

Device Modeling Report

COMPONENTS: Power MOSFET (Professional)
PART NUMBER: 2SK3799
MANUFACTURER: TOSHIBA
Body Diode (Professional) / ESD Protection Diode



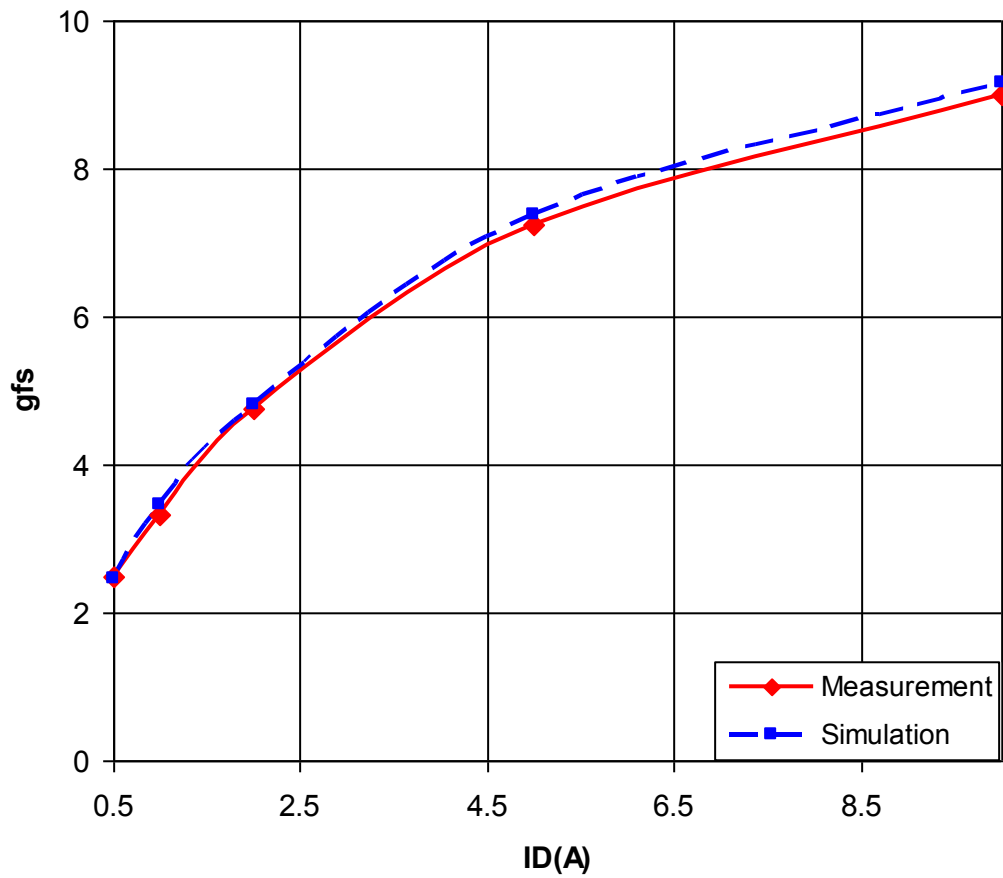
Bee Technologies Inc.

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	Mobility Modulation
KAPPA	Saturation Field Factor
VMAX	Maximum Drift Velocity of Carriers
XJ	Metallurgical Junction Depth
UO	Surface Mobility

