

Device Modeling Report

COMPONENTS: MOSFET (Model Parameters)
PART NUMBER: SSM3K15FS
MANUFACTURER: TOSHIBA
Body Diode (Model Parameters) / ESD Protection Diode



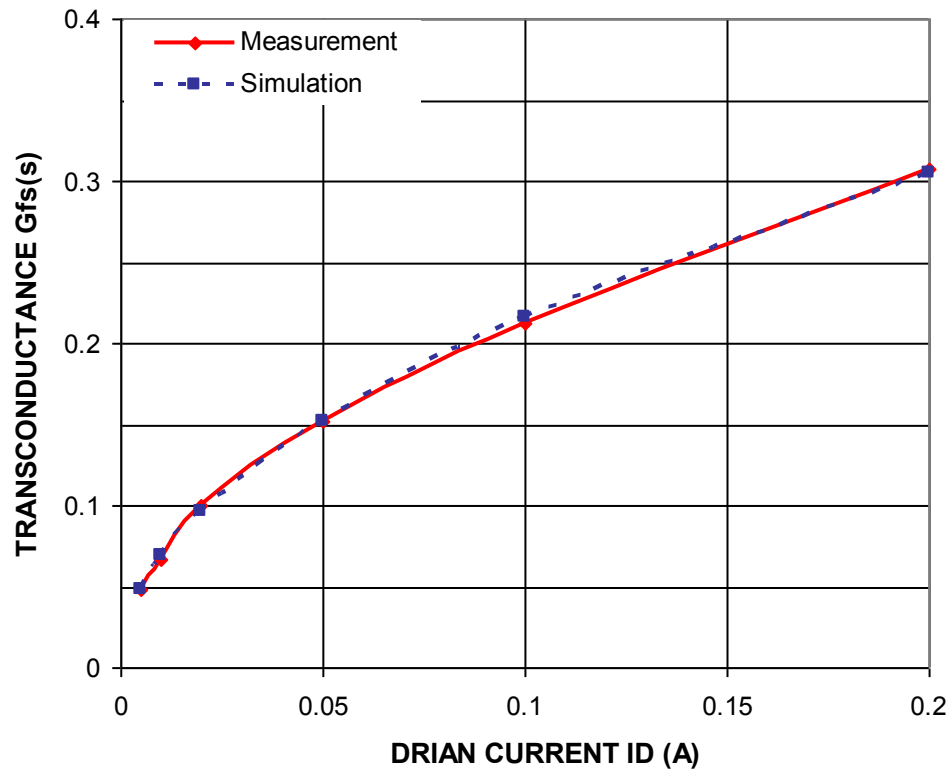
Bee Technologies Inc.

