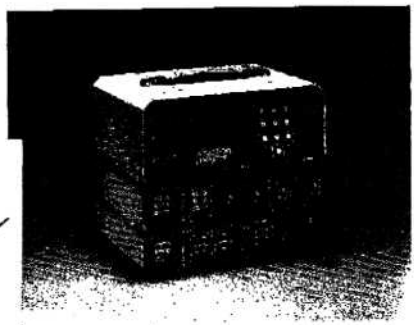
RT-200
Calibration Analyzer™

Operation/Service Manual



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INSTRUMENTS OF CARE

Functional Requirements:

Type of Medical Gas: Oxygen, Nitrogen, Nitrous Oxide, Carbon Dioxide, Medical Air, O_2/N_2 & O_2/N_2O

Pressure:

	Resolution	Range	Accuracy
1.	Low Range With .01 cm H_2O Resolution	0 to + 20.00 cm H_2O -20.00 to 0 cm H_2O	±1% of reading or ±2 digits at 21.1°C (70°F) ±2% of reading or ±2 digits at 15° to 35°C
2.	Low Range With .1 cm H_2O Resolution	0 to + 250 cm H_2O - 250 cm to 0 cm H_2O	±0.5% of reading or ±2 digits at 21.1° (70°F) ±1.5% of reading or ±2 digits at 15° to 35°C
3.	High Range With .01 psi Resolution	0 to + 20.00 psi -15.00 to 0 psi	±0.5% of reading or ±2 digits at 21.1°C (70°F) ±1.5% of reading or ±2 digits at 15° to 35°C
4.	High Range With .1 psi Resolution	- 15.0 to 100.0 psi	±0.5% of reading or ±1 digit at 21.1°C (70°F) ±1.5% of reading or ±1 digit at 15° to 35°C

Vacuum:

1.	Low Range With .1 mm Hg Resolution	0 to 185.0 mm Hg	±0.5% of reading or ±2 digits at 21.1°C (70°F) ±1.5% of reading or ±2 digits at 15° to 35°C
2.	High Range With 1 mm Hg Resolution	0 to 5170 mm Hg - 760 to 0 mm Hg	±0.5% of reading or ±1 digit at 21.1°C (70°F) ±1.5% of reading or ±1 digit at 15° to 35°C

Flow:

	Resolution	Gas (Mixture)	Range	Accuracy at 21.1°C (70°F)
1.	.01 lpm	O_2, N_2, Air O_2N_2, O_2N_2O, N_2O & CO_2	0 to 5 lpm 0 to 5 lpm	±2% reading or ±2 digits ±3% reading or ±2 digits
2.	.1 lpm	O_2, N_2, Air & O_2/N_2 O_2/N_2O, N_2O, CO_2	5 to 180 lpm 20 lpm	±1% reading or ±1 digit
3.	Volume .01 lit.	O_2, N_2, Air & O_2/N_2	3 liters	±1% reading or ±1 digit

	Resolution	Gas (Mixture)	Range	Accuracy
4.	Rate bpm With .1 bpm Resolution	--	2 to 150 bpm	at 15° to 35°C ±5% reading or ±1 digit
5.	Inspiratory Time With .001 Second Resolution	--	.1 to 5 Seconds	at 15° to 35°C ±5% reading or ±3 digit
6.	Expiratory Time With .01 Second Resolution	--	.1 to 99 Seconds	at 15° to 35°C ±5% reading or ±1 digit
8.	I:E Ratio With .01, .1 Resolution	--	1:.10 to 1:9.9	at 15° to 35°C ±5% reading or ±1 digit (Autoranges)

Dimensions:

Width: 31 cm (12")
Height: 26 cm (10⅓")
Depth: 29 cm (11⅓")

Weight:

7 kg (15⅓ lbs.)

