

Device Modeling Report

COMPONENTS: MOSFET (Model Parameters)
PART NUMBER: TPC8014
MANUFACTURER: TOSHIBA
REMARK: Body Diode (Model Parameters) /
ESD Protection Diode



Bee Technologies Inc.

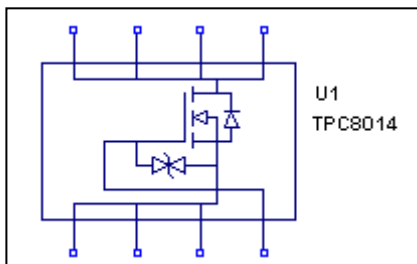
SPICE MODEL

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*$
*PART NUMBER: TPC8014
*MANUFACTURER: TOSHIBA
*VDSS=30V, ID=11A
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.SUBCKT TPC8014 1 2 3 4 5 6 7 8
M_M1 6 4 3 3 MTPC8014
X_U1 4 3 DZTPC8014
D_D1 3 6 DTPC8014
R_R1 1 3 0.01m
R_R2 2 3 0.01m
R_R5 5 6 0.01m
R_R7 7 6 0.01m
R_R8 8 6 0.01m
.MODEL MTPC8014 NMOS
+ LEVEL=3 L=720.00E-9 W=.45 KP=66.000E-6 RS=1.0000E-3
+ RD=6.8436E-3 VTO=2.3063 RDS=3.0000E6 TOX=40.000E-9
+ CGSO=2.0126E-9 CGDO=827.11E-12 RG=12.45
+ CBD=342.86E-12 MJ=.70573 PB=.3905
+ RB=1 N=5 IS=1E-15 GAMMA=0 KAPPA=0 ETA=0.5m
.MODEL DTPC8014 D
+ IS=824.87E-12 N=1.2770 RS=6.2420E-3 IKF=7.3139
+ CJO=3.0000E-12 BV=60 IBV=100.00E-6 TT=24.062E-9
.ENDS
.subckt DZTPC8014 1 2
D2 1 3 DZ2
D1 2 3 DZ1
.model DZ1 D
+ IS=0.01p N=0.1 ISR=0
+ CJO=3E-12 BV=22.423 IBV=0.001 RS=0
.model DZ2 D
+ IS=0.01p N=0.1 ISR=0
+ CJO=3E-12 BV=22.423 IBV=0.001 RS=411.11
.ENDS
*$

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Circuit Configuration

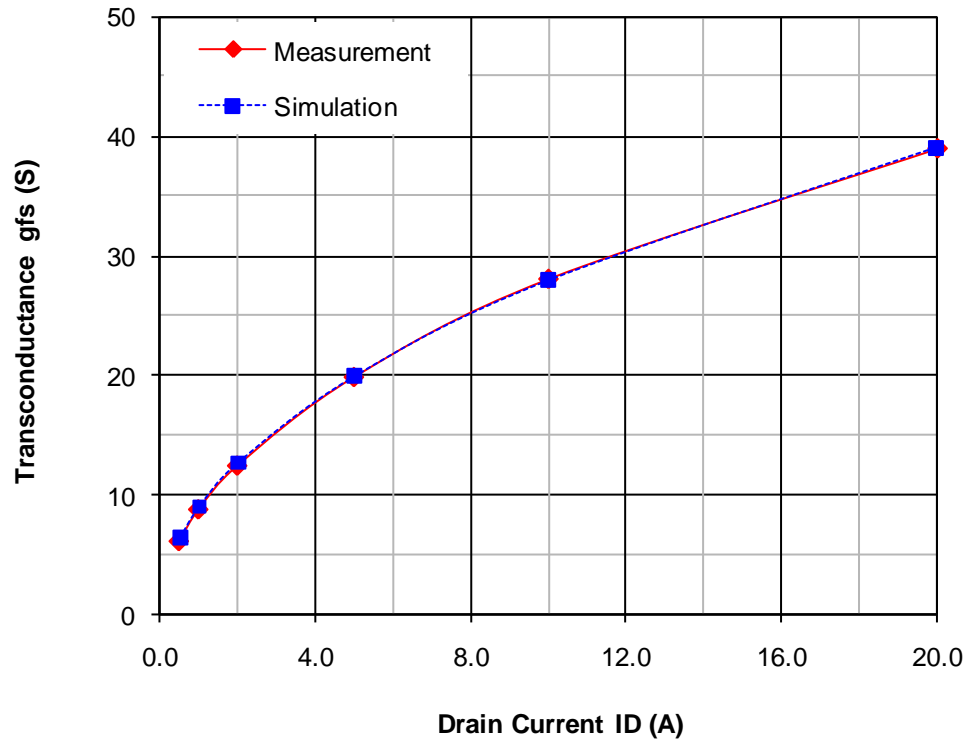


MOSFET MODEL

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	Mobility Modulation
KAPPA	Saturation Field Factor
VMAX	Maximum Drift Velocity of Carriers
XJ	Metallurgical Junction Depth
UO	Surface Mobility