Transconductance Characteristic

Circuit Simulation Result

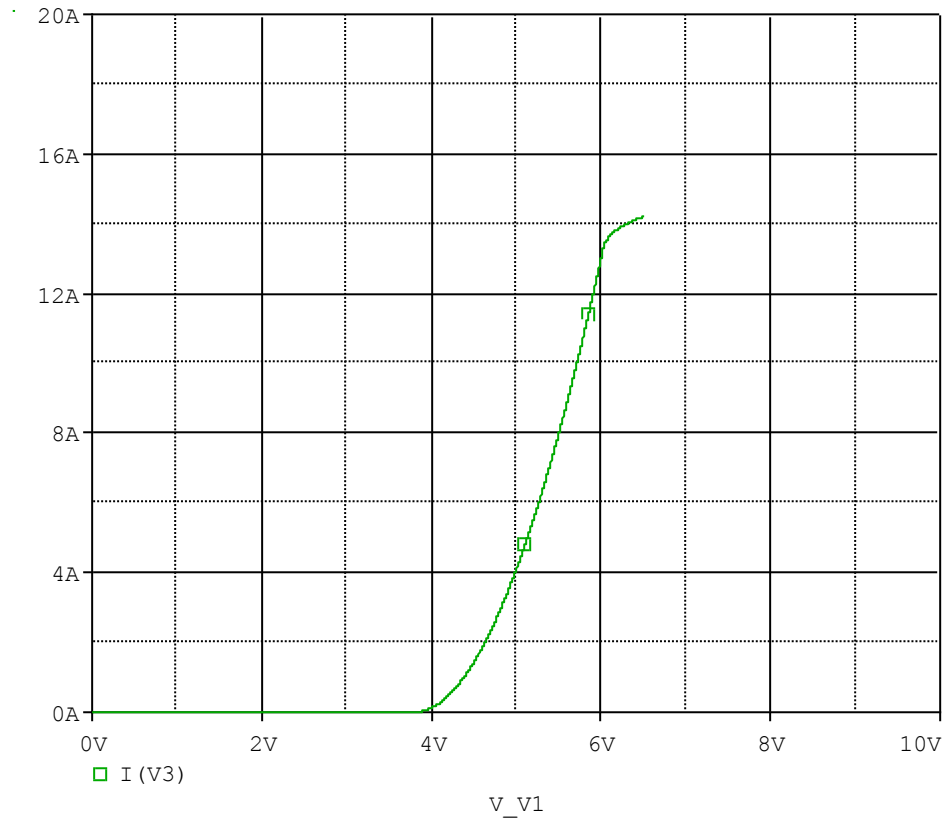


Comparison table

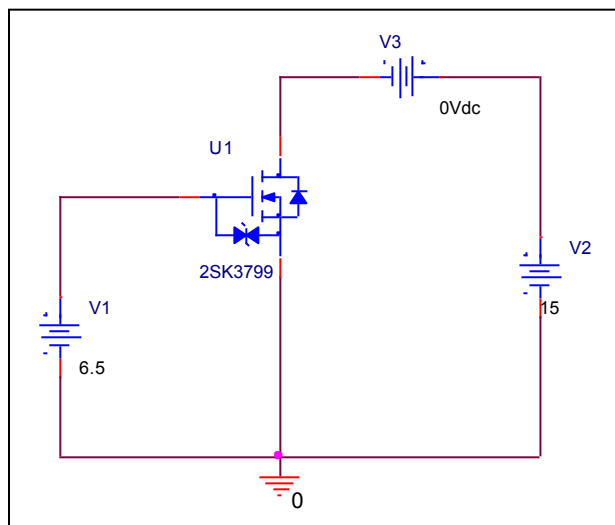
Id(A)	gfs		Error (%)
	Measurement	Simulation	
0.5	2.5	2.463	-1.480
1	3.333	3.448	3.450
2	4.762	4.808	0.966
5	7.246	7.386	1.932
10	8.989	9.164	1.947

