TCO_2M®

Transcutaneous CO_2/O_2 Monitor

Service Manual

Model 860

May 16, 1997

Catalog No. 6590-90-00

Novametrix Medical Systems Inc.
5 Technology Drive
Wallingford, Connecticut, U.S.A. 06492.

R Revision History

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G Guarantee

Equipment manufactured or distributed by Novametrix Medical Systems Inc., is fully guaranteed, covering materials and workmanship, for a period of one year from the date of shipment, except for certain disposable products and products with stated guarantees other than one year. Novametrix reserves the right to perform guarantee service(s) at its factory, at an authorized repair station, or at the customer's installation.

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Email **techline@novametrix.com**

Caution: Federal (U.S.A.) law restricts this device to sale, distribution, or use by or on the order of a licensed medical practitioner.

Service Policy

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  - Flat rate parts-exchange,
  - Flat rate return for repair
  - Time and Material,
  - Full warranty, discounted replacement sensors

C Contents

1 Safety

1.1 *Patient Safety*

- The location of the sensor on the patient should be changed periodically to minimize the risk of burns due to heating of the skin by the sensor. The risk of such a burn is dependent upon the sensor temperature, duration of application and physiological parameters including local perfusion, body temperature, and skin thickness.
- *TCO_2M* monitor has electrically isolated inputs. Patient leakage current flowing from the instrument to ground is limited to less than 10 µA at 120 V, 60 Hz. Patient isolation is greater than 10 MΩ, 2500 V rms at 60 Hz. For maximum patient and operator safety, the following procedures are recommended;
  - Keep the *TCO_2M* and its accessories clean.
  - Do not operate the *TCO_2M* when it is wet due to spills or condensation.
  - Do not touch the patient while making adjustments on the *TCO_2M* monitor.
  - Whenever possible, the *TCO_2M* monitor should be connected to the same circuit as other equipment in use on the same patient. Outlets that are on the same circuit can be identified by your hospital's engineering department.
- In areas where electromagnetic devices (i.e., electrocautery) are used, patient monitoring may be interrupted due to electromagnetic interference.
- The $PtcCO_2$ display reading (CO2) is factory set to reflect the metabolic factor for pCO_2 and the value is corrected only during patient monitoring—not during calibration. Refer to the User's Manual for more information.
- Components of this product and its accessories which have patient contact are latex free.
- Connect only Novametrix supplied transcutaneous sensors and gas calibrators to the *TCO_2M* Model 860 monitor front panel input connectors. Refer to "Accessories" on page 45 for listings and catalog numbers.

1.2 *Contraindications*

- In patients who are hemodynamically compromised, transcutaneous gas values may no longer reflect arterial gas values due to changes in blood flow to the tissue.
- Patients with extremely sensitive skin should be carefully evaluated prior to monitoring as sensor heat or adhesive ring application may cause skin irritation. Skin irritation due to the adhesive ring can be minimized by loosening the adhesive with alcohol or water prior to its removal from the patient.
- HALOTHANE INTERFERENCE. Halothane is the only known anesthetic gas affecting the reliability of transcutaneous oxygen ($PtcO_2$) measurement as demonstrated in in-vitro testing of the Transcutaneous Combination O_2/CO_2 Sensor (PN:4474). The affect of halothane on transcutaneous oxygen measurements in-vivo has not been determined. Halothane does not affect the transcutaneous carbon dioxide ($PtcCO_2$) measurement of the Transcutaneous Combination O_2/CO_2 Sensor. No known anesthetic gasses affect the performance of the Transcutaneous Oxygen Sensor (PN:6754) or the Transcutaneous Carbon Dioxide Sensor (PN:6752).

- $PtcO_2$ levels in excess of 150 mmHg may cause drift of $PtcCO_2$ portion of the 4474-00 Combination O_2/CO_2 Sensor using an 8900 Split Membrane NOVADISK®. This drift is not experienced with the 4474-39 Combination O_2/CO_2 Sensor and 8575 NOVADISK, nor with the Transcutaneous Oxygen Sensor (PN:6754) or the Transcutaneous Carbon Dioxide Sensor (PN:6752).

WARNING

Indicates a potentially harmful condition that can lead to personal injury.

- **Explosion Hazard:** Do NOT use the *TCO_2M* in the presence of flammable anesthetics. Use of this instrument in such an environment may present an explosion hazard.
- **Electrical Shock Hazard:** Always turn the monitor off before cleaning it. Do NOT use a damaged sensor or one with exposed electrical contacts.
- **Failure of Operation:** If the monitor fails to respond as described, do not use it until the situation has been corrected by qualified personnel.
- **Fire Hazard:** The *TCO_2M* and its sensors should not be exposed to elevated oxygen levels *at* elevated pressures. Use of this instrument in such an environment may present a fire hazard.
- For installation where the integrity of the external protective earth conductor arrangement is in doubt, the equipment should be operated from its internal battery only.
- No user serviceable parts inside. Refer servicing to qualified service personnel.

CAUTION

Indicates a condition that may lead to equipment damage or malfunction.

- Federal (U.S.A.) law restricts this device to sale, distribution, or use by or on the order of a licensed medical practitioner.
- No tension should be applied to the sensor cable.
- Avoid storing the monitor and sensors at temperatures less than -10° C or greater than +55° C (<14° F or >131° F).
- Do NOT immerse the monitor or sensors in liquids.
- Do NOT sterilize the monitor or the sensors.
- Electric Shock Hazard. Do NOT remove covers or panels. Refer servicing to qualified service personnel.
- Connect the line cord only to a grounded hospital-grade outlet.
- For continued protection against fire hazard, replace fuses only with those of the same type and rating.
- No user serviceable parts inside. Refer servicing to qualified service personnel.
- Operate at temperature between +10° C to +40° C (50-104° F), < 90% relative humidity (non-condensing).

2 Description

This manual is written for users of the Novametrix *TCO_2M* Transcutaneous monitor, Model 860. The *TCO_2M* is a dual parameter, noninvasive transcutaneous gas monitor. It provides reliable, continuous measurement, displays and alerts for transcutaneous oxygen tension ($PtcO_2$), transcutaneous carbon dioxide tension ($PtcCO_2$) and sensor temperature.

Transcutaneous oxygen is measured with an oxygen sensor consisting of two parts; 1) a modified Clark-type polarographic sensor, a silver anode, electrolyte and an oxygen permeable membrane, and 2) a heating section with two precision thermistors for measuring and controlling the sensor temperature. When the sensor is subjected to oxygen, the oxygen molecules diffuse through the membrane and create an electro-chemical reaction which causes current to flow through the cathode. An amplifier connected to the cathode measures the amount of current flowing and converts it to a value proportional to the oxygen tension at the sensor/membrane interface. This information is displayed as $PtcO_2$.

Transcutaneous carbon dioxide is measured with a sensor that utilizes a unique pH sensor based on the Stow-Severinghaus principle. The carbon dioxide sensor is composed of two parts; 1) a carbon dioxide sensor consisting of a pH sensor, reference sensor, electrolyte and a carbon dioxide permeable membrane, and 2) a heating section with two precision thermistors for measuring and controlling the sensor temperature. When the sensor is subjected to carbon dioxide, the carbon dioxide molecules diffuse through the membrane and react with the electrolyte. This reaction alters the pH of the electrolyte solution, which in turn changes the voltage across the pH and reference sensors. Since carbon dioxide is the only gas that can affect the pH of the electrolyte, there is a direct correlation between pH and the amount of CO_2 present. This relationship is expressed by the Henderson-Hasselbach equation:

$$pH = pKa + \log \frac{HCO_3}{0.03\ pCO_2}$$

An amplifier measures this voltage change and converts it to a value corresponding to the carbon dioxide tension at the sensor/membrane interface. This information is displayed as $PtcCO_2$.

The following sensors may be used with the *TCO_2M*:

Cat. No.	Sensor Type
4474-00	Combination O_2/CO_2 Sensor
4474-39	Combination O_2/CO_2 Sensor
6752	Carbon Dioxide Sensor
6754	Oxygen Sensor

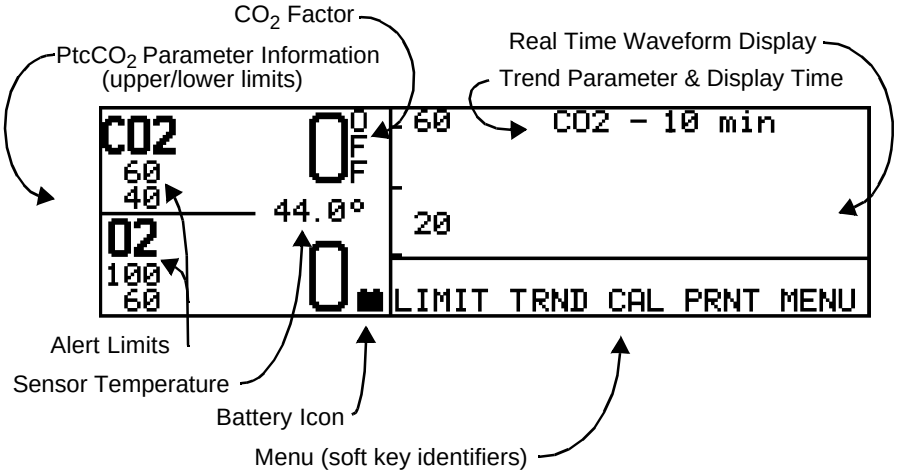
2.1 Conventions

The following conventions will be used throughout this manual:

- Normal text will be shown in this type.
- Message center displays, menu titles and displays will be shown IN THIS TYPE.
- The names of soft keys will be shown **IN THIS TYPE**.
- The image of front panel keys (hard keys) will be displayed as their icon, e.g.  - POWER key.

2.2 Summary of Operation

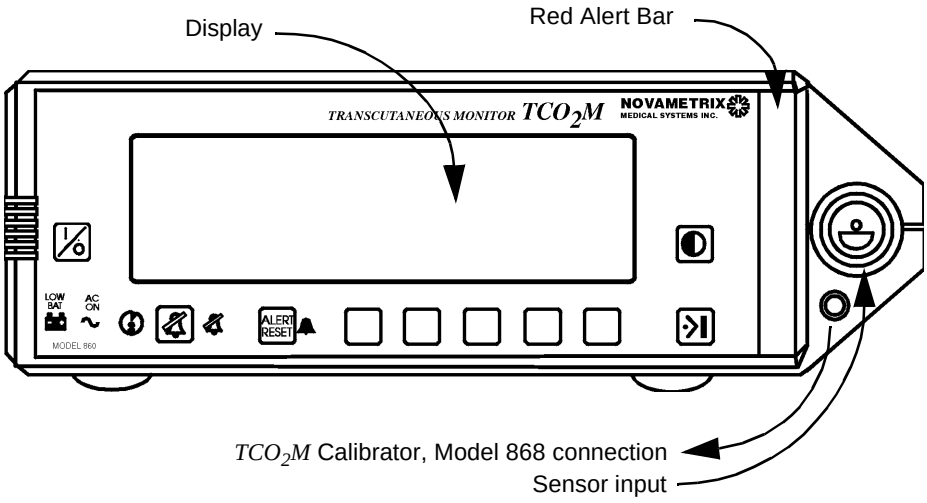
The front panel of the *TCO_2M* contains hard keys (dedicated front panel keys), soft keys (menu dependent keys) and icon symbols (illuminating indicators). When the monitor is powered up and passes its self-test, it will display a screen similar to the one below:



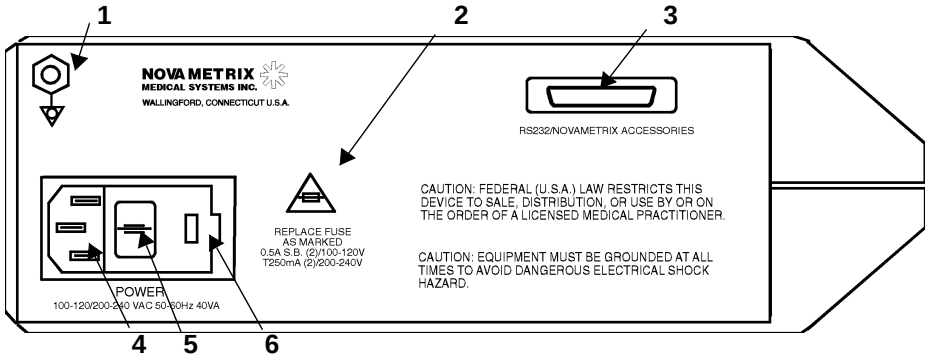
The display is arranged in different sections; parameter information for $PtcCO_2$ and $PtcO_2$, real time waveform display and the menu display. A full screen trend display is also available.

The first menu to appear in normal operation is the main menu, from here all other sub-menus are accessed by pressing particular soft keys.

2.3 Front and Rear Illustrations



	Power button - Press to turn the monitor on/off. -used on some models.		Audio disable icon - Flashes yellow when the audio has been disabled.
	"LOW BAT" - Red when battery is near depletion. (A similiar icon appears in the display when the monitor is running on battery power and gives a visual indication of the charge left on the battery.)	ALERT RESET	Alert Reset key - Press to acknowledge and reset alerts.
	AC indicator - Green when the monitor is connected to AC power and the rear panel power entry module switch is set to "|" (ON). Also indicates the battery is charging.		Alert indicator - Flashes red to indicate an alert condition.
			Event key - Press to mark an event in trend memory.
2	Two minute silence indicator - Illuminates yellow when the audio has been temporarily silenced using the two minute silence feature.		Contrast key - Press and hold to vary the contrast of the display.
	Audio key - Press to toggle two minute silence. Press and hold for audio disable.		Soft key - Five keys that function according to the command shown above each key in the display.



1 Ground stud. Use to connect monitor's chassis to earth ground.

2 Indicates fuse rating information for mains fuse.

3 RS232 port for Novametrix accessories.

4 Power cord receptacle and power cord retaining clip. Plug power cord into this receptacle. Use only hospital grade three wire plugs for connection via supplied power cord.

5 AC Line Power (Mains) Switch. Set to "**|**" allows AC Mains to power the monitor, set to "O" switches AC mains power off.

6 Voltage select/fuse compartment - Sets the mains operating voltage and houses mains fuses.

NOTE: The AC power line cord shipped with monitors for North America is a hospital grade, SJT style cord with a 120 VAC plug. All power line cords shipped with monitors for Europe are the european style with a 220-240 VAC plug. All other style power line cords, as required by the country of destination, are provided by the distributor of that country.

2.4 *Symbols*


Equipotentiality - Connection to monitor's chassis.


Patient Isolation - Identifies patient isolation connection as type BF.


Protective earth ground connection


High voltages present


Attention - Consult manual for detailed information.

Mains Fuse - Mains fuse rating for replacement fuses


Mains Power - AC mains switch "|" ON-connection to mains; "O" OFF-disconnection from mains.

3 Theory of Operation

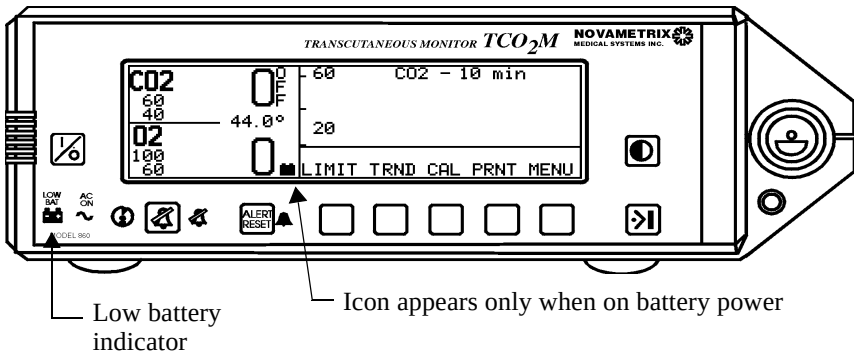
3.1 *2726 Power Supply Board*

The Power Supply Board contains the circuitry needed to charge the battery and to convert the necessary DC voltage from the AC line. Refer to the "POWER SUPPLY" schematic 2726-03 (location).

3.1.1 AC Mains and Battery Operation Overview

The *TCO_2M* is powered by an internal 12 volt battery that is automatically charged when the monitor is powered from the AC line. The green ∿ icon on the front panel illuminates when the line cord is connected and the rear panel power switch must be in the "|" (ON) position. This indicates that AC line power is charging the battery.

A fully charged battery will power the monitor for over three hours. While on battery power, the display screen shows a battery icon that "drains" as the battery charge is depleted; from a full charge, to half-charge, to nearly depleted. The monitor may not power up on battery power if the battery is not sufficiently charged.



As the battery voltage runs low (≈11.5 volts), the (battery indicator) on the front panel will turn red. At this point, the AC line should be reconnected to charge the battery.

If the monitor continues to be powered from a battery in a low voltage situation, at approximately 10.5 volts, a continuous alarm sounds for sixty seconds while the battery indicator will flash red. A "BATTERY VERY LOW PLUG IN AC POWER" message will appear. If this alarm is ignored, the monitor will shut down. The AC line should be connected to the monitor to recharge the battery before this occurs.

