Device Modeling Report

COMPONENTS: Power MOSFET (Professional)
PART NUMBER: TPCP8402
MANUFACTURER: TOSHIBA
Body Diode (Professional) / ESD Protection Diode
REMARK: Silicon N&P Channel MOS Type

Bee Technologies Inc.

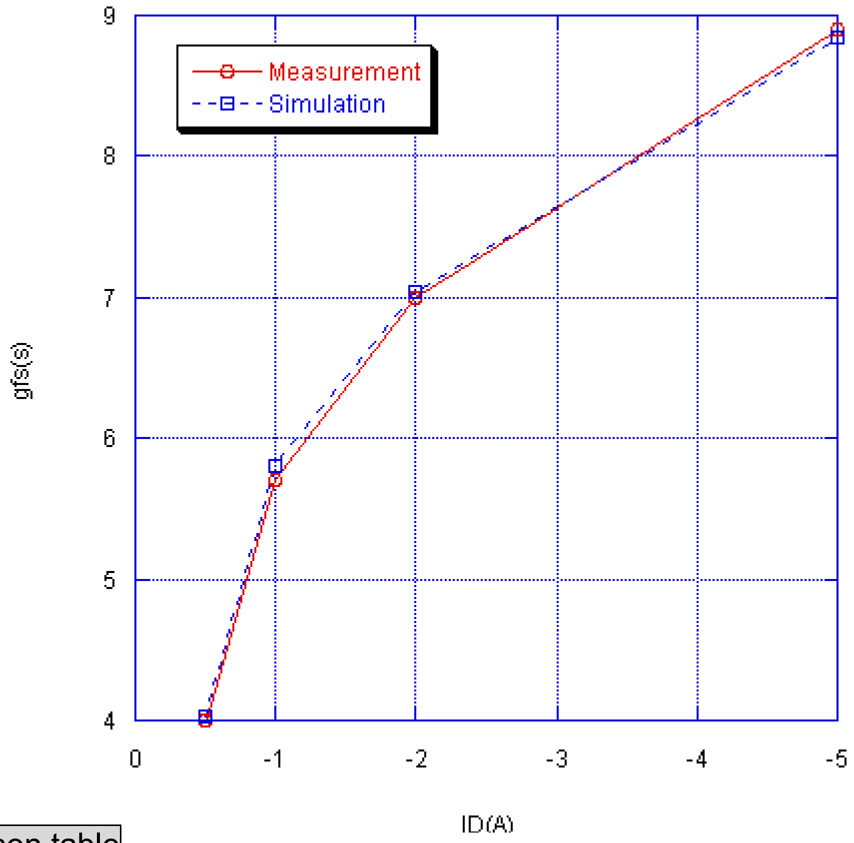
MOSFET MODEL

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

P-Channel Model

Transconductance Characteristic

Circuit Simulation Result

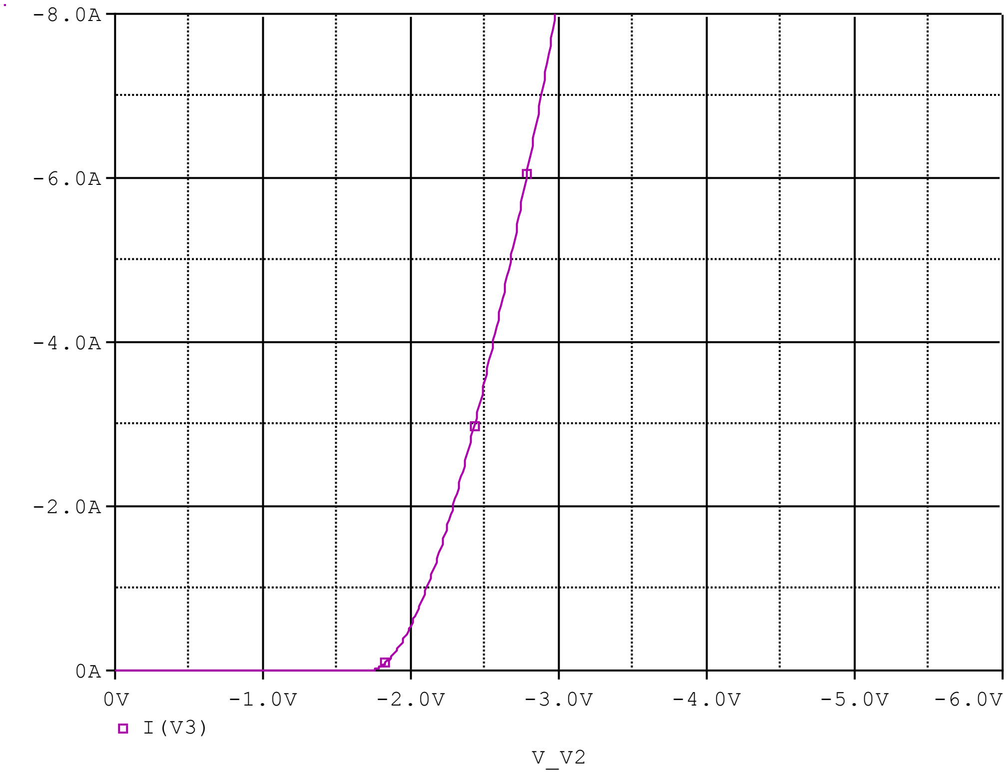


Comparison table

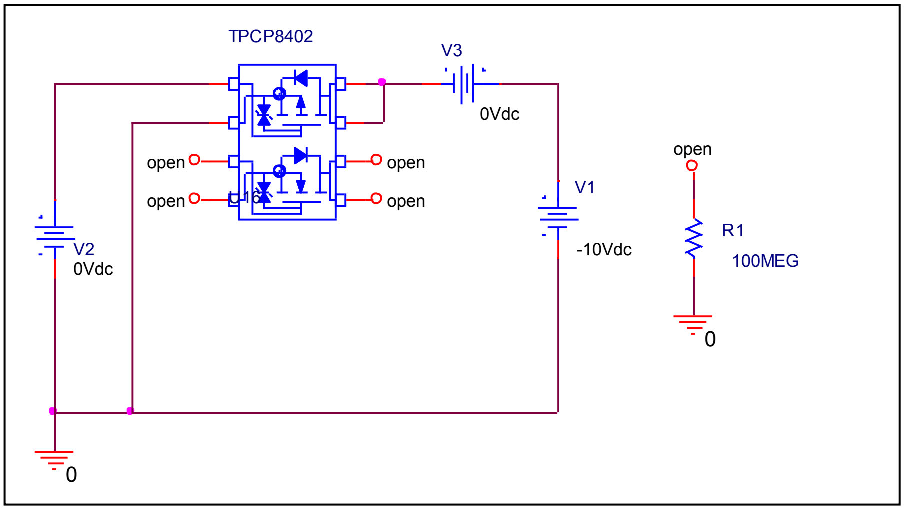
Id(A)	gfs		Error(%)
	Measurement	Simulation	
-0.500	4.000	4.025	0.625
-1.000	5.700	5.800	1.754
-2.000	7.000	7.036	0.514
-5.000	8.900	8.846	-0.606

