
TABLE OF CONTENTS

1.0 PURPOSE AND SCOPE.....	1
1.1 PURPOSE	1
1.2 SCOPE	1
2.0 REFERENCED PUBLICATIONS.....	1
3.0 PERSONNEL SAFETY	1
3.1 TRAINING.....	1
3.2 PERSONNEL SAFETY.....	1
4.0 CDM TESTER OPERATIONAL CONSIDERATIONS	2
4.1 CLEANING.....	2
4.1.1 <i>Test Cleaning</i>	2
4.1.2 <i>Device Cleaning</i>	2
4.2 ROUTINE VERSUS QUARTERLY CHECKS.....	2
4.2.1 <i>Tracking Factor/Offset Settings</i>	3
4.2.2 <i>Hardware Changes Requiring Waveform Verification</i>	3
4.3 HOLDING A PACKAGE IN PLACE, Z HEIGHT CAUTION.....	3
4.4 POGO PIN TIPS (ROUND VERSUS CONCAVE VERSUS SHARP)	5
4.5 HUMIDITY	5
4.6 CABLE CONNECTIONS	5
4.7 1-OHM CURRENT SENSING RESISTANCE MEASUREMENTS.....	5
5.0 OSCILLOSCOPE EFFECTS - SETTINGS	7
5.1 METROLOGY CONCERNs.....	7
5.2 PROPER CABLING AND ATTENUATOR SELECTION.....	7
5.3 PROPER OSCILLOSCOPE SELECTION	8
5.4 OSCILLOSCOPE VARIATION CONCERNs.....	8
5.5 PROPER DATA CAPTURE AND ANALYSIS.....	9
6.0 DETERMINING IF A CHARGE TIME (DELAY) IS NEEDED	9
6.1 PROCEDURE FOR DETERMINING IF A CHARGE TIME (DELAY) IS NEEDED	9
6.2 PROCEDURE FOR SETTING CHARGE TIME (DELAY)	10
7.0. WAVEFORM VERIFICATION PROCEDURE – FACTOR/OFFSET	11
7.1 FACTOR/OFFSET ADJUSTMENT METHOD.....	11
7.2 FACTOR/OFFSET ADJUSTMENT IMPACTS.....	14
7.3 FACTOR/OFFSET ADJUSTMENT METHOD DETAILS	15
7.3.1 <i>Positive Polarity Waveform Verification</i>	15
7.3.2 <i>Repeat with Negative Polarity</i>	29
8.0 WAVEFORM VERIFICATION PROCEDURE – SOFTWARE VOLTAGE	36

8.1 SOFTWARE VOLTAGE ADJUSTMENT METHOD	36
8.2 SOFTWARE VOLTAGE ADJUSTMENT METHOD DETAILS	39
8.3 ESTIMATION OF TEST VOLTAGES OTHER THAN THE ANSI/ESDA/JEDEC JS-002 TEST CONDITIONS	49
9.0 PACKAGE VARIABLES AFFECTING FICDM PEAK CURRENT AND PULSE SHAPE ...	50
9.1 THREE-CAPACITOR MODEL.....	50
9.2 INTERNAL PACKAGE IMPEDANCE AND DIE CIRCUIT EFFECTS	52
10.0 CALCULATION OF CHARGE AND EFFECTIVE CAPACITANCE.....	53
11.0 SINGLE DISCHARGE VERSUS DUAL DISCHARGE METHOD SELECTION	55
12.0 NO-CONNECT PIN TESTING CONSIDERATIONS.....	55
12.1 PULSE DETECTION, IP LOGGING, AND EVENT DETECTORS	55
12.2 OVER-STRESS/UNDER-STRESS RISK WHEN ZAPPING No-CONNECTS	57
12.3 CHOOSING THE CORRECT DISCHARGE METHOD FOR No-CONNECT PINS	58
13.0 FIRST PIN TESTED WAVEFORM	59
14.0 SMALL PACKAGE PARTS AND CDM.....	60
14.1 SMALL PACKAGES WITH GULL-WING LEADS	61
15.0 DIFFICULT TO TEST PACKAGES - TIP OVER POTENTIAL.....	62
15.1 TOXXX PACKAGES	62
15.2 MULTI-WATT PACKAGES.....	63
15.3 THICK PACKAGES	65
15.4 LONG LEAD PACKAGES.....	66
15.5 EXPOSED METAL PLATES AND HEAT SINKS	66
15.6 TEST PADS AND PINS DESIGNATED AS No-CONNECT (NC) OR Do-Not-Use (DNU)	67
16.0 CDM DATA REPORTING	68
17.0 BIBLIOGRAPHY	68