V_{gs}-I_d Characteristic

Circuit Simulation result

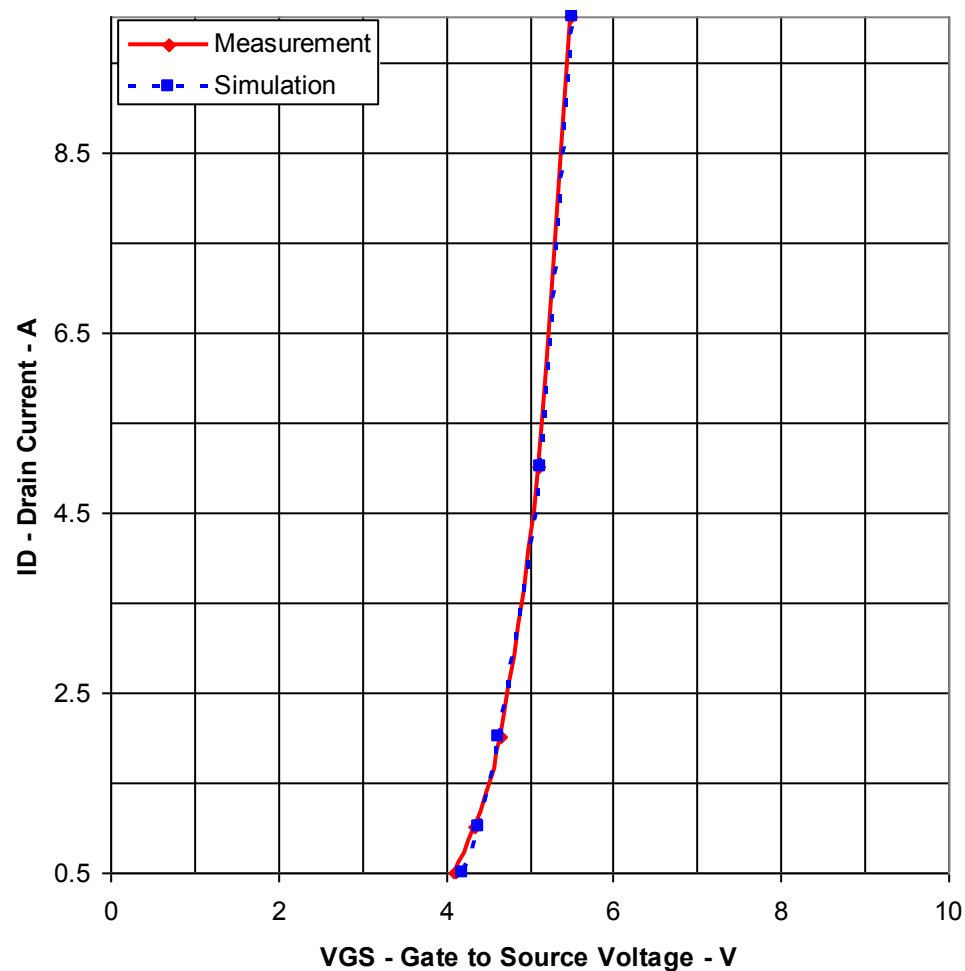


Evaluation circuit



Comparison Graph

Circuit Simulation Result

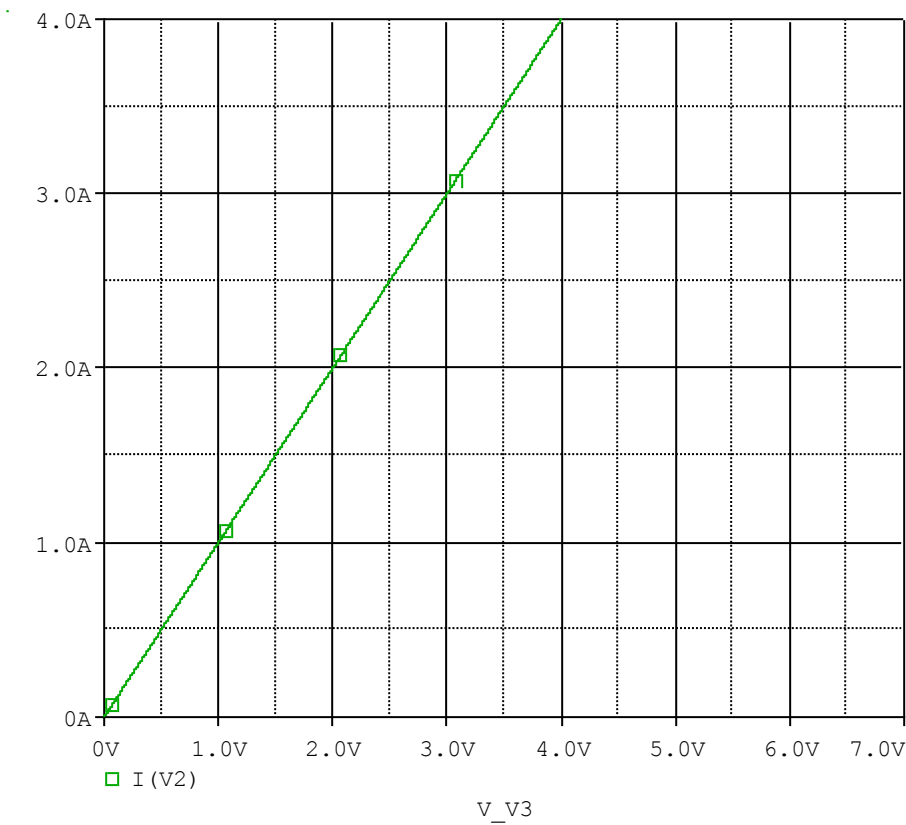


Simulation Result

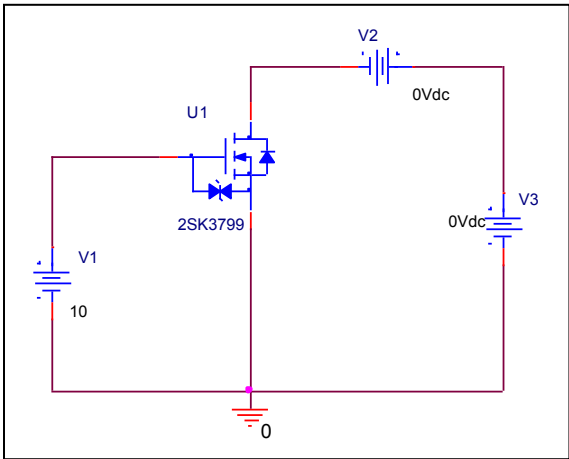
ID(A)	VGS(V)		Error (%)
	Measurement	Simulation	
0.5	4.1	4.2106	2.698
