

# Device Modeling Report

COMPONENTS: Power MOSFET (Professional)  
PART NUMBER: 2SK2417  
MANUFACTURER: TOSHIBA  
Body Diode (Professional) / ESD Protection Diode



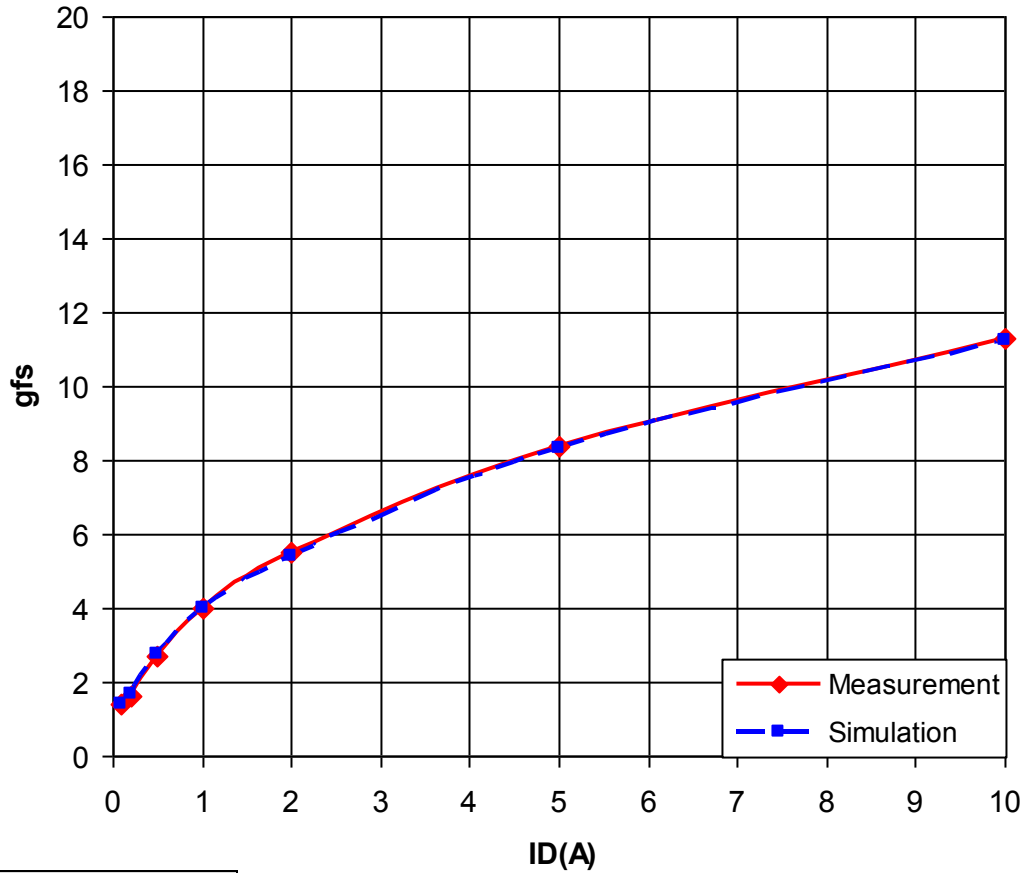
**Bee Technologies Inc.**

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

# Transconductance Characteristic

## Circuit Simulation Result

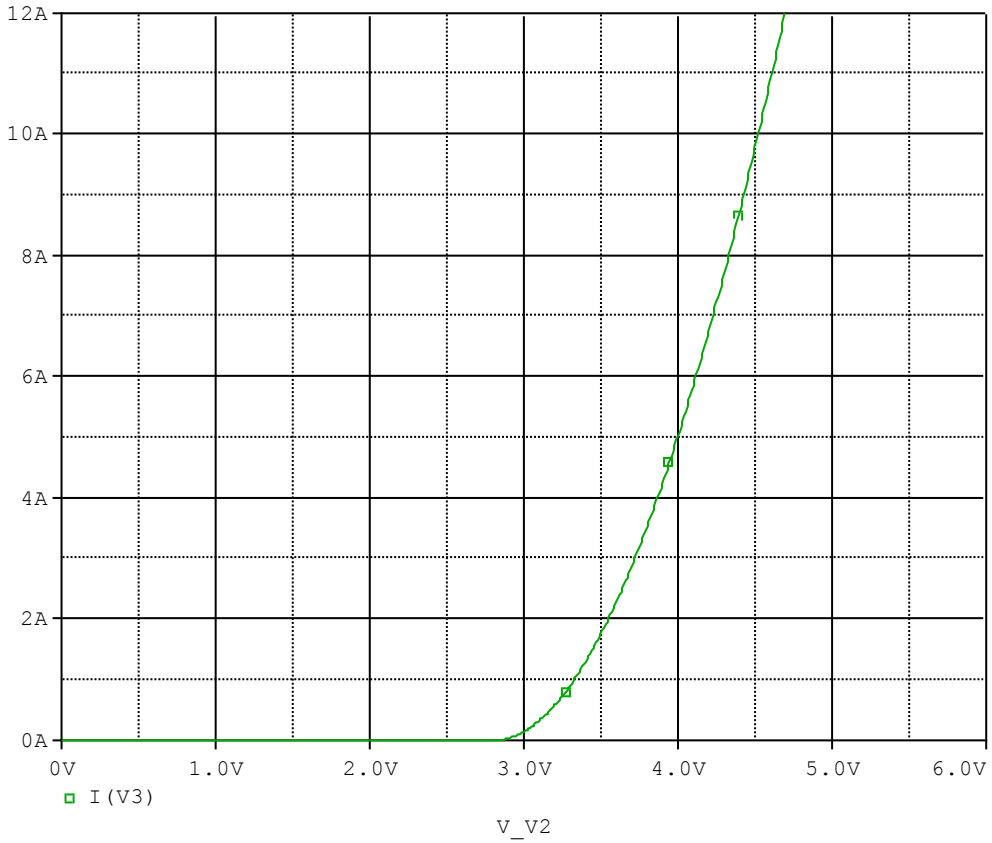


## Comparison table

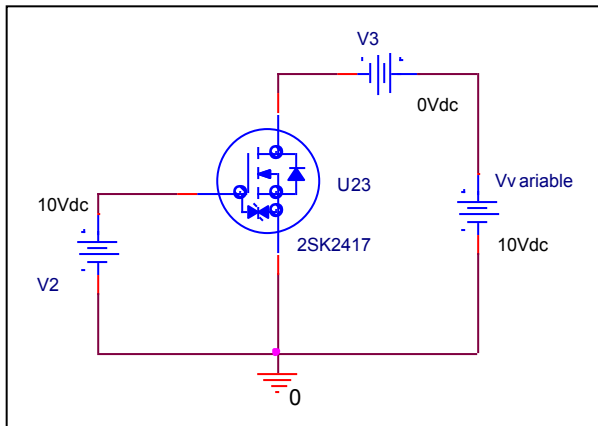
Id(A)	gfs		Error(%)
	Measurement	Simulation	
0.1	1.400	1.428	2.000
0.2	1.600	1.667	4.188
0.5	2.700	2.778	2.889
1	4.000	4.000	0.000
2	5.500	5.405	-1.727
5	8.400	8.333	-0.798
10	11.300	11.236	-0.566

