Device Modeling Report

COMPONENTS: Power MOSFET (Professional Model)
PART NUMBER: 2SK2412
MANUFACTURER: NEC
REMARK: N Channel Model
Body Diode (Professional Model) / ESD Protection Diode

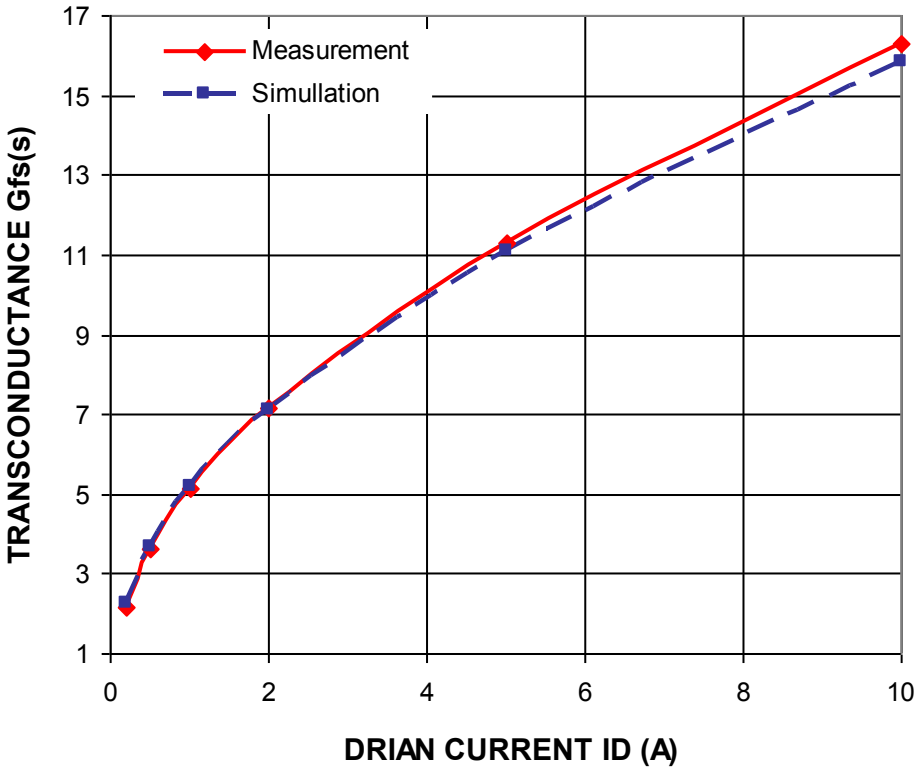
Bee Technologies Inc.

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 Characteristics

Circuit Simulation Result

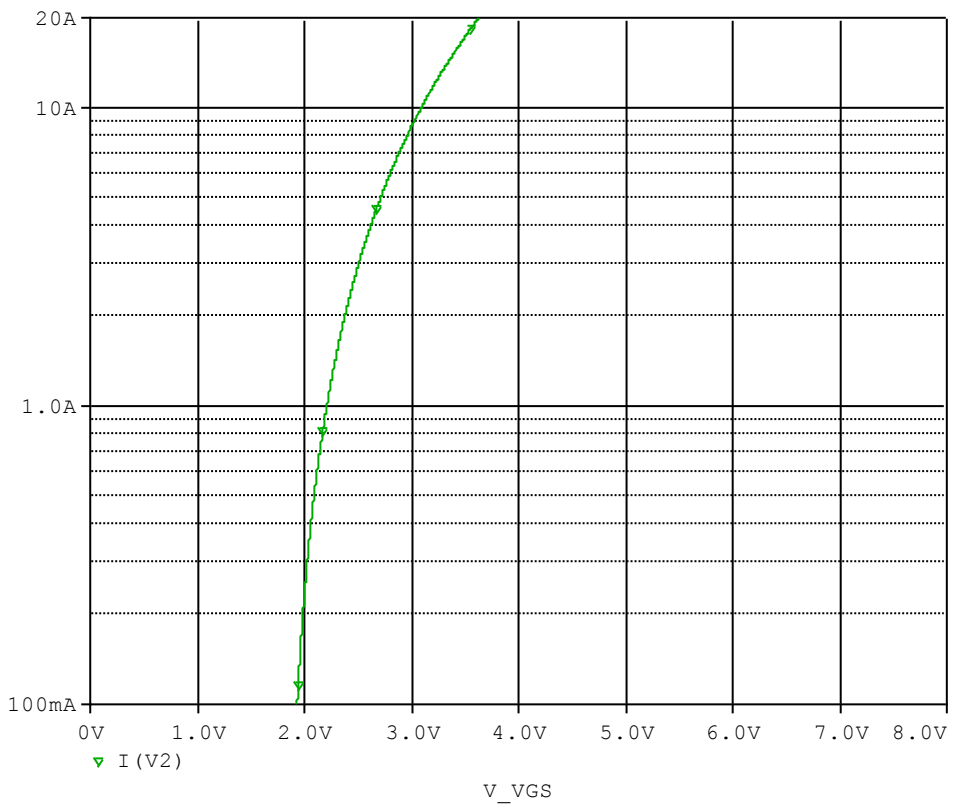


Comparison table

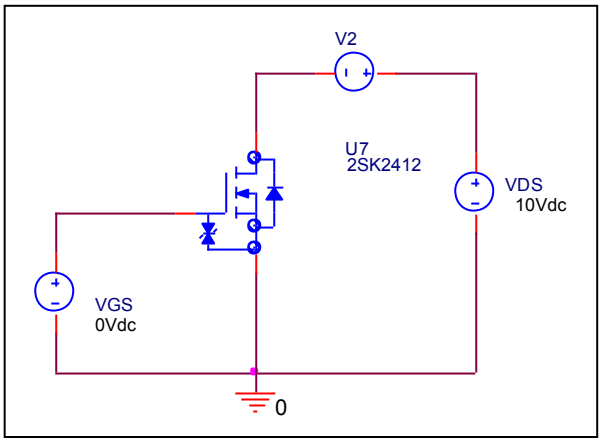
Id(A)	gfs(s)		Error(%)
	Measurement	Simulation	
0.2	2.174	2.240	3.040
0.5	3.650	3.700	1.380
1	5.155	5.200	0.880
2	7.180	7.092	-1.223
5	11.300	11.111	-1.672
10	16.300	15.823	-2.928

