

Device Modeling Report

COMPONENTS: Power MOSFET (Model Parameter)
PART NUMBER: TPC6108
MANUFACTURER: TOSHIBA
Body Diode (Model Parameter) / ESD Protection Diode



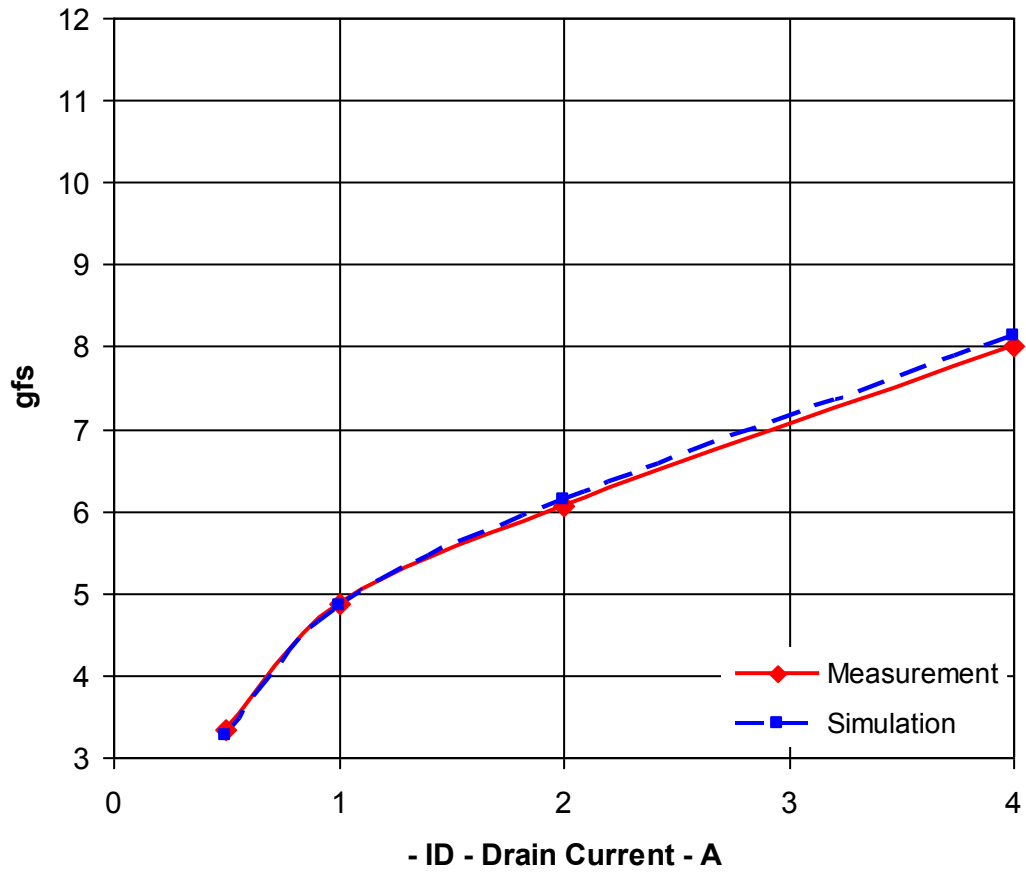
Bee Technologies Inc.

