

# Device Modeling Report

COMPONENTS: Power MOSFET (Professional)  
PART NUMBER: 2SK3111  
MANUFACTURER: NEC  
Body Diode (Professional) / ESD Protection Diode



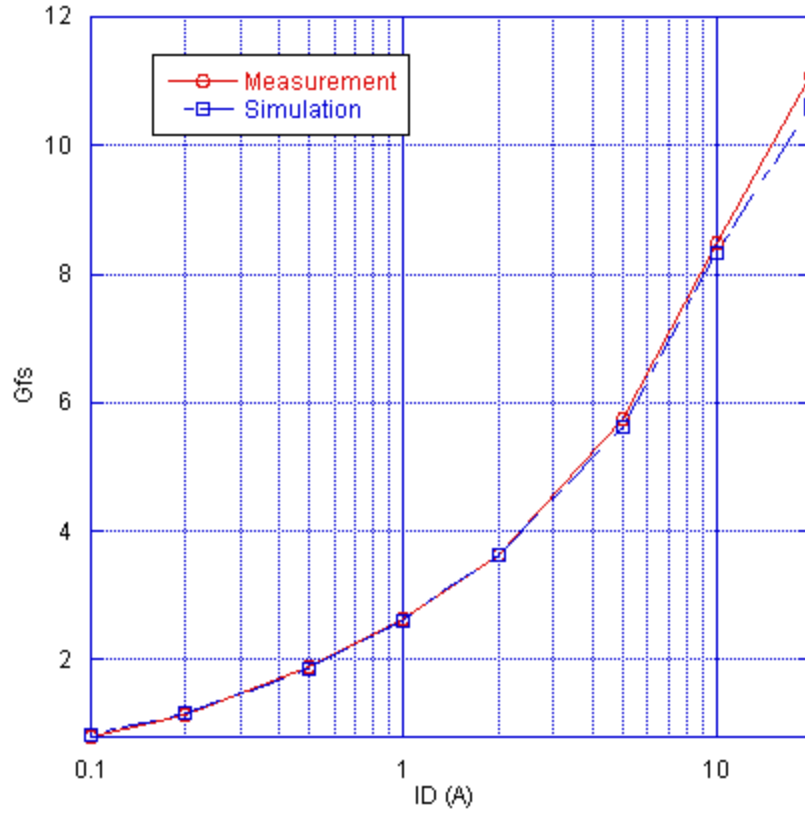
**Bee Technologies Inc.**

## 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

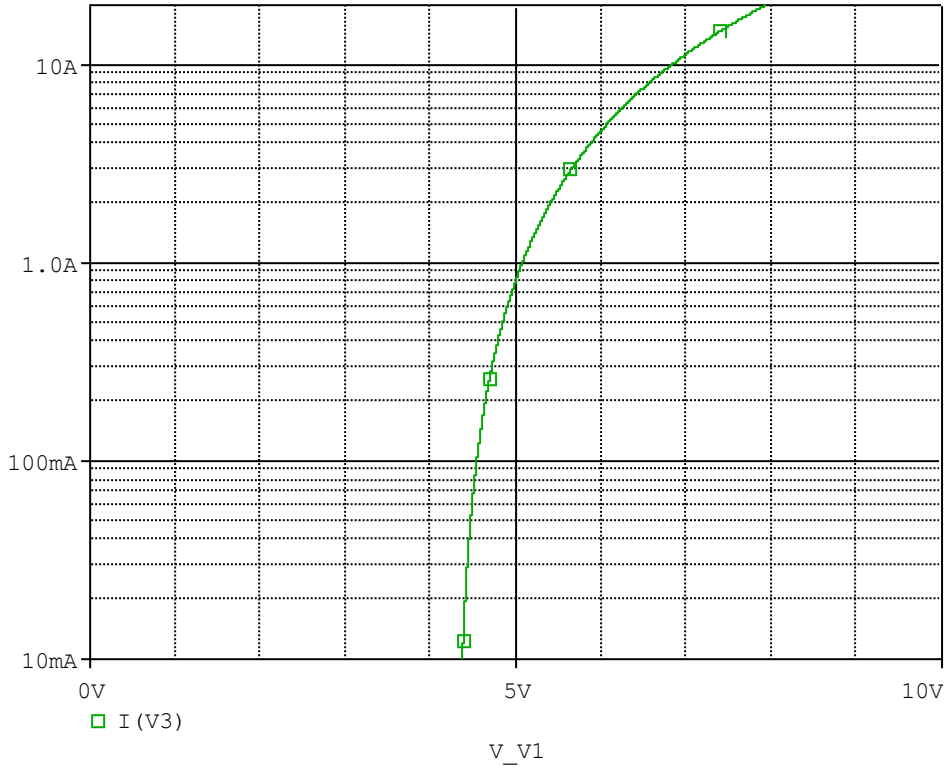


## Comparison table

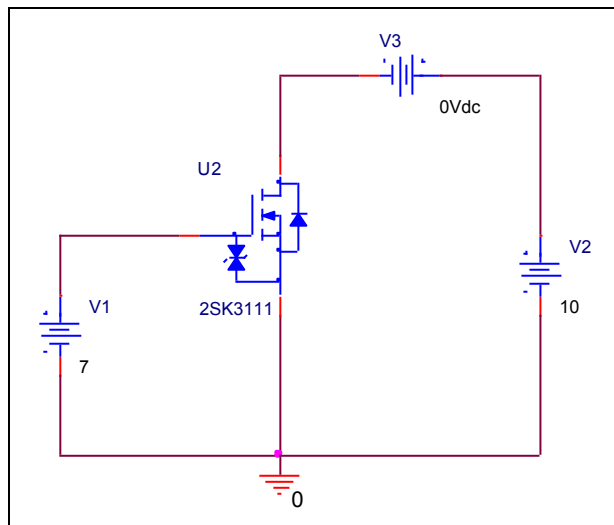
Id(A)	gfs		Error (%)
	Measurement	Simulation	
0.1	0.800	0.833	4.125
0.2	1.143	1.176	2.887
0.5	1.887	1.852	-1.855
1	2.632	2.597	-1.330
2	3.636	3.630	-0.165
5	5.747	5.618	-2.245
10	8.475	8.333	-1.676
20	11.111	10.644	-4.203

