

Device Modeling Report

COMPONENTS: Power MOSFET (Model Parameters)
PART NUMBER: 2SK2916
MANUFACTURER: TOSHIBA
Body Diode (Model Parameters) / ESD Protection Diode



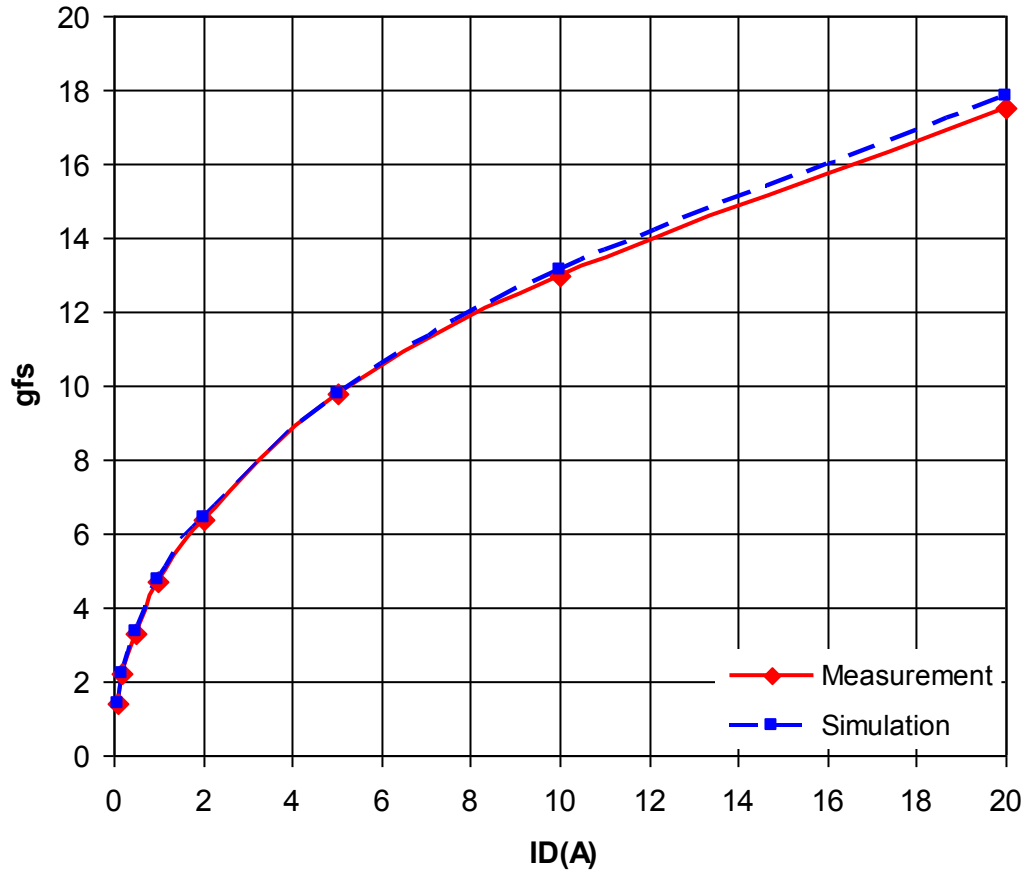
Bee Technologies Inc.