MOSFET MODEL PARAMETERS

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

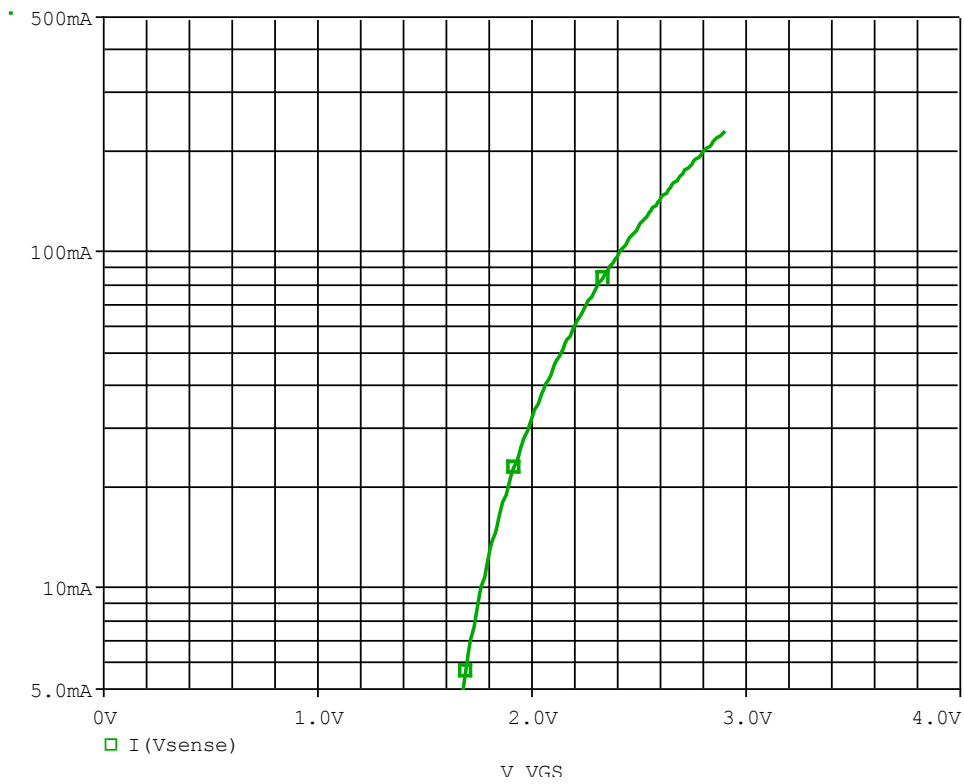


Comparison table

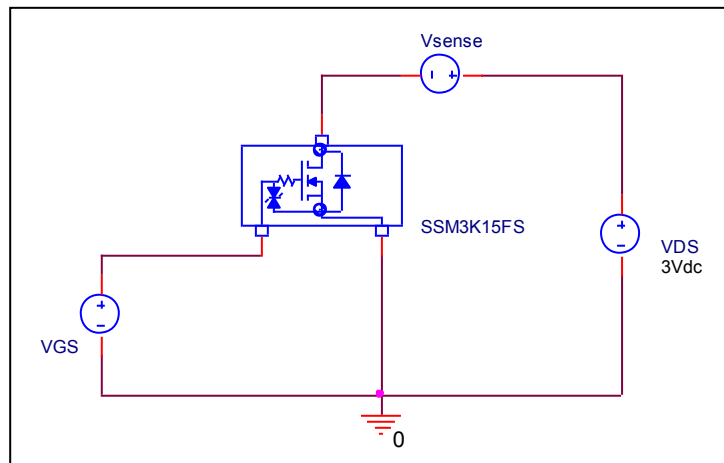
Id(A)	Gfs(S)		Error(%)
	Measurement	Simulation	
0.005	0.0476	0.0481	0.96
0.01	0.0667	0.0690	3.45
0.02	0.1000	0.0966	-3.38
0.05	0.1515	0.1524	0.61
0.1	0.2128	0.2155	1.29
0.2	0.3077	0.3044	-1.07

