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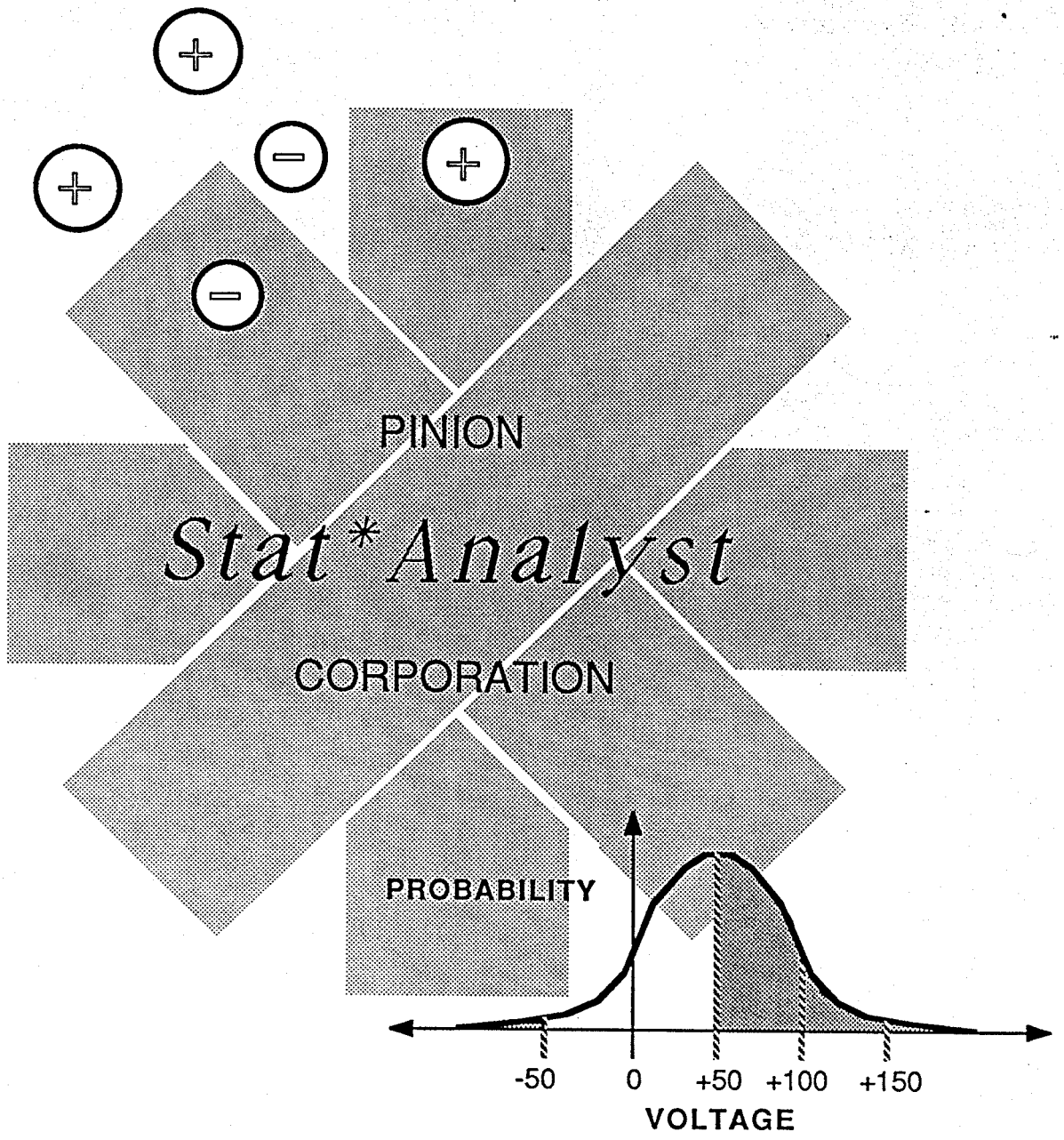
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STATISTICAL ESD PROTECTION ANALYZER

Operation Manual

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Chapter 1

INTRODUCTION

1.0 How to Use This Manual

The Pinion Stat*Analyst is the finest analytical ESD instrument available. The application versatility of this piece of equipment is limited only by the user's imagination. To this extent, the user will find it most valuable to become familiar with the extremely wide range of utility which the Stat*Analyst provides.

We have structured this manual in a fashion which permits even the uninitiated ESD equipment user to begin using the Stat*Analyst immediately. However, we highly recommend that the user examine the instrument's depth of capability by browsing thru all of its functions. You will find that such browsing is simple and easy because of consistent menu formats and operating terminology.

In addition to outlining step-by-step procedures, it is the aim of this manual to provide technically specific detail in order to promote a more complete understanding of the actual analytical processes.

1.1 The Stat*Analyst Provides Answers to Your Tough ESD Questions

This section reviews some of the aspects of an ESD control program that can be monitored by the Stat*Analyst. As a preface, the following typical questions of interest to management and production staff at manufacturing facilities can be answered by the measurements obtained with the Stat*Analyst.

*What is the average voltage on the personnel in the plant?

*What is the probability of assembly personnel having more that 150 volts, or 300 volts, or 800 volts, or 2000 volts, etc?

*Are the voltages on the personnel typically the same day after day?

*Do conductive floors really reduce the voltages on people?

*Should the plant purchase conductive flooring or use conductive floor coatings instead?

*How do various ankle straps and conductive shoes perform? Should the plant purchase them?

*Are the static preventive materials (antistatic bags, foam packing material, work mats, etc.) used in the plant effective at reducing charge build up.?

*What are the voltages on sensitive devices such as integrated circuits (ICs), when they are removed from their shipping containers? Are the containers really antistatic? What is the probability of a voltage sensitive device in a container having greater than 2,000 volts on it (or 1,000 volts, etc.)?

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*What phase in a particular manufacturing process is causing significant ESD damage to ESD sensitive components?

*How can management by convinced that there are ESD related problems in the plant? How can data be acquired that would be meaningful to them?

*Does air ionization play a major role in the total ESD protection program?

*Which air ionizer or ionization system is best for the task at hand?

*How well does a given ionizer hold its balance specifications over time?

*How often should an ionizer be cleaned & calibrated to maintain output?

*What is the AC and RMS voltage performance of a given ionizer?

*How can ESD clothing and furniture be evaluated for economic impact?

All the above questions can be answered easily and conveniently using the Stat*Analyst in one or both of its two main operating modes: Charged Object Analysis (COA) Mode and Charge Plate Monitor (CPM) Mode. Some typical applications are discussed below.

1.2 Charged Object Analysis (COA) Operation Mode

The Stat*Analyst is a versatile charge and voltage measuring instrument designed to measure the effectiveness of many aspects of an ESD control program. It is designed to measure and statistically interpret charge, capacitance and voltage. Statistical ESD data reduction to a clear concise graphical format is a key feature that separates the Stat*Analyst from other instruments currently on the market.

The Stat*Analyst may be used to measure voltage or charge on integrated circuits, PC boards, static preventive materials, and people and then statistically interpret the data. Rather than just reporting charge or voltage measurements as single entities, the Stat*Analyst contains a microprocessor-based system for data storage (up to 650 separate entries are possible for one evaluation). This is important because ESD evaluation measurements are inherently statistical in nature. As an example, when monitoring voltages on personnel it is not uncommon to obtain a reading of 10 volts on a person during one reading, and 5,000 volts during a reading made on the same person a few seconds later; the difference attributed to a quick movement made by the person under test. It becomes evident that many measurements should be made in order to provide a sufficient data base to apply mathematical averaging and standard deviation calculations. This provides the necessary base for probability calculations; yielding a repeatable result that is a more accurate indication of the voltage levels that are typical of the personnel or objects undergoing test. The Stat*Analyst provides these mathematical statistics instantaneously, allowing the operator to efficiently and quickly acquire meaningful data.

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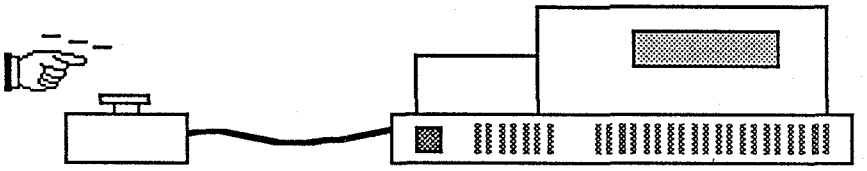
By evaluating charge and voltage as statistical quantities, the information obtained from the Stat*Analyst enables the user to make sensible decisions based on experimental data concerning the magnitude of ESD problems in the actual working environment. This capability is essential in order to effectively evaluate, improve, and monitor any ESD control program.

The Charged Object Analyzer (COA) operating mode incorporates two different input sensors: the PVT-100SA Personnel Voltage Tester and the FC-100/200SA Faraday Cup. In either case the Stat*Analyst functions as a powerful statistical computer to help you determine where the most damaging ESD conditions exist and which ESD solutions provide the most effective and economic answers for your specific needs.

1.21 Personnel Voltage Measurement

The PVT-100SA Personnel Voltage Tester is the Stat*Analyst input sensor used to measure the voltage on people. The PVT-100SA has a range of -10,000 volts to +10,000 volts. A READY indicator (green LED) is provided to show when the unit is ready to measure and process a new piece of data.

Personnel Voltage Test Configuration



Personnel Voltage Sensor (PVT-100SA)

Stat*Analyst Control Unit in COA Mode

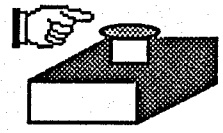
Figure 1: Personnel Voltage Test Set-Up

The Stat*Analyst personnel voltage test (as illustrated in figures 1 & 2) is a cost effective method for evaluating a company's ESD program by determining the probability of individuals having ESD potentials of critical magnitudes. By placing the PVT Sensor in the work environment where workers can touch the sensor frequently during the day, the subsequent data base collected can be summarized quickly with the push of a few buttons on the Stat*Analyst. The compiled information available is as follows:

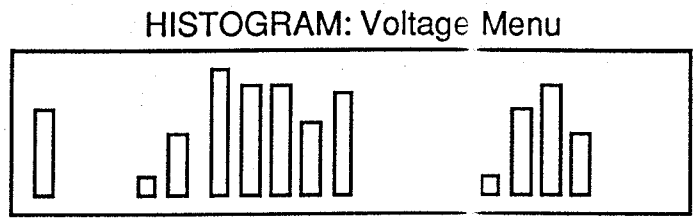
1. The number of readings taken.
2. The average voltage on personnel.
3. The standard deviation of the data taken.
4. The probability of personnel having an ESD critical voltage.

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EVALUATING ESD PROTECTION STATISTICALLY BY MEASURING VOLTAGE ON PERSONNEL



Use the Stat*Analyst
PVT-100SA
Personnel Voltage Tester
to directly measure
voltage on workers.



Also TEST and EVALUATE:
- Wrist Straps
- Heel Straps
- Conductive Floors
- Clothing & Furniture

... to name a FEW items.
All under ACTUAL work conditions.

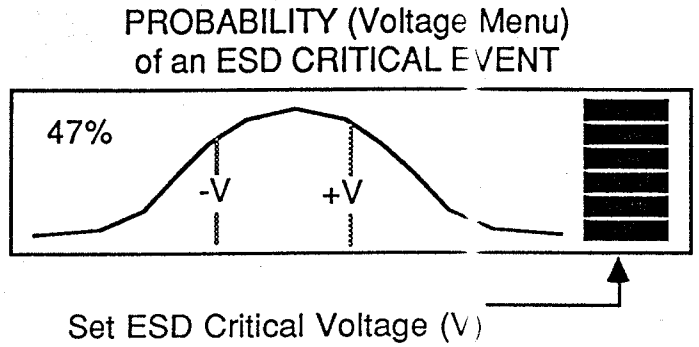


Figure 2:

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A statistical analysis is needed to meaningfully interpret triboelectrically generated voltages and charge. It allows evaluation of all types of grounding techniques used to reduce voltage on plant personnel. As an example, conductive flooring is commonly used for this purpose, when wrist straps are awkward or inconvenient. An alternative is to apply a conductive floor coating. Which method is better for the plant? Before spending large sums of money for unknown results, the two approaches can be evaluated by the Stat*Analyst in PVT Mode. Voltage measurements should be made on personnel for a few days to acquire a statistical base. If the personnel did not use any grounding techniques, large voltage averages will typically be measured. Make the same measurements on a small area of sample conductive flooring, along with a small area of conductive floor coating. Compare the results, and then make a decision on the effectiveness of each approach. The management and allocation of funds for ESD prevention obviously becomes easier with experimental data available in advance.

This methodology can be used to evaluate wrist straps, ankle straps, conductive shoes, floor mats, conductive chairs, etc., or any type of grounding technique. The bottom line will always be the same..., how much voltage is on the personnel. In addition, this type of evaluation can be done on a daily basis to monitor the controls that were decided upon. For example, routine voltage testing will detect when conductive floor finishes are becoming worn and ineffective. The voltages on the personnel will begin to rise day by day, and depending on the sensitivities of the devises used, an accurate decision can be made when a new coating should be applied.

1.22 Faraday Cup Measurements

The FC-100SA Faraday Cup sensor is used to measure the charge on objects placed within the inner cup. It has a range from -200 to +200 nanocoulombs. The FC-100SA contains an integral relay for removing the charge from (and zeroing) the inner cup. As will be seen later, FC-100SA also provides the means to measure the intrinsic capacitance of objects small enough to fit inside the cup.

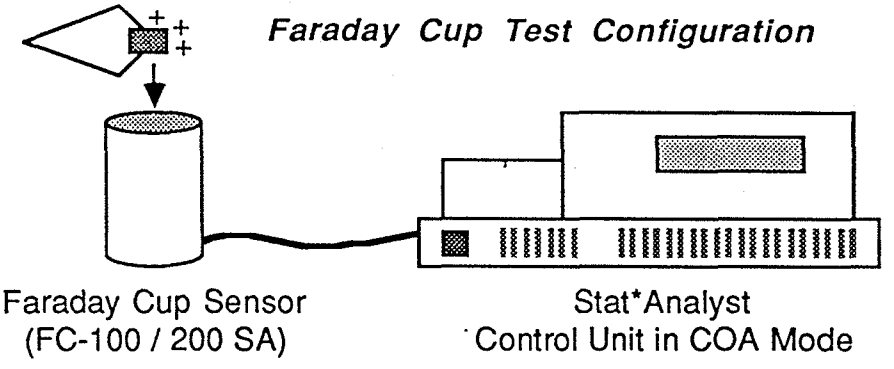


Figure 3: Faraday Cup Test Set-Up

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Measure Effectiveness Of IC Shipping Tubes

By using the Stat*Analyst Faraday Cup Sensor, IC shipping tubes can be evaluated. Many "antistatic" shipping tubes manufactured today are produced by dipping the regular plastic tubes into an antistatic solution. When the tubes are new, the coating provides an effective means of reducing charge build-up as the ICs shift around inside the tubes during handling. However, the antistatic coatings tend to evaporate over time (sometimes as little as a few days) resulting in the loss of ESD protection for the ICs inside. In addition, it is not uncommon for electronic component distributors to transfer ICs into other shipping tubes without proper sensitivity to ESD packaging techniques. As a result, it is important for the end customer to inspect voltage levels routinely on the ICs as they are received in their shipping tubes. By using the Faraday Cup Sensor attachment (See Figure 3), ICs can be placed directly from their tubes into the cup and voltage (derived from charge) measurements can be obtained. It is quite common to observe very small voltage levels on ICs that have been contained in effective antistatic tubes. It is also quite common to observe voltage levels in the thousands of volts on ICs that are contained in old antistatic tubes that have lost their effectiveness. Direct correlations to immediate and latent ESD failures can be observed when ICs (that have been subjected to large charge build-ups in their tubes) are inserted into final product PC boards. Final product yields can be improved significantly by using the Stat*Analyst Faraday Cup sensor to inspect voltage levels on incoming ICs from their shipping tubes routinely.

Measure Capacitance Of Objects

The measurement of charge (in nanocoulombs) on integrated circuits or other objects is the only parameter available with previous charge measuring devices. This data is not generally in a form that is easily interpreted by those more familiar with voltage levels at which various electronic components are susceptible to ESD damage. In addition, a given amount of charge may not be damaging to a device if its capacitance is such that the resulting voltage is low. The three fundamental values Q, C, and V are related by a simple formula; $Q = CV$, where Q is the charge in coulombs, C is the capacitance in farads, and V is the voltage in volts.

To measure capacitance, the Stat*Analyst provides a voltage source of 100 volts to charge an object to a known voltage. The object is then placed into the FC-100SA Faraday Cup, and the subsequent charge is measured. The capacitance is simply the charge divided by the voltage. This calculation is done automatically by the Stat*Analyst control unit when the Capacitance Mode is selected. Once the capacitance is known, the charge distribution, generated by measurements with the Stat*Analyst, is converted into a voltage distribution whereby probability calculations may be obtained based on voltage

As the capacitance of integrated circuits and components will vary according to their package and orientation with respect to ground, it is essential to convert charge measurement to voltage in order to meaningfully interpret the data. The measurement of charge (in nanocoulombs) alone does not provide a complete basis for ESD related studies.

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Measure Triboelectric Charge Generating Capacity Of Static Preventative Materials

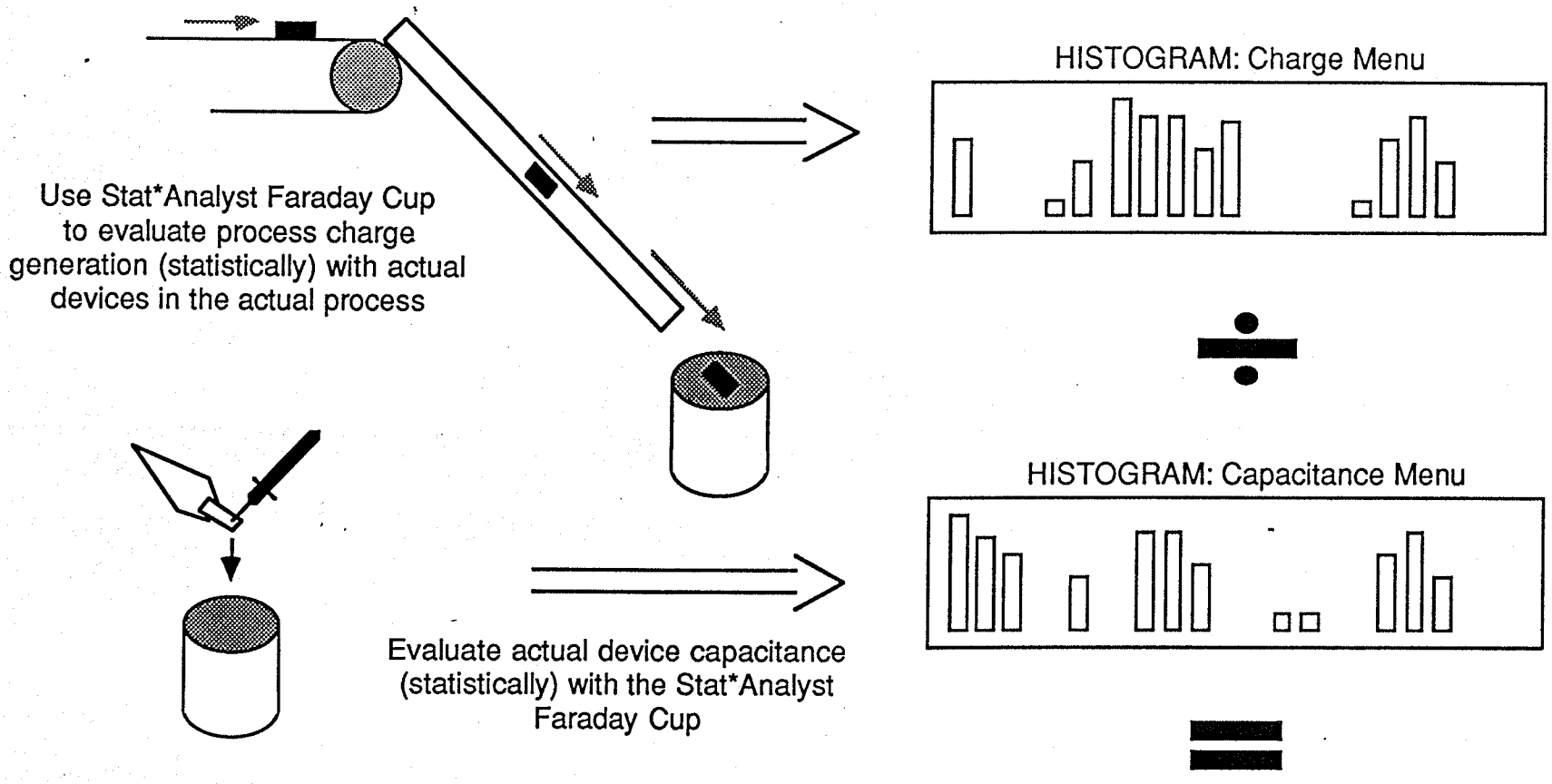
The triboelectric charge generating capacity of a material can be generalized as the measure of charge build-up that will occur when the material is rubbed against another material. This parameter, along with the surface resistivity of the material, needs to be monitored to insure an effective ESD program. For example, the surface resistivity of a pink poly antistatic bag may be 10^{10} ohms/square. The surface resistivity of a piece of paper may also be 10^{10} ohms/square due to water absorption by the paper. These parameters indicate that both materials will tend to dissipate charge away in the same time frame. However, the triboelectric charge generating capacity is extremely different for both materials. The paper will generate much more charge when rubbed together than the pink poly bag. Therefore, the triboelectric charge generating capacity defines the amount of charge that can build-up during rubbing and handling, while the surface resistivity defines the rate at which that charge can be dissipated away through the material.

The FC-100SA Faraday Cup Sensor may be used to provide these useful triboelectric charge measurements. A technique developed by 3M can be used for this purpose. It consists of a) rolling a small cylinder a defined distance across the material under test b) allowing it to fall into the Faraday Cup to measure the charge generated, and c) repeating the experiment a number of times to permit averaging and probability calculations (which are generated by the Stat*Analyst control unit). The charge generating capacity of the material is thus measured by the charge transferred onto the moving brass cylinder. Any similar technique, if done consistently, will allow the user to make comparative triboelectric charge measurements on static preventive materials such as antistatic bags, foams, packing materials, bench mats, floor mats, etc.

Isolate ESD Problems In Manufacturing Environments

Using the methodology in previous examples, objects can be placed into the FC-100SA at various stages in a production process and observed for charge build-up (refer to figure 4). These measurements may be used as an aid in isolating problem areas on the production line.

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EVALUATING ESD SENSITIVE PROCESSES AND DEVICES STATISTICALLY BASED ON V = Q / C

Figure 4:

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1.3 Charge Plate Monitor (CPM) Operating Mode

Air ionization characteristics are classically measured by a standardized device known as a charge plate. The Stat*Analyst's CPSA - Charge Plate Sensor (as illustrated in figure 5) consists of a 6 by 6 inch conductive plate isolated from a ground plane by TEFLON® standoffs. The plate has approximately 20 pf of capacitance to ground. The ground plane below the floating plate helps to maintain the plate capacitance to ground more constant as the sensor is placed near other objects.

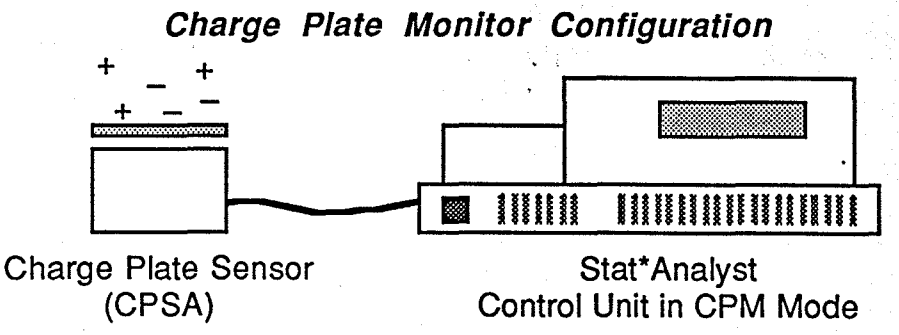


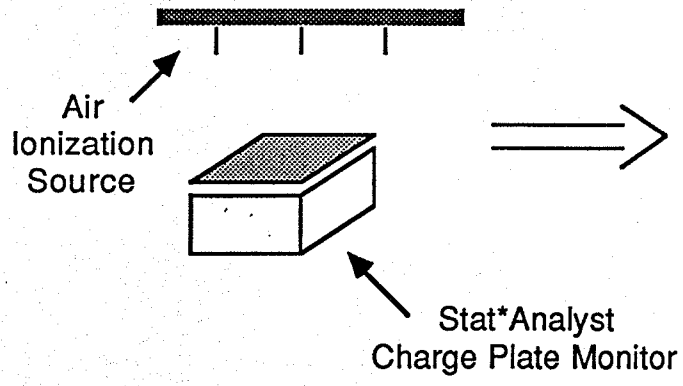
Figure 5: Charge Plate Monitor Test Set-Up

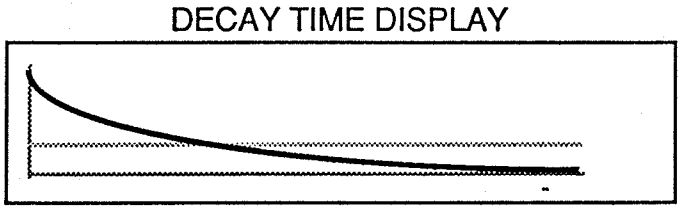
Below the electrically isolated plate is a field meter with up to 60 Hz frequency response. This allows the CPSA to accurately measure induced voltages from 60 Hz ionization sources. Also included in the sensor hardware is a compact DC/DC converter which can deliver high voltage of up to ±5500 volts. It provides the necessary high voltages used in the Decay Test Modes.

Finally, the CPSA sensor includes a solenoid driven mechanism for connecting the high voltage DC/DC converter to the floating plate. The solenoid mechanism has a travel distance of over 0.5 inches. A solenoid arrangement was used in the CPSA rather than a relay for two reasons. First, the isolation resistance of high voltage relays is typically too low to adequately isolate the floating plate after it has been charged in the Decay Mode. A leakage current of 10×10^{-9} amps would take only 10 seconds to completely discharge the plate from 5000 volts! Ideally, any drop in voltage on the plate should be from ion recombination from the ion source being evaluated. In addition, due to the ceramic material typically used in most high voltage relays, the insulation resistance drops dramatically in high humidity environments due to water accumulation on the relay surface. By contrast, the CPSA charging mechanism uses TEFLON® for its insulating material which is not hygroscopic, i.e., it is very resistant to water absorption. The net result is that the CPSA floating plate has an isolation resistance in excess of 10^{14} Ω. Secondly, most high voltage relays have an internal capacitance across the contacts of approximately 2 pf. This capacitance would effectively be in parallel with the floating plate capacitance. This would increase the effective plate capacitance by 10% and would have a comparable affect on data taken from the sensor. The CPSA solenoid mechanism is totally isolated from the floating plate when the plate is floating and as such, there is negligible increase in plate capacitance.

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EVALUATE AIR IONIZATION CAPABILITY BY MEASURING "DECAY TIME" WITH THE CHARGE PLATE MONITOR





Use AUTO MODE to run tests continuously or a specified number of times to get a COMPLETE STATISTICAL performance picture.

AUTO MODE: Decay Evaluation

	Tests	Avg t	Std t
+ DECAY	10	1.02	.04
– DECAY	10	1.01	.03

Figure 6:

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1.31 An Overview of Decay Testing

The basic idea behind a decay test (refer to figure 6) involves charging a floating plate to a known voltage and polarity, releasing the plate, and then monitoring the amount of time it takes for that plate to decay to a known voltage due to recombination while in the presence of an ionization source. The amount of time is referred to as the *decay time*. The shorter the decay time, the higher the density of ions present at the plate to recombine with the charges placed on the plate by the charging process. Conversely, as decay times increase, less ions are present to recombine with the charges on the plate. Logically, one can conclude, that the faster the decay times, the more effective an ionizer is in reducing static charges. (As we shall see, one must also consider Float Test data before making a final determination).

When the plate is charged to a positive voltage, negative ions are required to neutralize the manufactured charge. Conversely, when the plate is charged to a negative voltage, positive ions determine the rate at which the plate will decay. Thus it may be seen that it is important to perform decay tests at both polarities of initial starting voltages to insure uniform decay.

The sensor physical characteristics can have a significant effect on the measured decay times. The area of the plate, its capacitance relative to ground, and the presence of a ground plane near the floating plate can all influence the reading. In addition, the initial starting voltage and ending voltage will affect the calculated result. Consequently, it is important that these parameters be known and ideally standardized before one can accurately compare measurements taken by more than one individual. The CPSA plate is a 6 inch by 6 inch aluminum square supported over a ground plane by TEFLON® standoffs. The plate has a capacitance to ground of approximately 20 pf.

1.32 An Overview of Float Testing

The Float Test involves monitoring induced voltage on the CPSA floating plate sensor over time. It is used to evaluate the balance of an ionization source as well as the magnitude of any induced voltage oscillations that the source may generate.

There are five calculated parameters that the CPSA generates from the collected Float data:

- Average Voltage
- AC Voltage
- RMS Voltage
- Minimum Voltage
- Maximum Voltage

The **Average Voltage** is simply the numerical average of all the data points taken during the duration of a Float test and is used to measure the balance of an ionization source. The **AC Voltage** is the Root Mean Squared Voltage (RMS) of the data around the Average Voltage. It is numerically equal to the standard

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deviation of the test data. It is an indication of the amount of oscillation that an ionization system produces. The **RMS Voltage** is the Root Mean Squared Voltage of all the test data and is an overall quality number for an ionization source as it incorporates both the balance and oscillation data into a single parameter. The **Minimum Voltage** is the minimum reading taken during the Float test, while the **Maximum Voltage** is the maximum reading.

