Measurement Environment Solutions for Eliminating ESD/EOS Failures

(ESD: Electro Static Discharge / EOS: Electrical Over Stress)

Electronic components of electronic devices and measurement devices break down when subjected to high voltages caused by **electrostatic discharge (ESD)** or **electrical over-stress (EOS)**.
Signals sent to I/O connectors of electronic, measurement and other devices must be within the rated voltage or the devices may fail.
This document should be used to help build an environment that avoids **ESD** or **EOS**.

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http://www.anritsu.com/en-US/test-measurement/products/mp1800a

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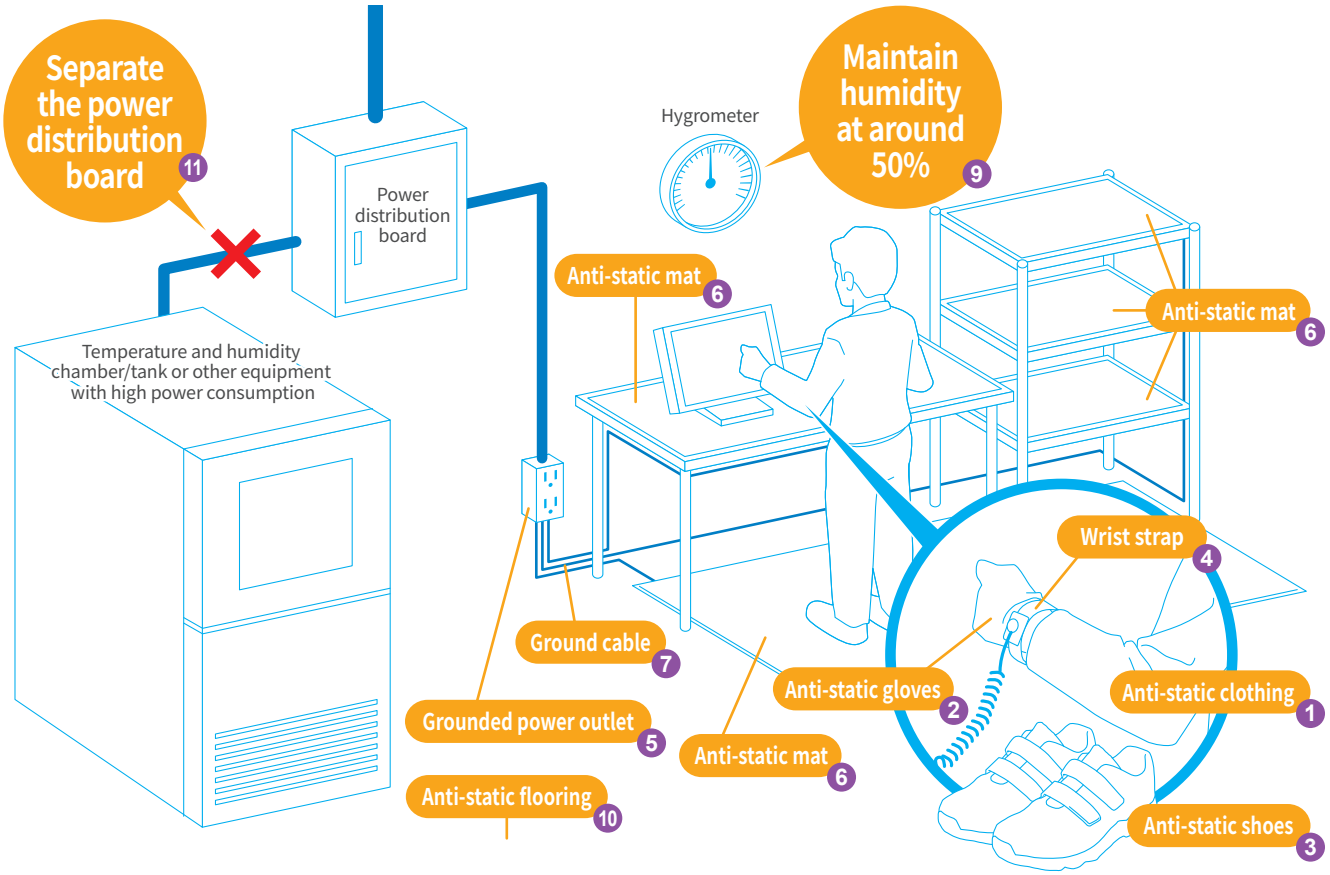
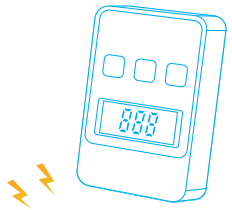
1. Creating a measurement environment



