

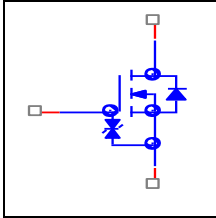
Device Modeling Report

COMPONENTS: Power MOSFET (Model Parameter)
PART NUMBER: 2SK2461
MANUFACTURER: NEC
Body Diode (Model Parameter) / ESD Protection Diode



Bee Technologies Inc.

Circuit Configuration

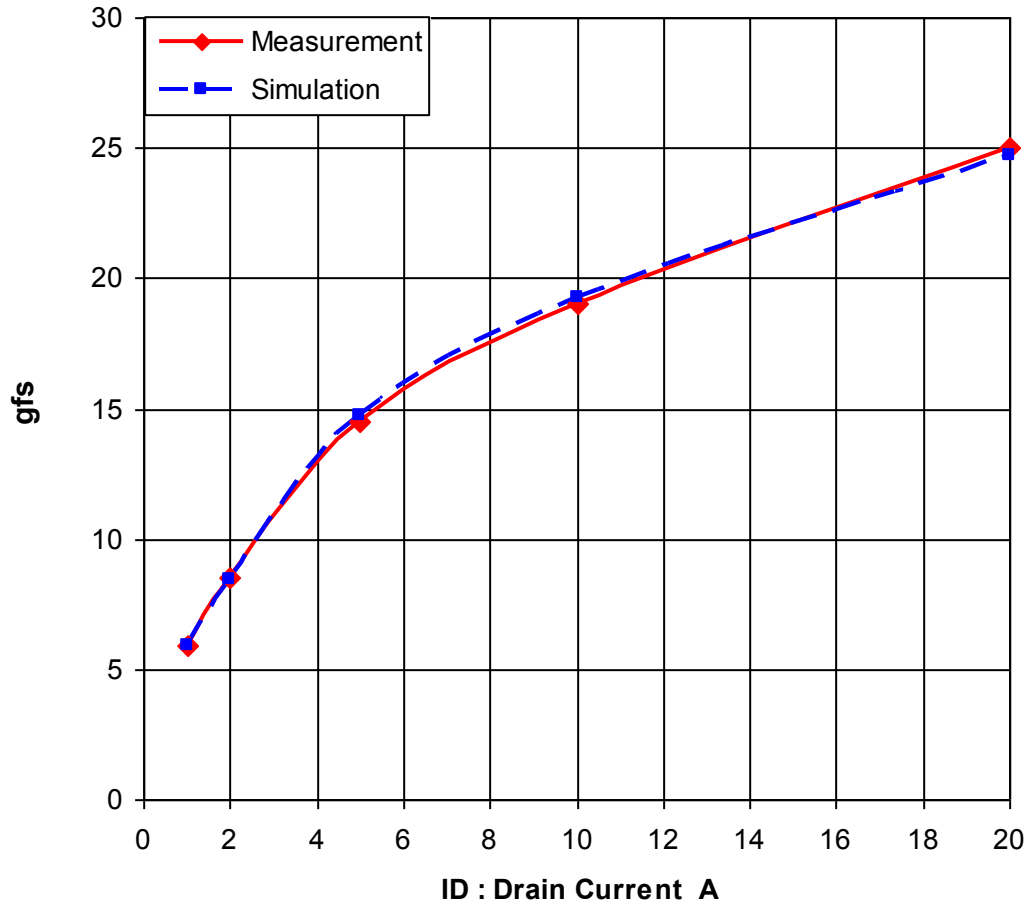


MOSFET MODEL

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

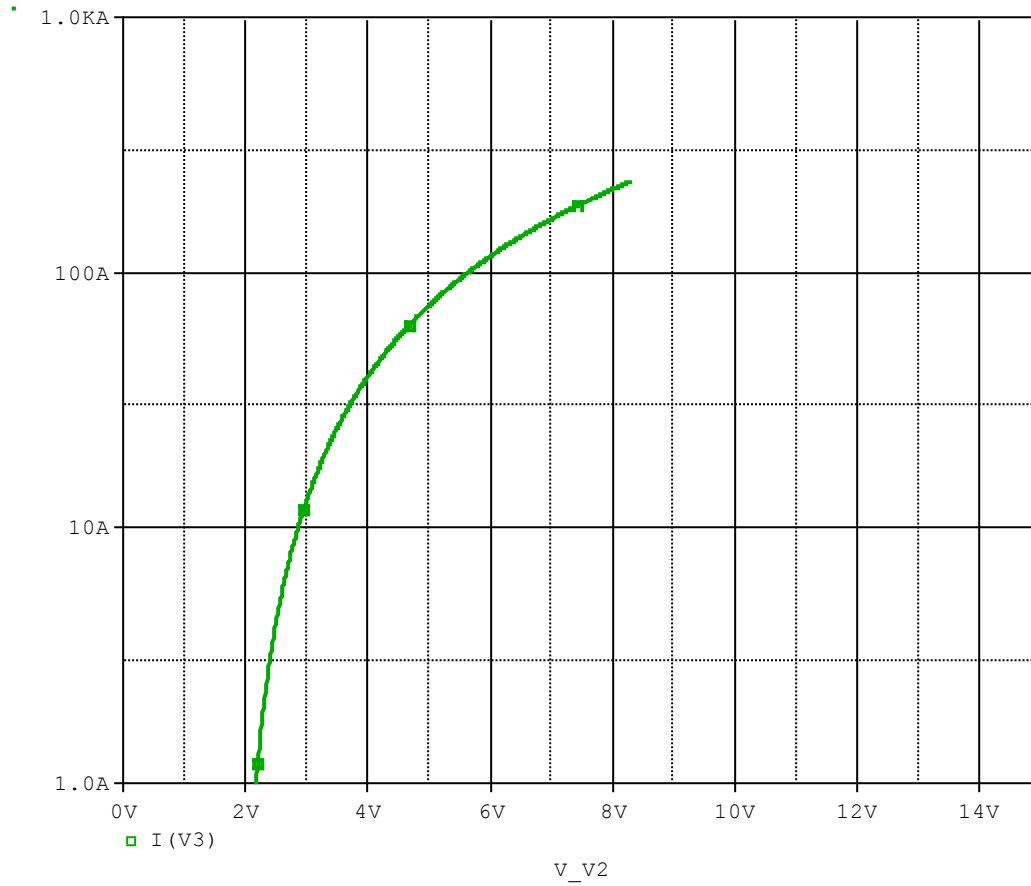


Comparison table

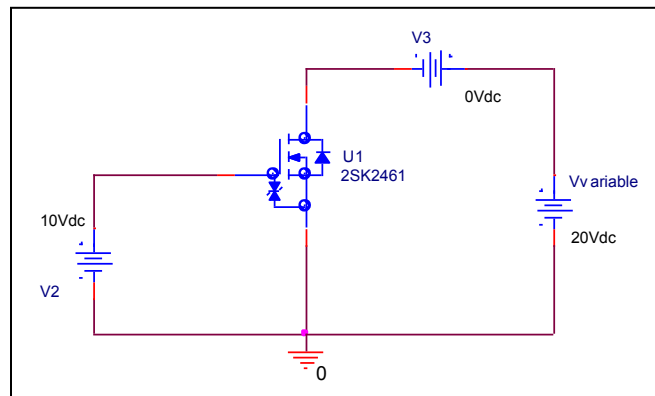
Id(A)	gfs		Error(%)
	Measurement	Simulation	
1.000	5.900	5.880	-0.339
2.000	8.500	8.470	-0.353
5.000	14.500	14.700	1.379
10.000	19.000	19.230	1.211
20.000	25.000	24.700	-1.200

