# Device Modeling Report

COMPONENTS: MOSFET (Professional Model)
PART NUMBER: 2SK3062
MANUFACTURER: NEC Corporation
REMARK: Body Diode (Professional Model) /
ESD Protection Diode

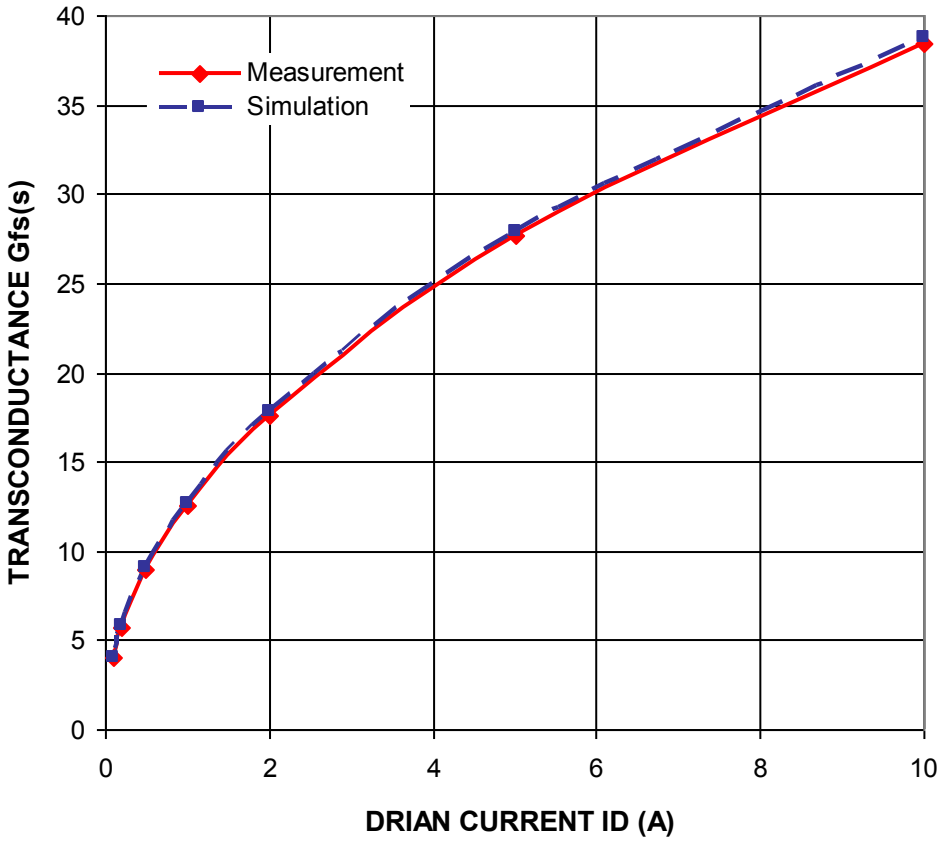

**Bee Technologies Inc.**

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

## Transconductance Characteristics

Circuit Simulation Result

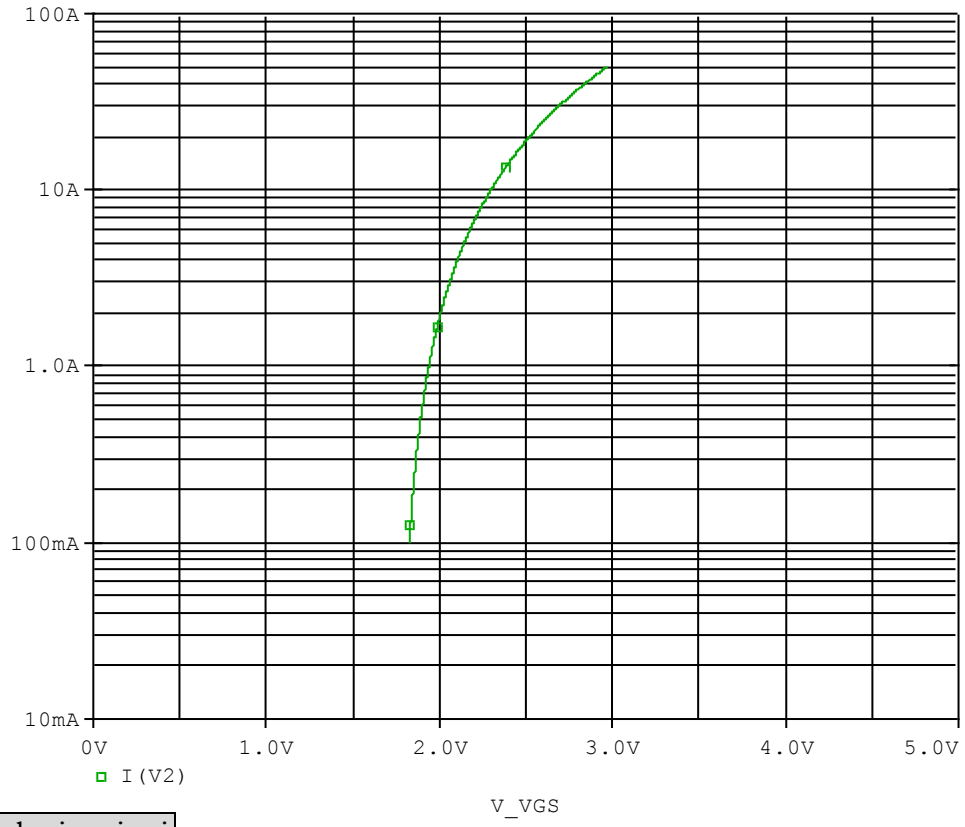



Comparison table

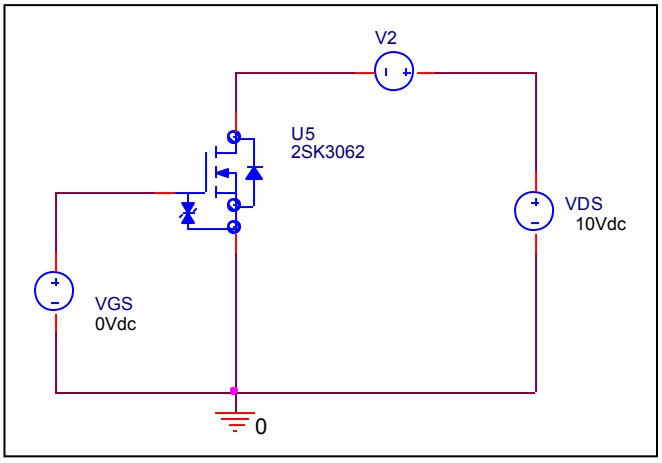
| Id(A) | gfs(s) | | Error(%) |
|---|---|---|---|
| | Measurement | Simulation | |
| 0.1 | 4.000 | 4.089 | 2.222 |
| 0.2 | 5.714 | 5.854 | 2.450 |
| 0.5 | 8.929 | 9.070 | 1.584 |
| 1 | 12.500 | 12.705 | 1.640 |
| 2 | 17.544 | 17.830 | 1.631 |
| 5 | 27.624 | 27.888 | 0.955 |
| 10 | 38.462 | 38.756 | 0.766 |

