Device Modeling Report

COMPONENTS: Power MOSFET (Standard)
PART NUMBER: IRFB9N60A
MANUFACTURER: International Rectifier
REMARK: Body Diode (Standard)

Bee Technologies Inc.

POWER MOSFET MODEL

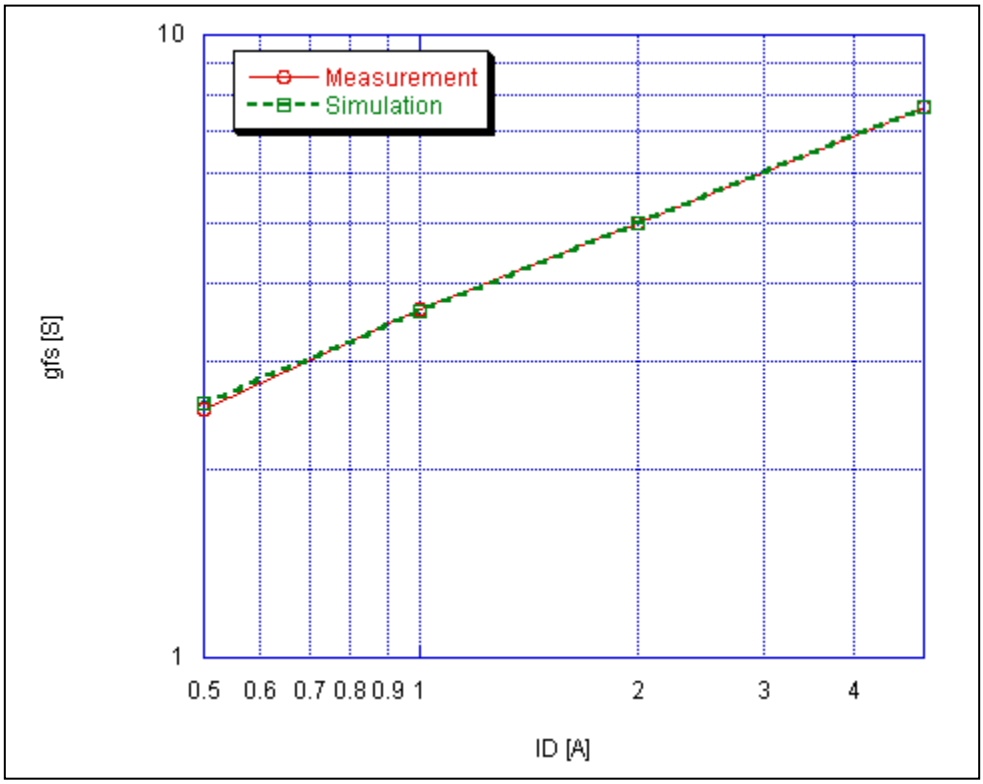
Pspice model parameter	Model description
LEVEL	
L	Channel Length
W	Channel Width
KP	Transconductance
RS	Source Ohmic Resistance
RD	Ohmic Drain Resistance
VTO	Zero-bias Threshold Voltage
RDS	Drain-Source Shunt Resistance
TOX	Gate Oxide Thickness
CGSO	Zero-bias Gate-Source Capacitance
CGDO	Zero-bias Gate-Drain 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