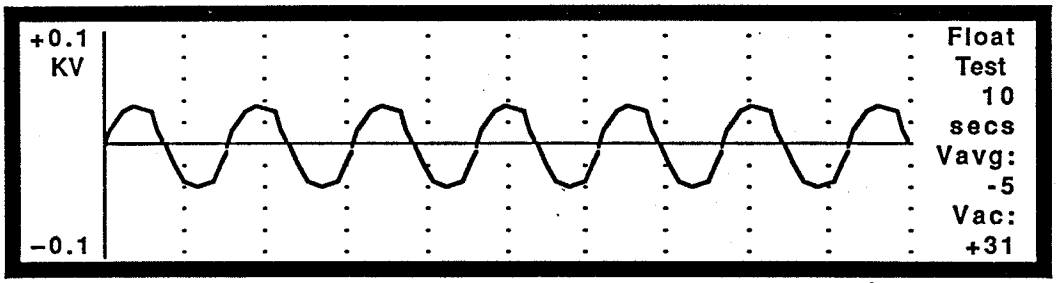


Figure 7: An Ionization Source with Small Voltage Oscillations

Balance alone is not enough. In the past, most analysis of ionization sources has focused on the average voltage induced on a floating plate. To adequately judge an ionization source, induced oscillation must be examined as well. An illustration will clarify this point. Figure 7 shows an ionization source with an average voltage of -5 volts and an AC voltage of 31 volts. Figure 8 shows an ionization source with an average voltage of +1 volts but with an AC voltage of 670 volts. If one only examined balance, than one would conclude that the

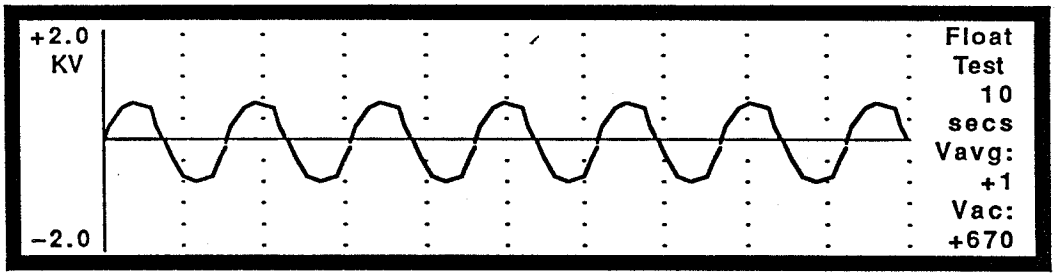
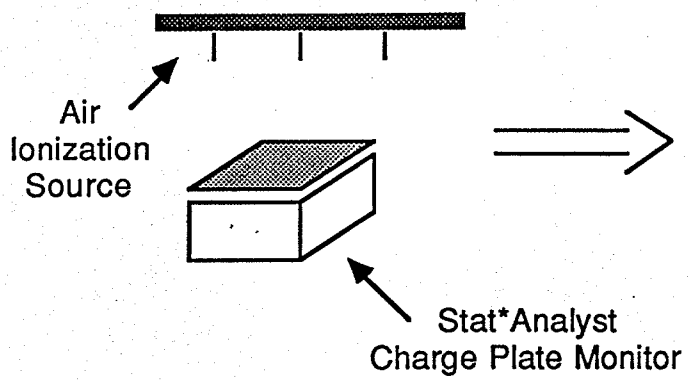


Figure 8: An Ionization Source with Large Voltage Oscillations

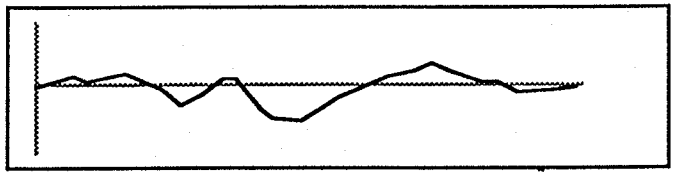
ionization source in Figure 8 was the superior of the two. On the contrary, that ionization source typically has all devices within its effect far away from ground potential and has significantly increased the probability of an ESD event. Indeed, because the energy on a device is proportional to the **square** of the voltage, the ionization source in Figure 8 generates peak energies on objects almost a million times higher than the supposedly inferior system in Figure 7! An ideal ionization system will have an average of zero volts, **and** an AC and RMS voltage of zero volts as well.

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EVALUATE AIR IONIZATION BALANCE BY MEASURING "FLOAT VOLTAGE" WITH THE CHARGE PLATE MONITOR



FLOAT VOLTAGE DISPLAY



Use AUTO MODE to run tests continuously or a specified number of times to get a COMPLETE STATISTICAL performance picture.

AUTO MODE: Float Evaluation

Tests: 10	Avg	Std
Average:	+0	0
AC Value:	1	0
RMS Value:	1	0
Minimum:	-3	.6
Maximum:	+3	.4

Figure 9:

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1.4 Customized Measurements

One of the greatest virtues of the Stat*Analyst is that it embodies the foregoing 3 functions within one portable instrument. While these functions have been presented in their more common applications as described above, it is important to keep in mind that other measurement applications will find great utility in the Stat*Analyst.

For example, the PVT sensor may be set up in conjunction with a particular ESD source of suspected intermittent character in an effort to monitor time or circumstantial effects. By putting the Stat*Analyst in auto mode and connecting a chart recorder to the BNC sensor output a time record of voltage threshold qualified ESD events can be made. (Consult PVT output specifications for details).

In applications where ESD sensitive parts are of such small physical dimension that static potential is impractical to measure either because of environmental noise or impedance considerations, the Faraday Cup offers the best analytical solution by gathering charge data for statistical evaluation. Such parts can be delivered or diverted from the actual triboelectric process under study directly to the Faraday Cup.

Evaluation of ESD protective measures or equipment is made easier by employing the charge plate monitor in specialized ways. For instance, static dissipative smocks which may come in contact with sensitive parts may be evaluated for discharge time by bringing the wearer grounded garment in contact with the precharged charge plate. Direct monitoring of the effectiveness of conductive floor coverings can be evaluated by connecting the subject to the charge plate in float mode to monitor any triboelectric generation and its subsequent discharge.

Using the proper input device is key to getting the most accurate results. To accomplish this it is important to become familiar with the electrical characteristics of each sensor. For more details consult chapter 5.

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1.5 Getting Familiar with the Stat*Analyst

The Stat*Analyst is fundamentally similar to a digital storage oscilloscope. It incorporates data storage and real time processing capability specially configured to accommodate the measurement of fundamental ESD parameters. A powerful statistical data reduction system provides ESD event probability directly from the input data. Last but not least the Stat*Analyst provides a host of input-output control facilities including analog, digital, hard copy printer and remote PC operation.
The large LCD display serves a dual purpose as both a readout and an operator prompting interface. You will soon discover, for example, that the 6 unlabeled function keys are defined on the LCD screen in accordance with the operating mode of each unique "menu window".

The sensor input port is electronically keyed to allow the Stat*Analyst to identify, at power up, which operating mode to assume. All that you need to do is select and connect the appropriate input sensor - the Stat*Analyst does the rest automatically!

All test configuration details are stored in battery backed memory so that once they are set there is no need to reset them except where measurement parameters change. This feature is a real time saver when setting up routine measurements. This same battery provides up to 4 hours of continuous operation away from a line voltage power source.

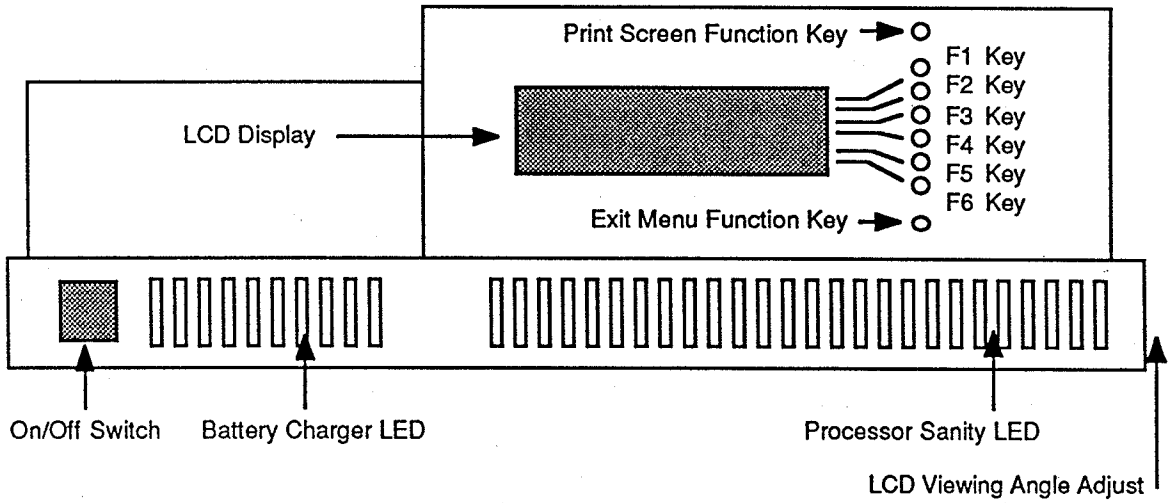


Figure 10: Stat*Analyst Front Panel Features

1.51 Control Locations & Features

Figure 10 is a front view of the Stat*Analyst front panel. The LCD, function keys, main On/Off switch, the LCD contrast adjust (knob located on the right side panel), and the locations of the processor sanity LED and battery charger LED are all noted.

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On/Off Switch

The main On/Off switch (located in the lower left front of the unit) performs a multiple task because the Stat*Analyst incorporates a battery back-up power supply (see Battery Charger LED section which follows). When the upper half of the switch is pressed AC power is delivered to the control electronics and the Stat*Analyst begins its power-up sequence. Pressing the lower half of the switch turns the unit off. **Make sure that a sensor is properly connected BEFORE turning the unit on. Disconnecting and/or reconnecting a sensor while the main control unit is activated may cause damage to the Stat*Analyst.**

Liquid Crystal Display (LCD)

The graphic LCD employed by the Stat*Analyst is a 64 x 256 bit multiplexed display. The display contrast may be adjusted by rotating the **LCD Viewing Angle Adjust** knob on the right side of the Stat*Analyst control unit.

PRINT SCREEN Function Key

The **PRINT SCREEN** Function Key is used to generate a copy of the current LCD screen on an attached external parallel printer. The date and time the copy is generated is printed as well. This button may be pressed at any time, but is ignored while graphical data is being drawn on the LCD. When the graph is complete, the **PRINT SCREEN** command may be executed. If no printer is attached or if the attached printer is not ready, the following error message is generated:

External Printer Not Ready

and the command is ignored. For graphical prints, one may optionally print a full page plot of the data. See Chapter 2, figure 16 for more information.

F1-F6 Function Keys

The **F1-F6 Function Keys** are used to execute the various commands that the Stat*Analyst supports. The functionality associated with a particular key in a specific menu is given by an adjacent label on the LCD. As an example, figure 11 shows the main menu of the Stat*Analyst. All 6 function keys are used by this menu. In this example, F1 is assigned the ZERO function, F2 is assigned the READ function, F3 is assigned the AUTO function, F4 is assigned the CLEAR function, F5 is assigned the CANCEL function, and F6 is assigned the GIVEN function.

To execute the specified function, simply press the associated function key. When a new menu is entered, a new set of function labels is drawn. If a blank label is next to a function key, then this simply means that for that particular menu, that function key is not used. Pressing a function key with a blank label has no affect. There are some screens (most notably, graphical output) where none of the F1-F6 function keys are defined. In these cases, there are no labels present on the LCD screen and pressing any of the F1-F6 keys has no affect.

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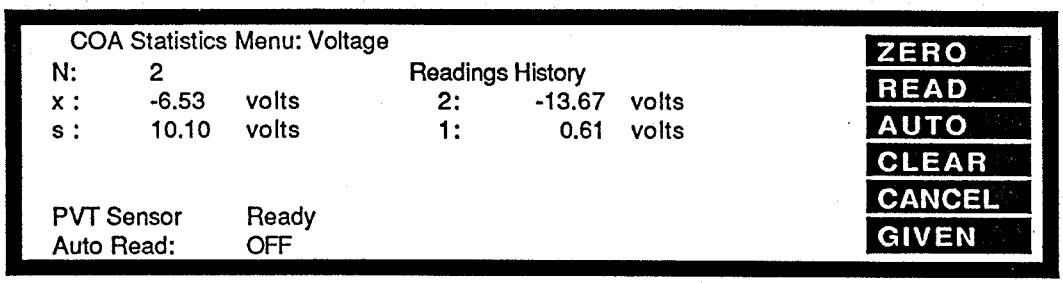


Figure 11: Sample Stat*Analyst Menu

EXIT MENU Function Key

The **EXIT MENU** Function Key is used to escape from the current menu to the next highest menu. It may be pressed repeatedly until the highest level menus are reached. At that point, pressing the **EXIT MENU** key will switch the display menu between the CPM (main menu) and the COA menu. The CPM menu permits measurements to be made only if the Charge Plate Monitor is attached; the COA menu permits measurements to be made if either the Faraday Cup or the Personnel Voltage Tester is attached. The Stat*Analyst will display an advisory message if attempts are made to make measurements when the required sensor is not currently connected. Be sure to turn the Stat*Analyst OFF BEFORE disconnecting and reconnecting the proper sensor.

The **EXIT MENU** function key is also used as an abort command in Decay Tests, Float Tests, the REMOTE mode, the AUTO Mode, and during a print operation on an external printer.

Battery Charger LED

The **Battery Charger LED** may be seen through the slots on the lower left front of the Stat*Analyst. It is on when the integral battery charger is enabled. This occurs when the On/Off switch is in the "OFF" position and AC power is present; this provides the maximum battery charger current. When the On/Off switch is in the "ON" position, the LED is off indicating the battery charger is disabled. At this time, a small trickle charge current is provided to the battery to maintain its current state.

Processor Sanity LED

The **Processor Sanity LED** may be seen through the slots on the lower right front of the Stat*Analyst. When the Stat*Analyst is operating, this LED blinks at approximately a 1 Hz rate. This indicates that the microprocessor is operating correctly. If this LED stops blinking, the processor has ceased functioning and the control unit will in all likelihood stop accepting any further input. If this should happen, turn the unit off, and turn it back on again. If the LED does not blink, then check that power is present for the Stat*Analyst. If power is available, and the LED will still not blink, then a hardware problem may exist.

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1.52 Input / Output Connection Locations

Figure 12 is a view of the Stat*Analyst rear panel. The Sensor Out BNC Connector, the Remote Interface RS-232 Connector, the Printer Interface Connector, the Power Entry/Fuse Holder Assembly, and the120/220 Voltage selector switch are all shown.

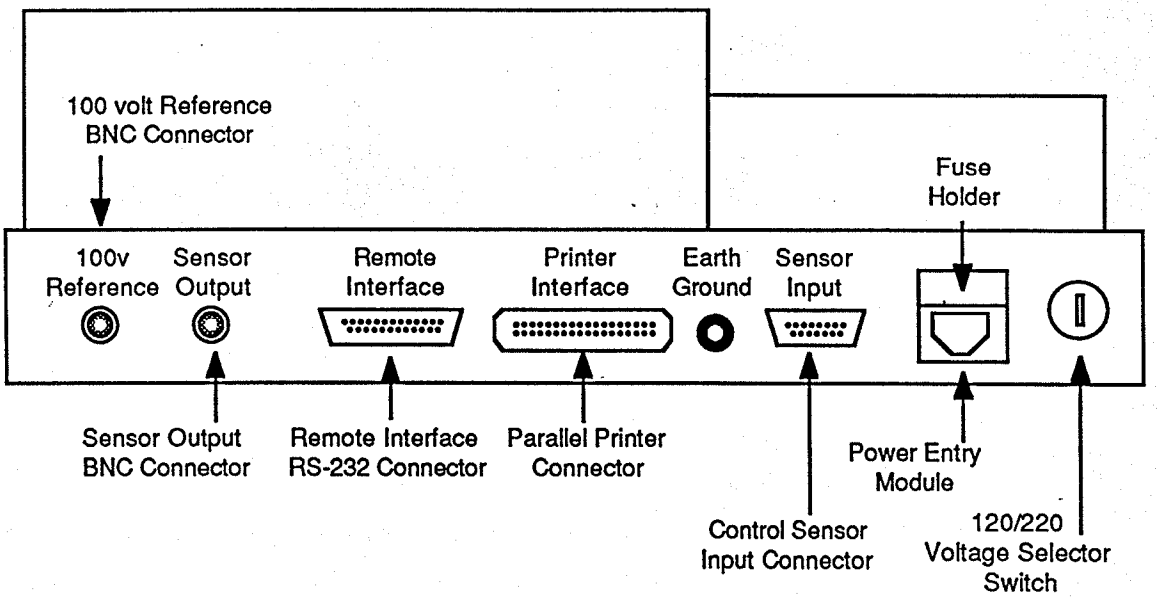


Figure 12: Stat*Analyst Rear Panel Features

Sensor Output

The **Sensor Output** (BNC connection) gives a continuous analog representation of the voltage on the Stat*Analyst floating plate. It is internally bufferred and is capable of delivering up to approximately 5 ma of current and is short circuit protected. The **Sensor Out** voltage is the Floating Plate voltage divided by the factor 573.4, and is always defined regardless of the current menu selected. As an example, a voltage of +2456 volts on the floating plate will produce a voltage of 4.28 volts on the Sensor Out Connector, while a voltage of -2456 will produce –4.28 volts.

Remote Interface

The **Remote Interface** Connector is a 25 Pin DSUB Connector supporting the RS-232 Standard. A computer or terminal may be attached to this port for controlling the Stat*Analyst from a remote location. The Stat*Analyst must first be placed in the REMOTE mode before any commands are accepted through this port. (See Chapter 6.)

Printer Interface Connector

The **Printer Interface** Connector is a 36 Pin connector supporting the CENTRONICS® type parallel interface. All print commands in the Stat*Analyst cause output to be sent to this connector. The Stat*Analyst requires an EPSON FX Series compatible graphics printer to print properly.

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Sensor Input Connector

The Sensor Input Connector is a 15 Pin Female DSUB connector to which the Stat*Analyst detachable sensor is connected. All power and control signals are generated from this connector.

NEVER PLUG OR UNPLUG THE Stat*Analyst SENSOR WHILE POWER IS APPLIED TO THE UNIT! DAMAGE TO THE CONTROL UNIT, SENSOR, OR BOTH MAY OCCUR.

Power Entry Module

The **Power Entry Module** serves two purposes. The removable power cord that is supplied with the unit plugs in here to supply AC power and a ground reference. Secondly, the AC fuse is located in the top of the assembly. To replace a fuse, first remove the power cord. Insert a small screwdriver under the tab located in the bottom of the fuse holder section. Pull on the tab until the fuse assembly comes free and slides out of the **Power Entry Module**. The fuse clips into the holder. To reinsert the fuse, slide the fuse assembly back into the **Power Entry Module** until it clicks into place.

120/220 Voltage Selector Switch

The **120/220 Voltage Selector Switch** should be set to the appropriate value of the supplied AC power **BEFORE** the Stat*Analyst is plugged into an AC outlet. To change the switch, insert a small screwdriver into the slot in the switch and rotate the switch until the desired voltage value is under the arrow at the top of the switch.

CPSA Sensor Connector

On the rear panel of the Stat*Analyst CPSA sensor is a companion 15 pin DSUB connector to the Sensor Input Connector on the Rear Panel of the control unit. These two connectors are jumpered together with the supplied 8 foot sensor cable (extended cables are available up to 15 feet in length).
NEVER PLUG OR UNPLUG THE Stat*Analyst SENSOR WHILE POWER IS APPLIED TO THE UNIT! DAMAGE TO THE CONTROL UNIT, SENSOR, OR BOTH MAY OCCUR.

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Chapter 2

GETTING STARTED

2.0 Start-Up Check List

2.01 ***Line Voltage Configuration:*** The **120/220 Voltage Selector Switch** should be set to the appropriate value of the supplied AC voltage. To change the switch, insert a small screwdriver into the slot in the switch and rotate the switch until the desired voltage value is under the arrow at the top of the switch.

2.02 ***Input Device Selection:*** Determine which type of input sensor will be required (see discussion in section 1.1 if not certain). Plug the sensor cable end into the sensor input port on the rear of the Stat*Analyst.

2.03 ***Confirm Battery Charging Status:*** With the main switch in the off position plug the line cord into the AC supply. The Battery Charger LED (red) should be visible through the front grill where shown in figure 10. If not, double check AC source voltage.

There are two distinct batteries within the Stat*Analyst. A small 3.0 volt lithium cell provides backup power to the real time clock chip. It is not a rechargeable cell and has a life of approximately 10 years.

A larger 3.0 amp-hour 12 volt lead acid battery provides primary power for running the entire Stat*Analyst for up to 4 hours of continuous operation. It is also responsible for maintaining RAM contents when the Stat*Analyst control unit is turned off. This battery is recharged by an integral battery charger that can deliver up to 700 ma at 15 volts. The battery charger is enabled when the Stat*Analyst control unit is off and it is plugged into an AC receptacle. The battery charger LED is lit when the battery is charging. A fully discharged battery should charge in approximately 12 hours.

IMPORTANT: **In the event that the battery becomes totally discharged or is disconnected or replaced - refer to section 7.23 for system initialization procedures.**

To run the Stat*Analyst on battery power, simply turn the unit on with the AC power cord not plugged in. The unit will automatically switch to battery power.

2.04 ***Power Up:*** When all cable connections are complete, the Stat*Analyst may be turned on by flipping the On/Off switch upward to the "ON" position. At initial power up, all dots on the LCD screen are turned on so that the LCD should appear dark. In addition, the processor sanity LED will begin to blink. After approximately 0.5 seconds, the LCD screen is cleared, followed by the initial LCD screen shown in figure 13. (The software version for your particular unit may be different.) During this period, the internal alarm is pulsed to verify its operation.

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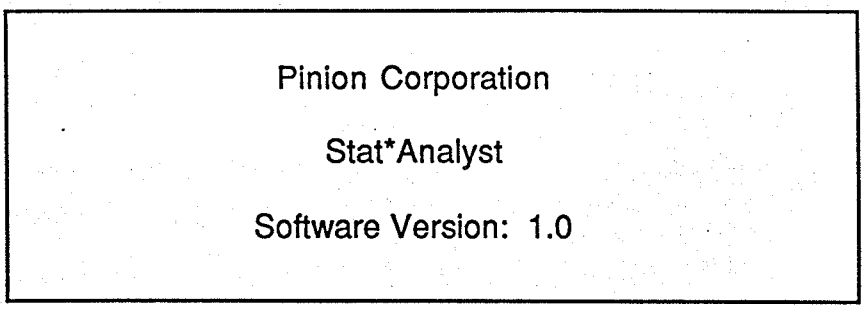


Figure 13: Stat*Analyst Title Screen

2.05 ***Adjust LCD Display Contrast:*** If display is blank or not readable adjust the contrast knob on the right side panel of the Stat*Analyst. A series of start-up exercises will be performed automatically to verify operational status; the sequence is described below.

After the initial LCD screen, a test is performed on internal PROM memory. There are five distinct memory devices checked. A PASS/FAIL indication is given for each. Following the PROM test a RAM test is performed on all internal RAM memory. Finally a test is performed on the extended RAM memory.

After the RAM test, the RAM memory is examined to see if it valid; i.e., the RAM is checked to see if the battery back-up function is maintaining RAM properly. If the RAM is found to be invalid, the following warning message is given:

Parameters Being Set to Default Values

This warning message will be issued if the system battery had been removed or if there is a malfunction in the power board circuitry. If this message appears it means that prior user parameter changes and options were lost; all configurable parameters will subsequently be set to factory defaults.

Once RAM validity has been established, the Stat*Analyst main menu is displayed as shown in figure 14

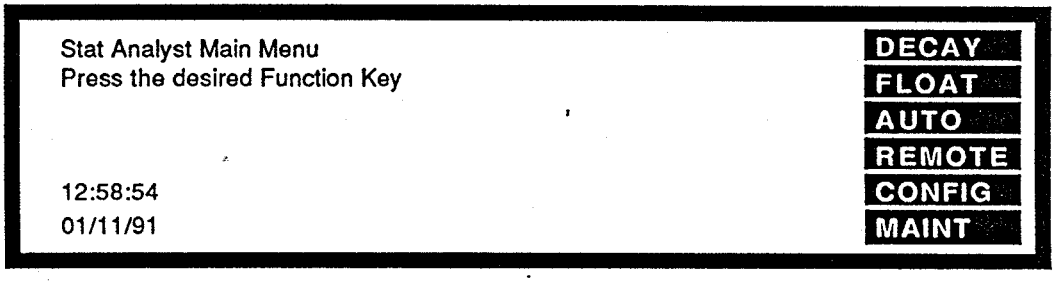


Figure 14: Stat*Analyst Main Menu (CPM Mode)

The real time clock is displayed and continuously updated in the lower left corner of the menu.

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If any of the power up diagnostics fail, turn the Stat*Analyst off and re-try the power up sequence. If the same error is encountered again, a hardware problem may exist with your unit. Please contact Pinion Corporation to resolve the difficulty.

2.06 ***Check For Low Battery Indication:*** When the 12 volt battery voltage drops to approximately 11.4 volts, a low battery indication is generated. As shown in Figure 15, a horizontal bar below the last function key label will blink at a 1 Hz rate when the battery needs to be recharged. This indication will be displayed in all LCD screens that have function key labels.

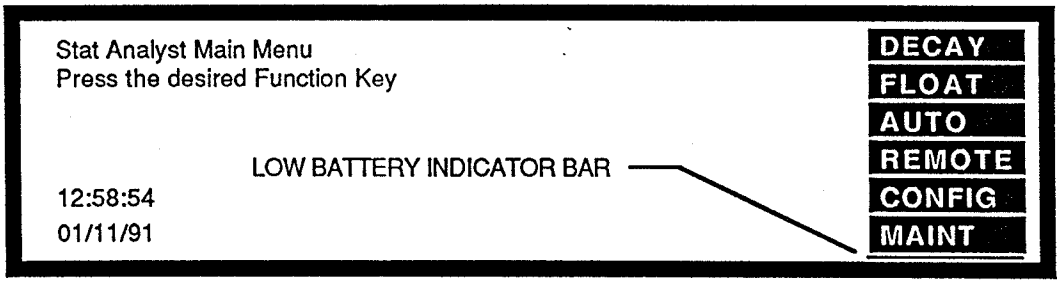


Figure 15: Stat*Analyst Low Battery Indication

2.07 ***Set Main Configuration Parameters:*** Select CONFIG by pressing the function key immediately to the right of the CONFIG label. The Main Configuration Menu as shown in figure 16 should appear.

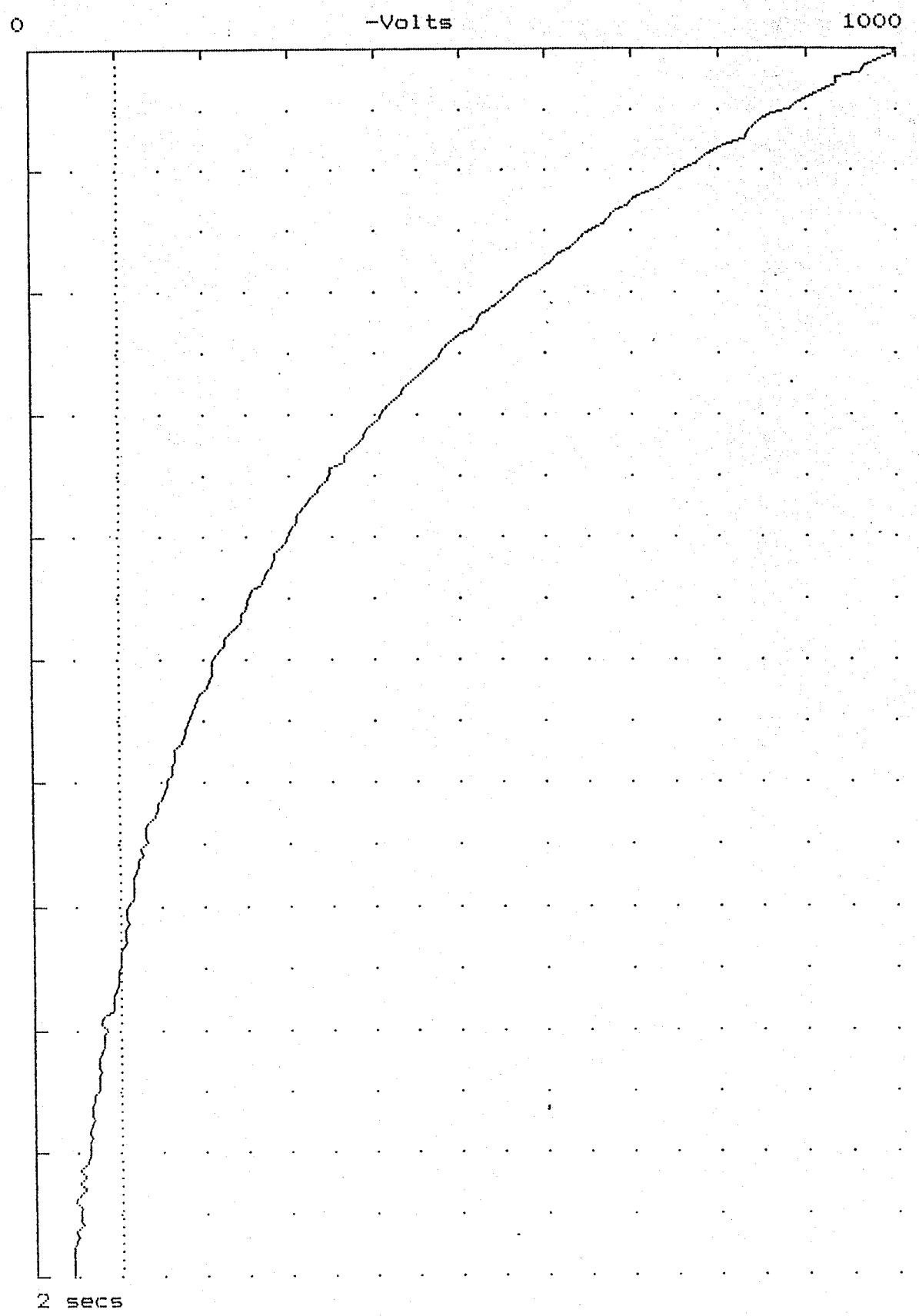


Figure 16: Main Configuration Menu

2.08 ***Set Printer Plot Option:*** Normally, when the Print Menu Function key is pressed, an exact copy of the current LCD display is generated on the printer. When graphical displays are present on the LCD, one may choose to generate a full page plot of the data rather than the small plot of the screen. To select the full page plot option, move the configuration cursor to the full page plot column with the arrow (← or →) keys. Press either the LOWER or HIGHER key(s) to toggle the option from "OFF" to "ON". Whatever state the option field is in when the Exit Menu function key is hit determines the type of graphical plot produced when the Print Menu function key is pressed.