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

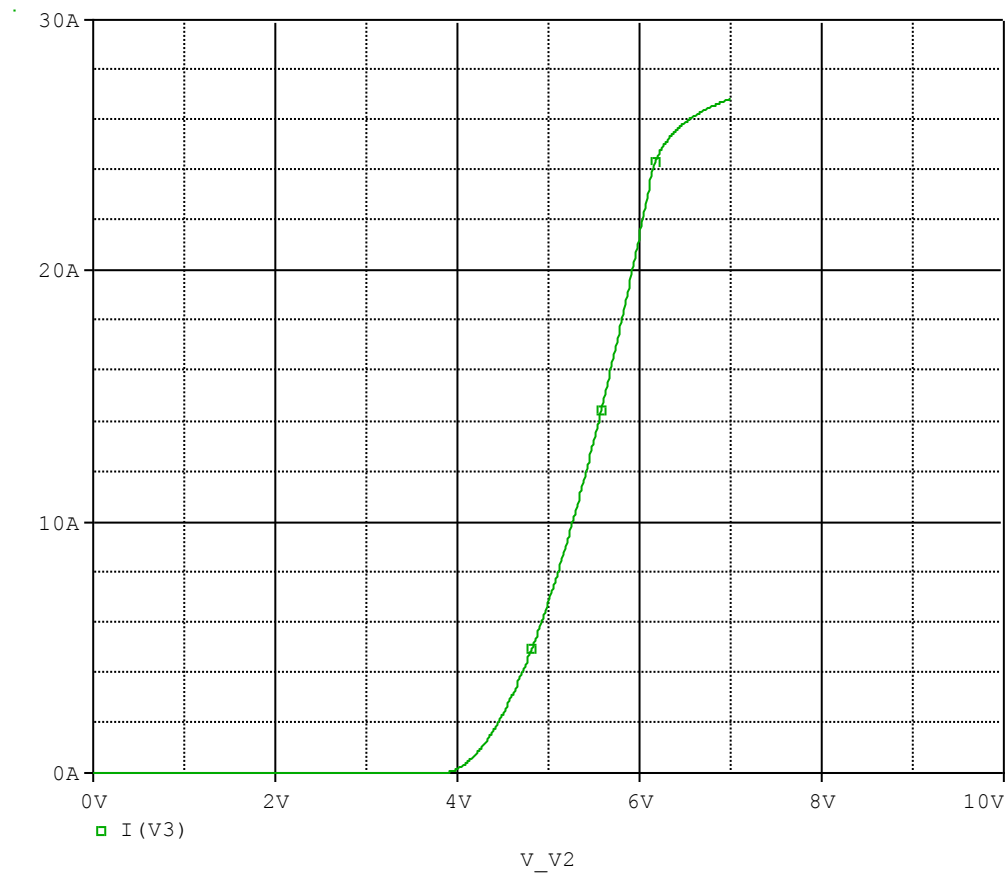


Comparison table

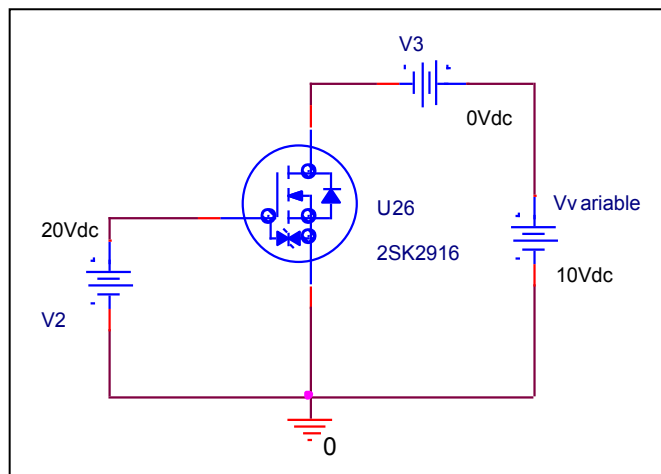
Id(A)	gfs		Error(%)
	Measurement	Simulation	
0.1	1.400	1.429	2.071
0.2	2.200	2.222	1.000
0.5	3.300	3.333	1.000
1	4.700	4.762	1.319
2	6.400	6.452	0.812
5	9.800	9.804	0.041
10	13.000	13.158	1.215
20	17.500	17.857	2.040