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

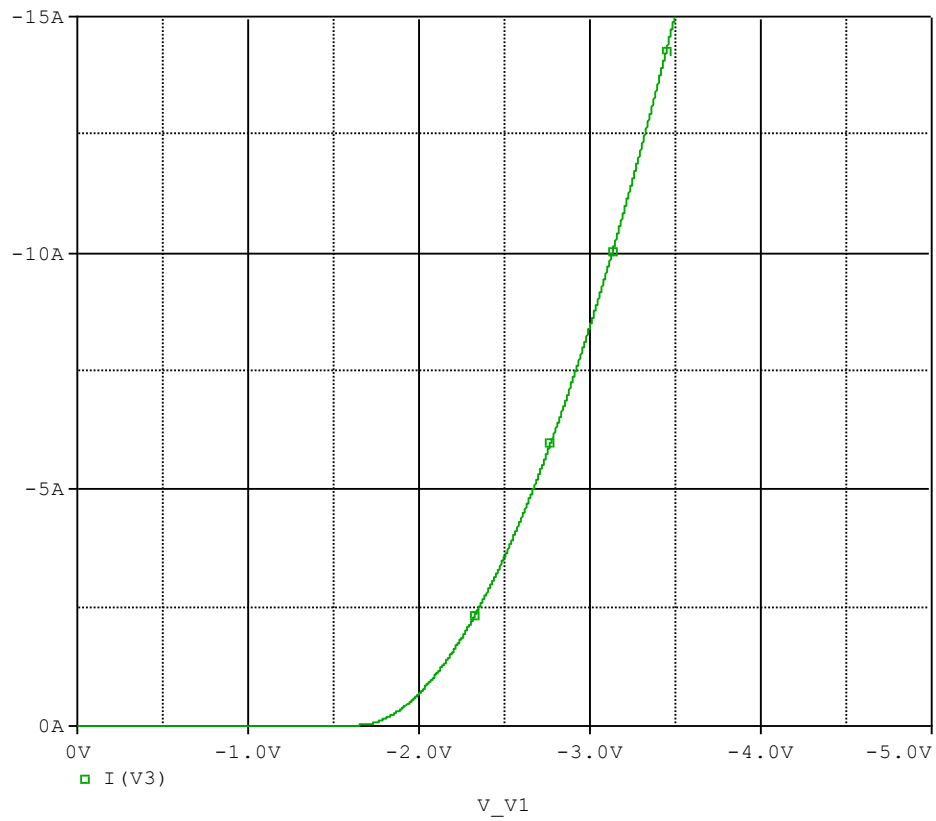


Comparison table

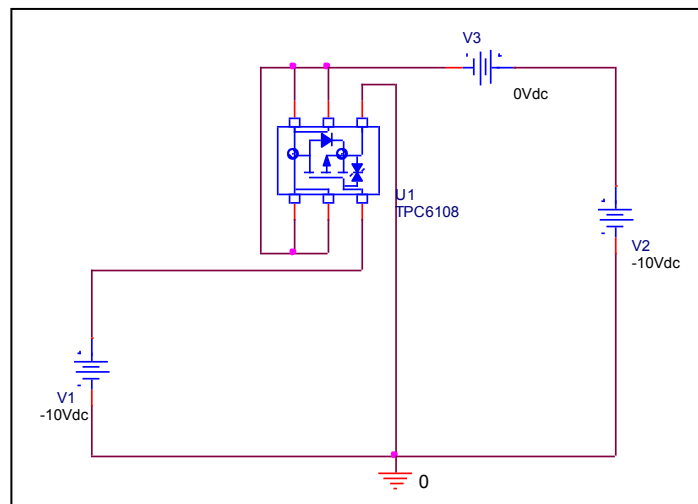
Id(A)	gfs		Error(%)
	Measurement	Simulation	
-0.500	3.333	3.260	-2.190
-1.000	4.878	4.850	-0.574
-2.000	6.061	6.135	1.221
-4.000	8.000	8.140	1.750