Vgs-Id Characteristic

Circuit Simulation result

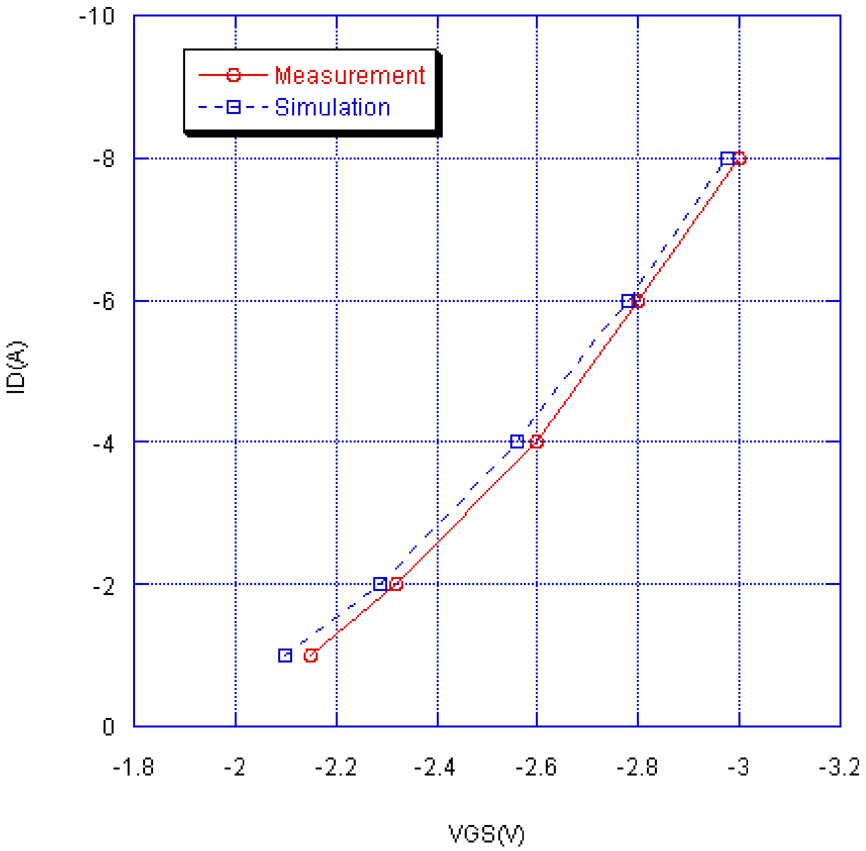


Evaluation circuit



Comparison Graph

Circuit Simulation Result

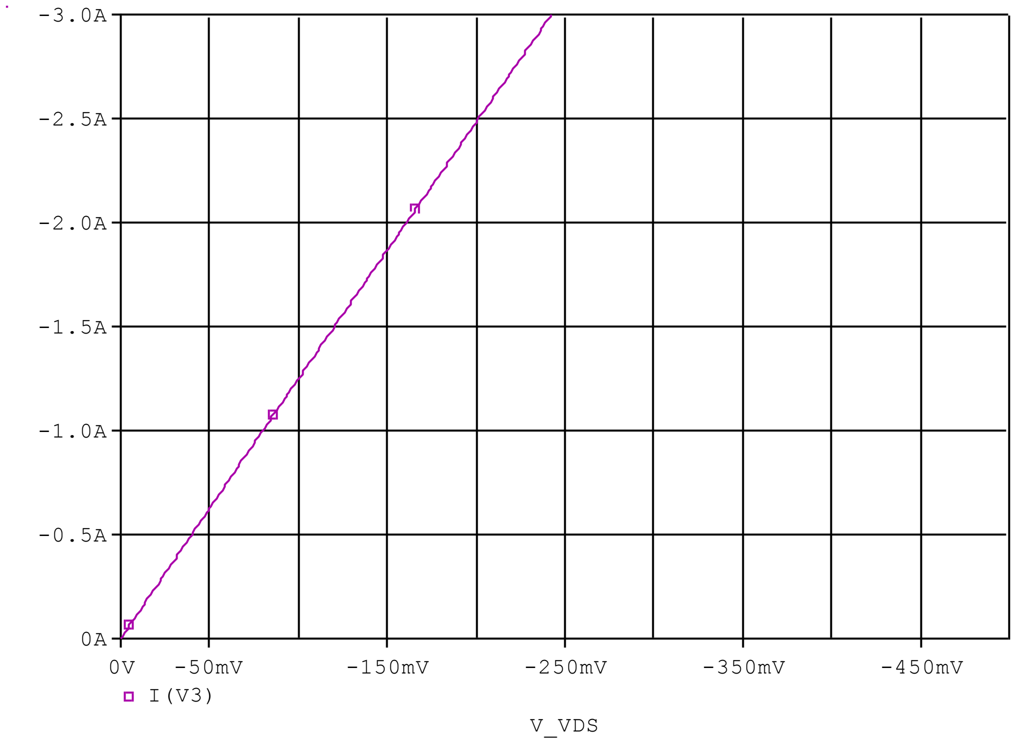


Simulation Result

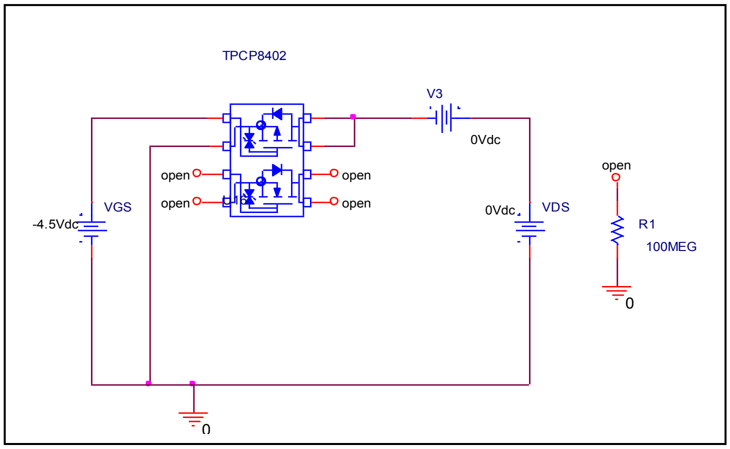
I_D(A)	V_{GS}(V)		Error (%)
	Measurement	Simulation	
-1.000	-2.150	-2.100	-2.325
-2.000	-2.320	-2.286	-1.465
-4.000	-2.600	-2.557	-1.653
-6.000	-2.800	-2.779	-0.750
-8.000	-3.000	-2.977	-0.767

Rds(on) Characteristic

Circuit Simulation result



Evaluation circuit

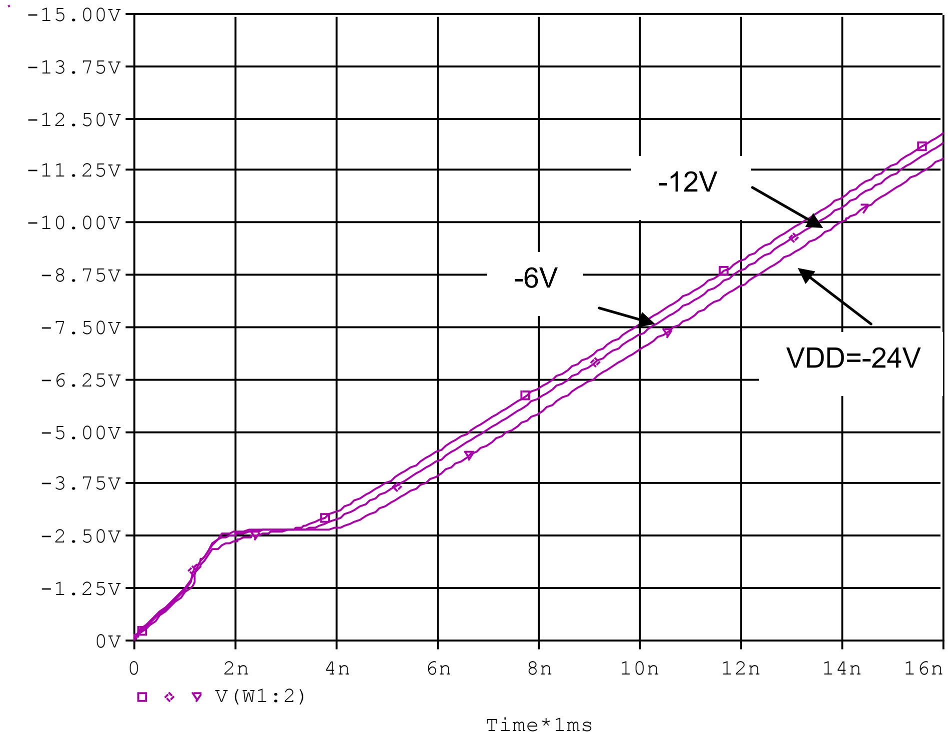


Simulation Result

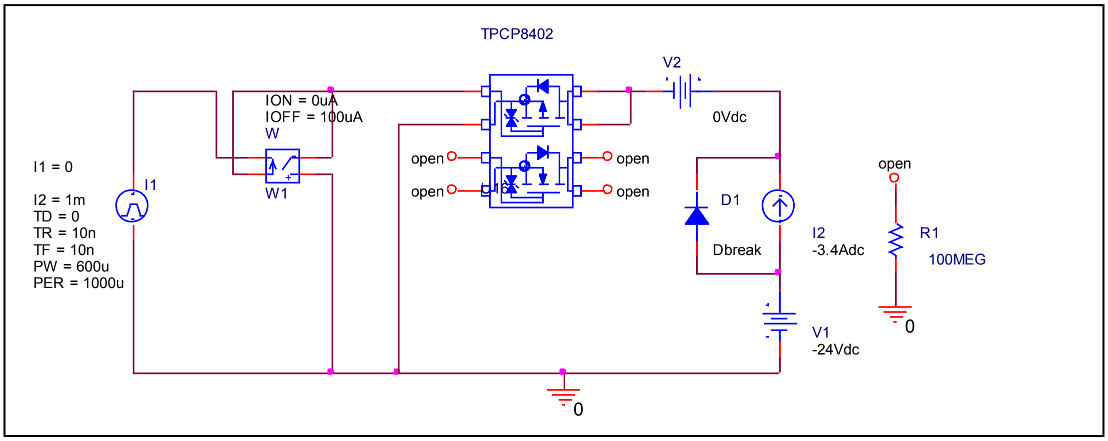
I_D=-1.7A, V_{GS}=-4.5V	Measurement		Simulation		Error (%)
R_{DS} (on)	80.000	mΩ	80.000	mΩ	0.000

Gate Charge Characteristic

Circuit Simulation result



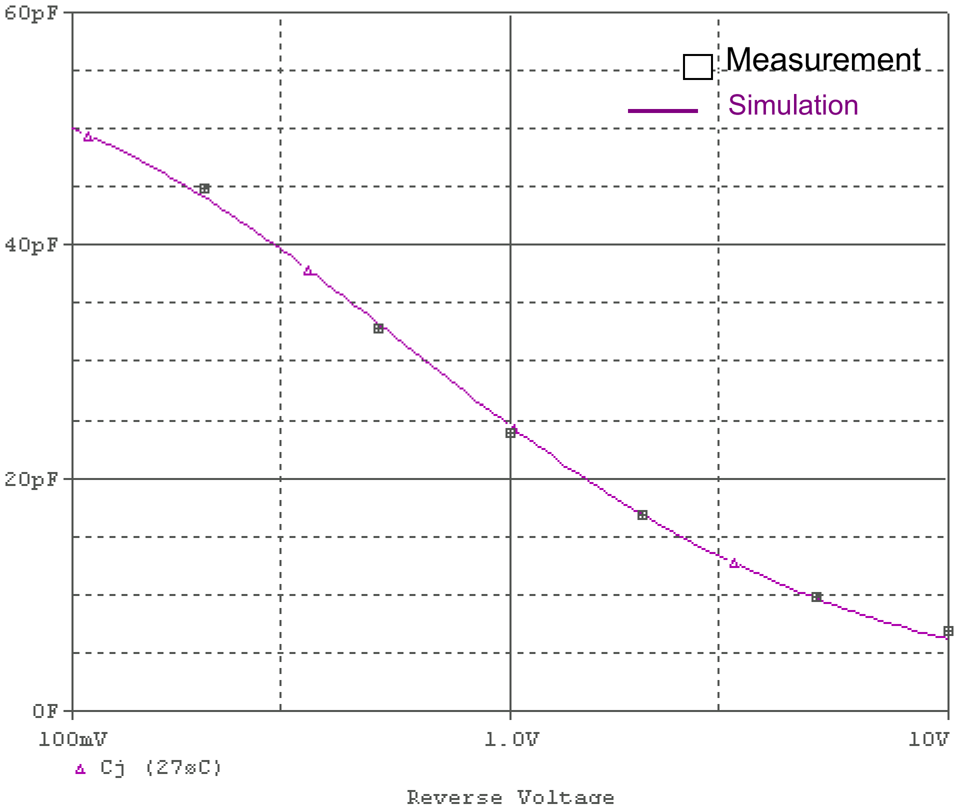
Evaluation circuit



Simulation Result

V_{DD}=-24V,I_D=-3.4A ,V_{GS}=-10V	Measurement		Simulation		Error (%)
Qgs	1.400	nC	1.393	nC	-0.500
Qgd	2.700	nC	2.712	nC	0.445
Qg	14.000	nC	14.000	nC	0.000

Capacitance Characteristic

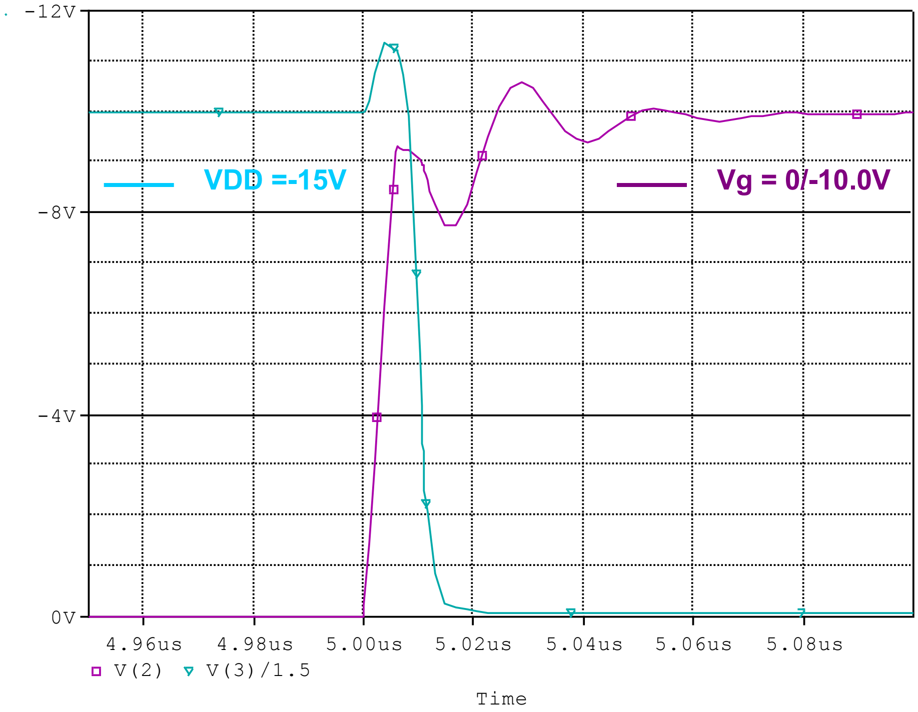


Simulation Result

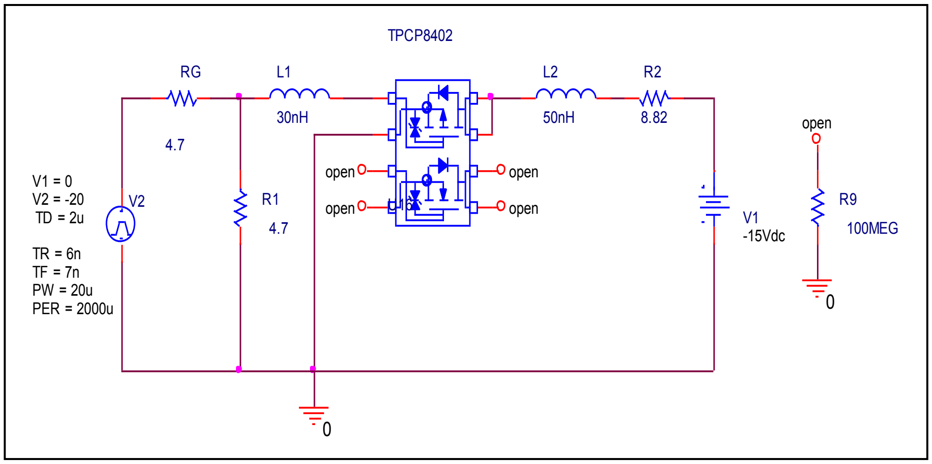
V_{DS}(V)	Cbd(pF)		Error(%)
	Measurement	Simulation	
0.200	45.000	44.300	-1.556
0.500	33.000	33.520	1.575
1.000	24.000	24.850	3.541
2.000	17.000	17.000	0.000
5.000	10.000	9.980	-0.200
10.000	7.000	6.870	-1.857