Regular ESD inspections

Item	Frequency	Notes
Anti-static clothing	Every six months	Resistance[Ω] : 1×10^{5}～1×10^{11}
Anti-static gloves	Inspect conduction: Daily Measure resistance: Every six months	Resistance[Ω] : 7.5×10^{5}～1×10^{12}
Anti-static shoes	Inspect conduction: Daily Measure resistance: Every six months	Resistance (individual measurement)[Ω] : 1×10^{5}～1×10^{8}
Wrist strap	Inspect conduction: Daily Measure resistance: Every six months	Resistance[Ω] : 7.5×10^{5}～3.5×10^{7}
Anti-static mat	Resistance: Every six months	Point-to-point resistance[Ω] : 1×10^{4}～1×10^{10}
Anti-static flooring	Resistance: Monthly	Ground resistance[Ω] : 7.5×10^{5}～1×10^{9}

ESD check using static tester 8



Electrostatically charged surface

ESD and EOS

<4M changes>

Always pay particular attention to ESD/EOS events after 4M changes (man, machine, material or method) related to personnel, equipment and machinery, work environment, or management system and method. Rechecking in line with this document is recommended after any 4M change.

ESD

<Worker-related solutions>

1 Anti-static clothing
Remove static electricity buildup from clothing to avoid inducing a charge in the surrounding environment.

2 Anti-static gloves
Suppress static discharges through current-limiting properties of gloves.

3 Anti-static shoes or heel strap
Prevent static electricity buildup in the body by grounding the worker's feet through contact between the shoe sole and anti-static flooring.

4 Wrist strap
Prevent static electricity buildup in the body by grounding the worker's body. Inbuilt 1 MΩ current-limiting resistors are also able to reduce discharge current (and prevent electric shock to the worker).

<Environment-related solutions>

5 Grounded power outlet
Always connect equipment to ground.

6 Anti-static mat
Prevent static electricity buildup by grounding workbench and shelf mats.

7 Ground cables for anti-static mats, wrist straps, etc.
Connect ground cables of 100 kΩ – 1 MΩ resistance to anti-static mats.

8 Static tester
Carry out regular ESD checks. Hold the static tester sensor close to the object to be tested to obtain a measurement.

9 Hygrometer
Prevent static electricity buildup through humidity control. Maintain humidity at around 50%. (Humidity has other effects in addition to ESD events, so use the target range of 40–60% as a reference point only.)

<Environment-related solutions (recommended)>

10 Anti-static flooring
Use anti-static flooring for safe diffusion and release of static electricity buildup.

EOS

<Temperature and humidity chamber/tank>

11 If testing equipment (either the device under test (DUT) or the measurement device) is connected to the same power outlet or power distribution board as other equipment with high power consumption, such as temperature and humidity chambers/tanks, power fluctuations will occur via the power supply when the other equipment is turned on or off. This can cause an EOS event to the I/O connectors of the testing equipment, which may damage the DUT or measurement device. Take measures to resolve this issue, such as using a separate power distribution board for temperature and humidity chambers/tanks and other equipment with high power consumption, to avoid affecting the power supply of the testing equipment.

