

Device Modeling Report

COMPONENTS: Power MOSFET (Model Parameter)
PART NUMBER: 2SJ511
MANUFACTURER: TOSHIBA
Body Diode (Model Parameter) / ESD Protection Diode



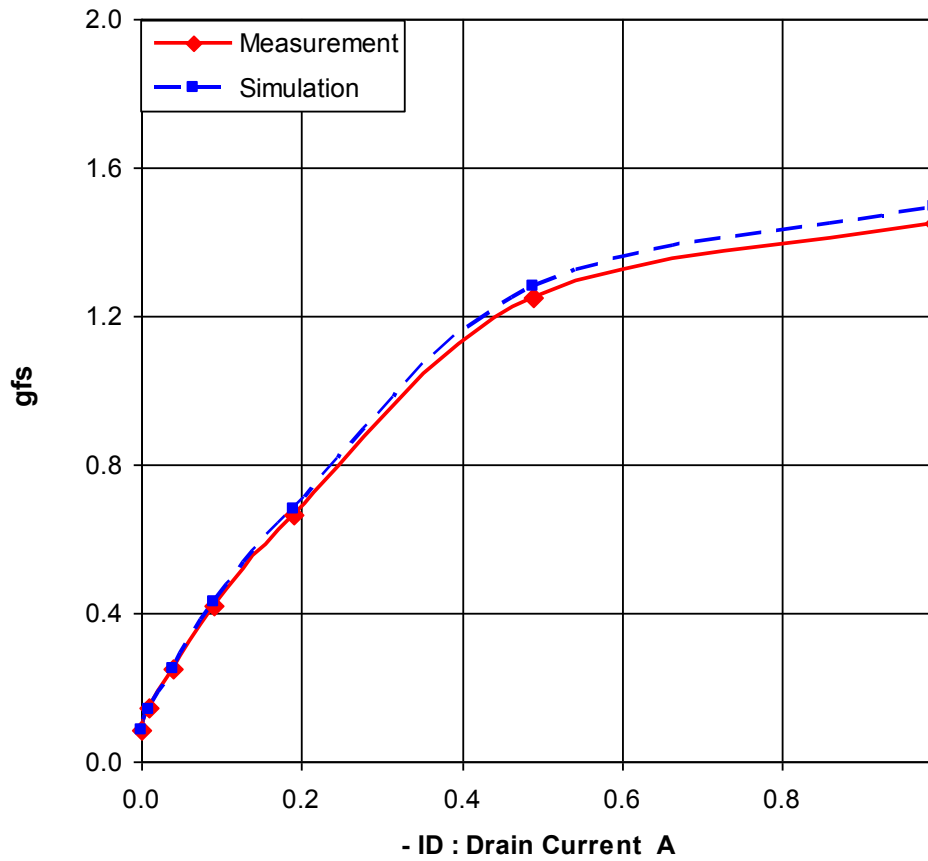
Bee Technologies Inc.

MOSFET MODEL

Pspice model parameter	Model description
LEVEL	
L	Channel Length
W	Channel Width
KP	Transconductance
RS	Source Ohmic Resistance
RD	Ohmic Drain Resistance
VTO	Zero-bias Threshold Voltage
RDS	Drain-Source Shunt Resistance
TOX	Gate Oxide Thickness
CGSO	Zero-bias Gate-Source Capacitance
CGDO	Zero-bias Gate-Drain Capacitance
CBD	Zero-bias Bulk-Drain Junction Capacitance
MJ	Bulk Junction Grading Coefficient
PB	Bulk Junction Potential
FC	Bulk Junction Forward-bias Capacitance Coefficient
RG	Gate Ohmic Resistance
IS	Bulk Junction Saturation Current
N	Bulk Junction Emission Coefficient
RB	Bulk Series Resistance
PHI	Surface Inversion Potential
GAMMA	Body-effect Parameter
DELTA	Width effect on Threshold Voltage
ETA	Static Feedback on Threshold Voltage
THETA	Modility Modulation
KAPPA	Saturation Field Factor
VMAX	Maximum Drift Velocity of Carriers
XJ	Metallurgical Junction Depth
UO	Surface Mobility