V_{gs}-I_d Characteristic

Circuit Simulation result

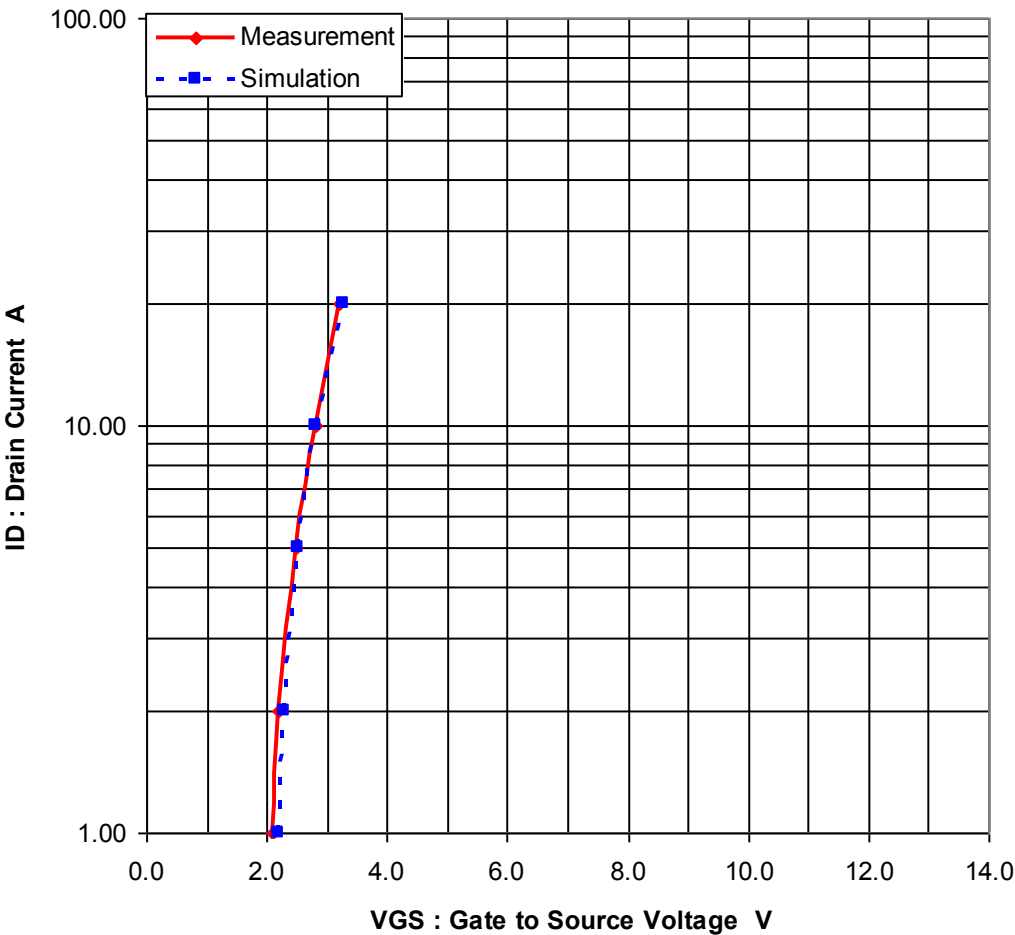


Evaluation circuit



Comparison Graph

Circuit Simulation Result

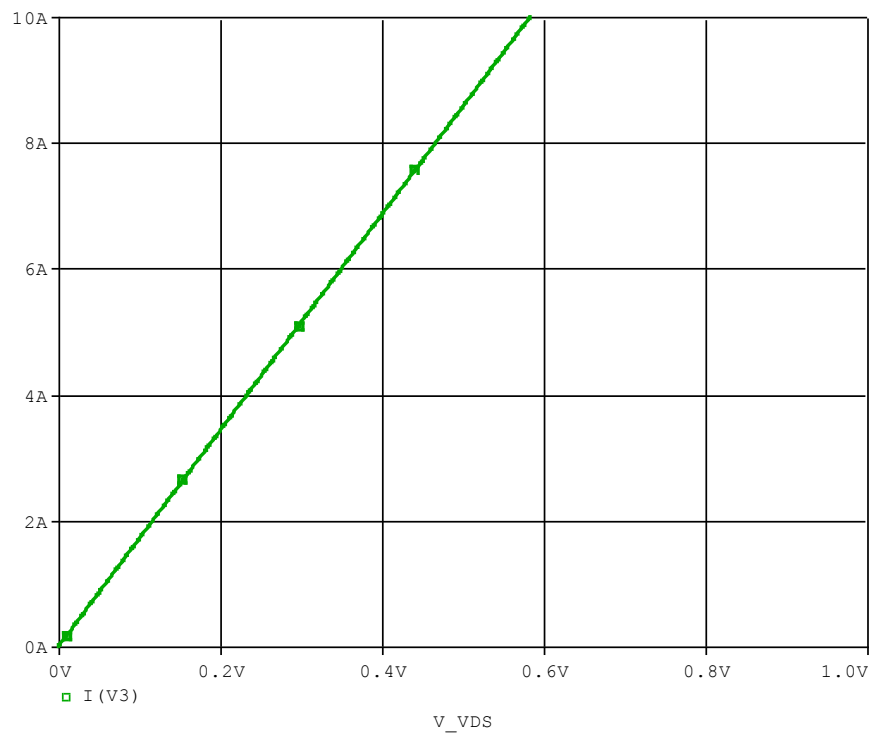


Simulation Result

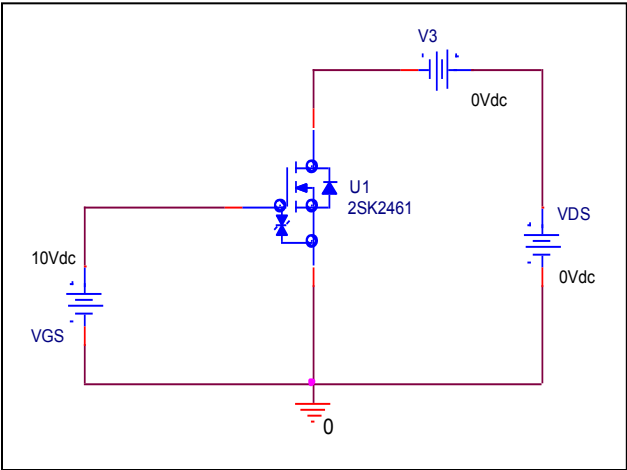
I_D (A)	V_{GS} (V)		Error (%)
	Measurement	Simulation	
1.000	2.100	2.190	4.286
