

Device Modeling Report

COMPONENTS: MOSFET (Model Parameters)
PART NUMBER: 2SK2415
MANUFACTURER: NEC Corporation
REMARK: Body Diode (Model Parameters) /
ESD Protection Diode



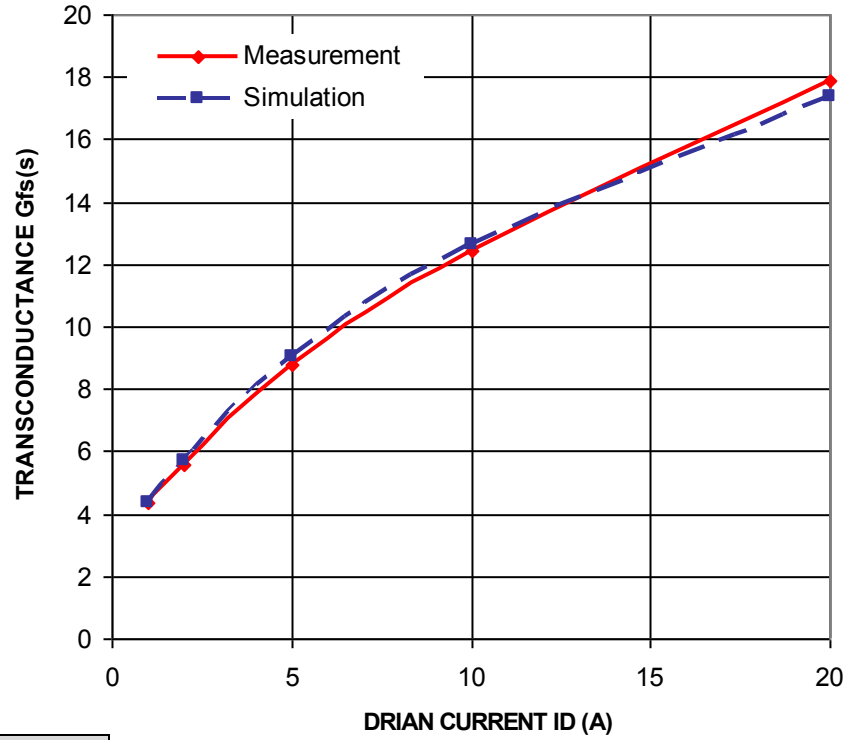
Bee Technologies Inc.

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

Transconductance Characteristics

Circuit Simulation Result

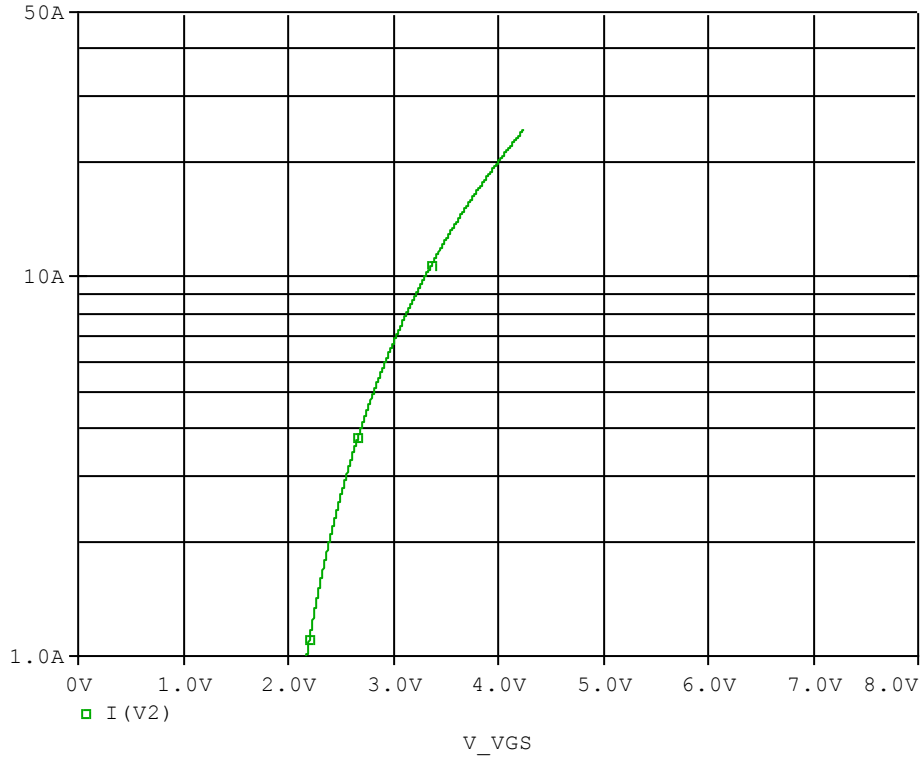


Comparison table

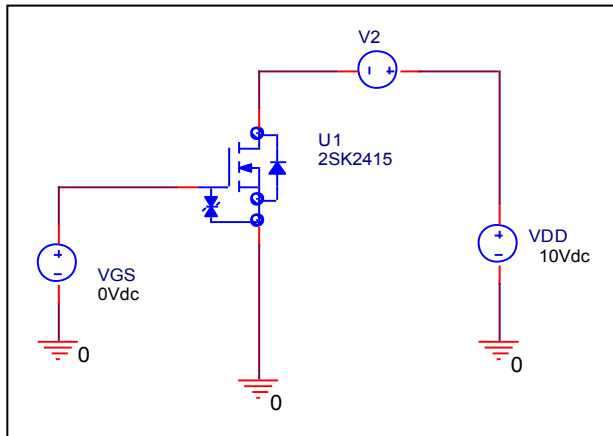
Id(A)	gfs(s)		Error(%)
	Measurement	Simulation	
1	4.390	4.348	-0.956
2	5.602	5.711	1.943
5	8.787	9.025	2.704
10	12.407	12.654	1.991
20	17.899	17.346	-3.087

