230-0X		X				X				O	
230-1X			X	X		X				O	
230-2X		O				X				O	
230-3X		O	O			X		X		O	
230-4X		O		O		X			X	O	
230-5X		O	O	O		X		X	X	O	
230-0X-Z		X				X	X			O	
230-1X-Z			X	X		X	X			O	
230-2X-Z		O				X	X			O	
230-3X-Z		O	O			X	X	X		O	
230-4X-Z		O		O		X	X		X	O	
230-5X-Z		O	O	O		X	X	X	X	O	

Table 1: Dynacalibrator Model 230 rear panel connections

X = Required connection

O = Optional connection

blank = No connection

Supply Inlet

All Dynacalibrators except those with -1X input configurations (separate carrier and dilution inlet ports) are equipped with a supply inlet fitting. Those with -0X input configurations (no internal pump) must have the supply inlet 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 30 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.

On all units with an internal pump, the supply inlet port is internally connected directly to the suction side of the pump. Since the output of the pump is equipped with a particulate filter and activated-charcoal scrubbers, the supply inlet port should normally be left unconnected, completely open, and clear of any obstructions, except as noted below for dusty environments.

If you need to alter the carrier and/or dilution streams by adding filters, scrubbers, dehydrators, etc., the recommended method is to connect these components in series with the bypass loops as described on the next page. If your unit is not equipped with bypass loops, you must consider the following before altering the stream into the supply inlet:

- If the unit or device connected to the supply inlet port generates a gas-flow-related pressure drop, thereby partially “starving” the pump (that is, increasing the vacuum at the pump’s suction port), the maximum flow output capability of the Dynacalibrator will likely be diminished.
- If the unit or device connected to the supply inlet is equipped with a supplementary pump providing an altered gas flow to the Dynacalibrator pump’s suction at a pressure greater than 0 psig, the life of the pump may be decreased. Increasing the suction pressure of the Dynacalibrator pump will not increase its output flow capability.

Whenever a Dynacalibrator is to be operated in an environment that has significant concentrations of dust or other particulate matter, we recommend a VICI Metronics Particulate Filter Assembly (PFA) connected to the supply inlet port. The disposable filter inside the PFA has been selected for its very low pressure drop. Use of a PFA will not diminish the output flow of the Dynacalibrator pump. The disposable filter part number is FC.



VICI recommends that Dynacalibrators equipped with internal pumps be operated either with their SUPPLY INLET port completely open and clear of obstructions or fitted with a low pressure drop VICI Metronics Particulate Filter Assembly.

Carrier/Dilution Inlets

All Dynacalibrators with input configurations -1X, -3X, -4X and -5X have a carrier inlet and/or a dilution inlet. The -1X configuration does not have an internal pump, so a source of pressurized gas must be connected to its carrier inlet and its dilution inlet. On the remaining three input configurations, these inlets are part of the gas stream bypass loops, discussed in a later paragraph. However, the bypass loops may be left disconnected, and since they are downstream from the internal pump, external pressurized gas sources may be connected to the dilution inlet and/or the carrier inlet. 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 16 psig maximum at these inlets.

Bypass Loops

Only those Dynacalibrators with internal pumps are equipped with fittings for bypass loops in either or both the carrier and dilution streams (input configurations -3X, -4X and -5X). The fittings – labeled CARRIER OUTLET, CARRIER INLET, DILUTION OUTLET, and DILUTION INLET – are downstream from the pump, so the loops must be completed in order for the internal pump to be used. The purpose of the loops is to expedite the installation of external filters, scrubbers, dehydrators, etc. into the two internal streams before each is mixed with the trace gas. All plumbing should be as short as possible, and the devices should not restrict the flow in either stream below their normal operating rates. If a separate gas supply is connected to either inlet, the input pressure should be between 7 and 16 psig, and the companion outlet should be capped.

If external devices are not required, then the outlet ports must be directly plumbed to their companion inlet ports.

Span and Zero Outlets

The primary outlet on the Model 230 is labeled SPAN OUTLET. A ZERO OUTLET fitting is included only on those units equipped with the non-pressurized internal pump option. 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.

The zero outlet port provides a scrubbed supply of ambient air for a zero point calibration. Since it is not pressurized, the zero outlet requires suction from the analyzer being calibrated.

Overflow Vent

All Dynacalibrators include an overflow vent to dump excess calibration gas, ensuring that analyzers sensitive to sample feed pressure receive zero and span gas 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.

Front Panel Controls and Indicators

The section entitled "Advanced Theory of Operation" beginning on page 22 includes more detailed information on the interrelation of the front-panel controls and indicators with the internal pneumatic and electrical flow of the units.

For units equipped with the Electronic Flow Control option, refer to page 36.