Transconductance Characteristic

Circuit Simulation Result

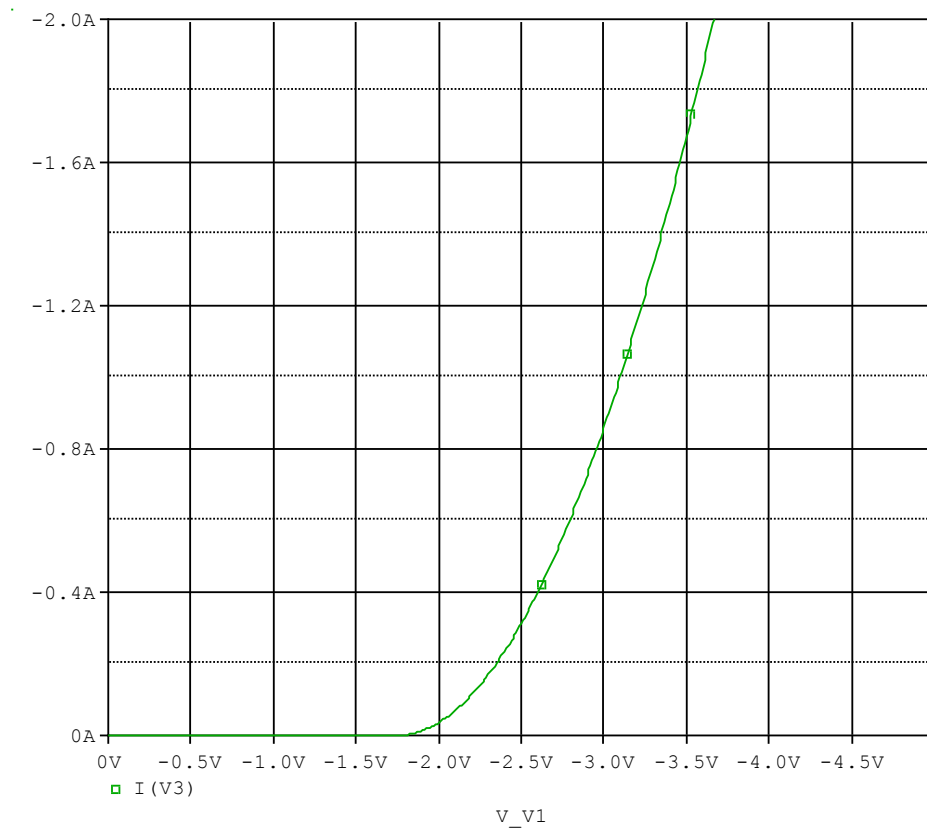


Comparison table

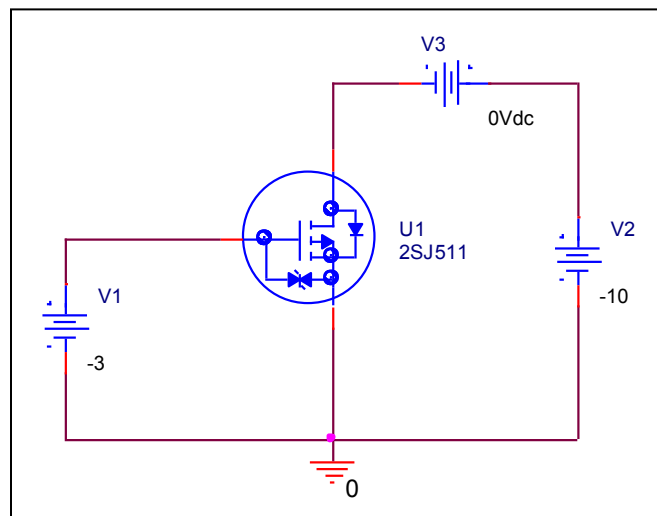
-Id(A)	g_{fs}		Error(%)
	Measurement	Simulation	
0.010	0.083	0.085	2.410
0.020	0.143	0.142	-0.699
0.050	0.250	0.248	-0.800
0.100	0.420	0.430	2.381
0.200	0.667	0.680	1.949
0.500	1.250	1.278	2.240
1.000	1.449	1.495	3.175