V_{gs}-I_d Characteristic

Circuit Simulation result

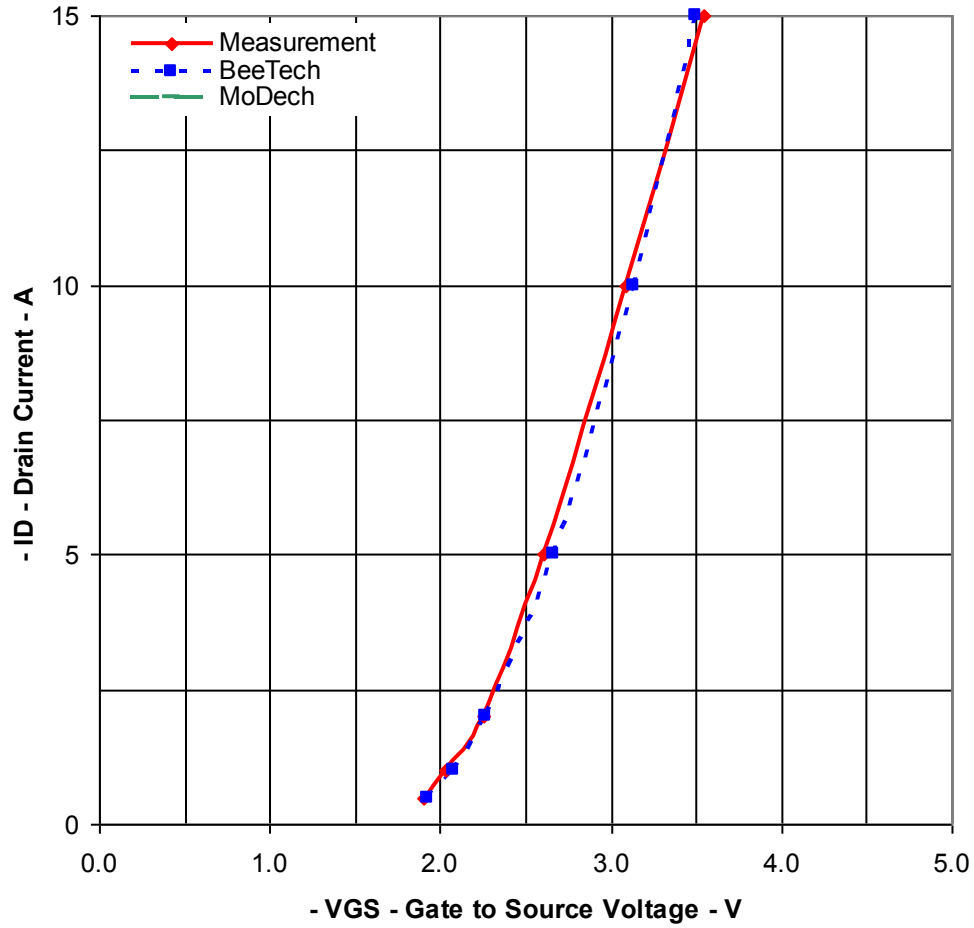


Evaluation circuit



Comparison Graph

Circuit Simulation Result

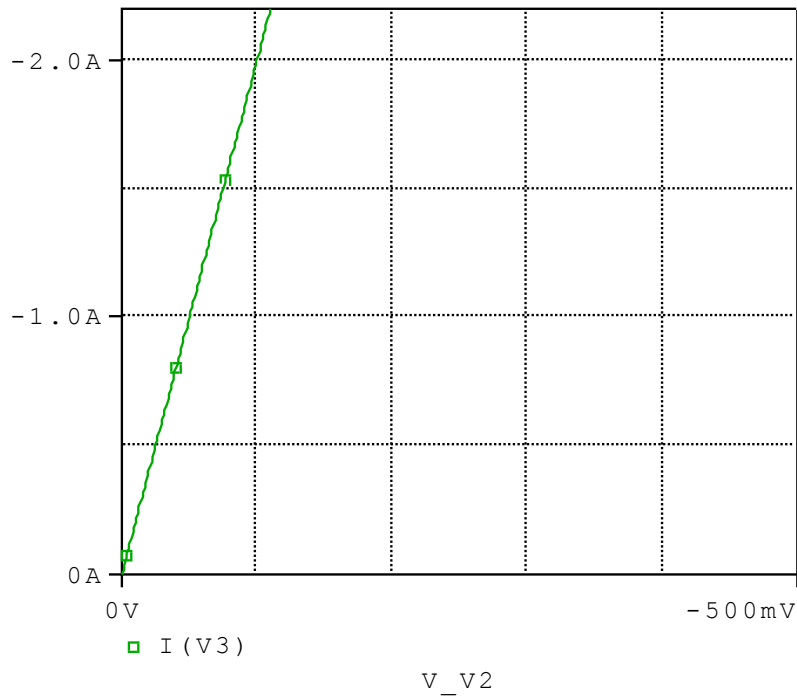


Simulation Result

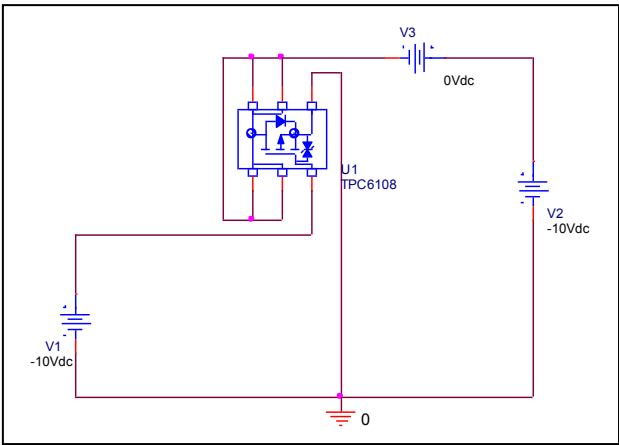
I_D (A)	$-V_{GS}$ (V)		Error (%)
	Measurement	Simulation	
-0.500	1.900	1.930	1.579
-1.000	2.030	2.078	2.365
-2.000	2.250	2.269	0.844
-5.000	2.600	2.669	2.654
-10.000	3.090	3.128	1.230
-15.000	3.550	3.496	-1.521

Rds(on) Characteristic

Circuit Simulation result



Evaluation circuit

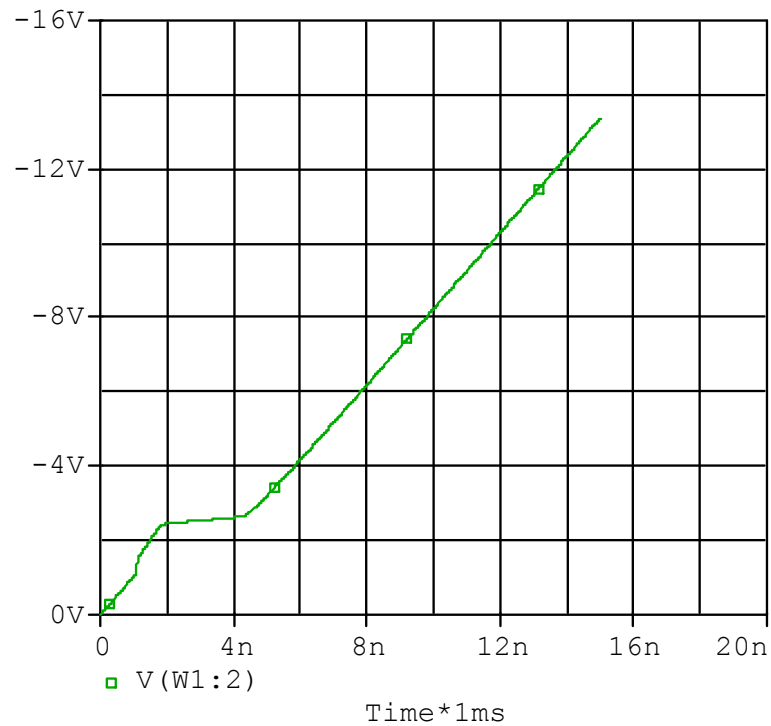


Simulation Result

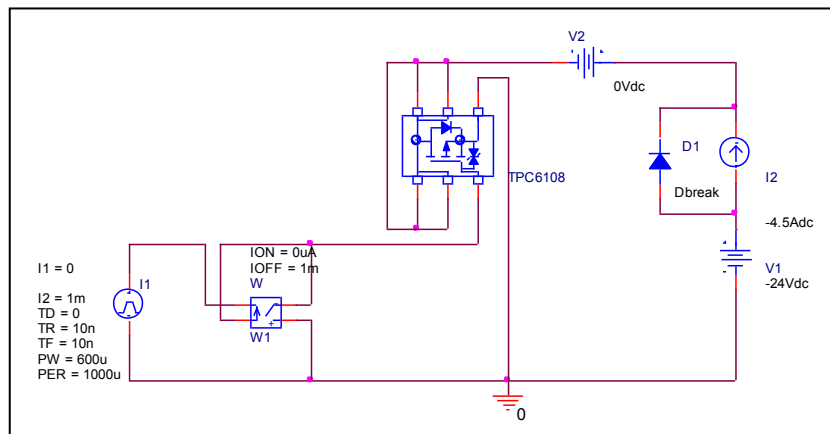
$I_D=-2.2A, V_{GS}=-10V$	Measurement		Simulation		Error (%)
$R_{DS(on)}$	50.000	mΩ	50.000	mΩ	0.000