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

Transconductance Characteristic

Circuit Simulation Result

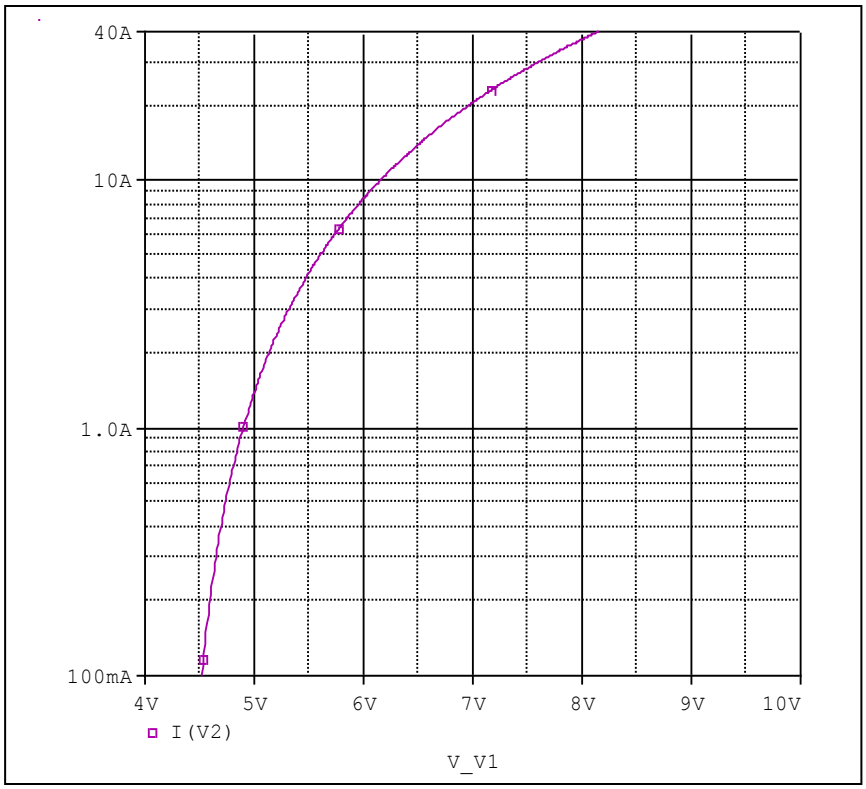


Comparison table

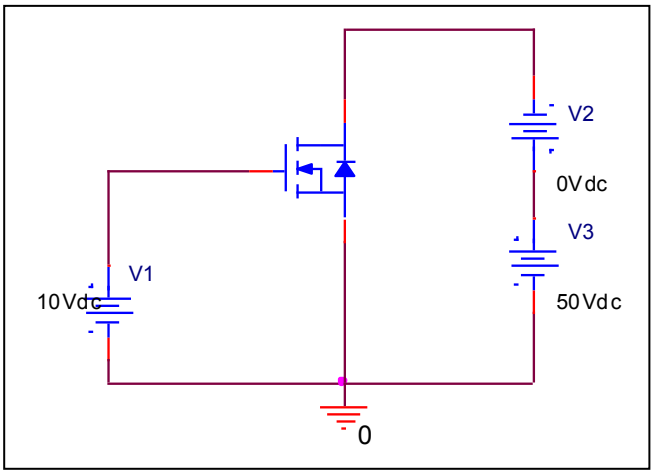
I_D(A)	g_{fs} (S)		Error (%)
	Measurement	Simulation	
0.5	2.5	2.565	2.60
1	3.63	3.591	1.07
2	5	5.005	0.10
5	7.69	7.69	0