Vgs-Id Characteristics

Circuit Simulation Result

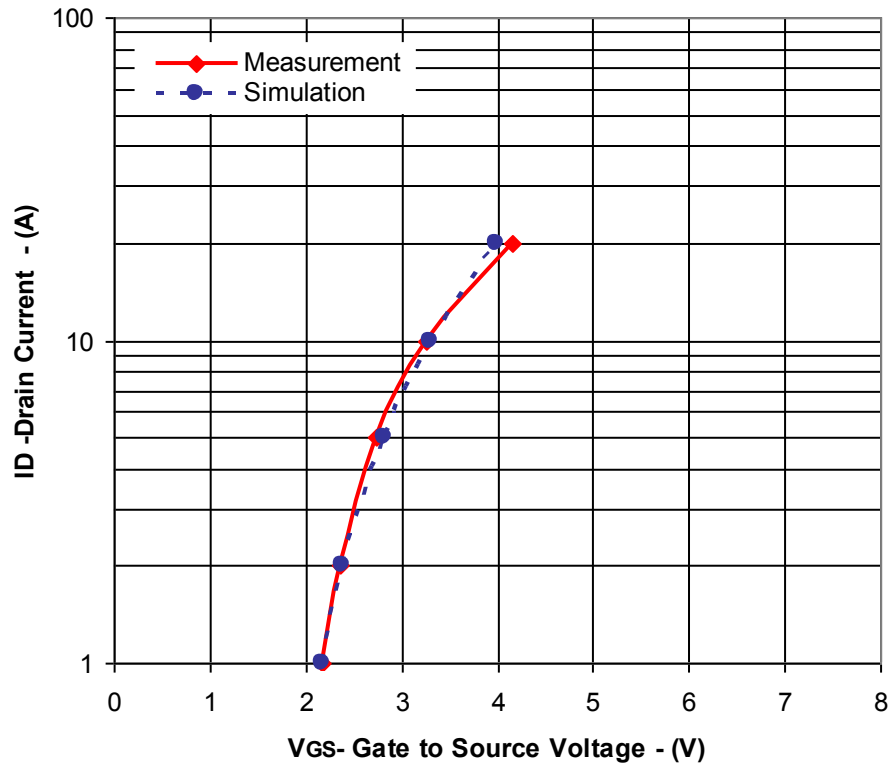


Evaluation circuit



Comparison Graph

Circuit Simulation Result

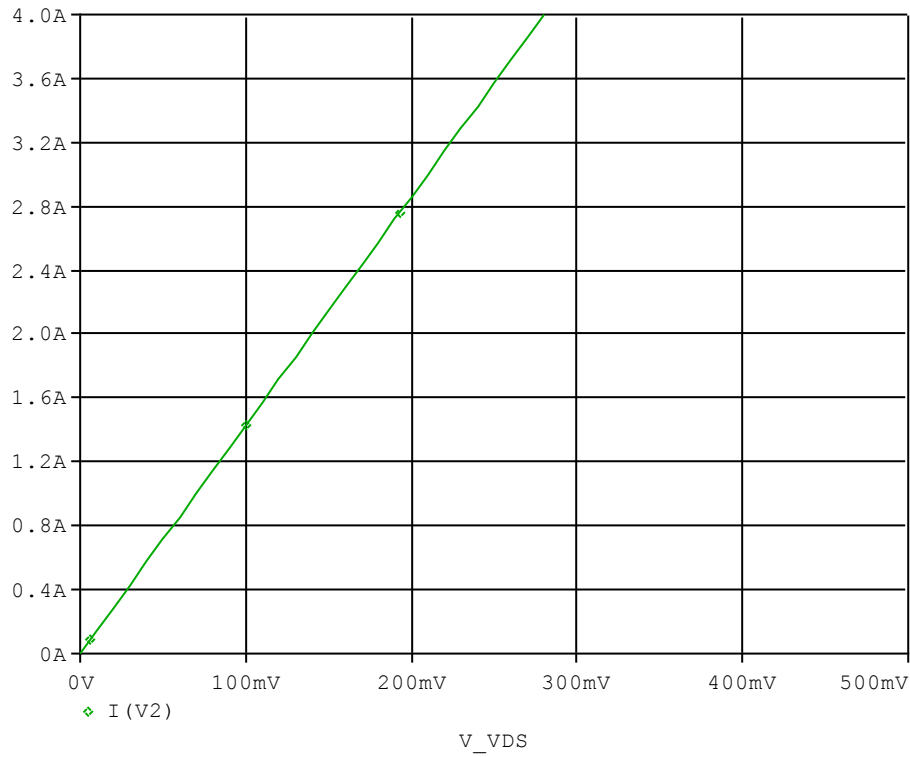


Comparison table

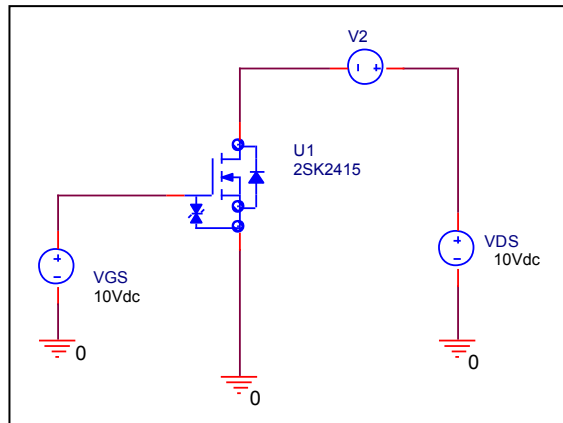
Id(A)	gfs(s)		Error(%)
	Measurement	Simulation	
1	2.180	2.177	-0.147
2	2.350	2.391	1.745