Transconductance Characteristic

Circuit Simulation Result

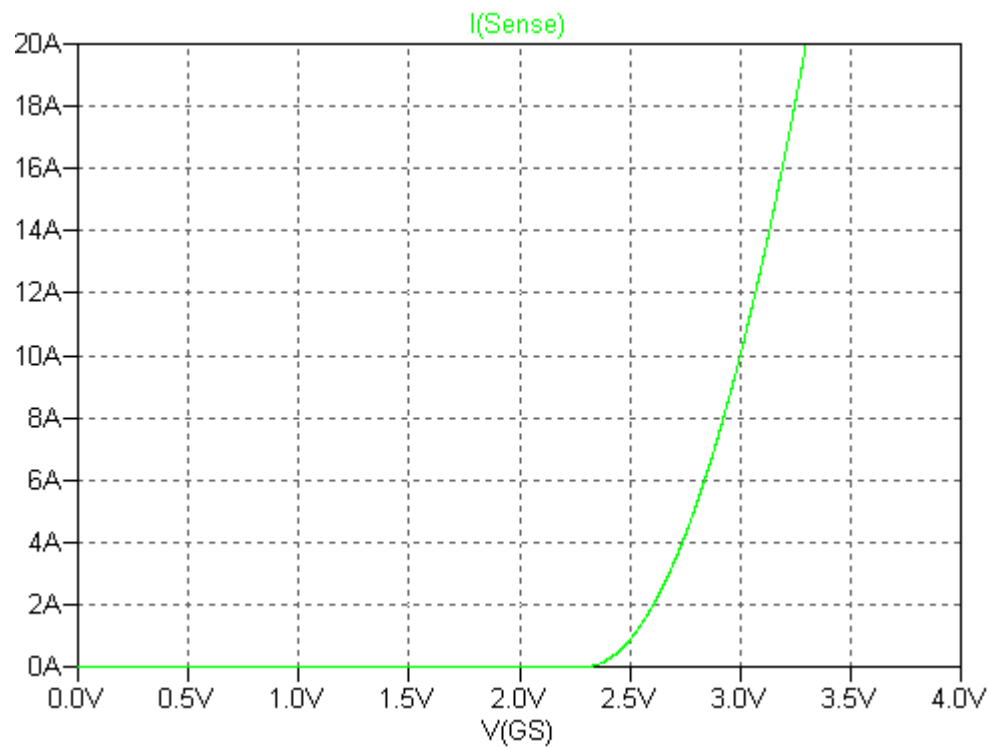


Comparison table

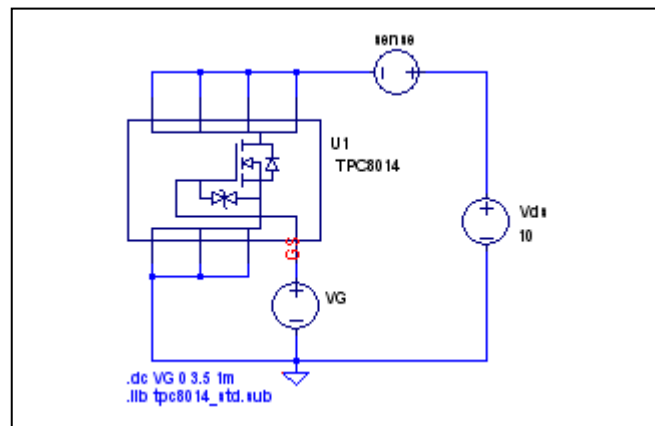
Id(A)	gfs(S)		%Error
	Measurement	Simulation	
0.5	6.100	6.381	4.61
1	8.750	9.000	2.86
2	12.400	12.681	2.27
5	19.800	19.902	0.52
10	28.000	27.913	-0.31
20	38.900	39.020	0.31

