

Device Modeling Report

COMPONENTS: Power MOSFET (Model Parameter)
PART NUMBER: TPCP8102
MANUFACTURER: TOSHIBA
REMARK: P Channel Model
Body Diode (Parameter) / ESD Protection Diode



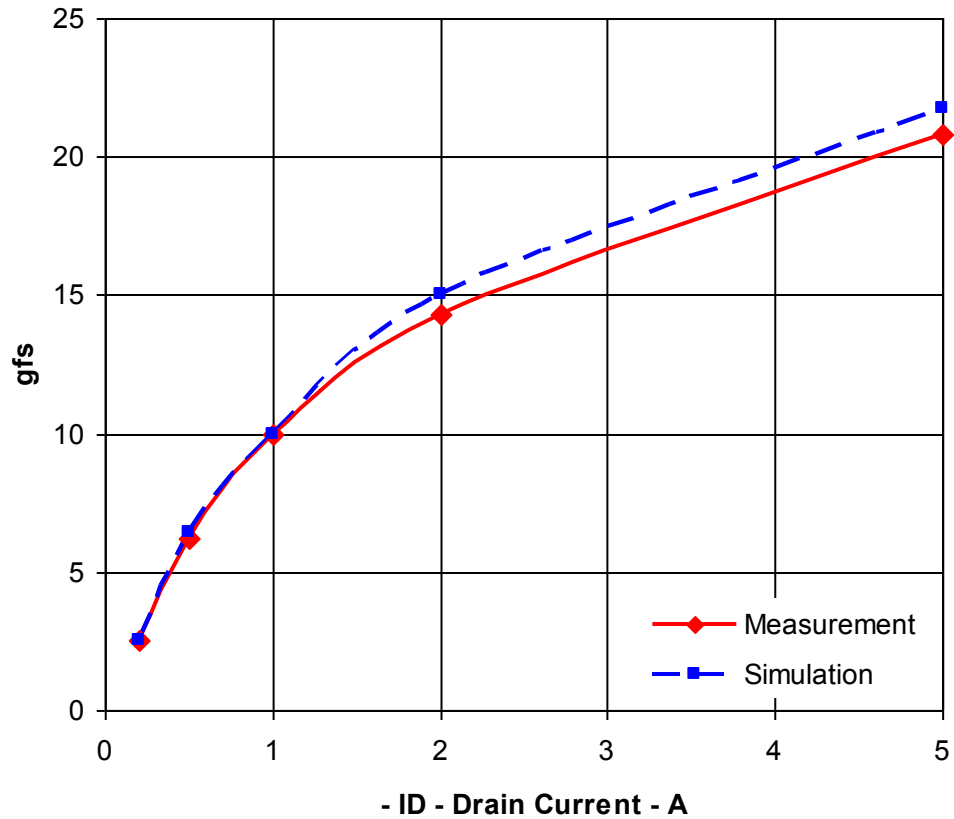
Bee Technologies Inc.