# Vgs-Id Characteristic

Circuit Simulation result

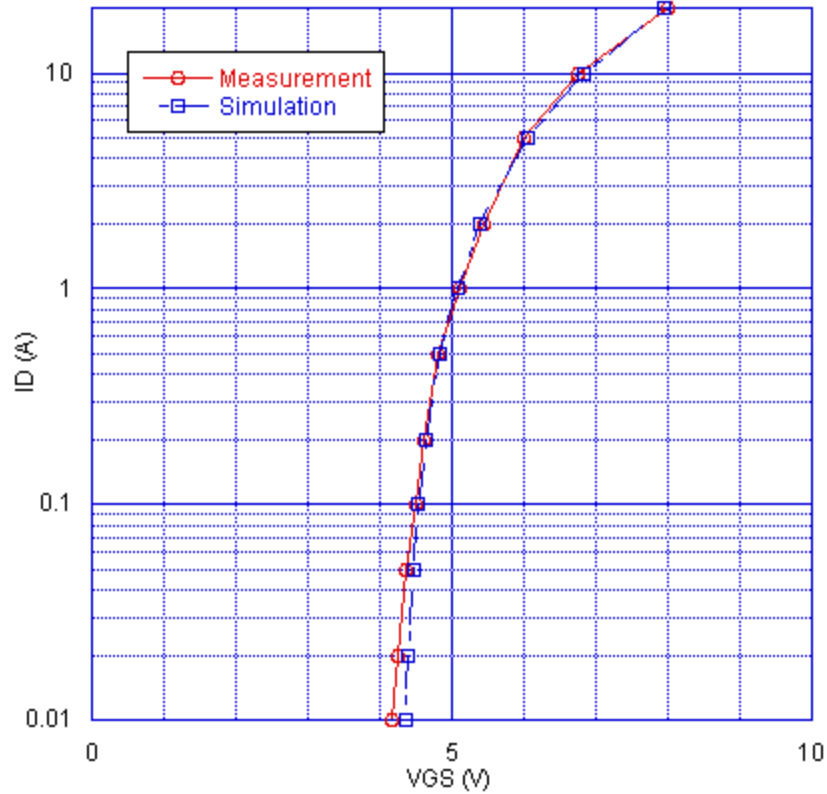


Evaluation circuit



## Comparison Graph

Circuit Simulation Result

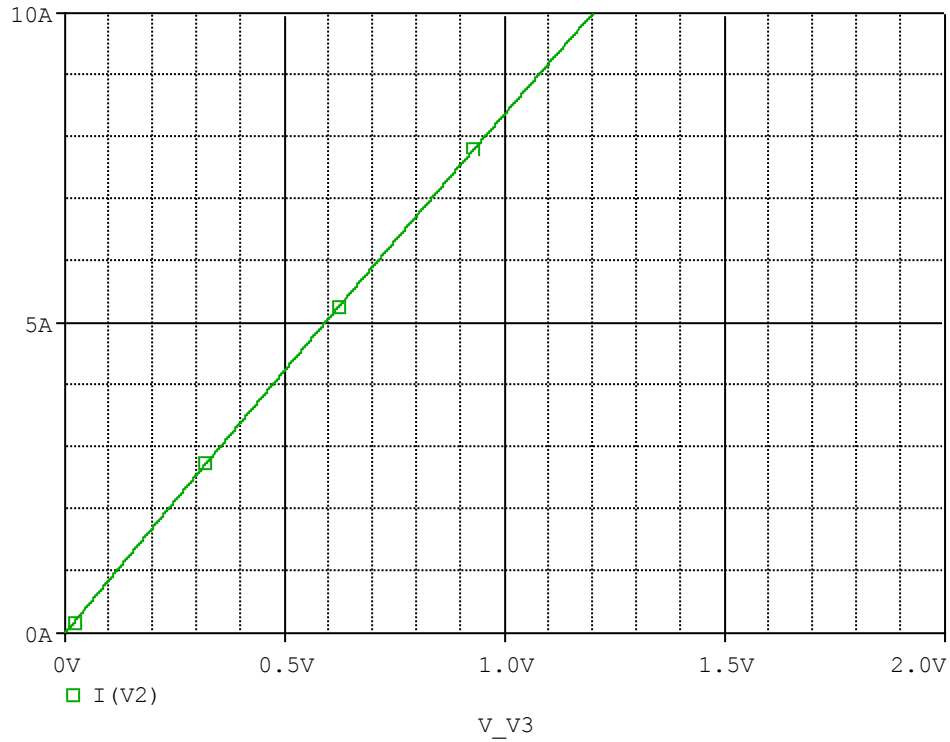


Comparison table

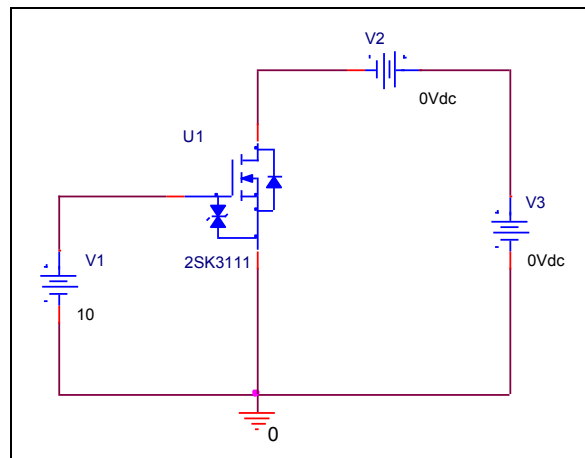
$I_D$ (A)	$V_{GS}$ (V)		Error (%)
	Measurement	Simulation	
0.01	4.18	4.371	4.560
0.02	4.25	4.403	3.600
0.05	4.35	4.466	2.667
0.1	4.5	4.538	0.844
0.2	4.6	4.639	0.848
0.5	4.8	4.842	0.875
1	5.1	5.073	-0.529
2	5.45	5.401	-0.899
5	6	6.063	1.050
10	6.75	6.826	1.126
20	8	7.933	-0.838

