ES621 Series Dynamic IV-Curve Test System
The **ES621 Advanced Dynamic IV-Curve Test System** is a complete TLP system designed to simulate ESD events (TLP/VF-TLP/HMM) and monitor devices (semiconductors, circuit modules, etc.) in transient high power time domain.

The TLP (transmission line pulse) test functions are designed to meet ANSI/ESD STM5.5.1-2008 test standards and offer high quality rectangular pulses to devices, recording both voltage and current through devices. This gives pulsed VI curves that allow users to characterize a device’s transient response over nanosecond time windows. Advanced automatic device failure detection methods are incorporated, such as leakage testing, static IV curves, fuse and spark testing.

The VF-TLP test functions are designed to simulate the CDM speed ESD event and capture the voltage across the DUT and current through the DUT under a very high speed (such as 100ps rise-time) ESD transient moment. This allows users to study the response speed and peak clamping voltage of a device.

The HMM (Human Metal Model) test function is an alternative test method to the IEC61000-4-2 system level ESD test. It gives the equivalent waveform to an ideal standard waveform for low ohm devices and eliminates many IEC gun test problems for component or wafer level tests: such as repeatability, imprecise gun tip, impedance mismatches, EMI interferences from unshielded relays, and special setups with large ground planes and coupling planes, etc.

The system features fully software controlled and customizable rise-time and pulse width selection, great compatibility with IVI instruments, compact size and affordable cost.

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**ES621 Features**

- **Pulse Width Selections**: Up to 7 programmable pulse-width selections up to 40A.
- **Rise-Time Selections**: Up to 7 programmable rise-time selections from 100ps to 50ns. 120A or lower amp models only.
- **Compact Size**: 3U rack-mount or smaller chassis. Roughly 17.5 x 5.5 x 13 inches and 20 lbs.
- **Cost-Effective**: Custom systems at a reasonable price. Contact sales@esdemc.com.
- **High Quality Waveform**: All TLP, VF-TLP, and HMM modules are tuned for the cleanest and most stable waveform shapes.
- **High Injection**: Maximum 160A pulse injection for low-Ohm DUT. 120A, 90A, 60A, 40A, and 30A models are available.
- **Great Control**: Our LabVIEW based software contains many test and analyze features, and can be customized for the best testing solution.
- **Gold Support**: ESDEMC provides test consultation, remote assistance, fast repair and replacement, and lifetime technical support.
ES621 Models

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HMM Specifications

**Standard Models**
- Up to 8kV IEC model current injection for low Ohm devices
- 30A first peak, 16 A at 30ns, 8A at 60ns
- First peak rise-time 700 to 1000 ps
- Option of 50 Ohm or 100 Ohm test setups

**High Current Models**
- Up to equivalent 15kV or 24kV IEC standard current injection for short circuit DUT
- First peak rise-time 700 to 1000 ps
- Option of 50 Ohm or 100 Ohm test setups
  - Type A: 50 Ohm system injects 90A first peak, 48A at 30ns, 24A at 60ns
  - Type B: 100 Ohm system injects 60A first peak, 32A at 30ns, 16A at 60ns

**Pulse Generator Specifications**
- Integrated precision high voltage supplies
- Operation Modes: Single, Sequence, Repeat, and Remote

At ESDEMC Technology, we can customize most model features to suit your testing needs.

Contact us at info@esdemc.com or 573-202-6411 for more information.
Our LabVIEW based TLP Software has great instrument compatibility. Use your existing instruments, or we can provide new instruments as a part of a complete ES621 system. Our software is well constructed and works directly with most available IVI instruments; such as Agilent, Tektronix, and Lecroy oscilloscopes. Instrument control drivers for older instruments can be customized and updated.

The ES621 software is designed to easily set-up testing parameters. In the Measurement Setup area, the operator can change the leakage test voltage, test polarity, how pulses are delivered to the DUT, and other testing choices. This allows for flexibility in testing. Our software can also be customized to fulfill special testing needs.

The software auto scales the oscilloscope to obtain the best signal level, saves raw data for reprocessing if desired, and performs leakage testing. Reprocessing is quick and easy as all parameters used during testing are saved to a file for future reference. The software also has a built-in analyze feature that can show the results of four device measurements simultaneously for quick comparison.
The ES621 generates very clean and stable waveforms with smooth rising edges.