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

Transconductance Characteristic

Circuit Simulation Result

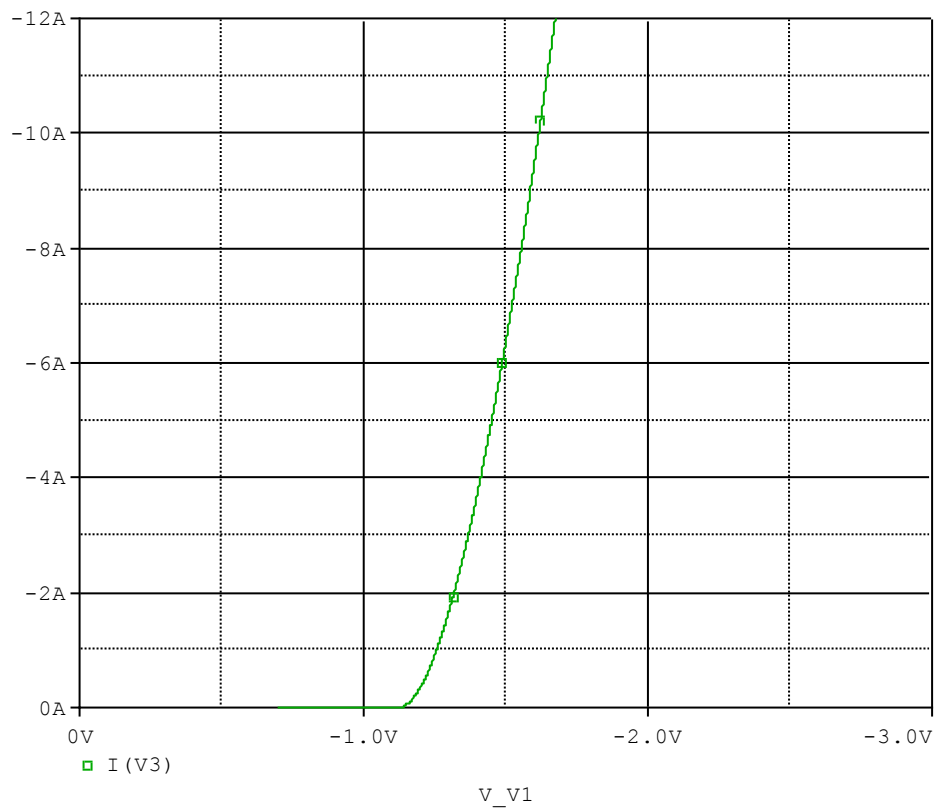


Comparison table

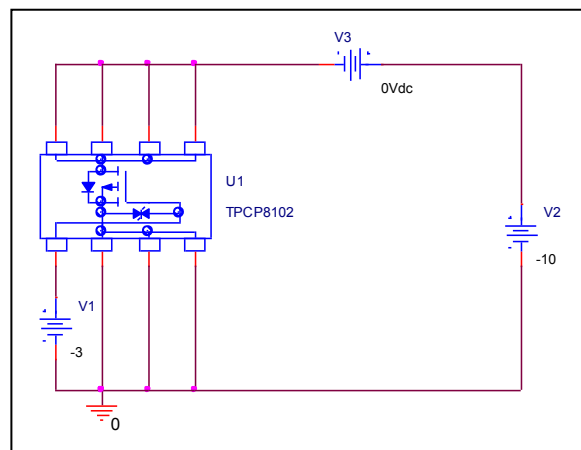
-Id(A)	gfs		Error(%)
	Measurement	Simulation	
0.2	2.500	2.557	2.280
0.5	6.250	6.400	2.400
1	10.000	10.000	0.000
2	14.286	15.000	4.998
5	20.833	21.714	4.229

