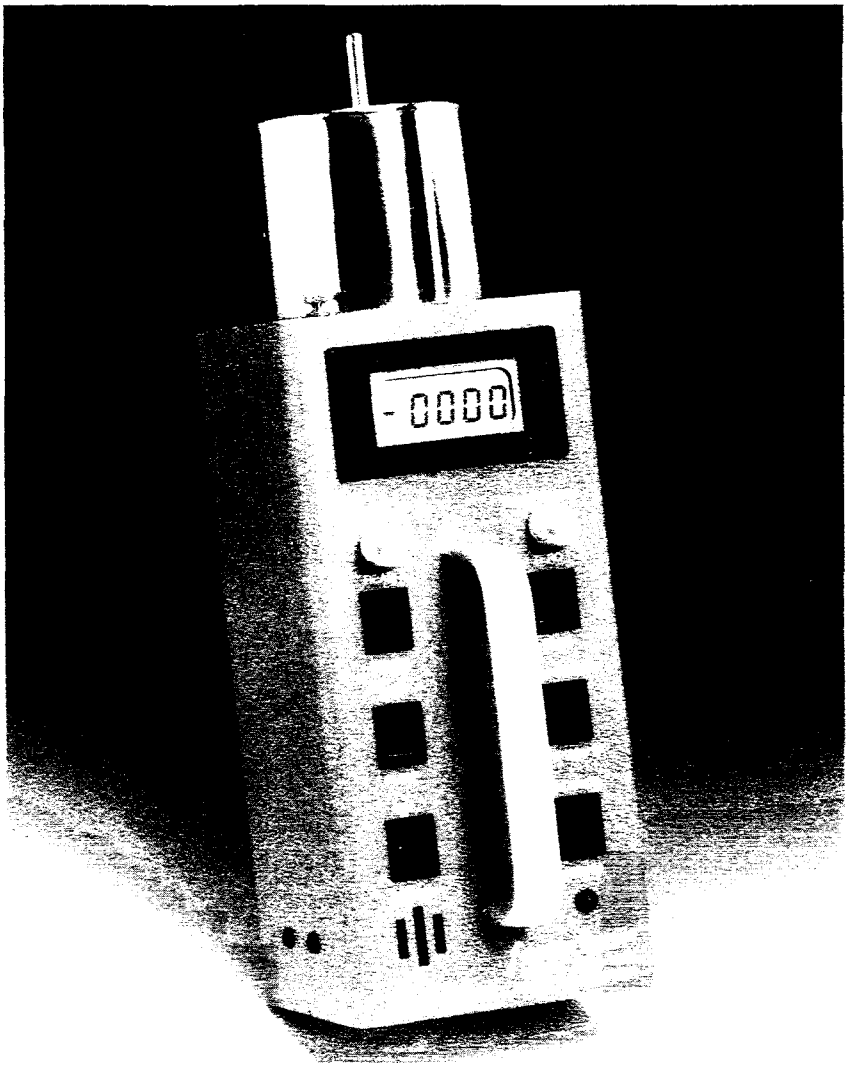
femto-TECH

INSTRUCTION MANUAL



MODEL PTM-1812

PORTABLE TRITIUM MONITOR

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MODEL PTM-1812

TABLE OF CONTENTS

R e v . 1 . 2
Published 09/93

***femto* - TECH, INC.**
325 Industry Dr. P.O. Box 8257
Carlisle, OH 45005 USA
Telephone (513) 746-4427 FAX (513) 746-9134

2. GENERAL DESCRIPTION

The **femto-TECH,** INC. Model PTM-1812 Portable Tritium Monitor is a precision airborne beta radiation detection instrument that serves as two instruments in one. The user can select between a perforated ion chamber shell for passive sampling or a solid ion chamber shell for active sampling. Both ion chamber shells are supplied with the instrument and are easily exchangeable in the field. In the passive configuration the PTM-1812 serves as a portable, continuous, real-time area monitor. In the active configuration, it uses an internal pump to pull samples from tritium containers, glove boxes, etc.