Switching Time Characteristic

Circuit Simulation result



Evaluation circuit

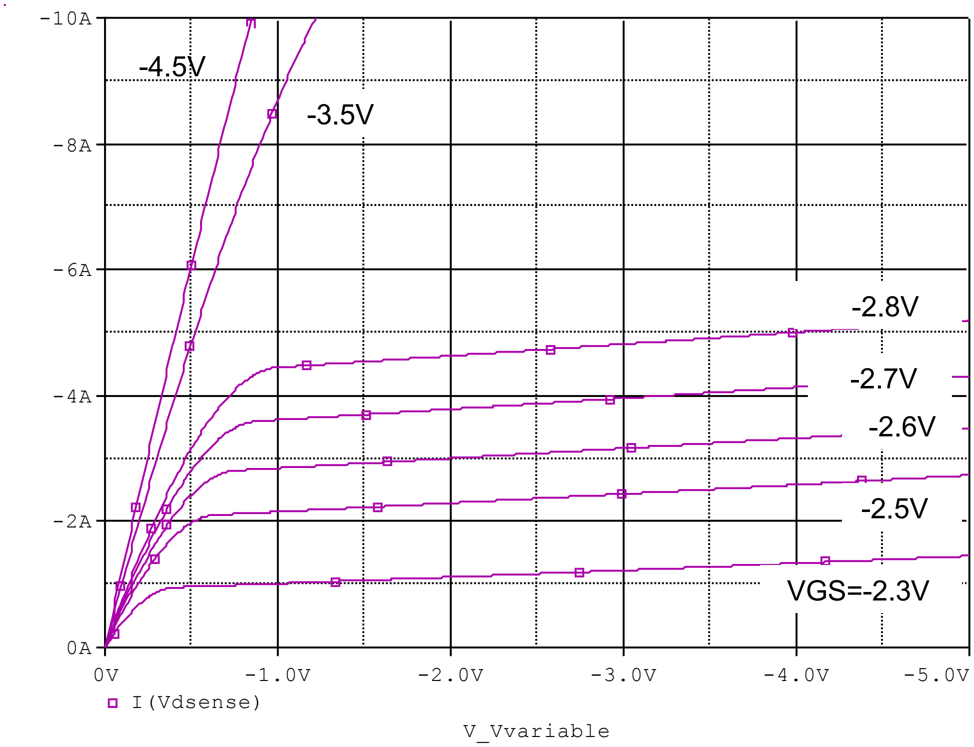


Simulation Result

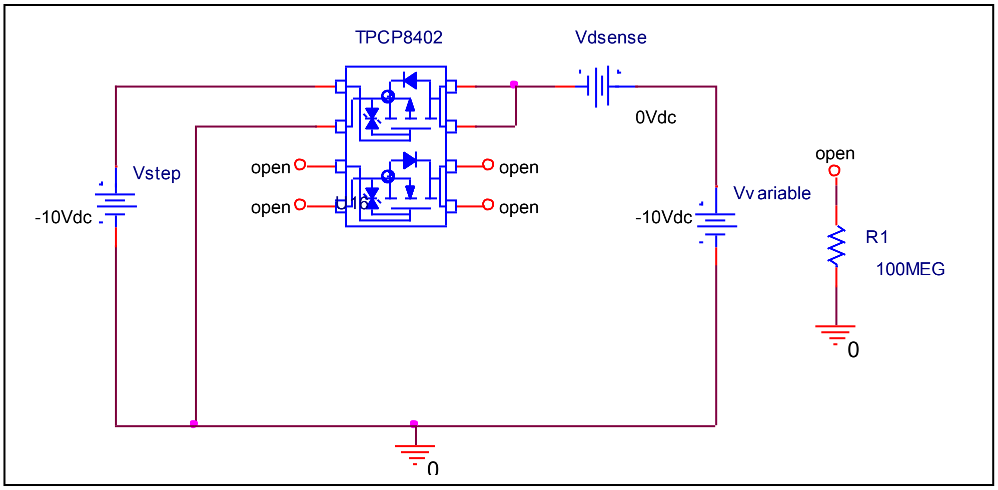
I_D=-3.4A, V_{DD}=-15V V_{GS}=0/10V	Measurement		Simulation		Error(%)
ton	12.000	ns	11.935	ns	-0.541