Vgs-Id Characteristics

Circuit Simulation Result

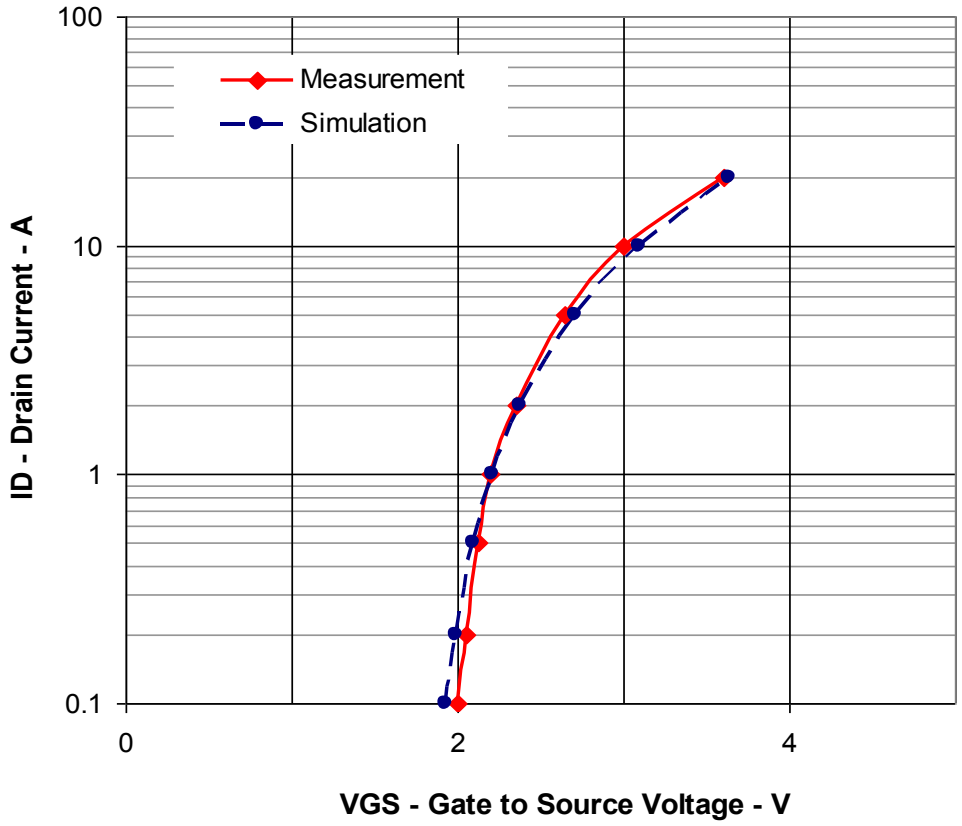


Evaluation circuit



Comparison Graph

Circuit Simulation Result

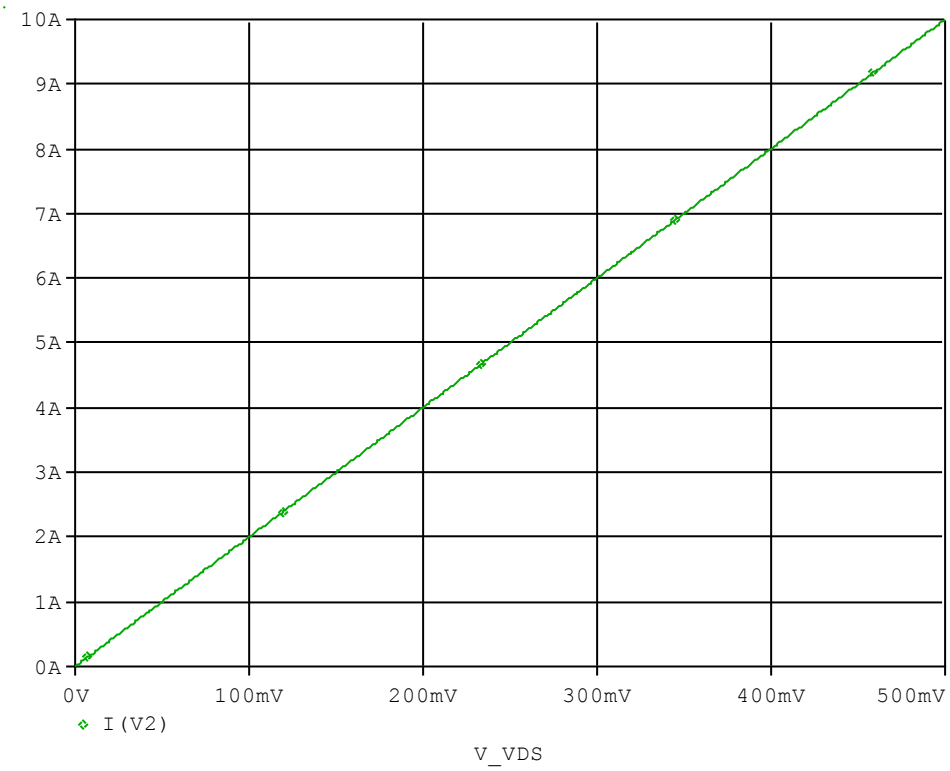


Comparison table

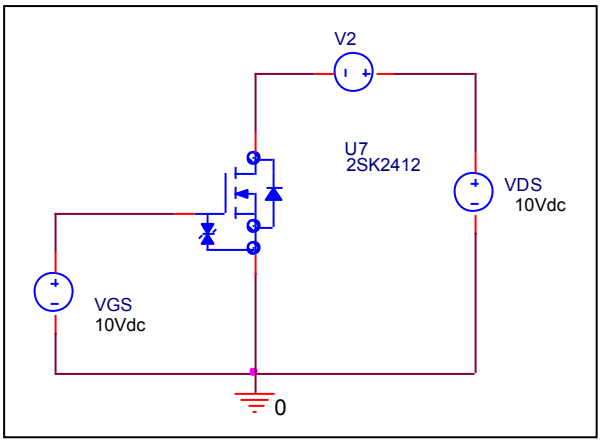
I_D(A)	V_{GS}(V)		Error (%)
	Measurement	Simulation	
0.1	2.000	1.932	-3.390
0.2	2.050	1.985	-3.171
0.5	2.120	2.091	-1.382