3. INTRINSIC CALIBRATION

The intrinsic calibration of the ion chamber used in a PTM-1812 system is established by the physical size and geometry of the ion chamber and the value of the feedback resistor (high-meg). NIST traceable tritium gas standards have been used to verify the electronic calibration factor for this type ion chamber. Production ion chambers maintain the same parameters as those that have been calibrated with the tritium gas standard. Therefore, the production ion chambers have the same intrinsic calibration. The feedback resistors of each production unit are measured once by the supplier of the resistors and a second time at femto-TECH. NIST traceable resistor standards and voltmeters are used to perform this measurement. A built-in electronic calibration adjustment provides field adjustment and calibration verification of all electronic components back to the feedback resistor. Field calibration checks can also be performed using a fixed geometry gamma source to provide a known amount of ionization in the ion chamber.

4. OPERATION

4.1 INITIAL SET UP

The **femto-TECH** Model PTM-1812 Portable Tritium Monitor is simple to use. The user should first decide whether active or passive sampling will be utilized. To install the correct chamber, the main power switch must be turned off. This is EXTREMELY IMPORTANT as the inner sensing chamber is connected to 12 volts and may result in the electronics being damaged if the outer chamber was to touch the main cabinet and the inner chamber while the power is on. The two brass retaining screws should be loosened enough to allow the chamber to be rotated clockwise until the flanges clear the screws. The chamber can then be lifted straight off. The correct chamber should then be installed and the retaining screws tightened only finger tight (do not over tighten). The main power should be turned on and the LCD front panel meter will come on. It is normal for the meter to show a very large value or the most significant digit (left most) on until the electrometer circuit comes into balance and stray static charges accumulated while the unit was off are neutralized. These charges will be nulled rapidly with the meter settling down to a constant value. Depressing and holding the zero switch for about 2 seconds will speed up the process.

4.2 CONTROLS

4.2.1 BATTERY STATUS

The two 12 volt batteries should be checked before use. Battery A powers the electrometer and front panel meter while Battery B supports the internal pump and the zeroing solenoid. The batteries are tested by rocking the battery switch each direction. If the red LED lights, the battery has sufficient charge. If the LED **does** not light, the charger for the unit should be plugged in and allowed to charge for a minimum of 8 hours. The monitor may be used during the charging time. A low battery indicator is also included in the LCD display. If a low battery is indicated on the display, the batteries should be charged. The LCD indicator may show low battery slightly before or after the red LED. This is normal due to component tolerances.

4.2.2 ZEROING THE INSTRUMENT

With the instrument on and the meter stabilized, the instrument should be zeroed. The zero switch should be pressed and held and the zero adjust knob rotated slowly until the meter displays 0000. The zero adjust knob is a ten turn pot with clockwise rotation increasing the value and counterclockwise decreasing the value. A click should be heard when the zero switch is pressed verifying operation of a solenoid used to null the sensing electrode. If the meter displays a negative value, the zero adjust should be turned clockwise until zero is obtained. This adjustment should be made gradually to allow the instrument to react.

4.2.3 ELECTRONIC INSTRUMENT TEST

An instrument test should be performed by pressing and holding the TEST switch (the zero switch rocked in the opposite direction). The meter should rapidly go up and settle at the 11000 ±330 in about 15 seconds. The instrument test utilizes current injection and verifies the electronics from the high meg resistor back to the meter readout. If the value is not correct, the steps to zero the instrument should be repeated.

4.2.4 ALARM READ/ADJUSTMENT

With the PTM-1812 zeroed and the instrument operation verified using the instrument test, the alarm adjustment should be made. The ALARM READ rocker switch should be held and the ALARM SET knob turned until the desired level in micro curies is reached. The ALARM SET is also a ten turn pot with clockwise rotation increasing the value and counterclockwise decreasing the value. With the alarm level set, the alarm operation can be verified by pressing the test button momentarily. As the alarm level is exceeded, the red LED will light and the audible alarm will sound. The audible alarm can be enabled or disabled by selecting the proper position of the ALARM SILENCE switch. When the TEST switch is released, the meter will start to drop. As the level drops below the Alarm level, the audible and visual alarms will cease.

