Device Modeling Report

COMPONENTS: MOSFET (Professional Model)
PART NUMBER: 2SK4065-DL-E
MANUFACTURER: SANYO
REMARK: Body Diode (Professional Model) /
ESD Protection Diode

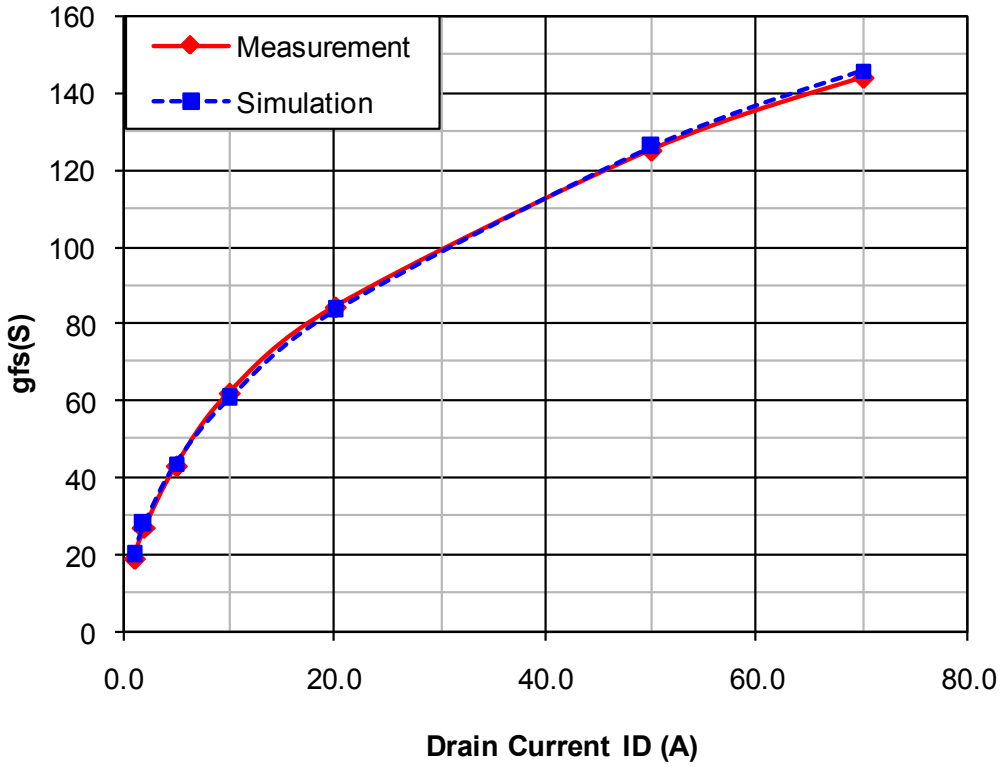
Bee Technologies Inc.