Vgs-Id Characteristic

Circuit Simulation result

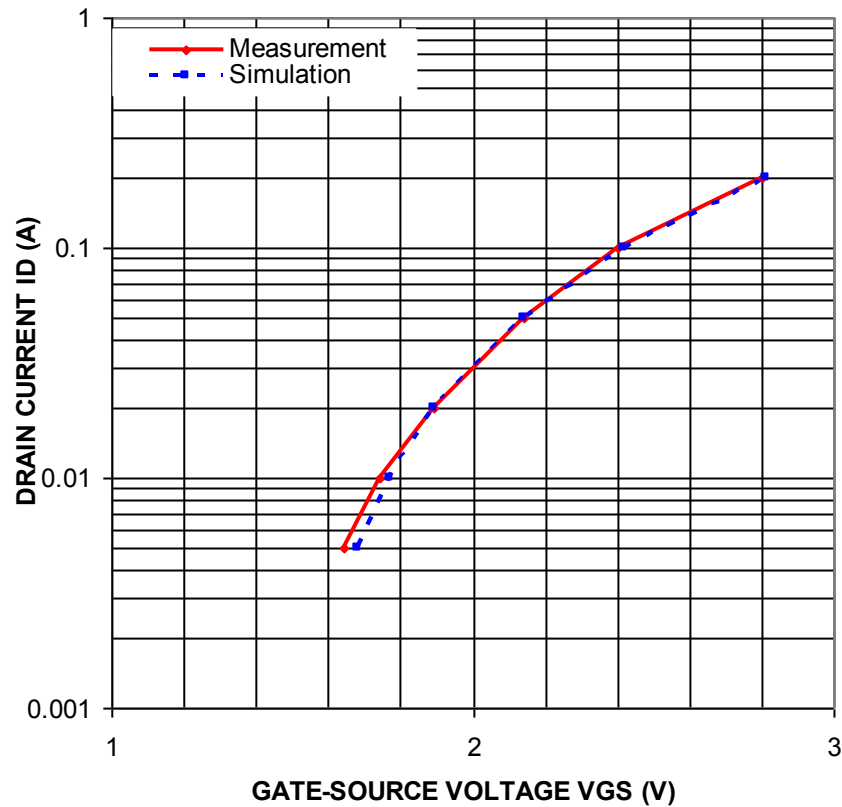


Evaluation circuit



Comparison Graph

Circuit Simulation Result

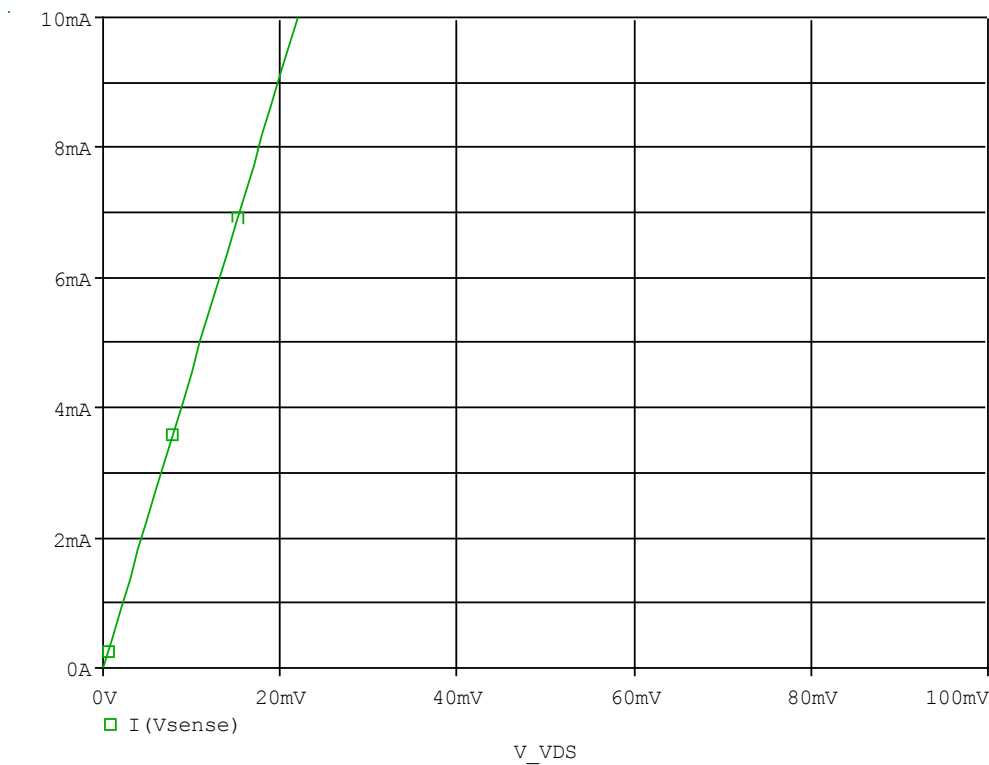


Simulation Result

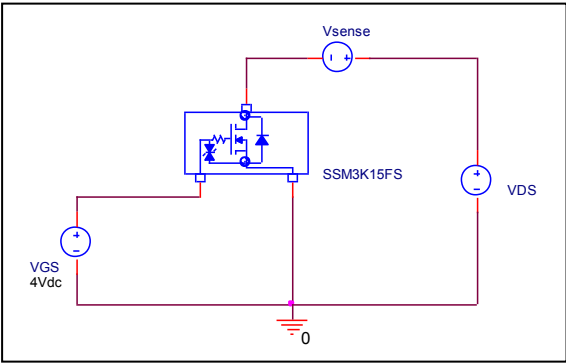
I_D (A)	V_{GS} (V)		Error (%)
	Measurement	Simulation	
0.005	1.6400	1.6808	2.4878
0.01	1.7400	1.7689	1.6609
0.02	1.8900	1.8931	0.1640
0.05	2.1400	2.1400	0.0000
0.1	2.4000	2.4184	0.7667
0.2	2.8000	2.8124	0.4429

Rds(on) Characteristic

Circuit Simulation result



Evaluation circuit

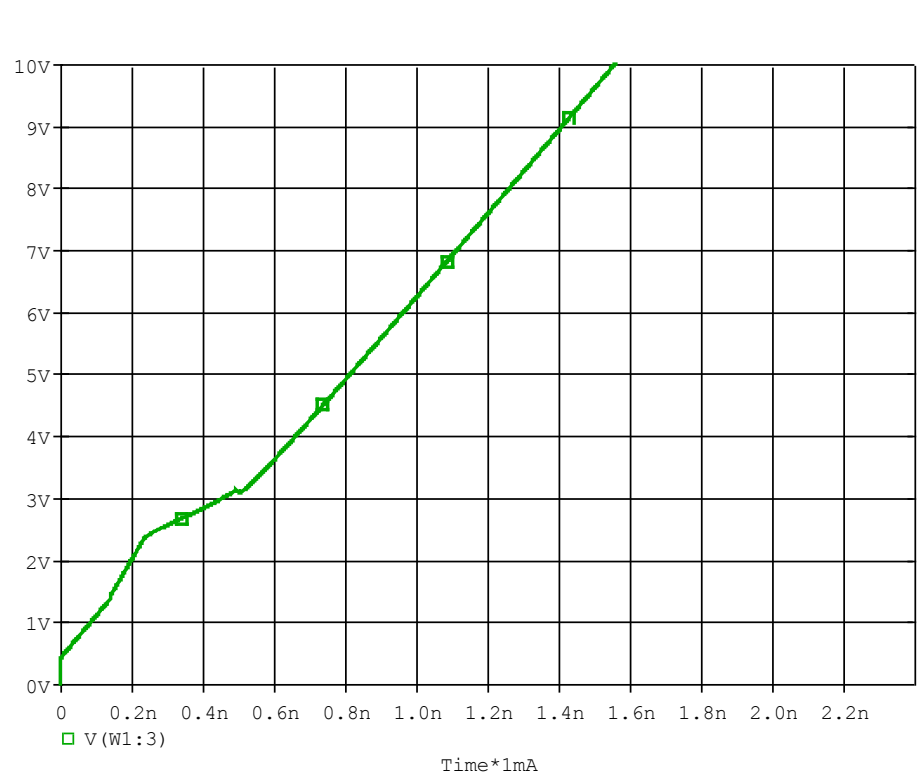


Simulation Result

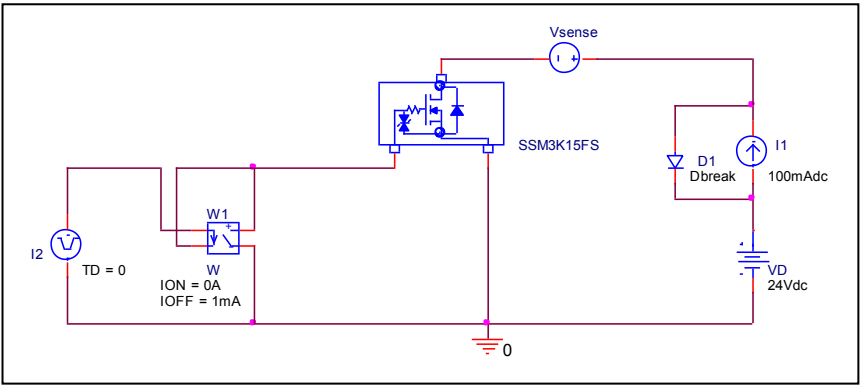
I _D =10mA, V _{GS} =4V	Measurement		Simulation		Error (%)
R _{DS} (on)	2.2	Ω	2.1997	Ω	-0.01

