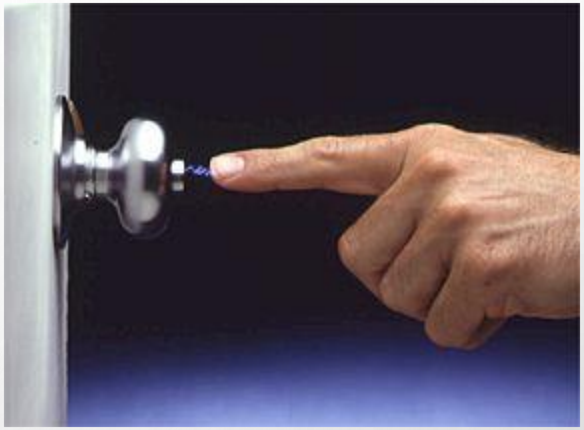
ESD ANALYSIS : HIGH SPEED CONNECTOR IN SMART PHONE

Anil Pandey

WHAT IS ESD?

•**ELECTROSTATIC DISCHARGE(ESD) IS THE SUDDEN AND MOMENTARY ELECTRIC CURRENT THAT FLOWS BETWEEN TWO OBJECTS AT DIFFERENT ELECTRICAL POTENTIALS CAUSED BY DIRECT CONTACT OR INDUCED BY AN ELECTROSTATIC FIELD.**



An Electrostatic Discharge (ESD) strike is a constant threat to device reliability and functionality. Many low-voltage core chips or system ASICs only offer device-level Human-Body Model (HBM) ESD device protection, which doesn't address the risks of system-level ESD strikes.

ESD Damage

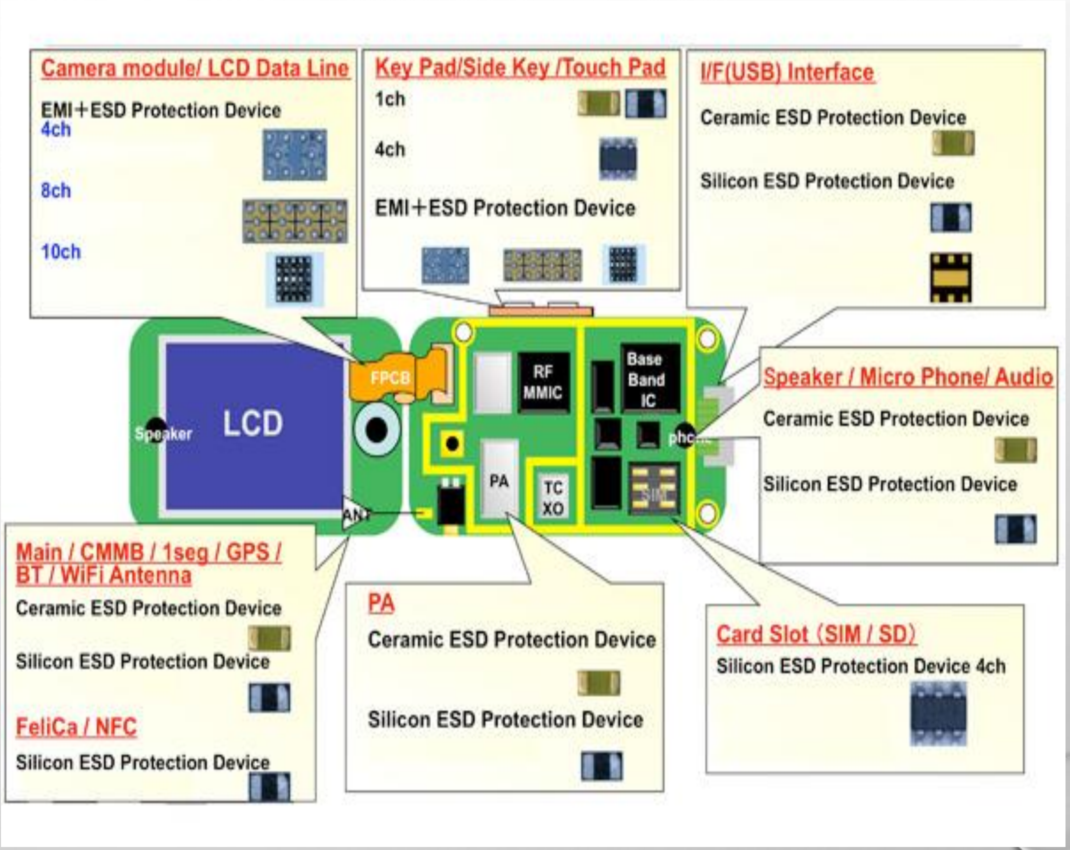
- Burn Out
- Breakdown of insulator
- Decrease of lifetime
- Software Failure

