

CHARGE DEVICE MODEL TEST FIXTURE

Model 9903



Operating Manual

10/12



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1.0 INTRODUCTION

The rapid advancement in the electronics industry during the past decade has placed an 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.

However, another type of discharge that is far more severe than the discharge from a person touching a device is the Charge Device Model (CDM). This occurs when the device itself becomes charged then touches ground a very fast rise time discharge can occur.

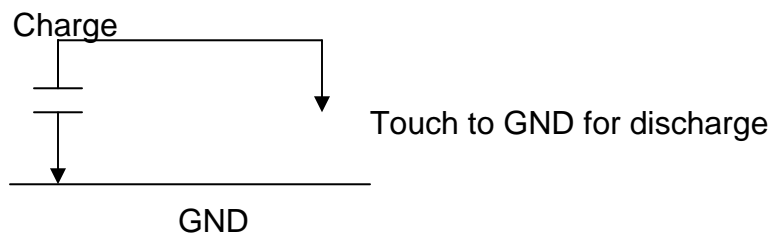


Figure 1.0-1: Basic Charge Device Model equivalent circuit

The CDM discharge is a function of the device capacitance that may be as low as a few picofarads or can be as high as several hundred picofarads. 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 Model 9903 Charge Device Test Fixture shown in Figure 1.0-1 is a completely integrated unit that provides the means of performing both direct charge and field induced CDM tests.

IMPORTANT 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 1.0-1: Model 9903 Charge Device Model Test Fixture

2.0 Description

The Charged Device Model (CDM) test is when a device is charged and then discharged directly to ground. To create a CDM the Device Under Test (DUT) is charged as if it was the capacitor and then discharged by grounding the desired pin manually by lowering a grounded spring loaded pin to the desired lead. Two different charging methods are specified.

The Field Induced Model charging method raises the DUT potential indirectly by induction and then the desired pin is grounded to generate the CDM discharge. The potential is raised by applying voltage to the field-charging electrode shown in Figure 2.0-1.

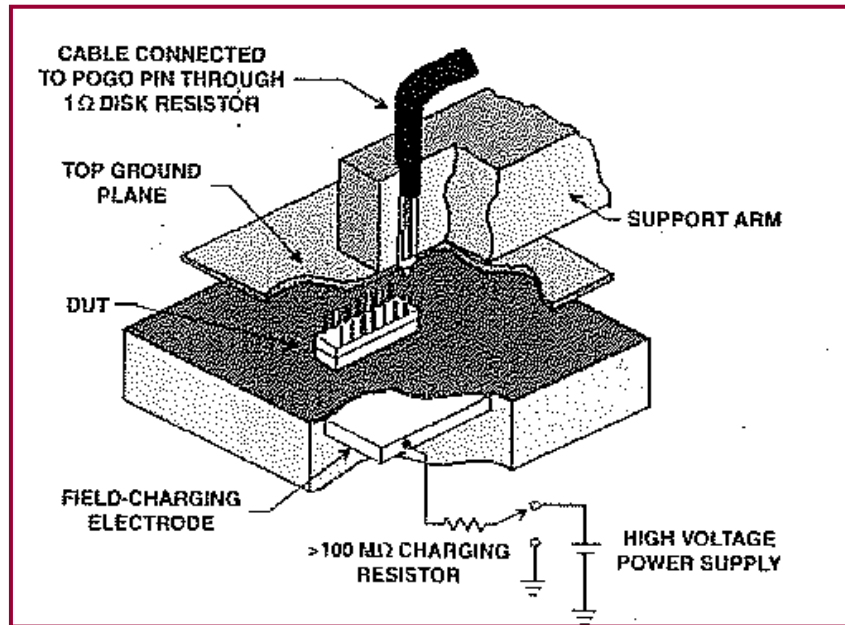


Figure 2.0-1: Field Induced Charge Device Model

Tests that are performed using Direct Charging is when the device is placed on a grounded surface with or without a dielectric isolator and one or more pins are charged directly through at least a 100 MegOhm resistor. The respective pin is then discharged directly to ground. Discharge rise times are in the picosecond range. The Models 910 and 9910 incorporate a 400 MegOhm series resistor in the charging circuit.

The Model 9903 in conjunction with either the ETS Model 910 with CDM modification or the Model 9910 enables the user to perform both Field Induced and Direct Charge tests.

The CDM Test Fixture shown in Figure 1.0-1 consists of a magnetic stainless steel field induction plate/ground plane and a control module that controls the charging and grounding function. It contains the upper ground plane, spring-loaded discharge pin and the discharge button. The internal control electronics time the charge and discharge function of the field induction plate and DUT. This enables the DUT to be charged and discharged multiple times at the same polarity. In addition, the module contains a radial 1 Ohm resistor for measuring the discharge current. The entire assembly is mounted on a press fixture for performing the test. To select field induction or direct charging a jumper wire connects the plate to the voltage output connector on the rear of the control module for field induced charging or to the ground connector that is also located on the rear of the module for direct charging. In the latter configuration, a 6" (152mm) charging lead with a 5" (127mm) minigrabber and 15 megOhm resistor to reduce the effects of parasitic cable capacitance when the test pin is both charged then discharged is connected to the voltage output. In addition, the 4 and 30pF calibration discs specified in ANSI/ESD-STM-5.3.1 and the 6.8 and 55pF discs specified in JEDS22-C101C are supplied.