TABLES

Table 1:	Small Verification Module Positive Waveform Summary – Factor/Offset Adjustment Method	28
Table 2:	Large Verification Module Positive Waveform Summary – Factor/Offset Adjustment Method	29
Table 3:	Small Verification Module Negative Waveform Summary – Factor/Offset Adjustment Method	35
Table 4:	Large Verification Module Negative Waveform Summary – Factor/Offset Adjustment Method	36
Table 5:	Small Verification Module Positive Waveform Summary – Software Voltage Adjustment Method	48
Table 6:	Large Verification Module Positive Waveform Summary – Software Voltage Adjustment Method	48
Table 7:	Effect on the Connected Pin Immediately Following a No-connect Pin at High Charge Level	58
Table 8:	Ip Data for Various Landing Positions of the Pogo	66

FIGURES

Figure 1:	Relative Position (Z Height or “Cruising Height”) of the Pogo Pin to the DUT During the Movement from Pin to Pin During Testing.....	4
Figure 2:	A Device Where the Adjustment of the “Cruising Height” Would be Critical to Avoid Hitting the Components in the Center of the Grid During Movement from Pin to Pin ...	4
Figure 3a:	Kelvin 4-Wire Resistance Measurement 1-Ohm Current Sensing Resistor Setup	6
Figure 3b:	Connection of the Kelvin 4-Wire Clips to the 1-Ohm Current Sensing Resistor Setup.	6
Figure 4:	Calculated Measurement Accuracy Versus Measurement Current for Different Types of Ohmmeters when Measuring a 1-Ohm Current Sensing Resistor	7
Figure 5:	Magnitude Response for Gaussian and Maximally-Flat Filters.....	8
Figure 6:	Example Characterization of Charge Time (Delay) Versus Ip.....	11
Figure 7:	Example Waveform Verification Flow for Qualification and Quarterly Checks Using the Factor/Offset Adjustment Method.....	13
Figure 8:	Example of the Impact of Factor Adjustment on the Average Ip for the Large Verification Module – High Bandwidth Oscilloscope	14
Figure 9:	Example of the Impact of Offset Adjustment on the Average Ip for the Large Verification Module – High Bandwidth Oscilloscope	15
Figure 10:	Example TC 500 Verification Flow for Qualification and Quarterly Checks Using the Factor/Offset Adjustment Method.....	16
Figure 11:	Initial Large Verification Module Reading at TC 500	17
Figure 12:	Large Verification Module Reading at TC 500 After Initial Factor Adjustment	18
Figure 13:	Large Verification Module Reading at TC 500 After Final Factor Adjustment.....	19
Figure 14:	Small Verification Module Reading at TC 500 After Final Factor Adjustment.....	20
Figure 15:	Example TC 125 Verification Flow for Qualification and Quarterly Checks Using the Factor/Offset Adjustment Method.....	20
Figure 16:	Large Verification Module Reading at TC 125	21
Figure 17:	Example TC 250 Verification Flow for Qualification and Quarterly Checks Using the Factor/Offset Adjustment Method	22
Figure 18:	Large Verification Module Reading at TC 250	23
Figure 19:	Example TC 750 Verification Flow for Qualification and Quarterly Checks Using the Factor/Offset Adjustment Method.....	23