5	2.730	2.818	3.223
10	3.250	3.303	1.615
20	4.150	3.994	-3.771

*Rds(on) Characteristic

Circuit Simulation result



Evaluation circuit

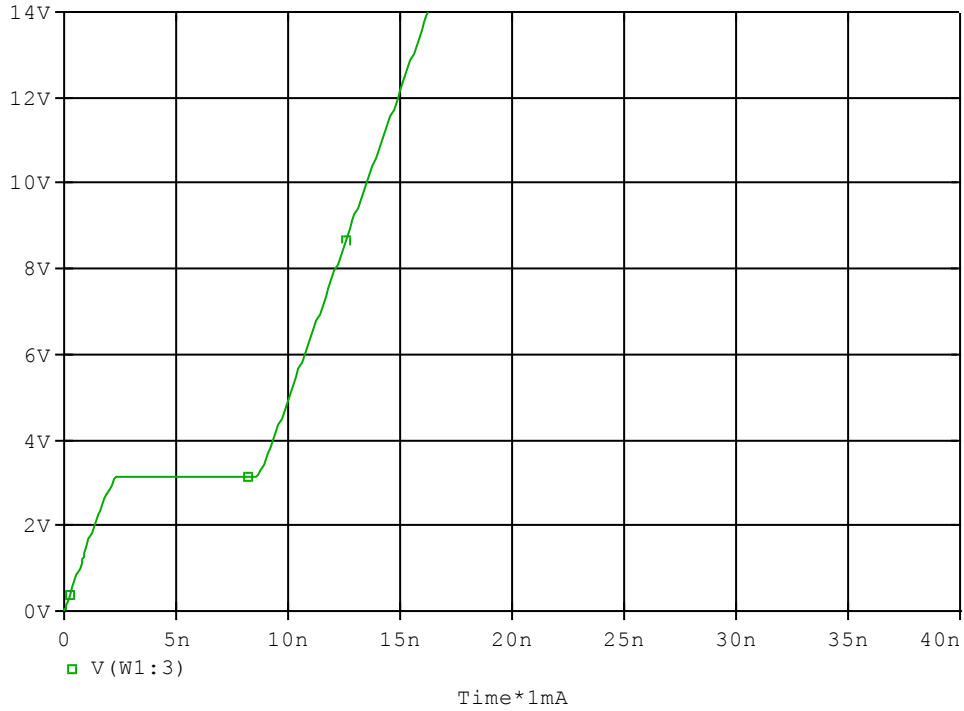


Simulation Result

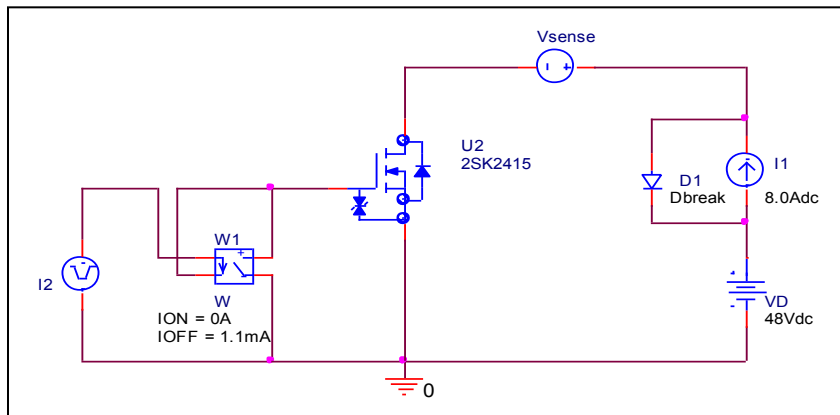
$I_D=4.0A, V_{GS}=10V$	Measurement		Simulation		Error (%)
$R_{DS} (on)$	0.07	Ω	0.07	Ω	0.000