Operating Conditions:

Temperature: +10° to +32.2° C (50 to 90°F)
Humidity: 35% to 75% (Non-Condensing)
Shock Loading: Less than 50 g's

Shipping Conditions:

Temperature: -40° to +60°C (-40° to 140°F)
Humidity: 10% to 90% (Non-Condensing)
Shock and Vibration Loading: Less than 50 g's

Storage Conditions:

Temperature: -28.9° to +60°C (-20° to 140°F)
Humidity: 35% to 99%
Shelf Life: 5 Years

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SYMBOLS

SYMBOL	DESCRIPTION
	"CAUTION", CONSULT ACCOMPANYING DOCUMENTS
	"OFF" (ON-OFF SWITCH)
	"ON" (ON-OFF SWITCH)
	TYPE B EQUIPMENT
	ALTERNATING CURRENT
	PROTECTIVE EARTH (GROUND)

SPECIFICATIONS

NOTE: All specifications are nominal and subject to change without notice.

Electrical Requirements:

AC 100 Volts 50/60 Hz (Fused for 1.0 amp)
AC 120 Volts 50/60 Hz (Fused for 1.0 amp)
AC 220 Volts 50/60 Hz (Fused for 0.5 amp)
AC 230 Volts 50/60 Hz (Fused for 0.5 amp)

Classification:

Protection Class I
Type B according to IEC 601-1
Equipment of Group II, according to MED GV

Operation:

Continuous

1.1 INTRODUCTION

Thank you for purchasing the RT-200 Calibration Analyzer. This instrument will help you maintain and test many pieces of hospital equipment. It accurately measures pressure, gas flow rate, tidal volume, breath rate, inspiratory/expiratory ratio and other functions. The RT-200's micro-processor based design provides features and accuracy not available on other pneumatic calibrators. Features include peak-detect mode, digital display, self-diagnostics, and others. On many parameters, accuracy is 1% or better.

The RT-200 is designed with a light-weight, portable, modular case. The unit is easily transported anywhere you need to make precise measurements. With this one device you can perform calibrations, service and preventive maintenance on most Respiratory Therapy and related equipment. The RT-200 offers convenience, accuracy and flexibility in one small package.

This owner's manual provides the information you need to get the most benefit from your RT-200 Calibration Analyzer. Please take the time to read it thoroughly.

1.3 CERTIFICATION & RECERTIFICATION

CERTIFICATION: Timeter Instrument Corporation certifies that this instrument has been thoroughly tested and inspected to meet its published specifications before being shipped from the factory. Enclosed are the results of this testing, showing the standard used during certification.

RECERTIFICATION: The recommended frequency of recertification is based on the frequency and type of use of the analyzer and the long-term stability of the internal electronic circuitry. As a general rule, the Timeter RT-200 should be tested and recertified every 12 months. To return your RT-200 to Timeter for recertification or factory service, follow the procedures in section 1.6 below, under the heading "CLAIMS, REPACKAGING AND FACTORY SERVICE." TO REDUCE DOWN TIME OF YOUR RT-200, CALL TIMETER CUSTOMER SERVICE IN ADVANCE TO SCHEDULE YOUR RECERTIFICATION.

1.4 INITIAL INSPECTION

Unpack the RT-200 Calibration Analyzer as soon as it is delivered. Save the box and packing for future shipping. Check the exterior of the unit for shipping damage. If there is exterior damage, DO NOT attempt to use the unit. Refer to the section below entitled "CLAIMS, REPACKAGING AND FACTORY SERVICE" (Section 1.6).

If there is no apparent damage, verify that the following items are included in the shipment:

A. Full Accessory Pouch (002-021) containing the following items:

		Part Number
1.	Two 24" lengths 3/16" ID vinyl tubing	911-003
2.	One 22mm ID x 22mm ID tubing adaptor	930-002
3.	One 22mm OD x 22mm OD tubing adaptor	930-003
4.	Two 22mm OD x 22mm ID x 3/16 ID tubing tee	930-004
5.	One 3/16" ID tubing tee	864-001
6.	One 1/4" ID tubing tee	002-007
7.	One 22mm ID x 3/16" ID tubing adaptor	930-001
8.	One 1 Amp 3AG fuses or as appropriate for for line voltage being used	503-001
9.	Thumb nut	814-002B
10.	Nipple	843-119
11.	External Filter (includes: Adaptor 812-002 with screen 607-002)	8004
12.	Two 1/2 Amp, 5 mm x 20mm, fuses	602-003

B. Dust Cover

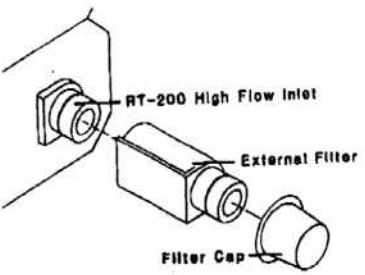
C. Any other items listed on the packing slip.