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

Transconductance Characteristic

Circuit Simulation Result

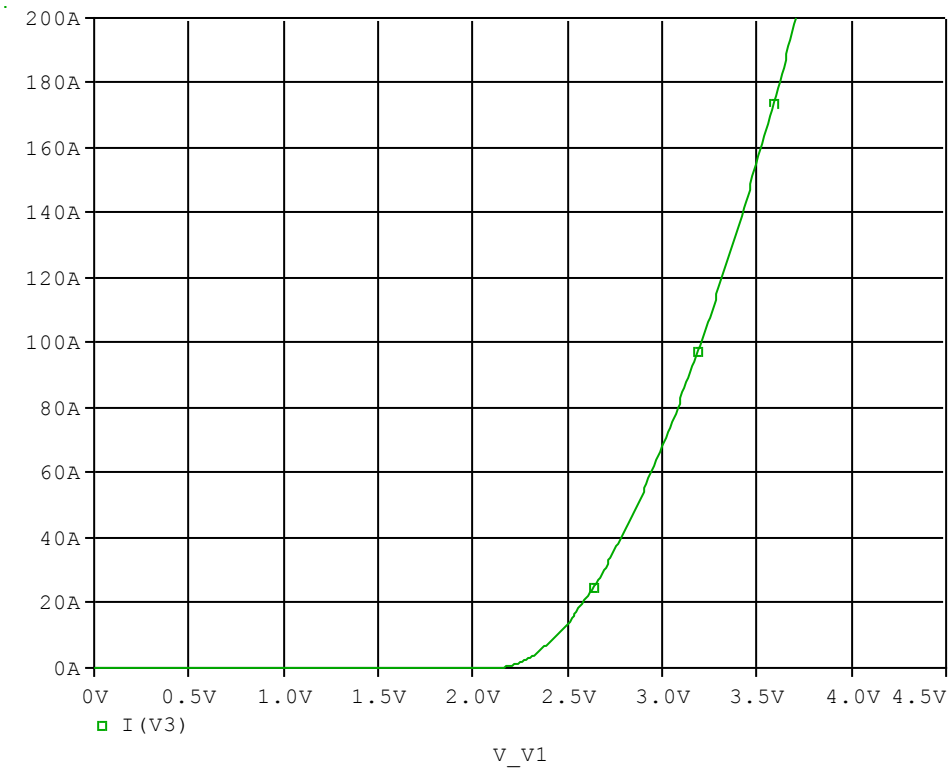


Comparison table

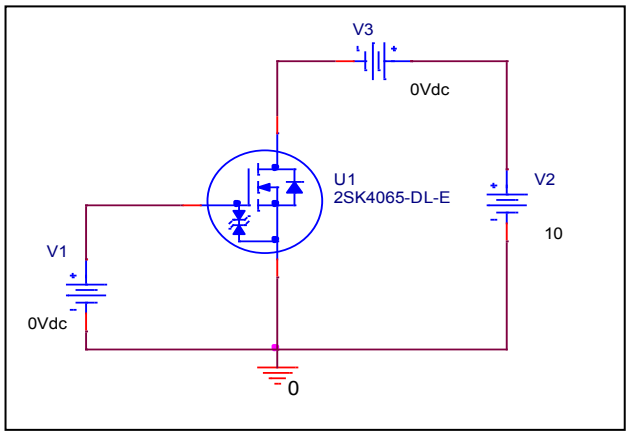
Id(A)	gfs(S)		Error (%)
	Measurement	Simulation	
1	19.000	19.944	4.97
2	27.000	28.016	3.76
5	43.000	43.627	1.46
10	62.000	60.622	-2.22
20	84.500	83.642	-1.02
50	125.000	126.126	0.90
70	144.000	145.866	1.30