2.000	2.200	2.300	4.545
5.000	2.500	2.520	0.800
10.000	2.800	2.820	0.714
20.000	3.200	3.270	2.187

Rds(on) Characteristic

Circuit Simulation result



Evaluation circuit

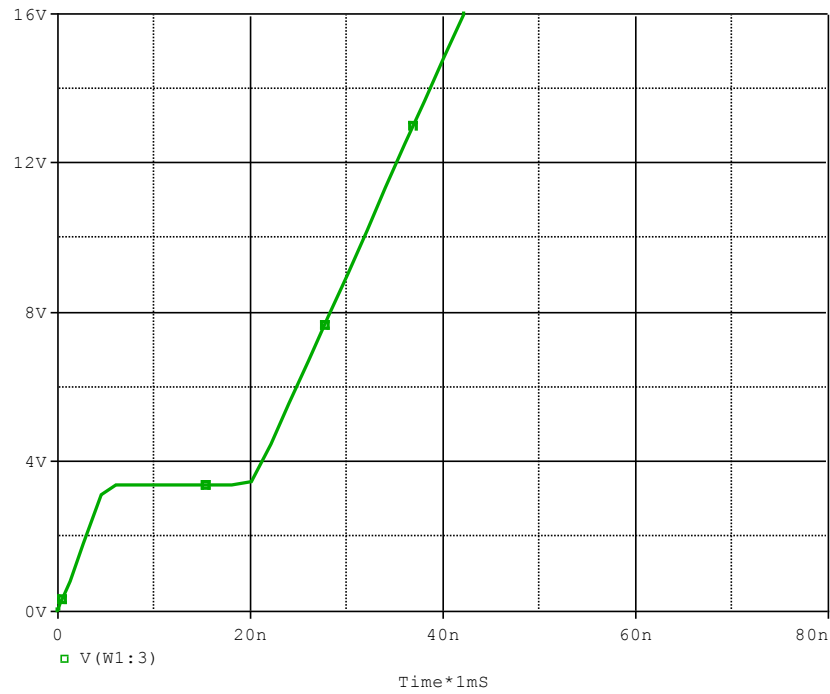


Simulation Result

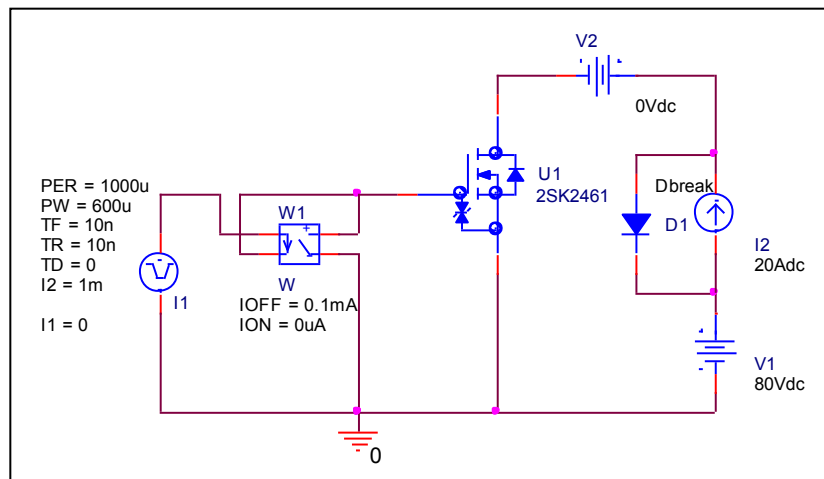
I _D =10A, V _{GS} =10V	Measurement	Simulation	Error (%)
R _{DS} (on) (Ω)	0.058	0.0583	0.517