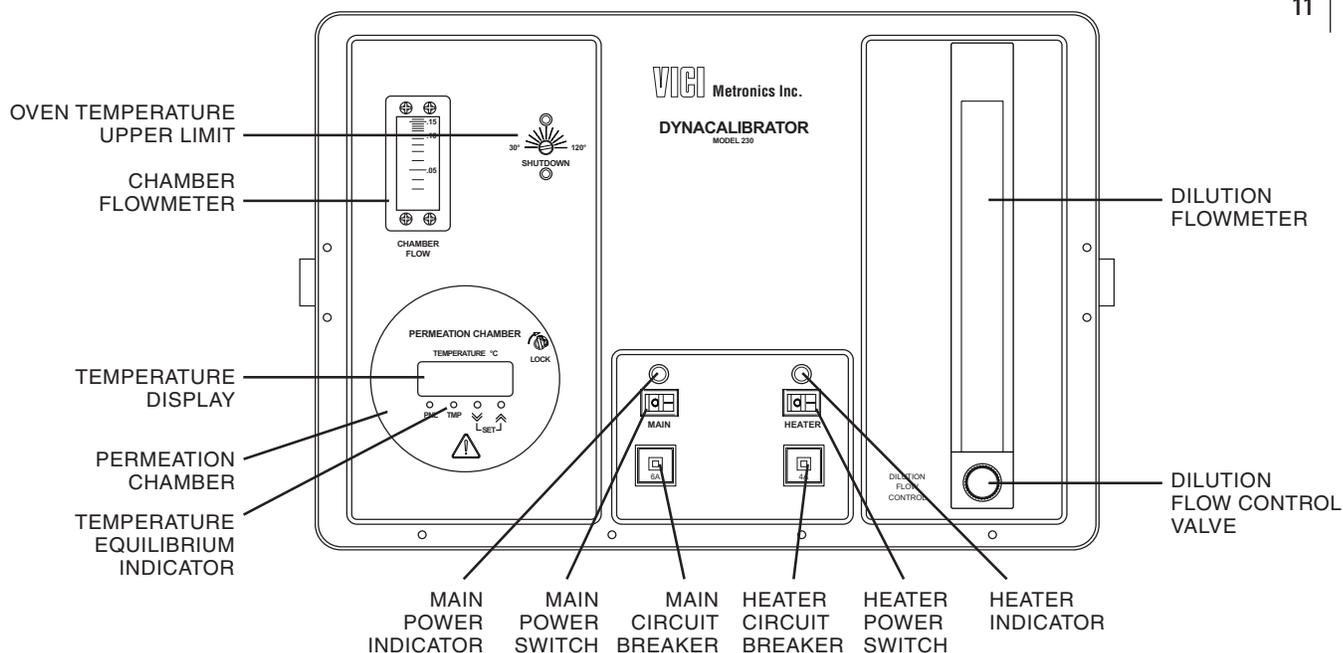


Figure 3: Model 230 front panel controls and indicators (Refer to page 36 for Electronic Flow Control option)

MAIN POWER switch, indicator, and circuit breaker

The rocker 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 rocker 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.

PERMEATION 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 16). 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

Turn the knob to adjust the flow rate of the dilution stream prior to mixing with carrier and trace gas.

DILUTION FLOWMETER

The ball float and gauge indicate the relative dilution stream flow rate into the mixing tee, as set 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.

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 Cl₂ @ 30°C
 Carrier flow: 500 ml/min

Then:

$$\begin{aligned} \text{Concentration (ppm)} &= \frac{K * P}{F} \\ &= \frac{(0.346)(21,000)}{500} = \mathbf{14.5 \text{ ppm}} \end{aligned}$$

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. *If you do not have the pump option:*
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 N₂ to perform a pressure/decay test to verify the leak integrity of the system before putting it into service.

Chamber Temperature

Important Chamber Temperature Considerations

- 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 3 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 16). 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 \wedge button.

To read the chassis environment temperature: press and hold the \vee button.

1. To set the desired temperature, simultaneously press the \wedge and \vee buttons, then release them. The PNL light will start flashing, indicating the controller is in the temperature set mode.
2. Use the \wedge and \vee 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 \wedge and \vee 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 16.

Setting the Oven Temperature Limit

A mechanical thermostat is integrated with the temperature control circuit for fail-safe temperature control to a limit set at the front panel control. The thermostat prevents 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 ($\pm 10^\circ\text{C}$). 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 adjust the setting clockwise 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 page 16.

Installing the Permeation Device(s)

1. Turn off the main power switch.
2. With the tool provided, rotate the panel lock screw 90° counterclockwise.
3. 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.

4. Unscrew the chamber cap with the tool provided.
5. Add or remove the permeation device(s) with the supplied forceps or other tool appropriate to the job..
6. Secure the chamber cap with the tool provided.
7. Run a pressure/decay test to make sure that the chamber cap is leak tight.
8. Reinstall the front panel assembly and rotate the panel lock screw 90° clockwise.
9. Turn on the heater power switch and 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 230 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 coefficients
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[®]

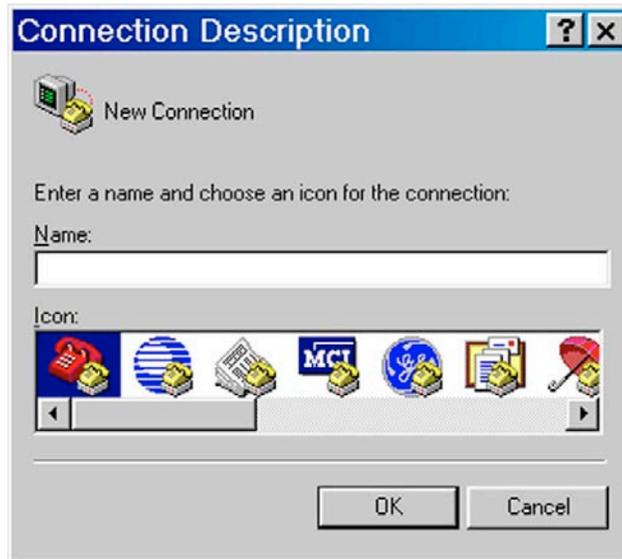
1. To open HyperTerminal in Windows[®], click Start > Programs > Accessories > Communications > HyperTerminal. The following screen will appear:



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



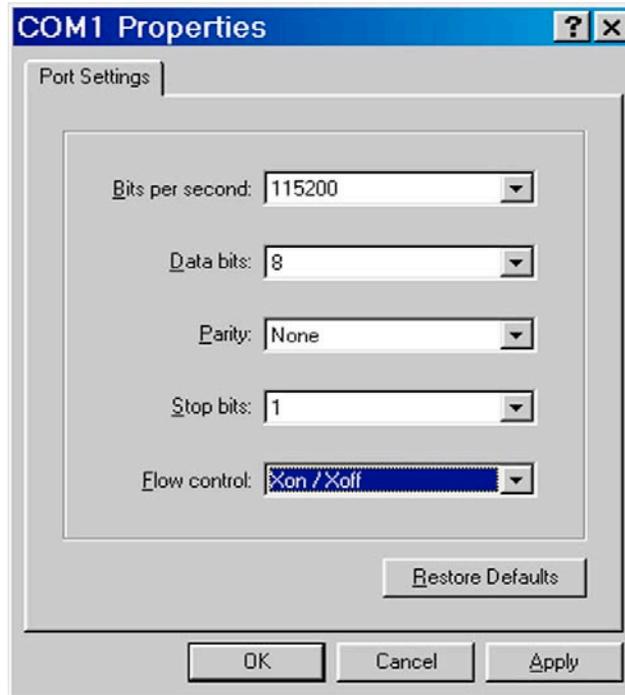
3. Click "OK", which reveals the next screen:



4. Enter a name, such as "dyna230", 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:

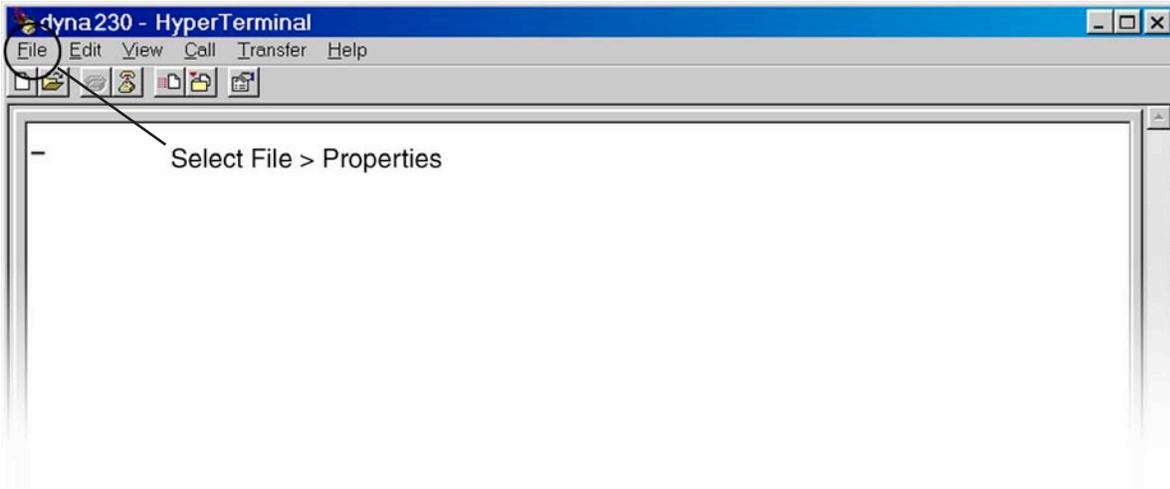


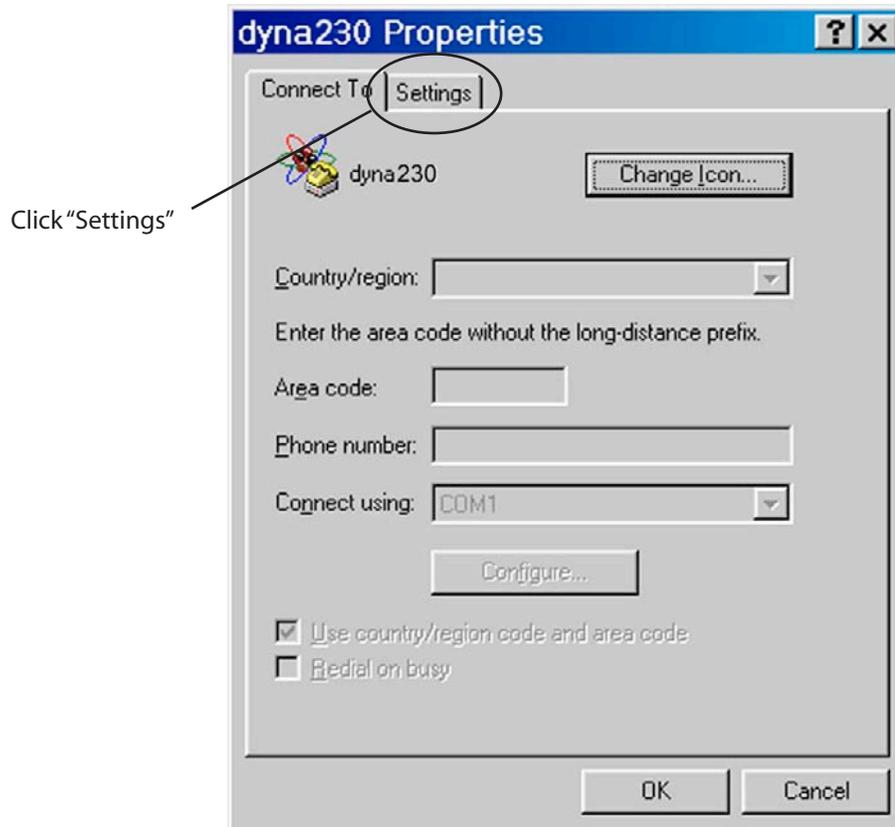
6. Select the appropriate COM port and click "OK" to bring up this screen:



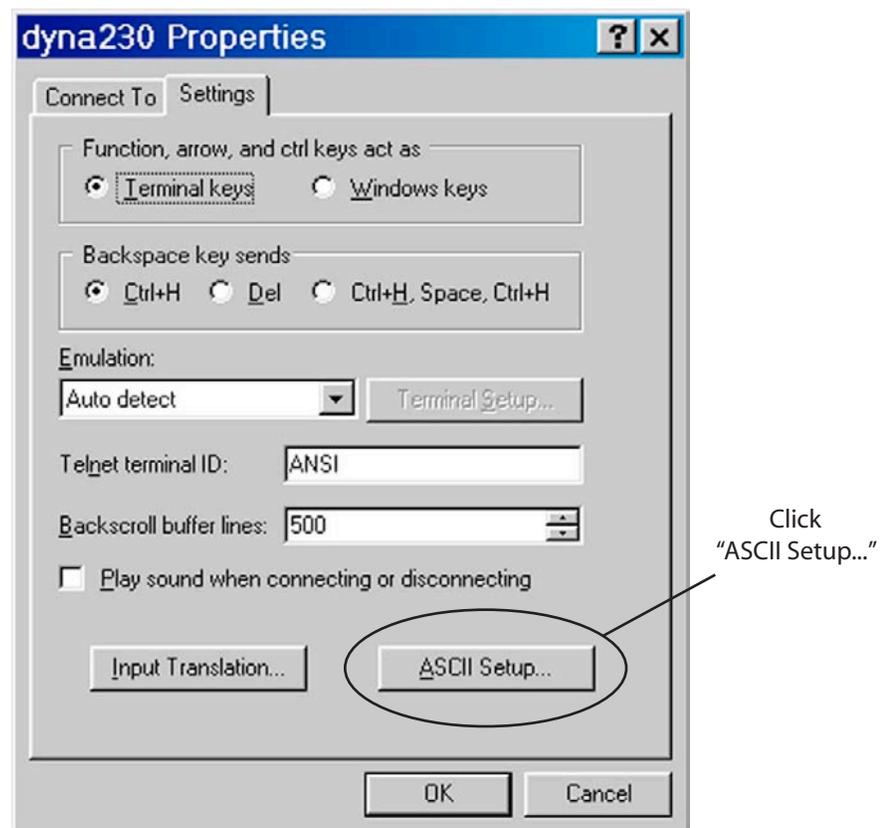
7. Set the port parameters as indicated above, and click "OK"