Gate Charge Characteristic

Circuit Simulation result



Evaluation circuit

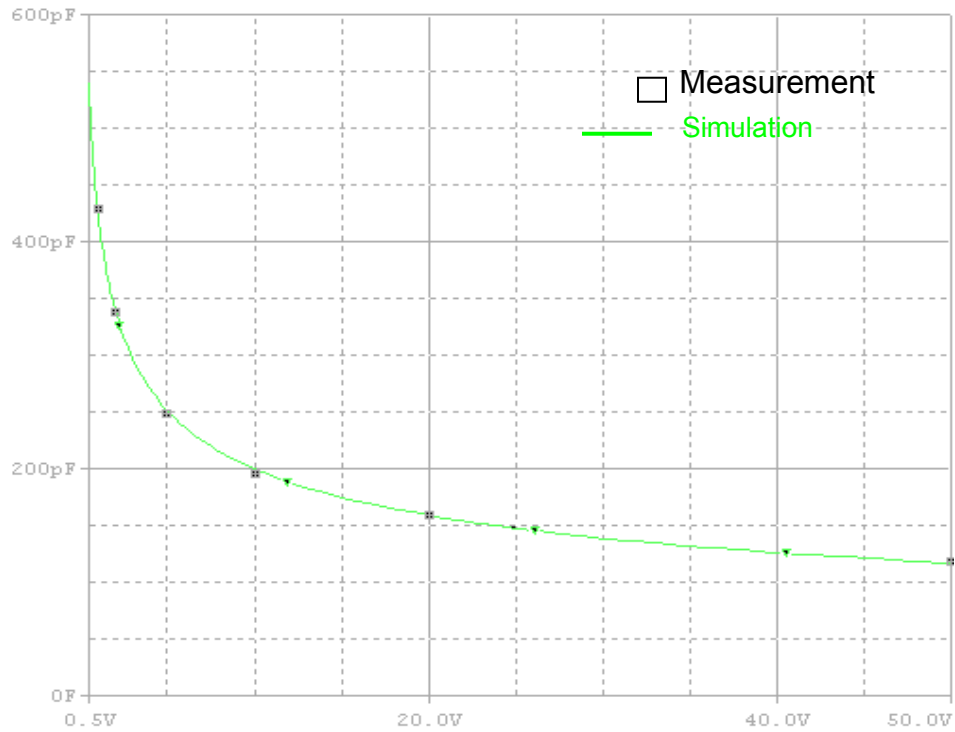


Simulation Result

$V_{DD}=48V, I_D=8.0A$ $V_{GS}=10V$		Measurement	Simulation	Error (%)
Qgs	ns	2.000	2.000	0.000
Qgd	ns	6.500	6.550	0.769

