

Device Modeling Report

COMPONENTS: Power MOSFET (Professional)
PART NUMBER: SSM3J13T
MANUFACTURER: TOSHIBA
Body Diode (Standard) / ESD Protection Diode



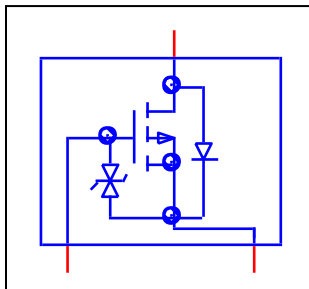
MOSFET MODEL

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	Modility Modulation
KAPPA	Saturation Field Factor
VMAX	Maximum Drift Velocity of Carriers
XJ	Metallurgical Junction Depth
UO	Surface Mobility

Body Diode Model

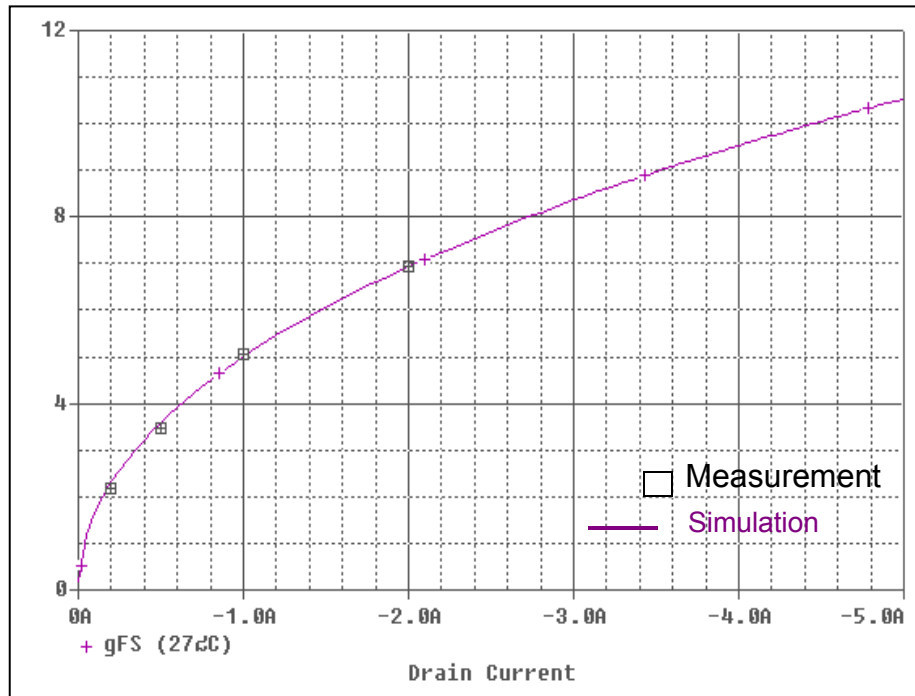
Pspice model parameter	Model description
IS	Saturation Current
N	Emission Coefficient
RS	Series Resistance
IKF	High-injection Knee Current
CJO	Zero-bias Junction Capacitance
M	Junction Grading Coefficient
VJ	Junction Potential
ISR	Recombination Current Saturation Value
BV	Reverse Breakdown Voltage(a positive value)
IBV	Reverse Breakdown Current(a positive value)
TT	Transit Time