8. Now we are at the dyna230 HyperTerminal screen (below). Select "File," then "Properties:

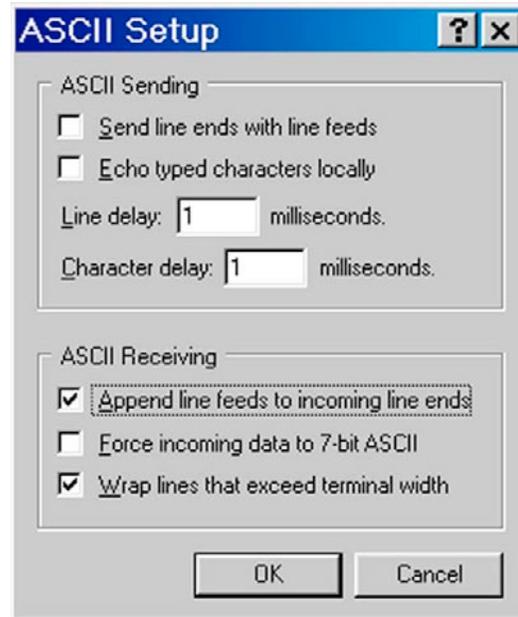




9. On the dyna230 Properties screen (above), click "Settings" to bring up the screen below.



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



- When the screen returns to Dyna230 HyperTerminal (page 18, bottom illustration), click "File", then "Save" to save this Dynacalibrator Model 230 communications setup.