Vgs-Id Characteristic

Circuit Simulation result

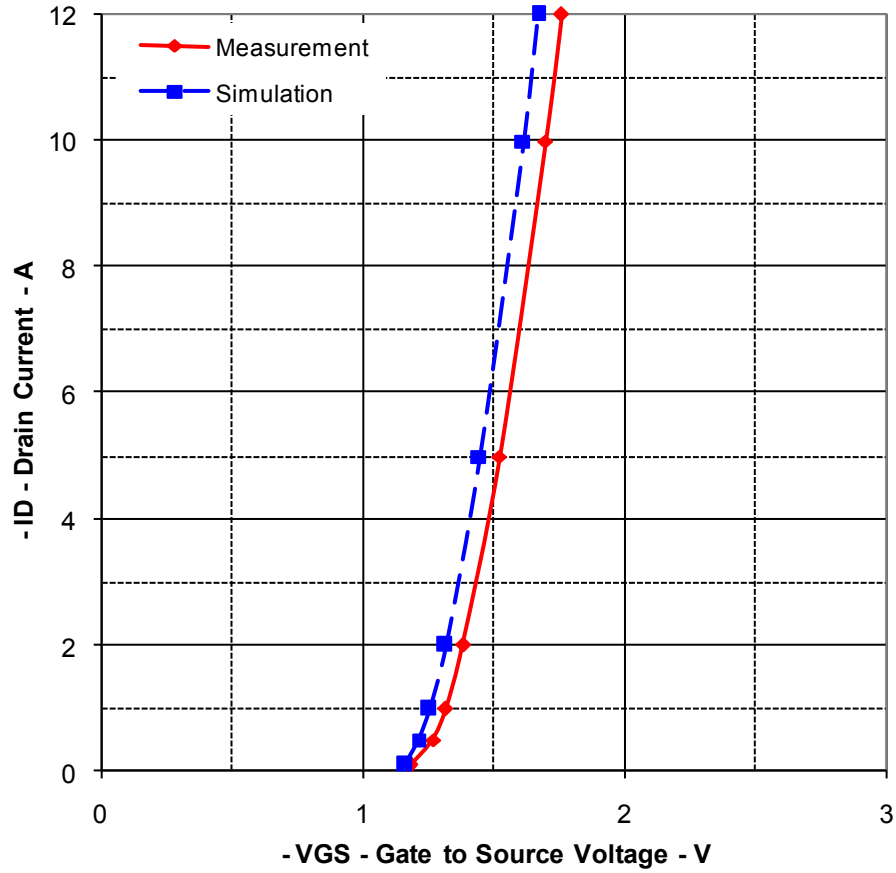


Evaluation circuit



Comparison Graph

Circuit Simulation Result

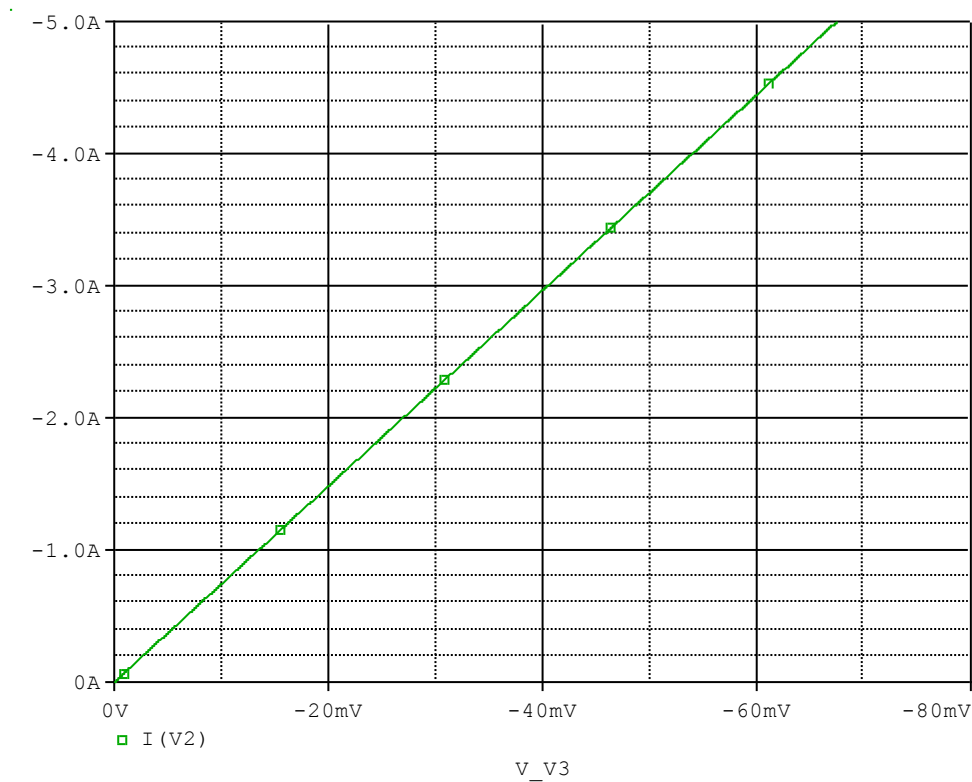


Simulation Result

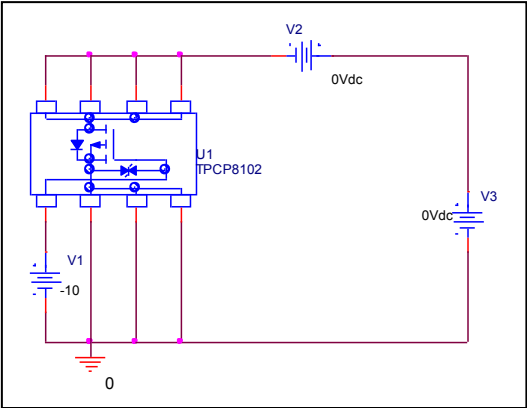
$-I_D$ (A)	$-V_{GS}$ (V)		Error (%)
	Measurement	Simulation	
0.1	1.185	1.163	-1.857
0.5	1.270	1.216	-4.252
1	1.320	1.256	-4.848
2	1.385	1.318	-4.838
5	1.525	1.450	-4.918
10	1.700	1.616	-4.941
12	1.760	1.674	-4.886

Rds(on) Characteristic

Circuit Simulation result



Evaluation circuit

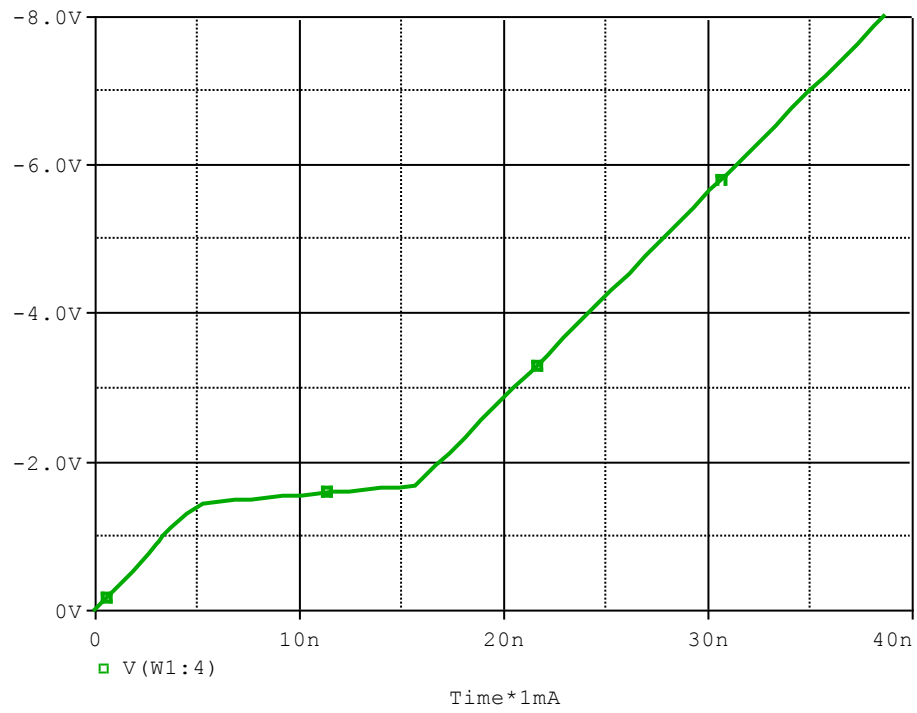


Simulation Result

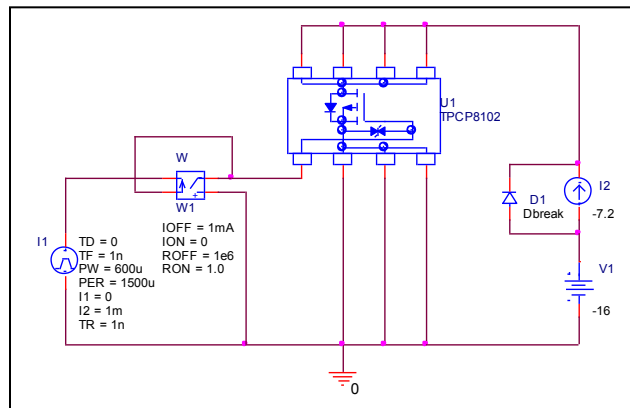
$I_D=-3.6A, V_{GS}=-4.5V$	Measurement		Simulation		Error (%)
$R_{DS(on)}$	13.500	mΩ	13.495	mΩ	-0.037

