

Device Modeling Report

COMPONENTS: Power MOSFET (Model parameter)
PART NUMBER: 2SK3565
MANUFACTURER: TOSHIBA
Body Diode (Model parameter) / ESD Protection Diode

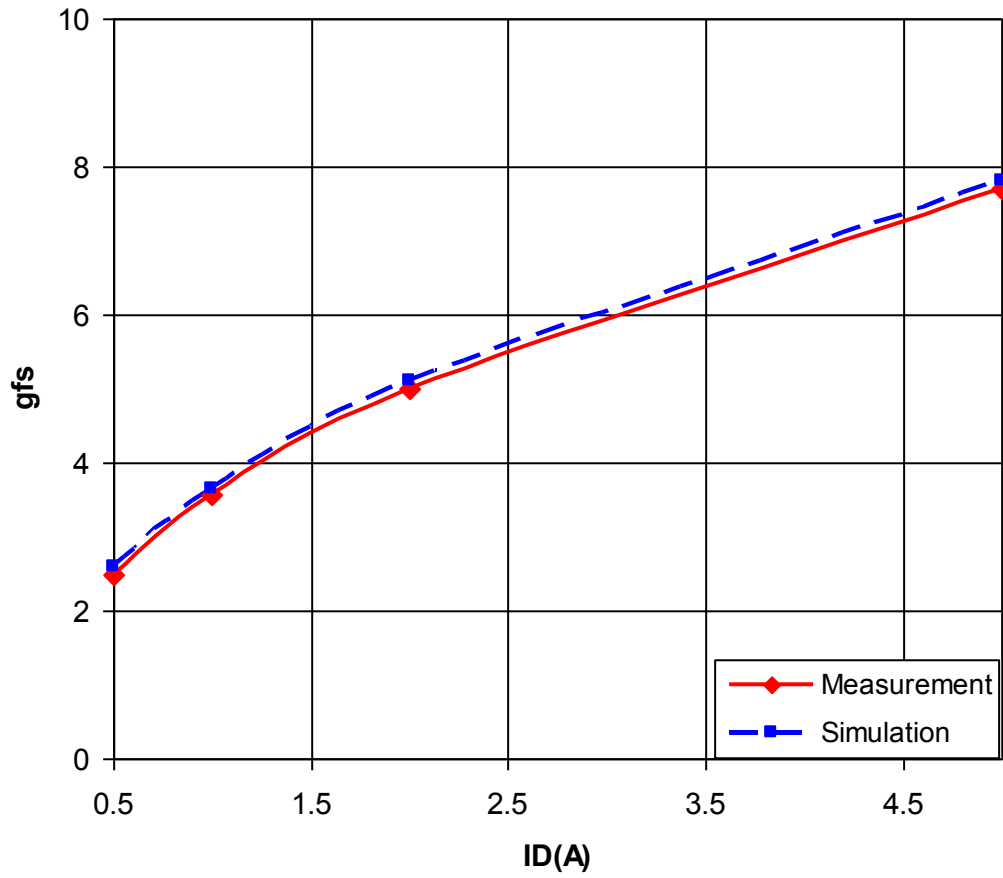


MOSFET MODEL

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

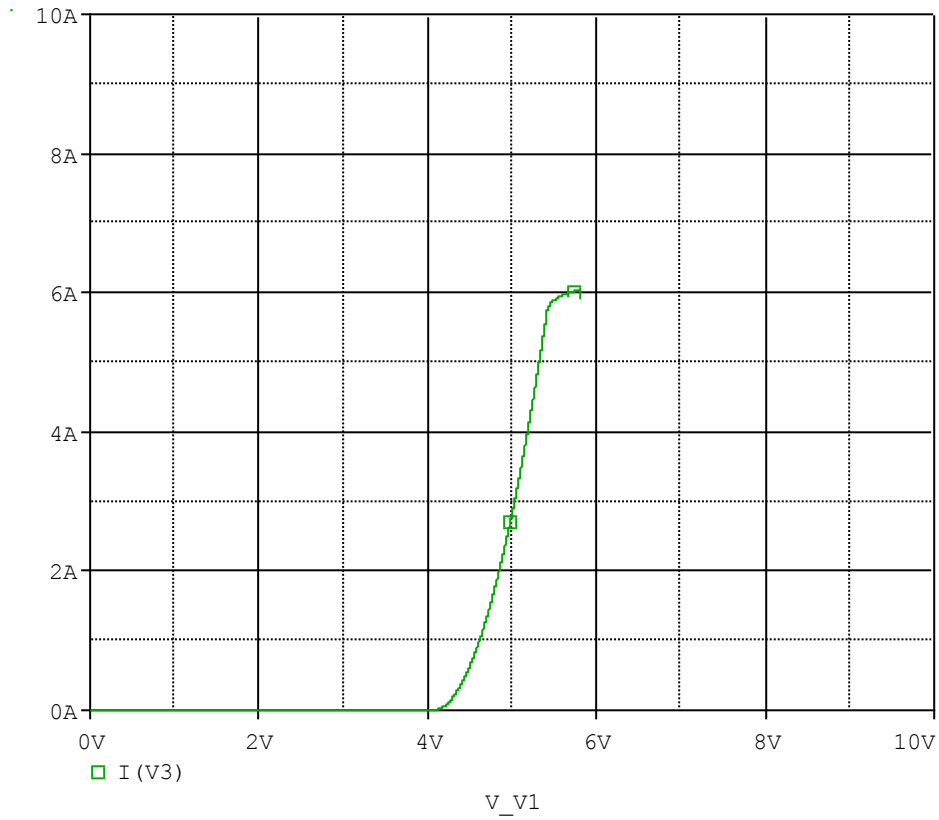


Comparison table

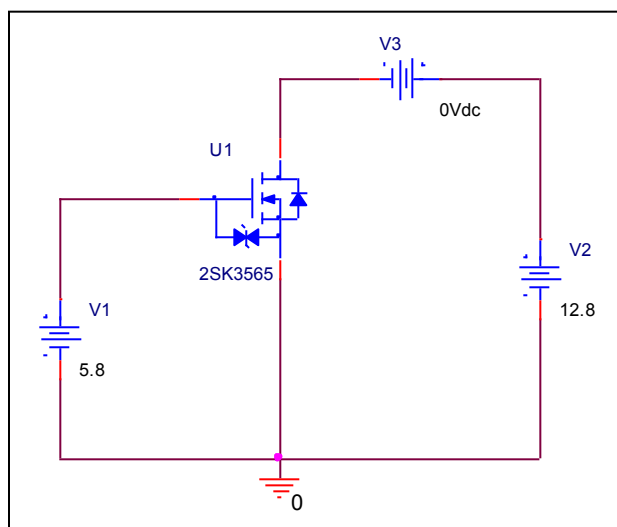
Id(A)	gfs		Error(%)
	Measurement	Simulation	
0.5	2.5	2.604	4.160
1	3.571	3.650	2.212
2	5	5.102	2.040
5	7.692	7.812	1.560