Vgs-Id Characteristic

Circuit Simulation result

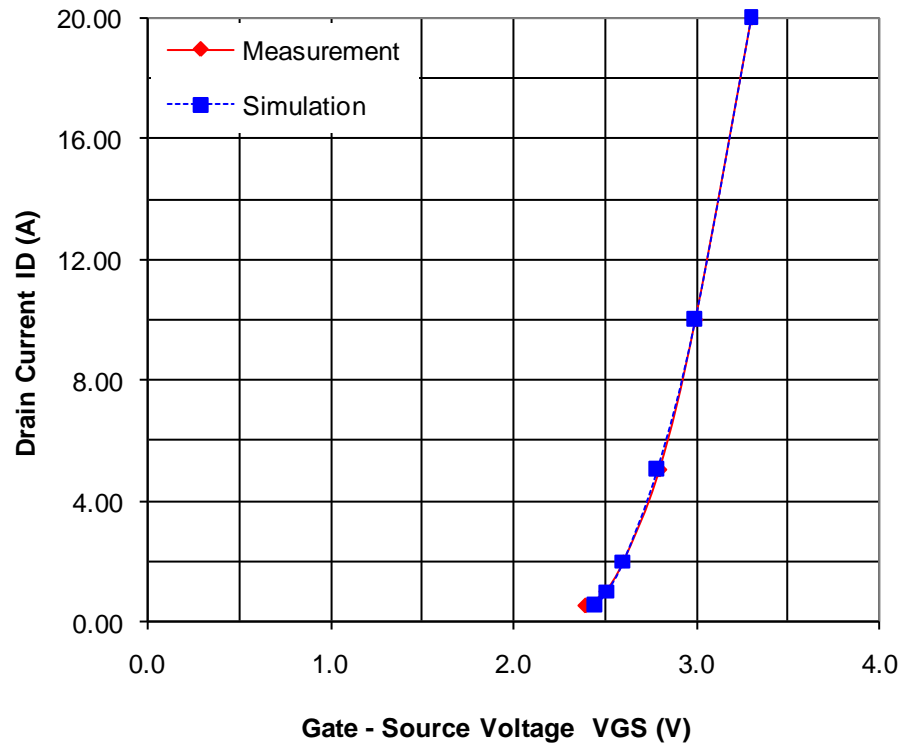


Evaluation circuit



Comparison Graph

Circuit Simulation Result

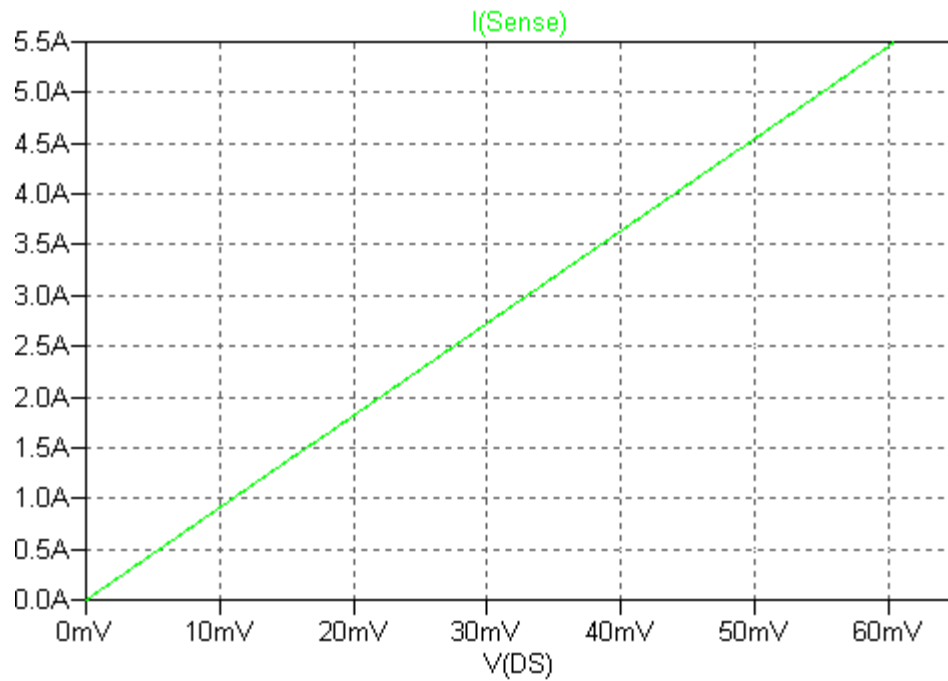


Simulation Result

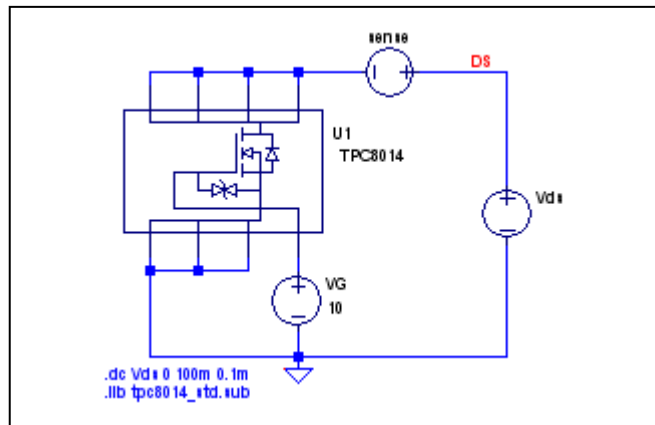
I _D (A)	V _{GS} (V)		%Error
	Measurement	Simulation	
0.5	2.400	2.450	2.08
1	2.500	2.515	0.59
2	2.600	2.607	0.27
5	2.800	2.791	-0.32
10	3.000	3.000	0.00
20	3.300	3.299	-0.04