Gate Charge Characteristic

Circuit Simulation result



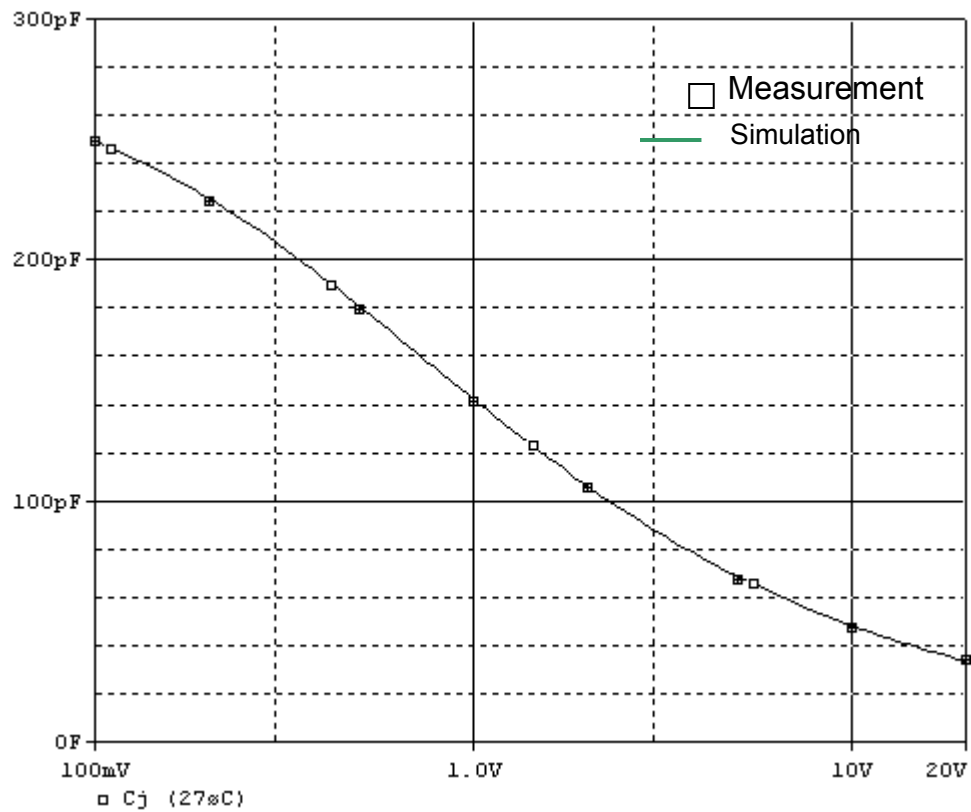
Evaluation circuit



Simulation Result

$V_{DD} = -16V, I_D = -7.2A$ $V_{GS} = -5V$	Measurement		Simulation		Error (%)
Qgs	5.400	nC	5.415	nC	0.278
Qgd	10.000	nC	10.018	nC	0.180
Qg	33.000	nC	27.823	nC	-15.688

