

Device Modeling Report

COMPONENTS: MOSFET (Model Parameter)
PART NUMBER: 2SJ537
MANUFACTURER: TOSHIBA
Body Diode (Standard) / ESD Protection



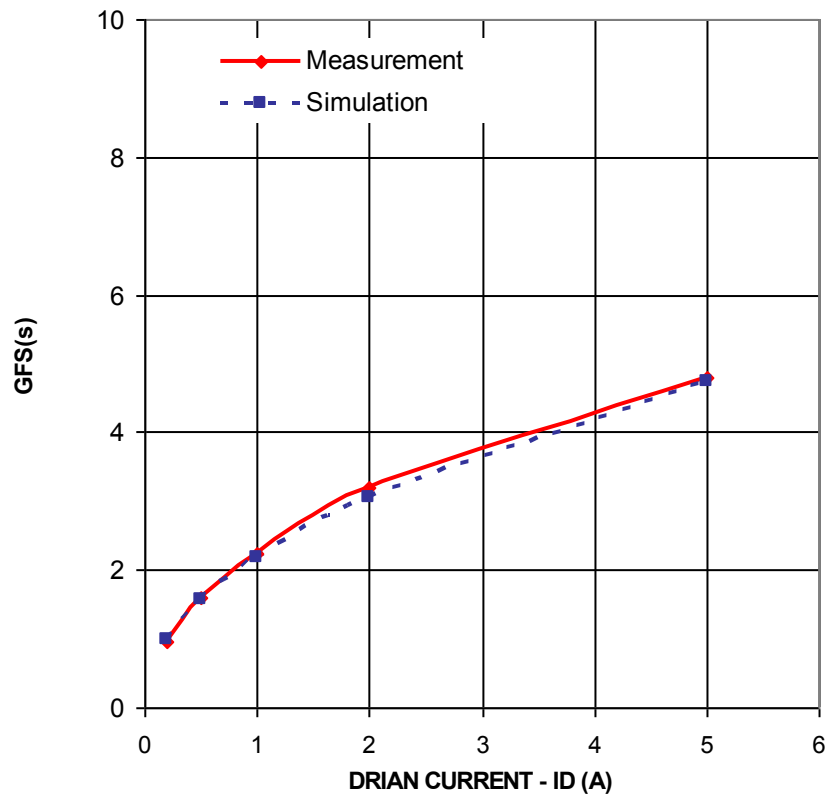
Bee Technologies Inc.