V_{gs}-I_d Characteristic

Circuit Simulation result

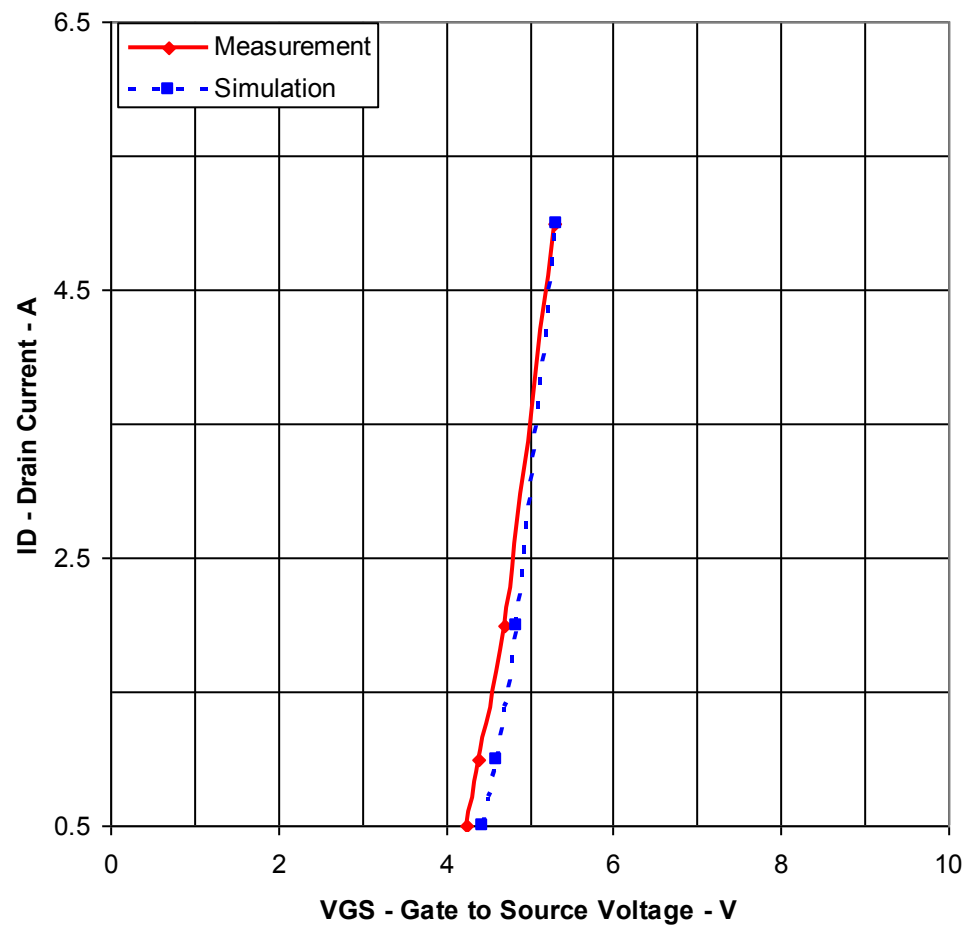


Evaluation circuit



Comparison Graph

Circuit Simulation Result

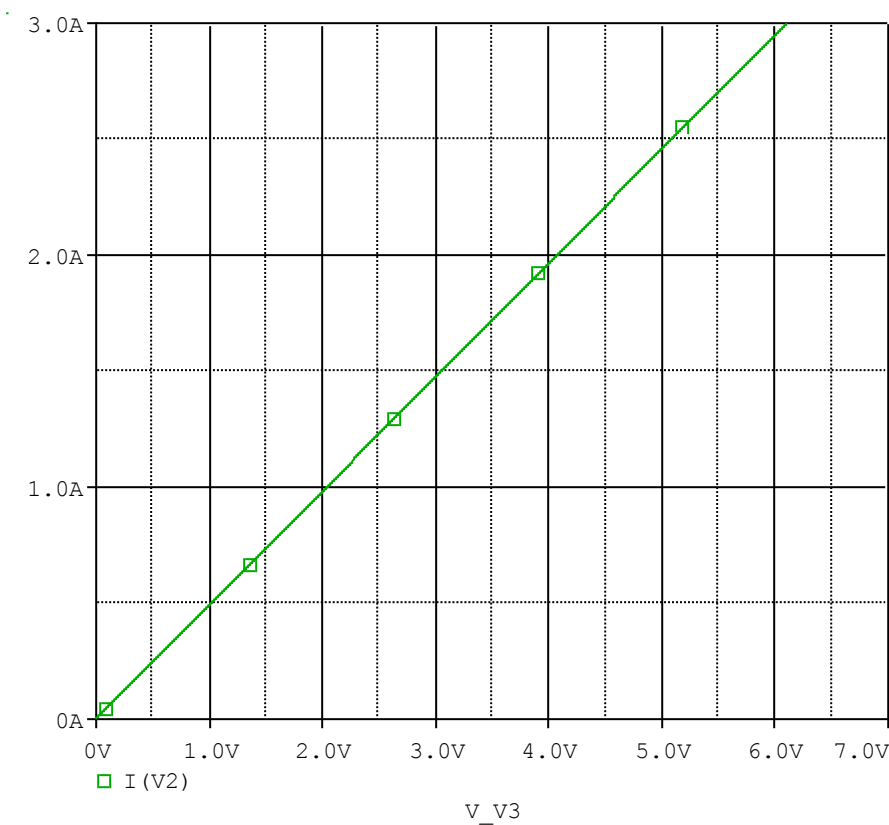


Simulation Result

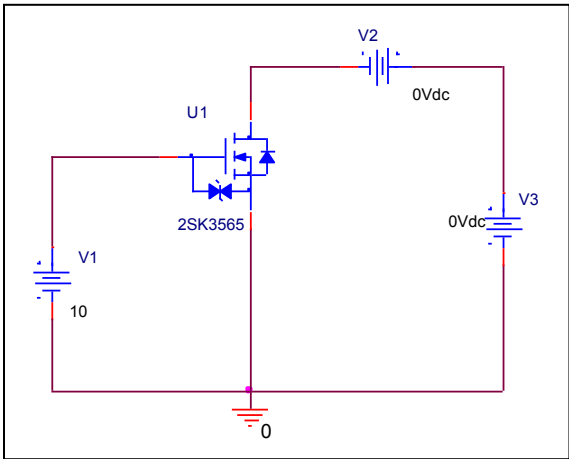
I_D (A)	V_{GS} (V)		Error (%)
	Measurement	Simulation	
