Device Modeling Report

COMPONENTS: Power MOSFET
PART NUMBER: 2SK3301
MANUFACTURER: TOSHIBA
Body Diode (Model Parameter) /ESD Protection Diode

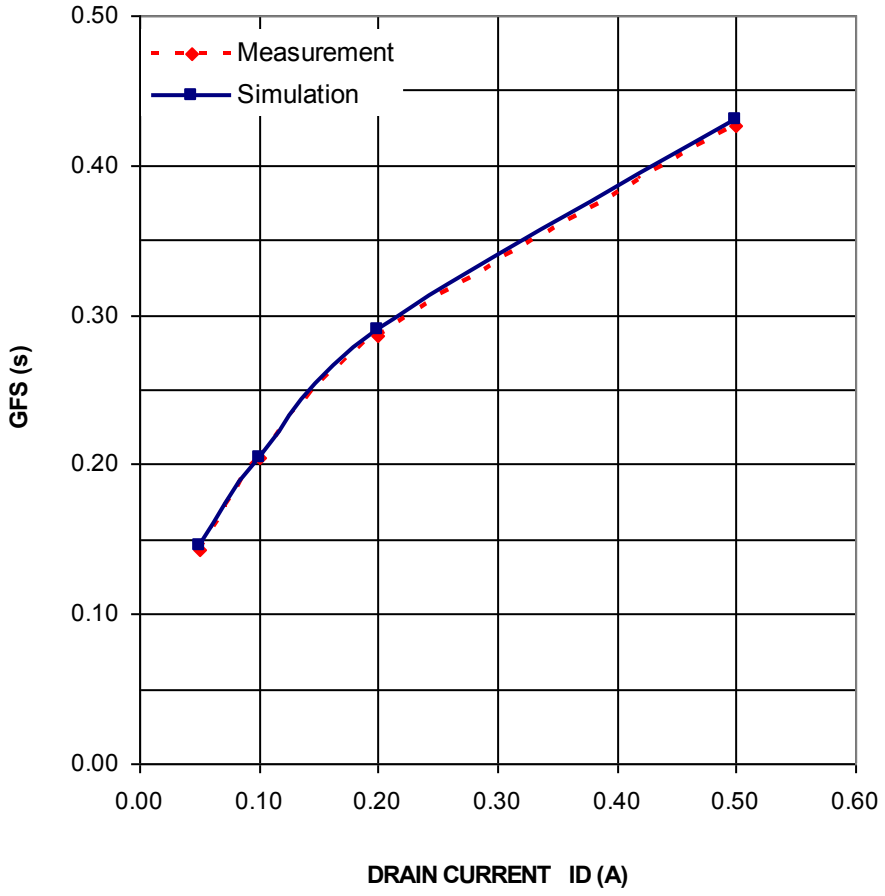
Bee Technologies Inc.