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

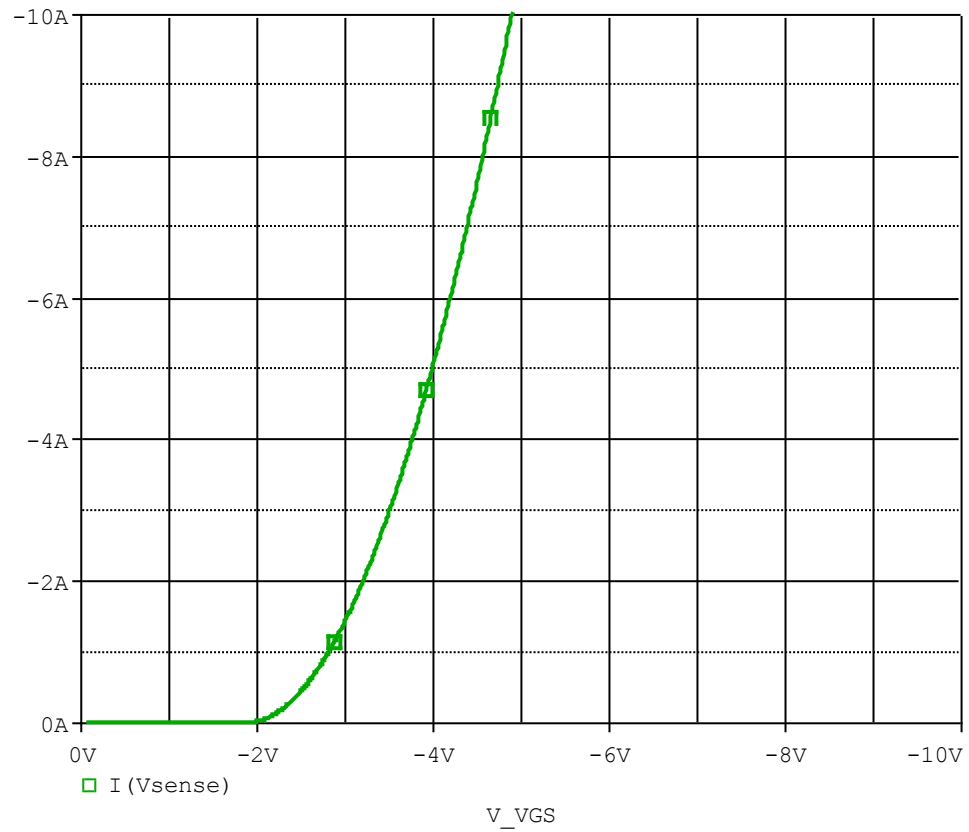


Comparison table

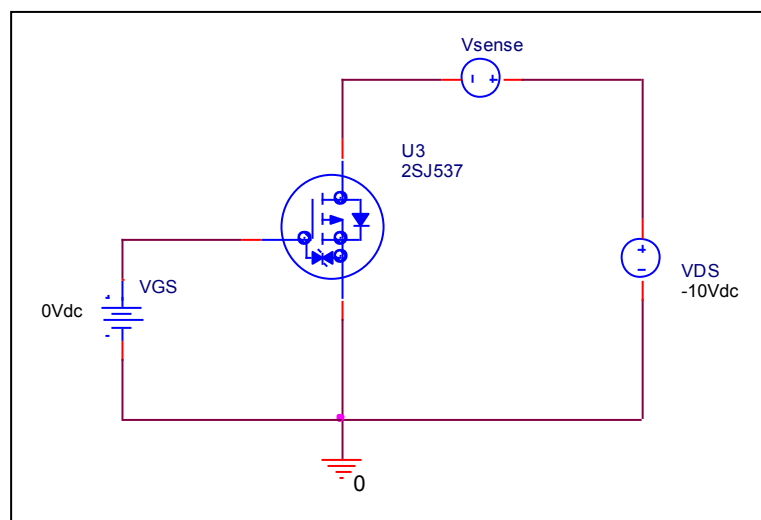
Id(A)	Gfs(S)		Error(%)
	Measurement	Simulation	
-0.200	0.950	0.989	4.105
-0.500	1.600	1.556	-2.750
-1.000	2.250	2.180	-3.111
-2.000	3.200	3.059	-4.406
-5.000	4.800	4.746	-1.125