0.5	4.25	4.449	4.682
1	4.4	4.6123	4.825
2	4.7	4.8462	3.111
5	5.3	5.3202	0.381

Rds(on) Characteristic

Circuit Simulation result



Evaluation circuit

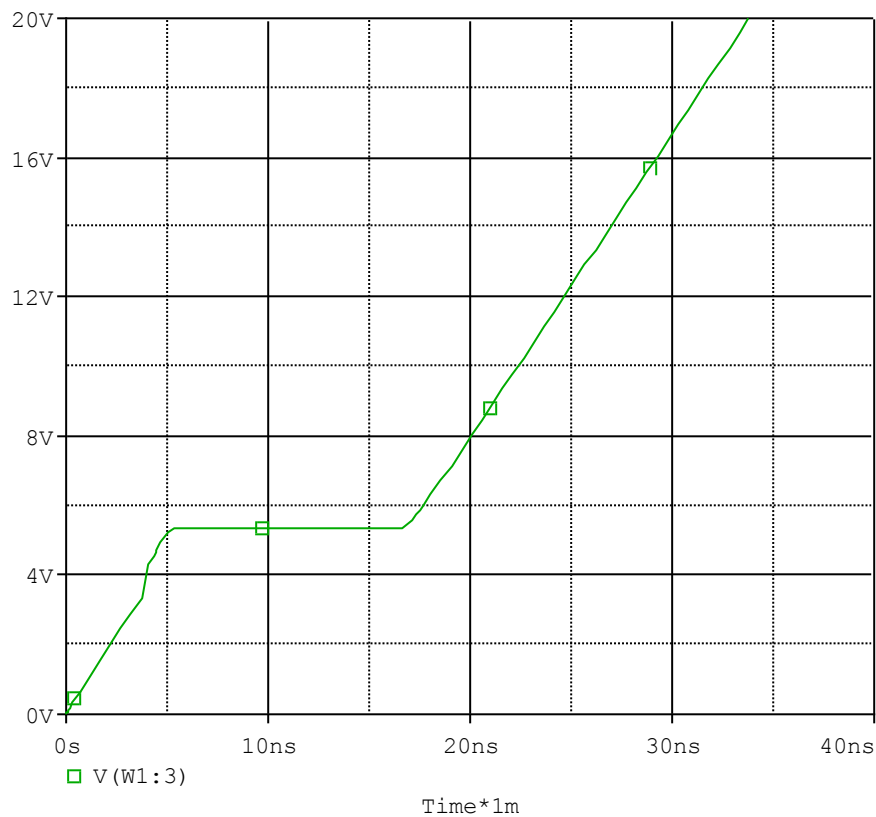


Simulation Result

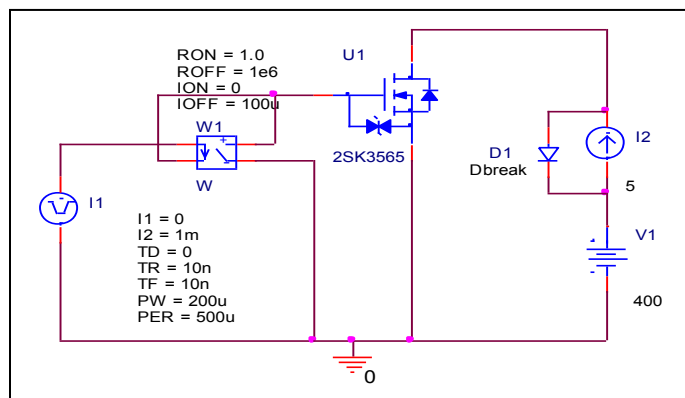
$I_D=3A, V_{GS}=10V$	Measurement		Simulation		Error (%)
$R_{DS(on)}$	2	Ω	2.035	Ω	1.75