Vgs-Id Characteristic

Circuit Simulation result

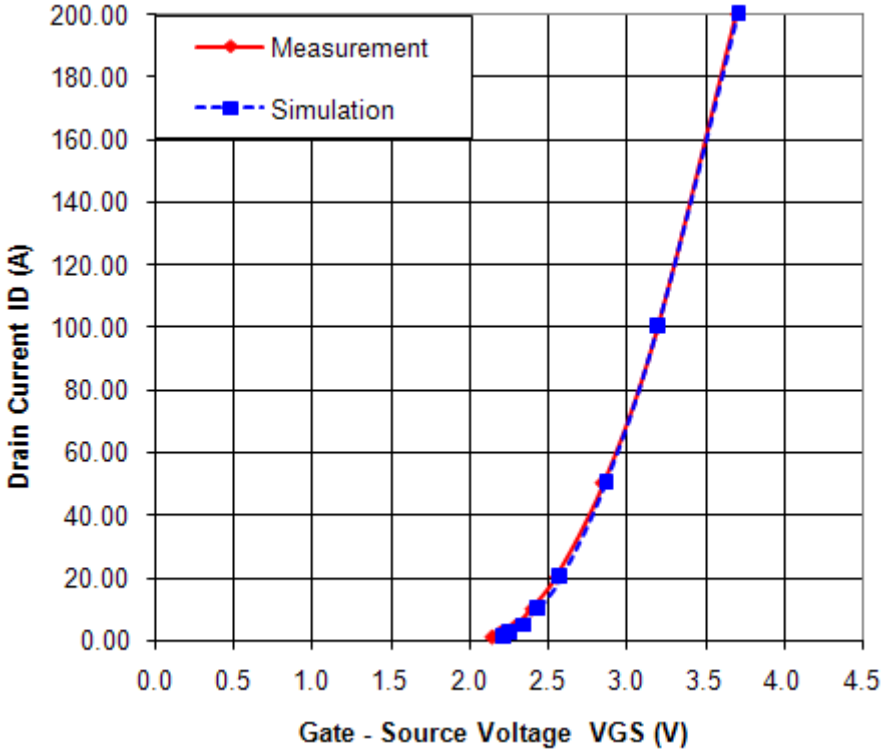


Evaluation circuit



Comparison Graph

Circuit Simulation Result

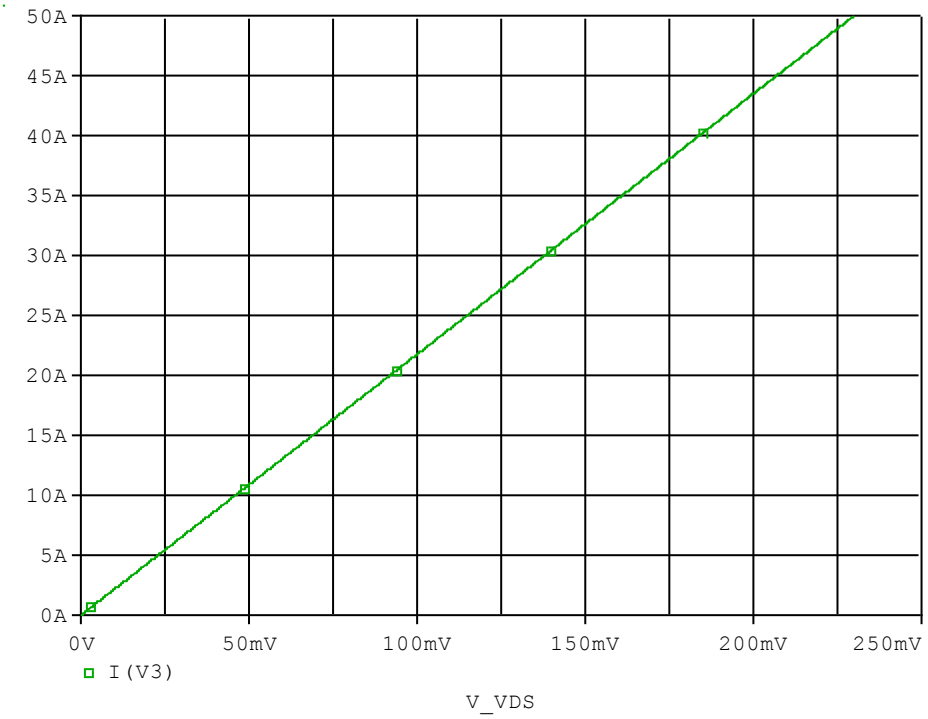


Simulation Result

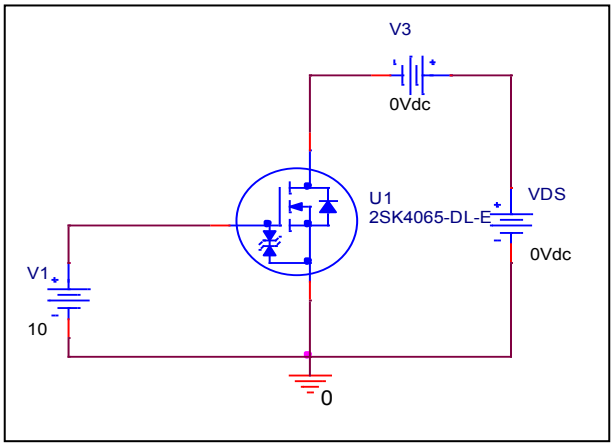
I_D(A)	V_{GS}(V)		Error (%)
	Measurement	Simulation	
1	2.150	2.223	3.39
2	2.200	2.264	2.93
5	2.300	2.348	2.09
10	2.400	2.444	1.82
20	2.550	2.582	1.26
50	2.850	2.867	0.59
100	3.200	3.204	0.12
200	3.700	3.710	0.26

Rds(on) Characteristic

Circuit Simulation result



Evaluation circuit

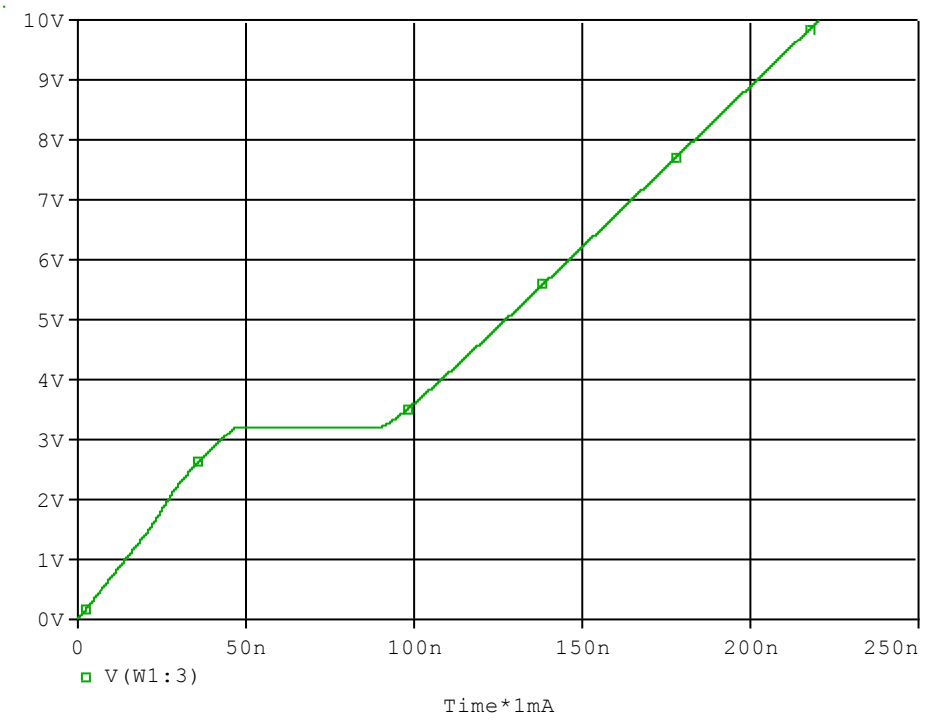


Simulation Result

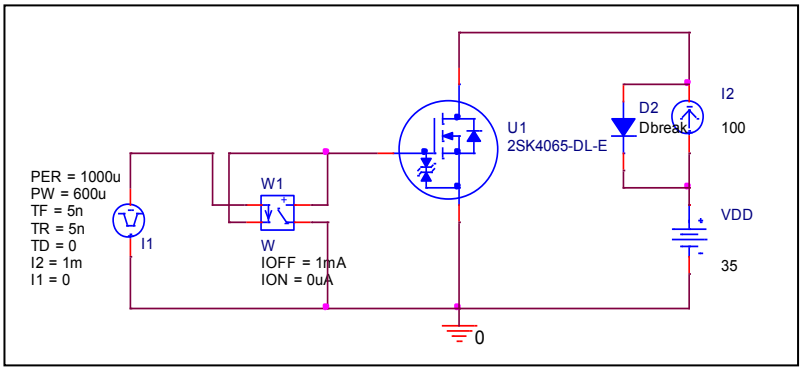
I_D = 50A, V_{GS} = 10V		Measurement	Simulation	Error (%)
R_{DS} (on)	mΩ	4.600	4.600	0.00

