

Device Modeling Report

COMPONENTS: Power MOSFET (Professional) /
PART NUMBER: TPCP8AA1
MANUFACTURER: TOSHIBA
Body Diode (Standard) / ESD Protection Diode
Schottky Rectifier (Professional)



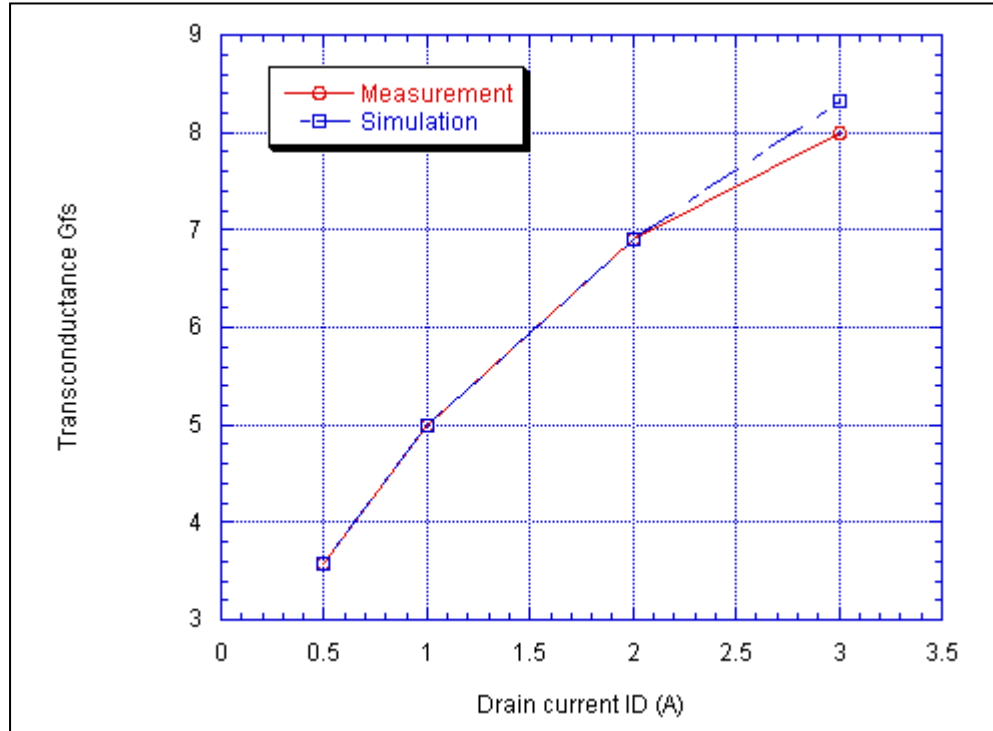
Bee Technologies Inc.

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

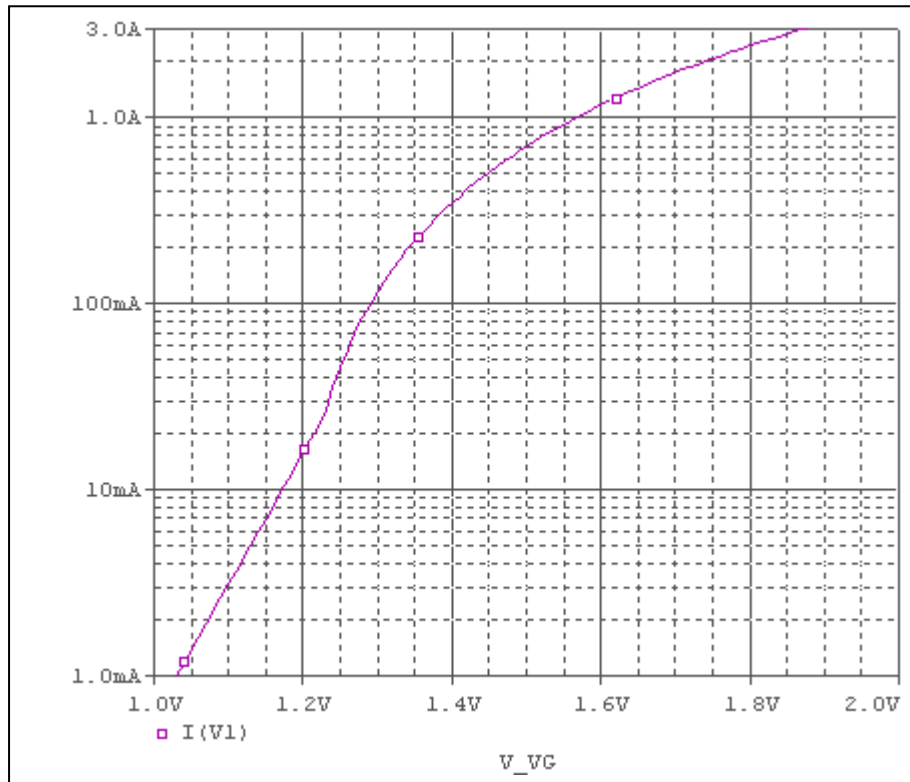


Comparison table

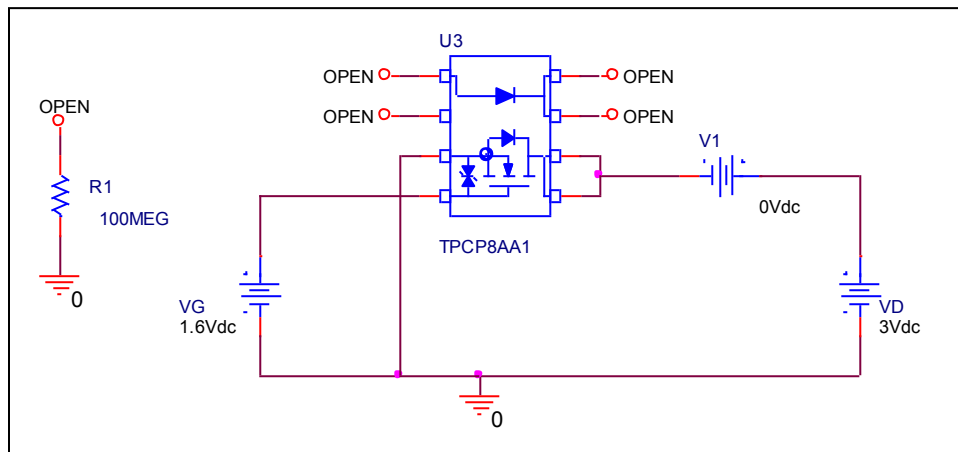
Id(A)	gfs		Error(%)
	Measurement	Simulation	
0.5	3.571	3.586	0.42005
1	5	4.9986	-0.028
2	6.897	6.908	0.15949
3	8	8.313	3.9125