Equivalent Circuit



Transconductance Characteristic

Circuit Simulation Result

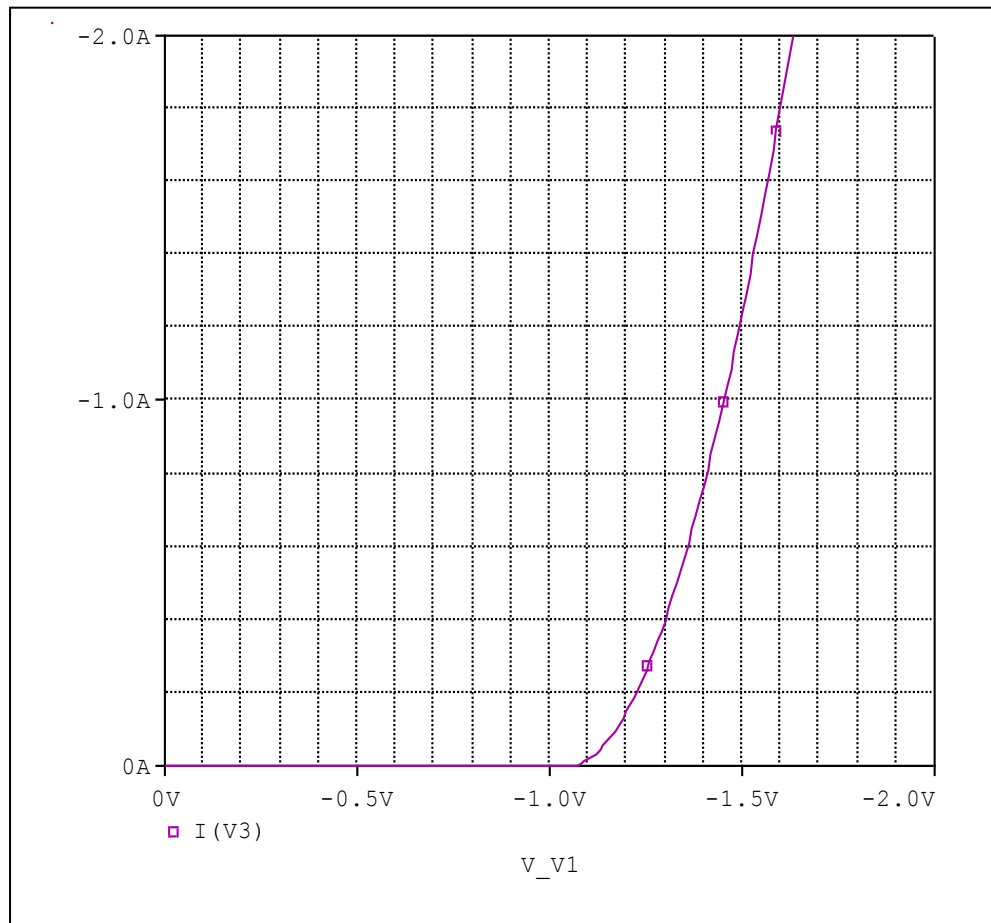


Comparison table

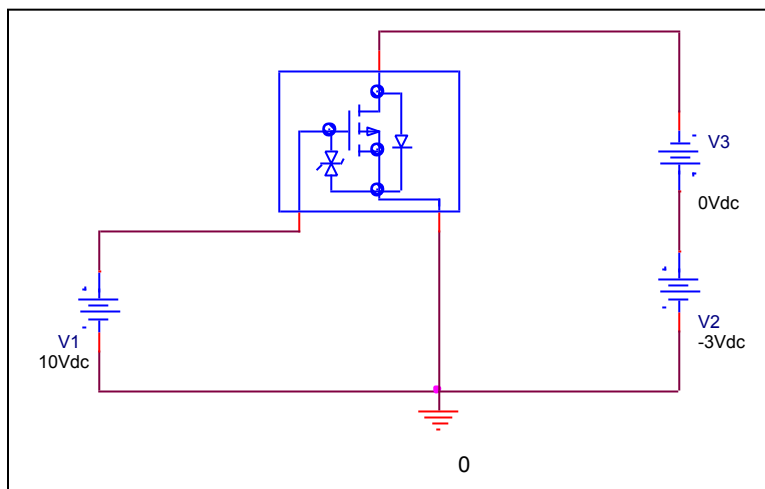
Id(A)	gfs		Error(%)
	Measurement	Simulation	
-0.2	2.2222	2.3	-3.501
-0.5	3.5	3.6	-2.857
-1	5.1	5.015	1.667
-2	6.9643	6.945	0.277