Gate Charge Characteristic

Circuit Simulation result



Evaluation circuit

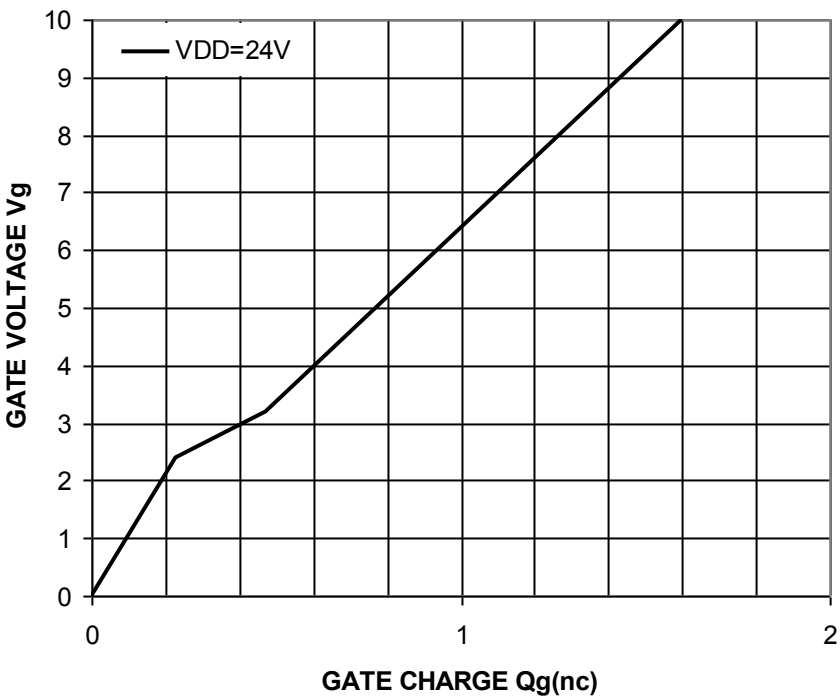


Simulation Result

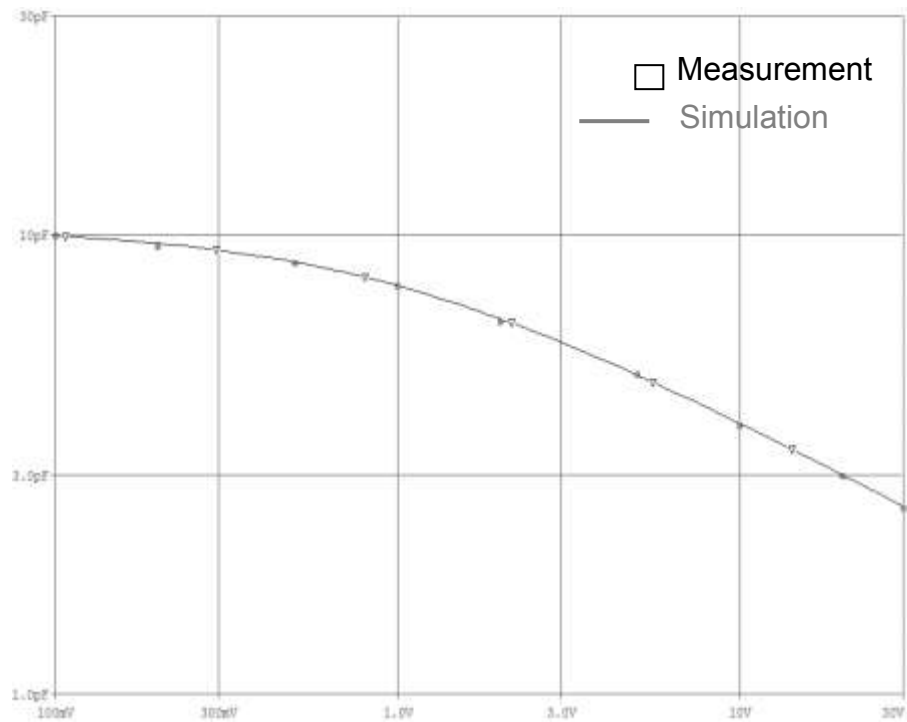
$V_{DD}=24V$, $I_D=100mA$	Measurement		Simulation		Error (%)
Qgs	0.2250	nC	0.2305	nC	2.4640
Qgd	0.2400	nC	0.2520	nC	5.0000