V_{gs}-I_d Characteristic

Circuit Simulation result

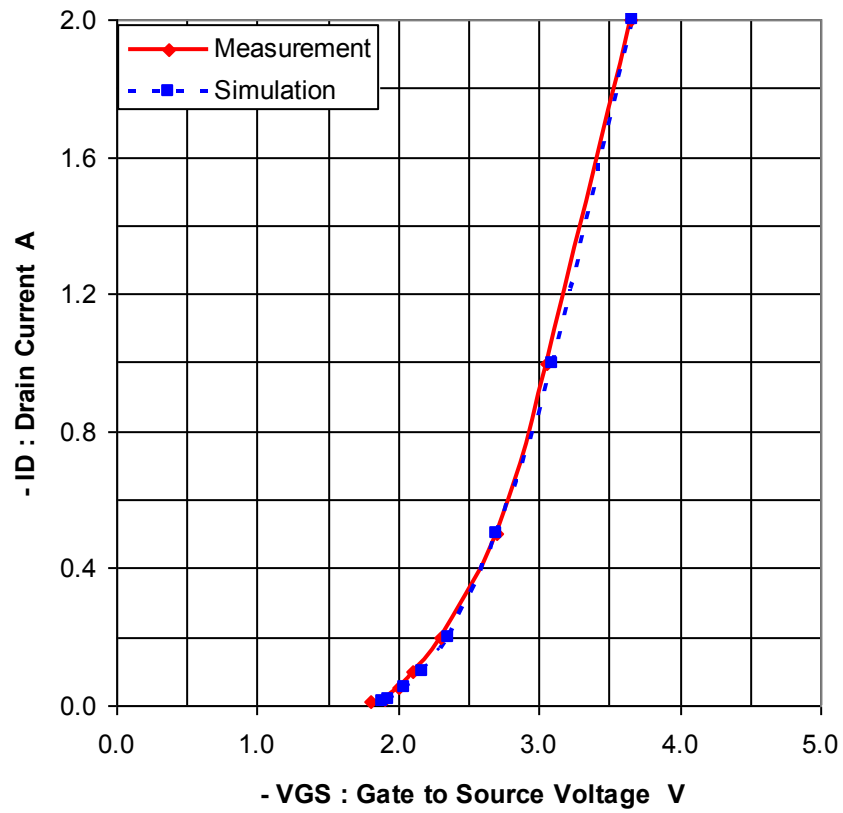


Evaluation circuit



Comparison Graph

Circuit Simulation Result

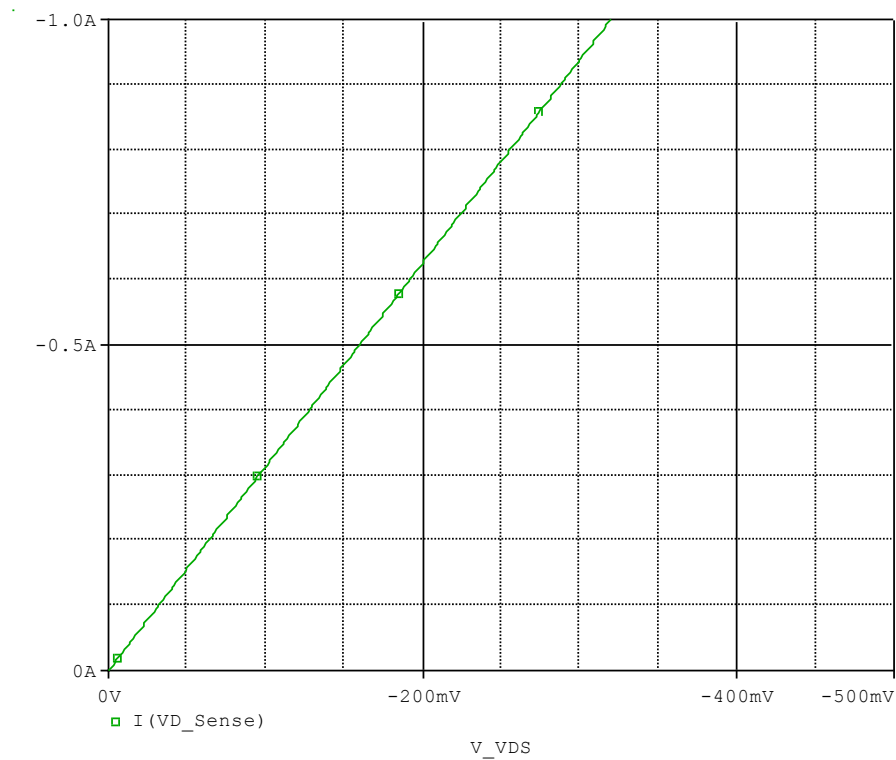


Simulation Result

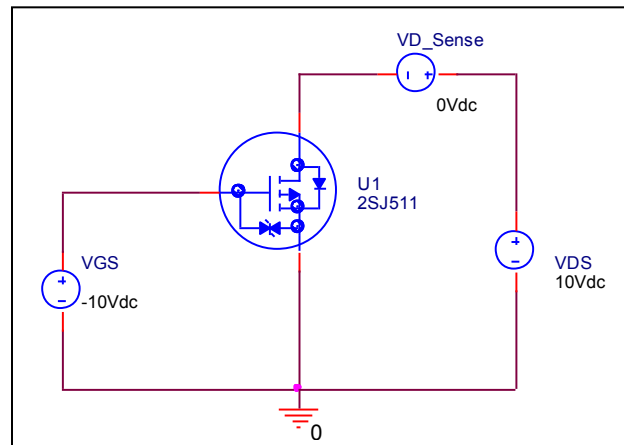
$-I_D$ (A)	$-V_{GS}$ (V)		Error (%)
	Measurement	Simulation	
0.010	1.800	1.887	4.833
0.020	1.900	1.938	2.000
0.050	2.000	2.041	2.050
0.100	2.100	2.175	3.571
0.200	2.300	2.351	2.217
0.500	2.700	2.703	0.111
1.000	3.050	3.099	1.607
2.000	3.650	3.666	0.438

