# Device Modeling Report

COMPONENTS: Power MOSFET (Professional)
PART NUMBER: TPCM8001-H
MANUFACTURER: TOSHIBA
Body Diode (Special) / ESD Protection Diode

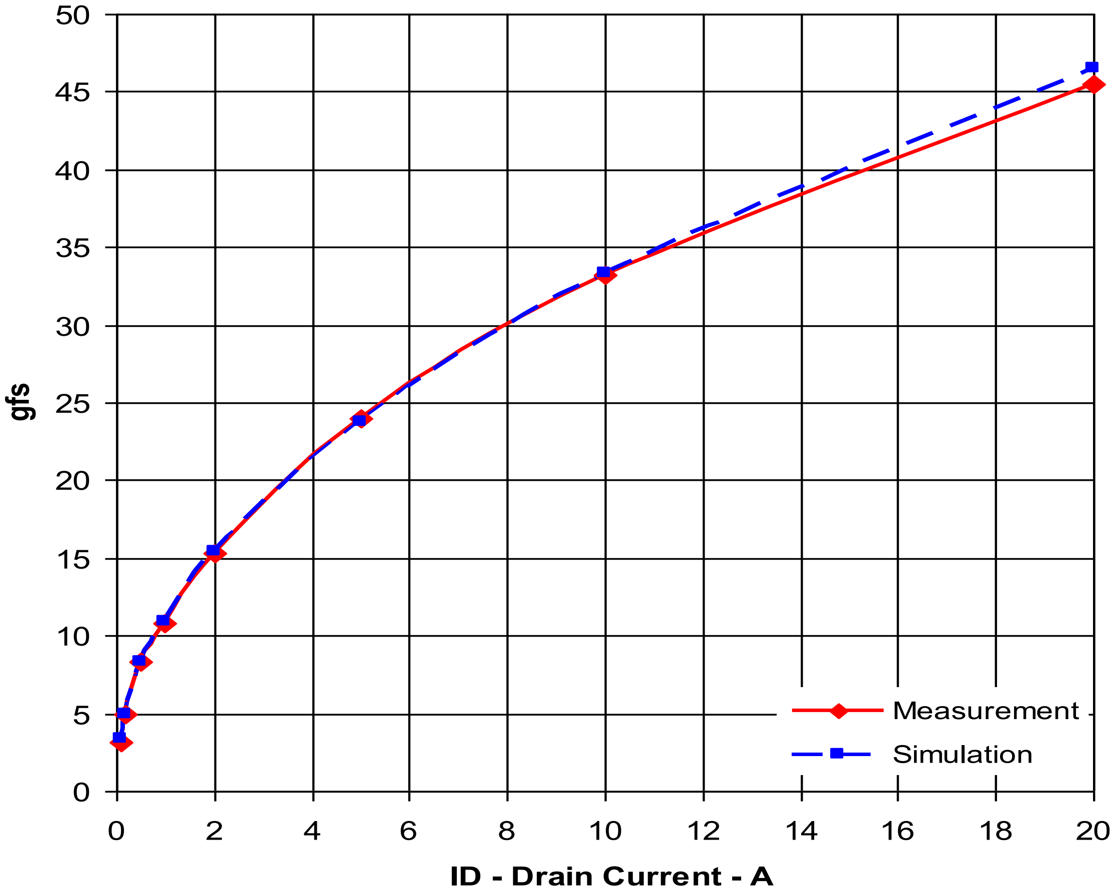
**Bee Technologies Inc.**

## 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

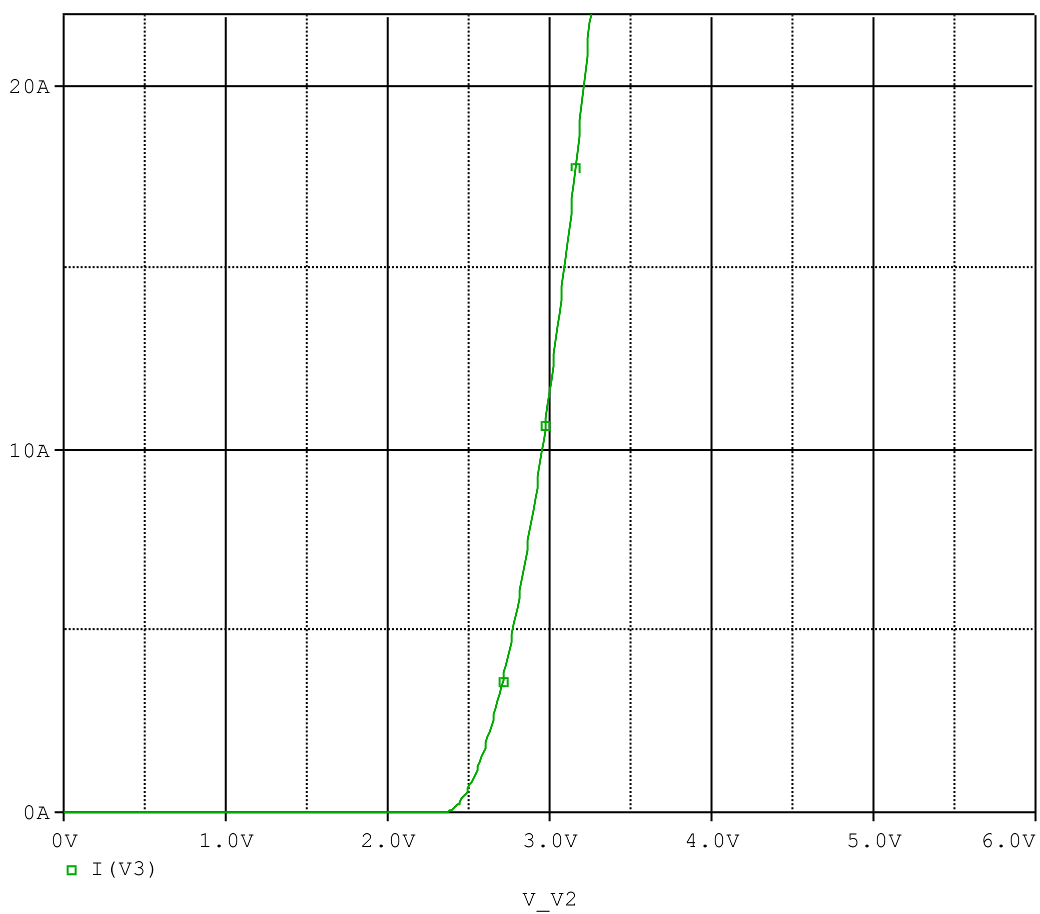


Comparison table

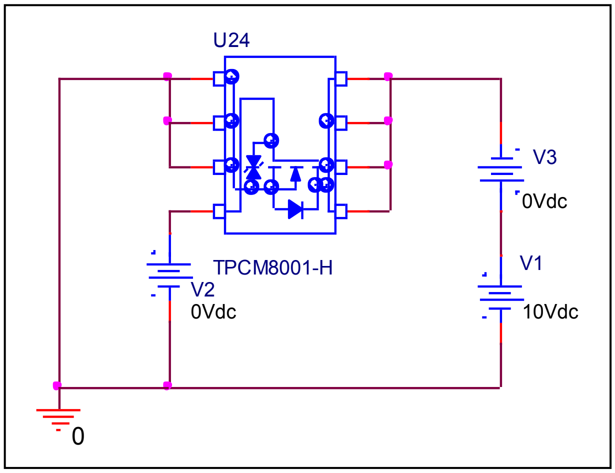
| Id(A) | gfs | | Error(%) |
|---|---|---|---|
| | Measurement | Simulation | |
| 0.1 | 3.200 | 3.333 | 4.156 |
| 0.2 | 5.000 | 5.000 | 0.000 |
| 0.5 | 8.300 | 8.333 | 0.398 |
| 1 | 10.850 | 10.950 | 0.922 |
| 2 | 15.300 | 15.385 | 0.556 |
| 5 | 24.000 | 23.810 | -0.792 |
| 10 | 33.200 | 33.333 | 0.401 |
| 20 | 45.500 | 46.512 | 2.224 |