Gate Charge Characteristic

Reference



Capacitance Characteristic

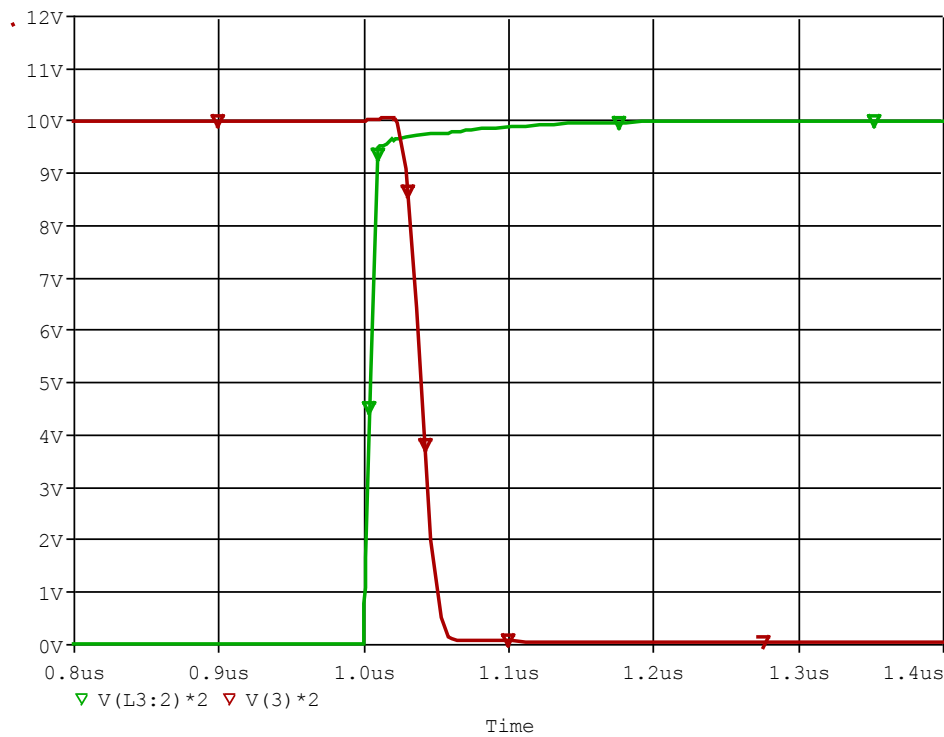


Simulation Result

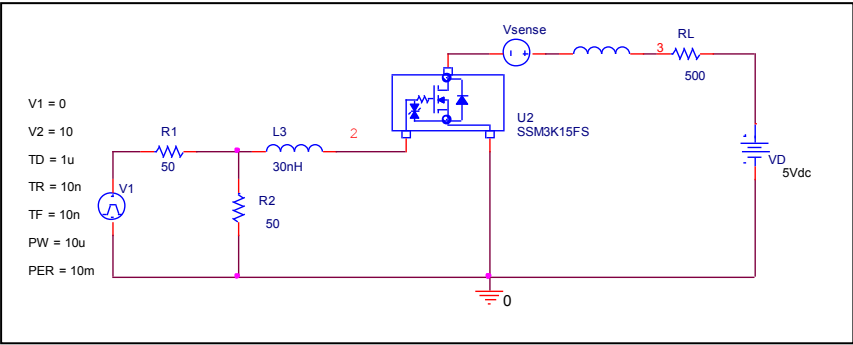
V _{DS} (V)	Cbd(pF)		Error(%)
	Measurement	Simulation	
0.1	10.0000	9.9373	-0.6270
0.2	9.5000	9.5740	0.7789
0.5	8.7000	8.7257	0.2954
1	7.8000	7.7356	-0.8256
2	6.5000	6.5580	0.8923
5	5.0000	4.9462	-1.0760
10	3.8500	3.8749	0.6468
20	3.0000	2.9900	-0.3333

