

Device Modeling Report

COMPONENTS: Power MOSFET (Model Parameter)
PART NUMBER: TPC6107
MANUFACTURER: TOSHIBA
REMARK: P Channel Model
Body Diode (Model Parameter) / ESD Protection Diode



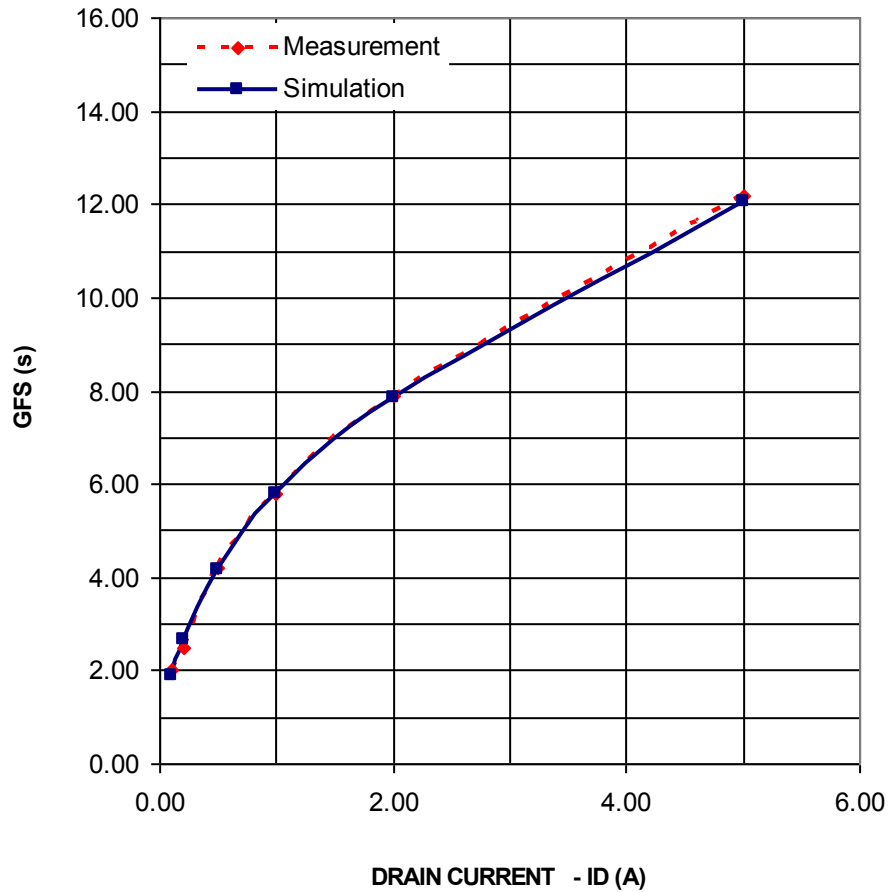
Bee Technologies Inc.