Gate Charge Characteristic

Circuit Simulation result



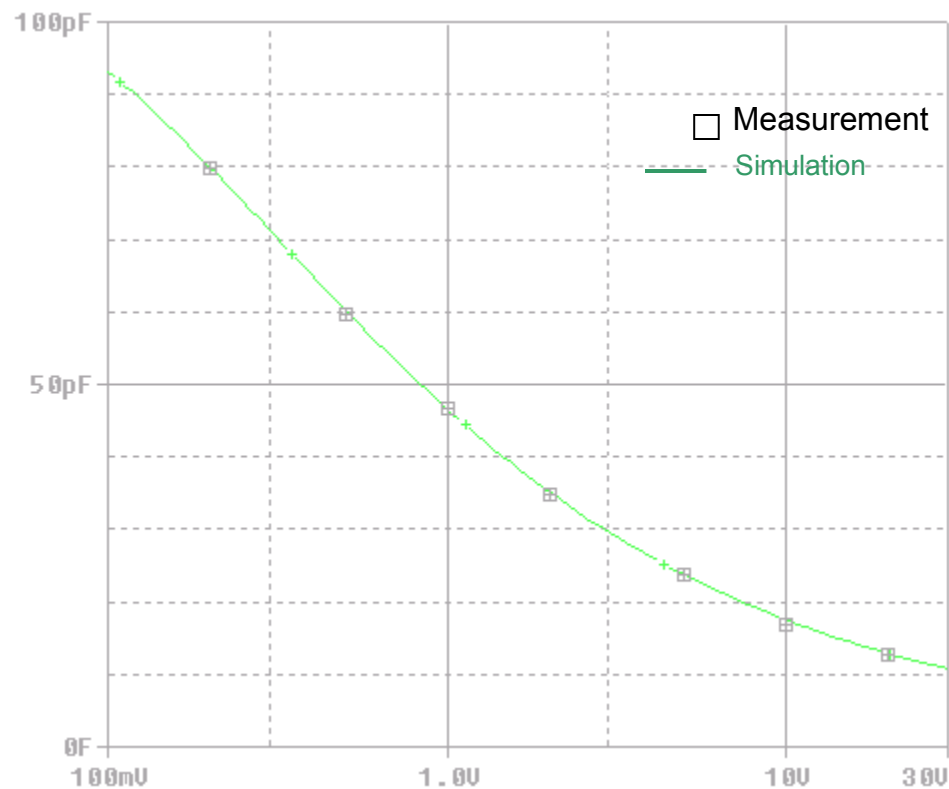
Evaluation circuit



Simulation Result

$V_{DD} = -24V, I_D = -4.5A$ $V_{GS} = -10V$	Measurement		Simulation		Error (%)
Qgs	1.800	nC	1.816	nC	0.889
Qgd	2.500	nC	2.506	nC	0.240
Qg	13.000	nC	11.722	nC	-9.831

