

Device Modeling Report

COMPONENTS: MOSFET (Model Parameter)
PART NUMBER: 2SJ334
MANUFACTURER: TOSHIBA
Body Diode (Model Parameter) / ESD Protection



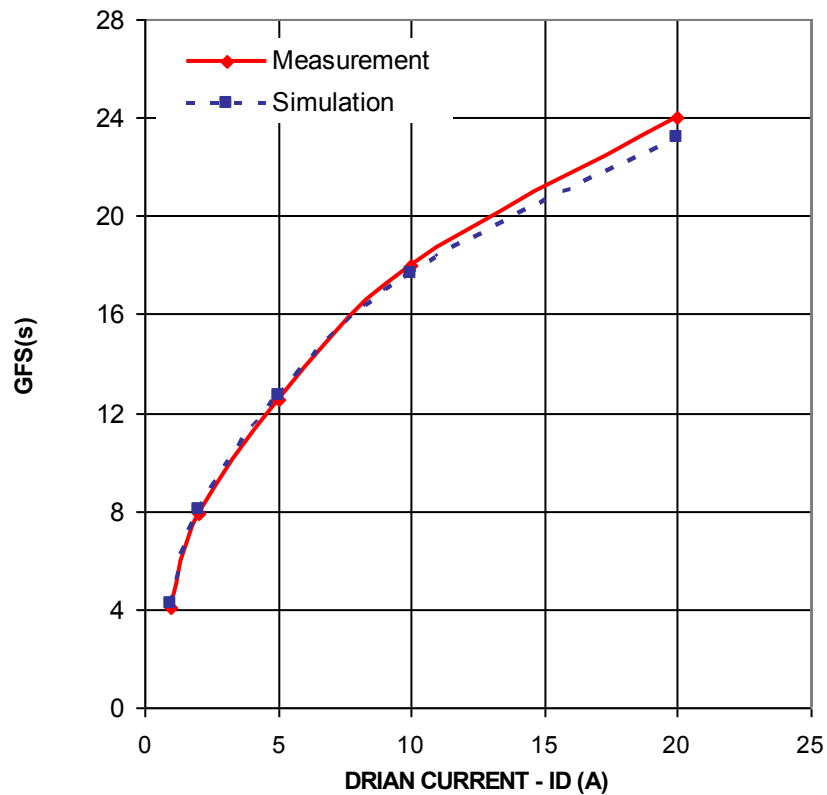
Bee Technologies Inc.