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

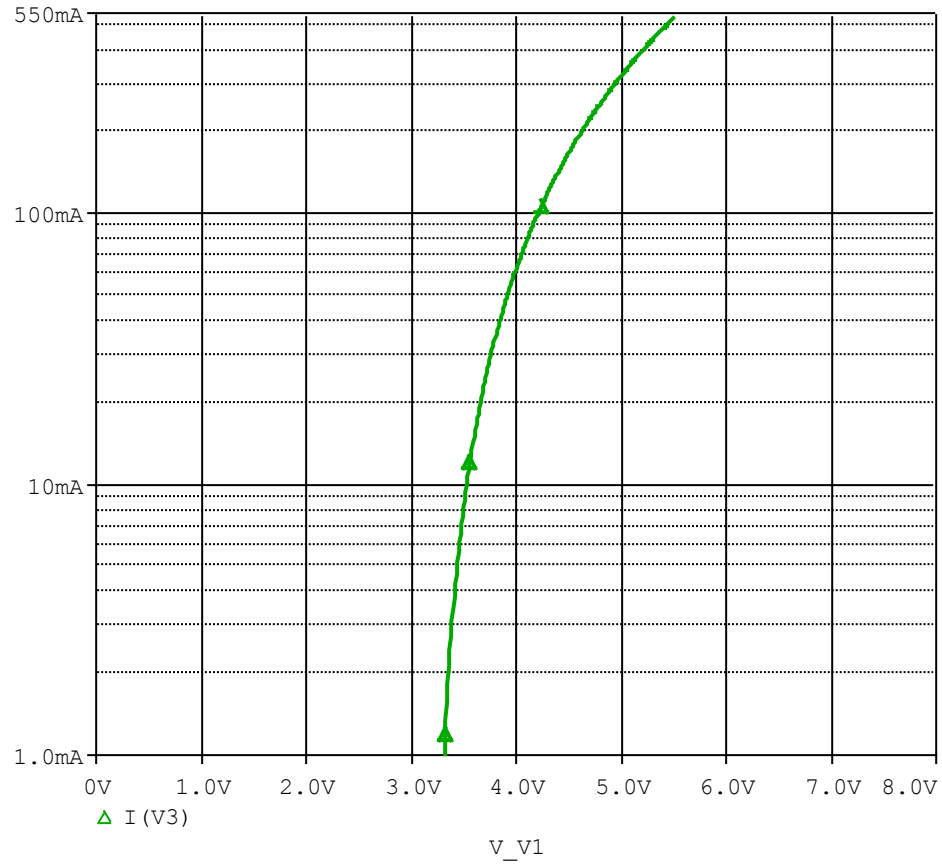


Comparison table

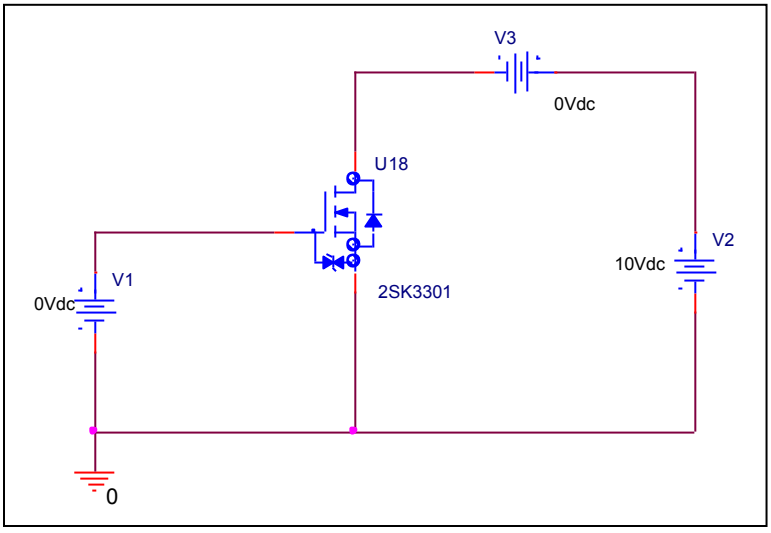
Id(A)	gfs		Error(%)
	Measurement	Simulation	
0.050	0.143	0.145	1.469
0.100	0.205	0.205	0.098
0.200	0.286	0.291	1.608
0.500	0.427	0.431	0.937