Vgs-Id Characteristic

Circuit Simulation result

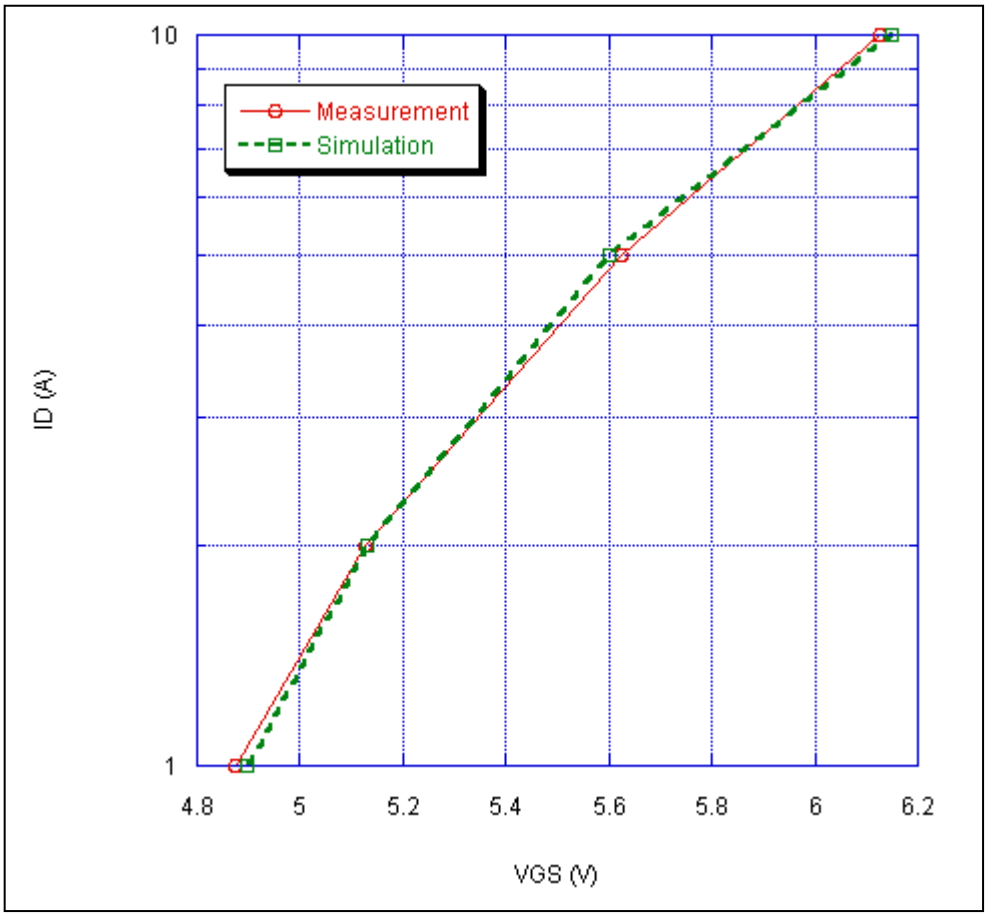


Evaluation circuit



Comparison Graph

Circuit Simulation Result

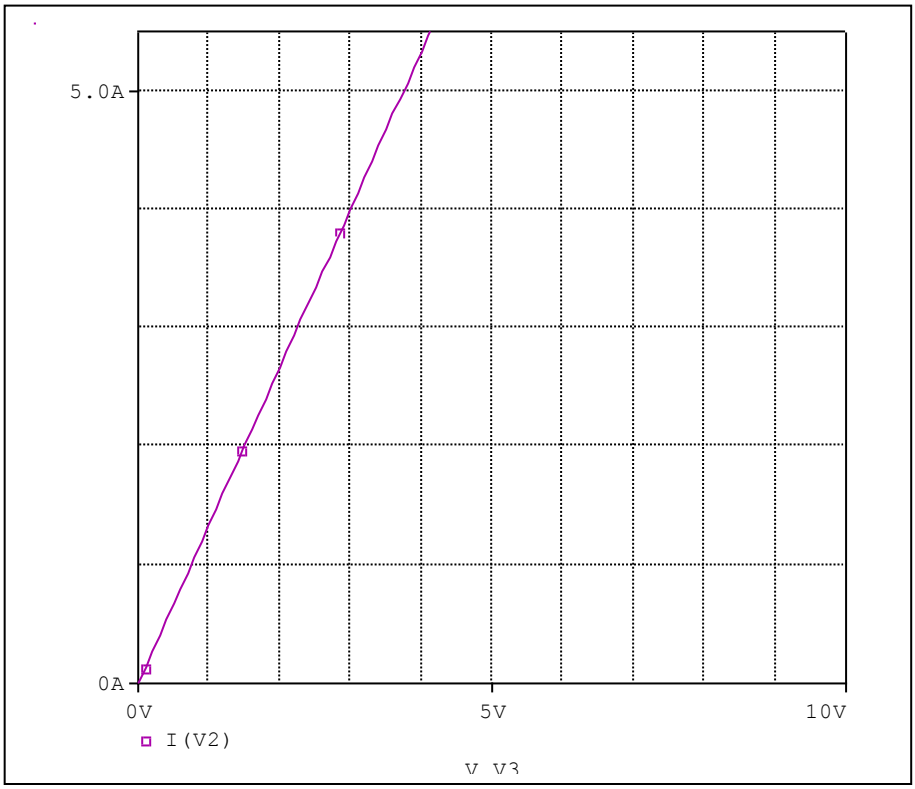


Simulation Result

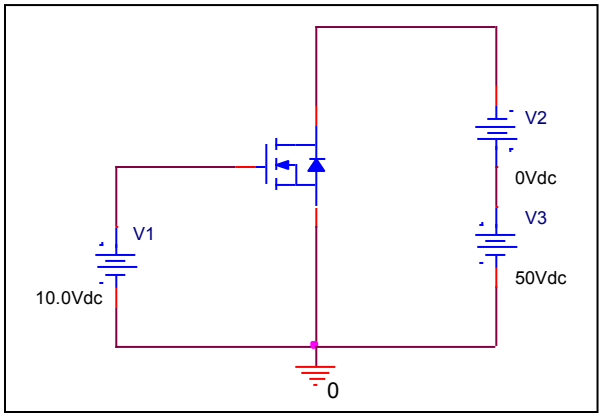
I_D(A)	V_{GS}(V)		Error (%)
	Measurement	Simulation	
1.000	4.875	4.898	0.478
2.000	5.125	5.131	0.111
5.000	5.625	5.602	-0.411
10.000	6.125	6.149	0.393