1. Creating a measurement environment (continued)

● Use the following anti-static items


Anti-static DUT packing case


Anti-static tools


Anti-static containers


Anti-static bubble wrap


Shielded bags

● Do not place the following items within about 50 cm of the DUT (actual measured voltages included for reference)

Plastic bags

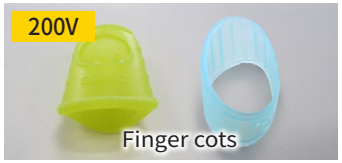
Bubble wrap cushioning

Water containers

CRTs

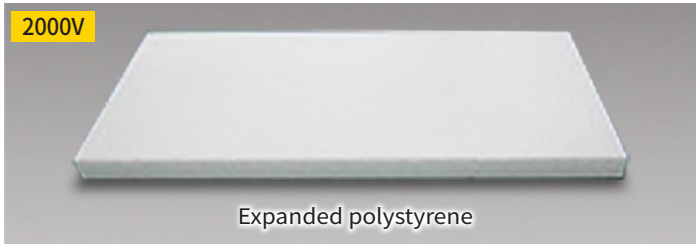
Printer paper and plastic containers

Plastic chairs



Finger cots

Ballpoint pens



Expanded polystyrene

ESD

<Material-related solutions>

● Use the following anti-static items

Materials must have conductive properties to prevent static electricity buildup.

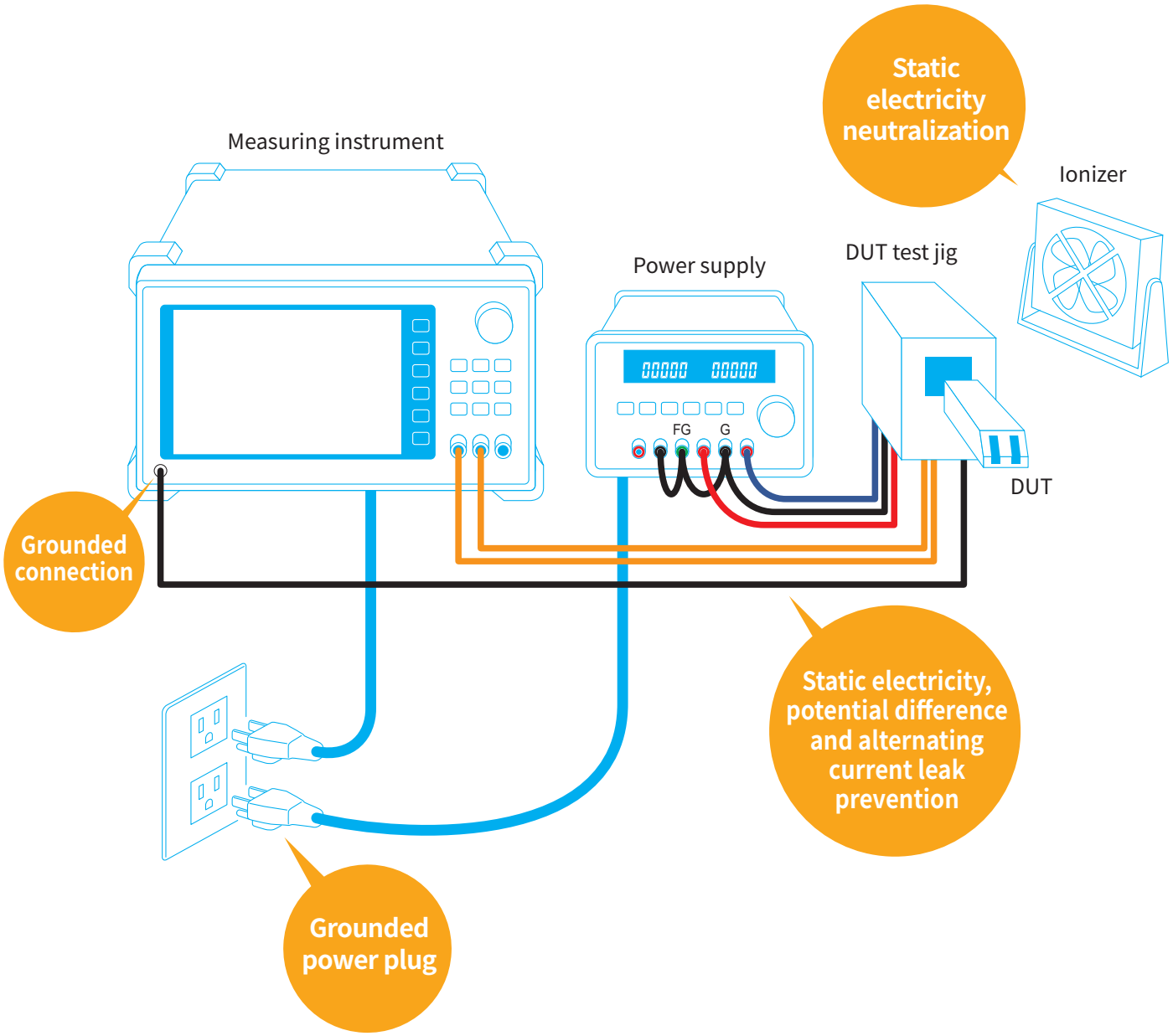
(Examples)
(1) Anti-static DUT packing case
(2) Anti-static tools
Tools must not be insulated. Ensure tools have anti-static material on handgrips and handles.
(3) Shielded bags
(4) Anti-static bubble wrap
(5) Anti-static containers