The PTM-1812 is now ready to be used. If active sampling is to be used, a short section of tubing should be installed on the pump outlet (in the endplate towards the user) and directed away from the user. The monitor will work best when held steadily or set on a solid surface.

4.3 AC/DC ADAPTER BATTERY/CHARGER

A 12 VDC adapter/charger is supplied with the unit. This adapter has the outer barrel as positive and the center pin as negative. If another unit is substituted by the user, it is very important that a unit of the same voltage, current, and polarity on the connection be used. Reversing the polarity will not charge the PTM-1812.

5. TRITIUM MONITORING

5.1 INTERFERENCE

The instrument is now ready to monitor tritium with the instrument zeroed and the alarm level set. Due to the sensitivity of the instrument, movement while attempting a measurement should be minimized because of gravitational effects (geotropism). The PTM-1812 utilizes a direct current (DC) ion chamber and a differential amplifier with a 7 second time constant (to reach 66%, 35 seconds to 100%) to discriminate against unwanted electromagnetic radiation. Perturbing factors that can effect the ion chamber readings include interfering ion sources such as smoke, aerosols, and ambient ions and background sources such as fission product gases, radon, or ambient gamma fields. In addition, memory effects may occur due to moisture and condensation, tritiated ammonia or tritiated organics. A felt filter may be used to minimize interfering ion sources while the design of the electrometer reduces the effects due to the alpha and beta decay of radon and its progeny. Better filters are not typically needed but if one is, a 10 micron filter should be sufficient to eliminate most offending particles without restricting air flow.

5.2 MEASUREMENTS

When exposed to tritium the PTM-1812 will rapidly rise to the level of the tritium present. In the active mode (pump on) equilibrium will be reached in less than a minute. In the passive mode, the PTM-1812 will sense the tritium immediately (less than 7 seconds) but equilibrium will depend upon the uniformity of the tritium concentration and the air convection currents in the vicinity of the instrument. Tritium naturally diffuses very rapidly in air (4 to 5 times faster than CO_2) due to its low molecular weight. A stable reading may not occur because of continuing diffusion. In these circumstances, the user may need to observe both peak and average readings. The high sensitivity of the PTM-1812 is maintained throughout the full dynamic range of the instrument so fluctuation of the low order digits is common (except in very stable environments such as what may be present in a **glovebox).** A reading may have to be made that approximates the average of the values displayed. For example, if the meter displays values between 120 and 130, with neither end of the range being dominant, the average could be estimated at 125 yCilm3.

6. TROUBLE SHOOTING

SYMPTOM	CAUSE	ACTION
Red LED does not light on battery test	Insufficient charge	Charge for at least 8 hours
Negative value on meter	Instrument zero not set	Zero adjustment procedure
Positive value on meter	Instrument zero not set	Zero adjustment procedure
Non zero value after zeroing	Gamma background	Subtract from tritium reading
Non zero value with no gamma	Memory due to contamination	Clean sensing volume
Instrument test not 11000	Electronics malfunction	Contact femto-TECH service
Instrument test not 11000	Zero not set	Zero adjustment procedure
Instrument reads but no pump	Pump battery discharged	Charge for at least 8 hours
Continuous alarm	Alarm level set too low	Readjust to higher value

PRECAUTIONS

Femto-TECH strongly recommends that any service work be performed only by a qualified service technician with electrometer experience. If it becomes necessary to clean the sensing chamber, **extreme** caution must be exercised to avoid damaging the field effect transistor connected to the center finned electrode. Before removing the inner screen (sensing) chamber, a safety ground lead **must be** attached to the high meg resistor first on the end that is solder to the printed circuit board and then to the resistor end that sits in the center electrode slot. The order of attachment is extremely important to avoid static electricity from destroying the FET. With the ground wire in place, the chamber, finned electrode, and base plate may be wiped clean. Only denatured alcohol, lint free wipes, and canned air should be used when cleaning the sensing chamber parts. Other cleaners will leave a residue which may cause malfunction of the instrument.