ESD PROTECTION OF AN SMART PHONE CIRCUIT

- ELECTROSTATIC DISCHARGE (ESD) LOOMS AS ONE OF THE BIGGEST THREATS TO A MOBILE PHONE'S SENSITIVE COMPONENTS. ESD IS A SUDDEN HIGH VOLTAGE SPIKE CAUSED BY CHARGED OBJECTS TOUCHING, OR IN CLOSE PROXIMITY TO, EACH OTHER. SINCE THESE VOLTAGE SPIKES TYPICALLY PRODUCE THOUSANDS OF VOLTS, THEY MAY DAMAGE SENSITIVE COMPONENTS (E.G., ICS) IN THE SYSTEM

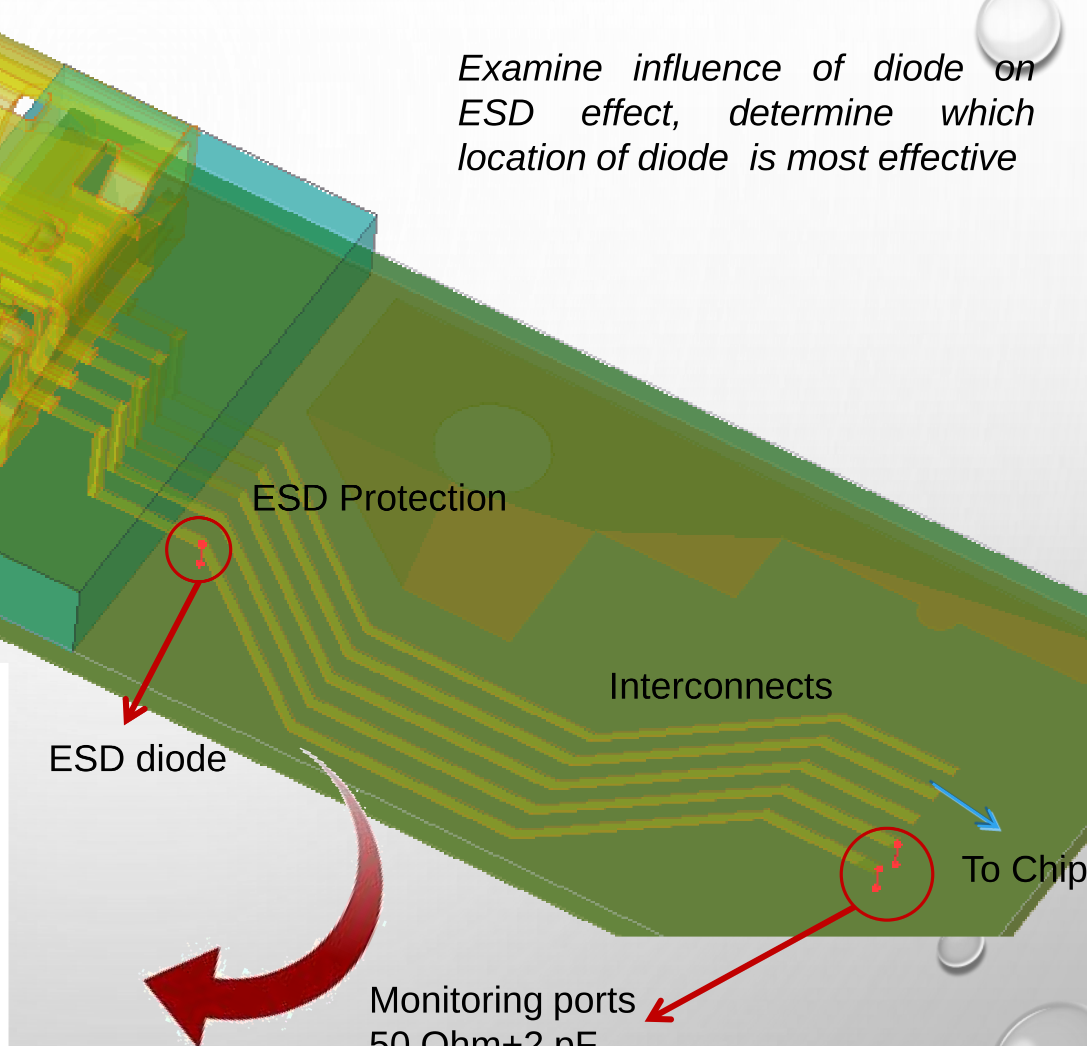
- The **IEC61000-4-2standard** defines standard test conditions that electronic equipment should withstand. It assumes that the user will take no precautions to prevent any ESD damage, and it defines a variety of levels that the equipment should withstand.