Figure 17 shows a Decay Test printed with the full page plot option and figure 18 presents a Float Test graph.

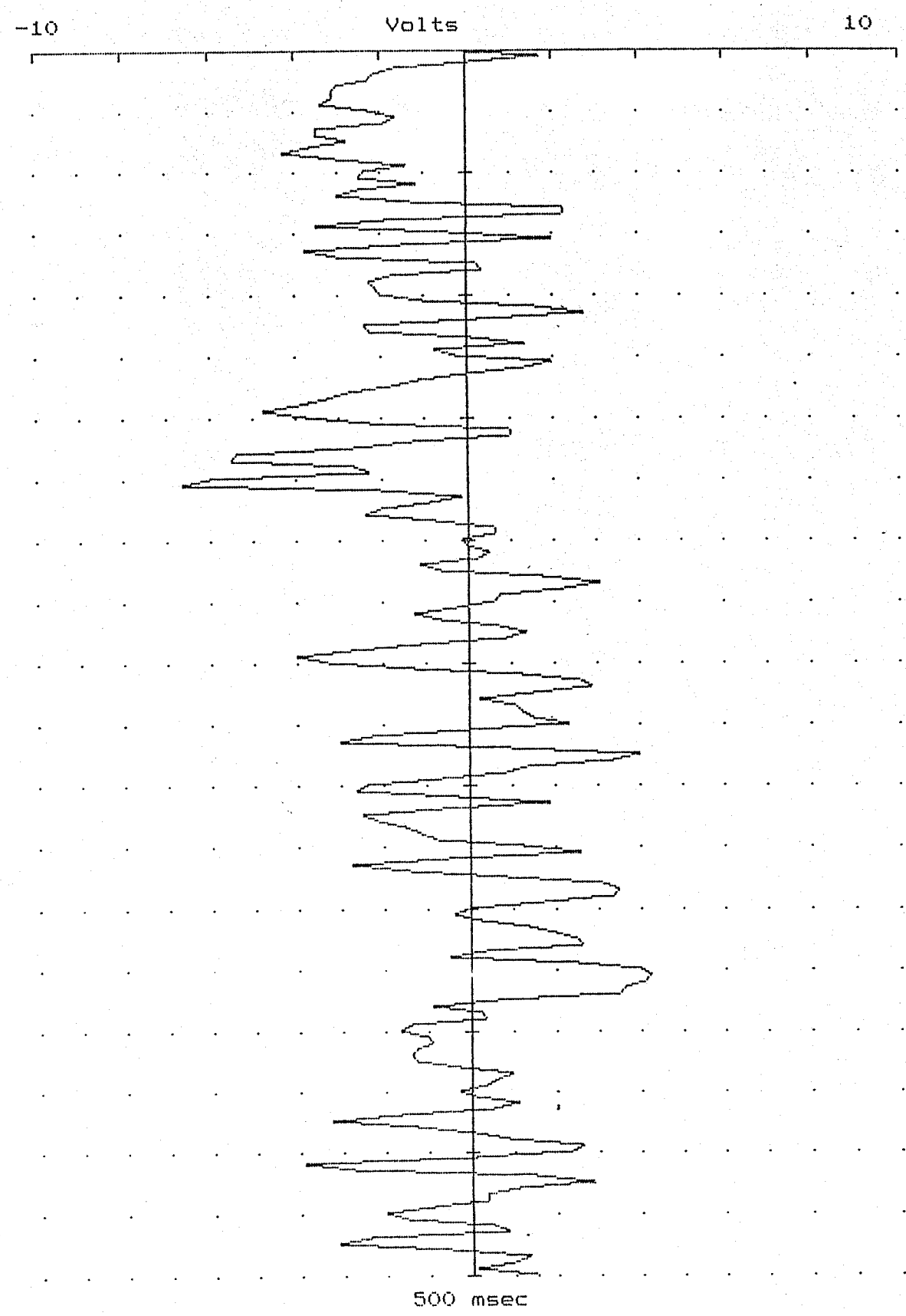
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Decay Time = 1.48 secs
Final Voltage = -44 volts

Figure 17: Full Page Decay Plot

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Average Voltage = 0 volts
AC Voltage = 2 volts

Figure 18: Full Page Float Plot

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2.09 ***Set the Real Time Clock:*** To change the real time clock, select the date or time variable to change with the left or right arrow function key as discussed in section 2.5. Then press the LOWER or HIGHER function key to change the parameter to the desired value. While either the time or date is selected, the real time clock is not updated. To initiate the new clock setting, either move the cursor to the FULL PAGE PLOT option or hit the Exit Menu function key.

This method of changing or setting machine or experiment parameters is consistent throughout the Stat*Analyst, you will find it helpful to become familiar with this operational technique.

2.1 Remote Mode Operation

The Stat*Analyst is equipped with an RS-232 communications port which allows commands to be issued remotely from a personal computer. Data retained in the Stat*Analyst can also be transmitted to a remote location. Full operational detail is provided in Chapter 6.

2.2 Maintenance: Calibration

As an added user friendly feature, the Stat*Analyst includes extensive calibration programs within its software. While the calibration programs are readily accessible, it is not recommended that the user engage these unless properly certified calibration instruments are available. Ordinarily the Stat*Analyst should not require calibration intervals of less than 6 months duration. Tampering with calibration settings should be discouraged unless administered by properly trained and duly authorized company personnel. Refer to Chapter 7 for specific details.

2.3 General Operating Notes:

2.31 Earth Ground Connection

The importance of a good earth ground cannot be overstated. Since you will be making all of your voltage measurements related to ground, it is a good idea to confirm the quality and integrity of your local earth ground. The round prong of the Stat*Analyst's line cord is bonded to measurement ground. In addition an earth ground jack is provided on the rear panel. **If you are operating the Stat*Analyst totally on internal battery power you must connect the earth ground jack to a confirmed local earth ground.**

2.32 Default Settings vs. Preferred User Parameters

All test parameters and user selectable options have default settings which will be assumed at initial start-up or whenever the internal battery goes dead or is removed. All of these options are stored in RAM memory along with other experiment data.

The Stat*Analyst's real time clock, on the other hand, is powered separately from a lithium battery which has approximately 10 years of life.

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2.33 Instrument Warm-Up Time

Typical instrument warm-up time is **15 to 20 minutes.** It is recommended that you allow at least this much time to pass **before beginning critical quantitative experiments.**

At this point you should be ready to go, **if not call PINION CORPORATION'S Customer Service** for assistance ~~(215)-721-7125~~ (available Monday thru Friday 8:00AM to 5:00PM east coast USA time).

2.34 Quick Reference Operator's Guides

You will find extensive use of graphics throughout this manual. One particular form which is very useful for gaining quick understanding of the Stat*Analyst is the ***Operator Guide*** as shown in figure 19. These guides are designed to show the functional integration of the user with the test process and the accompanying data flow. Each guide deals only with one major test type or instrument function so that maximum clarity is afforded. Generally speaking, the following example illustrates the presentation format which will be observed.

REMOTE MODE COMMUNICATIONS... Operator's Guide

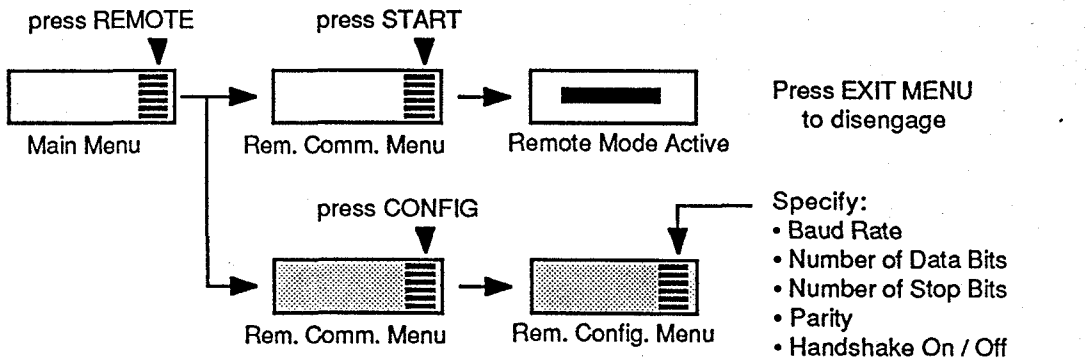


Figure 19:

The basic format of these guides is summarized below:

- Process flow progresses from the left to the right side of the page, meaning that the most general menus appear on the left and those which are most task specific appear on the right.
- Function Key Labels in the guides will generally appear in the same top to bottom order in which they appear on the Stat*Analyst LCD screen.
- Symbols and "icons" used in the guides resemble the actual graphics displayed wherever practical.
- Each "menu icon" is labeled in accord with the actual menu title which appears on the LCD display.
- Shaded "icons" represent operational steps or paths which are not primary to the test or procedure being described.
- Where multiple key strokes are required on a single menu, a brief descriptive list of key function is provided.

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Charge Plate Monitor (CPM) Operating Instructions

3.0 Air Ionization Measurements with the Charge Plate Monitor

As previously described the Stat*Analyst Charge Plate Monitor is designed to enable the air ionization user to evaluate the essential qualities of air ionization equipment of all varieties and types. Always allow adequate time (15 to 20 minutes) for **both** the Control Unit and the Charge Plate Device to **warm-up** before beginning a critical series of measurements.

3.1 Float (also known as Offset Voltage) Tests

This section introduces the concept of Float tests. It is one of the two fundamental types of Charge Plate Monitor tests which the Stat*Analyst performs; the other being the Decay test which is discussed in Section 3.2. The parameters extracted from the raw data that the Stat*Analyst automatically calculates for float tests will be discussed. A tutorial in how to use the Stat*Analyst to perform float tests will also be presented.

3.11 Doing a Float Test with the Stat*Analyst

Starting from the highest level menu (the menu that appears after power up), one simply presses the FLOAT function key to get into the FLOAT mode. Figure 20 shows the Float Test Menu. All the current test parameters are displayed on the menu. We will show you how to change them shortly. The parameters shown are the factory default parameters and may have been altered on your unit.

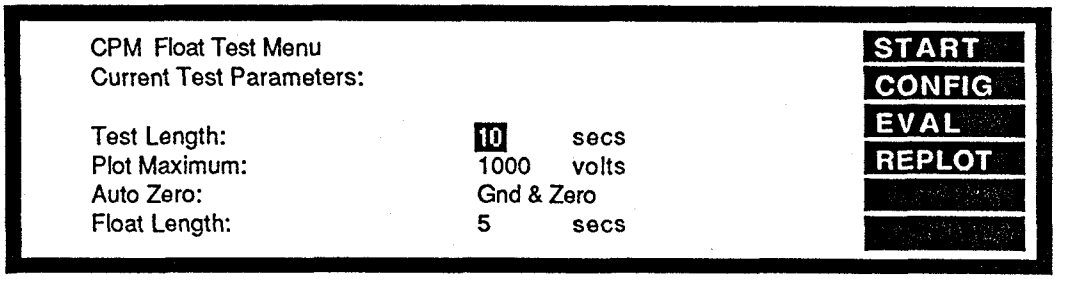


Figure 20: Float Test Menu

To begin a Float test with the shown parameters, simply press the START function key. A graph is drawn on the LCD as shown in Figure 21. The vertical label is labeled in units of kilovolts (KV) and the length of the test is shown on the horizontal axis. Assuming the Auto-Zero option is set to GND&ZERO (see the next section for a description of the Auto-Zero Option), the status field starts out indicating ZERO which discharges the floating plate to ground for a period of 3 seconds. Note that the Exit Menu key is ignored during this 3 second period. If the sensor offset read while the plate is grounded is too high, the following error is issued:

Sensor Offset Too High

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and an audible alarm is generated. This error indicates that the sensor may need recalibrating.

Next, the status field (located in the lower right corner of the display) switches to FLOAT which indicates that the plate is now isolated and coming to equilibrium in the ionization field. Following the FLOAT period, the status field changes to RUN and the measured data is plotted on the graph. The LCD bit on the horizontal axis corresponding to the active column is blanked to indicate the progress of the test. When the data gathering is complete, the status field will indicate CALC for a short amount of time, and the Average (Vavg) and AC Voltage (Vac) are printed on the LCD. At this point, the test is complete and the user has two options, one may hit the Exit Menu key to get back to the Float Menu, or the test results may be printed by pressing the Print Menu key (assuming a printer is attached). The data may be replotted later via the Replot feature (see Section 3.13).

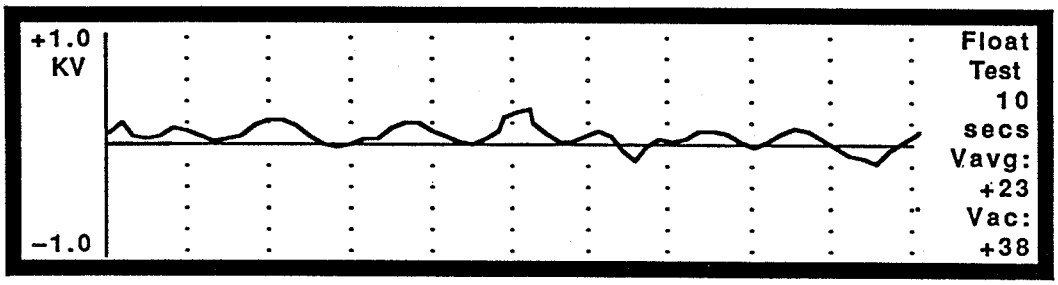


Figure 21: Float Test Plot

3.12 Float Test Configurable Parameters

There are 4 configurable test parameters for an Stat*Analyst Float Test as shown in Figure 20. They are the **Test Length, Plot Maximum, Auto Zero**, and **Float Length**. This section describes the significance of each. To change any of the parameters, the CONFIG function key is used. Following the descriptions given below, select the parameter to change with the up or down arrow, and change the parameter with the LOWER or HIGHER function key. Press the Exit Menu function key to set the changes and return to the Float Test menu.

Test Length - This parameter determines the length of the float test. One should run a test which captures several periods of the ionization source being evaluated (if known) especially if significant voltage oscillations are evident. The longer the test, the slower the sampling frequency, and hence the less accurate a waveform may appear if there is not enough sampled points per period. The possible test lengths are 125 msec, 500 msec, 1, 2, 5, 10, 20, 50, 100, and 200 seconds. The 125 msec test is actually a 500 msec test with only the first 50 data points plotted.

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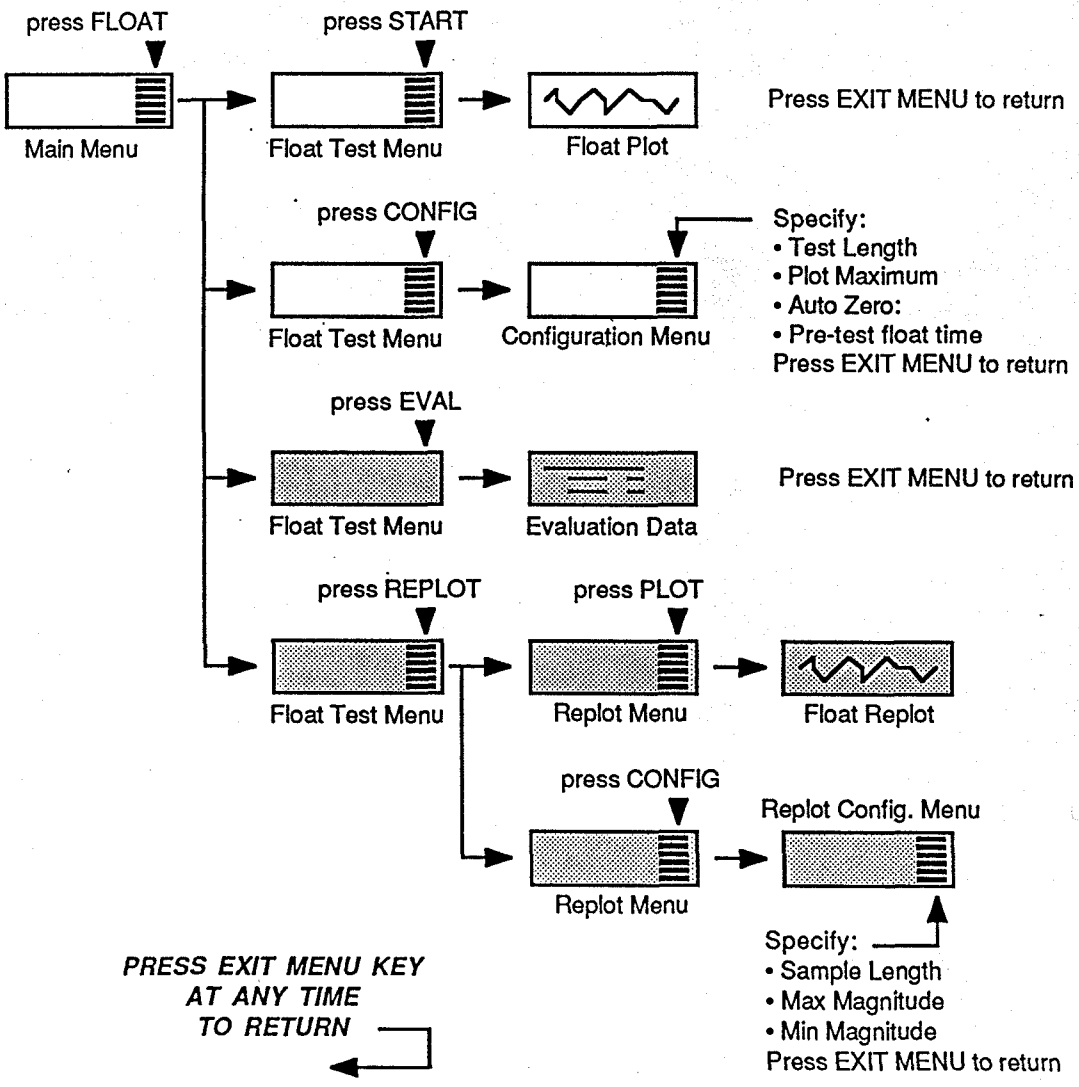


Figure 22:

Auto Zero - This option controls the grounding of the plate at the beginning of a float test. There are three possible choices: **GND&ZERO**, **GND ONLY**, and **NO GND**. Grounding (**GND**) involves discharging the plate to ground with the Stat*Analyst solenoid mechanism. **ZERO** refers to setting the internal sensor offset to the value read while the plate is grounded to compensate for any inherent offsets or drift in the electronics. If the **GND&ZERO** option is set and the offset read is too high, then an error message is printed and the test is aborted. The sensor may require recalibration or the solenoid mechanism may not be contacting the plate properly.

Float Length - This parameter controls the amount of time the plate is allowed to come to equilibrium before actual data is collected. This is especially important if the Auto Zero option is set to ground the plate at the start of a test. The Float period comes after the grounding operation. This value may range from 0 to 99 seconds.

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3.13 Float Test Graphical Replot

After a float plot has been completed using the FLOAT function key, the data points that make up that waveform are saved until the next +DECAY, -DECAY or FLOAT test is run. To replot this data, the Float REPLOT function key may be used. Figure 23 shows the Float Replot Menu that results from the execution of the REPLOT function key.

Current Data Not Float Type

If the data currently stored in memory is not a float test, then the error message (above) is printed and the float replot menu is not entered:

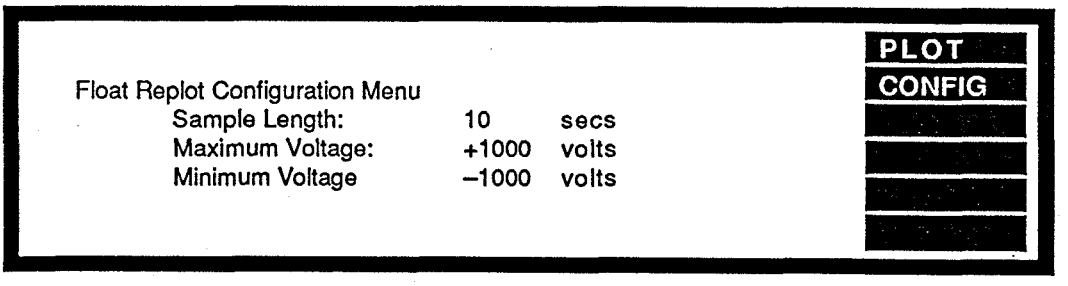


Figure 23: Float Replot Menu

The PLOT function key shown in Figure 23 will regenerate the graphical data. In the Float Replot Menu, one may chose the minimum and maximum voltage values to plot so that the graph may be expanded relative to the original data. The replot parameters are changed via the CONFIG function key.

To generate a printout of the replotted graphical data, simply press the Print Menu function after the graph has been redrawn on the LCD. One may optionally generate a full page plot by turning the FULL PAGE PLOT Option on before entering the Replot Menu (see Section 2.08).

3.2 Decay (also known as Discharge Time) Tests

This section introduces the concept of decay tests . It is one of the two fundamental types of tests that the Stat*Analyst performs; the other being the Float test which was previously discussed. The parameters extracted from the raw data that the Stat*Analyst automatically calculates for decay tests will be discussed. A tutorial in how to use the Stat*Analyst to perform decay tests will also be presented, along with a discussion of the various test parameters that exist.

3.21 Doing a Decay Test with the Stat*Analyst

Starting from the highest level menu (the menu that appears after power up), one simply presses the DECAY function key to get into the Decay mode. Figure 24 shows the Decay Test Menu. All the current test parameters are displayed on the menu. We will show how to change them shortly. The parameters shown are the factory default parameters and may have been altered on your unit.

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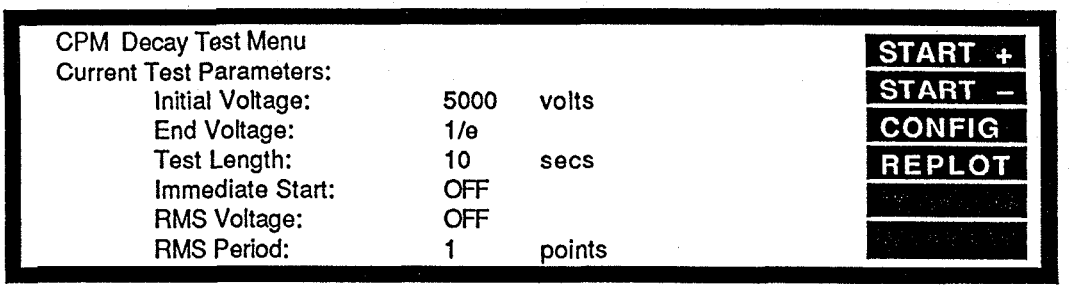


Figure 24: Decay Test Menu

To begin a positive decay test based on the shown parameters, press the START+ function key. A typical plot from a decay test is shown in Figure 26. The vertical axis is labeled with the start voltage, and the horizontal axis is labeled with the length of the test. A dashed horizontal line is drawn to indicate the selected stop voltage. The test status, which is indicated in the right of the LCD display, indicates **CHRG** which means the high voltage is enabled and connected to the plate. An audible clicking noise is normally heard when the decay test starts; it is the solenoid charging mechanism making contact with the plate. In the lower right portion of the LCD display, the current voltage on the plate is displayed to let the user know the progress of the plate charging process.

DECAY TESTING ... Operator's Guide

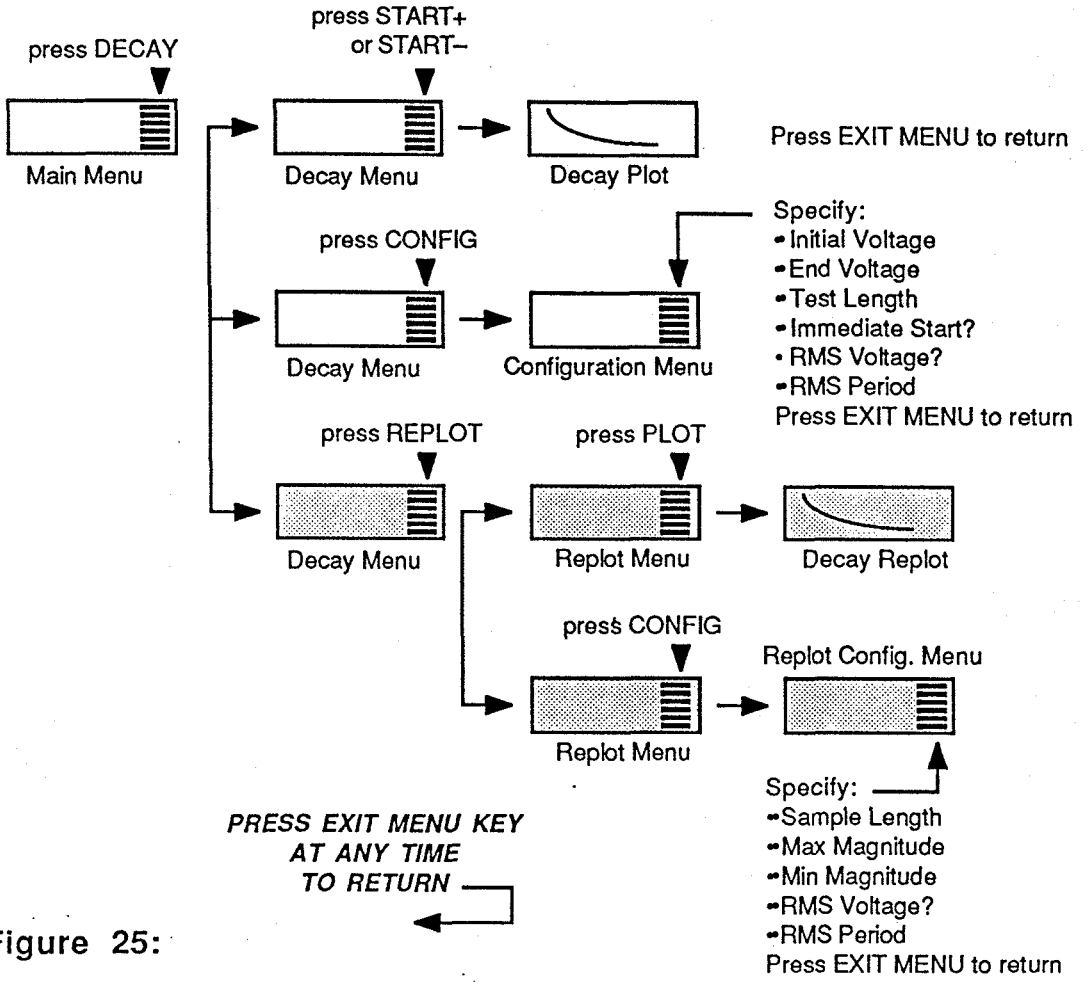


Figure 25:

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When the plate has charged to approximately 300 volts more than the initial start voltage, the solenoid is released, and the high voltage supply is turned off. At this point, the test status indicator (lower right corner) switches to **WAIT**, which indicates that the Stat*Analyst is waiting for the voltage to now fall below the initial start voltage to begin the test. The Stat*Analyst will wait in this condition. until the start voltage is reached, or the Exit Menu function key is hit to abort the test. The Stat*Analyst will wait approximately 10 seconds for the desired high voltage charge to be reached. If that time elapses and the unit still has not reached the start voltage, the charging process is terminated and the following error is generated along with the audible alarm:

Insufficient High Voltage

When the voltage has decayed to the start voltage, the test status changes to RUN and the data is plotted on the axis. The LCD bit on the horizontal axis corresponding to the active column is blanked to indicate the progress of the test. If the plot crosses the dotted stop line, the decay time is calculated and printed in the lower left corner of the LCD display in seconds. If the test ends before the stop voltage is reached, the decay time is extrapolated assuming an exponential display. If the Stat*Analyst extrapolated the decay time, the value is labelled xt. It should be noted that the extrapolated number is **only** an **estimate** and is provided to help the user determine the appropriate length that a decay test should be run. For more accurate results, decay times should always be determined by actually decaying below the stop voltage. The maximum decay time that the Stat*Analyst can directly determine is 10,000 seconds, while it can extrapolate values up to 99,999 seconds.

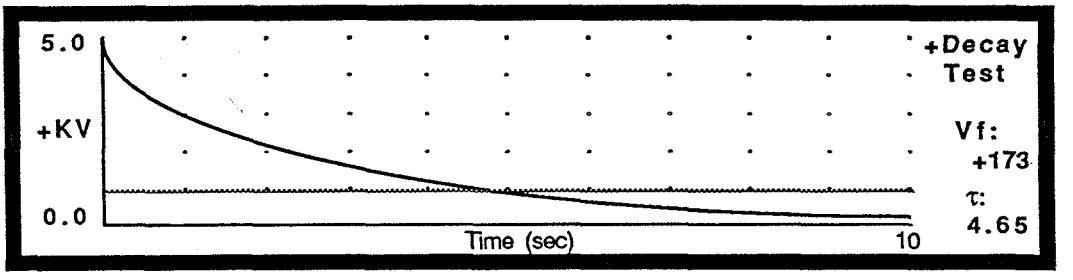


Figure 26: Decay Graphical Data

When the Decay Test is complete, the test status changes to DONE. In addition to the decay time, the plate voltage at the end of the test, Vf, is also determined and displayed on the LCD screen. At this point, the test is complete and the user has two options: one may hit the Exit Menu key to get back to the Decay Menu, or the test may be sent to the printer by pressing the Print Menu function key (assuming a printer is attached). The data may be replotted later by using the Replot feature (see Section 3.23). To perform a negative decay test, simply press the START-function key.