1	2.200	2.210	0.436
2	2.350	2.378	1.196
5	2.650	2.713	2.389
10	3.000	3.093	3.093
20	3.600	3.632	0.900

*Rds(on) Characteristic

Circuit Simulation result



Evaluation circuit

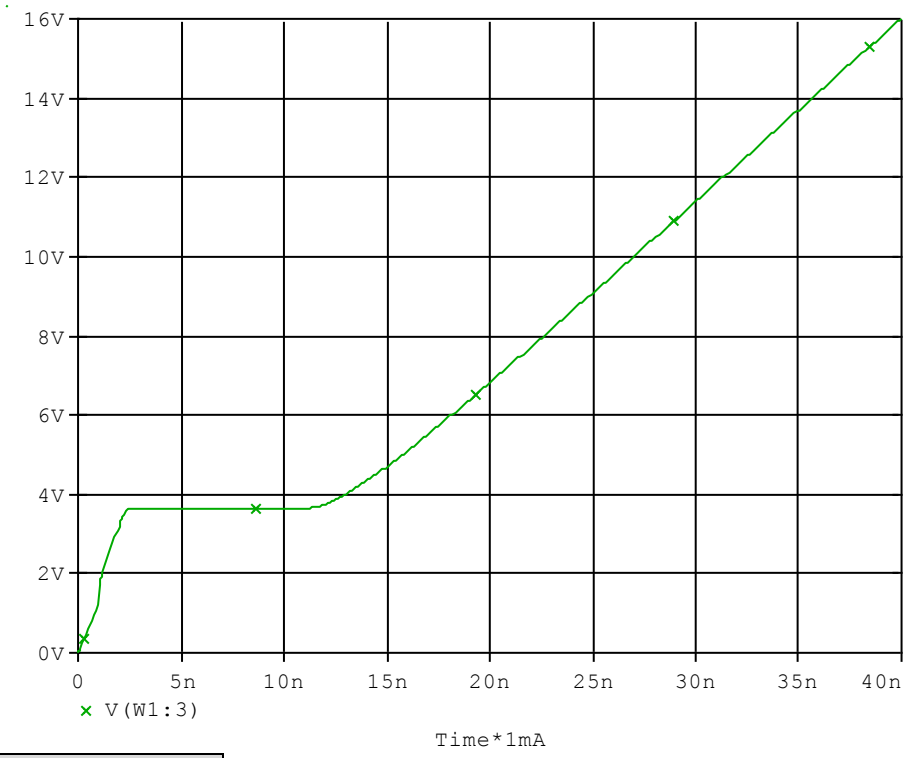


Simulation Result

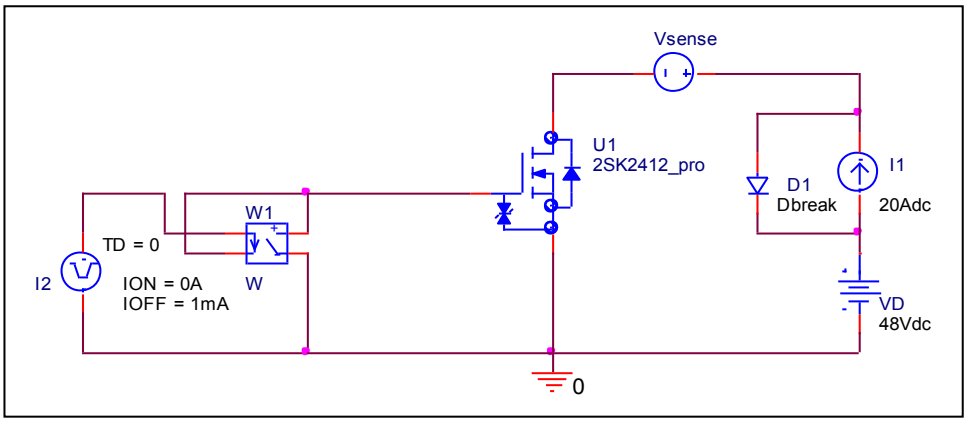
I_D=10, V_{GS}=10V	Measurement		Simulation		Error (%)
R_{DS} (on)	50	mΩ	50	mΩ	0.00