V_{gs}-I_d Characteristic

Circuit Simulation result

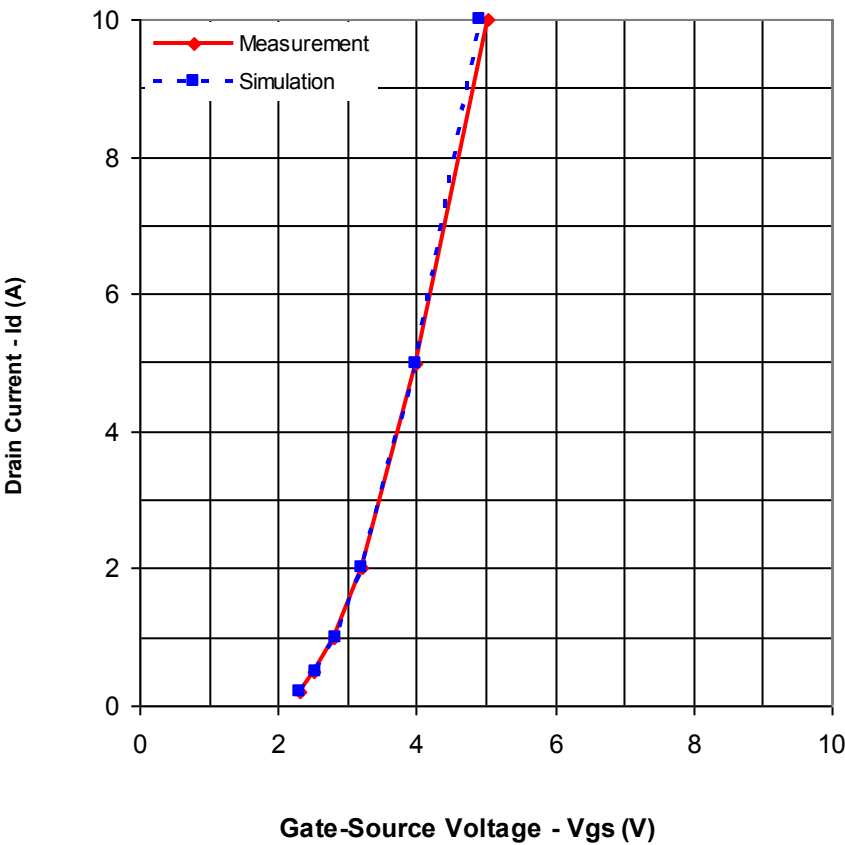


Evaluation circuit



Comparison Graph

Circuit Simulation Result

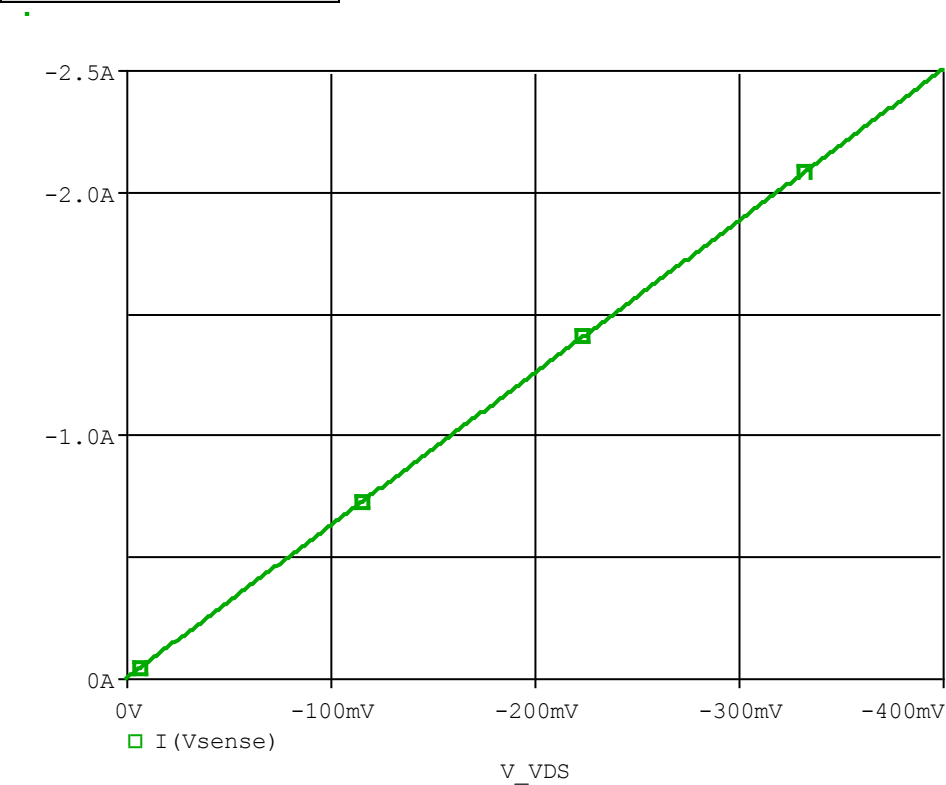


Simulation Result

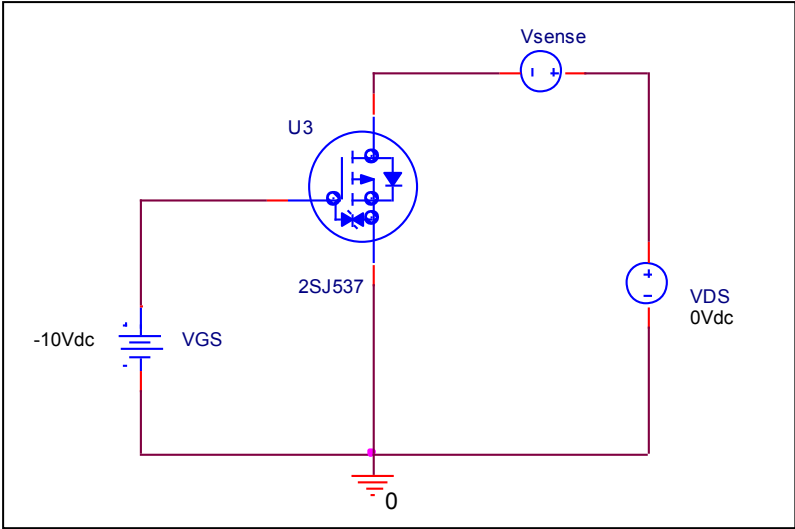
ID(A)	VGS(V)		Error (%)
	Measurement	Simulation	
-0.200	-2.300	-2.316	0.687
-0.500	-2.500	-2.552	2.080
-1.000	-2.800	-2.824	0.857
-2.000	-3.200	-3.213	0.406
-5.000	-4.000	-3.996	-0.100
-10.000	-5.020	-4.900	-2.390

Rds(on) Characteristic

Circuit Simulation result



Evaluation circuit

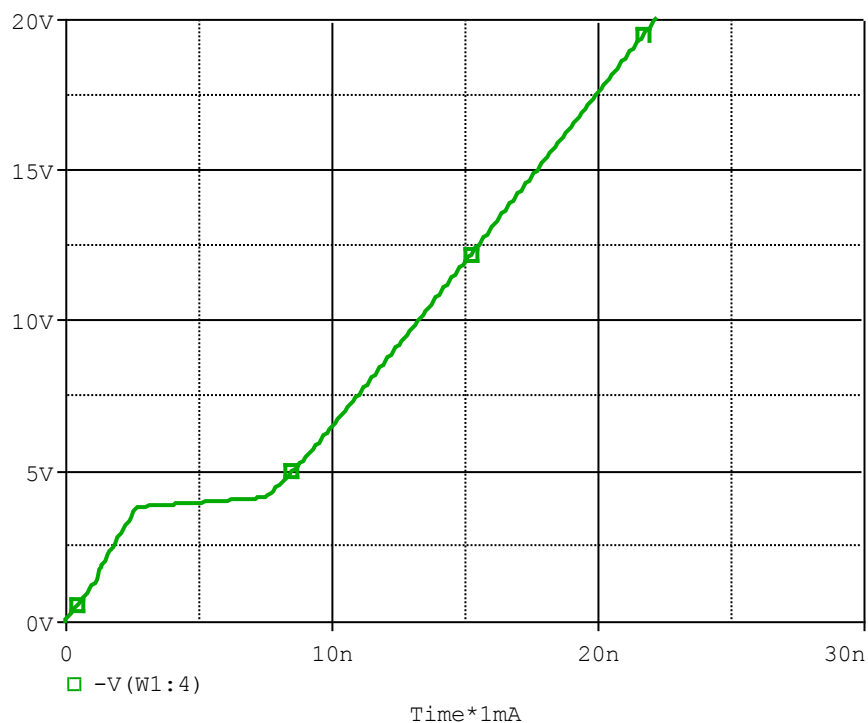


Simulation Result

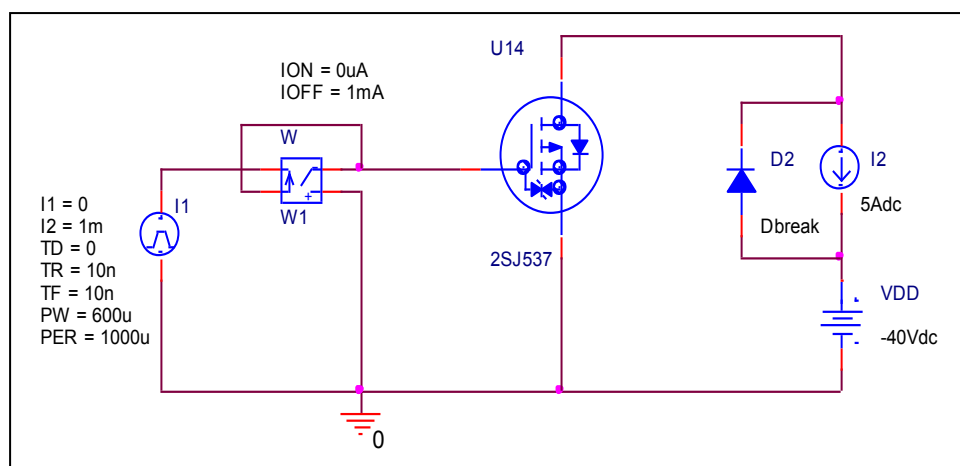
$I_D=-2.5A, V_{GS}=-10V$	Measurement		Simulation		Error (%)
$R_{DS(on)}$	0.160	Ω	0.160	Ω	0.000