V_{gs}-I_d Characteristic

Circuit Simulation result

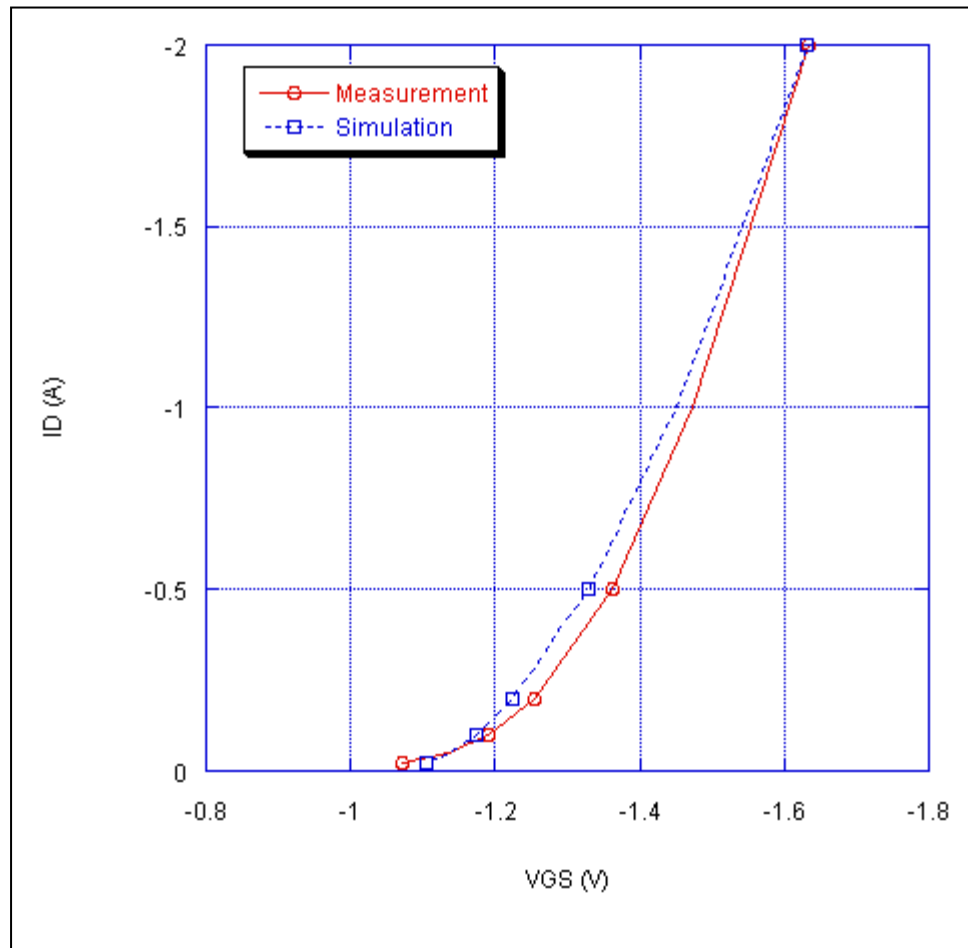


Evaluation circuit



Comparison Graph

Circuit Simulation Result

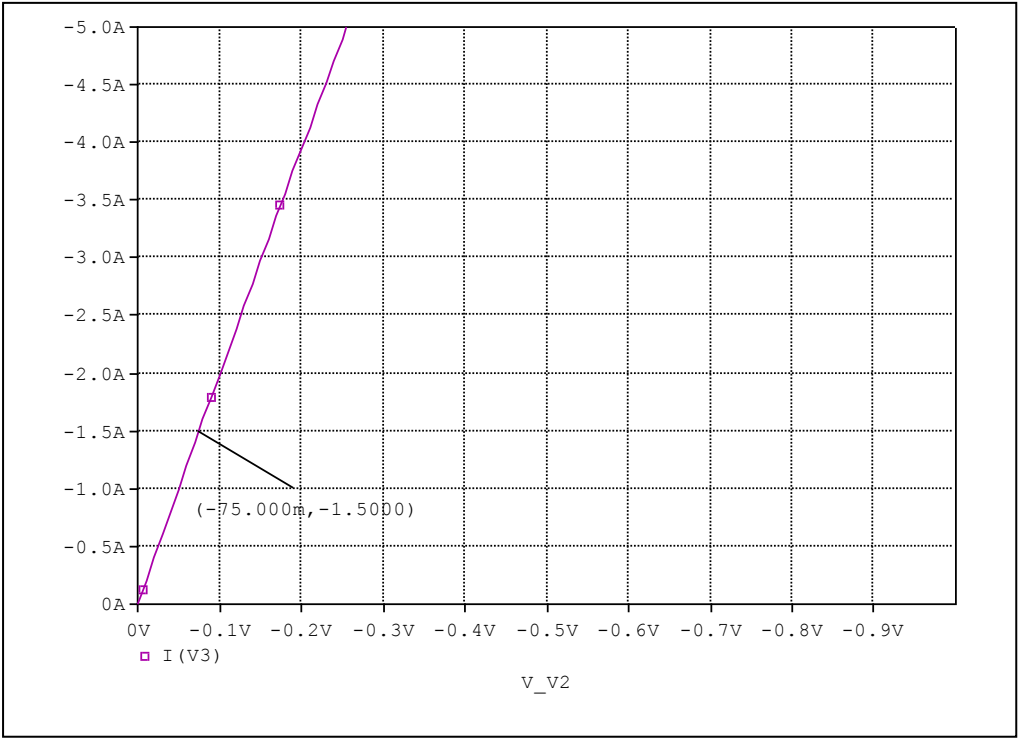


Simulation Result

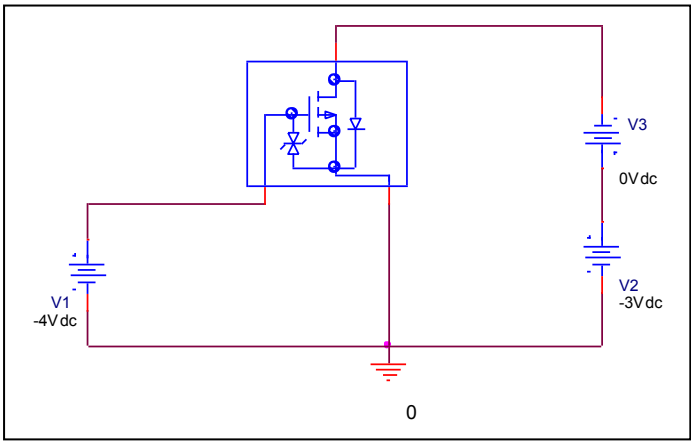
I_D (A)	V_{GS} (V)		Error (%)
	Measurement	Simulation	
-0.020	-1.072	-1.1049	-3.069
-0.050	-1.136	-1.1368	-0.070
-0.100	-1.190	-1.1731	1.420