Gate Charge Characteristic

Circuit Simulation result



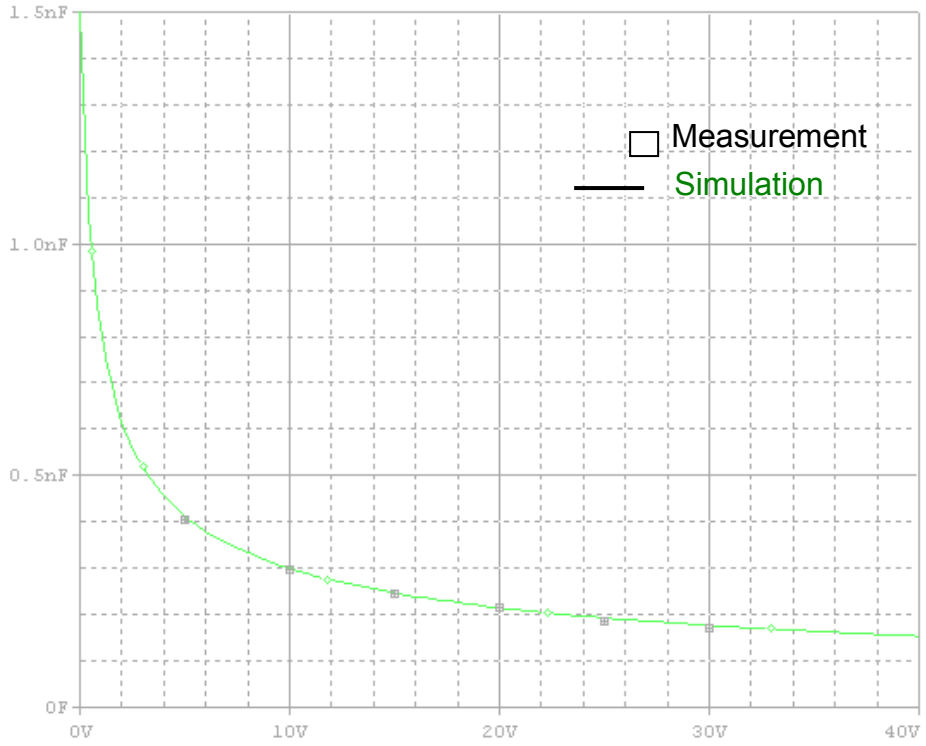
Evaluation circuit



Simulation Result

V_{DD}=35V, I_D=100A, V_{GS}=10V		Measurement	Simulation	Error (%)
Qgs	nC	40.000	40.059	0.15
Qgd	nC	50.000	50.056	0.11
Qg	nC	220.000	220.479	0.22