# Vgs-Id Characteristics

## Circuit Simulation Result

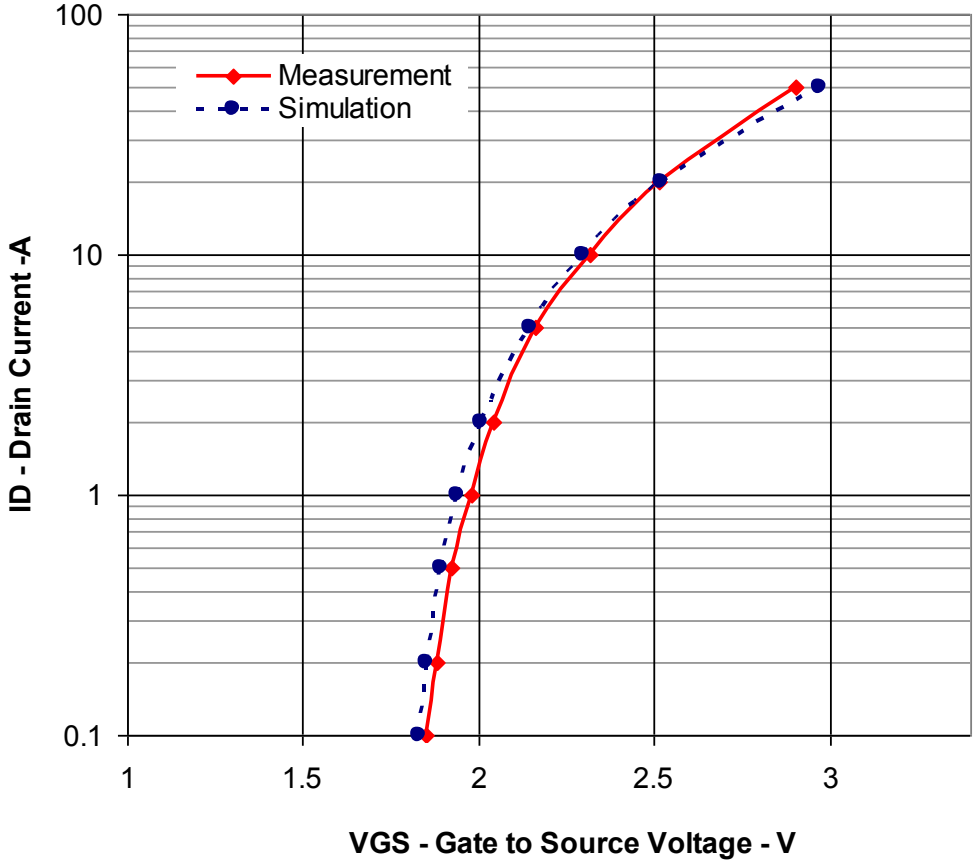



## Evaluation circuit



## Comparison Graph

Circuit Simulation Result

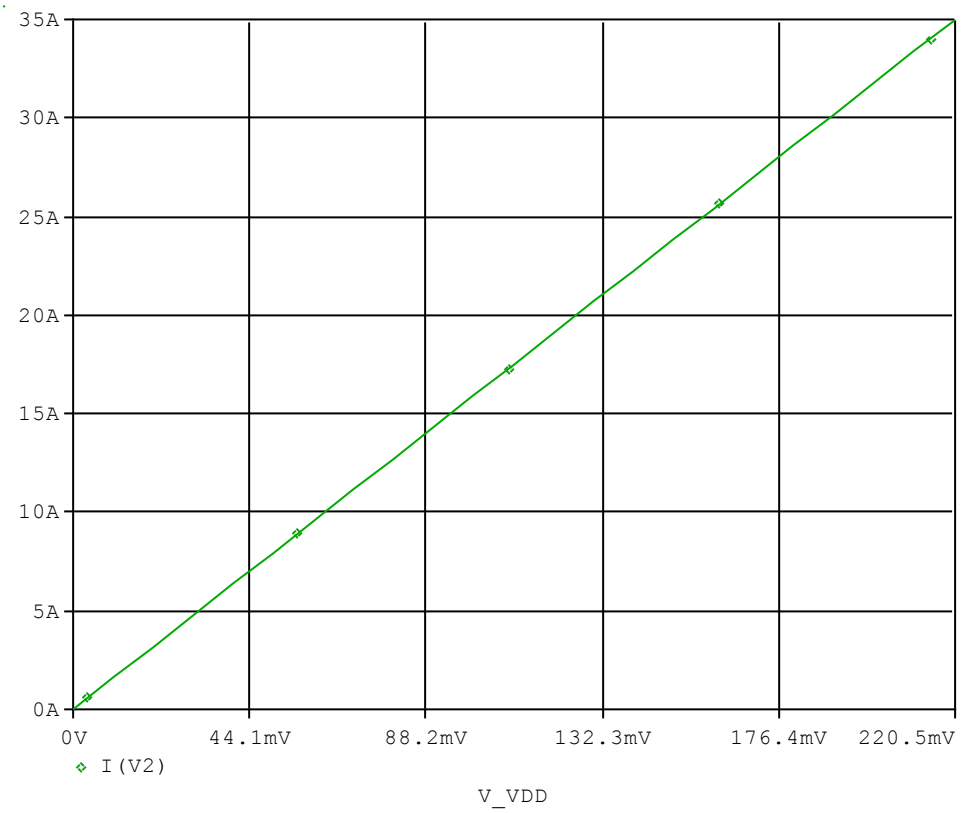



Comparison table

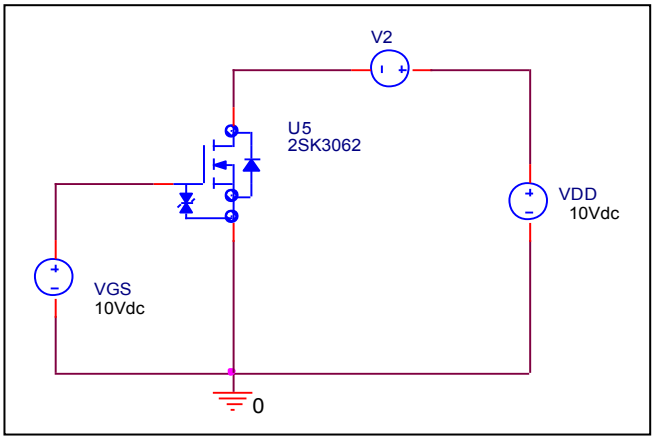
| $I_D$(A) | $V_{GS}$(V) | | Error (%) |
|---|---|---|---|
| | Measurement | Simulation | |
| 0.1 | 1.850 | 1.827 | -1.227 |
| 0.2 | 1.880 | 1.849 | -1.665 |
| 0.5 | 1.925 | 1.891 | -1.761 |
| 1 | 1.980 | 1.939 | -2.071 |