Gate Charge Characteristic

Circuit Simulation result



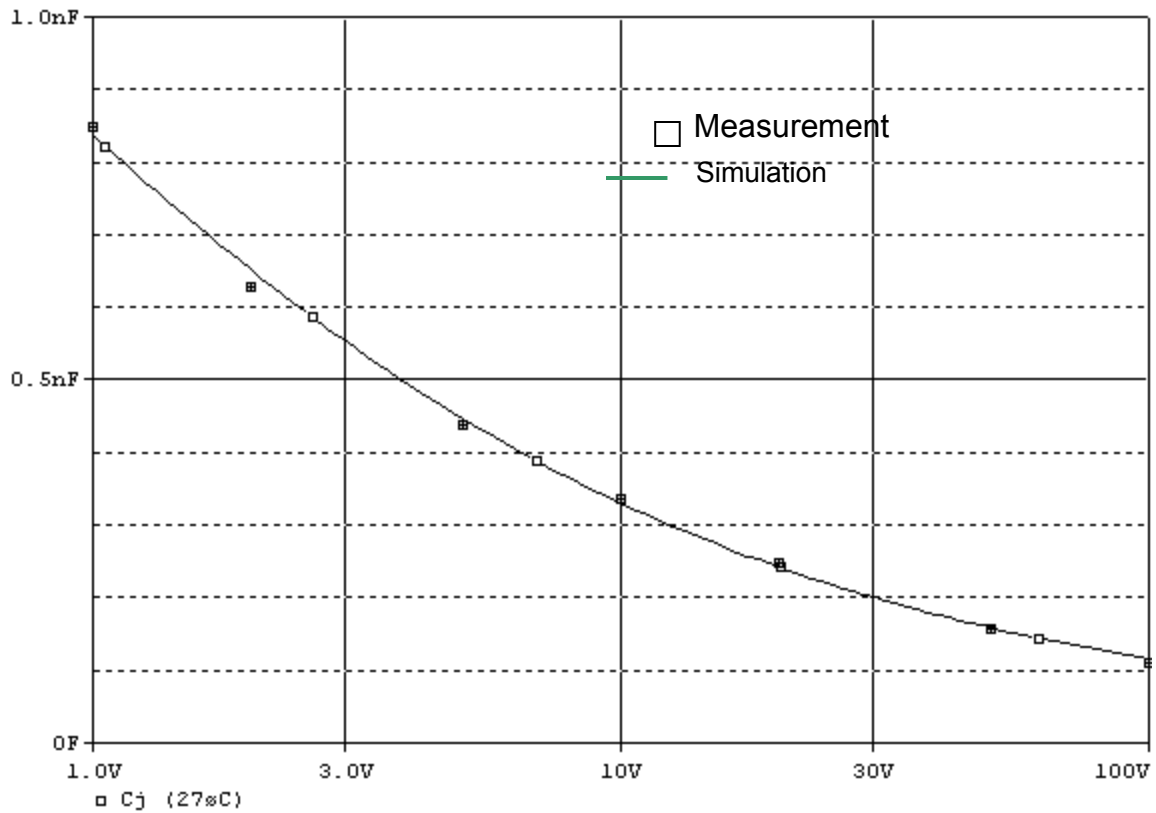
Evaluation circuit



Simulation Result

$V_{DD}=80V, I_D=20A$ $V_{GS}=10V$	Measurement	Simulation	Error (%)
Qgs(nc)	5.000	5.085	1.700
Qgd(nc)	15.000	14.915	-0.567
Qg(nc)	52.000	31.850	-38.750