Capacitance Characteristic

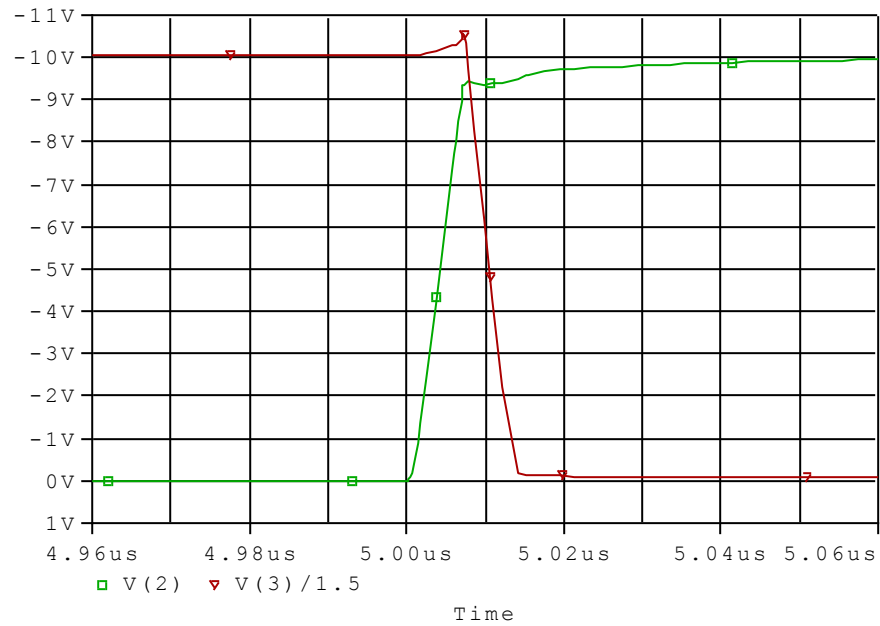


Simulation Result

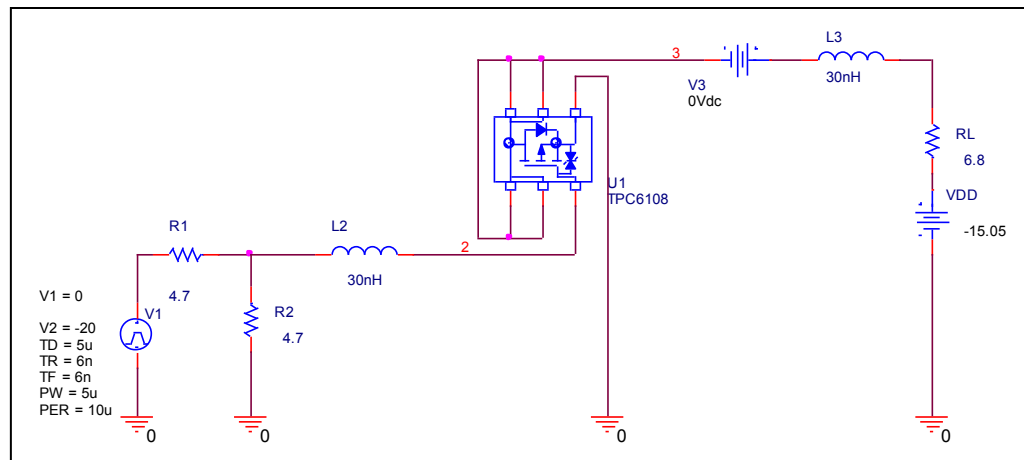
V _{DS} (V)	Cbd(nF)		Error(%)
	Measurement	Simulation	
-0.200	80.000	79.800	-0.250
-0.500	60.000	60.300	0.500
-1.000	47.000	46.550	-0.957
-2.000	35.000	35.030	0.086
-5.000	24.000	23.800	-0.833
-10.000	18.000	17.970	-0.167
-20.000	13.000	12.700	-2.308

Switching Time Characteristic

Circuit Simulation result



Evaluation circuit

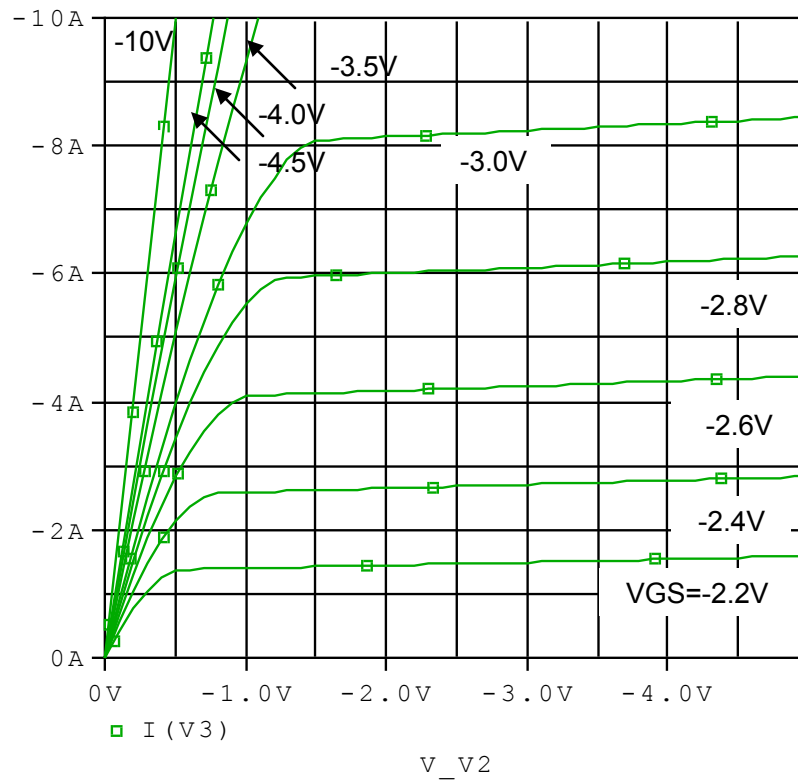


Simulation Result

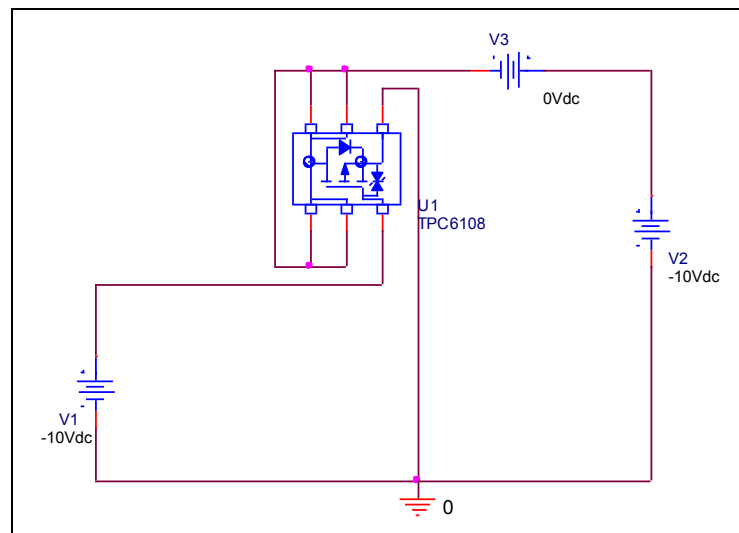
$I_D = -2.2A$, $V_{DD} = -15V$ $V_{GS} = 0/10V$	Measurement		Simulation		Error(%)
	ton	12.000 ns	12.015 ns	ns	