Figure 20: Large Verification Module Reading at TC 750	24
Figure 21: Example TC 1000 Verification Flow and Post TC 1000 Checks for Qualification and Quarterly Checks Using the Factor/Offset Adjustment Method	25
Figure 22: Large Verification Module Reading at TC 1000	26
Figure 23: Small Verification Module Reading at TC 125.....	26
Figure 24: Small Verification Module Reading at TC 250.....	27
Figure 25: Small Verification Module Reading at TC 750.....	27
Figure 26: Small Verification Module Reading at TC 1000.....	28
Figure 27: Initial Large Verification Module Reading at Negative TC 500.....	30
Figure 28: Large Verification Module Reading at Negative TC 500 After Final Factor Adjustment.....	30
Figure 29: Large Verification Module Reading at Negative TC 125	31
Figure 30: Large Verification Module Reading at Negative TC 250	31
Figure 31: Large Verification Module Reading at Negative TC 750	32
Figure 32: Large Verification Module Reading at Negative TC 1000	32
Figure 33: Small Verification Module Reading at Negative TC 125	33
Figure 34: Small Verification Module Reading at Negative TC 250	33
Figure 35: Small Verification Module Reading at Negative TC 500	34
Figure 36: Small Verification Module Reading at Negative TC 750	34
Figure 37: Small Verification Module Reading at Negative TC 1000	35
Figure 38: Example Waveform Verification Flow for Qualification and Quarterly Checks Using the Software Voltage Adjustment Method	38
Figure 39: Example TC 500 Verification Flow for Qualification and Quarterly Checks Using the Software Voltage Adjustment Method	39
Figure 40: Initial Large Verification Module at TC 500	40
Figure 41: Large Verification Module at TC 500 After Initial Software Voltage Adjustment to 410 Volts.....	41
Figure 42: Large Verification Module at TC 500 After Final Software Voltage Adjustment of 415 Volts.....	42
Figure 43: Small Verification Module at TC 500 After Final Software Voltage Adjustment of 415 Volts	42
Figure 44: Example TC 125 Verification Flow for Qualification and Quarterly Checks Using the Software Voltage Adjustment Method	43
Figure 45: Large Verification Module at TC 125 After Final Software Voltage Adjustment of 105 Volts	44
Figure 46: Small Verification Module at TC 125 After Final Software Voltage Adjustment of 105 Volts	44
Figure 47: Large Verification Module at TC 250 After Final Software Voltage Adjustment of 200 Volts	45
Figure 48: Small Verification Module at TC 250 After Final Software Voltage Adjustment of 200 Volts	45
Figure 49: Large Verification Module at TC 750 After Final Software Voltage Adjustment of 615 Volts.....	46
Figure 50: Small Verification Module at TC 750 After Final Software Voltage Adjustment of 615 Volts.....	46
Figure 51: Large Verification Module at TC 1000 After Final Software Voltage Adjustment of 815 Volts.....	47

Figure 52: Small Verification Module at TC 1000 After Final Software Voltage Adjustment of 815 Volts.....	47
Figure 53: Example Plot of Software Voltage Versus Target Test Voltage Used for the Software Voltage Adjustment Method	49
Figure 54: Illustration of the FICDM Capacitors.....	50
Figure 55: CDM Peak Current for Package Sizes Up to 2600 mm ² for 500-Volt Stress	51
Figure 56: Effect of Leaded/Leadless Packages on Peak Current Versus Package Area at 500 Volts.....	52
Figure 57: Typical CDM Waveform as Measured on a High Bandwidth Oscilloscope.....	54
Figure 58: Ip Logging on a Larger (52.5 mm x 51 mm) Package Looking at Three Valid IO Pins and Three No-connect Pins at 500 Volts.....	56
Figure 59: Ip Logging on a Smaller (15 mm x 15 mm) Package Looking at Two Valid IO Pins and Two No-connect Pins at 500 Volts	56
Figure 60: Comparison of Current and Charge of NC pin and Two Subsequent Pins.....	57
Figure 61: Dual Discharge Event for Connected and No-Connect Pins	59
Figure 62: Examples of Securing a Package Using FR4-Based “Holders”	60
Figure 63: Impact of Template Holders on CDM Ip	61
Figure 64: Examples of SOT23 With and Without Placement on Vacuum Hole	62
Figure 65: Examples of SC70 With and Without Placement on Vacuum Hole	62
Figure 66: Examples of Holding a Package in Place with Risk of Tipping	62
Figure 67: TOxxx Package	63
Figure 68: Ip Versus Charging Voltage of TOxxx Package – Tab Up Versus Down.....	63
Figure 69: Multi-Watt Package.....	64
Figure 70: Bending Package Leads to Alter the Pin Height	64
Figure 71: Pogo Pin Landing on Adjusted Lead	65
Figure 72: Adjusting Leads Back to Original Height on ESD Mat.....	65
Figure 73: Thick Package Limiting Pogo Pin from Landing on Lead.....	66
Figure 74: TO220 Package Depicting Pogo Landing Locations	66
Figure 75: Examples of Product with an Exposed Metal Plate/Heat Sink	67
Figure 76: Examples of Product with Pin/Balls Removed to Avoid Customer Use	68