Notify Timeter is any of these items are missing.

*** IMPORTANT ***

An external filter is included in the RT-200 Accessory Pouch to prevent dirt from affecting the accuracy of the high flow transducer. Before making hook-ups to the high flow range port, attach this filter.

When the high flow range port is not being used the external filter can be left in place. Cover the filter and the high range outlet on the back of the unit with the caps provided to prevent dirt from entering.



1.5 FUNCTIONAL TEST

If the RT-200 passes the initial inspection, perform the following test to verify that it functions properly.

A. Attach the RT-200 power cord to a Hospital Grade Outlet.

B. Turn the RT-200 on. The power switch is located on the rear panel of the control module (Model RT-201).

C. After a few seconds this reading will appear on the display:

E _ _

If the RT-200 fails to perform this test or "HELP E" appears on the display, see Section 1.6 below entitled "CLAIMS, REPACKAGING AND FACTORY SERVICE."

1.6 CLAIMS, REPACKAGING AND FACTORY SERVICE

If the RT-200 does not pass initial inspection or fails the functional test, notify the Timeter Service Department at the telephone number listed below within 7 days and corrective action will be taken. Unless damage occured after delivery, Timeter will repair or replace your RT-200 without waiting for the claim against the carrier.

If your RT-200 malfunctions, or if you have trouble using it, refer to Appendix A entitled "TROUBLE SHOOTING." This section offers simple solutions to difficulties you may encounter. To resolve persistent problems, call Timeter at the number listed below and ask for the RT-200 Service Department.

When returning the RT-200 system to the factory for any reason, use the following procedure:

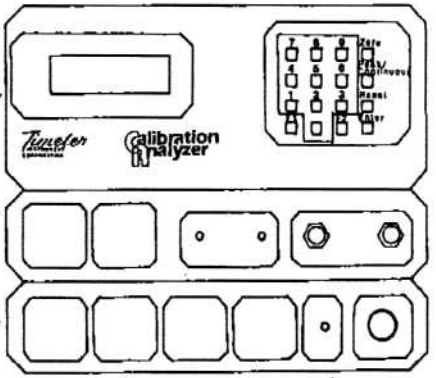
A. Call the factory to obtain return authorization.
B. Identify the unit to be returned to Timeter with a purchase order containing the name and address of the owner, the serial number and model number of the unit being returned and the specifics of the service required.
C. Carefully pack the unit in its original carton. If this carton is not available, call the Timeter Service Department for recommendations on suitable packing materials.
D. It is also recommended that you ship the unit fully insured. All shipments to Timeter must be prepaid. Shipping damage in transit to Timeter will be the responsibility of the customer.

Individual modules may be returned for service or recertication. Contact Timeter for details.

2.1 THE RT-200 SYSTEM

Figure 2.1 shows the "standard" RT-200. It consists of three modules: a Control Module and two "function" modules, flow and pressure, which maybe ordered seperately or as a system.

FIG.2.1



A. The Control Module (Model RT-201) is the "brain" of the RT-200, and controls all of its operations. The keypad and display are located on the Control Module.

B. The Pressure Module (Model RT-202) contains the transducers and circuitry for measuring various ranges of pressure and vacuum.

C. The Flow Module (Model RT-203) contains the transducers and circuitry for measuring gas flow rate, volumes, breath rate, inspiratory and expiratory times and I:E ratio.

The system can be expanded to include other modules as they become available.