V_{gs}-I_d Characteristic

Circuit Simulation result

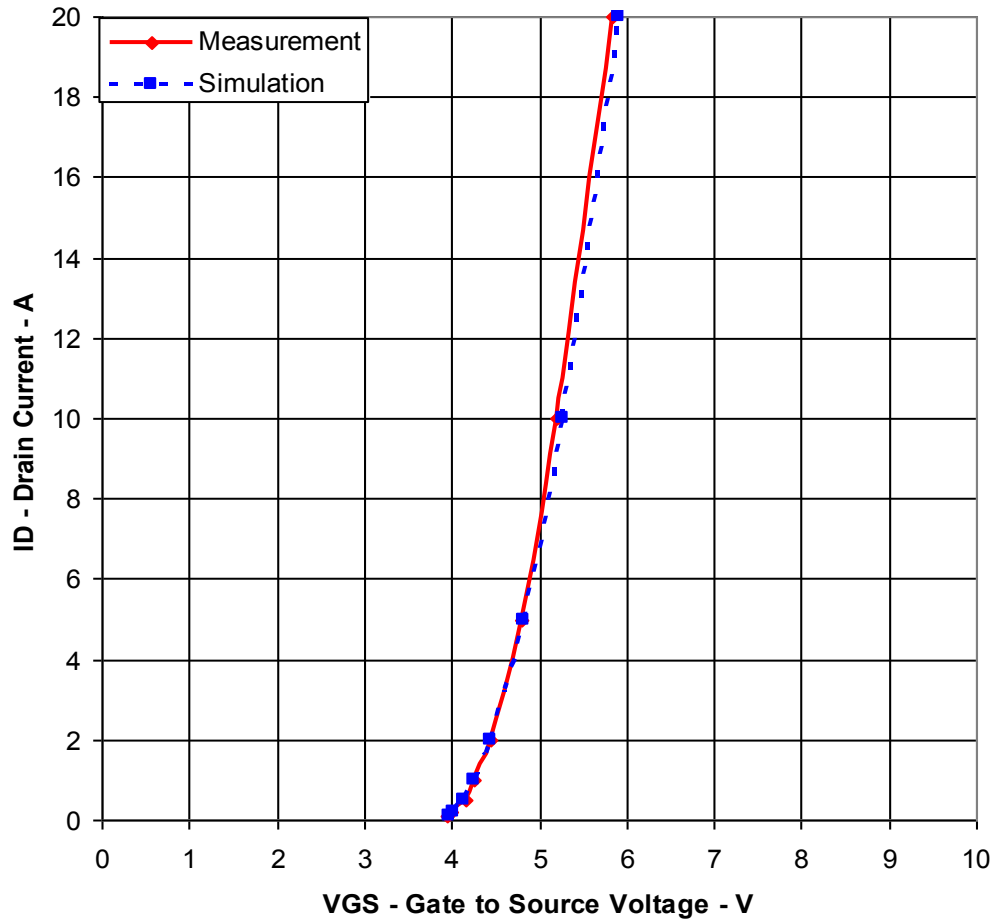


Evaluation circuit



Comparison Graph

Circuit Simulation Result

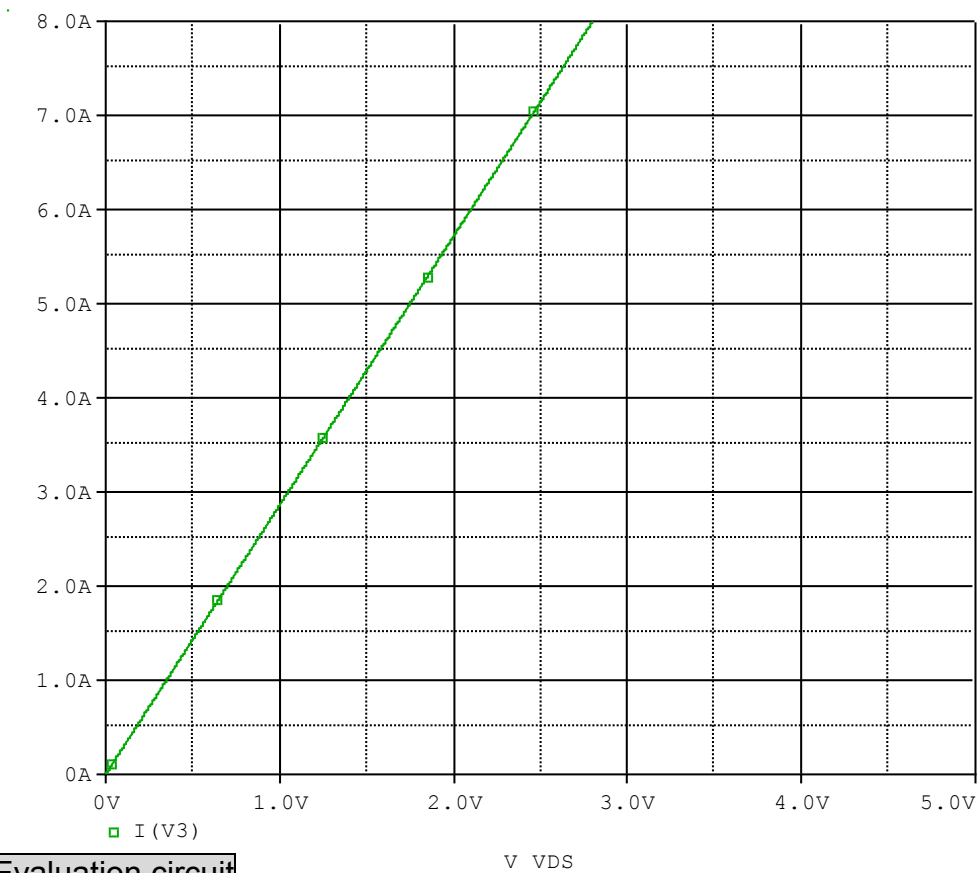


Simulation Result

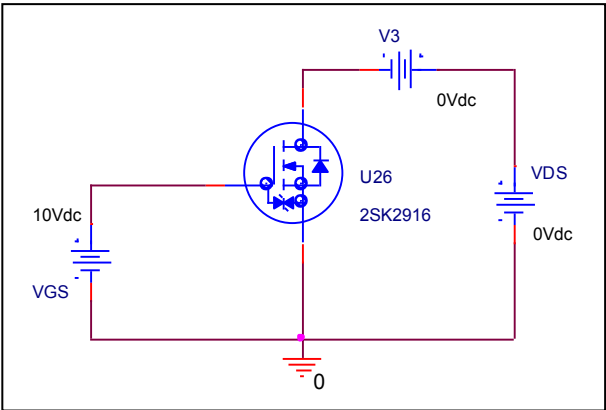
I_D (A)	V_{GS} (V)		Error (%)
	Measurement	Simulation	
0.1	3.950	3.963	0.329
0.2	4.000	4.02	0.500
0.5	4.150	4.132	-0.434