Capacitance Characteristic

Circuit Simulation result

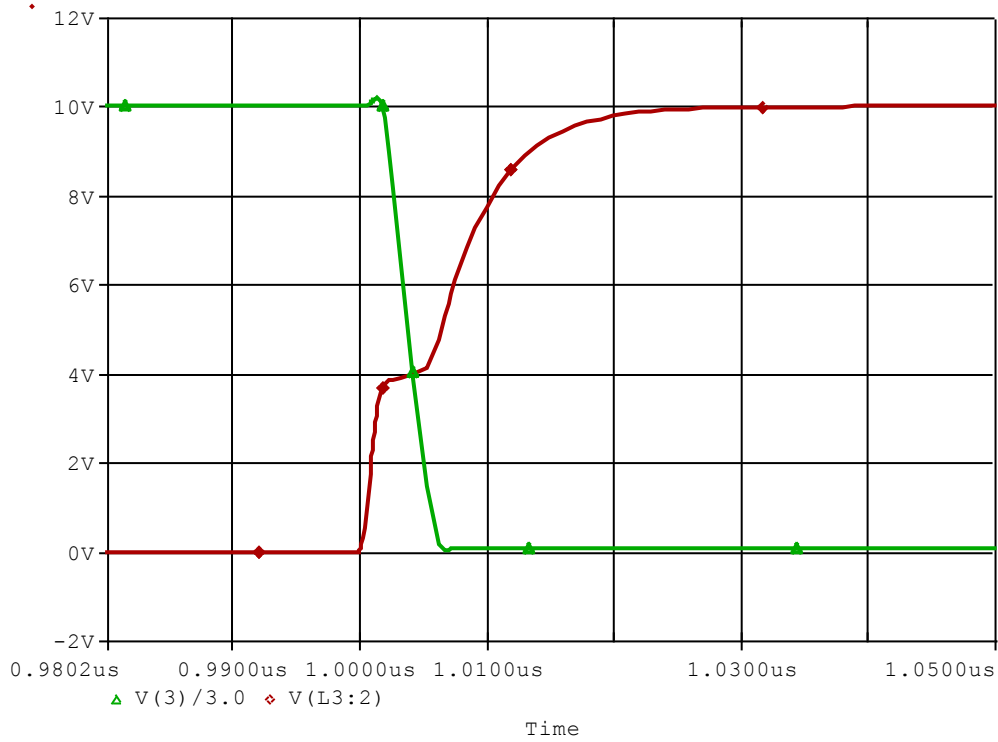


Simulation Result

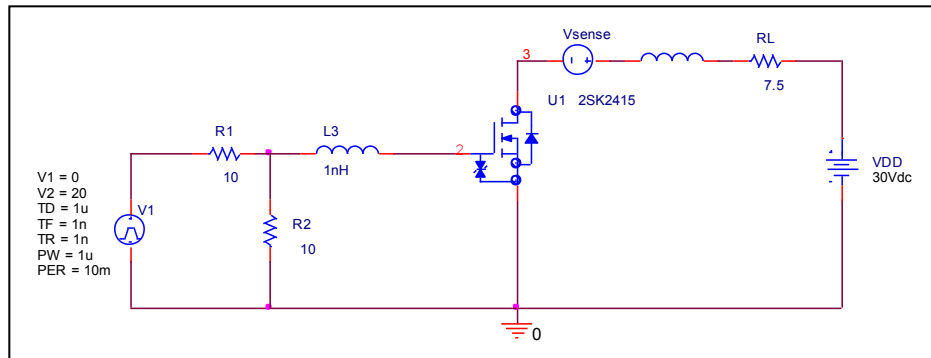
V _{DS} (V)	Cbd(pF)		Error(%)
	Measurement	Simulation	
1	430.000	428.422	-0.367
2	340.000	340.880	0.259
5	250.000	251.181	0.472
10	197.000	199.927	1.486
20	160.000	158.600	-0.875
50	120.000	116.986	-2.512

Switching Time Characteristic

Circuit Simulation result



Evaluation circuit

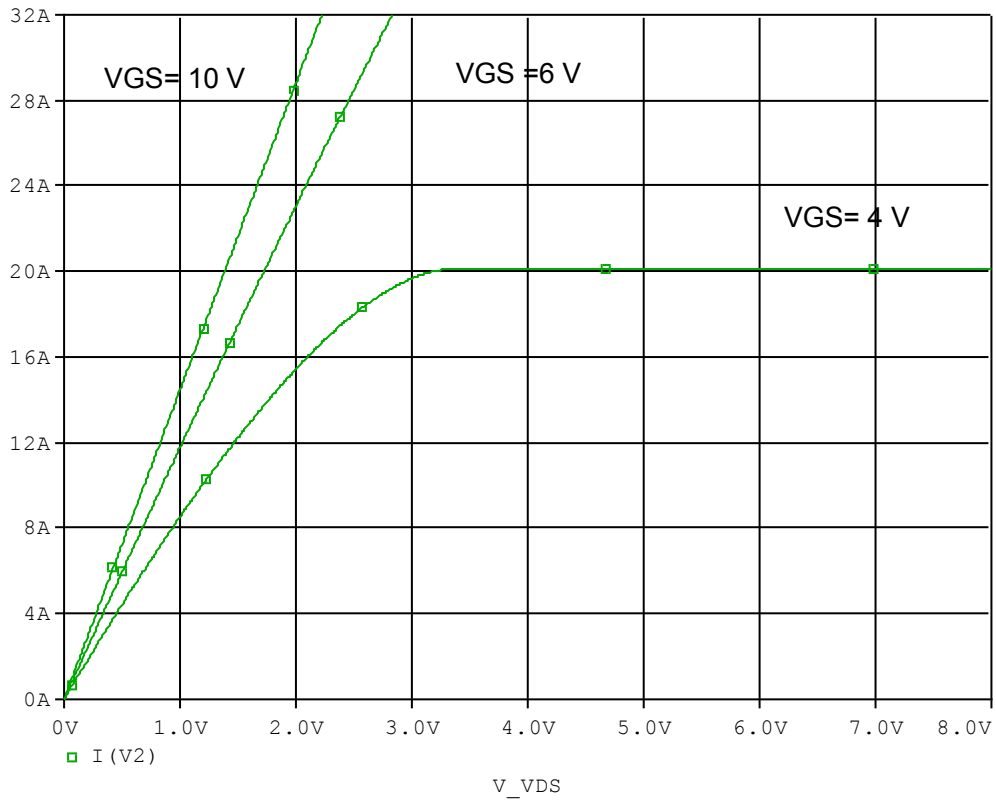


Simulation Result

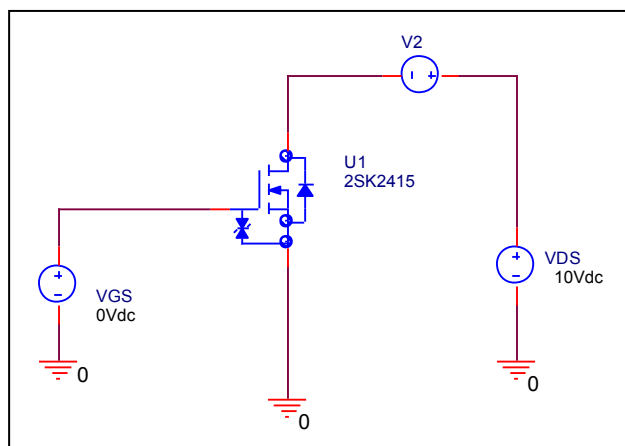
$I_D=4A, V_{DD}=30V$ $V_{GS}=0/10V$		Measurement	Simulation	Error(%)
t_d (on)	ns	5.000	4.982	-0.360

