

# Measurement Environment Solutions for Eliminating ESD/EOS Failures

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

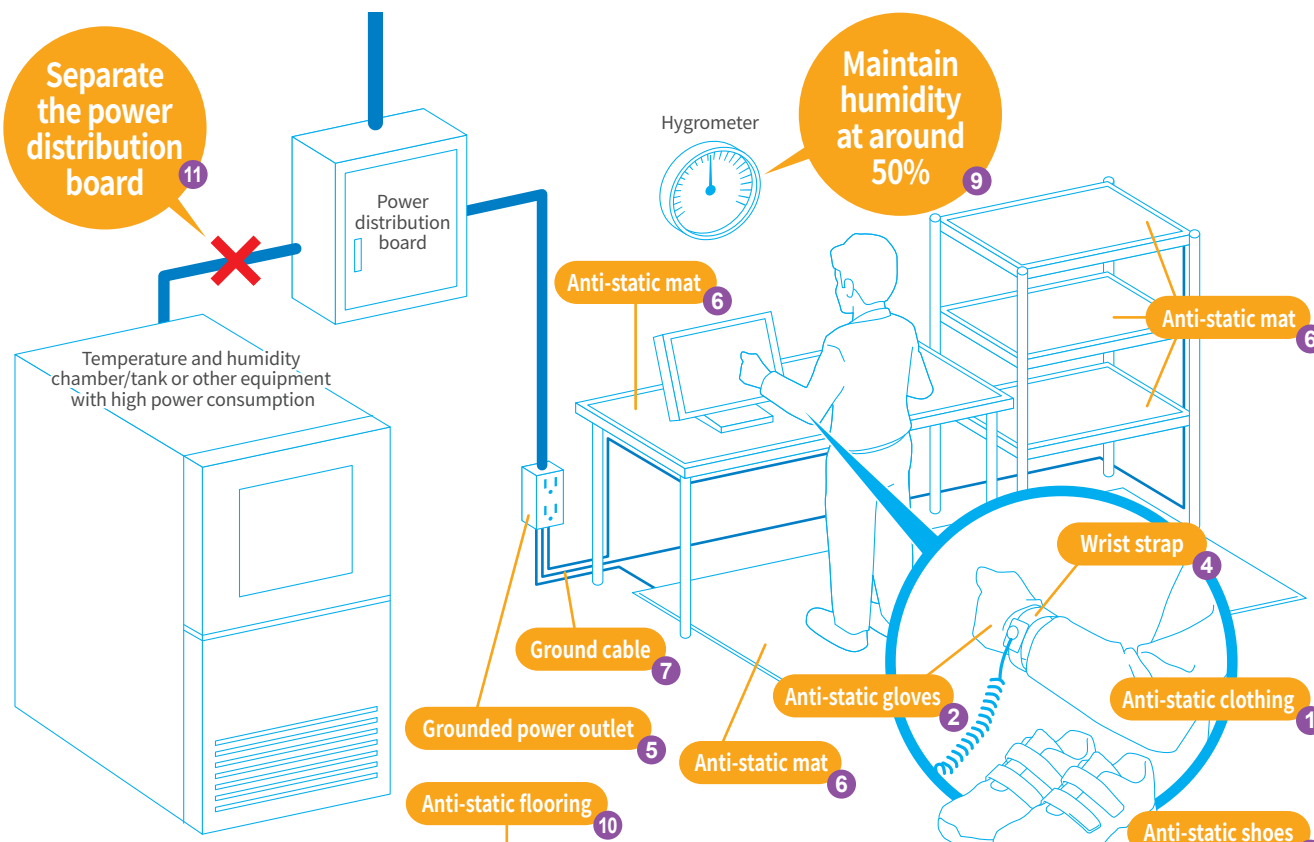
Electronic components of electronic devices and measurement devices break down when subjected to high voltages caused by **electrostatic discharge (ESD)** or **electrical over-stress (EOS)**. Signals sent to I/O connectors of electronic, measurement and other devices must be within the rated voltage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



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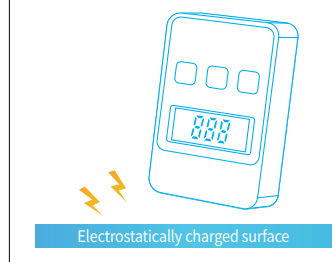
# 1. Creating a measurement environment