1	4.250	4.261	0.259
2	4.450	4.446	-0.090
5	4.800	4.823	0.479
10	5.200	5.264	1.231
20	5.850	5.919	1.179

Rds(on) Characteristic

Circuit Simulation result



Evaluation circuit

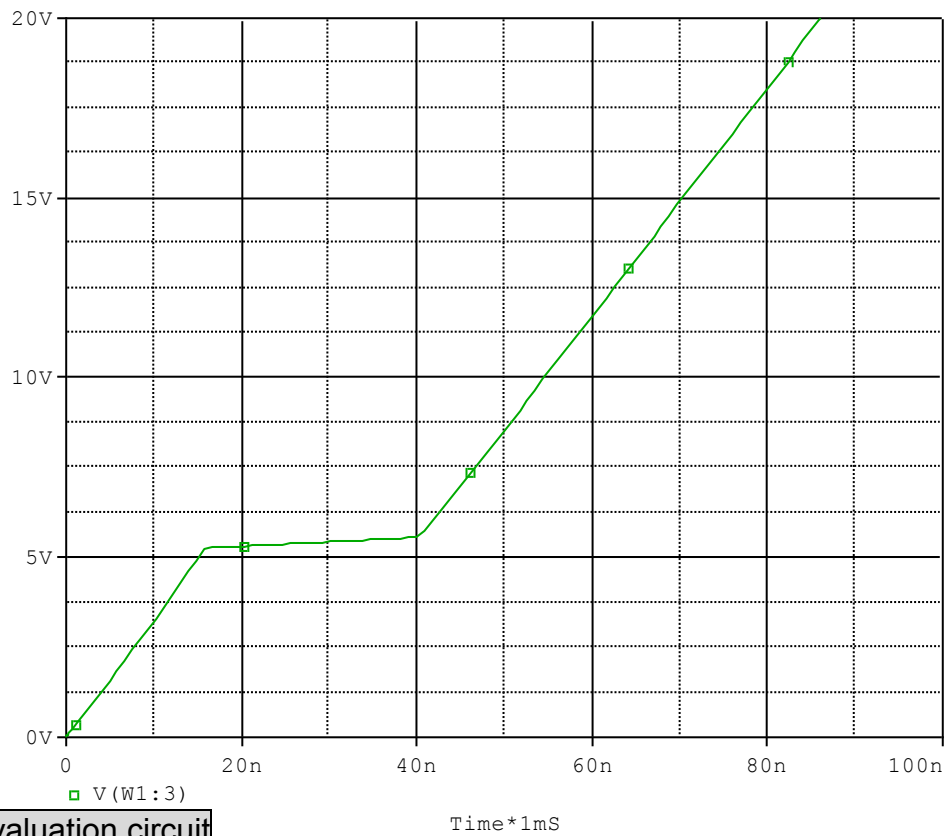


Simulation Result

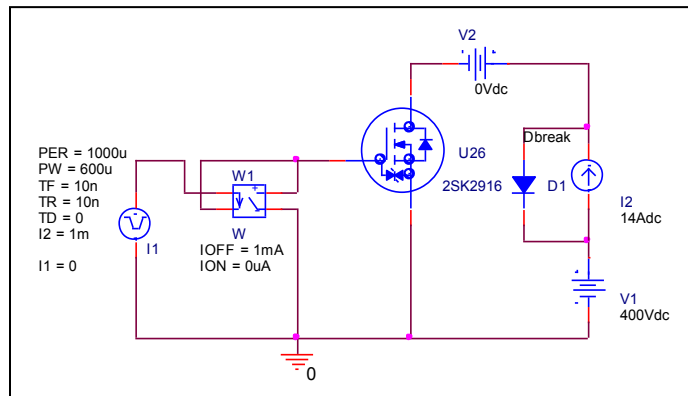
$I_D=7A, V_{GS}=10V$	Measurement		Simulation		Error (%)
$R_{DS(on)}$	0.35	Ω	0.349	Ω	0