Id-Rds(on) Characteristic

Circuit Simulation result



Evaluation circuit

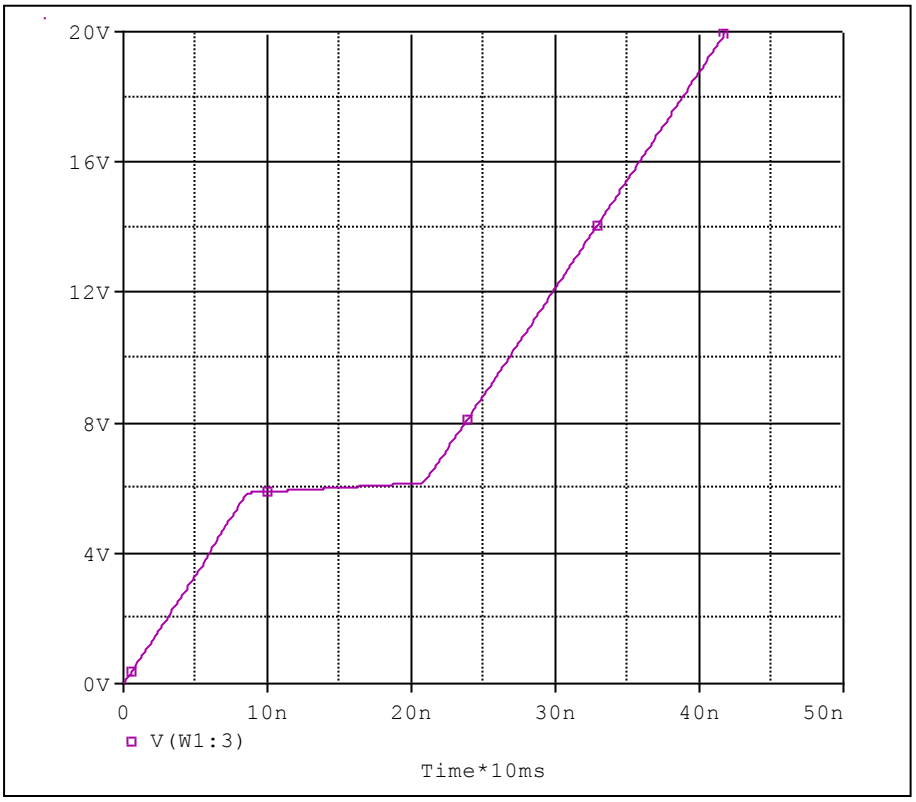


Simulation Result

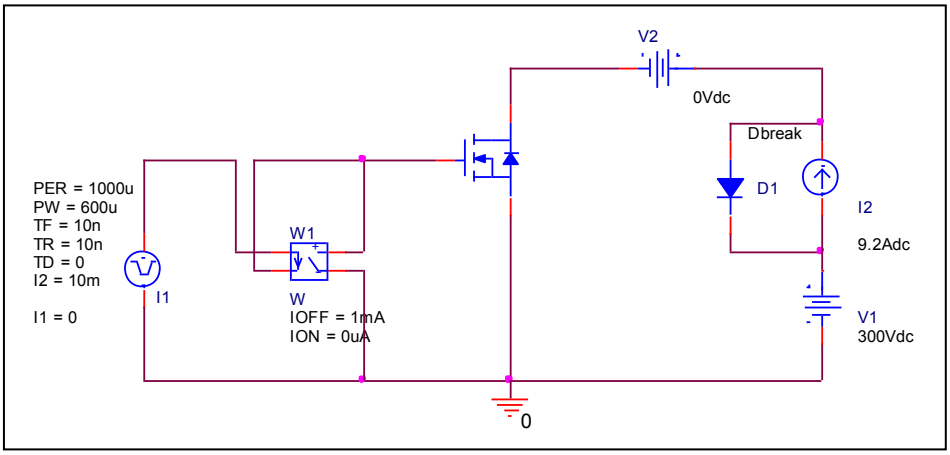
I_D=5.5, V_{GS}=10V	Measurement		Simulation		Error (%)
R_{DS} (on)	0.75	Ω	0.75	Ω	0

Gate Charge Characteristic

Circuit Simulation result



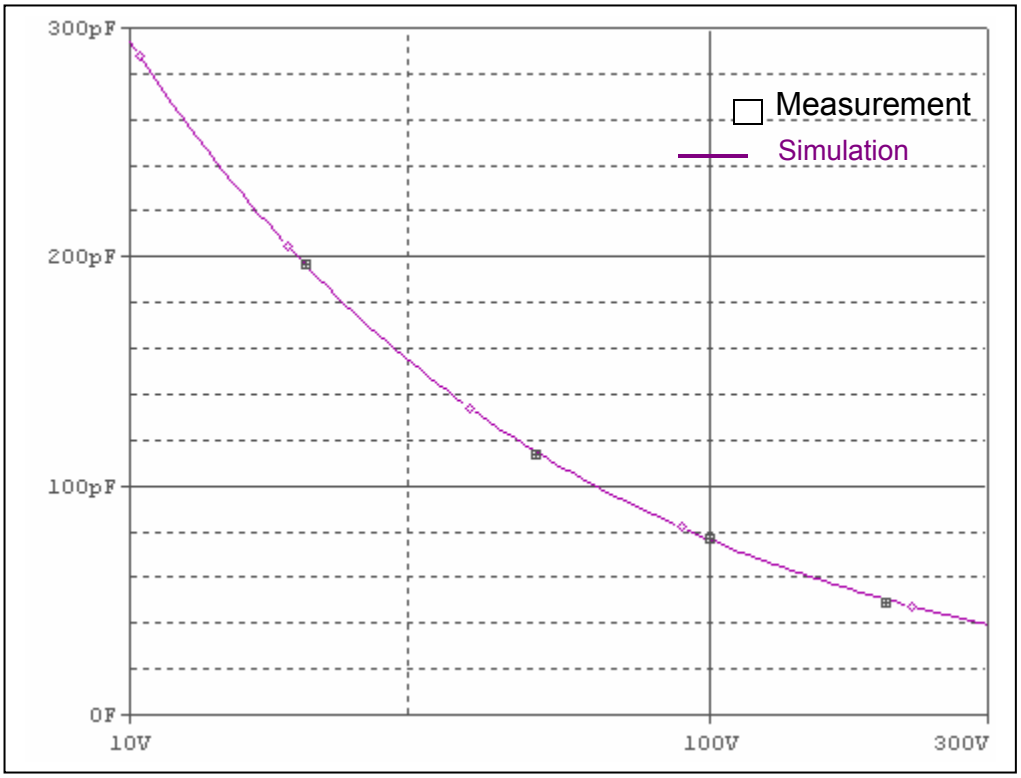
Evaluation circuit



Simulation Result

V_{DD}=300V,I_D=9.2A	Measurement		Simulation		Error (%)
Qgs	8.750	nC	8.750	nC	0.000
Qgd	12.000	nC	12.083	nC	0.692