V_{gs}-I_d Characteristic

Circuit Simulation result

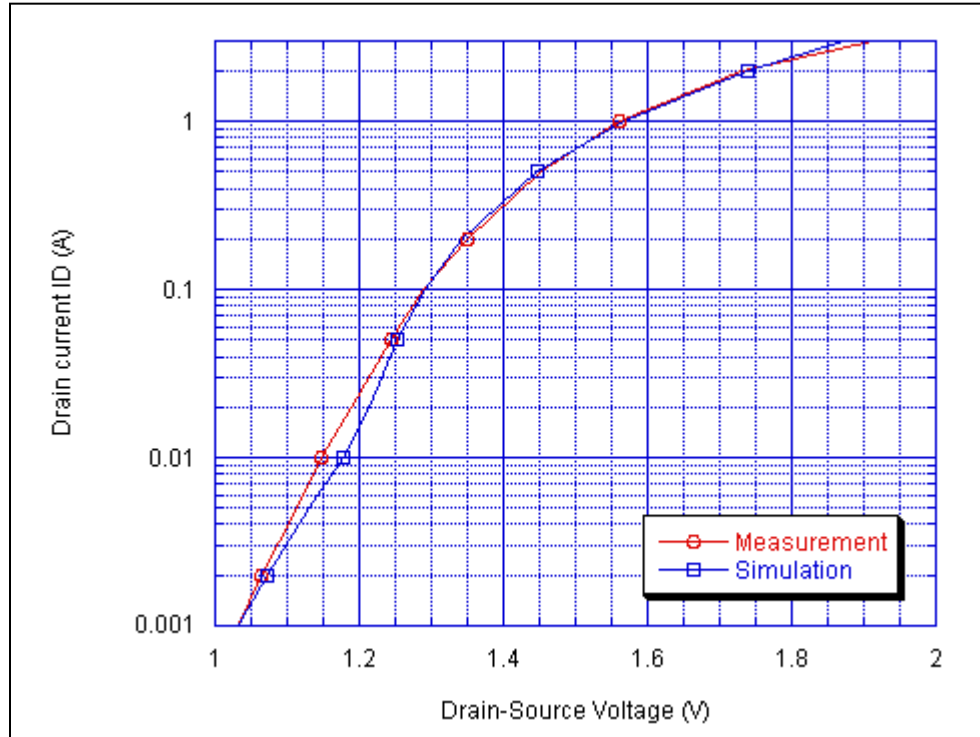


Evaluation circuit



Comparison Graph

Circuit Simulation Result

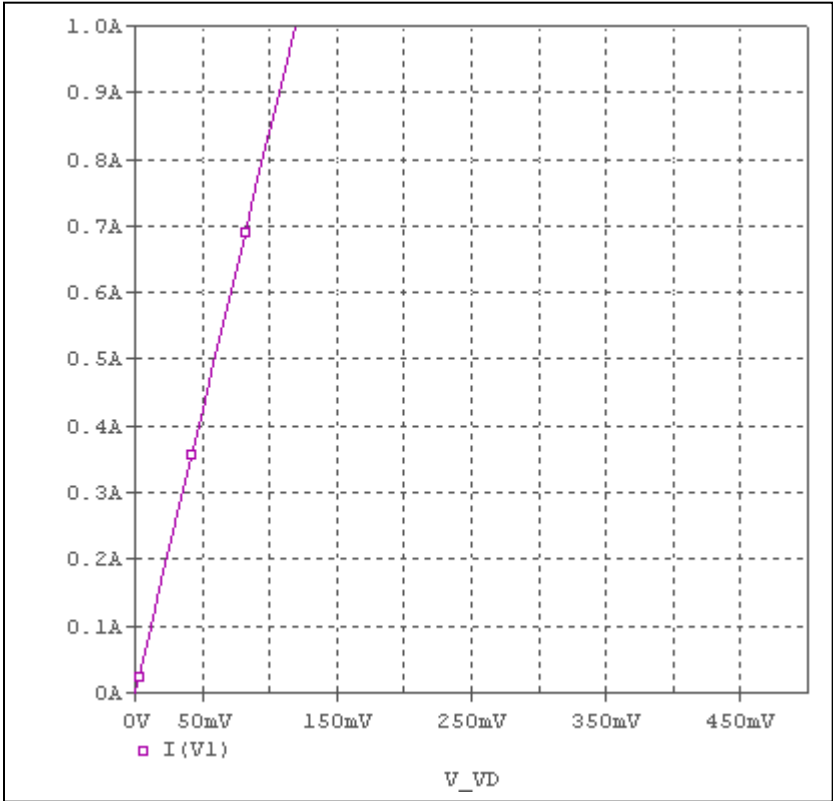


Simulation Result

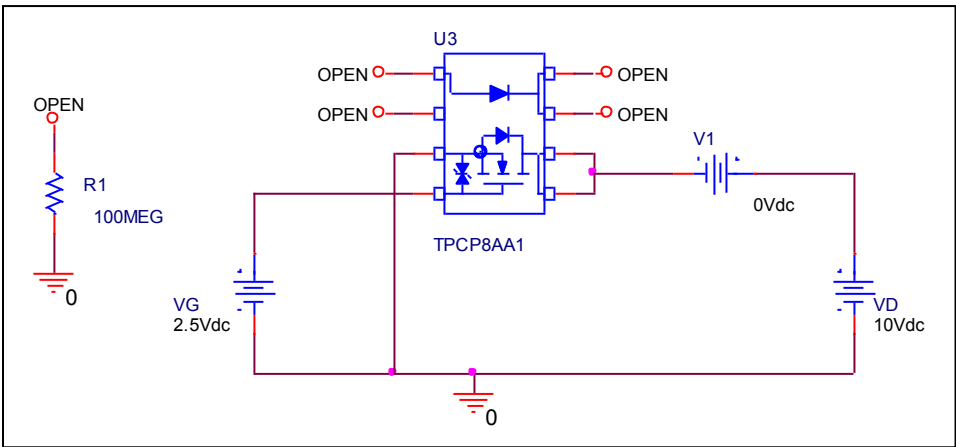
I_D (A)	V_{GS} (V)		Error (%)
	Measurement	Simulation	
0.001	1.03	1.0303	0.029126
0.002	1.065	1.0728	0.732394
0.005	1.114	1.1293	1.373429
0.010	1.148	1.1781	2.621951
0.020	1.188	1.2144	2.222222
0.050	1.244	1.2537	0.779743
0.10	1.29	1.2905	0.03876
0.20	1.35	1.3427	-0.54074
0.50	1.454	1.4473	-0.4608
1.000	1.56	1.5669	0.442308
2.000	1.73	1.739	0.520231

Id-Rds(on) Characteristic

Circuit Simulation result



Evaluation circuit

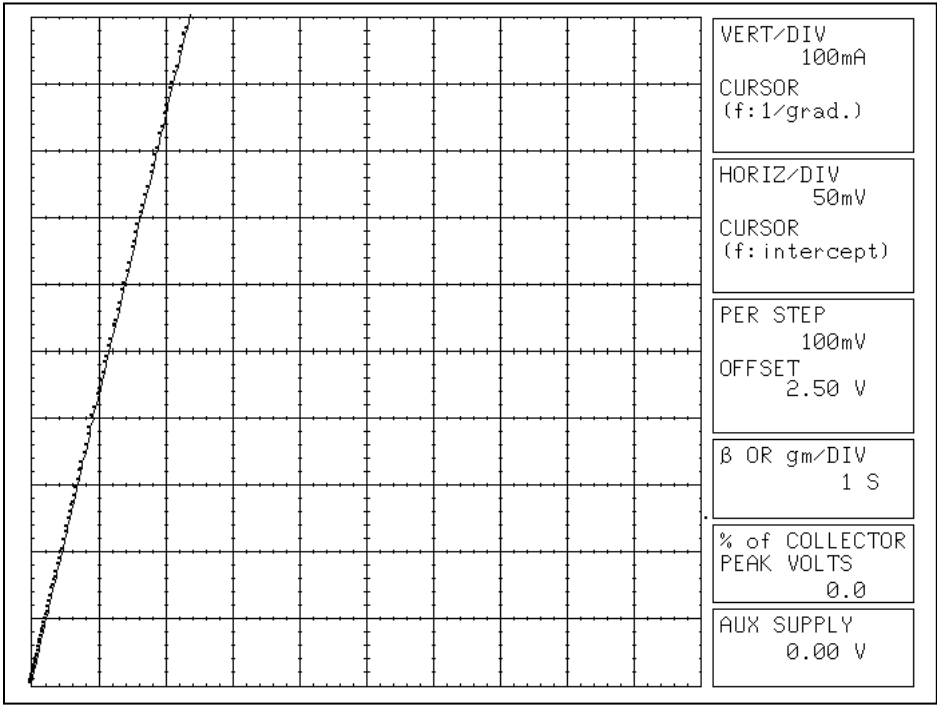


Simulation Result

$I_D=1.5A, V_{GS}=2.5V$	Measurement		Simulation		Error (%)
$R_{DS(on)}$	119.0625	mΩ	119.0625	mΩ	0.00