-0.200	-1.254	-1.225	2.313
-0.500	-1.362	-1.3301	2.342
-1.000	-1.474	-1.4520	1.493
-2.000	-1.634	-1.6307	0.202

Id-Rds(on) Characteristic

Circuit Simulation result



Evaluation circuit

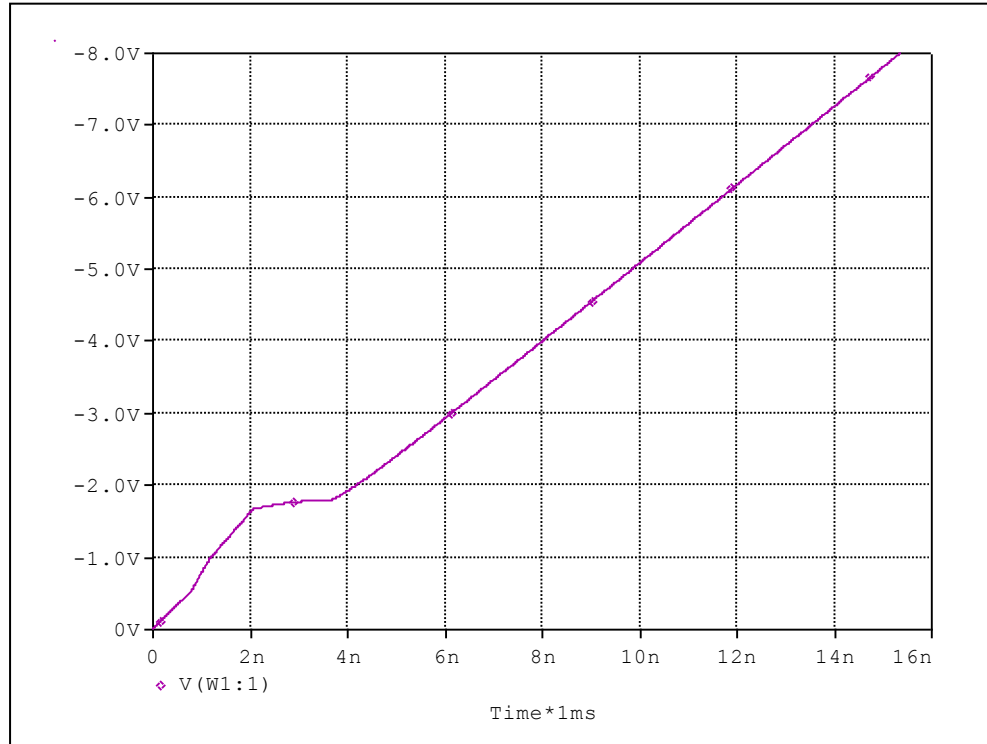


Simulation Result

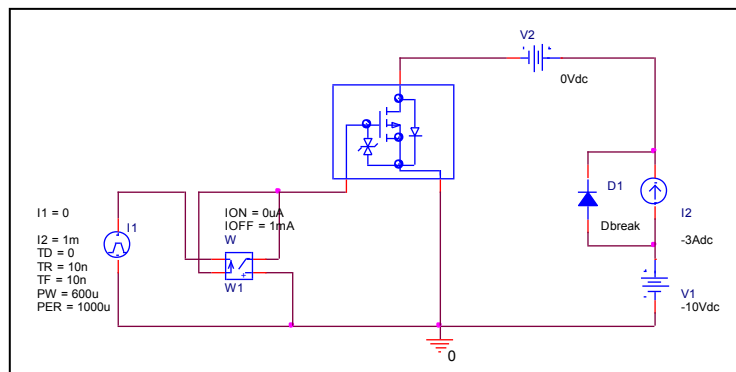
$I_D = -1.5A, V_{GS} = -4V$	Measurement		Simulation		Error (%)
$R_{DS(on)}$	50.00	mΩ	50.00	mΩ	0.00