Output Characteristic

Circuit Simulation result

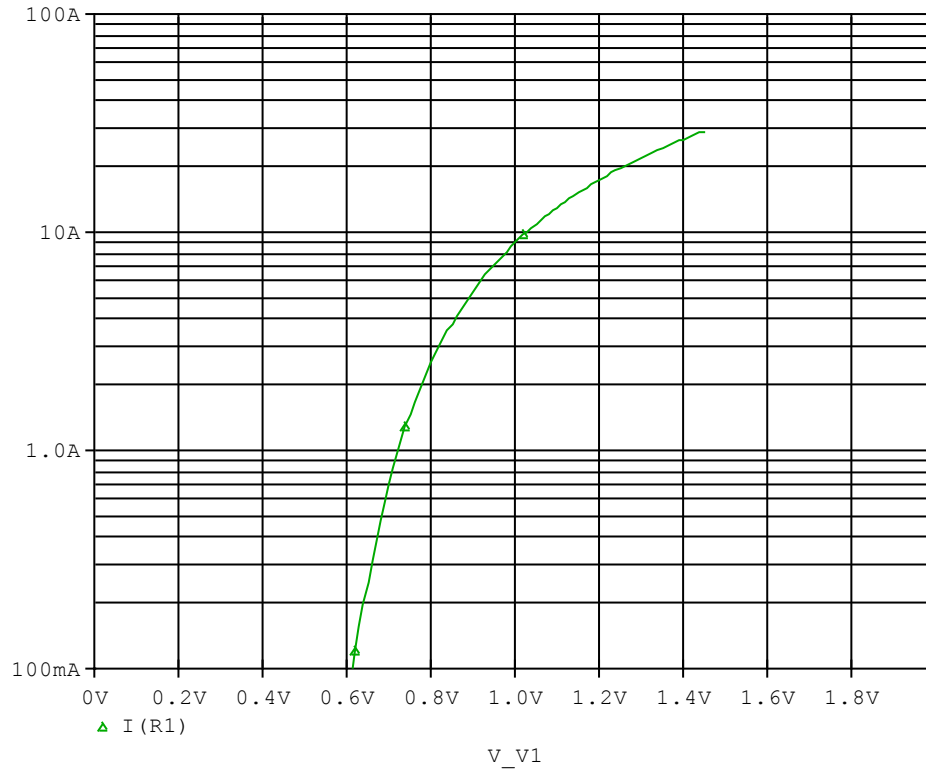


Evaluation circuit

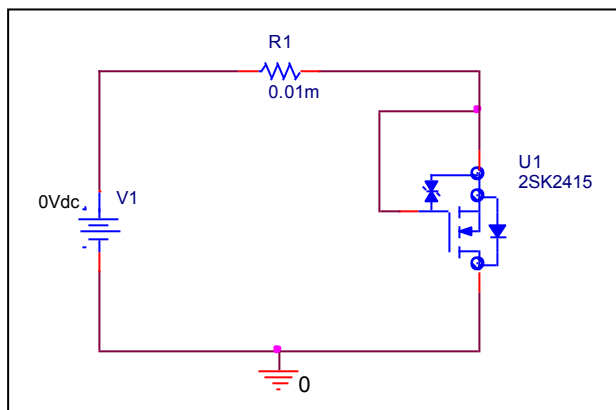


BODY DIODE SPICE MODEL Forward Current Characteristic

Circuit Simulation Result

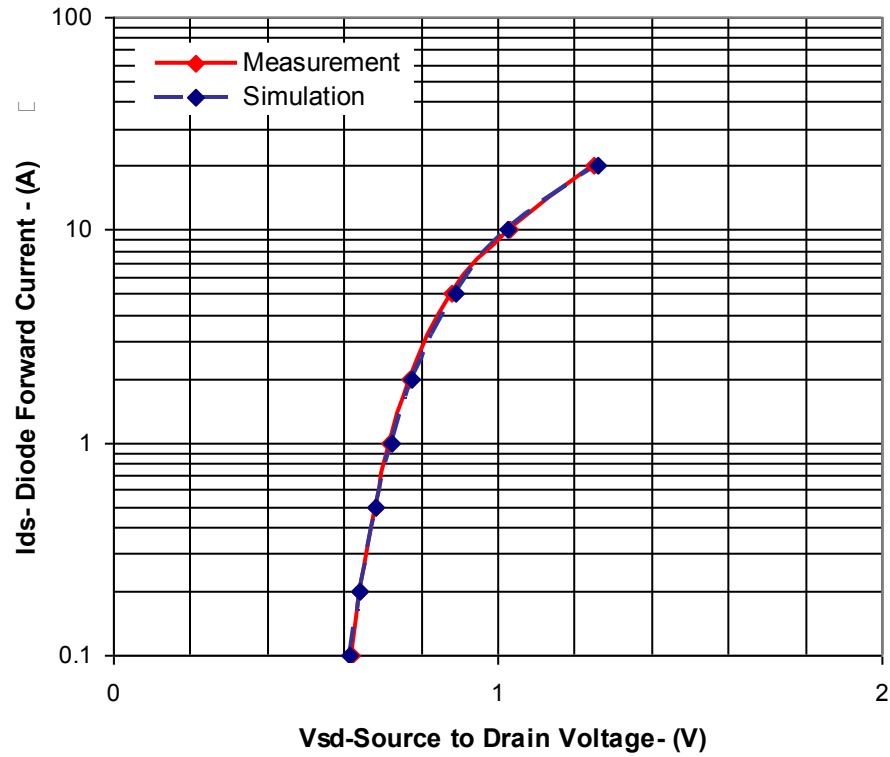


Evaluation Circuit



Comparison Graph

Circuit Simulation Result