# Vgs-Id Characteristic

Circuit Simulation result

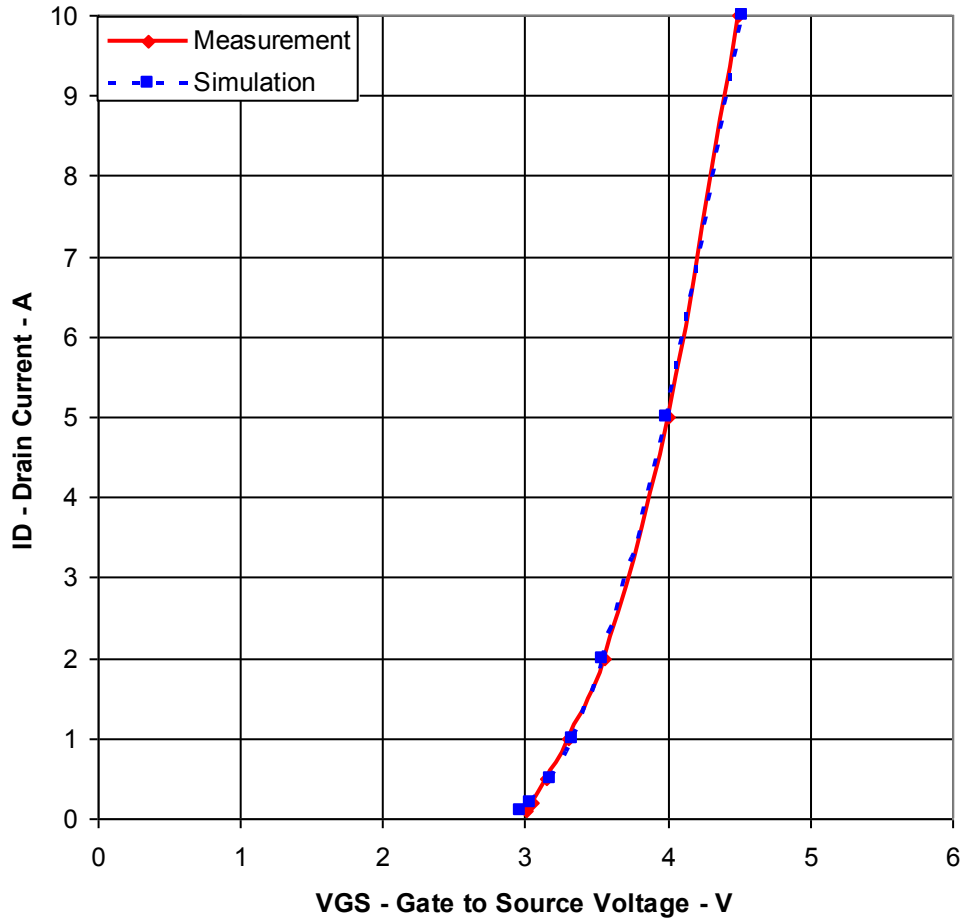


Evaluation circuit



# Comparison Graph

## Circuit Simulation Result

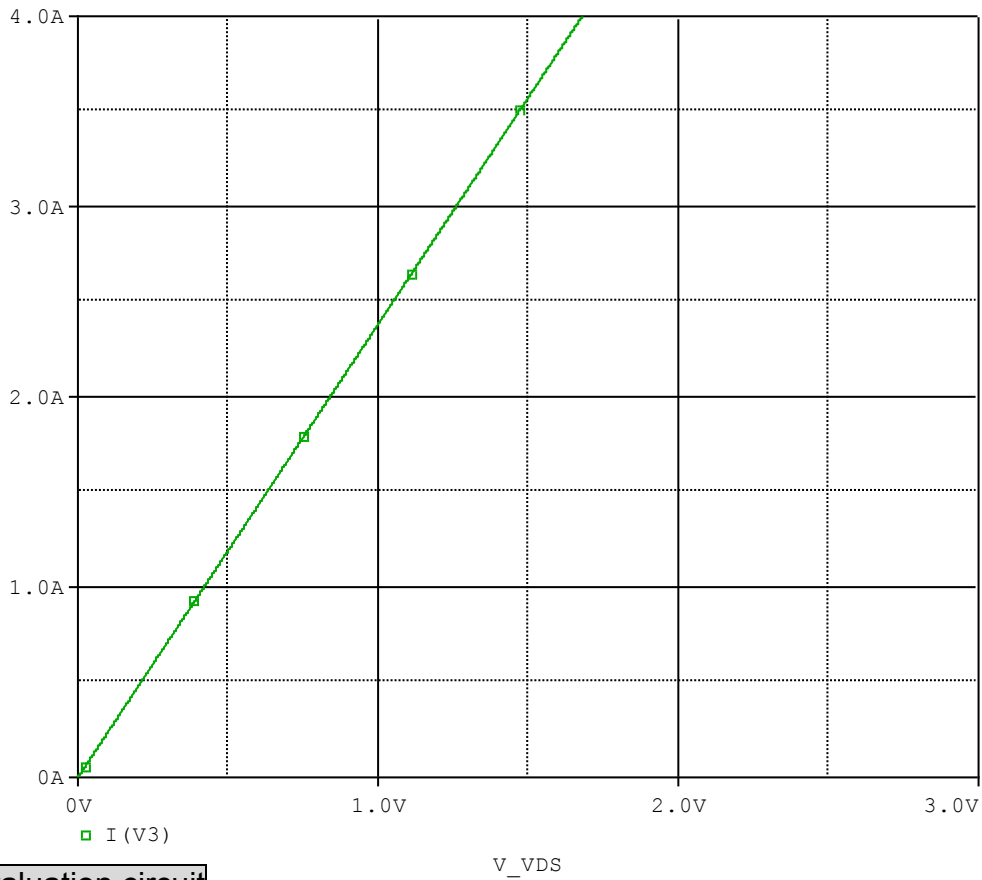


## Simulation Result

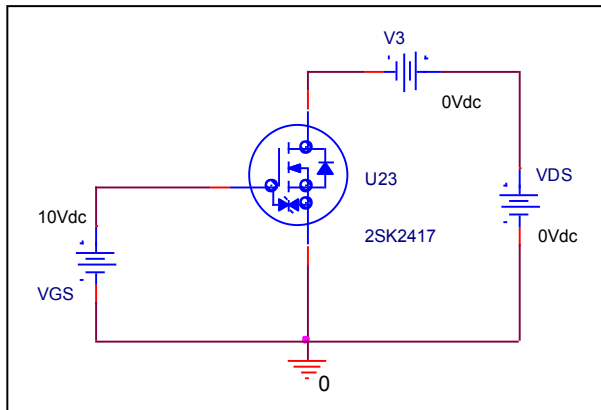
$I_D$ (A)	$V_{GS}$ (V)		Error (%)
	Measurement	Simulation	
0.1	3.000	2.968	-1.067
0.2	3.050	3.035	-0.492
0.5	3.150	3.171	0.667
1	3.300	3.326	0.788
2	3.550	3.547	-0.085
