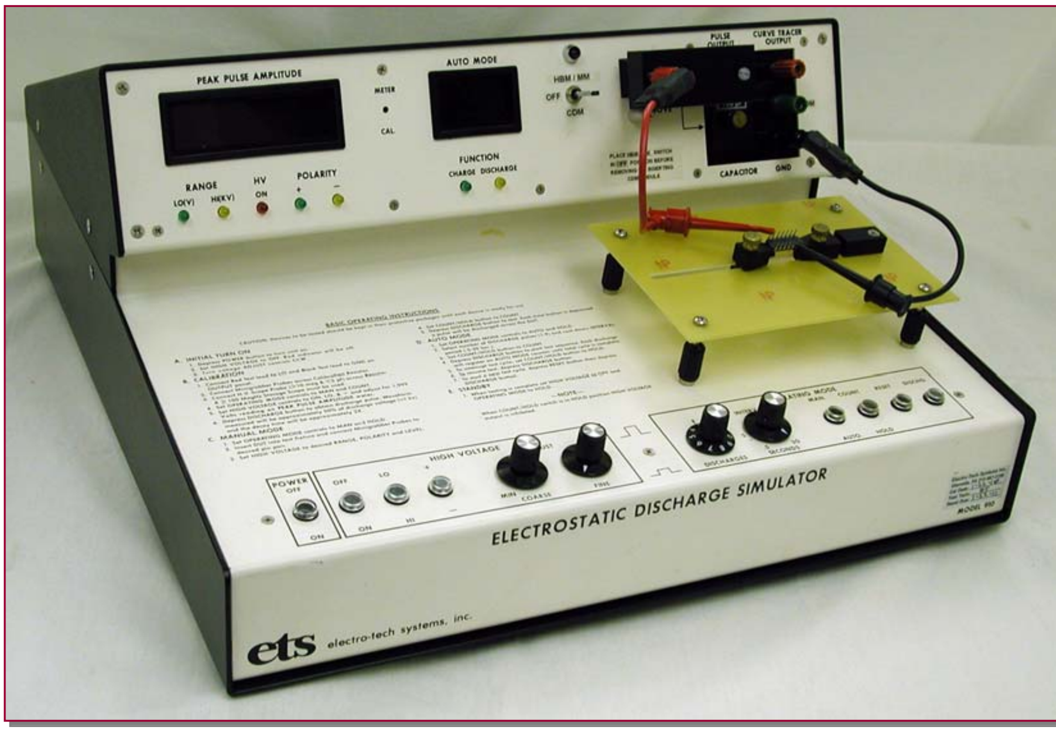
ELECTROSTATIC DISCHARGE SIMULATOR

Model 910



Operating Manual

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ets electro-tech systems, inc. www.electrotechsystems.com
3101 Mt. Carmel Avenue, Glenside, PA 19038 • Tel: (215) 887-2196 • Fax: (215) 887-0131

IMPORTANT
SAFETY INSTRUCTIONS
(Equipment containing HV)

The equipment described in this Manual is designed and manufactured to operate within defined design limits. Any misuse may result in electric shock or fire. To prevent the equipment from being damaged, the following rules should be observed for installation, use and maintenance. Read the following safety instructions before operating the instrument. Retain these instructions in a safe place for future reference.

POWER

POWER CORD: Use only the power cord specified for this equipment and certified for the country of use. If the power (mains) plug is replaced, follow the wiring connections specified for the country of use. When installing or removing the power plug **hold the plug, not the cord.**

The power cord provided is equipped with a **3-prong grounded plug (a plug with a third grounding pin).** This is both a safety feature to avoid electrical shock and a requirement for correct equipment operation. If the outlet to be used does not accommodate the 3-prong plug, either change the outlet or use a grounding adapter.

FUSES: Replace fuses only with those having the required current rating, voltage and specified type such as normal blow, time delay, etc. **DO NOT** use makeshift fuses or short the fuse holder. This could cause a shock or fire hazard or severely damage the instrument.

POWER LINE VOLTAGE (MAINS): If the line (mains) voltage is changed or isolated by an autotransformer the common terminal **must** be connected to the ground (earth) terminal of the power source.

OPERATION

CAUTION

Equipment designed to simulate a high voltage electrostatic discharge such as the Series 900 ESD Simulators and the Model 4046 Static Decay Meter utilize voltages up to 30kV. The basic nature of an ESD event will result in electromagnetic radiation in addition to the high level, short duration current pulse. **Therefore, personnel with a heart pacemaker must not operate the instrument or be in the vicinity while it is being used.**

DO NOT OPERATE WITH COVERS OR PANELS REMOVED. **Voltages inside the equipment consist of line (mains) that can be anywhere from** 100-240VAC, 50/60Hz **and in some equipment, voltages as high a** 30kV**. In addition, equipment may contain capacitors up to** 0.035 µF charged to 30kV and capacitors up to 0.5 µF charged up 6kV. Capacitors can retain a charge even if the equipment is turned off.

DO NOT OPERATE WITH SUSPECTED EQUIPMENT FAILURES. If any odor or smoke becomes apparent turn off the equipment and unplug it immediately. Failure to do so may result in electrical shock, fire or permanent damage to the equipment. Contact the factory for further instructions.

DO NOT OPERATE IN WET/DAMP CONDITIONS: If water or other liquid penetrates the equipment, unplug the power cord and contact the factory for further instructions. Continuous use in this case may result in electrical shock, fire or permanent damage to the equipment.

DO NOT OPERATE IN HIGH HUMIDITY: Operating the equipment in high humidity conditions will cause deteriation in performance, system failure, or present a shock or fire hazard. Contact the factory for further instructions.

DO NOT OPERATE IN AREAS WITH HEAVY DUST: Operating the equipment in high dust conditions will cause deteriation in performance, system failure, or present a shock or fire hazard. Contact the factory for further instructions.

DO NOT OPERATE IN AN EXPLOSIVE ATMOSPHERE: Operating the equipment in the presence of flammable gases or fumes **constitutes a definite safety hazard**. For equipment designed to operate in such environments the proper safety devices must be used such as dry air or inert gas purge, intrinsic safe barriers and/or explosion-proof enclosures.

DO NOT USE IN ANY MANNER NOT SPECIFIED OR APPROVED BY THE MANUFACTURER: Unapproved use may result in damage to the equipment or present an electrical shock or fire hazard.

MAINTENANCE and SERVICE

CLEANING: **Keep surfaces clean and free from dust or other contaminants. Such contaminants can have an adverse affect on system performance or result in electrical shock or fire. To clean use a damp cloth. Let dry before use.** Do not use detergent, alcohol or antistatic cleaner as these products may have an adverse affect on system performance.

SERVICE: Do not attempt to repair or service the instrument yourself unless instructed by the factory to do so. **Opening or removing the covers may expose you to high voltages, charged capacitors, electric shock and other hazards. If service or repair is required, contact the factory.**

1.0 INTRODUCTION

The rapid advancement in the electronics industry during the past decade has placed an ever increasing importance on the understanding of electrostatics and its effect on electronic devices and systems. Electrostatic discharge (ESD) is a common cause of microelectronic circuit failure. Many devices can be seriously damaged or destroyed by an electrostatic discharge below 20 Volts. The sensitivity to ESD of other components has also become evident through use, testing and failure analysis. The trend in technology towards greater complexity, increased packaging density and hence thinner dielectrics between active elements result in parts becoming even more sensitive to ESD.

Failure mechanisms of electrical and electronic parts due to ESD typically include thermal breakdown, metalization melt and bulk breakdown that are power dependent; dielectric breakdown, metalization to metalization arc over, surface breakdown and surface inversion that are voltage dependent.

ESD can also induce latent failure mechanisms in both MOS structures and bipolar junctions in both discrete devices and microcircuits. This latent failure mechanism results in performance degradation and eventually a failure.

Personnel are prime sources of ESD for damaging electrical and electronic parts. Electrostatic charges generated by rubbing or separating materials are readily transmitted to a person's conductive sweat layer charging that person. When a person handles or comes in close proximity to an ESD sensitive part, that part can then be damaged from a direct discharge by touching the part or by subjecting the part to an electrostatic field. The ESD from a human body can be reasonably simulated for test purposes from the circuit shown in Figure 1.0-1.