1	4.35	4.3839	0.779
2	4.65	4.6318	-0.391
5	5.1	5.134	0.667
10	5.5	5.5044	0.080

Rds(on) Characteristic

Circuit Simulation result



Evaluation circuit

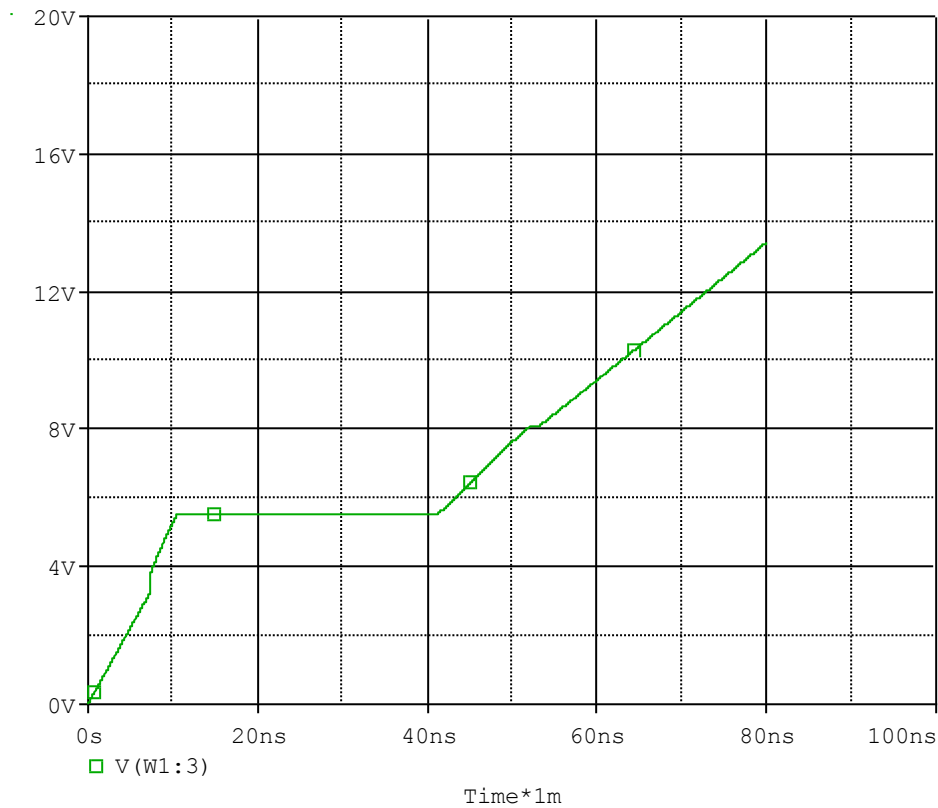


Simulation Result

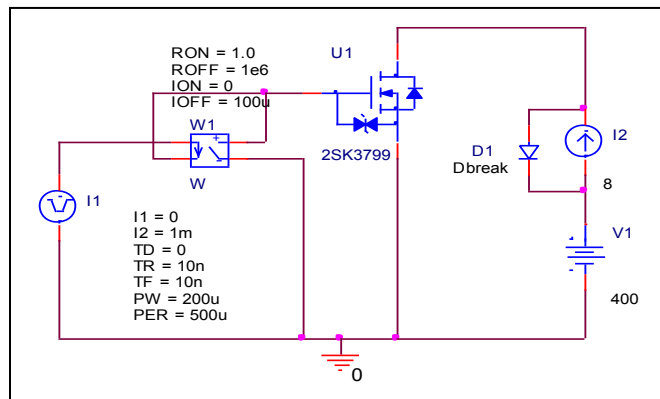
I _D =4A, V _{GS} =10V		Measurement		Simulation		Error (%)
R _{DS} (on)		1	Ω	1	Ω	0