Capacitance Characteristic

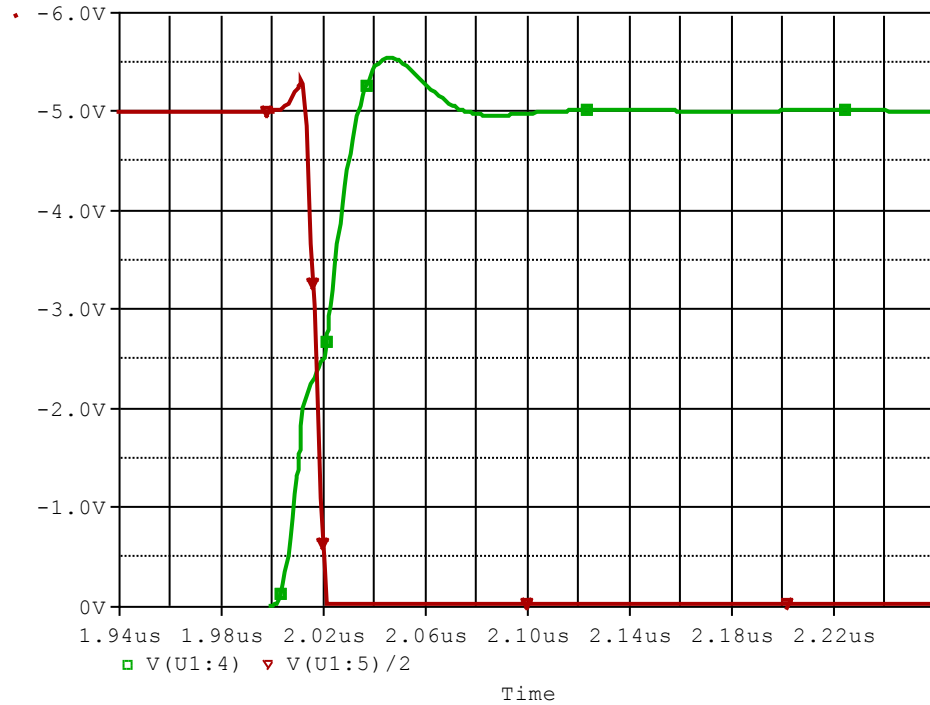


Simulation Result

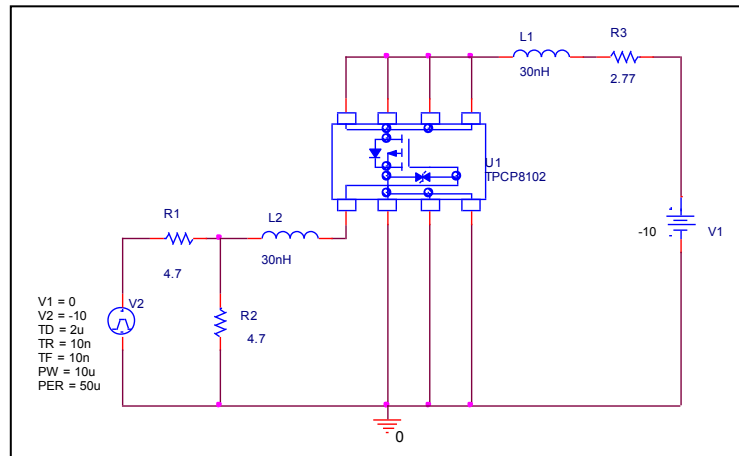
V _{DS} (V)	Cbd(pF)		Error(%)
	Measurement	Simulation	
0.1	250.000	249.500	-0.200
0.2	225.000	224.000	-0.444
0.5	180.000	181.000	0.556
1	142.000	142.000	0.000
2	106.000	106.000	0.000
5	68.000	68.050	0.074
10	48.000	48.000	0.000
20	35.000	34.990	-0.029

Switching Time Characteristic

Circuit Simulation result



Evaluation circuit

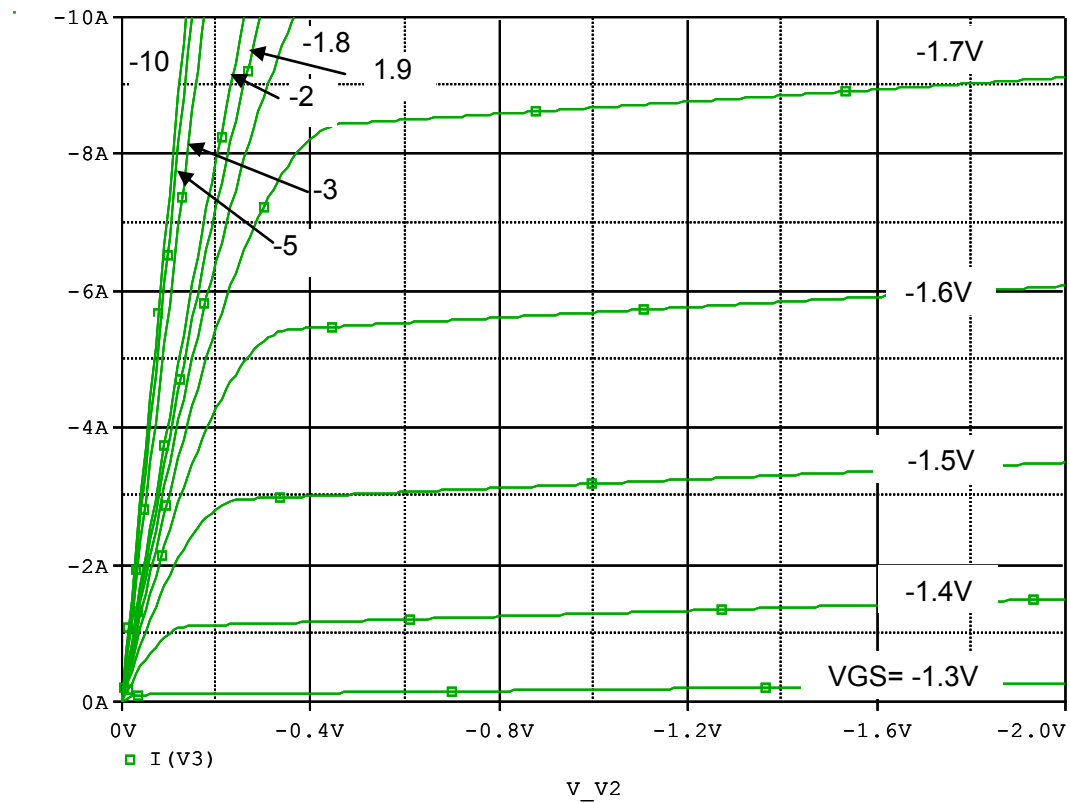


Simulation Result

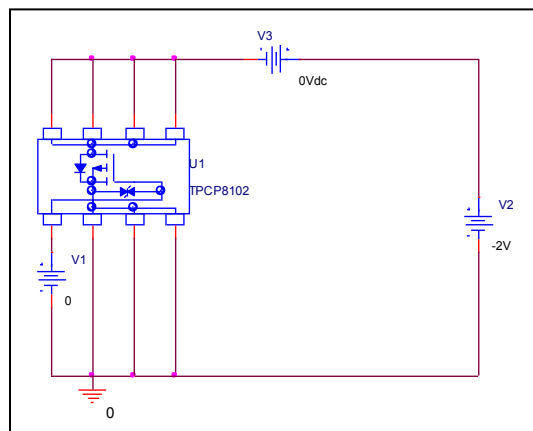
$I_D = -3.6A$, $V_{DD} = -10V$ $V_{GS} = -5V$	Measurement		Simulation		Error(%)
ton	14.000	ns	14.060	ns	0.429