Capacitance Characteristic

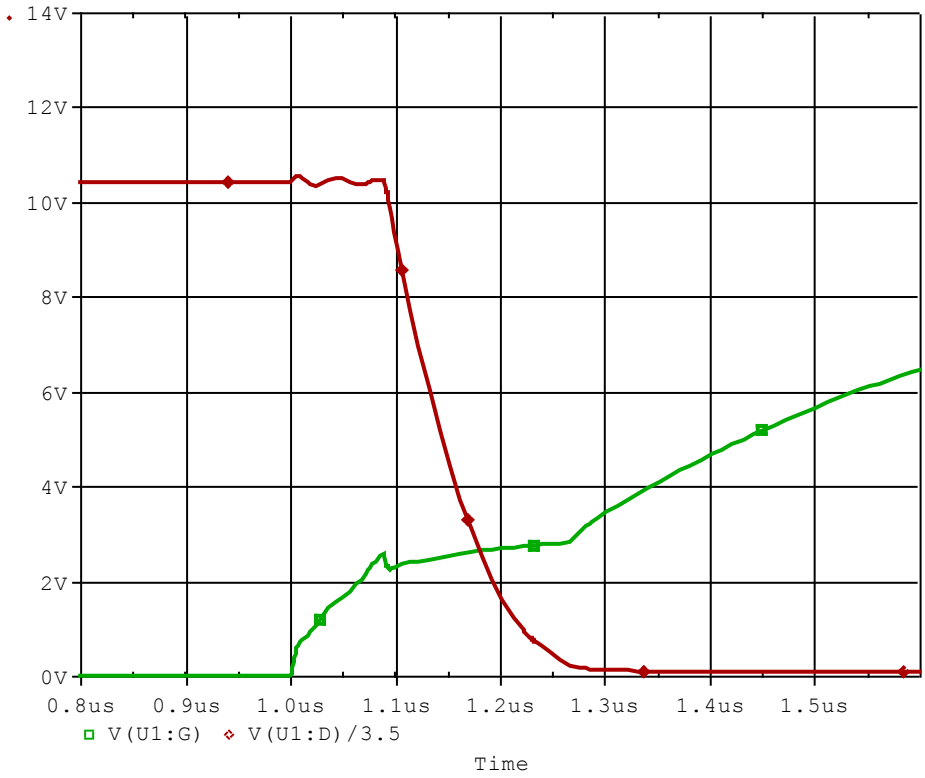


Simulation Result

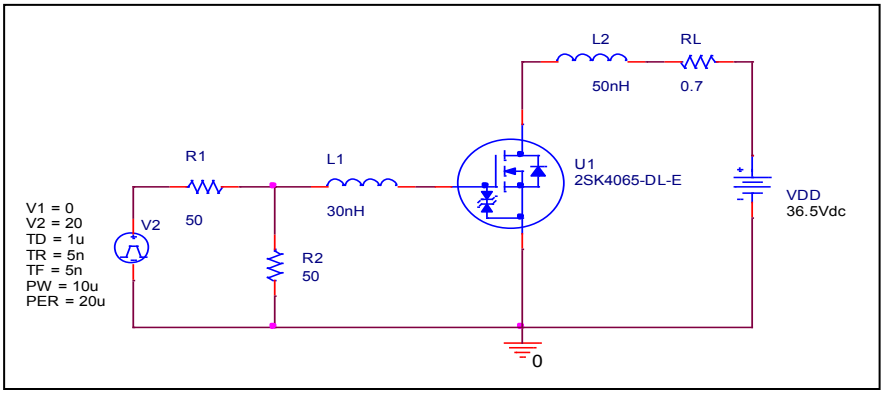
V_{DS} (V)	Cbd (pF)		Error (%)
	Measurement	Simulation	
0.00	1500.000	1500.000	0.00
5.00	410.000	413.330	0.81
10.00	300.000	299.470	-0.18
15.00	250.000	246.940	-1.22
20.00	220.000	215.080	-2.24
25.00	190.000	193.120	1.64
30.00	175.000	176.805	1.03

Switching Time Characteristic

Circuit Simulation result



Evaluation circuit

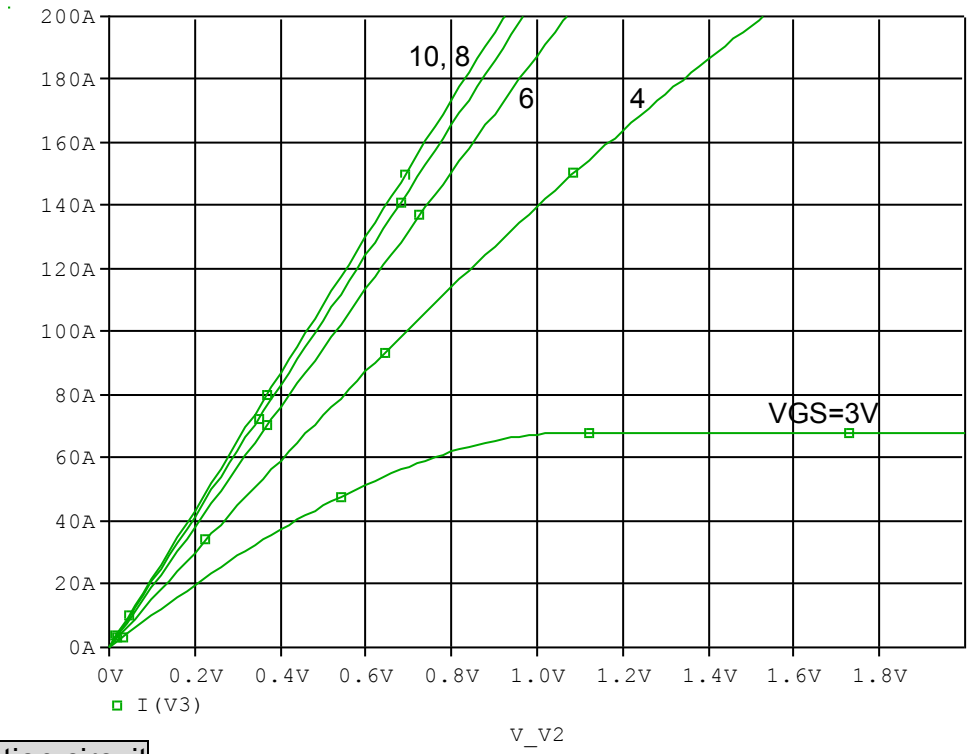


Simulation Result

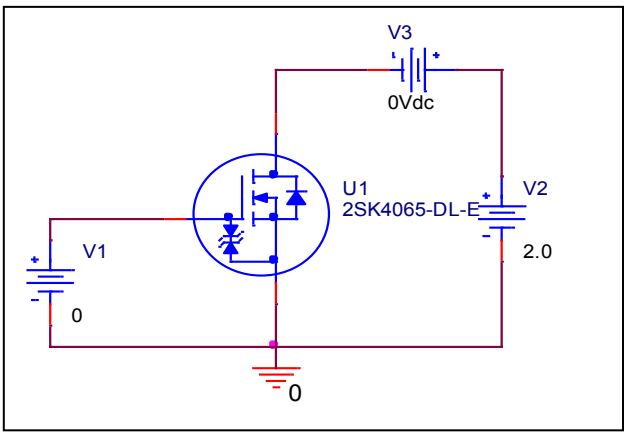
I_D=50A, V_{DD}=35V V_{GS}=0/10V		Measurement	Simulation	Error(%)
td(on)	ns	80.000	79.986	-0.02