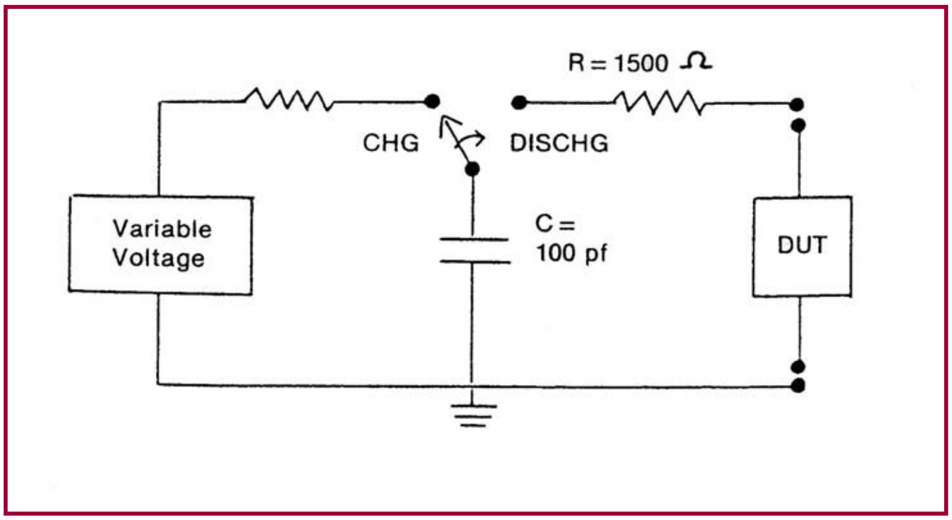


Figure 1.0-1: Basic Human Body Model equivalent circuit

This circuit is specified in Mil-Std-883E, Method 3015.7 and ESD-STM 5.1 to represent a human body discharge for ESD testing. The human body capacitance, however, may be as high as several hundred picofarads, but more typically 50 to

250 pf. Studies have shown that approximately 80% of the population tested have a capacitance of 100 pf or less. The variation in human capacitance is due to factors such as variations in the amount and type of clothing and shoes worn by personnel and differences in floor materials. Human body resistances can range from 100 to 100,000 ohms, but is typically between 1,000 and 5,000 ohms for actions that are considered pertinent to holding or touching ESD sensitive parts or containers of ESD sensitive parts. The variation in human body resistance is due to factors such as the amount of moisture, salt and oils at the skin surface, skin contact area and pressure. A value of 1,500 ohms provides a reasonable lower human body resistance value. In view of the above, Mil-Std-883E specifies a Human Body Model (HBM) using 100 pf discharged through 1,500 Ohms. For power sensitive parts, a change to a worst case Human Body Model capacitance (i.e., greater than 100 pf) could result in damage to ESD sensitive parts at voltage levels below those shown in Mil-Std-883E, Appendix 1. Therefore, a component that has been classified as non-ESD sensitive could actually become ESD sensitive under more stringent Human Body Model conditions. For voltage sensitive ESD parts, a variation in the capacitance value in the test circuit generally will not affect ESD sensitivity. However, a decrease in Human Body Model resistance will increase the voltage and power delivered to the e part that could adversely affect voltage and power sensitive ESD sensitive parts at lower HBM voltage levels. The Human Body Model specified is considered a reasonable test circuit for evaluating the sensitivity of ESD sensitive parts because personnel are generally the most common source of damaging ESD.

The Model 910 Electrostatic Discharge Simulator is an instrument specifically designed to simulate the electrostatic discharge produced by human handling and meets all of the testing requirements specified in Mil-Std-883E, Method 3015.7, ESD-STM 5.1, JEDEC TEST METHOD A114.A and other specifications based on the Mil-Std-883E model.

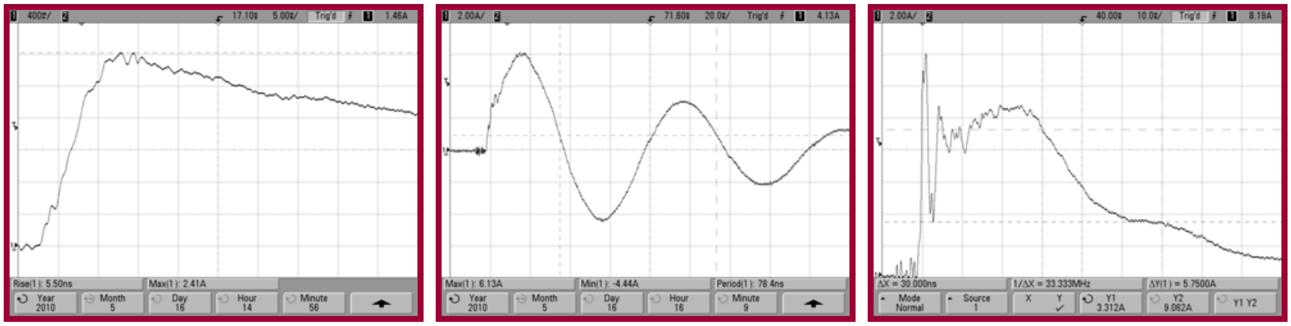
The Machine Model (MM) as defined in ESD-STM 5.2 is “An electrostatic discharge simulation test based on a discharge network consisting of a charged 200 picofarad capacitor and (nominally) zero ohms of series resistance. Actual series resistance and inductance are specified in terms of the current waveform through a shorting wire. The simulation test approximates the electrostatic discharge from a machine.” The Machine Model network is standard with the Model 910.

The Charged Device Model (CDM) as defined in ESD-STM 5.3 is when a component is slowly charged to a given voltage and then discharged to ground through one or more leads of the device. The CDM is available as an option.

Another model commonly used is the one specified in IEC61000-4-2. This model simulates a person holding a tool when discharging to a device. It is typically used for system ESD testing. The model (150pF/330Ω) can be added to the Model 910 as a customized option.

The Model 910 utilizes individual plug-in resistor and capacitor networks to achieve the required waveforms.

Figure 1.0-2 shows typical HBM, MM and IEC waveforms.



Human Body Model (HBM) (100pF/1500Ω) | Machine Model (MM) (200pF/0Ω) | IEC Hand/Tool Model (150pF/330Ω)

Figure 1.0-2: Typical HBM, MM and IEC waveforms

The Model 910 is available with the optional Model 9902 Remote Discharge Probe that operates only in the LO Range (up to 2000V) for HBM, MM and CDM Models. The Model 910 must be modified to provide the necessary signals to operate the Probe. The Probe shown in Figure 1.0-3 can be used as a handheld device or with the addition of remote cables, be attached to an automatic test system.

Figure 1.0-3: Model 9902 Remote Discharge Probe

2.0 EQUIPMENT DESCRIPTION

2.1 General

The Model 910 Electrostatic Discharge Simulator shown in Figure 2.0-1 is designed to produce discharge pulses that meet the requirements of Mil-Std-883E, Method 3015.7, and ESD-STM 5.1 for HBM and ESD-STM 5.2 for MM ESD sensitivity testing. The pulse amplitude may be set to any level from less than 20 Volts to 8.25kV, and may be either positive or negative. Two voltage ranges are provided; 0 to 2kV and 0 to 10kV. A digital readout indicates the voltage level stored in the Human Body Model (HBM) capacitor prior to discharge. In the Low Voltage Mode (0 to 2kV), the Digital Panel Meter (DPM) provides an adjustment resolution of ±1V. In the High Voltage Mode the resolution is ±10V. Device testing may be performed either manually or automatically. In the Manual mode, the user initiates each discharge pulse. In the Automatic mode, the user selects the number of discharge pulses desired (0-9) and the time interval between pulses (<0.5-20sec). When the DISCHARGE button is pushed the correct number of discharge pulses is produced. A HOLD button halts the test sequence in the Automatic mode or prevents an unintentional discharge in the Manual mode.

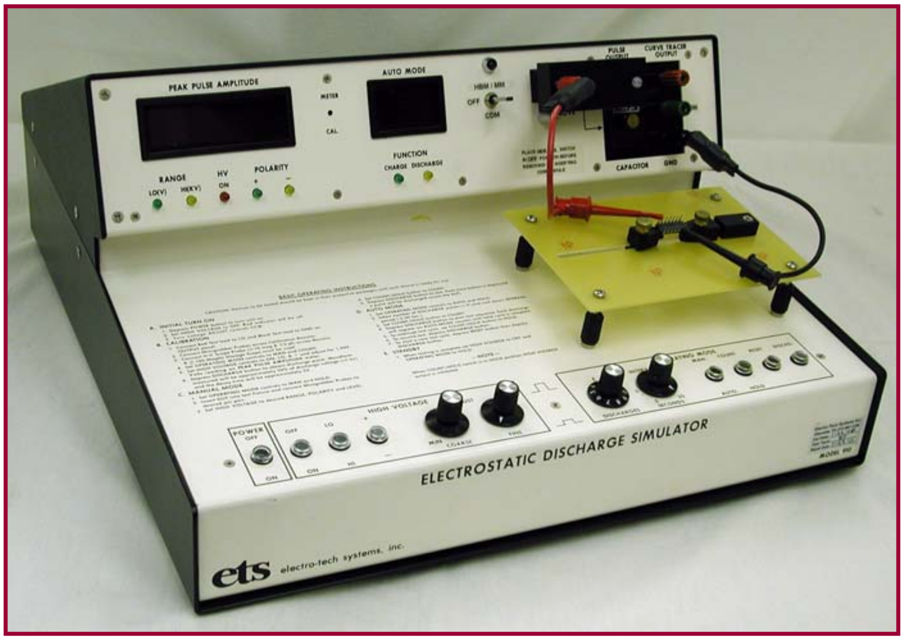


Figure 2.0-1: Model 910 ESD Simulator (with optional CDM)

Indicator lights on the front panel display the mode selected, the status (ON or OFF) of the high voltage power supply output and the charge/discharge state of the unit. A single digit LED readout indicates the number of discharge pulses produced in the Automatic mode and is extinguished in the Manual mode.

