Developing a cost effective curve tracer to easily identify a possible EOS/ESD damage.

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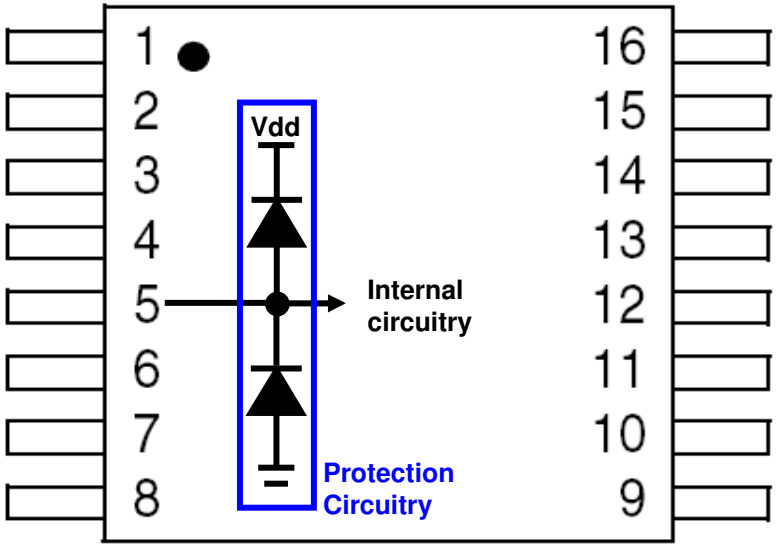
ESD Protection

Almost all pins of the Microcontroller have an internal protection against ESD (Electrostatic discharge).

It can be composed by fast diodes and capacitors to protect against surge at several kv (Kilo Volts).

Almost all pins have the protection to VDD and VSS, others just to VSS and a few of them, no protection.

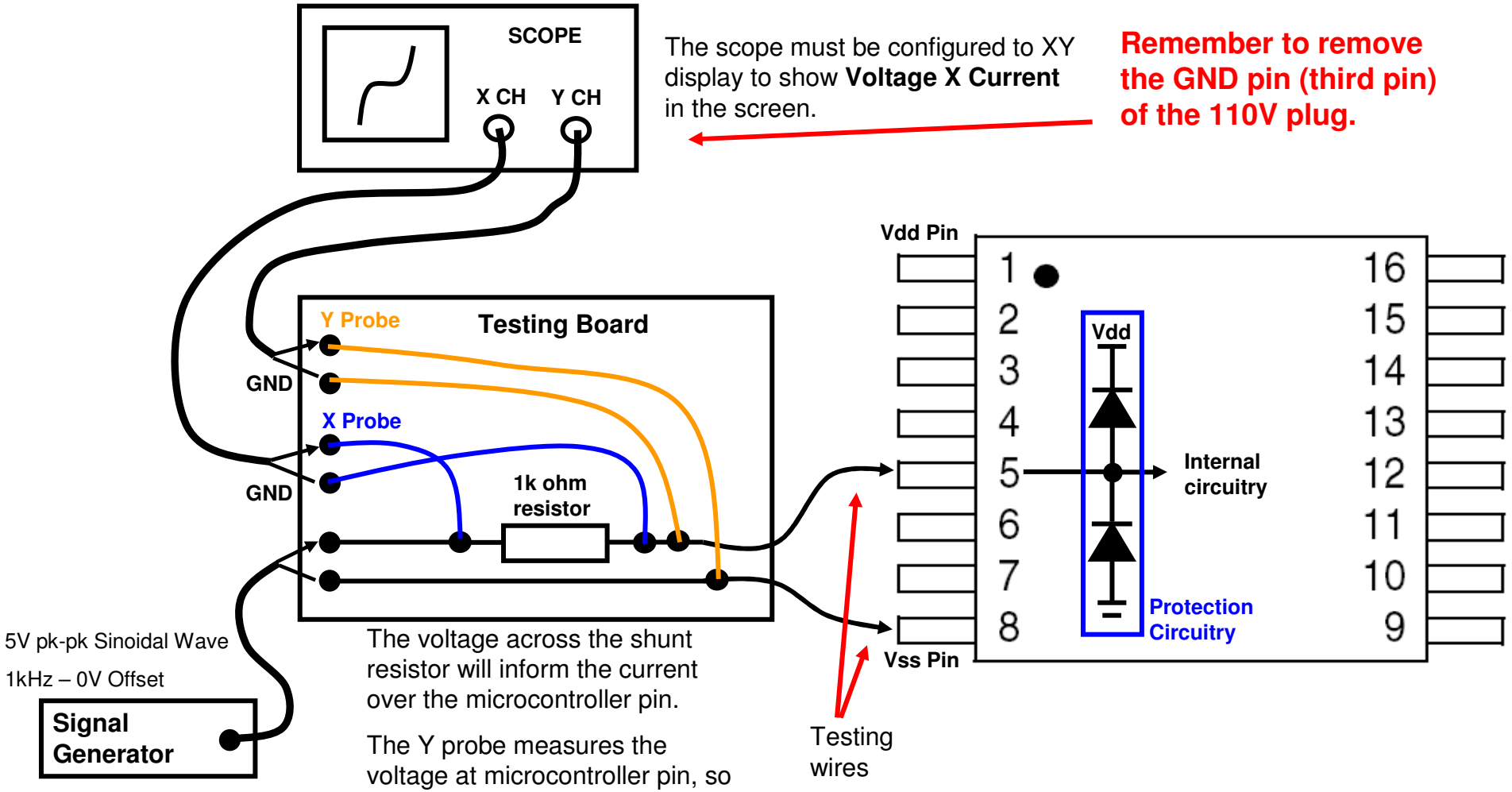
The best way to test is to compare the suspected IC with a good unit.