Gate Charge Characteristic

Circuit Simulation result



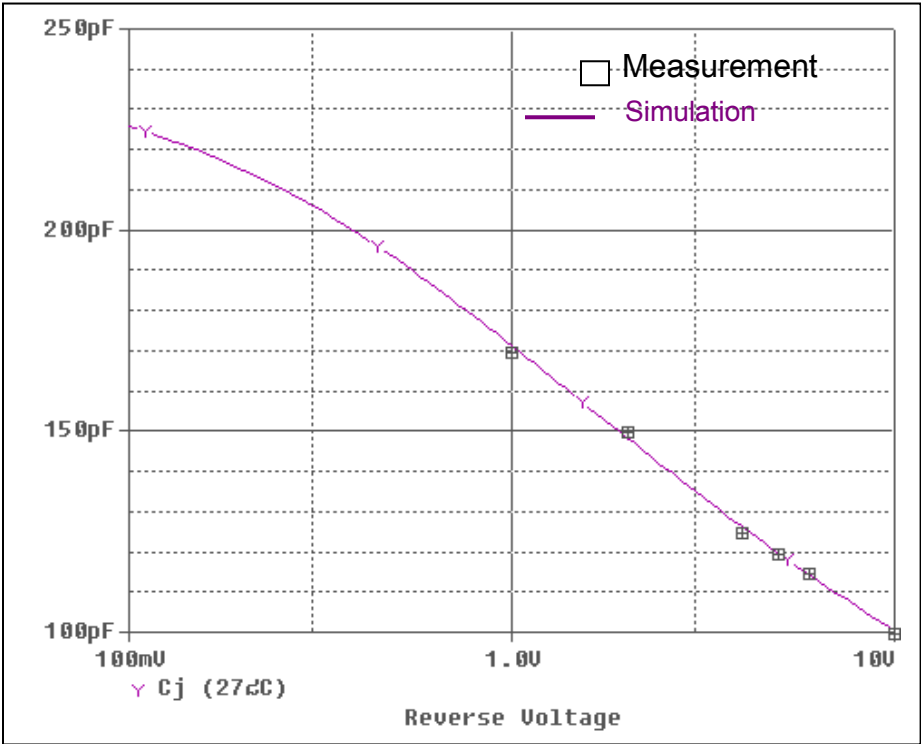
Evaluation circuit



Simulation Result

$V_{DD} = -10V, I_D = -3A$ $V_{GS} = -5V$	Measurement		Simulation		Error (%)
Qgs	2.060	nC	2.055	nC	-0.243
Qgd	1.500	nC	1.505	nC	0.333
Qg	9.750	nC	9.750	nC	0.000

Capacitance Characteristic

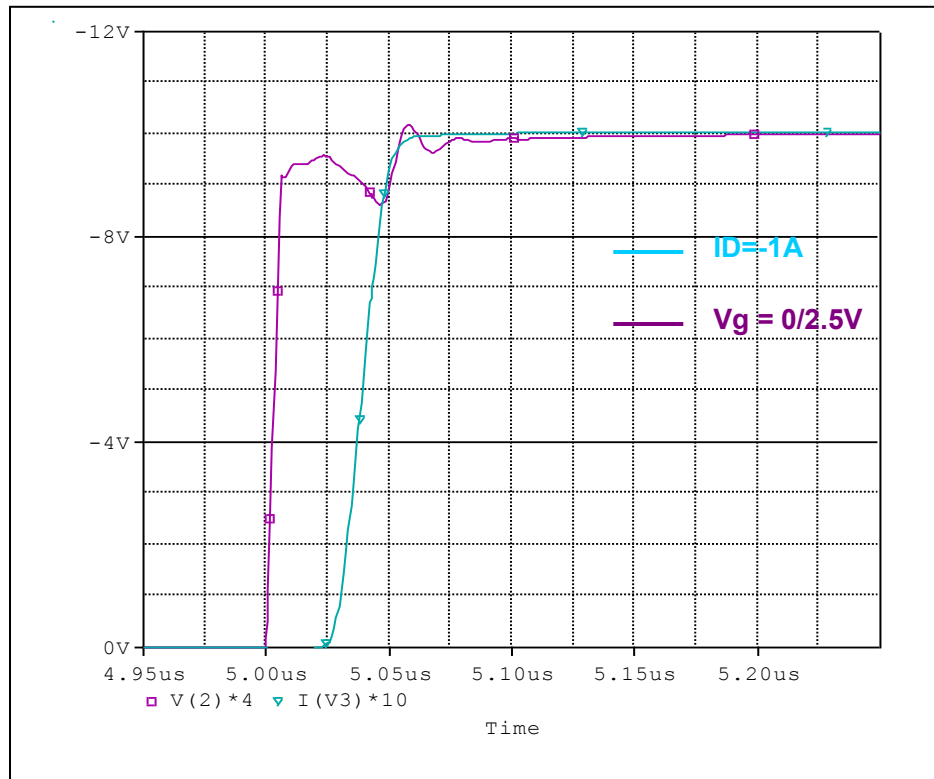


Simulation Result

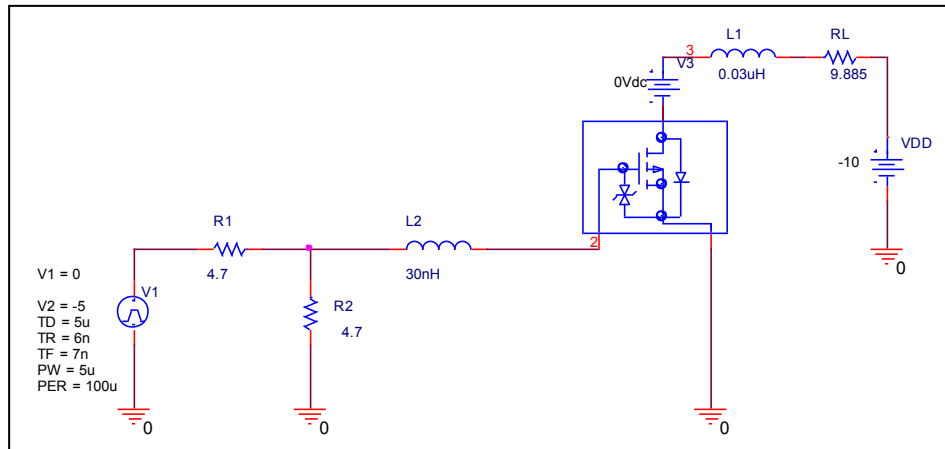
V _{DS} (V)	C _{bd} (pF)		Error(%)
	Measurement	Simulation	
1.00	170.00	171.25	-0.74
2.00	150.00	148.00	1.33
4.00	125.00	126.00	-0.80
5.00	120.00	119.50	0.42
6.00	115.00	114.50	0.44
10.00	100.00	100.40	-0.40