## Vgs-Id Characteristic

### Circuit Simulation result

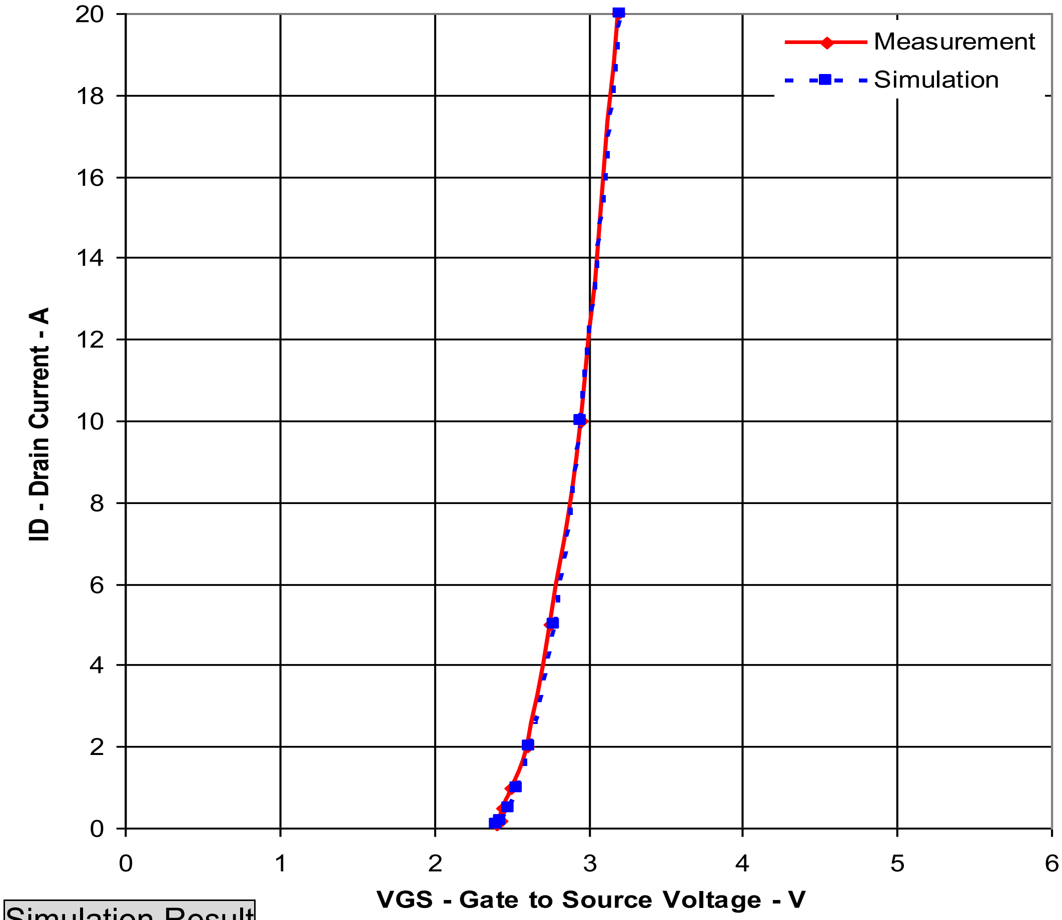


### Evaluation circuit



## Comparison Graph

Circuit Simulation Result

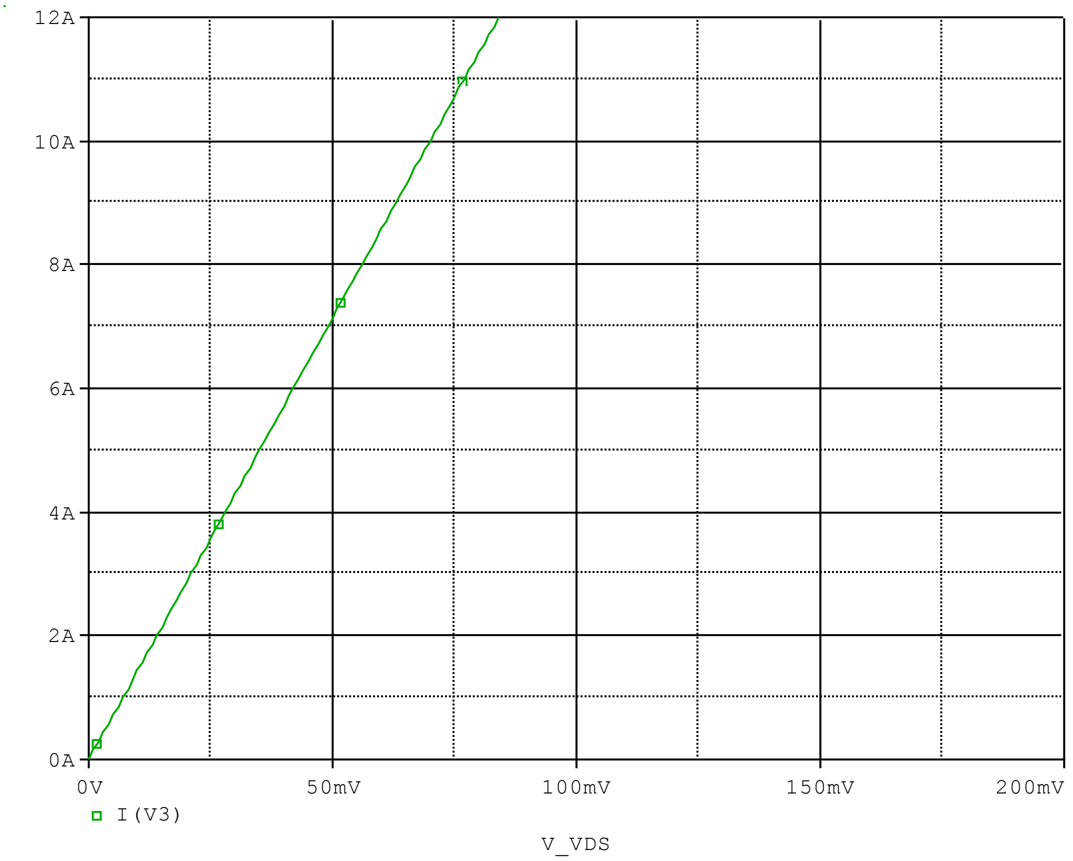


Simulation Result

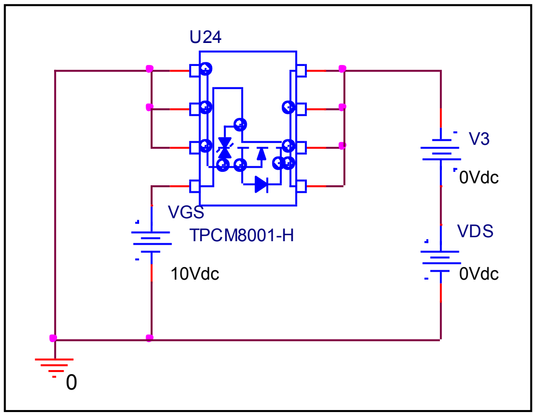
| $I_D$(A) | $V_{GS}$(V) | | Error (%) |
|---|---|---|---|
| | Measurement | Simulation | |
| 0.1 | 2.400 | 2.406 | 0.250 |
| 0.2 | 2.430 | 2.430 | 0.000 |
| 0.5 | 2.450 | 2.480 | 1.224 |
| 1 | 2.500 | 2.535 | 1.400 |
| 2 | 2.600 | 2.615 | 0.577 |
| 5 | 2.750 | 2.773 | 0.836 |
| 10 | 2.950 | 2.953 | 0.102 |
| 20 | 3.200 | 3.211 | 0.344 |