Gate Charge Characteristic

Circuit Simulation Result



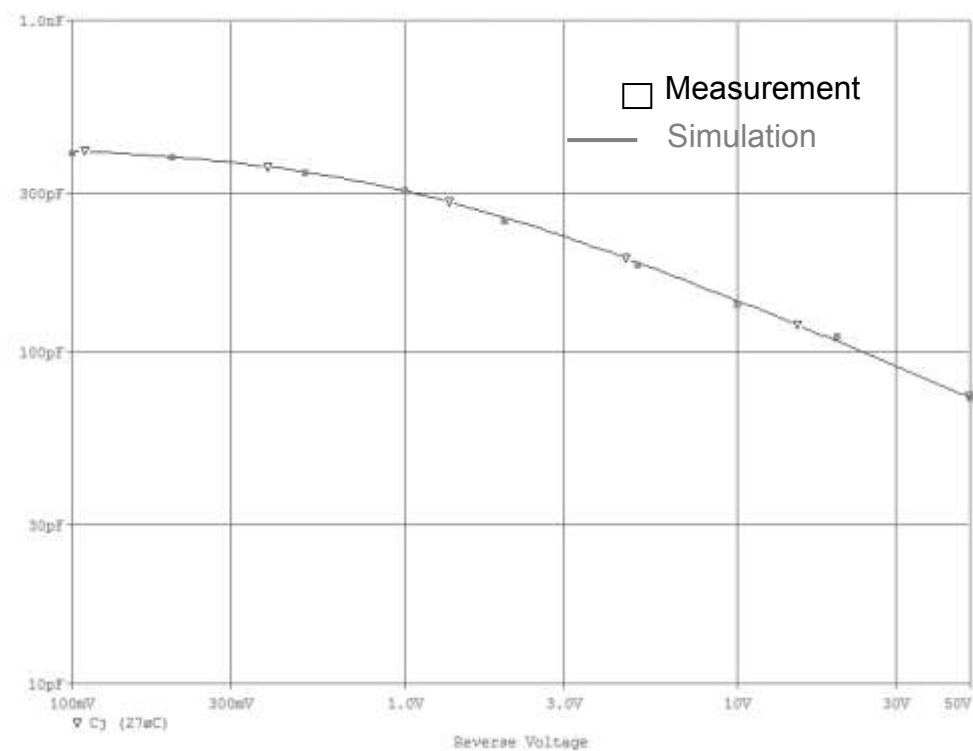
Evaluation Circuit



Simulation Result

$V_{DD} = -40V$, $I_D = -5A$, $V_{GS} = -10V$	Measurement		Simulation		Error (%)
Qgs	2.500	nC	2.556	nC	2.240
Qgd	5.000	nC	4.962	nC	-0.760
Qg	18.000	nC	13.325	nC	-25.972