R_{ds(on)} Characteristic

Circuit Simulation result



Evaluation circuit

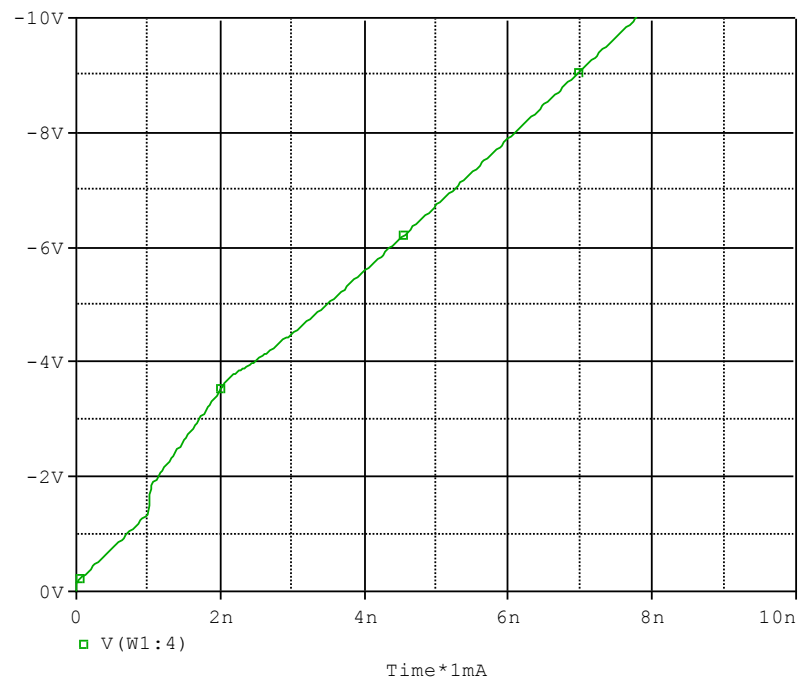


Simulation Result

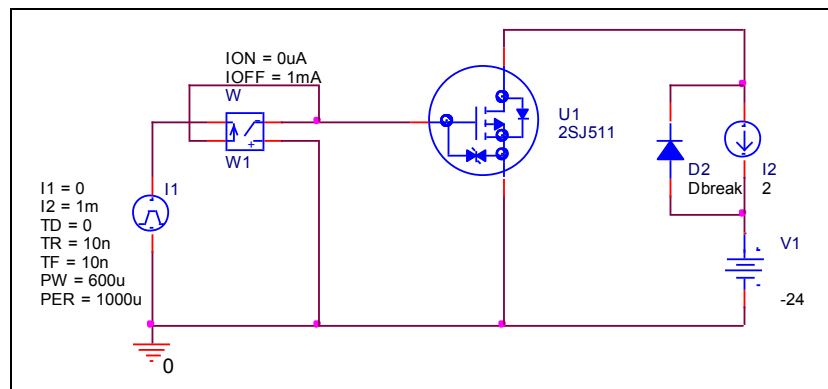
$I_D = -1A, V_{GS} = -10V$	Measurement	Simulation	Error (%)
$R_{DS(on)}$ (Ω)	0.320	0.320	0.000

Gate Charge Characteristic

Circuit Simulation result



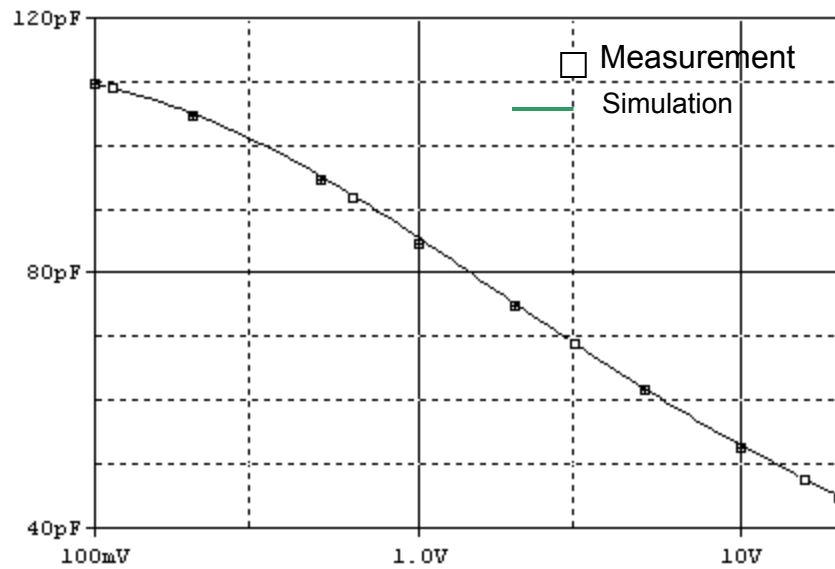
Evaluation circuit



Simulation Result

$V_{DD} = -24V, I_D = -2A$ $V_{GS} = -10V$	Measurement	Simulation	Error (%)
Q_{gs}(nc)	1.000	1.030	3.000
Q_{gd}(nc)	1.200	1.203	0.250
Q_g(nc)	10.000	7.792	-22.080