The 100 Ohm HMM module, by default, matches the theoretical ideal IEC Waveform precisely in all rising and falling curves.
## Accessories & Configurations

### Pulse Generators
- **ES621-PG Series**: TLP Pulse Generator (30-100A Available)
- **A620-RC**: Pulse Generator Remote Control Option
- **A6210**: IV Characterization Upgrade for ES621-PG Series

### Rise-Time Options
- **A621-PRT4**: Programmable Pulse Rise-Time X4 Module
- **A621-PRT7**: Programmable Pulse Rise-Time X7 Module
- **A621-MRT**: External Manual HV Pulse Ride-Time Filter Module

### Pulse-Width Options
- **A621-PPL4**: Programmable Pulse-Length X4 Module (VF-TLP)
- **A621-PPL7**: Programmable Pulse-Length X7 Module (TLP/VF-TLP)
- **A621-MPL**: External Manual Pulse Width Module

### High Impedance Injection Options
- **A621-HIP**: High Impedance Injection Probe Tip
- **A621-HIT**: High/Low Impedance Transformer with Auto Switch

### HMM Options
- **A621-30.HMM**: 8kV HMM for ES621-30
- **A621-160.HMM**: 24kV HMM for ES621-160

### Resistive Direct IV Test Method Options
- **A6210-D**: Software Option for ES621 Standard TLP Direct Measurement
- **A6213-D**: Resistive HV Directive Pulse Injection and IV Probe

### Resistive HMM Test Method Options
- **A6210-HMM**: Software Option for ES621 Standard TLP Direct Measurement
- **A6213-HMM**: Resistive HV HMM Pulse Injection and IV Probe

### Overlap TDR Test Method Options
- **A6213-T1**: HV Pulse Current and Voltage Probe
- **A6213-T2**: HV Pulse Pick Tee

### Non-Overlap TDR Test Method Options
- **A621-FS312**: Non-Overlap TDR Measurement Set-Up for VF-TLP

### Differential Injection and IV Measurement Options
- **ES651**: Differential ESD Injection and IV Measurement Probing System
- **A621-651DS**: Pulse Differential Splitter
- **A621-651IVPL**: IV Injection and IV Measurement Probe Left
- **A621-651IVPR**: IV Injection and IV Measurement Probe Right
- **A621-651PM**: Precision Probe Micromanipulator
- **A621-LTKDFM**: Leakage Tester Switch Module for the ES651 System

### Leakage Measurement Options
- **A621-LTK2400**: Source Meter Unit (Keithley Model 2400)
- **A621-LTKSO**: ES621 System Leakage Measurement Option
- **A621-LTKSEM**: Leakage Tester Module for Single Port ESD Injection
- **A621-LTP**: SMU ESD Protector

### DC Bias Tee
- **A621-BT1**: Compact Bias Tee
- **A621-BT2**: Medium Size High Power Bias Tee

### Oscilloscopes
- **A621-DPO3052**: Tektronix DPO3502 Digital Oscilloscope
- **A621-DPO3054**: Tektronix DPO3054 Digital Oscilloscope
- **A621-DPO7254C**: Tektronix DPO7254C Digital Oscilloscope
- **A621-DPO70604C**: Tektronix DPO70604C Digital Oscilloscope
- **A621-OSCEP**: Oscilloscope Channel Overvoltage Protector
**Test Methods and Accessories**

**Resistive Direct Test Methods**

**TLP Direct IV Measurement Method with the A6213-D**

The A6213-D measures the voltage and current directly at the DUT which is typically mounted onto a test board with a SMA connector. This probe is primarily intended for greater than 50ns pulse IV characterization of PCB mounted components.

**Advantages:**
1. Simple and direct current sensing.
2. Bandwidth starts from DC, great for long pulse/low frequency measurement.
3. No saturation error from current measurement.
4. Low cost IV measurement.