Output Characteristic

Circuit Simulation result



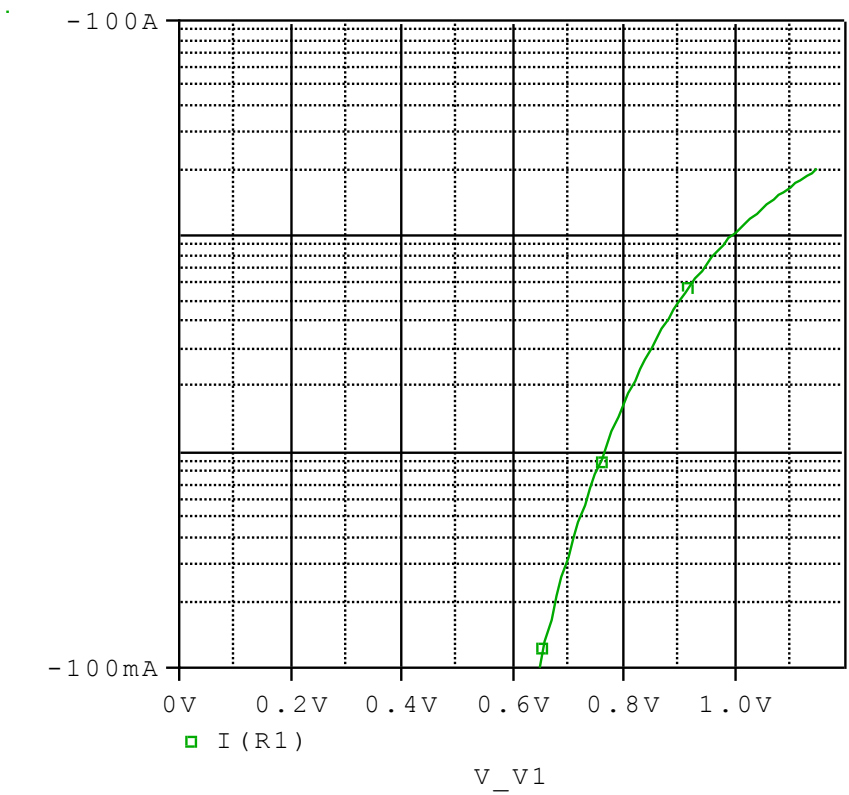
Evaluation circuit



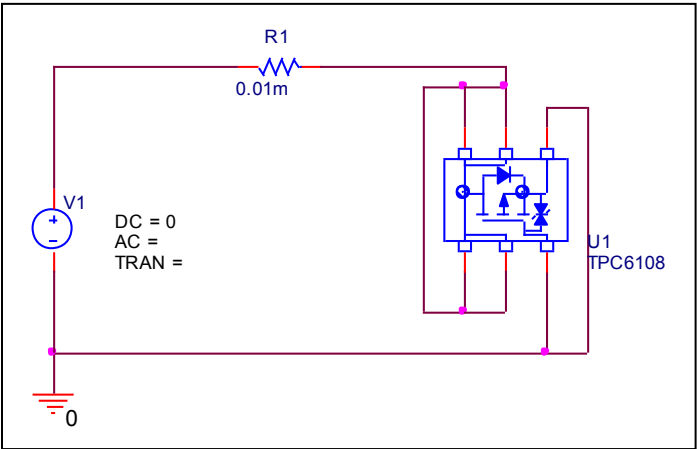
BODY DIODE SPICE MODEL

Forward Current Characteristic

Circuit Simulation Result

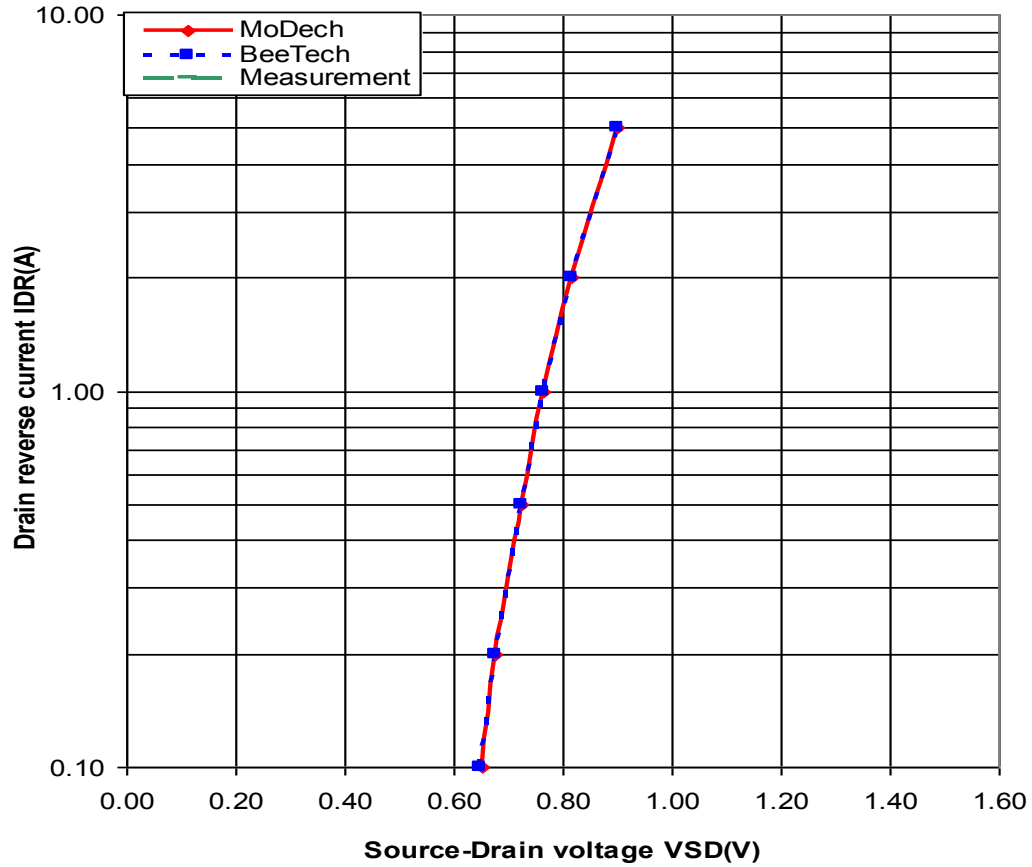


Evaluation Circuit



Comparison Graph

Circuit Simulation Result

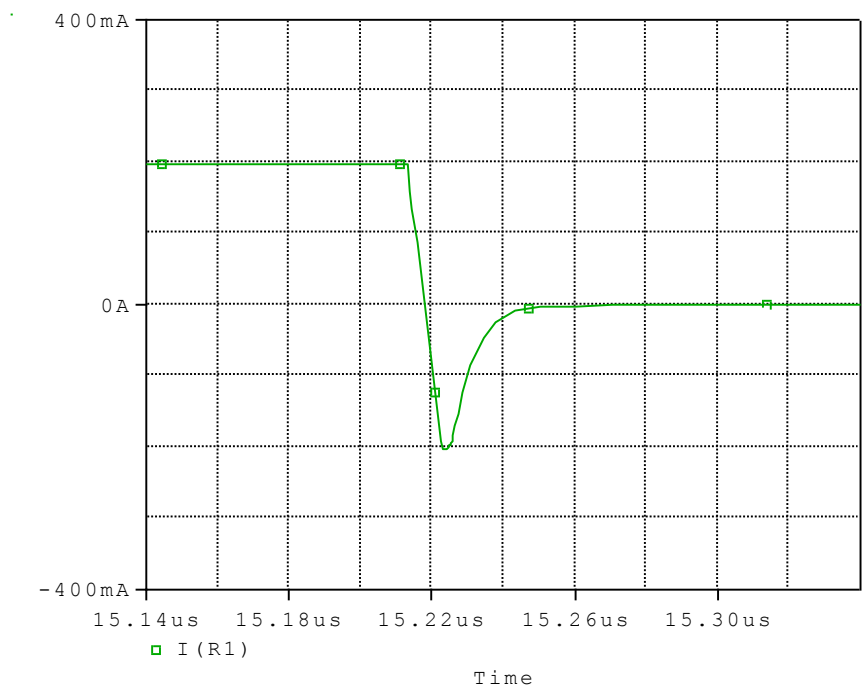


Simulation Result

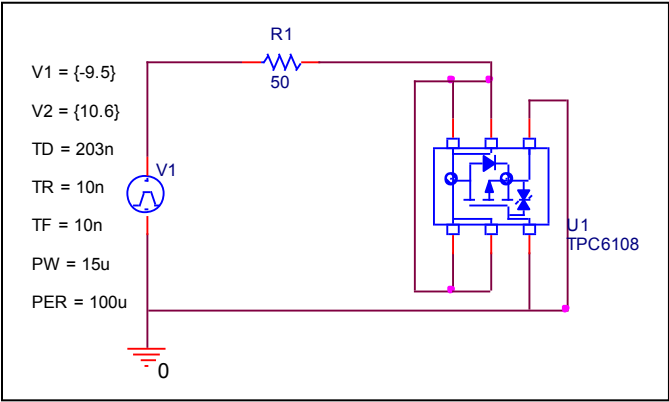