Capacitance Characteristic

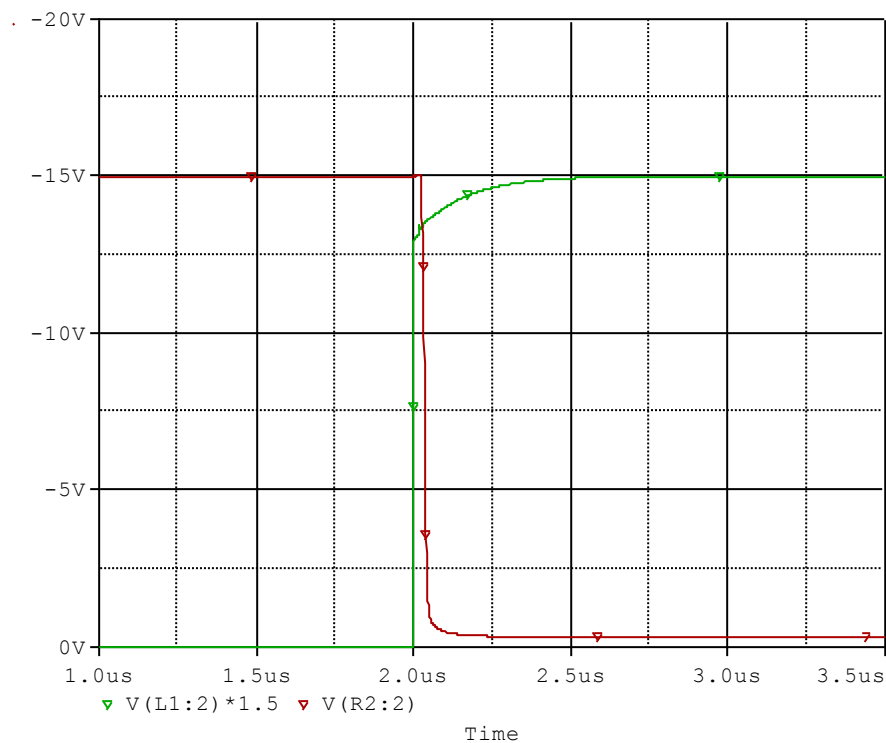


Simulation Result

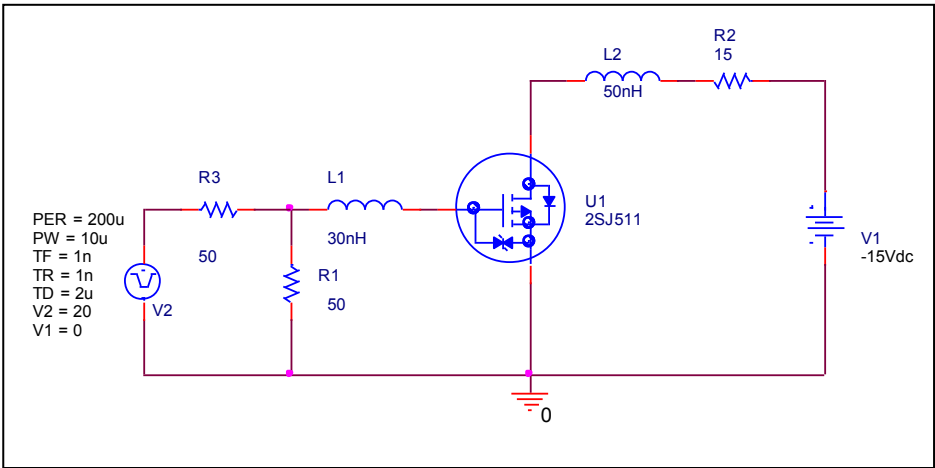
V _{DS} (V)	Cbd(pF)		Error(%)
	Measurement	Simulation	
0.100	110.000	109.500	-0.450
0.200	105.000	105.000	0.000
0.500	95.000	95.100	0.110
1.000	85.000	85.500	0.590
2.000	75.000	75.200	0.270
5.000	62.000	61.500	-0.810
10.000	53.000	52.800	-0.380
20.000	45.000	45.000	0.000

Switching Time Characteristic

Circuit Simulation result



Evaluation circuit

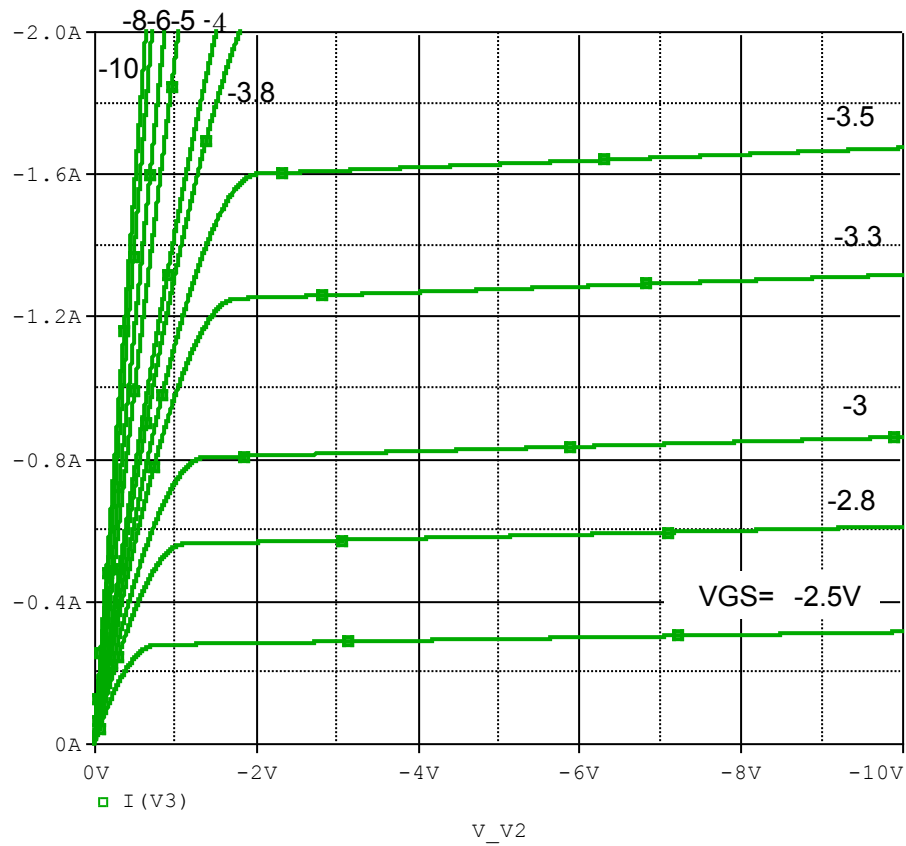


Simulation Result

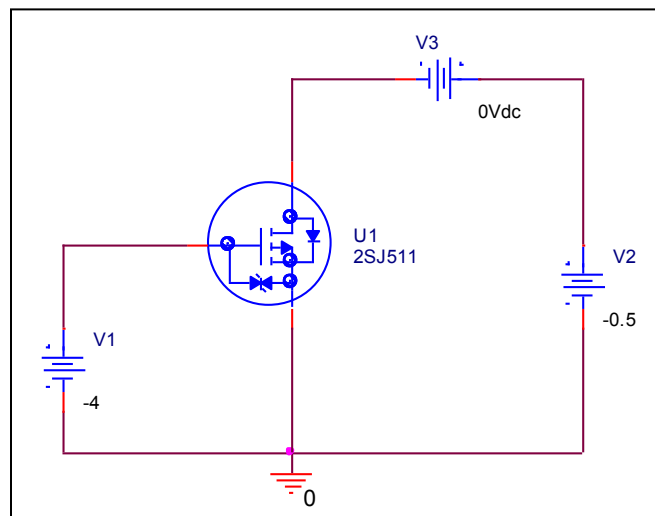
$I_D = -1A$, $V_{DD} = -15V$ $V_{GS} = -10V$	Measurement	Simulation	Error(%)
Ton(ns)	45.000	45.135	0.300