Gate Charge Characteristic

Circuit Simulation result



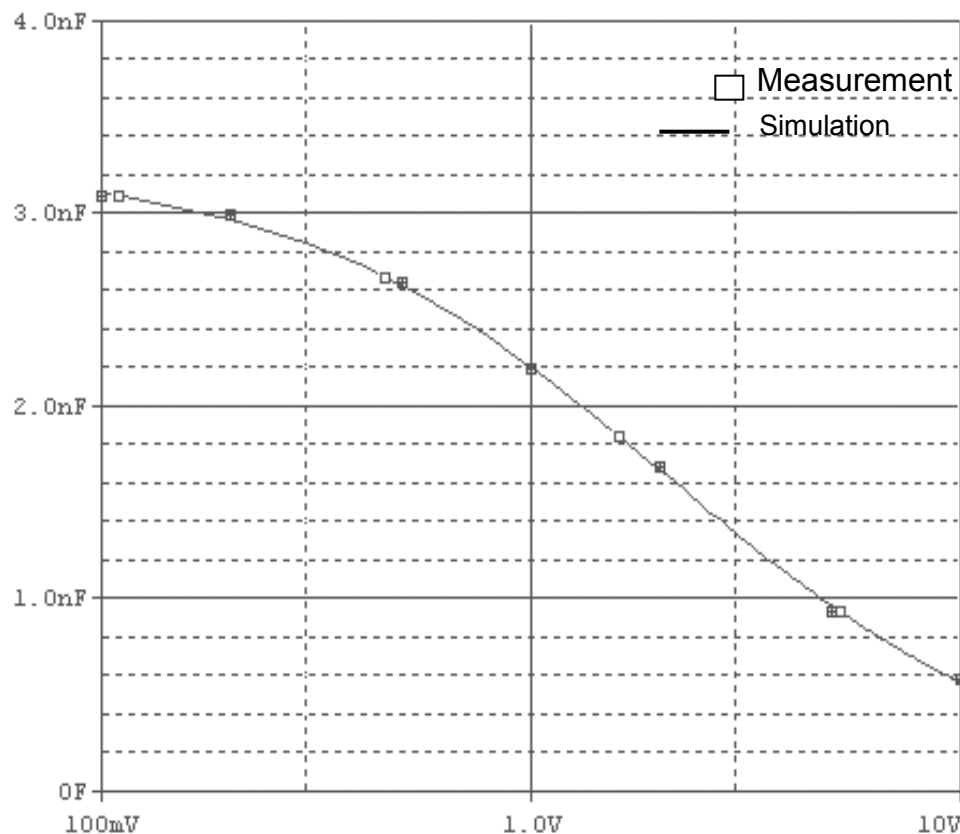
Evaluation circuit



Simulation Result

$V_{DD}=400V, I_D=8A$ $V_{GS}=10V$	Measurement	Simulation	Error (%)
$Q_{gs}(nC)$	15.000	14.945	-0.367
$Q_{gd}(nC)$	25.000	24.893	-0.428
Q_g	61.000	53.374	-12.502