Gate Charge Characteristic

Circuit Simulation result



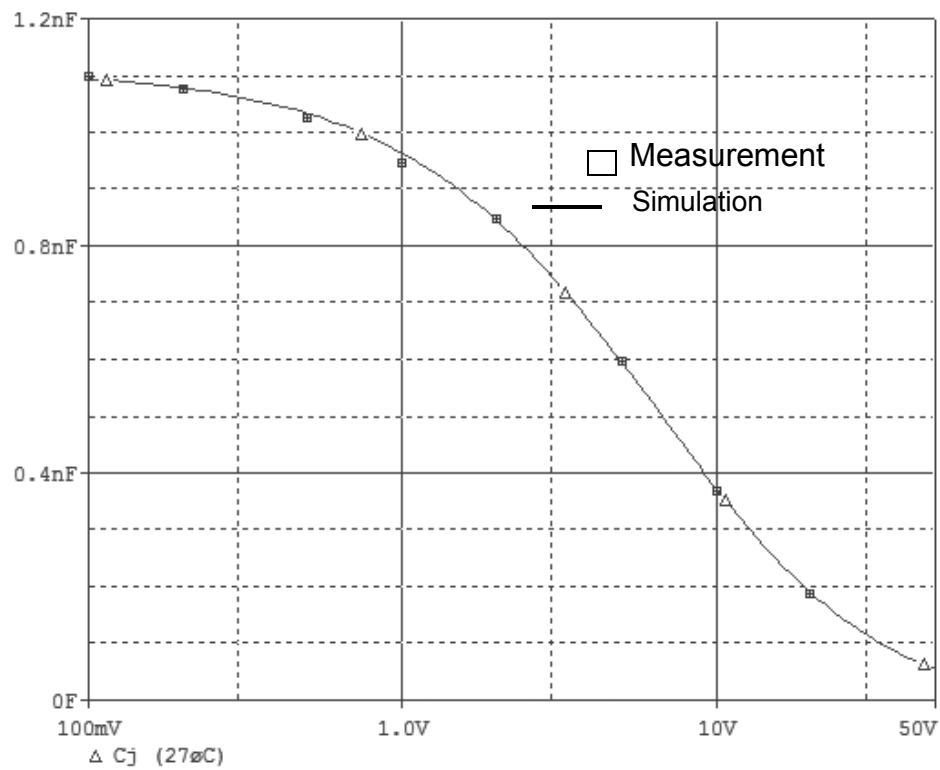
Evaluation circuit



Simulation Result

$V_{DD}=400V, I_D=8A$	Measurement		Simulation		Error (%)
Qgs	11	nC	11.037	nC	0.336
Qgd	29	nC	28.788	nC	-0.731
Qg	62	nC	62.449	nC	0.724