## Rds(on) Characteristic

### Circuit Simulation result



### Evaluation circuit

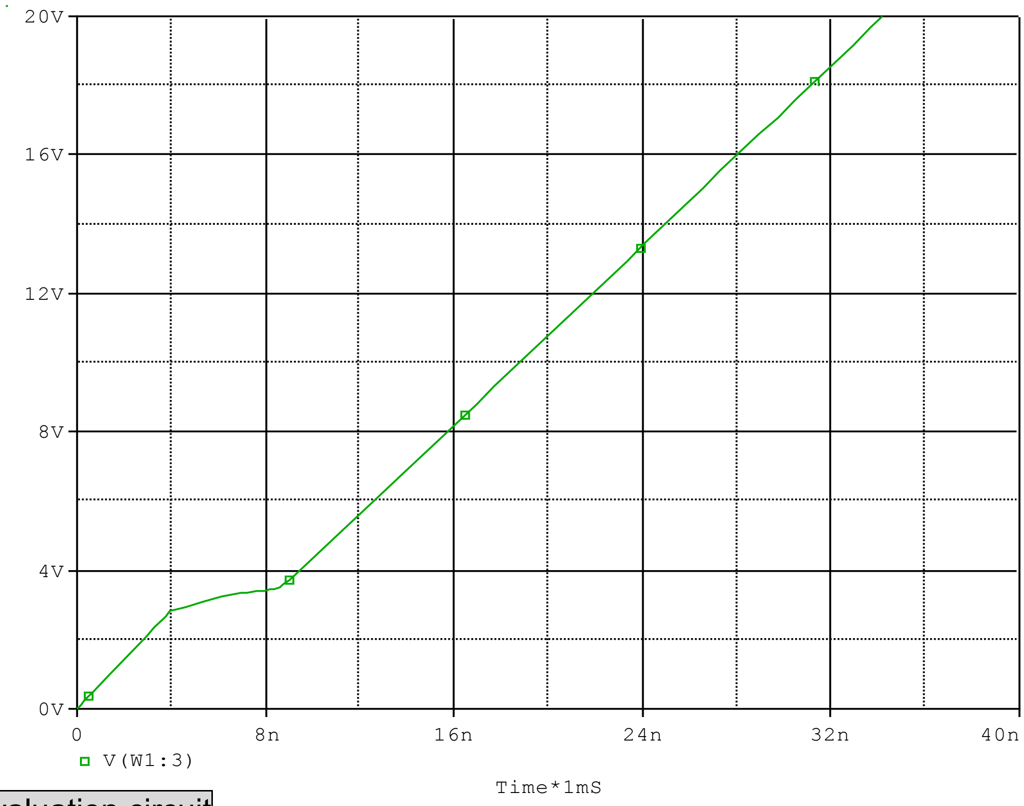


### Simulation Result

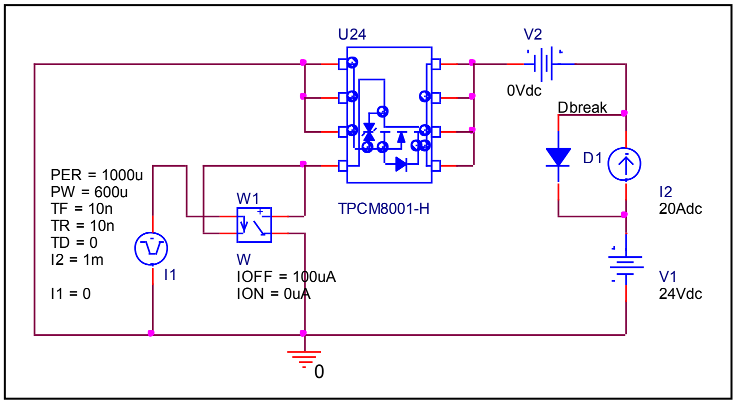
| $I_D$=14A, $V_{GS}$=10V | Measurement | | Simulation | | Error (%) |
|---|---|---|---|---|---|
| $R_{DS}$ (on) | 7.000 | mΩ | 7.000 | mΩ | 0 |

## Gate Charge Characteristic

### Circuit Simulation result



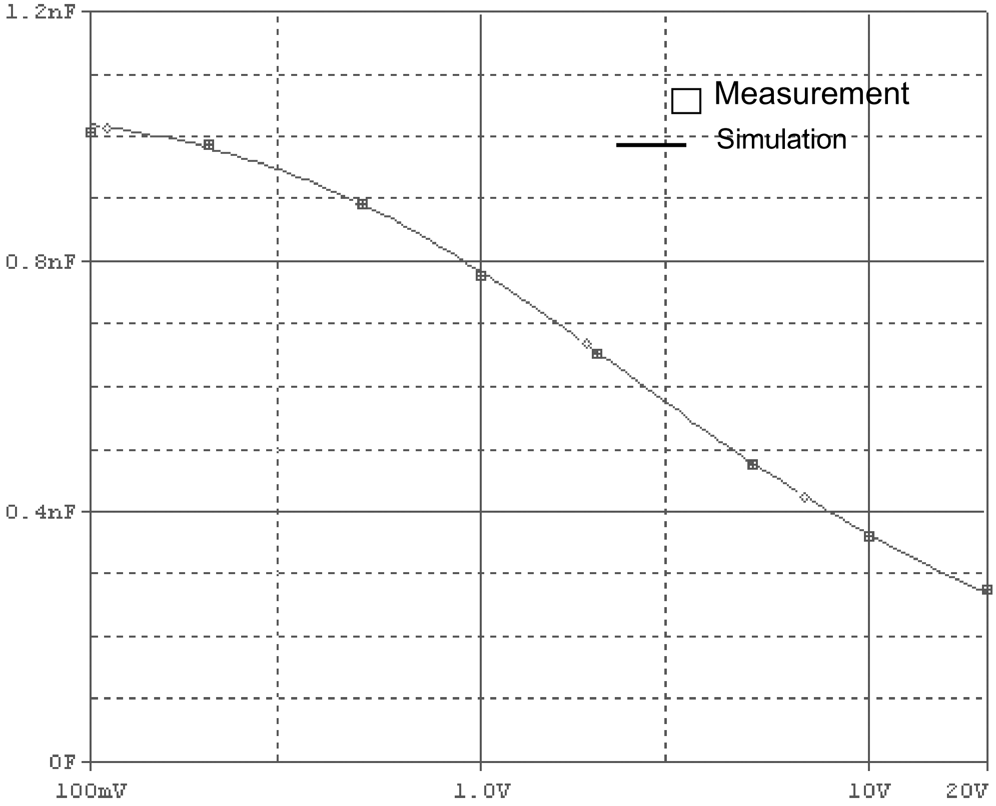
### Evaluation circuit



### Simulation Result

| $V_{DD}$=24V,$I_D$=20A ,$V_{GS}$=10V | Measurement | Simulation | Error (%) |
|---|---|---|---|
| Qgs(nC) | 3.900 | 3.929 | 0.744 |
| Qgd(nC) | 4.000 | 4.140 | 3.500 |
| Qg | 19.000 | 18.807 | -1.016 |