Adapter modules are available for holding a wide variety of devices and providing for their connection to the OUTPUT terminals of the Discharge Simulator. Standard with the Model 910 is a universal holding fixture that retains the device under test (DUT) so the minigrabber test leads can be connected to the appropriate pin pair as shown in Figure 2.0-2. Standard test fixtures with zero insertion force test sockets for DIP and SOIC type packages, shown in Figure 2.0-3, are also available as accessories along with custom designed fixtures for special applications. These test fixtures feature programming pins for tying groups of like V, signal and ground pins together as required in many specifications.

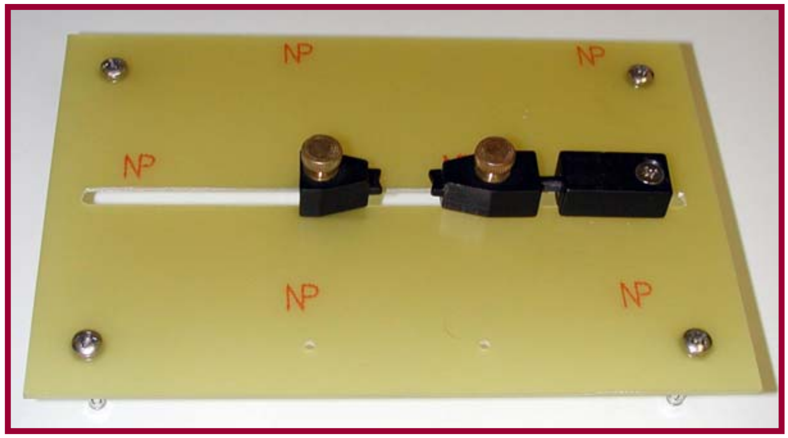


Figure 2.0-2: Standard universal DUT holding fixture

DIP-40 (.3-.6” Adj) SOIC-16 SOIC-28

Figure 2.0-3: Socketed DUT test fixtures

A front panel accessible calibration adjustment is provided to allow the user to calibrate the digital panel meter to correspond to the actual charge on the capacitor. A detailed description of all controls and indicators is provided in the following paragraphs.

2.2 Controls

All controls for operating the Discharge Simulator are located along the front edge of the unit as shown in Figure 2.0-4. Four types of controls are used: two position push button switches, momentary push button switches, rotary controls, and a ten (10) position rotary switch. The status of the 2-position push button switches are indicated by panel markings above and below each switch. The marking above each switch defines the mode with the switch in the up position. Accordingly, the marking below defines the state with the switch in the down position.

Figure 2.0-4: Front panel controls

2.2.1 Main AC Power ON/OFF

This self-latching (push-on-push-off) switch controls the AC power (MAINS) input to the unit. When placed in the down position, the AC power will be ON and the front panel indicator lamps will be illuminated.

2.2.2 High Voltage Controls

High Voltage ON/OFF: This switch (push-on-push-off) controls the high voltage output of the Simulator. In the down position, the high voltage output is turned on enabling the capacitor to be charged to the level shown on the DPM. When this switch is in the OFF position (up), the high voltage output is disabled.

High Voltage HI/LO Mode Select: This switch (push-on-push-off) selects either the LO Voltage Range (0 to 2kV) when in the up position or the HI Voltage Range (0 to 10K) when in the down position. The unit will change modes only if the HIGH VOLTAGE ON/OFF switch is in the OFF (up) position. The mode LEDs directly below the DPM shown in Figure 2.2-2 indicate the mode selected. **NOTE**: If the indicator lights indicate a mode that is different from that selected by the push buttons, the user must turn off the high voltage. The unit will then automatically switch to the correct mode. This is a safety feature which protects the unit's internal components from switching when high voltage is present.

High Voltage POLARITY (+/-) Select: This switch (push-on-push-off) selects the polarity of the discharge pulse that is to be generated by the Discharge Simulator. When in the up position, a positive pulse is produced and when down, a negative pulse. **NOTE:** As with the HI/LO mode select switch, the Simulator will only respond to a change in the setting of the POLARITY select switch when the HIGH VOLTAGE ON/OFF switch is in the OFF position.

High Voltage COARSE and FINE Adjust: These two controls adjust the level of the high voltage. This voltage will be near zero with both controls fully counterclockwise and increases as each control is rotated clockwise. The COARSE adjust control is used to set the high voltage level close to the desired level. The FINE adjust control is used for precise setting of this level. The adjustment range of the FINE control is approximately 600 volts; thus, if this control is set to its mid-position (12 o'clock) before the COARSE control is set, it will allow the output level to be adjusted by approximately ±300 Volts about the COARSE control setting.

2.2.3 Operating Mode Controls (LO and HI Ranges)

Manual Mode:

Manual/Auto Mode Select: This push-push switch, when in the MAN (up) position, places the unit in the MANUAL mode. The AUTO mode numeric indicator will be extinguished in this mode.

DISCHARGE Control (Manual Mode): This momentary push button switch causes the Simulator to produce one discharge pulse each time it is depressed. In this mode, the user should allow a minimum of about one (1) second between discharge pulses. If the discharge button is depressed more rapidly than once per second, an incomplete discharge cycle may be produced.

HOLD Button: This push-push switch, when in the COUNT (up) position, allows one discharge pulse to be produced with each depression of the DISCHARGE button. When placed in the HOLD (down) position, the Simulator is prevented from producing an output discharge pulse. This button should normally be left in the HOLD (down) position except when tests are being conducted. Using this control in this manner will insure that output pulses are obtained only when required and not at other times such as power up or during changing of test samples.

Automatic Mode:

MAN/AUTO Mode Select: This push-push switch, when placed in AUTO (down) position, places the unit in the Automatic mode. In this mode, the AUTO Mode numeric indicator will be illuminated.

DISCHARGES Selector: This ten-position switch selects the number of discharge pulses that will be automatically produced by the Simulator once the DISCHARGE button is depressed. It is set before the start of a discharge test sequence by rotating the control until the number on the control knob flange, corresponding to the desired number of pulses, is opposite the black pointer on the control panel.

INTERVAL Adjust: This rotary control is functional only in the Automatic mode and determines the time interval or delay between discharge pulses. The control is rotated clockwise to increase the time interval from a minimum of approximately 0.5 seconds to a maximum of 30 seconds. It should be noted that the interval setting of this control corresponds to the approximate “cool down” period between discharge cycles. Since each discharge cycle lasts about 0.65 seconds, the minimum discharge period (pulse to pulse duration) is about 1.1 seconds. This timing relationship is illustrated in Figure 2.0-5.

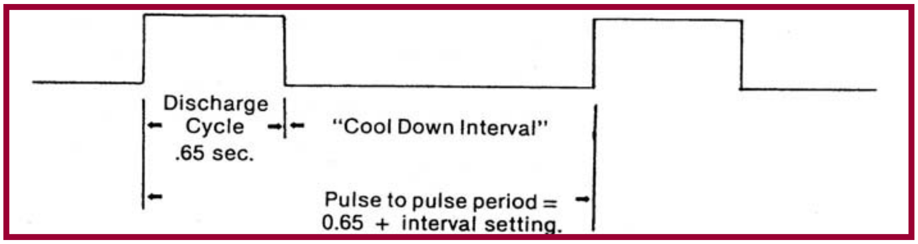


Figure 2.0-5: Automatic Mode Timing Cycle

METER CAL: This calibration control is used to decrease the value of the displayed charging voltage relative to the actual voltage stored in the Human Body Model capacitor. This control is set at the factory and should not be adjusted unless the instrument is being recalibrated.

Indicators: The Model 910 Electrostatic Discharge Simulator utilizes LED indicators for all status and numeric readouts. These are located on the vertical sloping portion of the enclosure above the control panel as shown in Figure 2.0-6.