| 2 | 2.040 | 2.007 | -1.613 |
| 5 | 2.160 | 2.143 | -0.773 |
| 10 | 2.315 | 2.298 | -0.721 |
| 20 | 2.515 | 2.521 | 0.219 |
| 50 | 2.900 | 2.972 | 2.469 |

## *Rds(on) Characteristic

Circuit Simulation result




Evaluation circuit

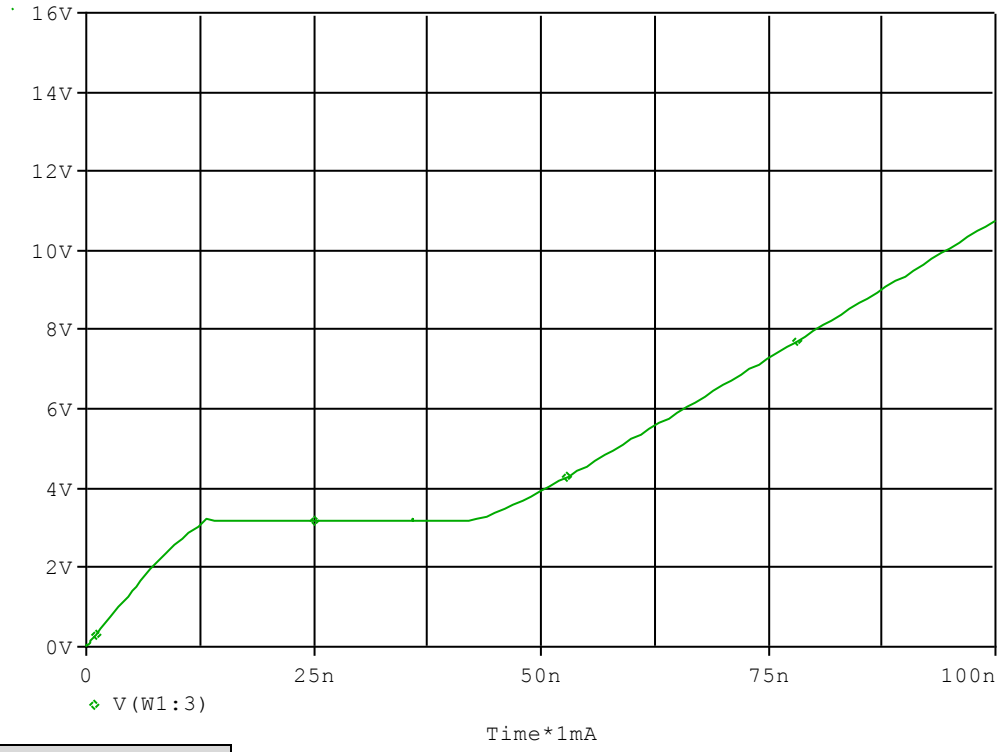



Simulation Result

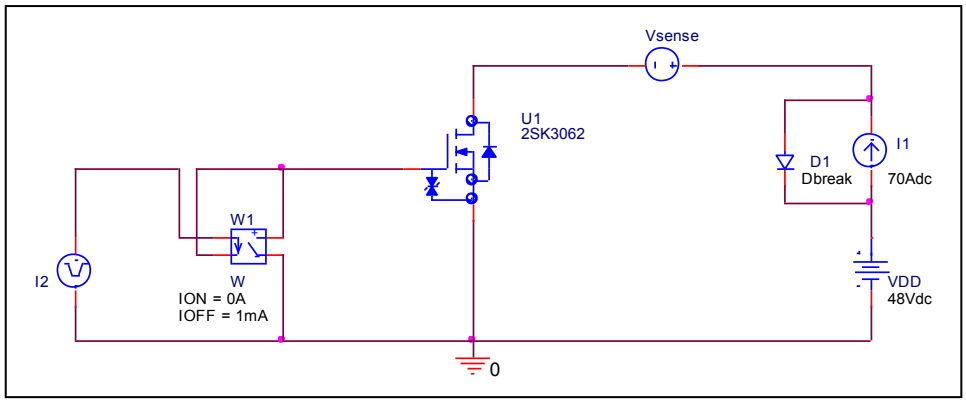
| $I_D$=35A, $V_{GS}$=10V | Measurement | | Simulation | | Error (%) |
|---|---|---|---|---|---|
| $R_{DS}$ (on) | 6.30 | mΩ | 6.30 | mΩ | 0.00 |