The adjustable fixture shown in Figure 2.0-2 holds devices up to 2.5x2.5" (64x64mm). The fixture itself has magnets to help align the desired pins with the discharge electrode.

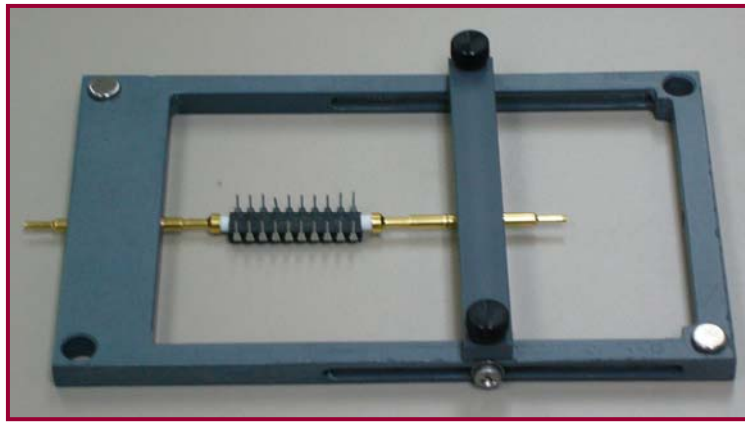


Figure 2.0-2: DUT Holding Fixture

The spring-loaded pins (Interconnect Devices Series S, Size 3) shown in Figure 2.0-3 are interchangeable. Three types are provided. They are round tip (J) for pad terminals, cup tip (G) for DIP style legs, and point tip (B) for very small contact points.

Series S		SIZE 3 .125 CENTERS						
STEEL PLUNGER TIPS		PROBE SPECIFICATIONS						
	A	Minimum Centers: .125 (3.18) Current Rating: 5 amps continuous						
	B	Spring Force: 4.0 or 7.0 oz. @ .170 (4.32) travel						
	C	Typical Resistance: < 20 mΩ						
	E	Maximum Travel: .250 (6.35)						
	F	Working Travel: .170 (4.32)						
	G	<table border="1"> <thead> <tr> <th>Rated Force oz (g)</th> <th>Preload oz (g)</th> </tr> </thead> <tbody> <tr> <td>4.0 (113)</td> <td>1.8 (51)</td> </tr> <tr> <td>7.0 (198)</td> <td>2.9 (82)</td> </tr> </tbody> </table>	Rated Force oz (g)	Preload oz (g)	4.0 (113)	1.8 (51)	7.0 (198)	2.9 (82)
Rated Force oz (g)	Preload oz (g)							
4.0 (113)	1.8 (51)							
7.0 (198)	2.9 (82)							
	H	MATERIALS						
	J	Barrel: Nickel/silver, gold plated						
	K	Spring: Stainless steel, gold plated						
		Plunger: Beryllium copper, gold plated over nickel or Duralloy™						
		Receptacle: Nickel/silver, gold plated, gold plated post						

Figure 2.0-3: Spring-loaded pin configurations

To change pins raise the test head to the top by loosening the lever on the rear. This will give sufficient room to be able to replace or change the pin. Then move the test head back to a position where the pin tip is approximately 0.25" (6mm) above the pin under test.

3.0 SET UP

The Model 9903 is designed to work with a minimum 1 GHz/4Gs sample oscilloscope with 50 Ohm input. It is connected to the oscilloscope via a 2' (61cm), 50 Ohm, low loss, semi-rigid cable.

3.1 System Set Up

3.1.1 Set-Up (Model 910 modified for CDM)

Connect the CDM Test Fixture to the Model 910 as shown in Figure 3.0-1.

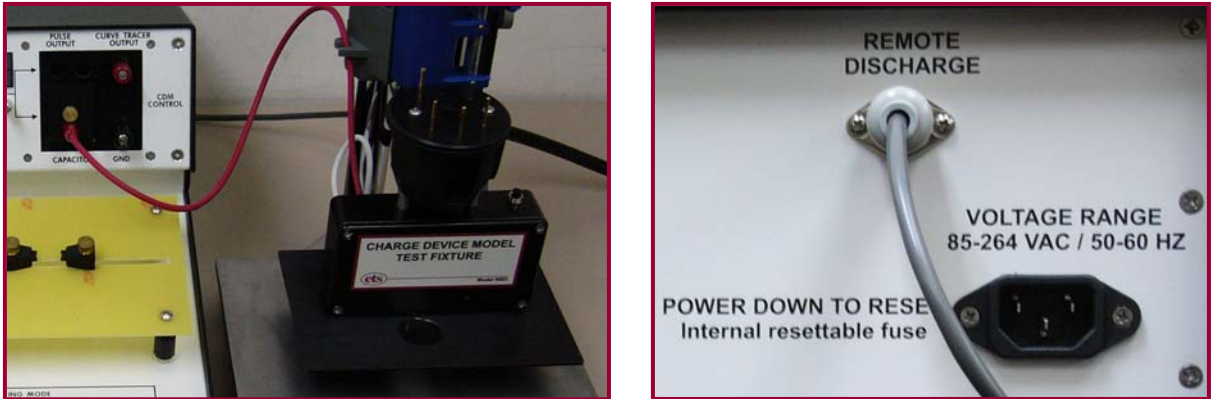


Figure 3.0-1: Model 9903 with Model 910

1. Plug the CDM Charging Module into the CAPACITOR location on the Simulator OUTPUT panel. This provides the voltage to the induction plate or to the device depending on the type of test.
2. Plug the red 0.080" pin plug from the CDM Test fixture into the CDM plug-in module.
3. Connect the 3-pin power plug into the REMOTE DIN connector located on the rear panel. This provides the power to operate the charge and discharge relays.
4. Connect the coaxial cable to the oscilloscope. **The scope input must be set to 50 Ohms.** The scope ground is the ground point to which the CDM is discharged. For testing at 500V using the small verification discs the cable can be connected directly to the scope input. For higher voltages and/or the large verification discs a 10:1 attenuator must be used.