Capacitance Characteristic

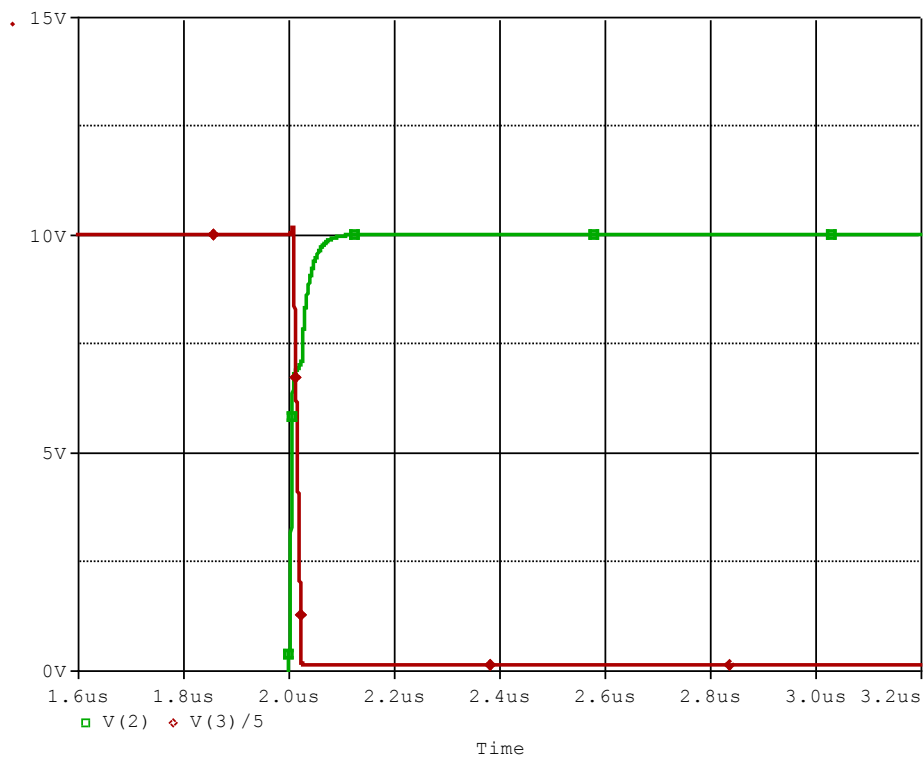


Simulation Result

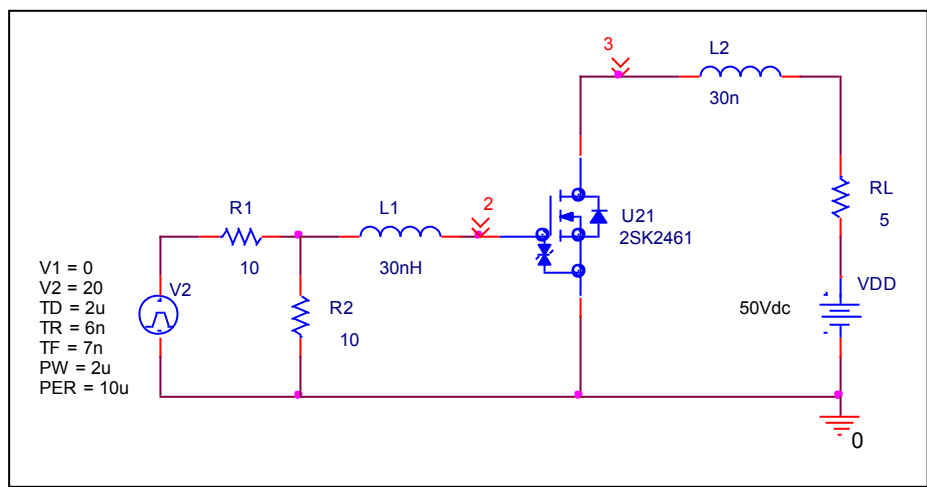
V _{DS} (V)	Cbd(pF)		Error(%)
	Measurement	Simulation	
1.00	850.00	849.00	-0.118
2.00	620.00	640.00	3.226
5.00	440.00	448.00	1.818
10.00	340.00	330.00	-2.941
20.00	250.00	243.00	-2.800
50.00	160.00	159.00	-0.625
100.00	114.00	113.00	-0.877

Switching Time Characteristic

Circuit Simulation result



Evaluation circuit

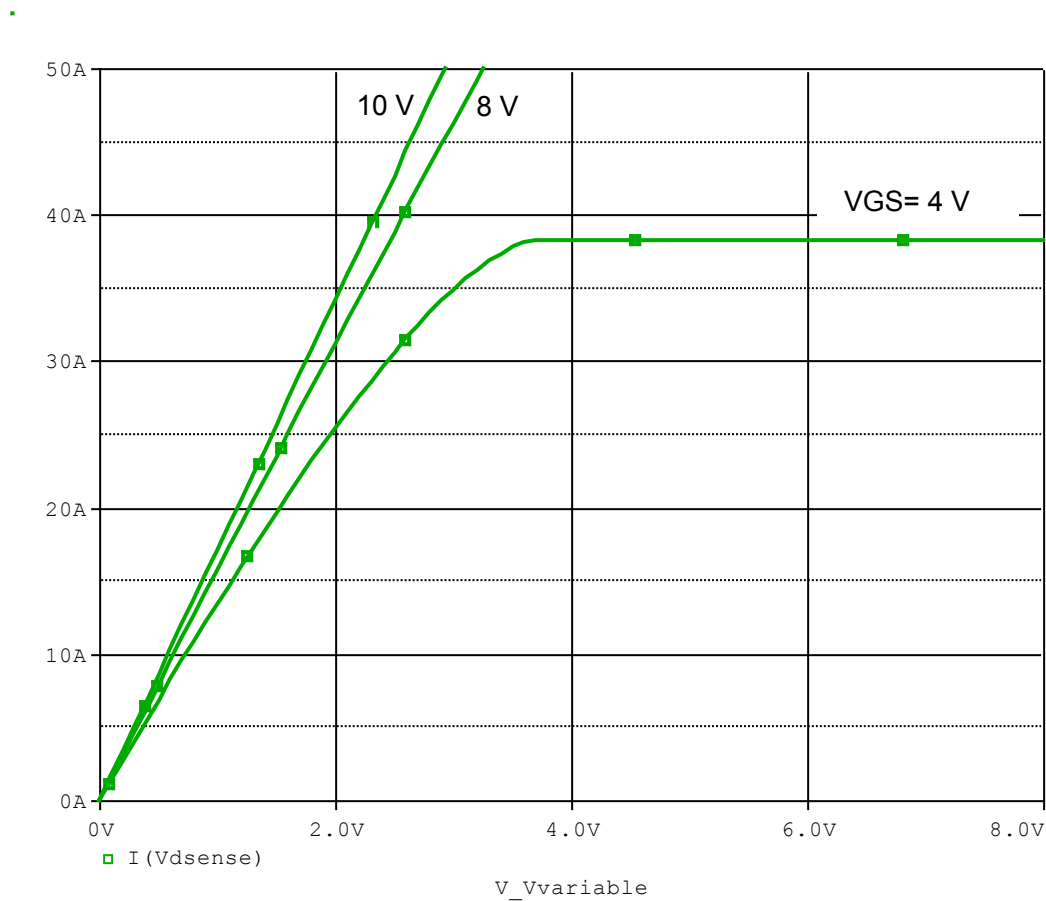


Simulation Result

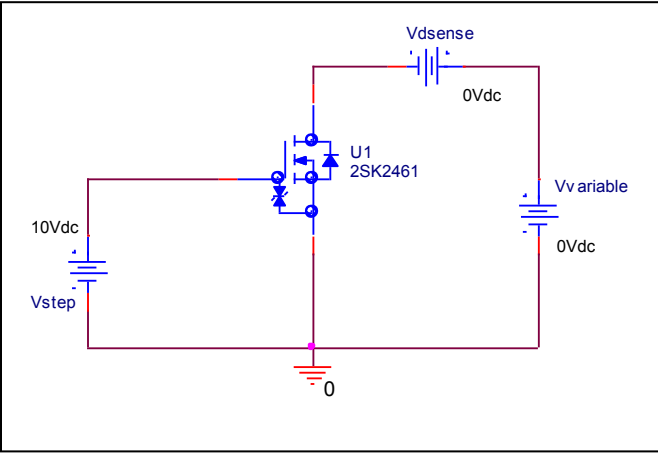
$I_D=10A$, $V_{DD}=50V$ $V_{GS}=10V$	Measurement	Simulation	Error(%)
Ton(ns)	21.000	21.158	0.752