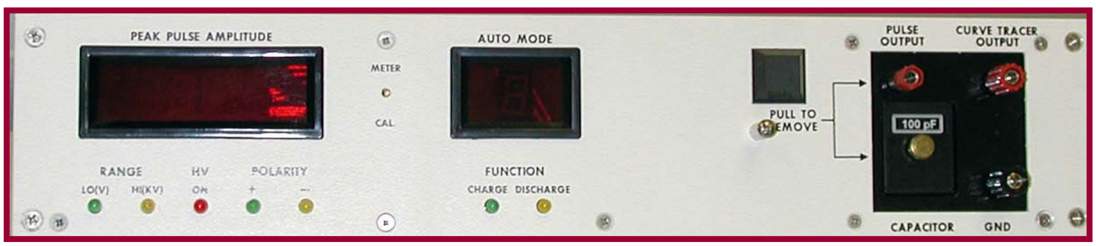


Figure 2.0-6: Display Panel

Status Indicators:

High Voltage Mode: Two indicators are provided to indicate which of the two voltage modes the unit has been set for. The GREEN indicator will be on when the unit is set for LO Voltage (0 to 2kV) while the AMBER indicator will be on when the HI Voltage Mode has been selected. These indicators, that display the actual mode programmed, are controlled by the HI/LO select switch and the HIGH VOLTAGE ON/OFF switch. **When the High Voltage switch is in the ON (down) position, changes in the setting of the HI/LO mode select switch will be ignored by the system, and the status lights will not alter their indication.**

High Voltage ON: This single RED indicator will be illuminated when the high voltage power has been turned on. It is a signal to the operator that high voltage may be present depending on the setting of the HI Voltage COARSE and FINE adjust controls.

Polarity Mode: Two indicators are provided to show which polarity has been selected. An illuminated GREEN light indicates that the output discharge pulse will be POSITIVE relative to system ground while AMBER indicates that the pulse will be NEGATIVE. **Like the High Voltage mode indicators, the polarity may be changed via the High Voltage +/- Polarity select switch only if the High Voltage ON/OFF switch is in the OFF (up) position.**

Charging/Discharge Indicators: Two indicators are provided to display the Charge/Discharge status of the Simulator. When the GREEN Charge indicator is illuminated, the internal circuits are in the Charge mode, allowing the capacitor to be charged to the desired voltage level. The AMBER Discharge light will flash when a discharge cycle is taking place (the capacitor is connected to the OUTPUT terminal).

Numeric Displays:

Charging Voltage: This 3½ digit LED display shows the actual high voltage level and polarity applied to the capacitor. In the LO Voltage Mode (GREEN "LO (V)" indicator on), the readout indicates the charging voltage directly in Volts. In the HI Voltage Mode (AMBER "HI (kV)" indicator on), a decimal point will appear on the display and the charging voltage will be displayed in kilovolts.

In the LO (0 to 2kV) Voltage Mode, the readout displays a maximum level of 1,999 Volts. If the operator sets the Charging Voltage to a level above this maximum, the readout will blank out indicating an overscale condition. This is normal and the readout will not be damaged by settings above the ±1,999V. Testing above ±1,999V, requires switching to the HI Voltage Mode.

AUTO MODE Count Indicator: This display is a single digit LED numeric readout that displays the discharge pulse count in the Automatic mode. In the Manual mode, this indicator is not illuminated. When the RESET switch is depressed, the AUTO mode count indicator will reset to zero and hold this count until the discharge cycle is started. Once the discharge cycle is started, the AUTO mode count indicator will automatically increase its count by one for each discharge pulse produced. Upon reaching the count set on the DISCHARGES selector, automatic test cycling is ended and the AUTO mode indicator will hold the final pulse count until the RESET button is depressed.

If, during an automatic test cycle, the HOLD button is depressed, the AUTO mode pulse counter will display the total number of discharges produced up to the time the HOLD button was depressed. If the HOLD button is then placed in the COUNT (up) position, and the DISCHARGE button is depressed, the test cycle will resume and the remaining pulses as set on the DISCHARGES control will be produced.

2.2.4 Output Panel

The Output Panel, shown in Figure 2.0-7 is located on the right side of the instrument and contains the RESISTOR, CAPACITOR, GROUND, and CURVE TRACER output jacks. The R-C modules are easily replaced by unplugging them from the panel.

The CURVE TRACER output is a standard banana jack that is connected to a high voltage relay. When the system is in the Charge mode the relay is closed connecting the CT output to the Discharge Resistor. This connects the CT output to the pin under test: When the system is in the Discharge mode the relay opens, thereby disconnecting the CT output from the DUT. It again closes when the system returns to CHARGE. This enables the user to check the DUT both prior to and after a discharge without removing any connectors.

NOTE:

The CURVE TRACER output is not connected when shipped from the factory. If the user wants to use this function the top cover must be removed and the CT .040” pin must be plugged into the .040” jack located on top of the discharge relay. **DO NOT USE ABOVE 5kV. Induced voltages may damage the Curve Tracer. User must determine suitability before using.**

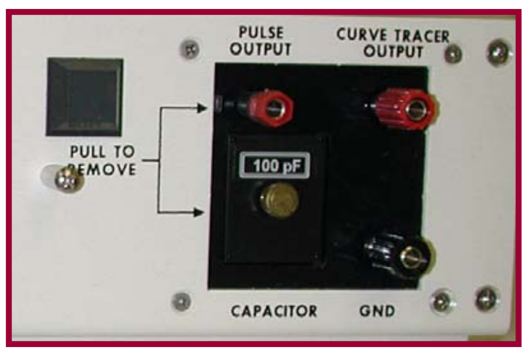


Figure 2.0-7: Output Panel

2.3 Rear Panel

The rear panel is shown in Figure 2.0-8. It contains the input power module (Mains) with fuse and a standard 0.160” (4mm) banana for ground. The Power module accepts the standard IEC power cord.

REMOTE DISCHARGE (Optional): This feature enables the Model 910 to have a computer or other remote trigger source to control the DISCHARGE cycle. **It can only be used in the MANUAL mode.** A 5-pin Din connector is installed for the optional remote discharge. It requires a 5V logic input with a minimum of 1mA. The required signal is a positive pulse from 0-5V, 200msec duration having a rise and fall time of less than 100μsec. Pin 1 of the DIN connector is signal ground and Pin 3 is the trigger signal, Pin 4 is system ground and Pin 5 controls the Optional Model 9902 trigger. In addition, a High Voltage connector is installed near the banana jack for the Model 9902.

Figure 2.0-8: Rear Panel

NOTE:

The Model 910 starting with Serial #358 utilizes universal switching power supplies that operate from 90-260VAC, 50/60Hz. <u>It will not be necessary to change the voltage settings or the ¾ Amp Sloblo (750mA Time Delay) fuse in the Power module.</u>

3.0 OPERATION

3.1 Initial Set-Up

Before connecting the Simulator to the AC line (MAINS), set the controls on the front panel to the following positions:

1. POWER ON/OFF - OFF (up)
2. HIGH VOLTAGE ON/OFF - OFF (up)
3. High Voltage COARSE and FINE adjust – both fully counterclockwise

3.1.1 Human Body and Machine Model Installation

The Model 910 ESD Simulator features plug-in components to achieve the HBM and MM networks. The HBM consists of a total 100pF of capacitance that is discharged through a 1500 Ohm resistor module that also contains a wave-shaping network to obtain the specified discharge waveform. These components are shown in Figure 3.0-1a along with the associated test leads. The high voltage discharge relay has an intrinsic capacitance of approximately 50pF, hence 50pF of capacitance is added internally to obtain the specified 100pF. The plug-in capacitor module labeled 100pF contains no additional capacitors. It may be used to obtain other capacitance values above 100pF.

The MM consists of a total of 200pF capacitance that is discharged through 0 Ohms to the DUT. The capacitor module labeled 200pF contains 100pF of capacitance that adds to the 100pF already built into the system. The plug-in 0Ω resistor is just a shorting bar that plugs into the output jack. This network plus associated test leads are shown in Figure 3.0-1b.

a. HBM discharge network　　　　b. MM discharge network

Figure 3.0-1: HBM and MM discharge networks

3.1.2 IEC 61000-4-2 Network

This network consists of 150pF discharged through 330Ω. Both the R and C components are connected in series within the module shown in Figure 3.0-2. The added 50pF capacitance described in Section 3.1.1 is must removed from the discharge relay input and moved into the individual modules. Both HBM and MM modules now include an additional 50pF capacitance and are labeled “100pF Special” and “200pF Special” respectively. The 0Ω MM resistor is plugged into the OUTPUT jack to complete the network.

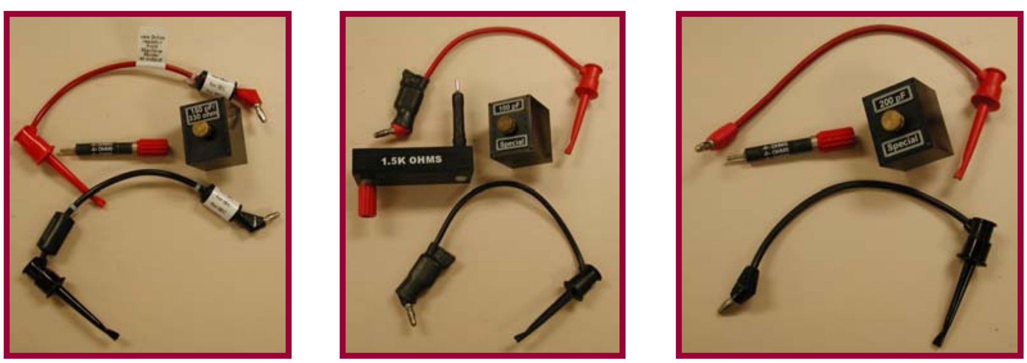


Figure 3.0-2: IEC 61000-4-2 RC network module and HBM &MM Special

3.1.3 Test Fixture and DUT Installation

Install the appropriate Test Fixture by pressing it gently into the four mounting jacks located on the sloping panel

When using the Standard Universal Clamp Test Fixture shown in Figure 3.0-3 (HBM Testing) secure the device under test (DUT) to the holding fixture on the Test Fixture using the spring-loaded clamp.