## Regular ESD inspections

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

## ESD check using static tester **8**



## 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



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



## 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

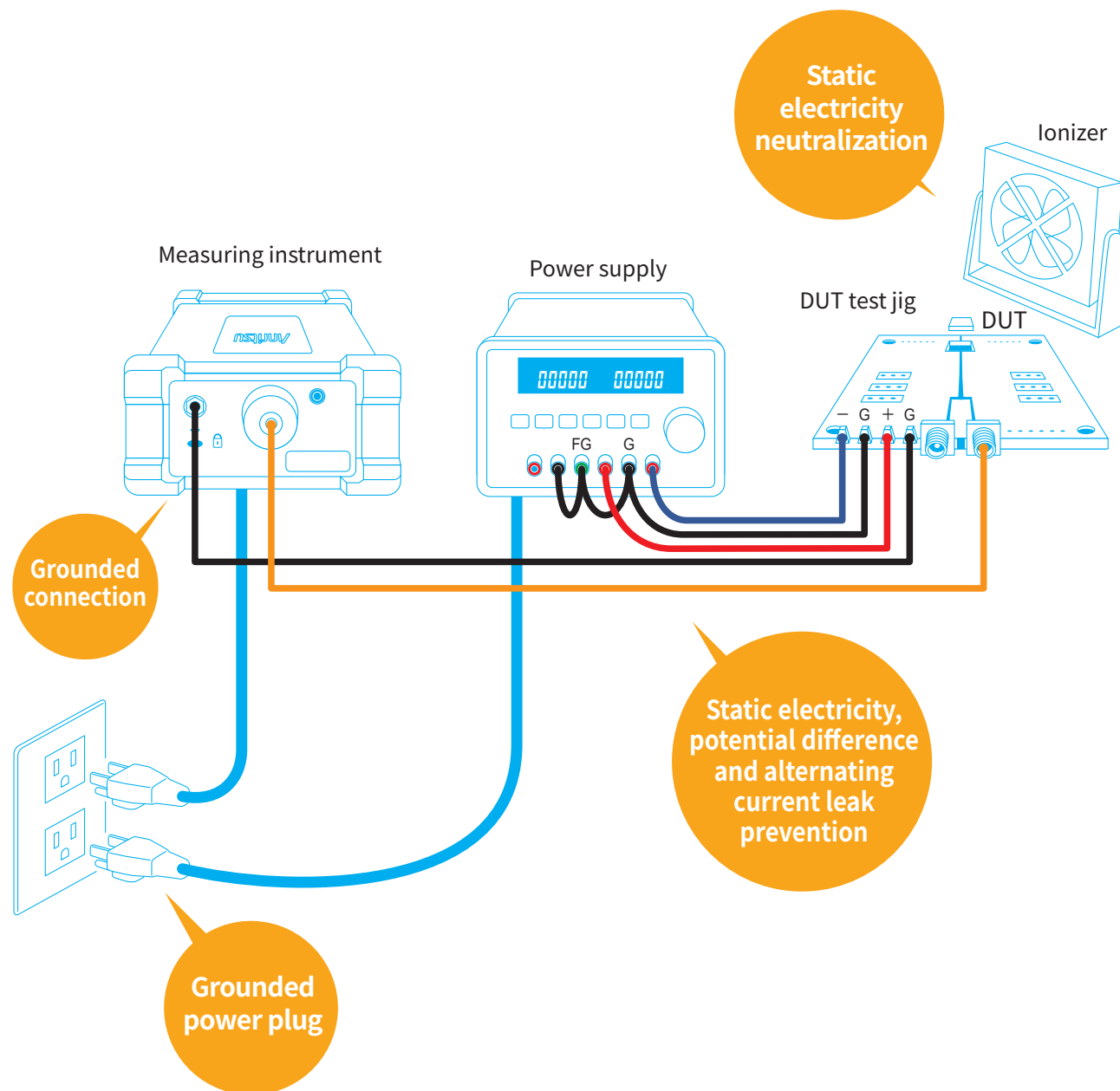
(11) LCDs

(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. If a measuring instrument does not have a ground connection terminal, contact the outer edge (ground) first when connecting the coaxial connector.

