

Device Modeling Report

COMPONENTS: Power MOSFET (Model parameter)
PART NUMBER: SSM3J112TU
MANUFACTURER: TOSHIBA
Body Diode (Model parameter) / ESD Protection Diode

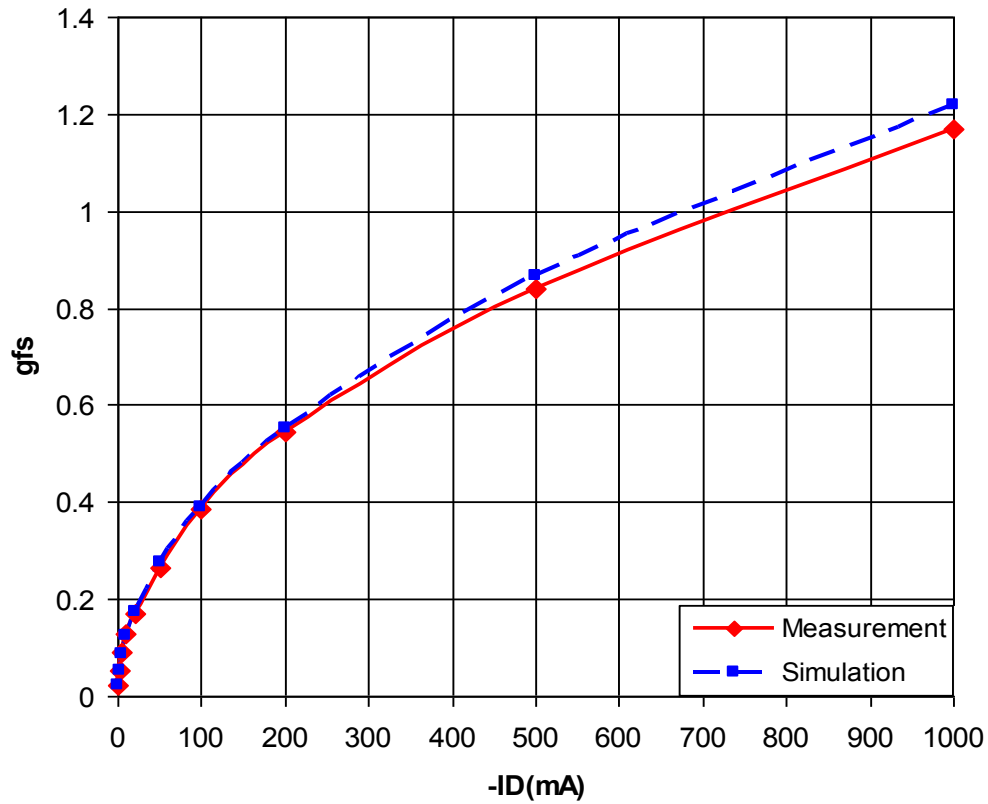


MOSFET MODEL

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

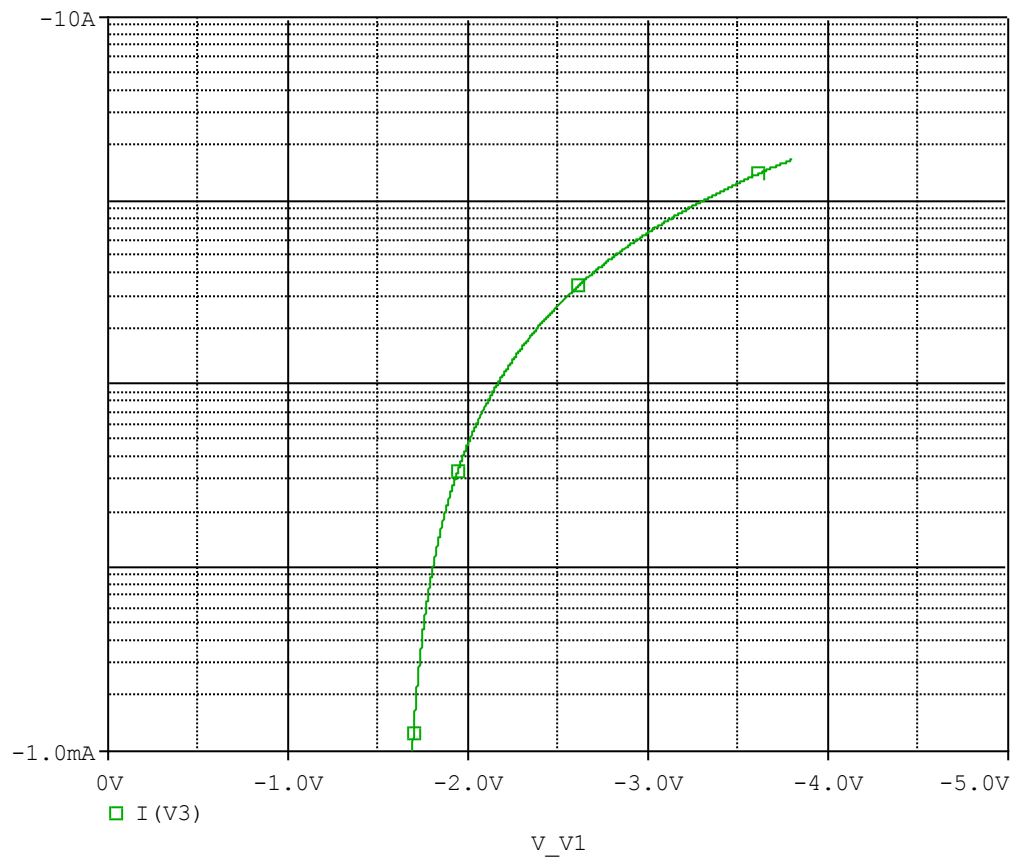


Comparison table

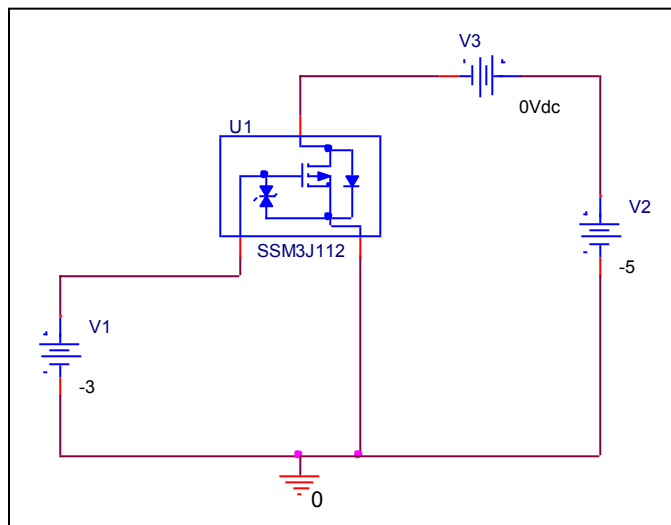
- I_D (mA)	g_{fs}		Error(%)
	Measurement	Simulation	
1	0.0232	0.023	0.870
2	0.0545	0.054	0.926
5	0.09	0.088	2.273
10	0.127	0.123	3.252
20	0.17	0.175	-2.857
50	0.265	0.276	-3.986
100	0.385	0.391	-1.535
200	0.545	0.551	-1.089
500	0.84	0.867	-3.114
1000	1.17	1.220	-4.098