Switching Time Characteristic

Circuit Simulation result



Evaluation circuit

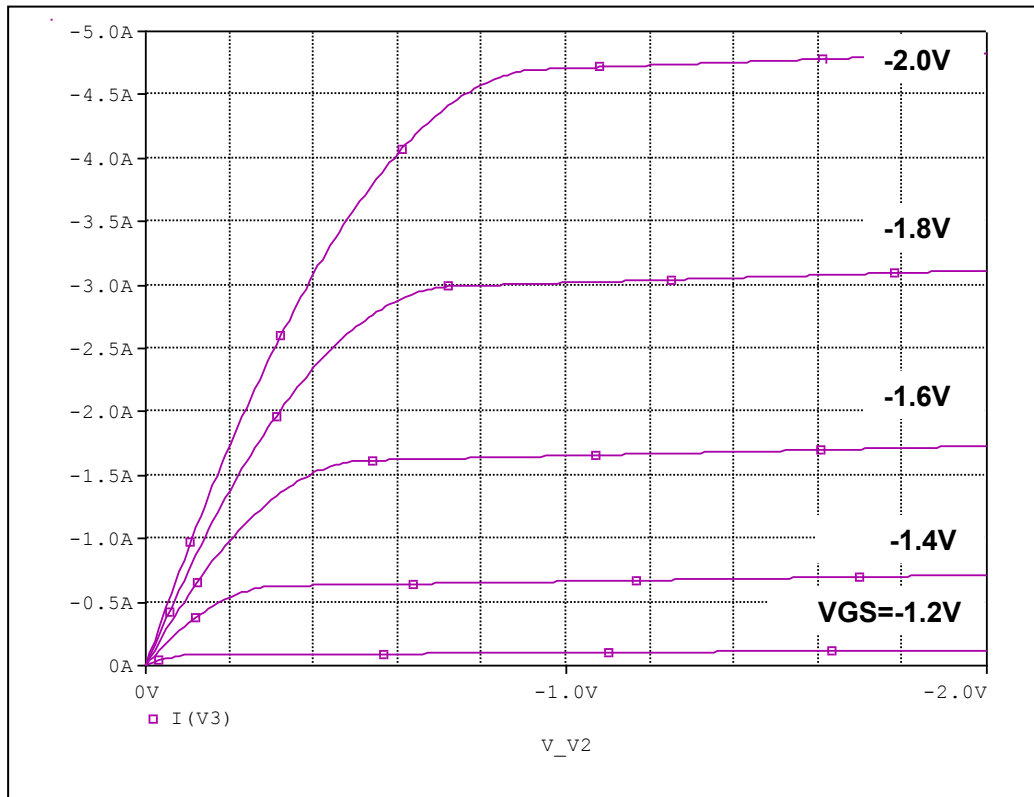


Simulation Result

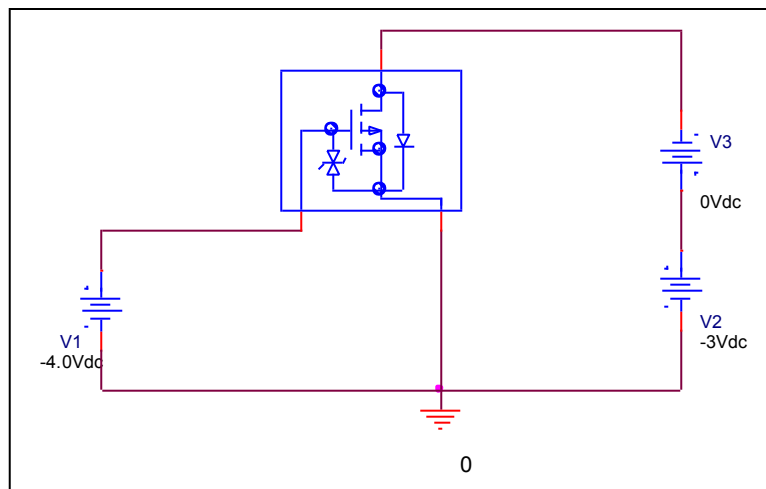
$I_D = -1A$, $V_{DD} = -10V$ $V_{GS} = 0/-2.5V$	Measurement		Simulation		Error(%)
ton	48.00	ns	47.99	ns	-0.02