● Do not place items within about 50 cm (an arm's length) of the DUT if they are not designed for anti-static use.

Static electricity may build up on items that have not been designed for anti-static use. Accidental contact with the DUT may damage the DUT or measurement device.

(Examples)
(1) Plastic bags
(2) Printer paper
(3) Plastic containers
(4) Water containers
(5) Finger cots (non anti-static)
(6) Ballpoint pens and mechanical pencils (plastic)
(7) Expanded polystyrene
(8) Bubble wrap cushioning (non anti-static)
(9) Plastic chairs
(10) CRTs
(11) LCDs
(12) Keyboards
(13) Computer mice
(14) Other items

2. Cautions when placing and connecting the DUT and measuring instrument



ESD and EOS

<Grounded connection>

Prevent static electricity buildup by grounding anti-static mats and wrist straps, etc. Before connecting the I/O connectors of measurement devices, or devices connected to those devices (including test circuits), make sure all the devices are connected to a ground cable.

<Grounded power plug>

Always connect equipment to ground.

<Power supply>

Use a frame ground for grounding.

ESD

<Ionizer>

Blow ionized air at the DUT and tools to neutralize any static electricity. Ionizers generate ionized air, which carries a charge that electrically neutralizes static electricity.

<DUT>

The device under test may also become electrostatically charged. Discharge the static electricity with an ionizer and ground connection.

EOS

<DUT>

Hot-plugging and powering devices on and off generate transient surge voltages (EOS) that often damage measurement devices. For this reason, check the measurement device and I/O connections in advance according to the EOS check method outlined on page 5.