Vgs-Id Characteristic

Circuit Simulation result

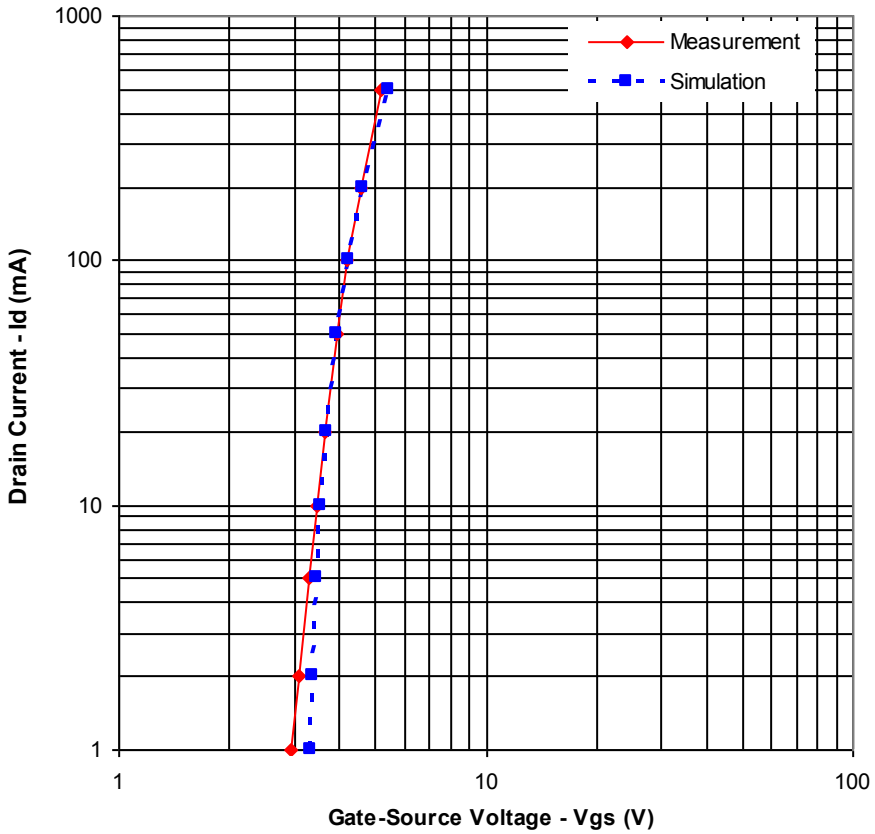


Evaluation circuit



Comparison Graph

Circuit Simulation Result

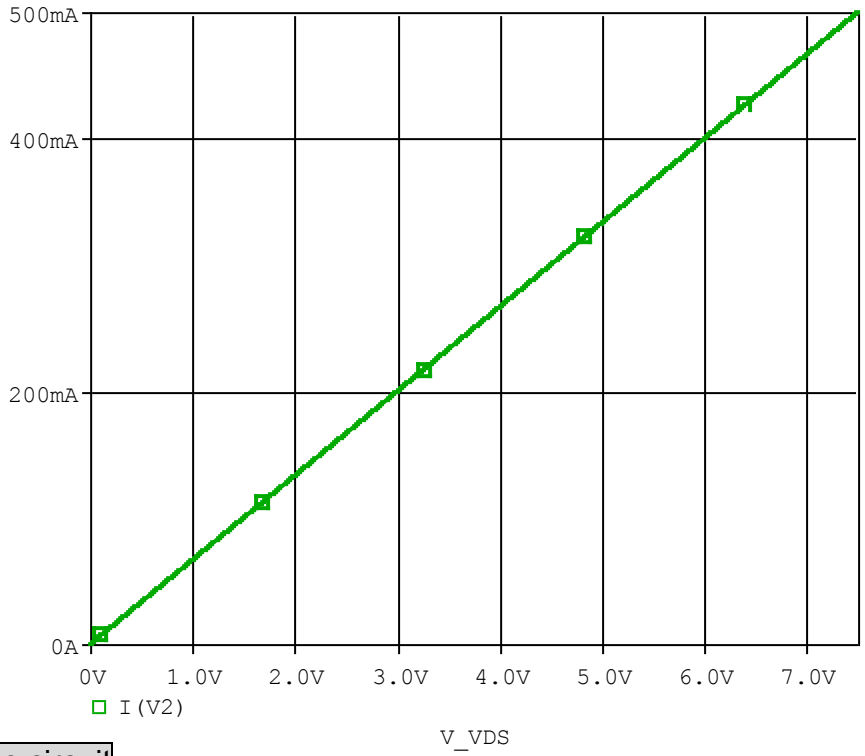


Simulation Result

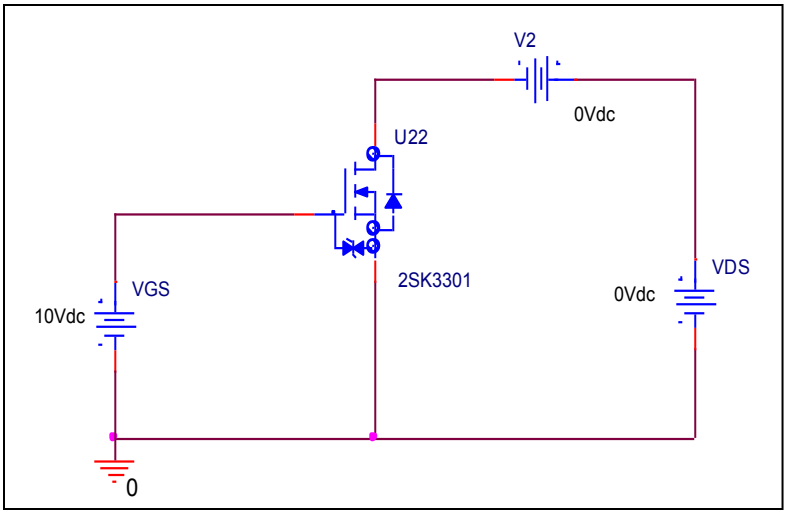
I_D(mA)	V_{GS}(V)		Error (%)
	Measurement	Simulation	
5.000	3.300	3.448	4.488
10.000	3.450	3.541	2.626
20.000	3.640	3.672	0.865
50.000	3.940	3.933	-0.173
100.000	4.190	4.223	0.776
200.000	4.550	4.638	1.941
500.000	5.200	5.454	4.883

Rds(on) Characteristic

Circuit Simulation result



Evaluation circuit

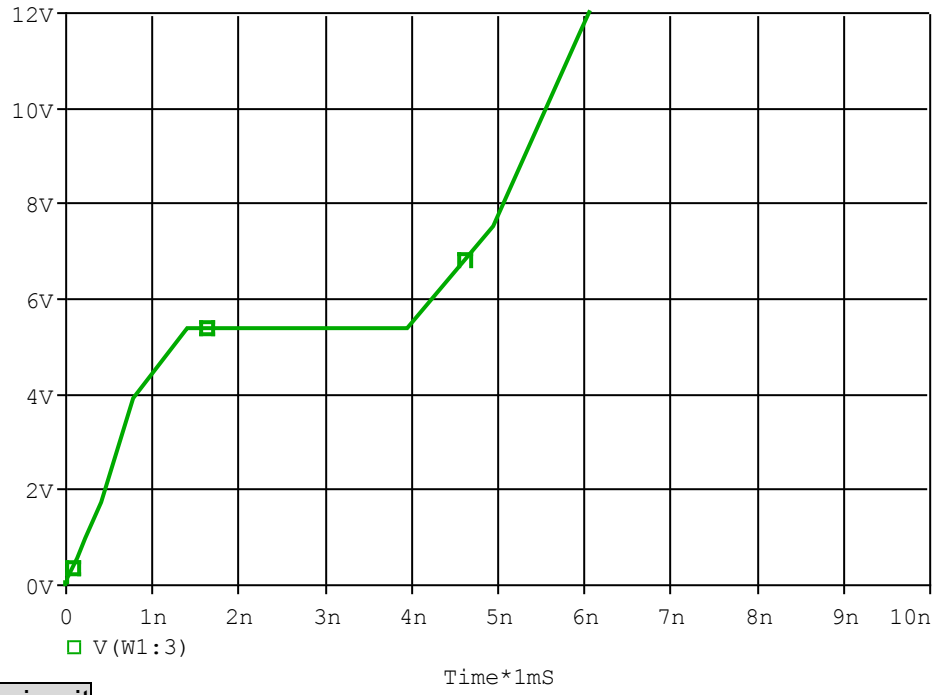


Simulation Result

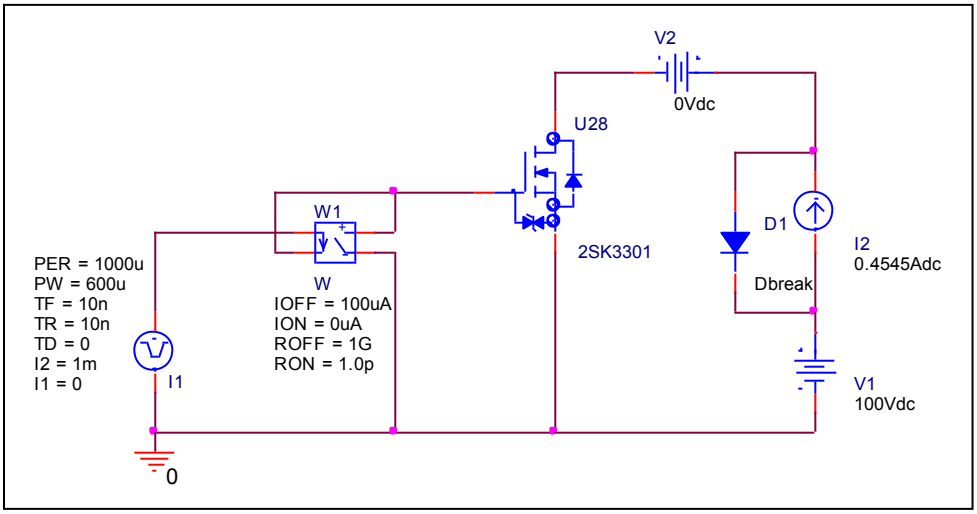
I_D= 0.5A, V_{GS}= 10V	Measurement		Simulation		Error (%)
R_{DS} (on)	15.000	Ω	15.000	Ω	0.000