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

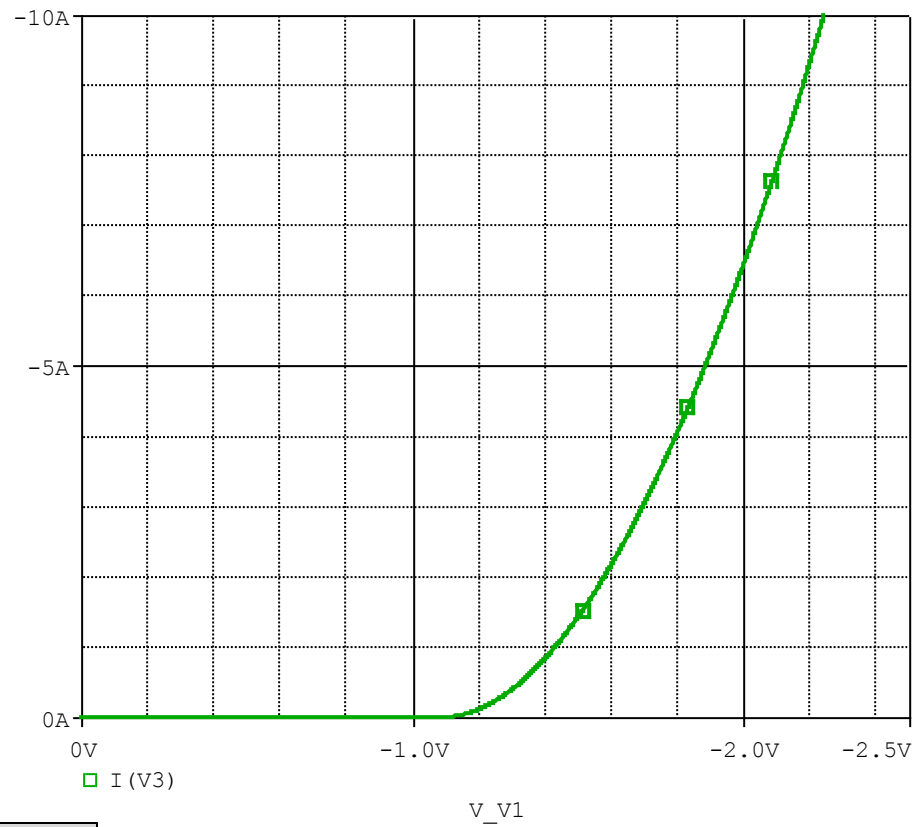


Comparison table

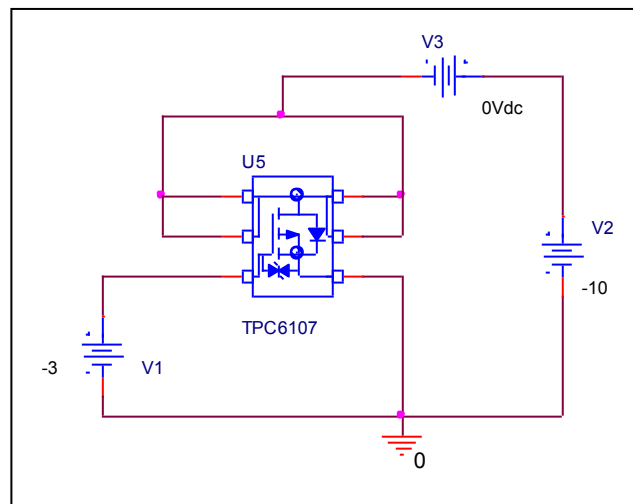
Id(A)	gfs		Error(%)
	Measurement	Simulation	
-0.100	2.000	1.904	-4.800
-0.200	2.500	2.672	6.880
-0.500	4.200	4.163	-0.881
-1.000	5.800	5.787	-0.224
-2.000	7.900	7.830	-0.886
-5.000	12.200	12.057	-1.172