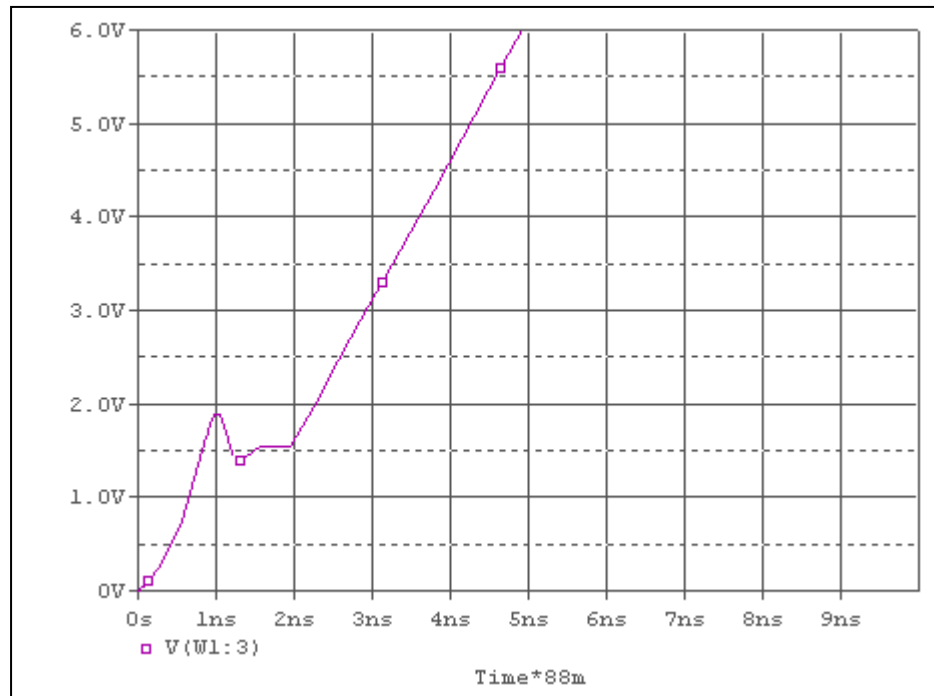
Id-Rds(on) Characteristic

Reference

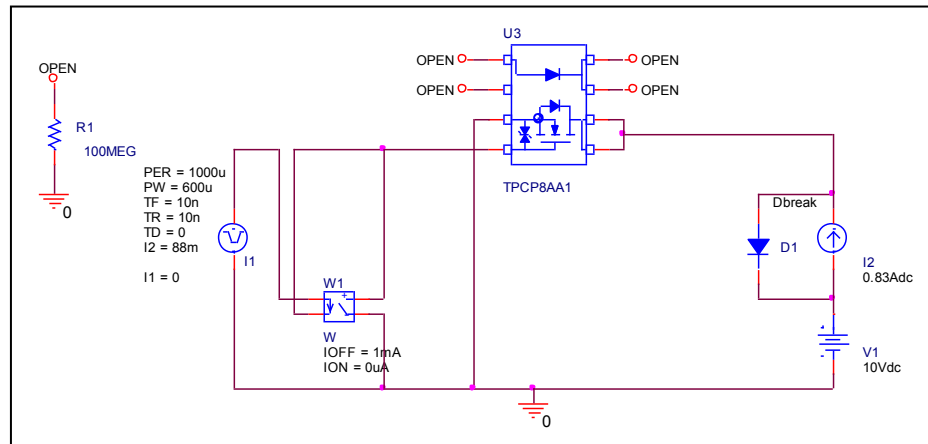


Gate Charge Characteristic

Circuit Simulation result



Evaluation circuit

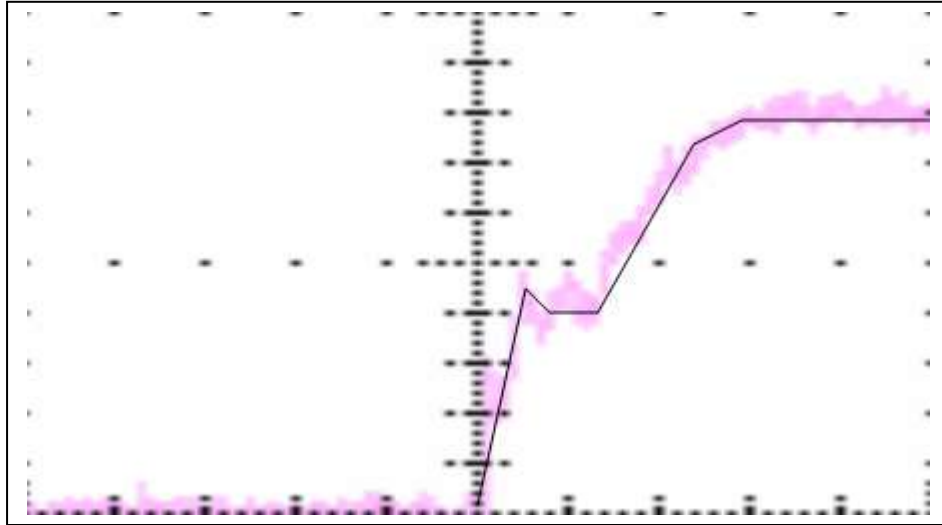


Simulation Result

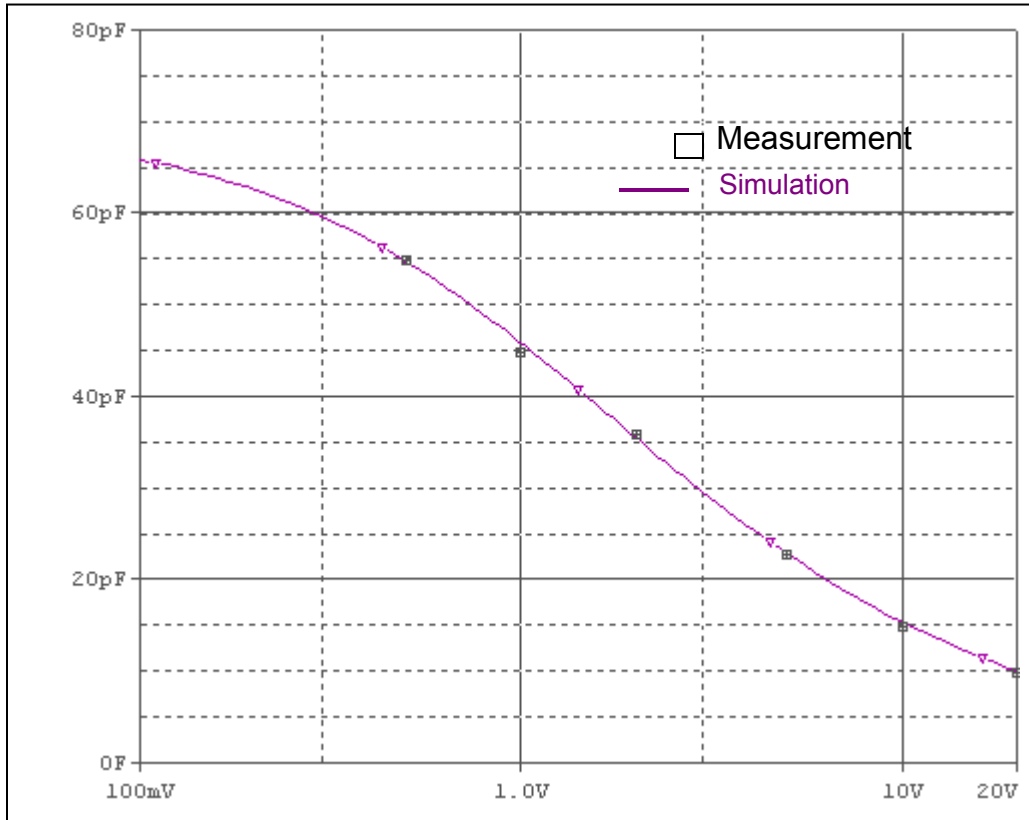
$V_{DD}=10V, I_D=0.83A$ $V_{GS}=6V$	Measurement		Simulation		Error (%)
Qgs	0.83	nC	0.83037	nC	0.044578
Qgd	1.13	nC	1.1294	nC	-0.0531
Qg	4.92	nC	4.918	nC	-0.04065

Gate Charge Characteristic

Reference



Capacitance Characteristic

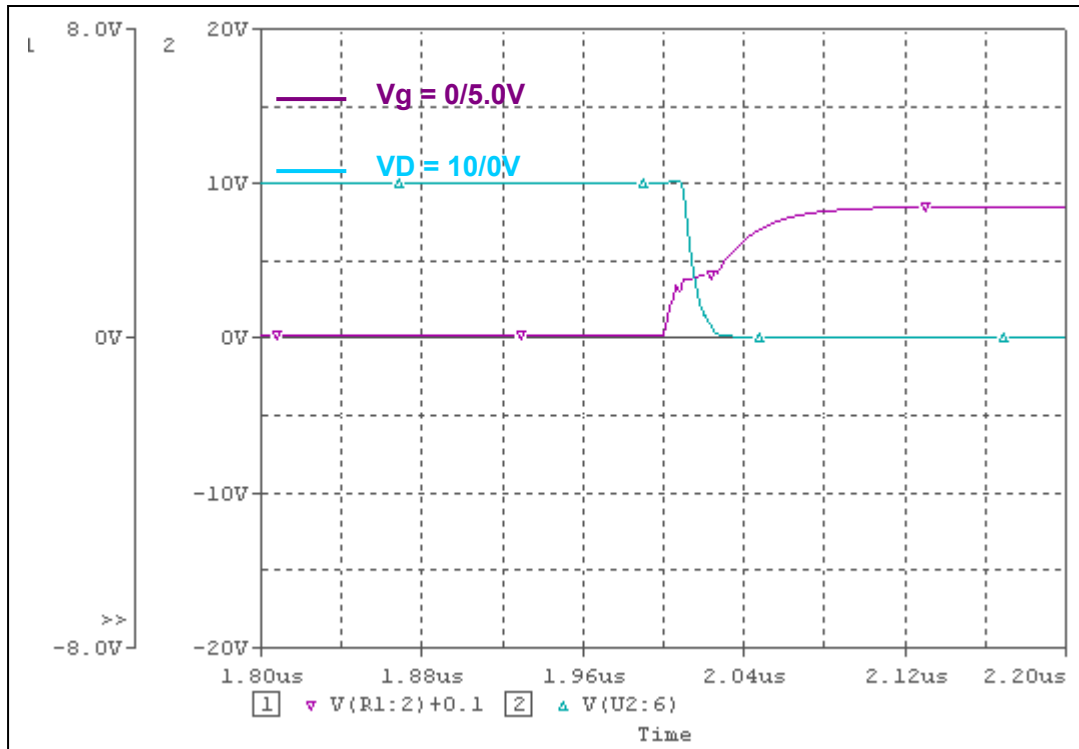


Simulation Result

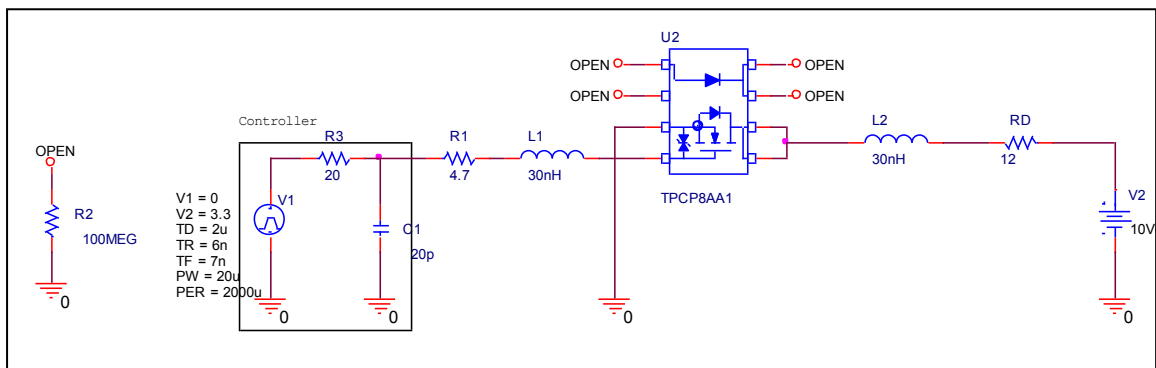
V _{DS} (V)	C _{bd} (pF)		Error(%)
	Measurement	Simulation	
0.5	55	54.65	-0.636
1.0	45	45.70	1.556
2.0	36	35.50	-1.388
5.0	23	22.93	-0.304
10.0	15	15.53	3.533
20.0	10	10.00	0.000

Switching Time Characteristic

Circuit Simulation result



Evaluation circuit

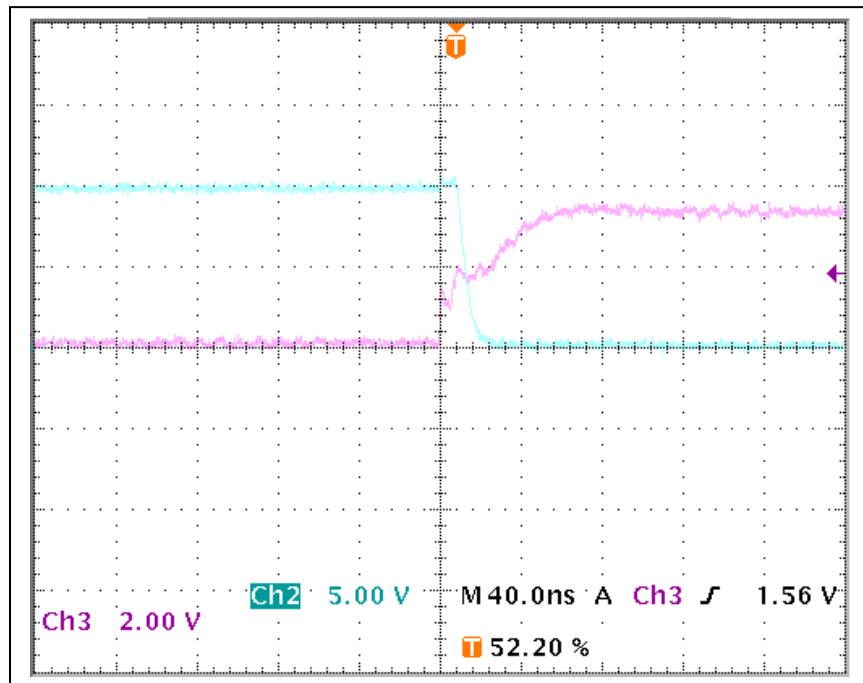


Simulation Result

$I_D = 1.5 A, V_{DD} = 10V$ $V_{GS} = 0/5V$	Measurement		Simulation		Error(%)
t_{on}	7.5	ns	7.5055	ns	0.0733