2.2 THE CONTROL MODULE

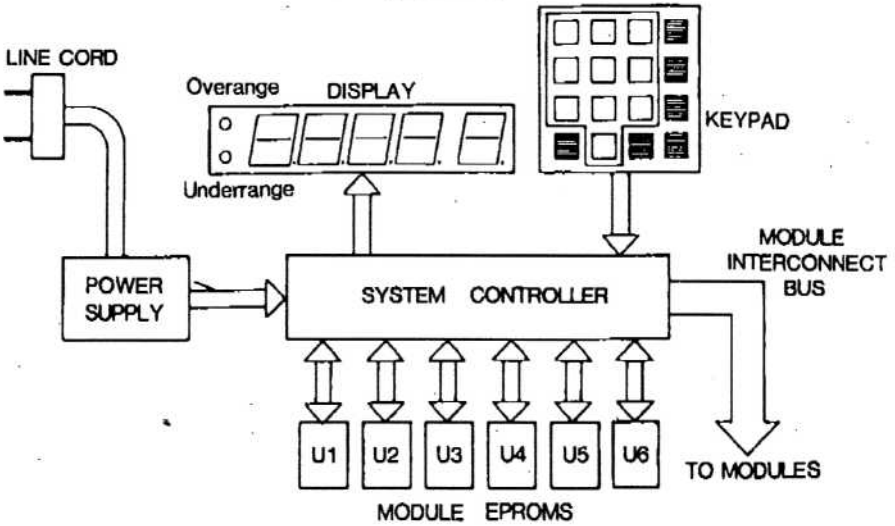
The Control Module performs two major tasks:

A. SELECTING FUNCTIONS: The Control Module allows you to select test functions. You do this by entering "Function Code" numbers on the keypad.
B. DISPLAYING READINGS: The Control Module computes test readings using information from the other modules and shows the result on the display.

The Control Module also:

- Supplies power to the other modules in the RT-200 system.
- Allows you to "Zero" test functions with the push of a button.
- Allows you to select "peak-detect" mode on many test functions.
- Shows you if a reading is overrange or underrange.
- Alerts you to various error conditions.

Figure.2.2



2.2.1 THEORY OF OPERATION - CONTROL MODULE

Figure 2.2 shows a block diagram of the Control Module (Model RT-201). The major component of the Control Module is the System Controller (Controller). The Controller is microprocessor-based and controls the operation of the system. The Keypad allows you to give commands directly to the Controller. For example, to measure air flow rate, you enter a code on the keypad which tells the Controller you want to use the air flow rate function. In response to this command, the Controller places a signal on the Module Interconnect Bus which activates the Flow Module. The transducers in the Flow Module convert gas flow rate to an electrical signal. The electrical signal is converted to digital form and sent to the Controller on the Module Interconnect Bus. The Controller analyzes this digital signal, computes the correct reading, and places it on the Display. The Module EPROMs contain specific data directing the Controller during signal processing. This data is placed in the EPROMs during factory calibration.

2.2.2 MODULE EPROMS

The Pressure and Flow modules (function modules) each have a Module EPROM which is installed on the Controller circuit board. (An EPROM is an integrated circuit which contains a computer program. The microprocessor in the Controller runs the program to control the RT-200's operations.) The Module EPROM must be properly installed for the associated function module to work. DO NOT remove or install EPROMs unless specifically instructed to do so by Timeter's Service personnel.

2.3 FUNCTION CODES

A function module (Flow or Pressure) typically contains several ranges or units of measure. The ranges and units of measure are identified by Function Labels which appear in the windows on the front panels of the each module. A two digit Function Code is printed on the panel next to these labels. Refer to the Figure 2.1. Other ranges, units of measure and and gases are available on a special order basis. You specify at the time of order whether you want a standard unit or a unit with some special units of measure. On the standard unit Function Code "11" refers to the 20 cm H20 function. On a "special" unit ordered with different units of meaasure, Function Code "11" may correspond to 7.2 in Hg or some other function. Regardless of this difference, the functions available on your unit are identified by the Function Labels and the corresponding Function Codes which appear on the front panels.