Output Characteristic

Circuit Simulation result

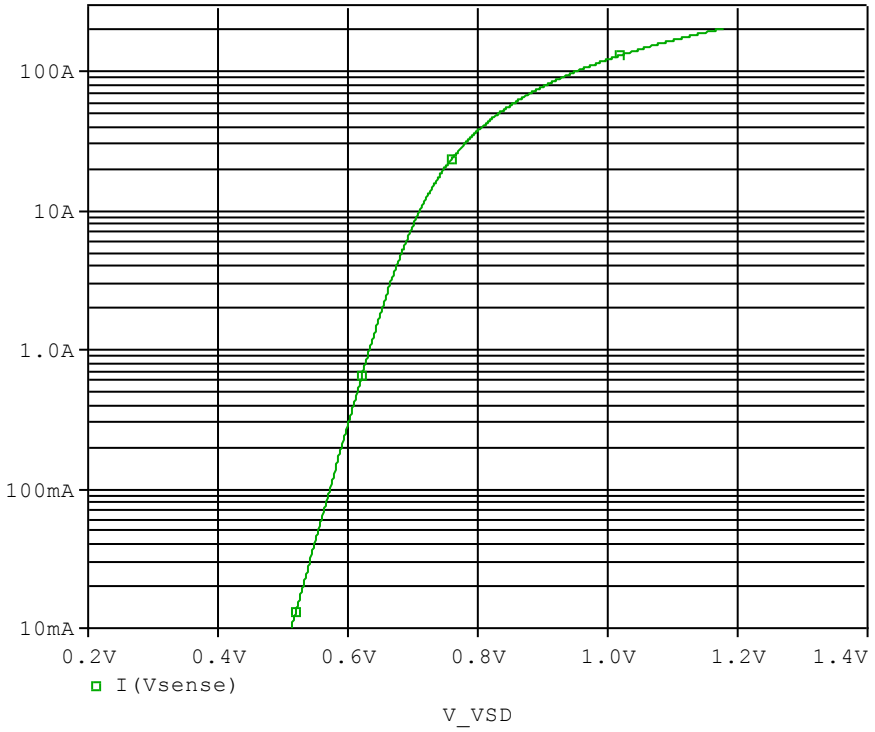


Evaluation circuit

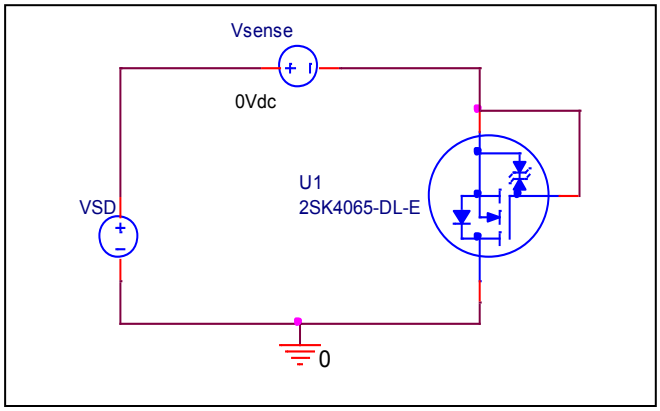


Forward Current Characteristic

Circuit Simulation Result

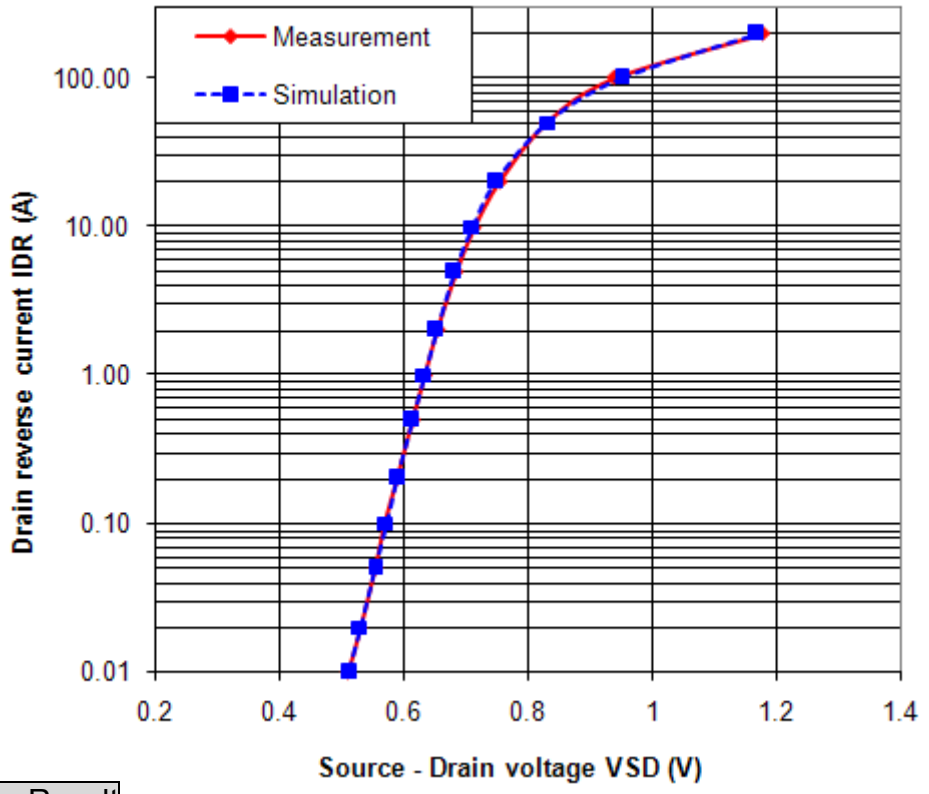


Evaluation Circuit



Comparison Graph

Circuit Simulation Result

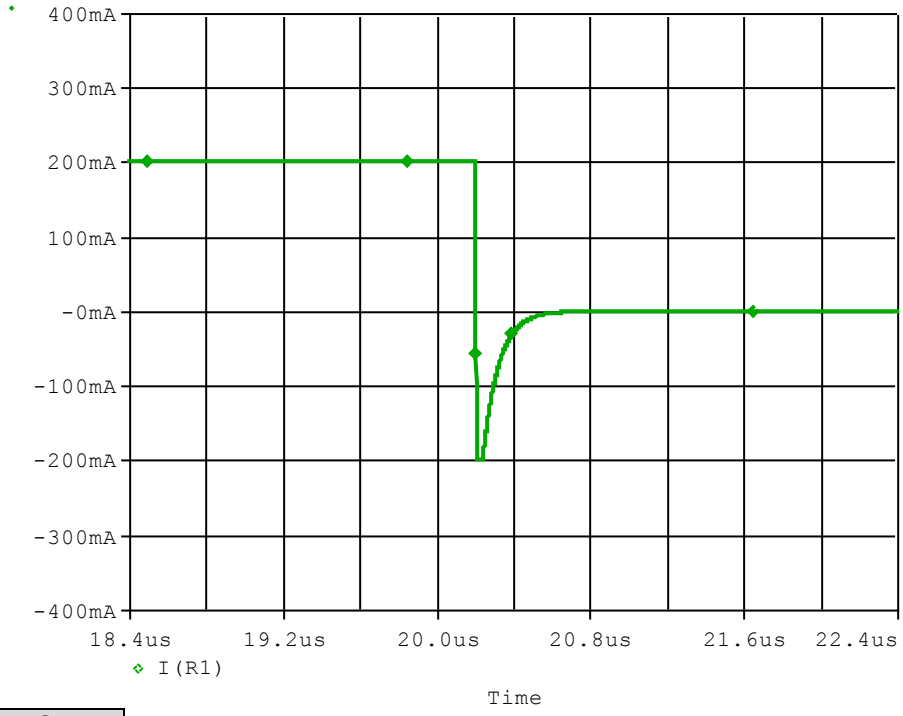


Simulation Result