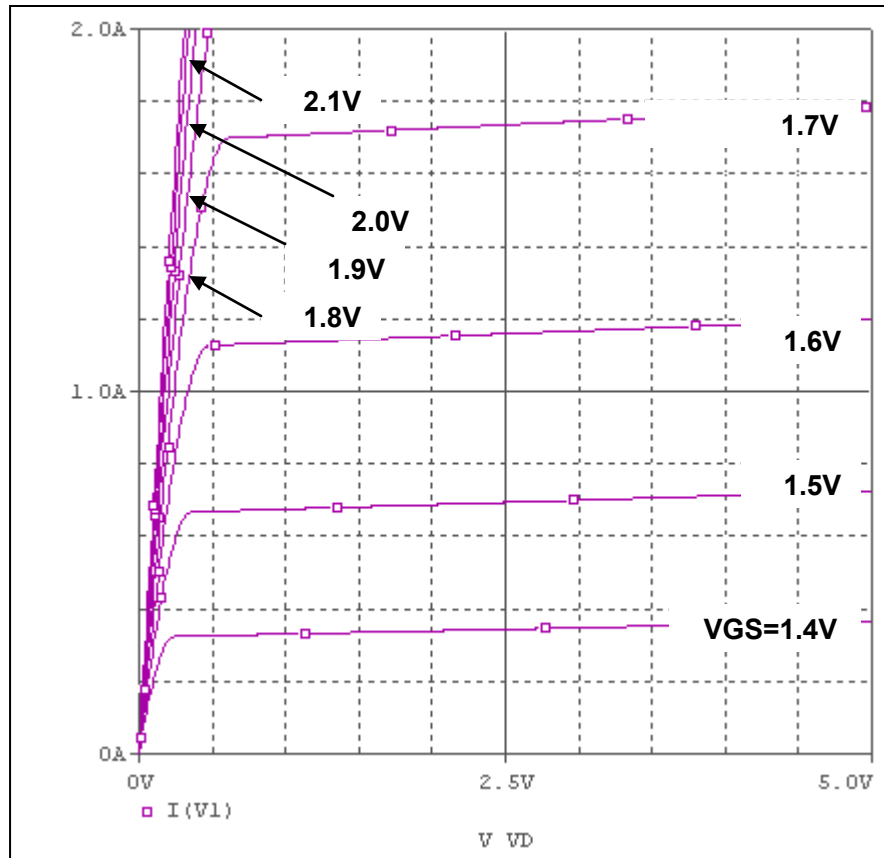
Switching Time Characteristic

Reference

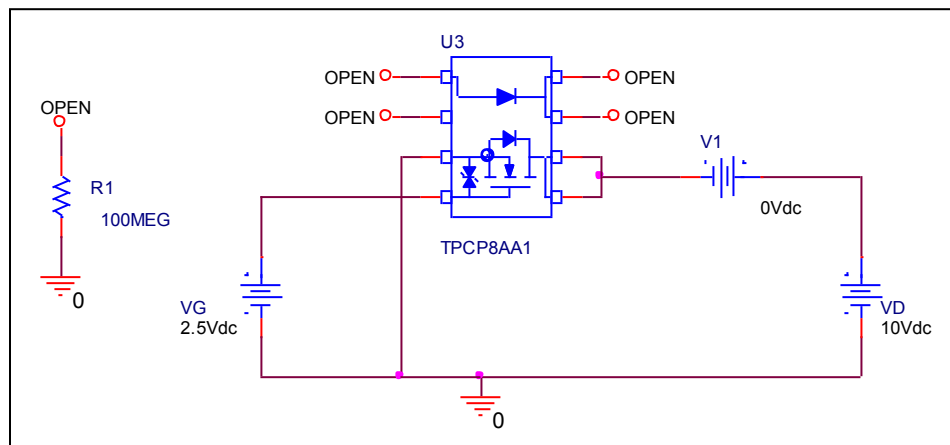


Output Characteristic

Circuit Simulation result

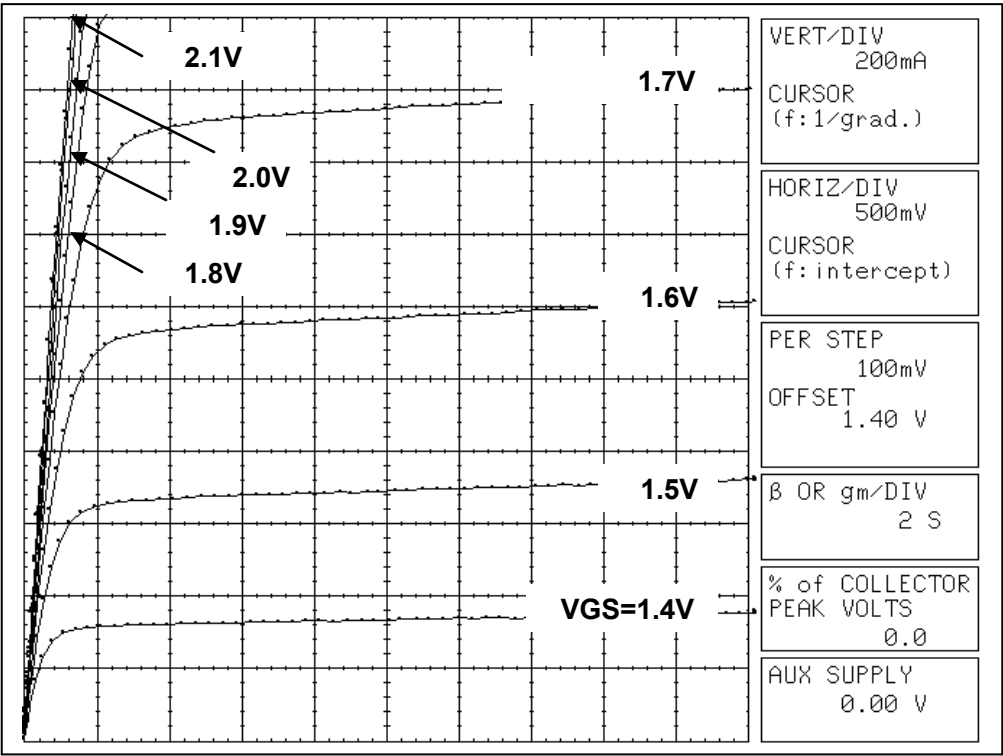


Evaluation circuit



Output Characteristics

Reference

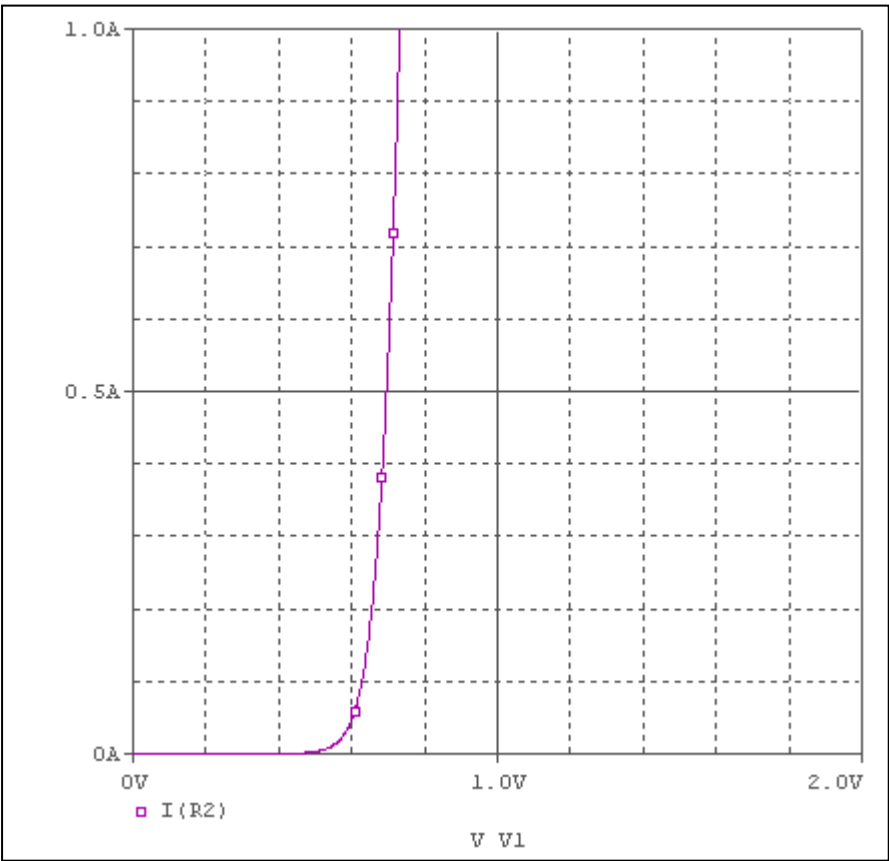


Body Diode Model

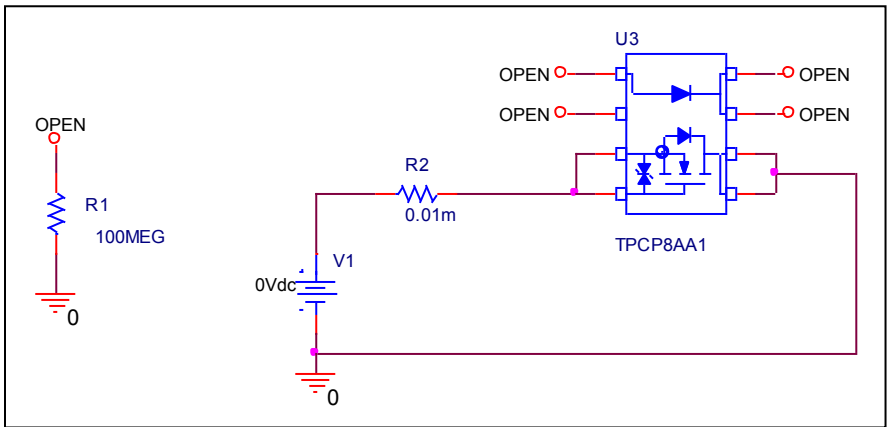
Pspice model parameter	Model description
IS	Saturation Current
N	Emission Coefficient
RS	Series Resistance
IKF	High-injection Knee Current
CJO	Zero-bias Junction Capacitance
M	Junction Grading Coefficient
VJ	Junction Potential
ISR	Recombination Current Saturation Value
BV	Reverse Breakdown Voltage(a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