5	4.000	3.997	-0.075
10	4.500	4.519	0.422

# R<sub>ds(on)</sub> Characteristic

## Circuit Simulation result



## Evaluation circuit

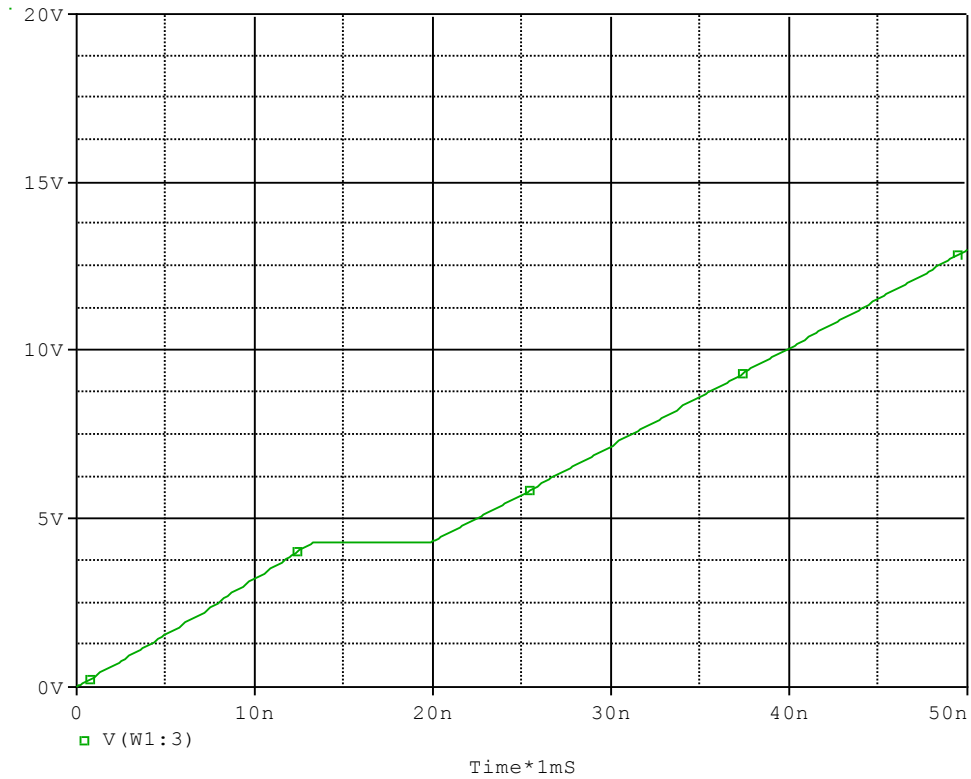


## Simulation Result

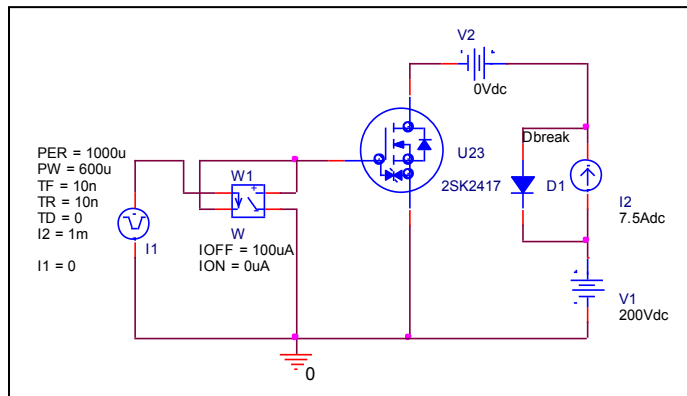
<b>I<sub>D</sub>=3.5A, V<sub>GS</sub>=10V</b>	<b>Measurement</b>		<b>Simulation</b>		<b>Error (%)</b>
<b>R<sub>DS</sub> (on)</b>	<b>0.420</b>	<b>Ω</b>	<b>0.420</b>	<b>Ω</b>	<b>0</b>