Output Characteristic

Circuit Simulation result



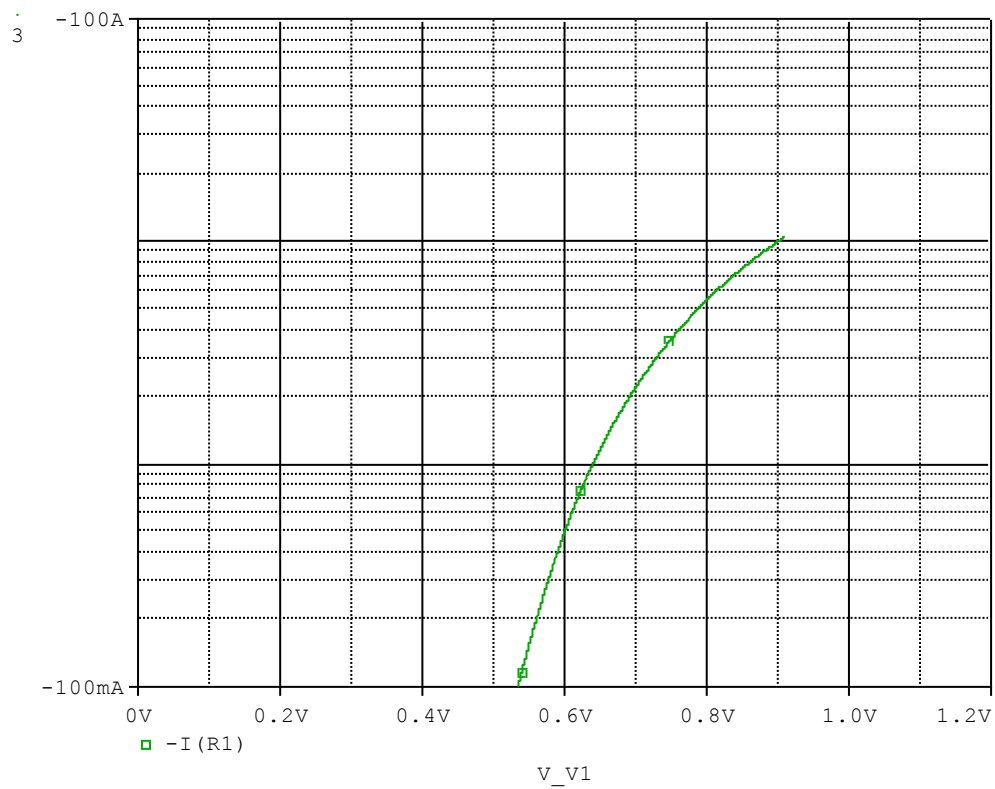
Evaluation circuit



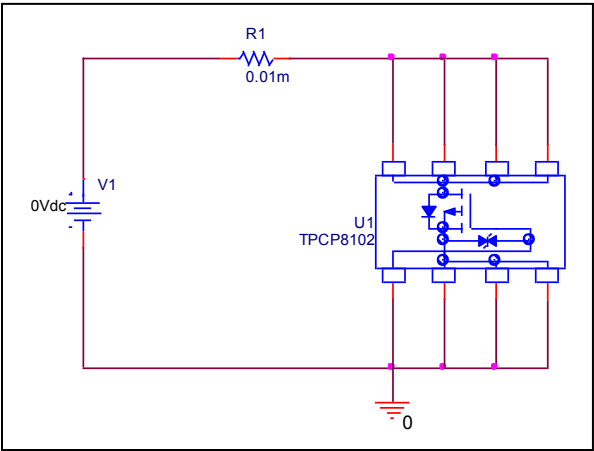
BODY DIODE SPICE MODEL

Forward Current Characteristic

Circuit Simulation Result

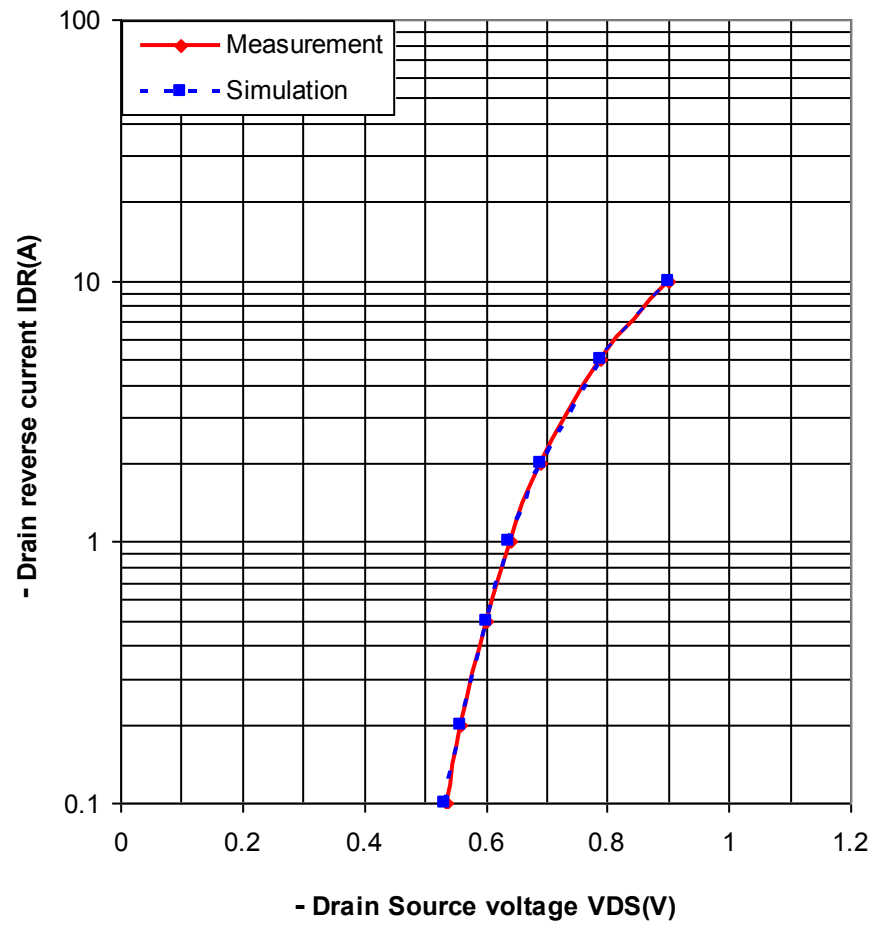


Evaluation Circuit



Comparison Graph

Circuit Simulation Result