Capacitance Characteristic

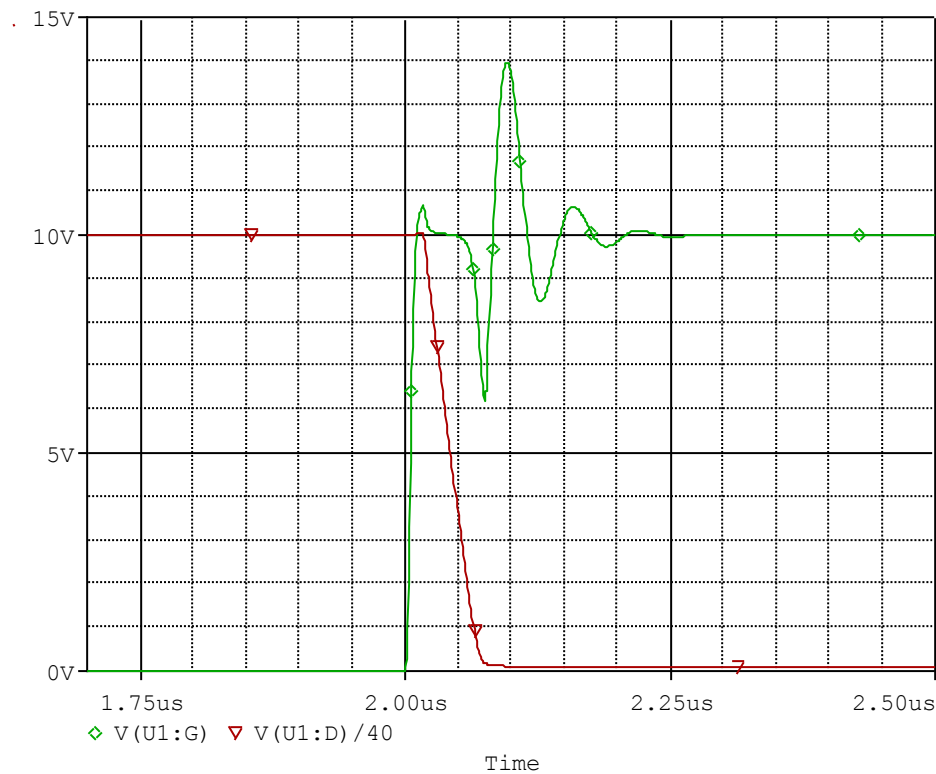


Simulation Result

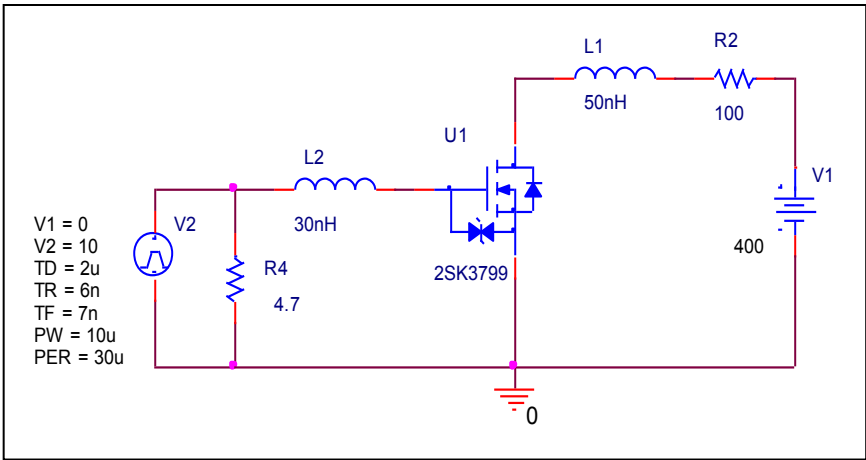
V _{DS} (V)	Cbd(pF)		Error(%)
	Measurement	Simulation	
0.1	1100	1095	-0.455
0.2	1080	1078	-0.185
0.5	1030	1032	0.194
1	950	963	1.368
2	850	845	-0.588
5	600	595	-0.833
10	370	375	1.351
20	190	190	0

Switching Time Characteristic

Circuit Simulation result



Evaluation circuit

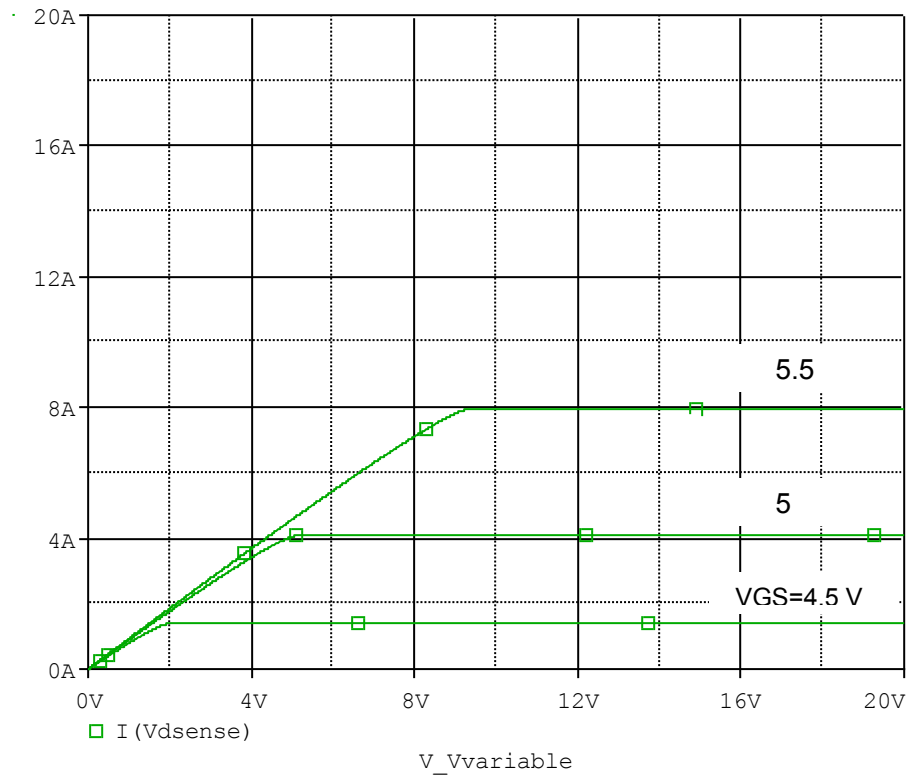


Simulation Result

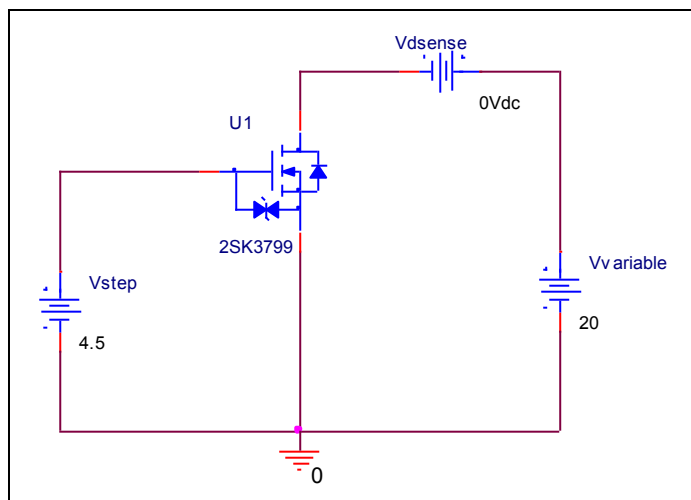
$I_D=4\text{ A}$, $V_{DD}=400\text{ V}$ $V_{GS}=0/10\text{ V}$	Measurement		Simulation		Error(%)
	ton	65.000 ns	65.182 ns	ns	