Capacitance Characteristic

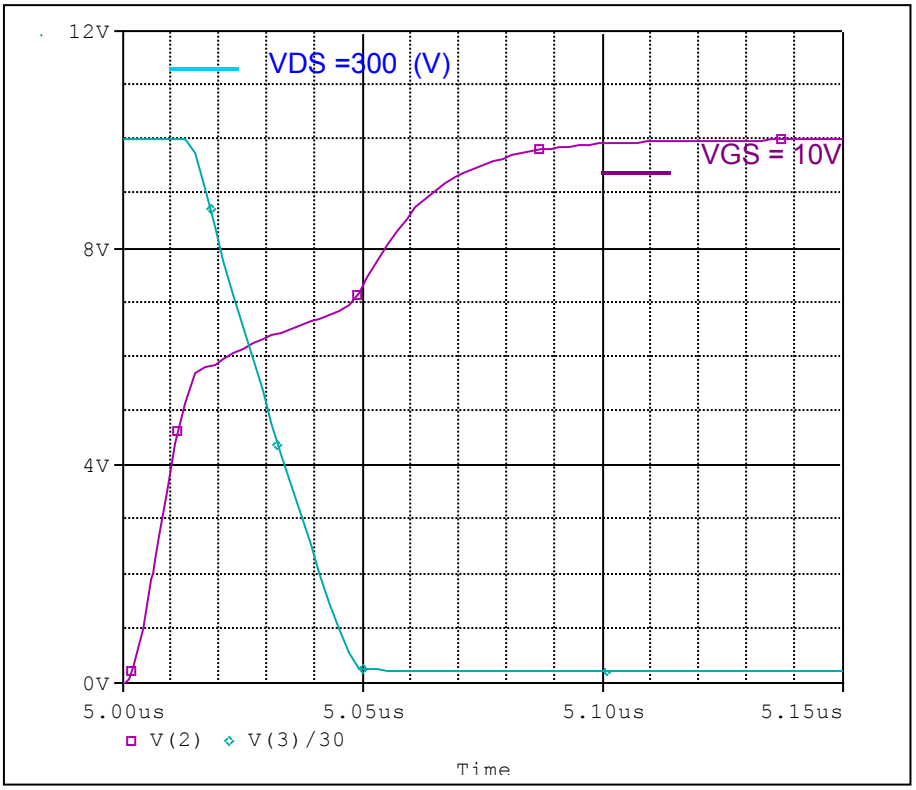


Simulation Result

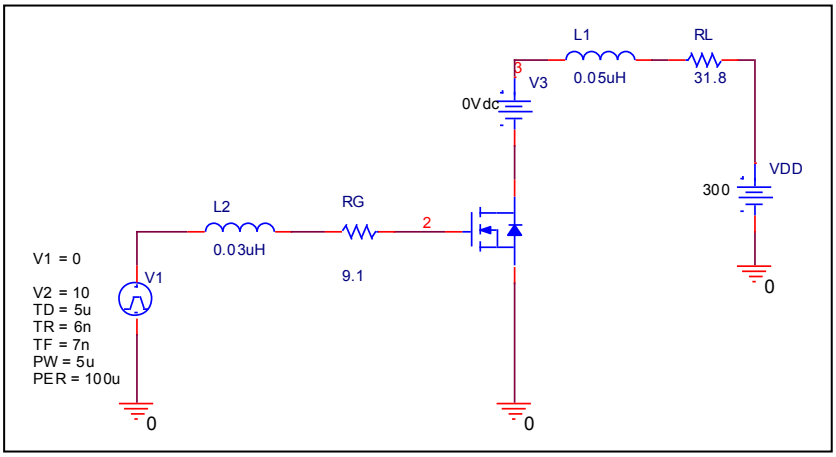
V_{DS}(V)	Cbd(pF)		Error(%)
	Measurement	Simulation	
10.000	300.000	294.000	-2.000
20.000	197.500	196.900	-0.304
50.000	115.000	114.400	-0.522
100.000	78.000	76.000	-2.564
200.000	50.000	50.500	1.000