3.1.2 AC Operation

Reference the Overall Wiring Diagram (see 6590-09). The AC line voltage enters the monitor at the rear panel Power Entry Module (PM301). This device contains a built in RFI power line filter, a double-pole single-throw switch that opens and closes both AC input lines, fuses and an input voltage selection key.

The filtered, switched and fused output of the Power Entry Module is fed to the primary coils of the system transformer, T301. Reference the Power Supply schematic 2726-03. The secondary output from T301 is rectified by D1 (bridge rectifier) and filtered by C1. The (loaded) DC voltage at this point is approximately 20 volts.

The 20 volts DC is fed to the battery charging regulator IC1 (pin 5) through Q1. Biasing for Q1 is accomplished by D2, R1, and R2 when AC power is applied. When running on battery power, Q1 is biased off by R1, R2, and D3. This prevents the battery from trying to power the battery charger regulator. Power to IC2 is also removed, this informs the monitor of the loss of AC via the LINEST line

The output of switching regulator IC1 pin4 is rectified and filtered by D4, C4, and L1, then fed to the battery through current sense resistor R3 and fuse F302, to J302 pin 1 (VBAT+). The battery float charge voltage is maintained at 13.2 volts except for fast charge that is regulated at 14.4 volts. The output is also monitored for over current conditions. These parameters are controlled by IC3 and associated circuitry. When the battery charge current exceeds a preset limit, IC3 pin 7 goes high which biases Q2 on, this in turn shorts out R12 which affects the feedback control (FB) to IC1 (pin 1). With R12 shorted out, the control resistors R14 and R13 set the output voltage to 14.4 volts. When the charge current lowers, IC3 pin 7 goes low which biases Q2 off, this puts R12 back into the feedback control which now consists of R12, R13 and R14; setting the voltage to 13.2 volts. When more than the maximum charge current flows through R3, IC3 pin 1 shorts IC1 pin 2 to ground, that shuts IC1 off until its next switching cycle. When the current reaches a safe level IC3 pin 1 allows IC1 to remain on.

The voltage switched by Q1 is also fed to IC2 as VCH (Voltage Charge). The output of this 5 volt regulator provides the LINEST (Line Status) signal to the main board. With AC applied, LINEST is high. LINEST goes low when the AC is disconnected.

3.2 *2533 CPU Interface Board*

The following sections detail the operation of the CPU Interface board. Refer to the “CPU INTERFACE” board schematic (2533-03).

3.2.1 Power On/Off Control Circuitry

See page 3 on schematic. The *TCO_2M* power on/off control circuitry consists of the VBACK supply (regulated by IC12), IC10, IC11 and the front panel power key.

When the battery or AC power is first applied to the power supply board (via VIN J102 pin 1), VBACK goes to +5 volts. This provides power to IC10 and IC11, and through the C26 and RP4 (pins 3,4) network at IC10 pin 8, sets IC10 pin 2 to a logic low.

The ON/OFF line is brought low each time the front panel power key is pressed. This sends the output at IC11 pin 10 high. This low-to-high transition clocks the (#1) D flip-flop portion of IC10. The output at IC10 pin 2 goes high and with each successive press of the power key, this output toggles to the opposite level (low or high). A high turns the *TCO_2M* on and a low shuts it off.

While the output at IC10 pin 2 is high, the MOSFET Q7 is turned on and pulls the gate of MOSFET Q8 to ground, thus causing Q8 to conduct as well. With Q8 conducting, the currently active monitor power source—either the AC power derived supply or the battery supply will flow through Q8 to the voltage input (pin 7) of the Pulse Width Modulator IC9. The output IC9 pin 6 will oscillate (at the frequency set by R13 and C15). This causes Q5 to switch on and off and provide a path to ground through the primary coils of T1 for the supply (line or battery) at T1 pins 9 & 10. Current flowing in the primary is measured at IC9 pin 3 and the duty cycle of the pin 6 output will vary with the load on the transformer.

Current flow in the transformer primary induces current in the three secondary coils and creates the ± V5 volt analog supplies, the VRAWI that powers the isolated RS232 circuitry, and the +5 volt VCC supply that power the remaining circuits in the monitor. The +V5 and -V5 supplies are rectified and filtered by

D4, D10, C10, C12, C68 and C69. The +V5 is regulated by IC7 and the -V5 by IC8. The VCC supply is rectified by D3, filtered by L1, C9 and C20 and fused at F1, and in addition, a feedback loop to IC9 contains VR1 which is factory adjusted to produce a +5.00 volt ± 0.05 volt VCC supply (measured under load).

3.2.2 Power Supplies

See page 3 on schematic. The secondary winding consisting of pins 1 and 2 are rectified and filtered by D1 and C1. The rectified voltage at this point is approximately 7 volts DC and is regulated to 5 volts by IC2. This isolated supply powers the isolated portion of the opto-isolators and the RS232 driver chip IC1. The unregulated voltage VRAWI is sent to the rear panel connector J101.

The backup voltage (VBACK) is regulated by IC12 from the VIN supply. Capacitors C22 and C27 serve as filters and D17 allows VCC to power VBACK circuitry when the monitor is on. At this point D18 is biased off so IC12 is idle. When the monitor is turned off and VCC collapses D18 is then forward biased and IC12 now supplies VBACK circuitry, D17 at this time is reverse biased and prevents power from reaching VCC.

3.2.3 Precision Reference Supplies

See page 4 on schematic. The circuitry of the Front End Board requires precise voltage supplies as references for the A/D convertor and operational amplifier circuitry. The precision references are generated by IC19B, Q6, and D16 for the +Vref (+2.048 v) supply, and by IC19A, Q4, and D12 for the -Vref (-2.048 v) supply.

Both of the precision references utilize the same method of placing the regulating diode in the feedback network of an operational amplifier. For clarity, only the positive reference will be discussed. The ICL8069, D16, is the temperature compensated 1.22 volt reference used in the feedback loop of the op-amp. The ICL8069 is a temperature compensated, but not current compensated device. The gain of the op-amp circuitry is approximately 1.7 times that of the ICL8069 voltage. This gain is set by resistors R85 and RP5-2, and potentiometer VR7. The point at which VR7 is tapped sets the gain, since it is connected to the inverting input of IC19B. The voltage from TP4 and that of the non-inverting input equals that of the zener voltage of D16. Capacitor C72 acts as a bypass and integrator to any noise across D16. Transistor Q6 is used as a current boost and low impedance source for the +2.048 volt output at TP4.

Both voltage references have their ICL8069's tied to the reference output of opposite polarity as a means of stabilization, tracking, and bias. By placing the zener in the feedback loop of the op-amp, the output is held at a constant voltage (Vz) times the gain of the circuit. This voltage will remain constant despite varying current draw.

3.2.4 Low Battery Voltage Shutdown

See page 3 on schematic. The CPU monitors the battery voltage and provides the user with a low battery indicator ( ), messages and alarms. However, if these are ignored, a hardware circuit will take over and shut off the monitor before the battery is damaged.

The pulse width modulator IC9 requires at least 7.6 volts at pin 7, its voltage supply, in order to operate. This pin typically draws 10 mA of current. The resistance of the R63 and Q8 combination is approximately 114 ohms. This equates to a voltage drop of approximately 1.14 volts. Therefore if the battery voltage drops under 9.0 volts (approximately), IC9 will not have sufficient voltage to operate and will shut down. Shutdown of IC9 stops current flow through transformer T1 and the secondary supplies shut down, effectively turning off the monitor.

When IC9 shuts down, its VREF output at pin 8 is pulled low. This forward biases D6 and causes the NAND gate output at IC11 pin4 to go high. The #2 flip-flop of IC10 is clocked, and the high at the D2 input (because $\overline{Q1}$ is High) is transferred to the Q2 output at pin 13. The high at pin 13 Sets the #1 flip-

flop causing the /$\overline{Q1}$ pin 2 output to go low. This low shuts off both MOSFETs Q7 and Q8, thereby blocking any supply voltage from IC9 pin 7. Normally, pressing the front panel power key would clock flip-flop #1 (at pin 3) and return the pin 2 output high—but the high output at pin 13 keeps the #1 flip-flop Set—and the power key has no effect.

If at this point the AC line is reconnected, MOSFET Q8 continues to block current from IC9 pin 7 and the monitor remains off. Connecting the AC line does however send the LINEST signal high. This line is brought to IC10 pin10 where it resets the #2 flip-flop, sending IC10 pin 13 Low and removing the set condition from flip-flop #1. Now, if the front panel power key is pressed, flip-flop #1 is clocked, IC11 pin11 goes high, MOSFETs Q7 and Q8 turn on, the supply to IC9 pin 7 is restored, the pulse width modulator restarts, energizes T1, and the monitor turns back on.

3.2.5 Microprocessor

See page 1 on schematic. A Hitachi HD64180RP microprocessor directs the actions of the *TCO$_2$M*. The processor, IC16, is operated at 6.144 MHz (half the12.288 MHz frequency of crystal Y1), has an 8-bit data bus and a 19-bit address bus (the 860 uses only 18-bits). The microprocessor also provides two asynchronous serial communication channels, a clocked serial I/O port and various interrupt and control signals. The +5 volt VCC supply to the processor is first sent through inductor FB1, a ferrite bead, before powering the chip at IC16 pin 32.

3.2.6 Memory

The *TCO$_2$M* system software is located at IC17, a 27C010 EPROM. The 128 K byte RAM, IC20, stores trend data, system power up settings (calibration parameters, serial output parameters, etc.), and provides an area for system memory requirements. Since IC20 is powered from the VBACK supply, RAM memory is retained when the monitor is turned off and it becomes available again when the monitor is turned back on.

The ROM at IC17 is read when its Chip Enable line (IC17 pin 22) is brought low by the $\overline{ROMCS}$ signal at IC25 pin 3, and the processor brings its Read line (IC16 pin 63) low—thereby activating the ROM Output Enable line at IC17 pin 24. Under these conditions, ROM data from the specified address bus location is made available to the data bus for use by the processor.

The RAM (IC20) is activated when its Chip Select line RAMCS* (IC20 pin 20) is brought low, via IC25 pin 8. When the ME* line at IC25 pin 5 is low, and the inverse of address line A17 at IC25 pin 4 is low, output pin 6 of IC25 will go low. This in turn will drive IC25 pin 10 low, with PWRON* low at IC25 pin 9, IC25 pin 8 will be low (RAMCS*). If at that time, $\overline{OE}$ (IC20 pin 22) is low, a RAM Read occurs, whereas a RAM Write will occur if $\overline{WE}$ (IC20 pin 27) is low.

3.2.7 Real Time Clock (RTC)

See page 2 on schematic. A Real Time Clock (IC24) provides the *TCO$_2$M* the ability to time stamp collected (printed) trend data. The 32.768 kHz crystal, Y3, provides the timing signals for the clock chip, IC24, which is powered from the VBACK supply so that the clock can continue to keep time when the monitor is turned off (provided the monitor's 12 volt internal battery is connected and maintains at least a nominal charge).

The RTC is activated when its Chip Select line (CS0) at IC24 pin 2 is brought low. With the monitor on PWRON will be low (IC25 pin 13, see page 1 on schematic), the RTC line will be brought low by the processor through IC22 pin 14, these lines drive RTCCS (Real Time Clock Chip Select IC25 pin 11) low. If at this time, the $\overline{RD}$ (IC24 pin 8) input is low, a RTC Read occurs, whereas a RTC Write will occur if the $\overline{WR}$ (IC24 pin 10) input is low. Addressing is handled by A0-A3 (pins 4-7) and data I/O through D0-D3 (pins 14-11).

3.2.8 Sound generator

See page 2 on schematic. A programmable tone generator, IC27, is used to drive the monitor's audio circuit. The tone generator is clocked by IC4 pin 9 (Q1). The tone generator is enabled by the processor when IC22 pin12 is brought low. While $\overline{CE}$ is low, $\overline{WR}$ is brought low and data bus information including frequency (pitch) and attenuation (volume) is accepted by the tone generator. The Ready signal (IC27 pin 4) goes low while accepting data and the processor is put into a Wait state until IC27 finishes its task; then Ready returns high and the processor continues its operations.

The AUDOUT output at IC27 pin 7 drives the audio amplifier IC26. The amplifier output is coupled through capacitors C55 and brought to J109 as the SNDOUT (Sound Out) line. The speaker which is mounted in the chassis is connected to J109.

3.2.9 Keypanel Interface

See page 2 on schematic. The 10 keys on the *TCO$_2$M* front panel are connected through a ribbon cable at J104. Each key (except power) is connected to an 8-bit latch (either IC14 or IC15). When any of these keys are pressed, the corresponding latch input is brought low. The processor continually reads the status of these latch outputs, the RDKEY enables IC14 when low and the RDKEY_2 line enables IC15 when brought low.

The power key ON/OFF signal is sent through J104 pin 15. The AC Line Status signal, LINEST, is generated by the power supply, and is high (+5 volts) when the monitor is connected to the AC line and the rear panel switch is set to "|". This +5 volt level is sent to the green ∿ indicator on the keypanel via J104 pin 16. The LINEST signal is also input to the latch at IC14 pin 8 so that the CPU can detect if the unit is operating on AC line power (IC14 pin 8 high) or on battery power (IC14 pin 8 low). Diode D9 keeps current from back feeding into IC14 when the monitor is turned off but still connected to the AC line.

The TML (Two Minute Lamp), AOL (Audio Off Lamp), ARL (Alert Reset Lamp), and BTL (Battery Lamp) LEDs are driven by the 8-bit latch IC13. When each of the corresponding signals is driven high the appropriate LED on the keypanel is illuminated.

3.2.10 Display Interface

See page 1 on schematic. The display is connected at J107 (see page 1 on schematic). It is controlled by the processor using the RD (Read), WR (Write), and DISPCS (Display Chip Select) lines. Data bits D0-D7 are used as input/output lines and A0 is used in conjunction with the RD and WR lines to distinguish between read and write operations as listed below.

A0	RD Low	WR Low
High	Status Read	Command Write
Low	Data Read	Data Write

See page 2 on schematic. The CNTRST (Contrast) line is controlled by pressing the front panel ◐ key. When depressed and held the processor controls the digital to analog converter IC29, line A0 is brought low along with WR and DACCS, the data on D0-D7 controls the voltage at IC30 pin 7. The output of IC30 pin 7, along with +V5 feeds a summing amplifier (IC30 pins 1, 2, 3). The output of the summing amplifier IC30 pin 1 controls the base of Q10 which in turn controls the contrast of the display through a variable negative voltage.

The backlight for the display is controlled by the DISPBR (Display Bright) line (see page 2 on schematic). When DSPBR is high the gate of Q16 is biased off, current flows from Vcc through R51 to IC45. This sets the backlight for low illumination. The illumination of the backlight is made greater when

DSPBR is made low, this biases Q16 on which essentially shorts out R51 allowing more current to flow into IC45 creating a full backlight.

3.2.11 I/O Device Controller

See page 1 on schematic. The ADC_CS, ZPRESS, HEATER, HYP, INTACK, FLWREN, SCK, and DIN lines are all controlled by IC28 when selected by the OPORT line (IC21E pin 10). The OPORT line will go high when the LATCH1 and WR line both go low at IC23D pins 13 and 12, this will send output pin IC23D pin 11 low which drives inverter IC21E pin 10 high enabling IC28.

ADC_CS: Analog to Digital Converter chip select
ZPRESS: Zero barometric pressure line
HEATER: Heater enable/disable
HYP: Hyperbaric mode line
INTACK: Interrupt acknowledge line
FLWREN: Flash write enable line
SCK: Serial clock line for the A/D converter
DIN: Data in line for the A/D converter

A 3 to 8 decoder is used to control the DACCS, RTC, DISPCS, AUD, KEYS, LATCH1, LATCH2, 2KEYS lines. When the IOE line goes low and the LIR line goes high being inverted by IC21A pin 2 and presented to IC22 pin 5 as a low enable line IC22 is enabled, Y0-Y7 will be driven low depending upon the A4, A5 and A6 lines on pins 1, 2, 3 respectively on IC22.

See page 2 on schematic. With the LPORT line high IC13 is enabled, this latches the data on lines D0-D7 on its output pins Q0-Q7, the outputs correspond to the following eight lines:
CALLOW-selects the low calibration gas on the Model 868 Calibrator
TML-Two Minute LED drives the LED on the front display.
AOL-Audio Out LED drives the LED on the front panel.
ARL-Alert LED drives the LED on the front panel.
KJL-drives Q17 when high which in turn drives the Alert Bar LEDs via J105.
BTL-Battery Low LED on the front panel.
DSPBR-controls the display backlight via Q16 and IC45
CALHIGH-selects the high calibration gas on the Model 868 Calibrator

3.2.12 Watchdog Timer

See page 1 on schematic. The Watchdog Timer provides a system reset function in the event a hardware or software “glitch” occurs.

At power up and at specific intervals thereafter, the microprocessor outputs a logic high to IC5 pin 6, WDOG (Watchdog). If the WDOG pulse does not appear at regular intervals, as the result of a software or hardware problem, the RC charges up and IC21 pin 8 goes low producing a low at IC16 pin 7 (CPU RESET line). The output at IC21D drives the RESET line of IC4. The Q14 output of IC4 will drive the output of IC3B, which in turn drives IC3A pin 5 a CPUINT (CPU interrupt) line. This will cause the processor to reset. The monitor then performs its power up self-test routines, and if the “glitch” has been cleared, the monitor resumes normal operation. If the problem still exists, a self-test or other error should be displayed.