Material

- To “build” the curve tracer it is necessary:
  - An Oscilloscope that is capable to show XY display.
  - A Wave Generator.
  - One 1kOhm resistor.
  - One standard PCB to solder the components.
  - Wires.

Testing the pins



Testing the pins

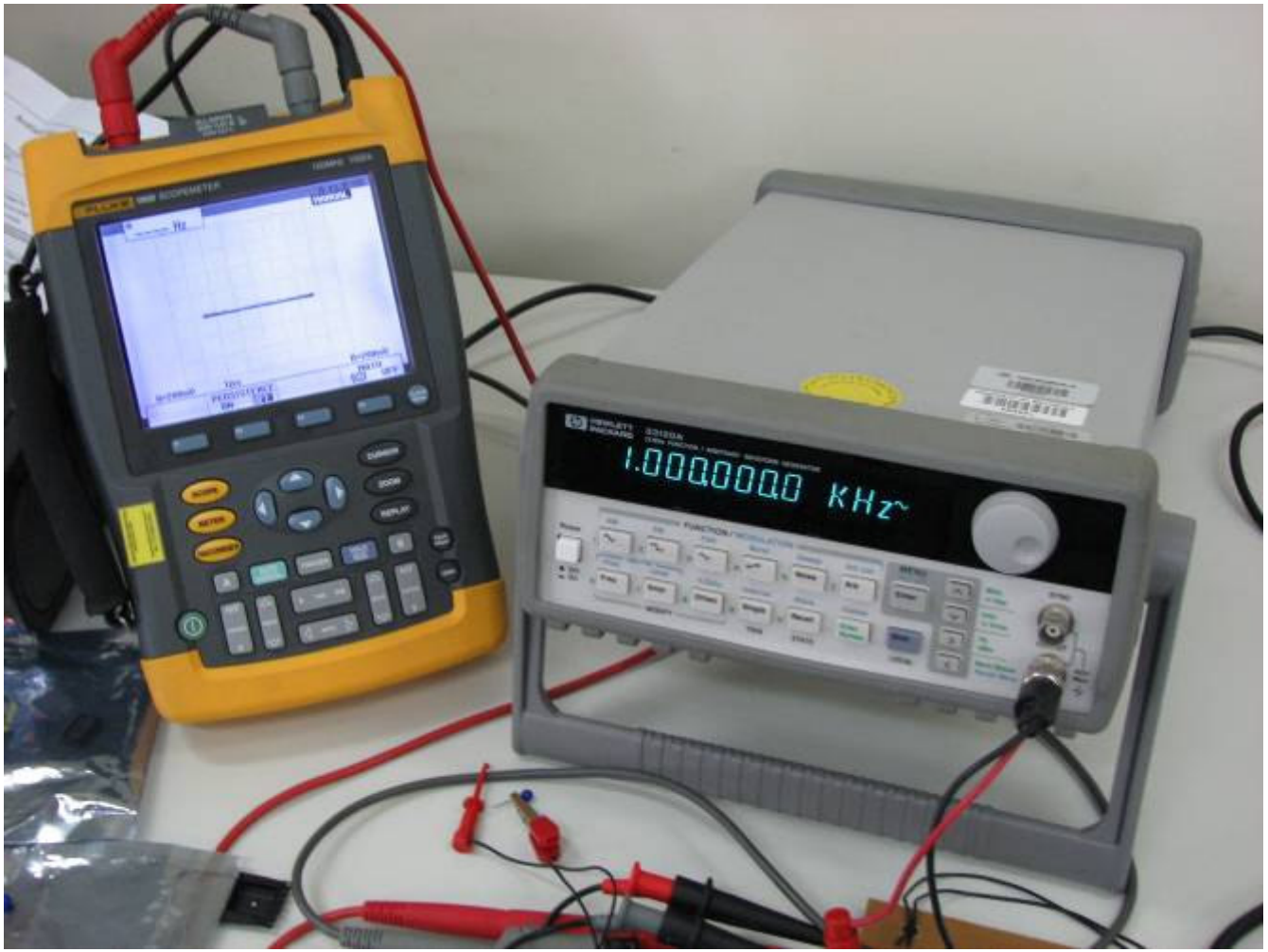
- Test Procedures:
  - Set the Scope to display XY instead of YT and connect it's probes to the testing board.
  - Set the wave generator for a Sinoidal Wave, 1Khz, 5Vpk-pk, 0V offset and connect the probe to the testing board.
  - Connect one of the testing wires to the IC's Vss and the other to any I/O pin.
  - Adjust the Volts/Div to best fit the wave in the screen.
  - Keep one of the testing wires connected to the Vss and test all microcontroller pins. Compare with a good device to be sure about the correct wave pattern.
  - If no abnormality found, repeat the above procedure but connected to the Vdd.