Switching Time Characteristic

Circuit Simulation result



Evaluation circuit

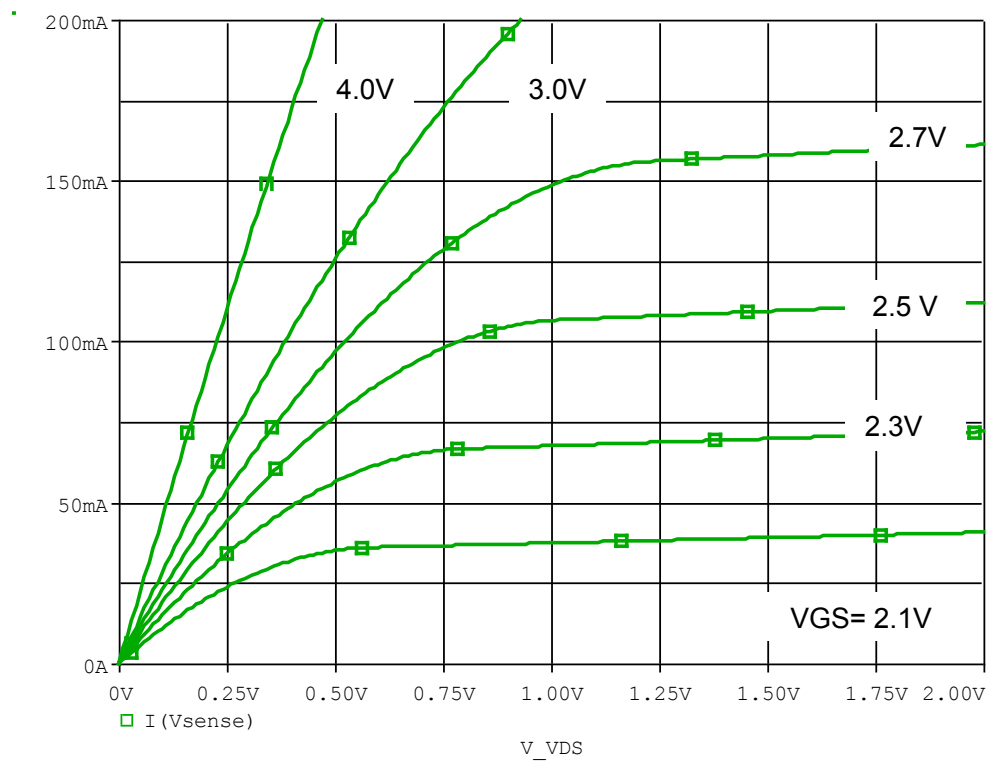


Simulation Result

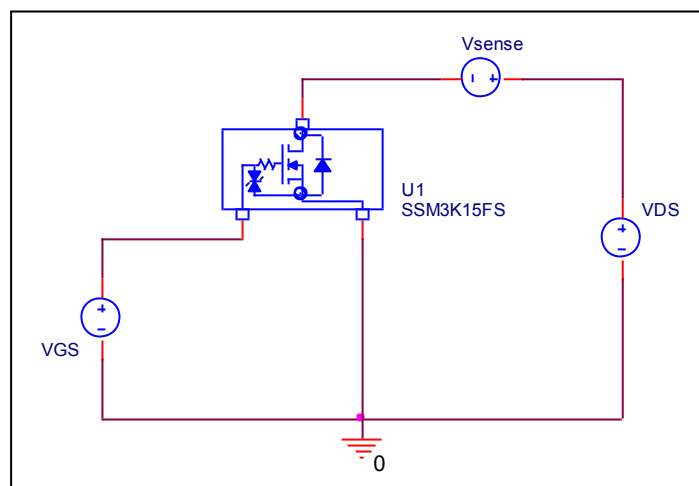
$I_D=10\text{mA}$, $V_{DD}=5\text{V}$, $V_{GS}=0/5\text{V}$	Measurement		Simulation		Error(%)
Td(on)	50.000	ns	49.992	ns	-0.02