## Rds(on) Characteristic

Circuit Simulation result



Evaluation circuit

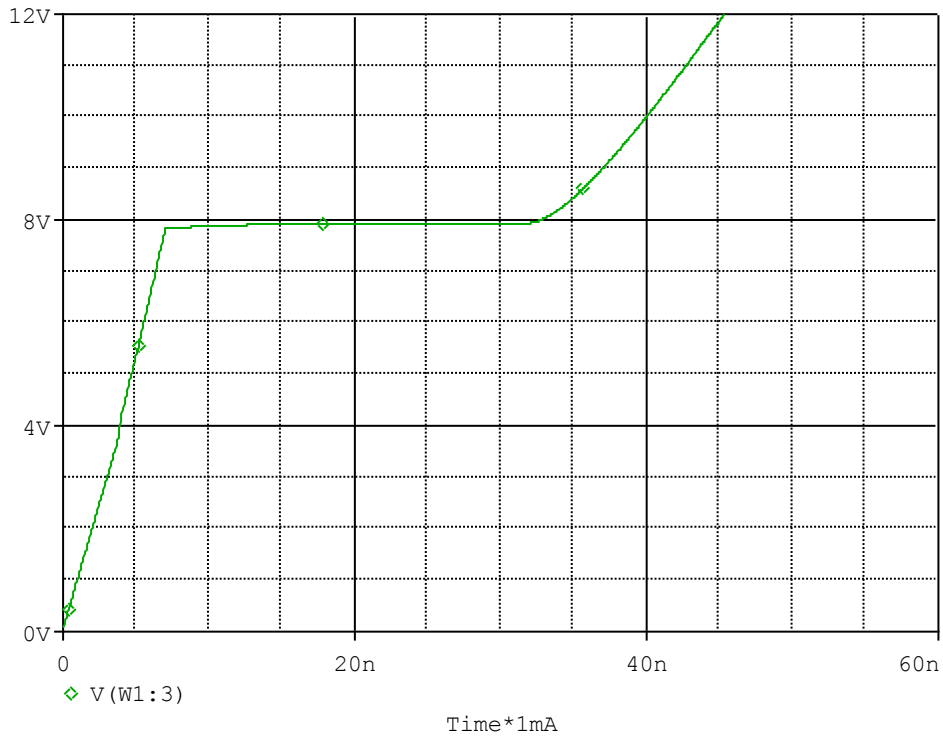


Comparison table

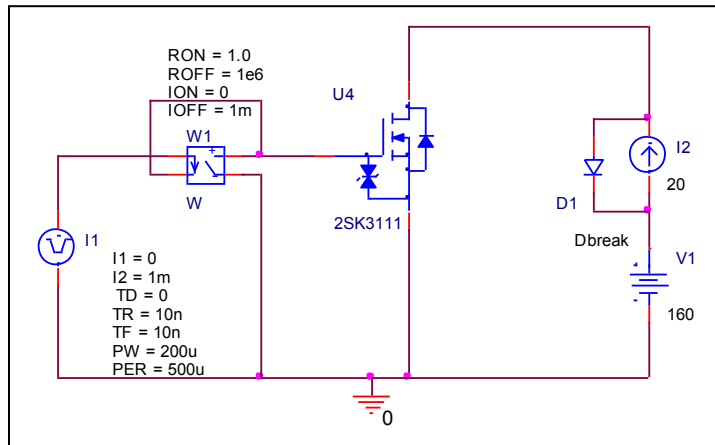
<b>I<sub>D</sub>=10A, V<sub>GS</sub>=10V</b>	<b>Measurement</b>	<b>Simulation</b>	<b>Error (%)</b>
<b>R<sub>DS</sub> (on) Ω</b>	<b>0.12</b>	<b>0.12</b>	<b>0-0.058</b>