2.4 KEYPAD

The Control Module front panel is shown in Figure 2.3. The keypad is on the right side of the panel. The functions of the various keys are:

Key(s)	Function
0 - 9	Used to enter Function Codes
Enter	After you type in a two-digit Function Code, pressing the Enter key causes the RT-200 to activate the desired function.
Zero	"Zeros" the display to compensate for any drift that occurs. When "zeroing", REMOVE ALL ALL CONNECTIONS FROM THE FUNCTION INLET FITTINGS. While the unit is "zeroing", the Controller tests the display by lighting all the segments in the display. After a second, a value of zero will appear on the display, indicating the RT-200 is ready to continue operation. The zero values are stored as long as the RT-200 remains powered up. If the unit is turned off or power is interrupted, they are lost. When the the RT-200 is turned on you will need to "zero" the functions you want to use. If you attempt to use a function which has not been zeroed, the Controller will place the following indication on the display:

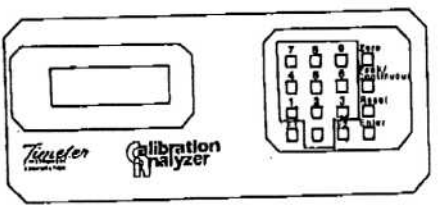


Figure 2.3

oooo o

Press the Zero key to set the zero value. It is a good practice to re-zero the RT-200 just before critical measurements. If special functions or triggering options are selected, these will be briefly displayed after the Zero key is pressed. (see below)

Key(s)	Function
Peak/ Continuous	This key allows you to switch from the peak-detect mode to the continuous (normal) mode and then back. In the Peak mode the RT-200 measures the peak value of the function. When the unit is in the Peak mode, a "p" will appear on the Mode section of the display. This key will have no effect when a function is selected for which peak-detect mode is not operational.
Reset	This key instructs the CONTROLLER to return to the initial power-up condition. The "E _ _" prompt will appear on the display. Zero offset values and special functions selected will remain. The RT-200 is now ready for commands from the keypad.
F1	This key allows flow and volume measurements of oxygen (02) and nitrogen N2) mixtures or oxygen and nitrous oxide (N2O) mixtures. It also allows a special mode to be entered for measuring inspiratory and expiratory time and I/E ratio on ventilators equipped with an inspiratory hold mode.
F2	This key allows tidal volumes to be accumulated for a selected number of breaths (2-10). The display will indicate the accumulated tidal volume and the number of breaths.
0 0	This is a special function that allows you to make corrections for gas pressure, temperature and humidity so that test results of flow and volume can be displayed in ATP, STP or BTPS units.

ATP: (ambient temperature and pressure) At power up the RT-200 defaults to ATP, assuming the temperature of the test gas is 70° F. If it is not, USE the ATP mode of the "0 0" function to enter the actual test gas temperature. This is helpful when testing devices that are calibrated in ATP

STP: (standard temperature and pressure) This corrects measurements to standard temperature (70° F) and standard pressure (760mm Hg). In this mode barometric pressure must be entered so the RT-200 can make necessary corrections. The RT-200 compensates for gas pressure, but gas temperature must be between 59-95°F. See note below.

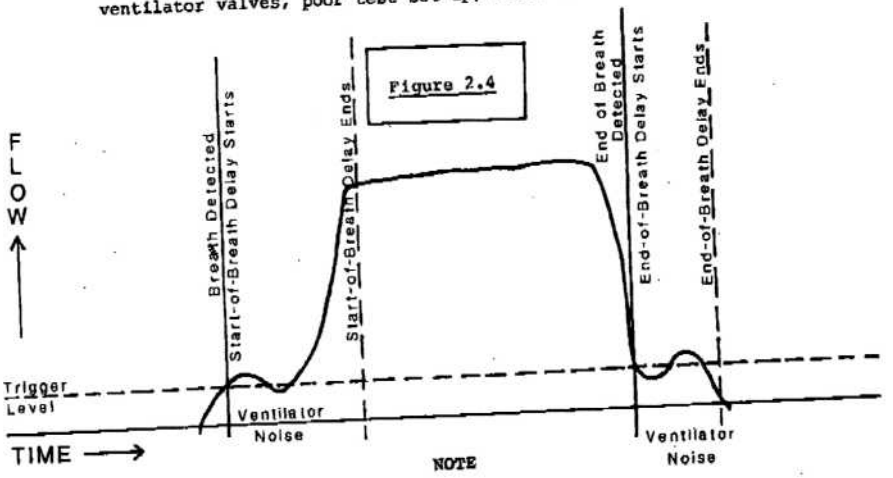
BTPS: (body temperature, 98.6°F and ambient pressure, saturated with water vapor) allows testing to be done using DRY gas from an oxygen cylinder (on oxygen ranges) or an existing humidity air source (on air ranges) and corrects the gas flow/volume to it equivalent BTPS reading. This is useful because **BTPS gas MUST NEVER be allowed to flow through the RT-200** or it will be damaged. The gas temperature must be between 59-95°F.