Gate Charge Characteristic

Circuit Simulation result



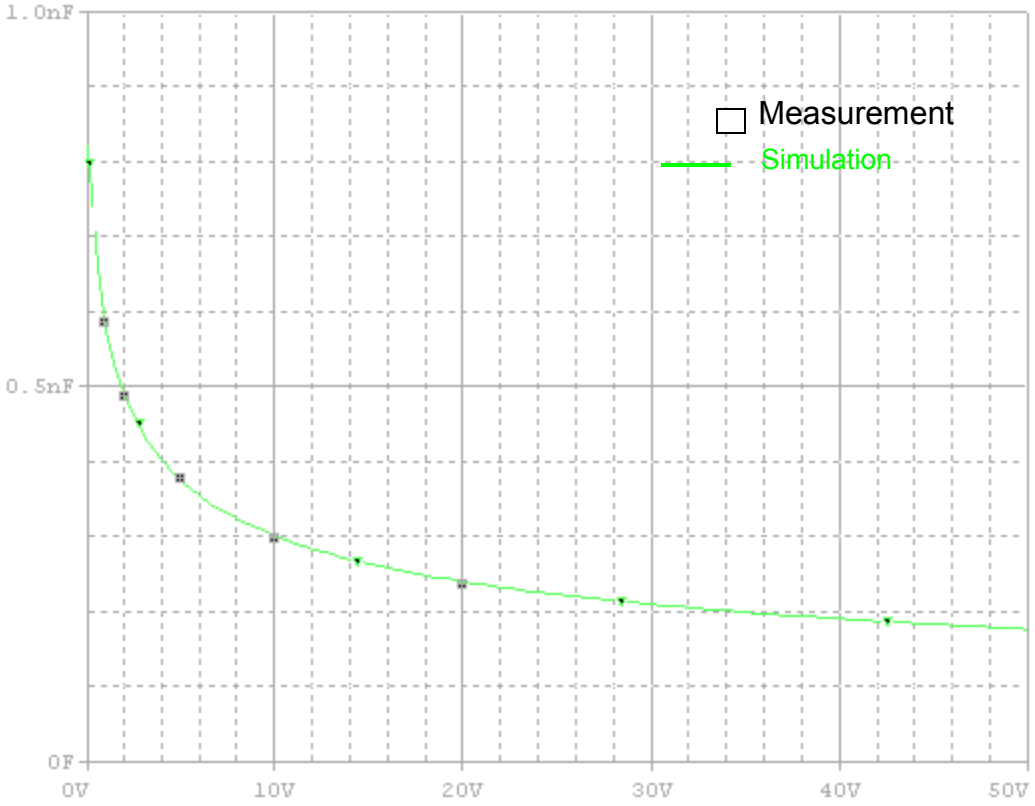
Evaluation circuit



Simulation Result

V_{DD}=48V,I_D=20A ,V_{GS}=10V		Measurement	Simulation	Error (%)
Qgs	nC	2.70	2.62	-2.96
Qgd	nC	8.90	8.96	0.67
Qg	nC	27.00	27.03	0.11