Gate Charge Characteristic

Circuit Simulation result



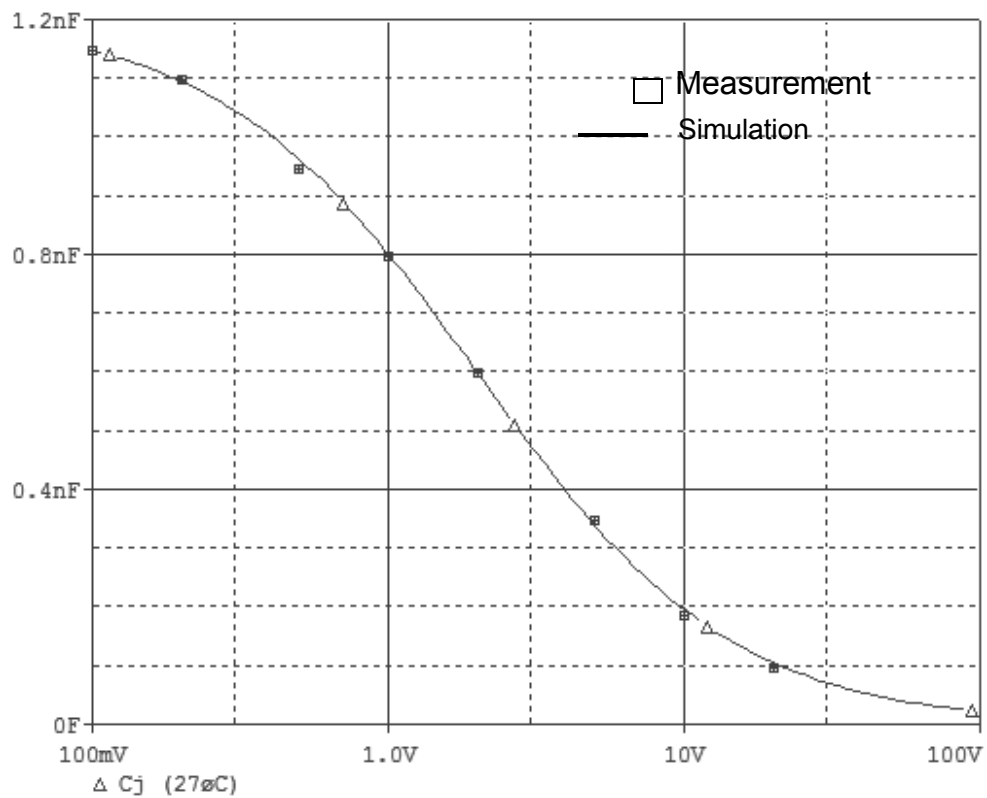
Evaluation circuit



Simulation Result

$V_{DD}=400V, I_D=5A$	Measurement		Simulation		Error (%)
Q_{gs}	5.2	nC	5.3228	nC	2.362
Q_{gd}	11.3	nC	11.269	nC	-0.274
Q_g	26	nC	22.358	nC	-14.008