R_{ds(on)} Characteristic

Circuit Simulation result



Evaluation circuit

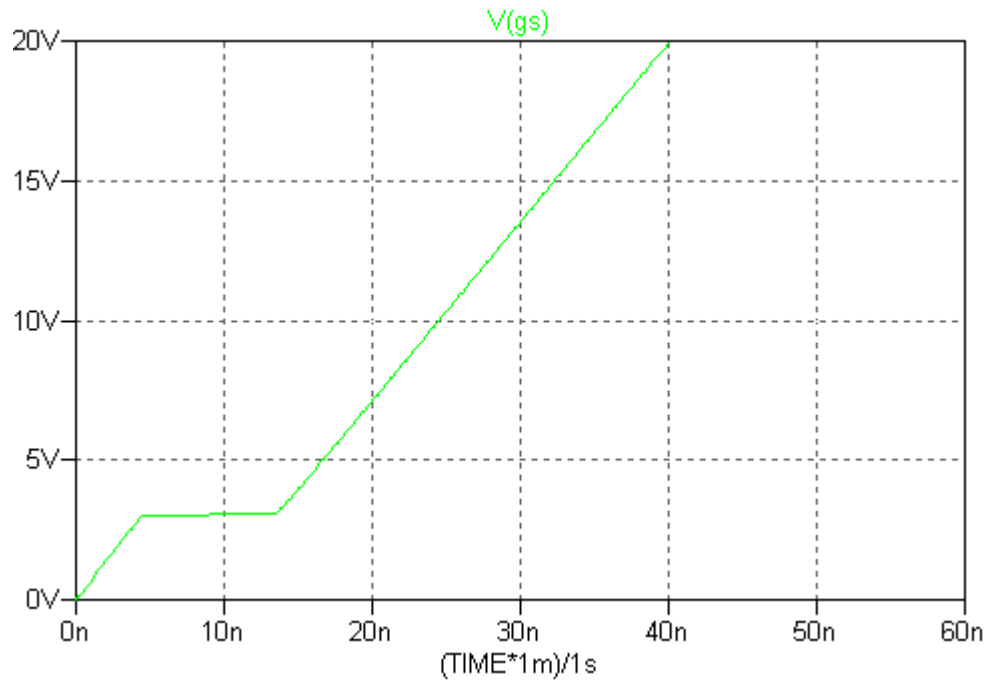


Simulation Result

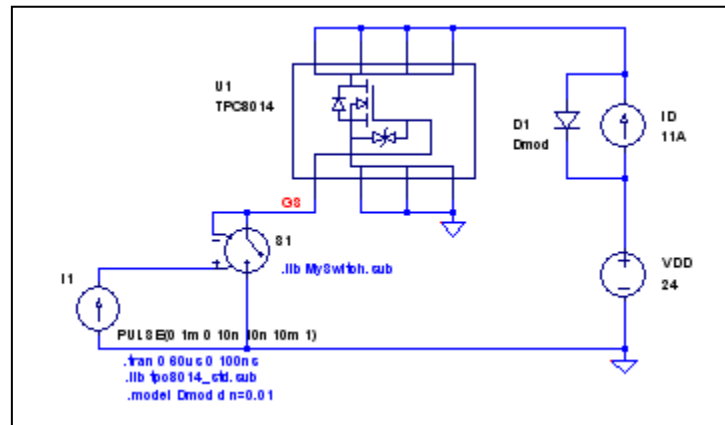
$I_D=5.5A$, $V_{GS}=10V$	Unit	Measurement	Simulation	%Error
$R_{DS(on)}$	m Ω	11.000	11.000	0.00

Gate Charge Characteristic

Circuit Simulation result



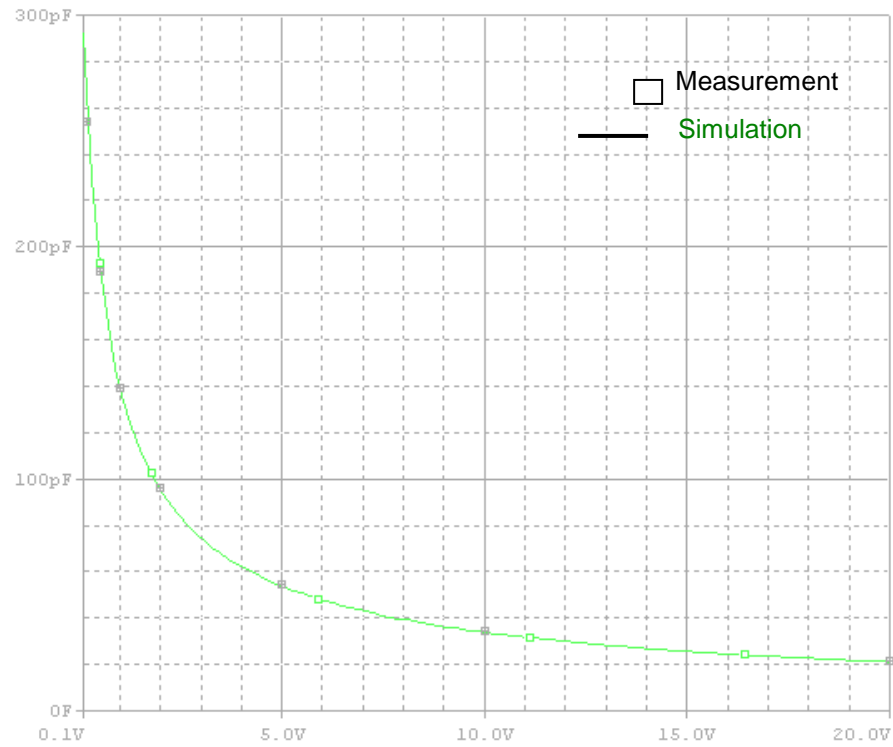
Evaluation circuit



Simulation Result

$V_{DD}=24V$, $I_D=11A$, $V_{GS}=10V$	Unit	Measurement	Simulation	%Error
Q_{gs}	nC	5.000	4.959	-0.83
Q_{gd}	nC	9.000	8.997	-0.04
Q_g	nC	38.000	25.047	-34.09