Capacitance Characteristic

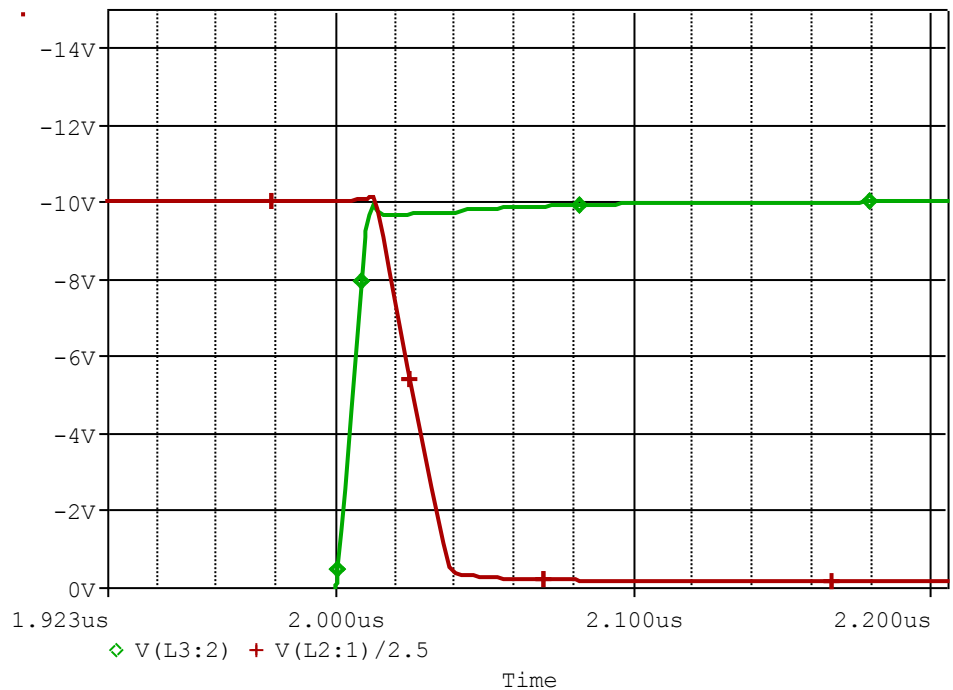


Simulation Result

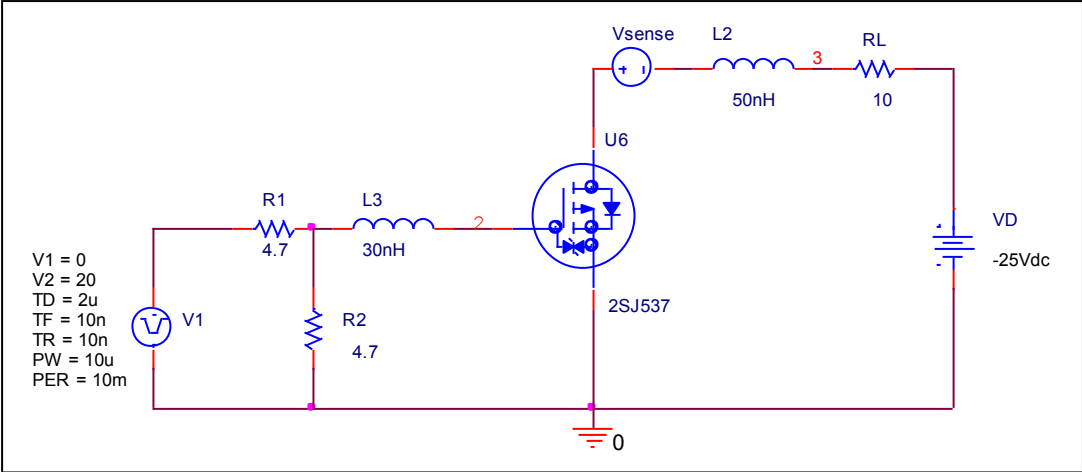
V _{DS} (V)	Cbd(pF)		Error(%)
	Measurement	Simulation	
0.100	400.000	405.000	1.250
0.200	390.000	392.000	0.513
0.500	370.000	370.000	0.000
1.000	310.000	310.000	0.000
2.000	250.000	250.000	0.000
5.000	180.000	184.000	2.222
10.000	140.000	138.000	-1.429
20.000	112.000	110.000	-1.786
50.000	73.000	70.000	-4.110

Switching Time Characteristic

Circuit Simulation Result



Evaluation Circuit

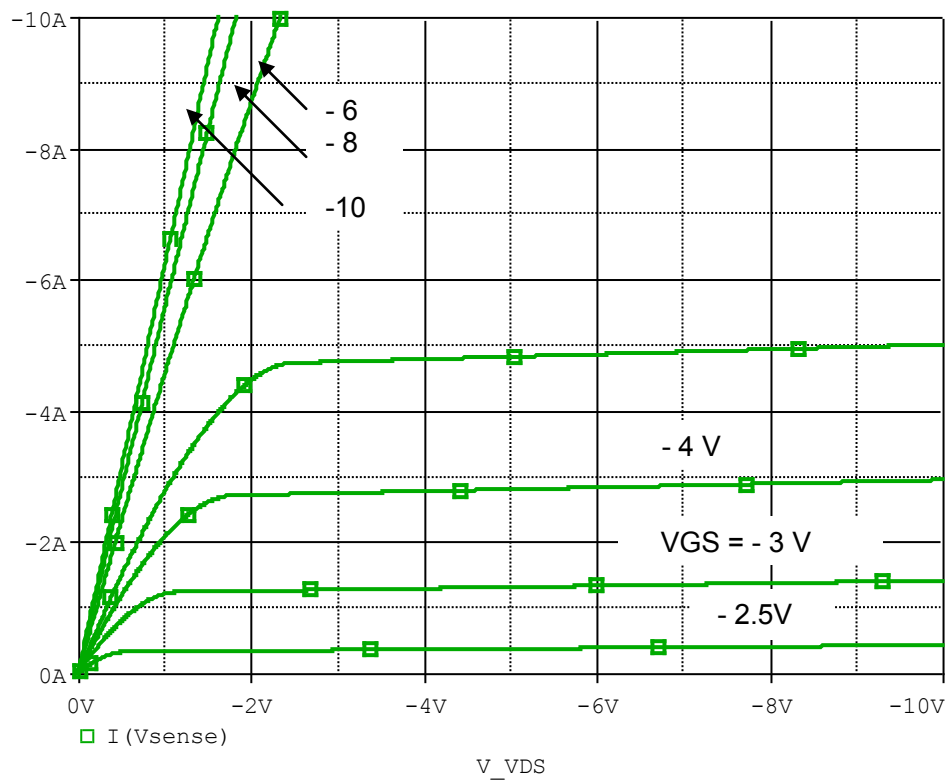


Simulation Result

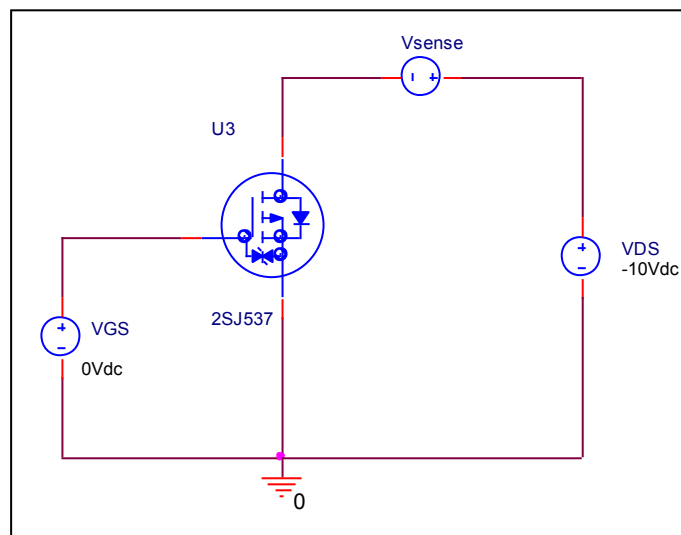
$I_D = -2.5A$, $V_{DD} = -25V$, $V_{GS} = 0/4V$	Measurement		Simulation		Error(%)
	Td(on)	35.000 ns	34.869 ns		