# Gate Charge Characteristic

## Circuit Simulation result



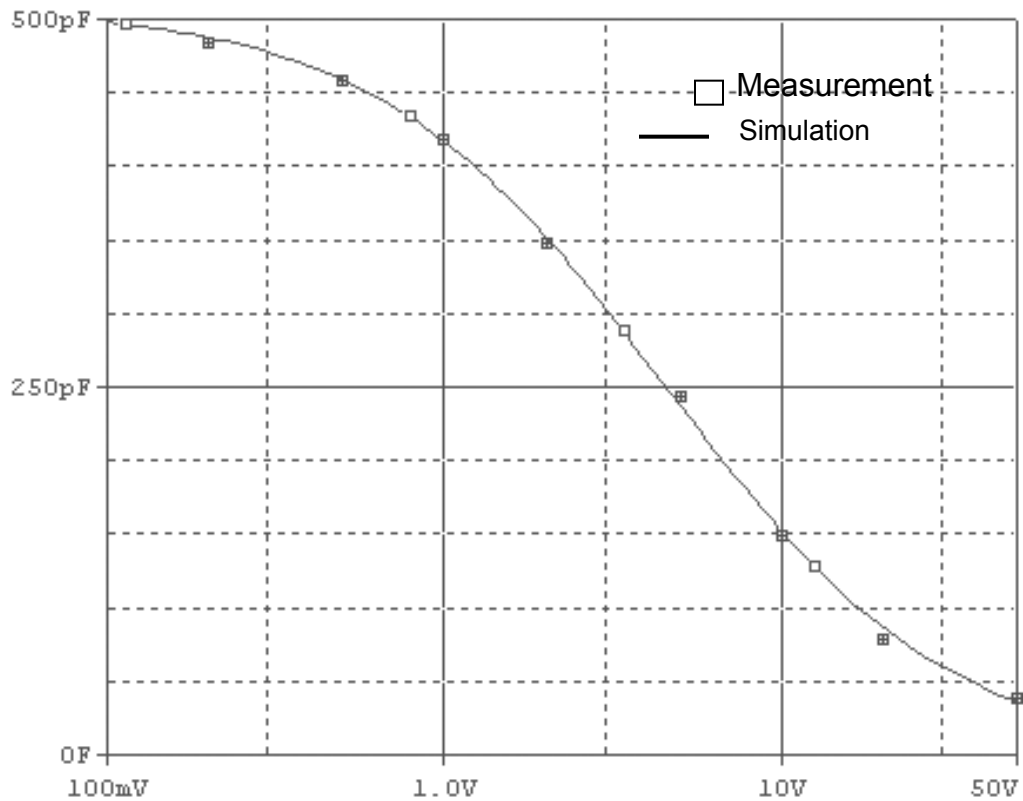
## Evaluation circuit



## Simulation Result

<b><math>V_{DD}=200V, I_D=7.5A</math> <math>, V_{GS}=10V</math></b>	<b>Measurement</b>	<b>Simulation</b>	<b>Error (%)</b>
<b>Qgs(nC)</b>	<b>13.000</b>	<b>13.109</b>	<b>0.838</b>
<b>Qgd(nC)</b>	<b>7.000</b>	<b>6.891</b>	<b>-1.557</b>
<b>Qg</b>	<b>40.000</b>	<b>39.783</b>	<b>-0.542</b>

## Capacitance Characteristic



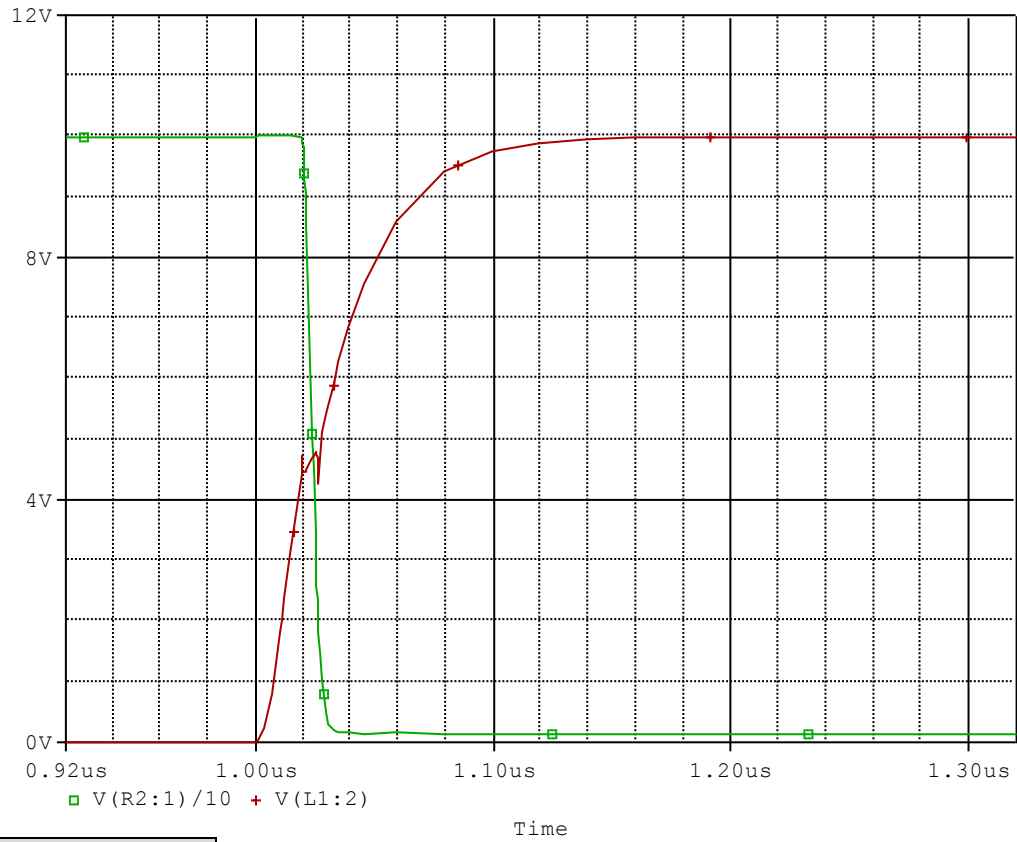
### Simulation Result

V <sub>DS</sub> (V)	Cbd(pF)		Error(%)
	Measurement	Simulation	
0.1	503.000	500.000	-0.596
0.2	487.000	485.000	-0.411
0.5	460.000	460.000	0.000
1	420.000	420.000	0.000
2	351.000	350.000	-0.285
5	248.000	245.000	-1.210
10	151.000	150.000	-0.662
20	83.000	80.000	-3.614
50	39.000	40.000	2.564