V_{gs}-I_d Characteristic

Circuit Simulation result

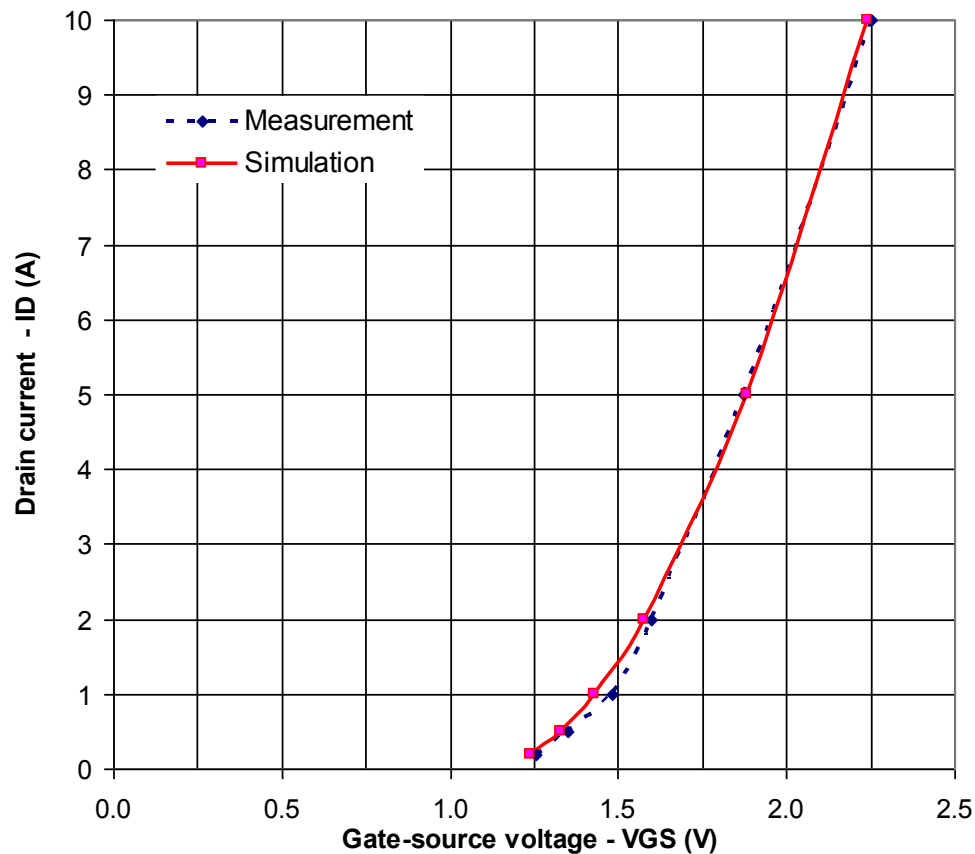


Evaluation circuit



Comparison Graph

Circuit Simulation Result

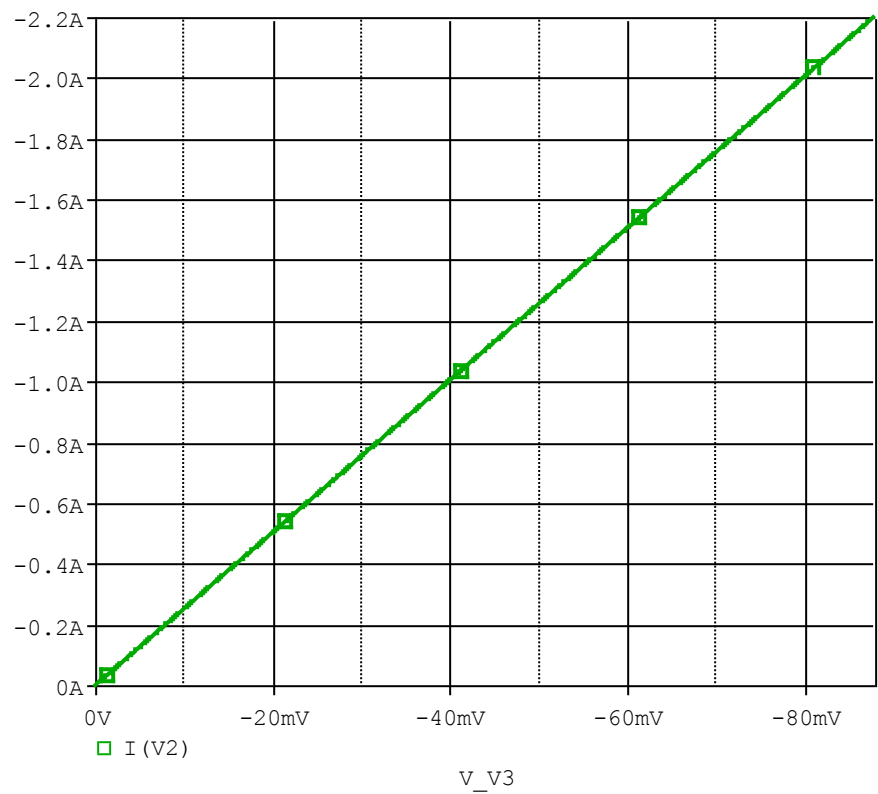


Simulation Result

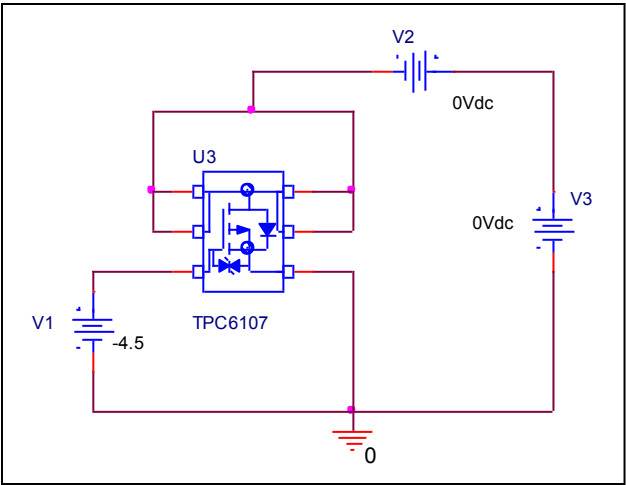
ID(A)	VGS(V)		Error (%)
	Measurement	Simulation	
-0.200	-1.255	-1.239	-1.275
-0.500	-1.350	-1.329	-1.556
-1.000	-1.480	-1.431	-3.311
-2.000	-1.600	-1.579	-1.313
-5.000	-1.870	-1.883	0.695
-10.000	-2.250	-2.243	-0.311

Rds(on) Characteristic

Circuit Simulation result



Evaluation circuit

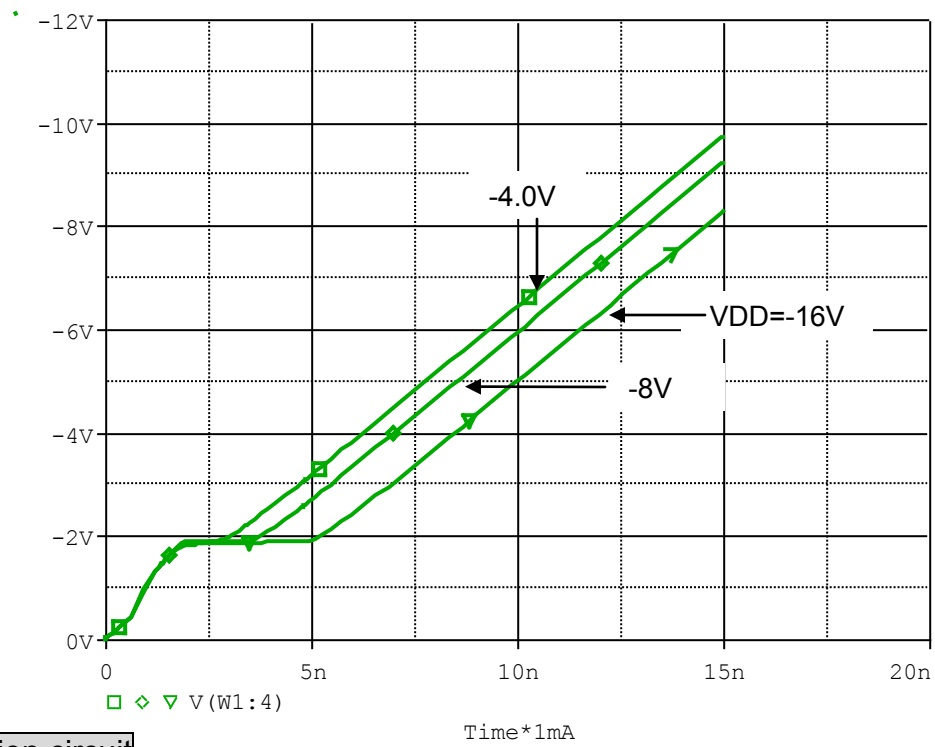


Simulation Result

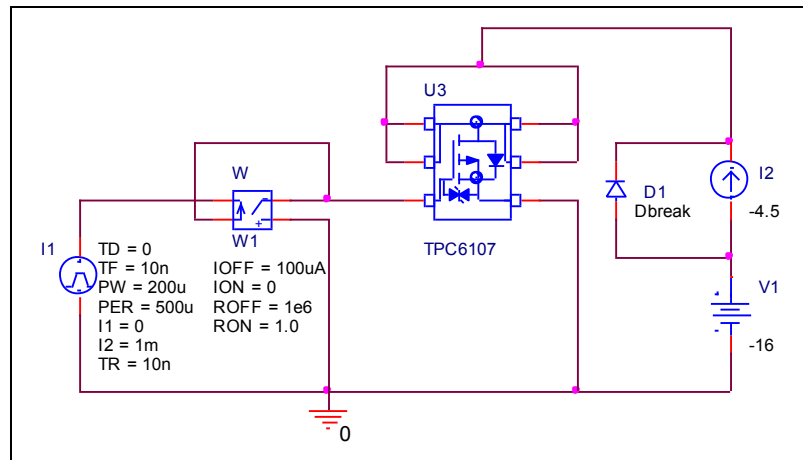
$I_D = -2.2A, V_{GS} = -4.5V$	Measurement		Simulation		Error (%)
$R_{DS(on)}$	40.000	mΩ	40.000	mΩ	0.000