## Gate Charge Characteristic

Circuit Simulation result



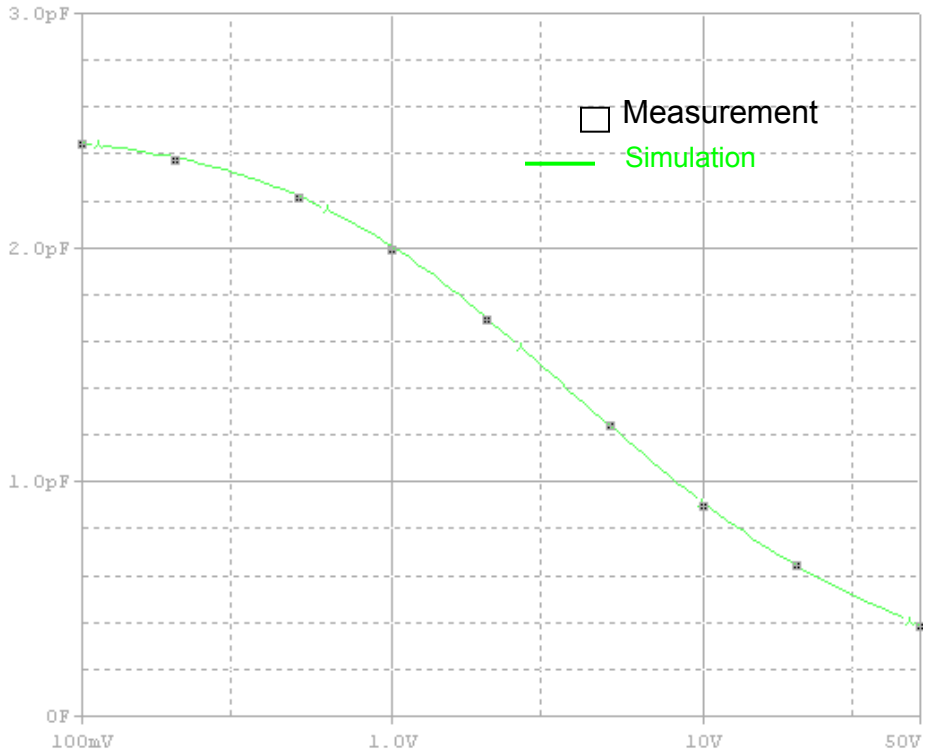

Evaluation circuit




Simulation Result

| $V_{DD}$=48V,$I_D$=70A ,$V_{GS}$=10V | | Measurement | Simulation | Error (%) |
|---|---|---|---|---|
| Qgs | nC | 13.000 | 13.029 | 0.223 |
| Qgd | nC | 30.000 | 29.993 | -0.023 |
| Qg | nC | 95.000 | 94.593 | -0.428 |