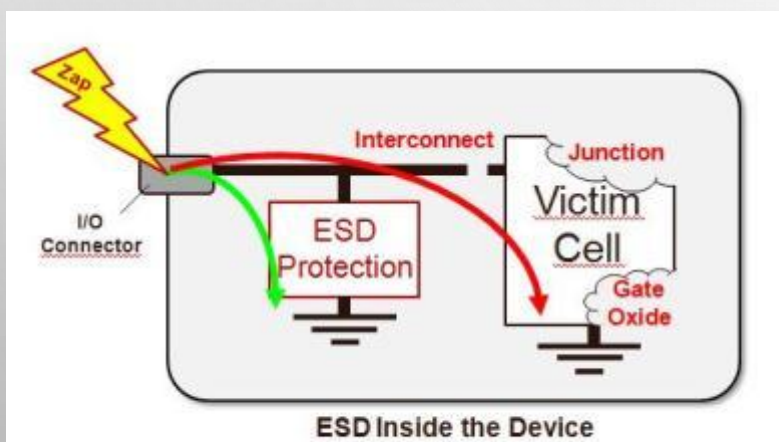
- The typical curve for an electrostatic discharge defined by IEC61000-4-2has a rise time of about 1 ns and a peak current level of around 30A.



PROJECT SETUP FOR ESD : MINI USB TO CHIP INTERCONNECT IN PHONE

Examine influence of diode on ESD effect, determine which location of diode is most effective