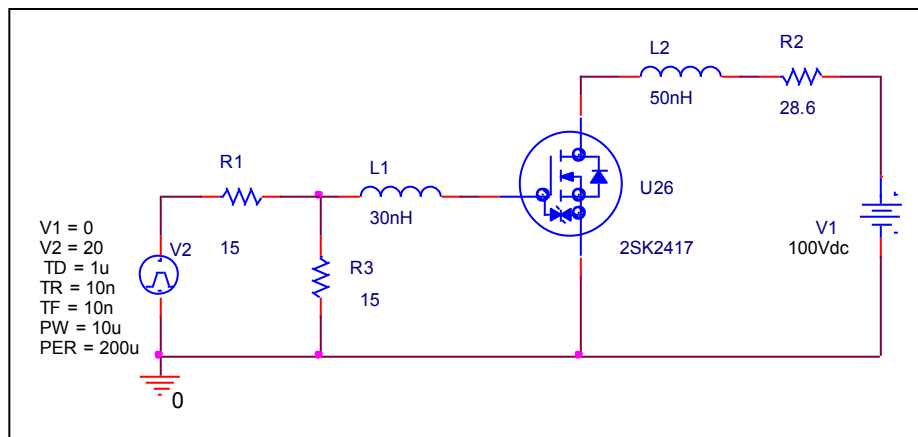


# Switching Time Characteristic

## Circuit Simulation result



## Evaluation circuit

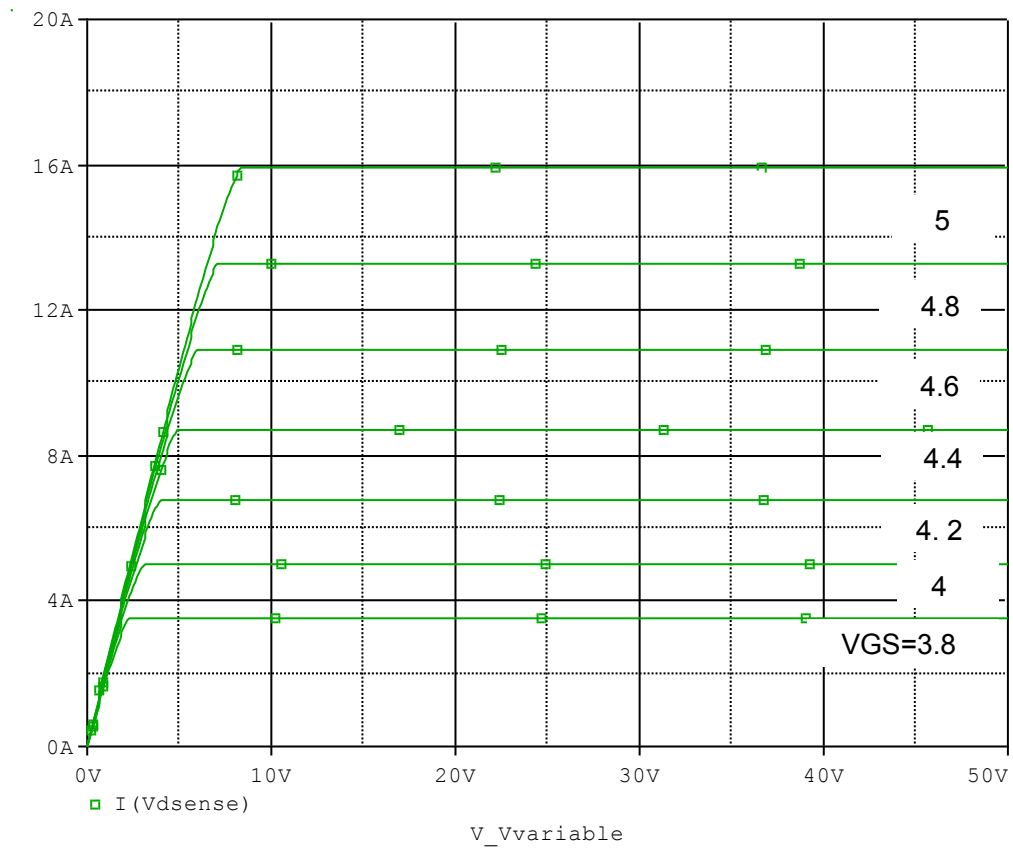


## Simulation Result

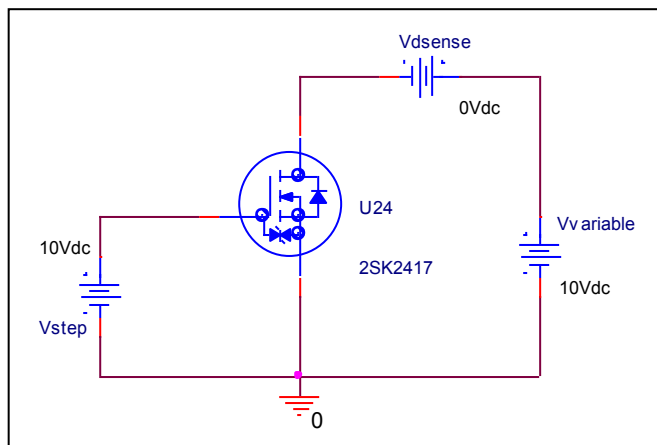
$I_D=3.5\text{ A}, V_{DD}=100\text{ V}$ $V_{GS}=0/10\text{ V}$	Measurement	Simulation	Error(%)
<b>Ton(ns)</b>	<b>20.000</b>	<b>20.529</b>	<b>2.645</b>