Output Characteristic

Circuit Simulation result

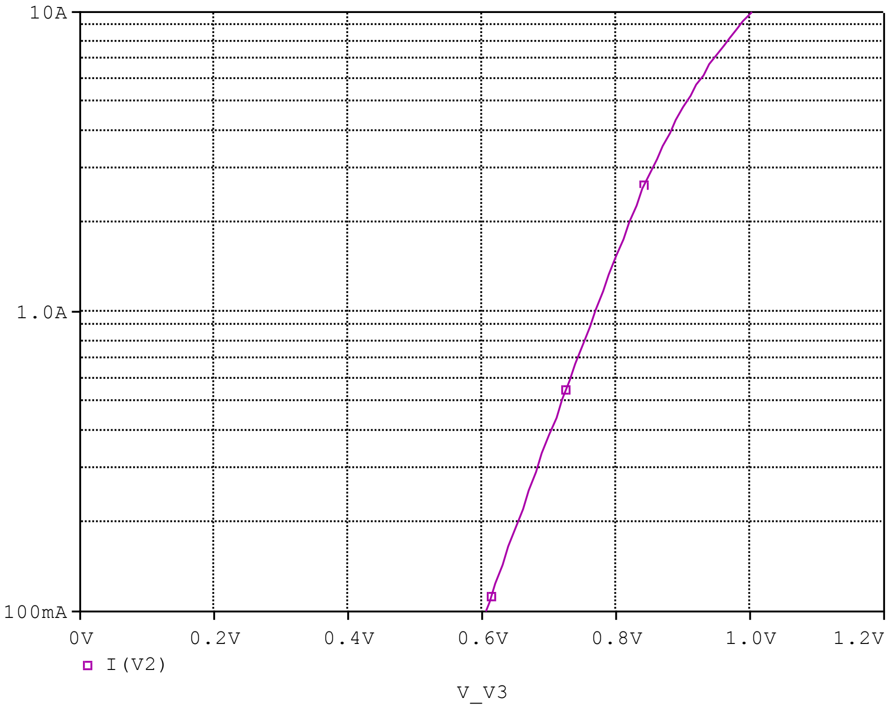


Evaluation circuit

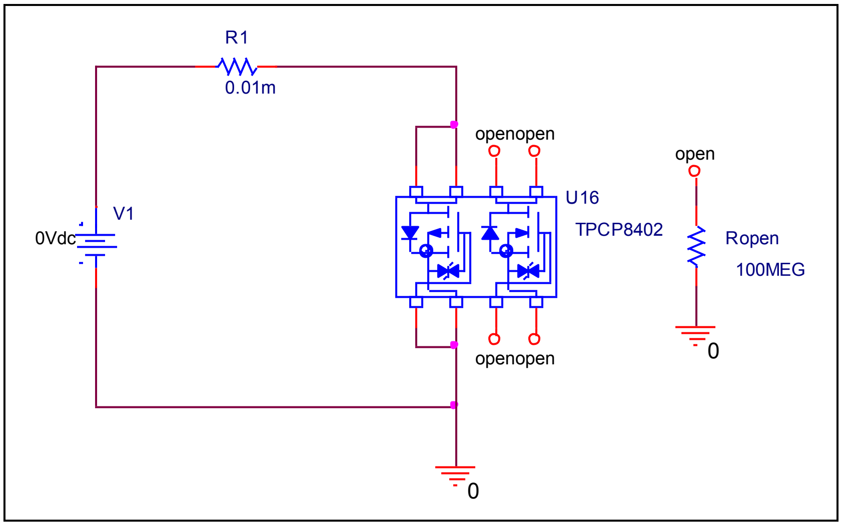


Forward Current Characteristic

Circuit Simulation Result

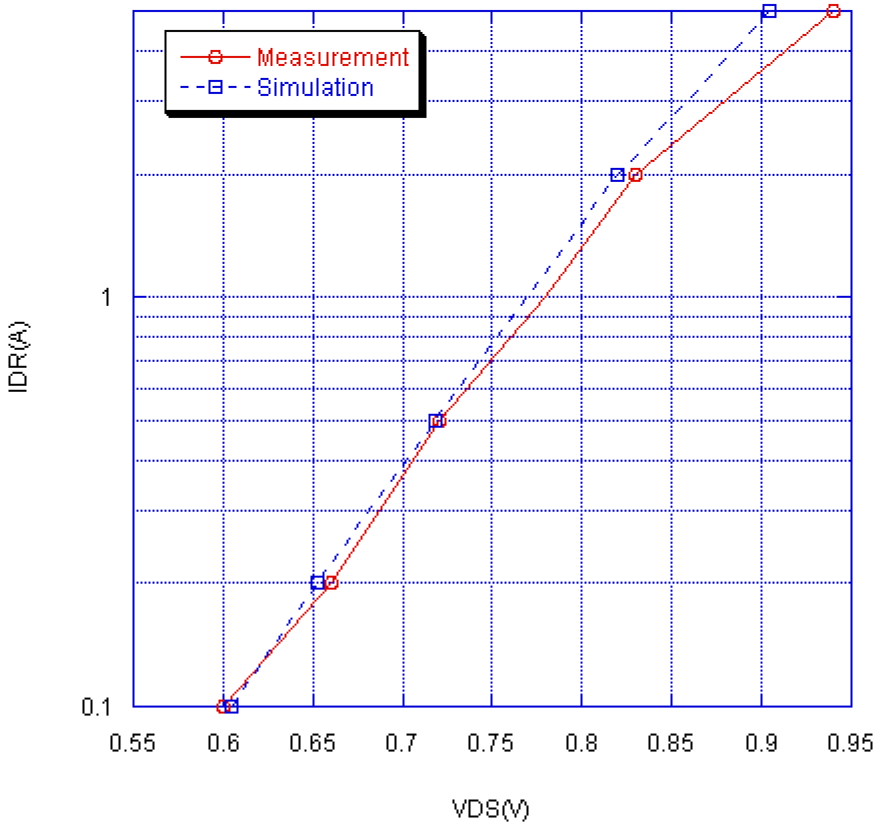


Evaluation Circuit



Comparison Graph

Circuit Simulation Result

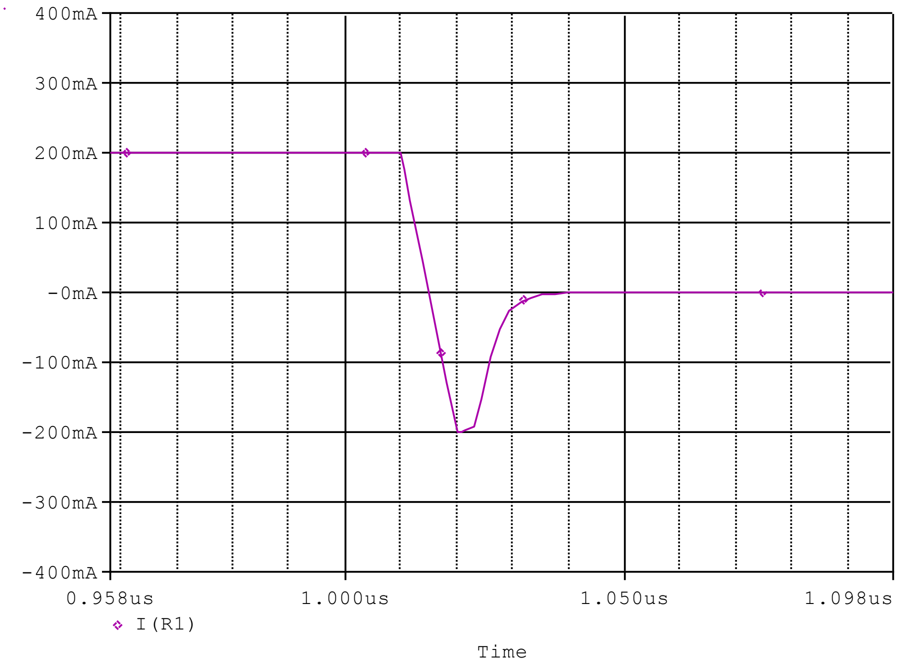


Simulation Result

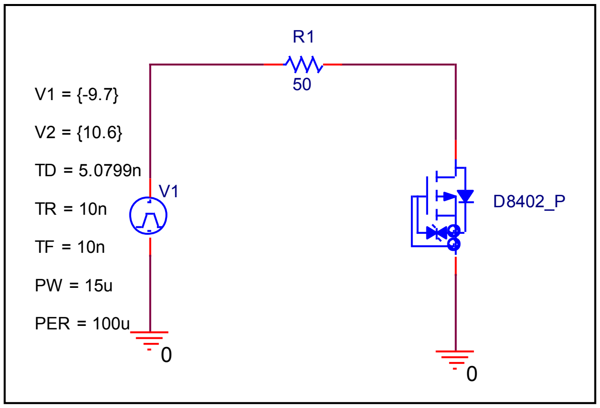
Ifwd(A)	Vfwd(V) Measurement	Vfwd(V) Simulation	%Error
0.100	0.600	0.605	0.833
0.200	0.660	0.653	-1.061
0.500	0.720	0.718	-0.278
1.000	0.780	0.769	-1.410
2.000	0.830	0.820	-1.205
5.000	0.940	0.904	-3.830

Reverse Recovery Characteristic

Circuit Simulation Result



Evaluation Circuit

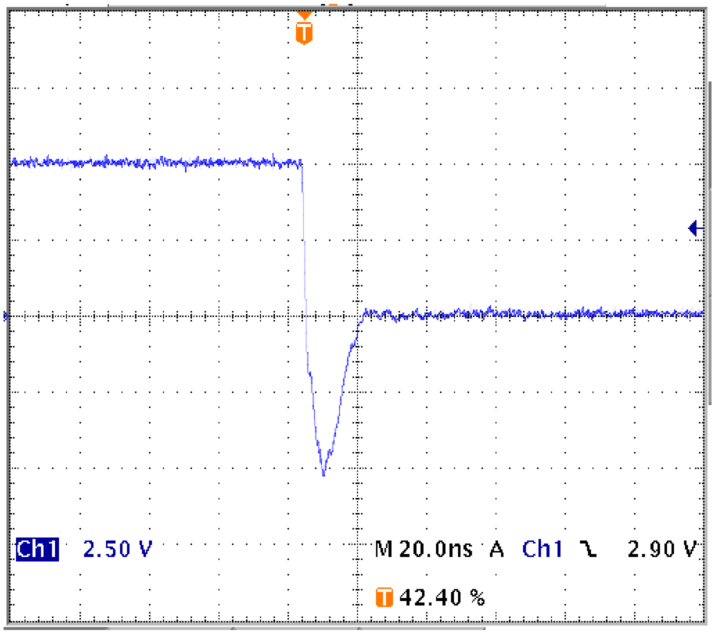


Compare Measurement vs. Simulation

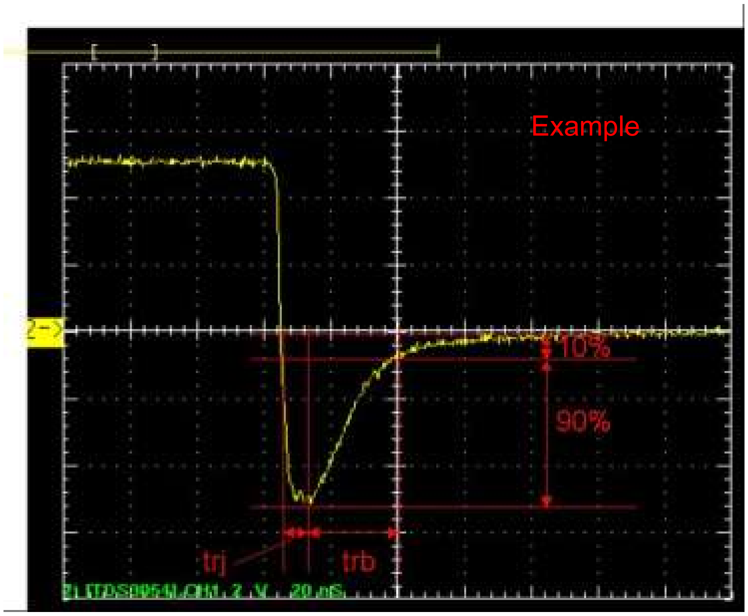
	Measurement		Simulation		Error (%)
trj	**5.200**	**ns**	**5.160**	**ns**	**-0.769**
trb	**10.400**	**ns**	**10.400**	**ns**	**0.000**
trr	**15.600**	**ns**	**5.240**	**ns**	**-2.307**

Reverse Recovery Characteristic

Reference



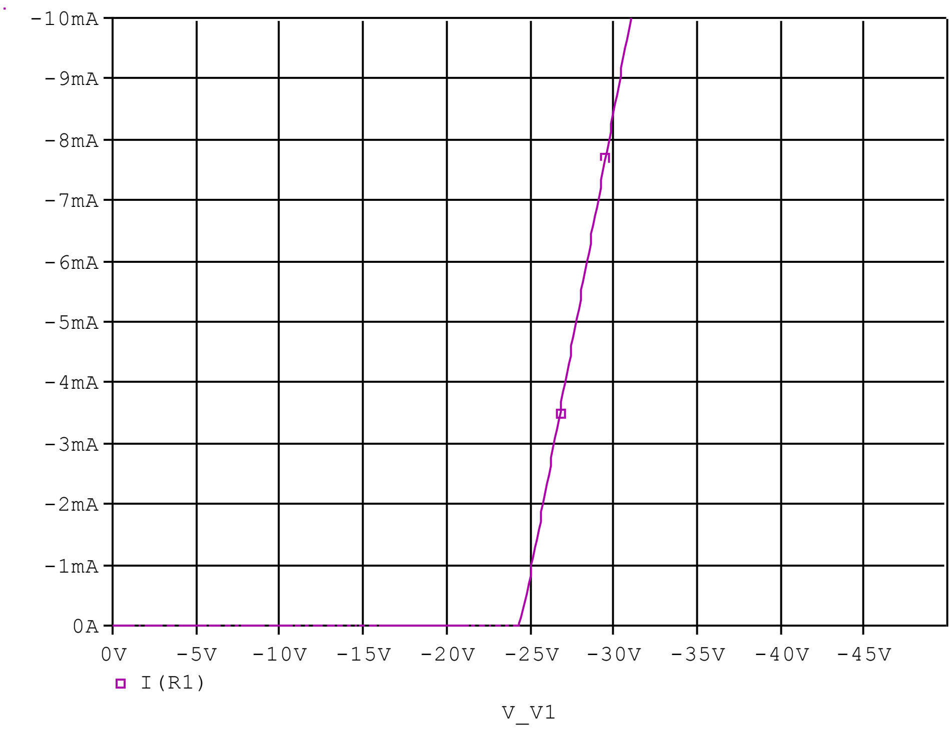
Trj=5.2(ns)
Trb=10.4(ns)
Conditions:Ifwd=Irev=0.2(A),Rl=50