3.1.2 Set-Up (Model 9910)

Connect the CDM Test Fixture to the Model 9910 as shown in Figure 3.0-2.

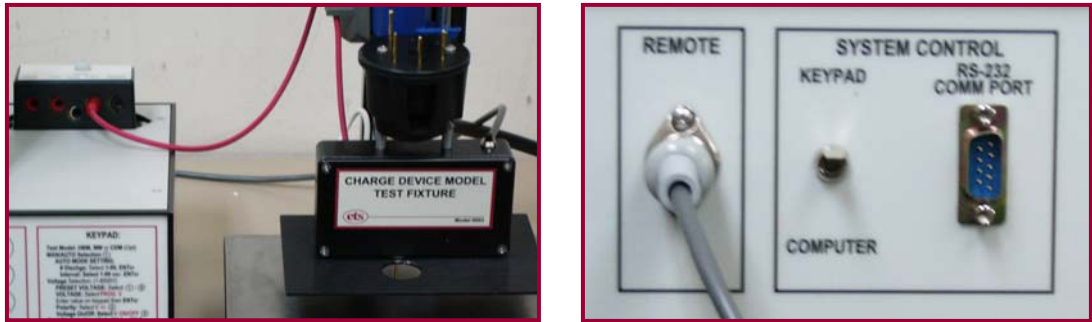


Figure 3.0-2: Model 9903 with Model 9910

1. Plug the red 0.080" pin plug from the CDM Test fixture into the CDM 0.080 pin jack on the Simulator OUTPUT panel. This provides the voltage to the induction plate or to the device depending on the type of test.
2. Connect the 3-pin power plug into the REMOTE DIN connector located on the rear panel. This provides the power to operate the charge and discharge relays.
5. Connect the coaxial cable to the oscilloscope. **The scope input must be set to 50 Ohms.** The scope ground is the ground point to which the CDM is discharged. For testing at 500V using the small verification discs the cable can be connected directly to the scope input. For higher voltages and/or the large verification discs a 10:1 attenuator must be used.

2.2 Charging Method

2.2.1 Field Induced Model

To configure the Test Fixture for Field Induced testing plug the red banana-banana cable into the red banana jack on the rear of the control module and the red banana jack on the plate as shown in Figure 3.0-3.

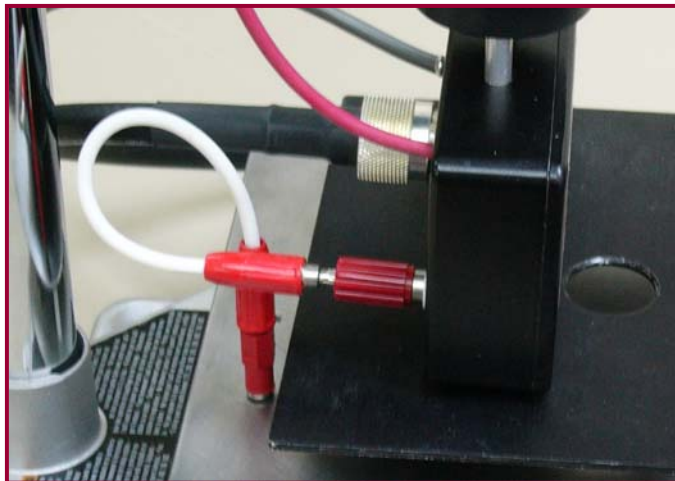


Figure 3.0-3: Field Induced connections

3.2-2 Direct Discharge Method

To configure the Test Fixture for Direct Charge testing plug the red banana-banana cable into the GND jack on the rear of the control module and the red banana jack on the plate as shown in Figure 3.0-4.