Wave Patterns

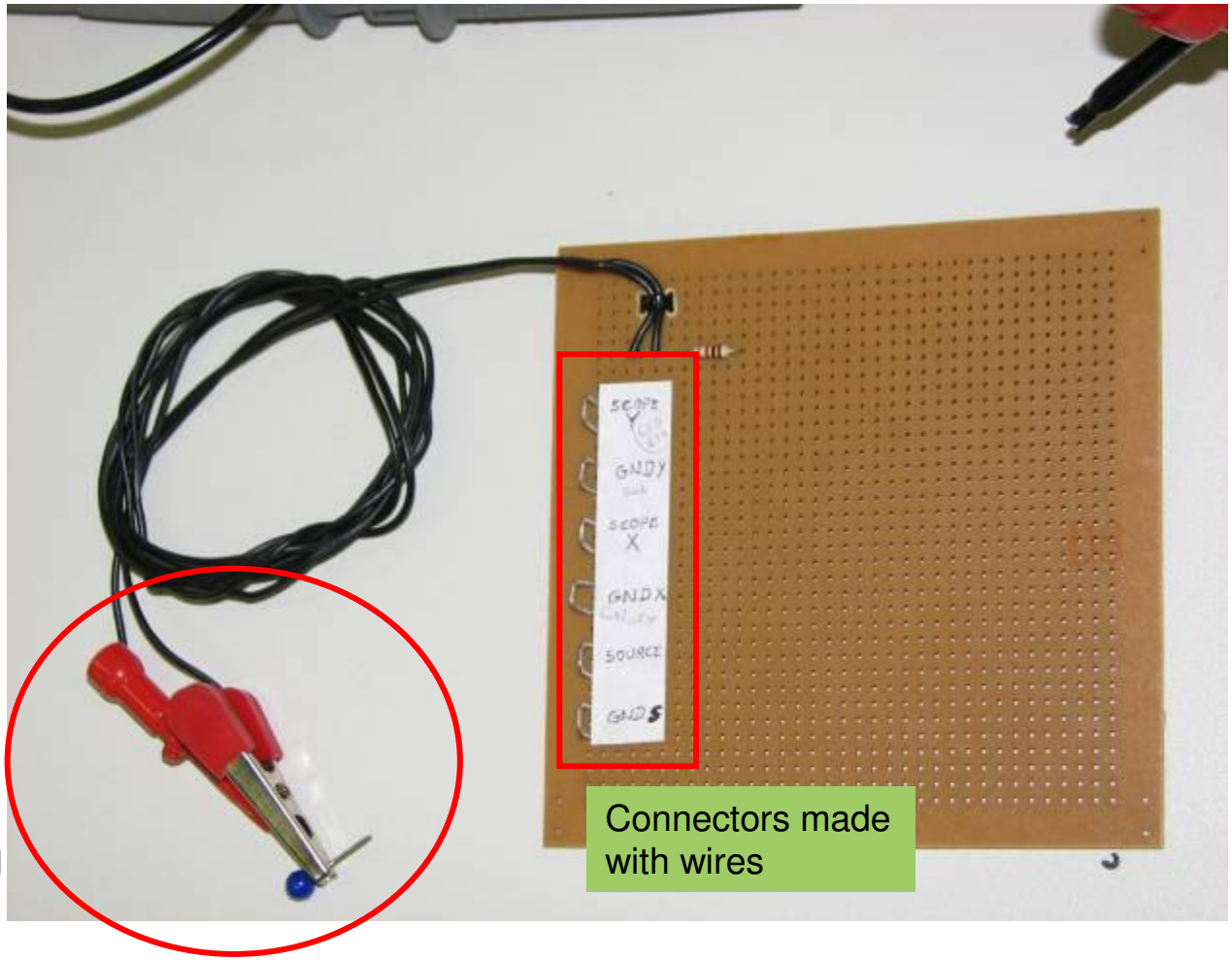
Almost all pins will show these wave patterns, but may vary from one component family to another.