Adjust the sliding post to provide the proper spring-loaded force on the DUT. When properly adjusted, the DUT will be securely held and is removed by sliding the spring-loaded portion of the holding fixture to the right.

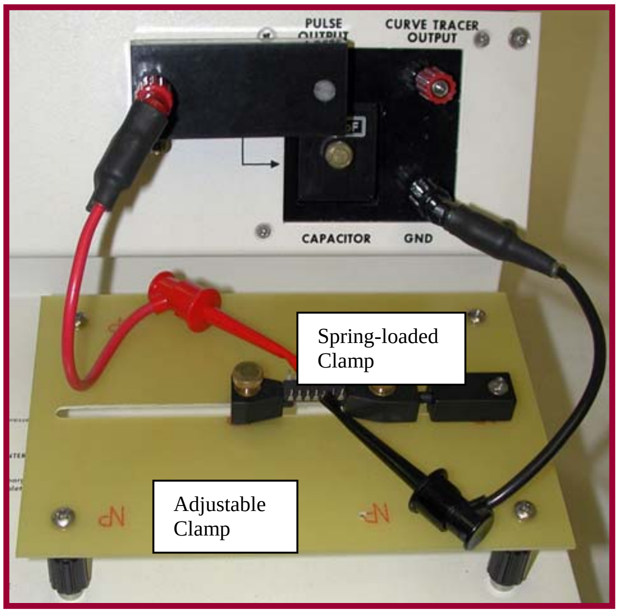


Figure 3.0-3: Universal Clamp Test Fixture (HBM)

When using one of the optional socketed DIP type DUT Test Fixtures shown in Figure 3.0-4 move the lever up to insert the package then move the lever down to lock the pins in place. For SOIC, flat pak and other multi pin arrays follow the instructions supplied with the respective test socket.

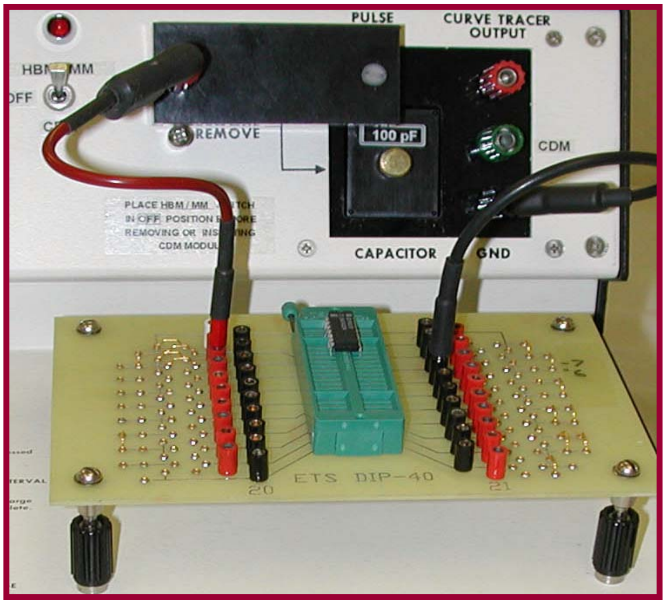


Figure 3.0-4: 40-pin DIP Socket Test Fixture (HBM)

3.1.4 Connecting Discharge Leads to DUT

Plug the red minigrabber test lead into the red OUTPUT jack and the black minigrabber test lead into the black GND jack. If a curve tracer or other test instrument is to be used to check the characteristics of the pin pair of the DUT before and after a discharge sequence, plug the Curve Tracer input lead into the CURVE TRACER OUTPUT banana jack on the Model 910 Discharge Panel. **For HBM use the leads with the black tubing at the plug end. For MM use the leads without the black tubing. <u>Incorrect leads will result in out of spec waveforms.</u>** Refer to Figure 3.0-1.

Connect the test lead spring-loaded minigrabber to the appropriate leads on the DUT mounted in the Universal Test Fixture as shown in Figure 3.0-3. Socket test fixtures use 0.080" (3mm) pin plugs. For the best possible output waveshape, the leads should be positioned such that they are away from one another by a minimum of ¾" (18mm) and away from the unit's chassis (ground). **Do not reverse the test leads when the opposite polarity is desired. Switch the HVPS to the opposite polarity.**

3.2 Initial Turn-On

Refer to Figure 2.0-4 for the location of the various controls described below.

3.2.1 Power

Turn on by placing the POWER ON/OFF switch in the ON (down) position. The Power ON state will be indicated by illumination of the colored status indicators. The AUTO Mode indicator may or may not be illuminated depending on the setting of the AUTO/MAN selector switch.

3.2.2 Charging Voltage Set-up

The Procedure described in this section is common to both the Manual and the Automatic Mode and should be followed independent of the mode selected.

HI/LO Voltage Select: Select the desired operating voltage by placing the High Voltage HI/LO switch in the LO position (up) for testing below 2000V or in the HI position (down) for testing at or above 2000V to a maximum of 8000V.

Polarity Select: Set the POLARITY switch to the desired output pulse polarity: up for positive, down for negative.

High Voltage ON: Depress this pushbutton to turn on the high voltage.

High Voltage Level Adjustment: Rotate the FINE adjust control clockwise until the pointer is in the twelve o'clock position. Rotate the COARSE adjust control clockwise until the approximate desired voltage level is indicated on the CHARGING VOLTAGE readout. Now re-adjust the FINE control to trim the voltage reading to the final level. Allow several seconds for the reading to stabilize, then, if necessary, re-adjust the FINE control. The unit is now ready to produce the desired output pulse.

3.2.3 MANUAL Mode

In the MANUAL mode (AUTO/MAN button in MAN (up) position), the operator is in complete control of the number of pulse discharges and the interval to be impressed on the DUT. To operate the Discharge Simulator in this mode, follow the above procedure, then proceed as described below.

3.2.4 Discharge Pulse Generation

With the COUNT/HOLD button to the COUNT (up) position, depress the DISCHG. button once each time a high voltage discharge pulse is required. The Amber DISCHARGE indicator will flash each time an output pulse is produced. At least one second should be allowed between pulses for the "cool down" period. After the DUT has been subjected to the desired number of pulses, place the COUNT/HOLD button in the HOLD (down) position, and turn off the high voltage supply by placing the High Voltage ON/OFF switch in the OFF (up) position. This last function is to ensure no discharges occur after the test and for safety when high voltages are being used. The function can be omitted if required.

To resume testing, turn on the High Voltage, if necessary re-adjust the FINE control, set the COUNT/HOLD button to COUNT, and when ready, depress the DISCHG. button.

3.2.5 AUTOMATIC Mode

In the Automatic Mode, the operator selects the number of discharge pulses desired and the interval between pulses. Upon depression of the RESET then the DISCHG. buttons, the Simulator proceeds to automatically generate the selected number of pulses at the chosen interval. The HOLD button may be used to hold the count at any time before the selected count is reached. To operate the Automatic Mode, follow the set up procedures in 3.1 and 3.2 then proceed as described in the following sub-paragraphs.

AUTOMATIC Mode Selection: Set the MAN/AUTO switch to the AUTO (down) position. The AUTO Mode numeric indicator will now be illuminated.

INTERVAL Adjustment: The INTERVAL adjust control, which provides for setting the "cool down" time interval between discharges is an uncalibrated control, and if accurate timing is required, must be calibrated against an external reference (e.g., digital watch, stopwatch with sweep hand, etc.). To accurately set the INTERVAL control, turn off the internal High Voltage Supply by setting the High Voltage ON/OFF switch to OFF (up). Set the INTERVAL control to 9, the COUNT/HOLD switch to COUNT then depress the RESET switch, and when ready, depress the DISCHG Switch. Using an external timing reference, measure the time interval between flashes of the AMBER DISCHARGE light. Adjust the INTERVAL control until the desired "cool down" period is obtained. (NOTE: The discharge cycle time has been set during assembly to 0.65 seconds, hence, the "cool down" time will be the time measured between flashes of the amber DISCHARGE light minus 0.65 seconds. Refer to Figure 2.0-3). After calibration, turn on the High Voltage (High Voltage ON/OFF switch to ON).

Discharge Pulse Count Setting: To select the number of discharge pulses, rotate the DISCHARGE selector until the desired number is opposite the point marking on the panel.