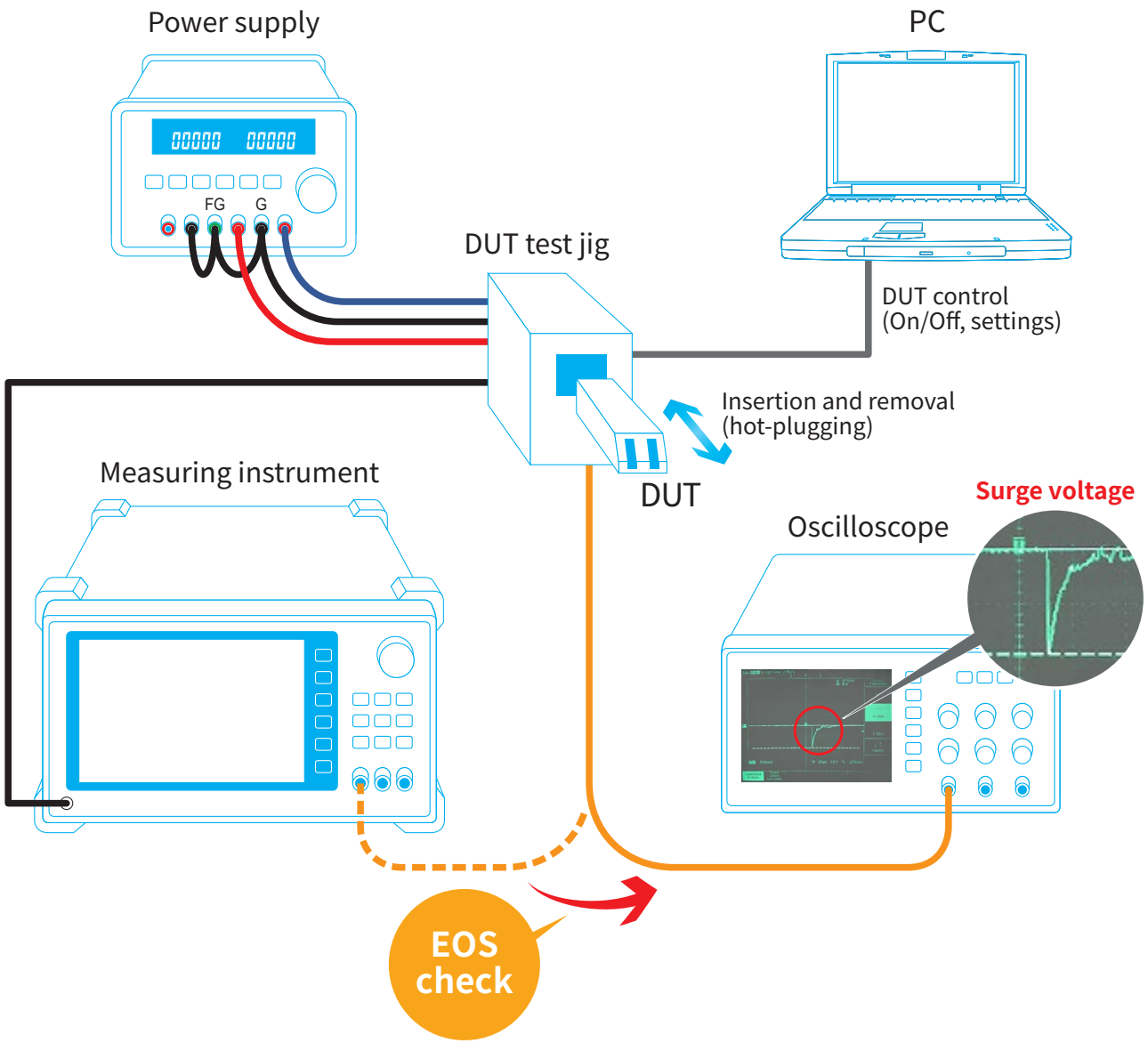
Surge voltages are more likely when performing any of the following operations.

(1) Powering on and off
(2) Inserting and removing power plug
(3) Hot-swapping the DUT
(4) Attaching and removing cables
(5) During DUT pulse output
(6) During DUT probe measurement (including test circuits) if a operational error causes an electrical short circuit
(7) Other operations

<Power supply>

Use of a chatter-free electronic switch power supply is recommended.

2. Cautions when placing and connecting the DUT and measuring instrument (continued)



EOS

<EOS check method>

(1) Remove the coaxial connector from the I/O connection on the measurement device, etc., and plug it into the oscilloscope.

(2) Set the oscilloscope input impedance at 50 Ω.

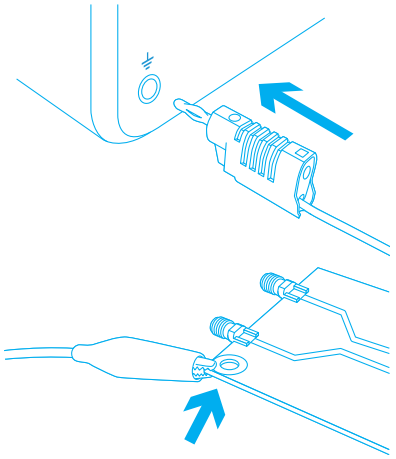
(3) Use single trigger mode and check for a surge voltage.