Both Vdd and Vss protection diode present	Only Vss protection diode present	No protection circuitry present

Equipments



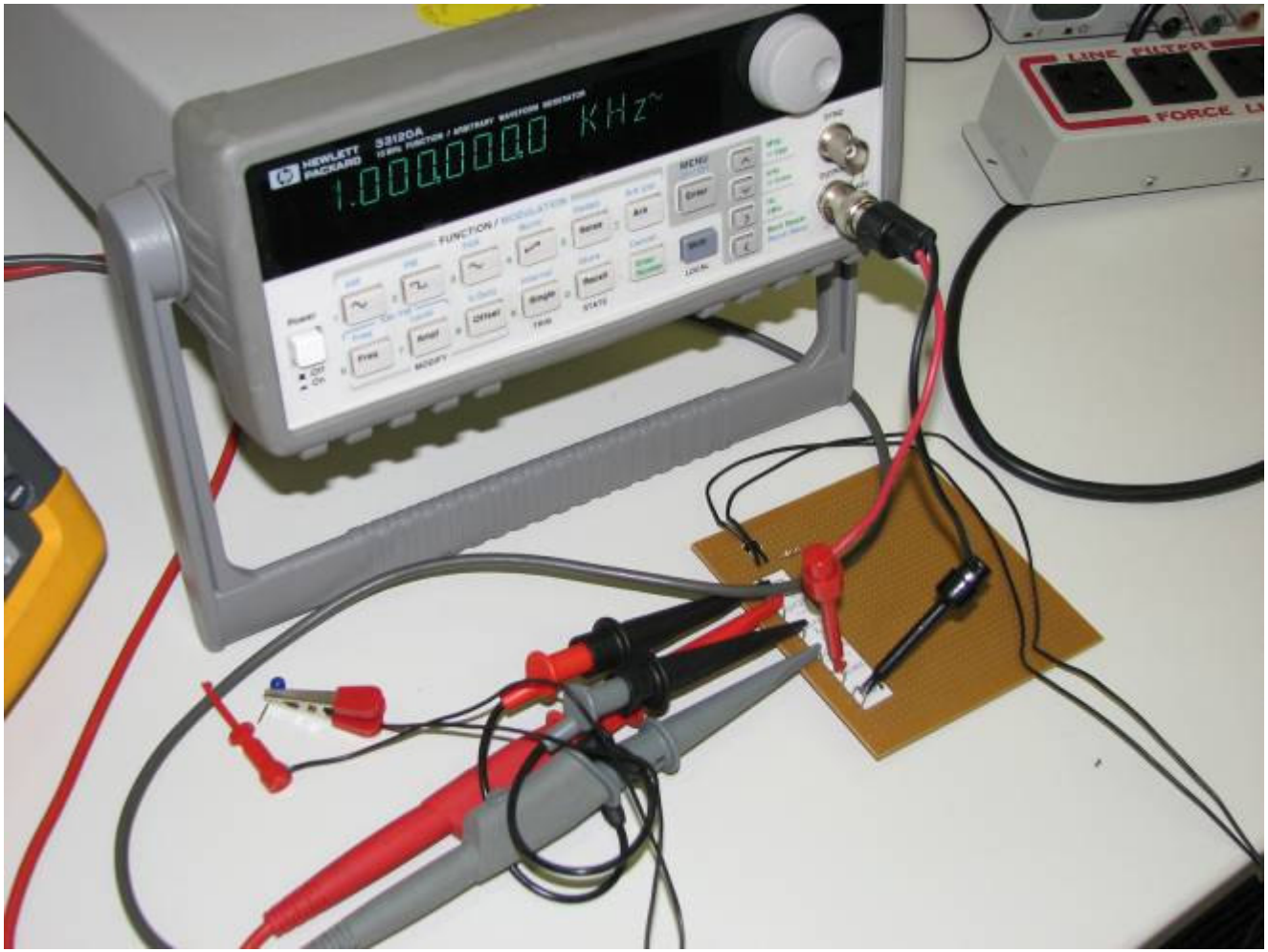
Testing Board



Testing wires

Connectors made with wires

Testing Board



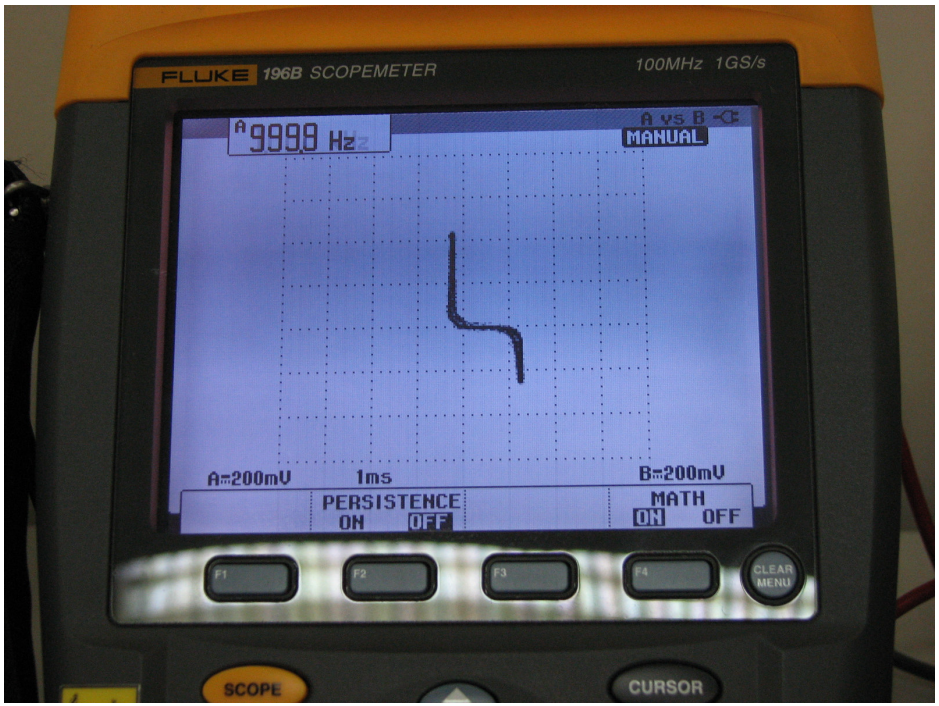
Testing the suspected IC