Output Characteristic

Circuit Simulation result

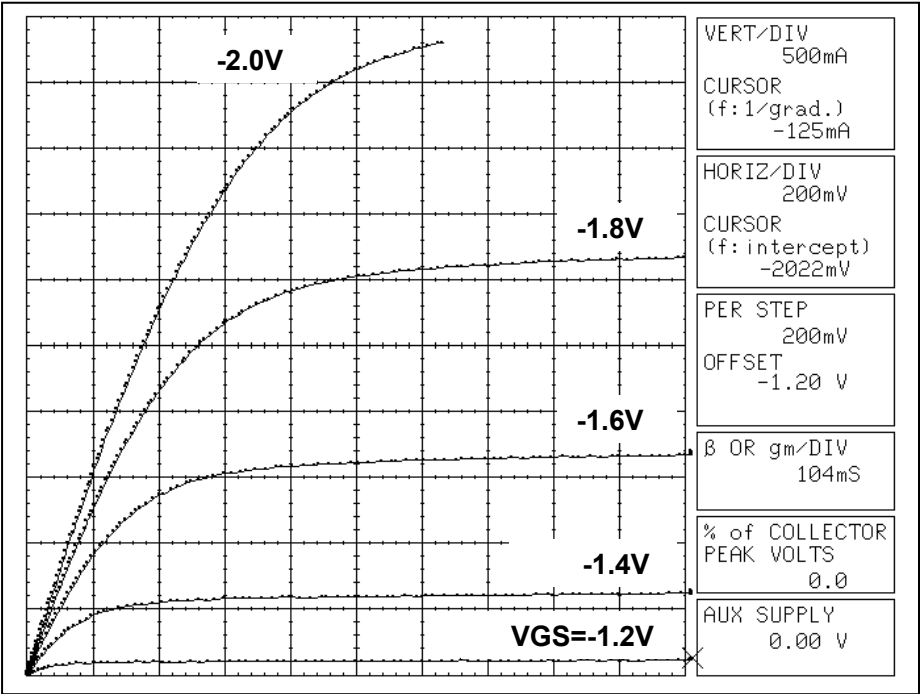


Evaluation circuit



Output Characteristics

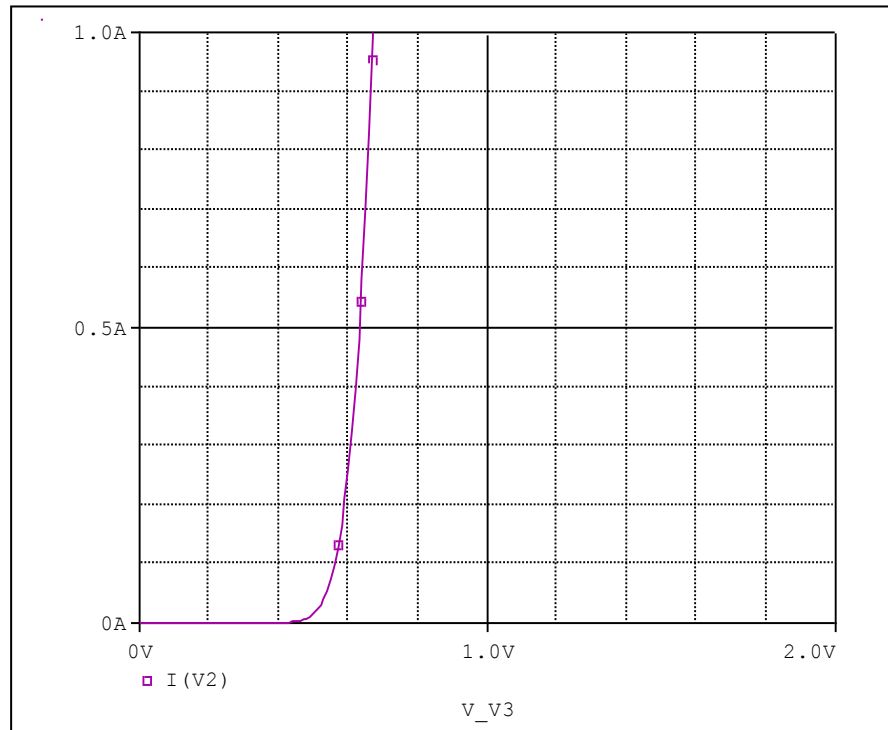
Reference



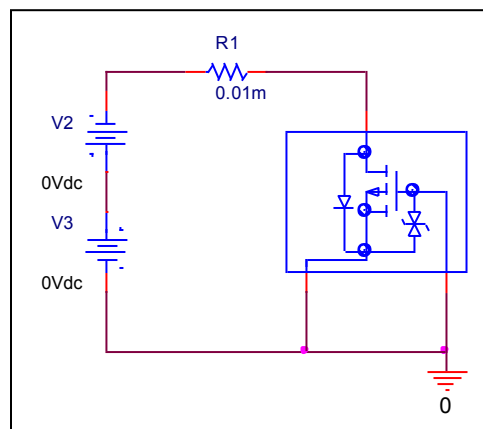
BODY DIODE

Forward Current Characteristic

Circuit Simulation Result

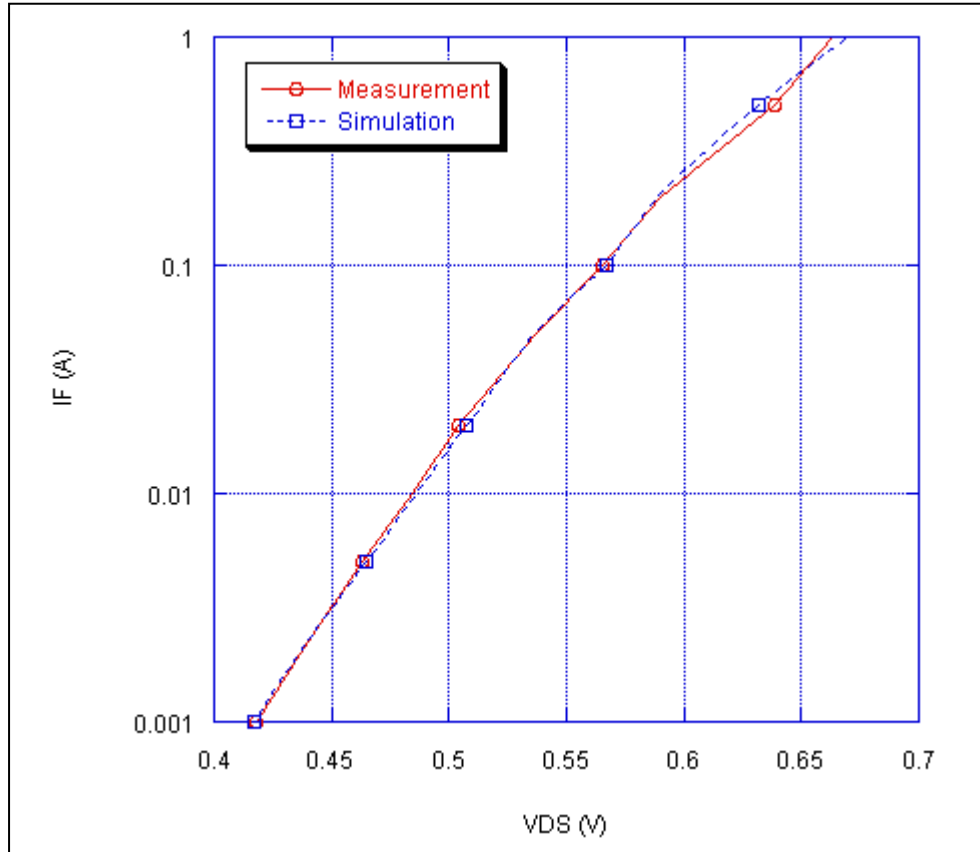


Evaluation Circuit



Comparison Graph

Circuit Simulation Result

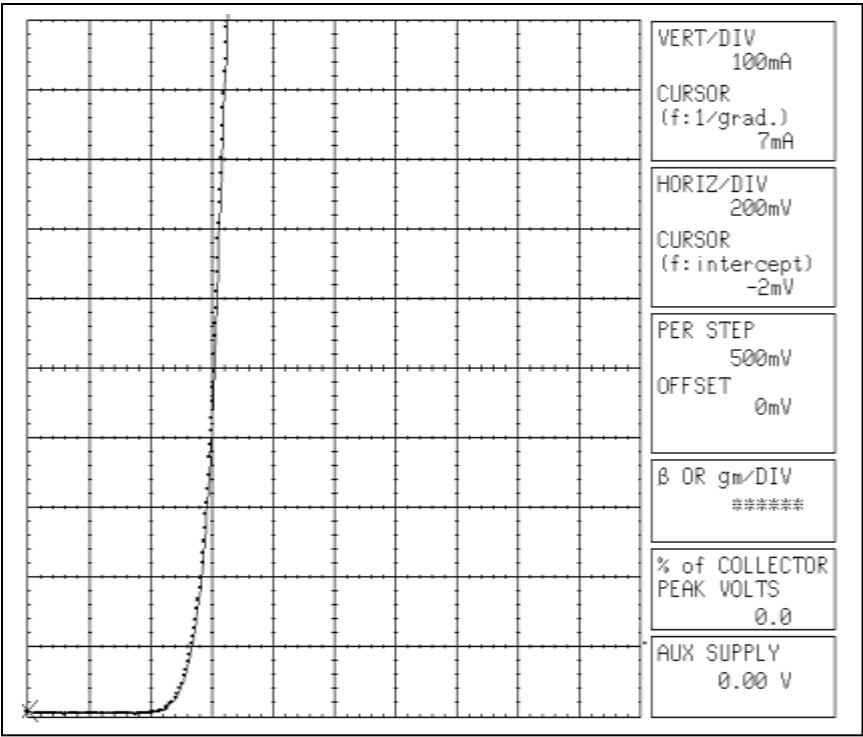


Simulation Result

lfwd(A)	Vfwd(V) Measurement	Vfwd(V) Simulation	%Error
0.001	0.418	0.417	-0.294
0.002	0.437	0.437	0.081
0.005	0.463	0.465	0.381
0.010	0.484	0.486	0.352
0.020	0.504	0.507	0.597
0.050	0.537	0.536	-0.111
0.100	0.565	0.567	0.285
0.200	0.590	0.588	-0.322
0.500	0.639	0.632	-1.084
1.000	0.663	0.670	1.120