# Output Characteristic

## Circuit Simulation result

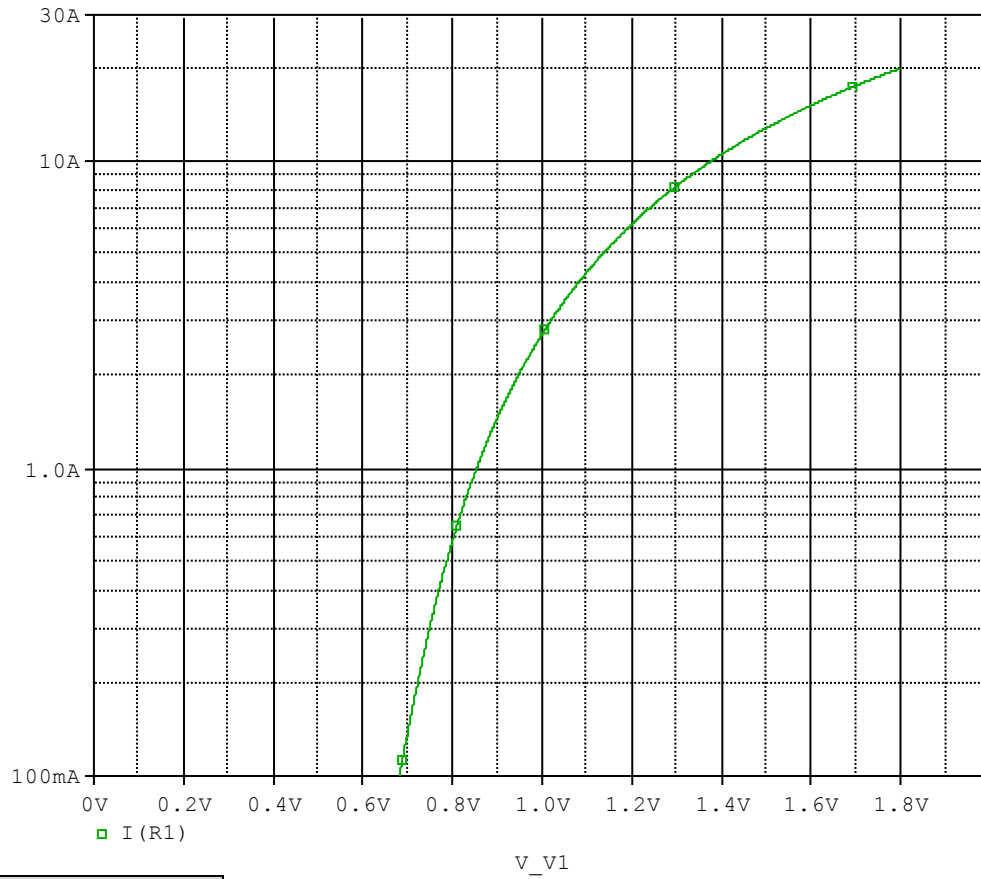


## Evaluation circuit

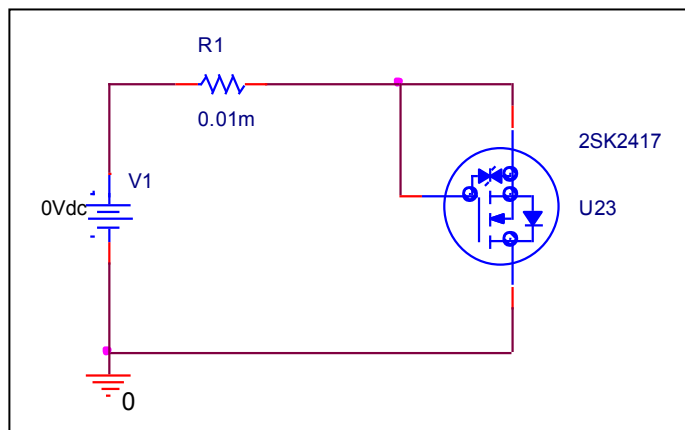


# Forward Current Characteristic

## Circuit Simulation Result

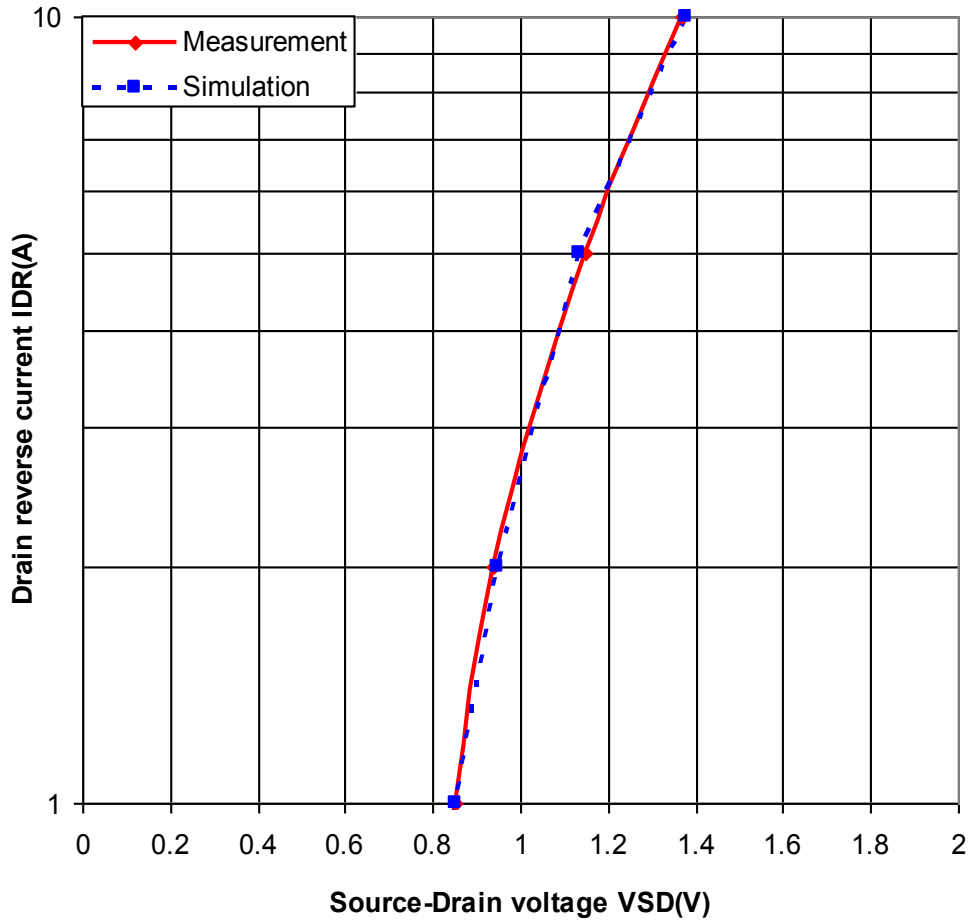


## Evaluation Circuit



## Comparison Graph

### Circuit Simulation Result

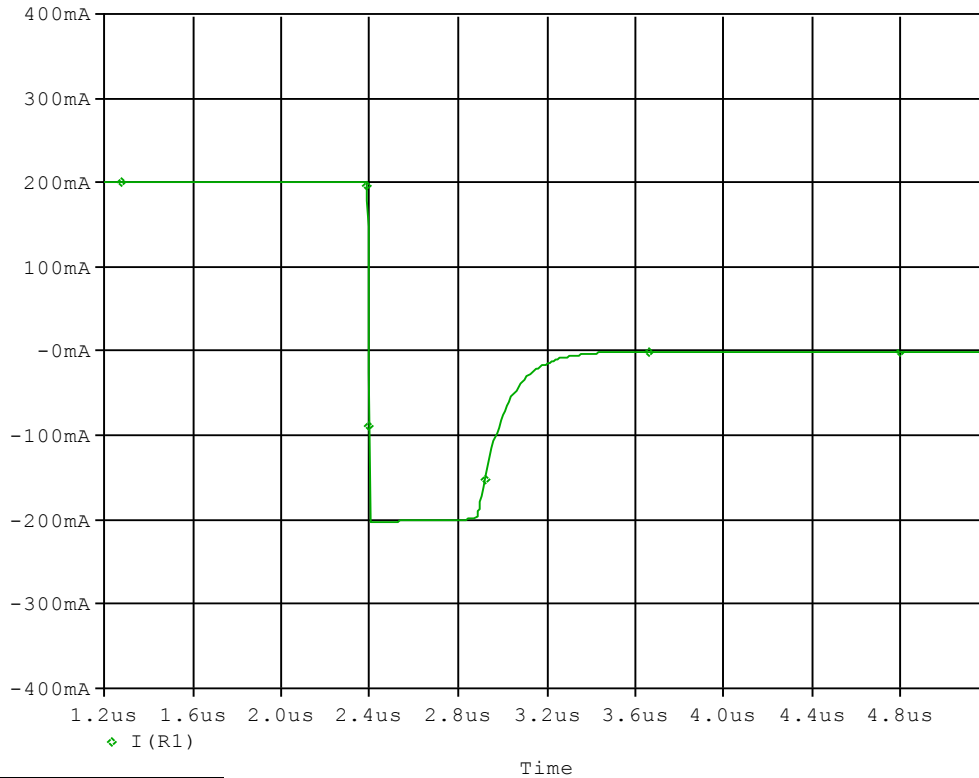


### Simulation Result

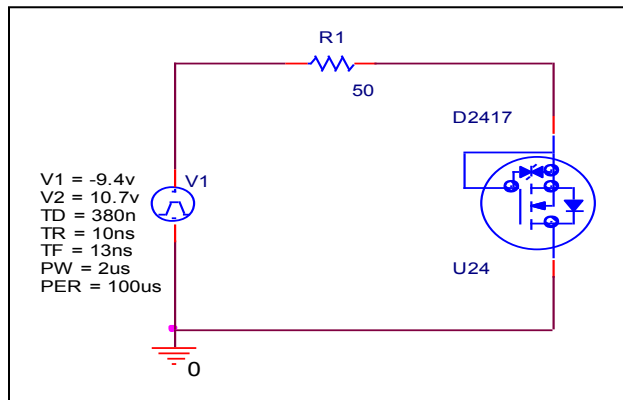
IDR(A)	VSD(V)		%Error
	Measuremen	Simulation	
0.1	0.700	0.681	-2.714