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3.22 Decay Test Configurable Parameters

There are 6 configurable test parameters for an Stat*Analyst Decay Test as shown in Figure 24. They are the **Initial Magnitude, End Voltage, Test Length, Immediate Start, RMS Voltage,** and **RMS Period.** This section describes the significance of each. To change any of the parameters, the CONFIG function key is pressed. Following the descriptions given below, select the parameter to change with the up or down arrow, and change the parameter with the LOWER or HIGHER function key. Press the Exit Menu function key to set the changes and return to the Decay Test menu.

Initial Magnitude - This parameter determines the starting voltage magnitude of a decay test; the polarity is determined by which function key is used to start the test. This value may range from 100 to 5000 volts in increments of 100 volts.

End Voltage - This parameter is used to calculate the decay time. Decay time is defined as the amount of time it takes for the ionized source to change the floating plate voltage from the start voltage to the end voltage. This value may be 1/e, where e is the natural number 2.7128...., a percentage of the start voltage ranging from 1% to 99% in increments of 1%, or it may be a fixed voltage ranging from 10 volts to 4900 volts. In the range from 10 to 90 volts, the increment is 10 volts, while in the range from 100 to 4900 volts, the increment is 100 volts. The end voltage must always be strictly less than the initial magnitude. When the Exit Menu key is hit to leave the Decay Config Menu, that condition is checked for. If an inconsistency is found, the following error message is printed:

End Voltage not less than Initial

The inconsistency must be corrected before the Decay Config Menu may be exited.

Test Length - This parameter determines the length the decay test will be run. One should run the shortest test possible that still allows the end voltage to be reached. This provides the maximum data sampling rate and hence the best resolution in determining the time constant. If the test is too short, the Stat*Analyst will automatically extrapolate assuming an exponential decay to determine a decay time. This value may then be used to modify the Test Length parameter to an appropriate value. The possible test lengths are: 1, 2, 5, 10, 20, 50, 100, 200, 500, 1000, 2000, 5000, and 10000 seconds.

Immediate Start - This option is used to skip the WAIT portion of a decay test. As a result, the initial start voltage is not as accurate as is the case when Immediate Start is OFF. This feature is useful for getting more realistic decay times for pulsing ionization systems with very slow characteristic frequencies. As an example, if an ionization system is running with a characteristic frequency of 0.1 Hz, then it will have a period of 5 seconds where it may only produce ions of a single polarity. If a positive decay test were being run and the ionization system just switched to a positive ionization cycle, then for a period of at least five seconds, there will be no decay on the plate because no negative ions are present. When the ionization system switches to the negative ionization cycle,

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decay will start, but with the immediate Start option OFF, the five seconds that no decay took place will not show up in the calculated decay time. It may be seen that with the Immediate Start option ON, decay times of slowly varying systems will vary depending on when the test is started relative to the ionization system voltage cycle.

RMS Voltage - The RMS (Root Mean Squared) Voltage option is a new technique developed by Pinion to take into account large peak to peak swings that some ionization systems generate into the decay time calculation. These large swings can have detrimental affects on devices within the ionization source range and can distort decay times based only on pure voltage. Consider Figure 27, which shows a decay test plot from 5000 volts of an ionization system with large (> 2000 volts) peak to peak swings. Note that the calculated decay time is 1.20 seconds for this plot as that is the first time the end voltage (dotted line) is reached. Also note that after the voltage on the plate exceeded the end voltage due to the large peak-to-peak swings of this particular system. It is obvious that the large peak to peak swings of this particular system aided greatly in reducing its calculated decay time. However, if one calculates the RMS voltage of the decay waveform over several periods of the ionization sources characteristic frequency, and then uses the resulting waveform to calculate a decay time, the resulting value is much worse. Such a plot is presented in Figure 28. Ionization systems with much smaller peak to peak swings have RMS decay times which are comparable to their normal decay times. When running in the RMS mode, the graphical plot takes a minimum of approximately 30 seconds to complete due to the various number of calculations that must be performed on each data point. Thus, decay tests with lengths of less than 30 seconds are not plotted in real time.

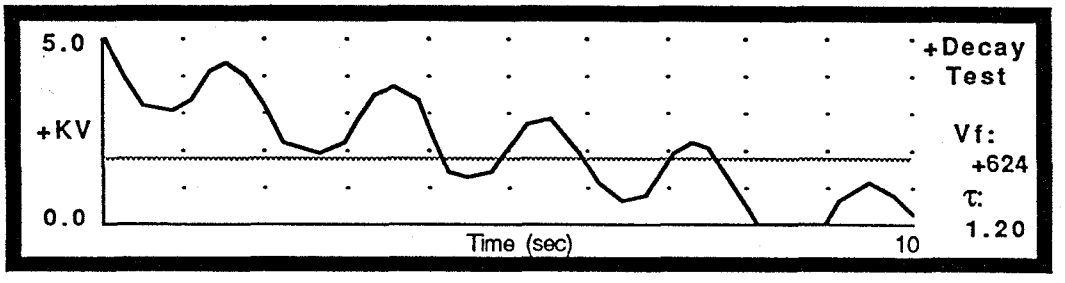


Figure 27: Normal Decay Plot with Large Voltage Oscillations

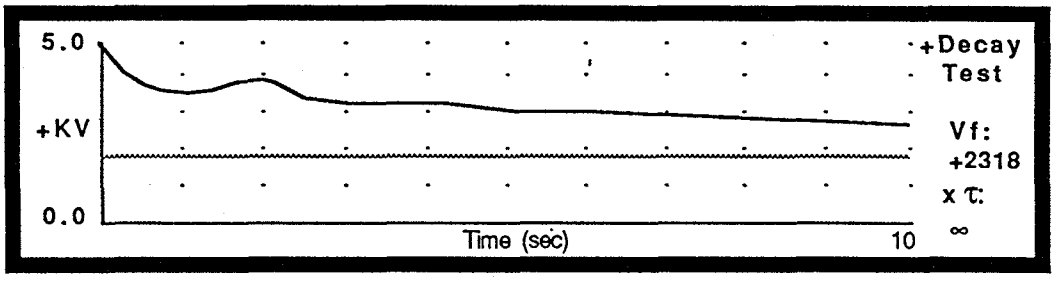


Figure 28: RMS Decay Plot of Figure 27 (RMS Period = 201 points)

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RMS Period - The RMS Period is used when the RMS Voltage Mode is ON. The RMS Voltage calculation is a sliding RMS value over a certain portion of the decay waveform. The entire waveform when digitized, consists of 201 data points. Thus, the RMS period may vary from 1 to 201 data points over which the sliding RMS calculation will be performed. An RMS period of 1 data point will correspond exactly to the normal voltage version of the decay plot, while a period of 201 will eventually do a calculation over the entire waveform. Normally, one chooses a RMS Period which consists of at least several periods of the ionization source waveform.

3.23 Decay Test Graphical Replot

After a decay plot has been completed using the +DECAY or -DECAY function keys, the data points that make up that waveform are saved until the next +DECAY, -DECAY or FLOAT test is run. To replot this data, the Decay REPLOT function key may be used. Figure 29 shows the Decay Replot Menu that results from the execution of the REPLOT function key.

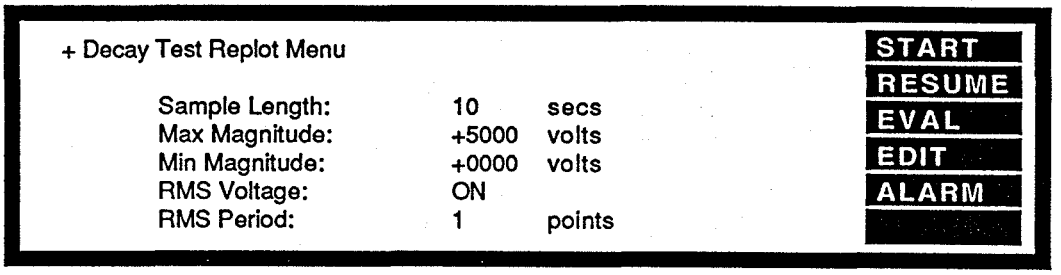


Figure 29: Decay Replot Menu

If the data currently stored in memory is not a decay test, then the following error message is printed and the decay replot menu is not entered:

Current Data Not Decay Type

The PLOT function key shown in Figure 29 will regenerate the graphical data. In the Decay Replot Menu, one may choose the minimum and maximum voltage values to plot so that the graph may be expanded relative to the original data. The replot parameters are changed via the CONFIG function key. In addition, data may be optionally plotted in the RMS voltage format regardless of whether the original data was taken with the RMS voltage option on. Thus one may experiment with the RMS concept and various RMS periods within the Replot Menu without having to rerun a decay test. To exit the plot once completed, hit the Exit Menu function key.

To generate a printout of the replotted graphical data, simply press the Print Menu function after the graph has been redrawn on the LCD. One may optionally generate a full page plot by turning the FULL PAGE PLOT Option on before entering the Replot Menu (see Section 2.08).

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3.3 Automatic (User Programmable) Tests

This section introduces the Automatic Test mode of the Stat*Analyst. It allows the instrument to run unattended performing a variety of user defined functions such as decay and float tests for a specified number of operations or it may be instructed to run continuously. The specific tests to be run are input to the Stat*Analyst via a simple programming language. A full set of editing commands is provided for complete flexibility. The average and standard deviations of multiple decay and float tests is readily available. Variable alarm thresholds may be set to monitor decay times and float test parameters. If a threshold is exceeded, an audible alarm is sounded, and the date and time of the event is recorded along with the value of the bad threshold.

3.31 The Auto Programming Language

The AUTO Menu is entered from the highest level menu by pressing the AUTO function key. Figure 30 shows the AUTO Menu. The Auto program is shown on the left side of the LCD display along with a line number for each entry. The particular test shown is the factory default program. It instructs the Stat*Analyst to perform a positive decay test, followed by a negative decay test, followed by a float test, with the entire sequence repeated 10 times. The parameters for the decay and float tests are the ones currently defined in the DECAY and FLOAT menus.

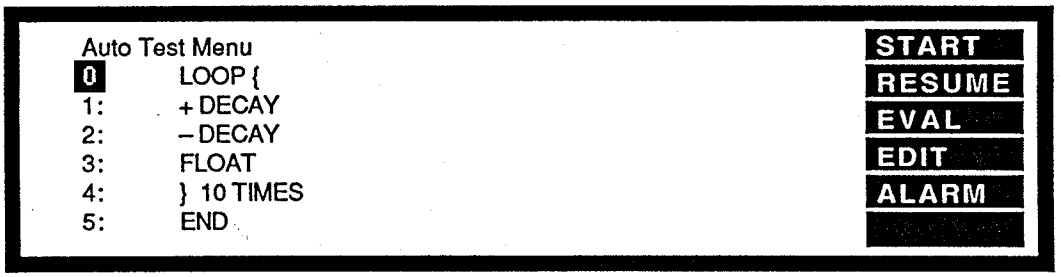


Figure 30: Auto Test Menu

There are 8 possible commands in the Stat*Analyst Auto Programming Language: **+DECAY, -DECAY, FLOAT, LOOP, TPRINT, GPRINT, ZERO,** and **CLEAR.**

+DECAY - Performs a Positive Decay test with the parameters currently defined in the Decay Menu.

- DECAY - Performs a Negative Decay test with the parameters currently defined in the Decay Menu.

FLOAT - Performs a Float test with parameters currently defined in the Float Menu.

LOOP - Execute the group of instructions surrounded by the braces { } N times where N is the loop count. The loop count can vary from 0 to 99 loops. A loop count of 0 is interpreted as loop continuously. Up to two levels of LOOP nesting is permitted.

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TPRINT - Performs a text print of the current test data to an attached printer. If the printer is not ready, then this command is aborted. Accumulated data on both float and decay tests are printed.

GPRINT - Performs a graphical print of the last Decay or Float test executed. The Replot parameters for either the Float or Decay types are used to determine the vertical axis values. If the Full Page Plot option is set, then a full size plot is printed; otherwise, a screen print is performed.

ZERO - Grounds the floating plate and resets the Stat*Analyst internal offset.

CLEAR - Clears the accumulated data for the AUTO Tests. Both the decay and float data is cleared and the number of tests is reset to zero. This is useful to prevent the accumulated data from overflowing. Only the first 99,999 test results are used to calculate average and standard deviation results. All other test results will not be included until the CLEAR command is issued.

3.32 Program Editing

The Stat*Analyst has full editing capabilities that allow the user to insert new commands, delete existing ones, and change loop counts. The Edit mode is entered by pressing the EDIT function key shown in figure 30. Figure 31 shows the EDIT menu. The top two function keys are the cursor control to select the desired line. The RESTOR or bottom function key is used to cancel all editing changes made in the current editing process and restore the program to the same state it was before the EDIT function was pressed. The LEDIT function key is used to modify the number of iteration for a loop. This function key is defined only if the current line selected is a loop end statement. The DELETE function key removes the current line selected. If the current line is either a loop start or loop end instruction, the other portion of the loop is also deleted.

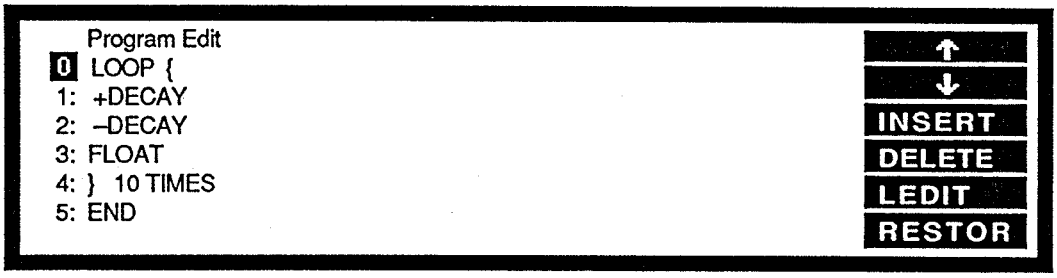


Figure 31: Program Edit Menu

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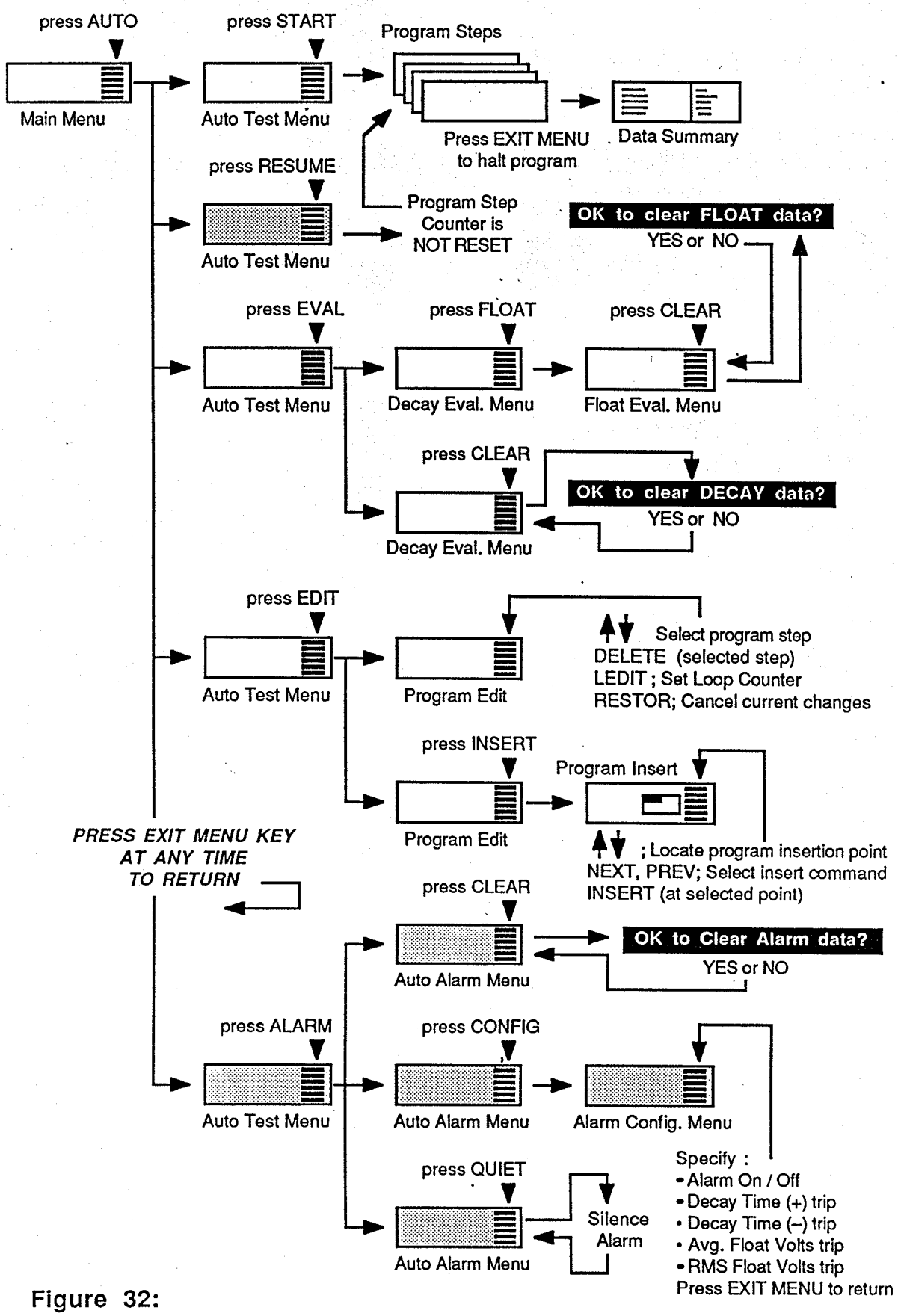


Figure 32:

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The INSERT function key is used to place a new instruction in front of the current selected line. Figure 33 is the Insert Menu. Use the arrows (↑ or ↓) for cursor control to select the line in which the new command is to be inserted in front of. The NEXT and PREV function keys are used to select one of the 8 possible programming commands.

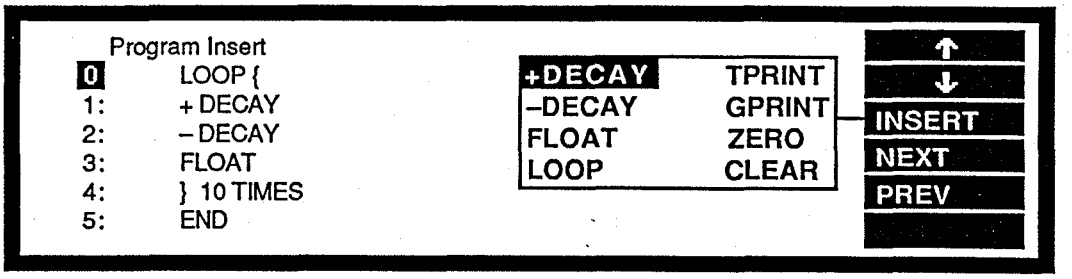


Figure 33: Auto Mode Edit Menu

The selected command is shown in inverse print in an area to the left of the function key labels. To actually insert the new command, hit the INSERT function key. If the selected line was the LOOP command, then the Stat*Analyst asks you to place the closing bracket for the loop. Note that the loop close must follow the loop open, and that only two levels of nesting are valid. Once the closing loop is placed, the Stat*Analyst allows the user to alter the loop count.

3.33 Auto Mode Alarms

The Stat*Analyst supports user programmable alarm thresholds for checking positive decay times, negative decay times, float balance, or float AC voltage. If a test is found to fail, an audible alarm is sounded and the data and time is recorded as well as the value that caused the alarm condition. The Alarm menu is entered by pressing the ALARM function key in Figure 30.

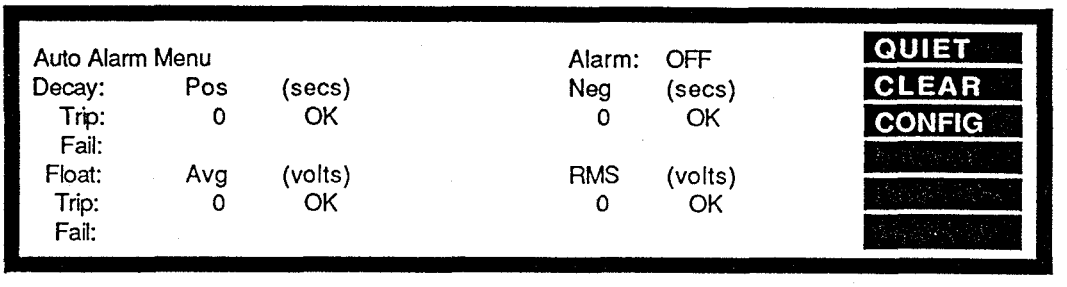


Figure 34: Alarm Menu

Figure 34 shows the Alarm Menu. Note the areas for each of the individual alarms. The **Trip** value is the maximum numerical value that any of the parameters may have without causing an alarm condition. To the right of the **Trip** value is the status field. It indicates **OK** if no failure has been found. If a failure is found, the parameter header is highlighted, and the failed value and date and time are printed on the LCD. To silence the audible alarm, the QUIET function key is used. To clear all the Alarm fields back to the **OK** condition, the CLEAR function key is used.

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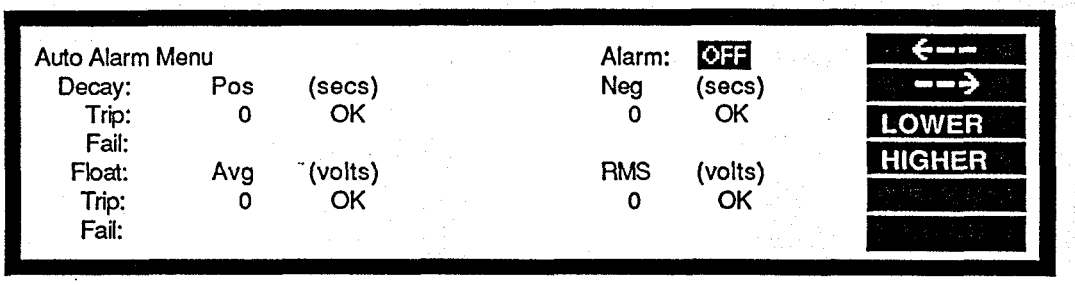


Figure 35: Alarm Status Menu

To enable alarm checking, the **Alarm** field in the upper right corner of the must indicate **ON**. To change this status field or any of the **Trip** values, the CONFIG function key is used. Once in the Alarm Config Menu (figure 35), use the arrow keys (← or →) to select the field to be changed, and then use the LOWER or HIGHER function keys to cycle to the desired value.

3.34 Running an Auto Test

Auto Run Mode		Alarm:	OFF
1:	FLOAT	# + Decay:	5
2:	ZERO	# – Decay	5
3:	+ DECAY	# Float	5
4:	ZERO	+t	.89
5:	– DECAY	–t	1.07
6:	} 5 TIMES	Vavg	-1 V
7:	END	Vac	1 V

Figure 36: Stat*Analyst Auto Run Mode

To start the Auto Test stored in memory, press the START function key shown in figure 30. Before each command is executed, the page shown in figure 36 is drawn which indicates the current line to be executed, the Alarm status, the total number of positive decay, negative decay, and float tests run, as well as the average of the decay times, average float value, and AC float value. When a loop command is encountered, the current iteration count is printed on the LCD. When the END command is reached, the test is complete. To stop the AUTO Run Mode, the Exit Menu key may be hit at any time. If the Auto mode is aborted via the Exit Menu Key, it may be restarted where it left off using the RESUME function key shown in Figure 21. This keeps all the loop counts at their previous value, while the START function key clears all loop counts back to zero.

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3.35 Auto Generated Data

As Decay and Float tests are run in the Auto mode, a running average and standard deviation for all the parameters discussed in Chapters 4 and 5 is maintained. Values for the **positive decay time, negative decay time, float average, float AC value, float RMS value, float minimum** and **float maximum** are all available. To access this data, press the EVAL function key in the Auto Menu shown in Figure 30. The Decay data is presented first. To examine the Float data, press the FLOAT function key in this new menu. In each of the Evaluation menus, a CLEAR function key is provided to reset the data values and counts back to zero.

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Charged Object Analyzer (COA) Operation Instructions

4.0 Statistical Analysis of Charged Objects

As previously described the Stat*Analyst provides powerful statistical computer capabilities to analyze data taken from PVT (Personnel Voltage Test) and FC-100/200 (Faraday Cup) Input Sensors.

4.1 Personnel Voltage Tester

The PVT-100 Personnel Voltage Tester is used to measure the voltage on people in the range of -10,000 volts to +10,000 volts. A green (LED) READY indicator is provided on the sensor to show when the unit is ready as well as when a reading has been taken.

4.11 PVT Test Operation

Make sure that the PVT-100SA is connected to the Stat*Analyst Control Unit - if not **TURN THE UNIT OFF BEFORE CHANGING INPUT DEVICES.** Allow adequate time (15 to 20 minutes) for the Control Unit and Sensor to **warm-up** before beginning a critical series of measurements.

After the normal start-up sequence the Charged Object Analyzer Menu will appear as shown in figure 37.

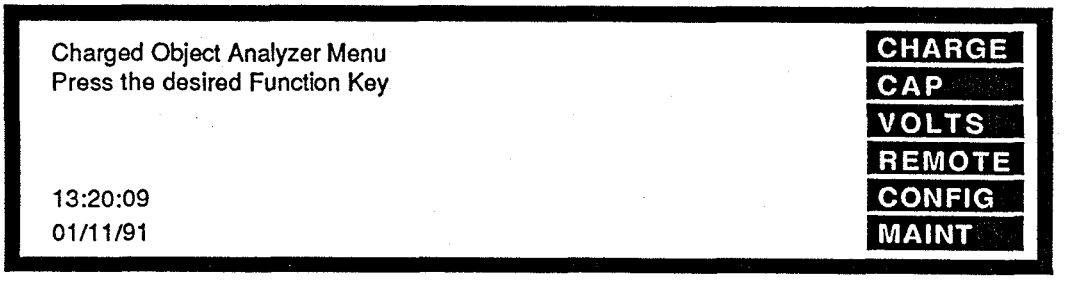


Figure 37: Charged Object Analyzer (COA) Main Menu

The familiar utility functions labelled REMOTE (see Chapter 6 for detail), CONFIG (see Section 2.08 for detail) and MAINT (see Chapter 7 for detail) have been previously described - you may wish to review those sections if you are not yet familiar with their meanings.

Press the function key labelled VOLTS; the Voltage Measurement Menu shown in figure 38 will appear. This menu summarizes the data currently stored in memory including actual data samples which will be displayed and can be examined by scrolling with the arrow (↑ or ↓) keys. If no data is present, as would be the case with initial start-up, no list will be observed.

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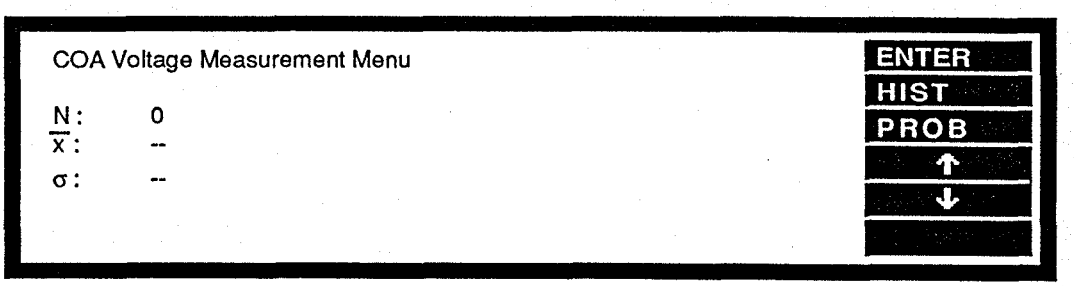


Figure 38: Voltage Measurement Menu

Where: N = Number of samples currently in memory
$\bar{x}$ = Average of all samples currently in memory
σ = Standard Deviation of all samples currently in memory

To enter new data press ENTER; the COA Statistics Menu will appear. This menu (as shown in figure 39) provides direct access to the current data base.

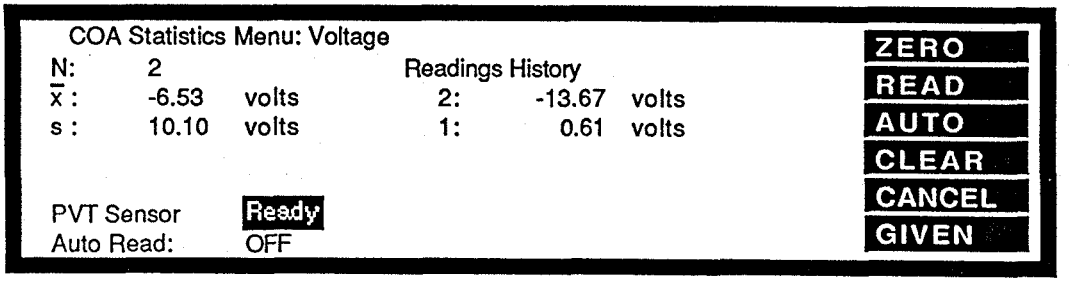


Figure 39: Voltage Statistics Menu

Status Indications:

PVT Sensor	"Ready" means data processing is completed. (Green LED on sensor also indicates ready)
Auto Read:	"ON" confirms auto trigger mode operation

Function Keys:

ZERO	Set PVT zero to externally supplied reference
READ	Take Voltage Sample. (Same as pressing the plate on the PVT sensor)
AUTO	Set (reset) the auto trigger option
CLEAR	Clear current data base
CANCEL	Clear only the last data reading
GIVEN	Set average and standard deviation from an external or "what if" data base (operator must CLEAR any existing data first).