Output Characteristic

Circuit Simulation result

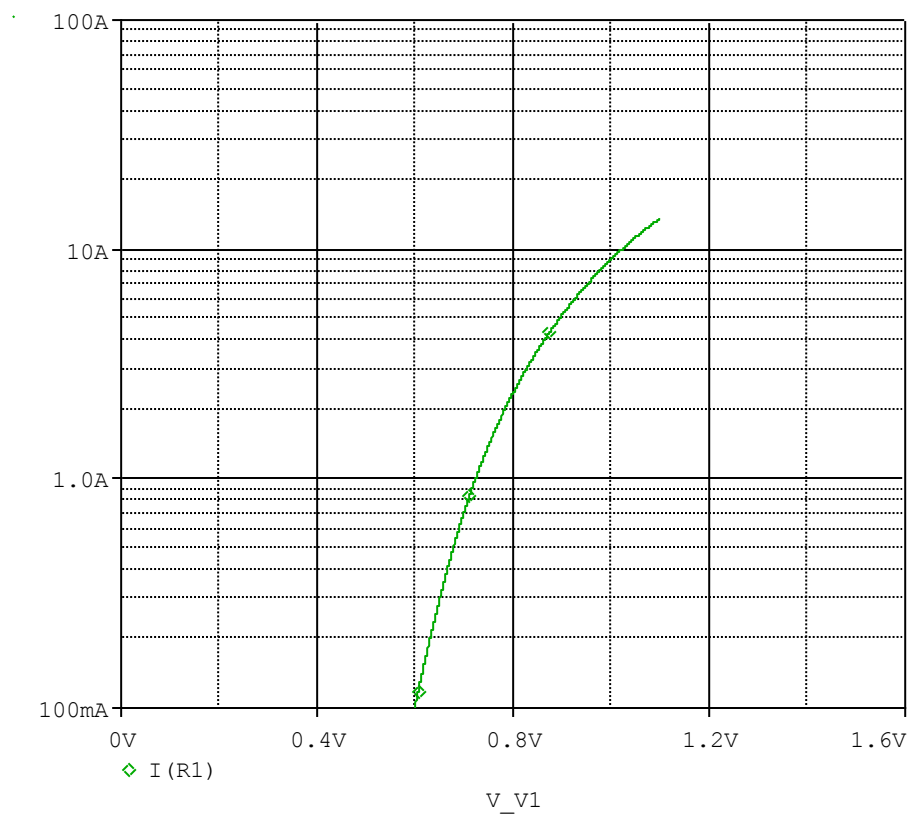


Evaluation circuit

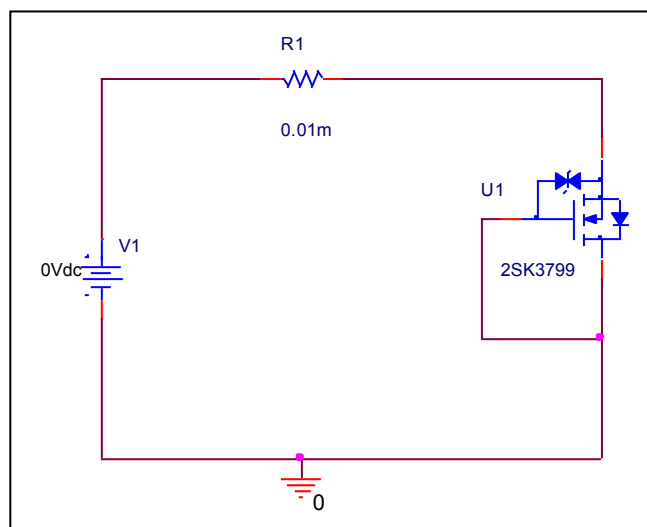


Forward Current Characteristic

Circuit Simulation Result

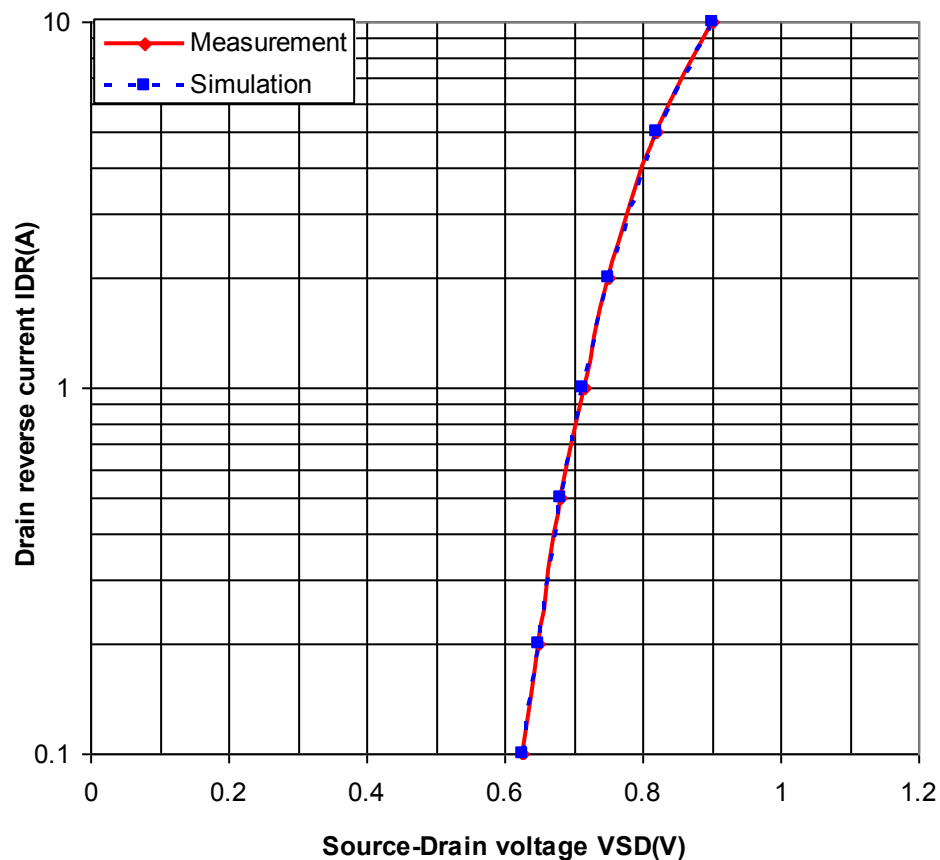


Evaluation Circuit



Comparison Graph

Circuit Simulation Result

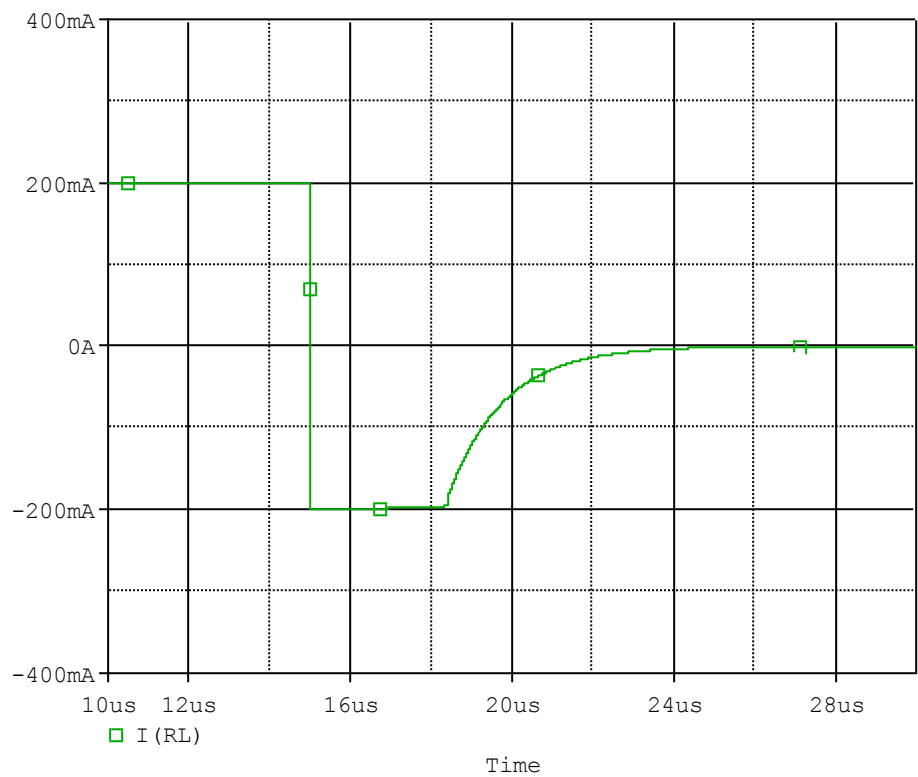


Simulation Result

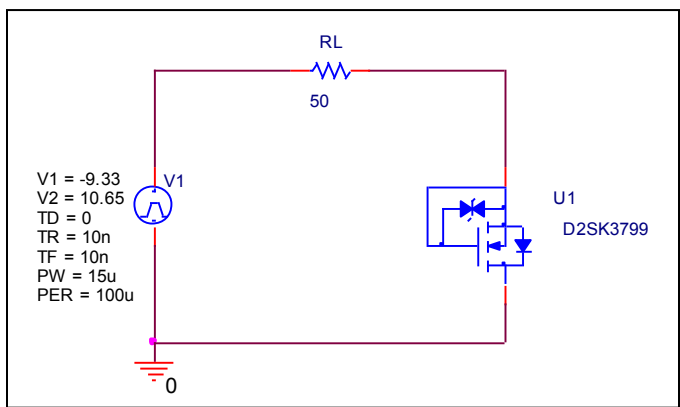
Ifwd(A)	VSD(V)		%Error
	Measurement	Simulation	
0.1	0.6	0.599	-0.167
0.2	0.63	0.63	0
0.5	0.68	0.678	-0.294
1	0.72	0.723	0.417
2	0.78	0.783	0.385
5	0.9	0.895	-0.556
10	1.02	1.022	0.196