## Capacitance Characteristic

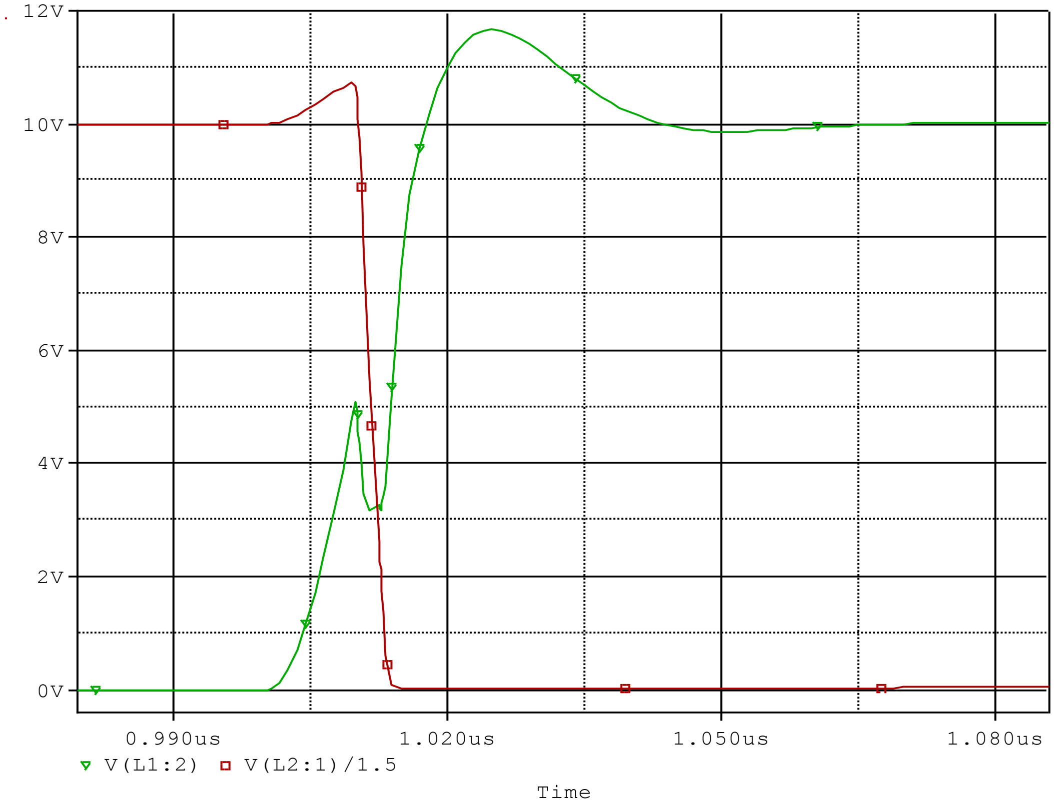


**Simulation Result**

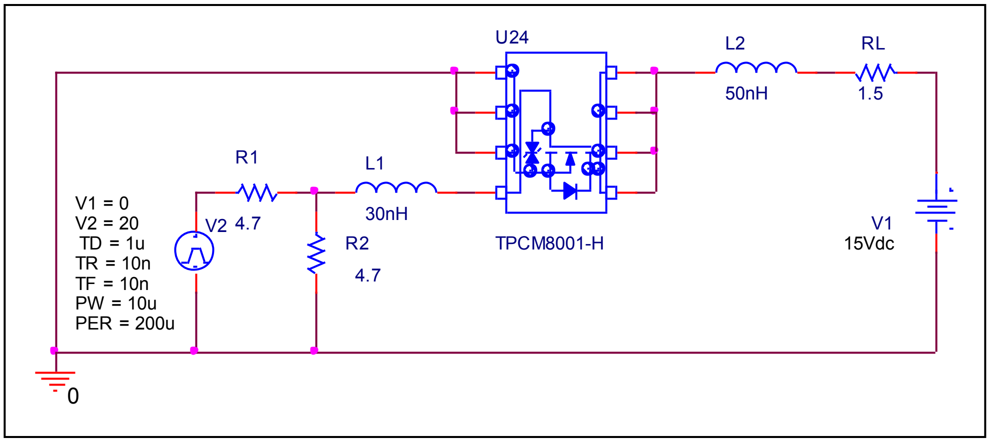
| $V_{DS}$(V) | Cbd(pF) | | Error(%) |
|---|---|---|---|
| | Measurement | Simulation | |
| 0.1 | 1010.000 | 1017.000 | 0.693 |
| 0.2 | 990.000 | 987.000 | -0.303 |
| 0.5 | 895.000 | 895.000 | 0.000 |
| 1 | 780.000 | 781.000 | 0.128 |
| 2 | 655.000 | 655.000 | 0.000 |
| 5 | 480.000 | 480.000 | 0.000 |
| 10 | 365.000 | 366.000 | 0.274 |
| 20 | 280.000 | 279.000 | -0.357 |