Gate Charge Characteristic

Circuit Simulation result



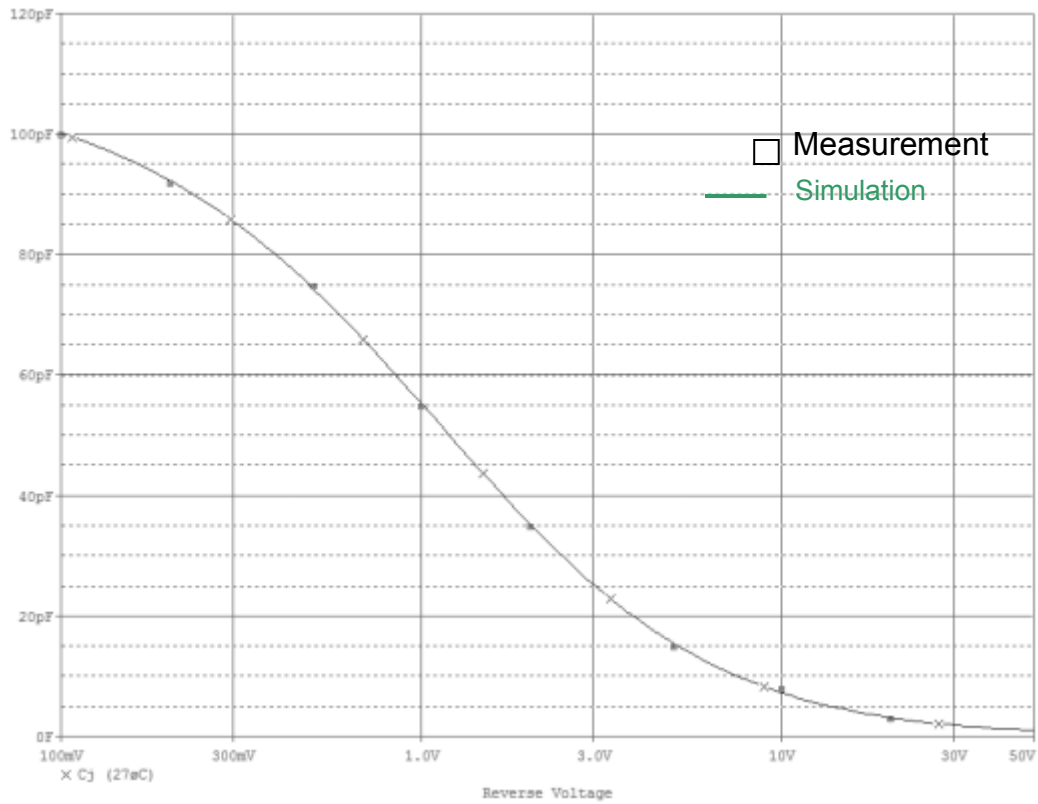
Evaluation circuit



Simulation Result

$V_{DD} = -16V, I_D = -4.5A$ $V_{GS} = -5V$	Measurement		Simulation		Error (%)
Qgs	2.000	nC	2.000	nC	0.000
Qgd	3.000	nC	3.020	nC	0.667
Qg	10.000	nC	10.045	nC	0.450