V_{gs}-I_d Characteristic

Circuit Simulation result

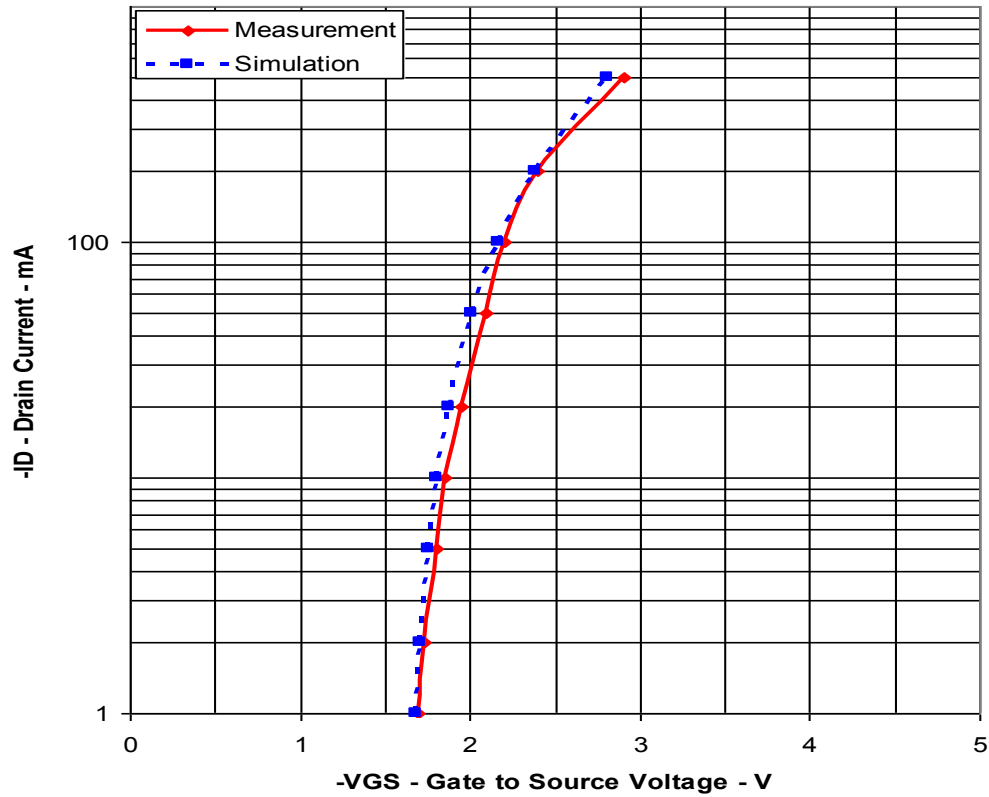


Evaluation circuit



Comparison Graph

Circuit Simulation Result

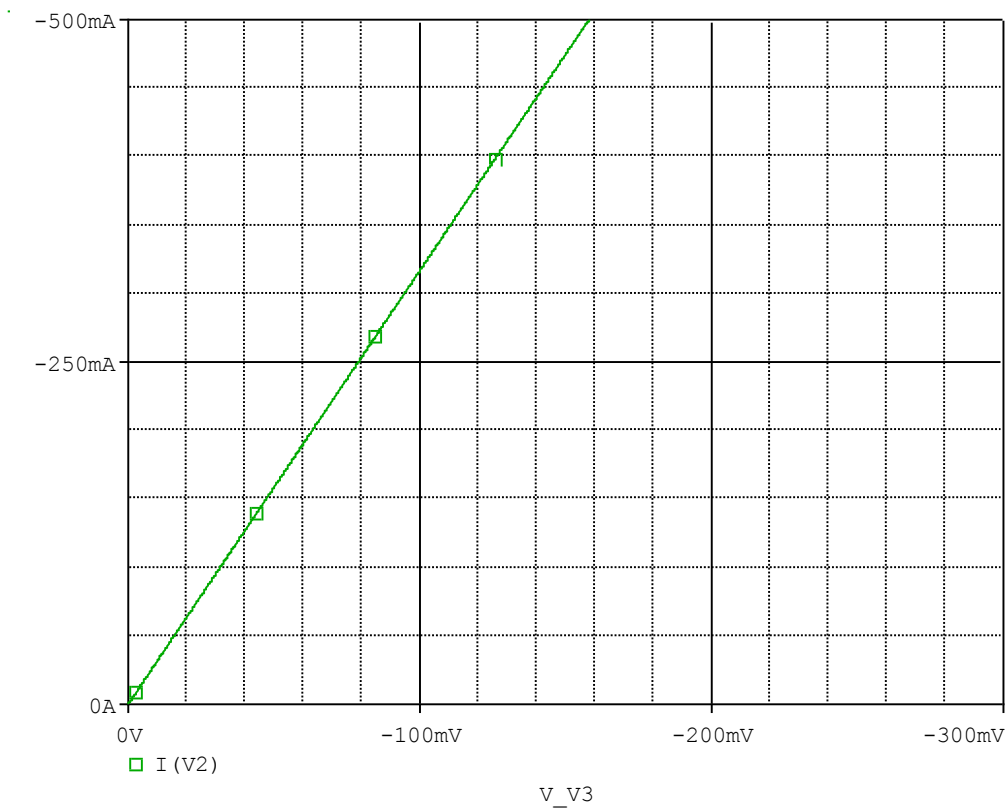


Simulation Result

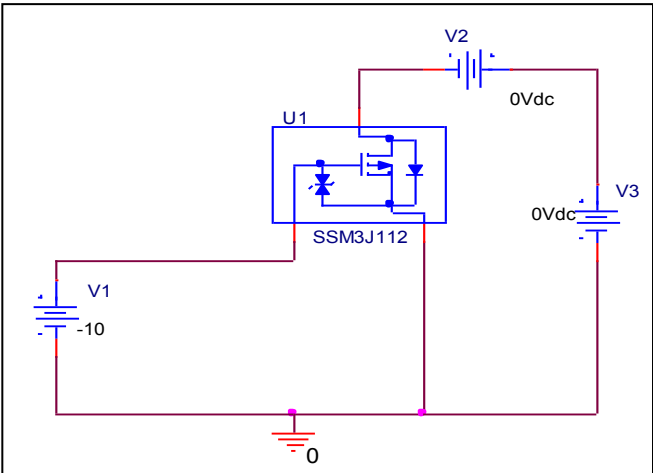
$-I_D$ (mA)	$-V_{GS}$ (V)		Error (%)
	Measurement	Simulation	
1	1.700	1.6887	-0.665
2	1.730	1.7121	-1.035
5	1.800	1.7552	-2.489
10	1.850	1.8037	-2.503