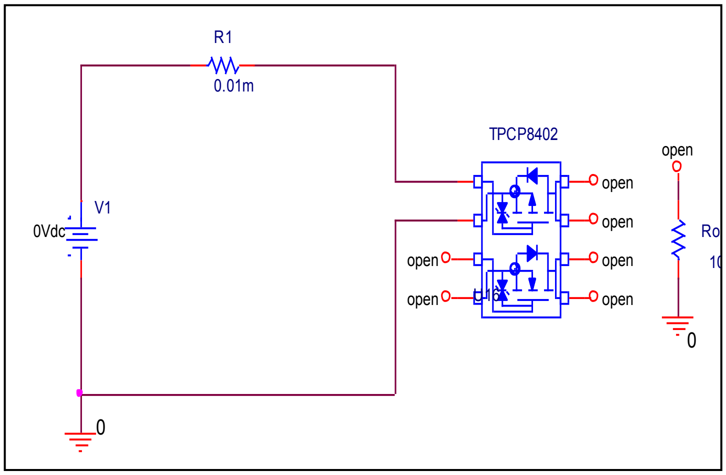
Relation between trj and trb

Zener Voltage Characteristic

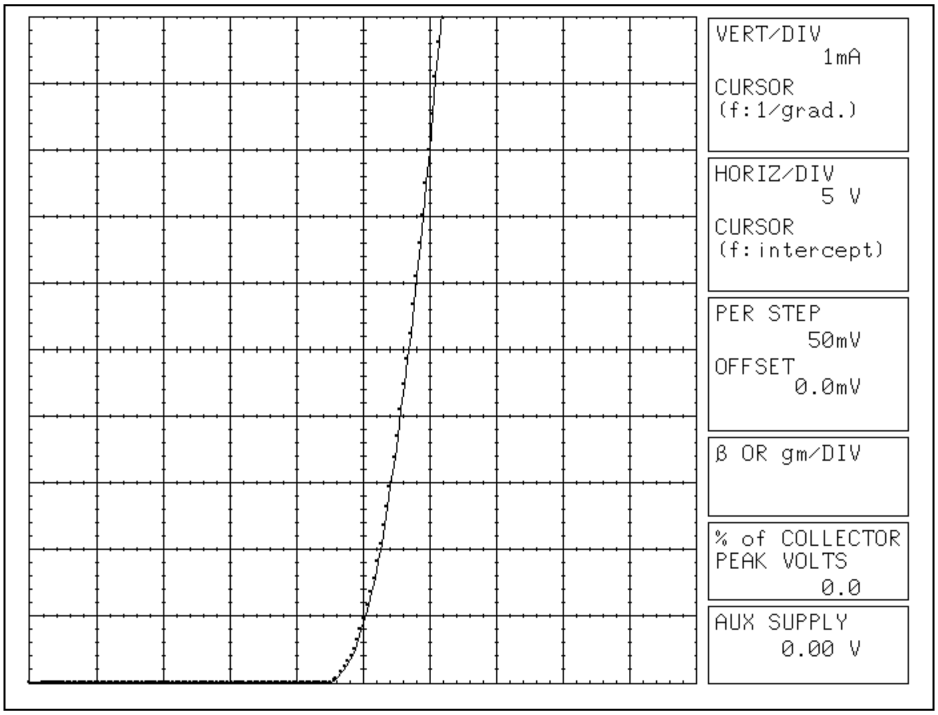
Circuit Simulation Result



Evaluation Circuit



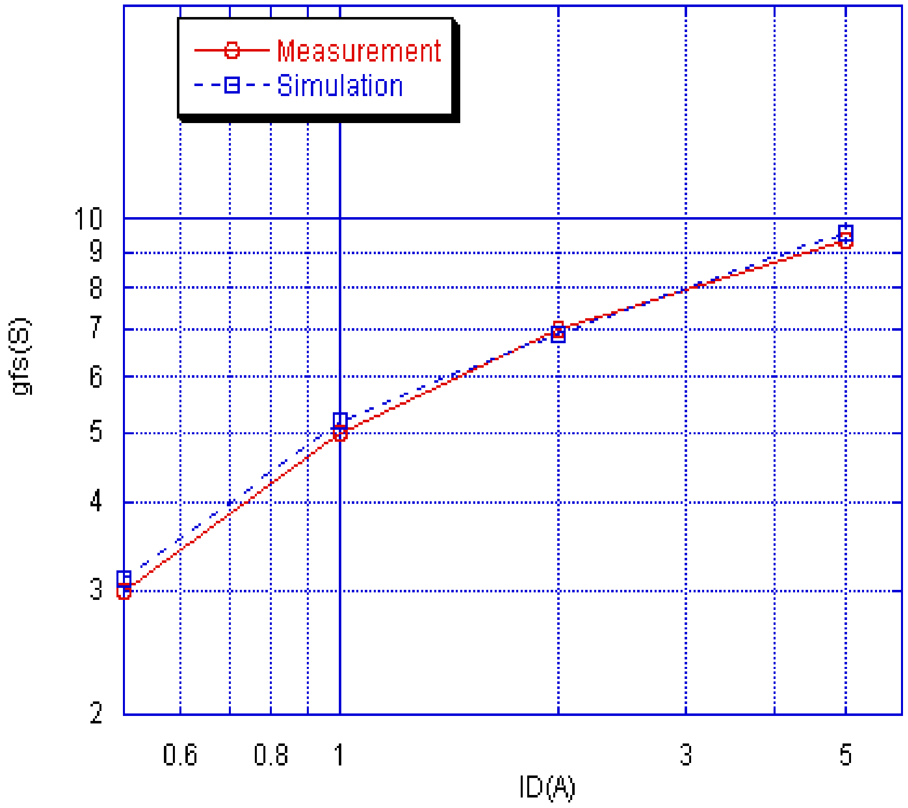
Zener Voltage Characteristic   Reference



N-Channel Model

Transconductance Characteristic

Circuit Simulation Result

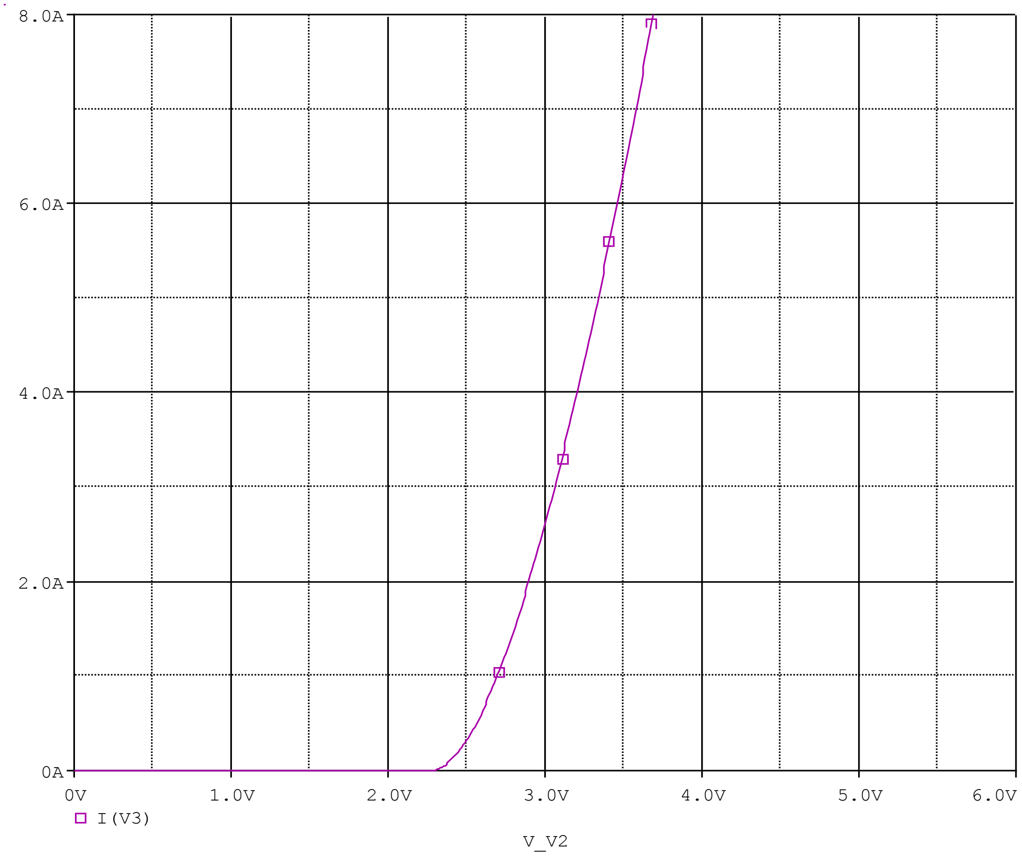


Comparison table

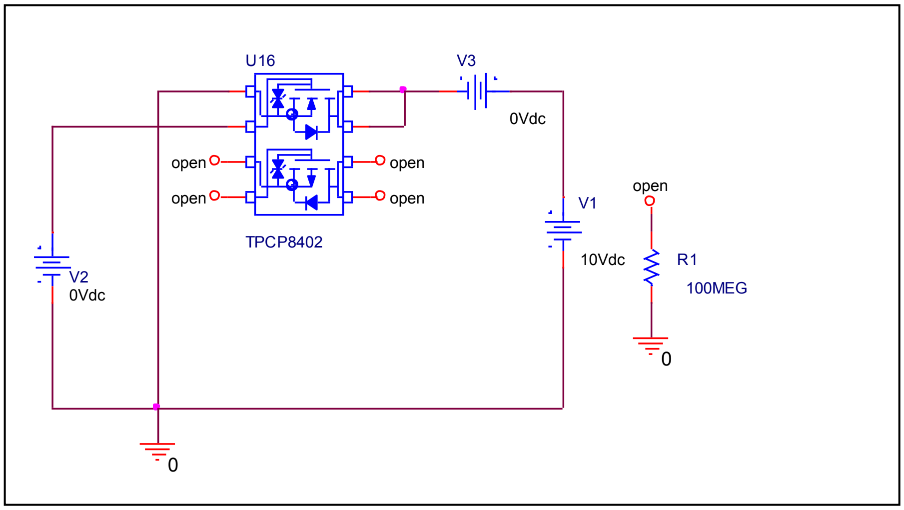
Id(A)	gfs		Error(%)
	Measurement	Simulation	
0.500	3.000	3.100	3.333
1.000	5.000	5.181	3.620
2.000	7.000	6.898	-1.457
5.000	9.300	9.572	2.924