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4.12 Plotting A PVT Voltage Data Histogram

The Stat*Analyst provides a simple graphical histogram function to allow you to quickly survey the distribution of data taken with the PVT sensor.

Starting from the COA Voltage Measurement Menu (figure 38) press the HIST key to activate the histogram plotting function. The Stat*Analyst will generate a display similar to the one shown in figure 40.

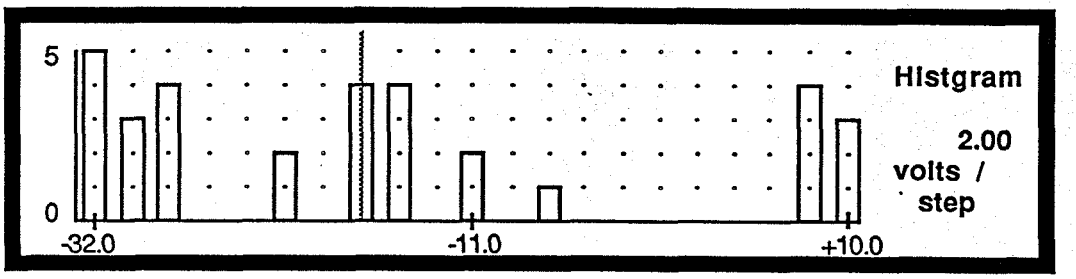


Figure 40: PVT Voltage Data Histogram

Twenty-one (21) bars are plotted across a linear horizontal axis which shows the minimum, maximum and mid-scale reference points. A dotted vertical line indicates the average voltage of the collective data. Each bar represents a sample "bin" or voltage "window" defined according to the volts/step legend shown on the display right. The volts/step value is uniquely determined by the 21 separate"bins" and the data minimum and maximum. The number of data values within each "bin" is given by the bar height as measured against the vertical axis.

To illustrate with the example of figure 40, there were 5 samples which fell within the voltage "window" of -32 to -30 volts as shown by the far left hand bar. The mid-point bar, positioned over -11, represents a window of -12 to -10 volts and contains 2 actual samples.

The vertical dotted line which indicates the data average is positioned on the horizontal axis in linear relationship to the 3 marked scale reference points.

The intent of this type of graph is not to show exact values but rather to indicate how the distribution is grouped in order to evaluate physical effects which may or may not have special significance. Clustering around a specific voltage usually indicates a well defined static generation condition which might be traced to certain personnel activities or unique clothing or footwear.

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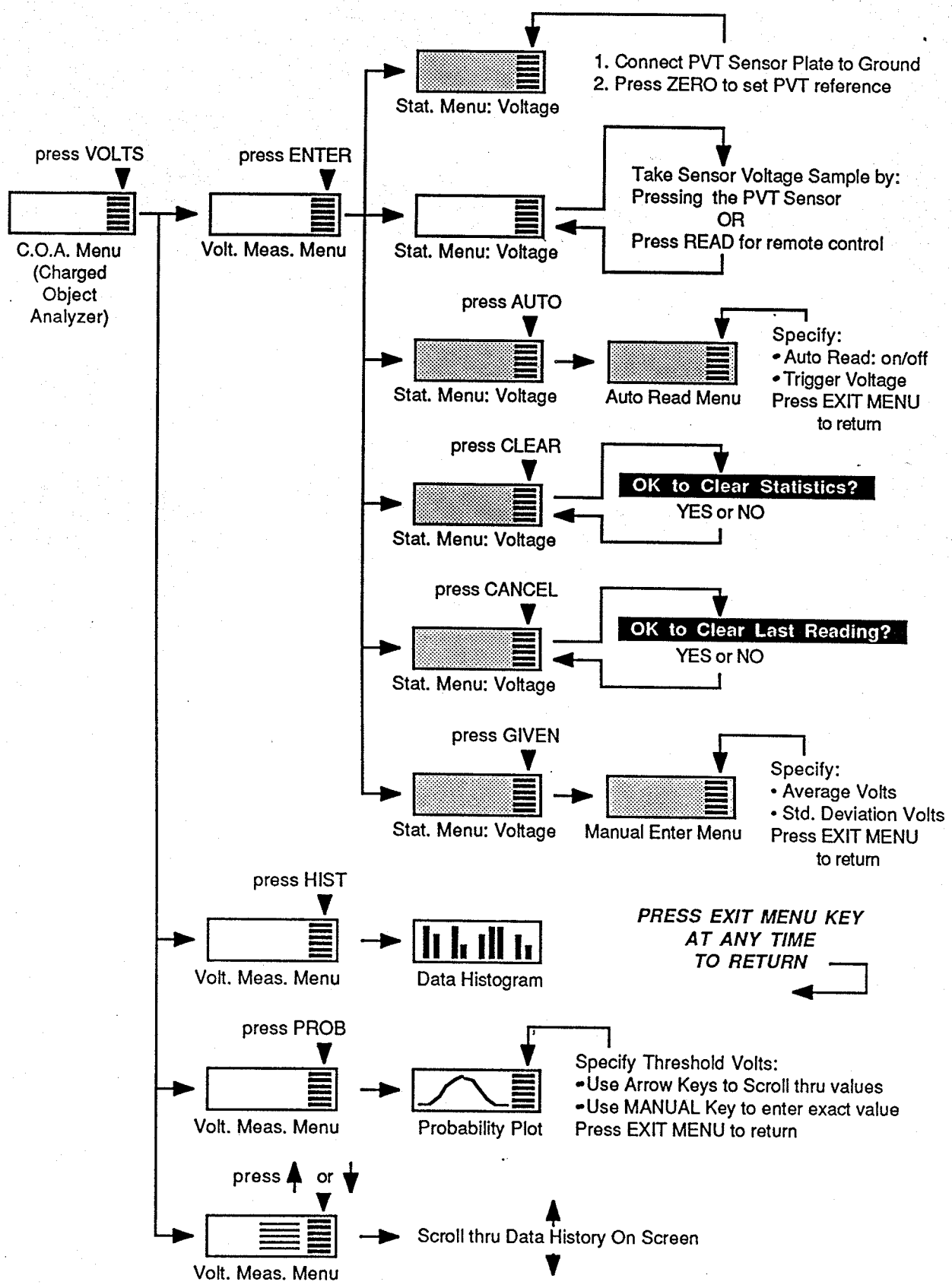


Figure 41:

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4.13 Plotting the Probability of an ESD Event

The ultimate goal of data gathering is to have objective evidence from which to draw accurate and productive conclusions. One such tool is probability analysis. The Stat*Analyst has the built-in capability to reduce data to a percent probability.

In addition to the data taken, the Stat*Analyst will need to know what the application critical ESD voltage threshold is. Much has been published in the electronics industry, for example, about the ESD sensitivity of various device technologies. The user will need to consult such sources or otherwise determine the critical ESD voltage.

Even if a specific voltage threshold is not known, the Stat*Analyst handles this threshold value as a given which can be changed to contemplate numerous "what if" possibilities for the same set of data.

Starting from the COA Voltage Measurement Menu (figure 38) press the PROB key to activate the probability plotting function. The Stat*Analyst will generate a display similar to the following:

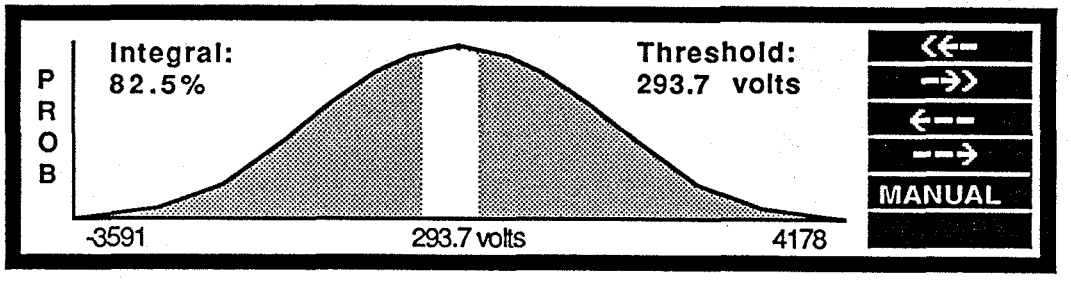


Figure 42: PVT Critical Voltage Probability Plot

The Stat*Analyst will automatically calculate the threshold voltage which corresponds to a 50% probability; meaning that the chance of experiencing a critical event is the same as the chance of not experiencing one. Other probabilities and corresponding thresholds of particular interest may also be selected.

Function Keys:

←←—	quickly lowers the threshold voltage
—→→	quickly raises the threshold voltage
←—	slowly lowers the threshold voltage
—→	slowly raises the threshold voltage

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If evaluation of a more precise voltage is required, pressing the MANUAL key will engage the menu shown in figure 43.

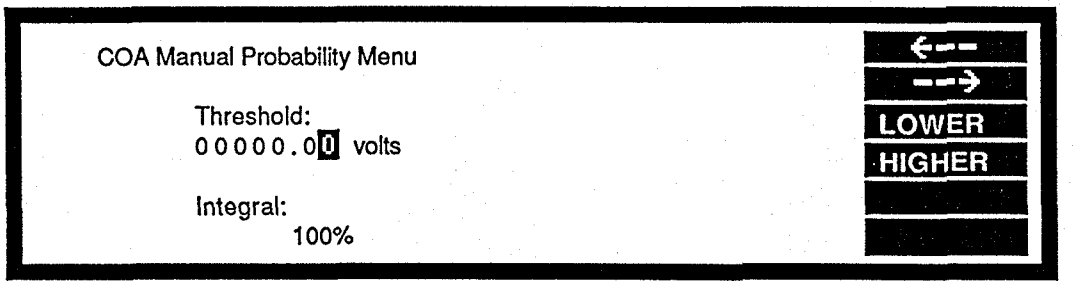


Figure 43: Manual Threshold Voltage Entry Menu

Function Keys:		
	←—	moves cursor left
	—→	moves cursor right
	LOWER	lowers the digit numerical value
	HIGHER	raises the digit numerical value

It should be clear that in order to avoid critical ESD events, the observer will be seeking low % probability figures for a given threshold sensitivity.

4.2 Faraday Cup Testing

In situations where direct voltage measurement is not practical or not possible because the measurement probe or apparatus would be physically or electrically too large to get accurate readings, one might consider charge transfer analysis.

If the capacitance of a given object can be accurately measured and if we can obtain readings of charge transfer, it is possible to determine the effective voltage present on the object.

By using the well known physical relationship:

$$Q = CV$$

where: Q = charge
C = capacitance
V = voltage

the Stat*Analyst can calculate voltage if the charge (Q) and the capacitance (C) are given ... via the rewritten equation:

$$V = Q / C$$

The Faraday Cup is a device specifically designed to measure charge. In particular the Stat*Analyst Faraday Cup measures charge ranging up to ±200 nanocoulombs (nc). Because we are able to precharge objects to given voltages it is possible to solve the equation above in still another way to determine capacitance:

$$C = Q / V$$

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To facilitate this, the Stat*Analyst is equipped with a precision 100 volt output reference. By applying this known voltage to a previously grounded object we have a known starting voltage. If we now drop this charged object into the Faraday Cup and measure the charge transfer, it will be possible to calculate the object's apparent capacitance.

By knowing an object's average capacitance and the average charge transfer from a given consistent operation or process we are able to determine what range of voltages will result. It is this utility that provides the basis for ultimately calculating the probability of an ESD critical event. We will therefore deal with the two basic functional tests with a Faraday Cup: measuring capacitance and measuring charge.

4.21 Measuring Capacitance with the Faraday Cup

Make sure that the FC-100/200SA Faraday Cup is connected to the Stat*Analyst Control Unit - if not **TURN THE UNIT OFF BEFORE CHANGING INPUT DEVICES**. Allow adequate time (15 to 20 minutes) for the Control Unit and the Sensor to **warm-up** before beginning a critical series of measurements.

After the typical start-up sequence the Charged Object Analyzer Menu (figure 44) will appear.

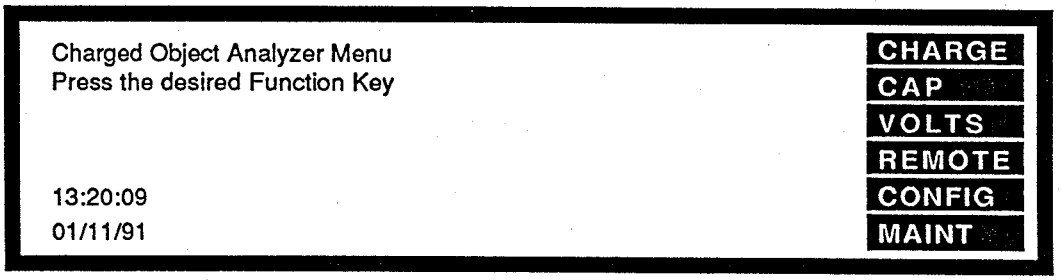


Figure 44: Main (COA) Menu

The familiar utility functions labelled REMOTE (see Chapter 6 for detail), CONFIG (see Section 2.08 for detail) and MAINT (see Chapter 7 for detail) have been previously described - you may wish to review those sections if you are not yet familiar with their formats.

Press the function key labelled CAP; the Capacitance Measurement Menu will appear. This menu summarizes the data currently stored in memory including actual data samples which will be displayed and can be examined by scrolling with the up and down arrow keys. If no data is present, as would be the case with initial start-up, no list will be observed.

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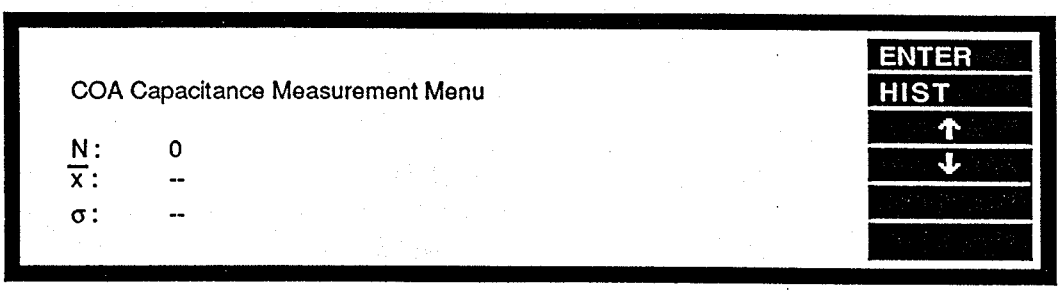


Figure 45: Capacitance Measurement Menu

Where: N = Number of samples currently in memory
$\bar{x}$ = Average of all samples currently in memory
σ = Standard Deviation of all samples currently in memory

To enter new data press ENTER; the COA Statistics Menu (figure 46) will appear. This menu provides direct access to the current data base.

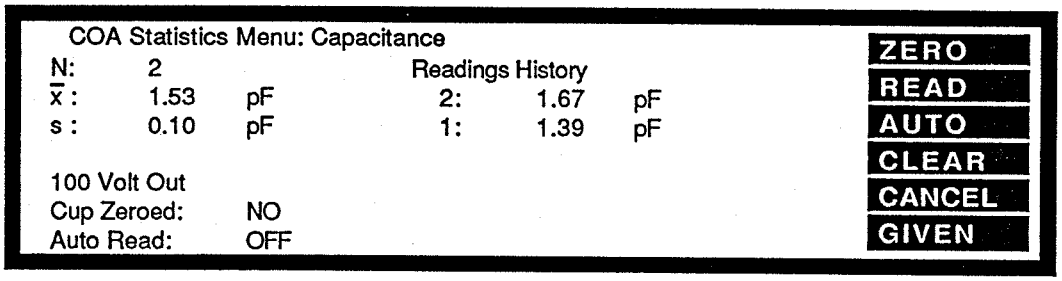


Figure 46: Capacitance Statistics Menu

Status Indications:
- 100 Volt Out: 100 volt reference output is enabled
- Cup Zeroed: "Yes" confirms ready for next reading
- Auto Read: "ON" confirms auto trigger operating

Function Keys:
- ZERO — Reset Cup to ZERO Potential
- READ — Take Capacitance READING
- AUTO — Set (reset) the AUTO trigger option
- CLEAR — Clear current data base
- CANCEL — Clear only the last data reading
- GIVEN — Load a known average capacitance into the Stat*Analyst instead of entering sample data (operator must CLEAR any existing data first).

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MEASURING CAPACITANCE WITH THE STAT*ANALYST

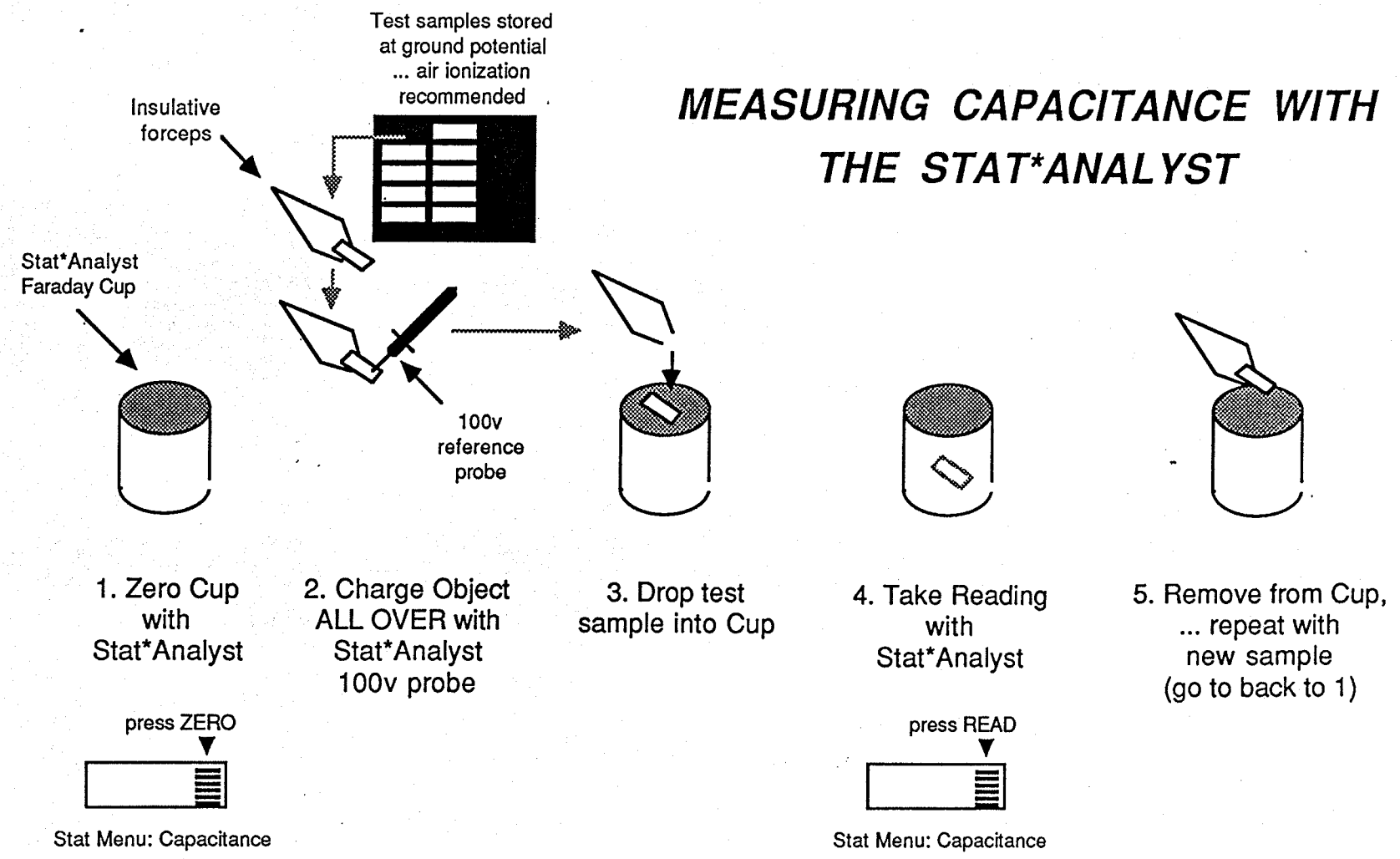


Figure 47:

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4.22 Plotting A Capacitance Data Histogram

Starting from the COA Capacitance Measurement Menu (figure 45) press the HIST key to activate the histogram plotting function. The Stat*Analyst will generate a display similar to the following:

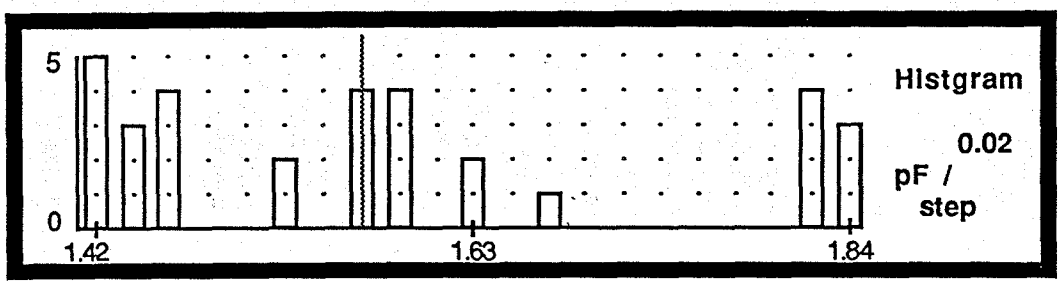


Figure 48: Capacitance Data Histogram

Twenty-one (21) bars are plotted across a linear horizontal axis which shows the minimum, maximum and mid-scale reference points. A dotted vertical line indicates the average capacitance of the collective data. Each bar represents a sample "bin" or capacitance "window" defined according to the pF /step legend shown on the display right. The pF /step value is uniquely determined by the 21 separate"bins" and the data minimum and maximum. The number of data values within each "bin" is given by the bar height as measured against the vertical axis.

The vertical dotted line which indicates the data average is positioned on the horizontal axis in linear relationship to the 3 marked scale reference points.

The intent of this type of graph is not to show exact values but rather to indicate how the distribution is grouped in order to evaluate physical effects which may or may not have special significance. Clustering around a specific value is often indicative of a unique physical attribute.

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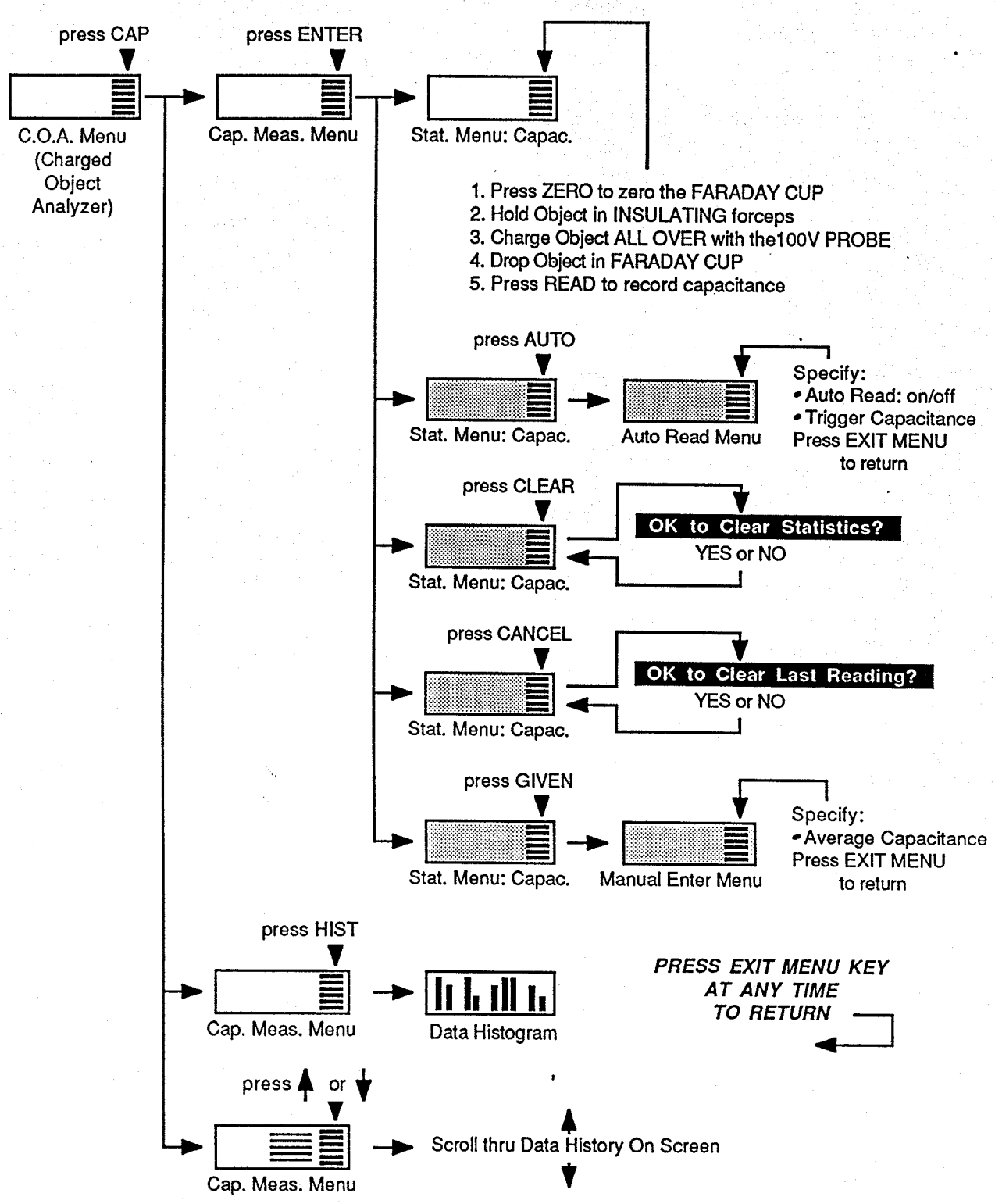


Figure 49:

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4.23 Measuring Charge with the Faraday Cup

Make sure that the FC-100/200SA Faraday Cup is connected to the Stat*Analyst Control Unit - if not **TURN THE UNIT OFF BEFORE CHANGING INPUT DEVICES**. Allow adequate time (15 to 20 minutes) for the Control Unit and the Sensor to **warm-up** before beginning a critical series of measurements.

After the normal start-up sequence the Charged Object Analyzer Menu (figure 50) will appear:

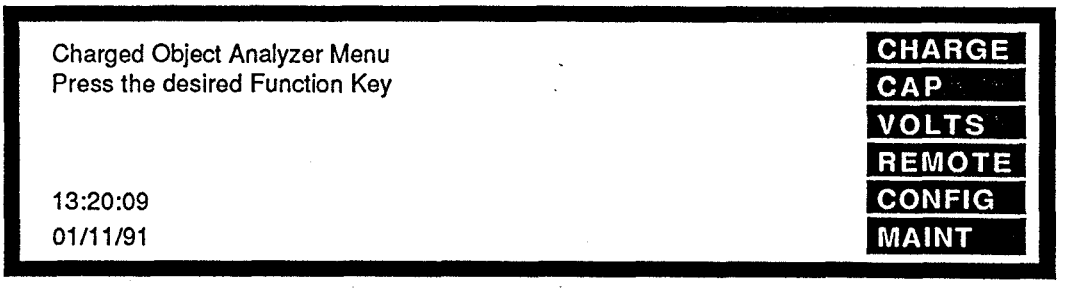


Figure 50: Main (COA) Menu

The familiar utility functions labelled REMOTE (see Chapter 6 for detail), CONFIG (see Section 2.08 for detail) and MAINT (see Chapter 7 for detail) have been previously described - you may wish to review those sections if you are not yet familiar with their formats.

Press the function key labelled CHARGE; the Charge Measurement Menu (figure 51) will appear. This menu summarizes the data currently stored in memory.

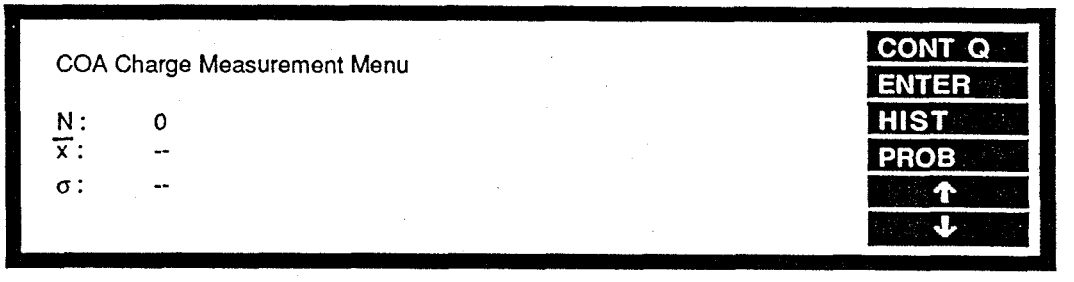


Figure 51: Charge Measurement Menu

Where: N = Number of samples currently in memory
$\bar{x}$ = Average of all samples currently in memory
σ = Standard Deviation of all samples currently in memory

The CONT Q function enables the Stat*Analyst to read charge transfer to the Faraday Cup continuously, this feature is useful for monitoring charge generation characteristics in relationship to various external physical parameters. In most cases a clip lead will be required to connect the charge source to the internal Faraday Cup. Zeroing is provided on demand by the ZERO function key in the Continuous Charge Menu.

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To enter single sample data press ENTER; the COA Statistics Menu will appear. This menu (figure 52) provides direct access to the current data base.