Figure 3.0-4: Direct Charge connections

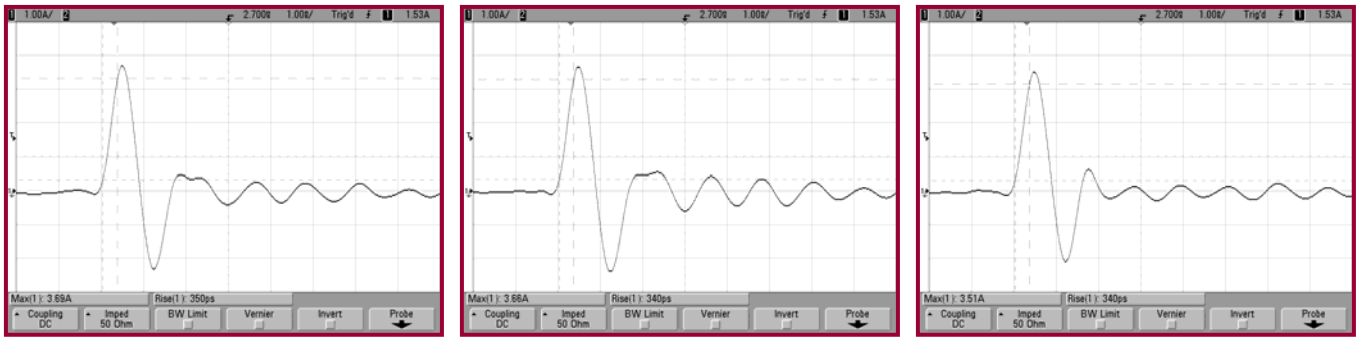
6.4 Waveform Verification

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. These deviations are small, but may be outside the limits specified. It is up to the end user to determine that the CDM waveforms measured with the specified verification modules will meet individual requirements.

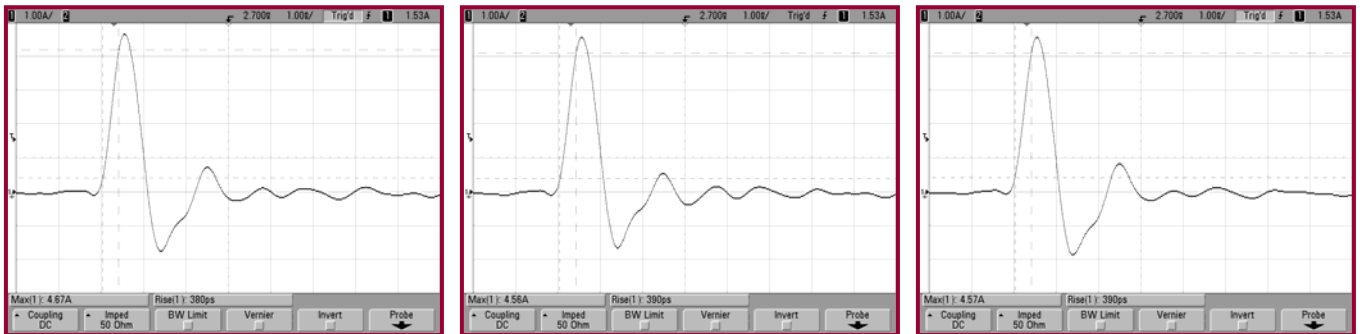
The CDM waveforms can be measured using the supplied 4 and 30pF STM5.3, and/or the 6.8 and 55pF JEDEC verification modules. The measurement procedure is the same for both methods. Typical waveforms over 3 discharges obtained with the Model 9903 CDM Test Fixture using the Field Induced charging method are shown in Figure 3.0-5a and the Direct Charging method in Figure 3.0-5b. Low amplitude can usually be compensated for by increasing the charging voltage since it is typically affected by losses caused by leakage, parasitic capacitance, verification module characteristics humidity etc. during charging. In addition, air discharge can easily result in a 20% variation in peak amplitude.

The actual resistance of the radial 1 Ohm resistor is 1.03 Ohms. The 3% variation should be factored in when measuring the actual peak current levels.

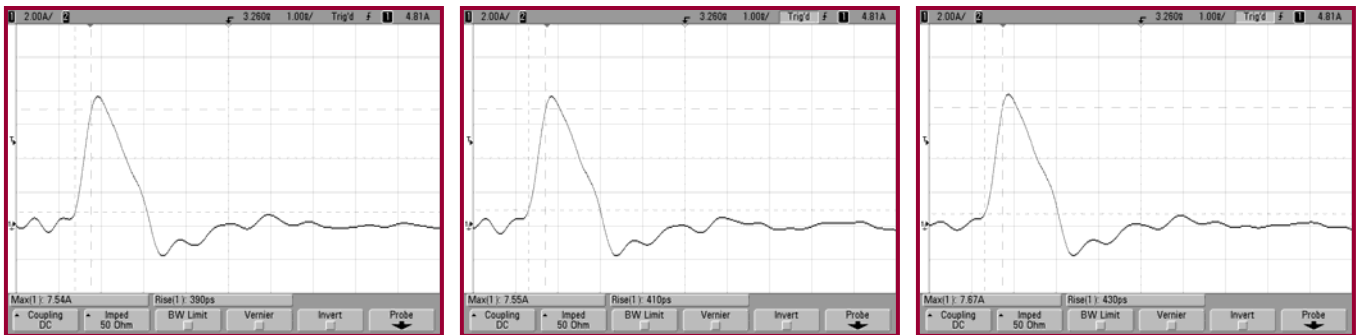
Performing direct discharge measurements with the charging probe connected will also affect the waveform by adding additional parasitic capacitance. The Model 9903 Probe contains a 15 megOhm resistor at the wire end of the 5" minigrabber.