**Disadvantages:**
1. Relatively large inductive connection for pulse injection and IV sensing causing ringing and error for short pulse.
2. Cannot measure IV cleanly for the first few nanoseconds.
3. Current sensing resistor needs to be wideband, robust, and very linear for transient high current.
4. Does not work at very high current (>30A)

**Configuration:**
1. ES621 Series Dynamic IV Curve Test System
2. A6210-D Software Option for ES621 Standard TLP Direct Measurement (included with ES621 System)
3. A6213-D Resistive HV Directive Injection and IV Probe
4. A621-LTKSEM Leakage Tester Switch Module for Single Port ESD Injection
Test Methods and Accessories

Resistive Direct Test Methods

HMM IV Measurement Method with the A6213-HMM

The A6213-HMM probe is intended for characterizing low-ohmic ESD protection devices mounted on a test board with SMA connector. The series combination of the low-ohmic DUT and the 47Ω resistor ensures suppression of reflections and an undistorted delivery of the HMM pulse to the DUT.

**Advantages:**

1. Simple and direct IEC61000-4-2 type pulsing.
2. No saturation for current measurement.

**Disadvantages:**

1. Load matching resistor needs to be wideband and linear for transient high current.

**Configuration:**

1. ES621 Series Dynamic IV Curve Test System
2. A6210-HMM Software Option for ES621 Standard TLP Direct Measurement (included with ES621 Software)
3. A6213-HMM Resistive HV HMM Pulse Injection and IV Probe
4. A621-LTKSEM Leakage Tester Module for Single Port Injection
Overlap TDR Measurement Method with Inductive Current Probe with the A6213-T1

For the best performance this probe should use its overlapping reflection capability (A6213-T1) to measure the DUT current, and the direct measurement ($R_v$) to measure the DUT voltage. For devices that have a dynamic resistance greater than 50Ω the current measurement is performed by a CT1, and for devices with less than 50Ω the current is measured by a resistive pick off tee ($R_i$). The software determines which to use by taking the average of both results and comparing it to 50Ω. This probe can also measure the DUT voltage just using the A6213-T1, but with low ohmic devices the voltage measurement suffers due to the small signal levels, the oscilloscope measurement resolution, and the mathematics behind the measurement, all contributing to voltage error. The probe can measure PCB mounted DUT or a wafer type, and a thru voltage can also be captured. In the software the operator will be able to select how to measure the DUT voltage (green notations in the Setup figure), and if they wish to measure the thru voltage (magenta notations).

**Advantages:**
1. No need for sample PCB. Pulse injection and IV sensing can be separated as Kelvin Probing method.
2. Great for 10ns+ pulse and relatively high frequency measurement.
3. Little inductance for DUT connection.
4. PCB or wafer measurements possible.

**Disadvantages:**
1. Cannot measure IV cleanly for short pulse (<10ns).
2. May not measure high impedance (>50Ω) DUT precisely depending on probe set-up.

**Configuration:**
1. ES621 Series Dynamic IV Curve Test System
2. A6213-T1 HV Pulse Current and Voltage Probe (CT1 and PickTee, Overlapping Reflection)
3. A621-LTKSEM Leakage Tester Switch Module for Single Port ESD Injection
Test Methods and Accessories

**TDR Test Methods**

Overlap TDR Measurement Method without Inductive Current Probe with the A6213-T2

As with the A6213-T1, this probe delivers the best performance with its overlapping reflection capability (A6213-T2) measuring the DUT current, and the direct measurement (Rv) to measure the DUT voltage. The difference between the T1 and T2 is there is no CT1 used in the T2 meaning the ability to measure high ohmic devices suffers from similar effects as the voltage measurement with low ohmic devices. The probe can measure PCB mounted DUT or a wafer type, and a thru voltage can also be captured. In the software the operator will be able to select how to measure the DUT voltage (green notations in the Setup figure), and if they wish to measure the thru voltage (magenta notations).