Gate Charge Characteristic

Circuit Simulation result



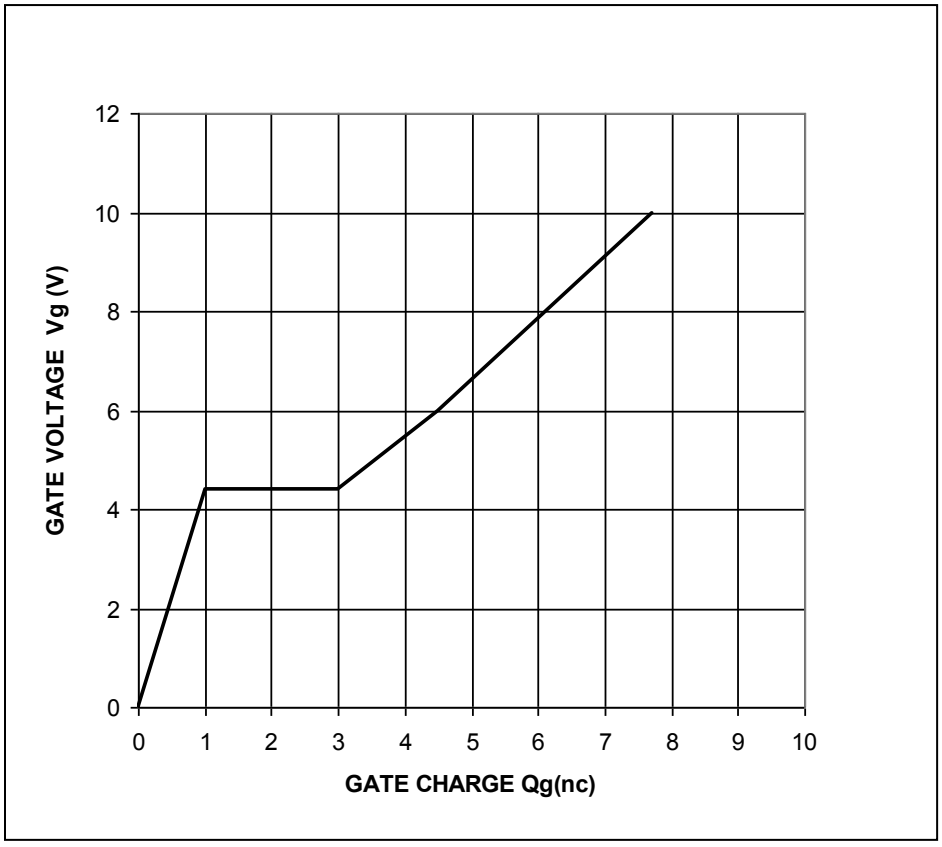
Evaluation circuit



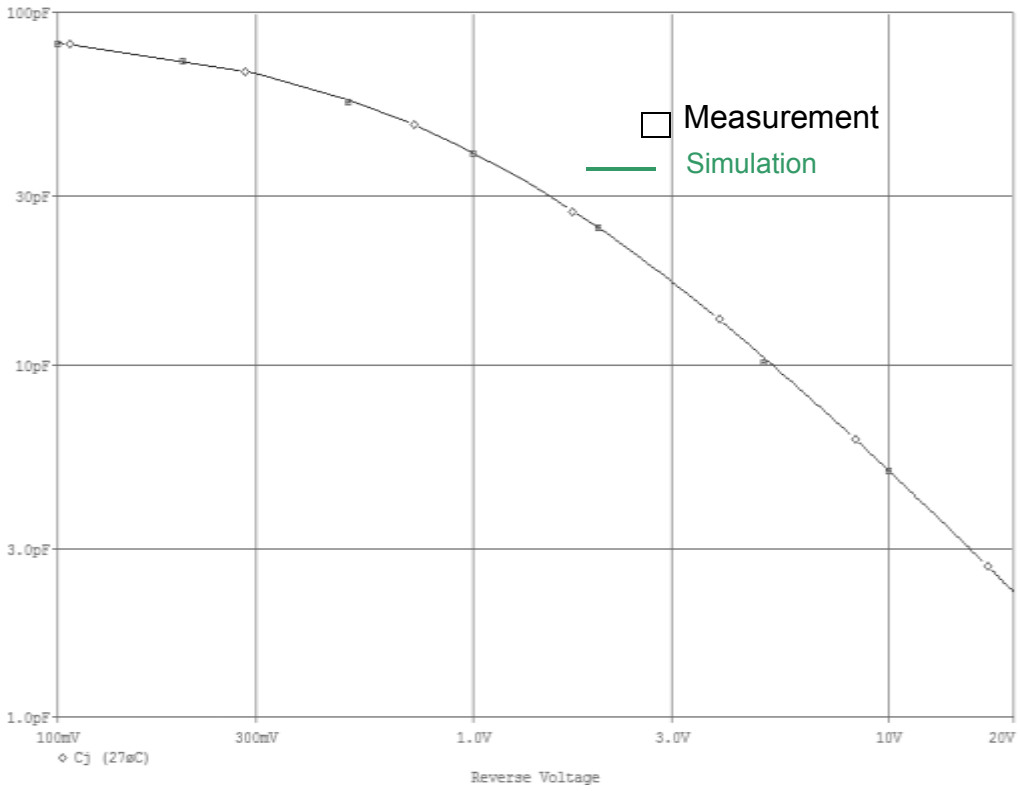
Simulation Result

V_{DD}=100V,I_D=45A ,V_{GS}=10V	Measurement		Simulation		Error (%)
Qgs	1.000	nC	1.411	nC	41.100
Qgd	3.000	nC	2.558	nC	-14.733
Qg	7.700	nC	5.570	nC	-27.662

Gate Charge Characteristic Reference



Capacitance Characteristic



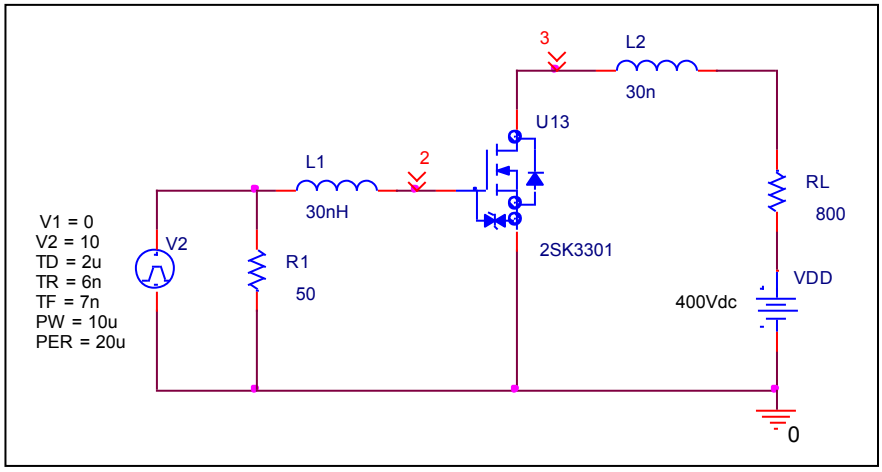
Simulation Result

V_{DS}(V)	Cbd(pF)		Error(%)
	Measurement	Simulation	
0.100	82.197	82.000	-0.240
0.200	72.541	73.000	0.633
0.500	55.139	56.000	1.562
1.000	42.188	41.000	-2.816
2.000	24.628	24.000	-2.550
5.000	12.243	12.000	-1.985
10.000	4.950	5.000	1.010
20.000	2.241	2.200	-1.808