Note that it's not mandatory to connect the X and Y scope probes in the correct position. If the probes are inverted, the wave will just be inverted. The most important is to compare the wave from a good device with a suspected device.

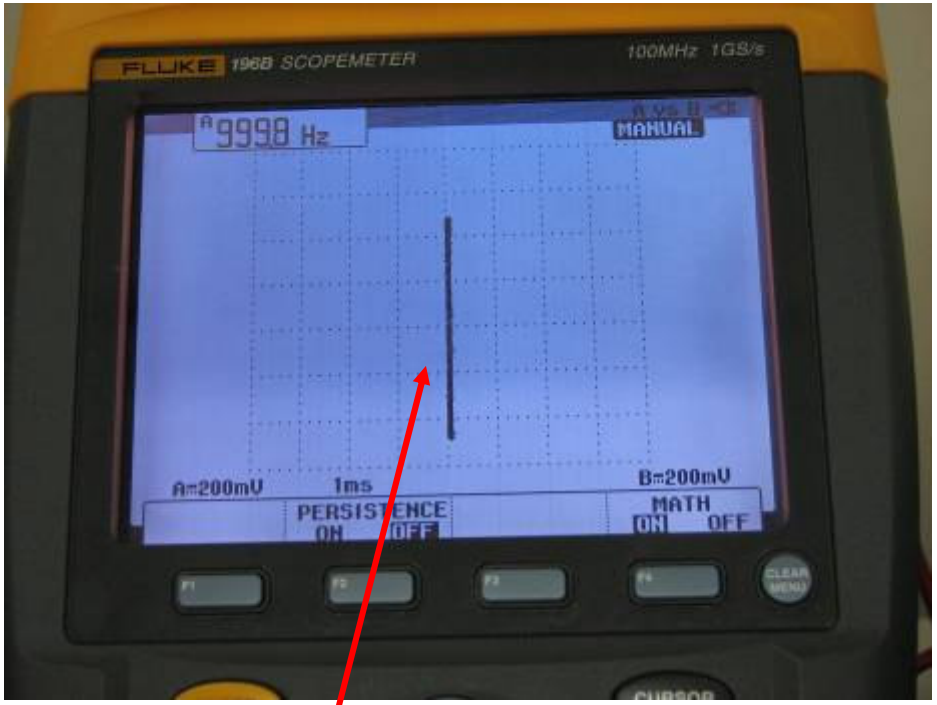
Case 1: Comparing units

Case 1: CQI# 384769A

Good Unit (IO to Vss)



Suspected Unit (IO to Vss)