Output Characteristic

Circuit Simulation result



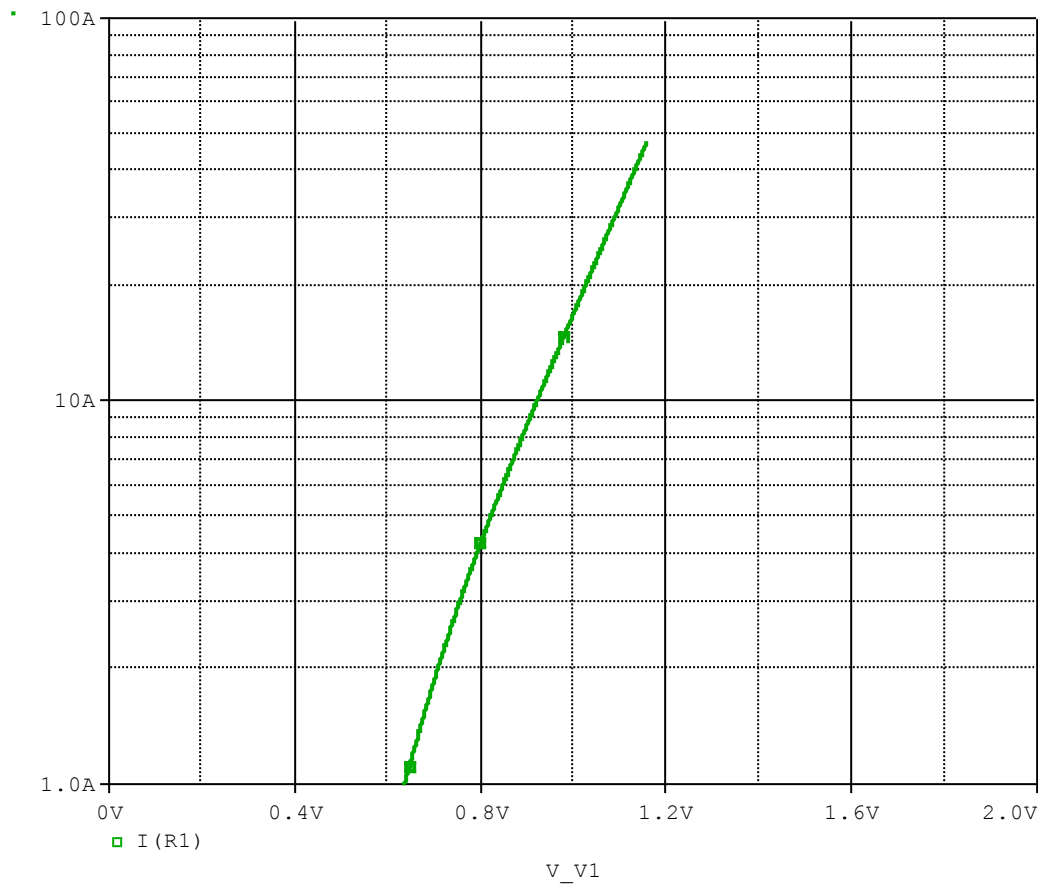
Evaluation circuit



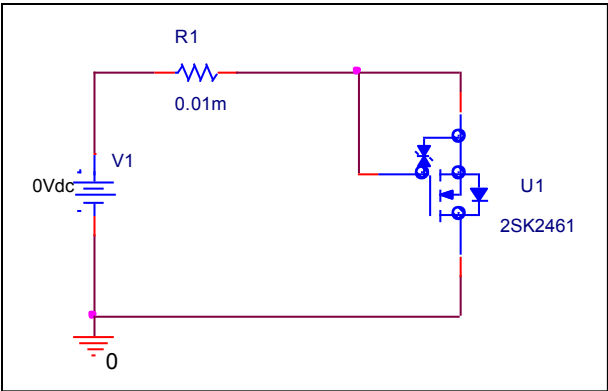
BODY DIODE SPICE MODEL

Forward Current Characteristic

Circuit Simulation Result

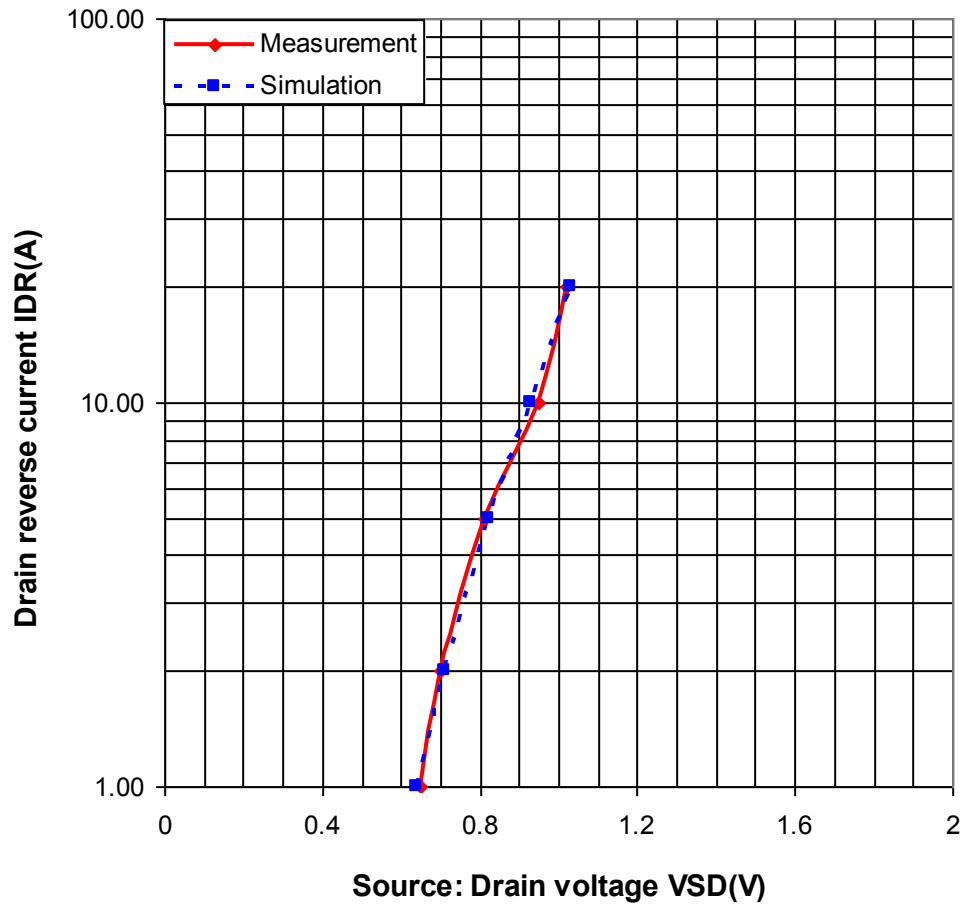


Evaluation Circuit



Comparison Graph