Switching Time Characteristic

Circuit Simulation result

Evaluation circuit

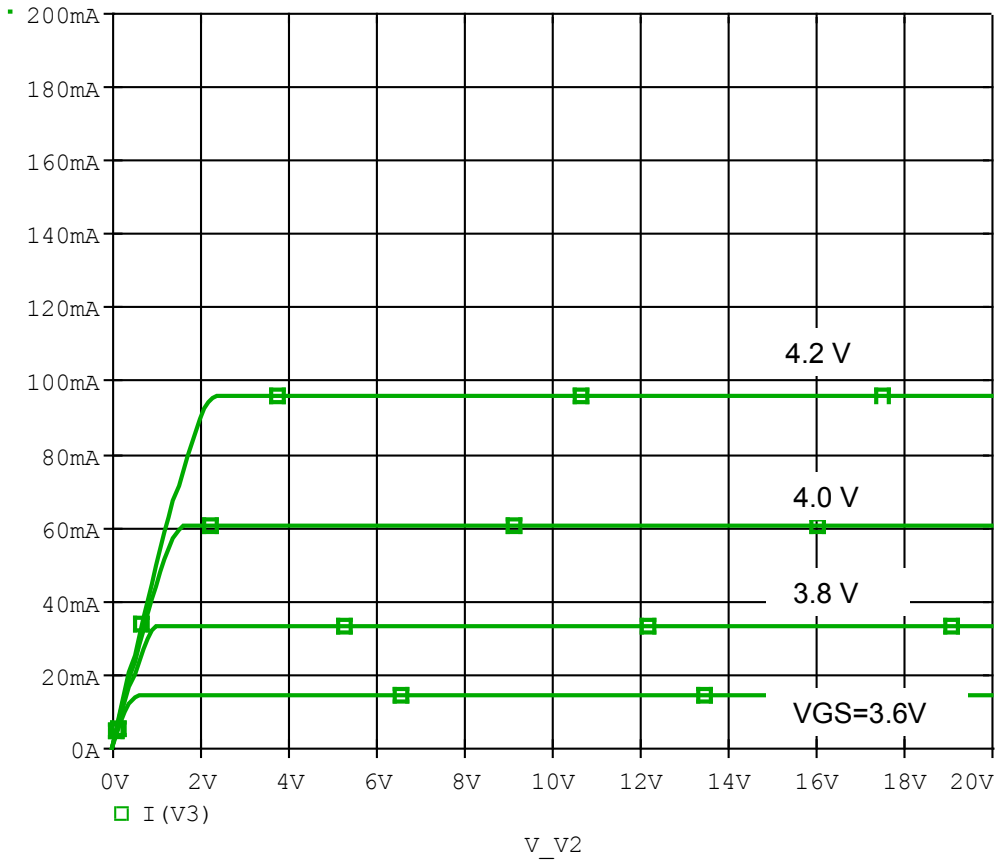


Simulation Result

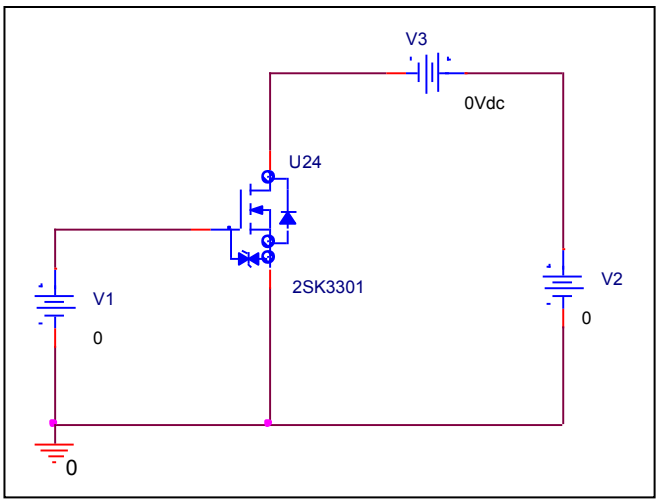
I_D=0.5A, V_{DD}=400V,V_{GS}=10V	Measurement		Simulation		Error(%)
ton	60.000	ns	59.477	ns	-0.872