Output Characteristic

Circuit Simulation Result

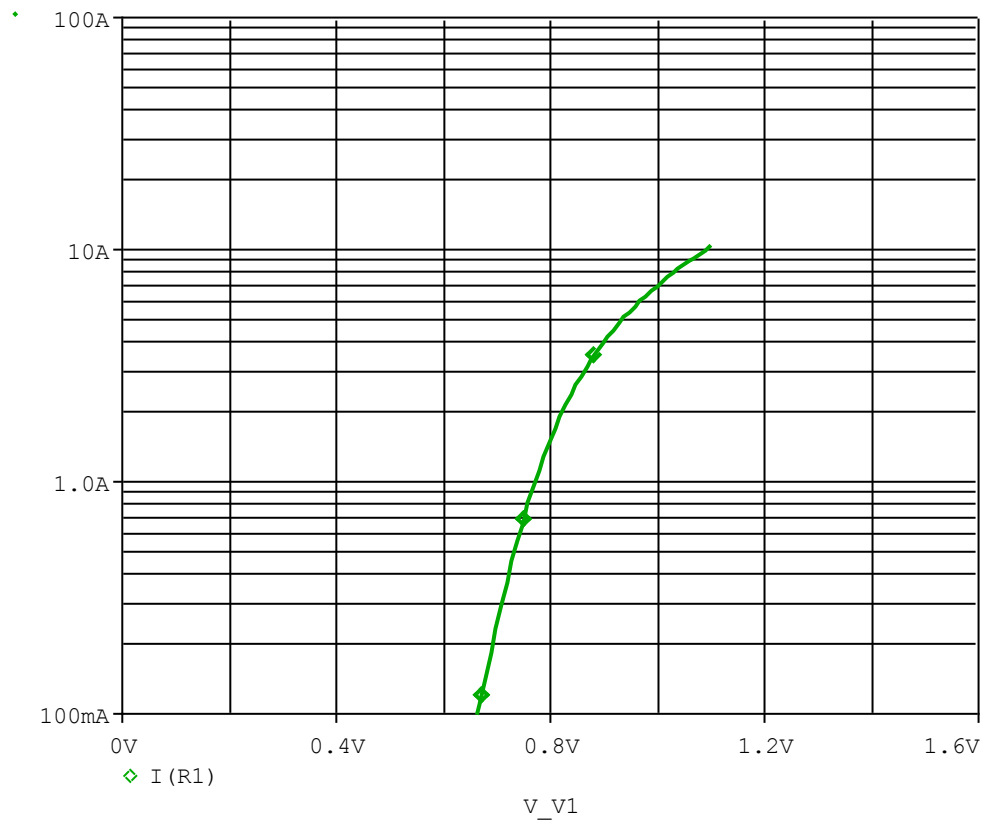


Evaluation Circuit

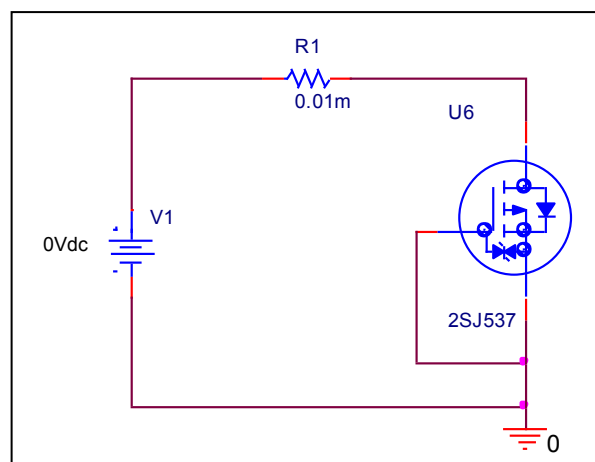


BODY DIODE SPICE MODEL Forward Current Characteristic

Circuit Simulation Result

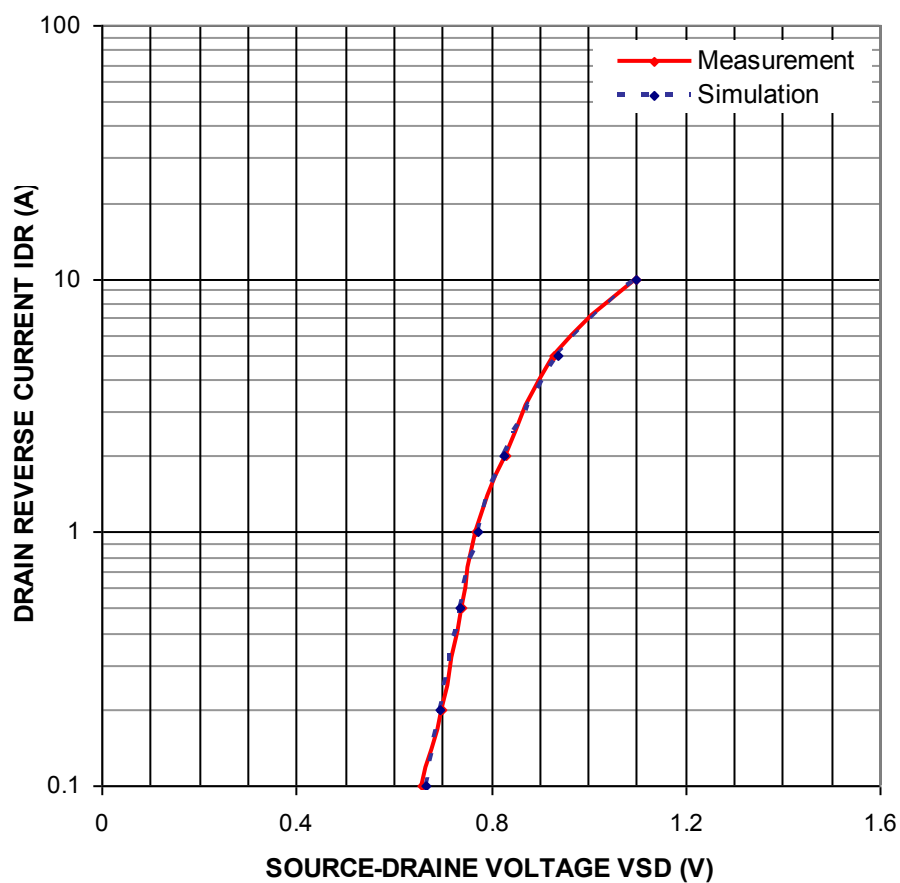


Evaluation Circuit



Comparison Graph

Circuit Simulation Result

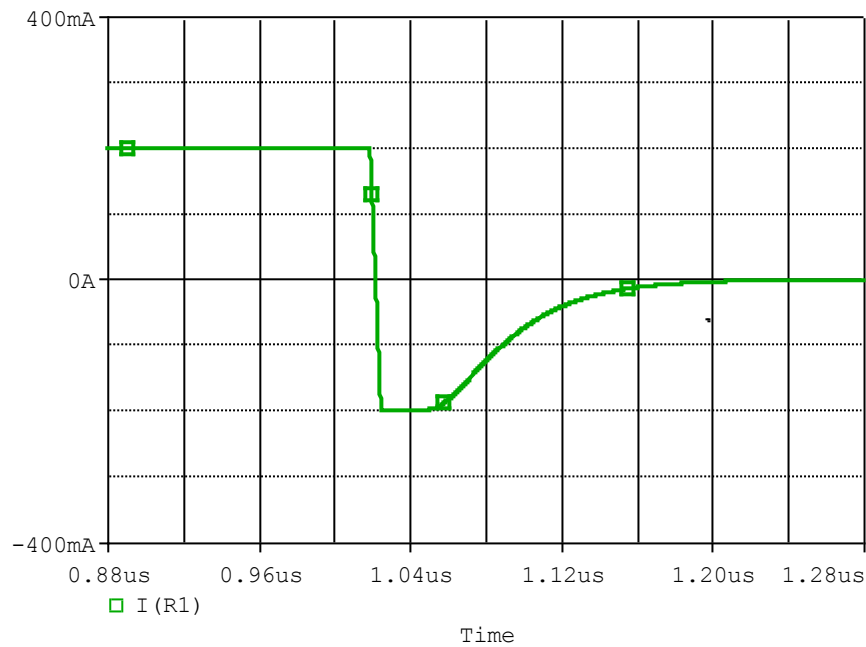


Simulation Result

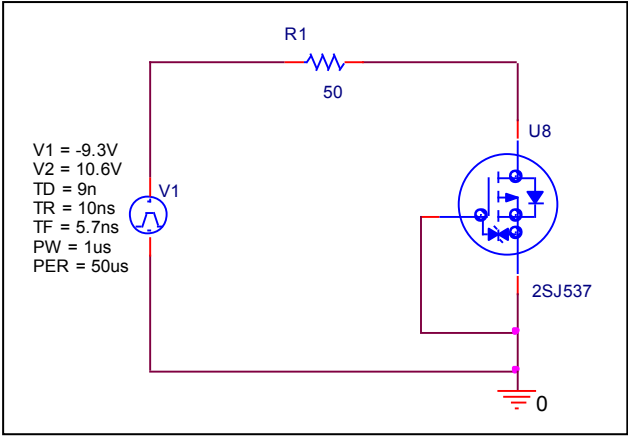
IDR(A)	VSD(V)		%Error
	Measurement	Simulation	