Capacitance Characteristic

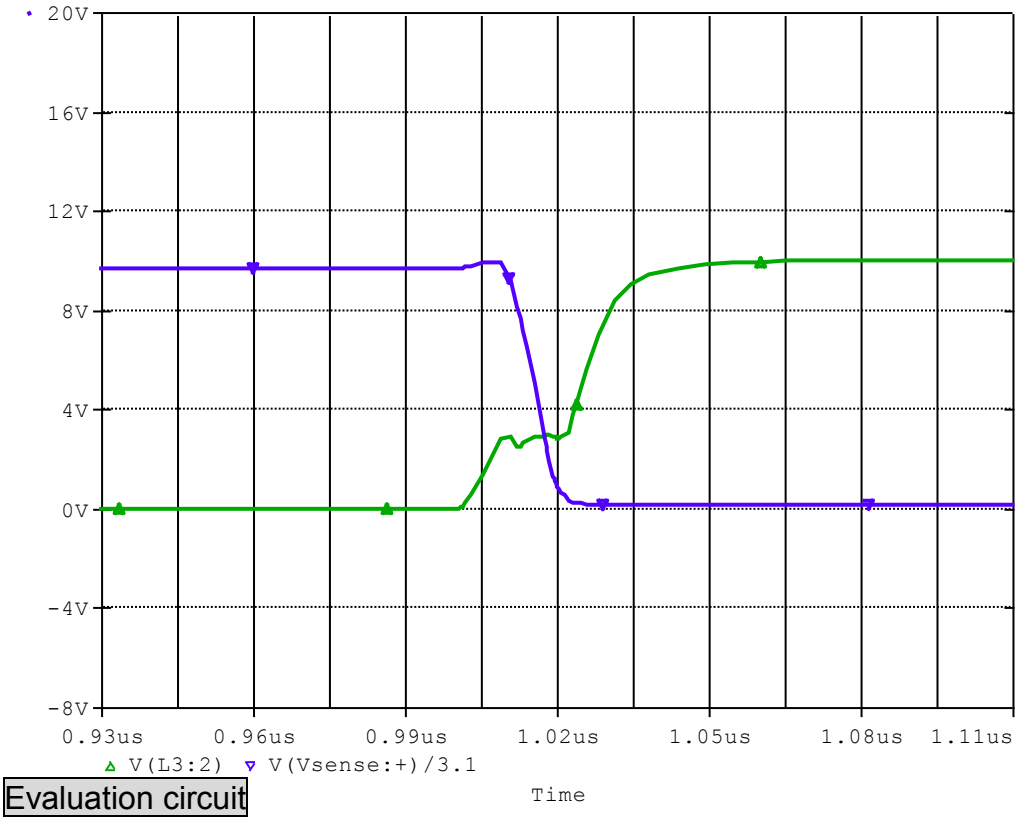


Simulation Result

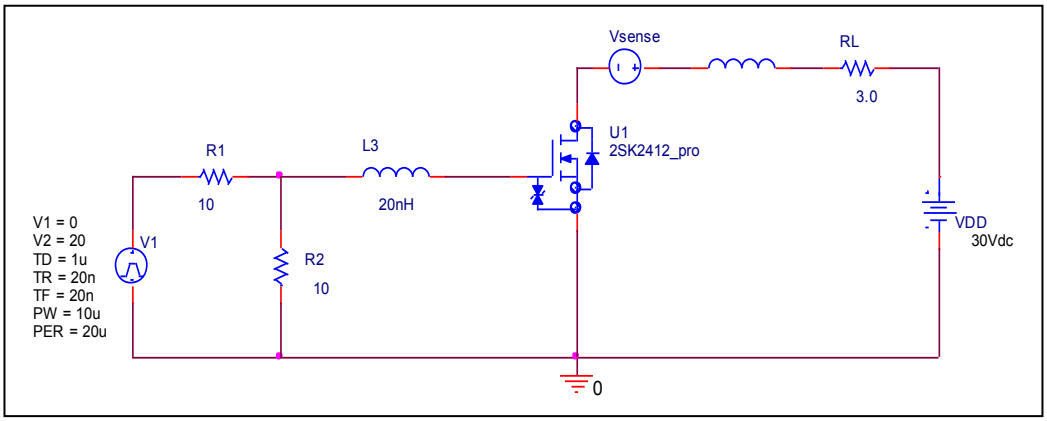
V_{DS}(V)	Cbd(pF)		Error(%)
	Measurement	Simulation	
1	590.000	588.500	-0.2542
2	490.000	489.200	-0.1633
5	380.000	381.224	0.3221
10	300.000	299.250	-0.2500
20	240.000	230.995	-3.7521

Switching Time Characteristic

Circuit Simulation result



Evaluation circuit

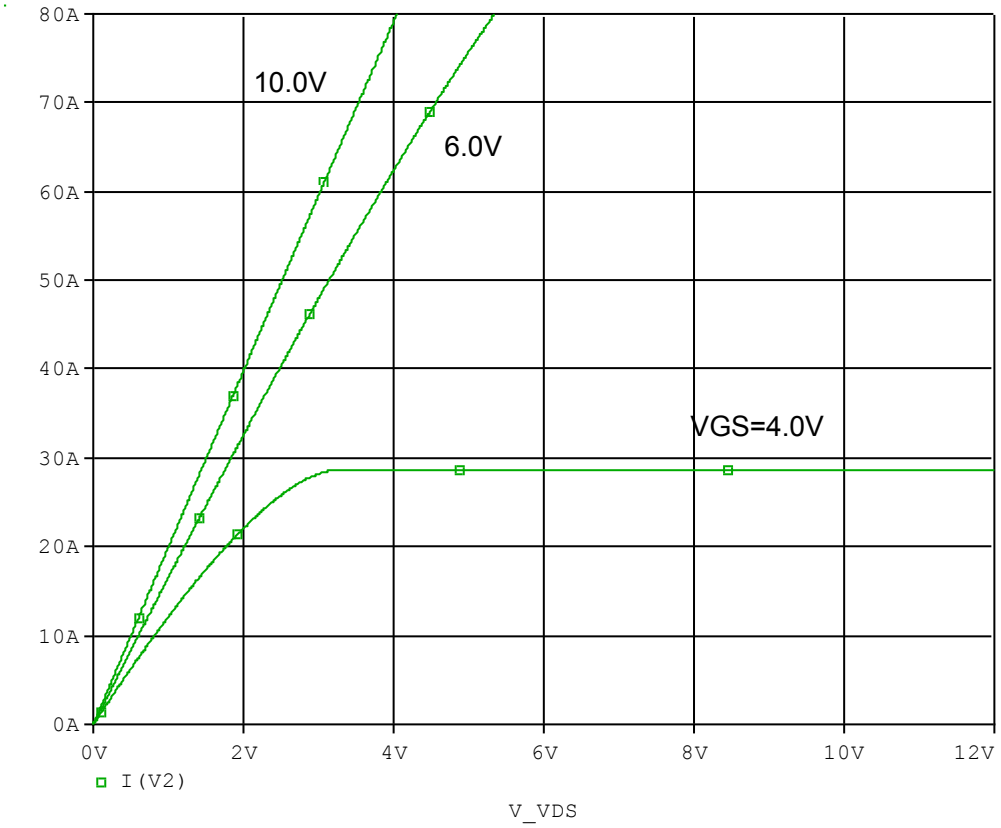


Simulation Result

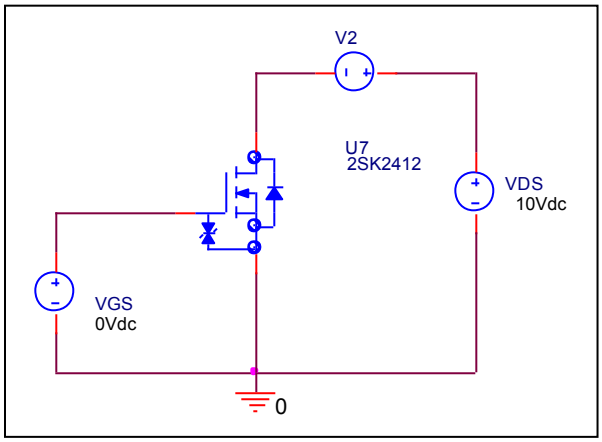
I_D=10A, V_{DD}=30V V_{GS}=0/10V		Measurement	Simulation	Error(%)
td(on)	ns	15.000	14.987	-0.087