7. CALIBRATION

The primary calibration control factors of the PTM-1812 are the physical size and geometry of the ion chamber and the high megaohm feedback resistor. Femto-TECH carefully checks these parameters for each production unit in our own factory against NIST traceable standards. If the user desires to perform a calibration check with NIST traceable tritium gas, it is best handled with a closed loop system where another calibrated tritium monitor serves as a transfer standard. The monitor used as the standard should be of equal or higher performance because of the quick response and high sensitivity of the PTM-1812. The Femto-TECH Models 224GB-U24 or 224RM-U24 tritium monitors are recommended because of their fast response and high precision. The intrinsic calibration only depends upon the volume of the ion sensing chamber and not on the plumbing volume to the chamber or any external system.

The calibration factor of the PTM-1812 or ionization chamber current is expressed in units of amperes per curie per cubic meter. This is derived using first principles and has been verified in the laboratory with tritium gas standards. With the ion current known and the high megaohm feedback resistor known, the value of microvolts per microcurie per cubic meter has been determined. Femto-TECH maintains a service to provide an electronic calibration when required. Call 513-746-4427 or FAX 513-746-9134 to obtain current pricing or to schedule the service.

8. BACKGROUND

Background is the undesired offset that may be present after zeroing the instrument. Typical sources are ion sources such as smoke or aerosols and ionizing radiation such as a gamma source. In the case of the ion sources, elimination of the sources or filtering are the best solutions to reduce the background. Any gamma may be reduced by shielding. If this is not possible, the gamma background must be subtracted from the reading.

9. WARRANTY

Femto-TECH, INC. warrants this product to be free of defects in workmanship and materials, and to perform per published specifications for a period of one year from shipping date, providing the unit has been properly stored, handled, and used within the specified environmental limits. This warranty is limited to repair or replacement at *femto-TECH's* option. Buyer assumes responsibility to apply femto-TECH, INC. products with due regard to safety where personal injury, death, or property loss is concerned, and *femto-*TECH, INC. and its employees accept no responsibility for these or other consequences. Femto-TECH, INC. recognizes no other warranty policy than this policy as stated, regardless of the fact that orders may be accepted which attempt to bind femto-TECH, INC. to other stipulations.

10. REPAIR POLICY

If this unit becomes defective due to workmanship or materials at any time within one year of purchase, return it to the distributor or dealer from whom the unit was purchased along with proof of purchase (sales slip, invoice, or receiving slip copy), for repair or replacement.

If the unit becomes defective beyond the one year warranty period, or was damaged due to physical abuse or attempts to operate the unit beyond its specification limits, warranty repair or replacement does not apply. However, femto-TECH, INC. maintains a repair service which can repair and return your damaged unit in proper operating condition. Call (513) 746-4427 or FAX (513) 746-9134 between the hours of 9 AM to 4 PM Eastern Standard Time for current service charges.

Prior to returning an instrument to the factory, the level of radioactive contamination must be determined. It may be necessary to decontaminate the instrument to ensure that it is acceptable for handling off site.