- The oscilloscope trigger voltage should be approximately +0.5 to +1 V when checking for positive surge voltage. Voltage should be approximately −0.5 to −1 V for improved likelihood of detection when checking for negative surge voltage.
- The time axis will depend on the DUT and testing equipment involved but start at approximately 100 µs/div for improved likelihood of detection.

3. Solutions

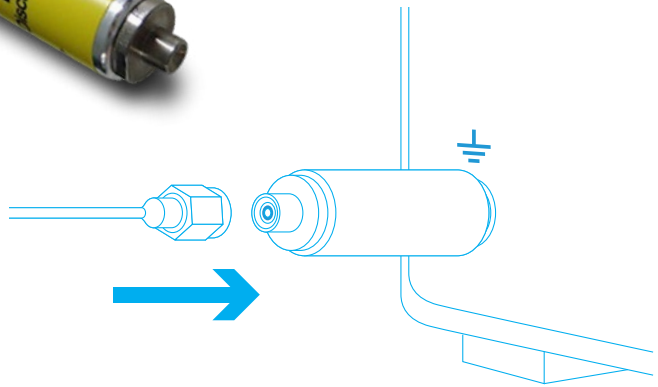
J1678A
ESD Protection Adapter-K

J1627A
GND connection cable



41KC-x
FIXED ATTENUATOR

G0342A
ESD DISCHARGER



K261
DC BLOCK

ESD and EOS

<J1678A ESD Protection Adapter-K>
Use of ESD Protection Adapters with I/O connectors is an effective solution for both ESD and EOS.

- Wideband : DC to 40 GHz
- Low Insertion Loss : <1.5 dB
- Low Reflection : >10 dB
- ESD Immunity : 1.8 kV
- I/O Interface : K-connector
- Small Package : 18×9.5×8 mm
- RoHS Compliant

<J1627A GND connection cable>
Use of GND Connection Cables between the ground terminals of measurement devices and the device to be measured (including test circuits) is recommended.

- Connector : Banana plug/Electrical clip

<41KC- x FIXED ATTENUATOR>
Use of attenuators for I/O connections will dampen over-voltage associated with any signal level margin. However, if the over-voltage cannot be attenuated and inputs/outputs exceed the rated voltage, damage may occur.

- Wideband : DC to 40 GHz
- I/O Interface : K-connector

ESD

<G0342A ESD DISCHARGER>
The coaxial cable external conductor and core may act as a capacitor and build up an electrostatic charge. Before use, discharge the cable by touching the coaxial cable core to the center of the ESD Discharger.

- Connector : SMA / K and V

EOS

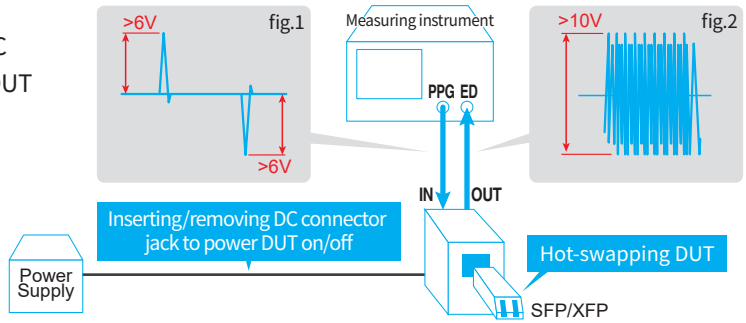
<K261 DC BLOCK>
Use of DC blocks is an effective solution for preventing direct currents. However, they are not very effective for preventing transmission of a steep surge voltage.