MOSFET MODEL PARAMETERS

PSpice model parameters	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

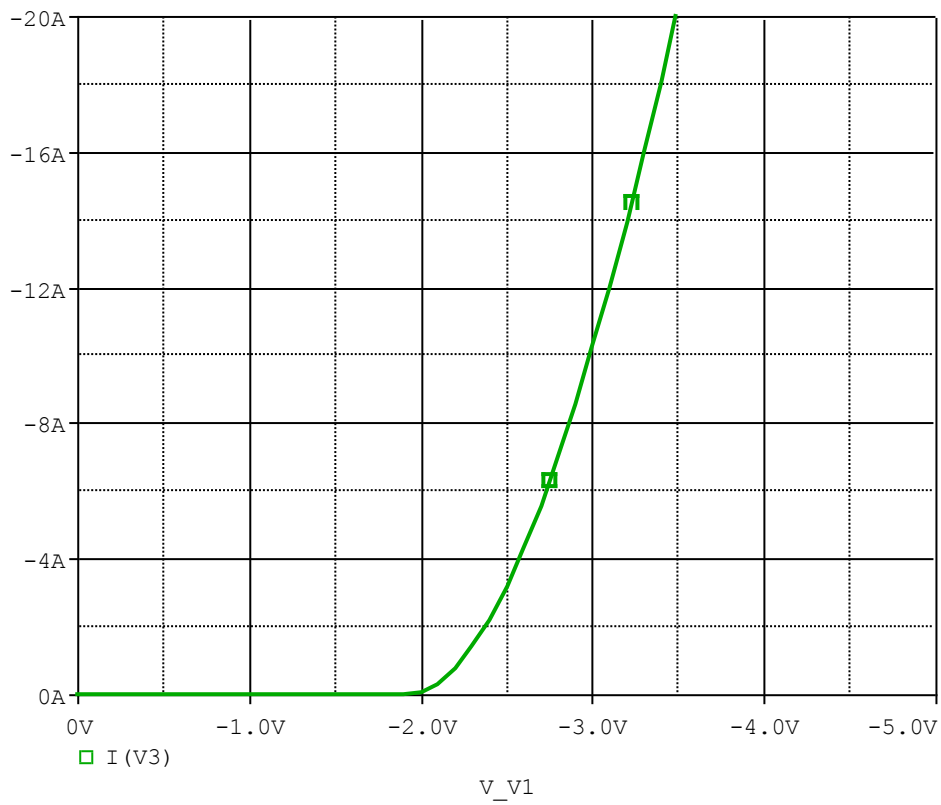


Comparison table

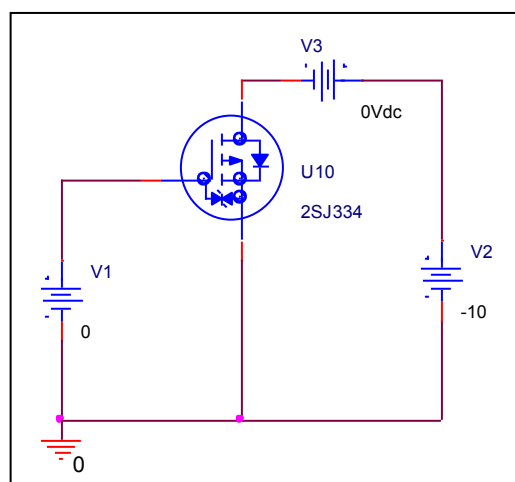
Id(A)	Gfs(S)		Error(%)
	Measurement	Simulation	
-1.000	4.100	4.230	3.171
-2.000	7.900	8.070	2.152
-5.000	12.500	12.729	1.832
-10.000	18.000	17.690	-1.722
-20.000	24.000	23.161	-3.496