Capacitance Characteristic

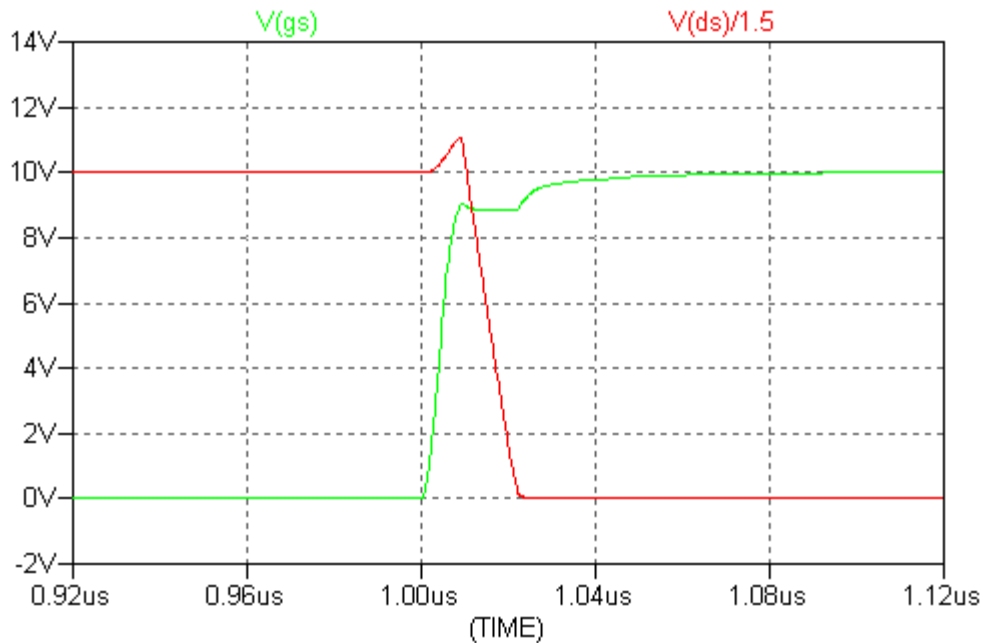


Simulation Result

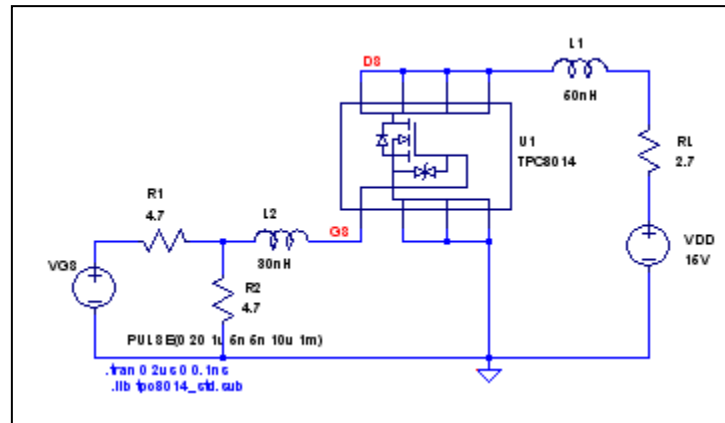
$V_{DS}(V)$	Cbd(pF)		%Error
	Measurement	Simulation	
0.100	300.000	291.900	-2.70
0.200	255.000	256.100	0.43
0.500	190.000	191.630	0.86
1.000	140.000	139.900	-0.07
2.000	97.000	95.500	-1.55
5.000	55.000	53.780	-2.22
10.000	35.000	33.840	-3.31
20.000	21.500	21.030	-2.19

Switching Time Characteristic

Circuit Simulation result



Evaluation circuit

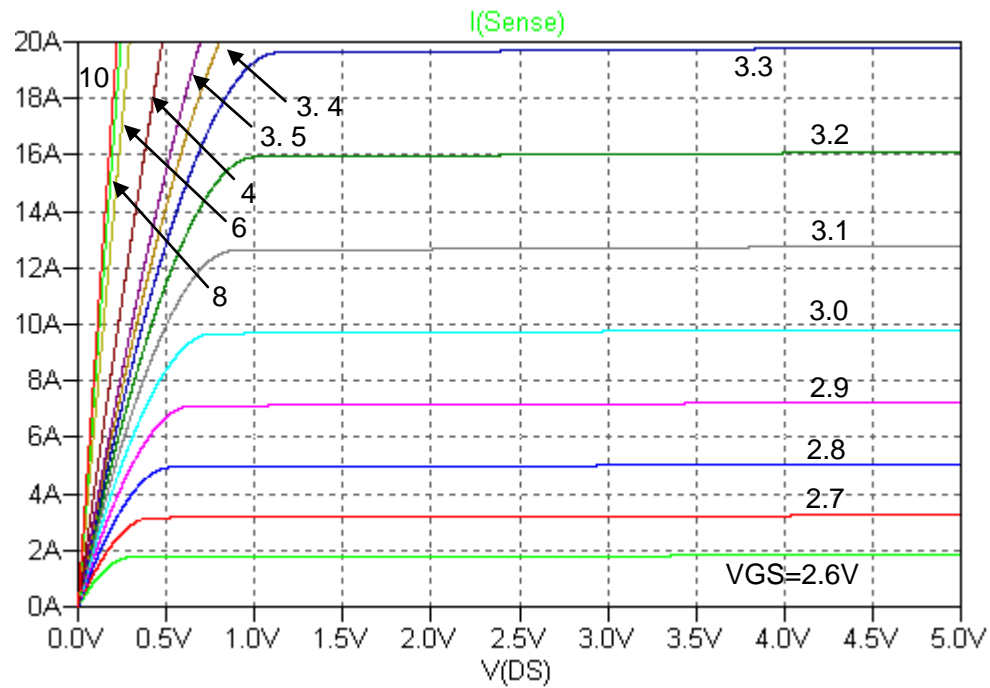


Simulation Result

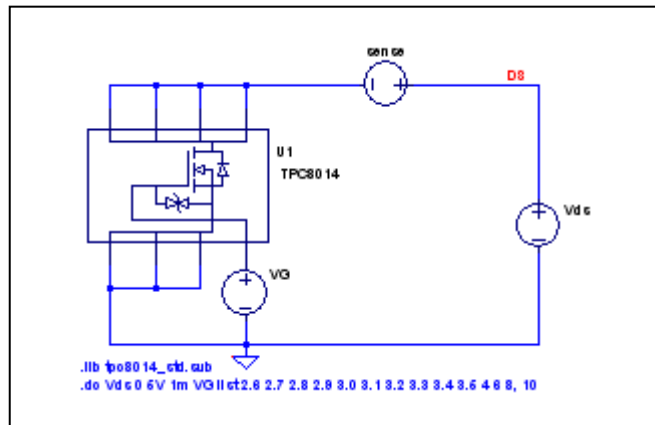
$I_D=5.5A$, $V_{DD}=15V$ $V_{GS}=0/10V$	Unit	Measurement	Simulation	%Error
t_{on}	ns	19.000	18.995	-0.03