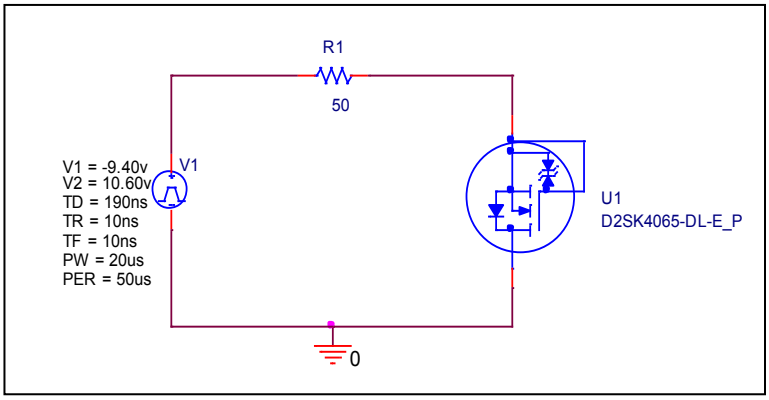
IDR(A)	VSD(V)		%Error
	Measurement	Simulation	
0.01	0.5100	0.5127	0.54
0.02	0.5300	0.5306	0.11
0.05	0.5550	0.5542	-0.14
0.1	0.5700	0.5721	0.38
0.2	0.5900	0.5902	0.03
0.5	0.6150	0.6143	-0.11
1	0.6350	0.6332	-0.29
2	0.6550	0.6530	-0.30
5	0.6850	0.6826	-0.34
10	0.7150	0.7105	-0.62
20	0.7550	0.7485	-0.86
50	0.8300	0.8325	0.30
100	0.9400	0.9511	1.18
200	1.1800	1.1704	-0.81