Automatic Discharge Pulse Generation: Depress the RESET button to set the AUTO mode counter to zero. When ready to start the automatic test sequence, momentarily depress the DISCHARGE button. The Automatic mode timing sequence starts with the interval delay, hence, the first discharge pulse will not occur until the INTERVAL time has lapsed. Upon reaching the end of the first interval, the AMBER DISCHARGE indicator will flash, the AUTO mode indicator will advance to the count of one and the first discharge pulse will be generated. This sequence will continue until the AUTO mode readout displays the same number as set on the DISCHARGES selector. At this time, the test is concluded, the Simulator automatically stops generating output discharge pulses, and the AUTO mode readout displays the final count of the number of discharges produced.

Nothing further will occur unless the operator wishes to repeat the test sequence. To do this, momentarily depress the RESET button, then depress the DISCHARGE button. The automatic discharge cycle will be repeated

Upon completion of testing set the High Voltage switch to OFF (up)

3.2.6 Interrupting AUTO Mode Count

To stop the discharge pulses in the AUTO mode before the full count is reached, two (2) methods may be used.

HOLD Button: If the HOLD button is depressed while automatic testing is in progress, and the full count as set on the DISCHARGES control has not yet been reached (AUTO mode indicator

DISCHARGES setting), the discharge pulses will be stopped and the AUTO mode indicator will hold the discharge pulse count as produced up to that point. To complete the unfinished count, set the COUNT/HOLD button to COUNT and then depress the DISCHARGE button. Unless the DISCHARGE button is depressed after the COUNT/HOLD button is set to COUNT, the automatic discharge sequence will not be resumed.

RESET Button: If the RESET button is depressed while the automatic discharge is in progress, the AUTO mode count will immediately reset to zero, and, upon release of the RESET button, and depression of the DISCHARGE button, the discharge sequence will start again, from zero.

NOTE:

THE DISCHARGE SIMULATOR IS CAPABLE OF PRODUCING HIGH VOLTAGE OUTPUT PULSES OF UP TO 8,000 VOLTS AT A STORED ENERGY LEVEL OF ABOUT 75x10^{-4} JOULES. WHEN IT IS NECESSARY TO HANDLE THE DUT OR ANY OF THE OUTPUT INTERCONNECT TEST LEADS, IT IS RECOMMENDED THAT THE HIGH VOLTAGE ON/OFF SWITCH BE PLACED IN THE OFF POSITION AND THE COUNT/HOLD BUTTON BE SET TO HOLD.

4.0 WAVEFORM VERIFICATION PROCEDURES

4.1 Human Body Model – Mil-Std 883E, Method 3015.7, ANSI/ESD-STM5.1 & JESD A114B.

These test methods require system calibration utilizing the discharge pulse current waveform. The Human Body Model is C=100pF and R=1500 Ohms.

The waveform must be verified using both + and –4kV charging voltages. The discharge current must be within $\pm$10% of the specified Ip value (2.67 Amps).

Photographs of the rise time, fall time, and peak current calibration are required.

Figure 4.0-1 shows the waveform requirements specified in Method 3015.7 and ANSI/ESD-STM5.1.

USE THE HBM TEST LEADS WITH THE BLACK TUBING AT THE PLUG END TO OBTAIN THE CORRECT WAVEFORM.

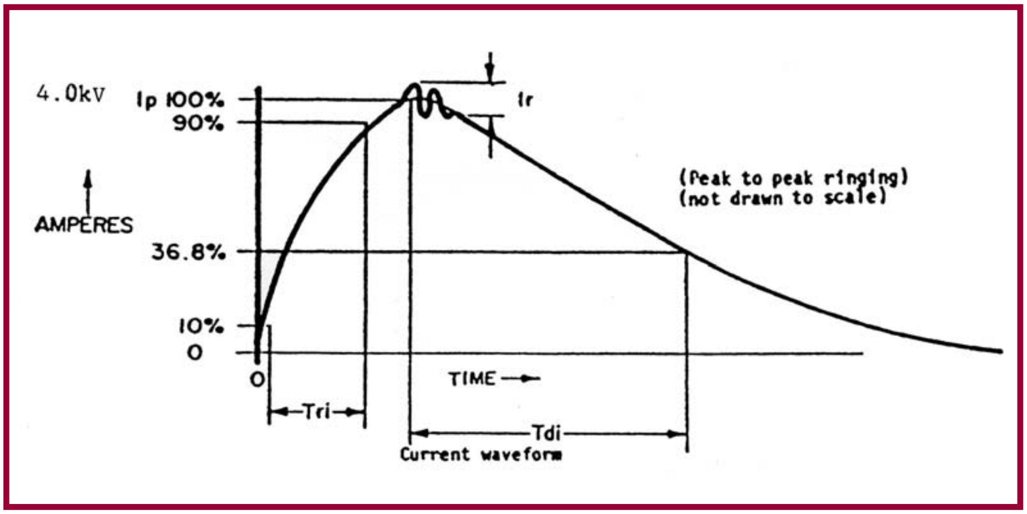
4.1.1 Set-Up

A high speed oscilloscope and current probe with a bandwidth of at least 350 MHz and a visual writing speed 4 cm/nsec minimum are required. Scopes satisfactory for this measurement are the Tektronix Model 2467 high-speed analog oscilloscope, or the Model 7834 or

7934 storage oscilloscopes. Digital Storage Oscilloscopes (DSO) should also have a minimum frequency response of 350 MHz or better and a sampling rate 1 Gs/sec or better. Tektronix TDS 300 and 3000 series, Agilent Technologies Model DSO6102A or any other oscilloscope that meet this criteria are satisfactory. If CDM testing is also to be performed then a 1GHz scope should be obtained to perform all three tests. Tektronix Models CT-1 or CT-2 current transducers are satisfactory for detecting the current pulse.

The 50 Ohm impedance of the current probe must be matched to the input impedance of the oscilloscope. For oscilloscopes with only a 1 MegOhm input impedance, a terminator is available to match the 50 Ohm impedance of the probe to the 1 MegOhm impedance of the scope. Because of the very high frequencies being measured it may be necessary to double shield the current probe.

Figure 4.0-1 is the waveform requirement.



The current pulse shall have the following characteristics:

T_r (rise time)	2-10 nanoseconds
T_d (decay time	150 ±20 nanoseconds
I_p (peak current)	within ±10%
I_r (ringing)	The decay shall be smooth, with ringing, break points, double time constants or discontinuities less than 15% I_p maximum, but not observable 100 nanoseconds after start of the pulse.

Figure 4.0-1: Current Waveform per Method 3015.7

To obtain this waveform place a 1.25” (31mm), 18 gauge wire through the CT-1 sensor then connect the minigrabber leads to the wire. The current probe (Tektronix CT-1) is polarized and is marked with a + on one side. When verifying a positive discharge pulse, the OUTPUT signal from the 1.5kΩ resistor should be connected to this side. When verifying a negative discharge pulse, the GND connection should be connected to this side. No changes in scope setting are necessary.

4.1.2 Calibration Procedure

Peak Current, Rise Time and Ringing at 4kV: Set the scope vertical amplifier sensitivity to 2 Volts/Div and the time base to 5 nsec/Div. If the CT-1 probe is used then the total current measurement range is 3.2 Amps (CT-1 Probe calibration is 5 Volts/Amp). Probes with different calibration will necessitate using different scope vertical amplifier settings. At a charging voltage of 4kV, the peak current, I_p, must be 2.67 amps $\pm$10% (2.40-2.93 Amps). If using the Tektronix Model 2067 analog scope, switch the vertical amplifier out of the CAL position and adjust the vernier such that a discharge pulse will go from the “0” graticule marking to the “100” graticule marking as shown in Figure 4.04. The rise time is defined as the time for the leading edge to rise from the 10% point to the 90% point. The specification calls for a rise time between 2 and 10 nsec. For the Model 910 ESD Simulator the rise time will normally fall between 2.5 and 8 nsec. The peak-to-peak ringing must be less than 15% of I_p.

If using a digital scope all the calculations are performed by the scope and displayed on the screen and printout as shown in Figure 4.0-4.

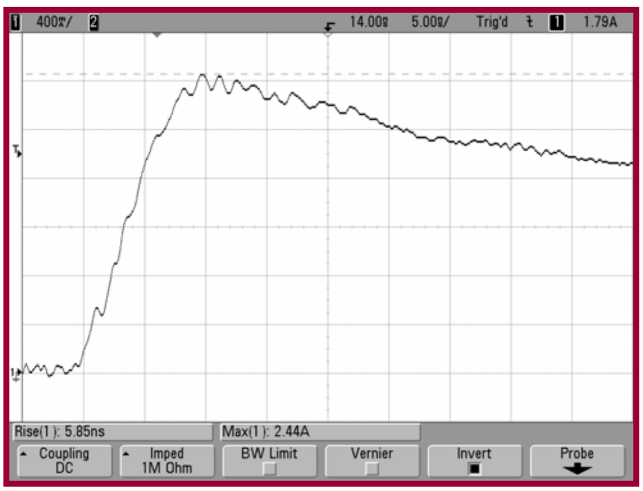


Figure 4.0-4: Rise Time and Ringing Waveform at 4kV

4.1.3 Fall Time at 4kV

Set the scope vertical amplifier sensitivity 2 Volts/Div, the same setting as was done for the rise time measurement. Change the time base to 50 nsec/Div. The discharge pulse should resemble that shown in Figure 4.0-5. The fall time (decay time) must be 150$\pm$20 nsec from the 100% point to the 37% point.