#### <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.

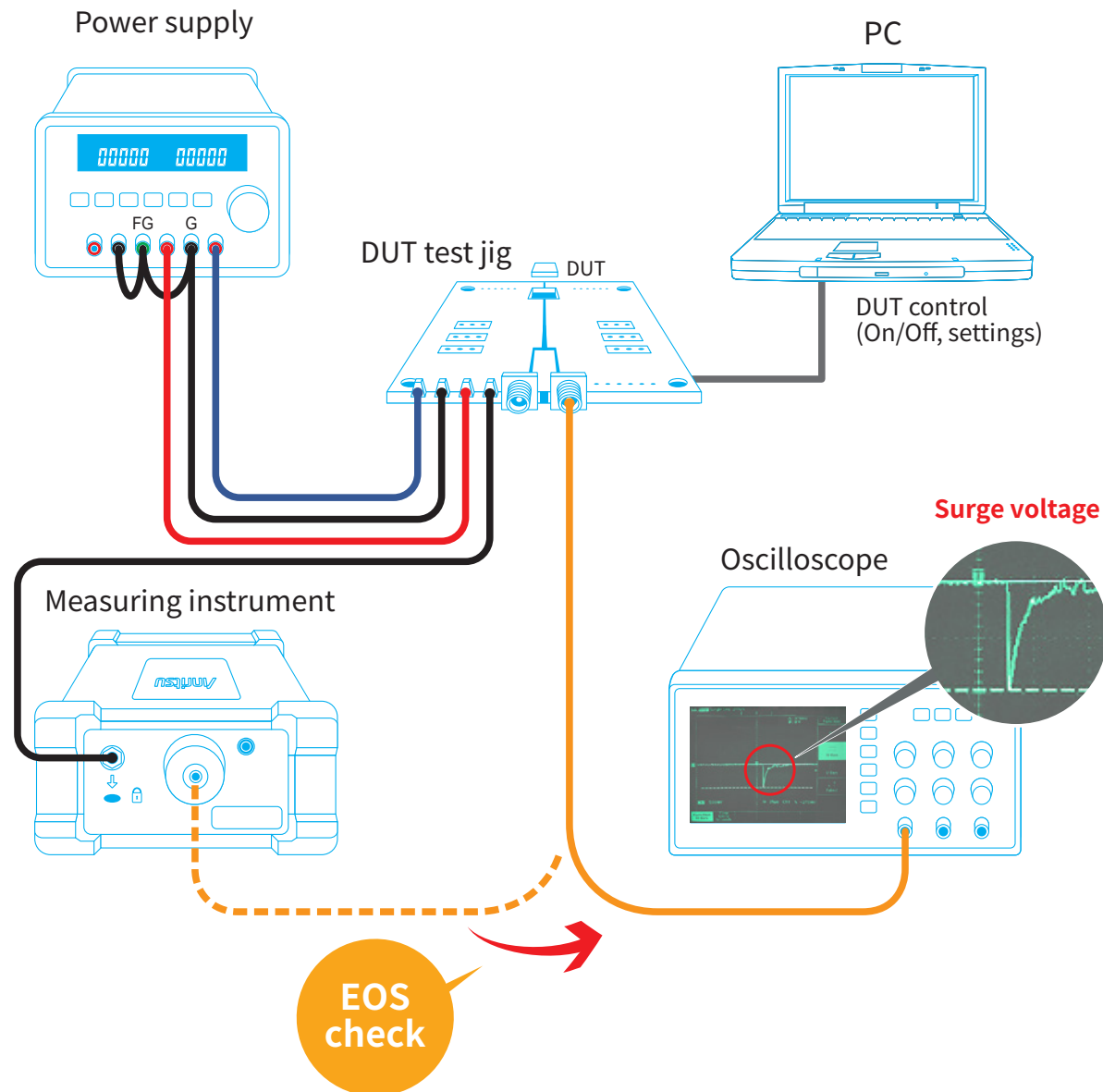
Surge voltages are more likely when performing any of the following operations.

- (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  $\Omega$ .
- (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  $\mu\text{s}/\text{div}$  for improved likelihood of detection.

## 3. Solutions

### J1678A

ESD Protection Adapter-K



### 41KC-x

FIXED ATTENUATOR



#### 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

##### <41KC- x FIXED ATTENUATOR>

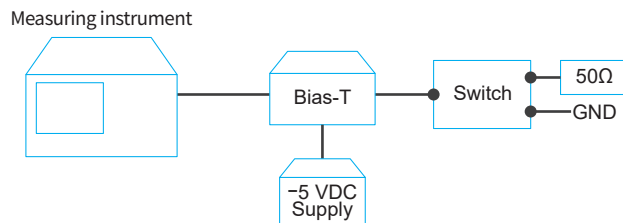
Use of attenuators for I/O connections will dampen over-voltage associated with any signal level margin. However, if the over-voltage cannot be attenuated and inputs/outputs exceed the rated voltage, damage may occur.