0.100	0.660	0.665	0.758
0.200	0.700	0.694	-0.857
0.500	0.740	0.735	-0.676
1.000	0.770	0.773	0.390
2.000	0.830	0.825	-0.602
5.000	0.930	0.939	0.968
10.000	1.100	1.099	-0.091

Reverse Recovery Characteristic (Body Diode)

Circuit Simulation Result



Evaluation Circuit

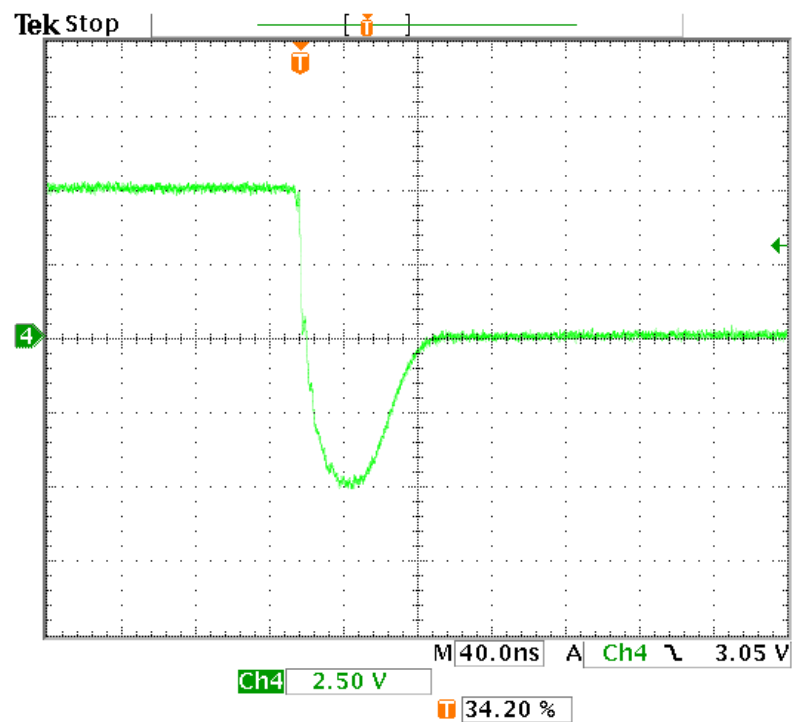


Compare Measurement vs. Simulation

	Measurement		Simulation		Error (%)
trj	33.600	ns	33.939	ns	1.009
trb	24.500	ns	23.276	ns	-4.996
trr	58.400	ns	57.215	ns	-2.029