3.2.13 RS232 Serial Communication

See page 3 on schematic. The *TCO_2M* supports serial (RS232) communication with external devices via the monitor’s rear panel connector. Signals to and from the rear panel RS232 connector are electrically isolated from the rest of the *TCO_2M* electronics by four opto-isolators (IC6, IC31-IC33).

An isolated secondary coil from transformer T1 is rectified and filtered by D1 and C1 before being input to the +5 volt regulator IC2. The regulated output of IC2 is sent to pin 25 of the 25-pin D connector via R27 on the rear panel in order to power the optional Analog Module. The supply also powers IC1.

The Dual RS232 Transmitter/Receiver, IC1, uses a single +5 volt supply (pin 16). The two Receive (Rx) inputs can accept ±30 volt levels, while the two Transmit (Tx) lines output ±9 volt levels. The four level translators within the chip turn the RS232 level signals to 5 volt TTL/CMOS compatible levels.

Two signals lines TX0 and TX1 transmit data from the CPU across the opto-isolators IC32 and IC33 to IC1. Here the signals are level shifted to the standard ±9 volt levels and sent to the rear panel connector.

The Receive (RX) line at J101 pin 2 and the Clear To Send (CTS) line at J101 pin 6 are input signals to the *TCO$_2$M*. They are level shifted by IC1 and sent across the isolation barrier by IC31 and IC6 respectively.

The transmit signal TX1, is dedicated to communication with the Optional Analog Module (Catalog Number 9622-01) which when connected to the rear panel connector, provides analog representations of signals, and a pass through port for the RS232 connector.

The transmit output TX0 from the CPU and the Receive (RX0) and Clear To Send ($\overline{\text{CTS}}$) inputs to the CPU are connected to the rear panel RS232 connector.

3.2.14 Calibrator Control

See page 3 on schematic. The *TCO$_2$M* controls the calibrator through opto-isolators IC34-IC36. When the calibrator is connected to the monitor, pin 4 of J103 is brought to ground potential and current flow through R58 and the LED portion of opto-isolator IC34. This brings the CALEN line low indicating that the calibrator is connected.

The CALHIGH and CALLOW lines control opto-isolators IC36 and IC35 respectively. These lines control the switching of the high gas and low gas during a sensor calibration. When the CALHIGH line is brought high, the LED portion of IC36 biases the transistor portion on, this in turn turns Q3 on and activates a solenoid valve in the calibrator that allows high calibration gas to flow. The CALLOW line operates in a similar manner with IC35 and Q2.

3.2.15 Barometric Pressure

See page 4 on schematic. The barometric pressure is measured by IC38. Amplifier IC37D is configured as a constant current source for the bridge circuit in IC38. Variations in the bridge circuit correspond to barometric pressure changes and are amplified by IC37A and IC37B. Amplifier IC37C serves as a buffer before the signal is brought to the Front End board multiplexor.

The ZPRESS line is used for circuit offset compensation. When ZPRESS is high, Q14 turns on, this biases Q15 on which effectively shorts IC38 pins 1 & 3. With IC38 effectively out of the circuit only the circuit's offset voltages will be present on the VBARRO line. The analog to digital converter can sample the VBARRO line and compensate for offset voltages.

Once the offset voltages have been taken into account and IC38 is back in circuit (ZPRESS low) VR2 can be adjusted for a correct barometric pressure reading. The processor automatically toggles the ZPRESS line to compensate for offsets as required, adjusting VR2 for a proper displayed value against a known barometer is all that is required.

3.2.16 Analog to Digital Conversion

See page 4 on schematic. The various analog voltages from the Front End board's multiplexor are converted to digital values by the ±18 bit analog to digital converter IC18. This is accessed by the processor when the ADC_CS line in brought low and data request is transmitted on the DIN (Data In)

line. The required information is transmitted to enable IC18 to select the desired signal from the multiplexor by selecting the appropriate address on the MUXA-MUXC lines. The selected analog signal is then output on the MUXOUT line and converted by IC18. The digital value is then transmitted back to the processor on the DOUT line (Data Out).

3.2.17 Temperature Control

See page 2 on schematic. The set temperature for the sensor is converted to an 8 bit word by the processor and is written to the B portion of the digital to analog converter IC29. This information is then converted to a voltage (TEMP) by IC30C. This output voltage is sent to the Front End board and is combined with the thermistor voltage and the negative reference voltage to control the heater modulator.

3.2.18 Battery Voltage Monitoring

See page 2 on schematic. The battery voltage from the power supply board is divided down by R47 and R48 and then buffered by IC19C. This voltage VB is brought to the Front End board multiplexor for digital conversion and monitoring by the processor. When the monitor is operating on battery power this line is monitored to determine the condition of the battery.

As the battery voltage runs low (≈11.5 volts), the (battery indicator) on the front panel will turn red. If the monitor continues to be powered from a battery in a low voltage situation a continuous alarm sounds for sixty seconds while the battery indicator will flash red. A "BATTERY VERY LOW PLUG IN AC POWER" message will appear. If this alarm is ignored, the monitor will shut down. The AC line should be connected to the monitor to recharge the battery before this occurs.

3.3 *2534 Front End Board*

The following sections detail the operation of the Front End board. Refer to the "FRONT END BOARD" schematic (2534-03).

3.3.1 Sensor Temperature Monitoring

The transcutaneous electrodes used with the *TCO_2M* are heated to help oxygen diffuse through the tissue to the sensor and to increase the response time to changes in skin surface carbon dioxide levels. The sensors contain two precision thermistors that are used to monitor and control the sensor temperature. The first thermistor, T1, is connected between E5 and E6, while the second thermistor, T2, is connected between E7 and E2. The wiring is kept separate to avoid a defect in one thermistor from affecting the other.

The resistors R19 and R116 and thermistor 1 form a voltage divider. The thermistor resistance (and the voltage drop across the thermistor) decreases as the electrode is heated. This voltage is monitored by IC8 whose gain and offset provide a linear output (TP5) between +2.048v at 30° C and -2.048v at 50° C. The inductor L2 in the divider string provides noise filtering of electro-surgical unit (ESU) interference. The thermistor 2 circuit works in the same manner except that the voltage polarities (TP4) are reversed (-2.048v at 30°C and +2.048v at 50°C). This circuit redundancy affords the *TCO_2M* an added measure of patient safety.

3.3.2 Sensor Heater Control

The heater element in the head of the sensor is connected to E8 and E9 and has a nominal value of 35Ω. Heater current flows from the +V5 supply, through Q3, L4, the heater element, then returning through L5, FET Q2, and through the 1Ω resistors R34 and R35, to ground.

The actual temperature of the electrode (as measured by thermistor-1 at TP5) is compared with the set temperature from the DAC on the CPU interface board. If the actual temperature is less than the set temperature (as is normally the case on power up) then the summing junction of IC15 (pin 13) will be

positive. This positive voltage will override the voltage controlled oscillator consisting of IC15B and IC15A and cause IC15 pin 7 to switch to the negative rail and shut off Q4. The +V5 at the gate of Q2 turns on the FET and allows heater current to flow (providing the Software Heater Control FET Q3 is also on) and the electrode starts to heat.

As the Actual temperature rises to the point where it equals the set temperature, the summing junction of IC15 (pin 13) goes to 0v and IC15 pin 14 switches to 0v. When this occurs the oscillator circuit takes over and pulses Q4 on and off to keep the temperature constant. The frequency at this point can vary from 0Hz (cold or extremely hot sensor) to 3KHz.

If the set temperature is lowered below the actual temperature, the summing junction of IC15 (pin 13) will be negative, IC15 pin 7 switches positive, Q4 turns on, and Q2 turns off until the electrode cools to the new temperature.

The capacitors C52 and C53 slow the temperature control process just enough so that variables, like ESU noise, do not cause electrode temperature variations.

Protection circuitry has been installed which monitors the raw voltage across “T1” coming back from the sensor. Op-amp IC17C operates as a comparator with one input at a reference of +1.89 volts. The other input is connected to Thermistor 1, before it is amplified by IC8. If the voltage at T1 ever goes above 1.89 volts then IC17C will go low. This turns Q5 on which biases Q3 off, preventing heater current from flowing.

3.3.3 Software Heater Shutdown Control

The FET Q3 is normally on. It provides a software based heater shut off. It acts as a backup safety circuit to the hardware heater control circuits. The HEATER line is normally high. This turns off Q5 and allows Q3 to turn on. This lets heater current flow (provided Q2, the hardware heater control, is also on). If the software senses a temperature fault, HEATER goes low, Q5 turns on, Q3 turns off, and the heater current is interrupted so that the electrode cools. The only way to reset the software heater control bit is to turn the monitor off and back on again (and providing that the fault has been corrected). This was done to increase patient safety.

There are two ways in which the software can sense a temperature fault. The first which has the slower reaction time (10 seconds) is via the HARDERR line. When the hardware detects a temperature fault this line is brought high and read by the processor, the processor reacts by setting the HEATER line low, turning the heater off. The second, which reacts in less than 5 seconds (if the HARDERR fails to function properly), operates by monitoring both T1 (TP5), and T2 (TP4). If the software detects a temperature fault the HEATER line is brought low turning the heater off.

3.3.4 Sensor Temperature Fault Monitoring

The Front End Board has a variety of safeguards built into the circuitry to monitor and control the sensor temperature. The processor monitors the sensor for over-temperature, difference between thermistors, and heater power dissipated. If an error is detected, the 860 will shut down the heater power to the sensor.

The operational amplifiers IC16A and IC16C form a window comparator whose thresholds are set to +50mv (at pins 2 and 12 respectively). Since the two thermistor circuits are identical, there should be no voltage differential across them. Resistors R54 and R55 are used to compare T1 and T2. Any voltage difference of 50mv (0.5° C) or greater will cause one of the comparator outputs to switch to the positive rail. This allows current to flow through R76 to charge up C41. If the fault condition exists for 5 to 8 seconds, C41 will charge past the +2.048v at pin 6 and the output at pin 7 switches positive.

IC16B is now latched at the positive rail by the feedback loop of D3 and R56. No changes at IC16A, IC16C, or IC16D can change it. The latch can only be reset by turning the entire monitor off and then back on. The cap C40 at IC16 pin 6 prevents inadvertent latching on power up.

If the fault lasts for less than 5 to 8 seconds, C41 will discharge through R56 and D3 to the negative rail at IC16 pin 7.

When IC16 pin 7 is at the positive rail two things happen. First, IC16B indicates a Hardware Fault to the CPU (a low at HARDERR). Secondly, Q4 turns on (regardless of the state of the heater control), which shuts off Q2, shutting down the heater circuit.

A Hardware Fault and shutdown of the heater circuit via Q4 and Q2 will also occur if the voltage measured by thermistor-2 (TP4) rises above 45.5°C. Comparator IC16D pin 9 is biased at +1.12v by resistors R77 and RP2 pins 6 & 5. When T2 (TP4) exceeds +1.12v (45.5°C), pin 8 will go high causing IC16B to latch setting the HARDERR line.

The circuit consisting of IC17D and Q6 insures reliable monitor operation at ambient temperatures less than 10°C (50°F). Cold temperatures may cause the thermistor values to be nonlinear. For this reason, if thermistor-1 is greater than +2.048v (or 30°C) IC17 pin 14 will switch positive and turn on Q6. This disables the window comparator at IC16A and IC16C so that IC16B will not go positive and latch out the heater circuit. Once the electrode heats up to 30°C, the thermistors will be in their linear region and IC17 pin 14 returns negative. This shuts Q6 off and re-enables the window comparator.

3.3.5 Sensor Heater Power- Local Power

The amplifier IC17b monitors heater power by integrating the pulse width modulated heater current (as measured through the resistors R34 and R35) to get an average DC value. The circuit consisting of R61, R62, and C44 filter out any voltage difference across the two grounds (analog and digital) used by the heater control circuit.

The voltage output at IC17b pin 7 is proportional to the average heater current which is proportional to heater power (also referred to as Local Power). The scale factor is 0.5mW/mv for +V=4.9v. This scale holds true for any heater resistance in the range of 35 +3.5 ohms. Note that a 5% decrease in +V will result in a measured value that is 5% higher than the actual value.

Heater power to the electrode is limited to 800mW. At 800mW the voltage will exceed the threshold at IC17A pin 3 causing IC17A pin 1 to switch positive. This positive voltage will cause Q4 to turn on. The heater circuit is forced to shutdown (via Q2) until the heater power drops back below the 800mW threshold. The lower voltage from IC17B causes IC17 pin 1 to switch back negative and the heater circuit is re-enabled.

3.3.6 Sensor Identification

The *TCO_2M* has been designed to accept several types of Novametrix transcutaneous sensors. The *TCO_2M* directly accepts the 4474-00 and 4474-39 sensors. The 4474-39 sensor, along with each adapter cable, contain a unique identification resistor. This sensor ID resistor connects to E3 and completes a voltage divider string along with RP1 pin 1 & 2. The op-amp IC15C buffers the voltage across the ID resistor and presents it to the multiplexor. The CPU samples the multiplexor and decides which type of sensor is being used. The following nominal voltages at IC15C pin 8 correspond to the different sensor types:

Sensor P/N	Description	Resistor	TP9 Volts
6752-00	CO2	19.1 KW	+1.344
6754-00	O2	53.6 KW	+1.726
4474-00	O2/CO2	none	+2.048
4474-39	O2/CO2	6.81 KW	+0.830

The detected sensor ID is utilized by the *TCO$_2$M* in a variety of ways. The first is to see if a valid sensor has been connected. If the measured voltage is not within 3% of the value listed an ID error message is displayed on the 860 message center. Secondly, if the sensor attached is a 6752-00 or 6754-00, the measured parameter is displayed and the other is blanked. The last function is to vary the gain of the O_2 circuitry.

3.3.7 Sensor Oxygen Value Measurement

The O_2 sensor outputs a current proportional to the amount of oxygen present at the sensor membrane/ patient interface. The O_2 sensor is biased at -700mv (nominal) via E4. The wiper of VR3 is at this potential, this forces the IC7 inputs to this potential also. The input network is biased such that an open input (no sensor connected) will yield 0.0v at IC7 pin 6. VR3 (O_2 Zero) is adjusted for this voltage. The output range is 0.0v to -3.0v with a scale factor of -50µv/pa (micro volts per pico ampere) input current.

When the monitor is set for hyperbaric operation the processor will set the HYP line high. This will bias Q7 off which in turn biases Q1 off. When Q1 is off then R5 is out of the circuit and the gain of IC4B will be reduced to compensate for the higher measurements expected in hyperbaric operation.

3.3.8 Sensor Carbon Dioxide Value Measurement

The CO_2 sensor outputs a voltage inversely proportional to the amount of CO_2 present at the sensor membrane/patient interface. The CO_2 signal is input to the unity gain buffer IC5 to provide a low impedance signal. The output from IC5 is tied to a guard ring and to the junction of C12 and C14. This puts both sides of C12 at the same potential to avoid leakage problems and to give filtering without overloading the very high impedance PtcCO_2 input signal.

The second CO_2 stage provides gain and offset. The output at IC4 pin 6 (TP6) has a range of -2.048v to +2.048v, where -2.048v represents a CO_2 input voltage of -27mv (nominal) and +2.048v corresponds to an input voltage of -310mv (nominal). The output of this stage is input to the MUX chip IC6, where it can be read by the processor.

3.3.9 Multiplexor

The various analog signals from the sensor and other lines that the processor must monitor are converted to digital values by an analog to digital converter on the CPU Interface board. This device looks at one analog signal at a time, converts the signal to a digital value, then transmits the value to the processor on command. Since there are several signals to be converted, and the converter can monitor only one signal at a time, a multiplexor is used to switch the desired signal for conversion as required.

The MUXA-MUXC lines from the analog to digital converter on the CPU Interface board selects one of the eight channels on the multiplexor IC6. The selected channel is then switched to the MUXOUT line for conversion. The following signals are handled by the multiplexor IC6:

Input	Signal
X0	Thermister 1 Signal
X1	O2 Signal
X2	Sensor ID
X3	CO2 Signal
X4	Thermister 2 Signal
X5	LP signal
X6	Battery Voltage
X7	Barometric Pressure

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4 Maintenance

This section contains the *TCO_2M* monitor and accessory maintenance information.

4.1 *Cleaning and Disinfecting*

4.1.1 Monitor/Calibrator

- Turn the monitor off and unplug from the AC mains before cleaning.
- Disconnect the calibrator from the *TCO_2M*, if connected, before cleaning.
- The monitor/calibrator can be cleaned and disinfected with solutions such as 70% isopropyl alcohol, 2% glutheralhyde, or 10% bleach. Then wipe with a clean water dampened cloth to rinse. Dry before use.
- Do not immerse the monitor/calibrator.
- Do not attempt to sterilize the monitor/calibrator.