Capacitance Characteristic

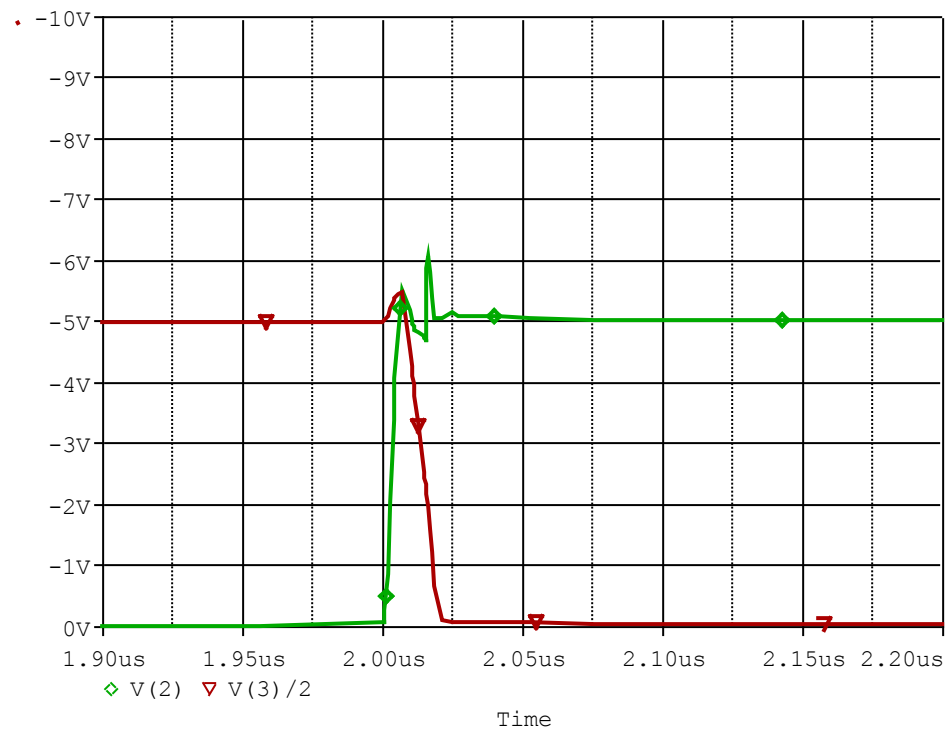


Simulation Result

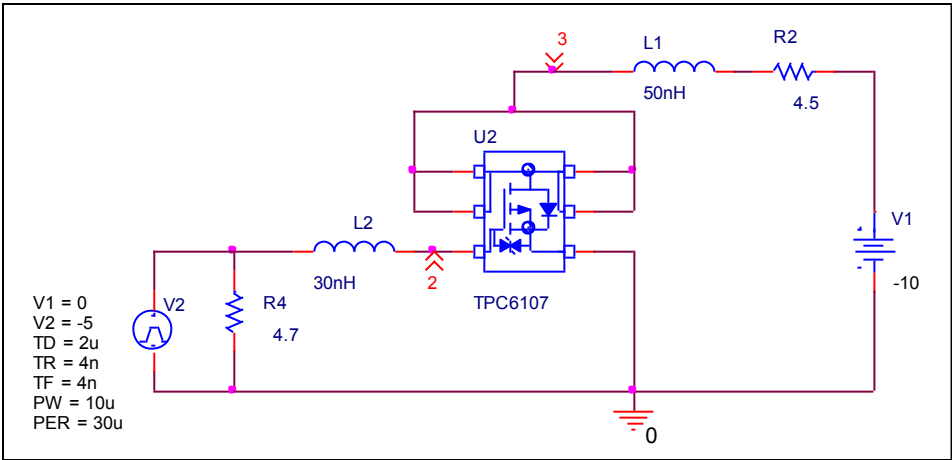
V _{DS} (V)	C _{bd} (pF)		Error(%)
	Measurement	Simulation	
-0.100	100.000	100.000	0.000
-0.200	92.000	90.000	-2.174
-0.500	75.000	74.000	-1.333
-1.000	55.000	53.000	-3.636
-2.000	35.000	34.500	-1.429
-5.000	15.000	14.500	-3.333
-10.000	8.000	8.000	0.000
-20.000	4.000	4.100	2.500

SwitchingTime Characteristic

Circuit Simulation result



Evaluation circuit

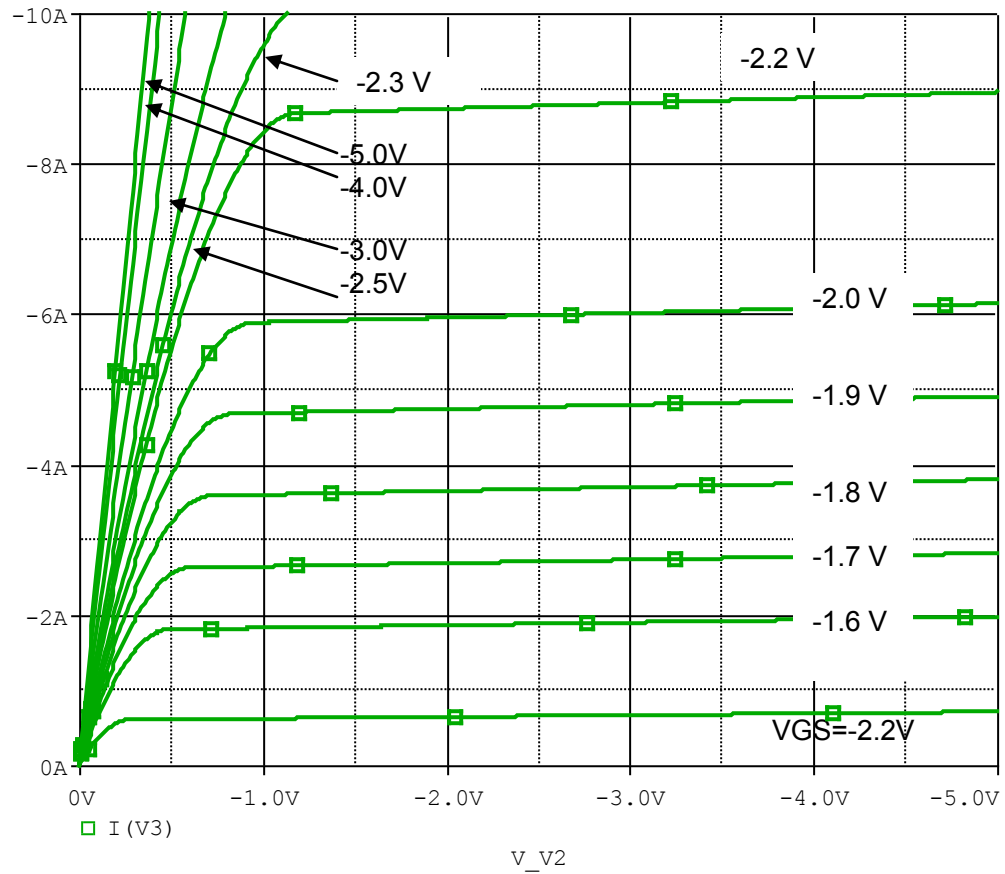


Simulation Result

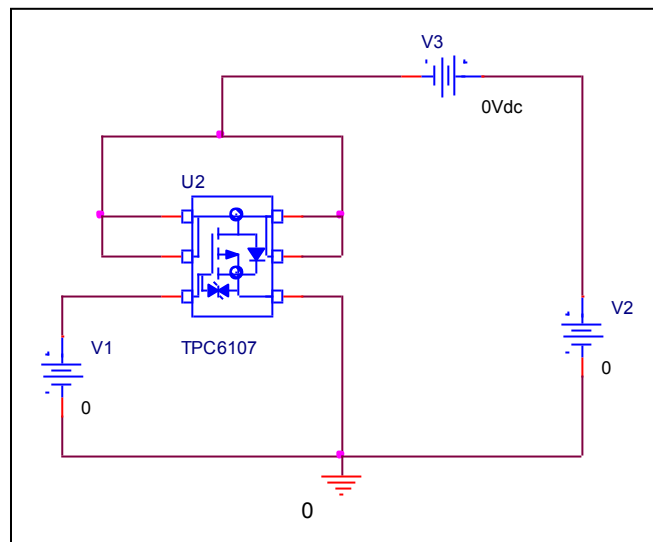
$I_D = -2.2A$, $V_{DD} = -10V$ $V_{GS} = -5V$	Measurement		Simulation		Error(%)
	ton	16.000 ns	15.893 ns	ns	