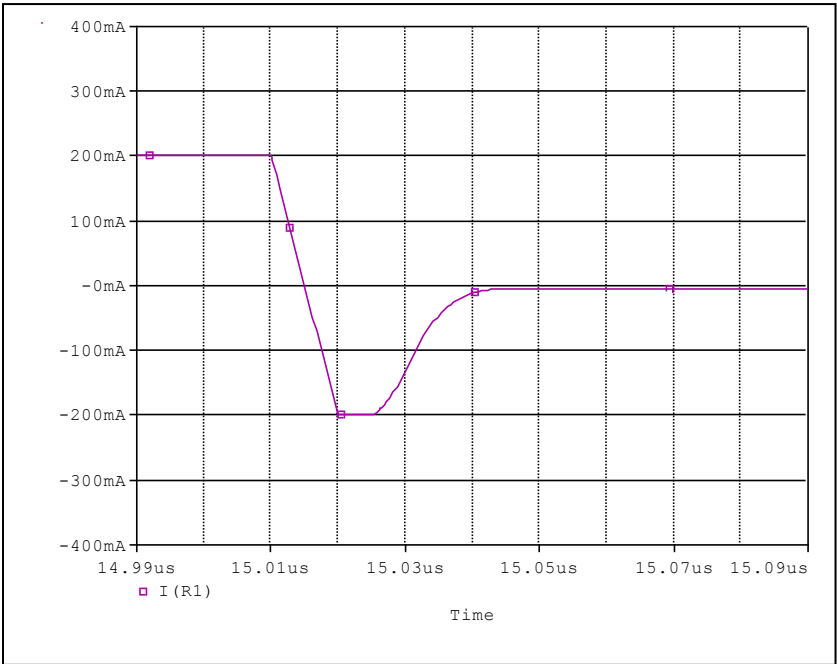
Forward Current Characteristic

Reference

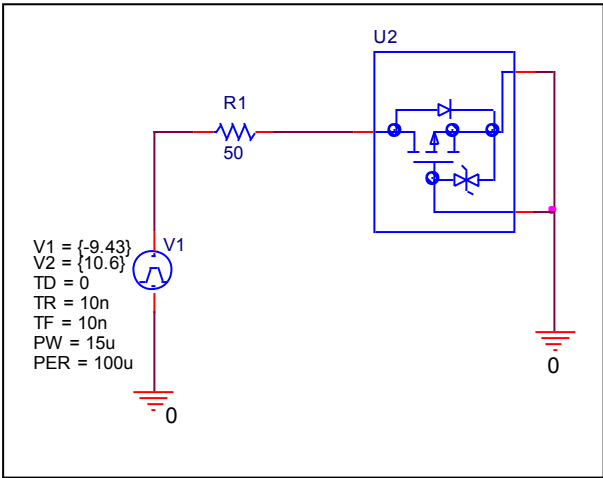


Reverse Recovery Characteristic

Circuit Simulation Result



Evaluation Circuit

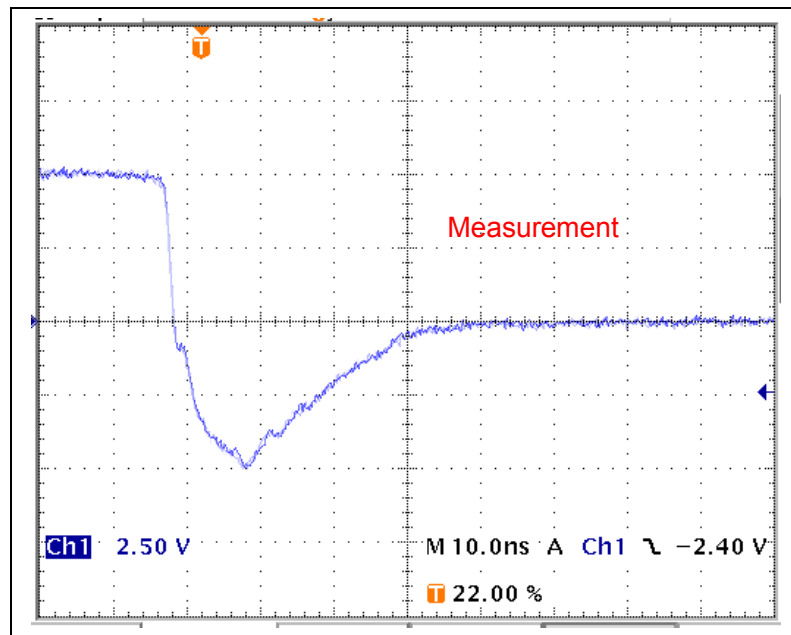


Comparison Table

	Measurement		Simulation		%Error
trj (ns)	9.8	ns	9.85	ns	0.510

Reverse Recovery Characteristic

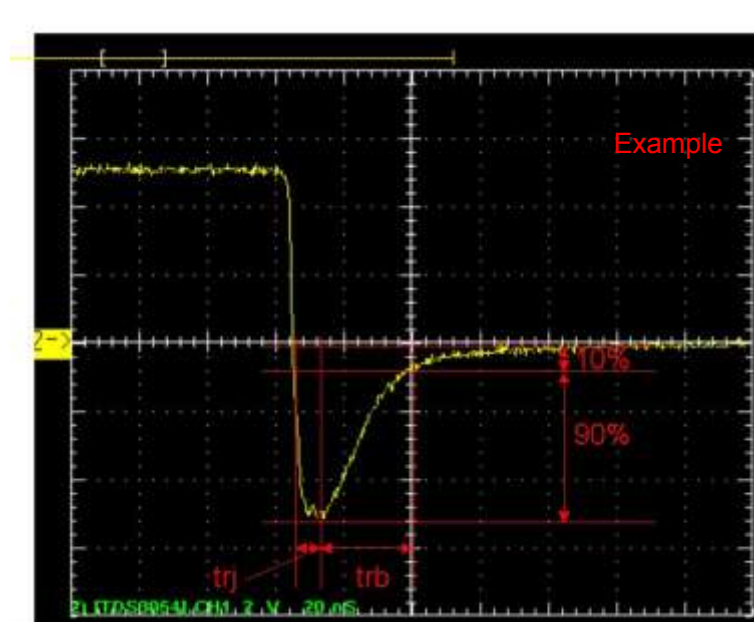
Reference



$T_{rj} = 9.8(\text{ns})$

$T_{rb} = 22(\text{ns})$

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

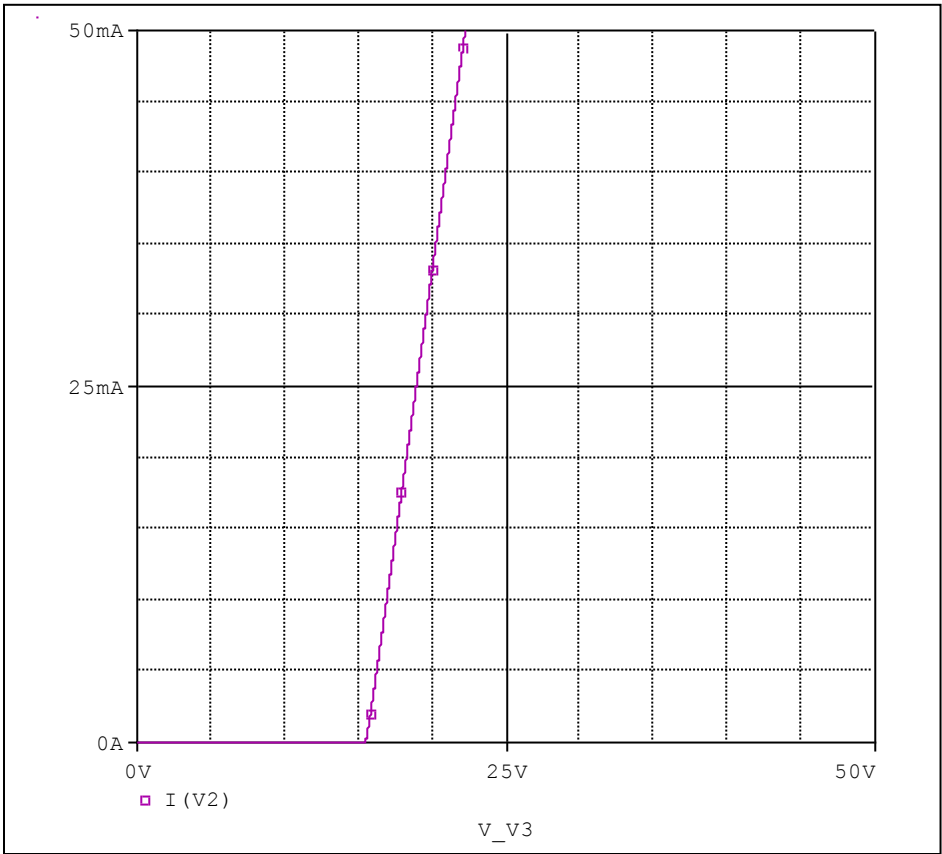


Relation between t_{rj} and t_{rb}

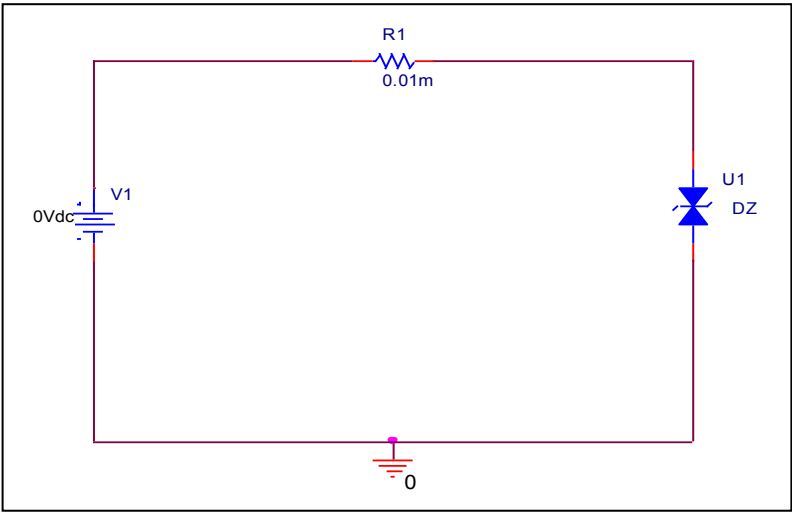
ESD PROTECTION DIODE

Zener Voltage Characteristic

Circuit Simulation Result



Evaluation Circuit



Zener Voltage Characteristic

Reference