# Gate Charge Characteristic

## Circuit Simulation result



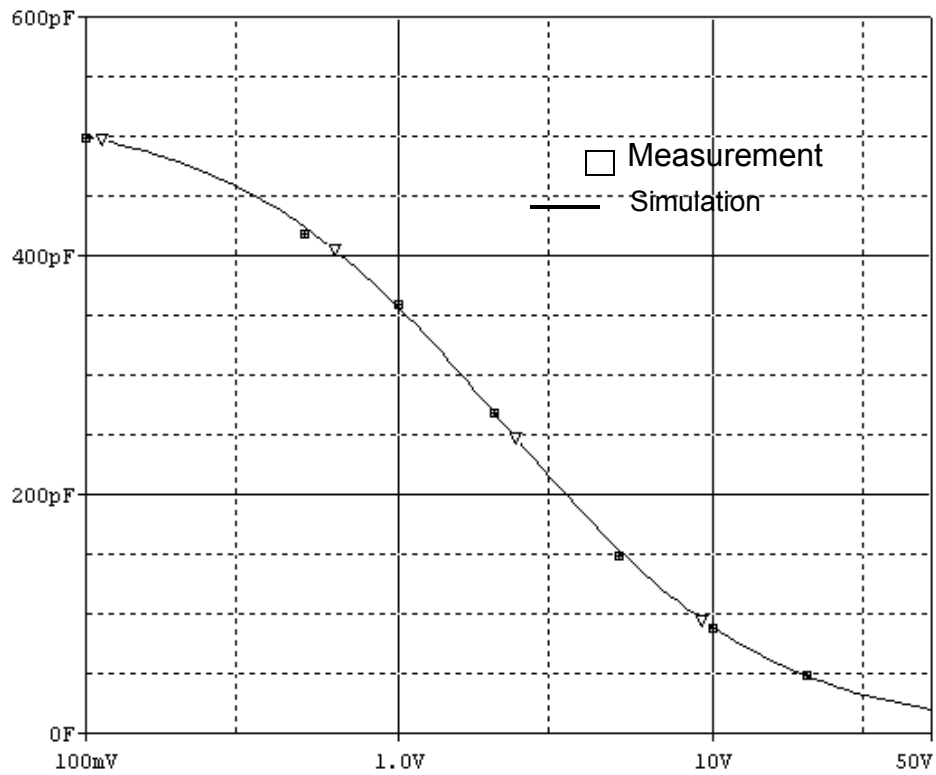
## Evaluation circuit



## Comparison table

$V_{DD}=160V, I_D=20A, V_G=10V$	Measurement	Simulation	Error (%)
<b>Qgs (nC)</b>	<b>7</b>	<b>7.0792</b>	<b>1.131</b>
<b>Qgd (nC)</b>	<b>25</b>	<b>24.926</b>	<b>-0.296</b>
<b>Qg (nC)</b>	<b>40</b>	<b>40</b>	<b>0</b>

## Capacitance Characteristic

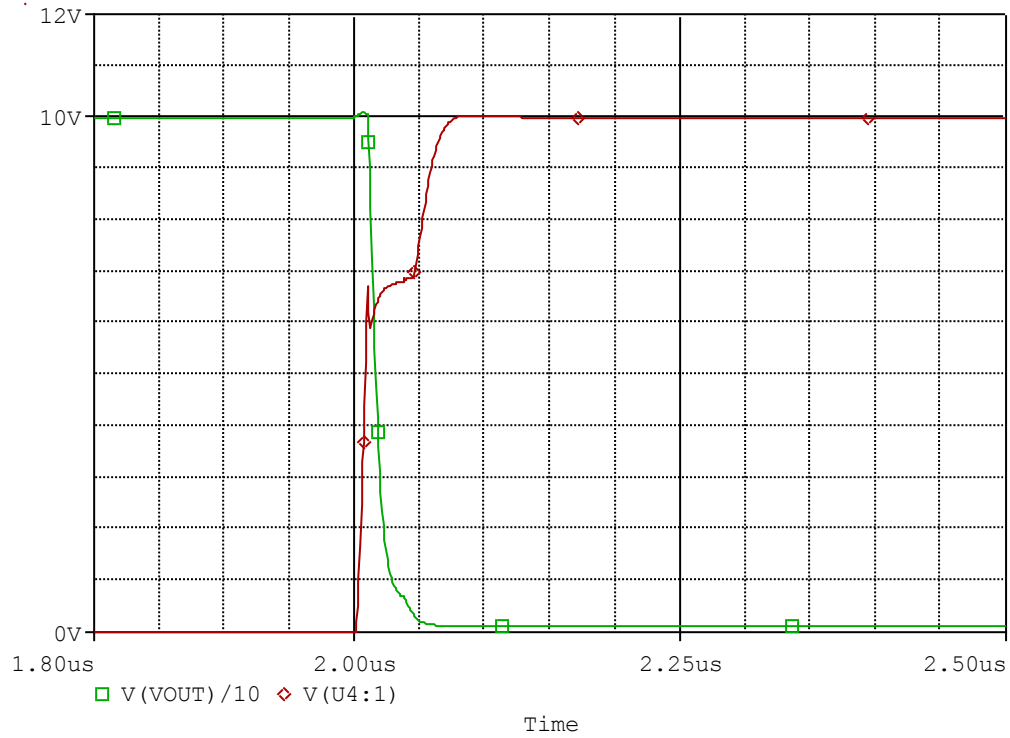


Comparison table

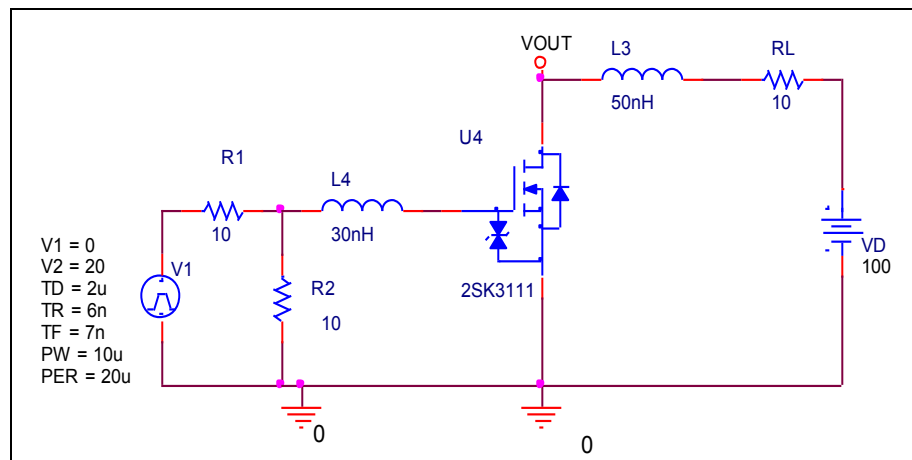
V <sub>DS</sub> (V)	Cbd(pF)		Error(%)
	Measurement	Simulation	
0.1	500	499	-0.200
0.5	420	425	1.190
1	360	356	-1.111
2	270	269	-0.370
5	150	154	2.667
10	90	89	-1.111
20	50	48	-4.000