0.2	0.720	0.721	0.139
0.5	0.760	0.786	3.421
1	0.850	0.853	0.353
2	0.940	0.945	0.532
5	1.150	1.135	-1.304
10	1.370	1.377	0.511

# Reverse Recovery Characteristic

## Circuit Simulation Result



## Evaluation Circuit

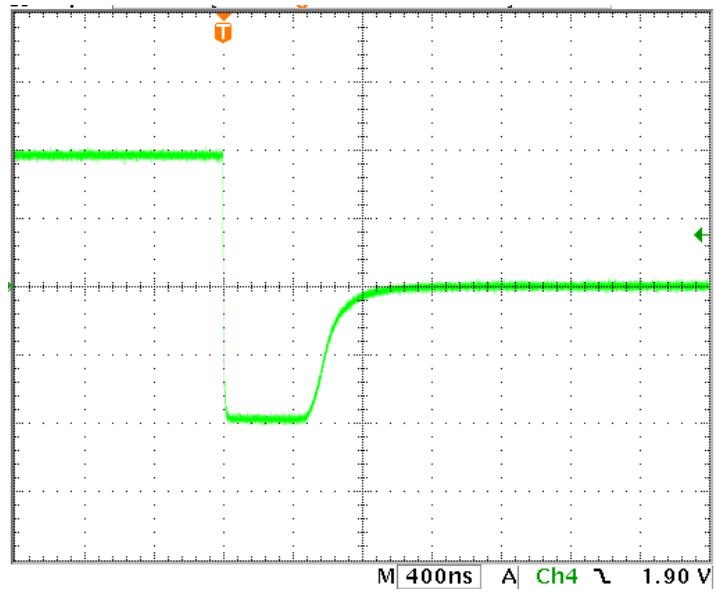


## Compare Measurement vs. Simulation

	Measurement	Simulation	Error (%)
<b>Trj(ns)</b>	<b>484.000</b>	<b>484.723</b>	<b>0.149</b>
<b>Trb(ns)</b>	<b>280.000</b>	<b>283.217</b>	<b>1.149</b>
<b>Trr(ns)</b>	<b>764.000</b>	<b>767.940</b>	<b>0.516</b>