20	1.95	1.8724	-3.979
50	2.1	2.0087	-4.348
100	2.2	2.1625	-1.705
200	2.4	2.3803	-0.821
500	2.9	2.8136	-2.979
1000	3.4	3.3037	-2.832

Rds(on) Characteristic

Circuit Simulation result



Evaluation circuit

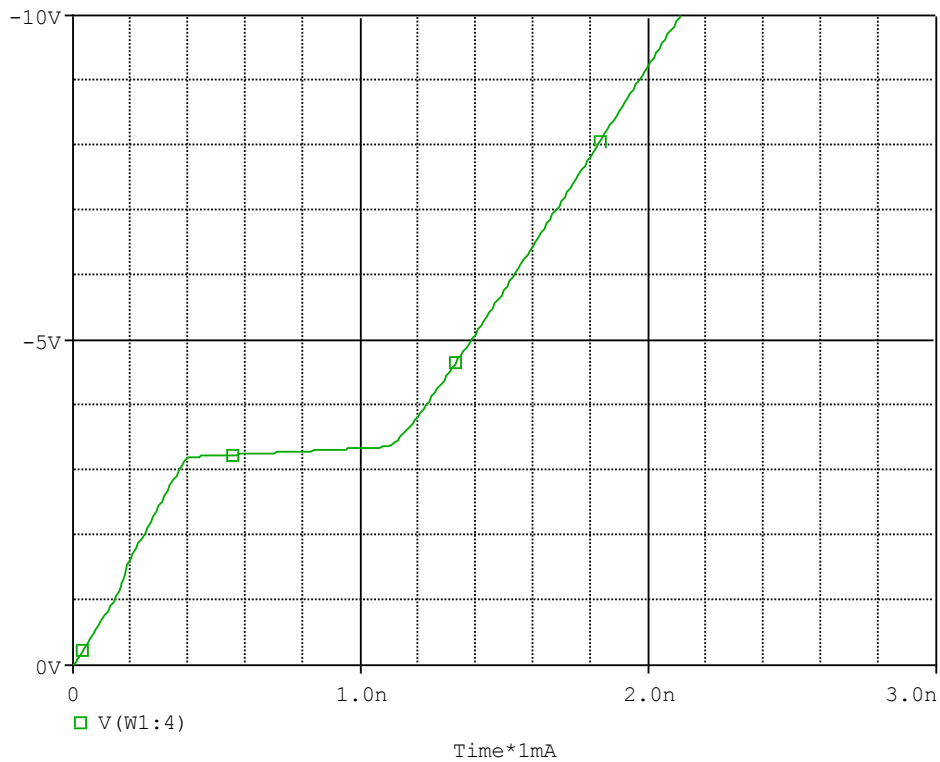


Simulation Result

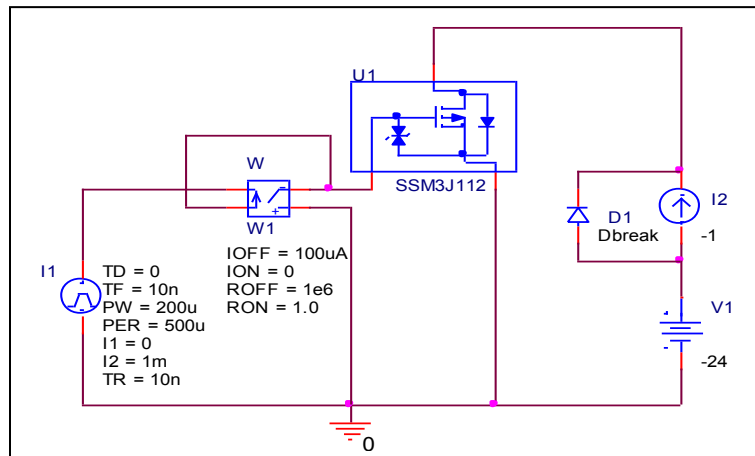
$I_D = -0.5A, V_{GS} = -10V$	Measurement		Simulation		Error (%)
$R_{DS(on)}$	310.000	mΩ	315.852	mΩ	1.888