Output Characteristic

Circuit Simulation result

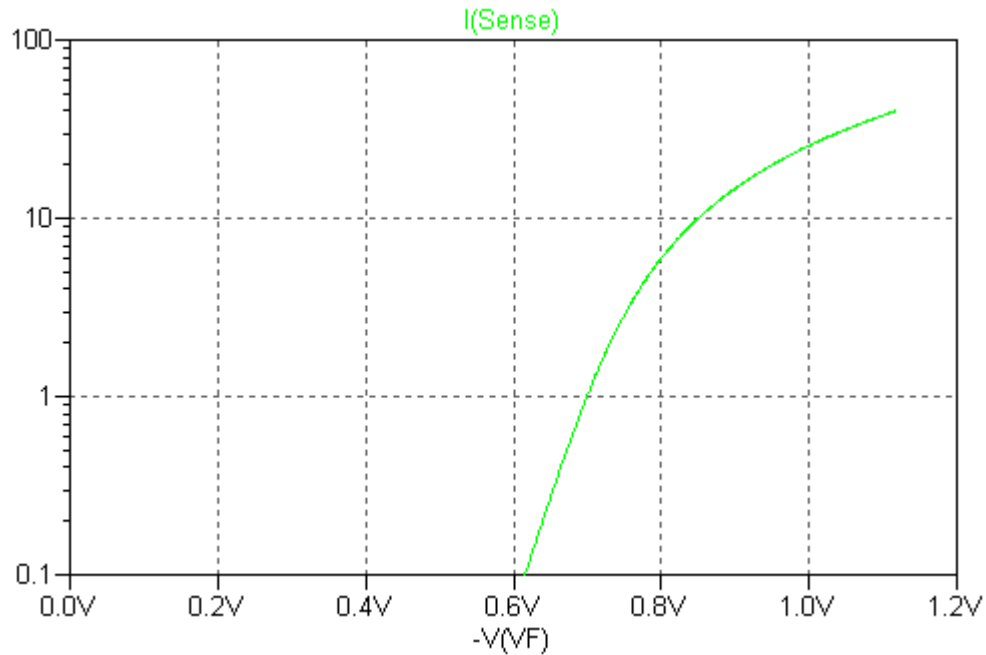


Evaluation circuit

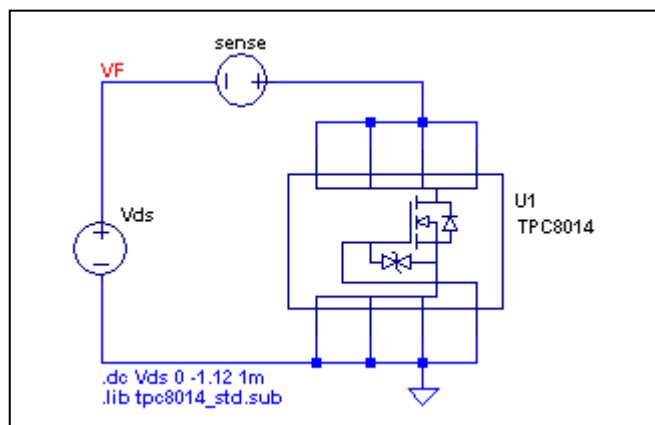


BODY DIODE SPICE MODEL Forward Current Characteristic

Circuit Simulation Result

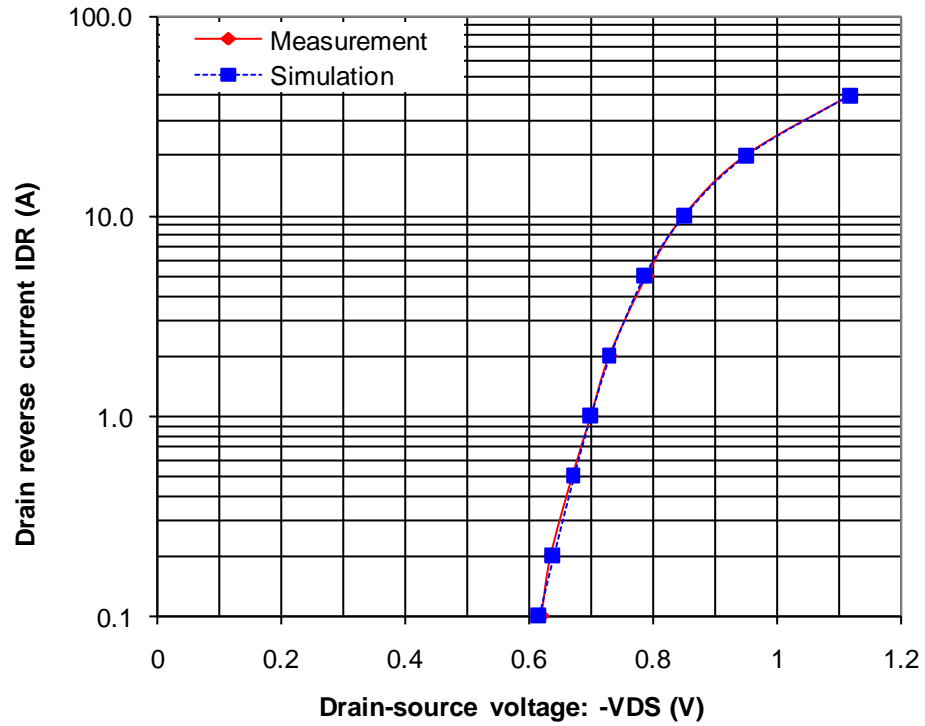


Evaluation circuit



Comparison Graph

Circuit Simulation Result