Output Characteristic

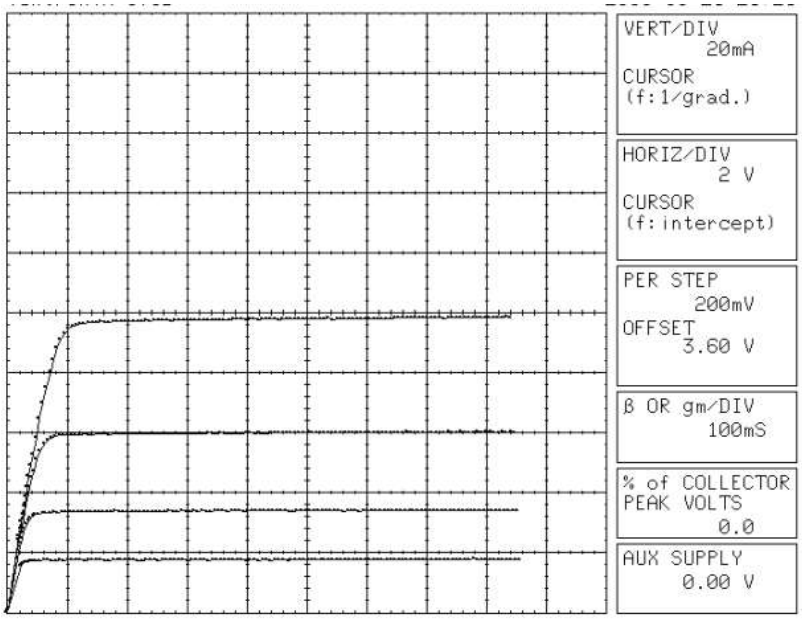
Circuit Simulation result



Evaluation circuit



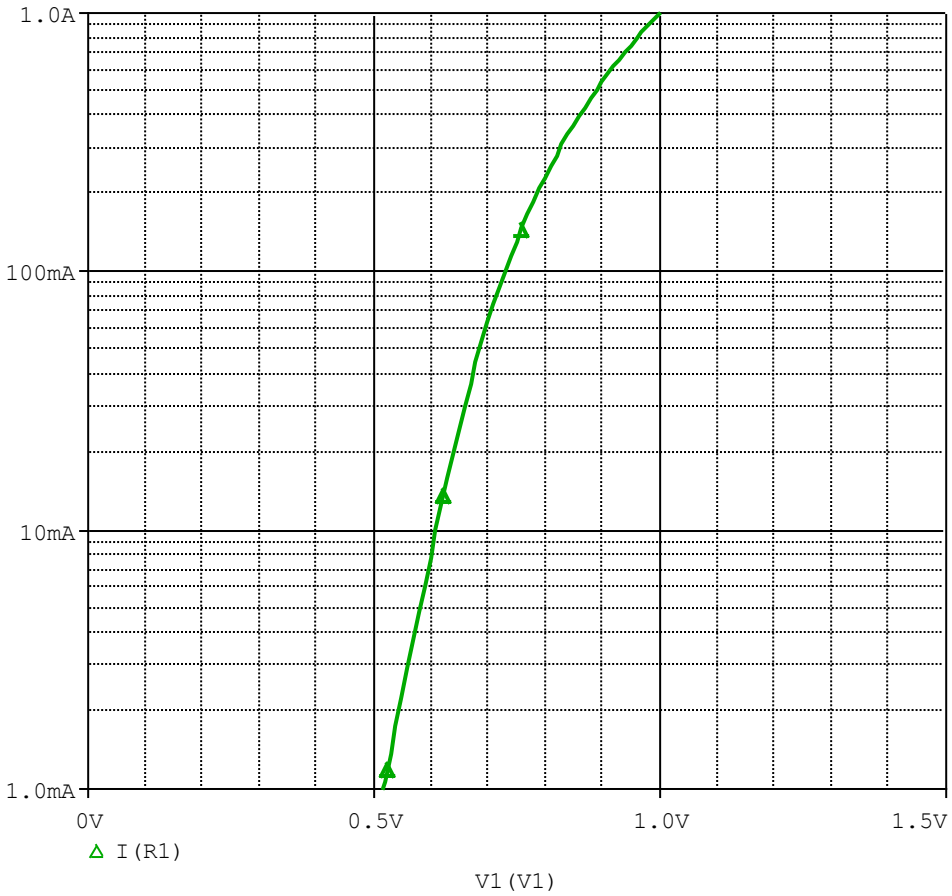
Output Characteristic Reference



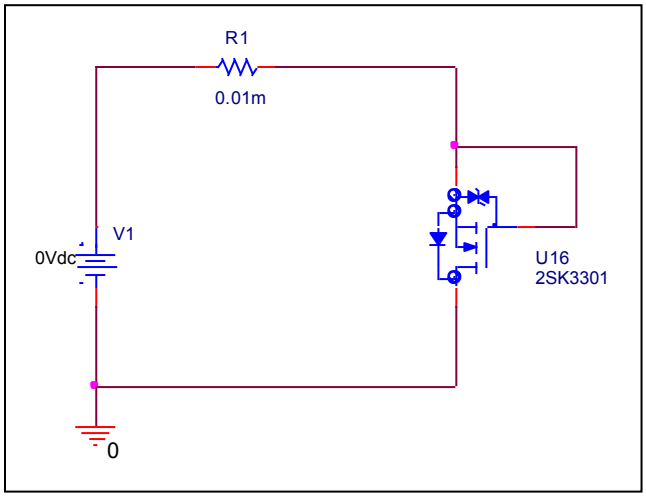
BODY DIODE SPICE MODEL

Forward Current Characteristic

Circuit Simulation Result

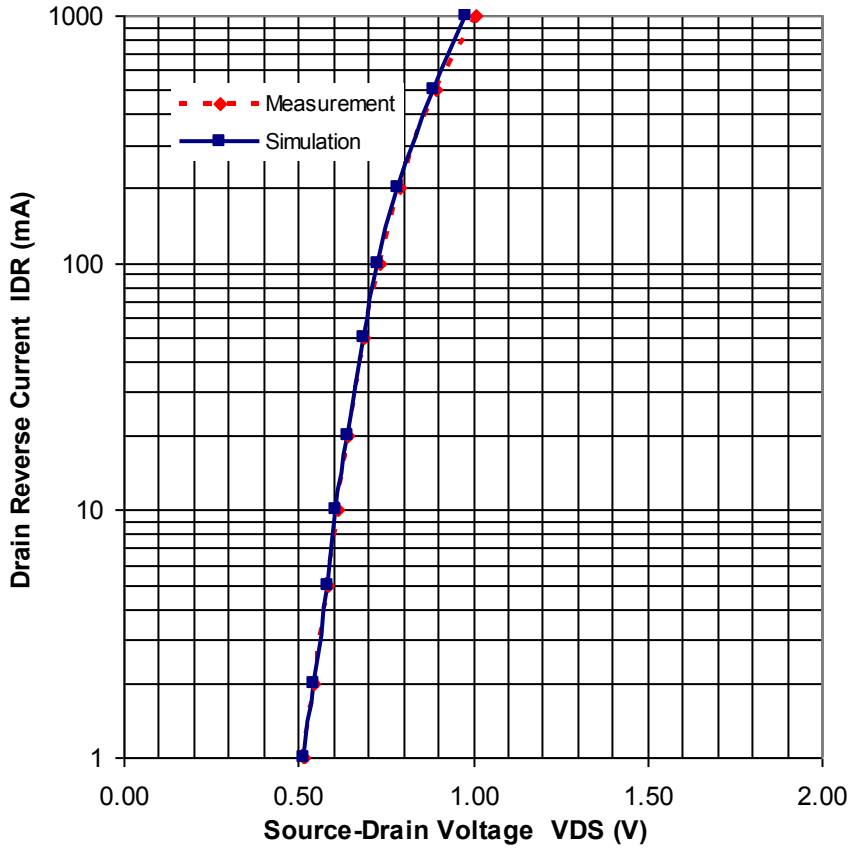


Evaluation Circuit



Comparison Graph

Circuit Simulation Result