Gate Charge Characteristic

Circuit Simulation result



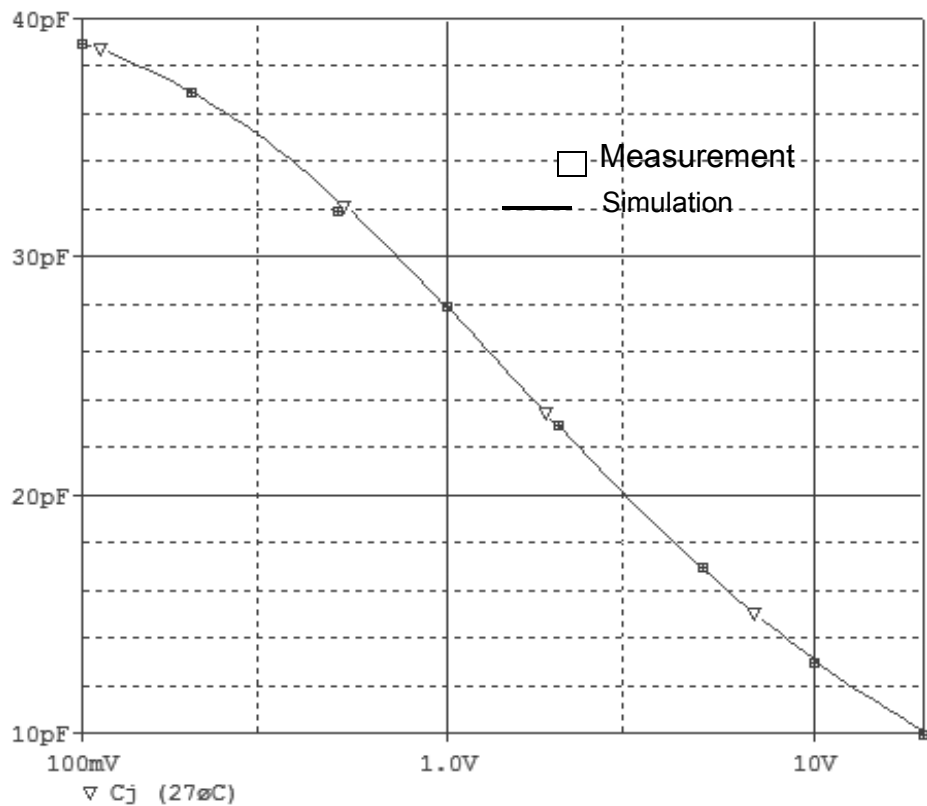
Evaluation circuit



Simulation Result

$V_{DD}=36V, I_D=3A$	Measurement		Simulation		Error (%)
Qgs	0.4	nC	0.4001	nC	0.025
Qgd	0.7	nC	0.6883	nC	-1.671
Qg	2.25	nC	2.1101	nC	-6.218