Switching Time Characteristic

Circuit Simulation result



Evaluation circuit

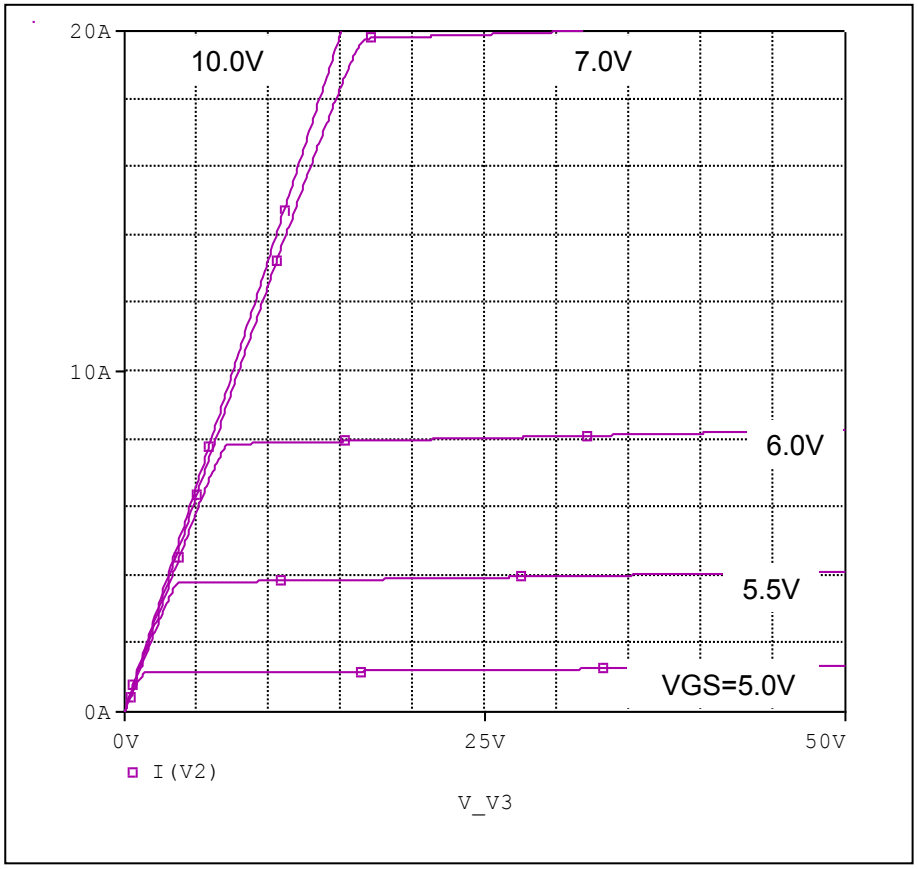


Simulation Result

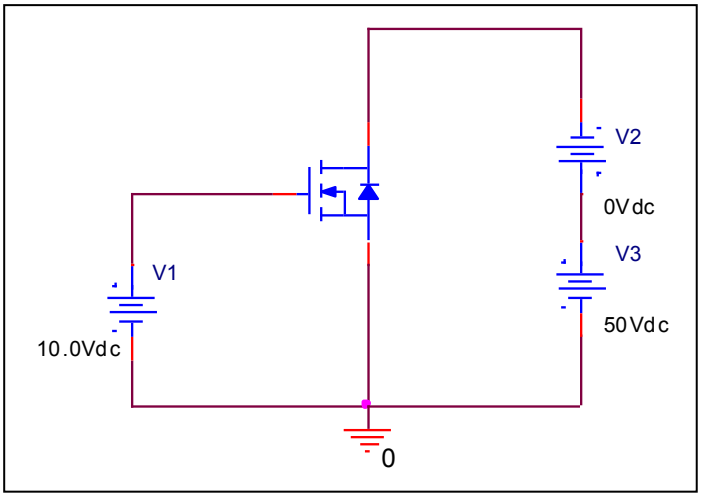
I_D=9.2A, V_{DD}=300V V_{GS}=0/10V	Measurement		Simulation		Error(%)
td (on)	13.000	ns	12.955	ns	0.038