V_{gs}-I_d Characteristic

Circuit Simulation result

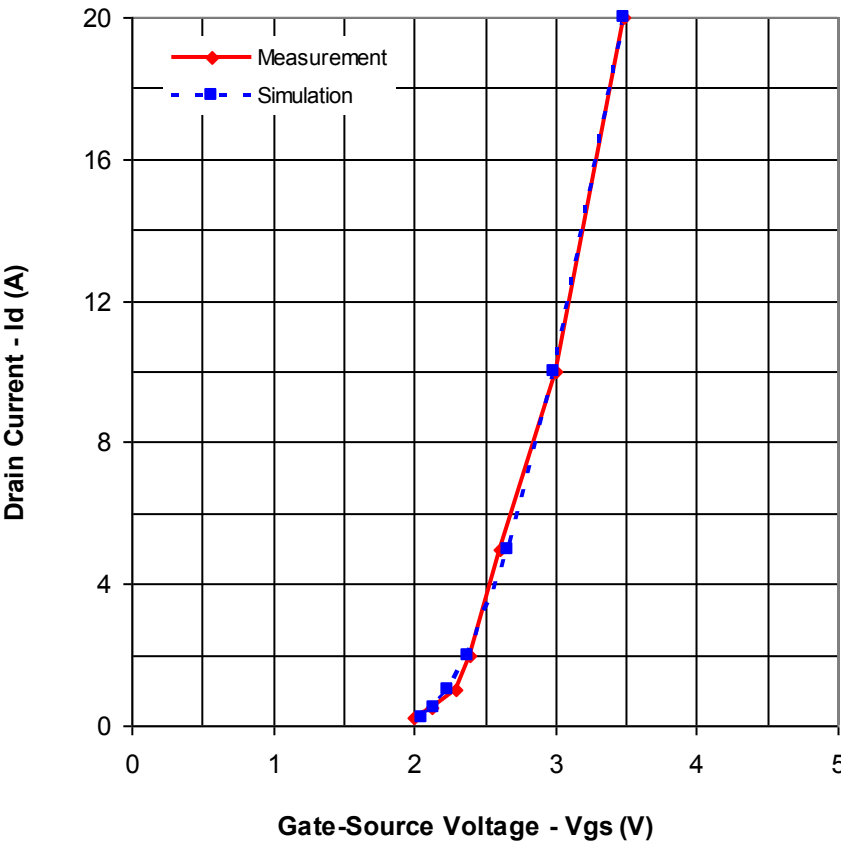


Evaluation circuit



Comparison Graph

Circuit Simulation Result

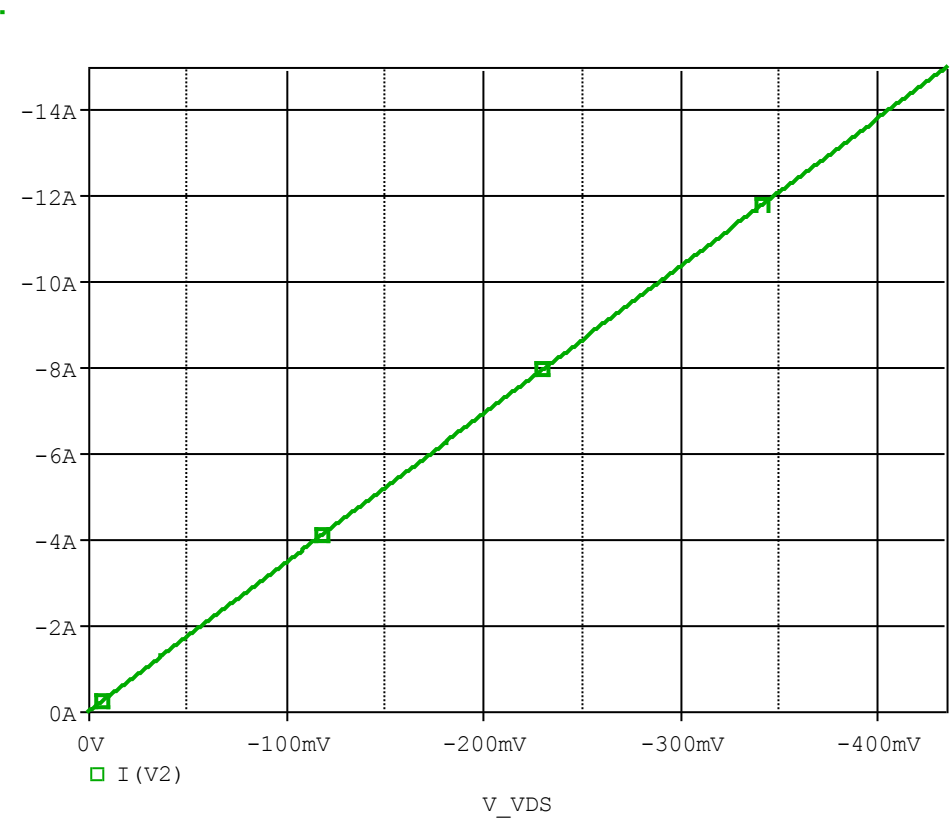


Simulation Result

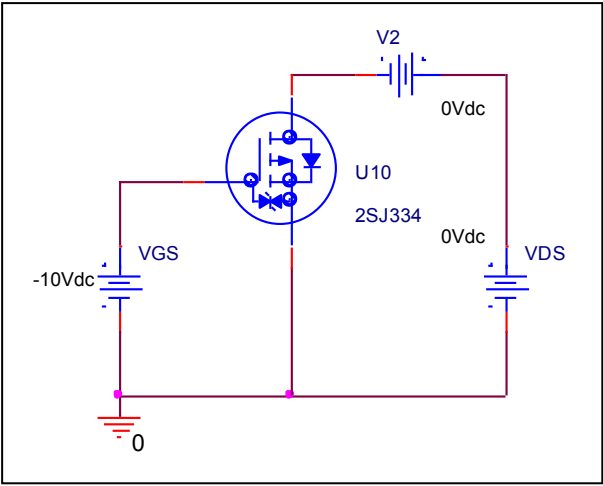
I_D (A)	V_{GS} (V)		Error (%)
	Measurement	Simulation	
-0.200	-2.000	-2.057	2.850
-0.500	-2.120	-2.144	1.132
-1.000	-2.300	-2.241	-2.565
-2.000	-2.400	-2.377	-0.958
-5.000	-2.600	-2.656	2.154
-10.000	-3.000	-2.988	-0.400
-20.000	-3.490	-3.486	-0.115

Rds(on) Characteristic

Circuit Simulation result



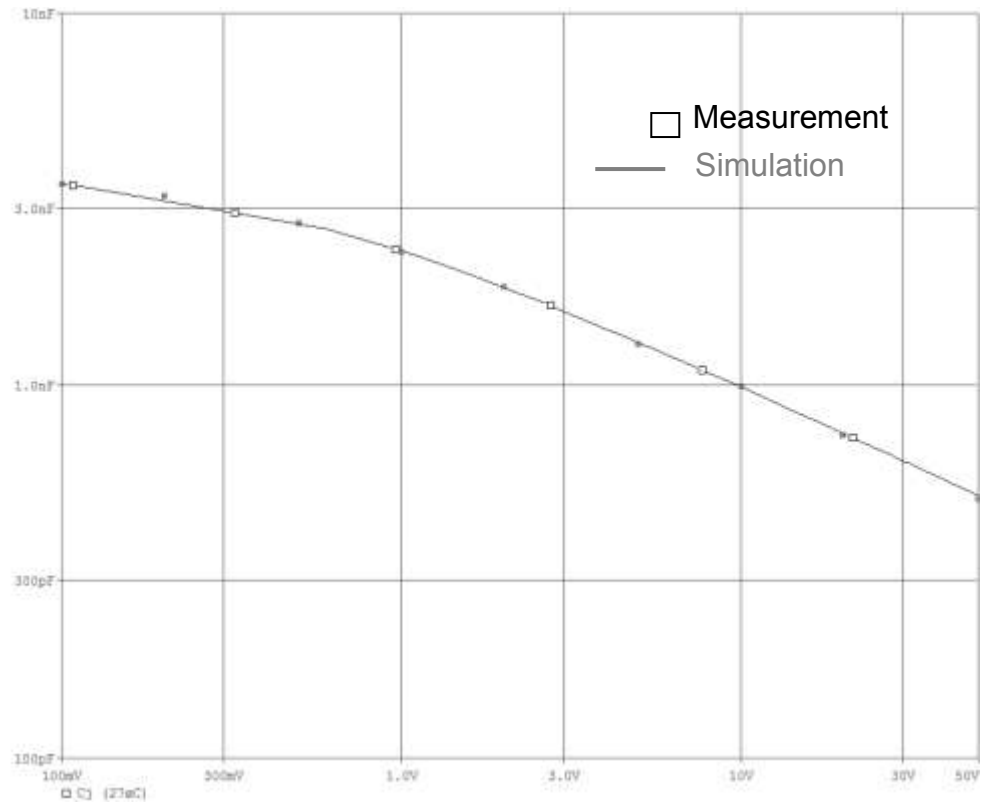
Evaluation circuit



Simulation Result

$I_D = -15A, V_{GS} = -10V$	Measurement		Simulation		Error (%)
$R_{DS(on)}$	29.000	mΩ	29.000	mΩ	0.000