## Capacitance Characteristic

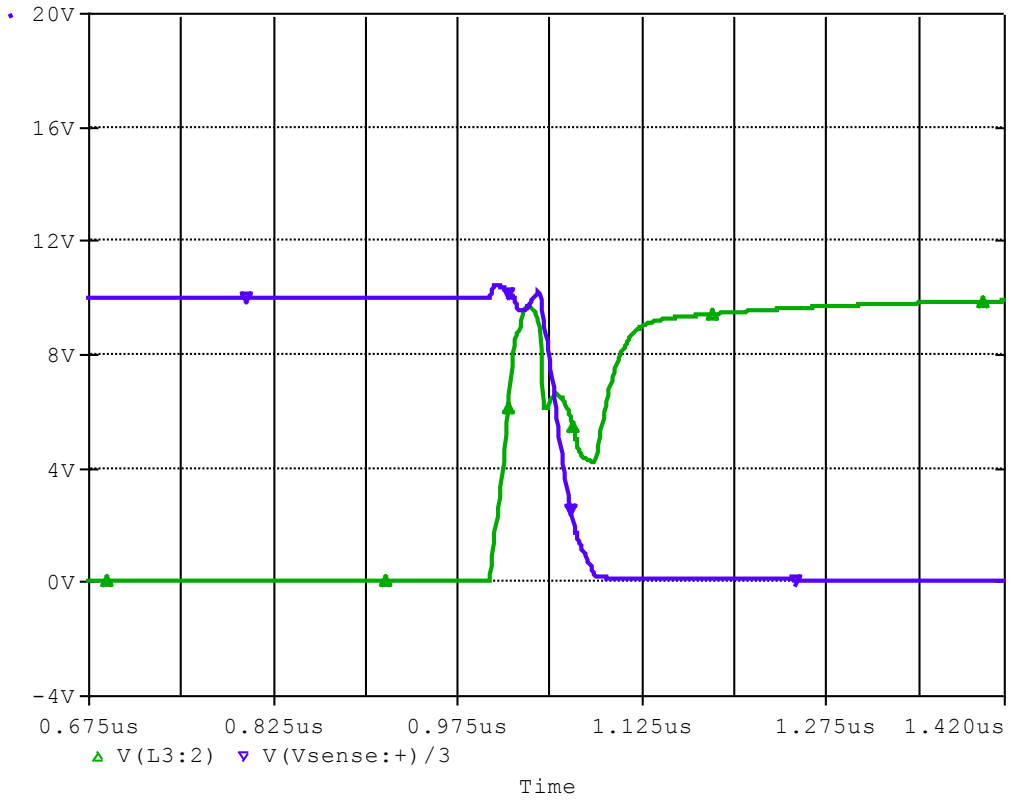



Simulation Result

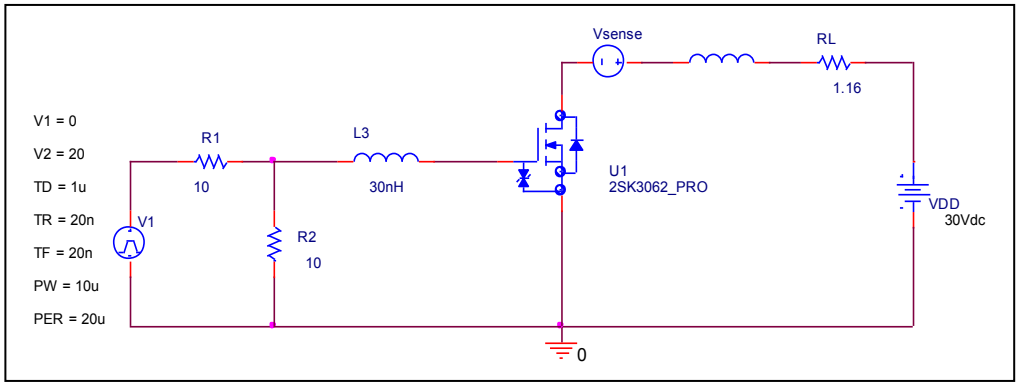
| $V_{DS}$(V) | Cbd (pF) | | Error(%) |
|---|---|---|---|
| | Measurement | Simulation | |
| 0.1 | 2.450 | 2.430 | -0.816 |
| 0.2 | 2.380 | 2.360 | -0.840 |
| 0.5 | 2.220 | 2.240 | 0.901 |
| 1 | 2.000 | 1.980 | -1.000 |
| 2 | 1.700 | 1.680 | -1.176 |
| 5 | 1.250 | 1.230 | -1.600 |
| 10 | 0.900 | 0.910 | 1.111 |
| 20 | 0.650 | 0.630 | -3.077 |
| 50 | 0.390 | 0.400 | 2.564 |

## Switching Time Characteristic

Circuit Simulation result




Evaluation circuit

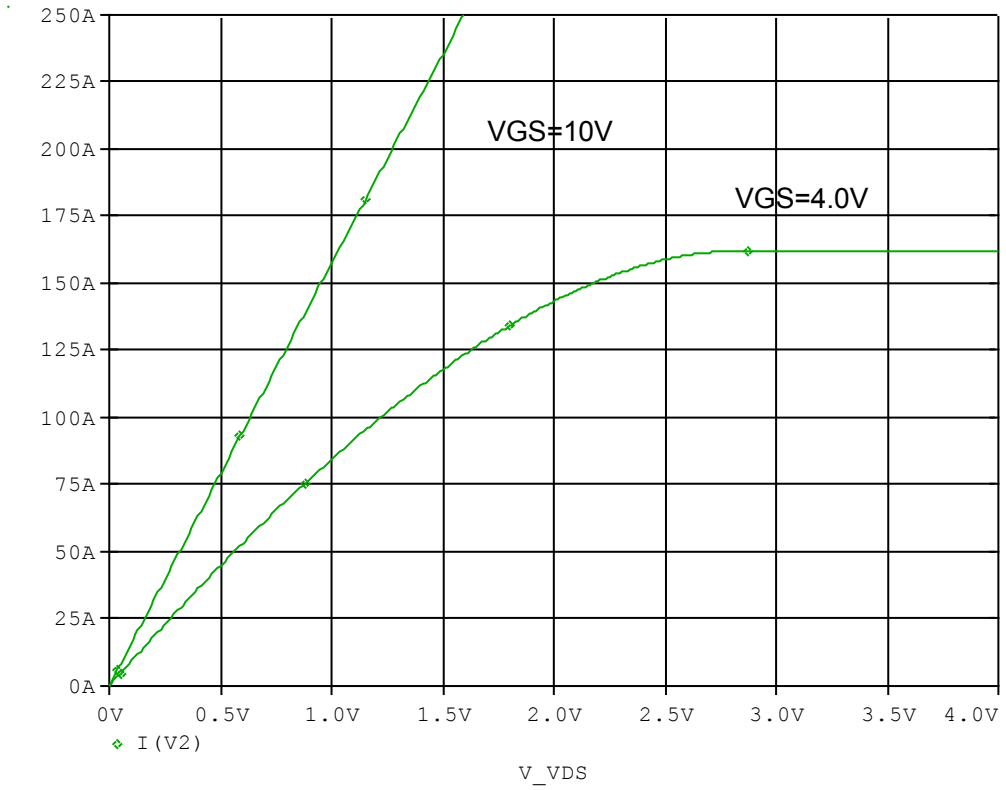



Simulation Result

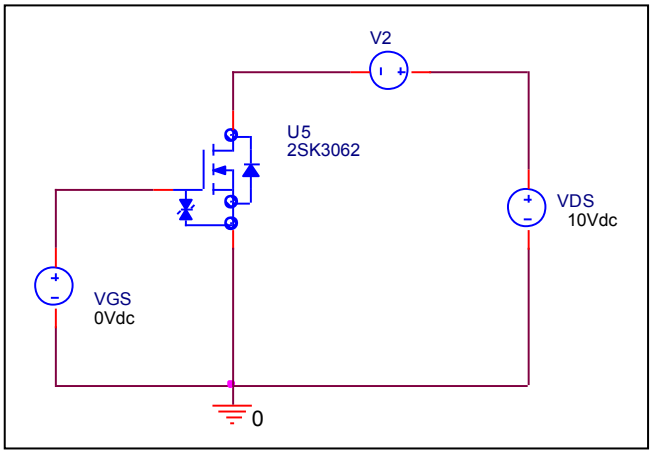
| $I_D$=35A, $V_{DD}$=30V $V_{GS}$=0/10V | | Measurement | Simulation | Error(%) |
|---|---|---|---|---|
| td (on) | ns | 75.00 | 84.91 | -0.120 |