NOTE: The RT-200 allows gas temperature to vary between 59-95°F, however, maximum accuracy is achieved using 70°F dry oxygen or 70°F 20% RH air.

Key(s) Function

0 1 This is a special function that allows you to modify the duration of the start and end-of-breath delays and the sensitivity of the triggering level. It applies to all measurements triggered by the start/stop of flow or pressure (see NOTE below). It can be useful in special circumstances where pnuematic noise, waveform ringing and overshoot cause false triggering.

CAUTION: This function should not be used to allow malfunctioning equipment to pass testing. Investigate and solve any abnormal pnuematic noise (leaky ventilator valves, poor test set-up, etc.) before using the "0 1" function.



The start of the breath is sensed when the flow reaches 1% of the full scale of the function being used (the triggering level can be raised to 4%). The RT-200 ignores valve noise for the first .05 second after the breath is sensed. This .05 second period is the built-in "start-of-breath delay." If the valve noise is still present at the end of the breath delay, the RT-200 will show a "HELP r" message on the display. Then it automatically "tries again" in case the problem was caused by a vibration in the test set-up or other irregularities. The "HELP r" message is also displayed if the breath delay is longer than the inspiratory time.

Likewise, the end of the breath is sensed when the flow drops to 1% of the full scale of the function being used (trigger level can be raised to 4%). The RT-200 ignores valve noise for the first .100 second after the breath ends. This .100 second period is the built in "end-of-breath delay." If the valve noise is still present after the end-of-breath delay, the RT-200 will show a "HELP F" message on the display. Then it automatically "tries again" in case the problem was caused by a vibration in the test set-up or other irregularities. The "HELP F" message is also displayed if the end-of-breath delay is longer than the expiratory time.

Likewise, when a peak pressure is selected, the trigger level is set at approximately 1% of the full scale of the function selected. On both peak flow and pressure, any peaks during the start-of-breath delay are ignored. On all other functions, data collection starts immediately with the start of the breath.

Key(s)	Function
0 9	Returns the special functions to power up conditions without losing zero values. To use press the 0 key and 9 key and press enter.

2.4.1 Application of Special Functions

The special functions apply to the test functions indicated in Figure 2.5.

Figure 2.5

◯ = AVAILABLE Ⓟ = AVALIABLE IN PEAK ONLY

SPECIAL FUNCTION	KEY(S)	PRESSURE	FLOW (LOW & HIGH)				TIDAL VOLUME		MINUTE VOLUME		TIME			
		ALL	AIR	O2	N2O	SPEC	AIR	O2	AIR	O2	BPM	TINSP	TEXP	I/E RATIO
O2/N2 MIXTURES	F1			◯				◯		◯				
O2/N2O MIXTURES	F1				◯									
HOLD MODE	F1											◯	◯	◯
ACCUMULATIVE VOLUME	F2						◯	◯						
ATP, STP, BTPS	0 + 0		◯	◯	◯	◯	◯	◯	◯	◯				
BREATH DELAYS, START & END-OF-, & TRIGGER LEVEL	0 + 1	Ⓟ	Ⓟ	Ⓟ	Ⓟ	Ⓟ	◯	◯	◯	◯	◯	◯	◯	◯