NUCLEAR PROTECTION LIABILITY STATEMENT

Femto-TECH expects that the engineer, the health physicist (HP), **or** the plant owner will obtain an agreement from the federal government indemnifying femto-TECH, its subcontractors and suppliers from and against any liability, whether in contract or tort (including negligence) or otherwise resulting from nuclear risks or hazards. The government shall waive any and all right of recourse against femto-TECH and its related entities, its subcontractors and suppliers with respect to loss, damage, claims of liability arising out of nuclear risks or hazards, regardless of the degree of fault, with the exception that the government may retain its right of recourse against an individual who has acted or omitted to act with the willful intent to cause nuclear damage. *Femto-TECH* expects the engineer, the HP, or the plant owner will obtain and maintain in force all insurance required by laws of the federal, state or local governments to maintain in effect the government indemnity, which shall be effective no later than the date nuclear material is first shipped to the project site and shall continue in effect until the liability of *femto*I ECH, its subcontractors and suppliers arising out of nuclear risks or hazards, in connection with the project shall cease. Termination of this contract shall not in any way affect the engineer, the HP, or plant owners obligations under this paragraph. The engineer, the HP, or the plant owner shall provide to femto-TECH evidence satisfactory to femto-TECH that the government indemnity and underlying insurance under the Nuclear Energy Liability-Property Insurance Association is in full force and effect.

NUCLEAR INSURANCE LIABILITY STATEMENT

The Owner shall secure and maintain in force an All Risk Builder's Risk Property Damage Insurance, a combined Builder's Risk and Operating Facility Property Damage Insurance, or an Operating Facility Property Damage Insurance Policy or policies as issued by the Nuclear Energy Liability-Property Insurance Association (NEL-PIA) or by NEL-PIA and the Mutual Atomic Energy Reinsurance Pool (MAERP), or by Nuclear Mutual Limited (NMI.), or equivalent. Said policy or policies shall cover all equipment, materials and structures at the Plant Site which are to become a part of the permanent Plant and all temporary structures to be used in or incident to construction of the Plant, in an aggregate amount equal to the actual cash value of such equipment, materials and structures (but not exceeding repair or replacement costs therefor) or the maximum principal amount available under the standard policy or policies of the insurer or insurers selected by the Buyer or Owner, whichever is less. Such policies of insurance may be subject to any of the standard deductibles, exclusions and conditions commercially available for such policies. To the extent covered by the foregoing policy or policies of property damage insurance in force at the time of any loss or damage at the Plant Site, the Owner hereby waives any and all right of recovery against Seller, its subcontractors and suppliers for any tier, for loss of, damage to or loss of use of any property at the Plant Site. In addition, neither Seller nor its subcontractors or suppliers of any tier shall have any liability to the Owner, arising out of the performance of this contract, for any nuclear incident arising out of or in connection with nuclear material handling, storage or loading at, or operation of, the Plant.

The Owner shall also arrange for additional protection against liability arising out of, or resulting from, nuclear incident in such amount and in such form as shall meet the financial protection requirements of the U. S. Nuclear Regulatory Commission under Section 170 of the Atomic Energy Act of 1954, as amended.