# Switching Time Characteristic

## Circuit Simulation result



## Evaluation circuit

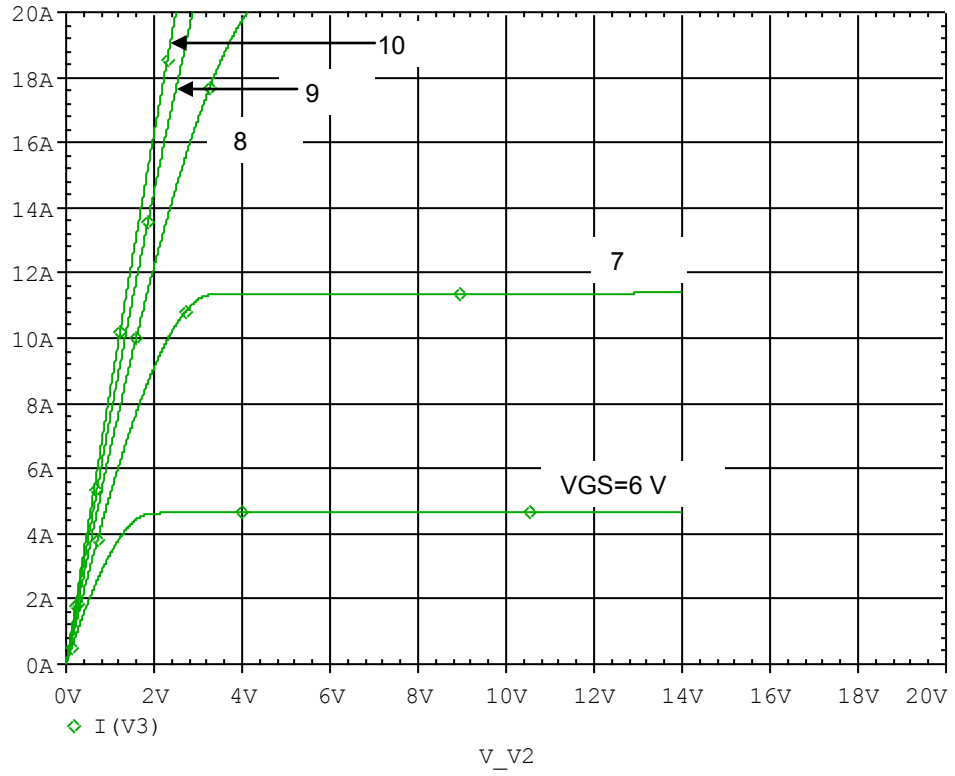


## Comparison table

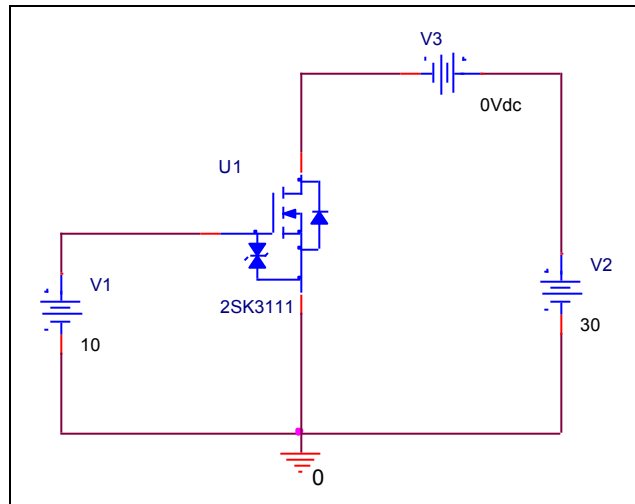
$I_D=10A, V_{DD}=100V,$ $V_{GS}=0V\sim 10V$	Measurement	Simulation	Error(%)
<b>ton (ns)</b>	<b>25</b>	<b>25.237</b>	<b>0.948</b>