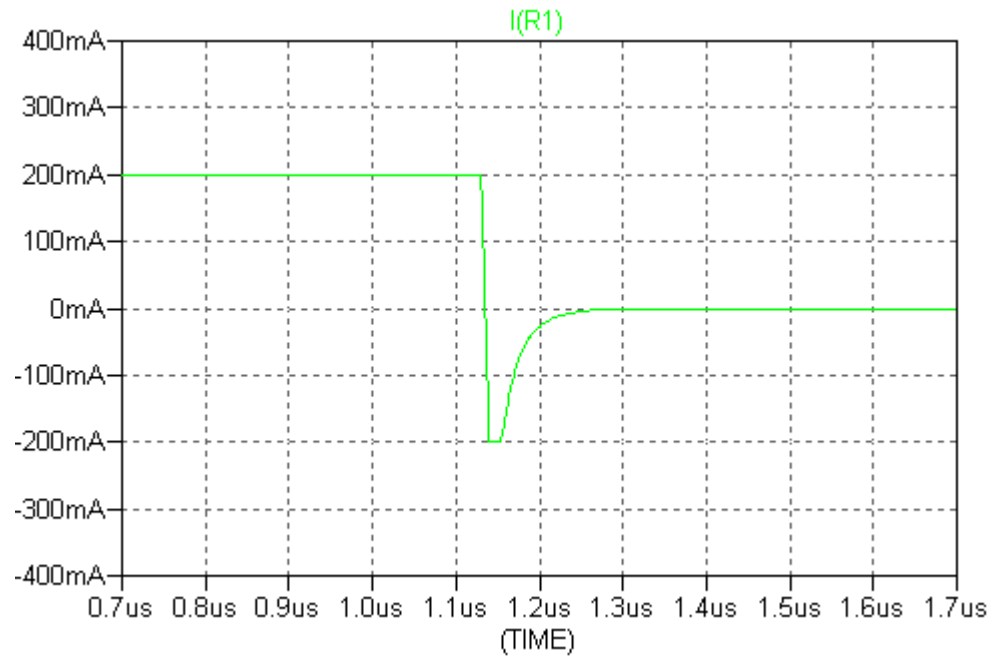


Simulation Result

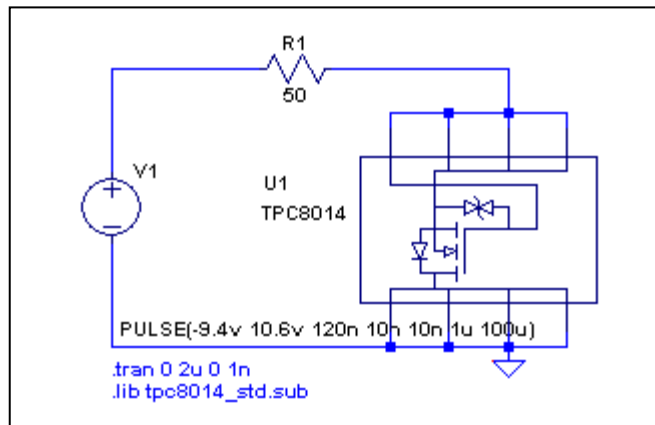
IDR (A)	$-VDS$ (V)		%Error
	Measurement	Simulation	
0.1	0.6200	0.6156	-0.71
0.2	0.6350	0.6394	0.69
0.5	0.6700	0.6722	0.32
1	0.7000	0.6993	-0.10
2	0.7300	0.7307	0.10
5	0.7900	0.7863	-0.47
10	0.8500	0.8504	0.05
20	0.9500	0.9516	0.16
40	1.1200	1.1195	-0.04