Output Characteristic

Circuit Simulation result



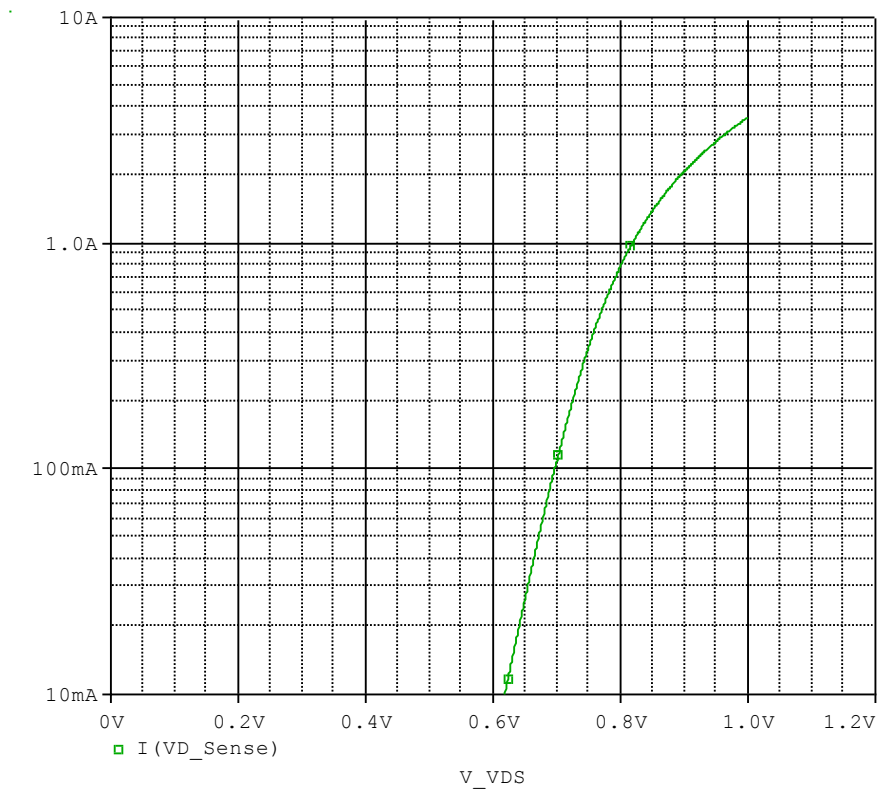
Evaluation circuit



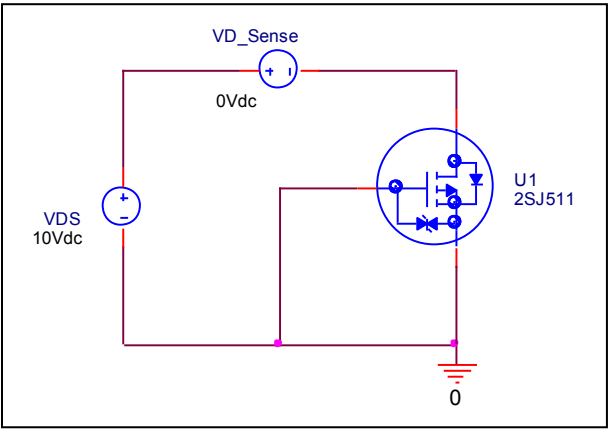
BODY DIODE SPICE MODEL

Forward Current Characteristic

Circuit Simulation Result

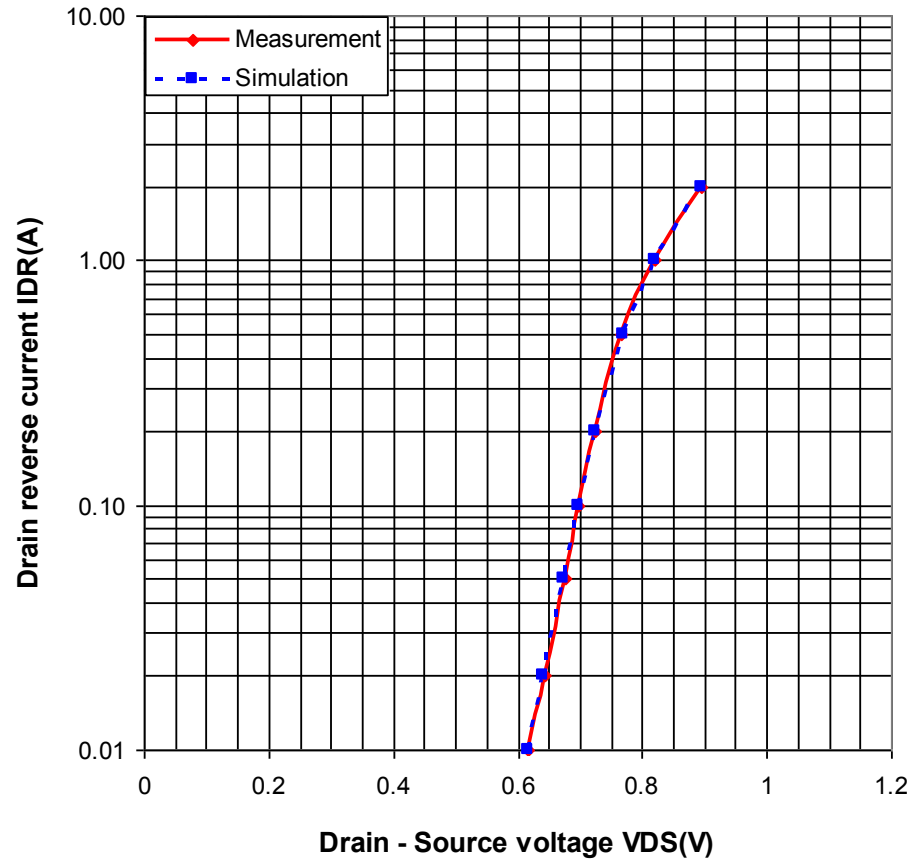


Evaluation Circuit



Comparison Graph

Circuit Simulation Result