Output Characteristic

Circuit Simulation result



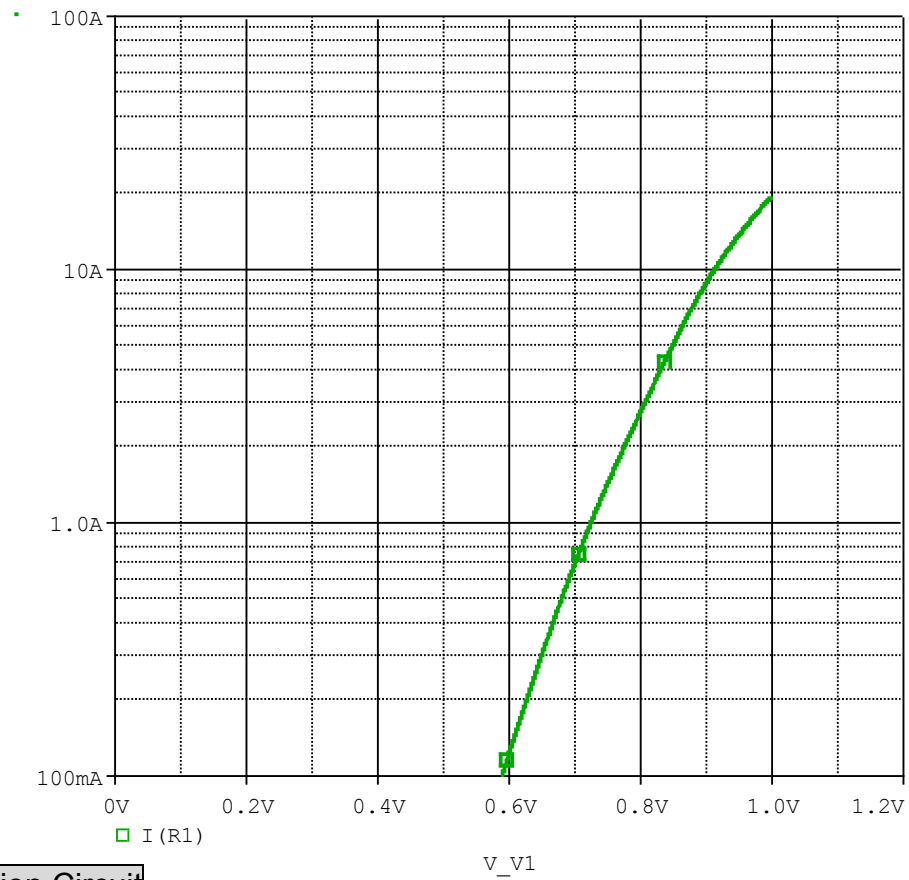
Evaluation circuit



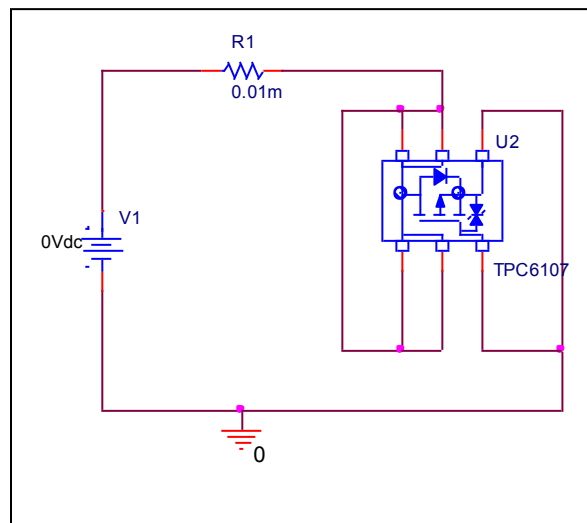
BODY DIODE SPICE MODEL

Forward Current Characteristic

Circuit Simulation Result

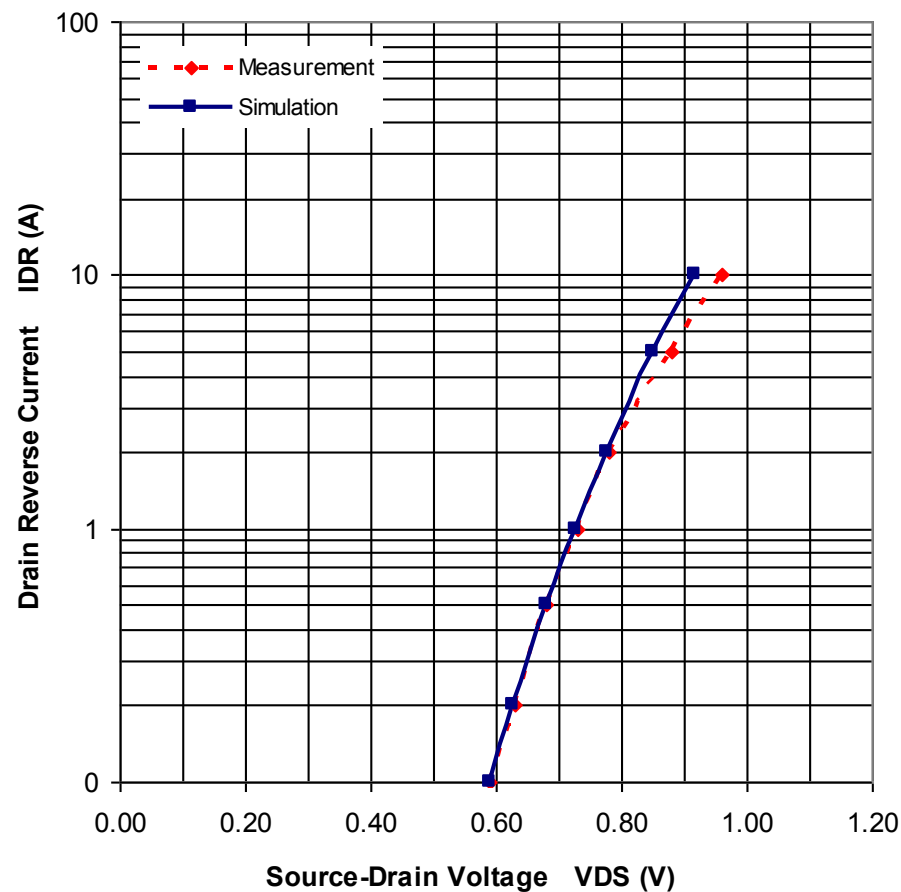


Evaluation Circuit



Comparison Graph

Circuit Simulation Result

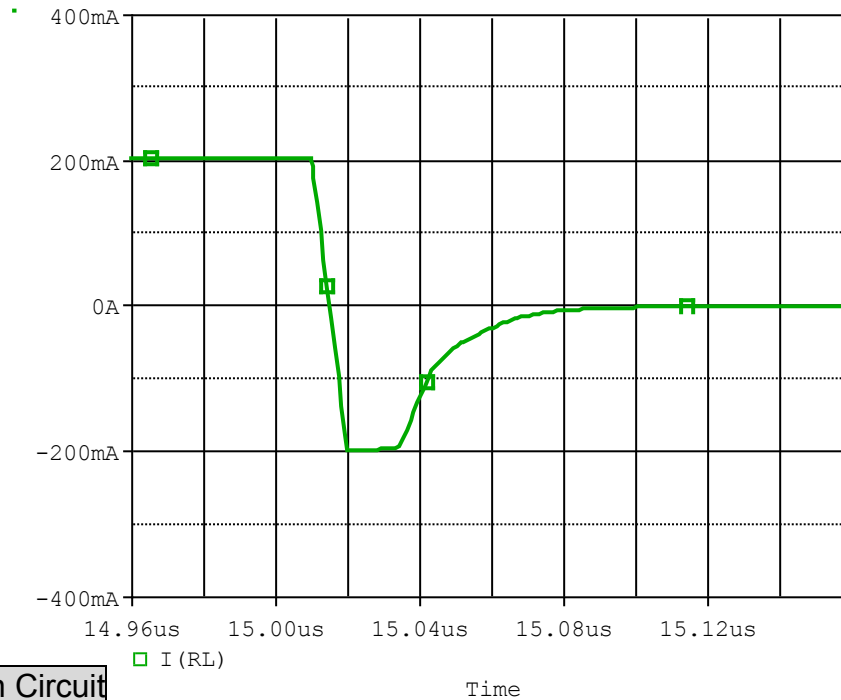


Simulation Result

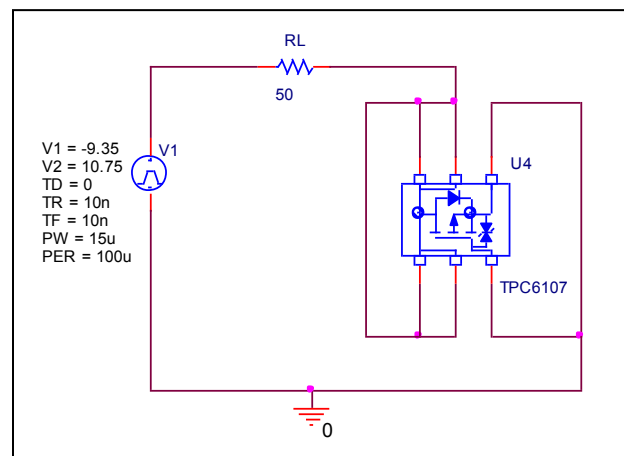
$I_{DR}(A)$	$V_{DS}(V)$ Measurement	$V_{DS}(V)$ Simulation	%Error