Reverse Recovery Characteristic

Circuit Simulation Result



Evaluation circuit

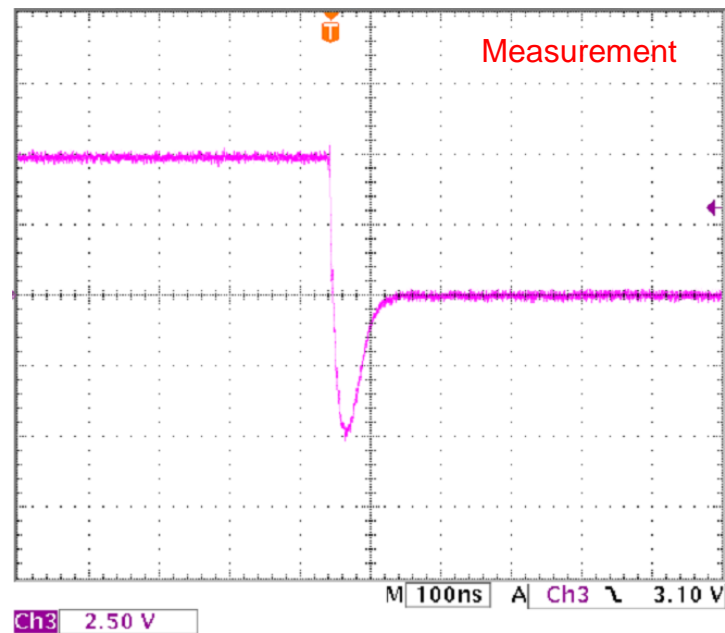


Compare Measurement vs. Simulation

Parameter	Unit	Measurement	Simulation	%Error
trj	ns	16.000	16.271	1.69

Reverse Recovery Characteristic

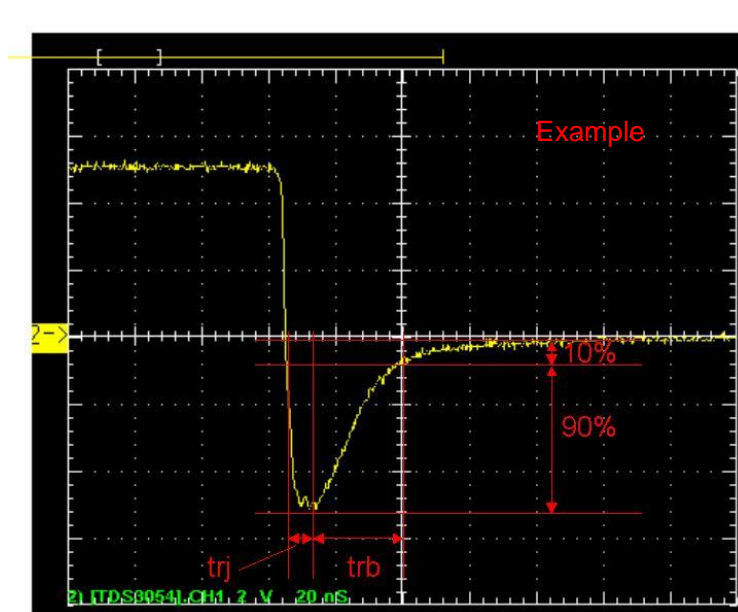
Reference



$T_{rj}=16.00(\text{ns})$

$T_{rb}=44.00(\text{ns})$

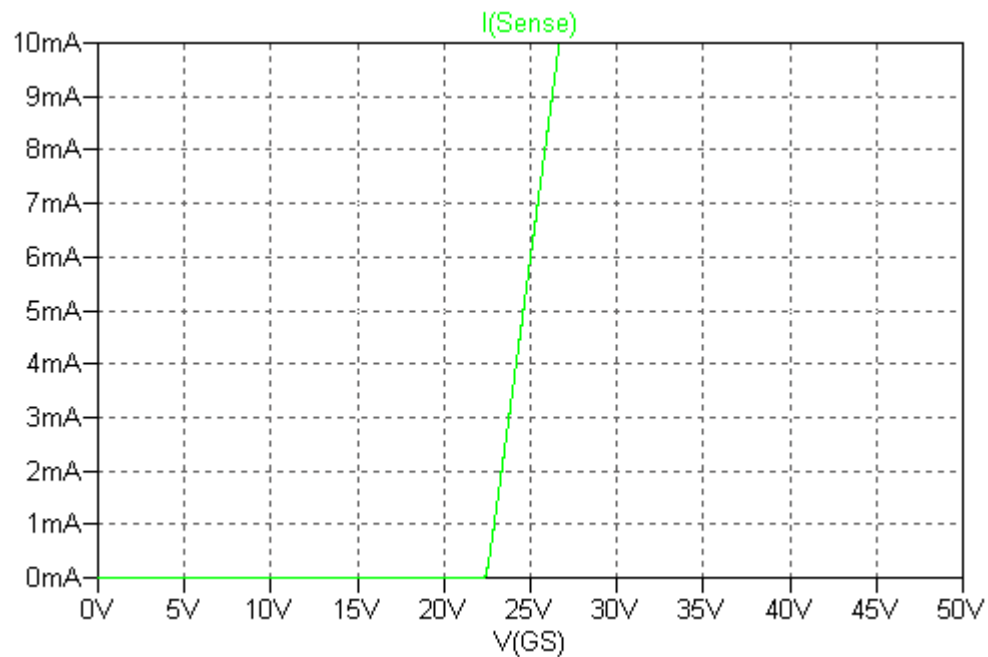
Conditions: $I_{fwd}=I_{rev}=0.2(\text{A})$, $R_l=50$



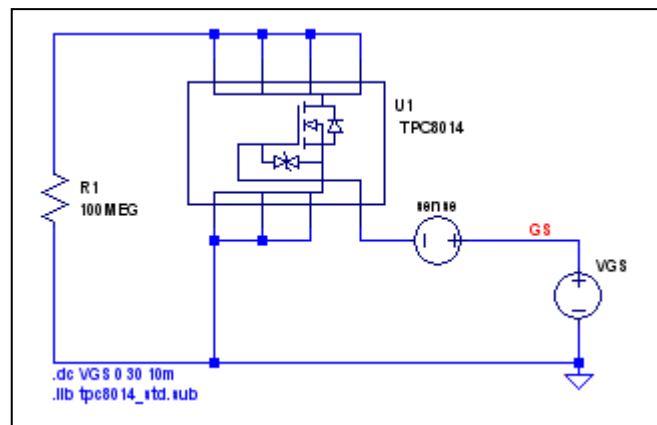
Relation between t_{rj} and t_{rb}

ESD PROTECTION DIODE Zener Voltage Characteristic

Circuit Simulation Result



Evaluation circuit



Zener Voltage Characteristic

Reference