## Switching Time Characteristic

### Circuit Simulation result



### Evaluation circuit

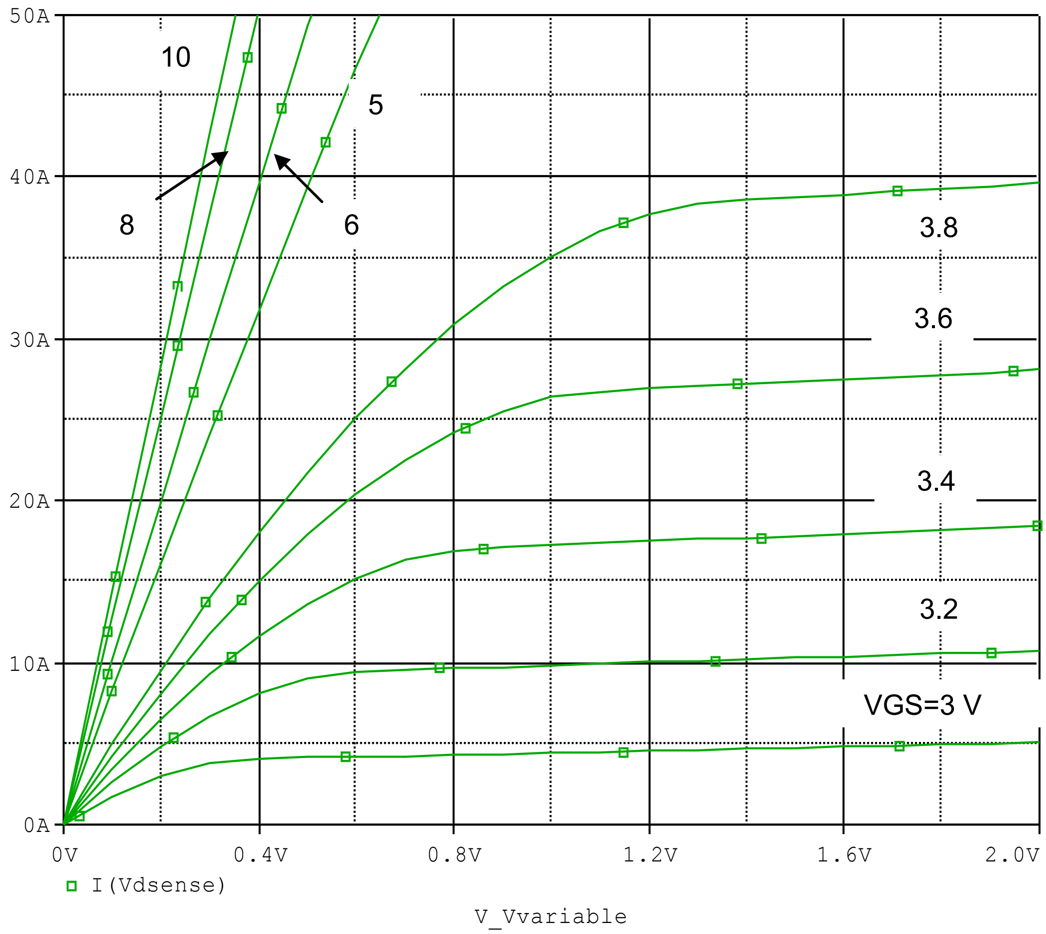


### Simulation Result

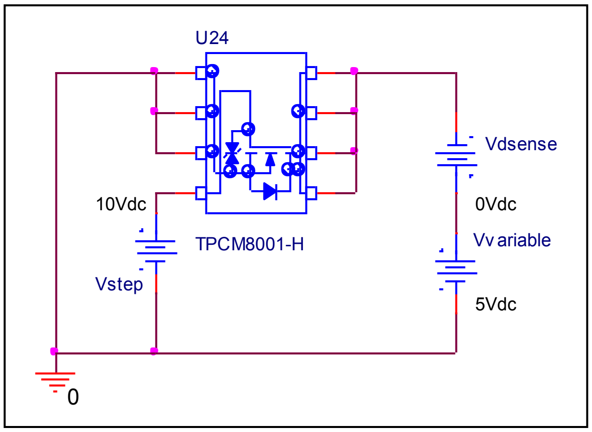
| $I_D$=14 A, $V_{DD}$=15V<br>$V_{GS}$=0/10V | Measurement | Simulation | Error(%) |
|---|---|---|---|
| Ton(ns) | 9.000 | 8.991 | -0.100 |