4.1.2 Sensors

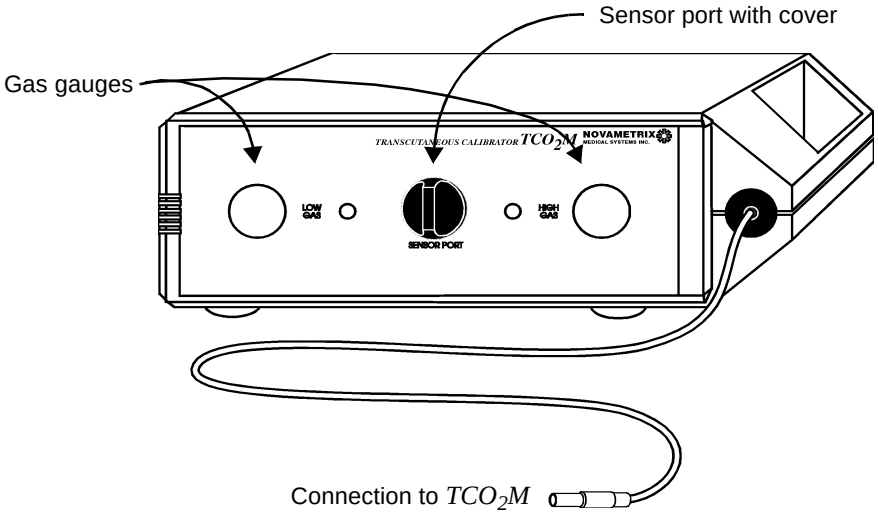
- The sensor should be cleaned with a *NOVADISK* membrane in place. It can be cleaned and disinfected with solutions such as isopropyl alcohol 70% solution, 2% glutheralhyde solution, or 10% bleach solution, then wiped with a clean water dampened cloth to rinse. Dry before use.
- After cleaning, ensure the selected sensor is mechanically sound; with no broken, frayed, or exposed wiring. Ensure that the connector is clean and dry with no signs of contamination or corrosion. Do not use a broken or damaged sensor or one with wet, contaminated or corroded contacts.
- Do not immerse the sensor.
- Do not attempt to sterilize the sensor.
- Refer to the User's Manual for information on cleaning and remembraning the sensor.

4.1.3 Calibrator

- Disconnect the calibrator from the *TCO_2M* if connected before cleaning.
- The calibrator can be cleaned and disinfected with solutions such as isopropyl alcohol 70% solution, 2% glutheralhyde solution, or 10% bleach solution. Then wipe with a clean water dampened cloth to rinse. Dry before use.
- Do not immerse the calibrator.
- Do not attempt to sterilize the calibrator.

4.2 *TCO$_2$M Calibrator, Model 868*

The *TCO$_2$M* Calibrator, Model 868 is intended to be used with the *TCO$_2$M* Transcutaneous Monitor, Model 860. The calibrator is used to expose a transcutaneous sensor to two precision gas mixtures as part of the sensor's calibration. The Monitor controls the actions of the Calibrator as well as providing power to the Calibrator.



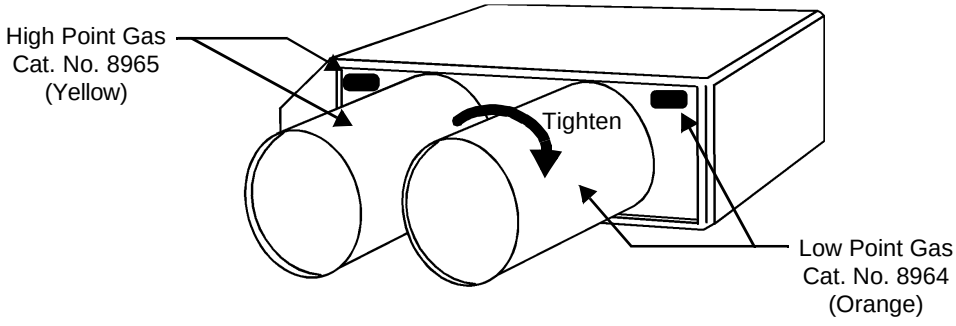
NOTE

Do not store the *TCO$_2$M* for more than three months with gas tank installed.

Setting up the Calibrator

To install calibration gas cylinders:

1 Check the cylinder part number and label color against the part number and color identifier on the rear panel.



2 Insert a Low Point Calibration Gas (Cat. N0. 8964) cylinder into the appropriate opening at the rear of the calibrator. Hand tighten the cylinder by rotating it in a clockwise direction until is firmly seated against the in the calibrator, then 1/8 turn more. The cylinder should turn easily. If not, remove and try again. Do not force it.

3 Install High Point Calibration Gas (Cat. N0. 8965) cylinder in the same manner.

4 Verify that both front panel pressure gages indicate pressures above zero.

Disconnecting Gas Cylinders

When the front panel pressure gauge reads “0” (while a cylinder is connected) the cylinder is empty and must be replaced. Do not attempt to calibrate a sensor with an empty cylinder.

To remove a cylinder:

1 Rotate the cylinder in a counter clockwise direction until free.

2 Dispose of cylinder in accordance to local regulations.

CAUTION

Do not attempt to refill empty cylinders or to dispose of in fire. Refer to labeling on cylinder for proper handling and disposal

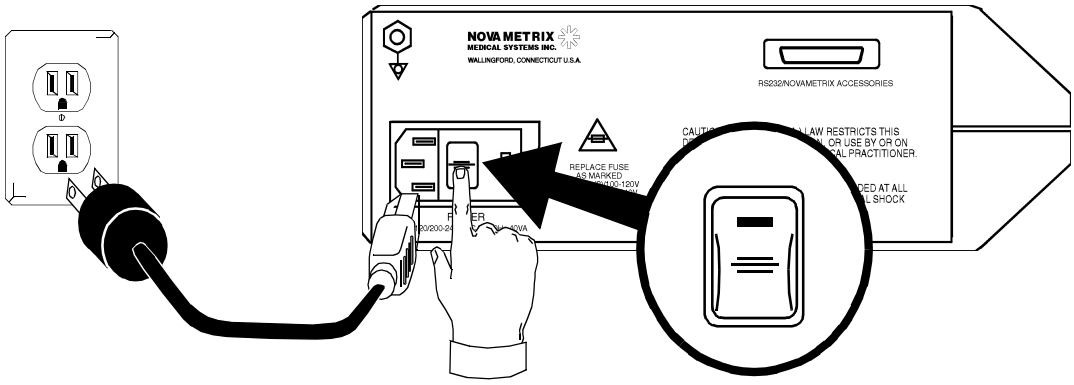
Connect the calibrator

Connect the calibrator to the *TCO$_2$M* by aligning the red dot on the calibrator cable connector with the red dot on the monitor’s front panel calibrator input connector and pushing the calibrator connector into place. It “clicks” into place when correctly seated.

4.3 *Battery Maintenance*

If the monitor has not been used or powered by AC for an extended time[1] (3 months or more) allow the battery to charge for 12 hours before use. The monitor may not power up on battery power if the battery is not sufficiently charged.

To charge the battery, connect the power cord (see below) and set the rear panel power switch ON (“|”). Check that the front panel ∿ icon is green. Allow the battery to charge for 12 hours to ensure a fully charged battery in the event that battery power is required.



NOTE

Be sure to dispose of batteries in accordance with local laws. Never dispose of batteries in a fire.

The AC power cord line shipped with monitors for North America is a Hospital Grade, SJT style cord with a 120 VAC plug. All other style power line cords shipped with monitors for Europe are the European style with a 220-240 VAC plug. All other style power line cords, as required by the country of destination, are provided by the distributor of that country.

1. The internal battery will slowly discharge over long periods of non-use.

4.4 Fuses

The rear panel power entry module indicates the AC (line) voltage setting for the monitor. Check that the voltage is correct before attaching the line cord and powering the monitor. The *TCO$_2$M* can be set to operate from 100-120 VAC 50/60Hz or 200-240VAC 50/60Hz.

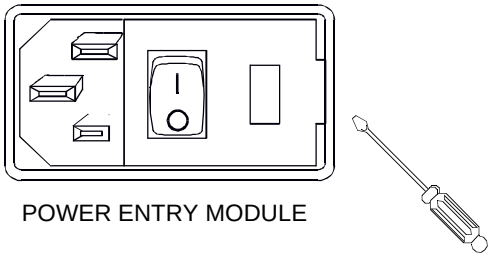
Refer to the following sections for fuse replacement and changing the mains voltage setting.

CAUTION

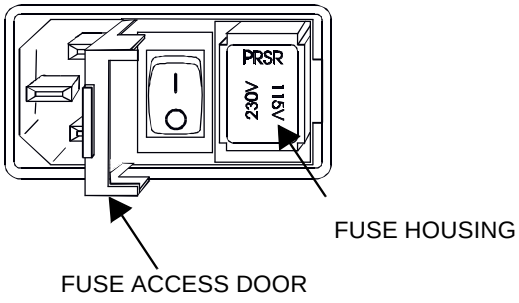
Replace fuses with the same type and rating. Verify proper fuse value for AC voltage setting (see table below).

AC Voltage	Fuses (Slo Blo)
100-120 VAC	0.5 A 250V
200-240 VAC	250mA 250V

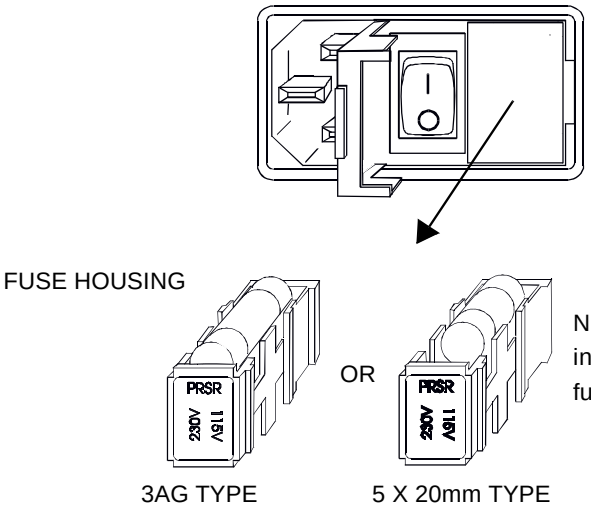
1. Check that the monitor is OFF.
2. Set the rear panel power entry module switch to OFF (“O”). Remove the line cord from the power entry module (if connected).
3. Using a flat blade screwdriver, pry the fuse access door open to expose the fuse housing. Note the orientation of the fuse housing (this determines the mains operating voltage).



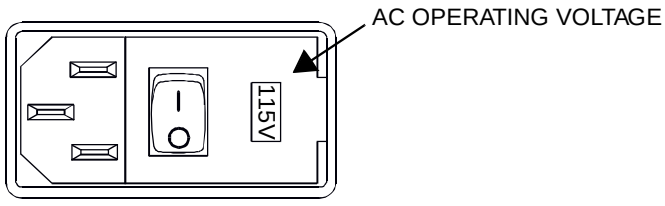
POWER ENTRY MODULE



4. Pry the fuse housing out from the power entry module.



5. Replace the blown fuse(s) with the proper type and rating.
6. Re-install the fuse housing. When positioning the housing into the power entry module ensure that it is oriented correctly. Press the fuse housing back into the power entry module.
7. Close the fuse access door and verify that the proper mains operating voltage is displayed.



4.5 *Changing AC Mains Voltage*

Depending upon which power supply assembly is installed in the monitor, replacing the fuses and adjusting the mains supply voltage will differ. Determine which assembly is installed then follow the appropriate instructions.

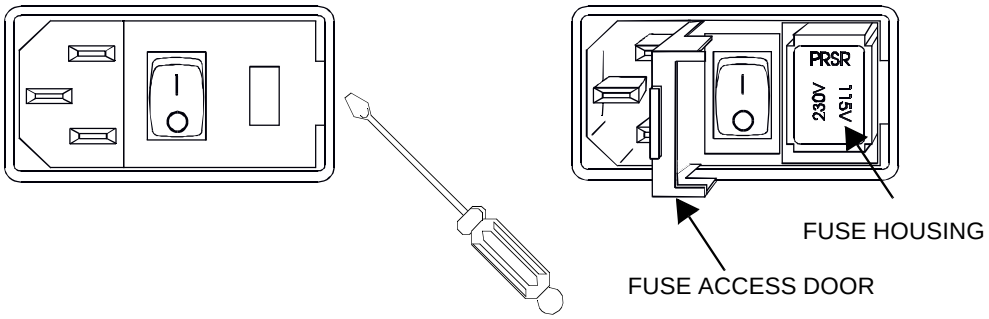
CAUTION

Replace fuses with the same type and rating. Verify proper fuse value for AC voltage setting (see table below).

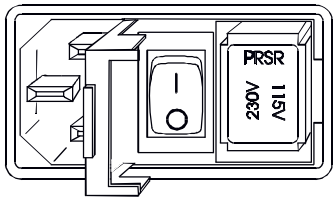
Mains Voltage	Fuses (Slo Blo)	Part Number
100-120 VAC	0.5 A 250V	515023
200-240 VAC	250mA 250V	515033

1. Check that the monitor is OFF.
2. Set the rear panel power entry module switch to OFF (“O”). Remove the line cord from the power entry module (if connected).

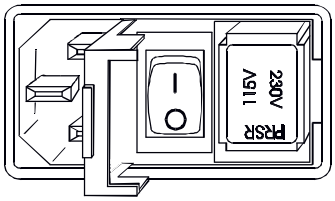
3. Using a flat blade screwdriver, pry the fuse access door open to expose the fuse housing. Pry the fuse housing out from the power entry module.



4. Install the proper type and rating fuse for the mains voltage setting required.
5. Position the housing into the power entry module so that the desired voltage is furthest away from the switch (see below).

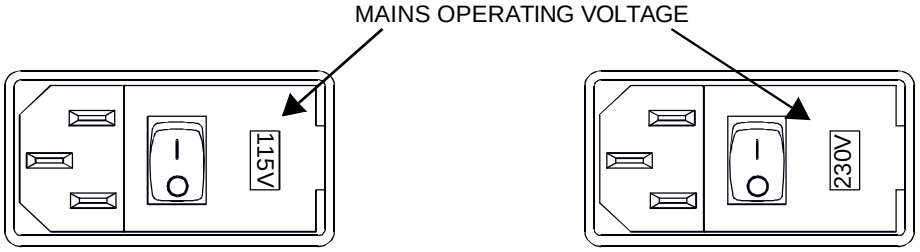


SET FOR 100-120V OPERATION



SET FOR 200-240V OPERATION

6. Close the fuse access door and verify the proper mains operating voltage is displayed.



4.6 *Assembly Exchanges*

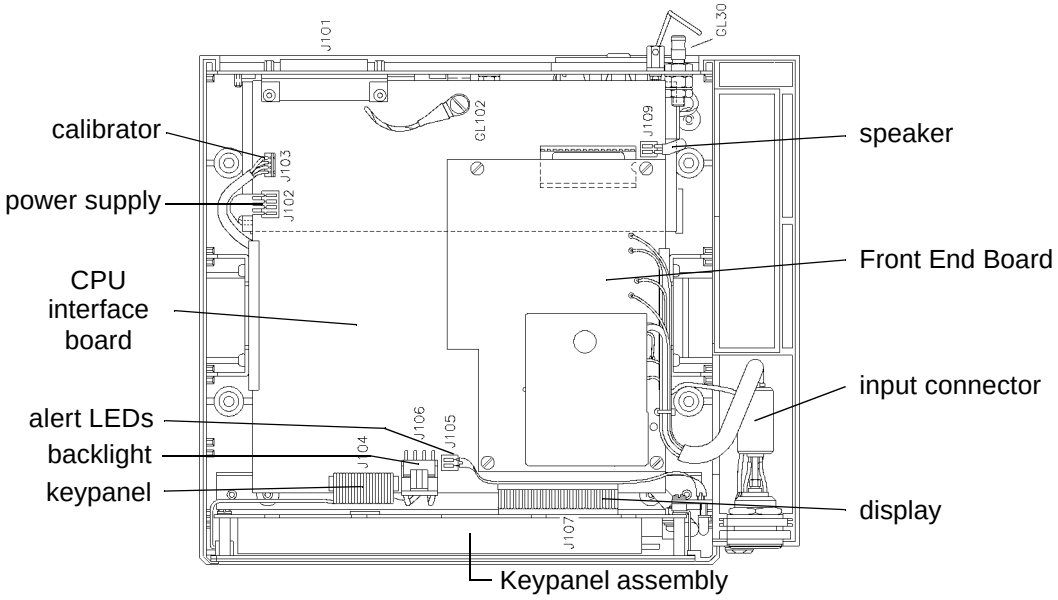
Disassembly should be performed by qualified service personnel only. Follow proper grounding precautions to avoid damage to internal components from static discharge.

4.6.1 Internal Assemblies

1. Ensure that the monitor is OFF. Disconnect the line cord and sensor. Turn the monitor upside down and remove the four cover screws from the bottom cover. Holding both case halves together, flip the monitor right-side up.
2. Carefully lift the top cover from the monitor (use a gentle rocking motion to lift first one side and then the other side, a little at a time). Set the red alert lens aside along with the top cover for safe keeping.
3. The separate assemblies of the monitor can now be removed.