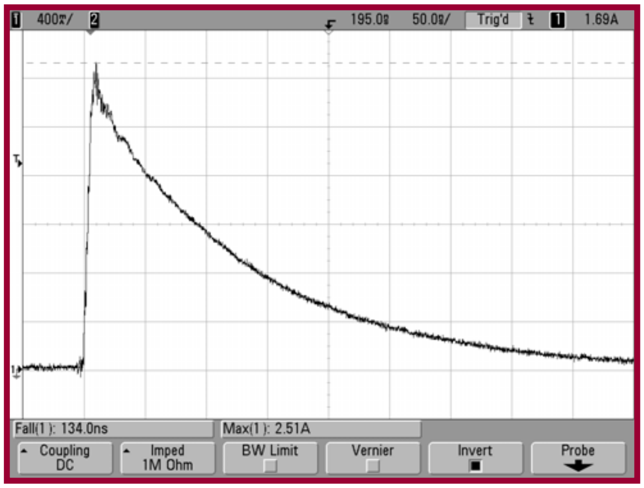


Figure 4.0-5: Discharge Pulse Fall Time Measurement at 4kV

4.1.4 Additional Information

The measurement of the current waveform can be significantly affected by the test instrument used. Excessive ringing and poor waveform characteristics could be a result of an incorrect test set-up or an oscilloscope that is not adequately shielded.

The charging voltage calibration is preset at the factory. No field adjustment should be made to the METER CAL adjustment.

The Model 910 incorporates a curve tracer output. The CURVE TRACER output connector is connected to the output side of the discharge relay when in the CHARGE Mode and is disconnected from this point during the DISCHARGE cycle. This switching function is accomplished by a high voltage relay. This relay, since it is part of the discharge circuit, does affect the purity of the discharge waveform. Disconnecting this relay from the discharge relay will reduce the ringing associated with the current waveform.

ANSI/ESD-STM5.1 also requires an additional calibration waveform using a 500Ω resistor to ground.

Other standards such as the JEDEC standards reference Method 3015.7 and/or ANSI/ESD-STM5.1. The specific standard to which testing will be performed should be referred to for the correct calibration of the Model 910 ESD Simulator.

4.2 Machine Model – ANSI/ESD-STM5.2

This standard requires system calibration utilizing the discharge pulse waveform obtained from a 200pF capacitor discharged through 0 Ohms to ground. The same oscilloscope and current transducer setup used for HBM verification are used for the MM verification waveforms.

The waveform must be verified using both + and -400 Volts through both a short circuit to ground and through a 500 Ohm resistor. Other stress levels of 100, 200 and 800 Volts may be performed using only the discharge through a short to ground.

A photograph or printout of the waveforms is required.

Figure 4.0-6 shows the waveform requirements for the discharge through a short to ground at 400 Volts and Figure 4.0-8 shows the waveform requirements through the 500 Ohm resistor to ground.

The MM capacitor module is keyed so when MM testing is selected the HI RANGE is disconnected and only the LO RANGE can be used. This allows MM testing from less than 20 Volts to 2000 Volts.

THE LEADS <u>WITHOUT THE BLACK TUBING</u> AT THE PLUG END MUST BE USED TO OBTAIN THE CORRECT MM WAVEFORM.

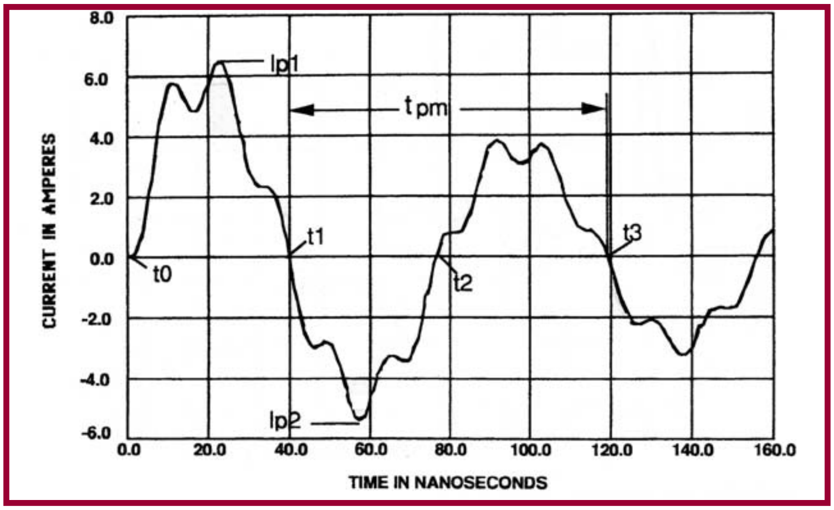


Figure 4.0-7: Current waveform through a short to ground

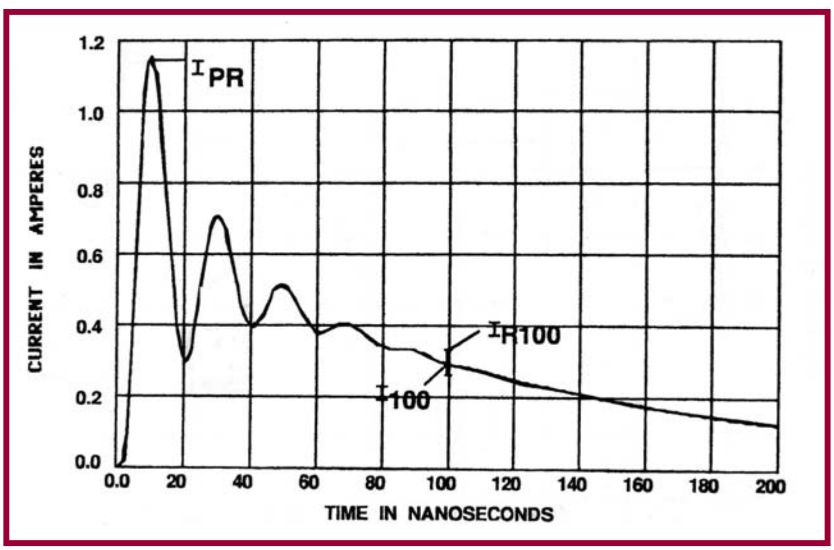


Figure 4.0-8: Current waveform through a 500 Ohm resistor to ground

5.0 DUT TESTING PROCEDURE

5.1 Set-Up

Set the High Voltage controls to the desired Range and Polarity. Turn the HIGH VOLTAGE ON and adjust for the desired voltage level.

Insert the DUT into either the clamping fixture or the appropriate optional zero insertion force Socket Test Fixture. Connect the minigrabber or to the desired pin pairs when the clamping fixture is used.

If a Socket Test Fixture is used, follow the procedure described in Figure 5.0-1 on how to program the module for the desired pin group configurations. **Use the .080” plug cables to connect the socket module to the Simulator output jacks.**

5.2 Test Procedure

If manual operation is desired, select MAN mode (button up). Set the COUNT/HOLD button to COUNT. Depress the DISCHARGE button to initiate a discharge across the DUT. Each time the DISCHARGE button is depressed a discharge will occur.

To reverse polarity, turn the HIGH VOLTAGE to OFF and set the COUNT/HOLD button to HOLD (optional), depress the POLARITY button for either + or -, then turn the HIGH VOLTAGE back on and set the COUNT/HOLD button to COUNT. **NOTE: The HIGH VOLTAGE must be turned off before Polarity or Range can be changed.**

If the AUTO Mode is desired, set the OPERATING Mode controls to AUTO and HOLD. Select the number of discharge pulses (1-9) and cool down interval period button to start the test sequence. These settings are typically 3 discharges at 1 second intervals. The first discharge will occur after the INTERVAL time selected has elapsed. Each discharge will register on the AUTO Mode display until the total number of cycles selected have been completed.

To interrupt the test cycle, set the COUNT/HOLD button to HOLD. To resume the test, depress the DISCHARGE button. To start a new cycle, depress the RESET button, then depress the DISCHARGE button.