- Wideband : 10 kHz to 40 GHz
- Low Insertion Loss : < 1 dB typical
- I/O Interface : K-connector

EOS examples

<Example 1> Inserting/removing DC connector jacks and hot-swapping DUTs

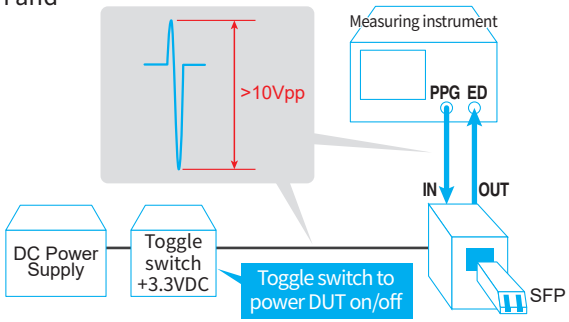
Inserting and removing the DC connector jack to power the DUT on and off generated a surge voltage (fig. 1).



Hot-swapping the DUT generated a surge voltage (fig. 2).

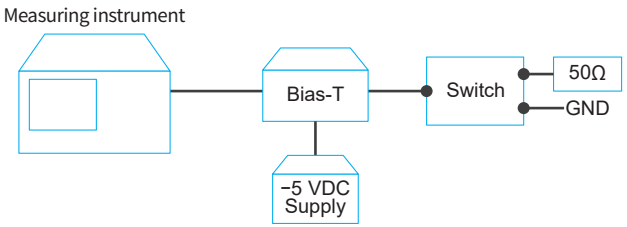
<Example 2> Using toggle switches for powering on and off

Using a toggle switch to power the DUT on and off generated a surge voltage (right).

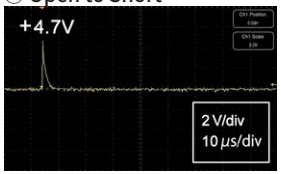


<Example 3> Dangers of using Bias-T devices

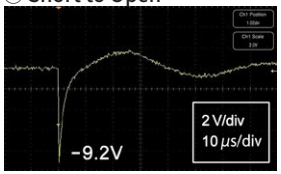
Switching between Open and Short or between Open and 50 Ω generated a surge voltage (right).



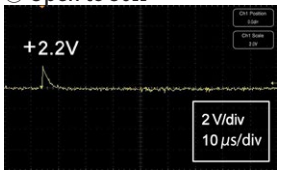
① Open to Short



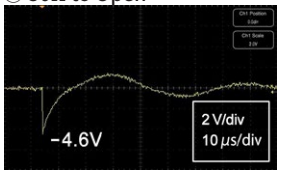
② Short to Open



③ Open to 50Ω



④ 50Ω to Open



EOS

Examples of EOS events

<Example 1>

Inserting/removing DC connector jacks and hot-swapping DUTs

A Test System (XFP/SFP) generated an abnormal surge voltage (above the rated voltage of the measurement device).

Solution

- Switch the power supply on and off instead of inserting and removing the DC connector jack. Change the hot-swapping procedure as well.

<Example 2>

Using toggle switches for powering on and off

A Test System (SFP) generated an abnormal surge voltage (above the rated voltage of the measurement device).

Solution

- Switch the power supply on and off instead of using a toggle switch.

<Example 3>

Dangers of using Bias-T devices

When powering a DUT from a Bias-T coil and using a probe to test the signal and ground, accidentally connected the probe signal to ground, which opened the circuit (removed while power supplied) and bounced the power stored in the coil back to the measurement device as a high voltage.