IDR(A)	VDS(V) Measurement	VDS(V) Simulation	%Error
0.100	0.650	0.649	-0.154
0.200	0.677	0.677	0.000
0.500	0.723	0.722	-0.138
1.000	0.765	0.764	-0.131
2.000	0.815	0.814	-0.123
5.000	0.900	0.900	0.000

Reverse Recovery Characteristic

Circuit Simulation Result



Evaluation Circuit

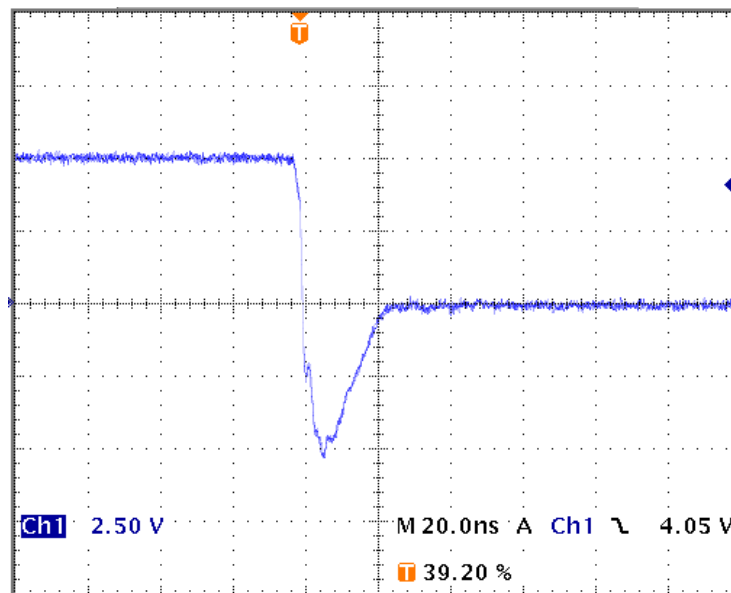


Compare Measurement vs. Simulation

	Measurement		Simulation		Error (%)
trj	6.400	ns	6.405	ns	0.078
trb	15.200	ns	14.483	ns	-4.717
trr	21.800	ns	20.888	ns	-4.183