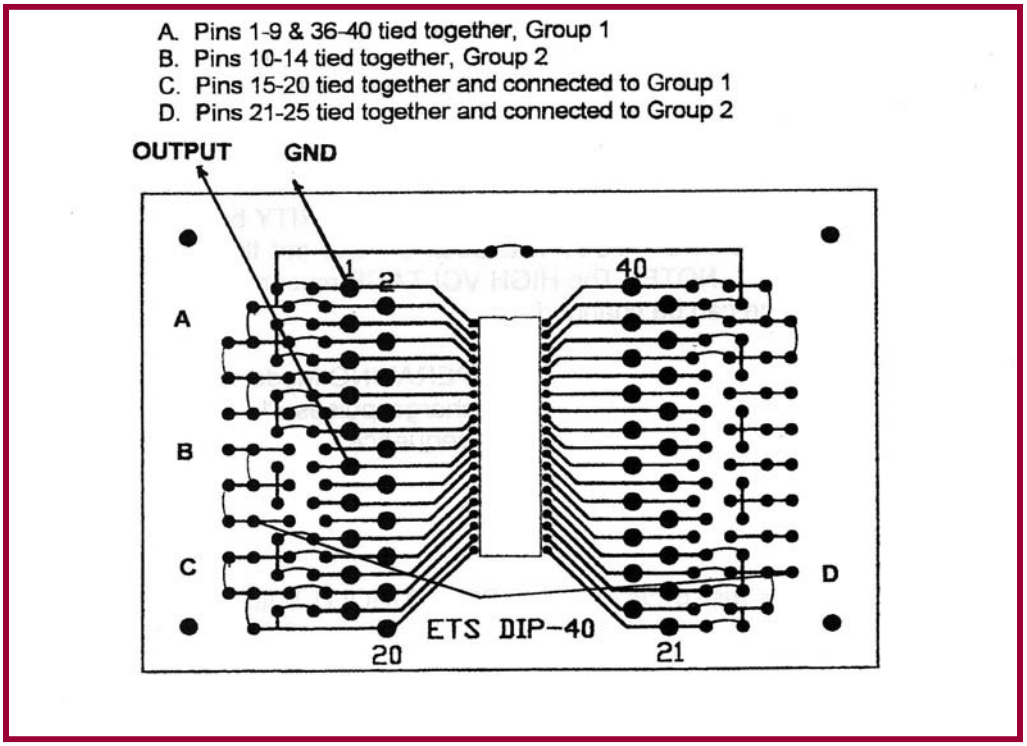


Figure 5.0-1: Programming IC Adapter Modules

5.3 HBM (Method 3015.7, ANSI/ESD-STM5.1 & JESD22-A114-B)

A sample of devices shall be characterized for the device ESD failure threshold using voltage steps of 500. 1000, 2000 and 4000 Volts as a minimum. Finer voltage steps may optionally be used to obtain a more accurate measure of the failure voltage. Testing may begin at any voltage step, except for devices which have demonstrated healing effects, including those with spark gap protection, which shall be started at the lowest step. Cumulative damage effects may be eliminated by retesting at the failure voltage step using a new sample of devices starting at one or two voltage steps lower than the failure threshold.

5.3.1 Control Settings

Initially select the LO Range, + Polarity and adjust the level to 500 Volts. Select the AUTO Mode and set the number of DISCHARGES to 3 and the INTERVAL (cool down period) to a minimum of 1 second.

5.3.2 Testing Procedure

Refer to the appropriate test standard being used to establish the correct testing protocol (starting voltage, number of discharges, pin combinations, etc).

5.4 MM (ANSI/ESD-STM5.2)

Machine Model testing is described in ANSI/ESD-STM5.2 that is available from the ESD Association at 7900 Turin Road, Rome, NY 13440. This Standard defines five component classification levels and four stress levels as shown in Figure 5.0-2. Testing protocol and pin combinations are also defined.

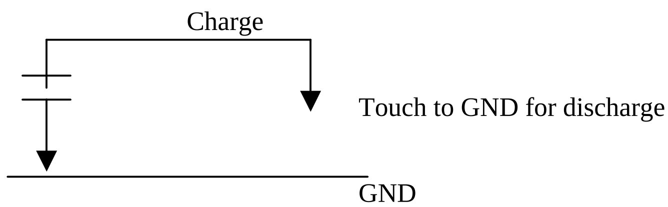
Level	First peak current into a shorting wire Ip1(Amps)	Peak current into 500 ohms I_{PR} (Amps)	Current into 500 ohms at 100ns (Amps)	Equivalent Charging voltage Vp (volts)
1 2 3 4	1.75 3.5 7.0 14.0	0.85 - 1.2	0.29	100 200 400 800

Figure 5.0-2: MM classification and stress levels

5.5 CDM (Charged Device Model) Option

The standard Model 910 is not configured to perform Charged Device Model testing directly. However, the charging system of the Model 910 incorporates a 400 MegOhm resistor in the charging circuit that allows an isolated device to be charged slowly enough not to cause an ESD discharge as specified in current CDM standards. In addition, the REMOTE output of the Model 910 provides 5V to operate an external CDM test fixture that is capable of performing both field induced and direct charging tests.

The Charge Device Model (CDM) is a more severe test than the standard HBM model since this event occurs when the device itself becomes charged then when touched to ground or a lower potential causes a very fast rise time discharge to occur as shown in Figure 5.0-3.



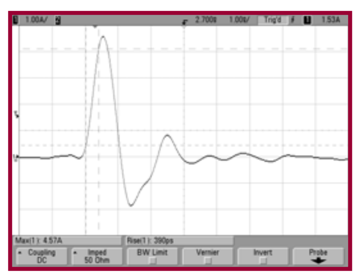


Figure 5.0-3: Basic Charge Device Model equivalent circuit

The CDM discharge is a function of the device capacitance that may be as low as a few picofarads (the example is a 6.8pF disc) or can be as high as several hundred picofarads (a complete assembly). This variation has a significant affect on the severity of the discharge. Small component packages may not be able to hold sufficient charge to meet specified discharge levels.

The Charged Device Model (CDM) test, as defined in standards JEDS22-C101C, ANSI/ESD-STM 5.3 and AEC-Q101-005 describe a test procedure where a component is slowly charged to a given voltage and then discharged to ground through one of the device leads. The CDM test permits either field induced or direct charge/discharge.

The optional Model 9903 Charge Device Test Fixture shown in Figure 5.0-4 is a completely integrated unit that provides the means of performing both direct charge and field induced CDM tests.

IMPRORTANT NOTE

The Model 9903 only provides the means to perform CDM testing. It does not produce verification waveforms that meet all the requirements specified in the test standards referenced above.

Figure 5.0-4: Model 9903 Charge Device Model Test Fixture

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6.0 WARRANTY

Electro-Tech Systems, Inc. warrants its equipment, accessories and parts of its manufacture to be and remain free from defects in material and workmanship for a period of one (1) year from date of invoice. It will, at it's discretion, either replace or repair without charge, F.O.B. Glenside, similar equipment or a similar part to replace any equipment or part of its manufacture which, within the above stated time, is proved to have been defective at the time it was sold. All equipment claimed defective must be returned properly identified to the Seller (or presented to one of its agents for inspection). This warranty only applies to equipment operated in accordance with Seller's operating instructions.

Seller's warranty with respect to those parts of the equipment that are purchased from other manufacturers shall be subject only to that manufacturer's warranty.

The Seller's liability hereunder is expressly limited to repairing or replacing any parts of the equipment manufactured by the manufacturer and found to have been defective. The Seller shall not be liable for damage resulting or claimed to result from any cause whatsoever.

This warranty becomes null and void should the equipment, or any part thereof, be abused or modified by the customer of if used in any application other than that for which it was intended. This warranty to replace or repair is the only warranty, either expressed or implied or provided by law, and is in lieu of all other warranties. Seller denies any other promise, guarantee, or warranty with respect to the equipment or accessories and, in particular, as to its or their suitability for the purposes of the buyer or its or their performance, either quantitatively or qualitatively or as to the products that it may produce The buyer is expected to expressly waive rights to any warranty other than that stated herein.

ETS must be notified before any equipment is returned for repair. ETS will issue an RMA (Return Material Authorization) number for return of equipment.

Equipment should be shipped prepaid and insured in the original packaging. If the original packaging is not available, the equipment must be packed in a sufficiently large box (or boxes if applicable) of double wall construction with substantial packing around all sides. The RMA number, description of the problem along with the contact name and telephone number must be included in formal paperwork and enclosed with the instrument. Round trip freight and related charges are the owner's responsibility.

WARNING:

WOODEN CRATES MUST NOT BE USED TO PACKAGE THE ELECTRONIC UNITS. PACKAGING OF DELICATE INSTRUMENTS IN WOODEN CRATES SUBSTANTIALLY INCREASES THE CONTENT'S SUSCEPTIBILITY TO SHOCK DAMAGE. ELECTRO-TECH SYSTEMS, INC. WILL NOT ASSUME RESPONSIBILITY FOR ADDITIONAL COST OF REPAIR DUE TO DAMAGE INCURRED DURING SHIPMENT DUE TO POOR PACKAGING.