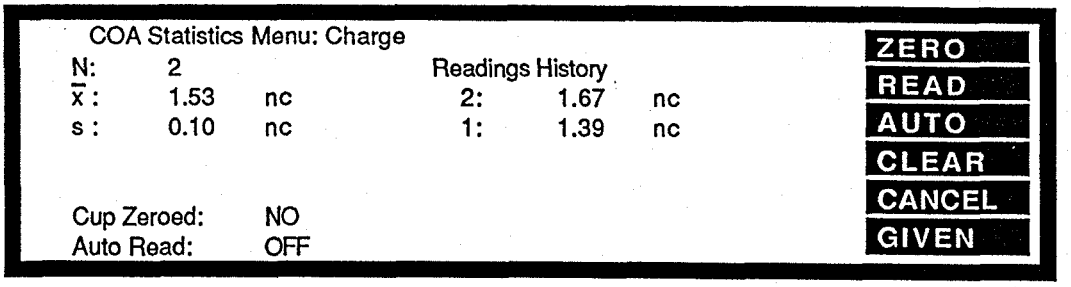


Figure 52: Charge Statistics Menu

Status Indications: Cup Zeroed: "Yes" confirms ready for next reading

Auto Read: "ON" confirms auto trigger operation

Function Keys:

ZERO	Reset Cup to ZERO Potential
READ	Take Capacitance READING
AUTO	Set (reset) the AUTO trigger option
CLEAR	Clear current data base
CANCEL	Clear only the last data reading
GIVEN	Load a known average capacitance into the Stat*Analyst instead of entering sample data. (CLEAR any existing data first).

4.24 Plotting A Charge Data Histogram

Starting from the COA Charge Measurement Menu (figure 51) press the HIST key to activate the histogram plotting function. The Stat*Analyst will generate a display similar to the figure 53.

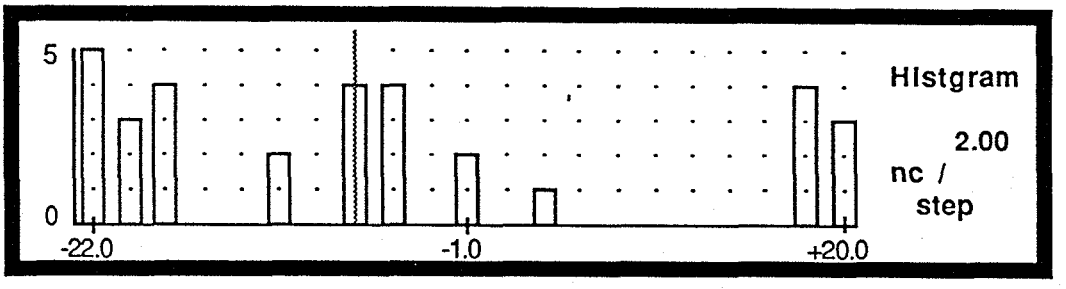


Figure 53: Charge Data Histogram

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MEASURING ESD CHARGE GENERATION WITH THE STAT*ANALYST

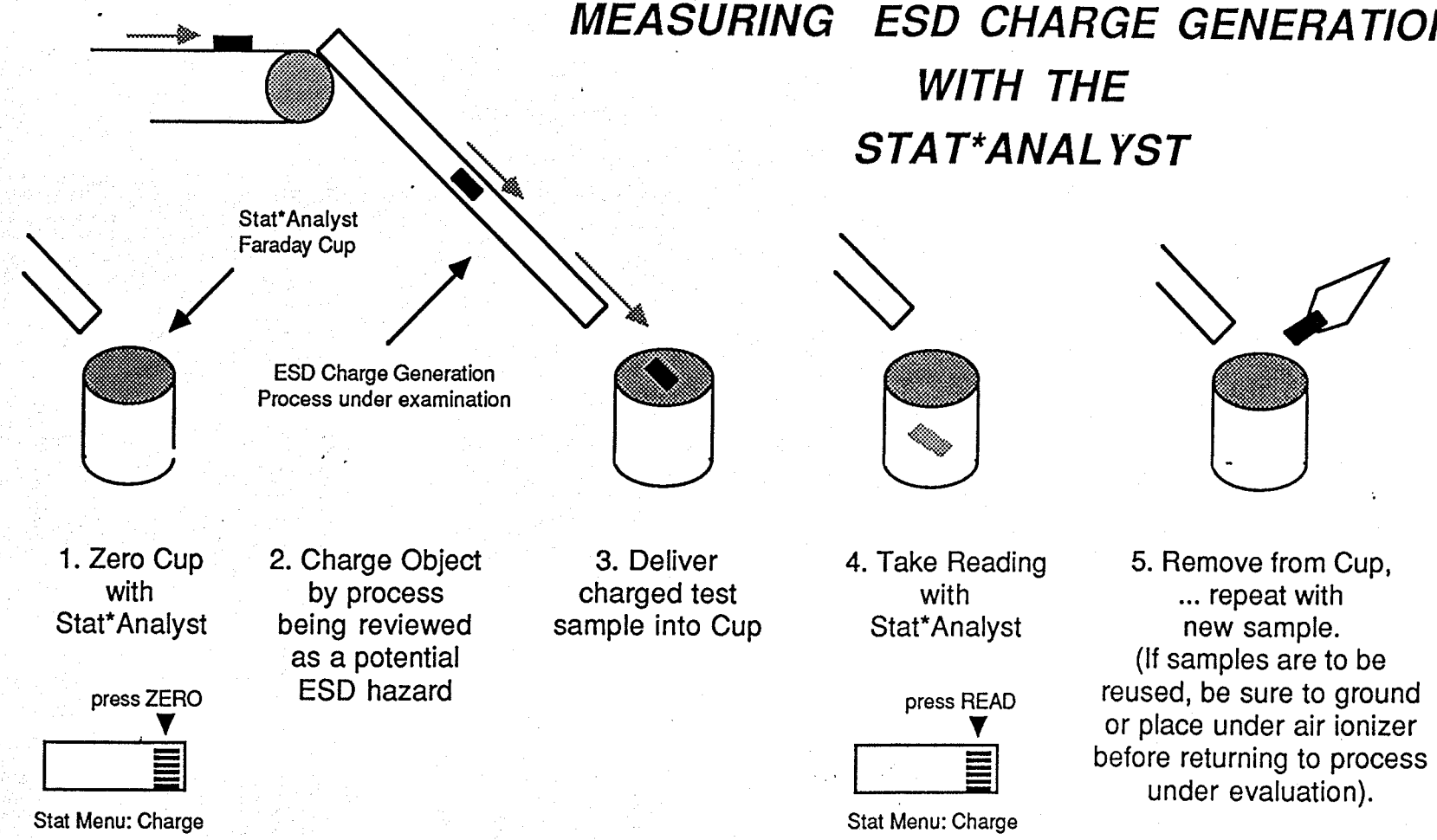


Figure 54:

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Twenty-one (21) bars are plotted across a linear horizontal axis which shows the minimum, maximum and mid-scale reference points. A dotted vertical line indicates the average charge of the collective data. Each bar represents a sample "bin" or charge "window" defined according to the nc /step legend shown on the display right. The nc /step value is uniquely determined by the 21 separate"bins" and the data minimum and maximum. The number of data values within each "bin" is given by the bar height as measured against the vertical axis.

The vertical dotted line which indicates the data average is positioned on the horizontal axis in linear relationship to the 3 marked scale reference points.

The intent of this type of graph is not to show exact values but rather to indicate how the distribution is grouped in order to evaluate physical effects which may or may not have special significance. Clustering around a specific value is often indicative of a unique physical attribute.

4.25 Probability of an ESD Event From Charge & Capacitance Data

Having charge and capacitance data histograms is useful for understanding the process and object attributes which may influence charge generation and transfer, but the single most useful tool is critical ESD event probability.

Given a specific critical voltage threshold, the Stat*Analyst will compute this probability based on the capacitance and charge data bases.

Even if a specific voltage threshold is not known, the Stat*Analyst handles this threshold value as a "given" which can be changed to contemplate numerous "what if" possibilities for the same set of data.

Starting from the COA Charge Measurement Menu (figure 51) press the PROB key to activate the probability plotting function. The Stat*Analyst will generate a display similar to figure 55.

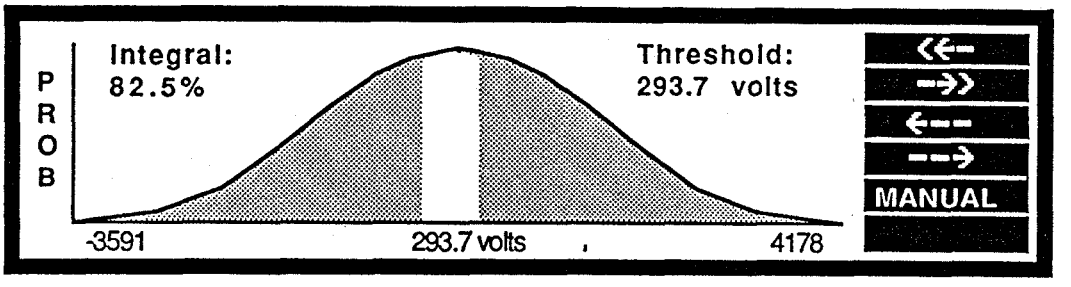


Figure 55: Critical Voltage Probability Plot - Based on Charge

The Stat*Analyst will calculate the threshold voltage which corresponds to a 50% probability; meaning that the chance of experiencing a critical event is the same as the chance of not experiencing a critical ESD event. Other thresholds and their corresponding probabilities may be examined with the function keys.

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Function Keys:		
	←←—	quickly lowers the threshold voltage
	—→→	quickly raises the threshold voltage
	←	slowly lowers the threshold voltage
	—→	slowly raises the threshold voltage

If evaluation of a more precise voltage is required, pressing the MANUAL key will engage the COA Manual Probability Menu (as shown in figure 56).

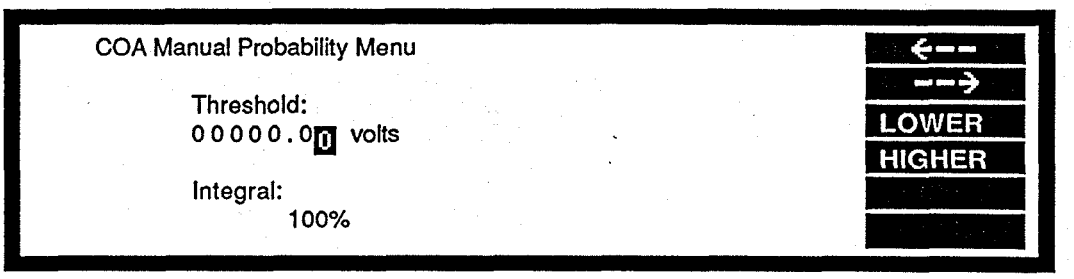


Figure 56: Manual Threshold Entry Menu

Function Keys:		
	←	moves cursor left
	→	moves cursor right
	LOWER	lowers the digit numerical value
	HIGHER	raises the digit numerical value

It should be clear that in order to avoid critical ESD events, the observer will be seeking low % probability figures for a given threshold sensitivity.

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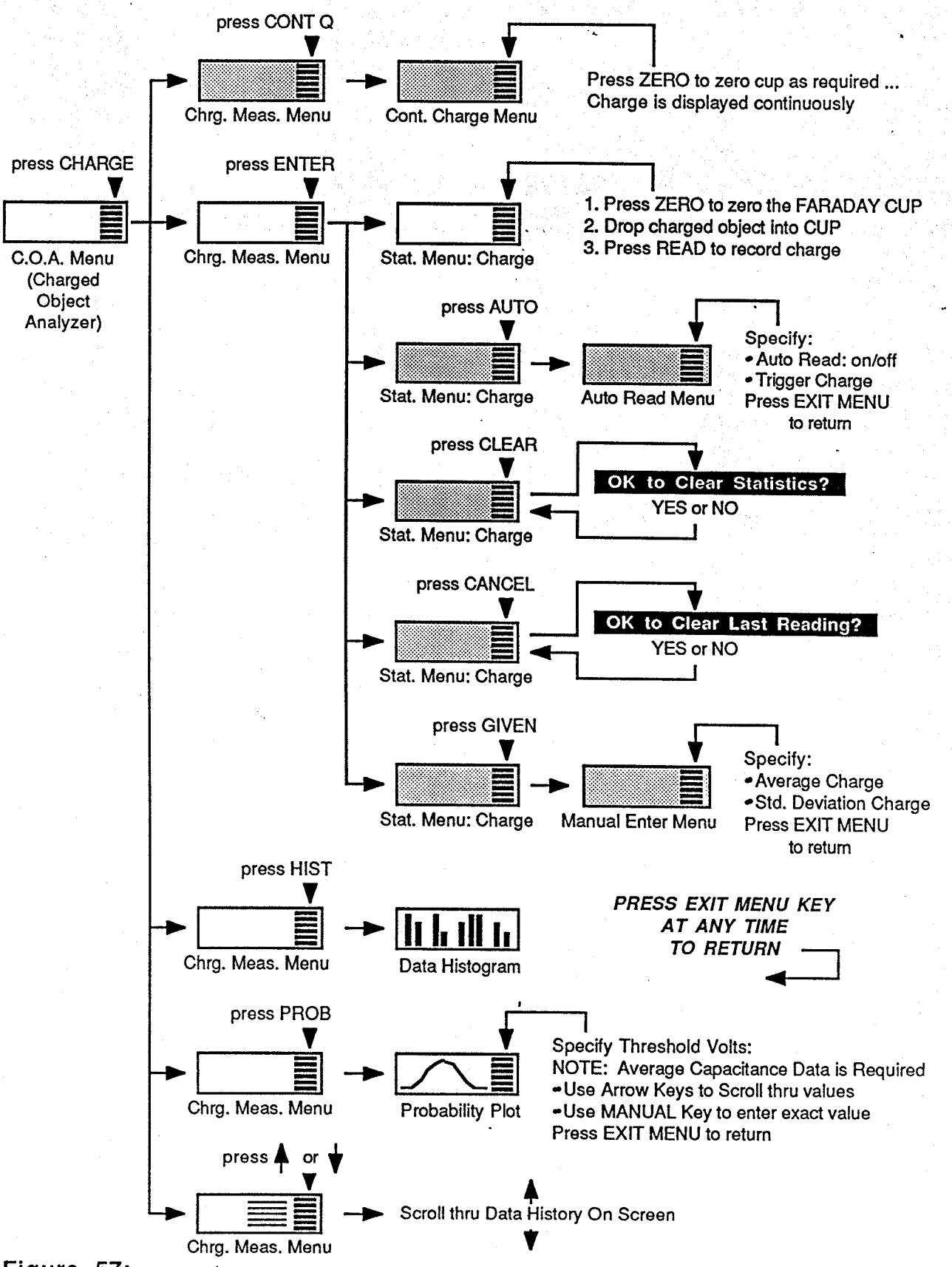


Figure 57:

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Chapter 5

STAT*ANALYST DESIGN DETAIL

5.0 Stat*Analyst Technical Detail

In order to derive greater benefit from the extensive versatility of the Stat*Analyst, one may find it helpful to understand the fundamentals upon which it operates. The following technical discussions are intended to provide such information.

5.1 Main Control Unit

The Stat*Analyst control unit is a powerful single board computer with an NSC-800 8 bit processor running at a 4 Mhz clock rate. It contains 88K of program memory and 8K of battery backed up RAM memory. It comes complete with a battery backed up real time clock, a UART for serial communication, and a parallel printer interface. For analog signal processing, a separate analog board has a 16 channel 12 bit Analog to Digital Converter (A/D) and a 12 bit Digital to Analog Converter (D/A). There is also a programmable gain operation amplifier for increased signal resolution. The Stat*Analyst control unit also provides for battery operation of up to 4 hours along with a high current battery charger.

The Stat*Analyst user interface consists of a 64 x 256 bit multiplexed graphic LCD display operating in conjunction with 8 push button function keys. An audible alarm is also present for alerting the user to error and alarm conditions.

The software running the Stat*Analyst is a menu driven hierarchical system that is designed to be user friendly. Typically, only one or two keystrokes are needed to run any test. In addition, the large graphic LCD allows messages to be printed on the screen to aid in its operation. Finally, the Stat*Analyst comes complete with calibration and diagnostic software to insure that it is operating properly.

5.2 The Charge Plate Monitor (CPSA) SENSOR

The Stat*Analyst Charge Plate Sensor consists of a 6 by 6 inch conductive plate isolated from a ground plane by TEFLON® standoffs. The plate has approximately 20 pf of capacitance to ground. The ground plane below the floating plate helps to maintain the plate capacitance to ground more constant as the sensor is placed near other objects.

Below the floating plate is a field meter with up to 60 Hz frequency response. This allows the Stat*Analyst to accurately measure induced voltages from 60 Hz ionization sources. Also included in the sensor hardware is a compact DC/DC converter which can deliver bipolar programmable high voltage of up to 5500 volts. It provides the necessary high voltages used in the Decay Test Modes.

Finally, the Stat*Analyst sensor includes a solenoid driven mechanism for connecting the high voltage DC/DC converter to the floating plate. The solenoid mechanism has a travel distance of over 0.5 inches. A solenoid arrangement was used in the

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Stat*Analyst rather than a relay for two reasons. First, the isolation resistance of high voltage relays is typically too low to adequately isolate the floating plate after it has been charged in the Decay Mode. A leakage current of 10 x 10^{-9} amps would take only 10 seconds to completely discharge the plate from 5000 volts! Ideally, any drop in voltage on the plate should be from ion recombination from the ion source being evaluated. In addition, due to the ceramic material typically used in most high voltage relays, the insulation resistance drops dramatically in high humidity environments due to water accumulation on the relay surface. By contrast, the Stat*Analyst charging mechanism uses TEFLON® for its insulating material which is not hygroscopic, i.e., it is very resistant to water absorption. The net result is that the Stat*Analyst floating plate has an isolation resistance in excess of 10^{14} Ω.

Secondly, most high voltage relays have an internal capacitance across the contacts of approximately 2 pf. This capacitance would effectively be in parallel with the floating plate capacitance. This would increase the effective plate capacitance by 10% and would have a comparable affect on data taken from the sensor. The Stat*Analyst solenoid mechanism is totally isolated from the floating plate when the plate is floating and as such, there is negligible increase in plate capacitance.

5.3 The Faraday Cup Sensor

The FC-100SA Faraday Cup sensor is used to measure the charge on objects placed within the inner cup with a range of -200 to +200 nanocoulombs. The FC-100 also contains an integral relay for removing the charge from the inner cup.

The fundamental basis of this device relies on the simple relationship Q = CV, where Q is charge in coulombs, C is capacitance in farads, and V is voltage in volts. A polystyrene capacitor with very high insulation resistance and very low dielectric absorption provides the conversion from charge to voltage. A very high input impedance amplifier manufactured with matched dual JFET transistors (input bias currents < 100 fa) buffers the capacitor. A variable gain amplifier provides a means of calibration for capacitance tolerances as well as drive for the cable connection to the control unit. A mechanical relay is connected across the polystyrene capacitor to completely discharge it when the Zero function is executed.

Physically, the internal cup is connected to the polystyrene capacitor through a spring loaded contact. The external cup is connected to ground to provide a Faraday shield for the inner cup.

When the FC-100 is used in the Capacitance mode to measure the value of a discrete capacitor by charging it to 100 volts and then discharging it into the cup, there will be a charge sharing effect with the internal polystyrene capacitor; i.e., not all of the charge will be drawn off the external capacitor, resulting in a lower measured capacitance value. The amount of charge remaining on the external capacitor is the ratio of the external capacitance to the sum of internal and external capacitance. As long as the external capacitance is significantly smaller than the internal capacitance, then the charge sharing is negligible.

5.4 The PVT-100SA Personnel Voltage Tester

The PVT-100 Personnel Voltage Tester is used to measure the voltage on people. It has a range of -10,000 volts to +10,000 volts. A READY indicator is provided on the lid of the PVT-100 to show when the unit is ready as well as when a reading has been taken.

By design, the PVT-100SA incorporates a high impedance input voltage divider and a very high input impedance operational amplifier which buffers the divider. Because of the large resistors used in the divider, input bias currents in the buffer are below 100 fa to maintain sufficient accuracies in the lower voltage ranges. A variable gain amplifier follows the buffer to provide for a means of calibration for resistor tolerances and adequate drive for the cable connection to the control unit. A switch is present which grounds the READ signal whenever the lid of the PVT-100 is pressed. A READ LED is included which is controlled by the control unit to indicate the current status of the sensor.

Physically, the PVT-100 consists of a small conductive plate supported on a TEFLON® standoff. It is important to keep this standoff clean to prevent excessive leakage at higher voltages. Handling of the standoff should be avoided, and it should never be cleaned with any anti-static or soapy solution. The probe connection is through the center of the standoff. The cover is not connected to the circuit ground and is to be grounded separately with the strap provided. The cover pivots when pressed to close a switch to indicate to the control unit that a reading is to be taken.

When an individual touches the PVT-100 Sensor, the charge on their body will begin to discharge through the resistive divider. The resistance values in the divider were chosen to be large so that by the time that the control unit has sensed the switch closure and read the sensor value, only a small part of the reading will have dissipated. For example, assuming a human body capacitance of 150 pf, this yields a time constant of 15 seconds with the 10^{11} ohm resistor in the PVT-100. The control unit requires about 100 msec to take a reading from switch closure, which means over 99.3% of the original reading is still present on the individual under test.

When the individual under test removes their hand from the PVT-100, the time constant associated with the probe changes dramatically. The capacitance is now the capacitance of the PVT-100 probe plate to ground which is approximately 1 pf. That corresponds to a time constant of only 100 msec which means over 99.9% of the charge placed on the probe from the just completed reading will discharge within 700 msec. The control unit delays approximately 2 seconds between readings to allow this discharge to take place so that two consecutive readings taken quickly do not interfere with one another.

5.5 Software: Charge vs. Voltage Measurements

To determine the voltage on objects (other than people), the Stat*Analyst measures their charge directly, and calculates the voltage from their capacitance. Charge is used because, given the conservation of charge, it does not change on an isolated body. The capacitance and voltage will vary as the orientation of the device relative to

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nearby objects changes. Charge is a fundamental quantity, while capacitance is a physical property that is dependent on many changing parameters.

Using a charge measuring device to calculate the voltage on people is not feasible as they act like batteries, constantly driving a charge into a charge measuring device giving falsely high readings. In addition, by placing the voltage measuring sensor in a work environment, sample voltage levels in that area may be obtained that are a result of capacitance and charge levels that are representative of typical values found in that area as personnel go about their normal duties.

5.6 Software: Statistical Analysis

This discussion serves to educate the reader in the mathematical methods used by the Stat*Analyst to statistically interpret the data acquired in the data gathering modes.

For probability calculations, it is assumed that the data follows a Gaussian Distribution (as illustrated in figure 58), which is a symmetric bell shaped curve centered around an average value. The standard deviation of the distribution is an indication of the width of the bell shaped curve. The larger the standard deviation, the more the bell is spread out. The average and standard deviation are calculated from the data obtained from the data gathering modes.

If the distribution is integrated, the resulting value is one. (i.e., the probability of any event happening is equal to one). The instantaneous probability of any specific value occurring is defined by the points on the curve. The probability of the average is the highest probability on the curve. The actual probability of the average occurring, however, is dependent on the standard deviation.

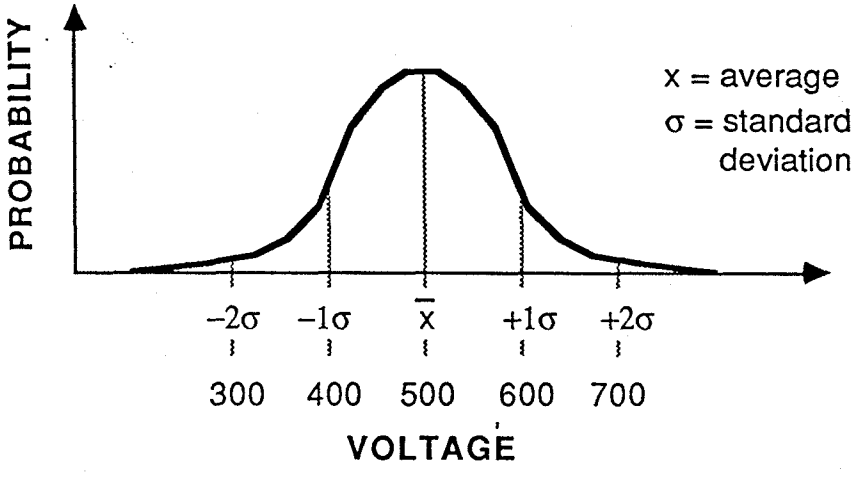


Figure 58: Gaussian Probability Distribution

As an example, assume statistics were taken in the PVT mode, and the average voltage ($\bar{x}$) on personnel was observed to be 500 volts with a standard deviation (σ) of 100 volts. Probability statistics are generated internally by the Stat*Analyst taking into account the average and standard deviation. In general, using the mathematical model stored in the Stat*Analyst computer memory, approximately 68% of the voltage

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values will fall within 1 standard deviation (1σ) around the average. Approximately 95% of the values will fall within 2 standard deviations (2σ) around the average. Specifically, in this example, that correlates to 68% of the voltage distribution falling between 400 and 600 volts and 95% between 300 and 700 volts. The operator can type in any voltage value on the Stat*Analyst data entry keyboard and observe the probability of a value in the distribution exceeding that threshold. As an example, given the above distribution, there is a 15.9% probability of a voltage exceeding 600 volts, while there is only a 2.28% chance of it exceeding 700 volts.

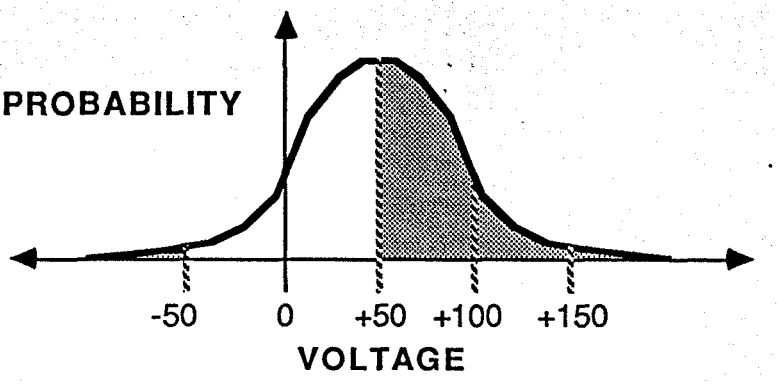


Figure 59: Distribution with Positive and Negative Values

It is likely that both positive and negative voltage readings will be observed in a generated data base. A typical distribution is illustrated in figure 59. The probability of a person having a voltage greater than 50 volts is calculated by integrating the curve to the right of the +50 Volt value and adding that to the integral of the curve to the left of the -50 Volt value. As shown, the negative absolute value of the "tail" of the curve is included in the calculation. Thus, the calculated probability is that the magnitude of the threshold will be exceeded. Because the sum of two integrals is used to calculate the probabilities, it is possible for the average voltage not to be at a probability of 50%. For the curve shown above, with an average of 100 volts and a standard deviation of 100 volts, the probability of a voltage exceeding 100 volts is 52.3% not 50%. The integral to the left of the vertical axis adds an additional 2.3% to the calculated probability.

It is possible to obtain measurements that would have an average of zero volts, since both positive and negative readings are possible. Relying on only the average voltage on people would not give an accurate analysis of the potential for ESD damage caused by higher voltages. By acquiring the average and standard deviation, meaningful conclusions can be drawn from the data.

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A more detailed mathematical analysis follows:
The probability function (f(N)) of the Gaussian distribution is given as:

(EQ. 1) $$f(N) = \frac{\exp(-N^2 / 2\sigma^2)}{\sqrt{2\pi\sigma^2}}$$

More generally, it is defined:

(EQ. 2) $$f(N) = \frac{\exp(-(N-a)^2 / 2\sigma^2)}{\sqrt{2\pi\sigma^2}}$$

Where: σ = standard deviation
a = average

The probability of a value being less then x, given a Gaussian distribution, is:

(EQ. 3) $$F(x) = \int_x^\infty f(N)\, dN$$

Solving this integral yields:

(EQ. 4) $F(x) = 1/2 + \text{erf}((x-a) / a)$ Where the error function is:

$$\text{erf}(x) = (1 / \sqrt{2\pi}) \int_0^\infty \exp(-y^2 / 2)\, dy$$

The probability of a value being greater than x, given a Gaussian distribution, is:

(EQ. 5) $G(x) = \int_x^\infty f(N)\, dN$ which yields

(EQ. 6) $G(x) = 1/2 - \text{erf}((x-a) / a)$

The probability of being greater than the absolute value of x, |x|, is given by the sum of EQ.3 and EQ.5:

(EQ. 7) $P(x) = F(-x) + G(x)$

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which may be rewritten as:

(EQ. 8) $$P(x) = 1 + \mathrm{erf}((-x-a) / a) - \mathrm{erf}((x-a) / a)$$

The erf function is implemented with a table lookup mechanism within the Stat*Analyst.

In addition to the probability calculations mentioned above, the average and standard deviations are also determined by the Stat*Analyst. In the data gathering modes, the average is calculated as:

(EQ. 9) $$\bar{x} = \frac{\sum_{i=1}^{N} x_i}{N}$$

Where $\bar{x}$ = Average x
x_i = "i" th sample
N = Number of samples

The standard deviation, σ, is defined as:

(EQ. 10) $$\sigma = \sqrt{\frac{\sum_{i=1}^{N} (\bar{x} - x_i)^2}{N-1}}$$

which may be rewritten:

(EQ. 11) $$\sigma = \sqrt{\frac{\sum_{i=1}^{N} x_i^2 - N\bar{x}^2}{N-1}}$$

Finally, in the CAP mode, the capacitance is calculated from the measured charge by assuming the device within the Faraday Cup is at a potential of 100 volts:

(EQ. 12) $$C = \frac{Q}{100 \text{ Volts}}$$

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Chapter 6

Remote Mode Operation via the RS-232 Port

6.0 Introduction

The Remote Mode allows a computer or terminal to run the Stat*Analyst remotely via the RS-232 connector on its rear panel. Decay tests along with float tests may be executed remotely. All float and decay test parameters discussed in sections 3.1 and 3.2 may also be set. In addition, the sensor plate may be grounded externally, with the internal offset optionally set. Finally, all processed data may be accessed along with the sampled data points from decay, float, charge, capacitance or voltage tests.