Output Characteristic

Circuit Simulation result

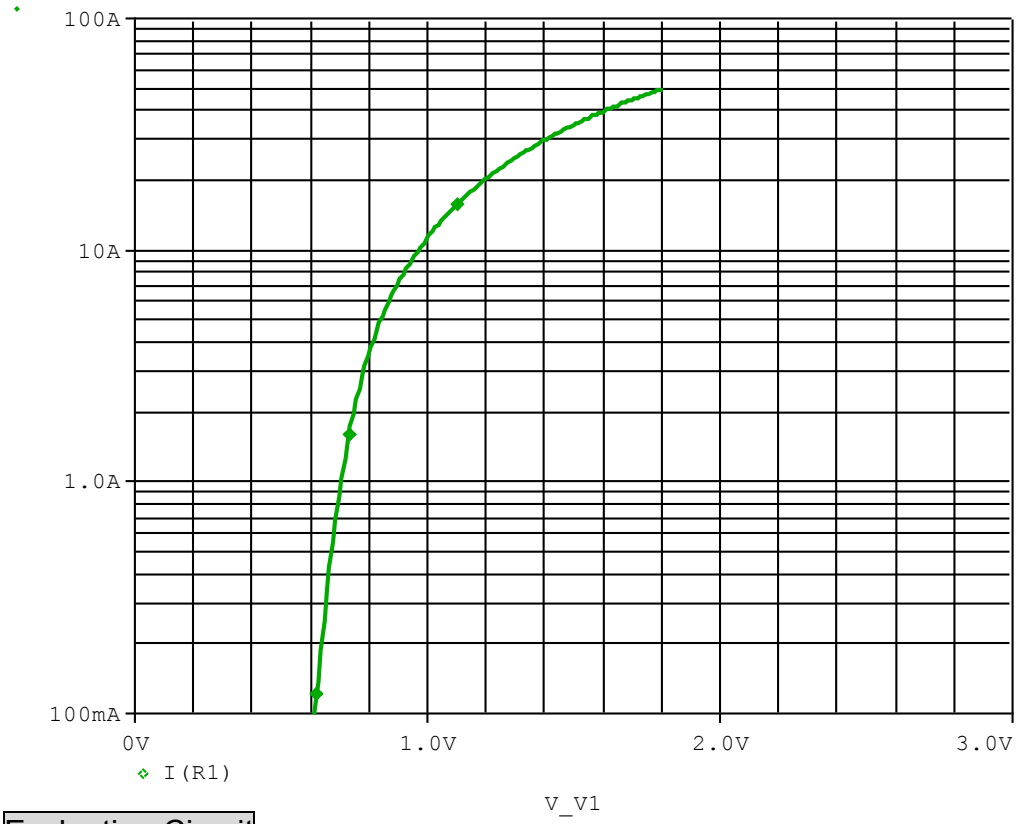


Evaluation circuit

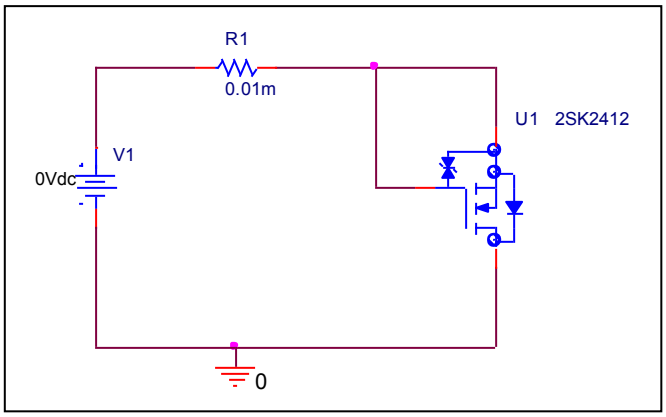


BODY DIODE SPICE MODEL
Forward Current Characteristic

Circuit Simulation Result

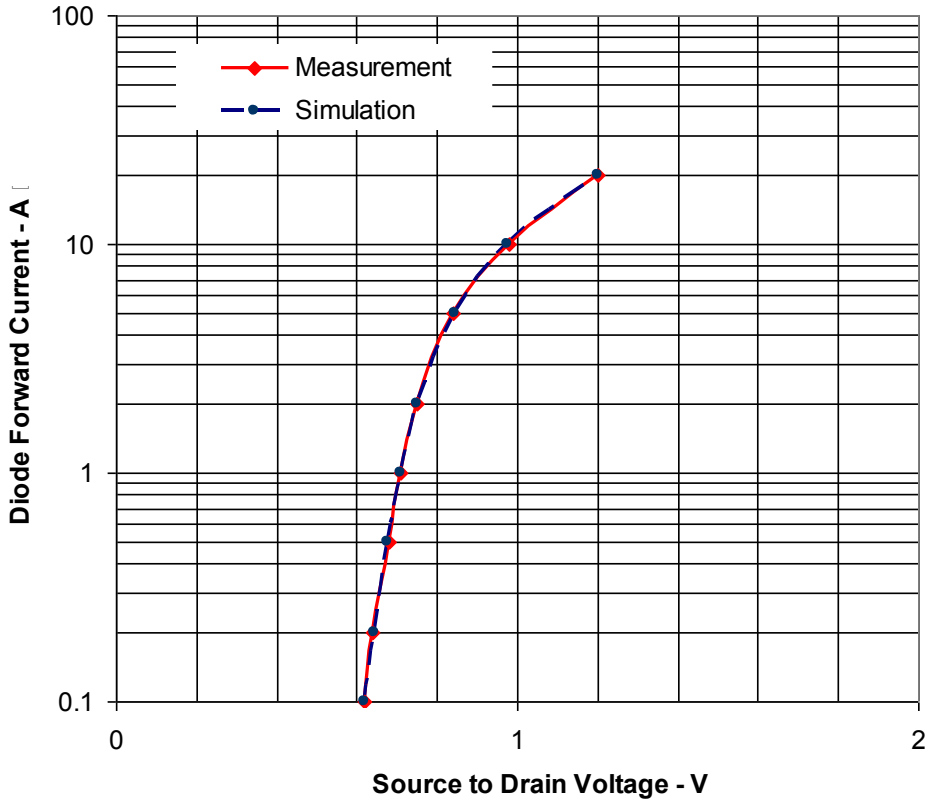


Evaluation Circuit



Comparison Graph

Circuit Simulation Result