Capacitance Characteristic

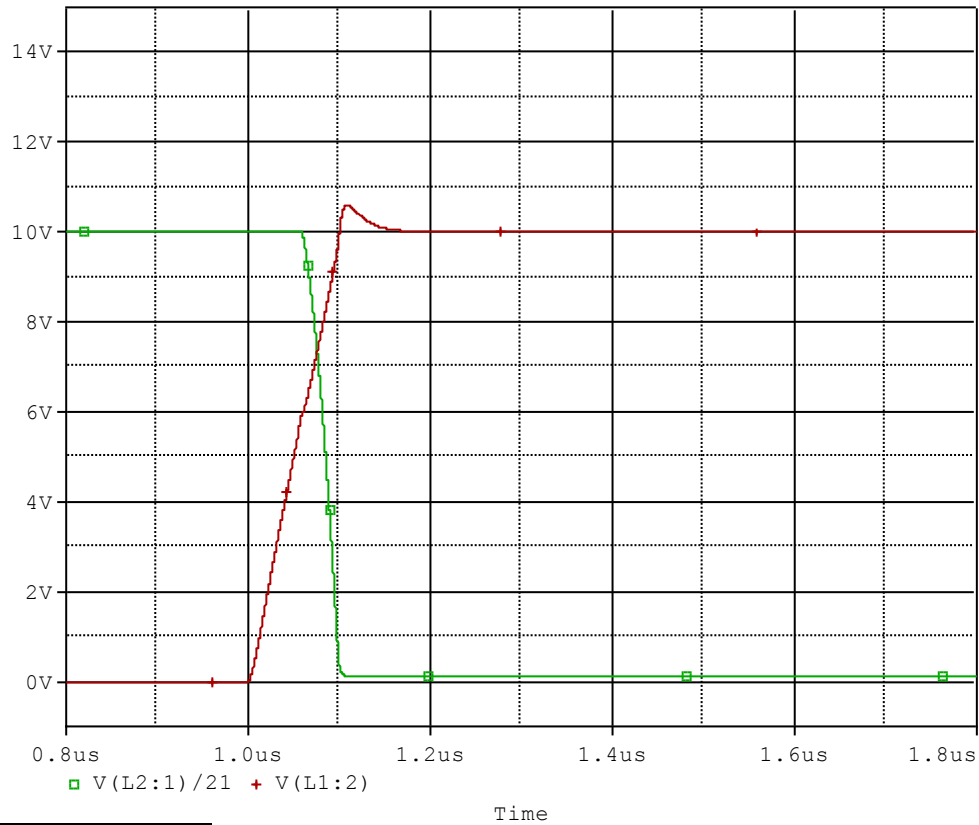


Simulation Result

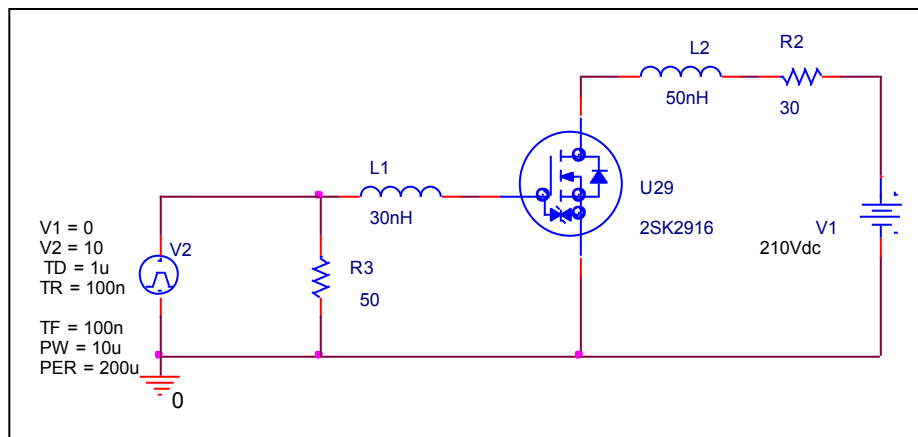
V _{DS} (V)	Cbd(pF)		Error(%)
	Measurement	Simulation	
0.1	3090.000	3100.000	0.324
0.2	3020.000	3000.000	-0.662
0.5	2650.000	2650.000	0.000
1	2200.000	2200.000	0.000
2	1710.000	1700.000	-0.585
5	930.000	950.000	2.151
10	600.000	590.000	-1.667

Switching Time Characteristic

Circuit Simulation result



Evaluation circuit

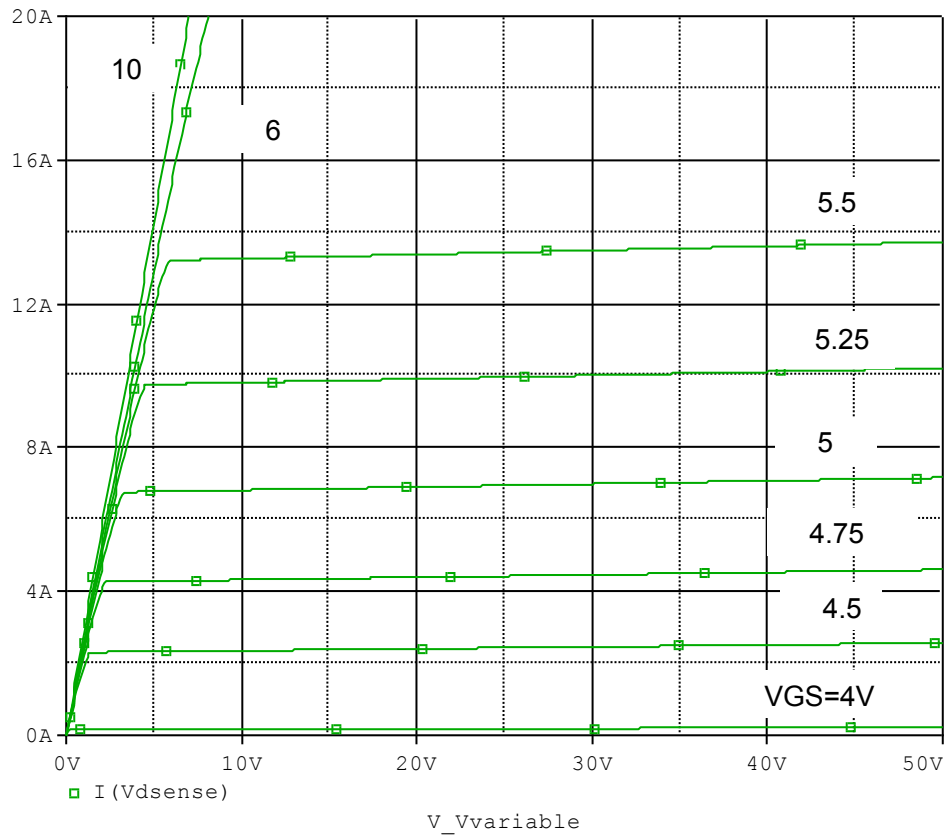


Simulation Result

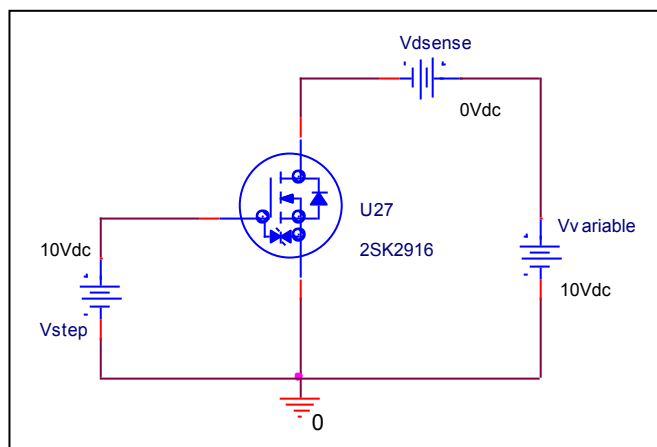
$I_D=7A, V_{DD}=210V$ $V_{GS}=0/10V$	Measurement	Simulation	Error(%)
Ton(ns)	85.000	85.074	0.087