## Output Characteristic

Circuit Simulation result

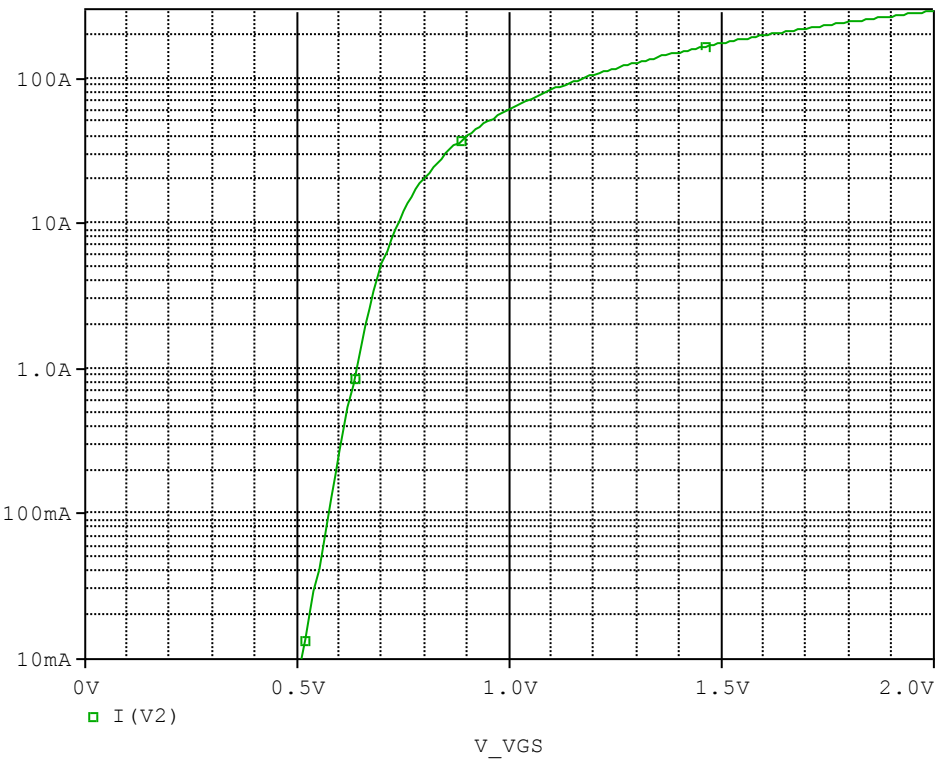



Evaluation circuit

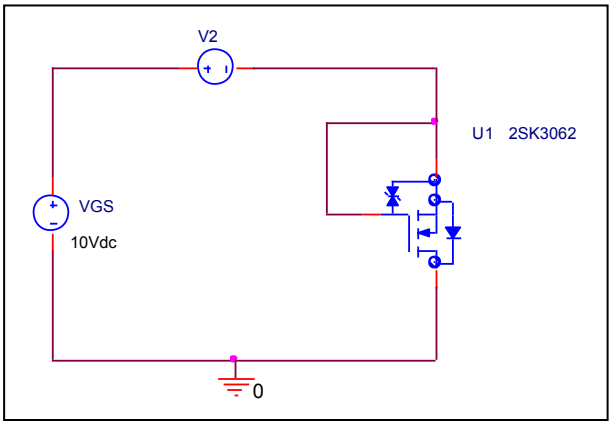


# BODY DIODE SPICE MODEL
# Forward Current Characteristic

## Circuit Simulation Result

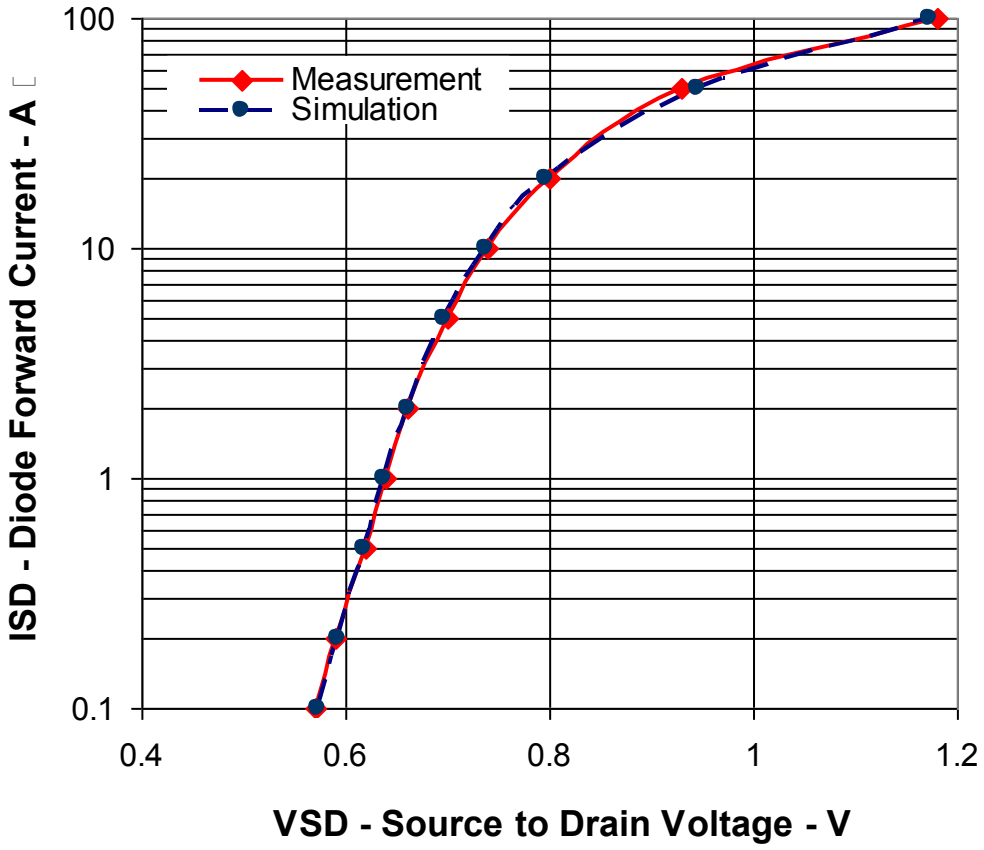



## Evaluation Circuit



## Comparison Graph

Circuit Simulation Result

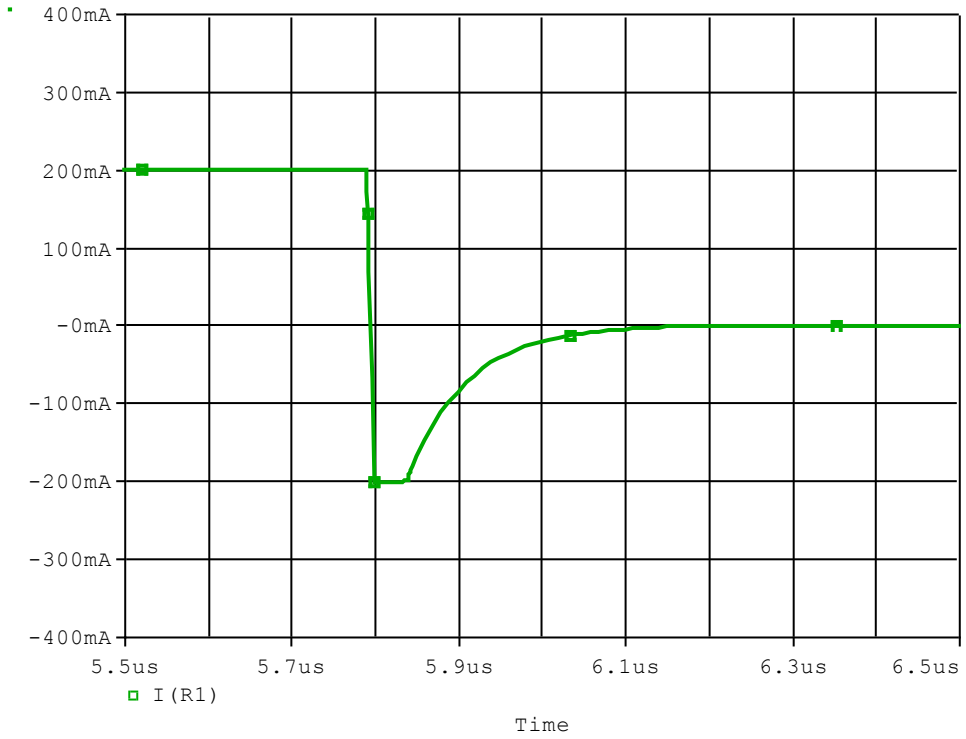



Simulation Result