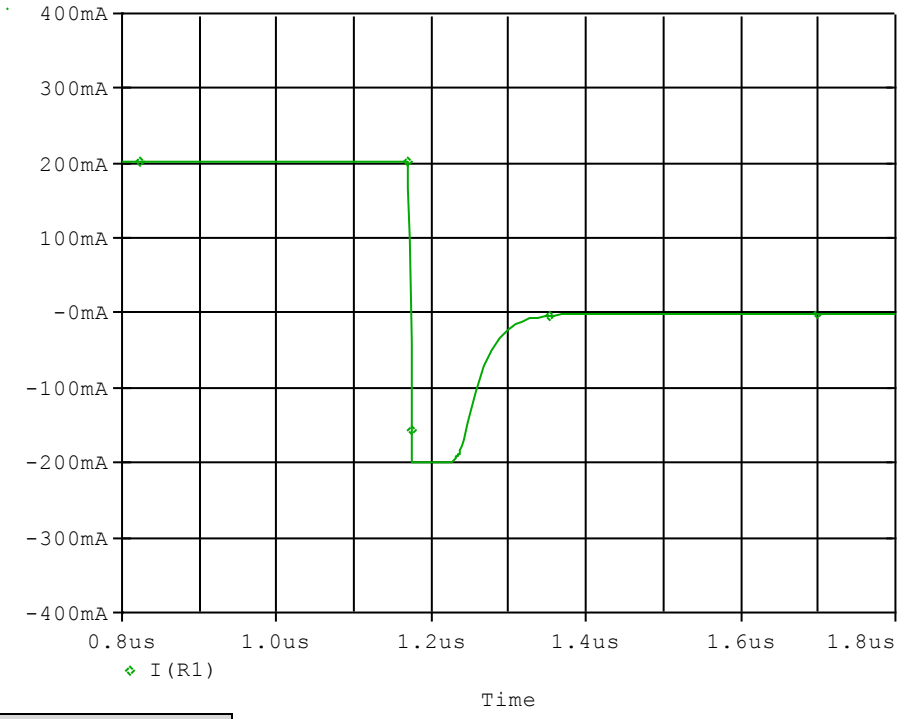


Simulation Result

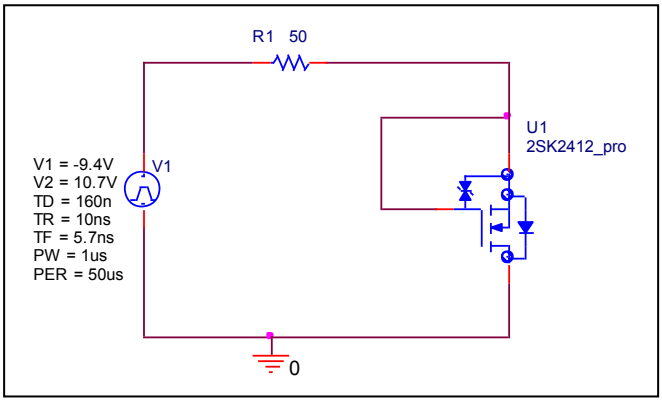
IDR(A)	VDS(V)		%Error
	Measurement	Simulation	
0.1	0.620	0.620	-0.032
0.2	0.640	0.642	0.359
0.5	0.680	0.676	-0.574
1	0.710	0.708	-0.268
2	0.750	0.751	0.173
5	0.840	0.846	0.679
10	0.980	0.975	-0.561
20	1.200	1.202	0.125