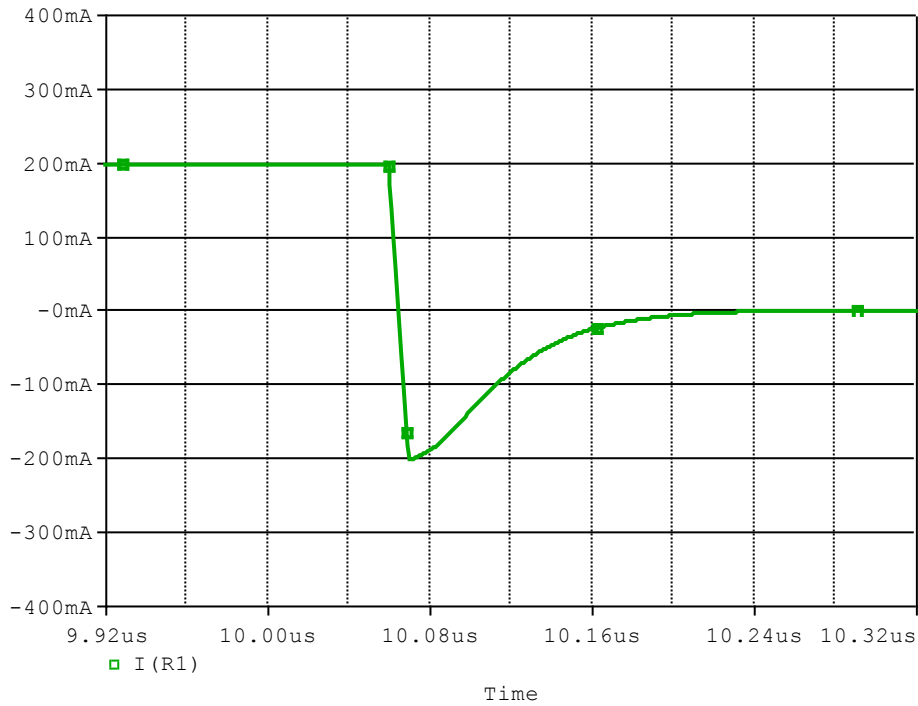


Simulation Result

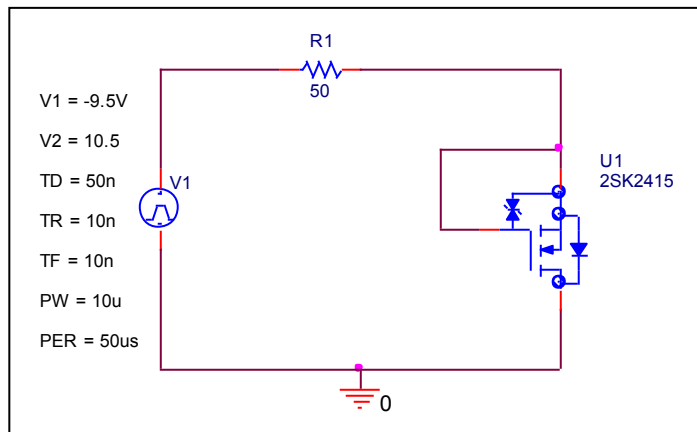
IDR(A)	VDS(V)		%Error
	Measurement	Simulation	
0.1	0.620	0.6129	-1.145
0.2	0.640	0.6404	0.062
0.5	0.680	0.6820	0.294
1	0.720	0.7223	0.319
2	0.770	0.7770	0.909
5	0.880	0.8890	1.022
10	1.030	1.0274	-0.252
20	1.250	1.2584	0.672