Capacitance Characteristic

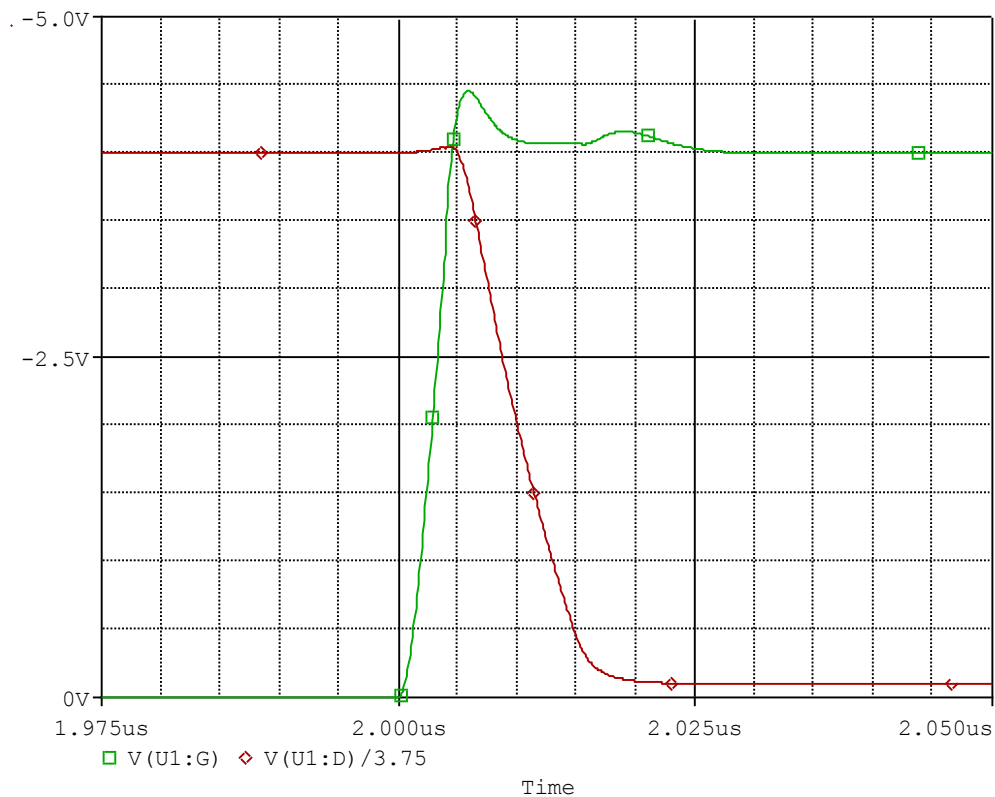


Simulation Result

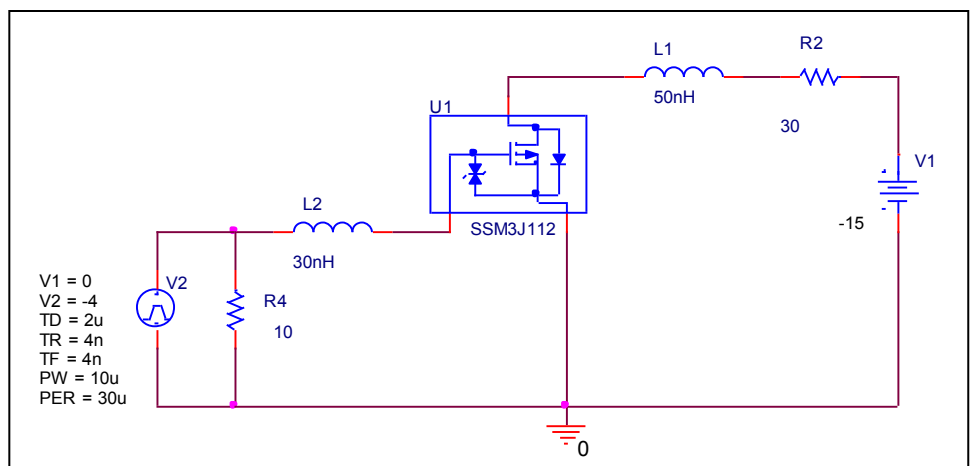
- V_{DS} (V)	Cbd(pF)		Error(%)
	Measurement	Simulation	
0.1	39	38.95	-0.128
0.2	37	36.9	-0.270
0.5	32	32.4	1.250
1	28	27.8	-0.714
2	23	22.9	-0.435
5	17	16.9	-0.588
10	13	13.1	0.769
20	10	10.05	0.500

Switching Time Characteristic

Circuit Simulation result



Evaluation circuit

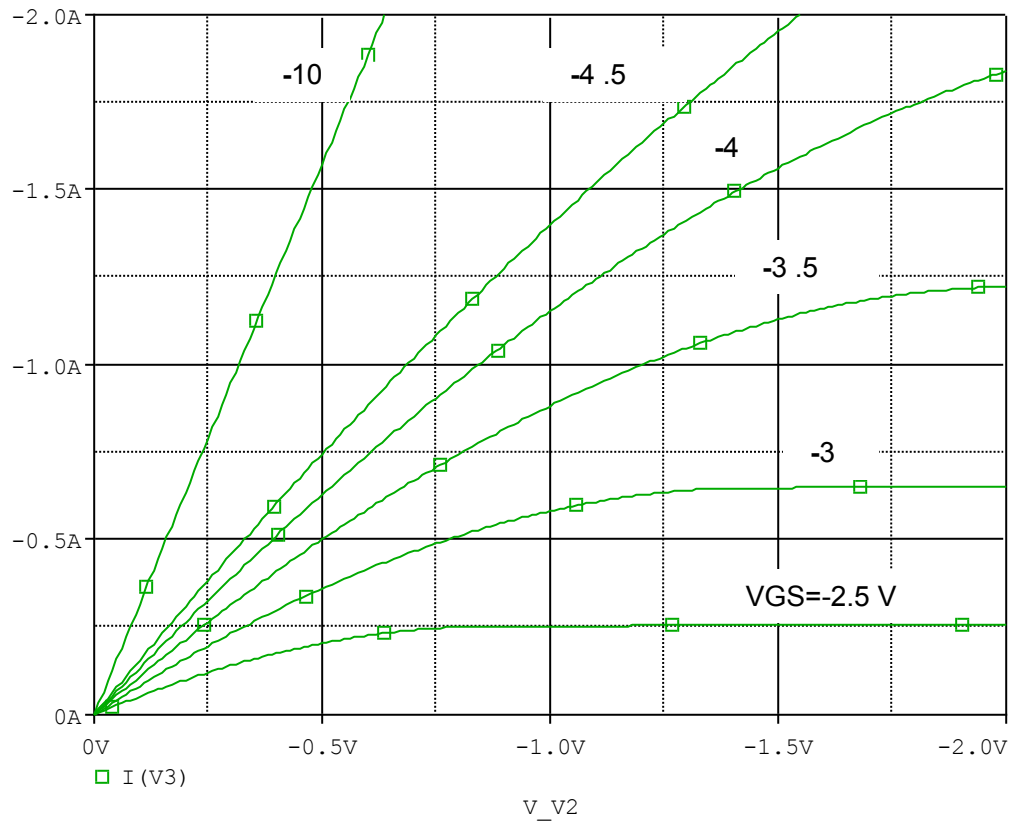


Simulation Result

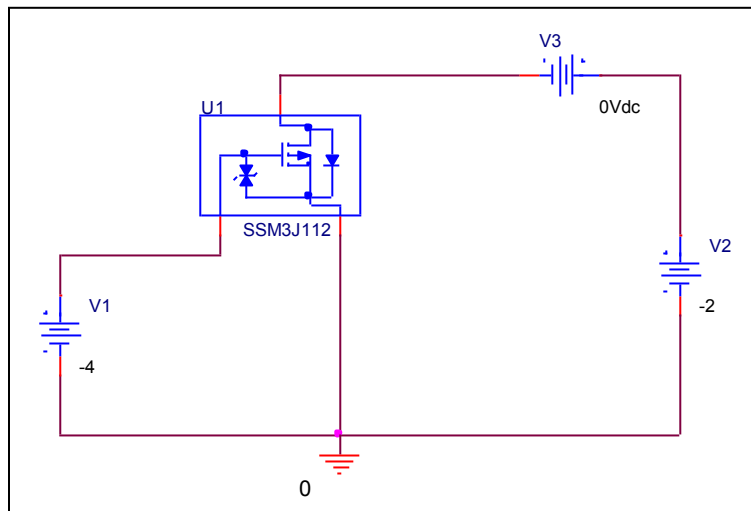
$I_D = -0.5 \text{ A}$, $V_{DD} = -15 \text{ V}$ $V_{GS} = 0/-4 \text{ V}$	Measurement	Simulation	Error(%)
Ton(ns)	14.000	14.024	0.171