The following text will be displayed in the HyperTerminal window when communication is first established with the Dynacalibrator Model 230:

```
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.

If the Model 230 is to be used for a multipoint calibration and is equipped with the internal pump option:

1. Connect the zero outlet to the analyzer input and wait for the analyzer reading to stabilize (usually about ten minutes) before calibrating or recording the reading.
2. Disconnect the zero outlet and connect the span outlet to the analyzer input.
3. Adjust the dilution flow control valve for each of the pre-calculated span points, aligning the center of the float in the dilution flowmeter to the selected scale reading. Allow the analyzer reading to stabilize after each flow adjustment.

Shutdown Procedure

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

1. Turn off the heater power switch.
2. With the tool provided, rotate the panel lock screw 90° counterclockwise.
3. Gently pull the front panel assembly out.



CAUTION: Use specific and appropriate precaution when opening the calibrator oven. Use procedures and protective equipment to avoid contact or exposure to the permeation device and/or gas vapors while opening the chamber cap and adding/removing/changing oven content.

4. Unscrew the chamber cap with the tool provided.
5. Add or remove the permeation device(s) with the supplied forceps.
6. Secure the chamber cap with the tool provided,
7. Reinstall the front panel assembly and rotate the panel lock screw 90° clockwise.
8. Place devices in the containers provided and store them in an appropriate place until further use is required. (A refrigerator or freezer is recommended.)
9. Allow the carrier flow to purge the chamber for about five minutes
10. Switch off the main power.
11. 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 13.

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 230 Dynacalibrators contain a single dilution flow control valve and rotameter. Since the Model 230 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.

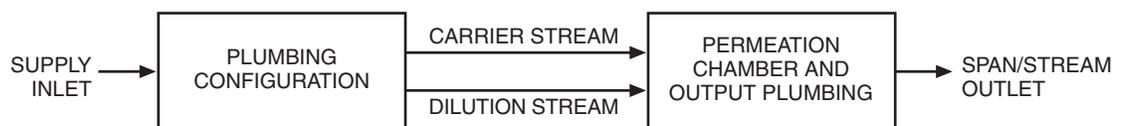


Figure 4: Basic block diagram

Plumbing Configurations

There are six different plumbing configurations available for each of the Dynacalibrator models. The plumbing configuration is defined by the first digit of the 2-digit numerical suffix to the basic model number, *e.g.*, Model 230-12 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 are rated for the different flow capacities of items such as for the main pump, the dilution flowmeter, etc. 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 5**) 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.

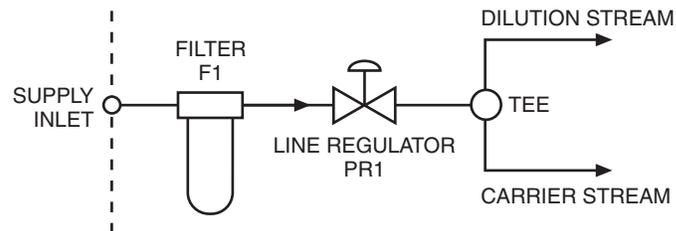


Figure 5: Diagram of configuration 0

Configuration 1

Figure 6 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.

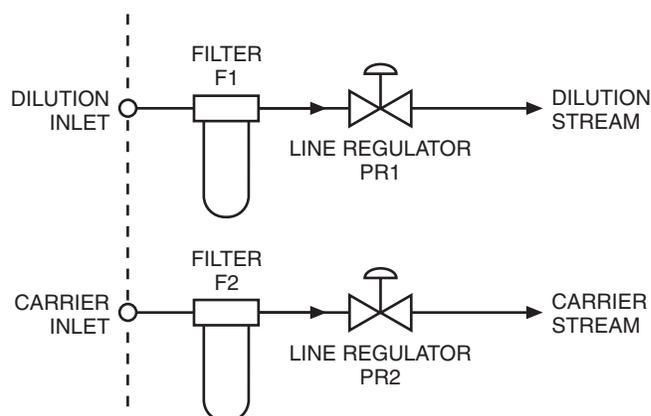


Figure 6: Diagram of configuration 1

Configuration 2