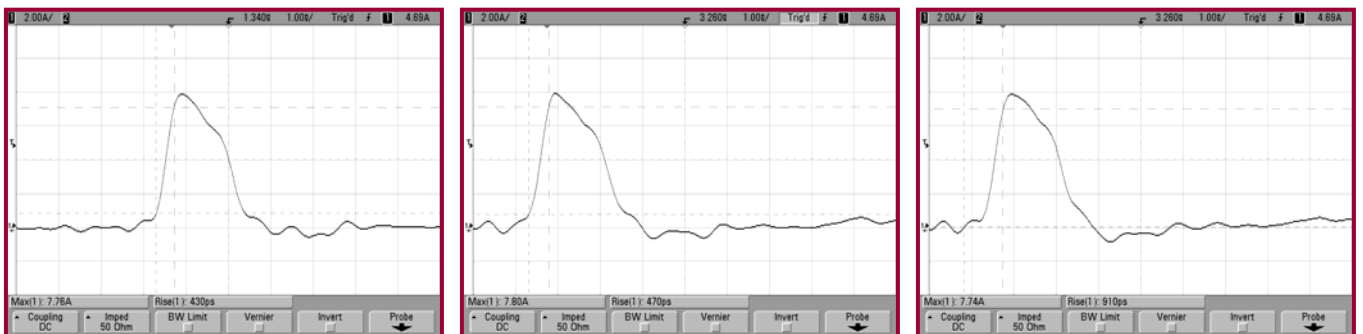
ESD STM 5.3, 4pF Disc @ 500V



JEDEC JDCS 22-C101E, 6.8pF Disc @ 500V



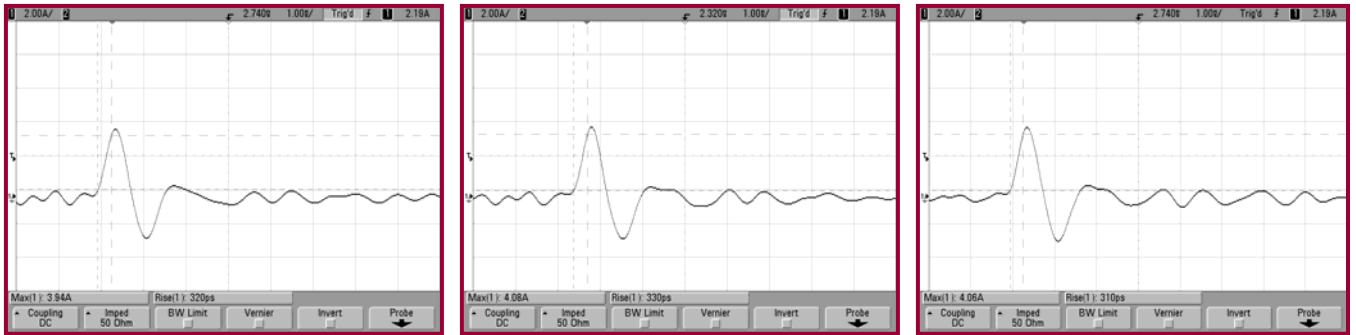
ESD STM 5.3, 30pF Disc @ 500V



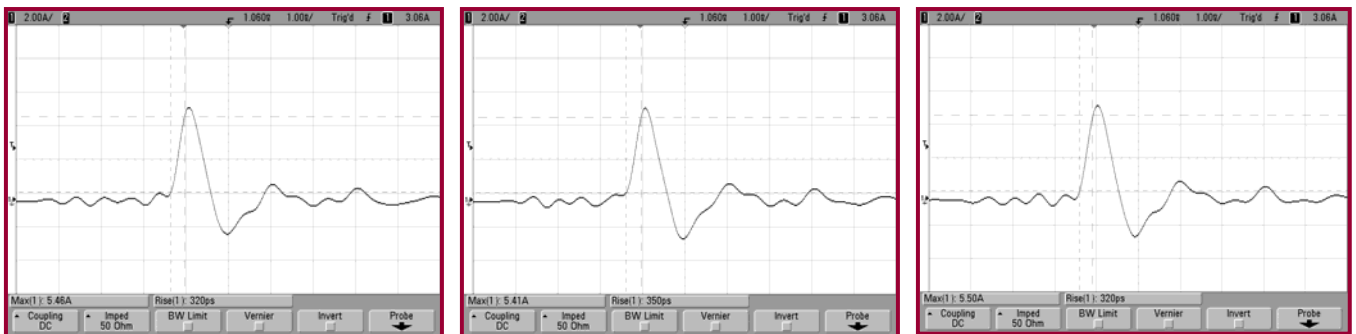
JEDEC JDCS 22-C101E, 55pF Disc @ 500V

Figure 3.0.5a: Typical Field Induce Model verification waveforms

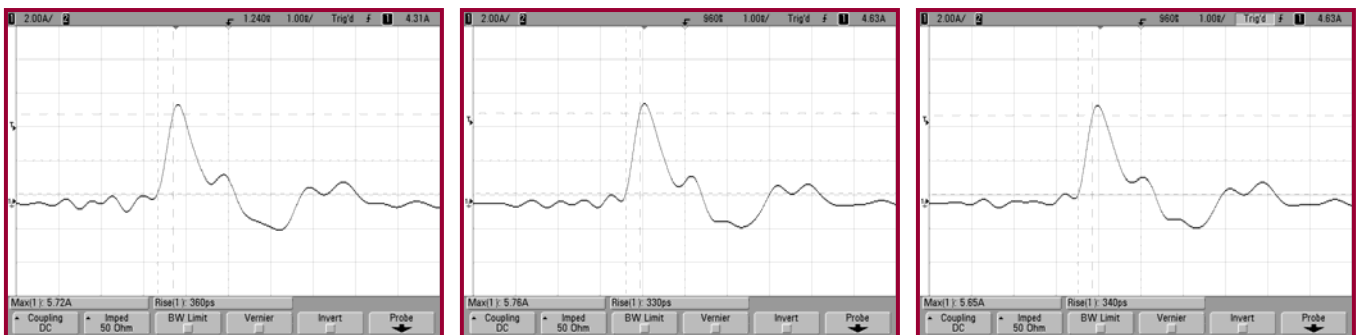
Figure 3.0-6 lists the waveform requirements for both the ESDA and JEDEC standards.