Output Characteristic

Circuit Simulation result



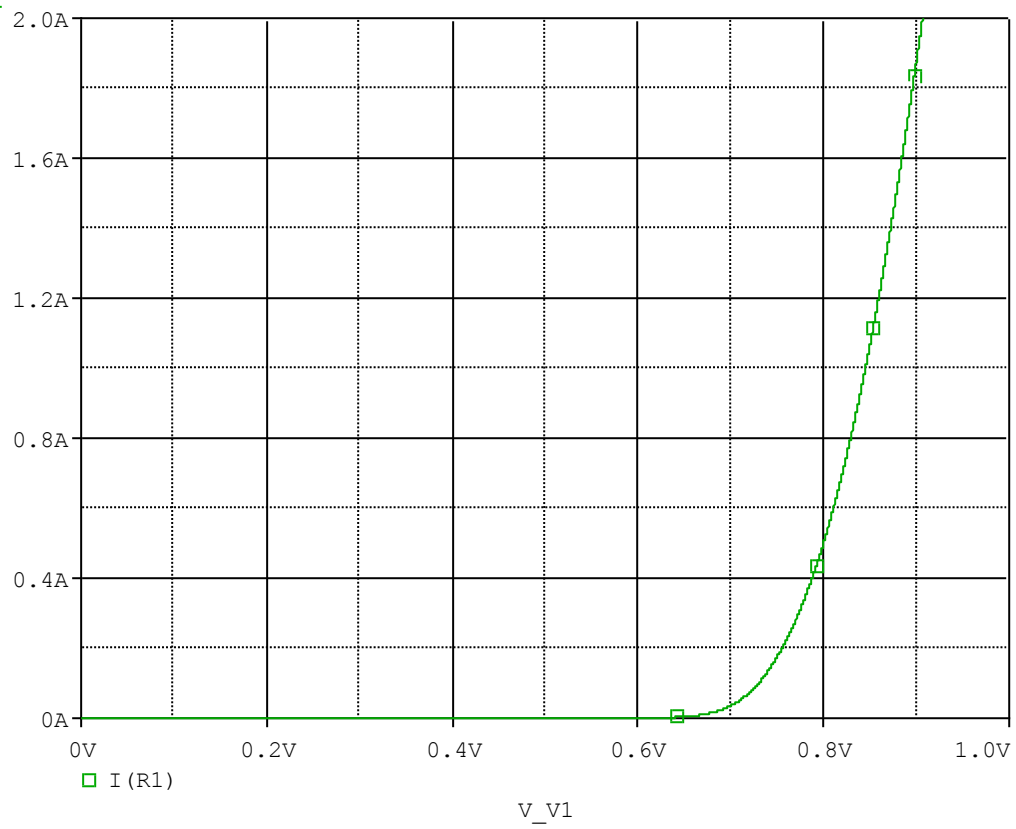
Evaluation circuit



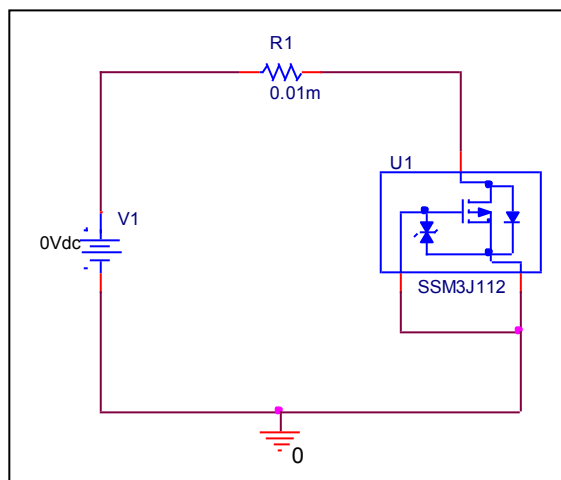
BODY DIODE

Forward Current Characteristic

Circuit Simulation Result

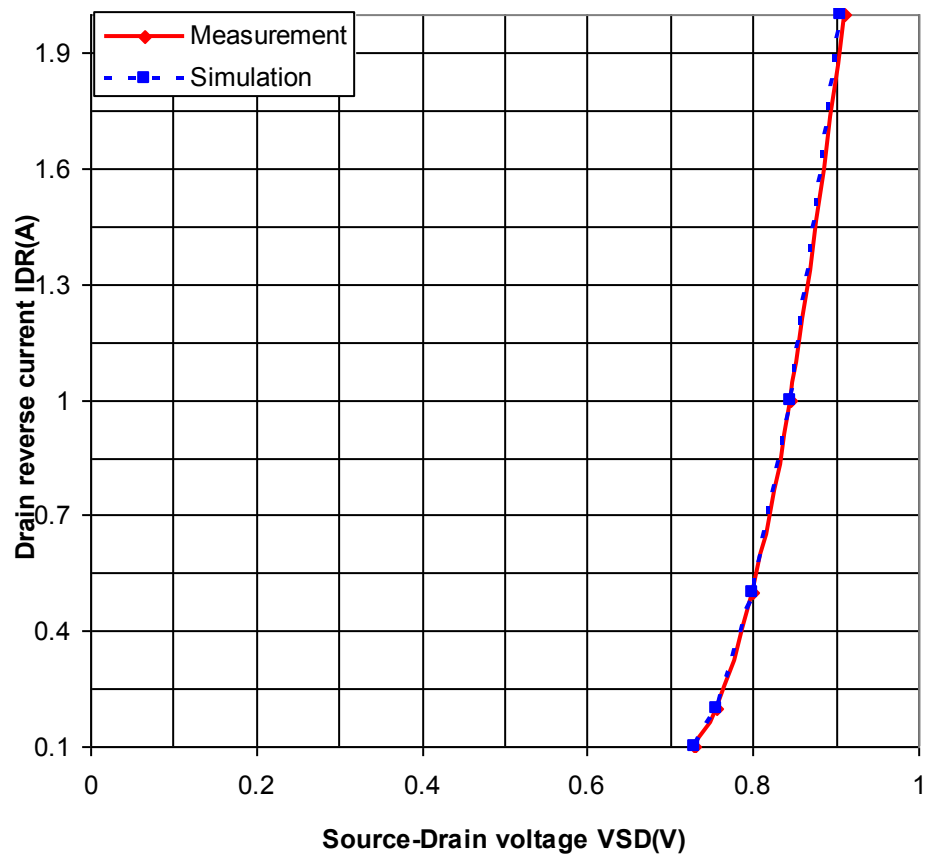


Evaluation Circuit