Capacitance Characteristic

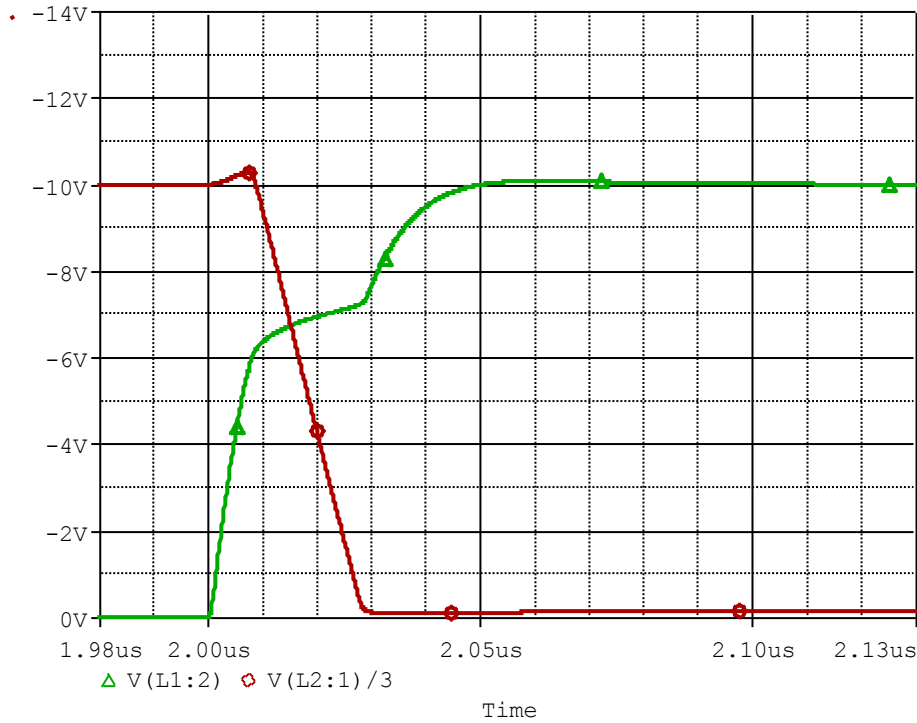


Simulation Result

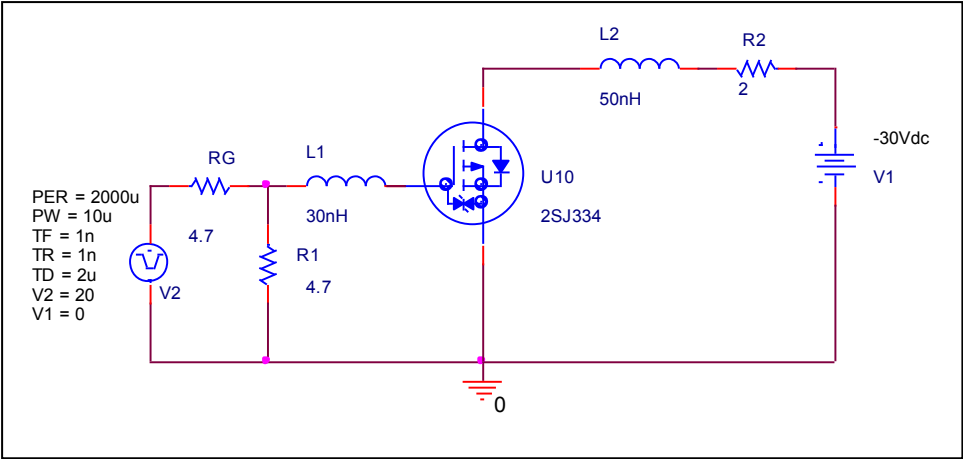
V _{DS} (V)	Cbd(pF)		Error(%)
	Measurement	Simulation	
0.100	3600.000	3500.000	-2.778
0.200	3200.000	3250.000	1.563
0.500	2700.000	2750.000	1.852
1.000	2300.000	2300.000	0.000
2.000	1900.000	1850.000	-2.632
5.000	1350.000	1300.000	-3.704
10.000	1000.000	1000.000	0.000
20.000	750.000	740.000	-1.333
50.000	480.000	500.000	4.167