4.6.2 Front End and CPU - Interface/Keypanel Assembly

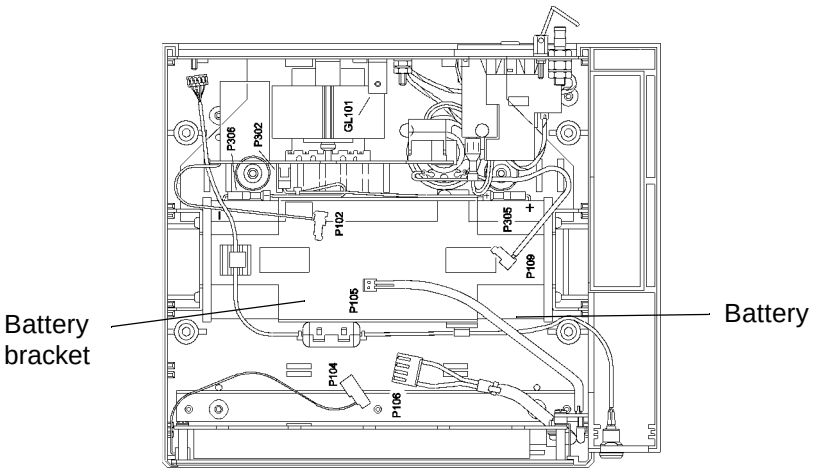
1. Disconnect J102 (power supply).
2. The Front End board is secured to the PCU Interface board via four (4) screws. Loosen and remove the four screws, using a side to side motion only, gently pry the Front End board off the CPU Interface board. The boards are interconnected via the header strip P108. Make sure to keep the shield with the Front End board. The Front End board is wired to the input connector.



3. The CPU interface board is secured to the rear panel by one screw that also secures the chassis ground connection. Loosen and remove this screw, then disconnect J109 (speaker) and J103 (calibrator) to slide the CPU - interface board/keypanel assembly out.
4. The rear panel and power supply assembly, and the battery can now be accessed. Make sure the power supply shield is in place when reassembling the monitor.

4.6.3 Replacing the internal battery

1. Disassemble the monitor to expose the battery (see “Internal Assemblies” on page 25).



2. Slide the battery bracket out from the bottom cover assembly. The calibrator connector cable may be secured to the bracket with tie-downs, be sure not to stress or damage the cable.
3. Disconnect J302 from the power supply board. Remove the old battery and replace with the new one. Remove the wire harness from the old battery and install on the new one; red is positive, black is negative. Connect the harness to J302 on the power supply board.

NOTE

Be sure to dispose of old battery in accordance to local laws.

4. Replace the battery bracket. Reassemble the monitor.

4.7 *Changing System Software*

New software releases may be made available from time to time. These new releases may add features or be maintenance upgrades. The system software is contained in EPROM IC17 on the CPU - Interface board.

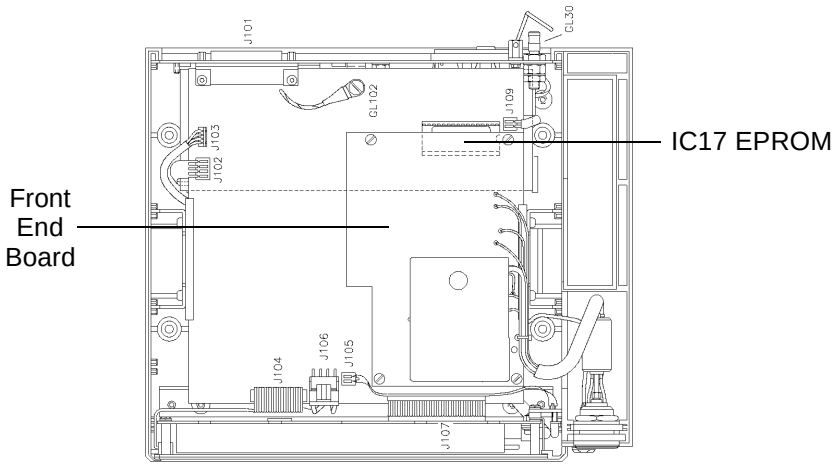
CAUTION

Be sure to observe proper grounding procedures to avoid possible damage to electronic circuits from static discharge

To install a new EPROM:

1. Ensure that the unit is off and unplugged. Remove the top cover as instructed in “Assembly Exchanges” on page 25.

2. Remove the Front End Board to gain access to IC17 (mounted in a socket). Refer to step 4.6.2.2.



3. Using an EPROM extraction tool or small flat blade screwdriver, carefully pry IC17 from its socket.
4. Place the new EPROM to the socket so that pin 1 is properly aligned. Press the new EPROM firmly into the socket, check for bent pins, ensure that all the pins are properly inserted into the socket.
5. Replace the Front End board and reassemble the monitor.
6. Replace old serial number label with new one, if supplied.

   New software upgrades are often accompanied by a serial number suffix, usually a letter, for identification. If a new serial number label is supplied, check that the serial number is identical with the exception of a new letter to identify the software upgrade (more suffix letters may be present if other changes are incorporated).

4.8 *Barometric Pressure*

The monitor measures the barometric pressure from an internal sensor. This sensor has been calibrated at the factory and should not need readjustment with normal use. To verify the barometric pressure, or to adjust the barometric pressure if necessary, perform the following:

1. With the monitor on press the **MENU** and ⏭ keys simultaneously until the engineering menu appears.
2. Check the current barometric pressure using a calibrated barometer. Verify the “BAR” value corresponds to the barometric pressure within one count. If not, adjustment of VR2 on the CPU-Interface board may be necessary. Refer to “2533-01 CPU - Interface Board Tests” on page 36.

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5 Troubleshooting

This section is intended as a guide in determining possible causes for monitor malfunctions. The first section lists symptoms with probable causes. If checking the causes offered does not remedy the problem, contact Novametrix Service Department. The second section lists messages that may appear on the display followed by the reason. Not all of the messages indicate a fault, but may indicate an improper operating condition or be a signal for required user interaction.

5.1 *General*

Below is a list of common symptoms that may occur with the *TCO_2M*. Following each symptom is a list of probable causes. In the event that none of the causes rectifies the symptom, contact Novametrix Service Department for assistance.

Monitor does not turn on:

- Attach the line cord, set the rear panel power switch to "|" (ON). Check that the front panel ∿ icon is illuminated.
- Verify the proper line voltage setting on the power entry module (located on rear panel).
- Verify the fuses in the power entry module are good.
- Check that the battery is sufficiently charged.
- Check the fuses/voltages on the Power Supply board.
- Perform the Electronic Tests (see section 7).

Monitor intermittently turns off by itself:

- If operating on battery power, battery voltage insufficient, recharge battery.
- AC power intermittent (if operating on AC power and battery is not sufficiently charged to power monitor with loss of AC power).

Monitor will not respond to keys:

- CPU lockup, power down monitor and power up. Verify self test passes and monitor resumes normal operation.

Sensor will not calibrate:

- Verify proper placement of sensor in calibrator.
- Check cable connection from calibrator to the monitor. Ensure good, clean contacts, check that the cable is not damaged. Verify that the LEDs on the calibrator illuminate and a "click" is heard when the gasses are switched on.
- Verify unexpired/good membrane/electrolyte solution.
- Defective sensor, use an alternate sensor. Refer to User's Manual on proper sensor maintenance and use.
- Verify proper membrane type.

5.2 Display Messages

Certain operating conditions, faults, or requirements may evoke special messages on the display. The messages and causes are listed below:

CALIBRATION MESSAGES	SYMPTOMS/CAUSES
CAL ERROR CO2 OFFSET	Calibration error, CO_2 offset out of range.
CAL ERROR CO2 SLOPE	Calibration error, CO_2 slope out of range.
CAL ERROR O2 OFFSET	Calibration error, O_2 offset out of range.
CAL ERROR O2 SLOPE	Calibration error, O_2 slope out of range.
CAL ERROR CO2 TIMEOUT	Calibration error, CO_2 threshold or stability error.
CAL ERROR O2 TIMEOUT	Calibration error, O_2 threshold or stability error.
CAL ERROR BAROMTRC PRES	Barometric pressure is less than 540 or greater than 800 mmHg.
CAL ERROR CALIB REMOVED	The calibrator has been disconnected prior to the completion of the sensor calibration.
ERROR - CALIBRATOR NOT INSTALLED	A calibration has been requested but the monitor detects that the calibrator is not connected.

PARAMETER MESSAGES	SYMPTOMS/CAUSES
O2-HIGH	The measured O_2 value is above the upper limit setting.
O2-LOW	The measured O_2 value is below the lower limit setting.
CO2-HIGH	The measured CO_2 value is above the upper limit setting.
CO2-LOW	The measured CO_2 value is below the lower limit setting.
S-TIMER EXPRD	The site is enabled and the timer duration has expired.
TEMP>0.2 C	The detected sensor temperature has exceeded the set temperature by more than 0.2°C.
10 MIN SITE TIMER EXPIRED	More than 10 minutes has passed since the site timer has timed out and it has not been reset - sensor heaters are shut off.
ERROR - BAROMETRIC PRESSURE < 540 mmHg	The detected barometric pressure has exceeded the lower limit.
ERROR - BAROMETRIC PRESSURE > 800mmHg	The detected barometric pressure has exceeded the upper limit.
O2 LIM OFF	The upper or lower alert limits for O_2 have been disabled.
CO2 LIM OFF	The upper or lower alert limits for CO_2 have been disabled.
LIM(S) OFF	Both O_2 and CO_2 alert limits have been disabled.

MONITOR MESSAGES	SYMPTOMS/CAUSES
BATTERY VERY LOW PLUG IN AC POWER	The monitor is running off of battery power and the battery has discharged to an extremely low level, too low for monitor operation.
MONITOR ERROR TEMPERATURE > 45.5 C	The detected sensor temperature has exceeded the 45.5°C maximum.
MONITOR ERROR THERMISTORS > 0.5 C	The detected temperatures from the sensor's thermistors deviate more than 0.5°C from each other.
MONITOR ERROR MAXIMUM POWER > 5 MIN	The maximum power allowable has been delivered to the sensor for 5 minutes.
SENSOR DISCONNECTED	The monitor detects that the sensor has been unplugged or disconnected.
MONITOR ERROR INVALID SENSOR ID	The monitor has detected an invalid type of sensor.
MONITOR ERROR HEATER DISABLED	The monitor has disabled the heater circuitry from the sensor.

SOFTWARE/HARDWARE MESSAGES	SYMPTOMS/CAUSES
MONITOR ERROR BAD MONITOR STATE	Software error.
MONITOR ERROR SOFTWARE ERROR 1	Software error.
MONITOR ERROR RAM SELF TEST FAILED	Power up RAM test error.
MONITOR ERROR ROM SELF TEST FAILED	Power up ROM test error.
MONITOR ERROR 10ms INT. TIMEOUT	Hardware interrupt overrun.
MONITOR ERROR 250ms INT. TIMEOUT	Software interrupt overrun.

SOFTWARE/HARDWARE MESSAGES	SYMPTOMS/CAUSES
MONITOR ERROR ILLEGAL INT1 INT	Software errors, contact Novametrix Service Department.
MONITOR ERROR ILLEGAL INT2 INT	
MONITOR ERROR PRT1 INT	
MONITOR ERROR DMA0 INT	
MONITOR ERROR ASC1 INT	
MONITOR ERROR NMI INT	
MONITOR ERROR ILLEGAL OPCODE FETCH	
MONITOR ERROR BAD STACK POINTER	
MONITOR ERROR STACK OVER-FLOW	
MONITOR ERROR CORRUPT SYSTEM MMU	
MONITOR ERROR FTS ILLEGAL TASK	
MONITOR ERROR DISP BUFFER OVERFLOW	

6 Functional Tests

The functional tests verify the overall functional integrity of the monitor and sensor. If the monitor and sensor do not pass these tests, remove from use and contact the Novametrix Service Department for repair/replacement assistance.

6.1 *Equipment Required*

- Line cord (supplied with unit) PN: 600026
- 4474-00 Probe
- *TCO_2M* Calibrator, Model 868
- High point calibration gas PN:8965
- Low point calibration gas PN:8964

6.2 *System Tests*

1. Press the key to turn the monitor on.
2. Install a 4474-00 electrode.
3. Verify the electrode heats up to 44.0 °C ± 0.1 °C (or the temperature that is currently selected).
4. Connect the *TCO_2M* Calibrator, Model 868 to the *TCO_2M* Monitor.
5. Enter the engineering screen by simultaneously pressing and holding the **MENU** and keys.
6. Press the **LOW** key and verify the calibrator's low LED is on. Verify the high LED is off.
7. Press the **HIGH** key and verify the calibrator's high LED is on. Verify the low LED is off.
8. Press the **OFF** key and verify both LEDs are off.
9. Install the 4474-00 electrode in the *TCO_2M* Calibrator, Model 868 probe nest. Press the **RUN** softkey to return to the main menu.
10. Calibrate the 4474-00 electrode. Press the **CAL** key followed by the **START** key. When the calibration is done remove the electrode from the calibrator's probe nest and allow to stabilize in room air. Verify reasonable O_2 (158 ± 5) and CO_2 values (0 ± 2).
11. Return to the engineering screen. Verify the *TCO_2M* barometric pressure (BAR) equals the actual barometric pressure.

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7 Electronic Tests

The electronic tests verify the operation of the electronic circuits within the *TCO_2M*, Model 860. These tests do not need to be performed on a regular (preventative) basis. Perform these tests only if the monitor fails to operate as expected and/or fails the "Functional Tests."

The electronic tests should be performed by qualified service personnel. The *TCO_2M* contains static sensitive devices. Follow proper grounding precautions when handling the internal components to avoid damage from static discharge.

If the monitor does not pass the electronic tests, remove it from use and contact the Novametrix Service Department for repair/replacement assistance.

This procedure assumes the technician performs each step as indicated - leaving the monitor in a known state prior to performing the next step. If steps are omitted or performed out of order, be sure that the monitor is set to the correct state before continuing.

7.1 *2726-01 Power Supply Board Tests*

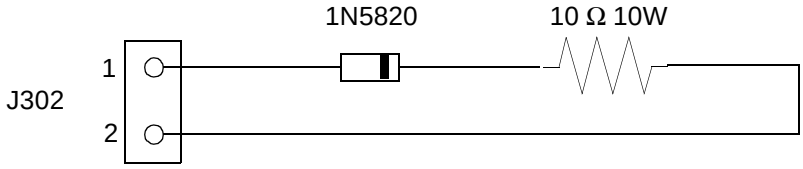
7.1.1 Equipment Required

- DVM (calibrated)
- 100 Ω 5W resistor
- 1N5821 diode and 10 Ω 10W resistor (see diagram in text)

7.1.2 Tests

1. Disassemble the *TCO_2M* to expose the power supply/rear panel assembly, see "Assembly Exchanges" on page 25.
2. Remove the connector from J302 on the power supply board. Carefully remove the power supply/rear panel assembly from the unit.
3. Connect the line cord to the power entry module (power supply/rear panel assembly). *Be careful - line voltage is now present on the power supply/rear panel assembly.*
   Set the power switch to "**|**", measure the voltage at J302, verify 13.2 VDC (use the negative terminal of C1 as ground reference for all measurements).
4. Measure the voltage across the positive terminal of C1 (VIN), verify approximately 25 ± 2VDC.
5. Measure the voltage on pin 3 of E302 (LINEST) with the DVM, verify 5 ± 0.2 VDC.
6. Monitor the voltage at F302 (VBATT) with the DVM, attach the 100 Ω resistor across the terminals of J302. Verify the voltage is 14.1 ± 0.4 VDC. Disconnect the resistor.

7. Connect the anode of the diode to pin one of J302, then the 10 Ω resistor between the cathode and pin 2 of J302 (see below). Verify that the voltage oscillates, this checks the current limit circuitry.



8. Disconnect the diode/resistor from J302.
9. Set the power switch off "**O**", remove the line cord from the power entry module. Re-install the power supply/rear panel assembly, connect the power cable to J302 on the power supply board, reconnect the power cable to the CPU - interface board.
   NOTE: Be sure all connections are oriented properly to avoid damage to the unit.