**Advantages:**

1. Pulse injection and IV sensing can be separated as Kelvin Probing method.

**Disadvantages:**

1. Cannot measure high impedance (>50Ω) DUT precisely.

**Configuration:**

1. ES621 Series Dynamic IV Curve Test System
2. HV Pick Tee Overlapping Reflection Probe
3. A621-LTKSEM Leakage Tester Switch Module for Single Port ESD Injection
Non-Overlap TDR IV Measurement Method with the FS312

For the best performance this probe should use its non-overlapping reflection capability (FS312-Tee) to measure the DUT current, and the direct measurement ($R_v$) to measure the DUT voltage. The FS312-Tee is intended for use with very short pulses (<10ns) due to the length of delay line required to measure with longer pulses. The dark blue traces denoted with an encircled 1, 2, and 3 must be measured with a network analyzer prior to probe use. The software requires $S_{21}$, $S_{31}$, and $S_{32}$ between these ports to determine the DUT current. Note that the attenuator at port 3 must be included into the $S$-parameter measurement. As with the A6213-T1 the DUT voltage can also be measured using just the FS312-Tee, but with low ohmic devices the voltage measurement suffers due to the small signal levels, the oscilloscope measurement resolution, and the mathematics behind the measurement, all contributing to voltage error. The probe can measure PCB mounted DUT or a wafer type, and a thru voltage can also be captured. In the software the operator will be able to select how to measure the DUT voltage (green notations in the Setup figure), and if they wish to measure the thru voltage (magenta notations).

**Advantages:**
1. Great for high frequency short pulse measurement.

**Disadvantages:**
1. Delay line set-up can be very cumbersome and lossy for long pulse (>10ns).
2. May not measure high impedance (>50Ω) DUT precisely depending on probe set-up.

**Configuration:**
1. ES621 Series Dynamic IV Curve Test System
2. A6213-FS312 Non-Overlap TDR Measurement Probe
3. A621-LTKSEM Leakage Tester Switch Module for Single Port ESD Injection
The ES651 is an innovative differential ESD signal injection and I/V signal measurement probing system. It is designed to handle ESD injection on complex DUT or ESD injection at different locations with very flexible probing distance. The system has integrated ESD current and voltage measurement setups on both polarity ends. Both voltage and current measurement system are fully calibrated up to 1 GHz for advanced ESD debugging and research measurements.

**Test Methods and Accessories**

* Differential ESD Injection with IV Measurement Test Method

**ES651 Differential ESD Injection Probe with IV Measurement Circuit Integrated**

The ES651 is an innovative differential ESD signal injection and I/V signal measurement probing system. It is designed to handle ESD injection on complex DUT or ESD injection at different locations with very flexible probing distance. The system has integrated ESD current and voltage measurement setups on both polarity ends. Both voltage and current measurement system are fully calibrated up to 1 GHz for advanced ESD debugging and research measurements.

**Configuration:**
1. ES621 Series Dynamic IV Curve Test System
2. ES651 Differential ESD Injection and IV Measurement System
3. A621-651DS Pulse Differential Splitter
4. A621-651VPL IV Injection and IV Measurement Probe-Left
5. A621-651-VPR IV Injection and IV Measurement Probe-Right
6. A621-651PM Precision Probe Micromanipulator
7. A621-651-LTKDFM Leakage Tester Module for ES651 Differential Injection Probe
8. A621-LTKSEM Leakage Tester Switch Module for Single Port ESD Injection
HVAT Series High Voltage RF Attenuators

To measure the signal of high voltage transient TLP pulse, the front stage wideband attenuator needs to be very robust in transient pulse and work linear up to the maximum voltage and duration pulses from the TLP. Normally high power RF attenuators cannot survive such pulse. ESDEMC offers a special HV pulse attenuator designed and tuned to measure fast rise-time pulses in order to characterize the pulse waveform shape, repeatability, and stability.

SOLZ Calibration Kit

A set of 50 Ohm sample printed circuit boards with Short, Open, 50 Ohm Load, and Zener Diodes with known IV-curves can be used to calibrate different IV measurement methods.

A621-LTKSEM

A high voltage RF coax switch module for switching DUT connections between TLP pulsing, IV measurement testing, and DUT failure/function testing (leakage current, static IV, VNA, etc.)
ES621-30 Rental Program

The ES621 Advanced Dynamic IV-Curve Test System is a complete TLP system designed to simulate ESD events (TLP/VF-TLP/HMM) and monitor devices (semiconductors, circuit modules, etc.) in transient high power time domain.

Rental systems are available in 30 amp injection current. All rental systems come with a laptop computer with LabVIEW analysis software.