Output Characteristic

Circuit Simulation result

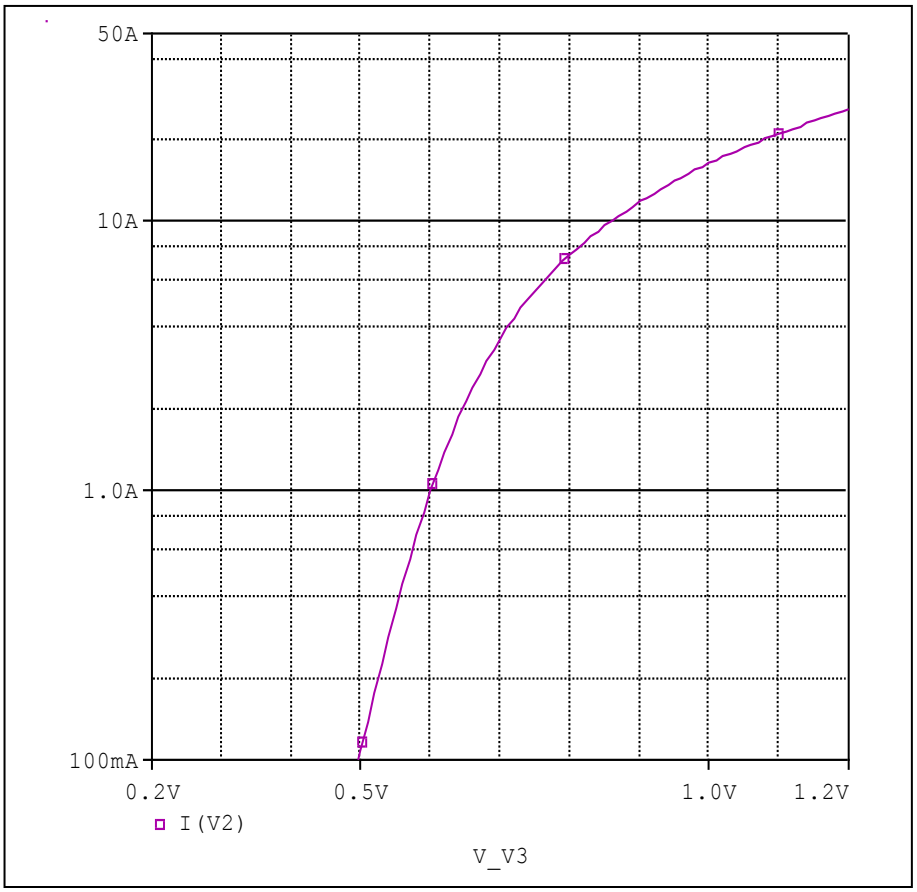


Evaluation circuit

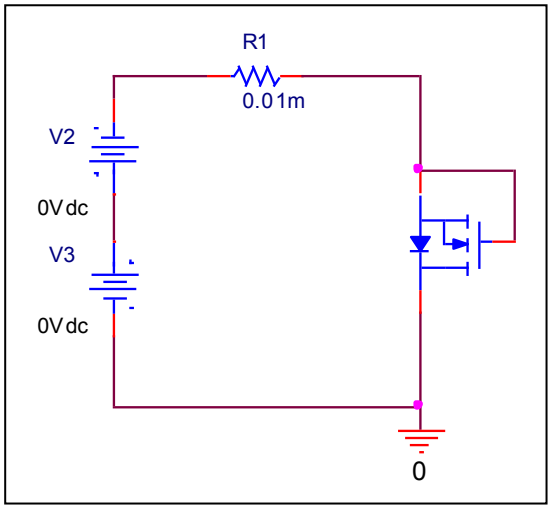


Forward Current Characteristic of Reverse Diode

Circuit Simulation Result

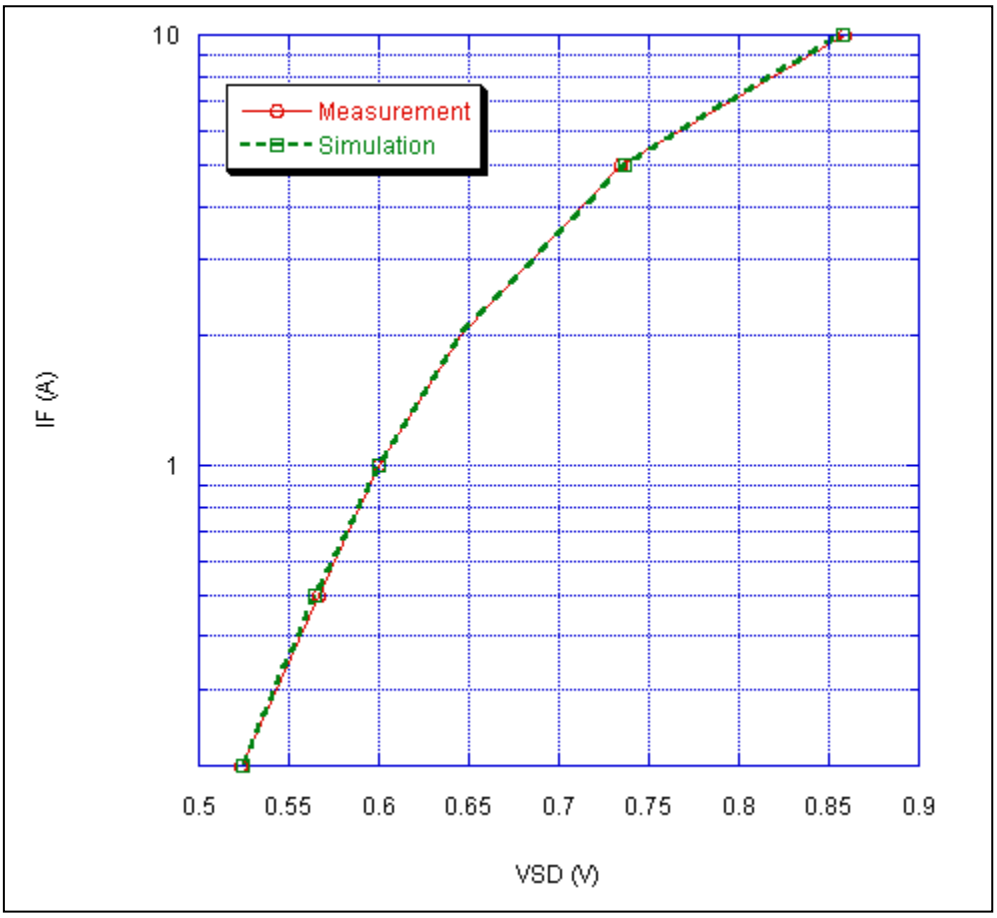


Evaluation Circuit



Comparison Graph

Circuit Simulation Result

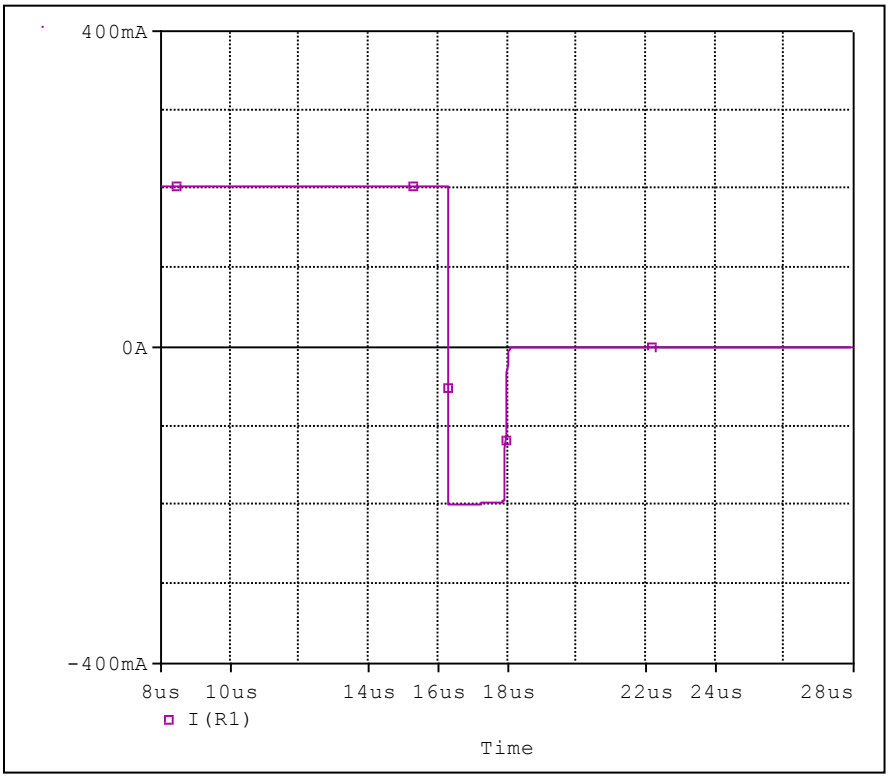


Simulation Result

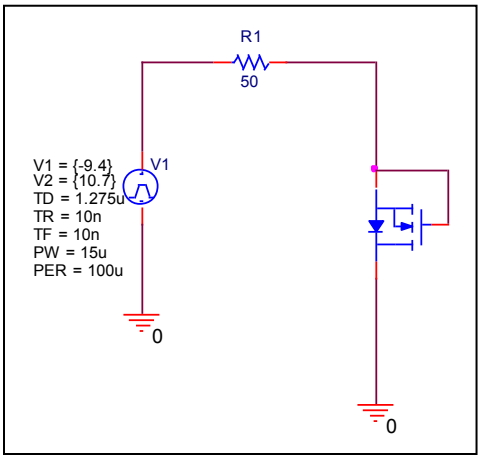
Ifwd(A)	Vfwd(V) Measurement	Vfwd(V) Simulation	%Error
0.200	0.523	0.525	0.325
0.500	0.567	0.565	-0.423