Switching Time Charac teristic

Circuit Simulation Result



Evaluation Circuit

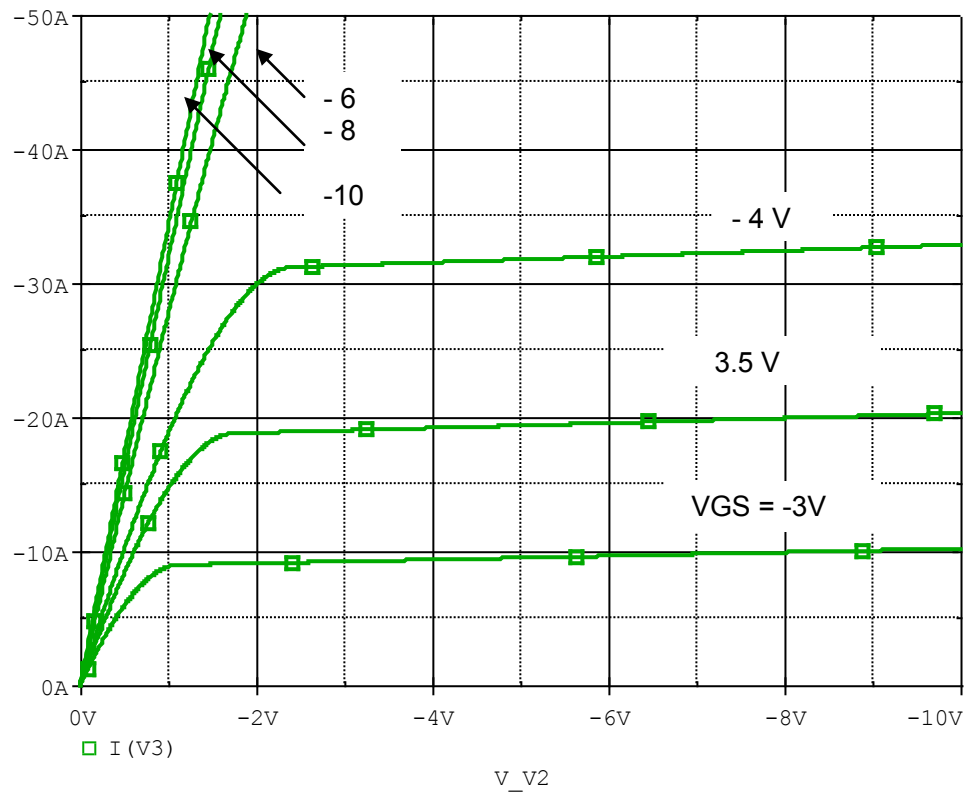


Simulation Result

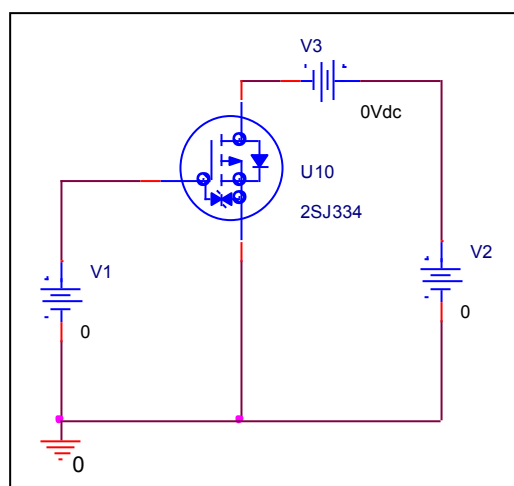
$I_D = -15A$, $V_{DD} = -30V$, $V_{GS} = -10V$	Measurement		Simulation		Error(%)
Td(on)	25.000	ns	25.145	ns	0.585