Output Characteristic

Circuit Simulation result



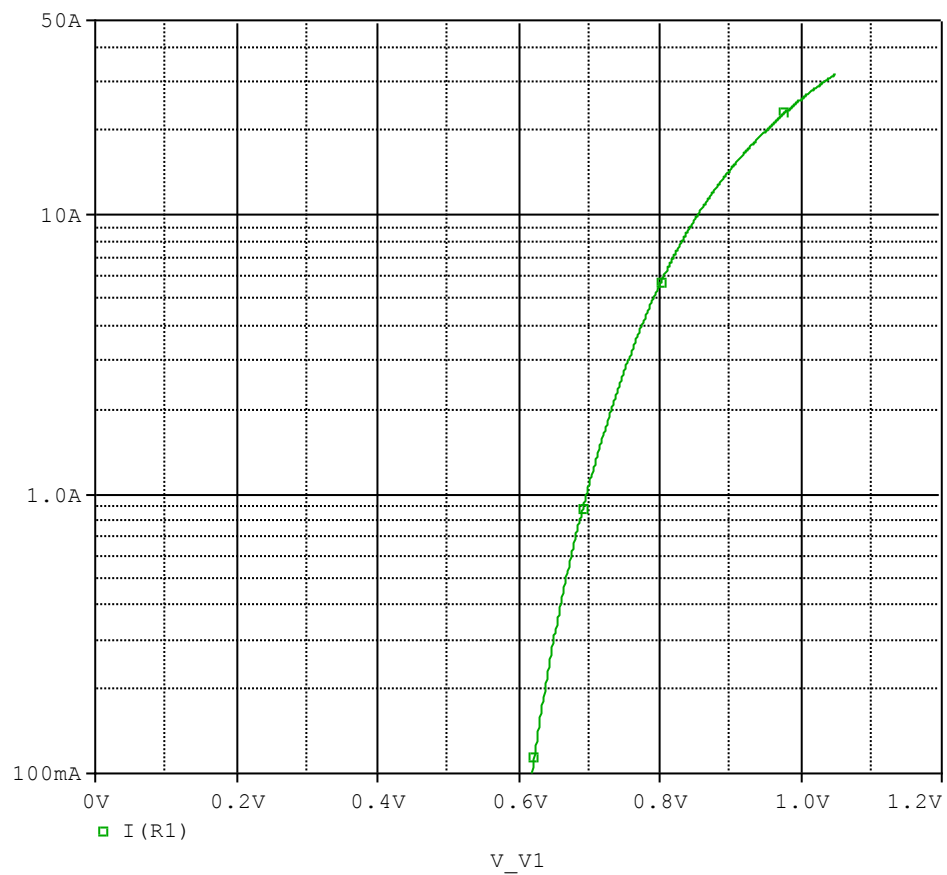
Evaluation circuit



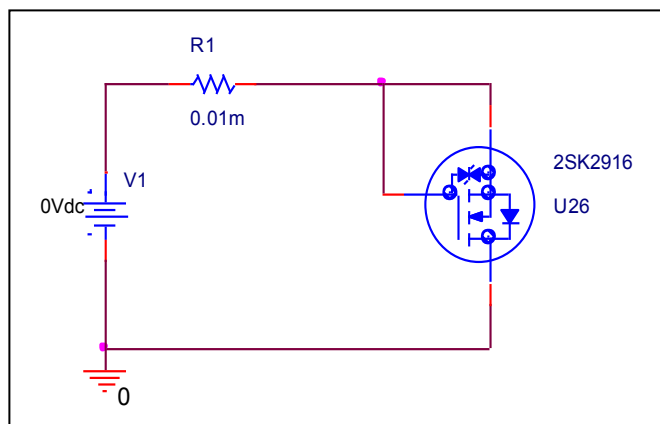
BODY DIODE

Forward Current Characteristic

Circuit Simulation Result

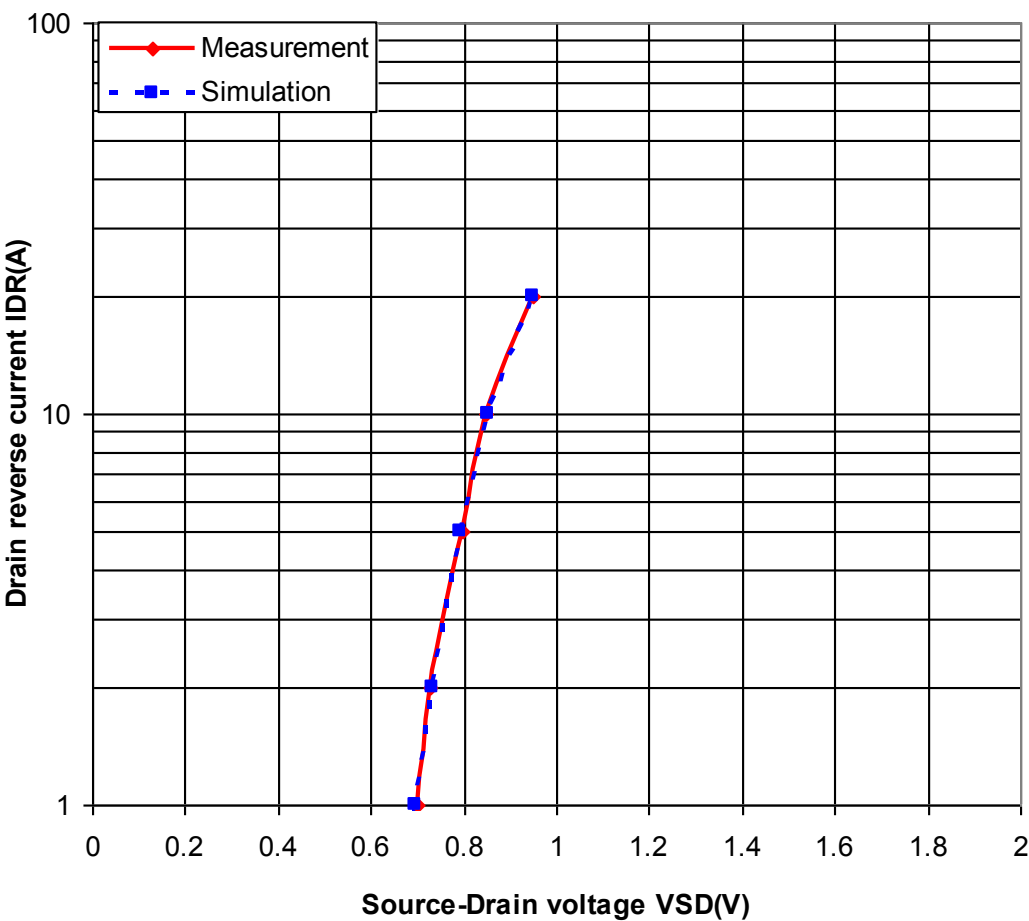


Evaluation Circuit



Comparison Graph

Circuit Simulation Result

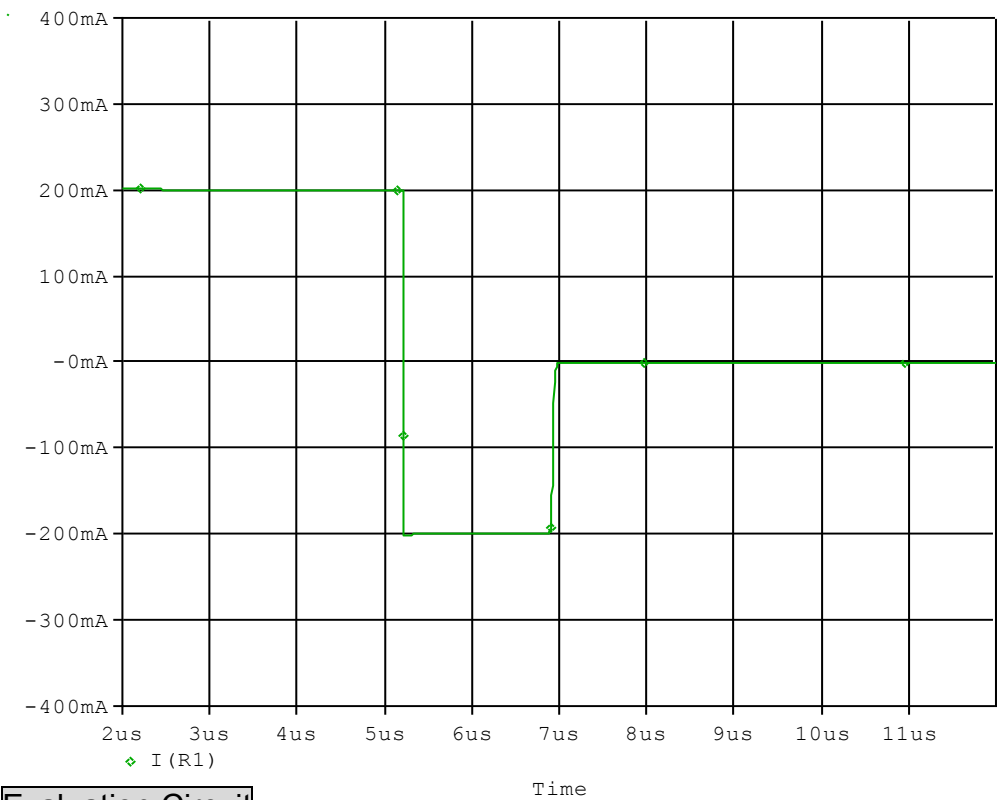


Simulation Result

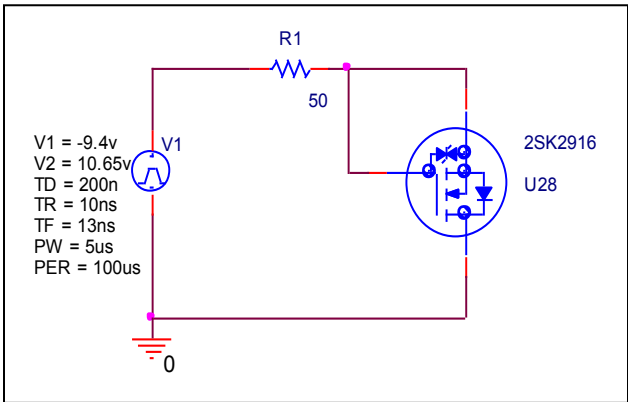
IDR(A)	VSD(V)		%Error
	Measuremen	Simulation	
0.1	0.620	0.618	-0.32
0.2	0.650	0.637	-2.00
0.5	0.660	0.667	1.06
1	0.700	0.696	-0.57
2	0.730	0.731	0.14
5	0.795	0.791	-0.50
10	0.850	0.854	0.47
20	0.950	0.949	-0.11