Capacitance Characteristic

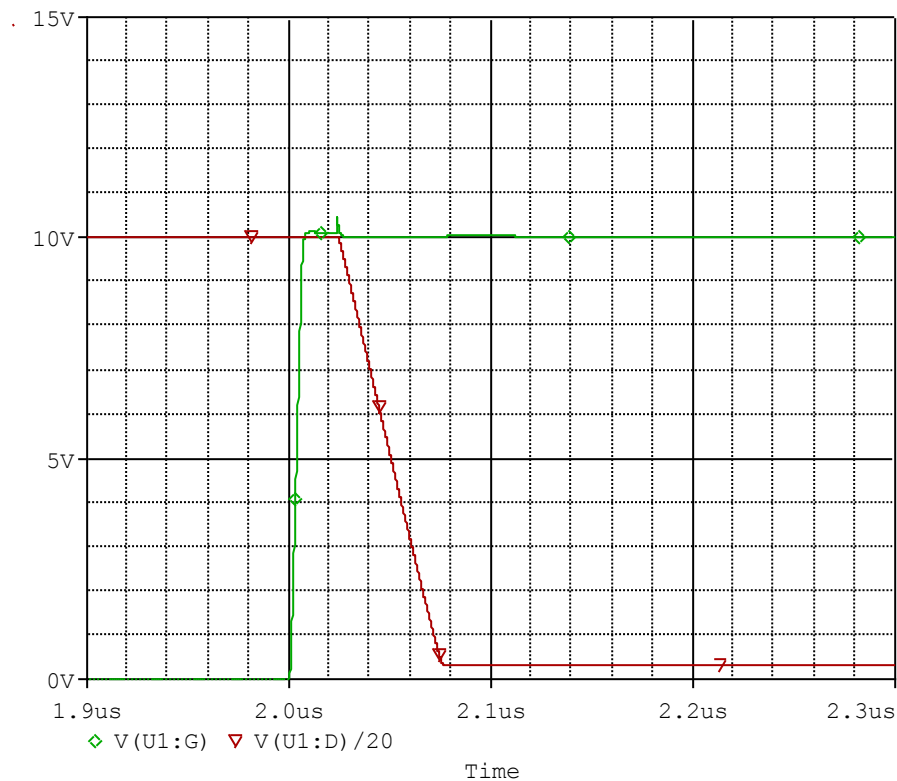


Simulation Result

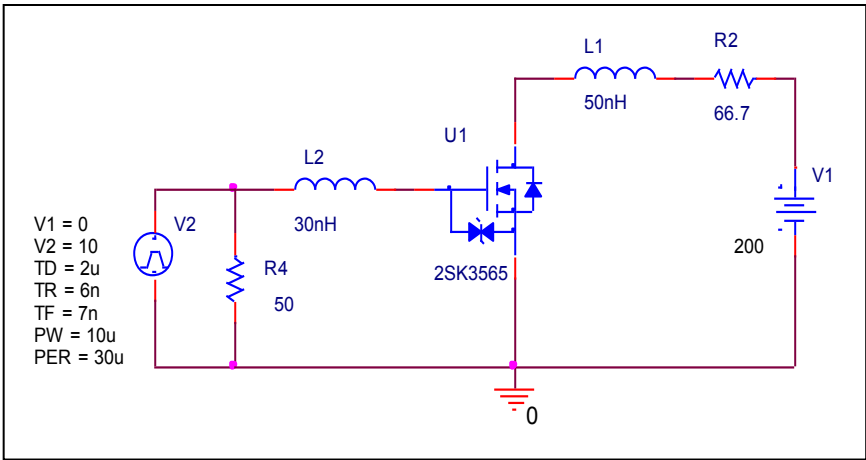
V _{DS} (V)	Cbd(pF)		Error(%)
	Measurement	Simulation	
0.1	1150	1145	-0.435
0.2	1100	1095	-0.455
0.5	950	960	1.053
1	800	800	0.000
2	600	598	-0.333
5	350	340	-2.857
10	190	195	2.632
20	100	105	5

Switching Time Characteristic

Circuit Simulation result



Evaluation circuit

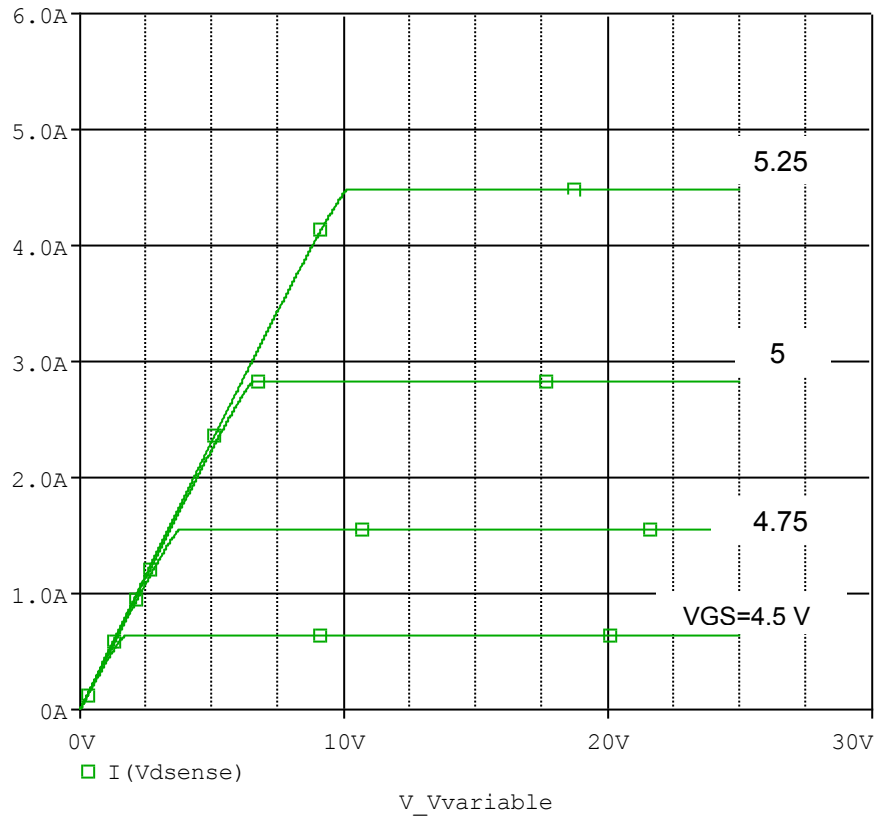


Simulation Result

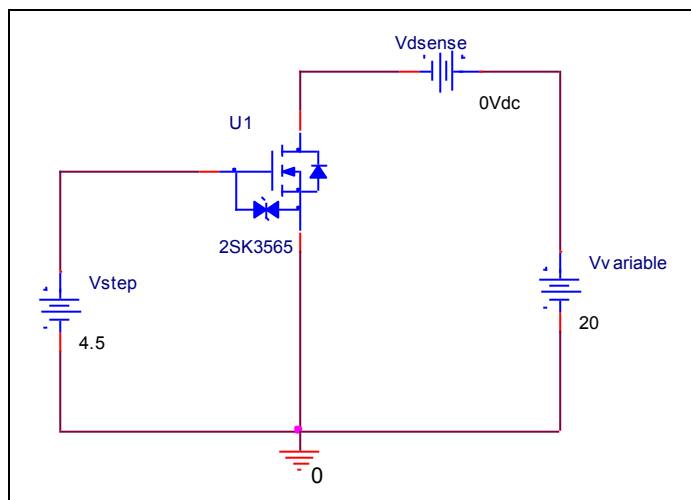
$I_D=3\text{ A}$, $V_{DD}=200\text{ V}$ $V_{GS}=0/10\text{ V}$	Measurement		Simulation		Error(%)
	ton	70.000 ns	70.495 ns	ns	
					0.707