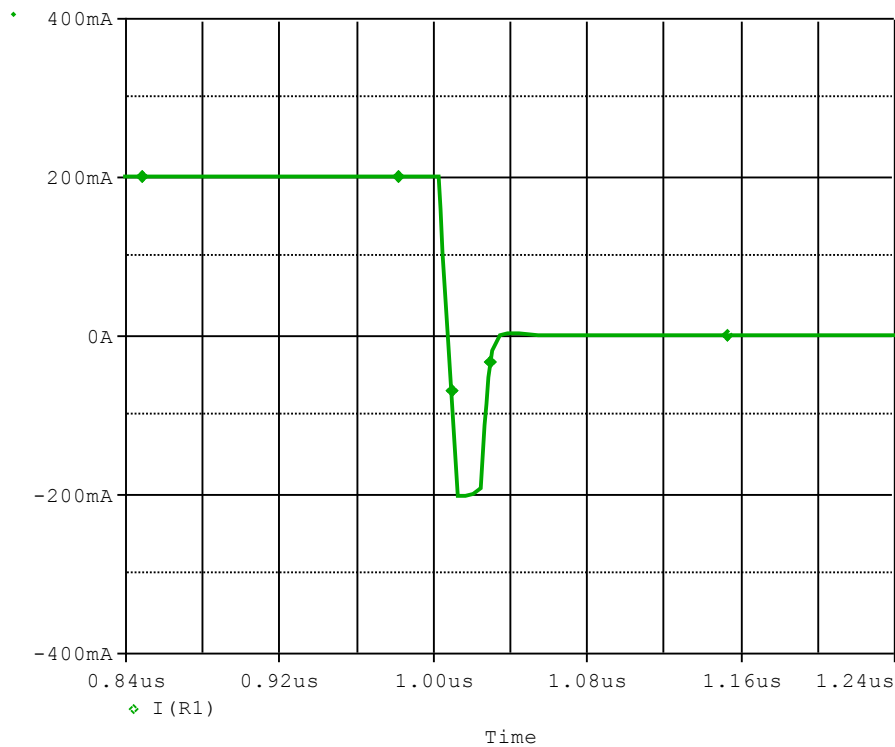


Simulation Result

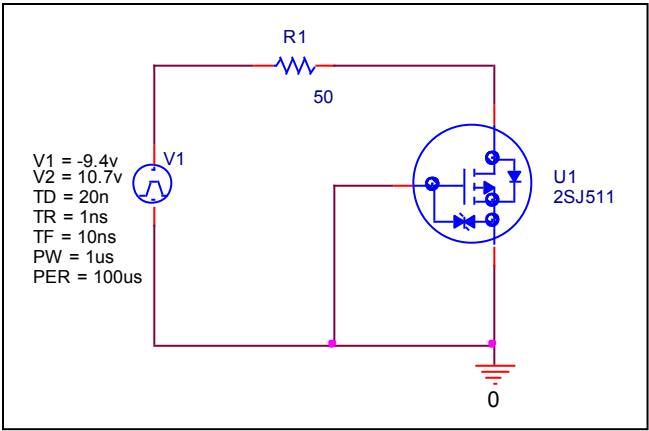
IDR(A)	VDS(V) Measurement	VDS(V) Simulation	%Error
0.010	0.615	0.616	0.163
0.020	0.642	0.641	-0.156
0.050	0.675	0.672	-0.444
0.100	0.698	0.696	-0.287
0.200	0.725	0.724	-0.138
0.500	0.765	0.768	0.392
1.000	0.820	0.819	-0.122
2.000	0.895	0.894	-0.112