Reverse Recovery Characteristic

Circuit Simulation Result



Evaluation Circuit

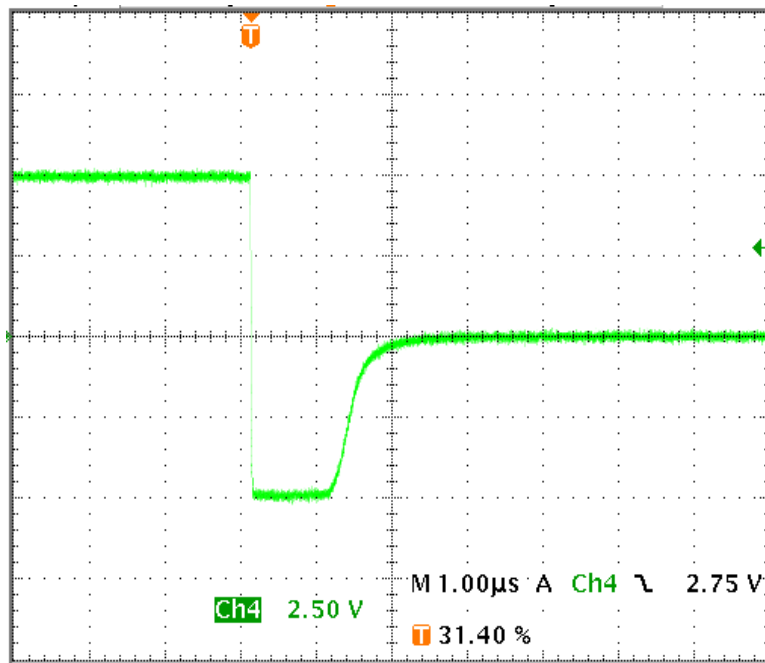


Compare Measurement vs. Simulation

Trr	Measurement	Simulation	Error (%)
Trj+Trb(us)	1.736	1.737	0.058

Reverse Recovery Characteristic

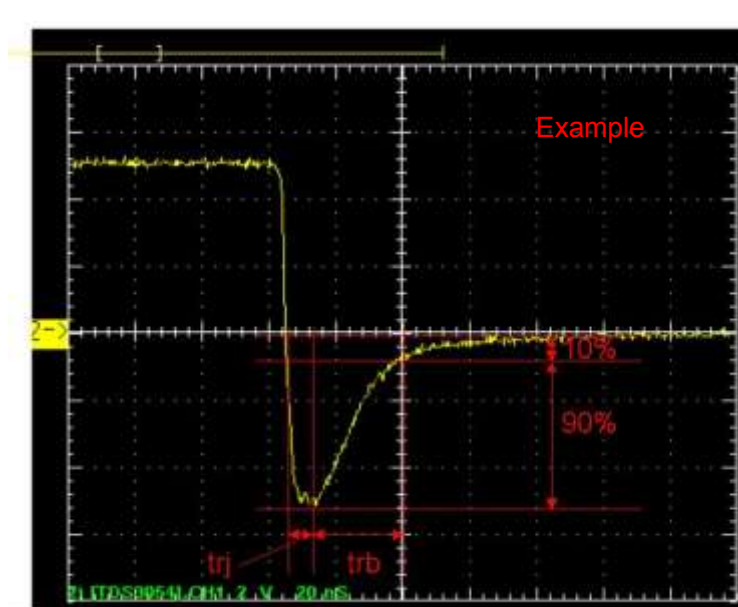
Reference



$T_{rr}=0.973(\mu s)$

$T_{rb}=0.763(\mu s)$

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

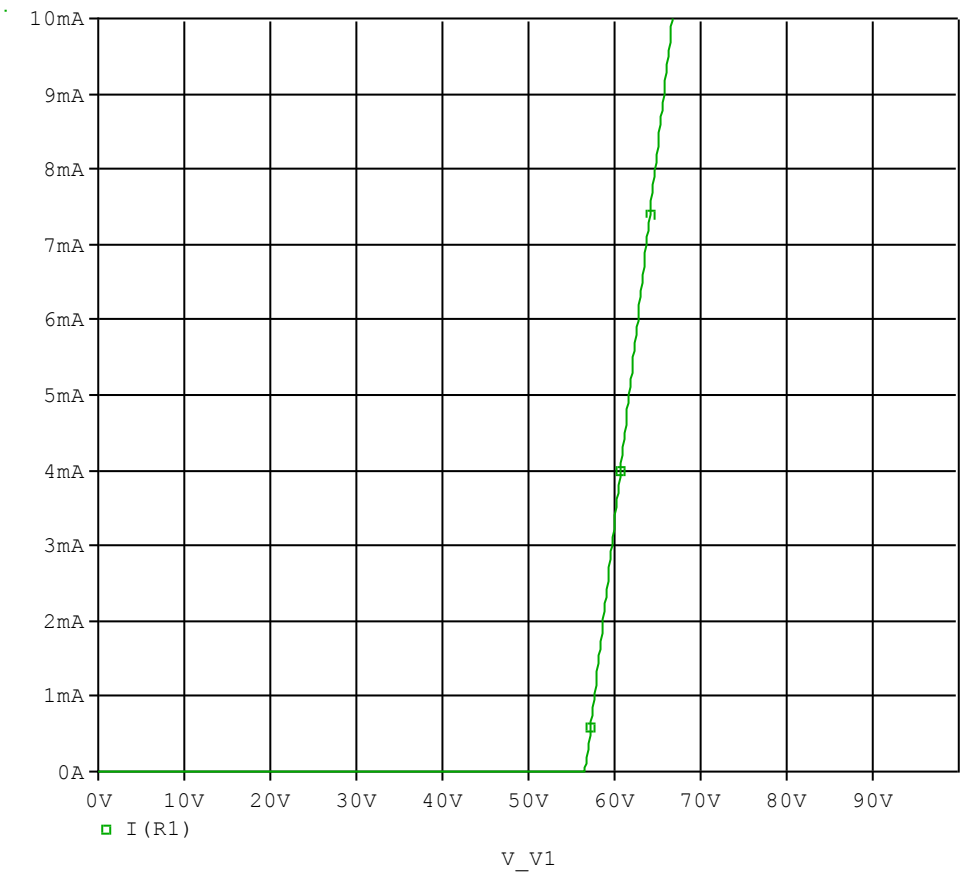


Relation between t_{rj} and t_{rb}

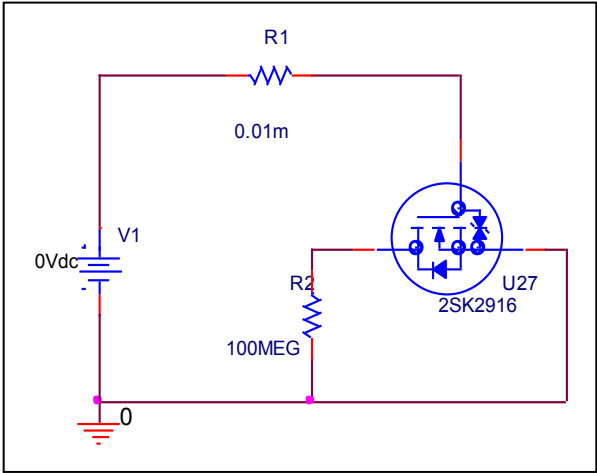
ESD PROTECTION DIODE

Zener Voltage Characteristic

Circuit Simulation Result



Evaluation Circuit



Zener Voltage Characteristic

Reference