Pump P1 (**Figure 7**) draws gas in through the supply inlet on the back panel and delivers it to accumulator AC1. The accumulator smooths out pressure pulses, with the back pressure regulator providing continuous pressure regulation to cover the dynamic range required. The output of the accumulator is passed through filter F1, and split by the tee into carrier and dilution streams.

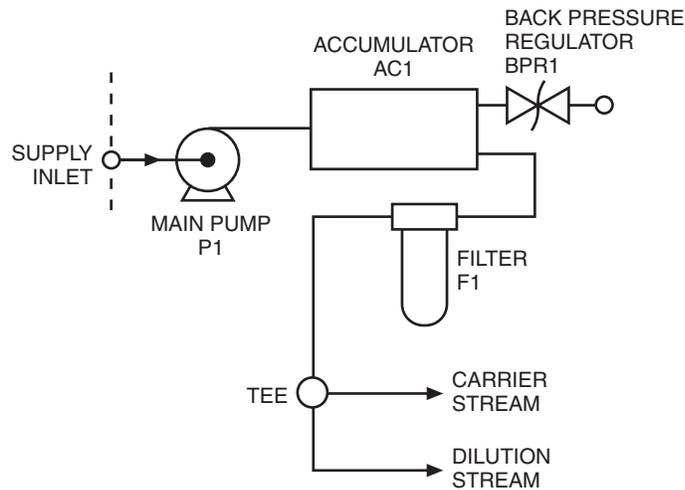


Figure 7: Diagram of configuration 2

Configuration 3

In this configuration (**Figure 8**), Pump P1 draws gas in through the supply inlet on the back panel and delivers it to accumulator AC1. The accumulator smooths out pressure pulses, with the back pressure regulator providing continuous pressure regulation to cover the dynamic range required. The output of the accumulator is passed through filter F1, with a tee at the filter output splitting the supply into carrier and dilution streams. The carrier stream is plumbed to the carrier outlet on the back panel, which must be plugged if an external carrier supply is used. This port can be connected through external scrubbing media (filters, driers, etc.) or simply looped to the carrier inlet port. Filter F2 removes particulates from the carrier stream. The dilution stream output of the tee is simply passed through filter F1.

Configuration 4

Input configuration 4 is shown in **Figure 9**. Pump P1 draws gas in through the supply inlet on the back panel and delivers it to accumulator AC1. The accumulator smooths out pressure pulses, with the back pressure regulator providing continuous pressure regulation to cover the dynamic range required. The output of the accumulator is passed through filter F2, with a tee at the filter output splitting the supply into carrier and dilution streams. The dilution stream is plumbed to the back panel dilution outlet, which must be plugged if an external dilution supply is used. This port can be connected through external scrubbing media (filters, driers, etc.) or simply looped to the dilution inlet port. Filter F1 removes particulates from the dilution stream. The carrier stream output of the tee is passed through filter F2.

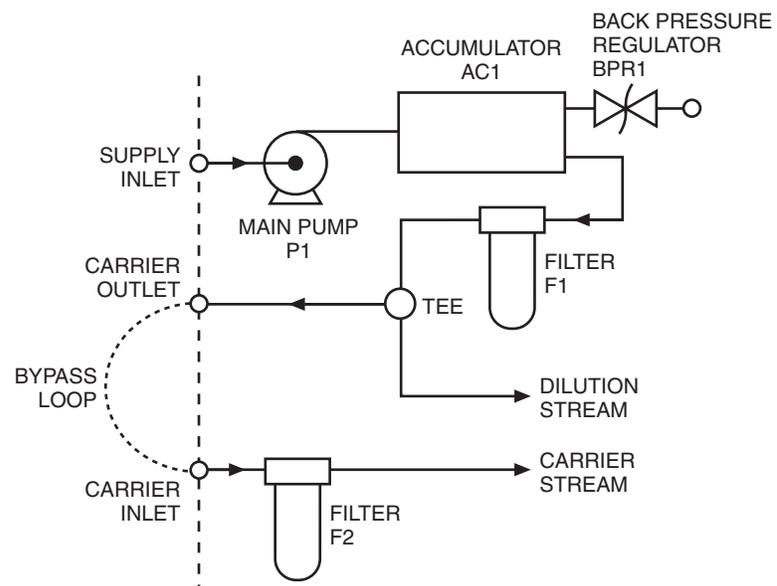


Figure 8: Diagram of configuration 3

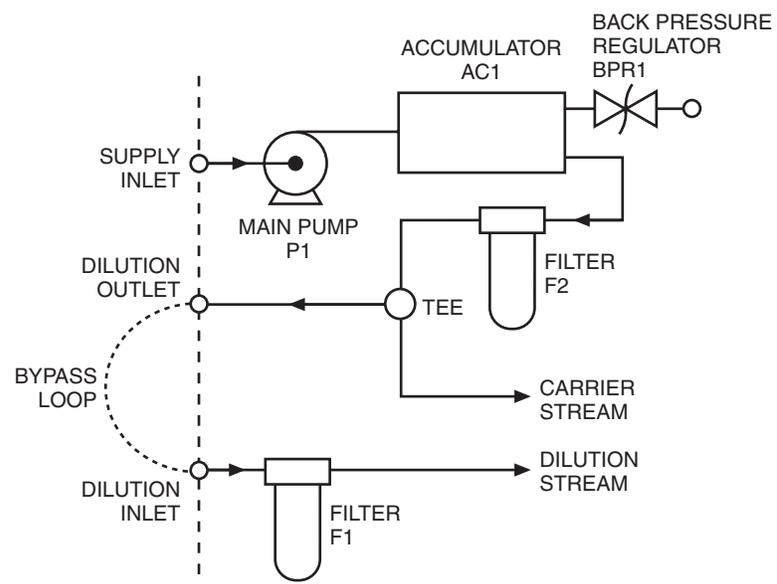


Figure 9: Diagram of configuration 4

Configuration 5

in this configuration (**Figure 10**), pump P1 draws gas in through the supply inlet on the back panel and delivers it to accumulator AC1. The accumulator smooths out pressure pulses, with the back pressure regulator providing continuous pressure regulation to cover the dynamic range required. A tee at the output of the accumulator splits the supply into carrier and dilution streams, each of which is plumbed to a back-panel outlet port which must be plugged if an external supply is used. These ports can be connected individually through external scrubbing media (filters, driers, etc.) or simply looped to their respective inlet ports. Filters F1 and F2 remove particulates from these two streams.