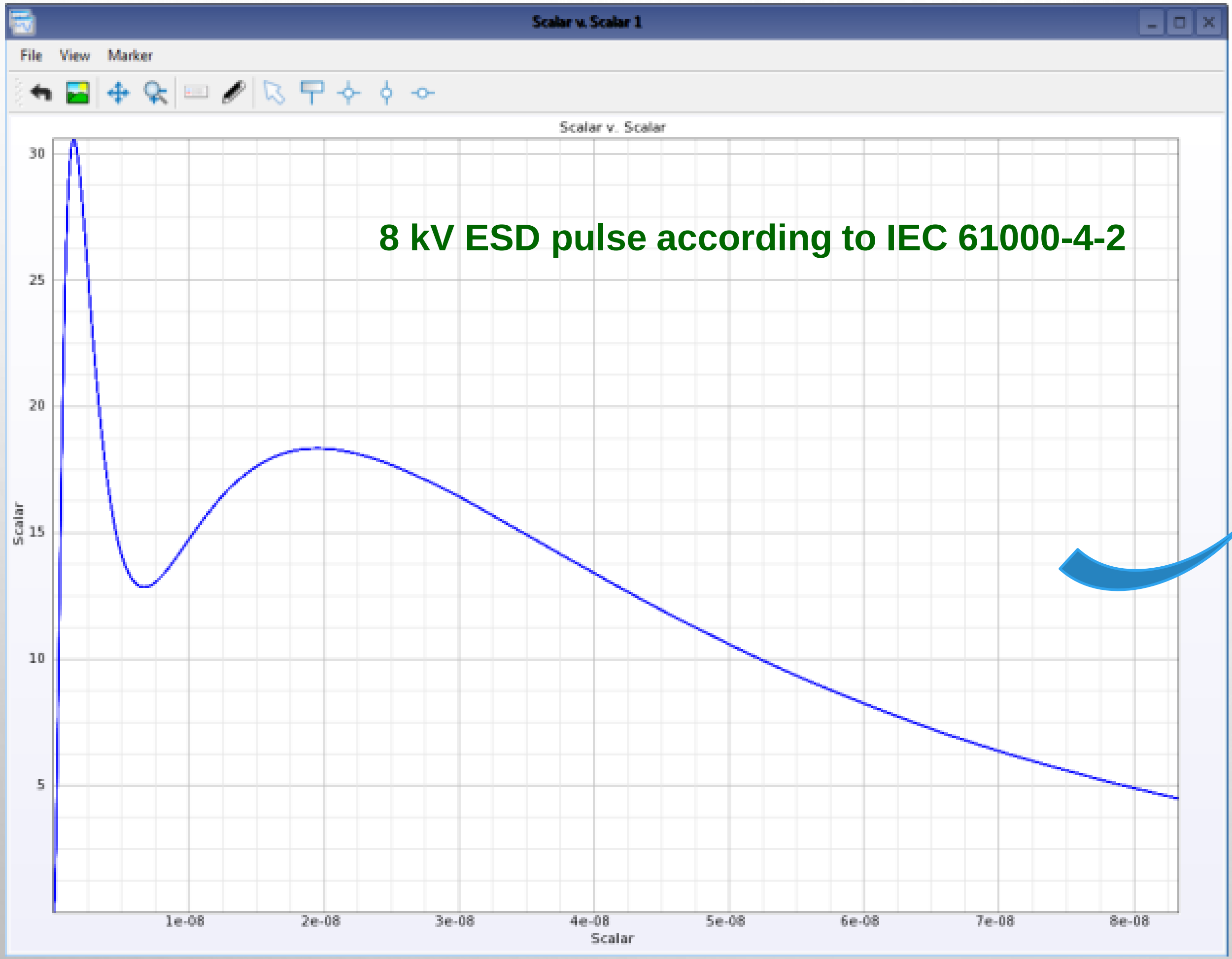
SETUP INPUT ESD CURRENT PULSE (PYTHON)

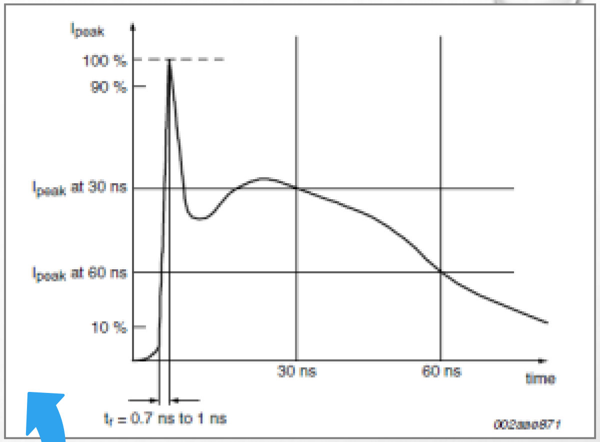
```
import math

t1 =1.1e-9
t2 = 2.0e-9
t3 = 12.0e-9
t4 = 37.0e-9
I1 = 34
I2 = 19
n = 1.8

k1 = math.exp(-t1/t2*math.pow(n*t2/t1,1/n))
k2 = math.exp(-t3/t4*math.pow(n*t4/t3,1/n))

myProject = empro.activeProject

timestep = myProject.parameters().evaluate("timestep")

def esd_waveform(t):
		out = (I1/k1)*(math.pow(t/t1,n))*math.exp(-
t/t2)/(1+math.pow(t/t1,n))
		out = out + (I2/k2)*(math.pow(t/t3,n))*math.exp(-
t/t4)/(1+math.pow(t/t3,n))
		return out

def esd_derivative(t):
		out = esd_waveform(t+timestep/2)
		out = out - esd_waveform(t-timestep/2)
		return out/timestep

…..
```

```
….

values = []
times = []
derivatives = []
for index in range(1500000):
		time = (index+1)*timestep
		times.append(time)
		values.append(esd_waveform(time))
		derivatives.append(esd_derivative(time))

myWaveform = empro.waveform.Waveform("ESD
Pulse")
myWaveformShape =
empro.waveform.TimestepSampledWaveformShape(val
ues,derivatives)
myWaveformShape.timestep = timestep
myWaveform.shape = myWaveformShape
myProject.waveforms().append(myWaveform)

from empro.toolkit import dataset,graphing
t = dataset.makeDataSet(times)
v = dataset.makeDataSet(values, dimensions = [t])
graphing.showXYGraph(v)
```