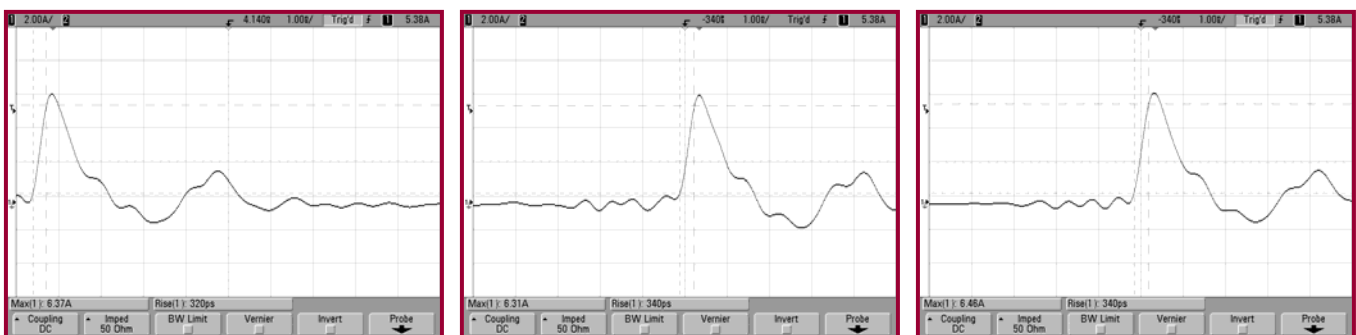
ESD STM 5.3, 4pf Disc @ 500V (Touch disc to charge, remove probe, discharge)



JEDEC JDCS 22-C101E, 6.8pF Disc @ 500V (Touch disc to charge, remove probe, discharge)



ESD STM 5.3, 4pf Disc @ 500V (Hold disc to charge then discharge)



JEDEC JDCS 22-C101E, 6.8pF Disc @ 500V (Hold disc to charge then discharge)

Figure 3.0.5a: Typical Direct Charging Method verification waveforms

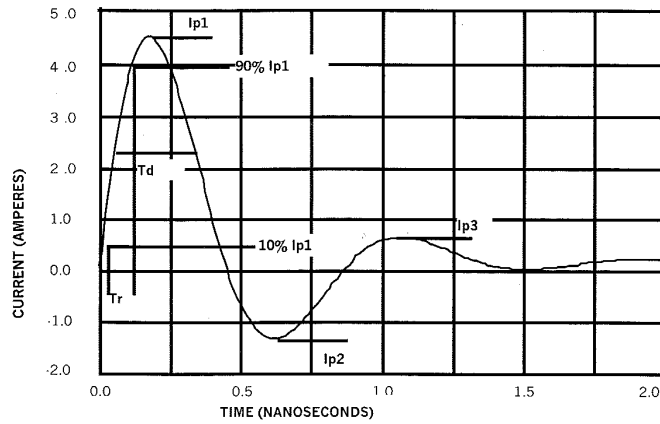


Figure 2: CDM ESD waveform for the standard verification modules using the one gigahertz bandwidth measurement system

Requirements for one gigahertz:

Charge Voltage Volts $\pm 5\%$	Symbol	4 pF Verification Module Amperes $\pm 20\%$	30 pF Verification Module Amperes $\pm 20\%$
125	I_{p1}	1.13	
250	I_{p1}	2.25	
500	I_{p1}	4.50	14.00
1000	I_{p1}	9.00	
1500	I_{p1}	13.50	
2000	I_{p1}	18.00	

Parameter	Symbol	4 pF Verification Module All Voltages	30 pF Verification Module 500 V only
Rise Time	t_r (ps)	<400 ps	<400 ps
Full width at Half Height	t_d (ps)	<600 ps	<1000 ps
Max 2nd peak	I_{p2}	<50% I_{p1}	<50% I_{p1}
Max 3rd peak	I_{p3}	<25% I_{p1}	<25% I_{p1}

Note 14: For the positive polarity: I_{p2} is the second peak, the undershoot negative peak; I_{p3} is the third peak, the overshoot positive peak. For the negative polarity: I_{p2} is the second peak, the overshoot positive peak; I_{p3} is the third peak, the undershoot positive peak.

a. ANSI/ESD-STM 5.3

Table 3 — CDM waveform characteristics

Standard test module		Test Number			
		#1	#2	#3	#4
		Small	Small	Large	Large
Test voltage (V)		500 ($\pm 5\%$)	1000 ($\pm 5\%$)	200 ($\pm 5\%$)	500 ($\pm 5\%$)
Peak current magnitude (A)	I_p	5.75 ($\pm 15\%$)	11.5 ($\pm 15\%$)	4.5 ($\pm 15\%$)	11.5 ($\pm 15\%$)
Rise time (ps)	t_r	<400	<400	-	-
Full width at half height (ns)	T_d	1.0 \pm 0.5	1.0 \pm 0.5	-	-
Undershoot (A, max.)	U-	<50% I_p	<50% I_p	<50% I_p	<50% I_p
Overshoot	U+	<25% I_p	<25% I_p	<25% I_p	<25% I_p