Output Characteristic

Circuit Simulation result



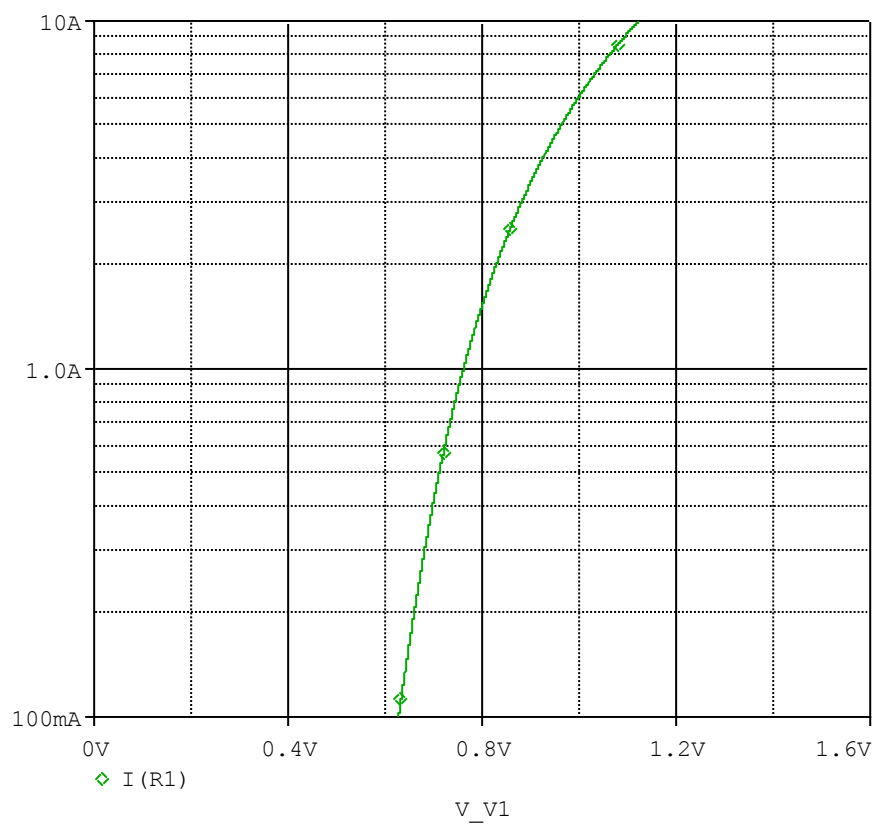
Evaluation circuit



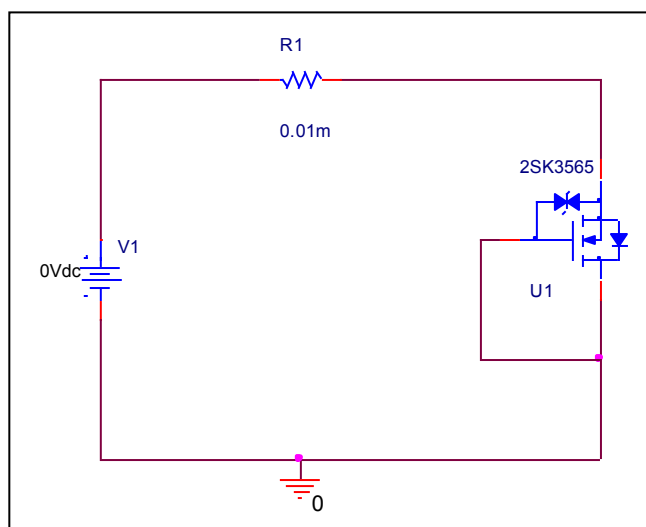
BODY DIODE

Forward Current Characteristic

Circuit Simulation Result

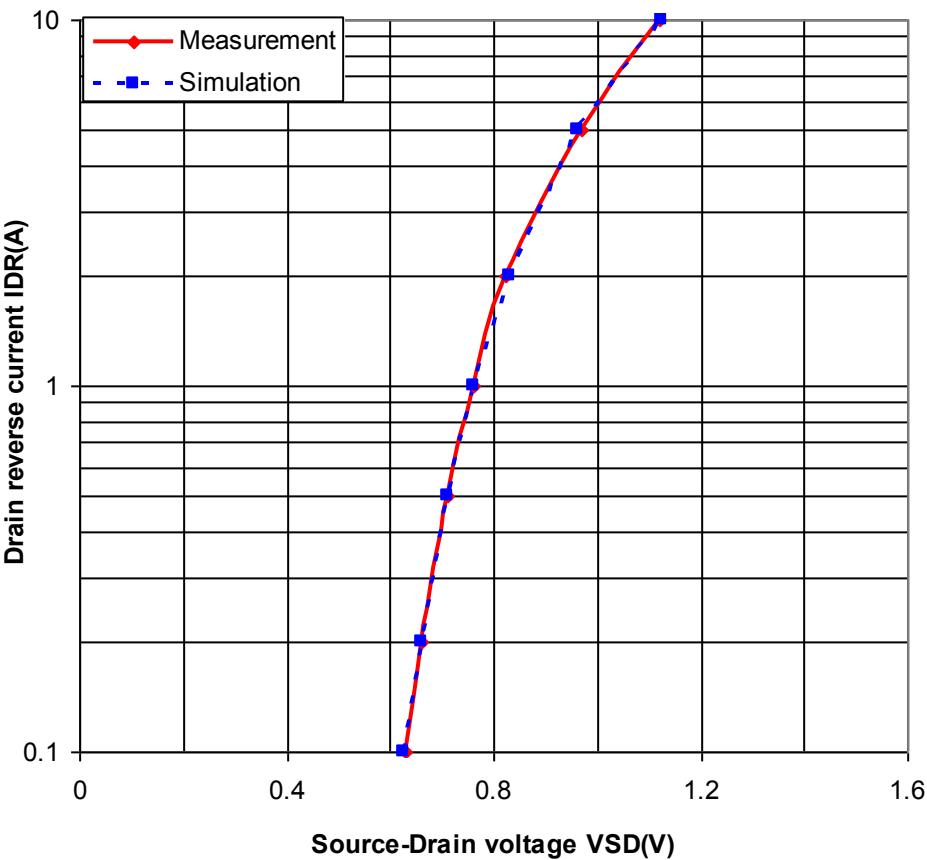


Evaluation Circuit



Comparison Graph