## Output Characteristic

### Circuit Simulation result

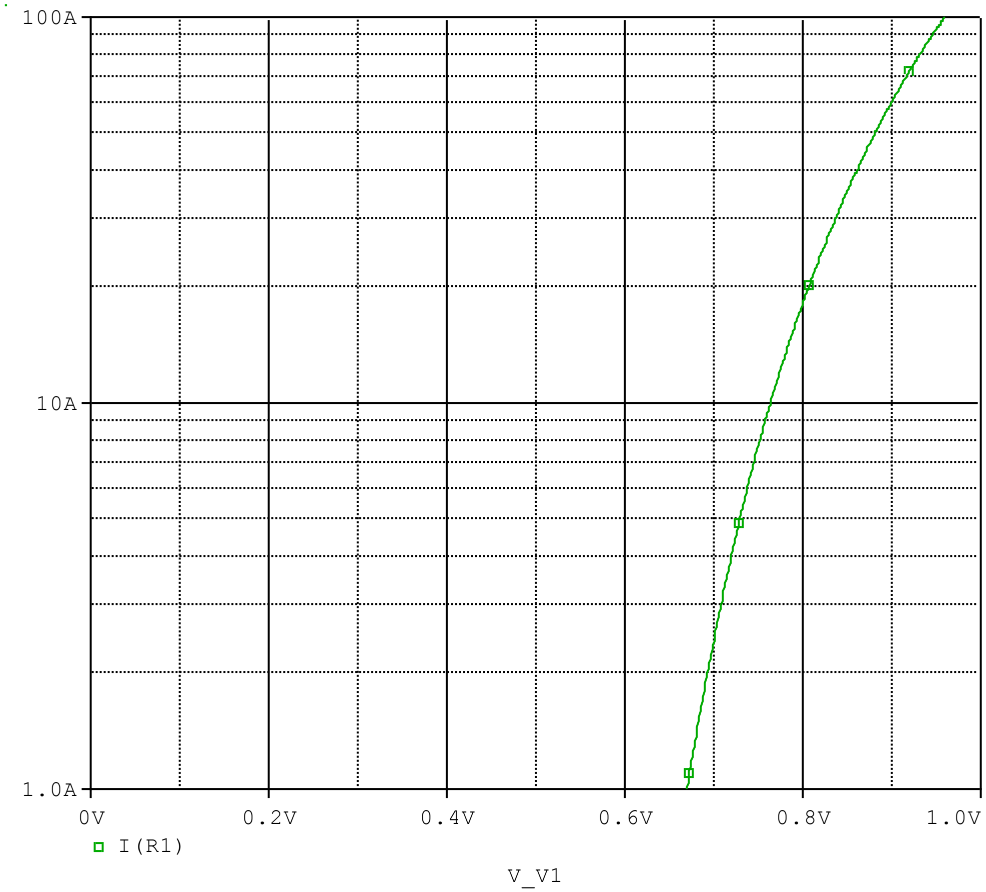


### Evaluation circuit

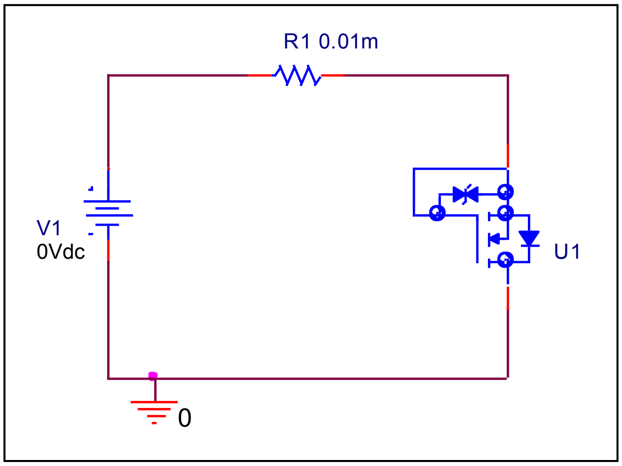


# Forward Current Characteristic

## Circuit Simulation Result

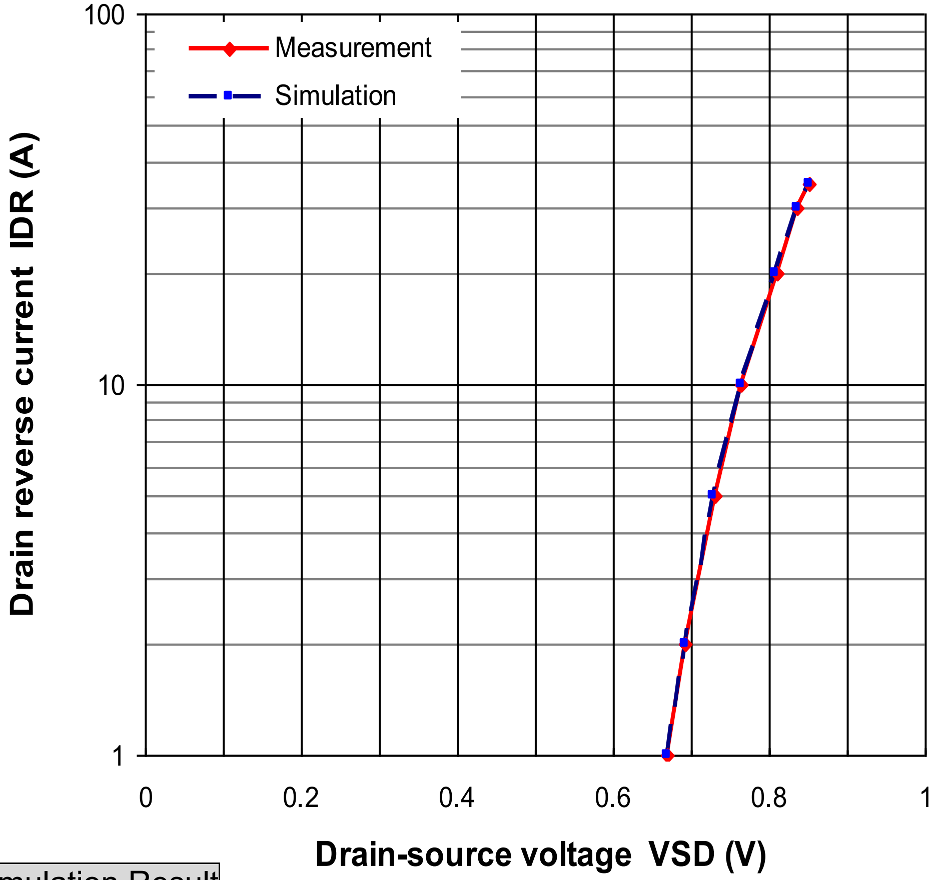


## Evaluation Circuit



## Comparison Graph

Circuit Simulation Result