Forward Current Characteristic

Circuit Simulation Result

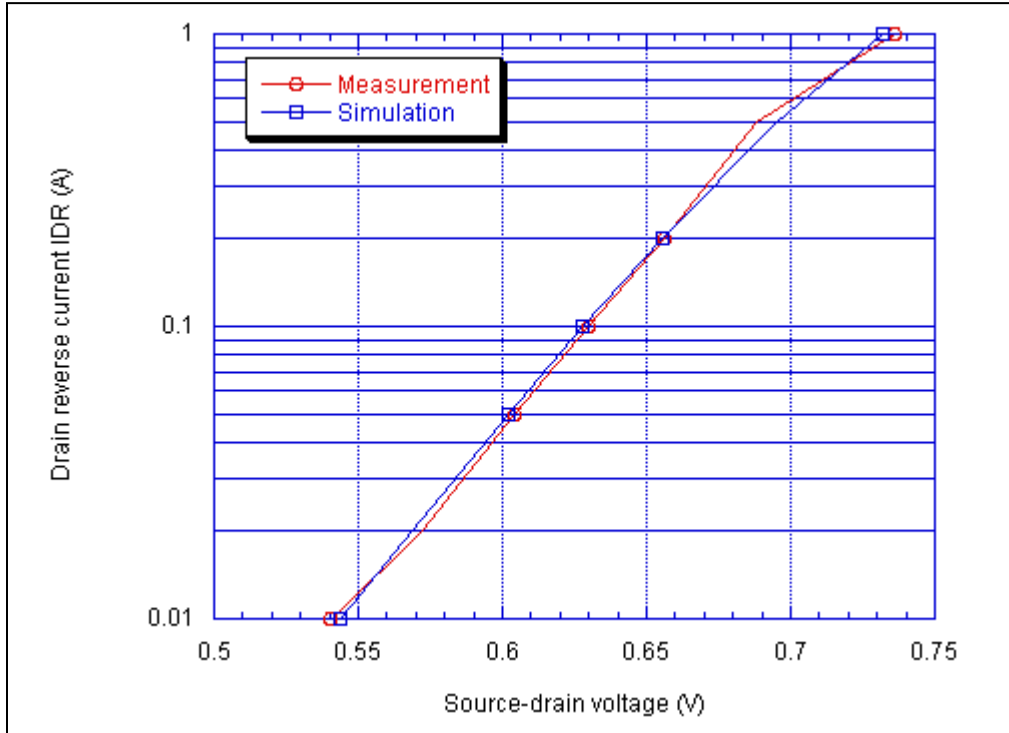


Evaluation Circuit



Comparison Graph

Circuit Simulation Result

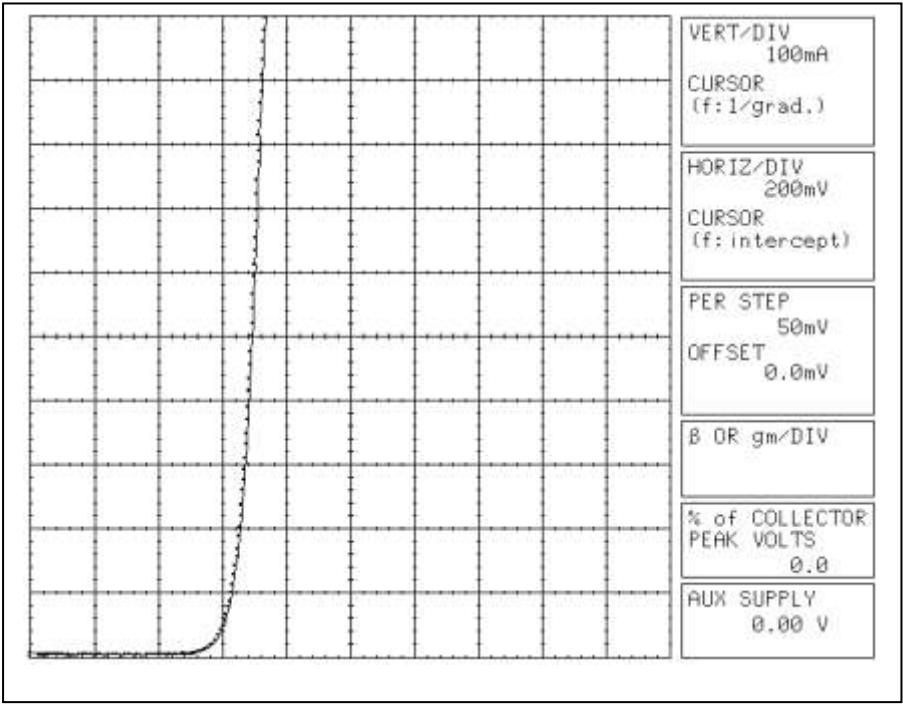


Simulation Result

Ifwd(A)	Vfwd(V) Measurement	Vfwd(V) Simulation	%Error
0.01	0.54	0.544	0.740741
0.02	0.572	0.569	-0.52448
0.05	0.604	0.602	-0.33113
0.1	0.63	0.628	-0.31746
0.2	0.656	0.6553	-0.10671
0.5	0.688	0.695	1.017442
1	0.736	0.732	-0.54348