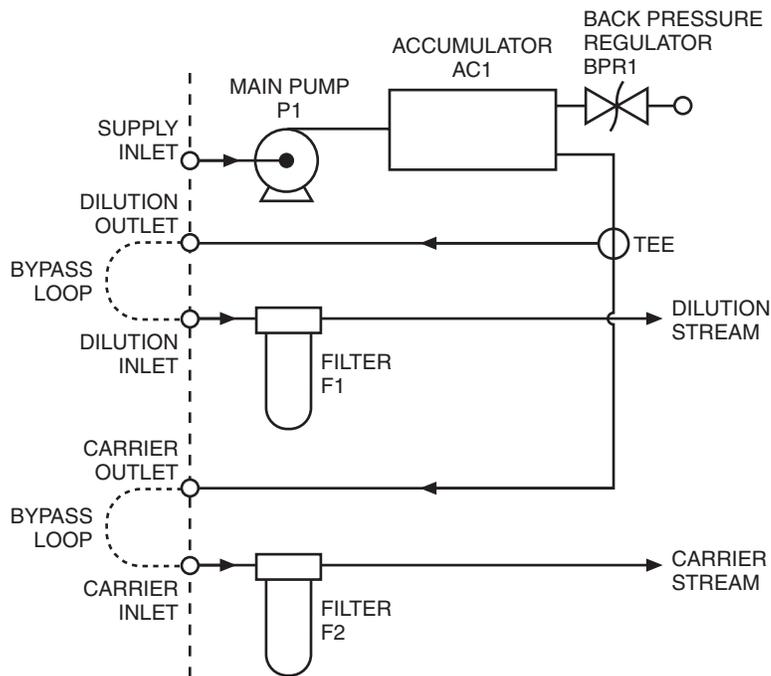


Figure 10: Diagram of configuration 5

Electrical Description

The basic wiring of the Model 230 is shown schematically in **Figure 11**. 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 for a replacement cord.

The main power switch S1 is on the front panel, along with the main circuit breaker CB1. 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 circuit breaker CB2 and indicator for power to the permeation chamber heater.

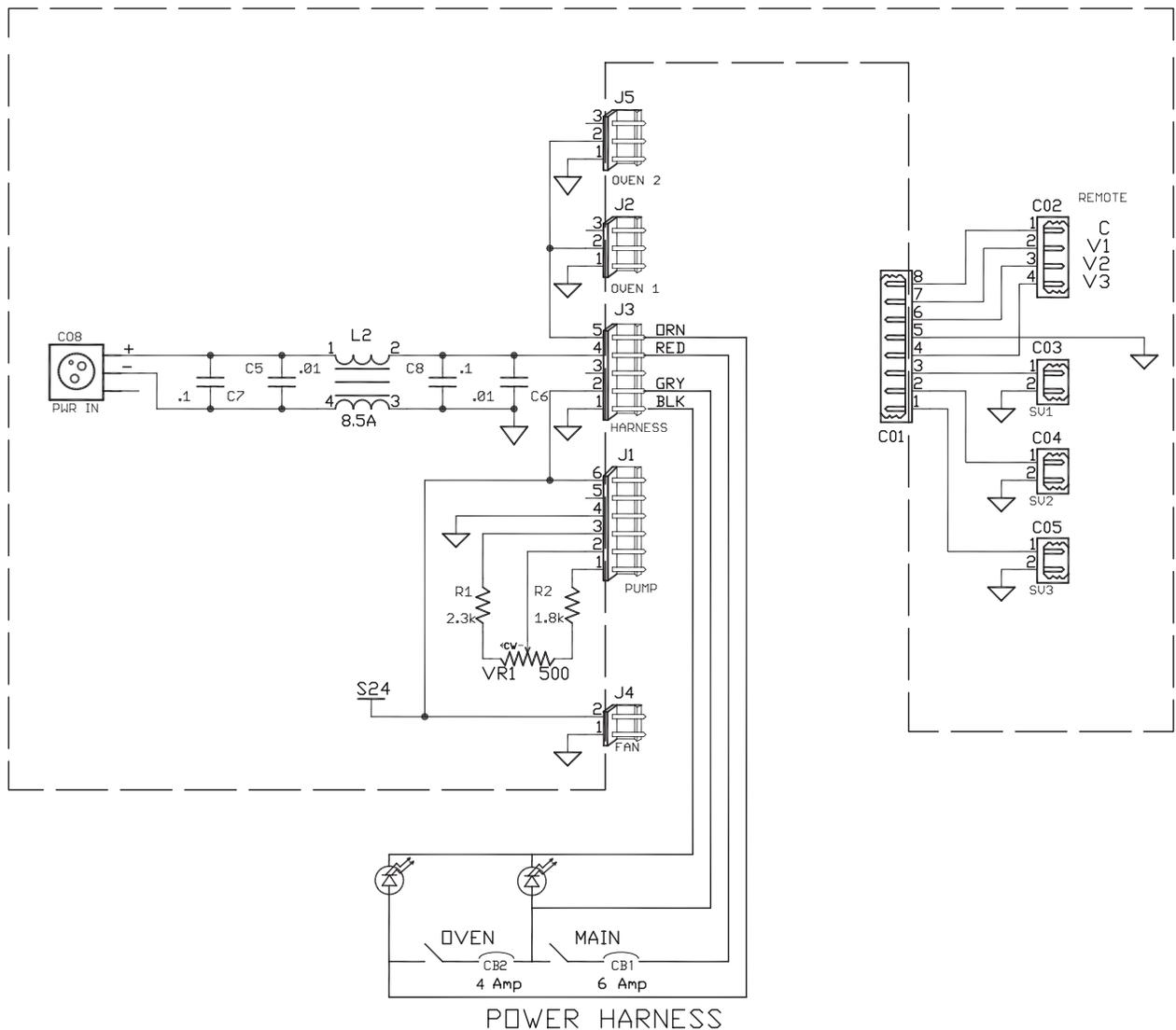


Figure 11: Model 230 electrical schematic
(Refer to page 37 for Electronic Flow Control option)

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 21 to remove the unit from service and the initial power-up procedure on page 13 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 21. Disconnect all power and plumbing.
2. Remove the top cover 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 13.

Carrier Flow Rate Verification

The carrier flow rate is maintained at a constant value through through the use of a control device. On models with the EE option this control device is an electronic mass flow controller (MFC), which is preset at the factory to provide a constant 100 sccm flow through the chamber. On other systems the flow is controlled with a differential pressure regulator which keeps a constant pressure on a precision orifice plate. The actual flow rate is fixed, and designated by letters at the time of manufacture. Check the certification which is included with the system to verify the factory settings for carrier flow.

Monitoring of flow on EE models is done by reading actual flow value from the front display. On standard models, there is a rotometer which is used only for 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.
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 $\pm 1\%$ 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 ($\pm 0.1^\circ\text{C}$) 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 22. 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 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. To remove the top cover, unscrew 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. To remove the top cover, unscrew 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.

Other Pneumatic Issues

Two other general categories of problems (aside from leaks) are occasionally encountered in the pneumatic system in the Dynacalibrator. In order of likelihood they are:

Main pump diaphragm(s) worn out

These elastomeric diaphragms are rated for more than 10,000 hours continuous operation at the output pressure used in the Dynacalibrator; however, they must occasionally be replaced. To complete the pump rebuilding process, follow the procedure called later in this section.

Line filter(s) clogged