Reverse Recovery Characteristic

Circuit Simulation Result



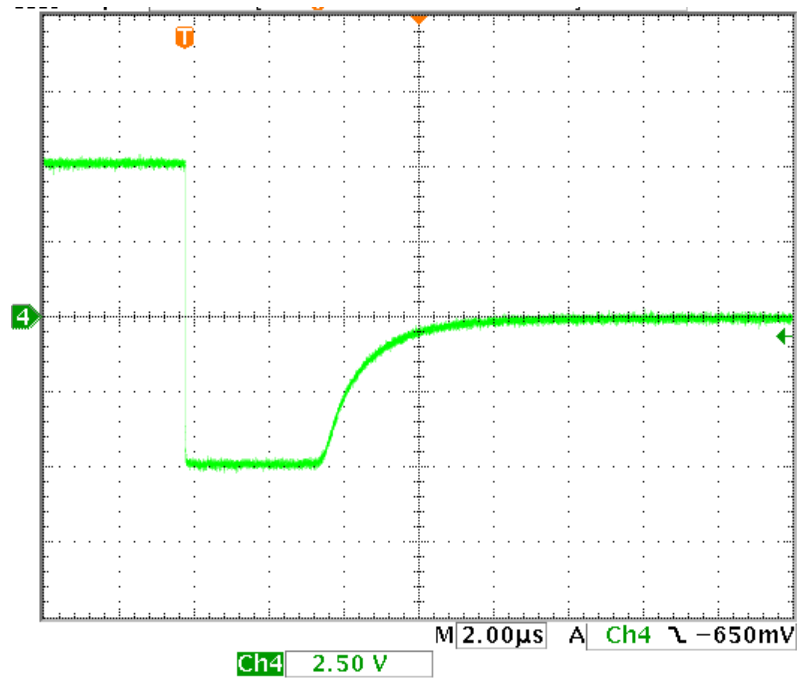
Evaluation Circuit



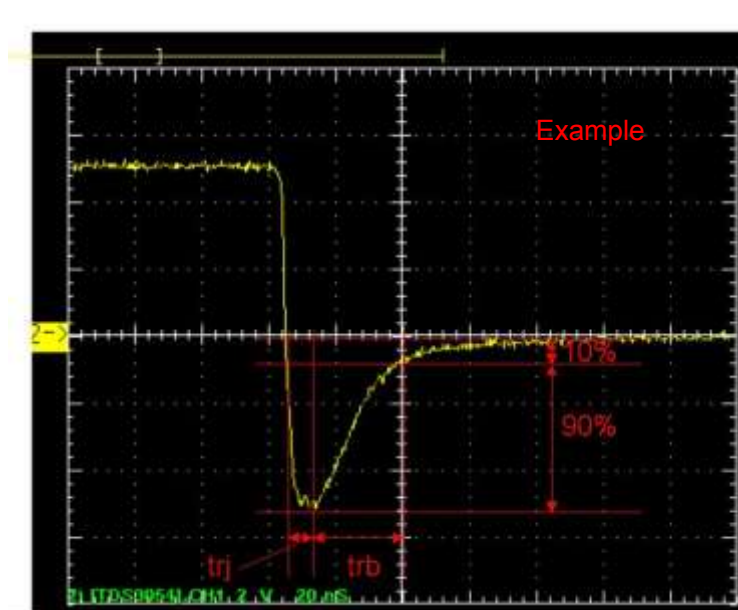
Compare Measurement vs. Simulation

	Measurement	Simulation	Error (%)
Trj(us)	3.32	3.32	0
Trb(us)	3.12	3.139	0.609
Trr(us)	6.44	6.459	0.295

Reference


$$T_{rj}=3.32(\mu s)$$
$$T_{rb} = 3.12(\mu s)$$

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

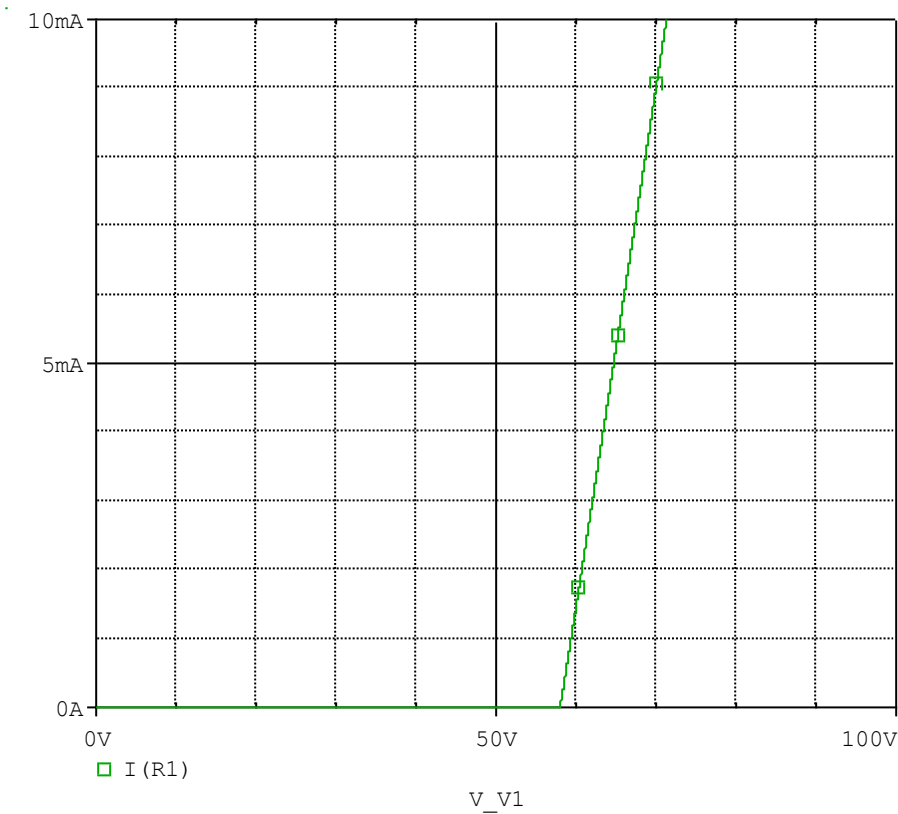


Relation between trj and trb

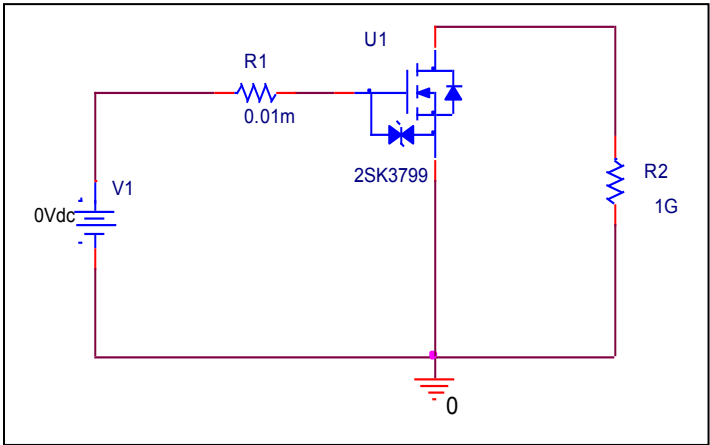
ESD PROTECTION DIODE

Zener Voltage Characteristic

Circuit Simulation Result



Evaluation Circuit



Zener Voltage Characteristic

Reference