Circuit Simulation Result

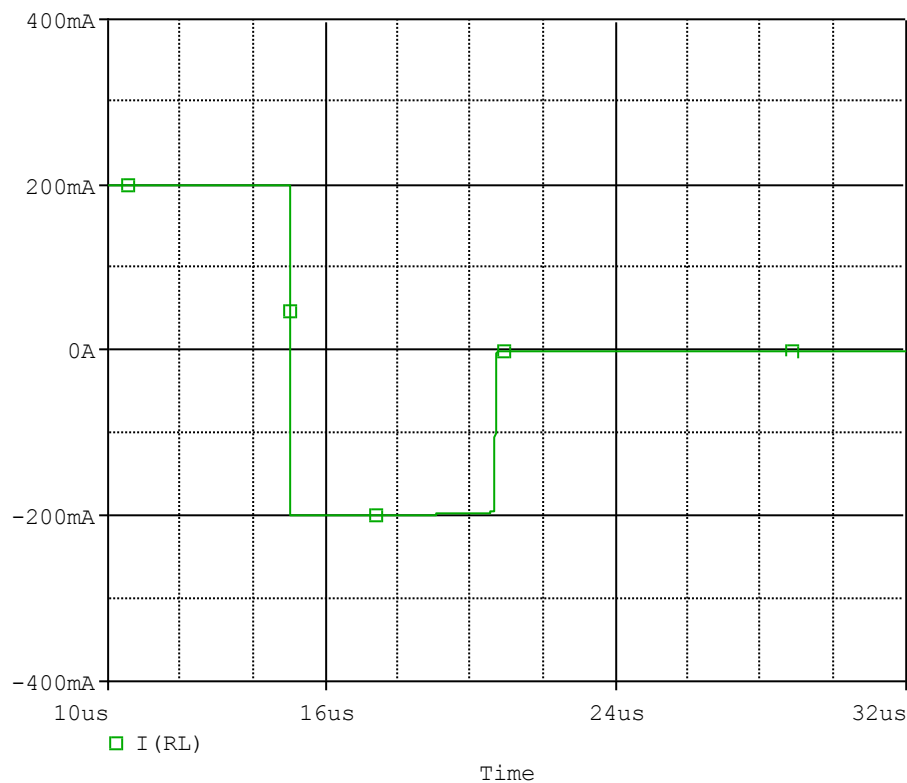


Simulation Result

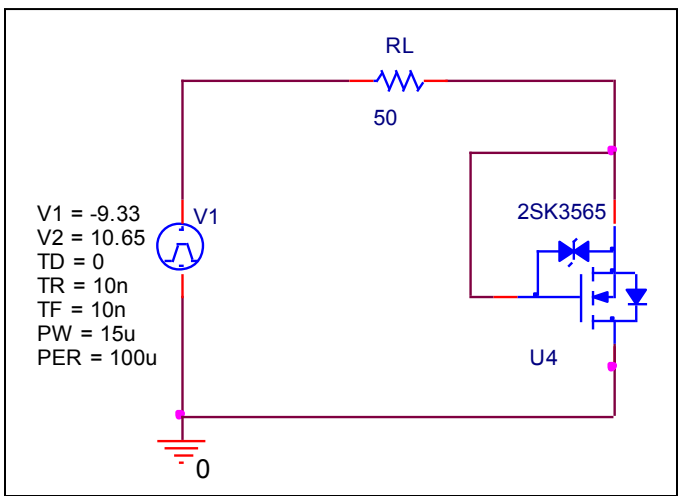
Ifwd(A)	VSD(V)		%Error
	Measuremen	Simulation	
0.1	0.63	0.628	-0.317
0.2	0.66	0.660	0
0.5	0.71	0.711	0.141
1	0.76	0.762	0.263
2	0.825	0.829	0.485
5	0.97	0.962	-0.825
10	1.12	1.123	0.268