Vgs-Id Characteristic

Circuit Simulation result

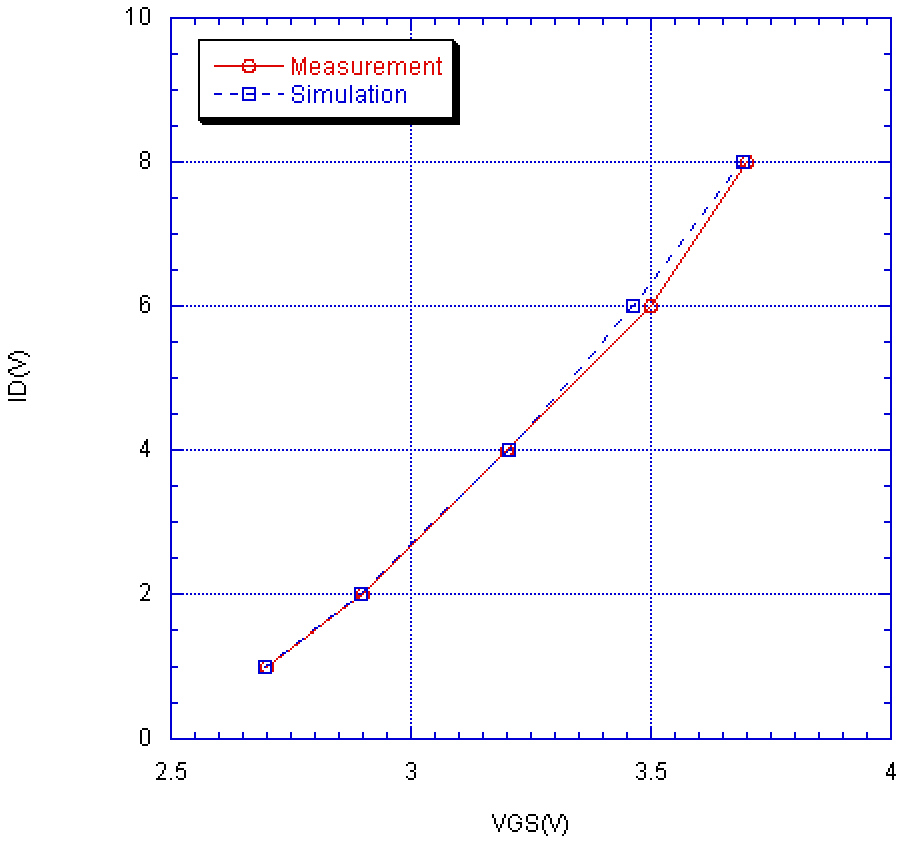


Evaluation circuit



Comparison Graph

Circuit Simulation Result

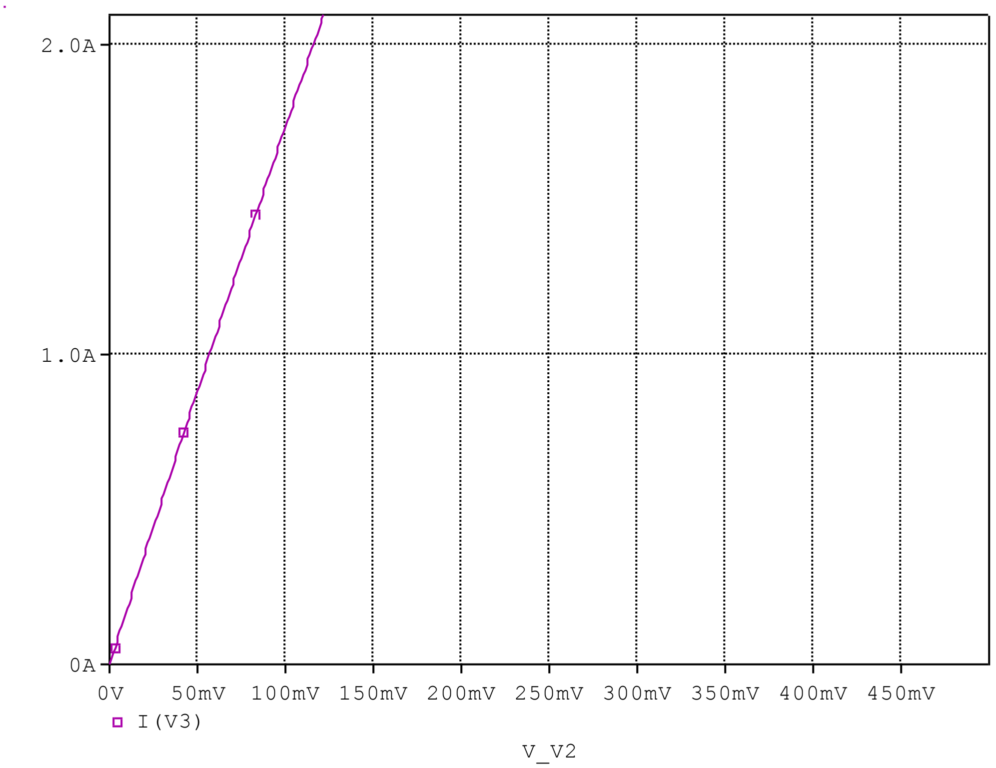


Simulation Result

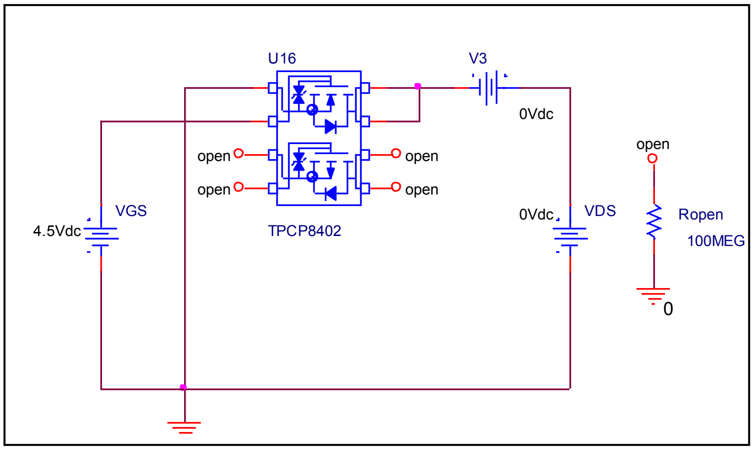
I_D(A)	V_{GS}(V)		Error (%)
	Measurement	Simulation	
1.000	**2.700**	**2.697**	**-0.111**
2.000	**2.900**	**2.896**	**-0.138**
4.000	**3.200**	**3.206**	**0.187**
6.000	**3.500**	**3.462**	**-1.086**
8.000	**3.700**	**3.691**	**-0.243**

Rds(on) Characteristic

Circuit Simulation result



Evaluation circuit

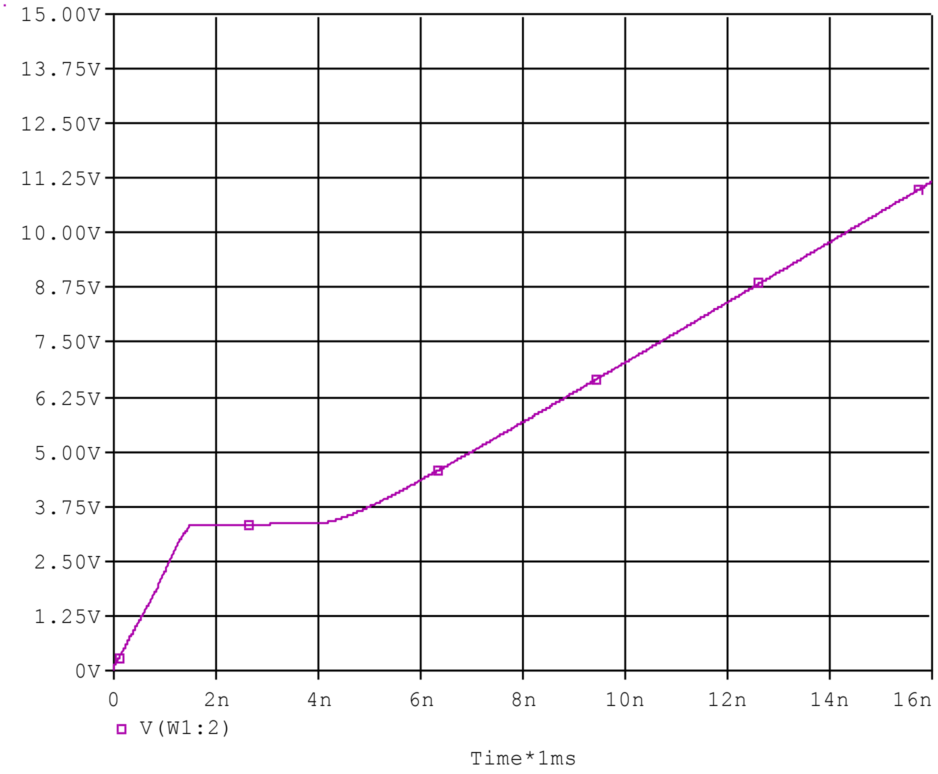


Simulation Result

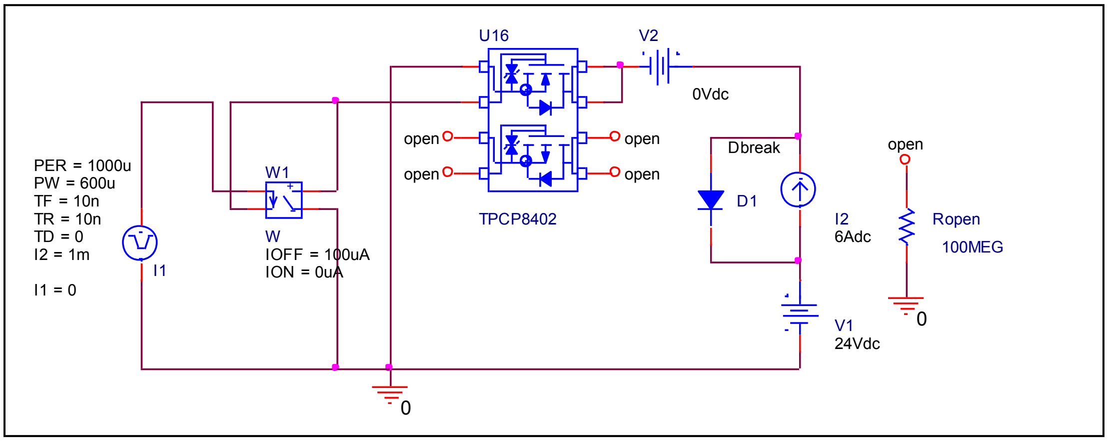
I_D=3.1A, V_{GS}=4.5V	Measurement		Simulation		Error (%)
R_{DS} (on)	58.000	mΩ	5.969	mΩ	-0.053

Gate Charge Characteristic

Circuit Simulation result



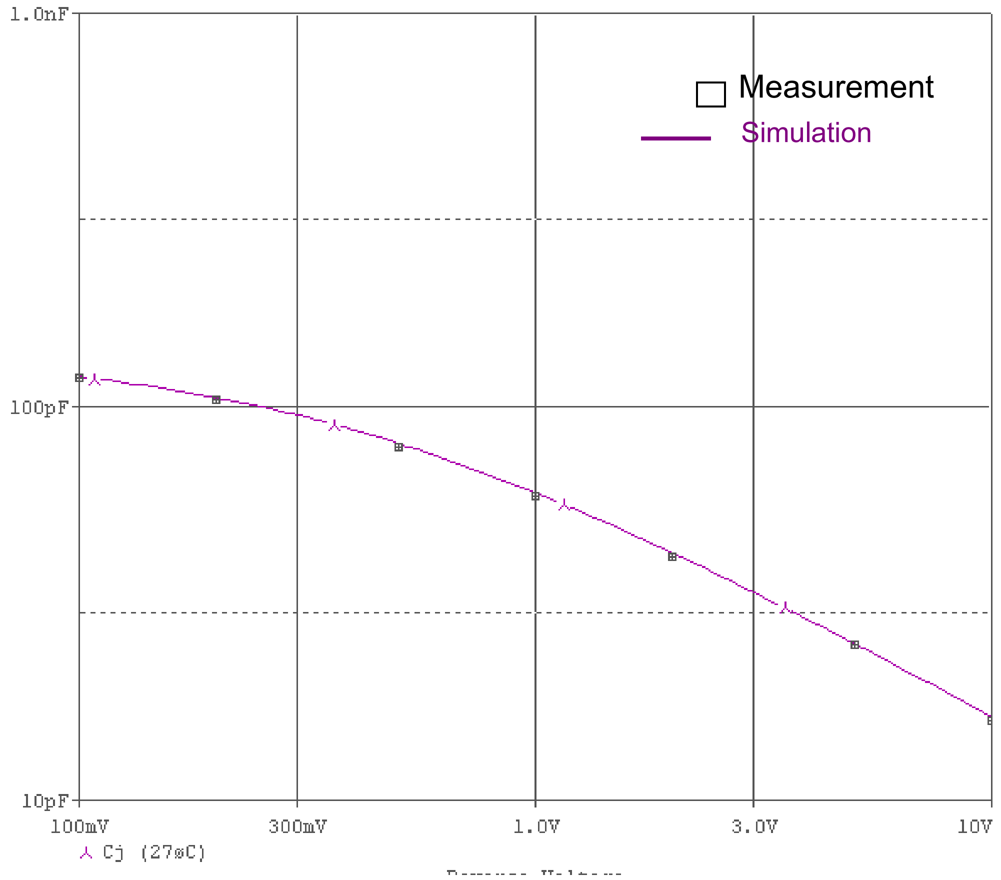
Evaluation circuit



Simulation Result

V_{DD}=24V,I_D=6A ,V_{GS}=10V	Measurement		Simulation		Error (%)
Qgs	**1.700**	**nC**	**1.658**	**nC**	**-2.470**
Qgd	**2.400**	**nC**	**2.400**	**nC**	**0.000**
Qg	**10.000**	**nC**	**10.000**	**nC**	**0.000**