## Reverse Recovery Characteristic

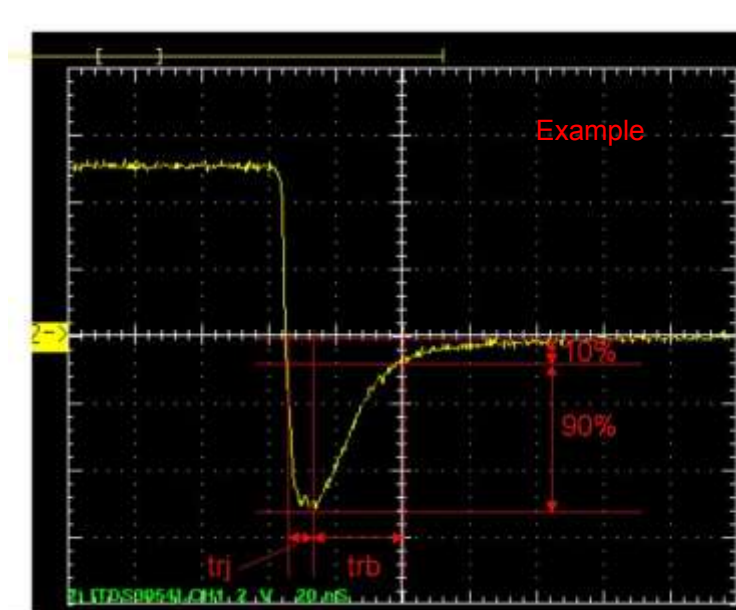
## Reference



$T_{rj}=484(\text{ns})$

$T_{rb}=28(\text{ns})$

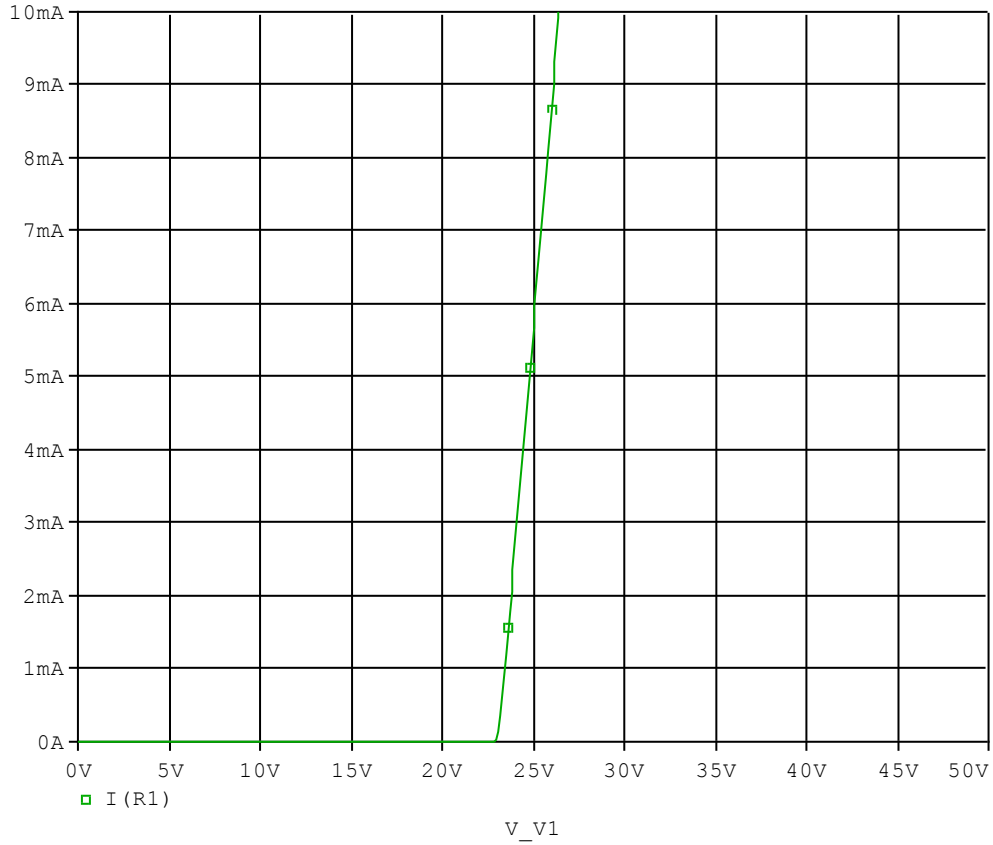
Conditions:  $I_{fwd}=I_{rev}=0.2(\text{A}), R_I=50$



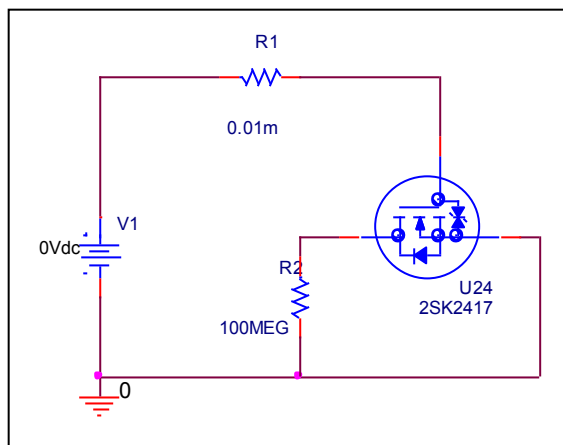
Relation between  $t_{rj}$  and  $t_{rb}$

# Zener Voltage Characteristic

## Circuit Simulation Result



## Evaluation Circuit



# Zener Voltage Characteristic

# Reference