Circuit Simulation Result

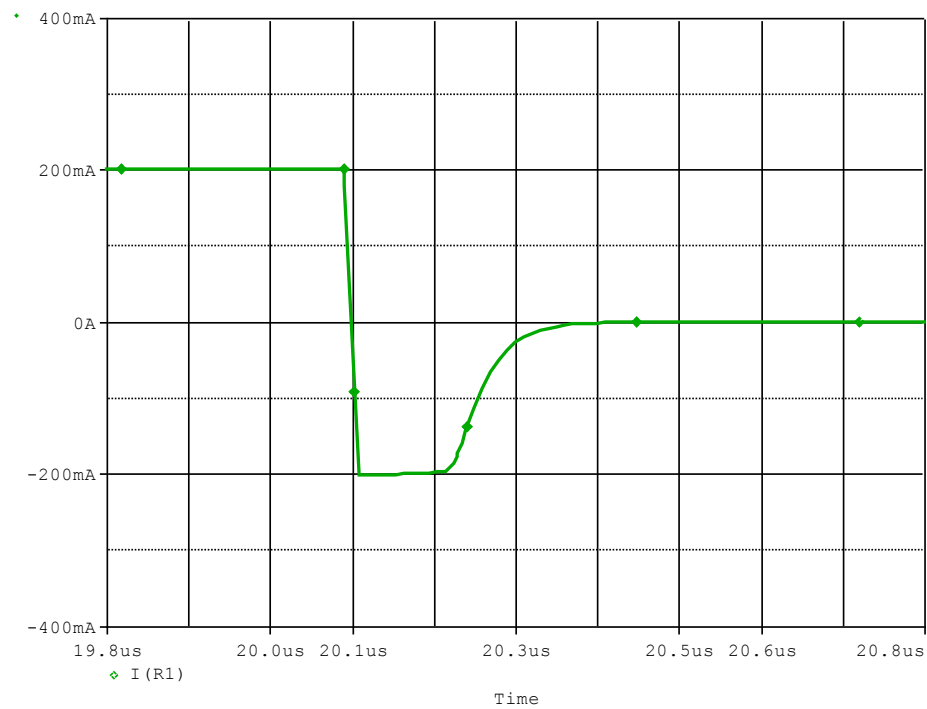


Simulation Result

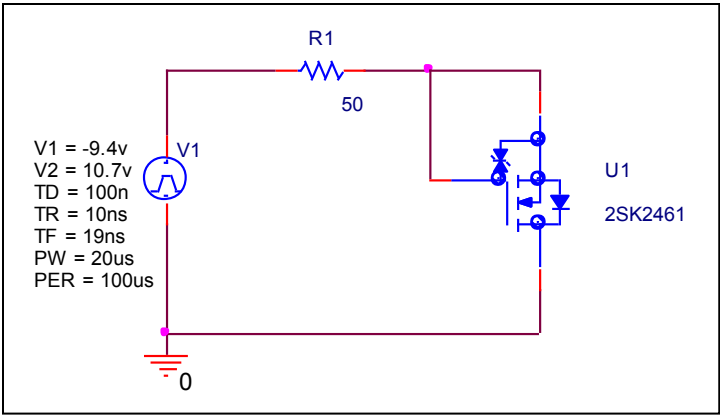
$IDR(A)$	$VSD(V)$ Measurement	$VSD(V)$ Simulation	%Error
1.000	0.650	0.640	-1.538
2.000	0.700	0.711	1.571
5.000	0.810	0.820	1.235
10.000	0.950	0.930	-2.105
20.000	1.020	1.028	0.784