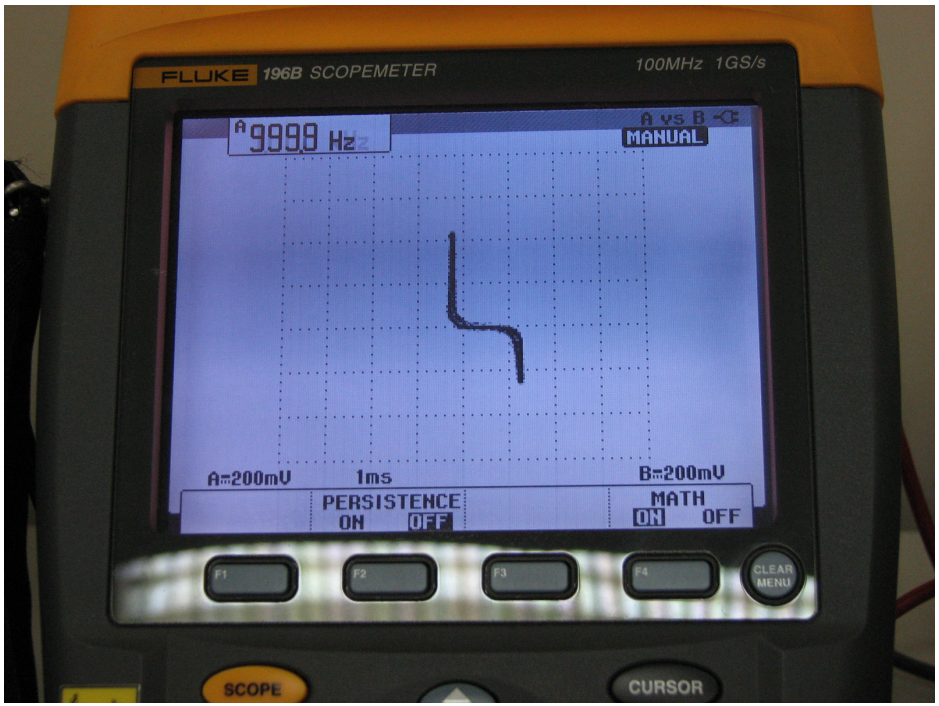
Sample A

Short Circuit between an IO to Vss.
A possible EOS!!

Case 1: Comparing units

Case 1: CQI# 384769A

Good Unit (IO to Vss)



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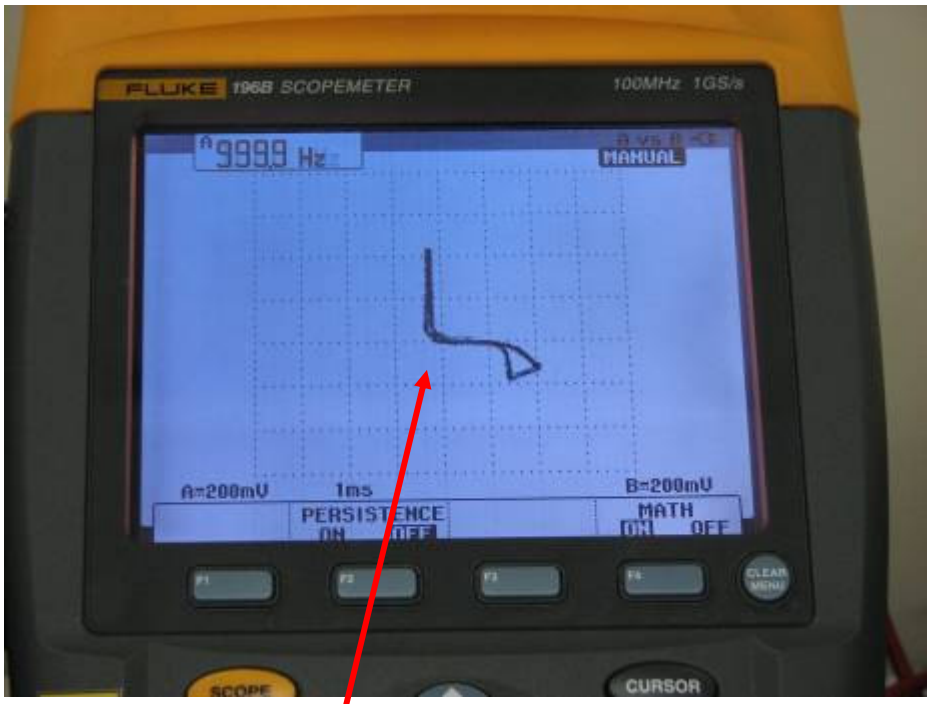


Sample B

Different pattern. It's a potential EOS or ESD.

Case 1: Failure Analysis

Case 1: CQI# 384769A

After sending the part for Failure Analysis (FA) in Nogales, it was proved the EOS measured with the Scope.