This problem tends to occur whenever the air or gas being drawn into the Dynacalibrator has a heavy particulate loading (dust). To see if the filter is clogged, unscrew the filter bowl, remove the filter cartridge, and replace the bowl. If this eliminates the problem, then the filter needs cleaning. To clean a filter, follow the directions in the maintenance section.

Appendix: Electronic Flow Control Option

Technical Data for Mass Flow Controllers

Specification	Mass Controller	Description
Accuracy	\pm (0.8% of reading + 0.2% of full scale)	At calibration conditions after tare
High accuracy option	\pm (0.4% of reading + 0.2% of full scale)	At calibration conditions after tare
Repeatability	\pm 0.2%	Full scale
Operating range	1/2% to 100%	Full scale
Turndown ratio	200:1	
Typical response time	100	Milliseconds (adjustable)
Standard conditions (STP)	25°C and 14.696PSIA	Mass reference conditions
Operating temperature	-10 to +50	°Celsius
Zero shift	0.02%	Full scale/°Celsius/Atm
Span shift	0.02%	Full scale/°Celsius/Atm
Humidity range	0 to 100%	Non-condensing
Controllable flow rate	102.4%	Full scale
Maximum pressure	145	PSIG
Input/Output signal digital	Mass flow, volumetric flow, pressure, and temperature	RS-232 or RS-485 serial or PROFIBUS or DeviceNet
Input/Output signal analog	Mass flow	0-5 VDC
Optional Input/Output signal secondary analog	Mass flow, volumetric flow, pressure, or temperature	0-5 VDC or 0-10 VDC or 4-20 mA
Electrical connections	8 pin mini-DIN, DB9, or DB15	
Supply voltage	12 to 30 VDC (15-30 VDC for 4-20 mA outputs)	
Supply current	0.250 amp (at 12 VDC, declining with increased supply voltage)	
Mounting attitude sensitivity	None	
Warm-up time	< 1	Second
Wetted materials	303 and 302 stainless steel, Viton®, silicone RTV (rubber), glass reinforced nylon, aluminum, brass, 430FR stainless steel, silicon, glass	

Front Panel Controls and Indicators

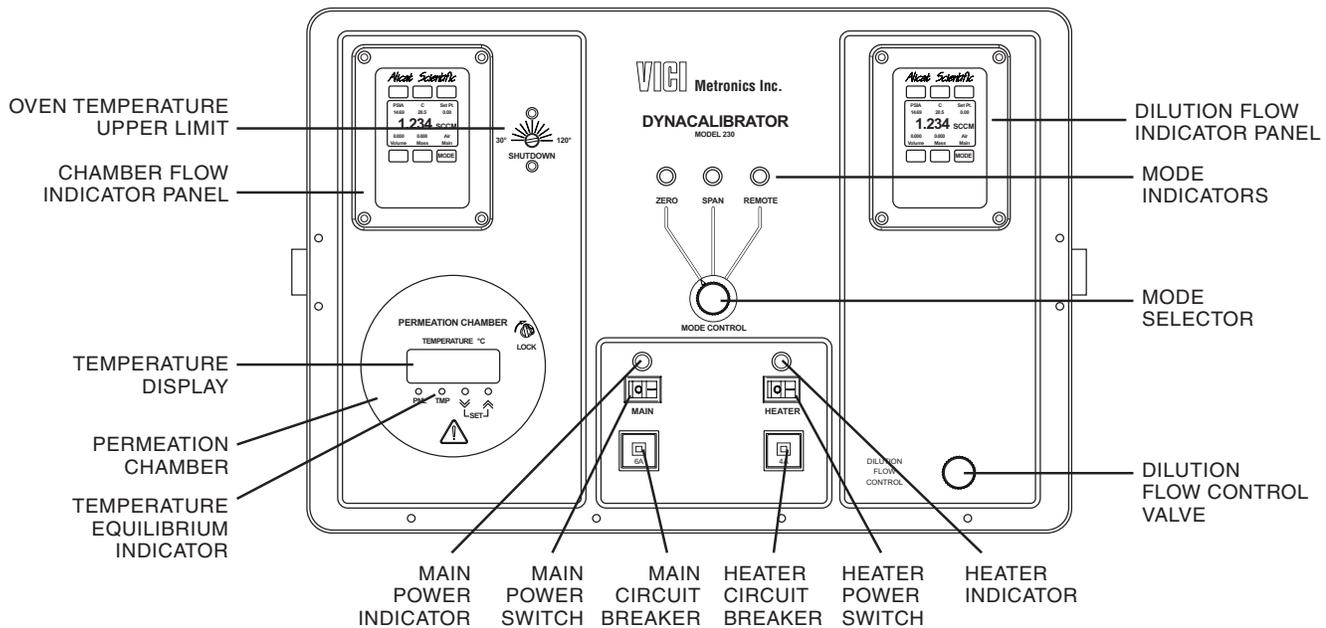


Figure 12: Front panel controls and indicators, Electronic Flow Control option

MAIN POWER switch, indicator, and circuit breaker

The rocker 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 rocker 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.

PERMEATION CHAMBER FLOW INDICATOR PANEL

Permeation chamber flow rates are read directly from this display. Carrier flow rates are factory set at 100 SCCM (typically), and should not be altered by the end user. Please contact VICI if a different carrier flow rate is required.

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 16). 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

Turn the knob to adjust the flow rate of the dilution stream prior to mixing with carrier and trace gas.

DILUTION FLOW INDICATOR PANEL

This indicator will show the dilution flow rate in SLPM as well as providing temperature and inlet pressure indications.

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.

Electrical Schematic

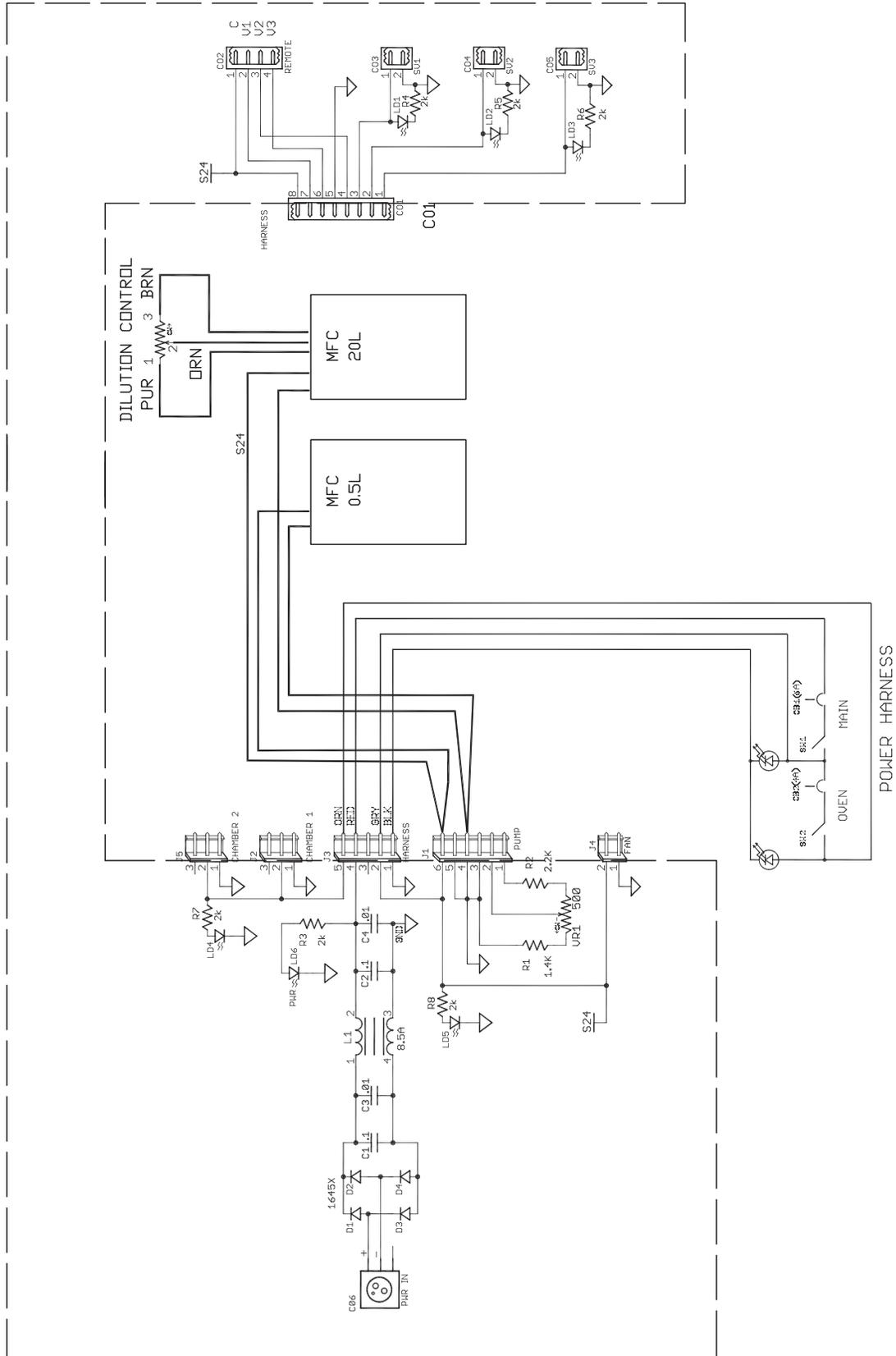


Figure 13: Model 230 electrical schematic, Electronic Flow Control option

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, resulting 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.