Comparison Graph

Circuit Simulation Result

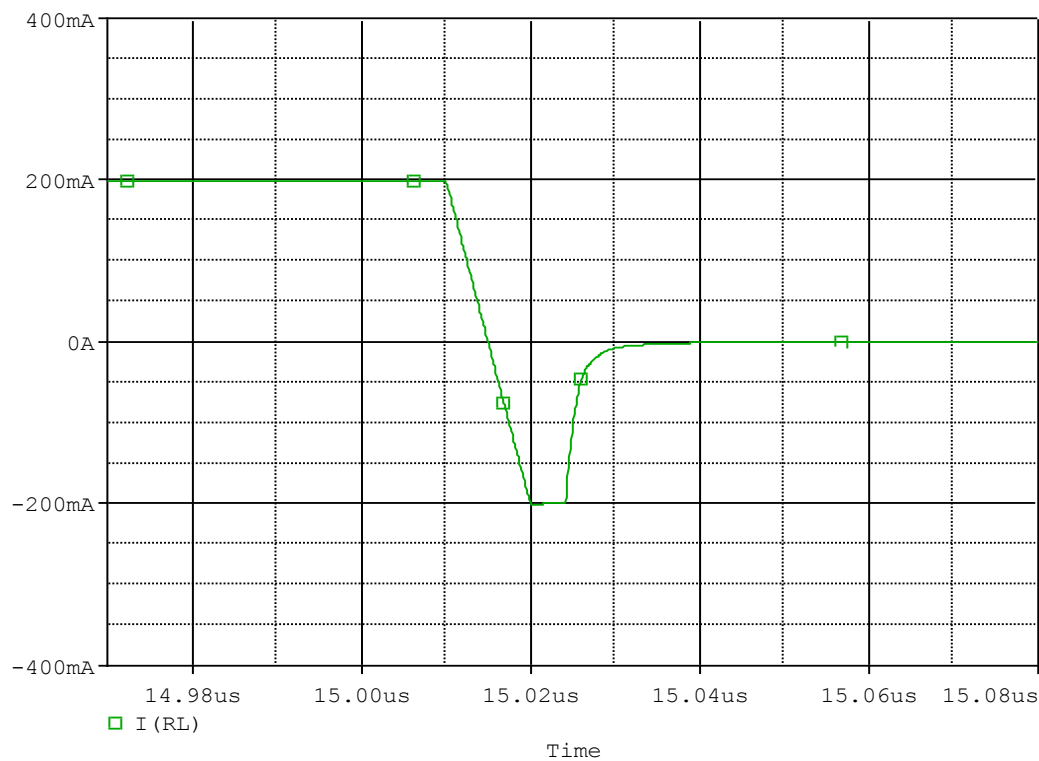


Simulation Result

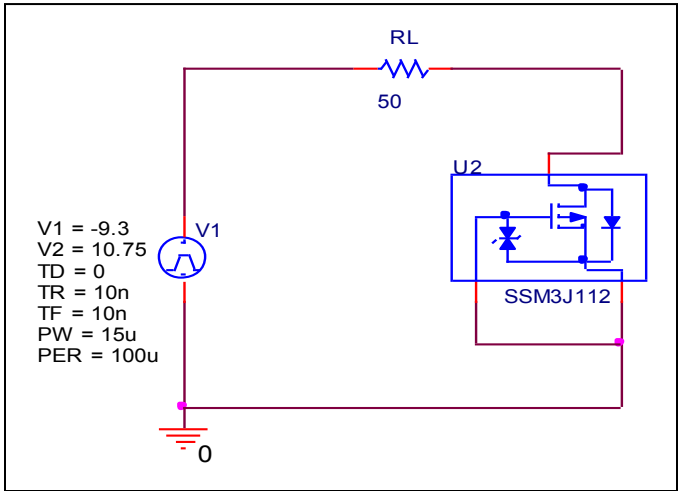
IDR(A)	VSD(V)		%Error
	Measuremen	Simulation	
0.1	0.73	0.7298	-0.027
0.2	0.755	0.7552	0.026
0.5	0.8	0.7998	-0.025
1	0.845	0.8450	0.000
2	0.91	0.9067	-0.363