Reverse Recovery Characteristics

Circuit Simulation Result



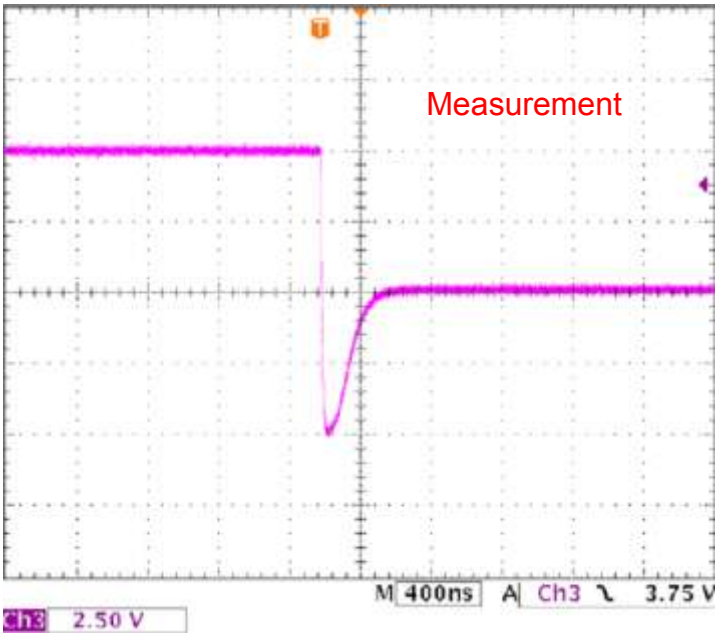
Evaluation Circuit



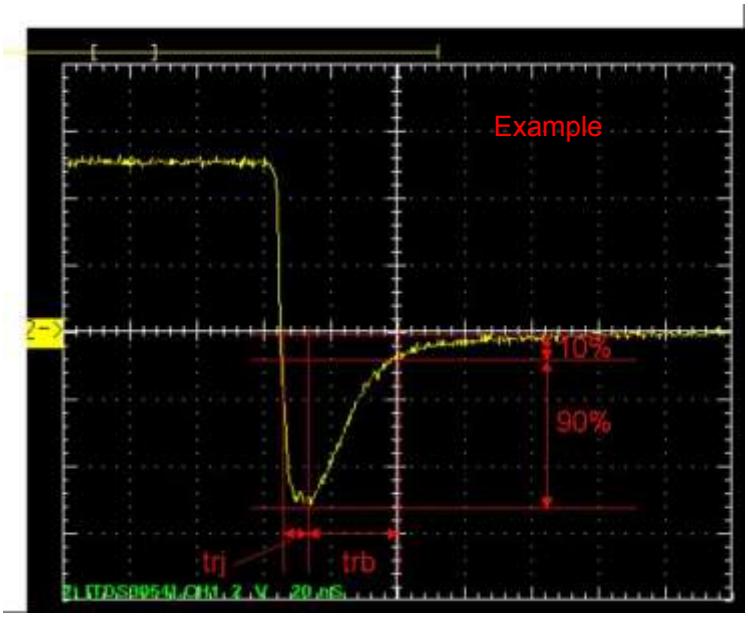
Compare Measurement vs. Simulation

		Measurement	Simulation	Error (%)
trj	ns	40.000	40.648	1.62
trb	ns	184.000	183.895	-0.06
trr	ns	224.000	224.543	0.24

Reverse Recovery Characteristic Reference



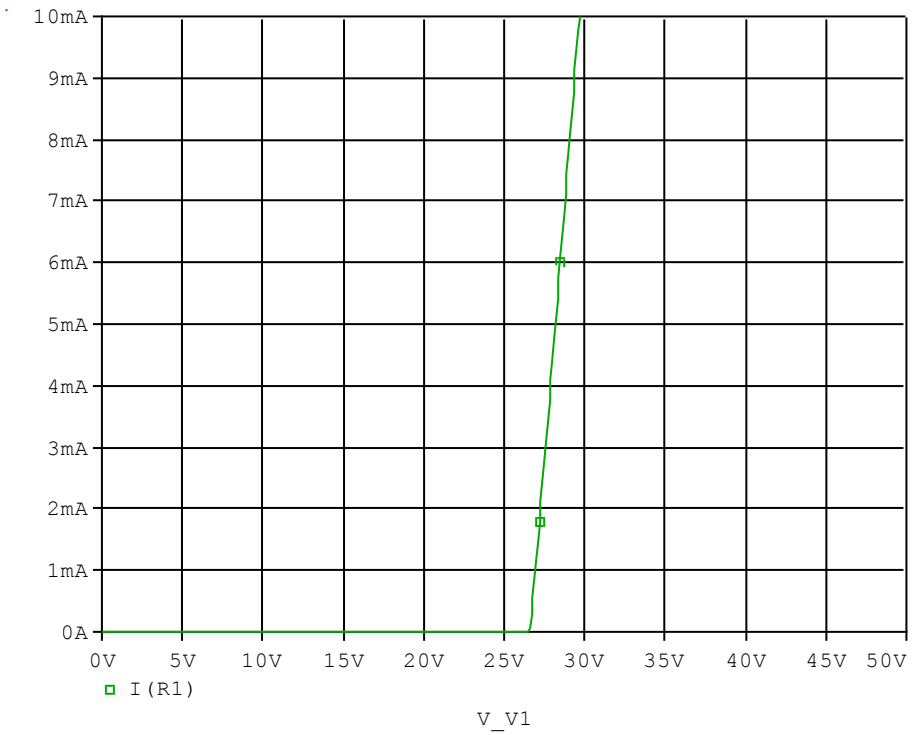
Trj=40(ns)
Trb=184(ns)
Conditions:Ifwd=Irev=0.2(A),Rl=50



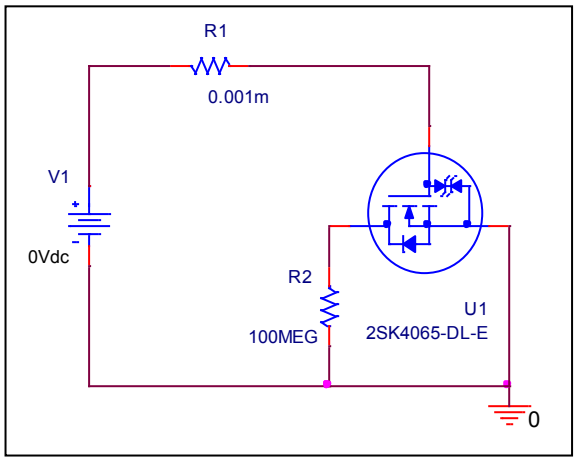
Relation between trj and trb

ESD PROTECTION DIODE SPICE MODEL
Zener Voltage Characteristic

Circuit Simulation Result



Evaluation Circuit



Zener Voltage Characteristic Reference