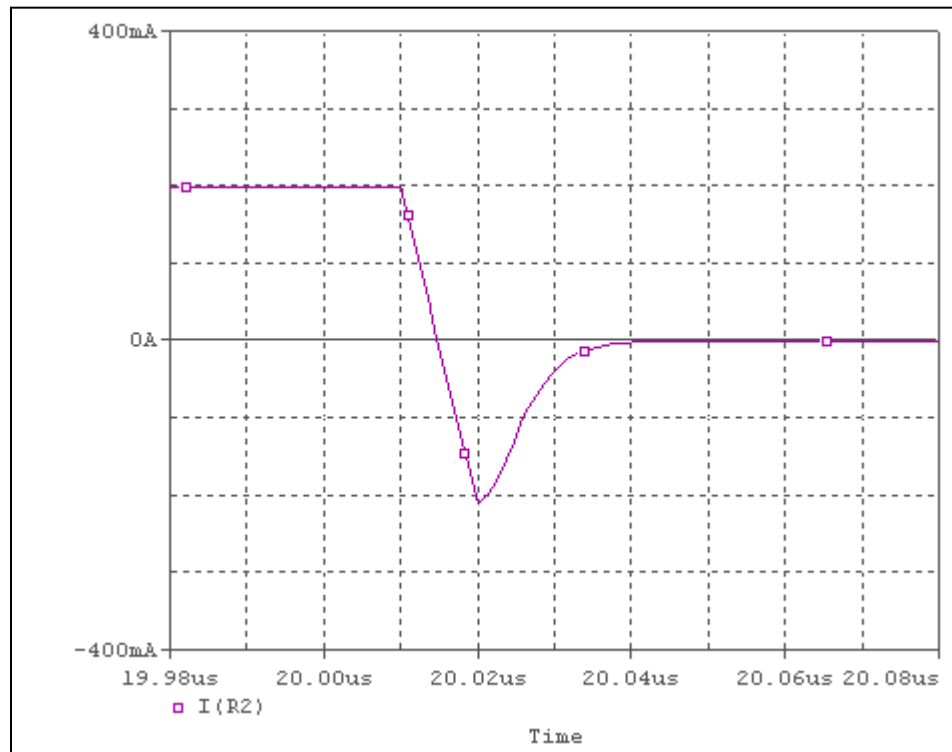
Forward Current Characteristic

Reference

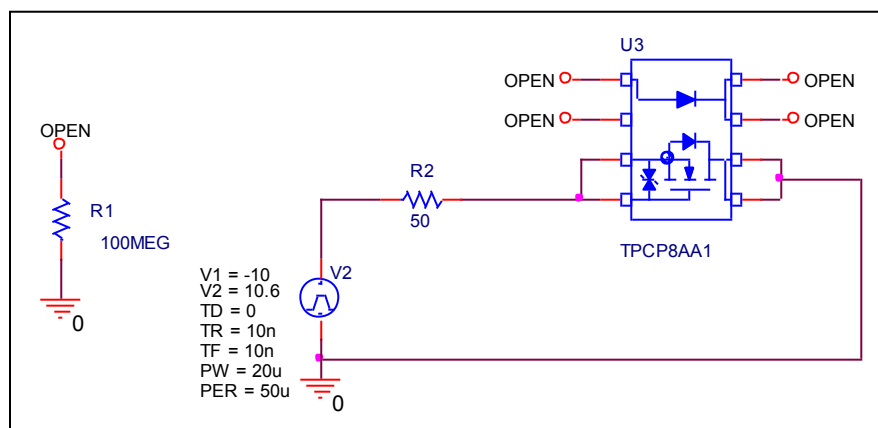


Reverse Recovery Characteristic

Circuit Simulation Result



Evaluation Circuit

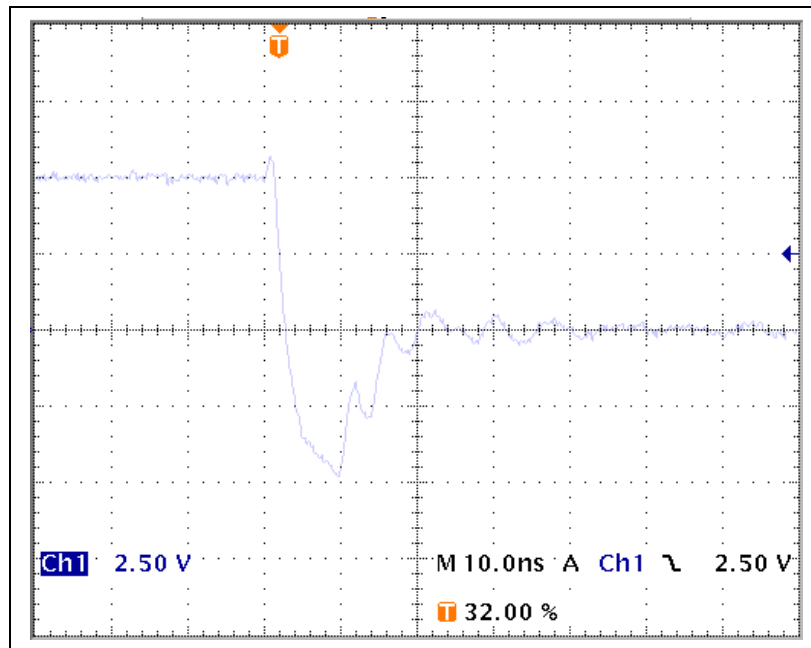


Compare Measurement vs. Simulation

	Measurement		Simulation		Error (%)
trr=trj+trb	17	ns	17.075	ns	0.44

Reverse Recovery Characteristic

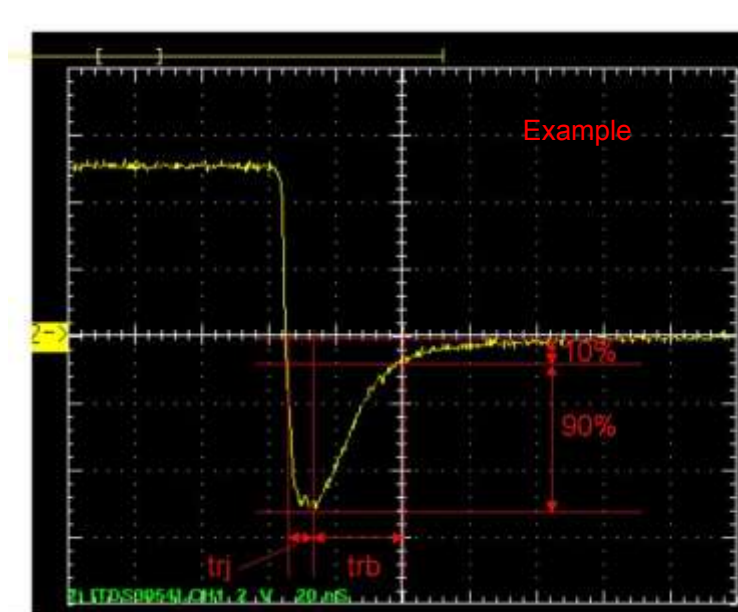
Reference



$Trj=6.6(ns)$

$Trb=10.4(ns)$

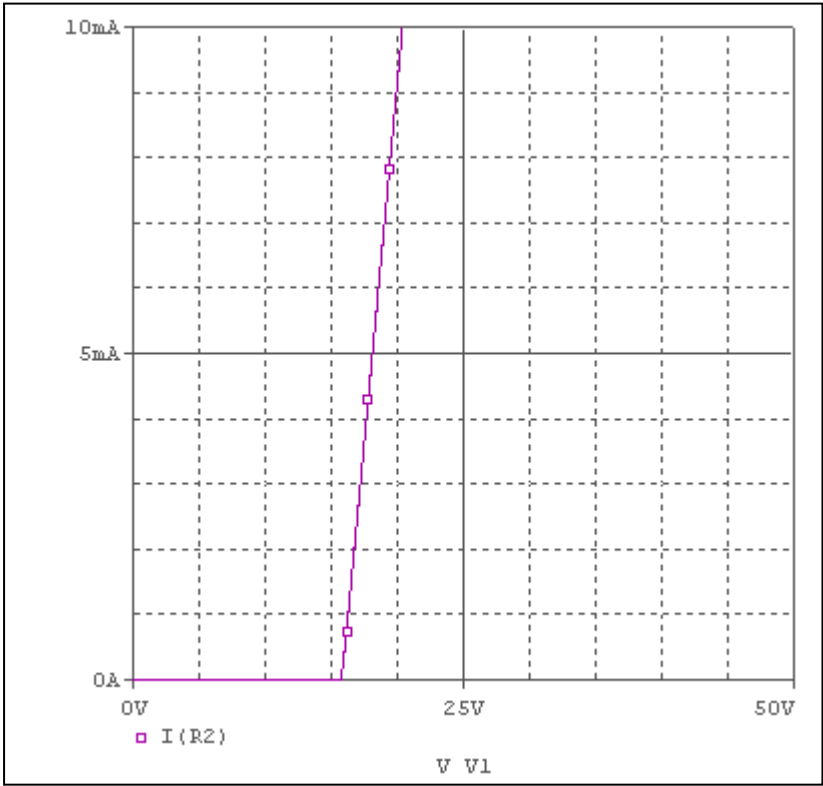
Conditions: $I_{fwd}=I_{rev}=0.2(A)$, $R_I=50$