Capacitance Characteristic

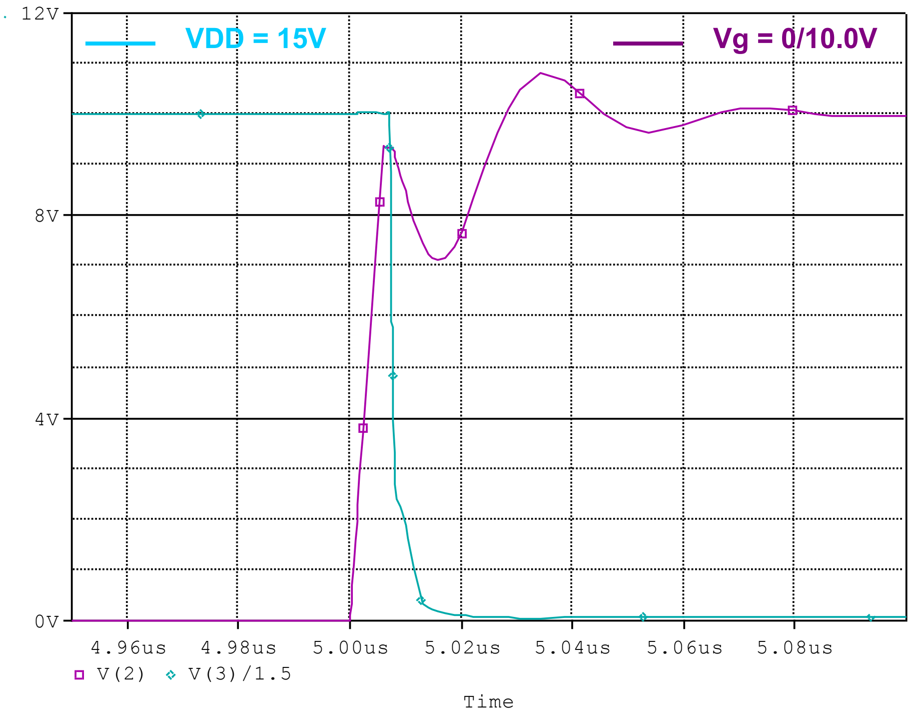


Simulation Result

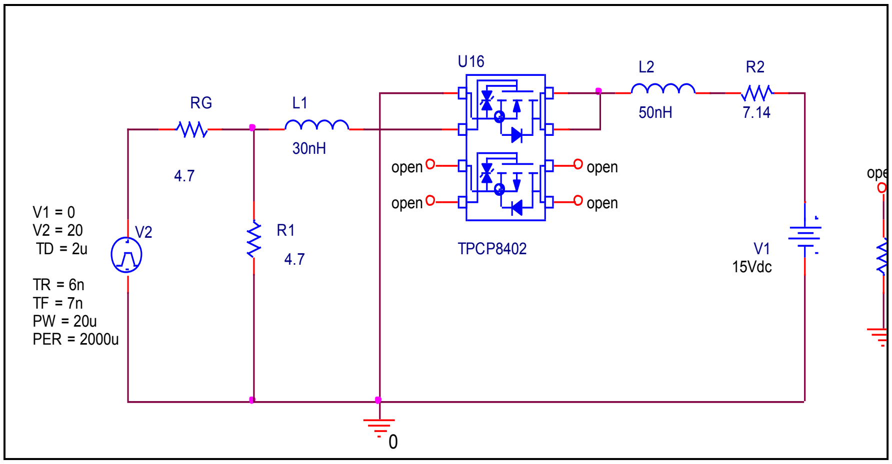
V_{DS}(V)	Cbd(pF)		Error(%)
	Measurement	Simulation	
0.100	120.000	120.000	0.000
0.200	105.000	106.215	1.157
0.500	80.000	81.540	1.925
1.000	60.000	60.876	1.460
2.000	42.000	43.052	2.505
5.000	25.000	25.000	0.000
10.000	16.000	16.120	0.750

Switching Time Characteristic

Circuit Simulation result



Evaluation circuit

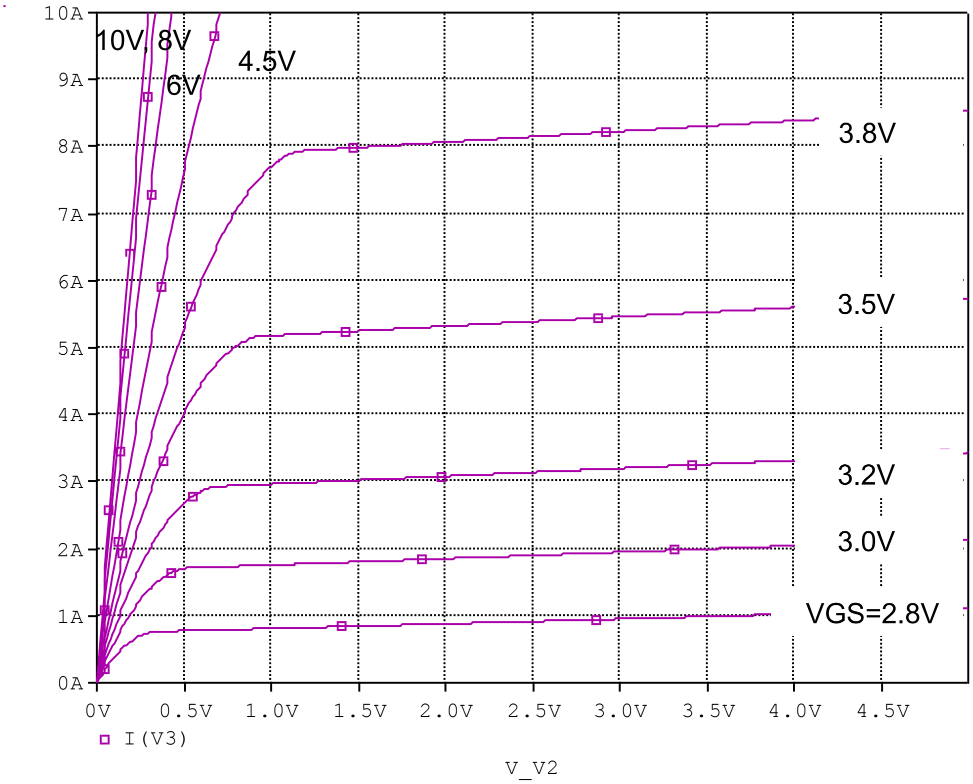


Simulation Result

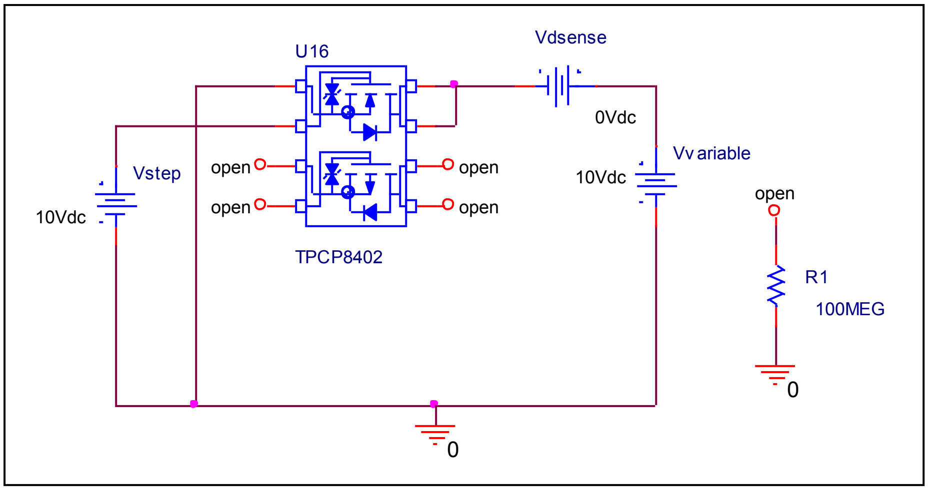
I_D=2.1 A, V_{DD}=15V V_{GS}=0/10V	Measurement		Simulation		Error(%)
ton	8.300	ns	8.700	ns	4.819