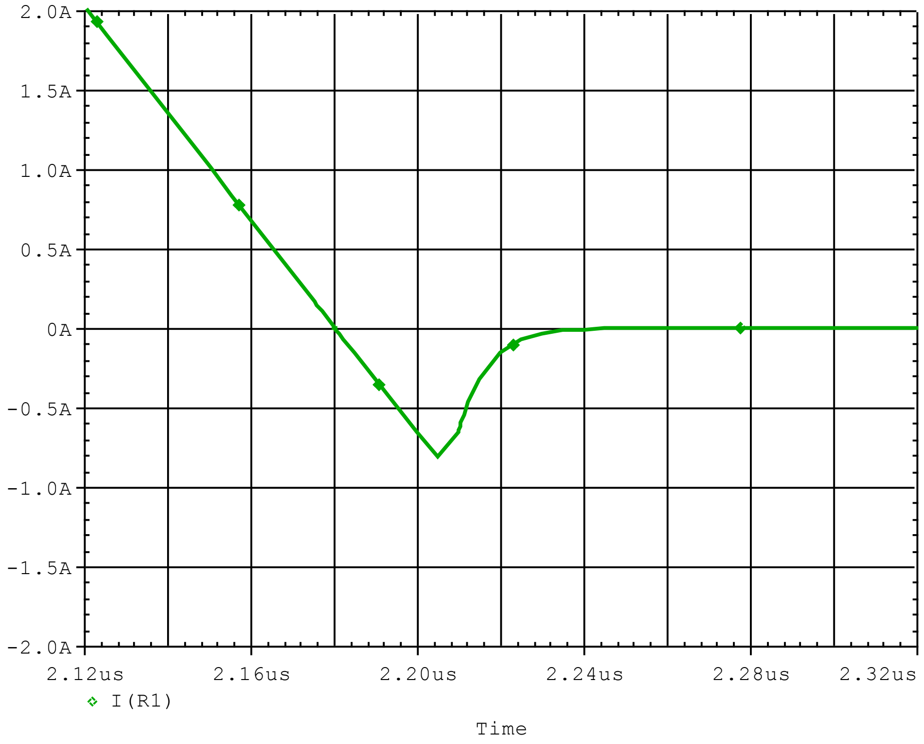


Simulation Result

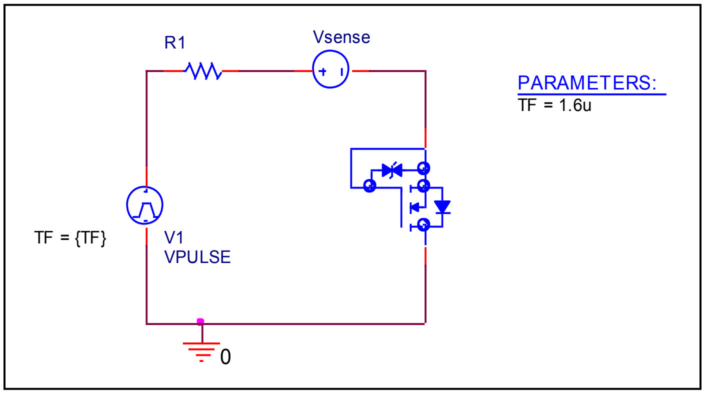
| IDR(A) | VSD(V) | | %Error |
|---|---|---|---|
| | Measurement | Simulation | |
| 1 | 0.6700 | 0.6690 | -0.15 |
| 2 | 0.6920 | 0.6930 | 0.14 |
| 5 | 0.7300 | 0.7290 | -0.14 |
| 10 | 0.7630 | 0.7630 | 0.00 |
| 20 | 0.8100 | 0.8070 | -0.37 |