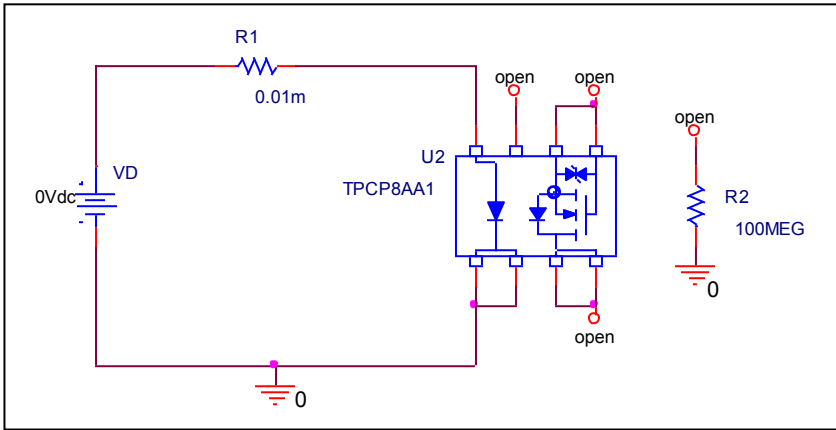
Relation between trj and trb

Zener Voltage Characteristic

Circuit Simulation Result

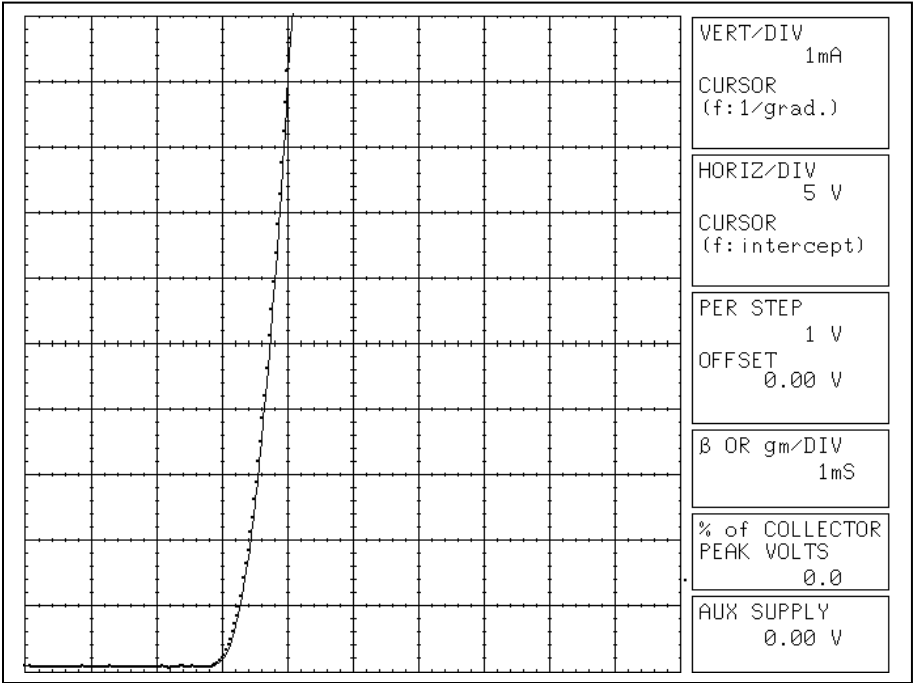


Evaluation Circuit



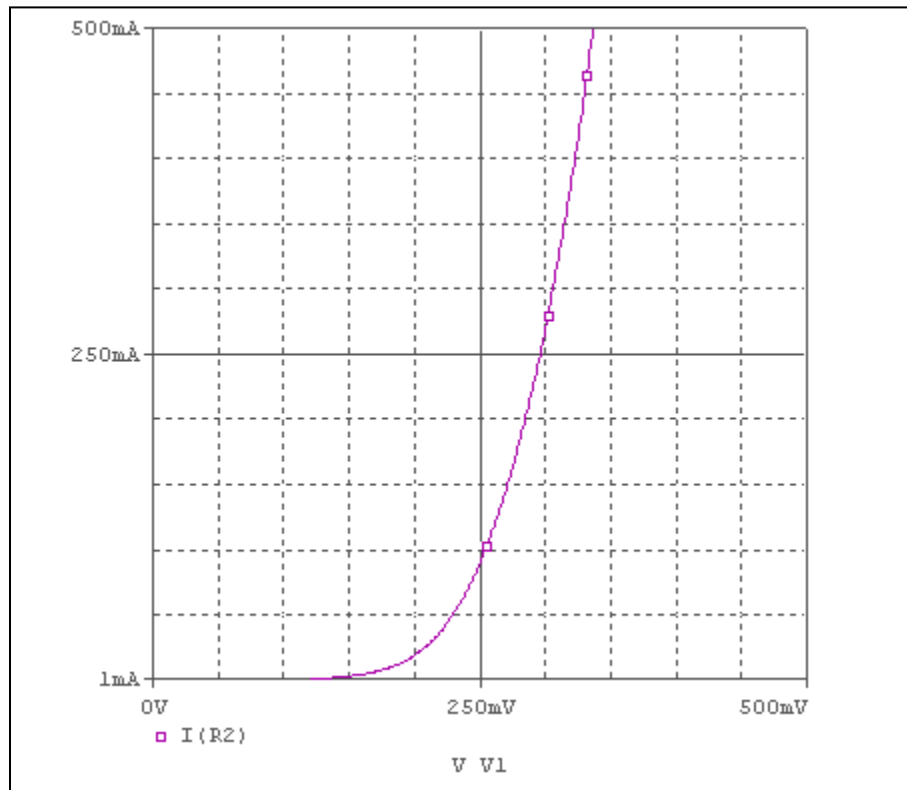
Zener Voltage Characteristic

Reference

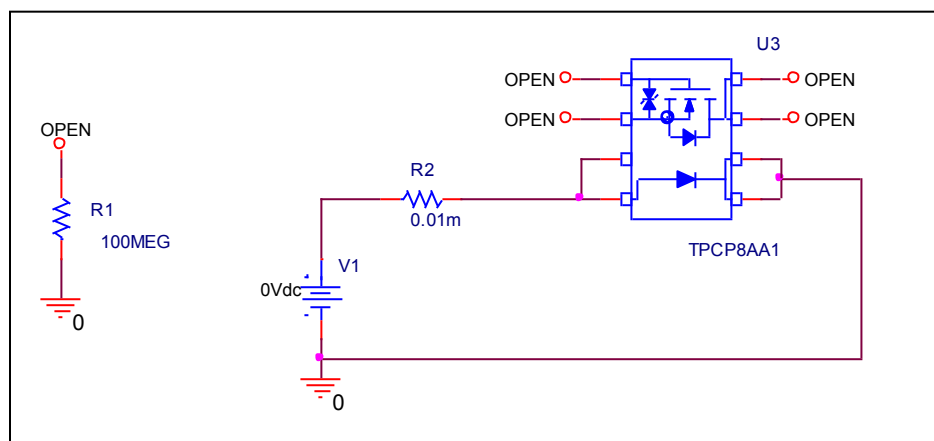


Forward Current Characteristic

Circuit Simulation Result

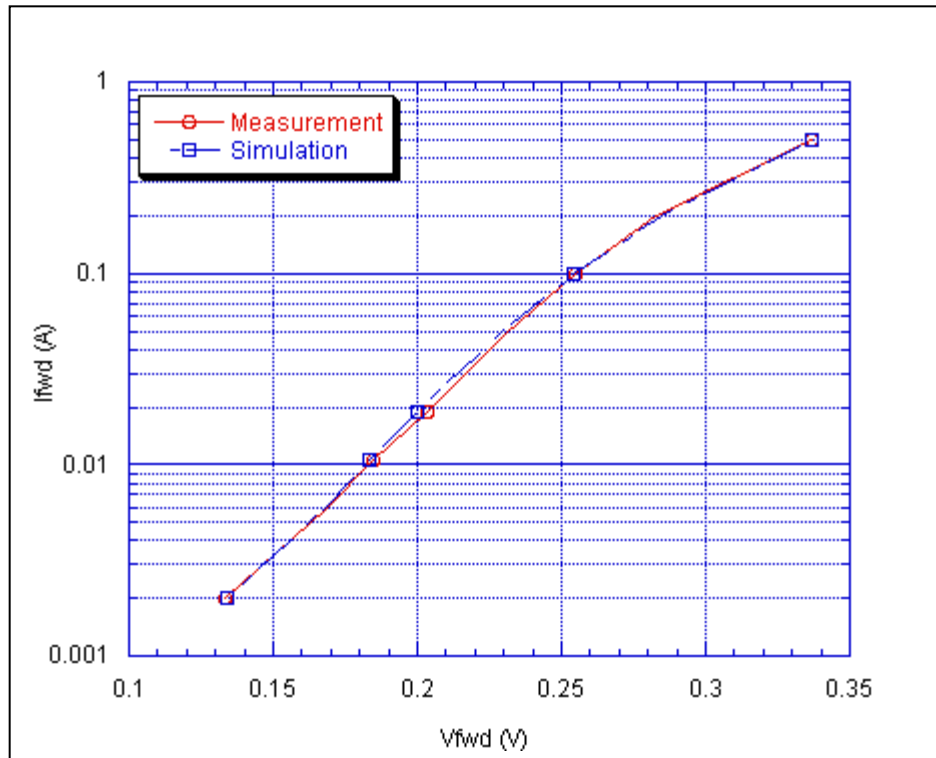


Evaluation Circuit



Comparison Graph

Circuit Simulation Result

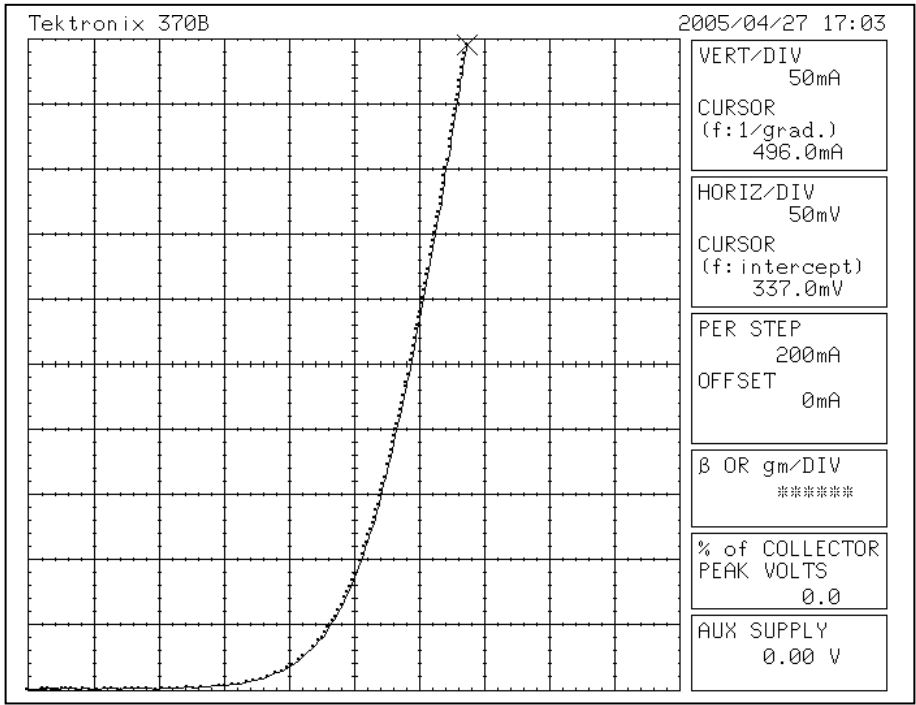


Simulation Result

Ifwd (A)	Vfwd (V)		%Error
	Measurement	Simulation	
0.002	0.1335	0.1339	0.2996
0.006	0.1685	0.1683	- 0.1186
0.0105	0.1845	0.1834	- 0.5962
0.019	0.2035	0.2000	- 1.7199
0.0485	0.2305	0.2284	- 0.9110
0.0995	0.255	0.2540	- 0.3921
0.2	0.2825	0.2846	0.7433
0.5	0.337	0.3366	- 0.1186