Reverse Recovery Characteristic

Circuit Simulation Result



Evaluation Circuit

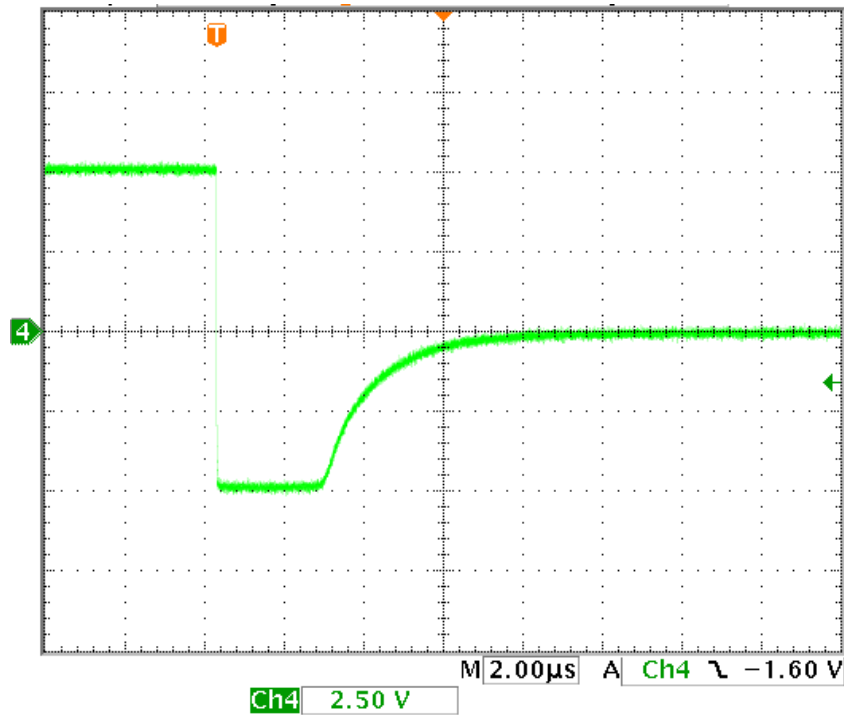


Compare Measurement vs. Simulation

Trr(ns)	Measurement	Simulation	Error (%)
Trj+Trb (us)	5.68	5.6807	0.012

Reverse Recovery Characteristic

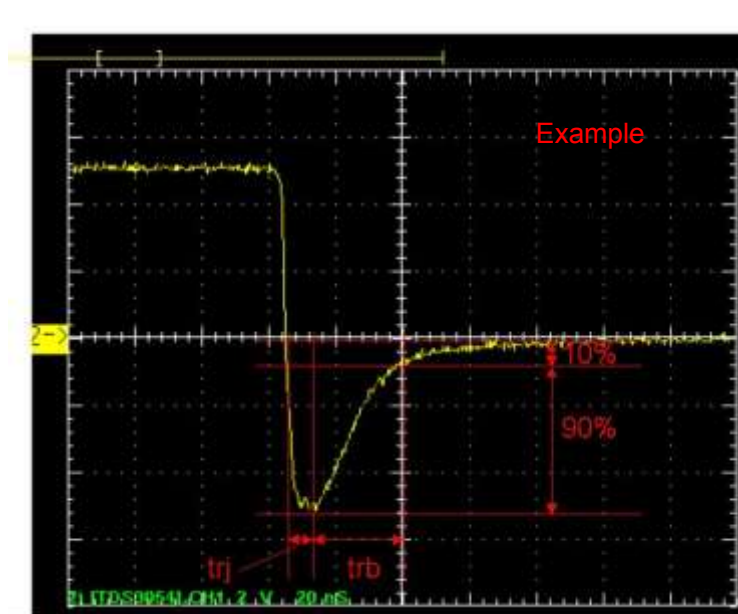
Reference



$T_{rr}=2.4(\mu s)$

$T_{rb}=3.28(\mu s)$

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

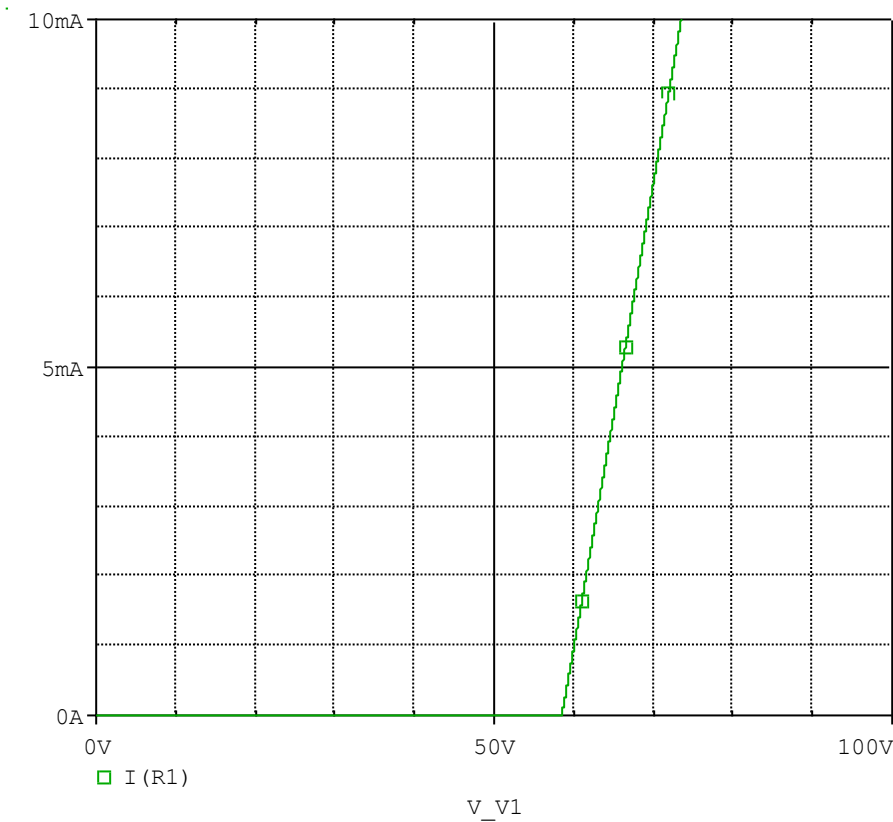


Relation between t_{rr} and t_{rb}

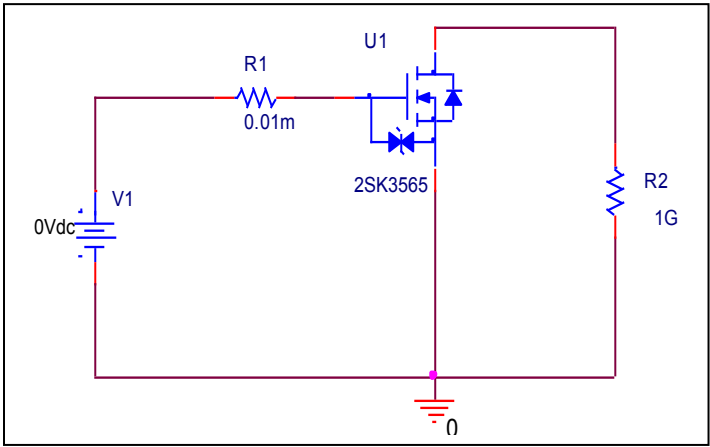
ESD PROTECTION DIODE

Zener Voltage Characteristic

Circuit Simulation Result



Evaluation Circuit



Zener Voltage Characteristic

Reference