Reverse Recovery Characteristic

Circuit Simulation Result



Evaluation Circuit

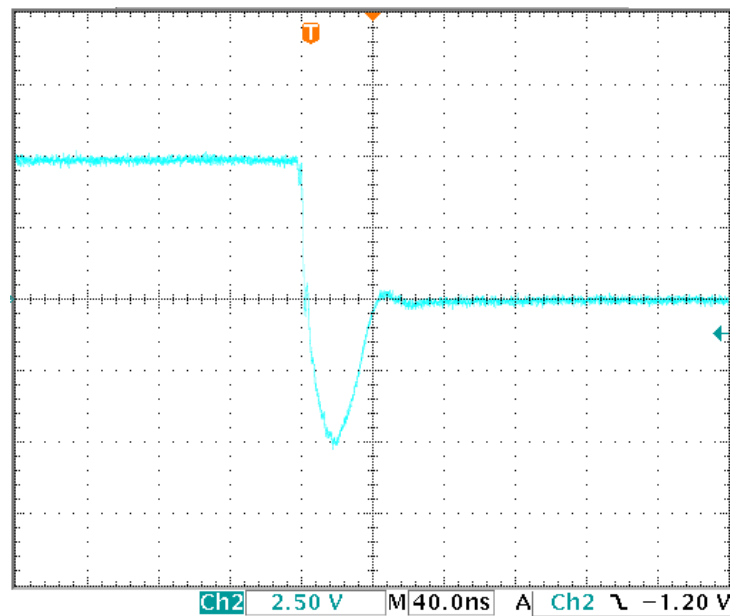


Compare Measurement vs. Simulation

	Measurement	Simulation	Error (%)
Trj(ns)	15.200	15.476	1.816

Reverse Recovery Characteristic

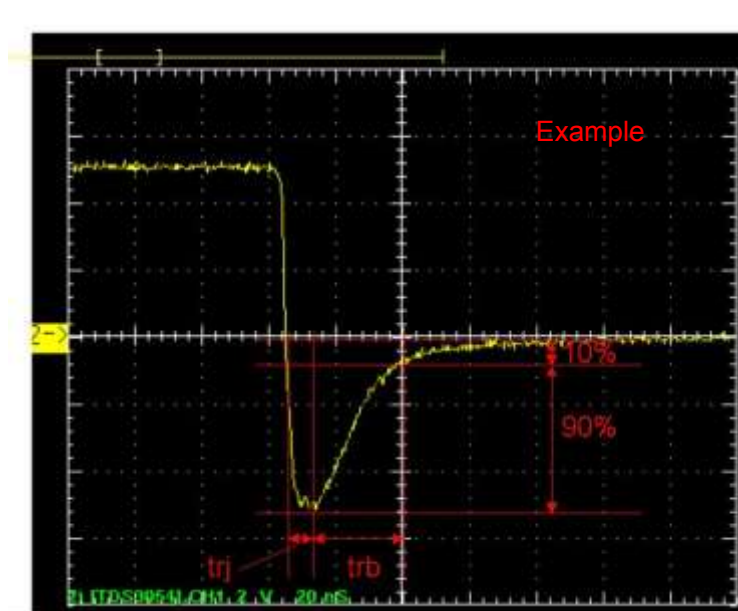
Reference



$t_{rr} = 15.2 \text{ (ns)}$

$t_{rb} = 20.8 \text{ (ns)}$

Conditions: $I_{fwd} = I_{rev} = 0.2 \text{ (A)}$, $R_I = 50$

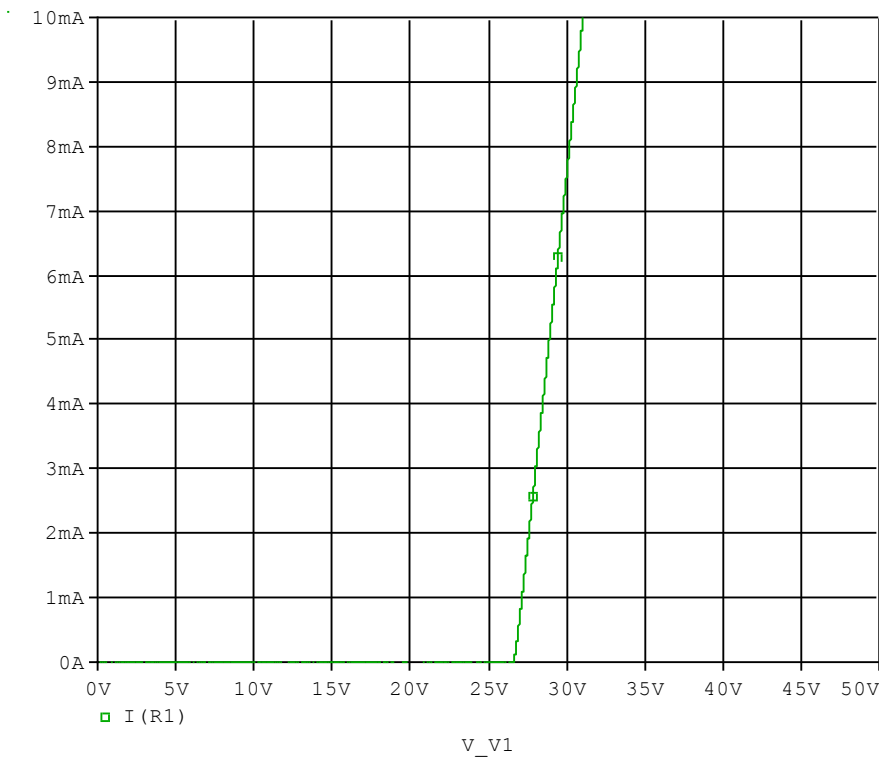


Relation between t_{trj} and t_{trb}

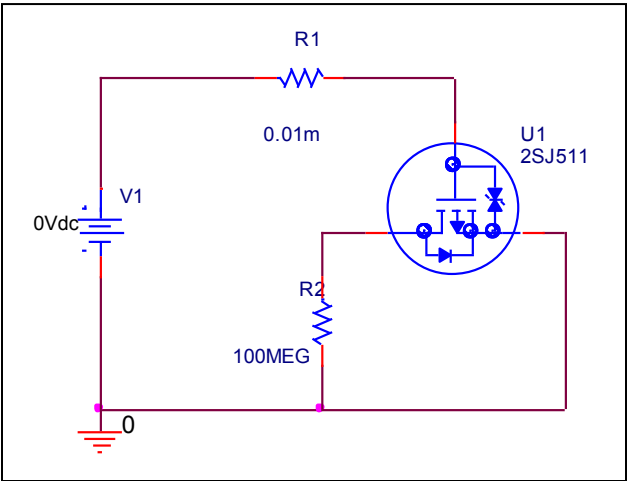
ESD PROTECTION DIODE SPICE MODEL

Zener Voltage Characteristic

Circuit Simulation Result



Evaluation Circuit



Zener Voltage Characteristic

Reference