Output Characteristic

Circuit Simulation Result



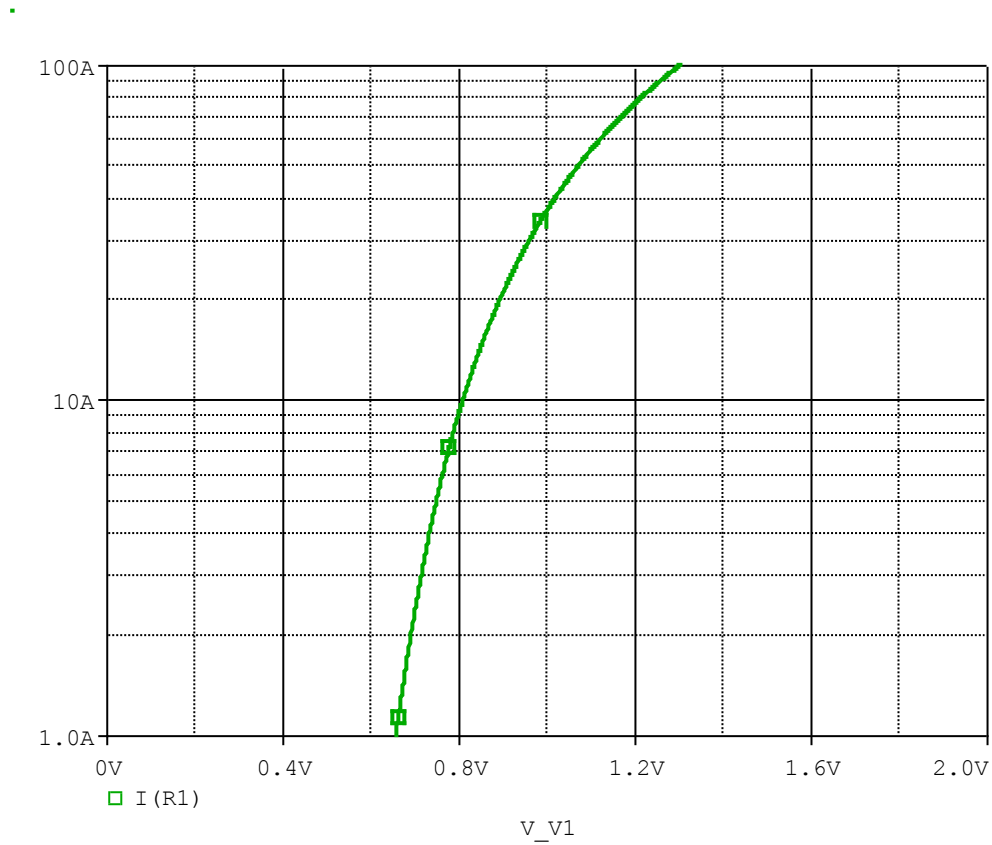
Evaluation Circuit



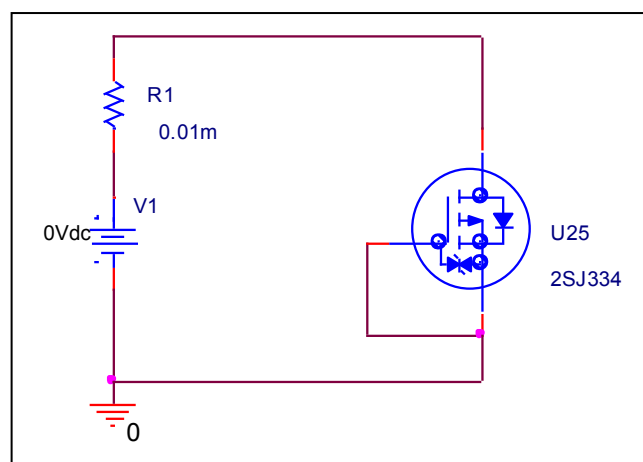
BODY DIODE SPICE MODEL

Forward Current Characteristic

Circuit Simulation Result

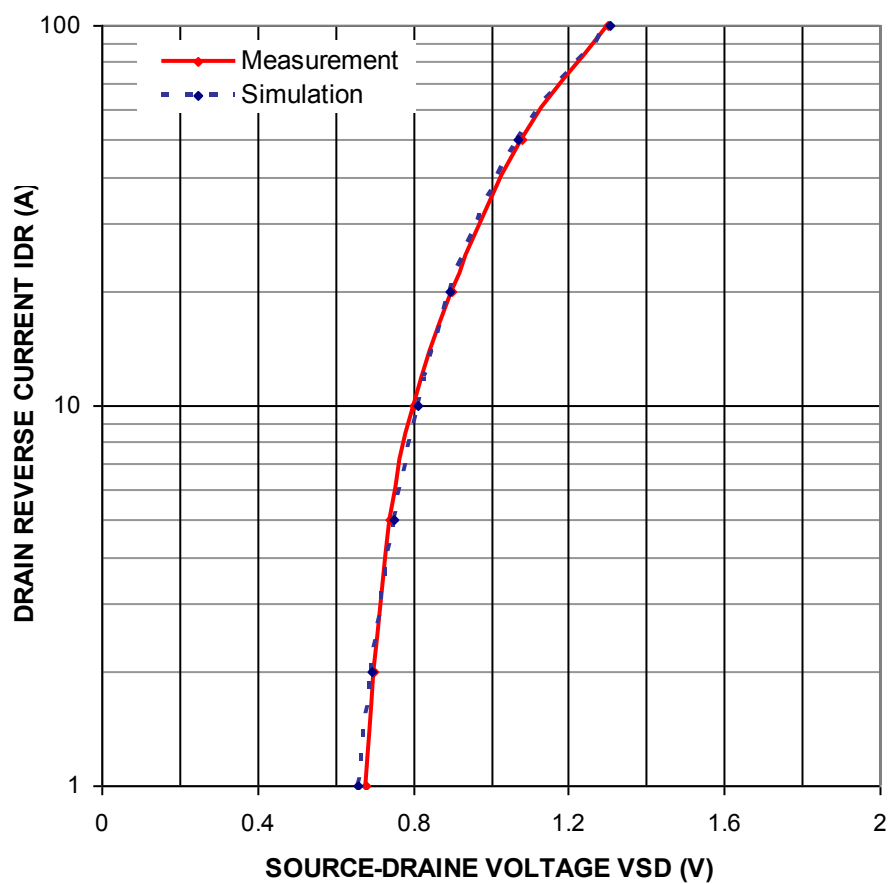


Evaluation Circuit



Comparison Graph

Circuit Simulation Result

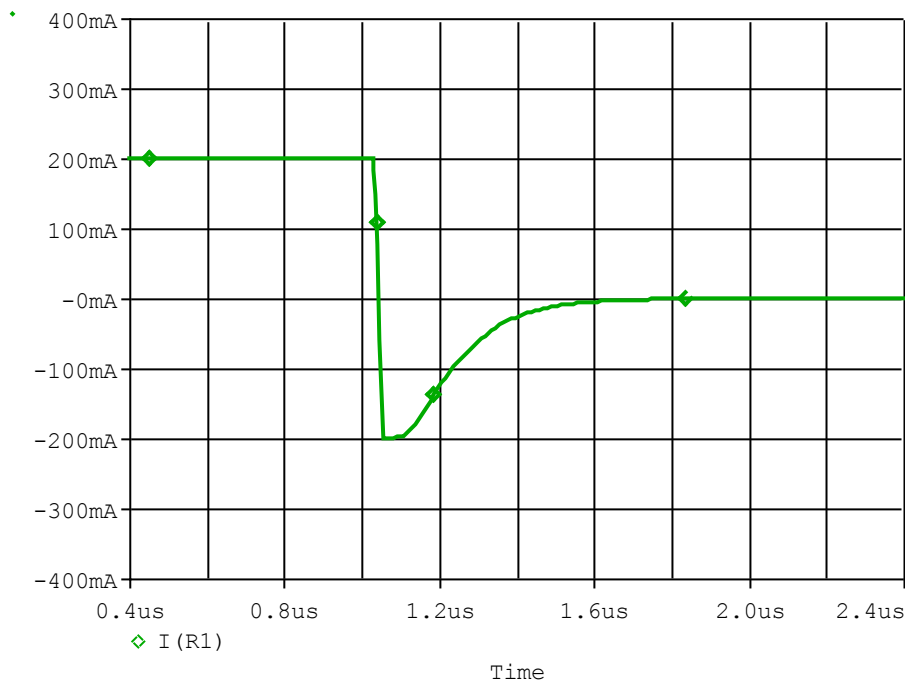


Simulation Result

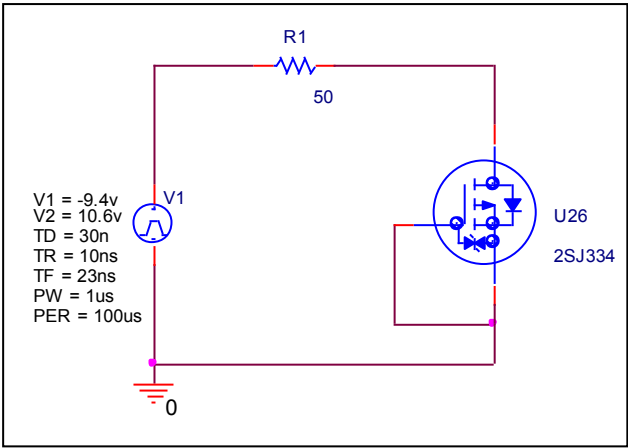
IDR(A)	VSD(V)		%Error
	Measurement	Simulation	