7.2 *2533-01 CPU - Interface Board Tests*

7.2.1 Equipment Required

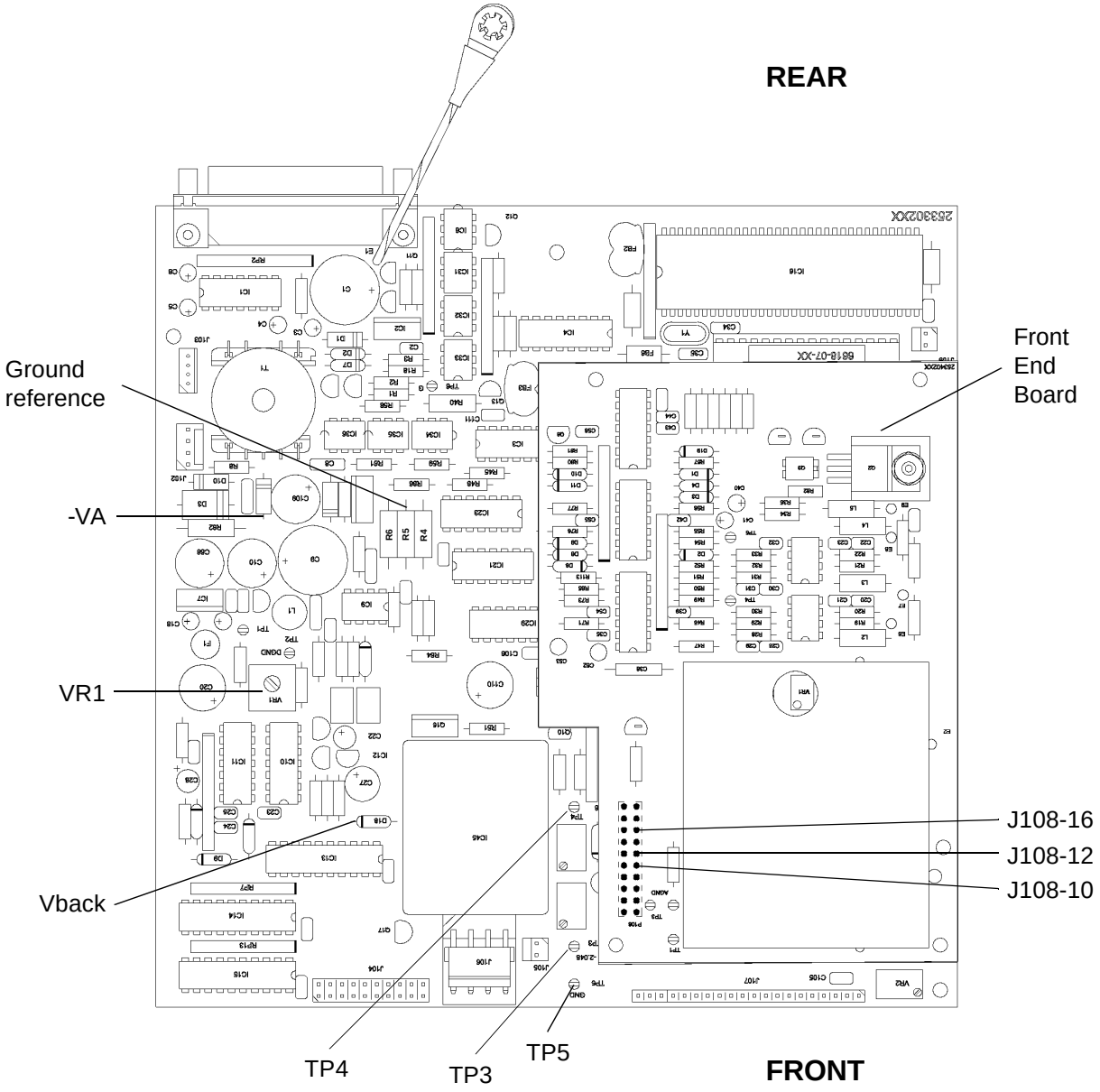
- DVM (calibrated)

7.2.2 Tests

This test is to be performed with the *TCO_2M* top cover removed, all the board assemblies are to remain intact.

1. Set the rear panel power switch on the *TCO_2M* to "**|**" and verify the green AC ON ∿ LED on the front panel illuminates.

2. Use the back side of R4, R5 or R6 located to the right of T1 for ground reference. Measure the cathode of D18 and verify 4.3 to 4.7 Vdc.



3. Power up the monitor while holding the **ALERT RESET** key. This will cause the unit to power up to factory defaults
4. Check for 5.00V at FB1, adjust VR1 if necessary .

5. Verify the following voltages:

Voltage	Location	Tolerance
-VA	D4 - Anode	-13.00 to -17.00 Vdc
+V5	J108 - 16 (on 2534 FE bd)	4.80 to 5.20 Vdc
-V5	J108 - 10 (on 2534 FE bd)	-4.80 to -5.20 Vdc
+VA	J108 - 12 (on 2534 FE bd)	13.00 to 17.00 Vdc
Vback	D18 - Cathode	4.50 to 4.80 Vdc

6. Measure TP3 for -2.048 Vdc ± 1 mV. Use TP5 for ground reference. Adjust VR6 if necessary.
7. Measure TP4 for 2.048 Vdc ± 1 mV. Use TP5 for ground reference. Adjust VR7 if necessary.
8. Enter the Engineering Screen by simultaneously pressing and holding the **MENU** and [>|] keys
9. Read and record the current Barometric Pressure from the Calibrated Barometer.
10. Check that the BAR value in the Engineering Screen matches the Barometric Pressure from setp 9. Adjust VR2 if necessary.

7.3 *2534-01 Front End Board Tests*

The front end board tests use the TB201 Test box that is included as part of the *TCO_2M* Transcutaneous Monitor, Model 860, Service Test Kit (Catalog No. 6914-00).

Contact NOVA-TECHnical Support 1-800-243-3444 for more information.

7.3.1 Equipment Required

- *TCO_2M* Transcutaneous Monitor, Model 860, Service Test Kit (Catalog No. 6914-00):
  - ID Test Jack
  - TB201 Test Box
  - 4478-01 cable
  - TF0012 test jack
- DVM (calibrated)

7.3.2 Tests

This test is to be performed with the *TCO_2M* top cover removed, all the board assemblies are to remain intact.

1. Turn the *TCO_2M* on. Measure TP2 for -2.040 Vdc ± 1 mV. Use TP3 as the ground reference. Adjust VR1 if necessary.
   NOTE: Make sure there is no probe or test jack connected to the monitor when making this measurement.

2. Install the ID Test Jack and verify the correct ID is displayed for each switch setting.

Switch Setting	ID
Open	74-00
53.6K	1625
19.1K	1957
6.81K	74-39
Short	INVLD

Verify Q5's collector is low for all switch positions except "Short", where it should be high after a five second delay. Verify "Monitor Error Invalid Sensor ID" is displayed and an audio alert is heard when Q5's collector goes high.

3. Change the ID Test Jack setting from short to 6.81K. Verify Q5's collector remains high. Turn the TCO_2M off.
4. Remove the ID Test Jack and connect the TB201 using the 4478-01 cable
5. Turn the *TCO_2M's* power on and monitor TP5. Verify the following:

T1 Setting	Voltage
37	0.614 ± 10mV
40	0.000 ± 10mV
45	-1.024 ± 10mV

6. Monitor TP4. Verify the following:

T2 Setting	Voltage
37	-0.614 ± 10mV
40	0.000 ± 10mV
45	1.024 ± 10mV

Note: Push the **CAL** key followed by the **SET** key. Use the △ ▽ arrow keys to change the monitor's set temperature.

7. Set T1 and T2 to 42.0
8. Set T1 to 42.4, check IC16 pin 14 is negative (-), return T1 to 42.
9. Set T2 to 42.4, check IC16 pin 1 is negative (-), return T2 to 42.
10. Set T1 and T2 to 43.0
11. Set T1 to 43.6, check IC16 pin 14 is positive (+), return T1 to 43.
12. Set T2 to 43.6, check IC16 pin 1 is positive (+), return T2 to 43.
13. Set T2 to 45.3, check IC16 pin 8 is negative (-), return to 43.
    Set T2 to 46.3, check IC16 pin 8 is positive (+), return to 43.
14. Disconnect the TB201 and Verify that IC16 pins 1 and 14 are negative.
    Reconnect the TB201.
15. Set T1 and T2 to 43.0. Select a monitor set temperature of 45.0°C.

16. Verify J108-13 goes low
17. Q4 collector goes high.
18. Perform each step listed below and after a 5 second delay check that J108/13 goes high (>3.0V), Q4's collector goes to 0 v ±100 mv and check that the listed error message appears. After each step set T1 and T2 to 43, verify the results do not change, and then recycle the system power.

TB201	Error Message
Set T1 to 43.6	MONITOR ERROR THERMISTORS > 0.5°C or MONITOR ERROR TEMP ERR-HTR OFF
Set T2 to 43.6	MONITOR ERROR THERMISTORS > 0.5°C or MONITOR ERROR TEMP ERR-HTR OFF
Set T1 and T2 to 46.3	MONITOR ERROR TEMPERATURE > 45.5°C

19. Enter the engineering screen by simultaneously pressing and holding the **MENU** and ⏭ keys.
20. Rotate T1 and T2 in unison and verify that the TB201 setting equals the displayed T1 and T2 values ± 0.1 (±0.2 at 37.0). Press the **RUN** key.
21. Select a monitor SET temperature of 42.5°C.
22. Set T1 and T2 to 42.3. Verify no temperature alert message is generated.
23. Select a monitor SET temperature of 42.0°C.
24. Set T1 and T2 to 42.0. Verify no temperature alert message generated.
25. Set T1 and T2 to 42.3. Verify a temperature alert message "Temp > 0.2°C" is generated.
26. Install TF0013 test jack (40 ohm). Enter the engineering screen by simultaneously pressing and holding the **MENU** and ⏭ keys.
27. Verify the POW display is 000 mW ±5 mW. Press the **RUN** key.
28. Select a monitor set temperature of 44.0°C. Enter the engineering screen by simultaneously pressing and holding the **MENU** and ⏭ keys.
29. Verify the POW display is > 450 mW and < 700 mW.
30. Install TF0012 test jack (30 ohm).
31. Verify the POW display is > 450 mW and < 900 mW.
32. This completes the Front End board tests.

7.4 *Safety Tests*

The safety tests should be done to verify the leakage and isolation properties of the monitor. The monitor should be fully assembled with no loose hardware, exposed or damaged parts before testing. Make sure that the test instruments used (hipot and leakage testers) are calibrated and conform to hospital guidelines.

1. Assemble the unit completely.
2. Apply 2.5KVAC for sixty seconds between earth ground and the shorted hot and neutral of the line cord. Verify there is no arcing or leakage.
3. Apply 4.0KVAC for sixty seconds between the shorted probe and the shorted hot and neutral of the line cord. Verify there is no arcing or leakage.
4. Apply 1.5KVAC for sixty seconds between the shorted probe and earth ground. Verify there is no arcing or leakage.
5. Measure the unit's leakage current as follows. Verify a leakage current less than 25uA.
   - Monitor grounded
   - Monitor ungrounded
   - Monitor ungrounded with polarity reversed

   * Note: For units operating at >200Vac the maximum leakage current is 50uA.
6. Using the shorted probe measure the patient leakage current to the AC line. Verify a leakage current less than 10uA.
   * Note: For units operating at >200Vac the maximum leakage current is 20uA.

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8 Specifications

These specifications for the Novametrix *TCO_2M® Transcutaneous CO_2/O_2 Monitor,* Model 860 are listed for informational purposes only, and are subject to change without notice.

8.1 *Monitor Model 860*

Measurement Range	Carbon Dioxide 0-255 mmHg (0-25.5 kPA). Oxygen 0-800 mmHg (0-99.9 kPA).
CO_2 Metabolic Correction	Displayed pCO_2 is compensated for metabolic factors related to the temperature effect and CO_2 production.
Parameter Alerts	CO_2 and O_2 limit alerts, audible and visible. User selectable, continuously displayed, retained in memory.
Alert Silence	Two minute alert silence with LED indicator. Audio Off with LED indicator (user can disable if needed).
Temperature Section	User selectable 37-45° C in 0.5° C increments. Can be continuously displayed. Audible & visible alarm if actual/set temperatures differ by >0.2° C. Two fully independent thermistors monitor and control temperature. Heater power shutdown with audible & visible alarm at over-temp (45.5° C) or if thermistors differ by >0.5°.
Site Timer	Automatically tracks sensor site duration, provides audible and visible alarms, automatic shutdown of heater power once timer expires. User selectable durations in 0.5 hour increments up to 5, 8, or 12 hour maximum, plus off.
Local Power	The power required to maintain sensor temperature is measured and displayed. Range: 0-800 mW. User selectable power reference point allows for quick power trend analysis (LPR).
Real Time Trends	Continuously displayed user selectable/scalable real time 10, 20, 30 minute trends of CO_2, O_2 or Local Power.
Trend/Histogram Memory	Battery backed 24 hour trends, 8 second resolution. Trend/Histogram displays 30 min, 2, 4, 8, 12 hours.
External Devices	Standard RS232 serial outputs: NovaCARD, computer, printer, others. Optional Analog Module, CO_2, O_2 and LP.
System	Power: 100-120/200-240 VAC, 50-60 Hz, 40 VA. Battery: Greater than 3 hour operation, 12 hour maximum recharge, lead-acid gel-cell. Display Type: Cold Cathode Display (CCD), 5 × 1.5 inches, W × H (12.7 × 3.8 cm). User adjustable contrast. Monitor Size: 3.3 × 9.0 × 8.0 inches, H × W × D (8.4 × 22.8 × 20 cm). Weight: 8 pounds (3.6 kg). Temperature: Operating 10-40° C (50-104° F), Storage -10-55° C (14-131° F). Relative humidity: 0-90% non-condensing. Altitude/Pressure: Automatic barometric pressure compensation. Range: 560-800 mmHg (71.9-106.6 kPa). Safety/Regulatory: Designed to comply with EC and TUV (IEC 601-1), UL (2601), and CSA (601-1-M90) standards.
EMC Emissions	EN55011:1991, Class A. Classification for Radiated and Conducted Emissions.
EMC Immunity	EN60601-1-2:1993. Collateral standard: Electromagnetic compatibility - requirements and test. Includes; IEC801-2 Electrostatic Discharge Requirements, IC801-3 Radiated Electromagnetic Fields, IEC801-4 Electrical Fast Transient Burst, IEC801-5 Surge Transients. Electromagnetic fields up to 3 V/m will not adversely affect system performance.

8.2 Sensors

Parameter	Combination CO_2/O_2, CO_2 only or O_2 only
Principle of Operation	Stow-Severinghaus pH/Clark-type polarographic
Response Time (t_{90})	CO_2 45 sec, O_2 12 sec
Stability	Better than 2 mmHg/hr
Diameter/Height	19/11 mm (0.75/0.41 in)

8.3 Gas Calibrator Model 868

Calibration System	Fully automatic using a true two-point sensor calibration against known gases.
Gas Cylinders	Type: PD Contents: 16 liters at 16.5 bar, 21° C (0.6 cu. ft. at 240 psig, 70° F).
Physical	Size: 3.3 × 9.0 × 16.5 in., H × W × D (8.4 × 22.8 × 41.9 cm) includes cylinders. Weight: 3 lbs (1.4 kg)
Power	All calibrator power provided by monitor

9 Accessories

Transcutaneous Monitor

6590-00 ***TCO_2M* Transcutaneous CO_2/O_2 Monitor, Model 860**

Combination O_2/CO_2 Sensor

4474-00 **Combination O_2/CO_2 Sensor** for use with Split Membrane NOVADISK

8900-00 **Combination O_2/CO_2 NOVADISK Kit** Pre-Soaked Split Membranes (30 per box)

Gas Calibrator

6633-00 **Transcutaneous Gas Calibrator, Model 868**

8964-00 **Low Point Calibration Gas** (4 cylinders per case)

8965-00 **High Point Calibration Gas** (4 cylinders per case)

Sensor Accessories

8285-00 **Sensor Adhesive Rings** (100 per box)

8805-00 **Sensor Adhesive Rings—Large** (100 per box)

8888-00 **Transcutaneous Sensor Contact Gel** (15 ml bottles, 6 per box)

8353-00 **Contact Medium Applicator** (10 bottles per box)

Carbon Dioxide Sensor

6752-00 **Carbon Dioxide Sensor**

8383-00 **Carbon Dioxide NOVADISK Kit** (24 per box)

Oxygen Sensor

6754-00 **Oxygen Sensor**

8286-00 **Oxygen NOVADISK Kit** (24 per box)

8200-00 **Contact Gel, Transcutaneous Oxygen Sensor** (1 tube, 60 ml)

8231-00 **Zero Oxygen Calibration Solution** (50 vials per box)

Serial/Analog Output & Accessories

5702-00 **Seiko DPU-411 Thermal Printer**, 120 vac (interface cable included)

5703-00 **Seiko DPU-411 Thermal Printer**, 220 vac (interface cable included)

300017 **Seiko DPU-411 Thermal Printer Paper** (5 rolls per box)

5694-00 **Cable** to Seiko DPU-411 Printer

5861-00 **Cable**, Seiko DPU-411 Printer (powers printer from TCO_2M)

5334-00 **Cable**, Serial Output to Personal Computer (25-pin connector)

5335-00 **Cable**, Serial Output to Personal Computer (9-pin connector)

9622-01 **Analog Module** for TCO_2M (includes RS232 pass-thru)

5333-00 **Cable**, Analog Output Module (open ended, 6 ft)

7106-10 **Transport Pouch** (for monitor)

7105-10 **Monitor Accessory Pouch with Printer Support**

7104-10 **Side Accessory Pouch** (included with monitor)

600026 **Power Cord** (included with monitor)

Mounting Systems

140030 **Wall Mount**

140031 **Wall Mount** (less Wall Channel)

140032 **Pivot Block Mount**

140033 **Transport Mount** (without swivel head)

140034 **Transport Mount** (with swivel head)

140035 **Countertop Mount** (11 inch Base)

140036 **Countertop Mount** (5 inch Base)

140037 **Portable Instrument Housing**

Extended Warranty

Warranty Extension: an additional 1 year(s) at time of purchase
(Normal Warranty: Monitor—1 year, Sensor—1 year, Calibrator—1 year)

6590-81 ***TCO_2M* Monitor, Model 860**

6633-81 **Model 868 Gas Calibrator**

6590-82 ***TCO_2M* Monitor & Gas Calibrator & Combination Sensor**

6590-83 ***TCO_2M* Monitor & Gas Calibrator & Single Parameter Sensor**

6590-84 ***TCO_2M* Monitor & Single Parameter Sensor**

6590-85 ***TCO_2M* Monitor & Combination Sensor**

Biomedical Engineering Service Test Kit

Service Test Kits include items and materials qualified service personnel may require to determine the functional integrity and/or accuracy of the system.