# Output Characteristic

## Circuit Simulation result

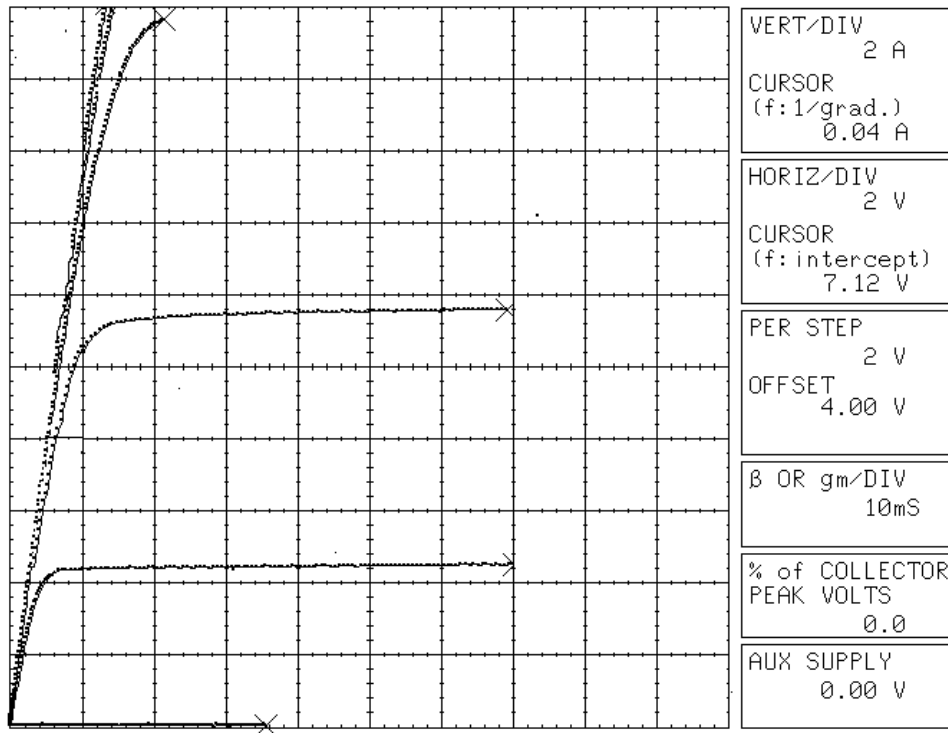


## Evaluation circuit



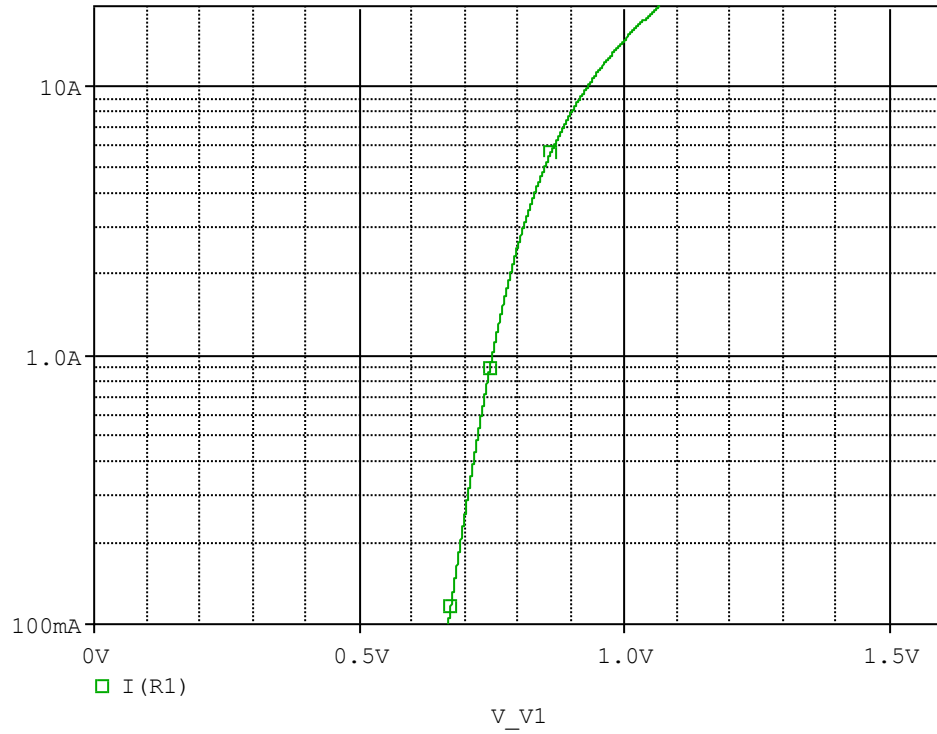
# Output Characteristic

# Reference

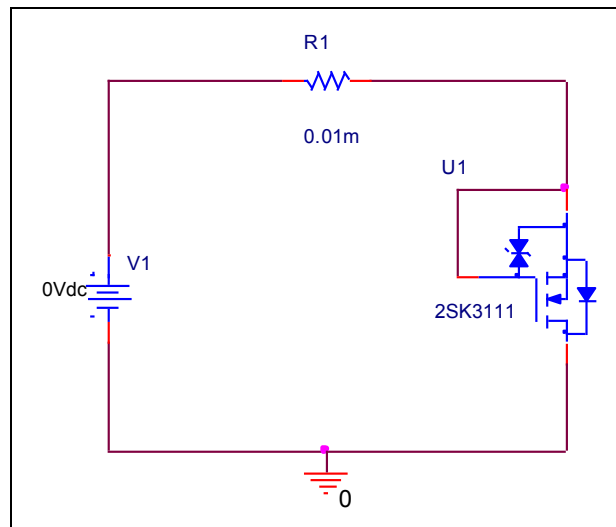


# Forward Current Characteristic

## Circuit Simulation Result

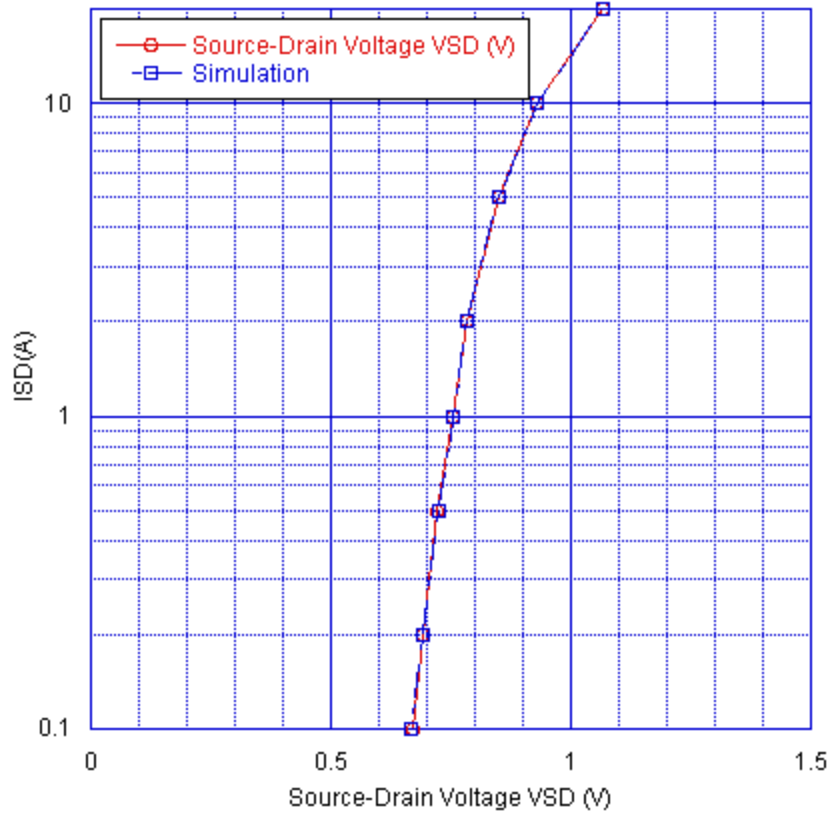