1.000	0.600	0.600	0.012
2.000	0.646	0.645	-0.146
5.000	0.734	0.737	0.354
10.000	0.859	0.858	-0.105

Reverse Recovery Characteristic

Circuit Simulation Result



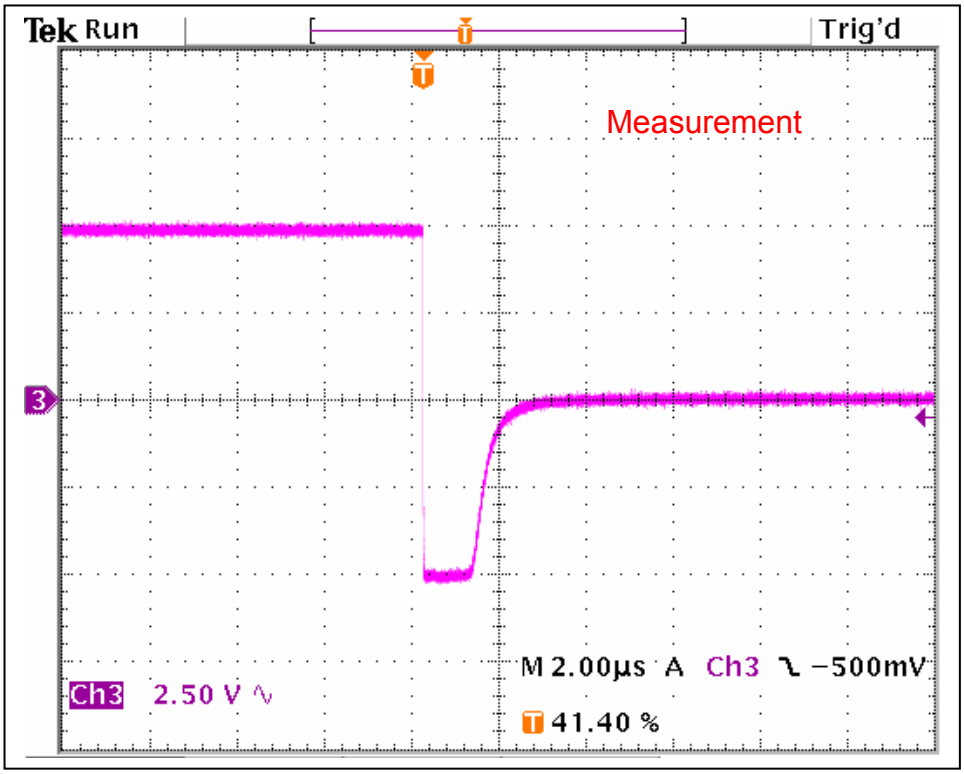
Evaluation Circuit



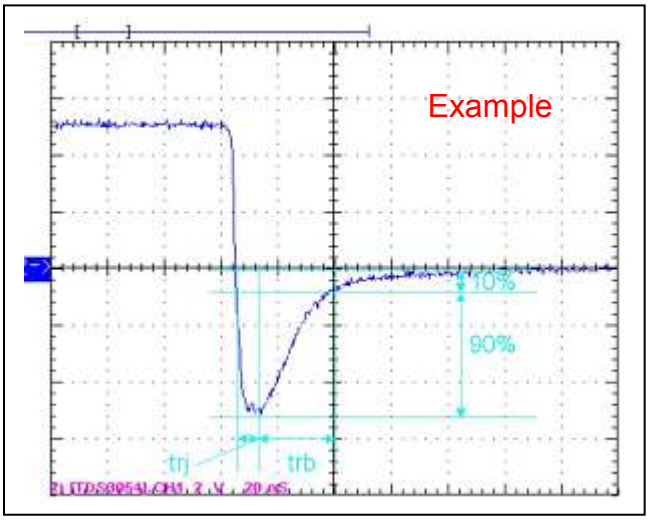
Compare Measurement vs. Simulation

	Measurement		Simulation		Error(%)
Trj +Trb	**1.720**	**us**	**1.721**	**us**	**0.058**

Reverse Recovery Characteristic Reference



trj = 1.08(us)
trb = 0.64(us)
Conditions: Ifwd=Irev=0.2(A), Rl=50



Relation between trj and trb