2.5 SELECTING A FUNCTION

There are four ways to select a function:

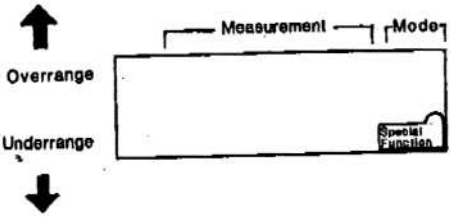
A. **Enter the FUNCTION CODE, then press the Enter key.** The CONTROLLER will select the function, but will not save a "zero value." The previous value (if there is one) will be used to compute new readings on the display. If no "zero value" was stored for this function, the CONTROLLER will place the "oooo o" message on the display.

B. **Enter the FUNCTION CODE, then press the Zero key.** The CONTROLLER will select the function and immediately save a "zero value." The advantage of this method is that the function is entered and zeroed with one keystroke.

C. **Enter the FUNCTION CODE, then press the Peak/Continuous key.** The CONTROLLER will select the function and immediately switch into peak-detect mode if it is allowable. No zero operation will be performed.

D. **Enter the first digit of the FUNCTION CODE, then press the Zero key.** Enter the second digit of the FUNCTION CODE and press the Peak/Continuous key. The CONTROLLER will select the function, immediately save a "zero value", and switch to peak-detect mode if it is available for that function. The outcome will be the same if the order of the Zero and Peak/ Continuous keys is reversed in this description.

Figure 2.6



2.6 DISPLAY

The RT-200 display consists of three sections. These sections are shown in Figure 2.6 and are explained below:

A. OVERRANGE AND UNDERRANGE INDICATORS: These are located directly to the left of the display. They indicate whether a display reading is outside of the accurate range on the RT-200.

The overrange lamp lights when the display reading exceeds the normal accurate range of the function selected. Readings taken when the overrange lamp is lit may be inaccurate. If the reading continues to rise, a point will be reached where the display will blank, and the overrange lamp will still be lit. This is called the "blanking point." This feature prevents the RT-200 from displaying readings which may be greatly inaccurate. The amount by which the "blanking point" exceeds the top of the range varies with each function and is listed on the individual function specification sheets included with this manual.

The underrange lamp lights when the display reading goes below negative ten or a reverse flow exists. Negative readings, down to -10, are displayed with a minus sign in the mode section of the display.

B. MEASUREMENT: This four-digit section of the display normally contains the measurement. Self-diagnostic messages may also appear in this section. See section 2.7 below for a list of the possible readings and messages which may appear on the display.

C. MODE: See section 2.7 for a list of the symbols which may appear in the mode section of the display.

2.7 POSSIBLE DISPLAY MESSAGES

This section lists the possible readings, codes and messages which may appear on the display. "123" is used to represent any numeric reading, X is used to represent a number from 1 to 9 or a letter.

DISPLAY	MEANING
E _ _	This is the keypad entry prompt. The CONTROLLER is waiting for you to type in a function code or some other command.
0000 0	Indicates that a function you have selected needs to be "zeroed" before readings can be taken.
0.01 -	A "minus" sign in the mode section indicates a reading below zero.
1.23 P	Indicates that the RT-200 is in peak-detect mode. The reading will not change until another peak is encountered.
1-2.3	I:E ratio reading.
° 100.3	Overrange lamp lit indicates a reading above the upper limit of the function.
°	Overrange lamp lit with blank display indicates that the reading is beyond the upper limit of the function.
.	Underrange lamp lit with blank display indicates that the reading is more than 10 below zero.
HELP X	This is a "HELP message. It indicates that an error condition has been encountered. See page 5.1 for a list of the "HELP" messages and their meanings.
. 1.23	Underrange lamp with display reading indicates that flow or peak pressure is occuring in a negative direction. The display indicates the last valid, positive reading.
100.3 .	Indicates a special function has been selected.
E _ _ P	Indicates that the Peak/Continuous key was pressed before the full FUNCTION CODE was entered. The CONTROLLER will place the RT-200 in peak-detect mode as soon as you enter the FUNCTION CODE and press the Enter key.