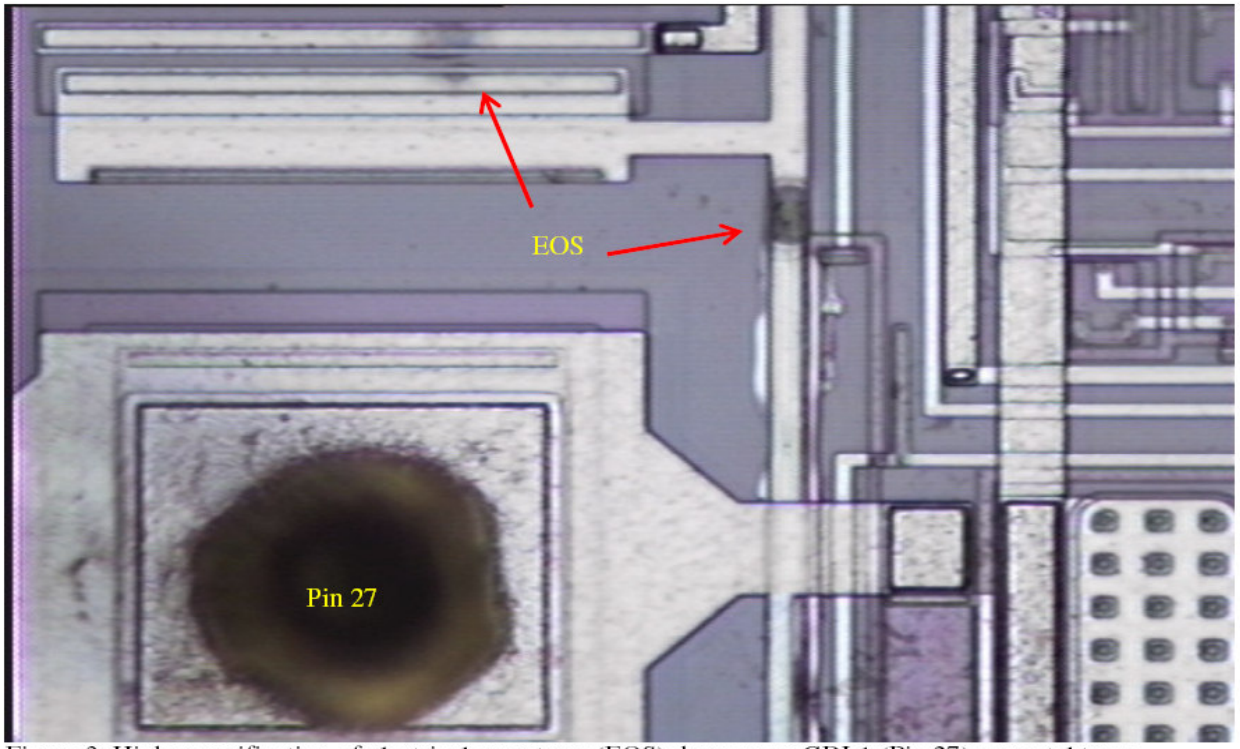
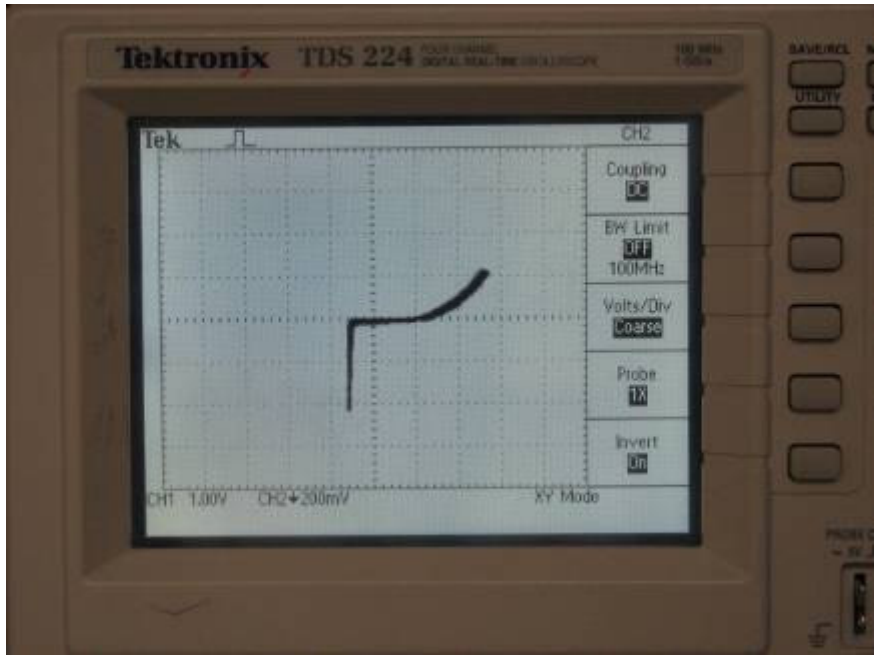


Figure 3. High magnification of electrical overstress (EOS) damage on GDL1 (Pin 27) on metal trace