6914-00 **Service Test kit, *TCO_2M* Transcutaneous Monitor, Model 860**

9999-96 **"Focus" Technical Training Seminar** (1 day course)
For class schedules call: 1-800-243-3444 Ext. 2565

10 *Parts*

10.1 *Model 860*

ASSY: 6590-00 02 MODEL 860 - TRANSCUTANEOUS CO_2 & O_2 MONITOR

LINE	PART NO	REV	QPA	DESCRIPTION
0001	1003-32	03	1	LABEL, SERIAL NUMBER
0002	1217-32	03	1	REPAIR LABEL
0003	4470-32	00	1	LABEL, CAUTION GROUNDING
0004	6590-01	02	1	MAIN ASSY
0005	6590-04		0	TEST PROCEDURE, SYSTEM
0006	6590-09	00	0	OVERALL WIRING DIAGRAM
0007	6590-23	00	1	USER'S MANUAL
0008	6590-40	00	0	DESIGN DOCUMENTATION
0009	6590-75	00	0	DEVICE MASTER RECORD
0010	6590-43	00	0	DATA SHEET
0015	315032		1	LABEL,"120 VAC"
0016	600026		1	LINE CORD, AC, 7 1/2 FT, HOSP GR PLUG
0017	315099		1	LABEL, CE

ASSY: 6590-01 03 MAIN ASSY

LINE	PART NO	REV	QPA	DESCRIPTION
0001	2533-01	03	1	CPU-INTERFACE BOARD ASSY
0002	2534-01	02	1	FRONT END BOARD ASSY
0003	5664-10	04	1	CHASSIS
0004	5713-01	01	1	SPEAKER ASSY
0005	5714-01	02	1	BATTERY HARNESS ASSY
0007	6612-01	02	1	REAR PANEL ASSY
0008	6614-01	01	1	INTERFACE CABLE ASSY, GAS CALIBRATOR
0009	6615-01	03	1	BOTTOM COVER ASSY
0010	6616-01	01	1	TOP COVER ASSY
0011	6619-01	00	1	FRONT PANEL ASSY
0012	6644-10	00	1	SHIELD, ANALOG FRONT END BOARD
0013	9621-16	02	1	LENS, ALERT
0014	6791-10	00	1	INSULATING SHIELD, FRONT END BOARD
0017	140002		2	CARD GUIDE, 2.5" L, SNAP-IN, NYLON, WHITE
0018	161067		0	TAPE, CL CELL, POLYCHLOROPRENE

LINE	PART NO	REV	QPA	DESCRIPTION
0020	280023		0	SPACER HEX #4-40 X 3/8 LG TAP THRU
0021	284200		0	#4-40 X 1/4 SLOTTED BINDING HEAD STEEL
0022	285000		0	LOCK WASHER, NO. 4, INTERNAL TOOTH, STEEL
0023	286205		0	6-32 X 3/4 S.B.H. CAD PLATED
0025	400024		1	BATTERY, 12V DC, 2.3 AMP HOUR, LEAD ACID
0027	608124		0	CABLE CLIP, SIDE OPEN, .160 DIA CABLE
0030	6815-10	00	1	INSULATING SHIELD, POWER SUPPLY

ASSY: 6612-01 02 REAR PANEL ASSY

LINE	PART NO	REV	QPA	DESCRIPTION
0001	2726-01	02	1	POWER SUPPLY BD ASSY
0002	4109-10	00	1	P.C. SUPPORT BKT
0003	5812-10	01	2	SPACER, SUPPORT
0005	6497-01	01	1	GROUND WIRE ASSY, POWER ENTRY MODULE
0006	6498-01	01	1	POWER CABLE ASSY, REAR PANEL
0007	6612-17	01	1	REAR PANEL SUBASSY
0008	6549-01	01	1	GROUND WIRE ASSY, 5 1/2 IN. L, REAR PANEL ASSY
0011	161008		0	ADHESIVE, 242, THREADLOCKER, MED STR, BLUE
0012	210149		1	POWER ENTRY MODULE, SEL FUSE, ON/OFF SW
0013	216059		1	CONNECTOR, PLUG, POTENTIAL COMPENSATION
0014	280188		0	STANDOFF, 3/8 DIA X 3/8 L, 6-32 THD THRU
0015	281500		0	NUT, HEX, NO. 4-40, STEEL, CADMIUM PLATE
0016	281501		0	NUT, HEX, NO. 6-32, STEEL, CADMIUM PLATE
0017	285000		0	LOCK WASHER, NO. 4, INTERNAL TOOTH, STEEL
0018	285001		0	LOCK WASHER, NO. 6, INTERNAL TOOTH, STEEL
0019	285005		0	FLAT WASHER, NO. 8, STEEL, CAD PL
0020	286219		0	SCREW, 6-32 X 1 1/4 (31.8) L, PAN HD, PHILLIP
0021	515023		2	FUSE, 1/2A, 250V, SLO-BLO, 5 X 20MM
0022	608033		1	WIRE CLIP & BUSHING SET, LINECORD RETAINER
0023	285013		0	NYL WASH, #4 NATURAL COLOR, .115 ID, .281 OD
0024	180036		1	FERRITE, SPLIT, 131 OHMS @100MHZ, RND CABLE
0025	315026		1	LABEL, EARTH SYMBOL

ASSY: 6615-01 03 BOTTOM COVER ASSY

LINE	PART NO	REV	QPA	DESCRIPTION
0001	4727-10	04	1	KICKSTAND, BEDRAIL
0002	5405-10	00	1	SHIELD, BATTERY
0003	5409-32	00	1	LABEL, WARNING, POLE MOUNT
0004	5760-16	00	2	LEFT FOOT, WHITE, KICKSTAND
0005	5761-16	00	2	RIGHT FOOT, WHITE, KICKSTAND
0006	5826-10	01	4	FOOT PAD, BOTTOM COVER
0007	5849-10	00	1	BRACKET, SUPPORT

LINE	PART NO	REV	QPA	DESCRIPTION
0008	6615-13	01	1	BOTTOM COVER PAINTING
0015	161007		0	ADHESIVE, 414, HIGH STRENGTH, COLOR: CLEAR
0016	161064		0	TAPE, 3/4 X 60 YDS, CLEAR, DOUBLE-SIDED ADHESIVE
0017	284261		0	SCREW, 4-40 X 5/8 L, PHILLIPS, 82 DEG FLT HD
0018	284264		0	SCREW, 4-40 X 1/4 L, SLOTTED 82 DEG FLT HD

ASSY: 6619-01 00 FRONT PANEL ASSY

LINE	PART NO	REV	QPA	DESCRIPTION
0001	2473-01	01	1	ALERT BOARD ASSY
0002	6547-27	00	1	MEMBRANE KEYPANEL
0003	5720-01	00	1	DISPLAY ASSY
0004	6278-10	00	1	SHIELD, VFD
0006	280033		0	SPACER #4 X 1/8 CLEARANCE
0007	280187		0	STANDOFF, .187 DIA X 5/8 L, 4-40 F/F THD,
0008	284200		0	#4-40 X 1/4 SLOTTED BINDING HEAD STEEL CAD
0009	284204		0	#4-40 X 1/2 SLOTTED BINDING HEAD STEEL CAD
0010	285000		0	LOCK WASHER, NO. 4, INTERNAL TOOTH, STEEL

ASSY: 2533-01 03 CPU-INTERFACE BOARD ASSY

LINE	PART NO	REV	QPA	DESCRIPTION
	151001		1	CAPACITOR .001UF 20% 100V MYLAR
	152001		2	CAPACITOR 6.8UF 25V 10% TANTALYTIC RAD. LEADS
	152040		3	CAPACITOR, 2.2UF, 35V, TANTALUM
	152045		7	CAPACITOR, 10UF 16V 0.2" PITCH
	152048		2	CAP, 4.7UF, 16V, 10%, ELECTROLYTIC, TANT
	152066		1	CAPACITOR, 220UF, 63V, RADIAL, ELECTROLYTIC
	152073		2	CAPACITOR, 100UF, 16V, 20%, ALUM, ELCTLT
	152075		2	CAPACITOR, 47UF, 25V, 20%, AL, ELCTLT, RADIAL
	152084		2	CAPACITOR, 470UF, 25V, 20%, AL, ELCTLYTC
	152085		2	CAPACITOR, 1500UF, 16V, AL ELCTLT, RADIAL
	152086		2	CAPACITOR, 1000UF, 16V, 20%, AL, ELCTLYTC
	153003		1	CAPACITOR, .01UF,50V, O.1 PITCH, X7R
	153012		6	CAPACITOR, 22PF, 100V, 2%, .1 SP, METAL CERAMIC
	153013		1	CAPACITOR, 33PF, 100V, 2%, .1 SP, METAL CERAMIC
	153021		1	CAPACITOR, .47UF,MULTILAYER CERAMIC
	153051		1	CAPACITOR, .22UF, 50V, 20%, .1(2.54)SP, MLTLY
	153052		1	CAPACITOR, .022UF, 50V, X7R, .100 SPACING
	154016		39	CAPACITOR, .1UF, 50V, 10%, .1 SP, X7R, DIPPED
	154046		1	CAPACITOR, 3900PF, 33V, 2%, POLYPROPELENE
	154057		1	CAPACITOR, 470PF, 100V, 10%, .2(5) SP
	154058		1	CAPACITOR, .022UF, 100V, 10%, .2 SP, MET POLY
	154060		1	CAPACITOR, .22UF, 63V, 10%, .2(5) SP, MET POLY

LINE	PART NO	REV	QPA	DESCRIPTION
	154076		2	CAPACITOR, .01UF, 63V, 1%, POLYPROPYLENE
	154088		1	CAPACITOR, .1UF, 50VDC, METALZD POLYCARBONATE
	161039		0	FOAM TAPE, 1/32THK X 2 1/2WIDE X 216FT DBL SD
	180010		1	INDUCTOR, 18UH, 10%, .200 SPACING, PC MOUNT
	180011		5	FERRITE BEAD, 22 AWG TCW WIRE THRU CORE
	180012		1	FERRITE BEAD, .138(3.5)OD, .031(.8)ID
	180033		2	EMI FILTER, 22PF, 20%, 100V, INT FER, 3 LEAD
	210051		1	CONNECTOR, 25 PIN, RECEPTACLE, R ANGLE
	211213		2	CONNECTOR, 2 PIN, POST HEADER
	211412		1	CONNECTOR, 4 PIN, HEADER, R ANGLE, PC MNT
	211414		1	CONNECTOR, 4 PIN, PLUG, FRICTION LOCK
	211421		1	CONNECTOR, 4 PIN, HEADER, STR, .079 SP
	212501		1	CONNECTOR, 20 PIN, HEADER, DUAL ROW, STR
	212529		1	CONNECTOR, 20 PIN, HEADER, STRAIGHT
	212538		1	CONNECTOR, 20 PIN, RECPT, DIL, STR, .1 SP
	215079		1	SOCKET, 32 PIN, DIP, .1 PIN SP, .6 ROW SP
	216029		0	TEST POINT, SPRING LOADED, 475 DEG C MAXIMUM
	230016		2	CRYSTAL, 32.768K HZ
	230018		1	CRYSTAL, 12.288MHZ, HC49U CASE, .192 SPACING
	2533-02	01	1	FAB, CPU-INTERFACE BOARD
	2533-03	03	0	SCHEMATIC, CPU-INTERFACE BOARD
	2533-04	01	0	TEST PROCEDURE,CPU-INTERFACE BD ASSY
	400035		1	INVERTER, DC TO AC, 5VDC INPUT, PC MOUNT
	470016		1	RESISTOR, 22 OHM, 1/4W, 10%, CARBON
	470111		3	RESISTOR, .33 OHM, 1/2W, 10%, METAL FILM
	472003		2	RESISTOR, 100 OHM, 1/4W, 1%, CARBON
	472007		6	RESISTOR, 475 OHM, 1/4W, 1%, CARBON
	472008		2	RESISTOR, 499 OHM, 1/4W, 1%, CARBON
	472011		4	RESISTOR, 1K OHM, 1/4W, 1%, CARBON
	472021		1	RESISTOR, 4.75K OHM, 1/4W, 1%, CARBON
	472030		11	RESISTOR, 10K OHM, 1/4W, 1%, CARBON
	472034		1	RESISTOR, 12.1K OHM, 1/4W, 1%, CARBON
	472039		2	RESISTOR, 15K OHM, 1/4W, 1%, CARBON
	472041		2	RESISTOR, 20K OHM, 1/4W, 1%, CARBON
	472045		1	RESISTOR, 30.1K OHM, 1/4W, 1%, CARBON
	472047		1	RESISTOR, 40.2K OHM, 1/4W, 1%, CARBON
	472058		3	RESISTOR, 100K OHM, 1/4W, 1%, CARBON
	472081		3	RESISTOR, 3.01K OHM, 1/4W, 1%, CARBON
	472089		3	RESISTOR, 249K OHM, 1/4W, 1%, CARBON
	472121		1	RESISTOR, 3.74K OHM, 1/4W, 1%, CARBON
	472127		1	RESISTOR, 32,4K OHM, 1/4W, 1%, CARBON
	472146		1	RESISTOR, 47.5K OHM, 1/4W, 1%
	472170		1	RESISTOR, 22.1K OHM, 1/4W, 1%
	472227		1	RESISTOR, 47 OHM, 1/4W, 1%, METAL FILM

LINE	PART NO	REV	QPA	DESCRIPTION
	472255		2	RESISTOR, 1 OHM, 1/4W, 1%, METAL FILM
	472268		1	RESISTOR, 8.66K OHM, 1/4W, 1%, METAL FILM
	472281		1	RESISTOR, 698K OHM, 1/4W, 1%
	473514		1	RESISTOR, 100K OHM, 1/4W, .1%
	473529		1	RESISTOR, 4.75K OHM, 1/4W, .1%, 50PPM
	473551		1	RESISTOR, 20K OHM, 1/4W, .1%
	473563		1	RESISTOR, 33.2K OHM, 1/4W, .1%, 25PPM, METAL
	473564		1	RESISTOR, 1.72K OHM, 1/4W, .1%, 50PPM, METAL
	474006		1	RESISTOR, 20 OHM, 2W, 5%, METAL OXIDE
	474032		2	RESISTOR, 10 OHM, 1/2W, 5%, CARBON
	474089		2	RESISTOR PACK, 100K OHM, 2%, 8 RES, 9 PIN
	474091		1	RESISTOR PACK, 10K OHM, 2%, 9 RES, 10 PIN
	474098		3	RESISTOR PACK, 100K, 2%, 5 RESISTORS, 10 PIN
	474100		1	RESISTOR PACK, 1K, 2%, 5 RESISTORS, 10 PIN
	474101		3	RESISTOR PACK, 10K, 2%, 5 RESISTORS, 10 PIN
	474132		1	RESISTOR PACK, 41K OHM, 2%, 4 ISOL RES, 8 PIN
	474135		1	RES PACK, 100 OHM, 2%, 5 ISOL RES, 10 PIN
	475001		1	POT,CERMET 200 OHM, (TOP)
	475005		2	POT, CERMET 1K OHM, (TOP)
	475034		1	POTENTIOMETER, 2K OHM, 10%, 1 TURN, TOP ADJ
	481000		2	DIODE, ZENER, ICL8069CCSQ, 1.2 V REF
	481501		7	DIODE, 1N4148, SIGNAL, SILICON, HIGH SPEED
	481534		1	DIODE, BAT82, SCHOTTKY, MINIATURE, DO-34 PACK
	481541		4	DIODE, UF4002, 100V, 1A, FAST RECOVERY
	481542		1	DIODE, UF5400, 50V, 3A, FAST RECOVERY
	483002		4	2N3906 PNP SILICON SWITCHING
	483017		4	TRANSISTOR, BC214C, PNP, SILICON
	484010		2	NPN TRANSISTOR 2N3904
	484523		1	VOLTAGE REGULATOR, LM79L05ACZ, NEGATIVE, 100M
	484531		2	VOLTAGE REGULATOR, LM341T5.0, +5V, 500MA
	484533		1	VOLTAGE RGLTR, MIC2950-05BZ, ADJUSTABLE,
	485510		1	VN10LM VMOS F.E.T.
	485520		1	TRANSISTOR, BS250, P-CHANNEL MOSFET
	485527		1	MOSFET, IRF9523, .8 OHMS, 60V, P-CHANNEL
	485528		1	MOSFET, IRF540, .085 OHMS, 100V, N-CHANNEL
	485529		3	TRANSISTOR, VN0610L, N-CHANNEL, ENHANCEMENT
	486048		1	IC, HM628128LP-12, 128K X 8 BITS RAM, DIP
	486255		1	IC, SN76496AN, PROGRAMMABLE TONE GENERATOR
	486276		1	IC, LT1081CN, DUAL RS232C DRIVER/RCVR, 5V
	486285		1	IC, HD64180R1P6, HIGH INTEGRATION CMOS 8-BIT
	486298		1	IC, MM74HC4020N, 14-STAGE BINARY CNTR
	486305		1	IC, MSM6242BRS, CMOS REAL TIME CLOCK/CALENDAR
	486344		1	IC, MAX132CNG, 18-BIT A TO D SERIAL OUT
	486600		1	IC, CD4013B, DUAL D-TYPE FLIP FLOP