Source has to be modified if you change the time step (in other words if the mesh is changed)

SETUP INPUT ESD CURRENT PULSE (PYTHON SCRIPT)





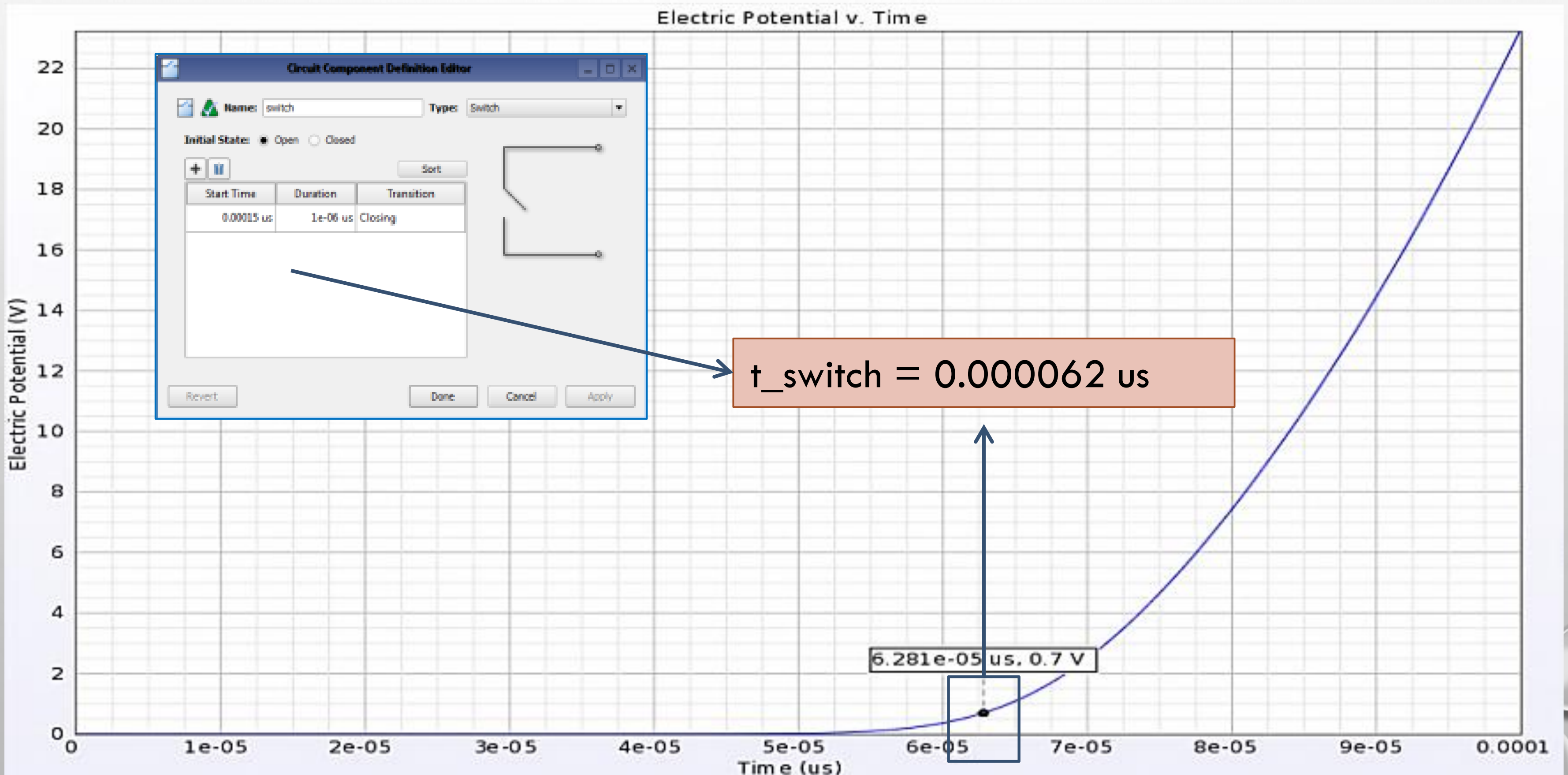
- ESD Pulse: 1-2 us
- Time step 5.5e-14 s