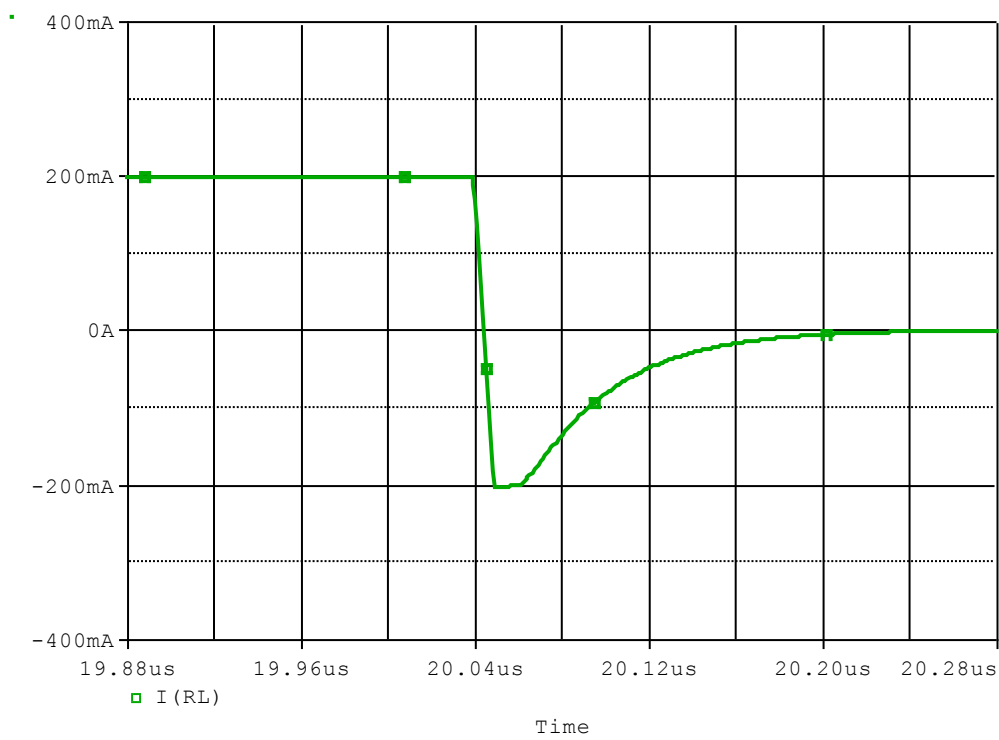


Simulation Result

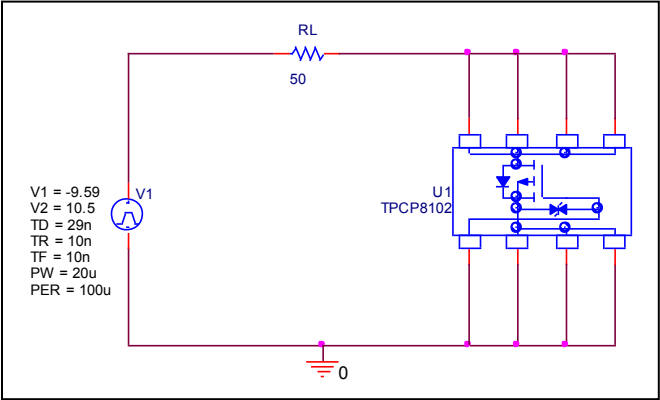
-IDR(A)	-VDS(V) Measurement	-VDS(V) Simulation	%Error
0.100	0.535	0.534	-0.187
0.200	0.560	0.560	0.000
0.500	0.600	0.600	0.000
1.000	0.640	0.639	-0.156
2.000	0.690	0.691	0.145
5.000	0.790	0.788	-0.253
10.000	0.900	0.900	0.000