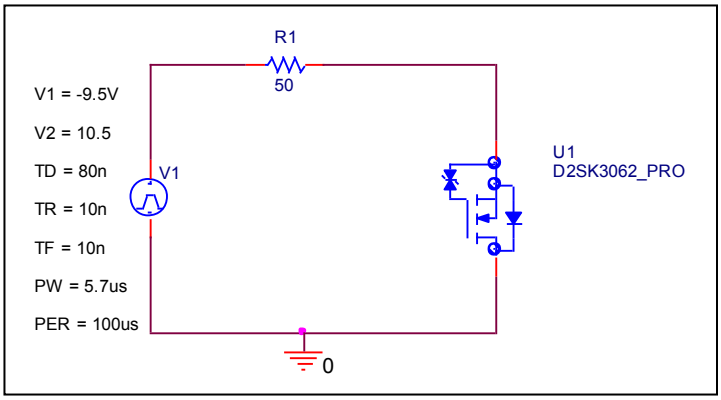
| IDR(A) | VDS(V) | | %Error |
|---|---|---|---|
| | Measurement | Simulation | |
| 0.1 | 0.570 | 0.573 | 0.474 |
| 0.2 | 0.590 | 0.592 | 0.271 |
| 0.5 | 0.620 | 0.617 | -0.484 |
| 1 | 0.640 | 0.638 | -0.375 |
| 2 | 0.660 | 0.660 | 0.045 |
| 5 | 0.700 | 0.697 | -0.429 |
| 10 | 0.740 | 0.736 | -0.500 |
| 20 | 0.800 | 0.796 | -0.450 |
| 50 | 0.930 | 0.946 | 1.720 |
| 100 | 1.180 | 1.173 | -0.576 |