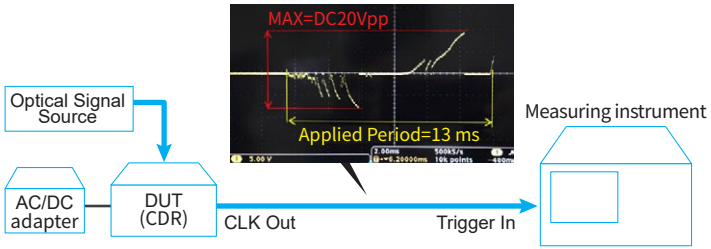
Solution

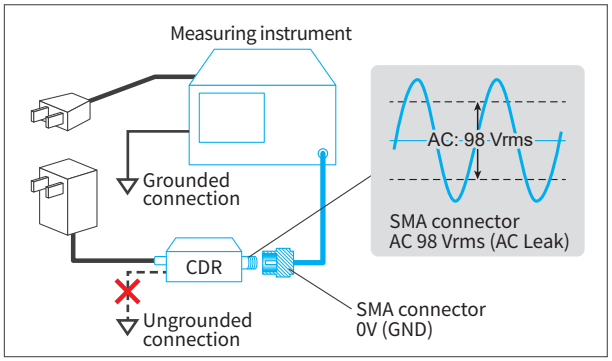
- Take care to avoid short circuits when using a probe, etc. for debugging.
- Do not insert or remove connectors when DC voltage is being supplied.
- Switch the DC power supply on or off after all connections have been made.

EOS examples (continued)

<Example 4> Alternating current leaks from DUT

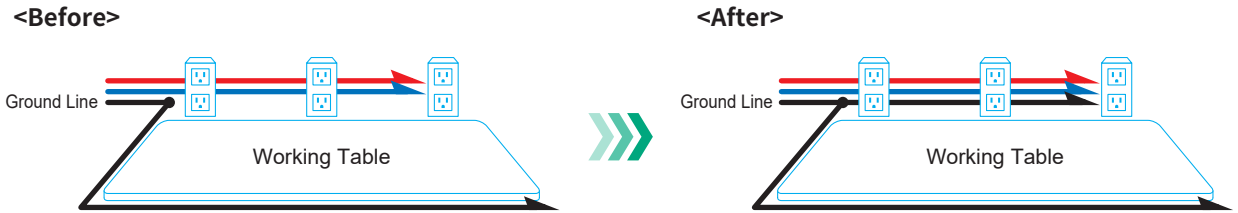
CDR modules generated the following voltage.





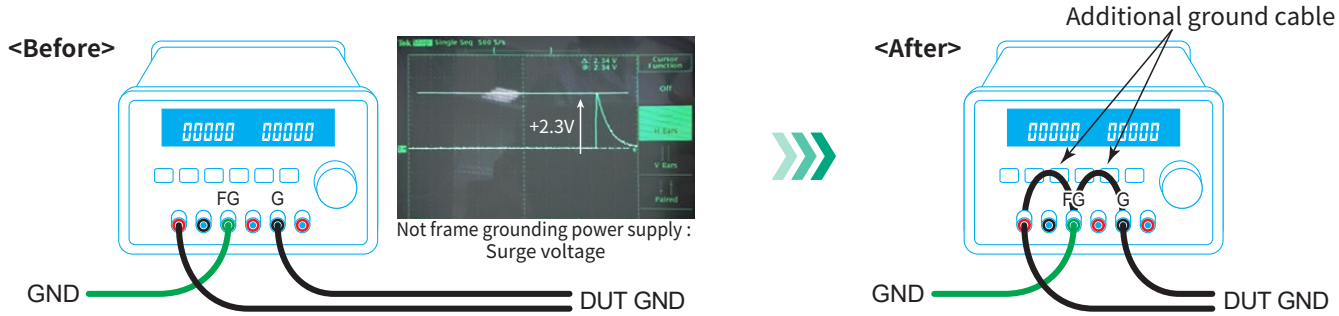
<Example 5> Not grounding power outlets

Alternating current leaked when the power outlet ground line was not connected.



<Example 6> Not frame grounding power supplies

Powering the DUT on and off when the device was not connected to ground generated the following surge voltage.



EOS

Examples of EOS events

<Example 4>

Alternating current leaks from DUT

Alternating current leaked (over-voltage) when the CDR module was not connected to ground.

Solution

- Connect the CDR module to ground to avoid over-voltage output from the module.

<Example 5>

Not grounding power outlets

Alternating current leaked from a device connected to a power outlet when the work area power outlet ground line was not connected.

Solution

- Connect the work area power outlet ground line.

<Example 6>

Not frame grounding power supplies

The power supply was not frame grounded, so the DUT connected to the power supply was not connected to ground, which caused an alternating current leak from the connected device.

Solution

- Connect the power supply frame ground to be used as the power supply ground.