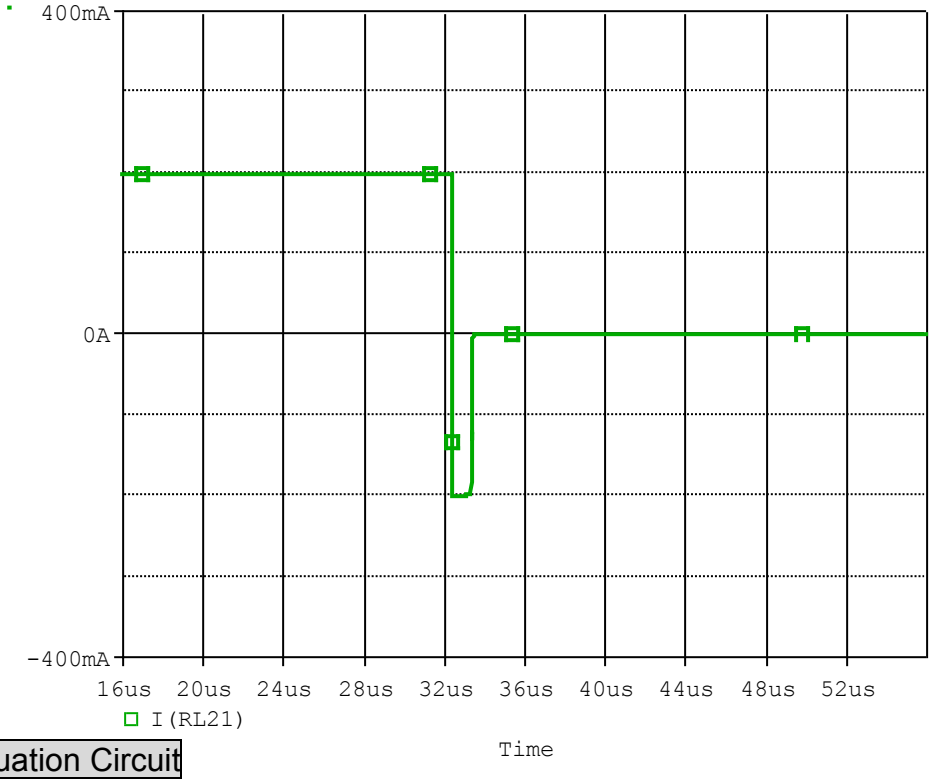


Simulation Result

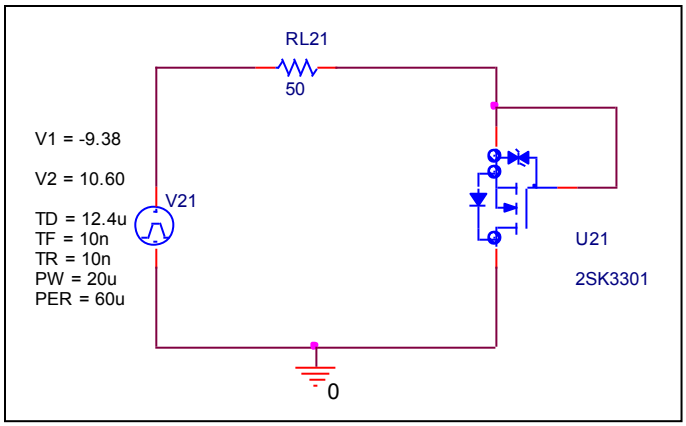
IDR(A)	VDS(V) Measurement	VDS(V) Simulation	%Error
1.000	0.516	0.518	0.388
2.000	0.546	0.545	-0.183
5.000	0.584	0.582	-0.342
10.000	0.612	0.610	-0.327
20.000	0.644	0.640	-0.621
50.000	0.688	0.686	-0.291
100.000	0.734	0.730	-0.545
200.000	0.788	0.786	-0.254
500.000	0.896	0.889	-0.781
1000.000	1.006	0.980	-2.584