Output Characteristic

Circuit Simulation result

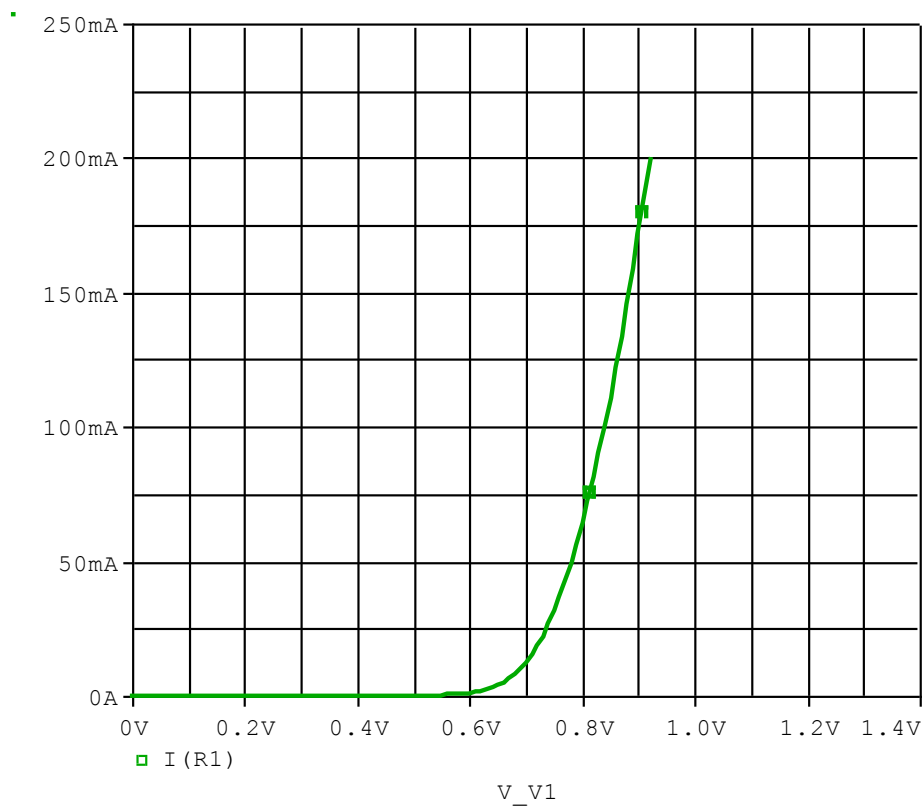


Evaluation circuit

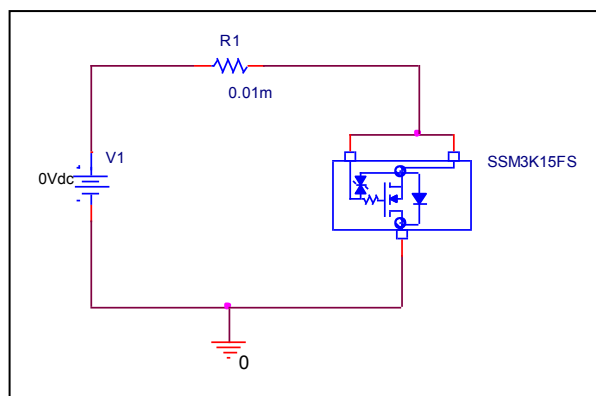


BODY DIODE SPICE MODEL Forward Current Characteristic

Circuit Simulation Result

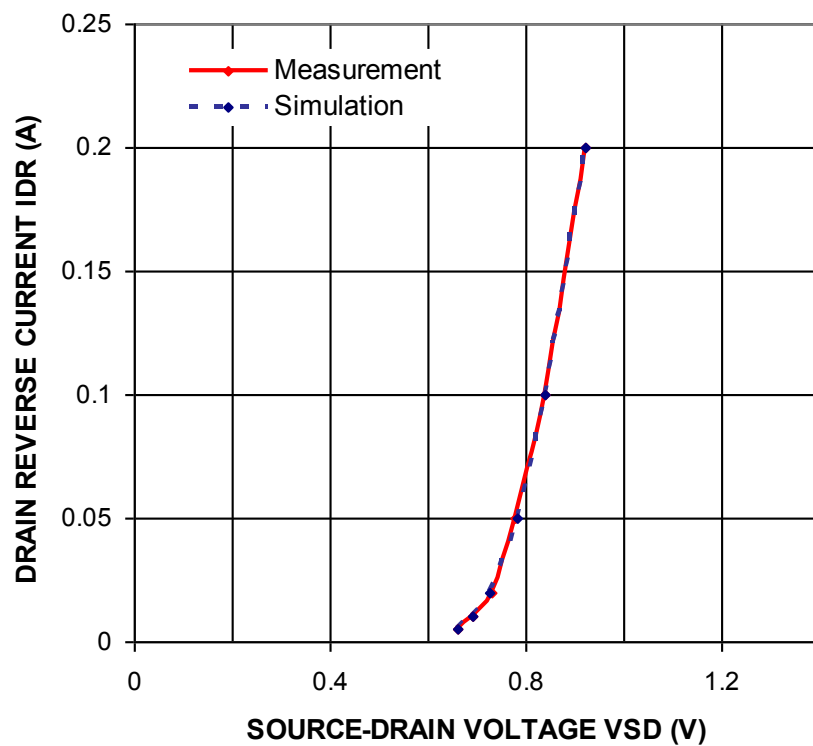


Evaluation Circuit



Comparison Graph

Circuit Simulation Result

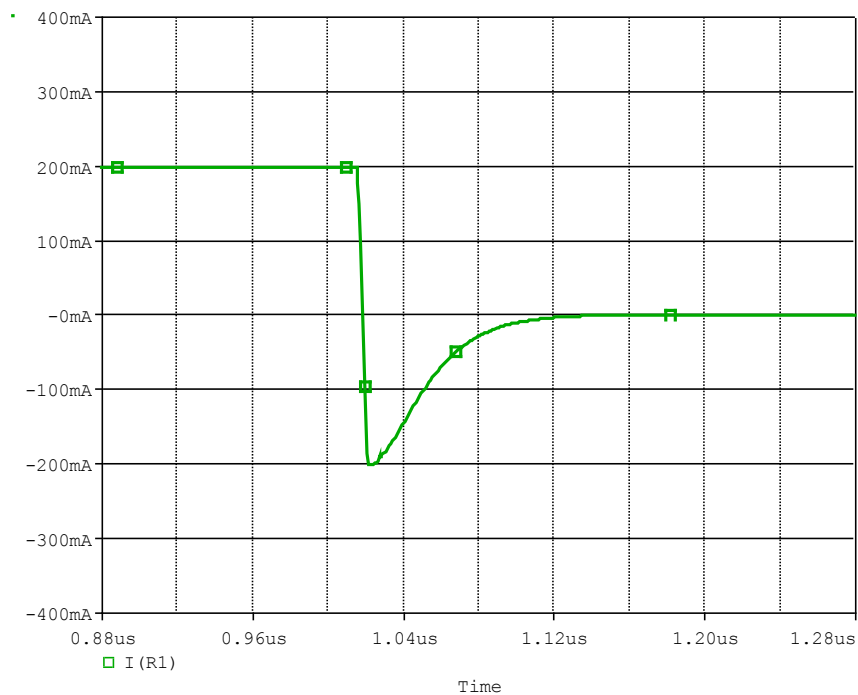


Simulation Result

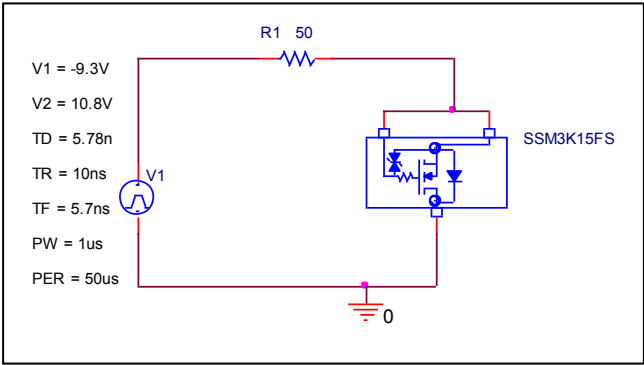
IDR(A)	VSD(V)		%Error
	Measurement	Simulation	
0.005	0.6600	0.6599	-0.0152
0.010	0.6900	0.6902	0.0290
0.020	0.7250	0.7241	-0.1241
0.050	0.7800	0.7807	0.0897
0.100	0.8400	0.8395	-0.0595
0.200	0.9200	0.9200	0.0000

Reverse Recovery Characteristic (Body Diode)