TLP/VF-TLP Specifications
- Up to 30A maximum injection current
- 7 rise-time selections from 250ps to 50ns, additional options can be added with automatic control extension box (extra fee may apply)
- 7 pulse width selections from 2ns to 100ns, additional options can be added with automatic control extension box (extra fee may apply)
- Pulse voltage control in 0.1V

HMM Specifications
- Up to 8kV IEC model current injection for low ohm devices
- 30A first peak, 16A at 30ns, 8A at 60ns
- First peak rise-time 700 ~ 1000ps
- 50 Ohm or 100 Ohm test setups

Rental Systems Include
- ES621-30 Advanced IV-Curve Test System
- ES621-30
- Oscilloscope
- Picoammeter
- Laptop computer with LabVIEW analysis software
- One day of training at our facility in Rolla, MO (travel costs are not included)
- Additional training days as needed (extra fee may apply)
- Technical support via telephone or email. Video conferencing is also available.
ESDEMC Technology warrants to the owners, each instrument and sub-assembly manufactured by them to be free from defects in material and workmanship for a period of one year after shipment from the factory. This warranty is applicable to the original purchaser only.

Liability under this warranty is limited to service, adjustment or replacement of defective parts (other than tubes, fuses, or batteries) on any instrument or sub-assembly returned to the factory for this purpose, transportation prepaid.

This warranty does not apply to instruments or sub-assemblies subjected to abuse, abnormal operating conditions, or unauthorized repair or modification. Since ESDEMC Technology has no control over conditions of use, no warranty is made or implied as to the suitability of our product for the customer's intended use.

**THIS WARRANTY SET FORTH IN THIS ARTICLE IS EXCLUSIVE AND IN LIEU OF ALL OTHER WARRANTIES AND REPRESENTATIONS, EXPRESS, IMPLIED OR STATUTORY INCLUDING BUT NOT LIMITED TO THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS.**

Except for obligations expressly undertaken by ESDEMC Technology in this warranty, the Owner hereby waives and releases all rights, claims and remedies with respect to any and all guarantees, express, implied, or statutory (including without limitation, the implied warranties of merchantability and fitness), and including but without being limited to any obligation of ESDEMC Technology with respect to incidental or consequential damages, or damages for loss of use. No agreement or understanding varying or extending the warranty will be binding upon ESDEMC Technology unless in writing signed by a duly authorized representative of ESDEMC Technology.

In the event of a breach of the foregoing warranty, the liability of ESDEMC Technology shall be limited to repairing or replacing the non-conforming goods and/or defective work, and in accordance with the foregoing; ESDEMC Technology shall not be liable for any other damages, either direct or consequential.

**FACTORY REPAIR:**

Return authorization is required for factory repair work. Products being returned for repair must be accompanied by a copy of a dated invoice and a Return Material Authorization (RMA) number. To obtain an RMA number, call customer service. Repairs will be returned promptly. Repairs are normally returned to the customer within 10 business days after receipt by ESDEMC Technology. Return (to the customer) UPS charges will be paid by ESDEMC Technology on warranty work. Return (to the customer) UPS charges will be prepaid and added to invoice for out-of-warranty repair work.

All products returned by air or by an overnight service will be expedited. Expedited factory repairs will be returned to the customer by the same mode of transportation by which the product was returned for repair (i.e., products returned to the factory by an overnight service will be returned to the customer by an overnight service). **NOTE:** Return (to the customer) transportation expenses for expedited factory repairs will always be at the expense of the customer despite the warranty status of the equipment.

**MODIFIED EQUIPMENT:**

Products returned for repair that have been modified will be not tested unless the nature and purpose of the modification is understood by ESDEMC representatives and does not render the equipment untestable at the repair facility. ESDEMC Technology will reserve the right to deny service to any modified equipment returned to the factory for repair regardless of the warranty status of the equipment.
ESDEMC Technology LLC is a worldwide test and measurement solution provider in electrostatic control, electrostatic discharge (ESD), electromagnetic compatibility (EMC), high voltage power supply, and high voltage RF test and measurement.

ESDEMC Technology is devoted to delivering creative, flexible, and cost-effective solutions and top-level consulting services. We offer customized design services to satisfy various customer needs.

ESDEMC Technology LLC is a Corporate Member of the ESD Association.