Reverse Recovery Characteristic

Circuit Simulation Result



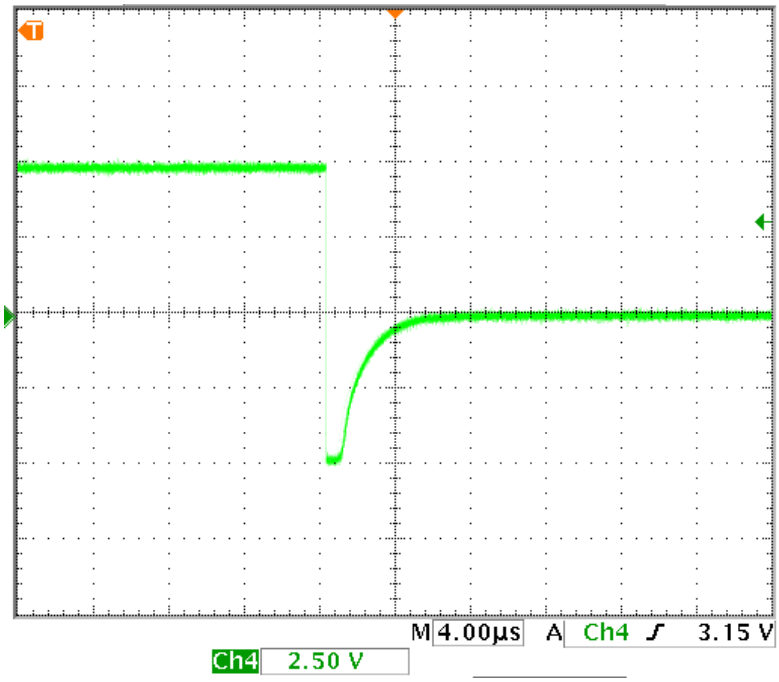
Evaluation Circuit



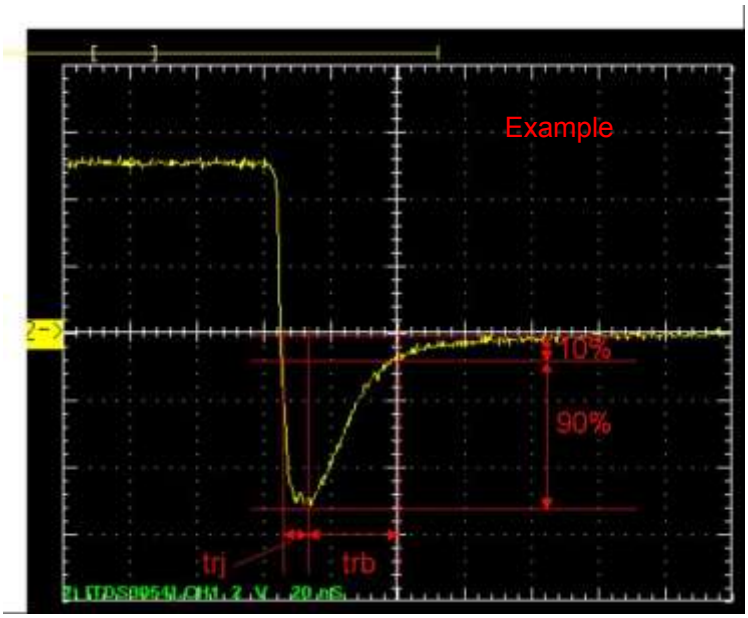
Compare Measurement vs. Simulation

	Measurement		Simulation		Error (%)
trj	0.900	us	0.902	us	0.222
trb	2.800	us	1.049	us	-62.536
trr	3.700	us	1.951	us	-47.270

Reverse Recovery Characteristic Reference



Trj=0.90(us)
Trb=2.8(us)
Conditions:Ifwd=Irev=0.2(A),Rl=50

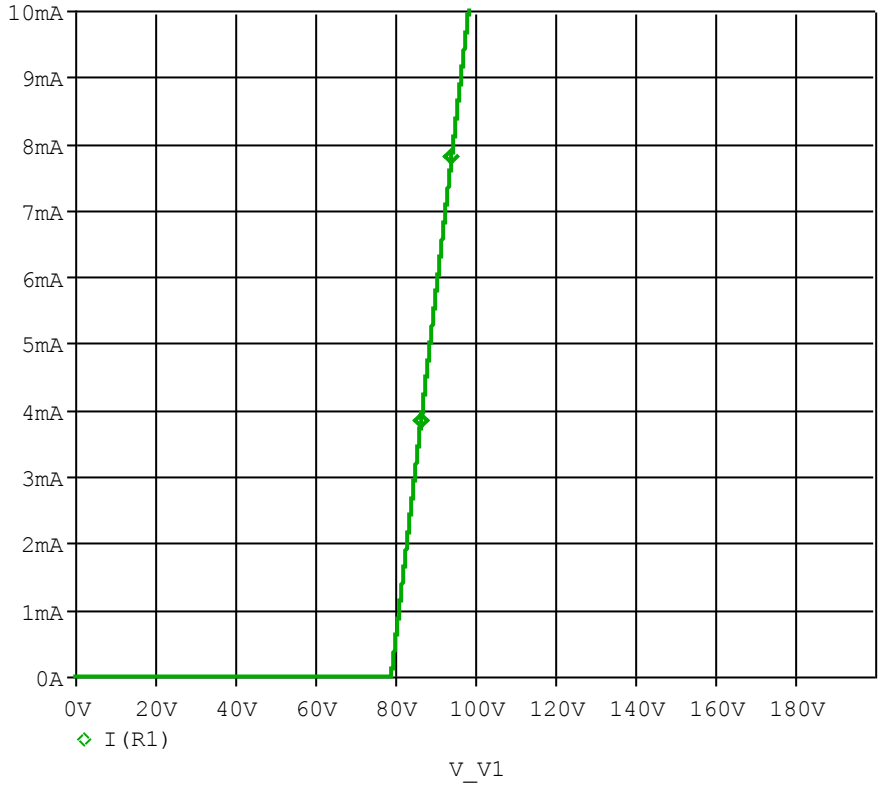


Relation between trj and trb

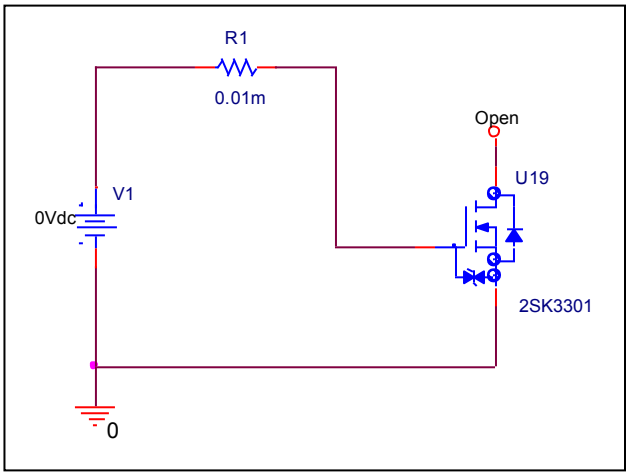
ESD PROTECTION DIODE SPICE MODEL

Zener Voltage Characteristic

Circuit Simulation Result



Evaluation Circuit



Zener Voltage Characteristic Reference