1.000	0.680	0.658	-3.235
2.000	0.700	0.692	-1.143
5.000	0.740	0.749	1.216
10.000	0.800	0.810	1.250
20.000	0.900	0.896	-0.444
50.000	1.080	1.070	-0.926
100.000	1.300	1.304	0.308

Reverse Recovery Characteristic (Body Diode)

Circuit Simulation Result



Evaluation Circuit

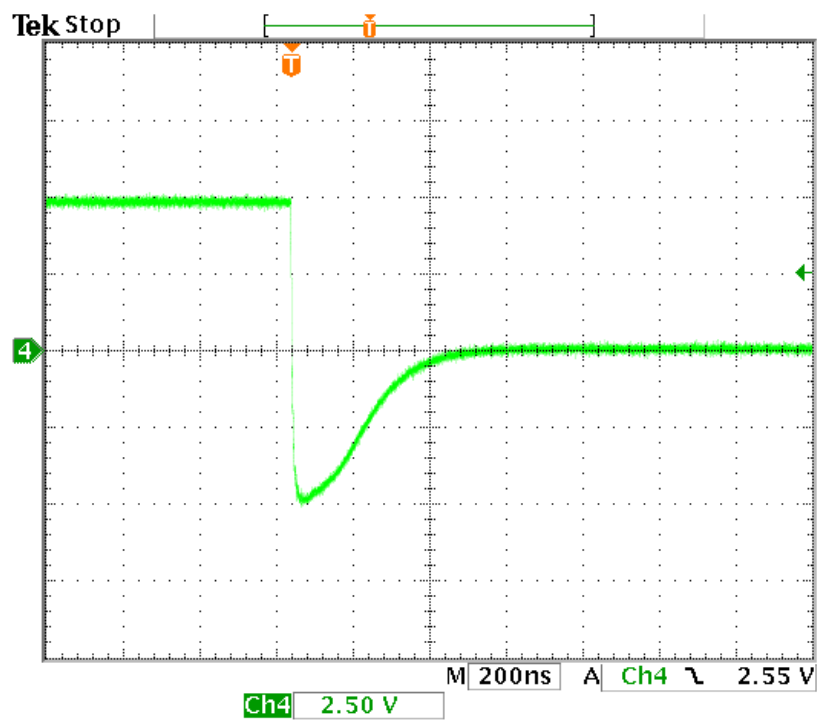


Compare Measurement vs. Simulation

	Measurement		Simulation		Error (%)
trj	60.000	ns	60.554	ns	0.923
trb	300.000	ns	329.825	ns	9.942
trr	360.000	ns	390.379	ns	8.439