Reverse Recovery Characteristic (Body Diode)

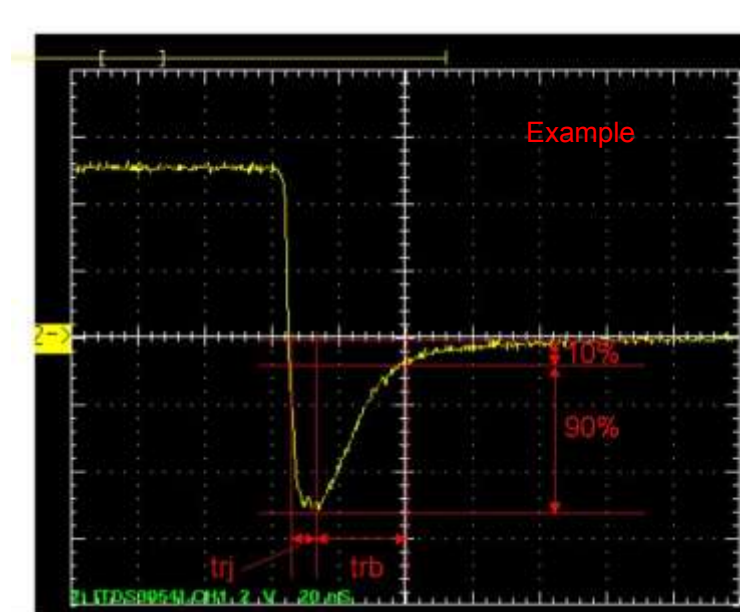
Reference



$T_{rj} = (33.6\text{ns})$

$T_{rb} = (58.4\text{ns})$

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

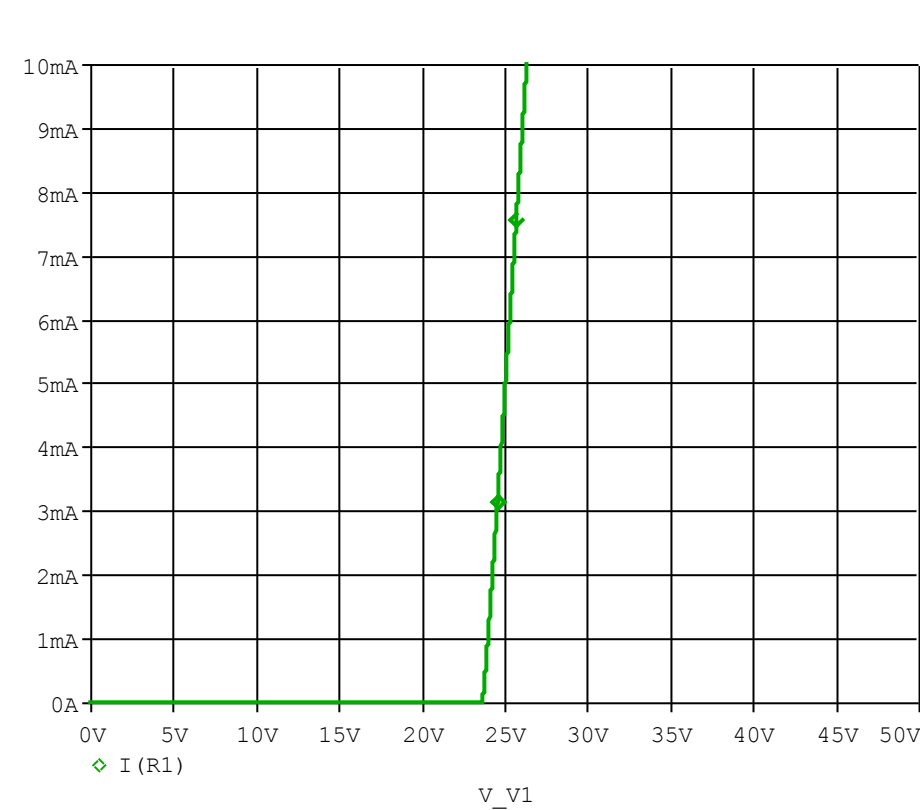


Relation between t_{rj} and t_{rb}

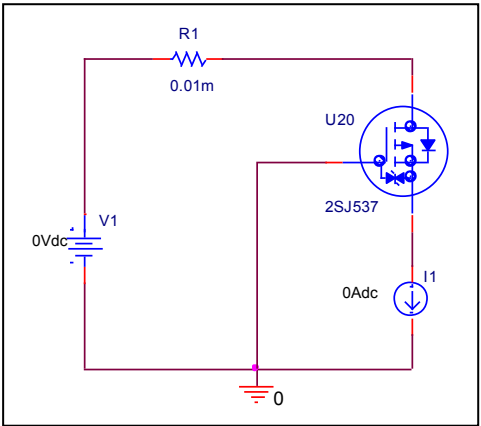
ESD PROTECTION DIODE SPICE MODEL

Zener Voltage Characteristic

Circuit Simulation Result



Evaluation Circuit



Zener Voltage Characteristic

Reference