Output Characteristic

Circuit Simulation result

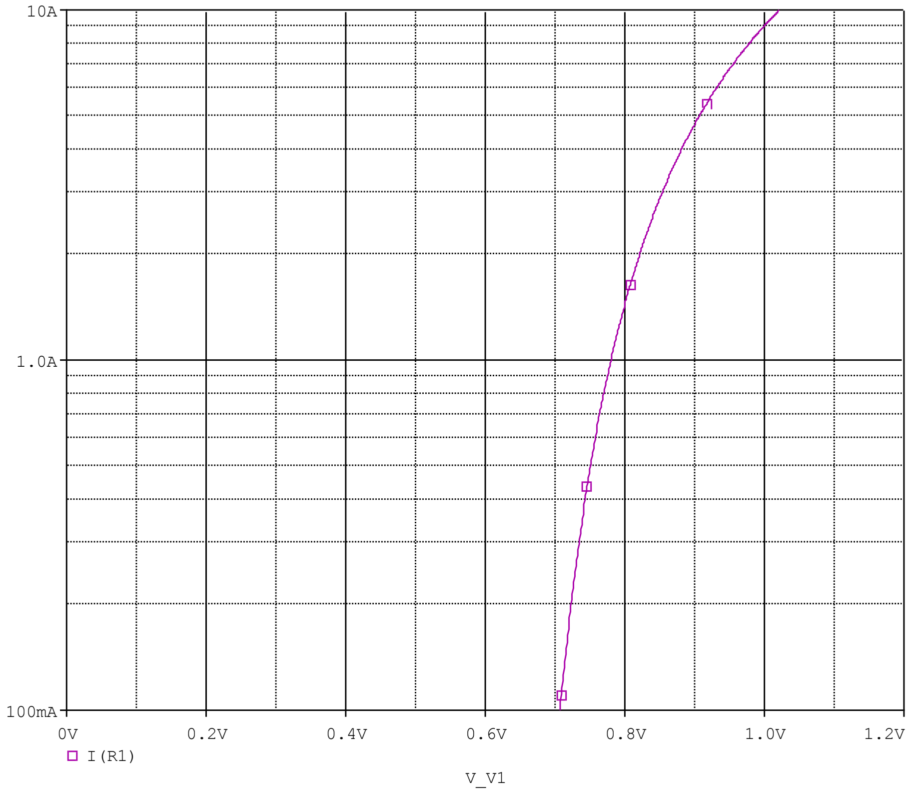


Evaluation circuit

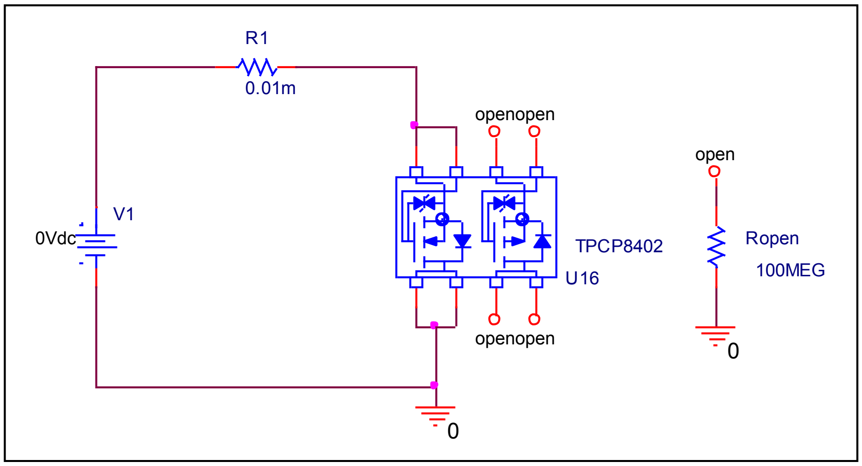


Forward Current Characteristic

Circuit Simulation Result

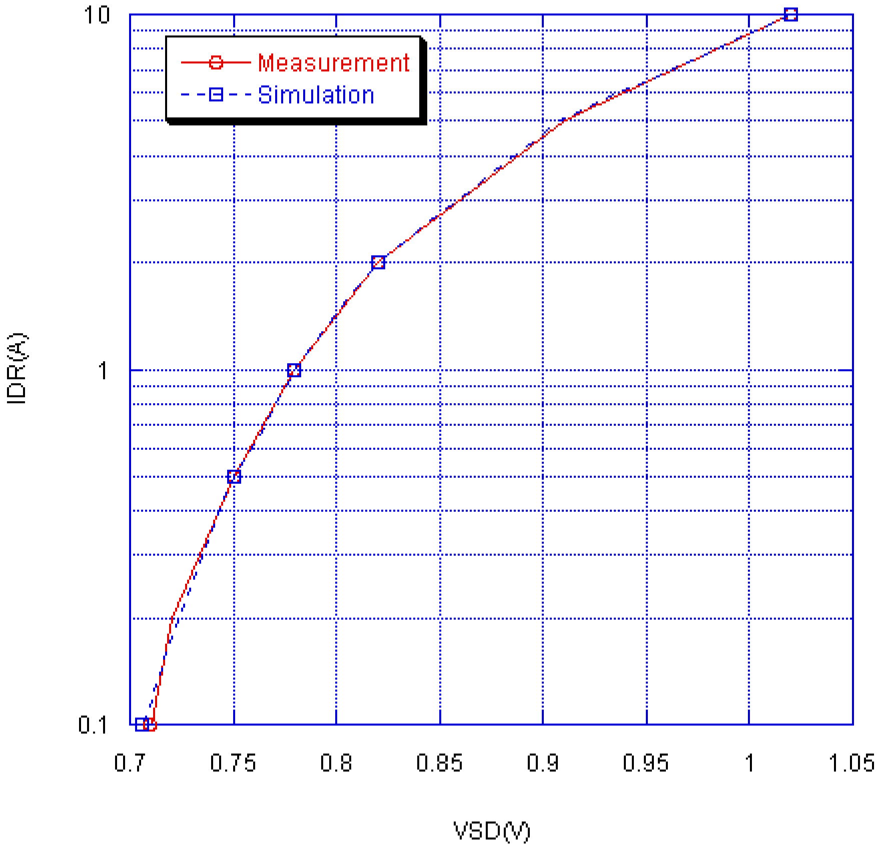


Evaluation Circuit



Comparison Graph

Circuit Simulation Result

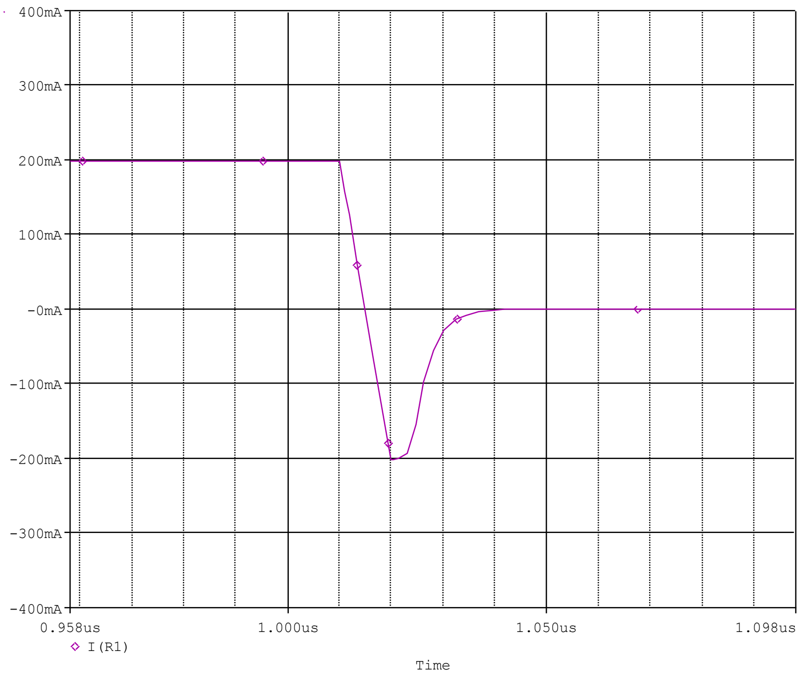


Simulation Result

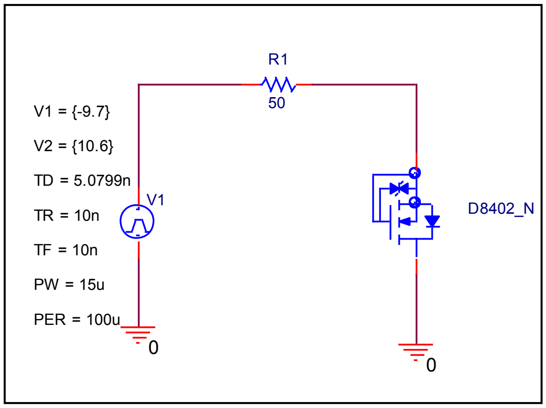
Ifwd(A)	Vfwd(V) Measurement	Vfwd(V) Simulation	%Error
0.100	0.710	0.706	- 0.563
0.200	0.720	0.723	0.416
0.500	0.750	0.750	0.000
1.000	0.780	0.780	0.000
2.000	0.820	0.820	0.000
5.000	0.910	0.908	- 0.219
10.000	1.020	1.020	0.000

Reverse Recovery Characteristic

Circuit Simulation Result



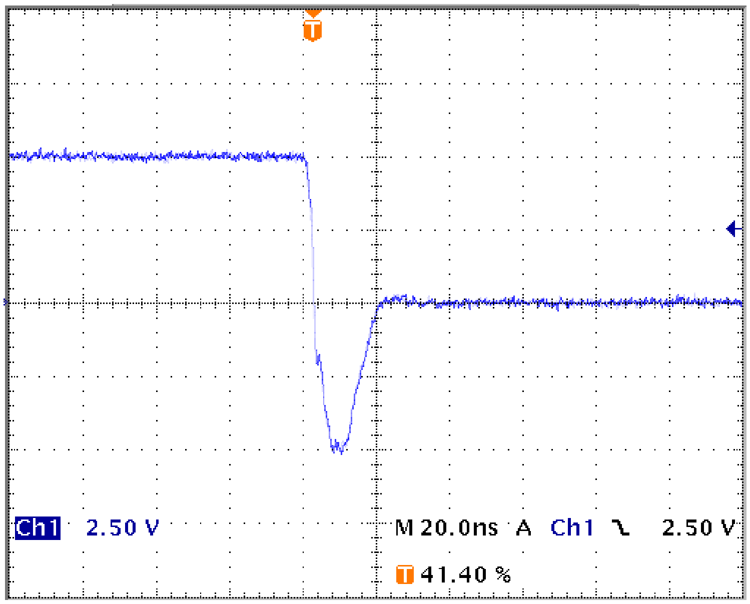
Evaluation Circuit



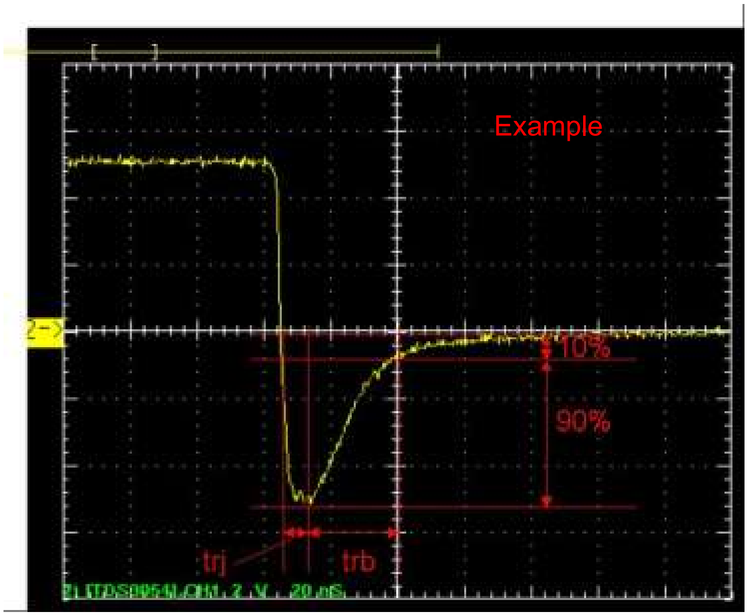
Compare Measurement vs. Simulation

	Measurement		Simulation		Error (%)
trj	**4.800**	**ns**	**4.800**	**ns**	**0.000**
trb	**11.600**	**ns**	**11.600**	**ns**	**0.000**
trr	**16.400**	**ns**	**16.400**	**ns**	**0.000**

Reverse Recovery Characteristic



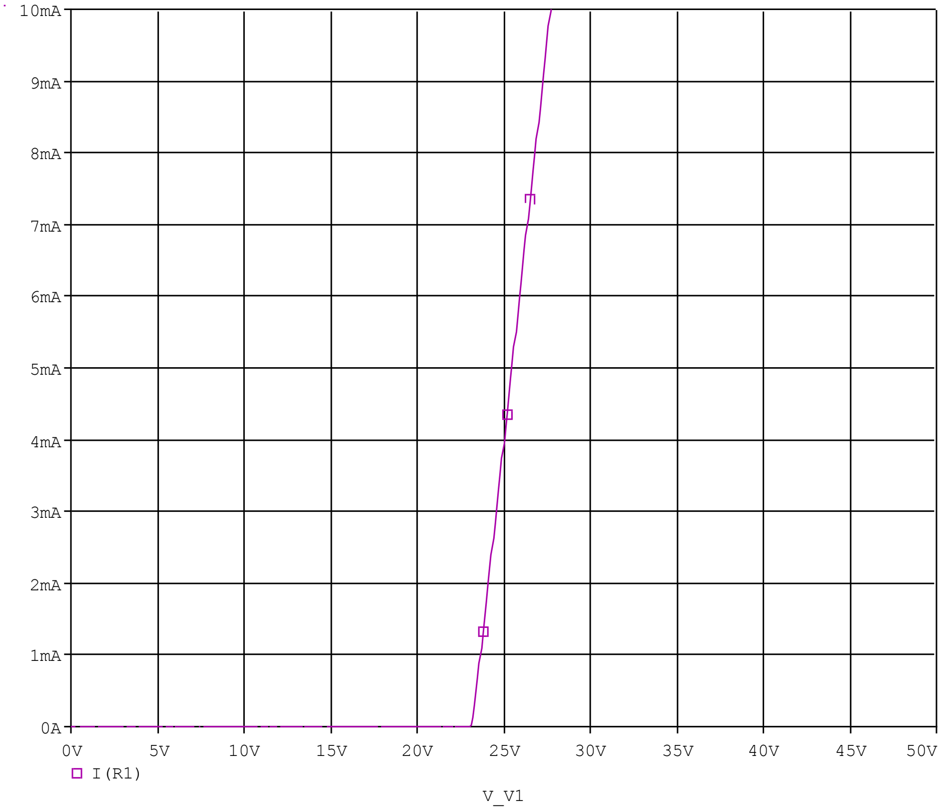
Trj=4.8(ns)
Trb=11.6(ns)
Conditions:Ifwd=Irev=0.2(A),Rl=50



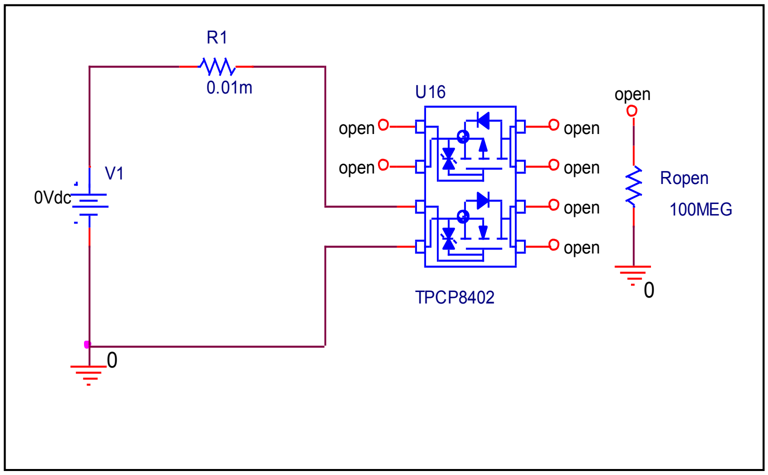
Relation between trj and trb

Zener Voltage Characteristic

Circuit Simulation Result



Evaluation Circuit



Zener Voltage Characteristic **Reference**