LINE	PART NO	REV	QPA	DESCRIPTION
	486606		1	CD4093BE QUAD 2 INPUT NAND GATE
	486625		2	MC74HC32N I.C. QUAD 2 INPUT OR GATE
	486651		1	MM74HC138 I.C. 3 TO 8 LINE DECODER
	486675		1	MM74HC14N, IC,CMOS
	486676		1	MM74HC74N, IC, CMOS
	486680		4	IC, MM74HC573AN, OCTAL D-TYPE LATCH, 3 STATE
	486685		1	AD7528JN, IC, CMOS INTERFACE
	486743		3	IC, TL064BCN, OP AMP LOW OFFSET
	487009		3	IC, 4N32, OPTOISOL, IR EMITTER TO PDARLINGTON
	487061		1	IC, TBA820M, MONOLITHIC INTEGRATED AUDIO AMP,
	487064		4	IC, CNY17-III, PHOTON COUPLED ISOLATOR
	487065		1	IC, UC3843N, CURRENT MODE PWM CONTROLLER
	487102		1	IC, 1220A-015A-3N, PRESSURE SENSOR, 8 PIN
	487119		1	IC, LTC699CN8, UPROCESSOR SUPV CKT, 8 PIN
	515072		1	FUSE, 1A, 125V, VERY FAST-ACTING, PLUG-IN
	515511		1	FUSEHOLDER, VERT, 5A, 125V, PC MOUNT
	5712-10	01	1	TRANSFORMER, MAIN BD
	5833-01	01	1	GROUND WIRE ASSY, MAIN BOARD
	6618-07	13	1	PROGRAM, EPROM ASSY, SYSTEM

ASSY: 2534-01 02 FRONT END BOARD ASSY

LINE	PART NO	REV	QPA	DESCRIPTION
	151001		1	CAPACITOR .001UF 20% 100V MYLAR
	151002		3	CAPACITOR .01UF 20% 200V MYLAR
	151005		2	CAPACITOR .1UF 20% 100V MYLAR
	151006		1	CAP 1UF 20% 50V METIPOLY (METALIZED POLYCARB.
	152042		1	CAPACITOR, 1UF, 35V, RADIAL
	152048		3	CAP, 4.7UF, 16V, 10%, ELECTROLYTIC, TANT
	154016		28	CAPACITOR, .1UF, 50V, 10%, .1 SP, X7R, DIPPED
	180004		3	CHOKE, 100UH, 10%, SHIELDED
	180007		3	INDUCTOR, 1UH, AXIAL LEADED
	212537		1	CONNECTOR, 20 PIN, HEADER, DIL, STR, .1 SP
	216029		0	TEST POINT, SPRING LOADED, 475 DEG C MAXIMUM
	216071		0	TERMINAL, TEFLON INSULATED, PRESS IN-PLACE
	281500		0	NUT, HEX, NO. 4-40, STEEL, CADMIUM PLATE
	284200		0	#4-40 X 1/4 SLOTTED BINDING HEAD STEEL CAD
	285000		0	LOCK WASHER, NO. 4, INTERNAL TOOTH, STEEL
	310006		1	INSULATING WASHER
	472021		3	RESISTOR, 4.75K OHM, 1/4W, 1%, CARBON
	472022		2	RESISTOR, 4.99K OHM, 1/4W, 1%, CARBON
	472023		1	RESISTOR, 5.11K OHM, 1/4W, 1%, CARBON
	472030		5	RESISTOR, 10K OHM, 1/4W, 1%, CARBON
	472036		1	RESISTOR, 13.3K OHM, 1/4W, 1%, CARBON

LINE	PART NO	REV	QPA	DESCRIPTION
	472039		1	RESISTOR, 15K OHM, 1/4W, 1%, CARBON
	472040		2	RESISTOR, 16.2K OHM, 1/4W, 1%, CARBON
	472047		2	RESISTOR, 40.2K OHM, 1/4W, 1%, CARBON
	472058		2	RESISTOR, 100K OHM, 1/4W, 1%, CARBON
	472060		3	RESISTOR, 121K OHM, 1/4W, 1%, CARBON
	472065		2	RESISTOR, 200K OHM, 1/4W, 1%, CARBON
	472072		1	RESISTOR, 475K OHM, 1/4W, 1%, CARBON
	472073		5	RESISTOR, 499K OHM, 1/4W, 1%, CARBON
	472075		5	RESISTOR, 1M OHM, 1/4W, 1%, CARBON
	472122		1	RESISTOR, 130K OHM, 1/4W, 1%, CARBON
	472130		2	RESISTOR, 324K OHM, 1/4W, 1%, CARBON
	472137		1	RESISTOR, 562K OHM, 1/4W, 1%
	472140		1	RESISTOR, 332K OHM, 1/4W, 1%
	472172		2	RESISTOR, 133K OHM, 1/4W, 1%
	472186		1	RESISTOR, 36.5K OHM, 1/4W, 1%
	472203		2	RESISTOR, 7.5 OHM, 1/4W, 1%, METAL FILM
	472255		2	RESISTOR, 1 OHM, 1/4W, 1%, METAL FILM
	472901		2	RESISTOR, 50M OHM, 3/4W, 1%, 80 PPM/C
	473512		4	RESISTOR, 10K OHM, 1/4W, .1%
	473515		3	RESISTOR, 49.9K OHM, 1/4W, .1%
	473520		2	RESISTOR, 39.2K OHM, 1/4W, .1%
	473526		2	RESISTOR. 6.190K OHM, 1/4W, .1%
	473530		2	RESISTOR, 4.22K OHM, 1/4W, .1%
	473551		1	RESISTOR, 20K OHM, 1/4W, .1%
	474098		1	RESISTOR PACK, 100K, 2%, 5 RESISTORS, 10 PIN
	474101		1	RESISTOR PACK, 10K, 2%, 5 RESISTORS, 10 PIN
	475049		1	POTENTIOMETER, 10K OHM, 10%, M TURN, TOP ADJ
	481501		10	DIODE, 1N4148, SIGNAL, SILICON, HIGH SPEED
	483002		2	2N3906 PNP SILICON SWITCHING & AMPLIFIER TRA
	484010		1	NPN TRANSISTOR 2N3904
	485510		2	VN10LM VMOS F.E.T.
	485515		1	TRANSISTOR, BUZ71A, F.E.T. N-CHANNEL POWER
	485516		1	TRANSISTOR, IRFD 9120, 9-CHAN ENHANCEMENT
	486673		1	I.C. CD4051B CMOS ANALOG MUX/DMUX
	486704		2	IC, OP07CN8, OP AMP, ULTRA L VOLT OFFSET
	486737		2	LOW INPUT CURRENT OP AMP CA3420E
	486743		3	IC, TL064BCN, OP AMP LOW OFFSET
	486816		1	IC, LT1013CN8, DUAL PRECISION OP AMP, 8 PIN
	608001		0	CABLE TIE, .094 X 3.62L, SELF-LKG
	6609-01	00	1	INPUT CABLE ASSY, O2 & CO2
0001	2534-02	02	1	FAB, FRONT END BOARD
0002	2534-03	02	0	SCHEMATIC, FRONT END BOARD
0003	2534-04	01	0	TEST PROCEDURE, FRONT END BD ASSY

10.2 *Model 868 Calibrator*

There are two versions of the Transcutaneous Calibrator. The current version is listed first under "Newer Calibrator" and the different assemblies of the older version are listed under "Older Calibrator". The older version can be identified by the two gas guages that are located to the left of the front panel, the HIGH gas guage is above the LOW gas guage. The newer version has the guages located to either side of the SENSOR port.

10.2.1 Newer Calibrator

ASSY: 6633-00 01 TRANSCUTANEOUS CALIBRATOR - MODEL 868

LINE	PART NO	REV	QPA	DESCRIPTION
0001	1217-32	03	1	REPAIR LABEL
0002	6070-32	01	1	LABEL, SERIAL NUMBER
0003	5827-32	03	1	WARNING LABEL, EXPLOSION HAZARD
0004	6617-32	00	1	INSTRUCTIONS LABEL, TOP COVER
0005	6873-01	01	1	MAIN ASSY
0007	6633-06	00	0	ACCESSORIES LIST
0009	6633-40	00	0	DESIGN DOCUMENTATION
0011	6633-75	01	0	DEVICE MASTER RECORD
0012	6705-13	01	1	TOP COVER PAINTING
0015	286205		0	6-32 X 3/4 S.B.H. CAD PLATED

ASSY: 6873-01 01 MAIN ASSY, MODEL 868 - TC CALIBRATOR

LINE	PART NO	REV	QPA	DESCRIPTION
0001	6633-43	00	0	DATA SHEET
0002	6662-17	00	1	REAR PANEL SUBASSY
0003	6704-13	01	1	BOTTOM COVER PAINTING
0004	6761-16	00	1	ALERT LENS, WHITE
0005	6779-10	00	2	REGULATOR, SINGLE STAGE
0006	6865-01	01	1	FRONT PANEL ASSY
0007	6866-10	00	1	REGULATOR PANEL
0008	6869-10	00	1	TANK SUPPORT, LONG
0009	6873-04	00	0	TEST PROCEDURE, REGULATOR, MAIN ASSY
0015	161000		0	TEFON TAPE, 1/4 IN. WIDE, WHITE
0016	240056		4	FOOT, RUBBER, .81 SQ X .3 HI W TAPER, WHITE,
0017	250043		2	PRECISION FLOW RESTRICTOR,TYPE L BRASS BARB #
0018	250158		2	FITTING, CONNECTOR, 1/8-NPT MALE TO 1/8 OD TU
0019	280111		2	GASKET, 1/8" I.D.X 19/64" O.D.X.020" THK, BUN
0020	281500		0	NUT, HEX, NO. 4-40, STEEL, CADMIUM PLATE
0021	285000		0	LOCK WASHER, NO. 4, INTERNAL TOOTH, STEEL
0022	288216		0	SCREW, 8-32 X 1/4 L, BUTTON HEAD HEX SOCKET
0023	161008		0	ADHESIVE, 242, THREADLOCKER, MED STR, BLUE

ASSY: 6865-01 01 FRONT PANEL ASSY, MODEL 868 - TC CALIBRATOR

LINE	PART NO	REV	QPA	DESCRIPTION
0001	2541-01	01	1	CALIBRATOR BOARD ASSY
0002	6695-10	01	1	PROBE NEST
0003	6696-10	00	1	KNOB, PROBE NEST
0004	6697-10	01	1	SHAFT, PROBE NEST
0005	6861-16	00	2	GAGE PANEL MOUNT
0006	6865-17	01	1	FRONT PANEL SUBASSY
0011	160036		0	SOLVENT, METHYLENE CHLORIDE (DICHLOROMETHANE)
0012	161000		0	TEFON TAPE, 1/4 IN. WIDE, WHITE
0013	161075		0	ADHESIVE, 430, FAST-SETTING, GENERAL PURPOSE
0014	161091		0	ADHESIVE, 425, FAST SETTING, THREADLOCKER
0015	250027		0	URETHANE HOSE (BLUE) 1/16 I.D. X 1/8 O.D.
0016	250152		2	GAUGE, 0-300 PSI, ROUND, PANEL MOUNT
0017	250156		1	FITTING, TEE, FOR 1/16 ID TUBING, W 10-32 THD
0018	250157		2	FITTING, CONNECTOR, 1/8-NPT FEMALE TO 1/8 OD
0019	280081		1	O-RING, .551 ID X .070 BEAD SILICONE
0020	280229		1	SPRING, COMPRESSION, .18 OD X .5 L, .02 DIA
0021	280230		1	RETAINING RING, FOR 1/8 DIA SHAFT
0022	281500		0	NUT, HEX, NO. 4-40, STEEL, CADMIUM PLATE
0023	285000		0	LOCK WASHER, NO. 4, INTERNAL TOOTH, STEEL
0024	250160		2	TUBING, PFA, 1/8 IN. OD WITH 1/32 IN. THK WAL

ASSY: 6662-17 00 REAR PANEL SUBASSY, MODEL 868 - TC CALIBRATOR

LINE	PART NO	REV	QPA	DESCRIPTION
0001	6662-10	00	1	PANEL, REAR
0002	6662-32	01	1	FACEPLATE, REAR PANEL

10.2.2 **Older Calibrator**

ASSY: 6633-01 01 MAIN ASSY, MODEL 868 - TC CALIBRATOR

LINE	PART NO	REV	QPA	DESCRIPTION
0001	4645-01	04	2	REGULATOR ASSEMBLY
0002	6662-17	00	1	REAR PANEL SUBASSY
0003	6698-01	01	1	FRONT PANEL ASSY
0004	6704-13	01	1	BOTTOM COVER PAINTING
0005	6710-10	01	1	TANK SUPPORT, ANGLE
0006	6761-16	00	1	ALERT LENS, WHITE
0007	6785-10	00	1	REGULATOR PANEL
0008	6792-10	00	1	BULKHEAD SPACER, REGULATOR PNL
0009	6633-04	01	0	TEST PROCEDURE, REGULATOR, MAIN ASSY
0016	161019		0	PIPE SEALANT, 592, COLOR: WHITE
0017	161092		0	ADHESIVE, 262, THREADLOCKER, HIGH STRENGTH

LINE	PART NO	REV	QPA	DESCRIPTION
0018	240056		4	FOOT, RUBBER, .81 SQ X .3 HI W TAPER, WHITE
0019	250042		2	BRASS REDUCER BUSHING, 1/8" NPT TO #10-32
0020	250043		2	PRECISION FLOW RESTRICTOR,TYPE L BRASS BARB
0021	250128		0	TUBING, TEFZEL, .093 ID X .125 OD
0022	250154		2	FITTING, MALE ELBOW, 1/8 OD TUBING TO 1/8-NPT
0023	280111		2	GASKET, 1/8" I.D.X 19/64" O.D.X.020" THK, BUN
0024	281500		0	NUT, HEX, NO. 4-40, STEEL, CADMIUM PLATE
0025	285000		0	LOCK WASHER, NO. 4, INTERNAL TOOTH, STEEL

ASSY: 6698-01 01 FRONT PANEL ASSY, MODEL 868 - TC CALIBRATOR

LINE	PART NO	REV	QPA	DESCRIPTION
0001	6695-10	01	1	PROBE NEST
0002	6696-10	00	1	KNOB, PROBE NEST
0003	6697-10	01	1	SHAFT, PROBE NEST
0004	6698-17	00	1	FRONT PANEL SUBASSY
0005	6701-10	01	1	MOUNTING PLATE, PRESSURE GAUGE
0006	6759-01	02	1	INPUT CABLE ASSY
0010	161019		0	PIPE SEALANT, 592, COLOR: WHITE
0011	250027		0	URETHANE HOSE (BLUE) 1/16 I.D. X 1/8 O.D.
0012	250057		2	SOLENOID VALVE, REED TYPE
0013	250152		2	GAUGE, 0-300 PSI, ROUND, PANEL MOUNT
0014	250153		2	BULKHEAD FITTING, FEMALE, 1/8 OD - 1/8-NPT
0015	250156		1	FITTING, TEE, FOR 1/16 ID TUBING, W 10-32 THD
0016	280000		0	SPACER HEX #4 THREADED X 1/2" LONG
0017	280081		1	O-RING, .551 ID X .070 BEAD SILICONE
0018	280229		1	SPRING, COMPRESSION, .18 OD X .5 L, .02 DIA
0019	280230		1	RETAINING RING, FOR 1/8 DIA SHAFT
0020	280231		0	STANDOFF, 1/4 HEX X 1 3/8 L, 4-40 FEMALE THD
0021	281500		0	NUT, HEX, NO. 4-40, STEEL, CADMIUM PLATE
0022	284203		0	#4-40 X 3/16 SLOTTED BINDING HEAD STEEL CAD.
0023	285000		0	LOCK WASHER, NO. 4, INTERNAL TOOTH, STEEL
0024	285049		4	LOCKWASHER, INT TOOTH, FOR 3/8 DIA SCR, ZINC
0025	608001		0	CABLE TIE, .094 X 3.62L, SELF-LKG
0026	608002		1	TY-MOUNT. ADHESIVE, 3/4" X 3/4"
0027	161075		0	ADHESIVE, 430, FAST-SETTING, GENERAL PURPOSE
0028	161092		0	ADHESIVE, 262, THREADLOCKER, HIGH STRENGTH
0029	161091		0	ADHESIVE, 425, FAST SETTING, THREADLOCKER