Reverse Recovery Characteristic

Circuit Simulation Result



Evaluation Circuit

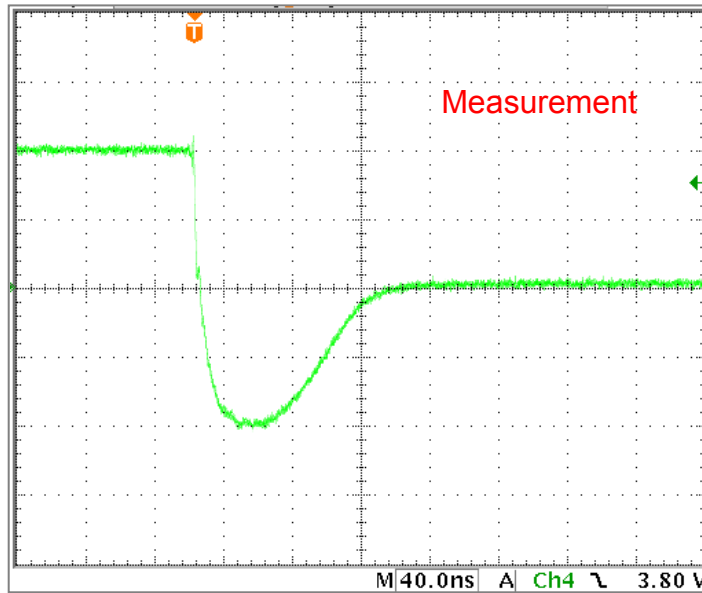


Compare Measurement vs. Simulation

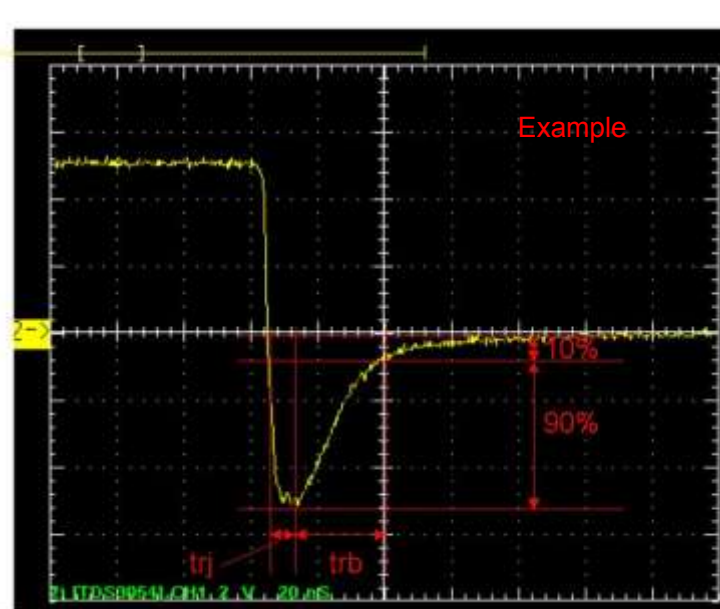
	Measurement	Simulation	Error (%)
trr (ns)	105.00	104.00	-0.950

Reverse Recovery Characteristic

Reference



Trj=35 (ns)
Trb=70 (ns)
Conditions: Ifwd=Irev=0.2(A), RI=50

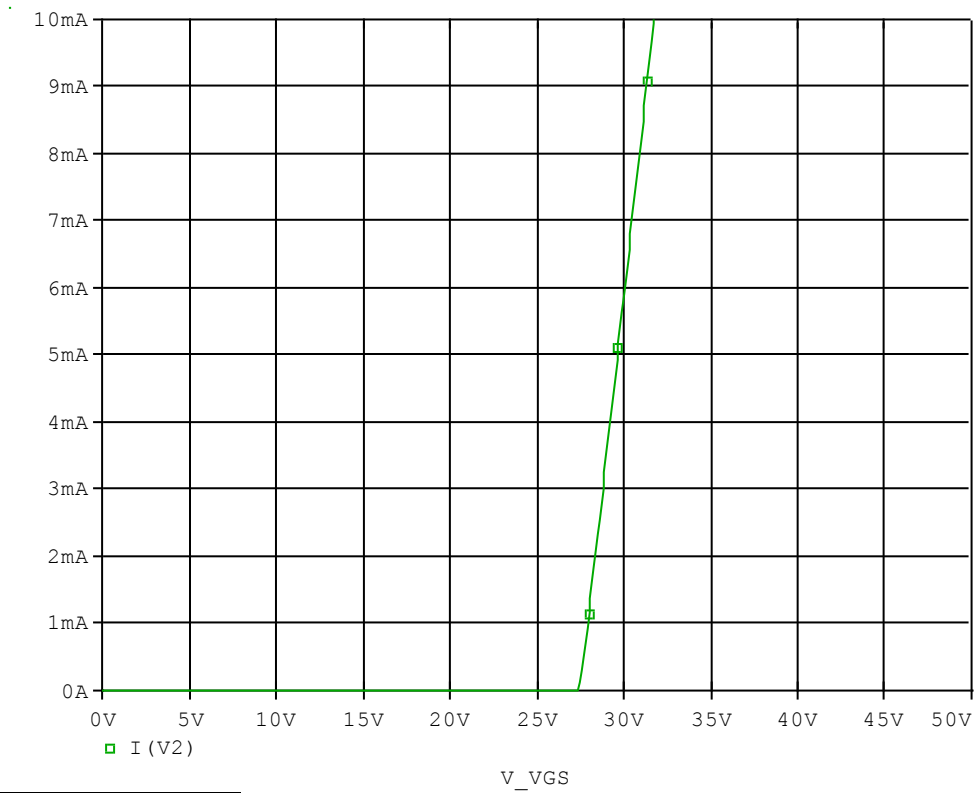


Relation between trj and trb

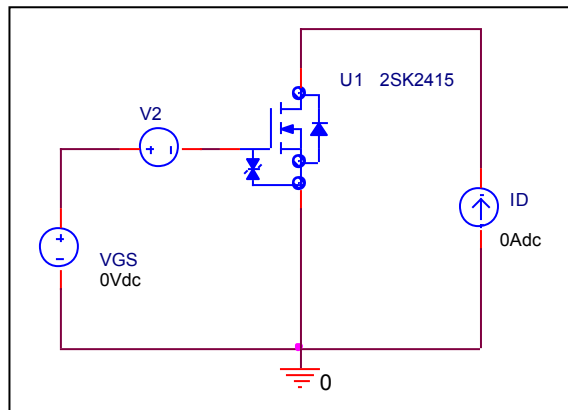
ESD PROTECTION DIODE SPICE MODEL

Zener Voltage Characteristic

Circuit Simulation Result



Evaluation Circuit



Zener Voltage Characteristic

Reference