0.100	0.590	0.590	0.000
0.200	0.630	0.628	-0.317
0.500	0.680	0.680	0.000
1.000	0.730	0.726	-0.548
2.000	0.780	0.777	-0.385
5.000	0.880	0.851	-3.295
10.000	0.960	0.915	-4.687

Reverse Recovery Characteristic

Circuit Simulation Result



Evaluation Circuit

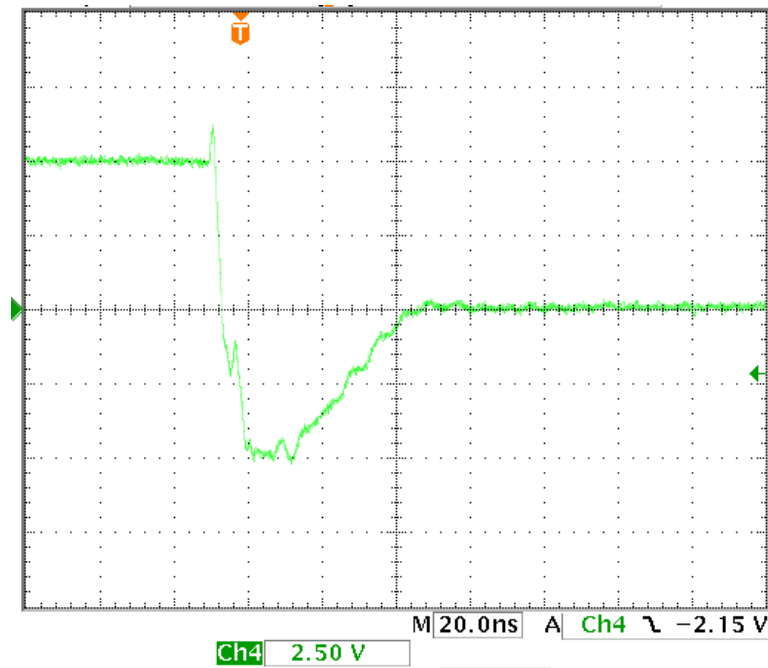


Compare Measurement vs. Simulation

	Measurement		Simulation		Error (%)
trj	18.400	ns	18.652	ns	1.370
trb	27.000	ns	31.579	ns	16.959
trr	45.400	ns	50.231	ns	10.641