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

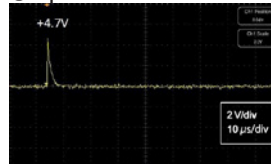
## EOS examples

### <Example 1> Dangers of using Bias-T devices

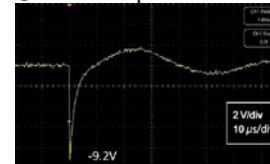
Switching between Open and Short or between Open and 50 Ω generated a surge voltage (right).



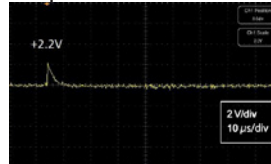
① Open to Short



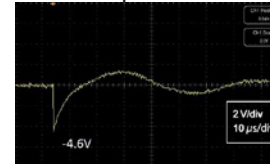
② Short to Open



③ Open to 50Ω



④ 50Ω to Open



#### EOS

##### Examples of EOS events

##### <Example 1>

##### 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.

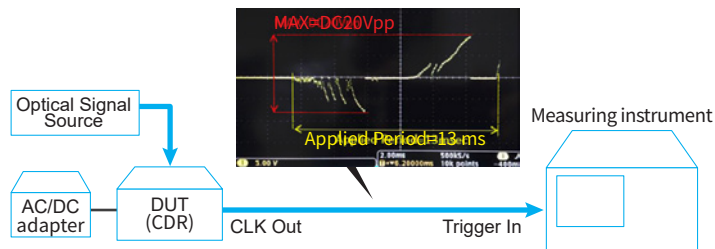
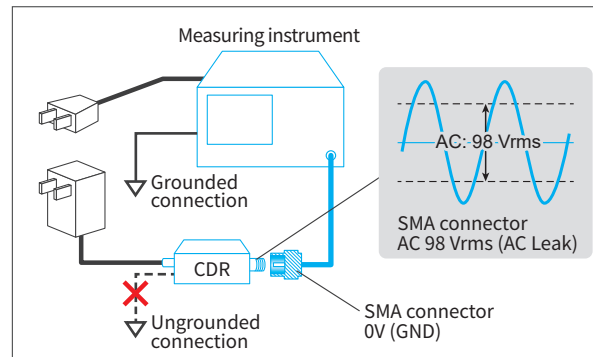
##### Solution

- 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 2> Alternating current leaks from DUT

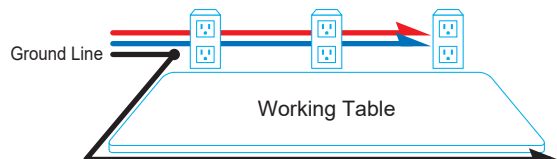
CDR modules generated the following voltage.



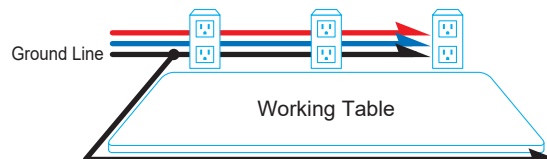
## <Example 3> Not grounding power outlets

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

<Before>



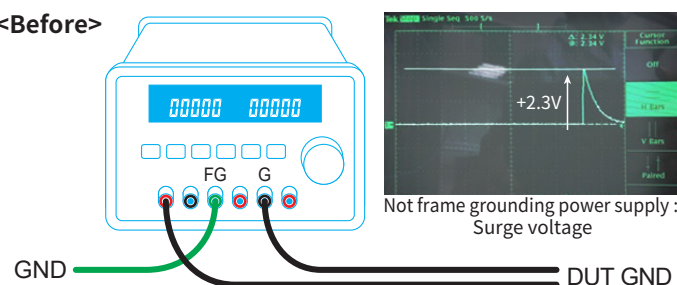
<After>



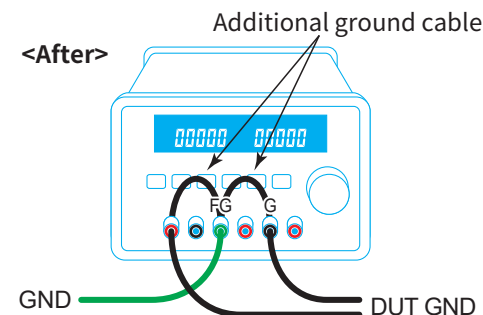
## <Example 4> Not frame grounding power supplies

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

<Before>



<After>



## EOS

### Examples of EOS events

#### <Example 2>

##### 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 3>

##### 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 4>

##### 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.