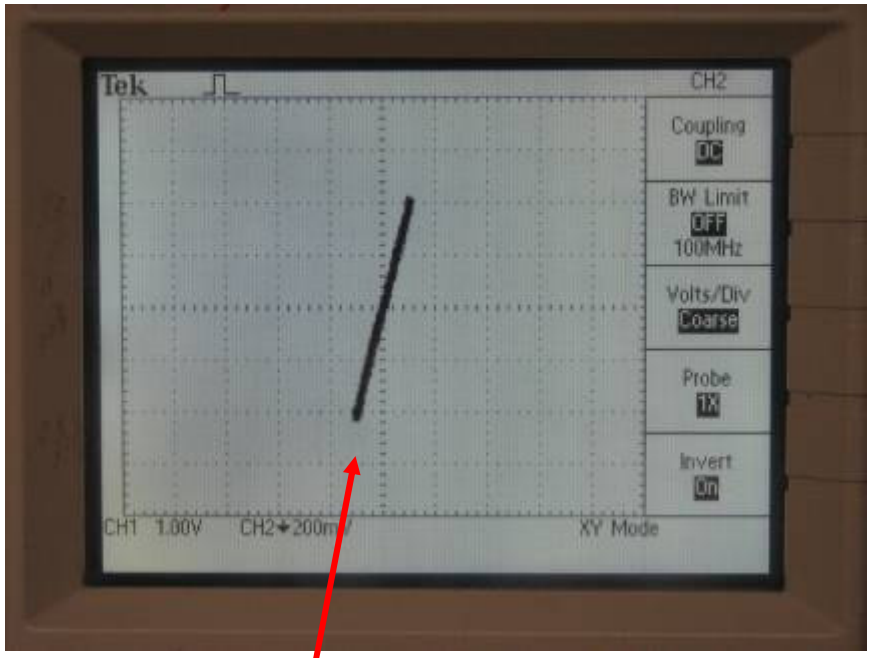
Case 2: Comparing units

Case 2: CQI# 395639A

Good Unit (measure Vdd to Vss)



Suspected Unit (measure Vdd to Vss)



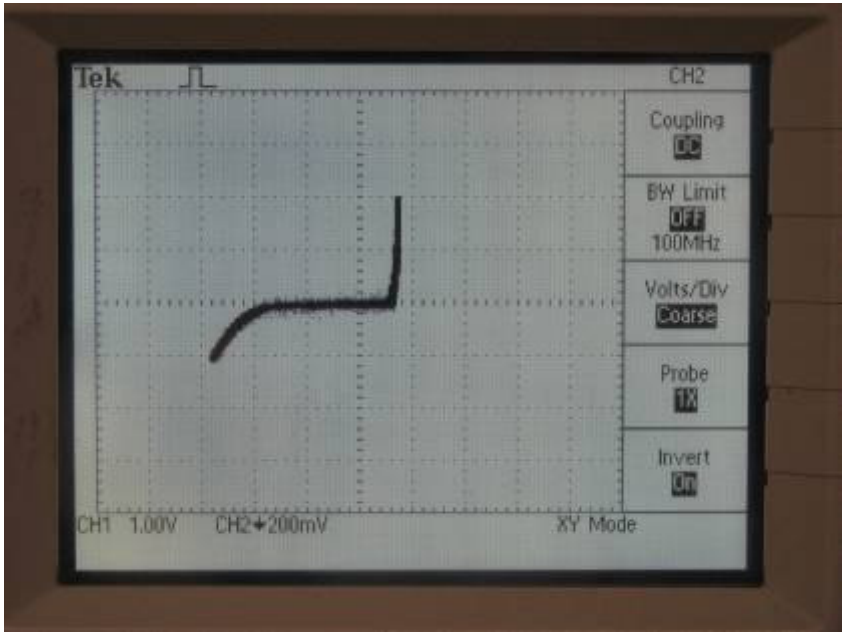
Sample A

Short Circuit between Vdd to Vss.
A possible EOS!!

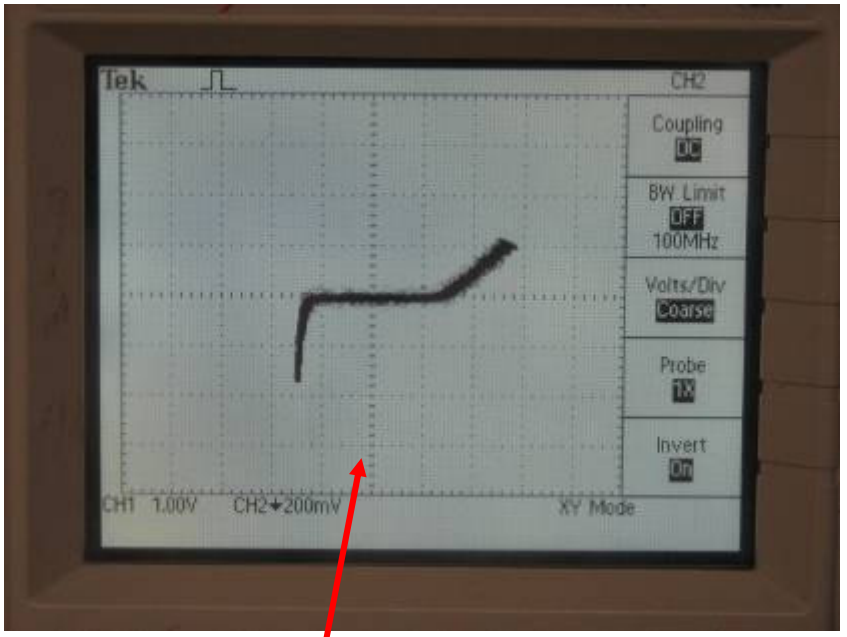
Case 2: Comparing units

Case 2: CQI# 395640A

Good Unit (IO to Vss)



Suspected Unit (IO to Vss)



Sample B

A possible EOS/ESD!!

Summary

- This is a simple method to test the IO's and verify any leakage or a potential EOS / ESD.

- It can be applied to all IC's, but there is a physical limitation for very small footprints, which needs special sockets to adapt the probes.