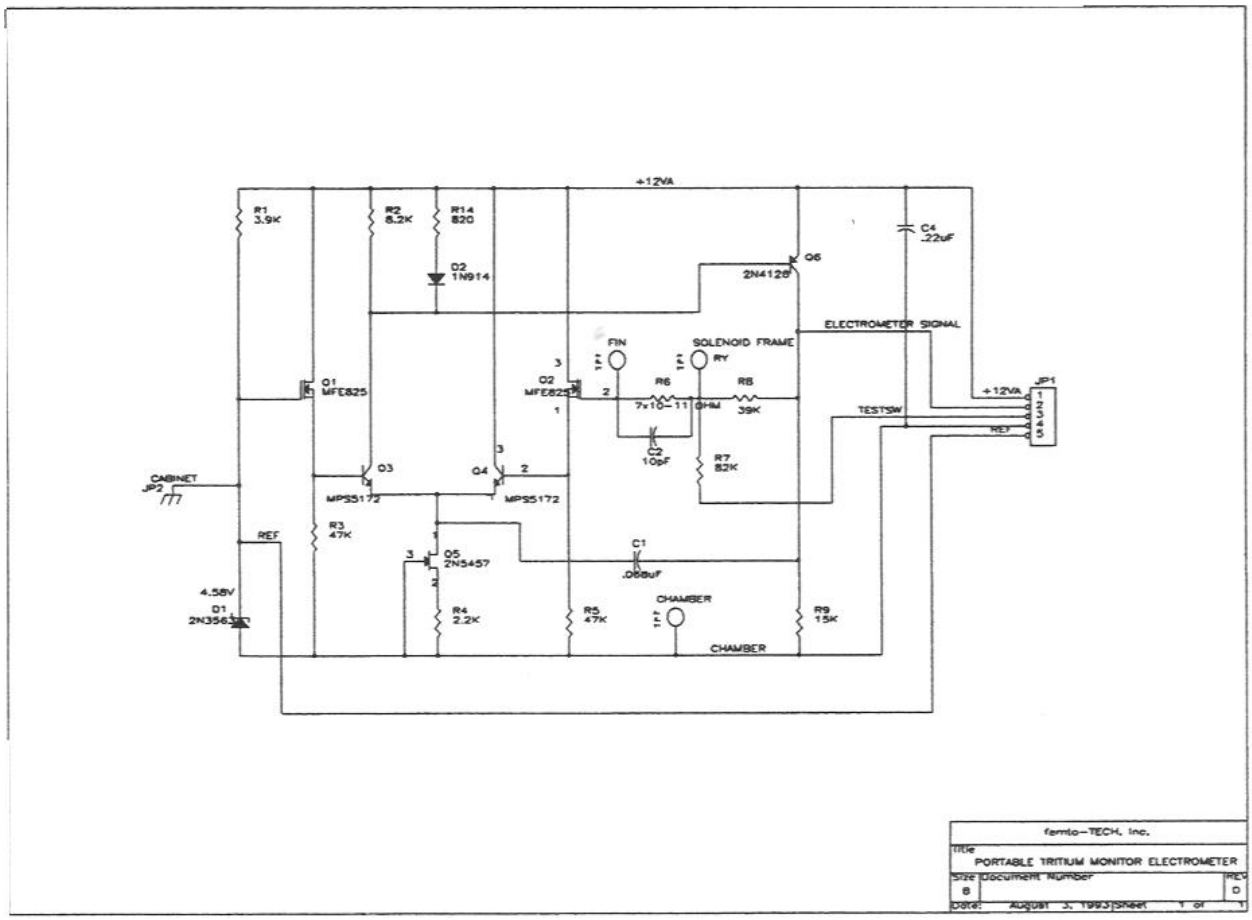
As used herein, the term "Nuclear Incident" means any occurrence or series of occurrences causing bodily injury, sickness, disease, or death, or loss of or damage to property, arising out of or resulting from the radioactive, toxic, explosive or other hazardous properties of radioactive material.

DELAYS

Although time is of the essence, *femto- TECH* shall not be liable for delays in delivery or failure to manufacture or delivery due to causes not foreseeable which are beyond its control, such as acts of God, acts of civil military authorities, governmental priorities, fires, strikes, floods, epidemics, war, riot, late start-up, malfunctions, or shutdowns. In the event of any such delay, the date of delivery shall be extended for the period equal to the time actually lost by reason of the delay (and price escalation shall continue without hiatus). In the event of rejection of non conforming goods, femto-TECH shall have reasonable time to correct the non conformance.

MAXIMUM LIABILITY

Femto-TECH's maximum liability is the total of any Purchase Order.