## Evaluation Circuit



## Comparison Graph

Circuit Simulation Result

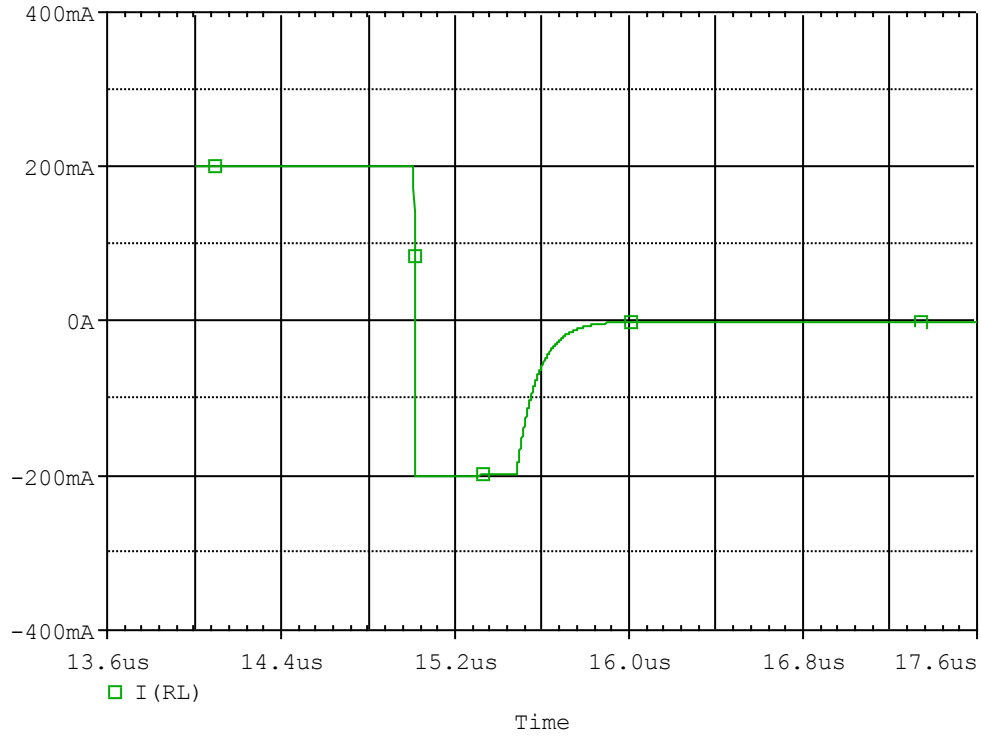


Comparison table

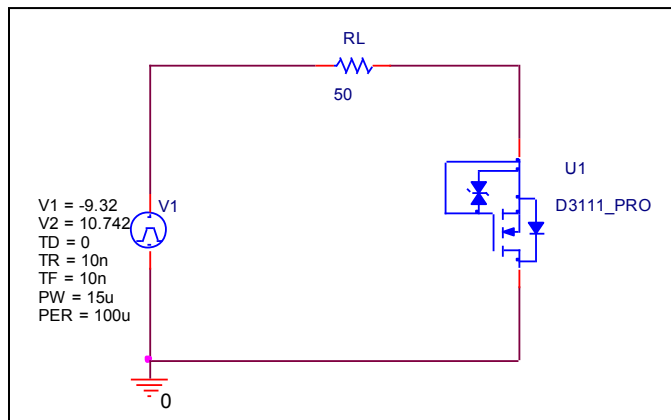
$I_{SD}$ (A)	VSD(V)		%Error
	Measurement	Simulation	
0.1	0.67	0.668	-0.299
0.2	0.69	0.691	0.145
0.5	0.72	0.724	0.556
1	0.755	0.752	-0.397
2	0.785	0.785	0
5	0.85	0.85	0
10	0.93	0.930	0
20	1.067	1.067	0