Reverse Recovery Characteristic (Body Diode)

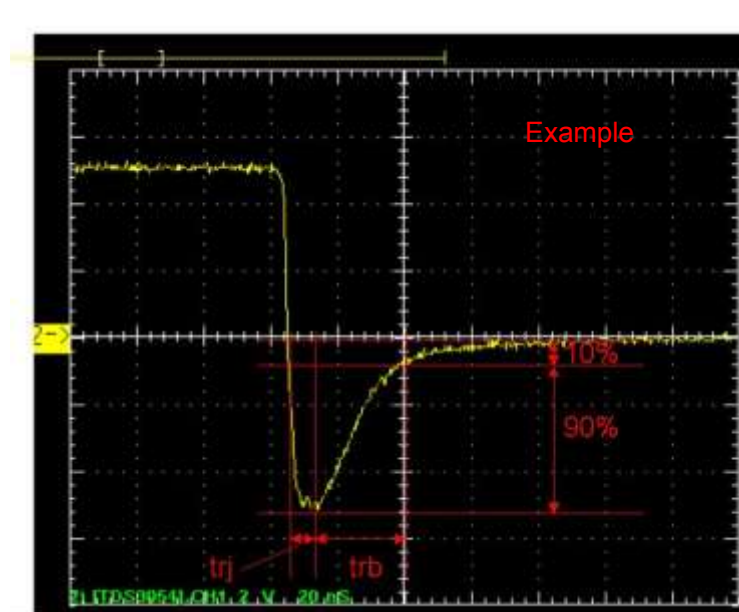
Reference



$T_{rj} = (60\text{ns})$

$T_{rb} = (300\text{ns})$

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



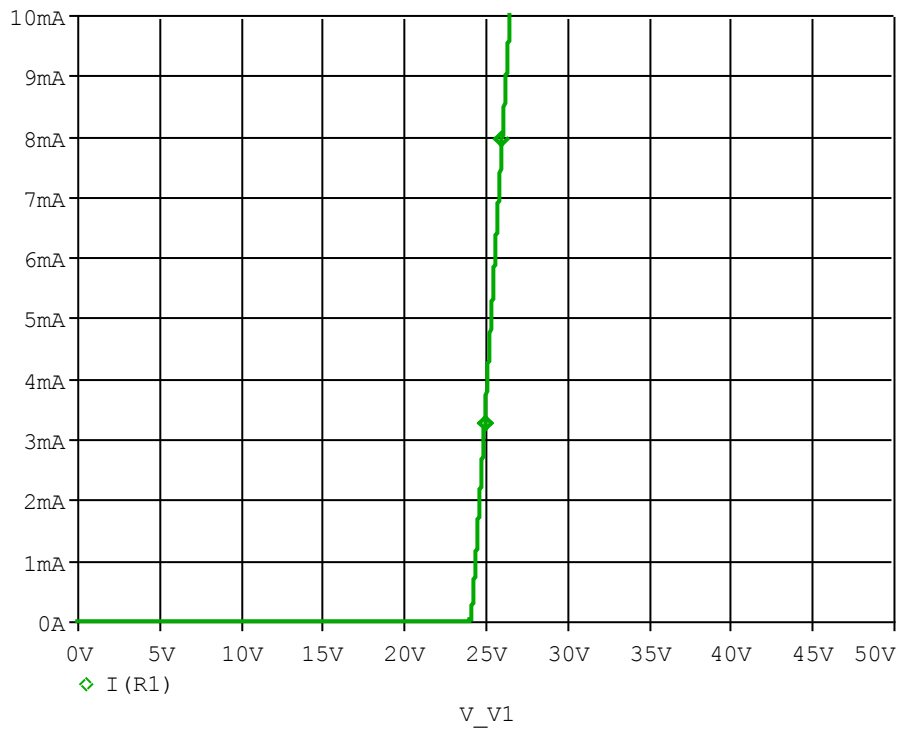
Relation between t_{rj} and t_{rb}

ESD PROTECTION DIODE SPICE MODEL

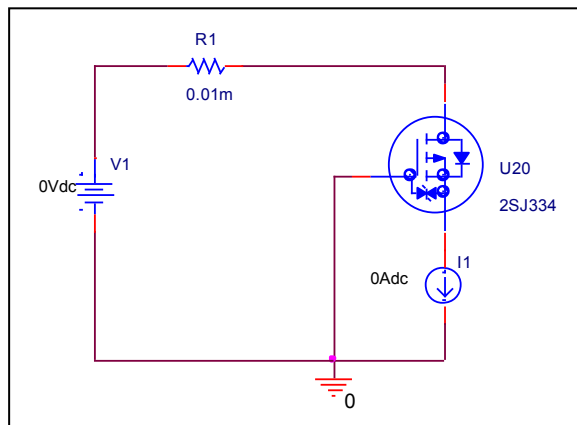
Zener Voltage Characteristic

Circuit Simulation Result

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Evaluation Circuit



Zener Voltage Characteristic

Reference