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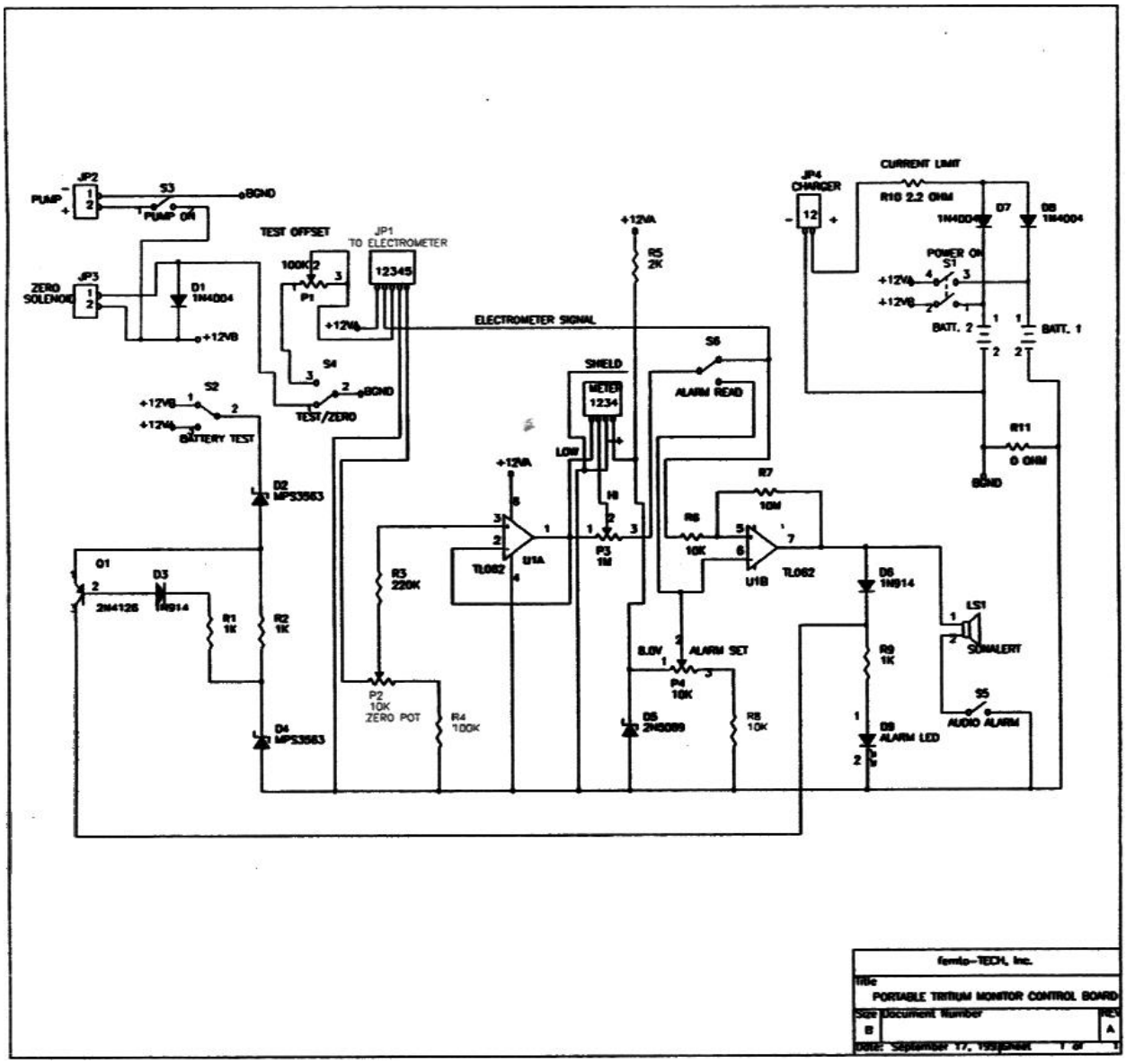