## Reverse Recovery Characteristic

Circuit Simulation Result



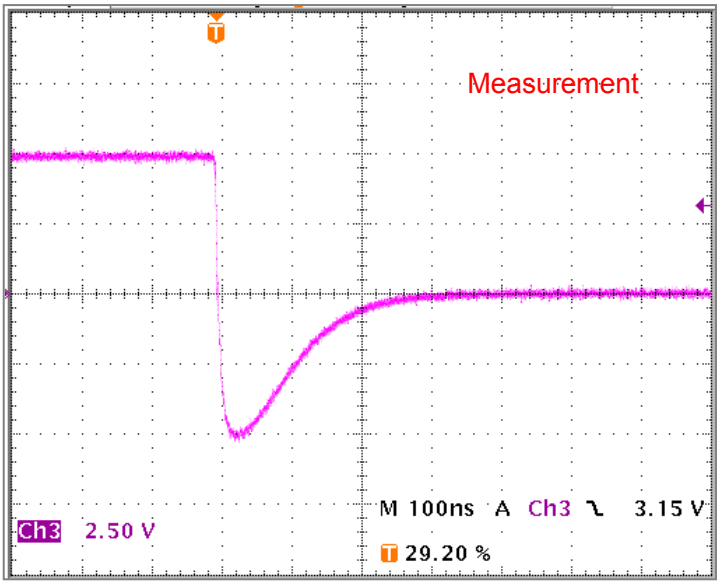

Evaluation Circuit



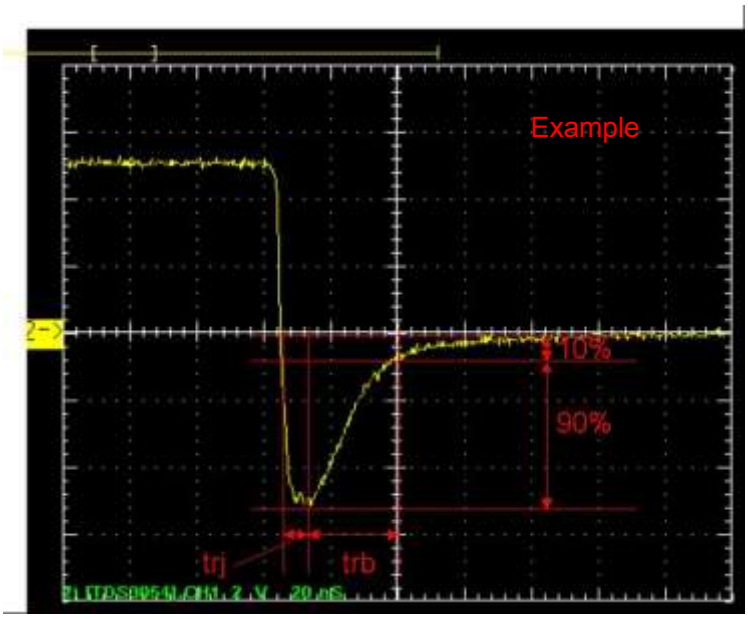

Compare Measurement vs. Simulation

| | | Measurement | Simulation | Error (%) |
|---|---|---|---|---|
| trj | ns | 46.00 | 45.91 | -0.20 |
| trb | ns | 162.00 | 161.53 | -0.29 |
| trr | ns | 208.00 | 207.44 | -0.27 |

## Reverse Recovery Characteristic Reference



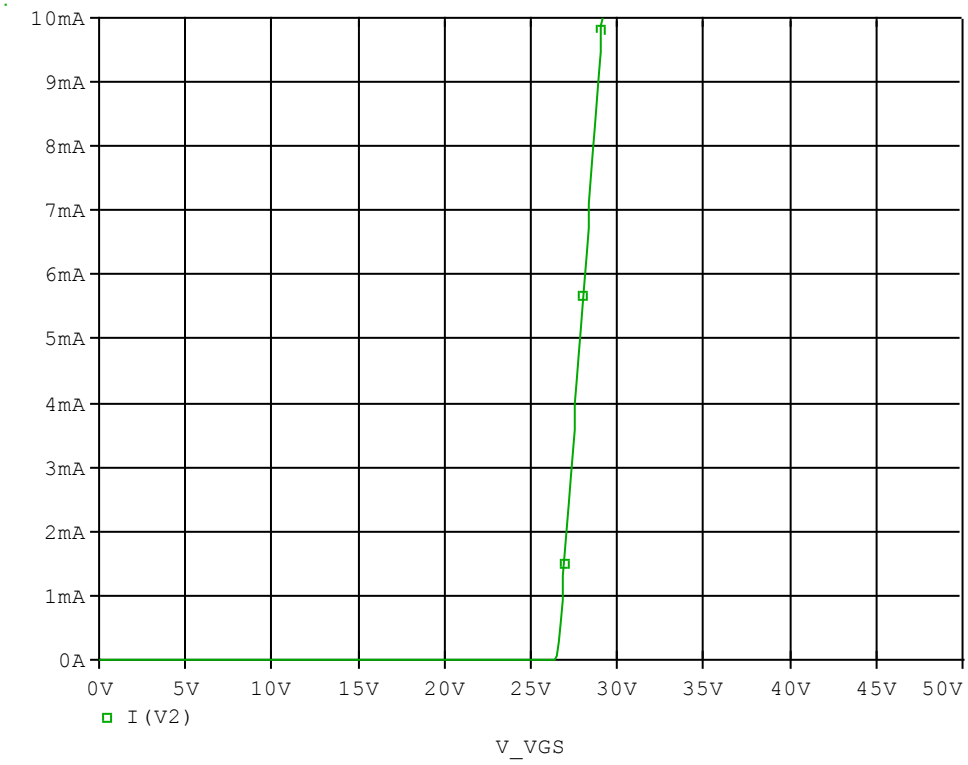

Trj=46.00(ns)
Trb=162.00(ns)
Conditions:Ifwd=Irev=0.2(A),Rl=50



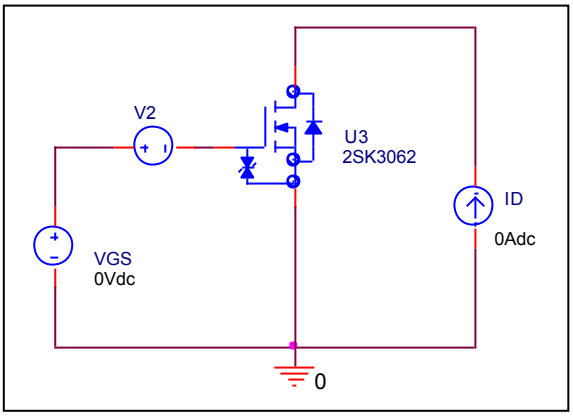

Relation between trj and trb

# ESD PROTECTION DIODE SPICE MODEL
## Zener Voltage Characteristic

### Circuit Simulation Result




### Evaluation Circuit



## Zener Voltage Characteristic Reference