Reverse Recovery Characteristic

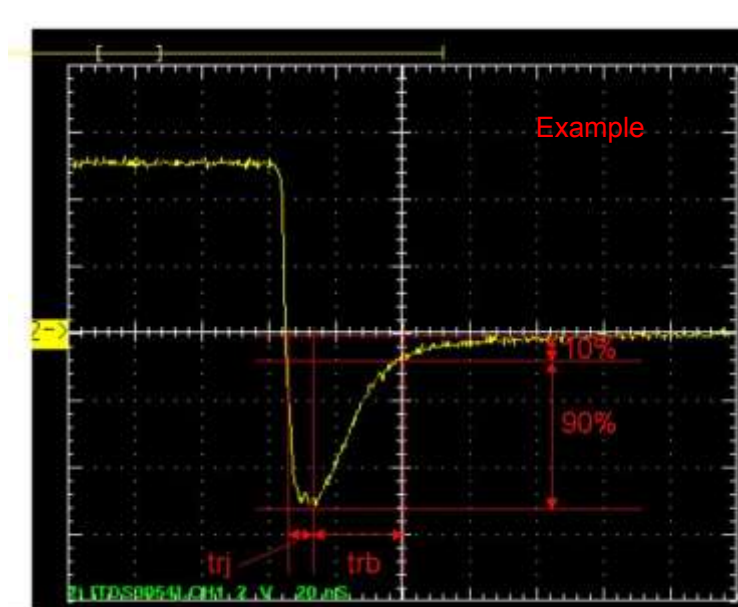
Reference



$T_{rr}=18.4(\text{ns})$

$T_{rb}=27.0(\text{ns})$

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

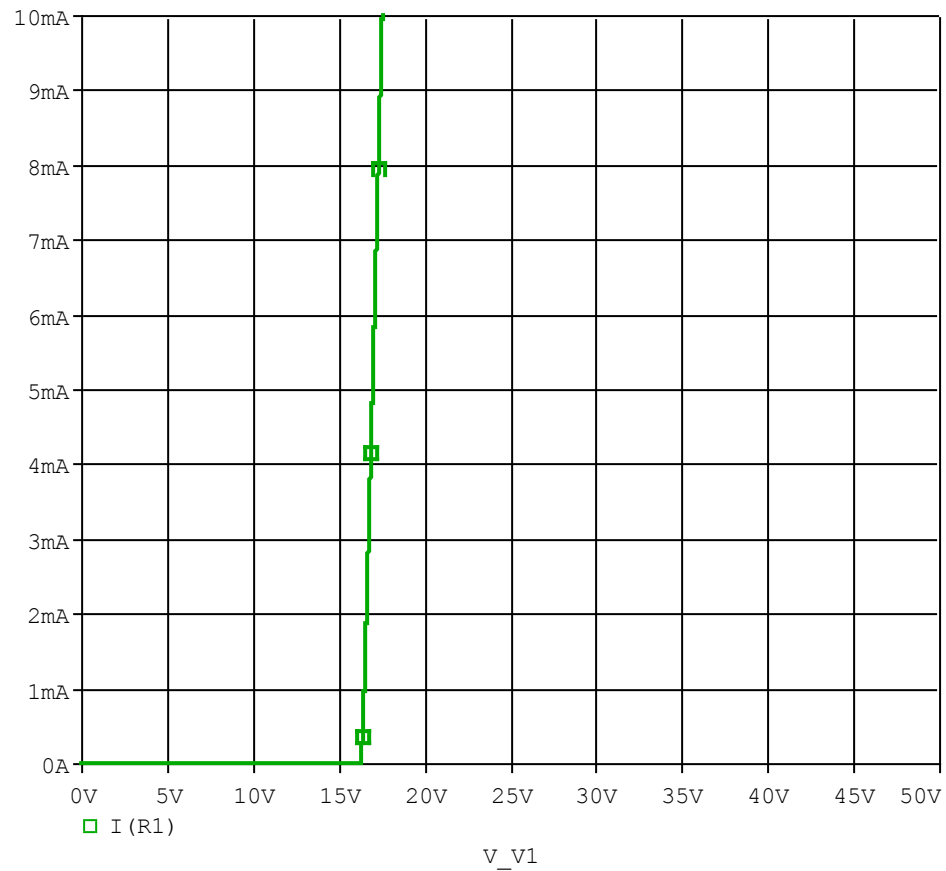


Relation between t_{rr} and t_{rb}

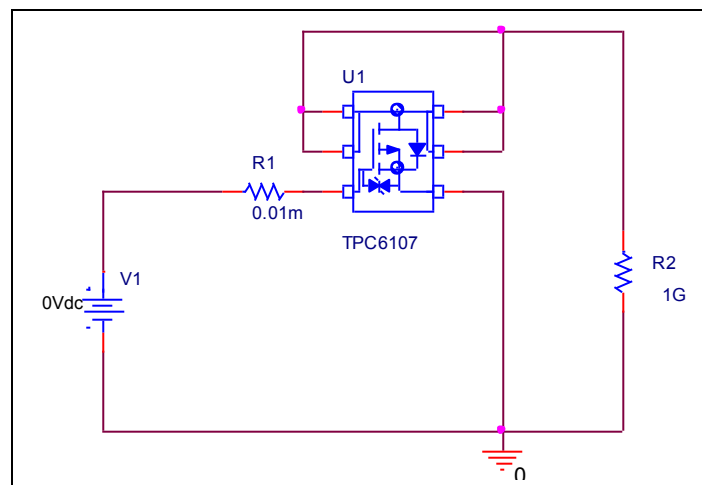
ESD PROTECTION DIODE SPICE MODEL

ZenerVoltage Characteristic

Circuit Simulation Result



Evaluation Circuit



Zener Voltage Characteristic

Reference