femto-TECH, Inc.		
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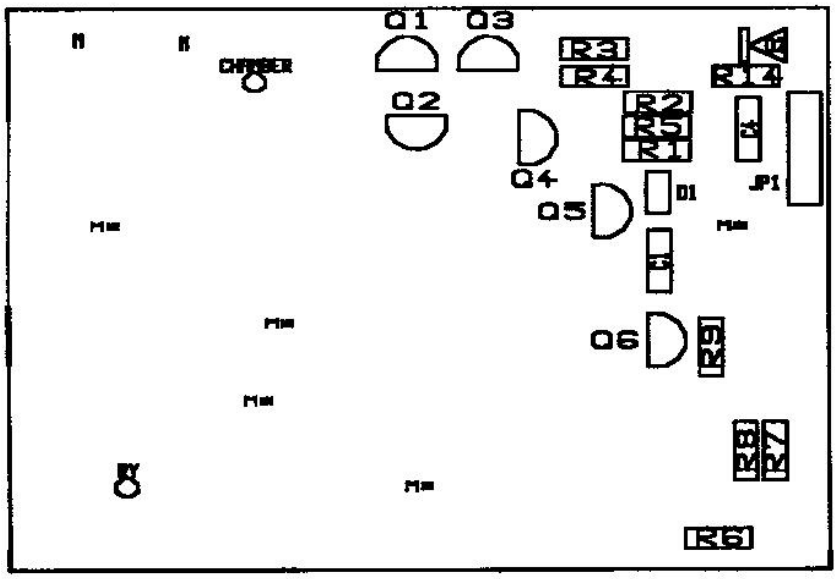
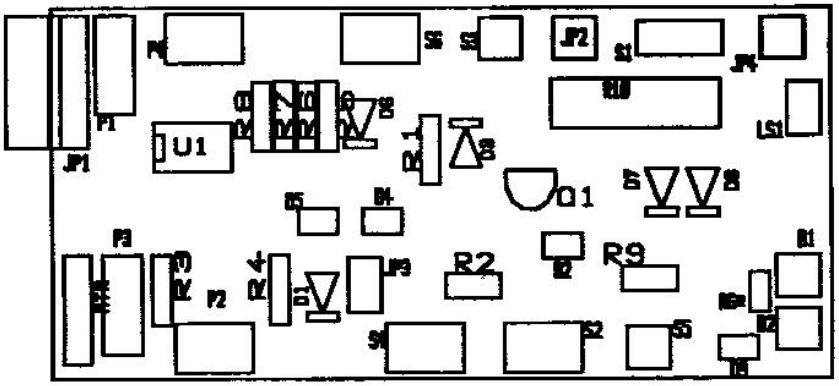
APPENDIX B

PC BOARD ASSEMBLY DRAWINGS





APPENDIX C

PC BOARD PARTS LIST

PORTABLE TRITIUM MONITOR ELECTROMETER BOARD

Model PTM-1812 Bill Of Materials June 22, 1993 11:09:10 Revision: D

Item	Quantity	Reference	Part
1	1	C1	.068uF Capacitor
2	1	C2	10pF Capacitor
3	1	C4	.22uF Capacitor
4	1	D2	1N914 Diode
5	1	D1	2N3563 Transistor
6	2	Q1,Q2	MFE825 FET
7	2	Q3,Q4	MPS5172 Transistor
8	1	Q5	2N5457 Transistor
9	1	Q6	2N4126 Transistor
10	1	R2	8.2K Resistor
11	1	R1	3.9K Resistor
12	2	R2,R4	2.2K Resistor
13	2	R3,R5	47K Resistor
14	1	R6	7×10^{11} OHM Resistor
15	1	R7	82K Resistor
16	1	R8	39K Resistor
17	1	R9	15K Resistor
18	1	R14	820 Resistor

PORTABLE TRITIUM MONITOR CONTROL BOARD

Model PTM-1812 Bill Of Materials August 27, 1992 11:08:47 Revision: A

Item	Quantity	Reference	Part
1	2	D3,D6	1N914 Diode
2	2	D2,D4	MPS3563 Transistor
3	1	D5	2N5089 Transistor
4	3	D1,D7,D8	1N4004 Diode
5	1	P1	100K Potentiometer
6	2	P2,P4	10K Potentiometer
7	1	P3	1M Potentiometer
8	1	Q1	2N4126 Transistor
9	3	R1,R2,R9	1K Resistor
10	1	R3	220K Resistor
11	1	R4	100K Resistor
12	1	R5	2K Resistor
13	1	R6	10K Resistor
14	1	R7	10M Resistor
15	1	R8	18K Resistor
16	1	R10	2.2 Ohm Resistor
17	1	U1	TL062 Op amp