> 2M time steps

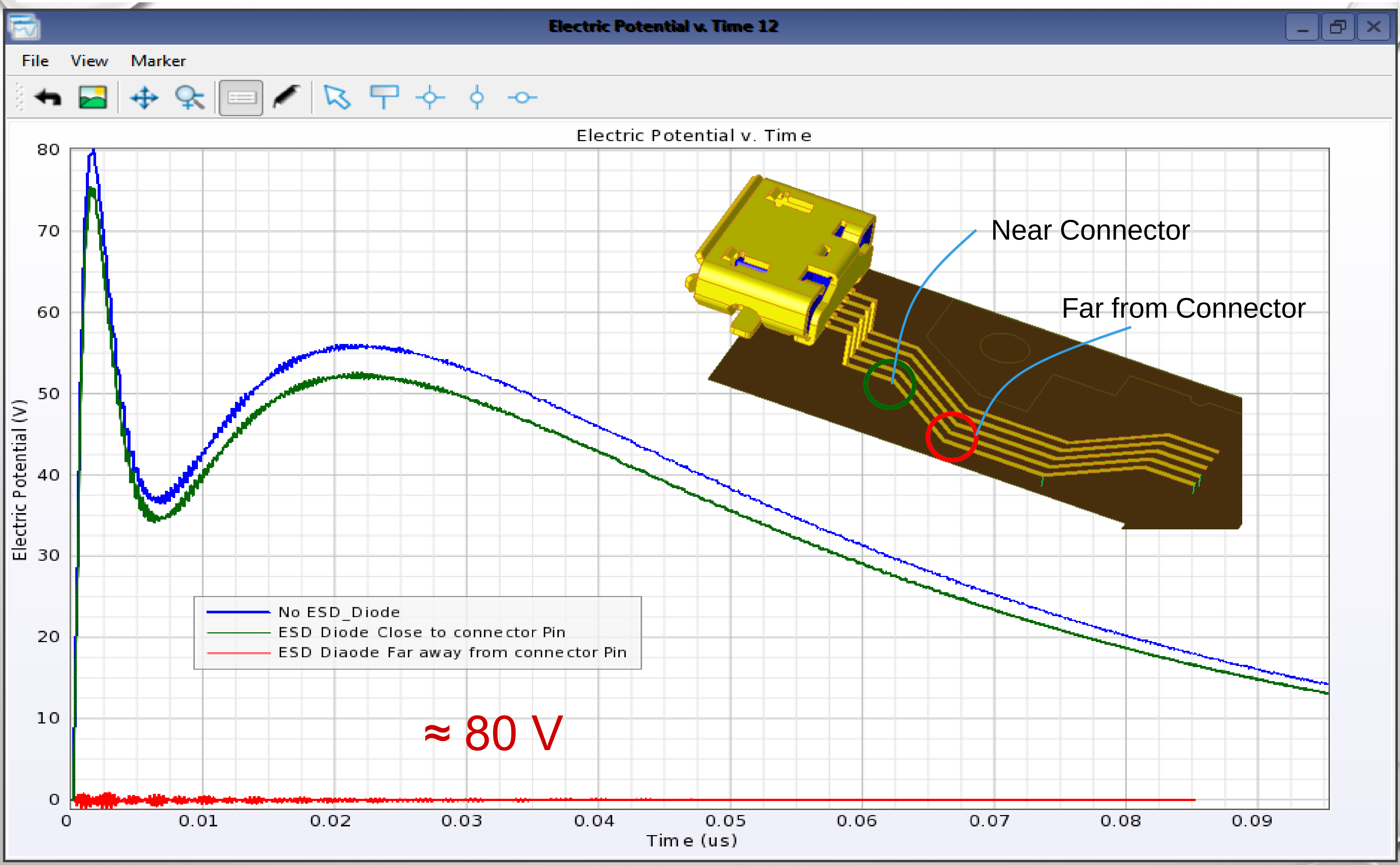
SIMULATIONS

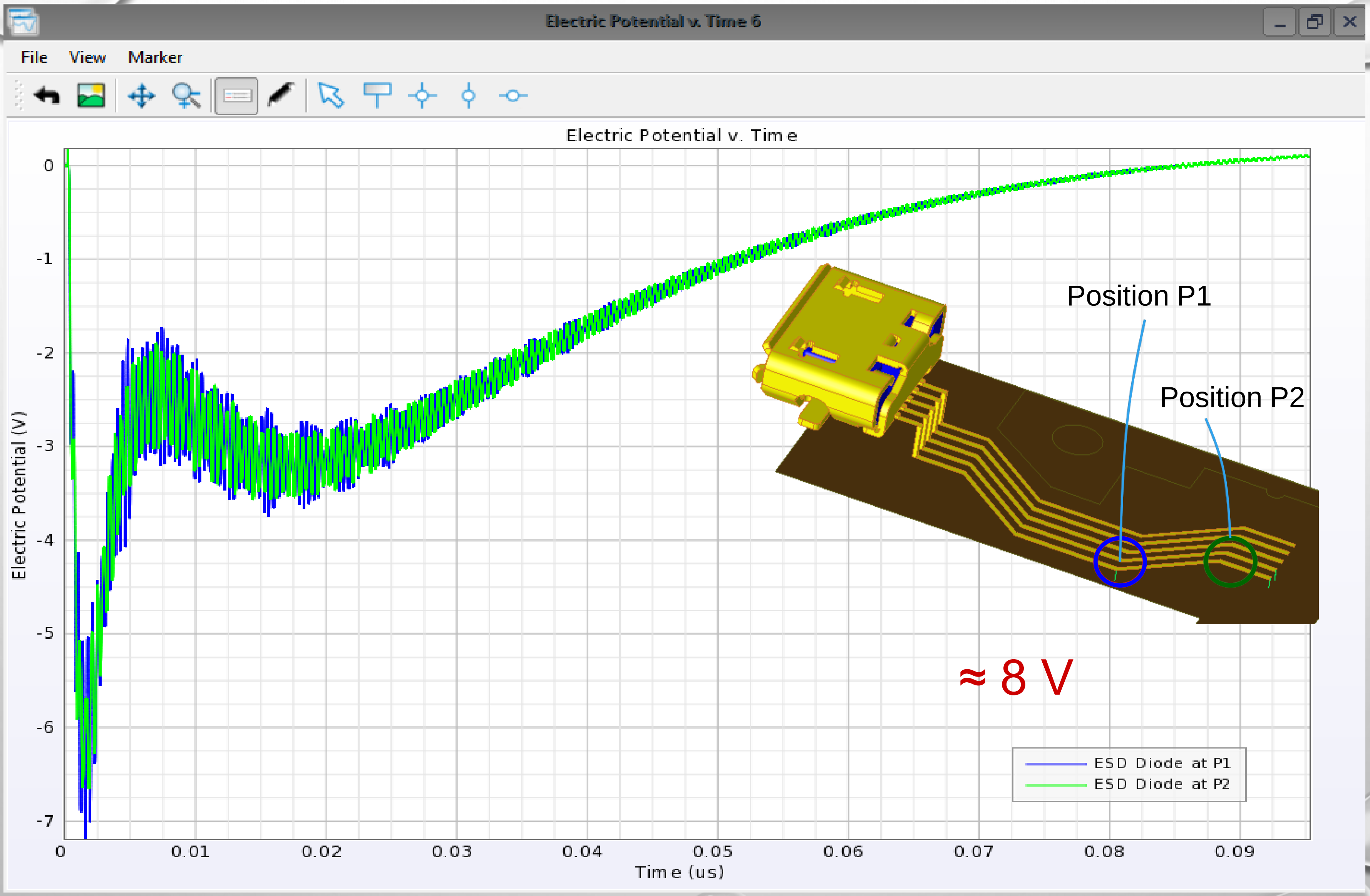
Instead of using diode model, switch model has been used (FDTD simulation with diode can become unstable)

1. Setup simulation with open (100 kohm load) @ location diode
2. Monitor the voltage @ diode, determine when voltage > 0.7 V = t_switch