Reverse Recovery Characteristic

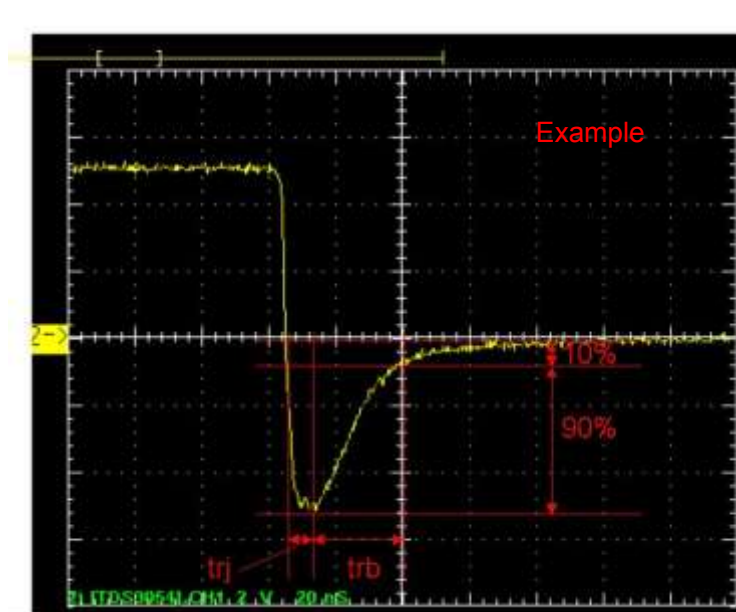
Reference



$T_{rr}=6.4(\text{ns})$

$T_{rb}=15.2(\text{ns})$

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

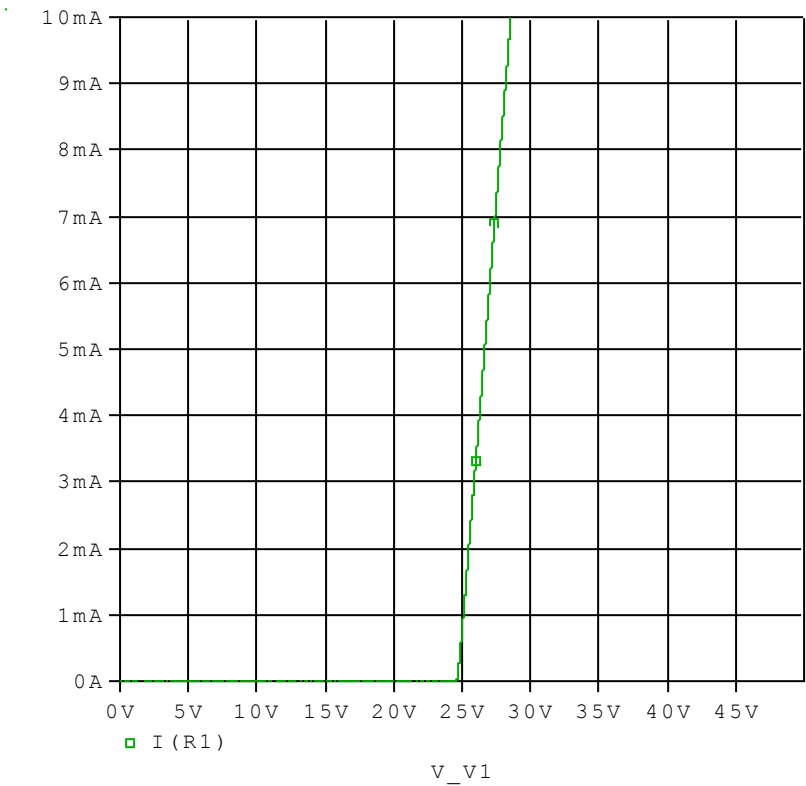


Relation between t_{rr} and t_{rb}

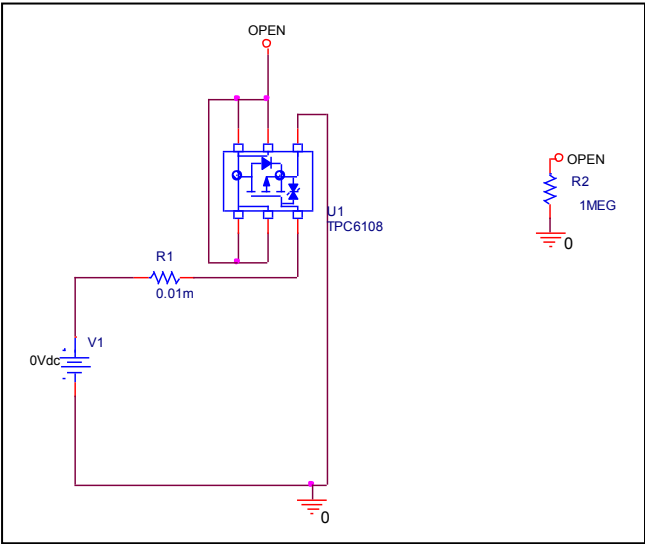
ESD PROTECTION DIODE SPICE MODEL

Zener Voltage Characteristic

Circuit Simulation Result



Evaluation Circuit



Zener Voltage Characteristic

Reference