# Reverse Recovery Characteristic

## Circuit Simulation Result



## Evaluation Circuit

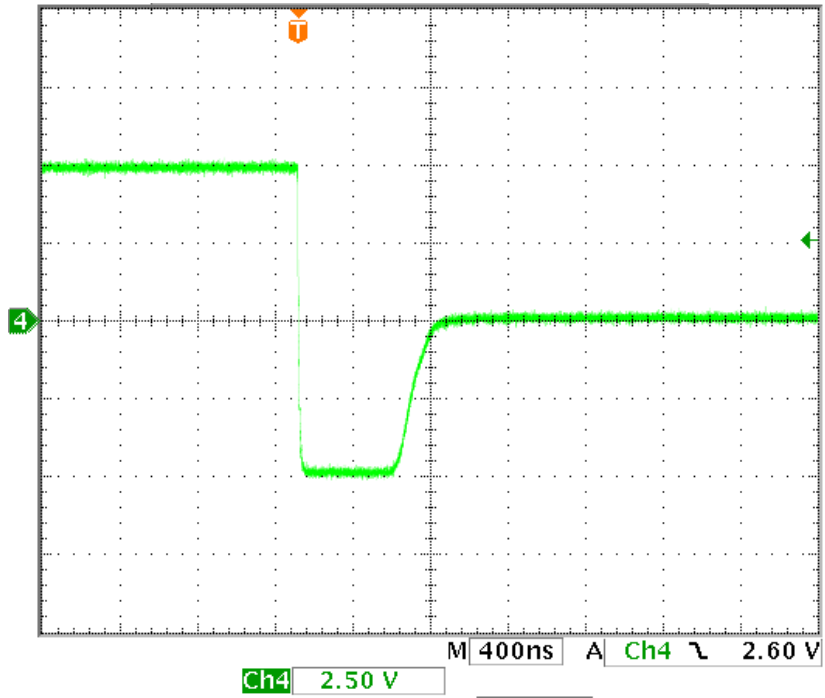


## Comparison table

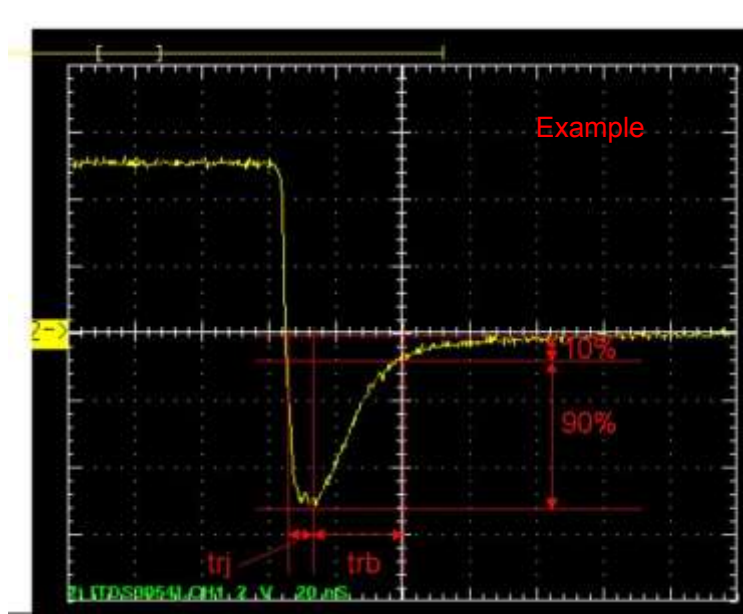
	Measurement	Simulation	Error (%)
<b>trj (ns)</b>	<b>440</b>	<b>441.886</b>	<b>0.429</b>
<b>trb (ns)</b>	<b>240</b>	<b>241.949</b>	<b>0.812</b>
<b>trr (ns)</b>	<b>680</b>	<b>683.835</b>	<b>0.564</b>

# Reverse Recovery Characteristic

# Reference



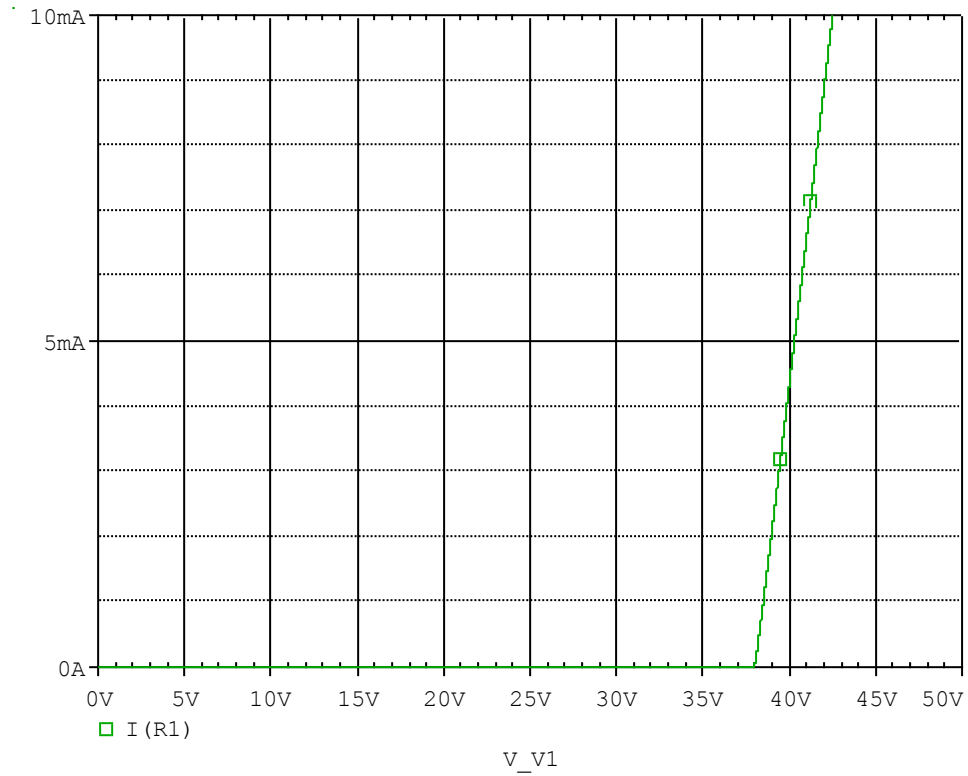
Trj=440(ns)  
Trb=240(ns)  
Conditions: Ifwd=Irev=0.2(A), RI=50



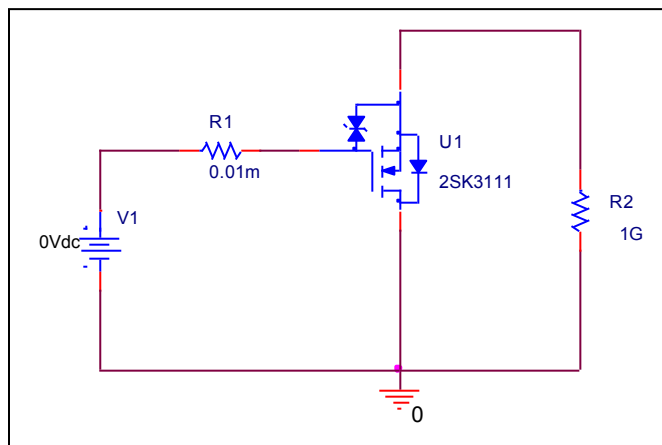
Relation between trj and trb

# ESD PROTECTION DIODE Zener Voltage Characteristic

## Circuit Simulation Result



## Evaluation Circuit



# Zener Voltage Characteristic

# Reference