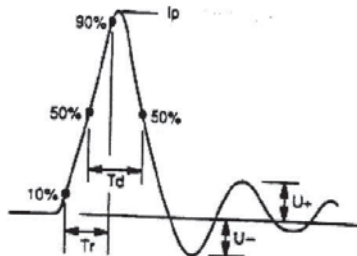


Figure 2 — CDM current waveform

b. JEDS22-C101E

Figure 3.0-6: ANSI/ESD-STM 5.3 and JEDS22-C101E Waveform requirements

6.4.1 Field Induced Measurement

1. Configure the Test Fixture for Field Induced Measurements per Section 3.2.1.
2. Adjust the height of the Press test head so that the ground plane is approximately 0.5" (12mm) above the induction plate using the lever located on the rear of the test head.

Place the non-disc side of the 4 or 6.8pF verification module in intimate contact with the metal surface of the field induction plate. It should be centered under the Discharge Electrode spring-loaded pin. Place the supplied magnet to the right of the disc to ensure intimate contact with the plate as shown in Figure 3.0-7. **(If the magnet is placed on the left side, it may interfere with the relays inside the test head module.)**

3. Set the Model 910 or 9910 to 500V. (For the Model 910 the plug-in CDM Adapter limits the voltage to just the low range of 2000V. For the Model 9910, select the CDM function. This limits the voltage to 1000V. **Under no circumstances should the Model 9903 be operated above 2000V. This will destroy the timing relays.**) Depress and release the Charge button on the Fixture module. The red CHARGE LED will light for approximately 2 seconds. While the LED is on, quickly lower the module enabling the spring-loaded pin to contact the disc to discharge it. **MAINTAIN CONTACT WITH THE DISC UNTIL THE LED TURNS OFF.** This allows the disc to remain grounded while the induction plate returns to ground. Repeat at least 2 more times. The waveforms for the 4.0 and 6.8pF discs will look similar those shown in Figure 3.0-8. Record and save the data.

If this procedure is not followed, the disc will not charge for the next test. This timing sequence is critical for the field induced measurement. Subsequent measurements at the same polarity can then be performed. If the sequence is broken first lower the test head **WITHOUT DEPRESSING THE CHARGE BUTTON ON THE MODULE** in order to ground the disc then repeat the measurement.

4. Repeat the above procedure for measurements at -500V.
5. Other voltage levels can be used.

Refer to the respective specifications for more procedure details.

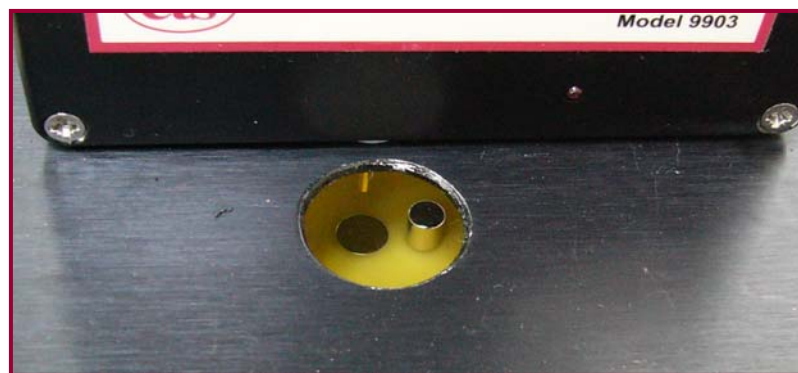
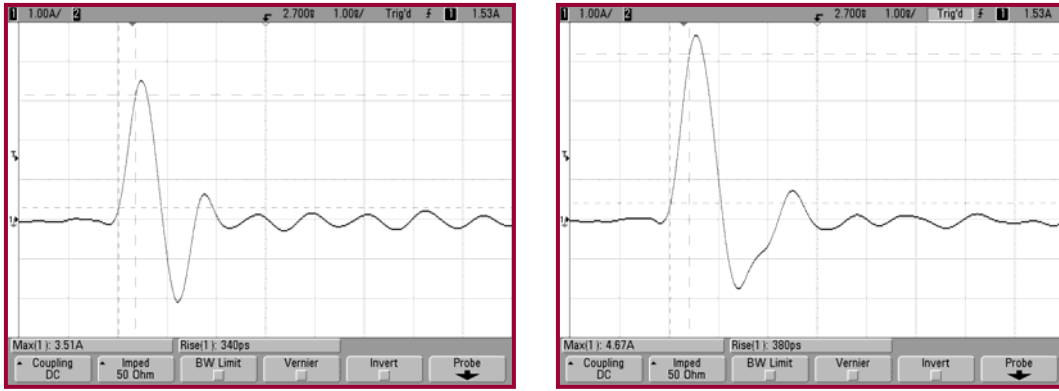


Figure 3.0-7: Verification module alignment



a. 4.0pF Disc

6.8pF Disc

Figure 3.0-8: Typical Induced Charge waveforms for small discs

6.4.2 Direct Charge Measurement

1. Configure the Test Fixture for Direct Charge Measurements per Section 3.2.2.
2. Adjust the height of the Press test head so that the ground plane is approximately 0.5" (12mm) above the induction plate using the lever located on the rear of the test head.