Circuit Simulation Result



Evaluation Circuit

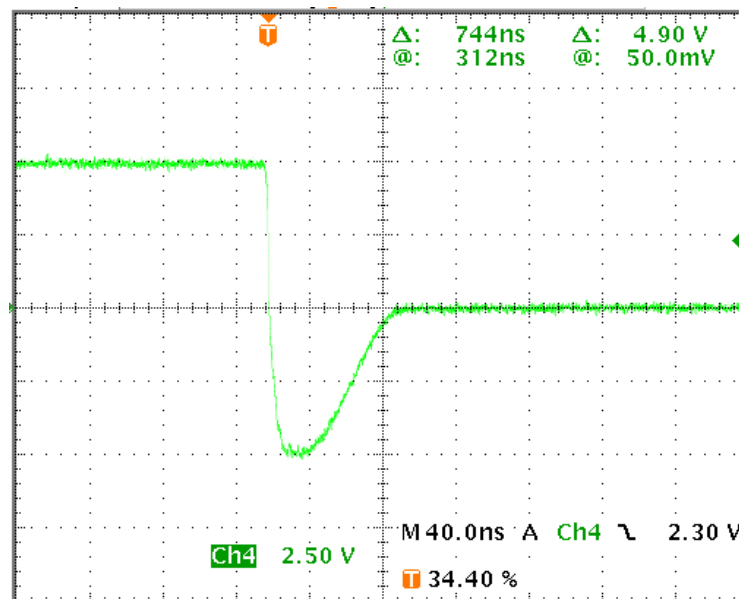


Compare Measurement vs. Simulation

	Measurement		Simulation		Error (%)
trr	61.600	ns	69.549	ns	12.90

Reverse Recovery Characteristic (Body Diode)

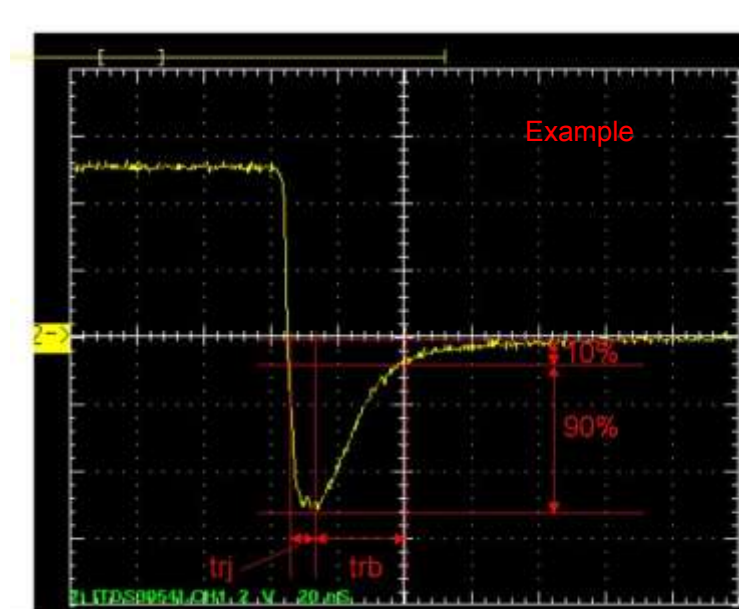
Reference



$Tr_j = (24. \text{ns})$

$Tr_b = (37.6 \text{ns})$

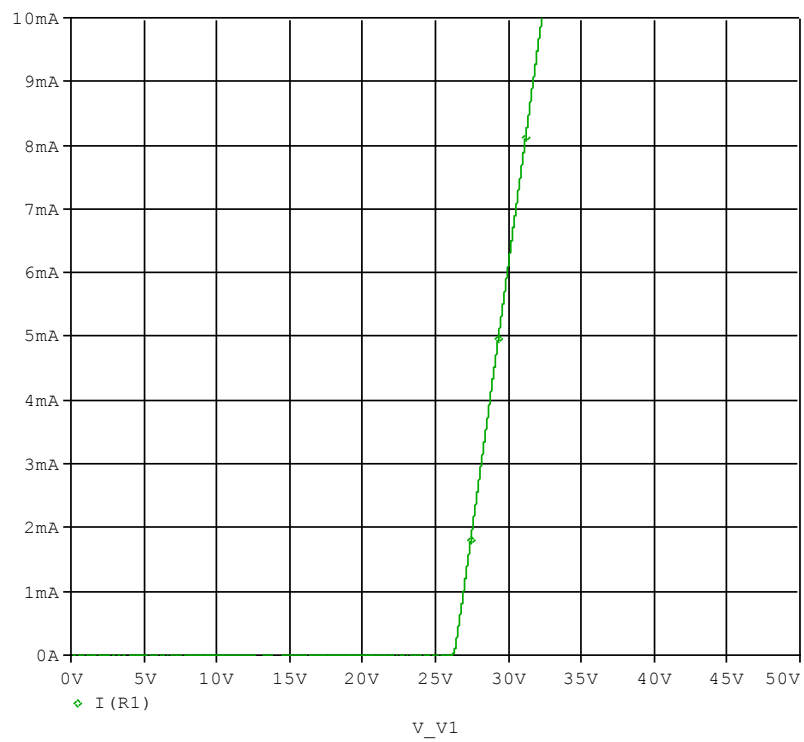
Conditions: $I_{fwd} = I_{rev} = 0.2(\text{A})$, $R_I = 50$



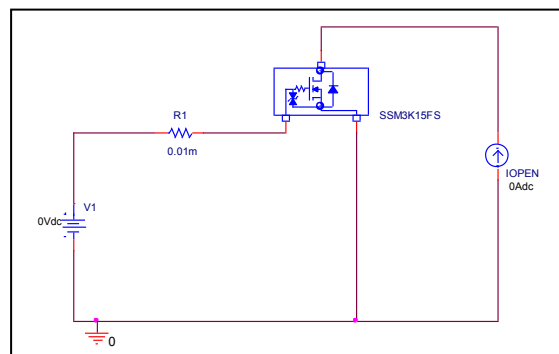
Relation between tr_j and tr_b

Zener Voltage Characteristic

Circuit Simulation Result



Evaluation Circuit



Zener Voltage Characteristic

Reference