For connector detail consult section 8.22

6.1 Personal Computer Software

As an added convenience Pinion Corporation has provided a special package of MS-DOS PC ready software to interface directly with the Stat*Analyst in remote mode. This package comes bundled with the unit as a standard feature.

With this software you can quickly and easily access data for spreadsheet or database work without having to use the low level language and formats which follow. For more details consult the software documentation.

6.2 Command Interface

The Stat*Analyst remote command interface consists of ASCII character sequences. All commands are a single character followed by a number of option fields separated by commas, and are terminated with a new line (ASCII 10). When the Remote Mode is enabled, the Stat*Analyst waits for external commands, examines them once they are received for correct syntax, and responds with the ASCII character '.' if the command was recognized and will be executed. If the command was invalid, or not recognized, the Stat*Analyst responds with the ASCII character '?'. When the Stat*Analyst is ready for the next command, it sends out a new line followed by the ASCII character '>'.

The correct operation of the Remote Interface connection can be verified by sending a new line to the Stat*Analyst when it issues its ready character ('>'). If the interface is valid, the Stat*Analyst will simply respond with its ready sequence again. Any command issued remotely can be terminated by ,sending a BREAK to the Stat*Analyst.

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6.21 Command Formats

There are seven commands that the Stat*Analyst remote interface supports: **Decay Test, Float Test, Zero Plate, Processed CPM Data, Sampled CPM Data, Processed COA Data** and **Printer Plot Format.** All commands are terminated with a new line character. All parameters for each command are separated by commas.

Remote Decay Command: 'D'

The Remote Decay Command is used to initiate either a positive or negative decay test from a remote location. The command has the following format (note that the space after the D is shown for clarity and should not appear in the actual command):

D Pol,StartV,EndV,Length,ImmStart,RMSmode,RMSperiod

Pol is the polarity of the test and is either the ASCII character '+' or '-'.

StartV is the starting voltage of the test and may range from 1 to 50, which corresponds to the start voltage divided by 100.

EndV is the ending voltage of the test used in the decay time calculation and may take values in the range 0 to 158. A value of 0 corresponds to an end voltage of 1/e of the start voltage. Values in the range 1 to 99 are taken as a percentage of the starting voltage. Values in the range from 100 to 109 correspond to fixed end voltages in the range from 10 to 90 volts according to the formula (ENDV - 100) * 10. Values in the range 110 to 158 correspond to fixed voltages in the range 100 to 4900 volts according to the formula (ENDV - 109) * 100. For example, an ENDV value of 105 is translated to a fixed end voltage of 50 volts while an ENV value of 142 means an fixed end voltage of 3300 volts.

Length is the length of the test and may take the values 0 to 12 which correspond to test lengths 1, 2, 5, 10, 20, 50, 100, 200, 500, 1000, 2000, 5000, and 10,000 seconds respectively.

ImmStart is used to activate the immediate start option. To run a decay test with the immediate start option on, Imm Start is set to an ASCII 'Y'. To disable the immediate start option, specify an ASCII 'N'.

RMSmode indicates whether the decay test should be run in normal or RMS mode. To activate RMS mode, specify an ASCII character 'Y'. To run in normal voltage mode, specify an ASCII character 'N'.

RMSperiod specifies the number of data points to use if the RMS Mode is active to calculate an RMS voltage. Note that this field must be present even if RMS Mode is 'N' or off. RMS Period values are in the range 1 to 201.

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As an example, the following ASCII string will instruct the Stat*Analyst to perform a positive decay test from 4300 volts with an end voltage of 10% and a length of 1000 seconds. In addition, immediate start is off, voltage mode is normal, and the RMS period is set to 50 points:

D+,43,10,9,N,N,50

Remote Float Command: 'F'

The Remote Float Command is used to initiate a float test from a remote location. The command has the following format (note that the space after the F is shown for clarity and should not appear in the actual command):

F Mag,Length,AutoZero,FloatLength

Mag is the maximum voltage expected for the test. This sets the internal programmable gain amplifier gain, and may range from 1 to 500 and corresponds to the maximum voltage divided by 10.

Length is the length of the float test. It ranges from 0 to 9 which corresponds to 125 msec, 500 msec, 1, 2, 5, 10, 20, 50, 100, and 200 seconds respectively.

AutoZero is used to specify the plate grounding options that occur before the float test runs. A value of 0 instructs the Stat*Analyst to ground the floating plate and set the internal offset. A value of 1 tells the Stat*Analyst to only ground the plate and do not set the internal offset, while a value of 2 instructs the Stat*Analyst to not ground the Stat*Analyst floating plate.

FloatLength ranges from 0 to 99 and tells the Stat*Analyst how long to delay at the start of a float test in seconds.

As an example, the following ASCII string instructs the Stat*Analyst to perform a float test with a maximum voltage magnitude of 100 volts and a test length of 10 seconds. In addition, the plate is grounded, the internal offset is set, and the plate is allowed to float 10 seconds before the data collection process begins:

F10,5,0,10

Remote Zero Command: 'Z'

The Remote Zero Command is used to ground the Stat*Analyst floating plate from a remote location. It allows the internal offset to be optionally set. The command has the following format (note that the space after the Z is shown for clarity and should not appear in the actual command):

Z ?

? is an ASCII 'Y' if the offset should be set and an ASCII 'N' if the offset should not be set.

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As an example, the following ASCII string grounds the Stat*Analyst plate and does not set the internal offset:

ZN

CPM Processed Data Command: 'P'

The CPM Processed Data Command is used to retrieve data from the Stat*Analyst following a Decay or Float Test. The command has the following format:

P

The command first returns an ASCII character to identify the data being returned. A '0' indicates that no data is currently stored in the Stat*Analyst. Either no decay or float test has been run, or the last test was not run to completion. A '1' or '2' indicates that the last test run was a negative or positive decay test, respectively. The data following this identity character has the format:

,TimeConstant,FinalVoltage

TimeConstant is the calculated decay time in seconds. A decimal point will be present in this value.

FinalVoltage is the plate voltage at the end of the Decay test in volts.

An identity character of '3' indicates that float data is being returned with the following format:

,Average,AC,RMS,Minimum,Maximum

Average is the average test voltage in volts.

AC is the AC test voltage in volts.

RMS is the RMS test voltage in volts.

Minimum is the minimum voltage recorded during the test.

Maximum is the maximum voltage recorded during the test.

As an example, if a positive decay test was just run, with a decay time of 10.23 seconds and a final voltage of -10 volts, the Read Processed Data Command will return the ASCII string:

1,10.23,-10

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If a float test was the last test performed, with an average of 0 volts, an AC value of 5 volts, an RMS value of 5 volts, a minimum value of -22 volts, and a maximum value of +22 volts, the Read Processed Data Command will return the ASCII string:

3,0,5,5,-22,22

CPM Sampled Data Command: 'S'

The CPM Sampled Data Command is used to retrieve data from the Stat*Analyst following a Decay or Float Test. The data returned is the 201 sampled points that are taken every time a test is executed. The command has the following format:

S

The command first returns an ASCII character to identify the data being returned. A '0' indicates that no data is currently stored in the Stat*Analyst. Either no decay or float test has been run, or the last test was not run to completion. A '1' or '2' indicates that the last test run was a negative or positive decay test, respectively. An identity character of '3' corresponds to float data. The data following this identity character has the format:

,Data1,Data2,...,Data201

DataN is the **N**th data sample in volts.

COA Processed Data Command: 'E'

The COA Processed Data Command is used to retrieve data from the Stat*Analyst following a Charge, Capacitance or Personnel Voltage Test. The command has the following format:

E N

Where N is an integer value as follows:

0	Retrieves Charge Data
1	Retrieves Capacitance Data
2	Retrieves Personnel Voltage Data

The command first returns an ASCII character to identify the data being delivered. A '0' confirms that Charge Data follows, '1' confirms that Capacitance Data follows and '2' confirms that Personnel Voltage Data follows. The data stream immediately after these identity characters has the format:

,Mode,NumberSamples,Average,StdDeviation,Data1,Data2 ...

Mode designates whether the stored data is manually set or is statistically determined from raw data. 'M' confirms manual mode, 'S' confirms statistical mode.

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NumberSamples is the number of actual readings processed.

Average is the calculated or given average value.

StdDeviation is the calculated standard deviation.

DataN ... is actual raw data values taken in statistical mode, received in actual order of entry (N).

Remote Printer Plot Command: 'G'

The Remote Printer Plot Command is used to designate the form which will be used to print hardcopy of the last test performed on the attached printer. The command has the following format:

G ?

Where **?** is an ASCI character as follows:

Y	Produces Full Page Plots
N	Produces LCD Size Plots (these plots will be reconstructed on the LCD screen and will require some additional processing time)

6.22 REMOTE Mode Error Messages

In the event of an error due to hardware malfunction during remote mode operation, the Stat*Analyst will issue a single "E" return character. The most common causes are listed below:

- Insufficient high voltage generation during a DECAY test.
- Excessive internal offset voltage required in a FLOAT test.
- Excessive internal offset voltage required in a ZERO reset.
- No data of the requested type currently in memory.
- External printer is not ready, off-line or is not connected properly.

6.23 Activating the Remote Mode

From the Main Menu enter the Remote Menu by pressing the REMOTE function key. The Remote Communications Menu will be displayed. To start the Remote mode given the parameters listed, press the START function key. The Stat*Analyst responds with the following message:

Remote Mode Active

To end the Remote Mode, hit the Exit Menu Key.

6.24 Configuring the Remote Mode

There are 5 configurable parameters for the Stat*Analyst Remote Mode. They are the **Baud Rate**, the number of **Data Bits**, the number of **Stop Bits**, **Parity**,

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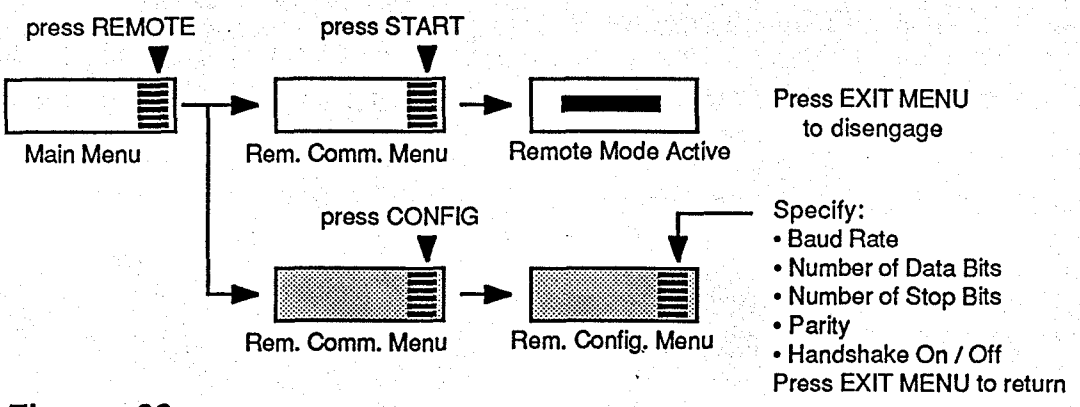


Figure 60:

and the **Handshake** mode. To change any of the parameters, press the CONFIG function key on the Remote Communications Menu. Figure 61 shows the Config Menu, use the up and down arrows to select the parameter to change, and use the LOWER and HIGHER function keys to cycle to the desired value.

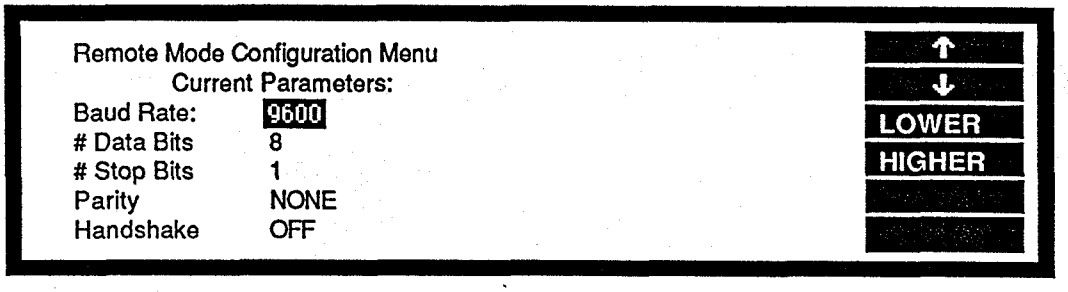


Figure 61: Remote Mode Configuration Menu

Baud Rate - This value determines the rate at which the data bits will be transmitted to and from the remote computer. The available baud rates are 50, 75, 110, 150, 300, 600, 1200, 2400, 4800, and 9600.

Number of Data Bits - This determines the number of data bits present in data transmission. It is either 7 or 8 bits.

Number of Stop Bits - This sets the number of stop bits sent at the end of each character transmission. It may be either 1 or 2 bits.

Parity - Parity is used to double check if there were any bit errors in transmission. Its possible values are "EVEN", "ODD", "1" or "0" or "NONE".

Handshake - This option enables or disables hardware handshaking. If OFF, no hardware handshaking is performed and data transmission will run at the maximum rate. The Stat*Analyst can run at 9600 baud with no handshaking required. If the option is ON, then both the DSR and CTS pins in the RS-232 interface must be high for the Stat*Analyst to initiate transmission to the remote device.

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Chapter 7

Maintenance Instructions and Procedures

7.0 General Recommendations

The Stat*Analyst is a precision measurement instrument and as such should be placed on a routine calibration schedule. In order to simplify this process the Stat*Analyst has built-in step-by-step, easy to follow procedures. Because of this easy access it may be tempting for users to make adjustments between formal calibrations - this sort of activity should be discouraged as it may diminish the overall instrument calibration integrity.

A copy of the Stat*Analyst Calibration Manual is included with each unit and is a separate document from this Operator's Manual. It is suggested that the Calibration Manual be retained by your particular calibration facility. If your company does not have in-house calibration service, Pinion Corporation offers full calibration services - contact our Customer Service Dept. for details and arrangements.

7.1 Care and Maintenance

As is the case with sensitive electronic instruments of all types, reasonable care should be exercised when handling the Stat*Analyst and its input devices.

Cleanliness is most important when caring for the Stat*Analyst's ultra-high impedance input devices. Even seemingly minor amounts of dust, dirt or smoke which settle on highly insulative surfaces can cause measurement difficulty. The TEFLON® stand-offs supporting the CPSA charge plate may be cleaned using the procedures called out in the separate Stat*Analyst Calibration Instructions, but recalibration is highly recommended if cleaning is required.

The Stat*Analyst Control Unit may be carefully wiped with cleaning solutions which are safe for use on and around acrylic plastics. **The LCD display window should not be cleaned with any type of abrasive pads or cleansers.**

7.2 Built-in Diagnostics and Main Configuration Status

Self Diagnostics is performed automatically each time the Stat*Analyst is turned on, however, the user may find it necessary to reconfirm status during long periods of use. To facilitate this the Stat*Analyst has easily accessible sub-system diagnostic menus.

7.21 Main Configuration Status

Before beginning diagnostics it may be worthwhile to check the main configuration parameters: printer plot format and the real time clock. As shown in the following Operator's Guide this menu is accessible from either main menu (CPM or COA) by pressing the CONFIG key.

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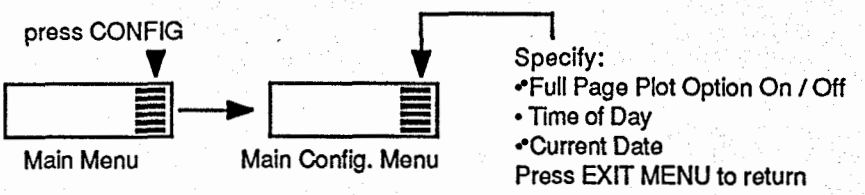


Figure 62:

7.22 Diagnostics Programs

The following general diagnostic functions are available to the user from the Stat*Analyst Maintenance Menu.

OFFSET (Internal Offset Voltage Reset): The Stat*Analyst's main instrumentation amplifier is the keystone of all its analog measurement functions. Since most measurements are made to an absolute zero volt reference, it is essential that this sub-system has ZERO offset volts. This zeroing function is performed automatically (when so configured) with each Float test, however the user may wish to periodically reconfirm this condition. This need is served directly by the OFFSET key under the maintenance menu. Following the MAINTENANCE Operator's Guide below will lead to the Internal Offset Menu which displays the current status.

There are four functional parameters presented. The *Sensor (with offset)* indicates the current reading from the floating plate sensor in volts with the offset taken into account. This is the value that is used in decay and float tests. The *Sensor (no offset)* is the raw reading from the sensor. The *Current offset* is the value that the AIM has stored internally. The *Current gain* is the gain factor being used to read the currently connected sensor. For raw sensor readings below 500 volts, a gain factor of 10 is used to improve resolution. Above 500 volts, a gain factor of 1 is used.

To set the Internal Offset, the ZERO function key is used. It will connect the solenoid to the top plate to make sure it is discharged, and then calculate and store a new offset. Internally, the Stat*Analyst can compensate for a sensor offset of up to 170 volts in magnitude. Above this value, an error message is generated, and the sensor may have to be recalibrated.

CALIB (Sub-System Calibration Instructions): As previously discussed, it is highly recommended that operation of these programs be referred to properly equipped facilities under a routine calibration program (see section 7.0). Calibration instruction support is published in a separate Calibration Manual.

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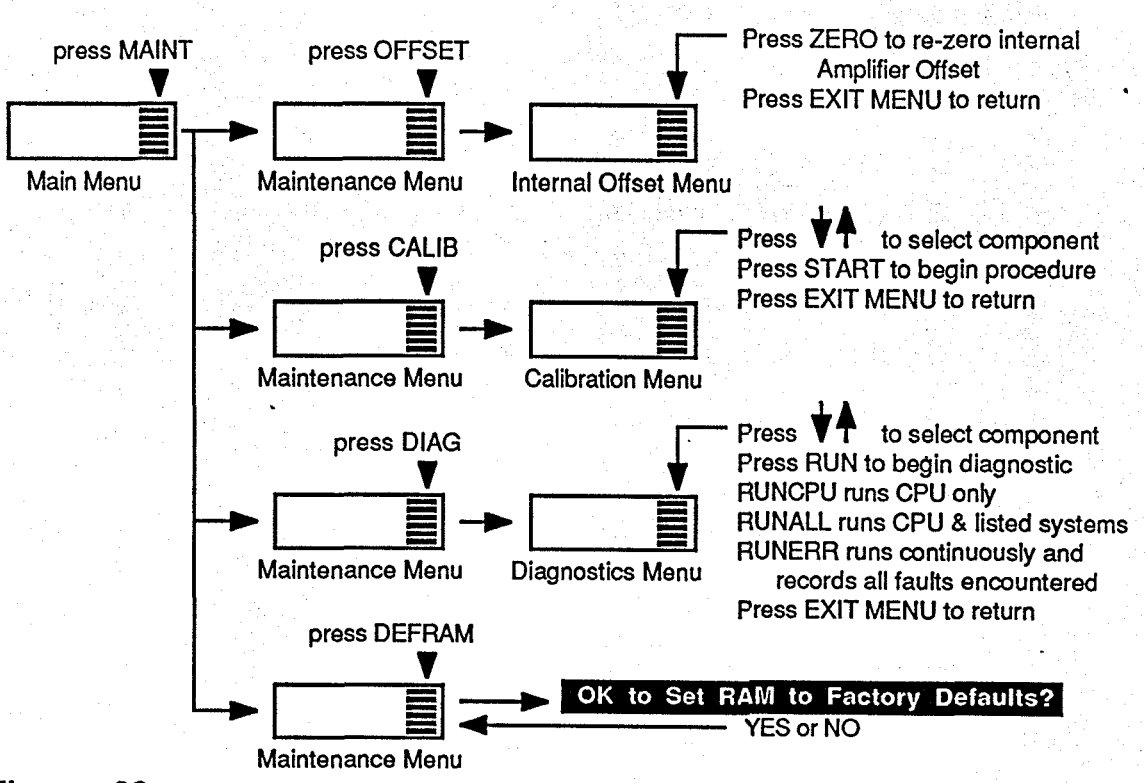


Figure 63:

DIAG (Sub-System Diagnostic Tests): There are seven major digital and/or analog sub-systems operating within the Stat*Analyst System which may be tested from the Diagnostic Menu. Four of these sub-systems may be tested in **either** the CPM or the COA Operating Mode:

PROM	Tests the checksum for the 5 Software PROMs.
RAM	Tests the main RAM (data) memory.
ANALOG	Tests the Analog to Digital conversion accuracy.
EXP. RAM	Tests the expanded RAM (data) memory.

Two of these systems relate only to Charge Plate operation and therefore may only be tested in CPM Operating Mode:

HIGH VOLTAGE	Tests the charge plate's high voltage power supply.
SENSOR	Tests the charge plate's internal fieldmeter.

In order to test the last sub-system the Stat*Analyst must have the Personnel Voltage Tester (PVT-100SA) attached and the 100 volt reference probe connected in the COA Operating Mode:

100 V OUT	Tests the 100 volt reference used to measure capacitance. (Touch the 100 volt probe tip to the PVT-100SA input plate).

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To run an individual test, first select it using the up/down (arrow) function keys. Press the RUN function key to start the test. To continually test the Stat*Analyst, use the RUNALL function key. This cycles through all five tests continuously until the test is interrupted with the EXIT MENU function key. A count of the number of test loops is maintained in the upper right hand corner of the LCD display. If a failure should occur, the failing test is left on the screen, no further testing is performed, and the internal alarm is sounded.

DEFRAM (Reset RAM to Factory Default Values): To set all internal parameters to the factory default conditions, the DEFRAM function key may be used. The Stat*Analyst prompts the user to make sure that this is a deliberate action to prevent RAM from accidentally being reset.

7.23 Battery Power Interruption Restart Procedure

Since the RAM memory stores configuration and other important operating data, it is important to confirm the integrity of the information stored there after any sort of power interruption. This is easily done by running one complete instrument diagnostic loop:

- From the Main Menu select MAINT
- From the Maintenance Menu select DIAG
- From the Diagnostic Menu select RUNERR
- Run until the loop counter shows at least 2 loops
- Exit back to the Main Menu and proceed normally

Failure to observe this procedure could lead to an operational "lock-up" condition of the microprocessor where the function keys seem to be dead. This condition can be terminated by turning the main power switch off and back on, causing the Stat*Analyst to restart. After the normal startup sequence go directly to the procedure above in order to avoid another "lock-up" condition.

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Chapter 8

Stat*Analyst General Specifications

8.0 Software

Current Software is version 1.0, dated 4/5/91. Upgrades will be made available as refinements and new features are developed - consult Pinion Customer Service for updates and details. The entire software package is contained on 4 PROMs located in the base of the main Stat*Analyst Control Unit.

8.1 Hardware

8.11 Main Control Unit

Microprocessor: 4 MHz NSC800 8 Bit CPU

Memory: 88K PROM (program software)
8K battery backed RAM (data storage)
8K battery backed RAM Extension (data storage)

Printer Interface: CENTRONICS® Parallel

Remote Interface: RS-232C Serial

Main Battery: 12Volt, 3Amp Hour Sealed Lead Acid Battery

Battery Charger: 700 ma (max)

Battery Life: ~ 4 hours

Control Unit Physical:

Width:	18.8 in.
Height:	5.5 in.
Depth:	10.0 in.
Weight:	16.5 lbs

100 Volt Reference Output: 100VDC ± 2% (current limited with 1 megohm series resistance)

Environment:

Operating Temperature:	0 - 40 degrees Celsius
Humidity:	up to 85% RH (non-condensing)

Power: 110/220 volts (field selectable), 50/60 Hz

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8.12 Charge Plate Monitor: CPSA

Sensor Unit Physical:

Width:	6.1 in	Sensor Plate Isolation:	$> 10^{14}\ \Omega$
Height:	4.0 in	Sensor Plate:	6" x 6" Aluminum
Depth:	5.8 in	Sensor Capacitance:	20 pf ± 10%
Weight:	4 lbs		

Sensor Type: Electrostatic Fieldmeter, Vibrating Reed Type

Sensor Gain Accuracy: 1% at DC
3% to 20 Hz (Typ.)
10% to 60 Hz (Typ)

Sensor Settling Time: < 35 msec (to Spec)

Sensor High Voltage Source: –5000 to +5000 calibrated volts (current limited with 100 megohm series resistance)

Float Test Selectable Ranges:

Time Ranges:	0.125, 0.500, 1, 2, 5, 10, 20, 50, 100, 200 seconds
Voltage Ranges:	± 10 to ± 100 volts in 10 volt steps
	± 100 to ± 5000 volts in 100 volt steps

Decay Test Selectable Ranges:

Time Ranges:	1, 2, 5, 10, 20, 50, 100, 200, 500, 1000, 5000, 10000 sec.
Initial Voltage:	100 to 5000 volts (+ or –) in 100 volt steps
	1/e x Initial Voltage
	1 to 99% x Initial Voltage in 1% steps
	0 to 90 volts (+ or –) in 10 volt steps
	100 to 4900 volts (+ or –) in 100 volt steps

8.13 Personnel Voltage Tester: PVT-100SA

Sensor Unit Physical:

Height	3"
Width	4.25"
Depth	4.25"
Weight	1 lbs.

Voltage:

Displayed Value	Displayed Accuracy
0.00 - 1000 volts	± 1% + 1 volt
1000 - 3000 volts	± 5% + 5 volts
3000 - 6000 volts	± 10% + 10 volts
6000 - 10,000 volts	± 15% + 10 volts

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8.14 Faraday Cups: FC-100SA and FC-200SA

Sensor Unit Physical:	FC-100SA	FC-200SA
Height	5.5"	12.5"
Outside Diam.	4"	10"
Cup Inside Diam.	2.5"	8.75"
Cup Depth	2.5"	7"
Weight	2 lbs.	5 lbs.

Sensor Droop: 0.1 nc / minute (maximum); 0.052% / minute

Sensor Drift: .0002 nc / second (maximum)

Charge:	Displayed Value	Displayed Accuracy
	0.000 - 1.999 nc	0.6% + 0.002 nc
	2.00 - 19.99 nc	0.5% + 0.01 nc
	20.0 - 199.9 nc	0.5% + 0.1 nc

Capacitance:	Displayed Value	Displayed Accuracy
	0.00 - 19.99 pF	2.6% + 0.02 pF
	20.0 - 199.9 pF	2.5% + 0.1 pF
	200. - 1999 pF	2.5% + 1.0 pF

Temperature Coefficient: 0.04% / °C; +15 to +35°C

8.2 Port Specifications

8.21 Analog Output Port: Scale Factors

Cable Connector Required: male; BNC type

The Stat*Analyst Analog Output Signal is buffered raw sensor output. Buffer drive capability is 5 ma maximum load current. Nominal voltage swing is ± 10 volts. Signal is continuously available regardless of control unit sampling activity.

Zero reference is not absolute - the Stat*Analyst Control Unit performs the auto-zero function. On critical reference measurements a zero input reading should be taken to establish the corresponding analog signal reference point.

Scale factors for each analog function are as follows:

Charge Plate Monitor:	multiply signal by 573.4 to get volts
Personnel Voltage:	multiply signal by 1000 to get volts
Faraday Cup:	multiply signal by 20 to get nanocoulombs

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8.22 Connector Pin-out for RS-232 Port

Cable Connector Required: 25 pin male; D-Sub type

The Stat*Analyst transmits serial data on pin 3 and receives data on pin 2.

PIN	SIGNAL	PIN	SIGNAL
1	GND	14	NC
2	RxD	15	NC
3	TxD	16	NC
4	CTS	17	NC
5	RTS	18	NC
6	DTR	19	NC
7	GND	20	DSR
8	DCD	21	NC
9	NC	22	NC
10	NC	23	NC
11	NC	24	NC
12	NC	25	NC
13	NC		

8.23 Connector Pin-out for Centronics Printer Port

Cable Connector Required: 36 pin male; standard printer type

PIN	SIGNAL	PIN	SIGNAL
1	STROBE /	2	GND
3	DATA0	4	GND
5	DATA1	6	GND
7	DATA2	8	GND
9	DATA3	10	GND
11	DATA4	12	GND
13	DATA5	14	GND
15	DATA6	16	GND
17	DATA7	18	GND
19	NC	20	GND
21	BUSY	22	GND
23	NC	24	GND
25	NC	26	NC
27	NC	28	NC
29	NC	30	GND
31	GND	32	TYPE
33	GND	34	NC

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9.0 Pinion Warranty and Factory Services

Your Stat*Analyst is covered by a Factory Warranty (copy below) against defect in materials or workmanship for a period of ONE YEAR from date of shipment to you, the customer.

Pinion Corporation also offers a factory service and calibration program to help keep your Stat*Analyst in fine operating condition. Three levels of calibration certification are available:

Standard Factory Issue
Certified to NIST
Certified to MIL-45662-A

Consult our Customer Service Dept. for warranty service, repair and/or calibration costs. Upon receipt, our Calibration Department will carefully inspect your instrument and determine if any repairs are indicated, if so we will advise you of the condition and additional costs, if any, before proceeding.

Pinion Corporation stands ready to serve you the customer in any way which we can. If you have questions or comments about the Stat*Analyst or any other Pinion Product please don't hesitate to call on us.