Reverse Recovery Characteristic

Circuit Simulation Result



Evaluation Circuit

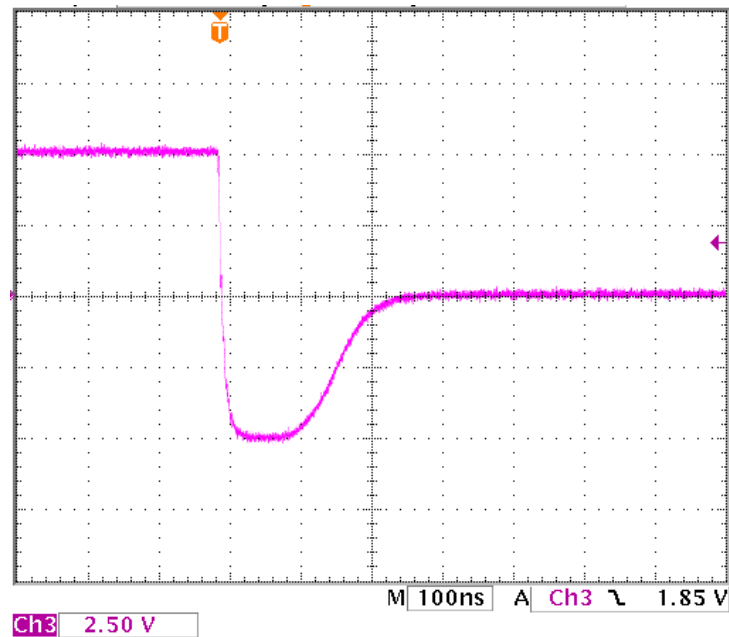


Compare Measurement vs. Simulation

	Measurement	Simulation	Error (%)
Trr(ns)	210.000	209.622	-0.180

Reverse Recovery Characteristic

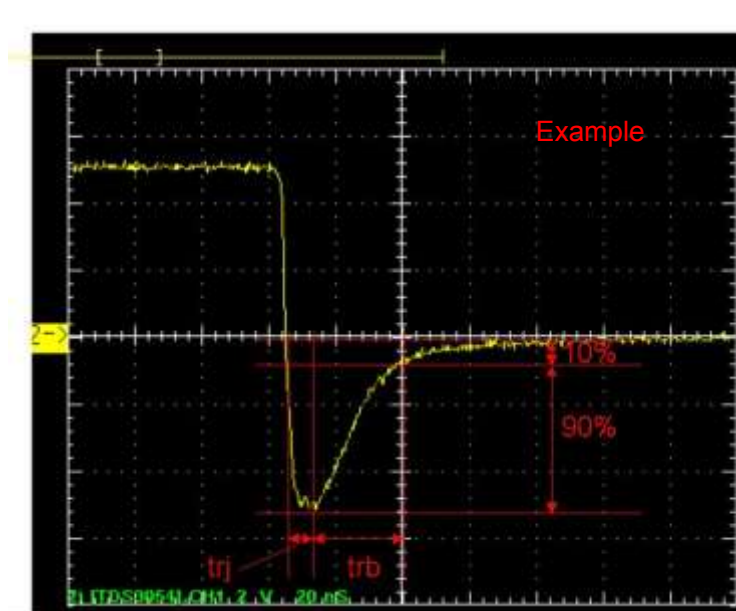
Reference



Trj= 104 (ns)

Trb= 106 (ns)

Conditions: Ifwd=Irev=0.2(A), RI=50

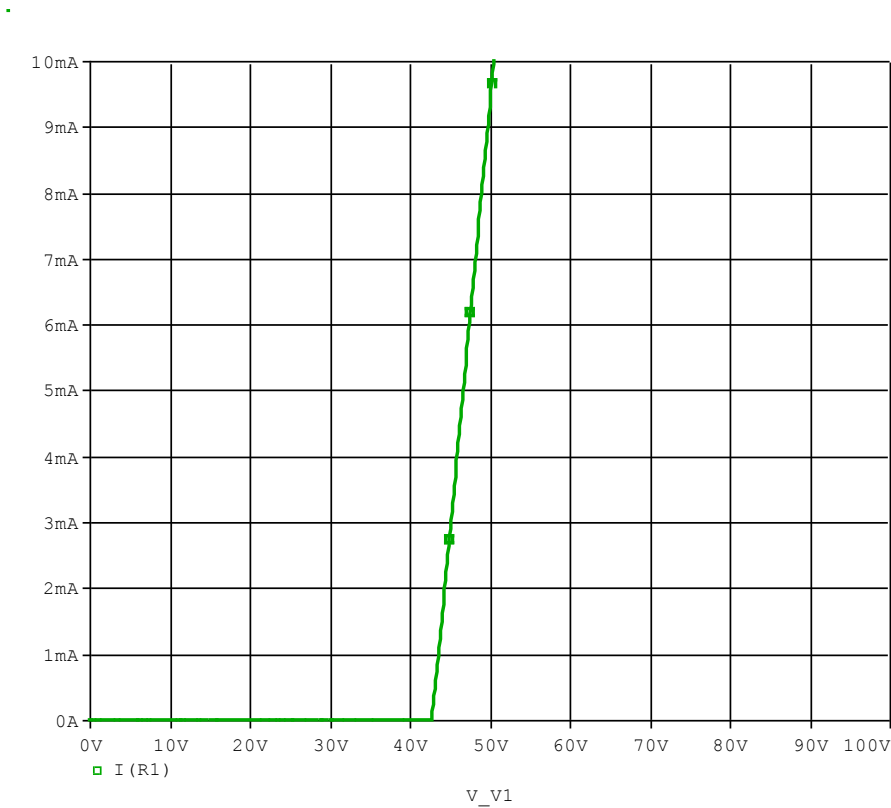


Relation between trj and trb

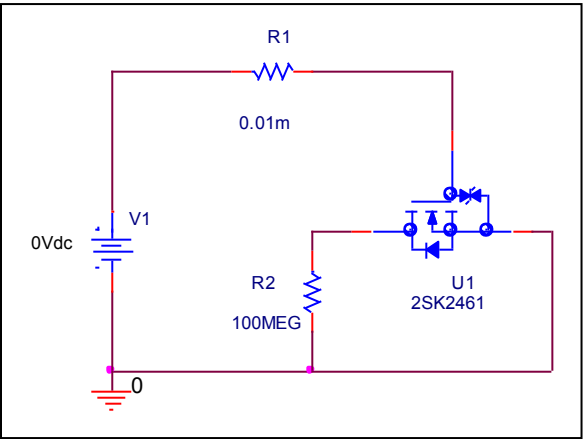
ESD PROTECTION DIODE SPICE MODEL

Zener Voltage Characteristic

Circuit Simulation Result



Evaluation Circuit



Zener Voltage Characteristic

Reference