Reverse Recovery Characteristic

Circuit Simulation Result



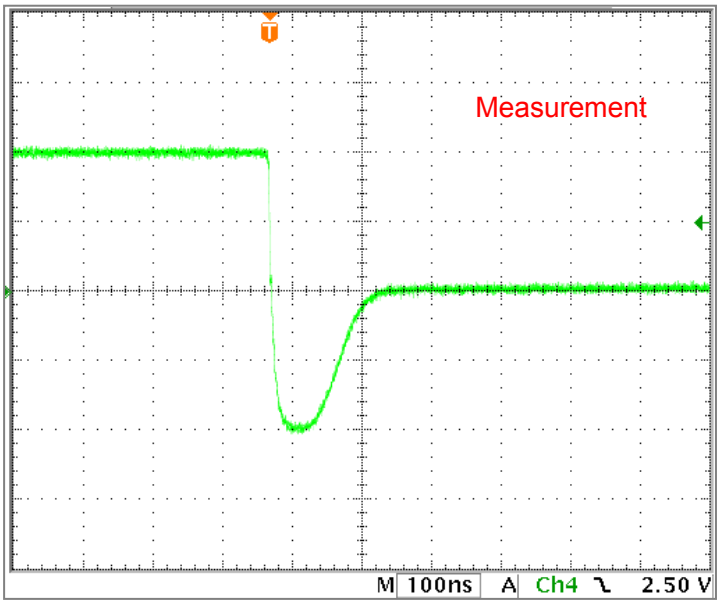
Evaluation Circuit



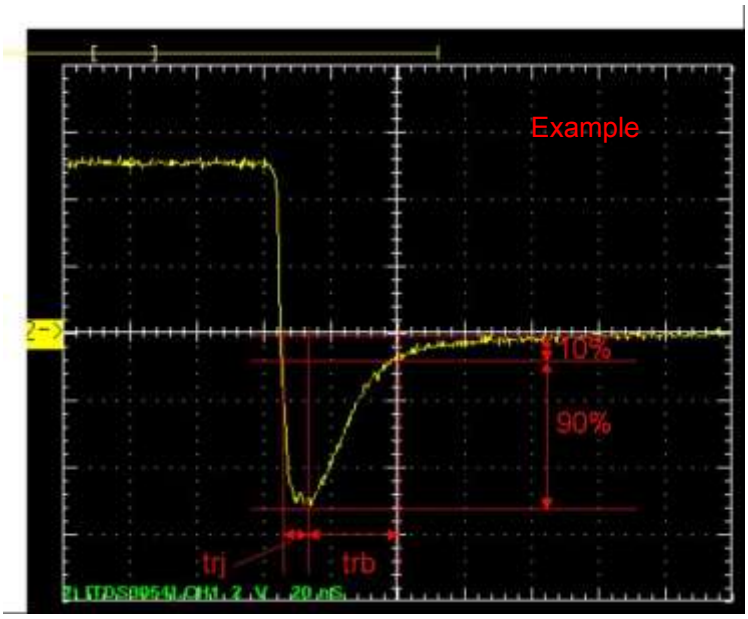
Compare Measurement vs. Simulation

		Measurement	Simulation	Error (%)
trj	**ns**	**60.10**	**59.63**	**-0.79**
trb	**ns**	**69.70**	**69.66**	**-0.06**
trr	**ns**	**129.80**	**129.28**	**-0.40**

Reverse Recovery Characteristic Reference



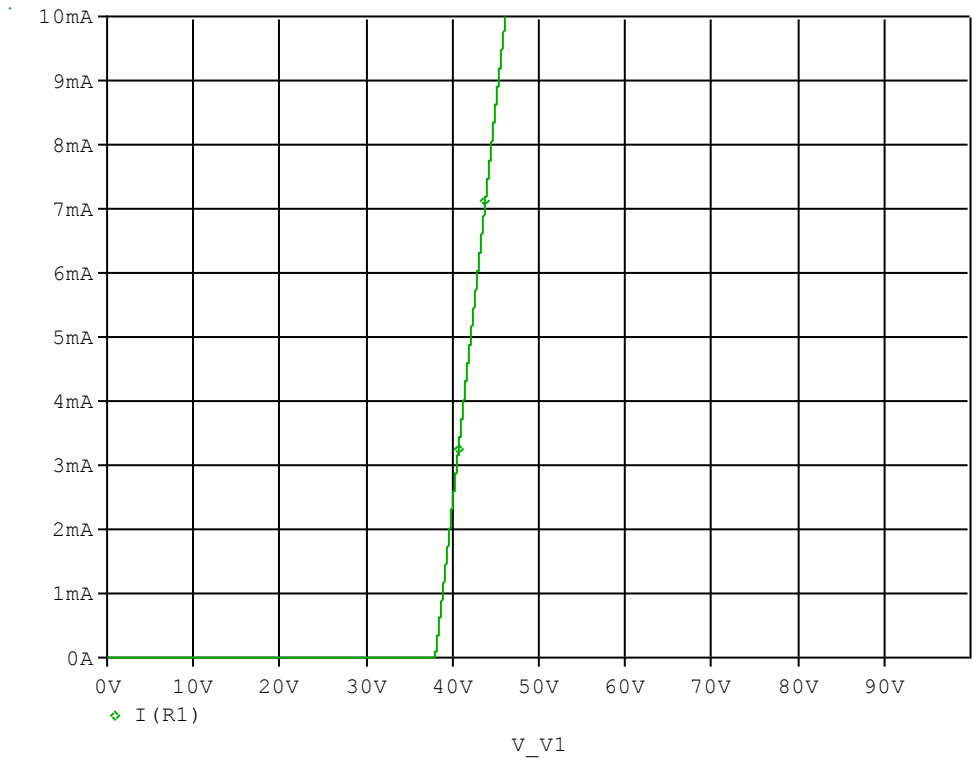
Trj=60.10(ns)
Trb=69.70(ns)
Conditions:Ifwd=Irev=0.2(A),Rl=50



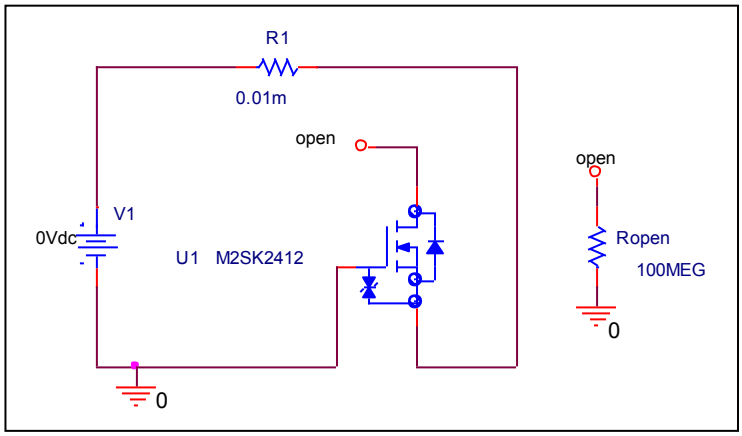
Relation between trj and trb

ESD PROTECTION DIODE SPICE MODEL
Zener Voltage Characteristic

Circuit Simulation Result



Evaluation Circuit



Zener Voltage Characteristic Reference