Our business hours are 8:00AM to 5:00PM Eastern Time, Monday thru Friday except for holidays or inclimate weather. Ask for Customer Service:

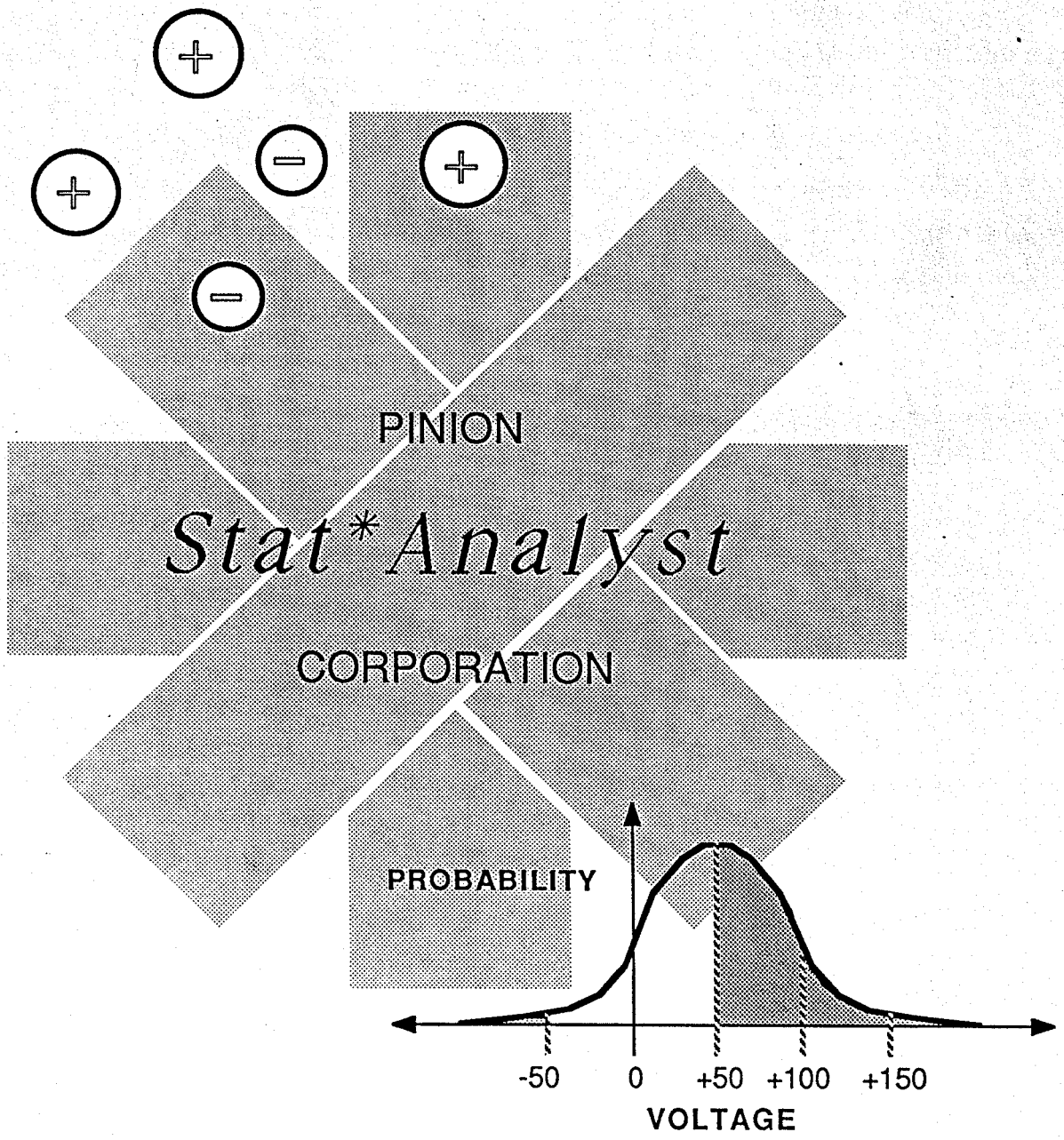
Phone:	215 - 721 - 7125	Write to:	Pinion Corporation
FAX:	215 - 721 - 7156		150 South Front Street
			Souderton, Pa. 18964

PINION LIMITED WARRANTY POLICY

Pinion products are warranted to the original purchaser to be free of defects in materials and workmanship for various time periods as indicated in Pinion literture, instructional manuals and/or packaging. You should consult the literature, instructions, packaging for each product to determine the specific warranty period for that product.... If a Pinion product proves to be defective in materials or workmanship within its specified, published warranty period, it will be repaired or replaced (at Pinions option) free of charge or expense, provided that it is returned to Pinion transportation charges prepaid.

This warranty does not extend to products which have been subjected to misuse, abuse, neglect, accident, alteration, improper installation, or use in violation of the printed instructions furnished by Pinion. This warranty neither applies to batteries, nor damage to the product caused by the use of faulty batteries. Final determination as to whether any product is actually defective rests solely with Pinion. This warranty is expressly in lieu of all other agreements and warranties, expressed implied, or statutory, and Pinion has no other obligations or liabilities in connection with this product in no event shall Pinions obligation or liability hereunder exceed the purchase price of this product. PINION SHALL NOT IN ANY EVENT BE LIABLE FOR ANY INCIDENTAL OR CONSEQUENTIAL DAMAGES. This warranty gives you specific legal rights, and you may also have other rights which vary from state to state. Some states do not allow the exclusion or limitation of incidental or consequential damages or implied warranties, so the above limitation or exclusion may not apply to you.

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STATISTICAL ESD PROTECTION ANALYZER

Calibration Instructions

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1.0 General Calibration Requirements

Calibration should only be performed by qualified personnel with proper equipment. Some procedures which follow require operation of high voltage sources which may present LETHAL SHOCK HAZARDS - ONLY PROPERLY TRAINED TECHNICIANS should attempt these operations !!

The calibration procedure is included as part of the Stat*Analyst Software for convenience but this Calibration Manual should be followed should any discrepancies or conflicting instructions be evident.

The Stat*Analyst and sensors should be allowed to warm up 15 to 20 minutes before attempting calibration. It is important that the calibration be performed in the sequence, with the main unit being calibrated first, then the sensors. Stat*Analyst power supply adjustments are not critical and should not require adjustment in the field, but procedures are included for completeness.

Equipment Required

Multimeter	equal to Keithley 197
Programmable Current Source	Keithley 220
Frequency Counter	precision type; minimum of 6 digit accuracy
Low Voltage Digital Calibrator	+10.0000 to –10.0000 volts, ± 1%
High Voltage Supply	0 to +5000 volts, ± 1%
High Voltage Calibrator	100 volts ± 0.1%

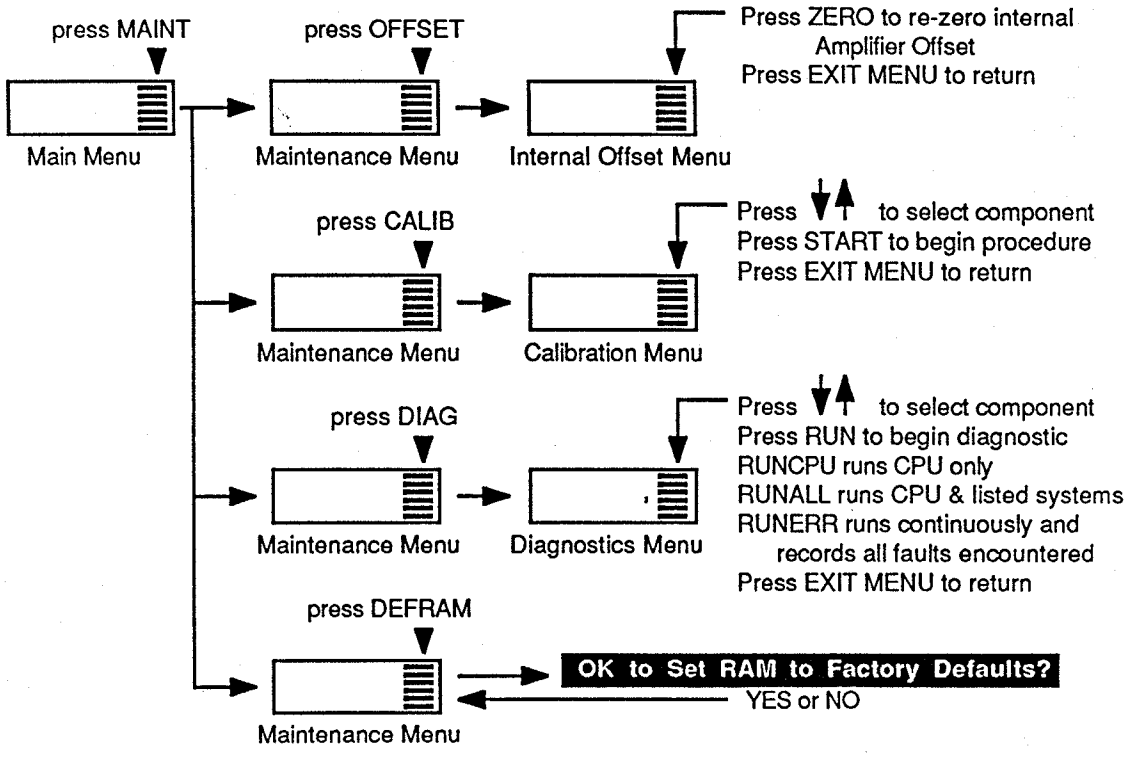


FIG. 1: Diagnostics & Calibration Menus

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To enter the calibration mode from the main power-on screen press the **MAINT** function key followed by the **CALIB** function key. (See FIG. 1)

There are nine areas in the Stat*Analyst that require calibration: the Programmable Operation Amplifier, Analog to Digital Converter, External Sensor Offset, External Sensor Gain, External Sensor Frequency, Real Time Clock, External Sensor Power, and the Battery Charger. The Stat*Analyst provides a separate routine to guide the user through the various steps necessary for calibrating each area, with step by step instructions printed on the LCD screen. To start a calibration routine, select the desired test with the **up/down** arrow function keys and pressing the **START** key.

2.0 Main Unit Calibration

Items requiring calibration on the "Analog" board are the Prog Op Amp, A/D and D/A. The board is accessed by removing the two screws from the rear of the unit that hold the top cover on. The cover is then lifted from the rear and slid back slightly. The internal cables are long enough to rest the lid's two rear tabs in the slots in the front of the base. There are two boards plugged into the Main CPU board. The closest to the front is the "Analog" board and the second is the "Stat*Analyst Expansion" Board. There are five of seven pot locations populated on the board. On the various calibration screens provided, the pots are referred to as "–", "0", and "X". The "–" refers to the vacant pot locations on the left, the "0" refers to the pot to be adjusted and "X" refers to the other pots. See FIG. 2 for pot locations.

2.1 Prog Op Amp (Prog Amplifier Offset Calibration):
(SENSOR MUST BE DISCONNECTED)

1. Jumper TP1 & TP9 on the Analog board
2. Place voltmeter +lead on TP2 and the –lead on TP9
3. Adjust R9 [pot location: – – **XX XXO**] until the voltmeter reads 0.000 ±.002 volts (See Fig. 2)

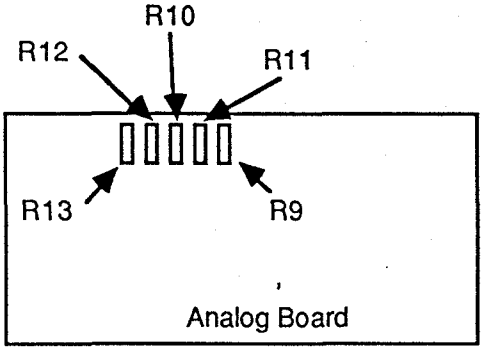


FIG. 2: Analog Board Pot Locations

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2.2 A/D (A/D Converter Calibration):

(SENSOR MUST BE DISCONNECTED)

1. Place voltage source +lead on TP1 and the –lead on TP9.
2. Set the voltage source to –9.9976 volts.
3. Adjust R11 [pot location: – – **XX XOX**] to give a transition on the Stat*Analyst display from 0 to 1.
4. Depress Exit Menu Key to continue.
5. Set the voltage source to +9.9927 volts.
6. Adjust R10 [pot location: – – **XX OXX**] to give a transition on the Stat*Analyst display from 4094 to 4095.

2.3 D/A (D/A Converter Calibration):

(SENSOR MUST BE DISCONNECTED)

1. Place voltmeter +lead on TP5 and the -lead on TP9
2. Adjust R13 [pot location: – – **OX XXX**] until the voltmeter reads -10.000 ± .002 volts.
3. Depress Exit Menu Key to continue.
4. Adjust R12 [pot location: – – **XO XXX**] until the voltmeter reads +9.995 ± .002 volts.

2.4 CPU Real Time Clock:

The real time clock crystal frequency is adjusted by trim capacitor C8 on the Stat*Analyst Main CPU board. See FIG. 3 for the location of TP1 and C8. Access to the CPU board is the same as the "Analog" board. See preceding paragraphs.

1. Attach frequency counter to TP1 of the CPU Board.
2. Configure the frequency counter on falling edges.
3. Adjust C8 until a frequency of 1.00000Hz is obtained.

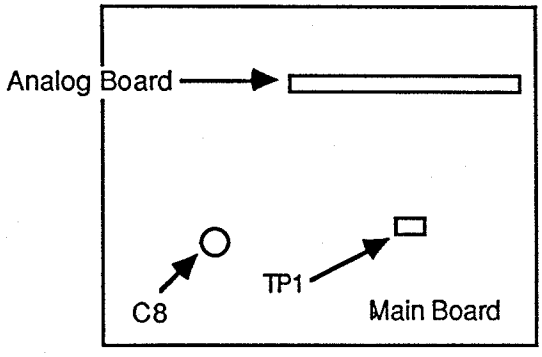


FIG. 3: Main Board

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2.5 Power Supply Calibration

The **Sensor Power** and the **Battery Charger** adjustments are located on the power supply board. These values are not critical and should not require field adjustment but procedures are included for completeness. To access the power supply board remove the two screws on the rear which secure the top lid. Disconnect the four cables which come from the assemblies in the lid. Place the lid aside. Remove the twelve screws from all four sides of the base assembly. Lift the top up carefully and disconnect the ON/OFF switch cable from the PCB. See FIG. 4 for locations.

2.51 Sensor Power:

Jumper pins 1 & 2 of the ON/OFF connector on the PCB:

1. Place the +lead of the voltmeter on TP2 of the power supply board and the –lead on TP1. (See FIG 4).
2. Adjust P2 until a voltage of +8.60 ± .05 volts is obtained.

2.52 Batt Charger:

Jumper pins 3 and 4 of the ON/OFF connector on the PCB:

1. Place Voltmeter +lead on TP3 of the power supply board and the –lead on TP1.
2. Adjust P1 until a Voltage of +15.7 ± .1 volts is obtained.

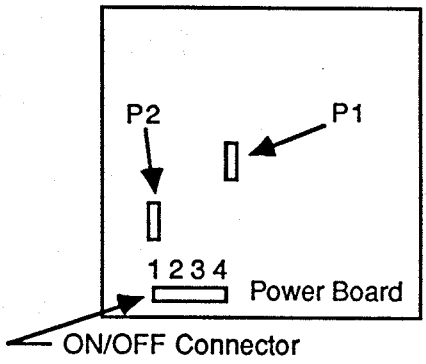


FIG. 4: Power Board

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3.0 Sensor Calibration

Sensor Calibration should only be done FOLLOWING the Main unit calibration. Sensor Offset and Sensor Gain apply to the three types of sensors available, each procedure being different depending upon the sensor attached. Sensor frequency applies only to the Charge Plate Monitor Sensor. Sensors should not be connected or disconnected with the power on.

3.1 Charge Plate Monitor Sensor

The adjustments require the sensor interior to be exposed. This is accomplished by carefully pulling the floating plate from its standoffs on the sensor. Remove the four screws at the corners. The entire assembly can then be lifted out of the case and set across the top of the case with the internal components exposed. Care should be taken to ensure clearance for the solenoid assembly when removing. See FIG. 5 for the location of the three adjustment pots (R38, R5 and R6).

3.11 CPM Sensor Frequency:

1. Attach Sensor with interior exposed and floating plate re-installed.
2. Connect frequency counter to IC A3 pin 10 or 11.
3. Adjust R6 until a frequency of 10.245 ± .01 kHz is obtained.

3.12 Sensor Offset:

1. Attach sensor with interior exposed and floating plate re-installed.
2. Jumper the sensor's floating plate to ground.
3. Adjust R38 until a reading of 0 ± 5 volts is obtained.
   Display indicates voltage.

3.13 Sensor Gain:

1. Attach sensor with interior exposed and floating plate re-installed.
2. Apply +5000 volts ± 1% to the sensor floating plate.
3. Adjust R5 until a reading of 5000 ± 10 volts is obtained.
   Display indicates voltage.

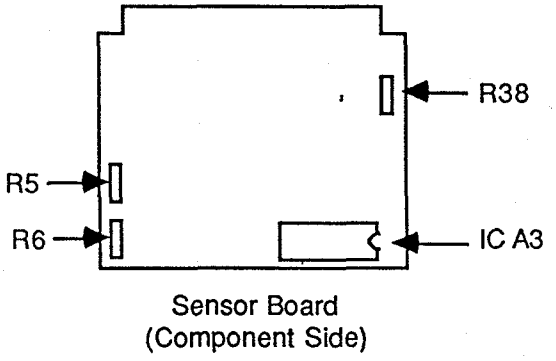


FIG. 5: CPM Sensor Board

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3.2 Faraday Cup Sensor - FC100SA/200SA

Calibration of a charge measurement device such as a Faraday Cup requires a special technique to be able to accurately meter the amount of charge delivered to the cup. If you are not familiar with charge measurement methods please refer to section 5.0 for a detailed description of the charge generation procedures employed below.

Remove the inner cup by removing the conductive pad at the bottom of the cup. Remove the screw(s) holding the cup to the base. The PC board is now accessible for calibration. See FIG. 6 for locations

3.21 Sensor Offset:

1. Attach the sensor with the inner cup removed.
2. Power up the unit and wait 15 minutes for the equipment to warm up.
3. Jumper the **base** of the spring loaded pin to the ground tab (GP1) near the sensor connector.
4. Place the voltmeter +lead on TP1 near P4 (See FIG. 6) and the –lead of the meter to the Ground terminal GP1.
5. Adjust P2 (coarse) and P1 (fine) to obtain a reading of 0.00 ± .01 mV.
6. Connect the voltmeter +lead to TP2 next to P5.
7. Adjust P5 to obtain a reading of 0.0 ± .1 mV.

3.22 Sensor Gain:

The directions shown on the Stat*Analyst display should be reviewed, but in order to display and view the nc value in this calibration step it is necessary to put the Stat*Analyst in the Charge, Continuous Read mode.

1. Connect the voltmeter to the "Sensor Out" BNC connector of the rear of the Stat*Analyst.
2. Connect the current source to the base of the spring loaded pin of the sensor and the ground and shield of the triax cable to the ground terminal (GP1).
3. Apply 195nc of charge into the sensor and adjust P4 until the sensor out voltage is within 0.05% of the calculated charge (ie: 195nc/20 = 9.750 ± .005 volts.
4. Check for symmetrical operation by applying -195nc of charge into the sensor. Adjust P4 accordingly and repeat steps 3 & 4 until symmetrical.
5. Reassemble cup. Install foam spacer 1 inch from the top of the inner cup. Allow 15 minutes settling time before use.

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3.23 Faraday Cup Verification Procedure:

1. Connect the Faraday Cup FC100/200SA to the calibrated Stat*Analyst. Let both instruments warm up for a minimum of 15 minutes.
2. Enter the **COA Statistics Menu: Capacitance**, depress the **CLEAR** function key to clear the data base. Take 10 readings zeroing the Faraday Cup before each reading by depressing the **ZERO** function key. Use the **READ** function key to take each reading. The distribution should have an average of 0 nc and a standard deviation of 0 or 1 nc.
3. Enter the **COA Charge Measurement Menu**, depress the **CONT Q** function key and and zero the cup by depressing the **ZERO** function key. After one minute, the current reading should be less than 0.012 nc.
4. Attach the programmable current source to the inner cup of the Faraday Cup. Set the current level for 39 na for a period of 5 seconds with a compliance voltage of 4 volts. Attach the voltmeter to the SENSOR OUT BNC connector on the rear of the Stat*Analyst. Allow the preset current to flow into the cup for the selected time period. After the current is turned off, note the peak voltage value at the SENSOR OUT BNC connector. Read the voltage after a one minute period. There should be no more than a 5 mv drop.
5. If it is not already known, measure the capacitance of the current source cable. Zero the of the Faraday Cup. Using the same parameters as step 4, generate 195 nc of charge and calculate the charge reaching the Faraday Cup. Measure the output voltage at the SENSOR OUT BNC connector. That value should be the calculated charge in nanocoulombs divided by 20 with 0.4% tolerance. For example, if the calculated charge was 194 nc, the nominal output voltage should be 9.7 volts.

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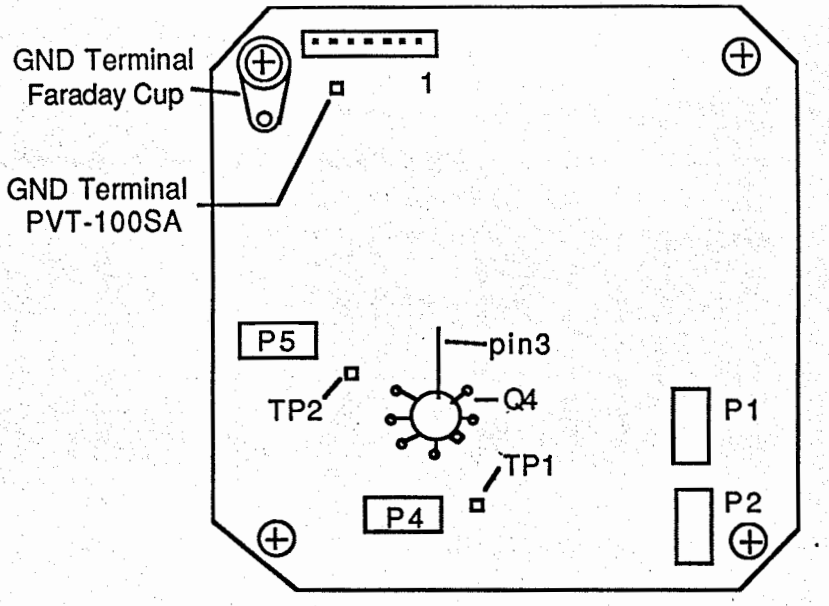


FIG. 6: PVT-100SA Sensor Board

3.3 Personnel Voltage Sensor - PVT100SA

Remove the four (4) screws holding the lid to the base. Carefully lift the lid from the base. The PC board is now accessible for calibration.

3.31 Sensor Offset:

1. Attach the sensor with the base removed.
2. Power up the unit and wait 15 minutes for the equipment to warm up.
3. Jumper Q4 Pin 3 to the ground terminal (GP1) near the sensor connector.
4. Place the voltmeter +lead on TP1 near P4 (See FIG. 6) and the –lead of the meter to the Ground terminal GP1.
5. Adjust P2 (coarse) and P1 (fine) to obtain a reading of 0.00 ± .01 mV
6. Connect the voltmeter +lead to TP2 next to P5.
7. Adjust P5 to obtain a reading of 0.0 ± .1 mV.

3.32 Sensor Gain:

The directions shown on the Stat*Analyst display should be reviewed, but in order to perform this calibration step it is necessary to put the Stat*Analyst in the **INTERNAL OFFSET MENU** screen under the **MAINT** mode.

1. With the voltmeter still connected to TP2 and GND as in step 6 above and Q4 pin3 still connected to ground depress the **ZERO** function key.
2. Remove the jumper between ground and Q4 pin3.
3. Apply 100 VDC ± 0.1% to the top of the sensor probe (attach the Gnd connection to the ground terminal GP1 provided next to the connector).
4. Adjust P4 until the sensor out voltage is 100.0 ± 0.5 mV.

(procedure continued - next page)

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5. Check for symmetrical operation by applying -100 VDC ± 0.1%. Adjust P4 accordingly repeating steps 3 & 4 until symmetrical.
6. Re-assemble the sensor. **Caution:** do not to tighten the four screws to the point of causing the lid to bind. A small amount of locktite on the screws will prevent loosening.

3.33 PVT-100SA Verification Procedure

1. Connect the PVT-100SA to the calibrated Stat*Analyst. Let both instruments warm up for a minimum of 15 minutes.
2. Enter the **COA Statistics Mode: Voltage.** Clear the existing data by depressing the **CLEAR** function key
3. Ground the isolated conductive plate on top of the PVT100SA to ground and depress the **ZERO** function key. Take 10 readings by depressing the **READ** function key. The average should be 0 or 1 volt with a standard deviation of 0 or 1 volt.
4. Remove the ground from the PVT-100SA and connect the output of the high voltage supply to the top of the sensor. Apply the voltages in the following table and verify the proper reading on the Stat*Analyst. **AUTO MODE** should be OFF and readings taken by depressing the **READ** function key. Both positive and negative voltages should be applied.

INPUT VOLTAGE (volts)	Stat*Analyst DISPLAY (volts)
500, 0.1%	495 - 505
1000, 0.1%	990 - 1010
3000, 0.5%	2850 - 3150
6000, 1.0%	5400 - 6600
8500, 1.5%	6220 - 9780

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4.0 Stat*Analyst Diagnostics

Diagnostics are supplied in the Stat*Analyst to aid in the verification of performance of the equipment as well as helping to isolate problems which may be encountered.

Diagnostics are included for the CPU board, analog board, expansion board and the CPM sensor. Diagnostics are performed in two ways:

1) During the power up routine, the CPU and Expansion board diagnostics are performed to verify PROM, RAM and Expansion RAM memory locations
2) From the main power on screen depress the **MAINT** function key followed by the **DIAG** function key

NOTE: *Do not shut off power to the Stat*Analyst during a RAM or Expansion Ram tests. These tests write and read to each memory location and then restores the original data to that location. Data may not be restored properly if powered down during these tests.*

The diagnostic tests provided are:

PROM — Checksum calculation for the Stat*Analyst Proms

RAM — Tests all main system RAM locations and restores original data

Analog — Tests the programmable operation amplifier, the internal analog multiplexer, the analog to digital converter and the digital to analog converter

Exp RAM — Tests the Expansion Board RAM locations and restores original data

High Voltage — Tests the high voltage DC/DC converter in the CPM sensor for adequate voltage generation

Sensor — Tests the solenoid and field meter portion of the CPM sensor

100V Out — Tests the 100VDC BNC output used for COA capacitance data gathering. You must apply the voltage to the sensor with the probe supplied. This test is NOT RUN IN DIAGNOSTIC LOOPS.

With the **CPM sensor** attached, the Stat*Analyst zeros the plate, then turns on the 100VDC output and allows you to measure the voltage for a period of 10 seconds. **NOTE:** For proper readings, apply the voltage with the probe supplied to the edge of the float plate after completion of zeroing function . Additional mass affects the capacitance of the plate thus affecting the measurement. With the **PVT-100SA** sensor attached, the Stat*Analyst turns on the 100VDC output and measures the voltage applied.

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The method above only gives a Pass/Fail indication due to the impedance of the sensor.

An alternate 100V confirmation method requires a 100pfd, 0.1% capacitor with 100V minimum rating and the Faraday Cup Sensor:

1. Configure the **AUTO READ** threshold to be 50pfd or less. (See Operations Manual - Measuring Capacitance for further detail).
2. Return to the COA Statistics Menu: Capacitance.
3. Depress the **ZERO** function key to zero the cup.
4. Attach the ground connection of the probe to one lead of the cap and touch the other lead with the probe point. Touch that lead to the inner cup of the Faraday Cup and immediately take a capacitance reading. A reading of 97. to 103. pf meets the specified performance requirement.

NOTE: *In order to measure the 100VDC output without using aStat*Analyst sensor, a high impedance voltmeter capable of measuring 100V is required. The 1MΩ series resistor at the 100V output drops up to 10% of the voltage when a voltmeter with an input impedance of 10MΩ is used giving a reading of around 90Volts. The input impedance of the voltmeter must be at least 100MΩ to obtain a proper measurement of 97 to 103 VDC.*

Diagnostic tests listed above may also be run continuously in a looping format (total number of loops executed is displayed in the upper right hand corner of the display). Three different operational diagnostic modes are as follows:

RUNCPU Runs All Stat*Analyst diagnostic tests except sensor tests. Operation terminates automatically when the first error is detected.

RUNALL Runs all Stat*Analyst diagnostic tests including the CPM sensor. Operation terminates automatically when the first error is detected.

RUNERR Runs all Stat*Analyst diagnostic tests including the CPM sensor. This program continues to run on an error but logs and indicates the number of errors each specific test is being performed.

NOTE: *Due to the nature of the COA sensors, no loop diagnostics are performed for COA Sensor Verification.*

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Cc may be measured by driving current down the current source cable while it is open circuited. Program the power supply to provide 3 na for 5 seconds (15nc) with voltage limiting set at 100 volts. Cc may be calculated as

$$CC = 15 \text{ nc} / V$$

where "V" is the peak GUARD voltage measured at the rear of the current source.

6.0 Pinion Warranty and Factory Services

Your Stat*Analyst is covered by a Factory Warranty (copy attached) against defect in materials or workmanship for a period of ONE YEAR from date of shipment to you, the customer.

Pinion Corporation also offers a factory service and calibration program to help keep your Stat*Analyst in fine operating condition. Three levels of calibration certification are available:

Standard Factory Issue
Certified to NIST
Certified to MIL-45662-A

Consult our Customer Service Dept. for warranty service, repair and/or calibration costs. Upon receipt, our Calibration Department will carefully inspect your instrument and determine if any repairs are indicated, if so we will advise you of the condition and additional costs, if any, before proceeding.

Pinion Corporation stands ready to serve you the customer in any way which we can. If you have questions or comments about the Stat*Analyst or any other Pinion Product please don't hesitate to call on us.

Our business hours are 8:00AM to 5:00PM Eastern Time, Monday thru Friday except for holidays or inclimate weather. Ask for Customer Service:

Phone: 215 - 721 - 7125

FAX: 215 - 721 - 7156

Write to: Pinion Corporation
150 South Front Street
Souderton, Pa. 18964

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