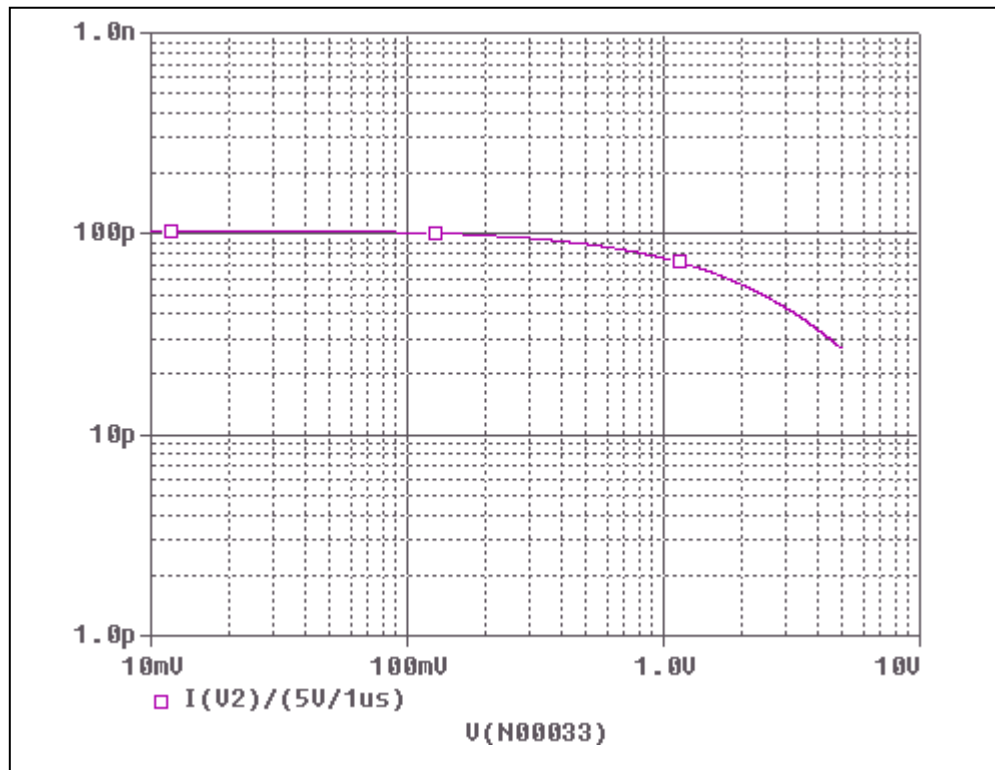
Forward Current Characteristic

Reference

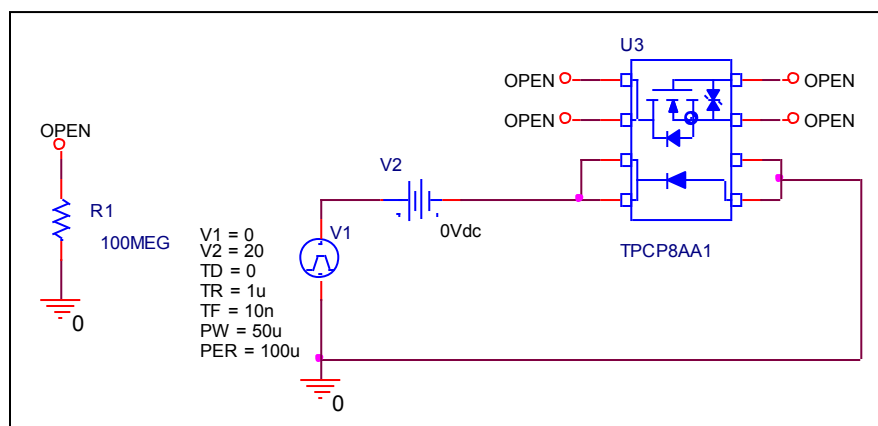


Junction Capacitance Characteristic

Circuit Simulation Result

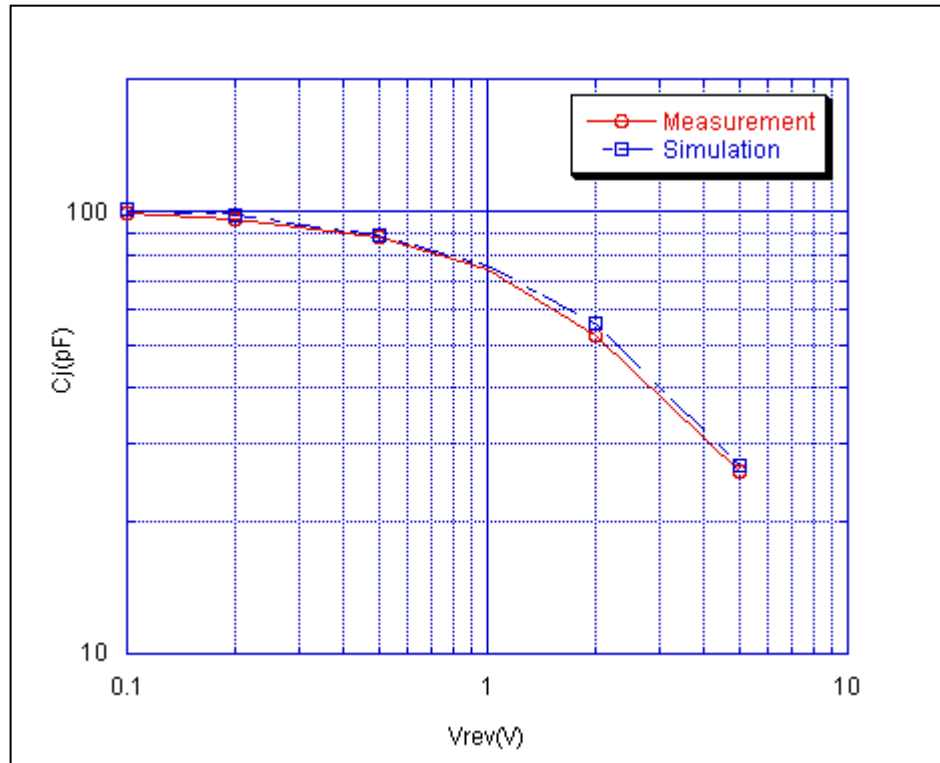


Evaluation Circuit



Comparison Graph

Circuit Simulation Result

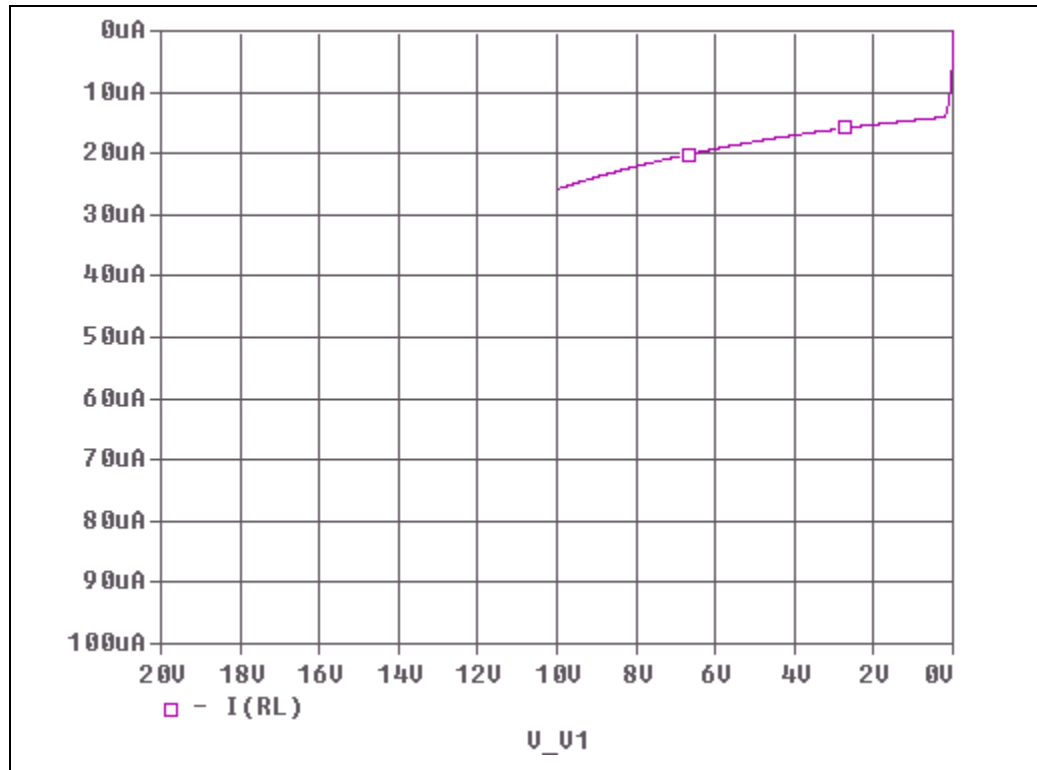


Simulation Result

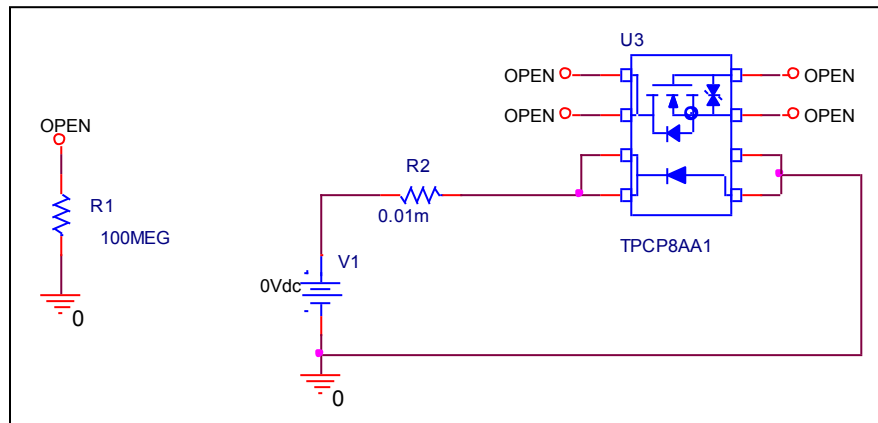
Vrev(V)	Cj(pF)		%Error
	Measurement	Simulation	
0	103.62	103.620	0.0000
0.1	99.524	101.764	2.2507
0.2	96.701	98.391	1.7476
0.5	87.313	89.032	1.9687
1	74.087	75.671	2.1380
2	52.873	56.228	2.5627
5	25.806	26.561	1.7441

Reverse Characteristic

Circuit Simulation Result

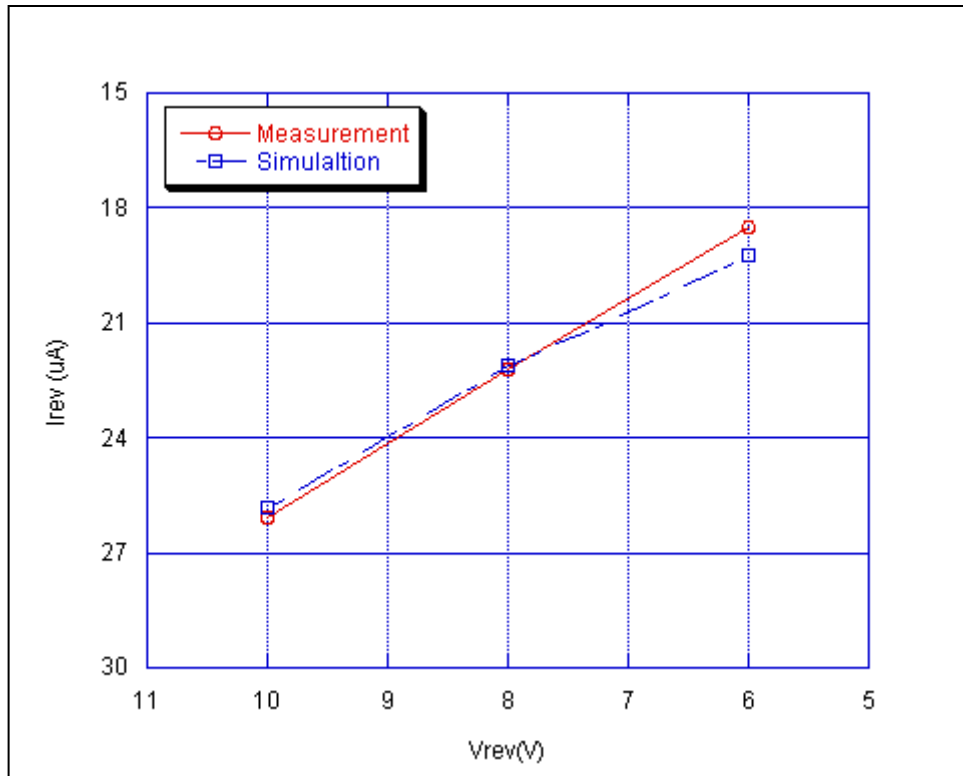


Evaluation Circuit



Comparison Graph

Circuit Simulation Result



Simulation Result

Vrev(V)	Irev (uA)		%Error
	Measurement	Simulation	
6	18.5	19.23	3.94594
8	22.2	22.09	- 0.49549
10	26.1	25.81	- 1.11111

Reverse Current Characteristic

Reference