Reverse Recovery Characteristic

Circuit Simulation Result



Evaluation Circuit

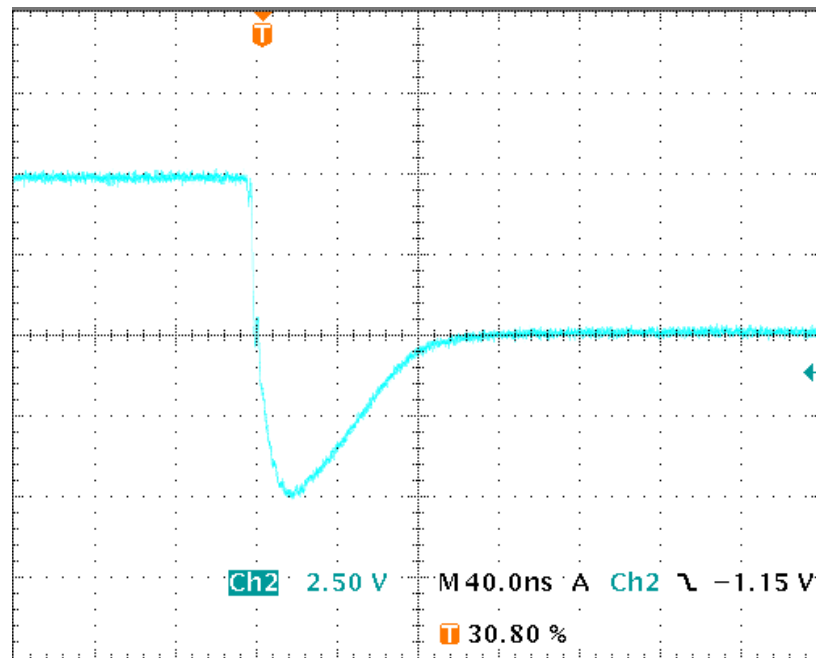


Compare Measurement vs. Simulation

	Measurement		Simulation		Error (%)
trj	17.600	ns	17.657	ns	0.324

Reverse Recovery Characteristic

Reference

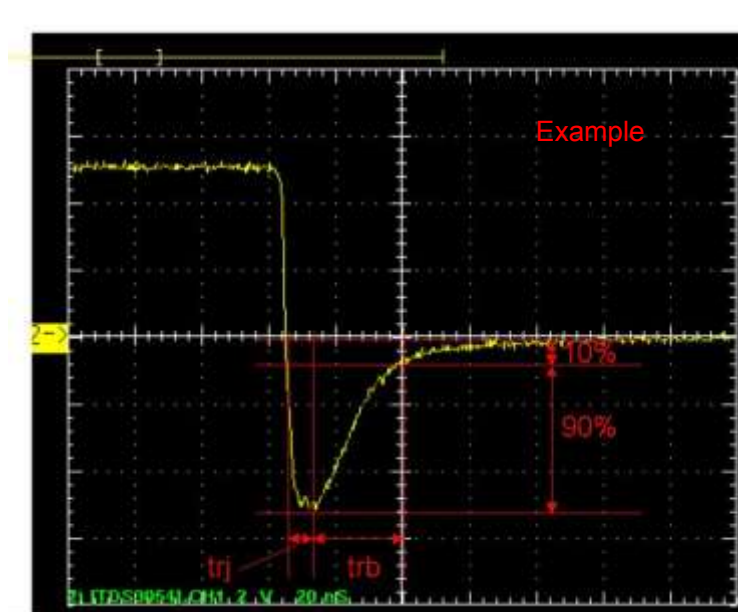


$T_{rj}=17.6(\text{ns})$

$T_{rb}=60.8(\text{ns})$

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

ρ

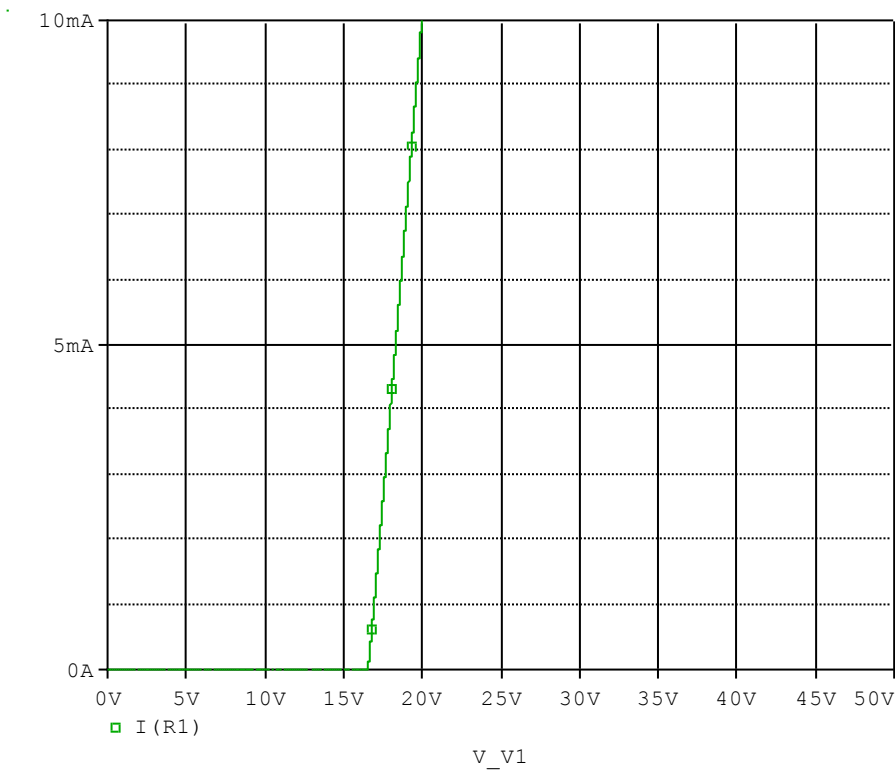


Relation between t_{rr} and τ_{rb}

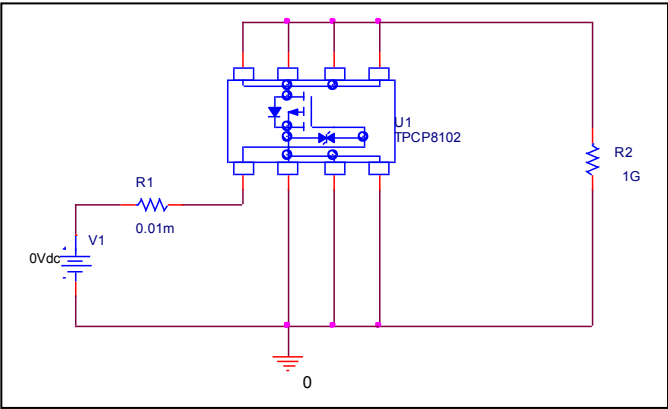
ESD PROTECTION DIODE SPICE MODEL

Zener Voltage Characteristic

Circuit Simulation Result



Evaluation Circuit



Zener Voltage Characteristic

Reference