Place the non-disc side of the 4 or 6.8pF verification module in intimate contact with the metal surface of the grounded plate. It should be centered under the Discharge Electrode spring-loaded pin. Place the supplied magnet to the right of the disc to ensure intimate contact with the plate as shown in Figure 3.0-7. **(If the magnet is placed on the left side, it may interfere with the relays inside the test head module.)**

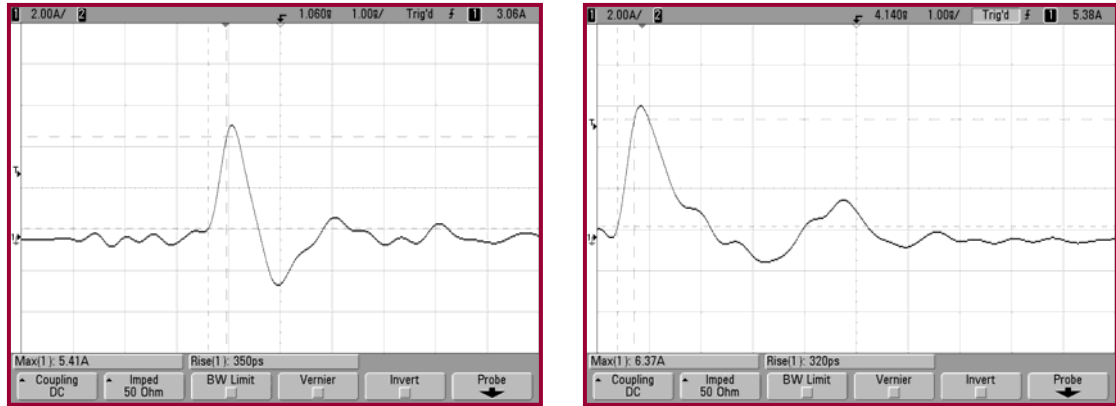
3. Set the Model 910 or 9910 to 500V. (For the Model 9910 select the CDM function.) There are two direct charging methods.

Touch with minigrabber contact: Depress the Charge button on the Fixture module. While the LED is on, touch the probe to the disc. Then quickly lower the module enabling the spring-loaded pin to contact the disc to discharge it. **MAINTAIN CONTACT WITH THE DISC for approximately 1 second.** This allows the disc to remain grounded ensuring total discharge.

Maintain probe contact to the disc: Depress the Charge button on the Fixture module. While the LED is on, quickly lower the module enabling the spring-loaded pin to contact the disc to discharge it. **MAINTAIN CONTACT WITH THE DISC for approximately 1 second.** This allows the disc to remain grounded ensuring total discharge. A 15 megOhm resistor in the probe minimizes the parasitic capacitance effects of the probe.

Repeat the measurement at least 2 more times. The waveforms for the 4.0 and 6.8pF discs will look similar those shown in Figure 3.0-9. Record and save the data.

4. Repeat the above procedure for measurements at $-500V$.
5. Other voltage levels can be used.



a. Touch and remove

Probe remains connected

Figure 3.0-9: Typical Direct Charge waveforms for 6.8pF discs

6.5 DEVICE TESTING

The recommended stress levels are slightly different between the JEDEC and ANSI/ESD specifications as listed in the table below.

Level	JEDEC Level V	ANSI/ESD Level V
1	100	125
2	200	250
3	500	500
4	1000	1000
5	2000	1500
6	-	2000

6.5.1 Test Procedure

1. Place the DUT either in the holding fixture or directly onto the plate. For metal encased devices, a 2 mil dielectric may have to be placed on the plate.
2. Align the spring-loaded pin to the DUT pin to be discharged as shown in Figure 6.5-1.
3. Lower the module to both verify the alignment and to initially ground the pin. **Do Not Push the Discharge Button.**
4. If not already set then set the voltage to the desired level.

5. **For Field Induce charging**, depress the Discharge button momentarily, then quickly lower the test head enabling the spring-loaded pin to discharge the DUT. The discharge waveform will be displayed on the scope. **Continue to hold the lever down until the red LED indicator goes out.**
6. **For Direct Charging**, either touch the minigrabber probe to the desired pin or connect it to the pin.

Touch with minigrabber contact: Depress the Charge button on the Fixture module. While the LED is on, touch the probe to the disc. Then quickly lower the module enabling the spring-loaded pin to contact the disc to discharge it. **MAINTAIN CONTACT WITH THE DISC for approximately 1 second.** This allows the disc to remain grounded ensuring total discharge.

Maintain probe contact to the disc: Depress the Charge button on the Fixture module. While the LED is on, quickly lower the module enabling the spring-loaded pin to contact the disc to discharge it. **MAINTAIN CONTACT WITH THE DISC for approximately 1 second.** This allows the disc to remain grounded ensuring total discharge. A 15 megOhm resistor in the probe minimizes the parasitic capacitance effects of the probe.

7. For each component, apply 3 positive and 3 negative discharges to each pin. Observe the discharge on the oscilloscope. Allow at least several seconds between charge/discharge cycles.



Figure 6.5-1: DUT/Discharge pin alignment

7.0 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 its 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 or 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.