Reverse Recovery Characteristic

Circuit Simulation Result



Evaluation Circuit

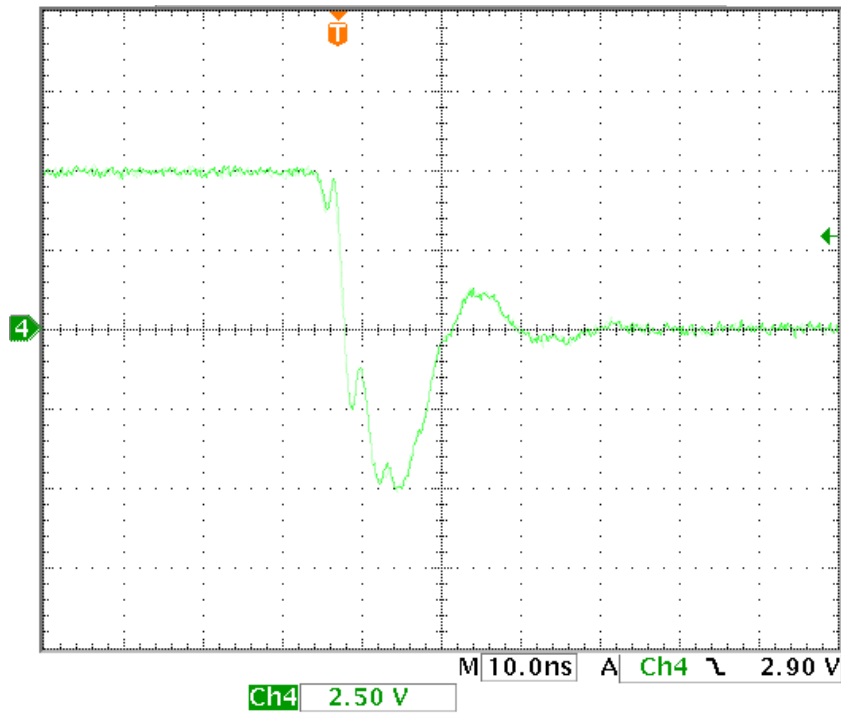


Compare Measurement vs. Simulation

Trr(ns)	Measurement	Simulation	Error (%)
Trj+Trb (ns)	12	12.198	1.65

Reverse Recovery Characteristic

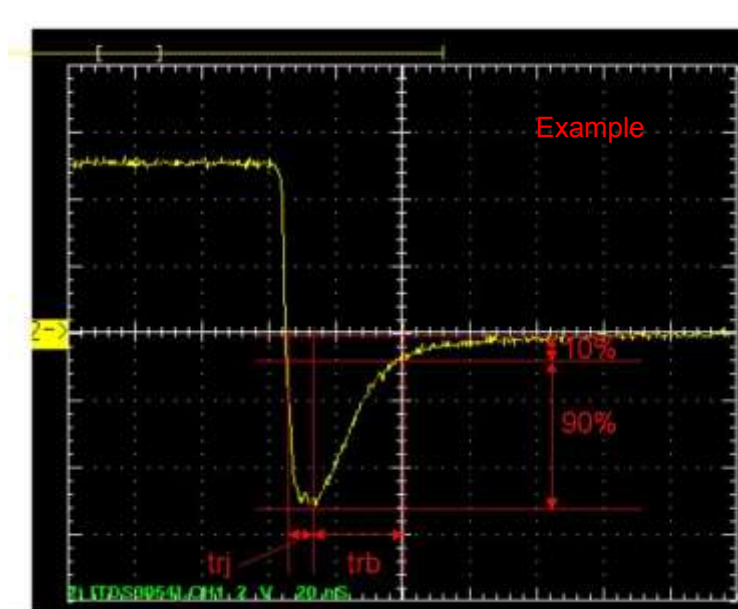
Reference



$T_{rr}=7.2(\text{ns})$

$T_{rb}=4.8(\text{ns})$

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

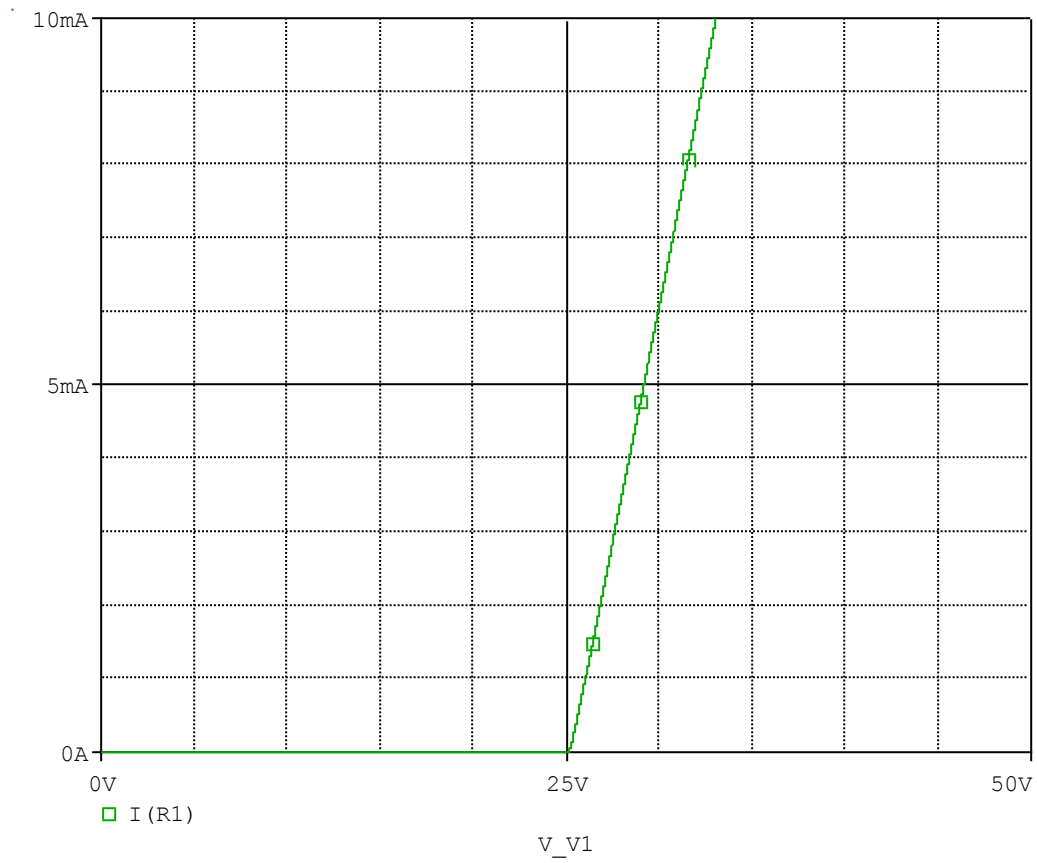


Relation between t_{rj} and t_{rb}

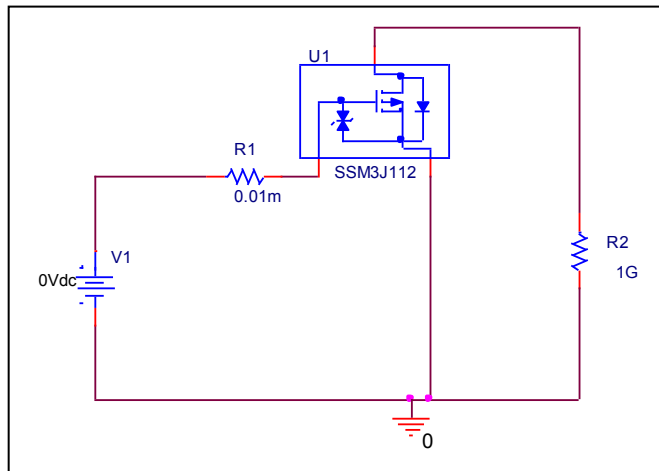
ESD PROTECTION DIODE

Zener Voltage Characteristic

Circuit Simulation Result



Evaluation Circuit



Zener Voltage Characteristic

Reference