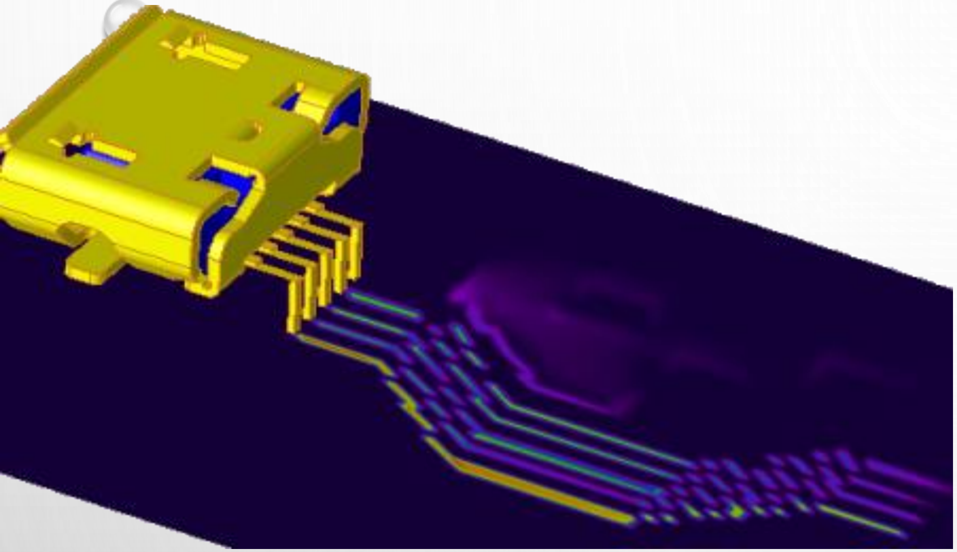
ESD DIODE CLOSE TO CONNECTOR



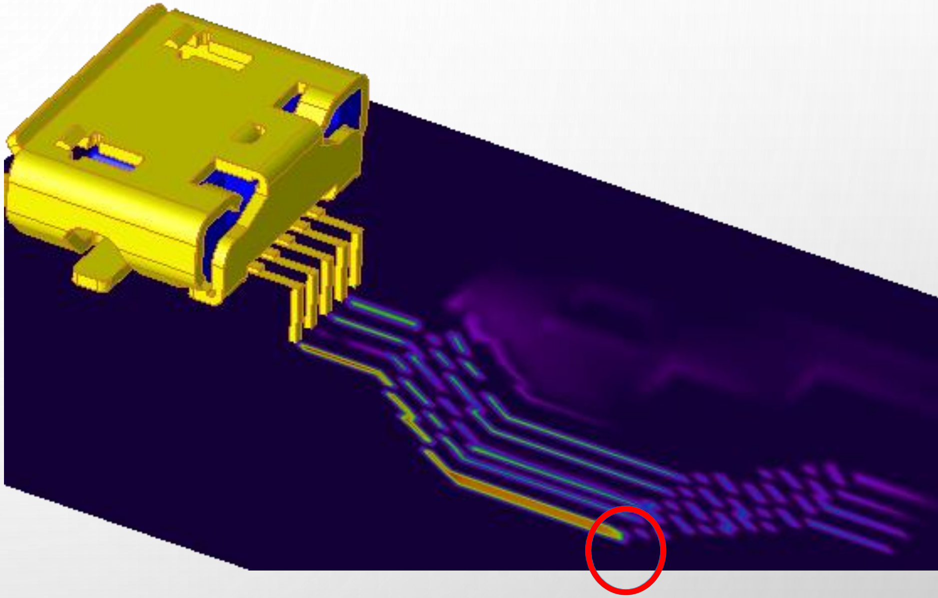


Electric Potential v. Time 6
File
View
Marker
Electric Potential v. Time
Electric Potential (V)
Time (us)
0
-1
-2
-3
-4
-5
-6
-7
0
0.01
0.02
0.03
0.04
0.05
0.06
0.07
0.08
0.09
Position P1
Position P2
≈ 8 V
ESD Diode at P1
ESD Diode at P2

SURFACE CURRENT ON A MOBILE PHONE



No ESD Diode



No ESD Diode placed

When there is no ESD diode induction current (Jc) is passing from connector to chip . After placing ESD diode high current is not passing beyond ESD diode location