# Reverse Recovery Characteristics (Body Diode)

## Circuit Simulation Result



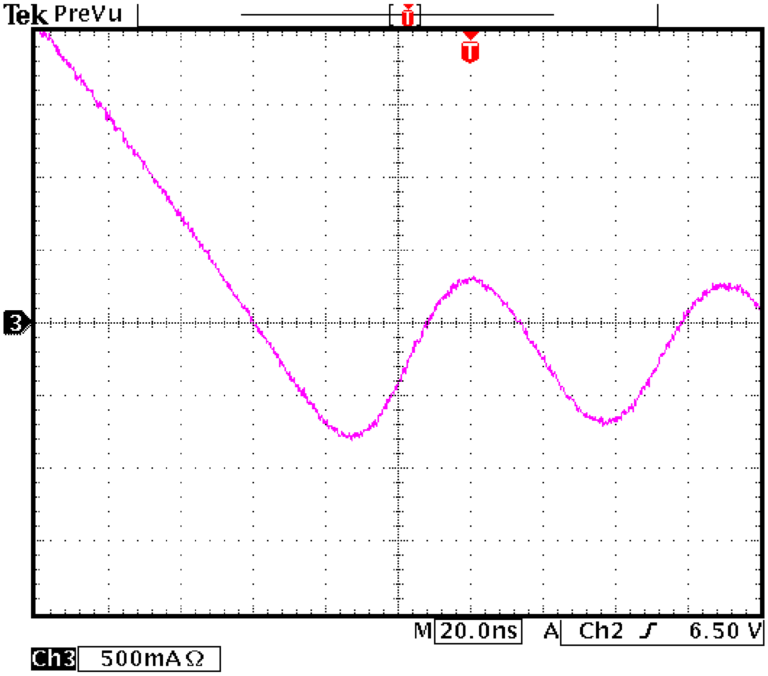
## Evaluation Circuit



## Compare Measurement vs. Simulation

| | Measurement | | Simulation | | Error (%) |
|---|---|---|---|---|---|
| **trr** | **42.8** | **ns** | **42.58** | **ns** | **-0.51** |

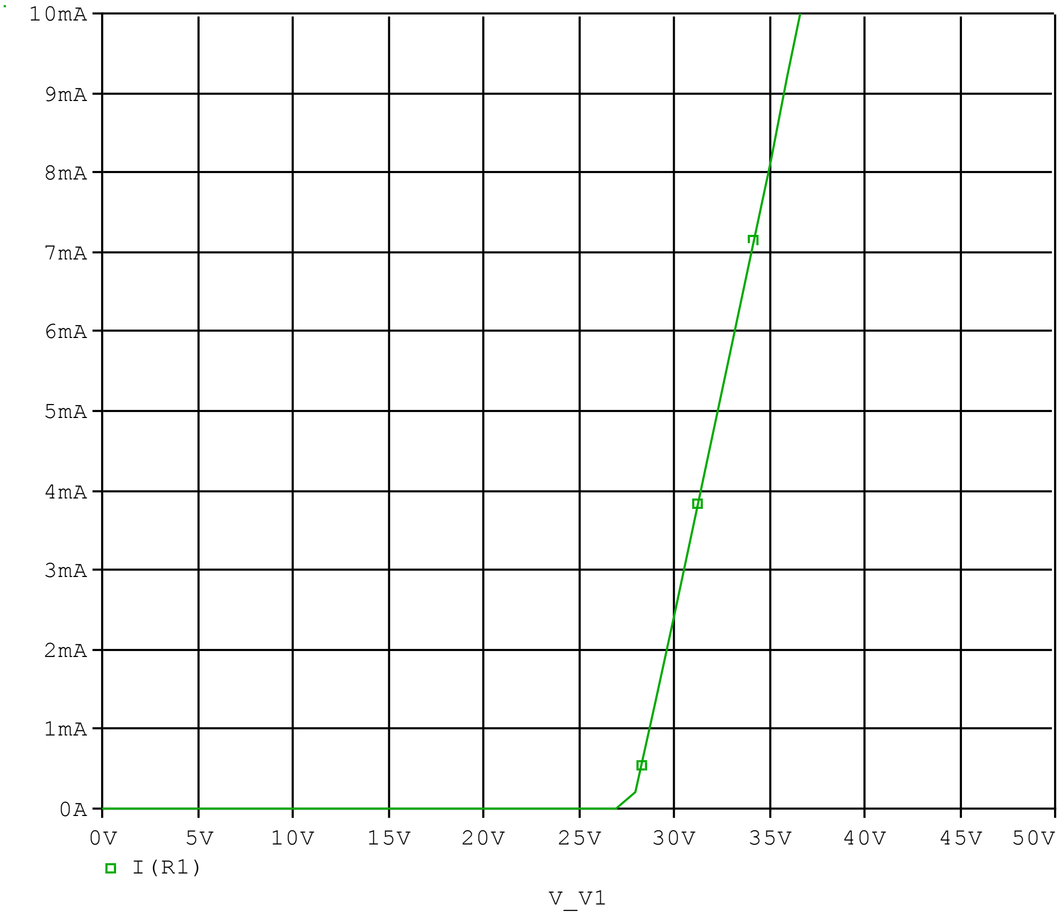
## Reverse Recovery Characteristic (Body Diode) Reference



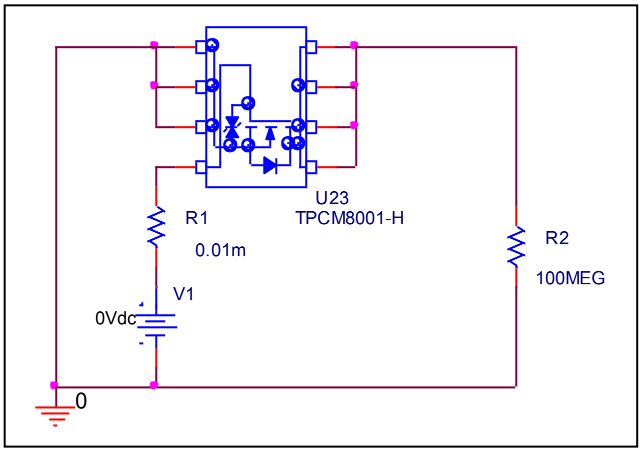
Trr=42.8ns
Conditions:Ifwd=di/dt=30A/us

## Zener Voltage Characteristic

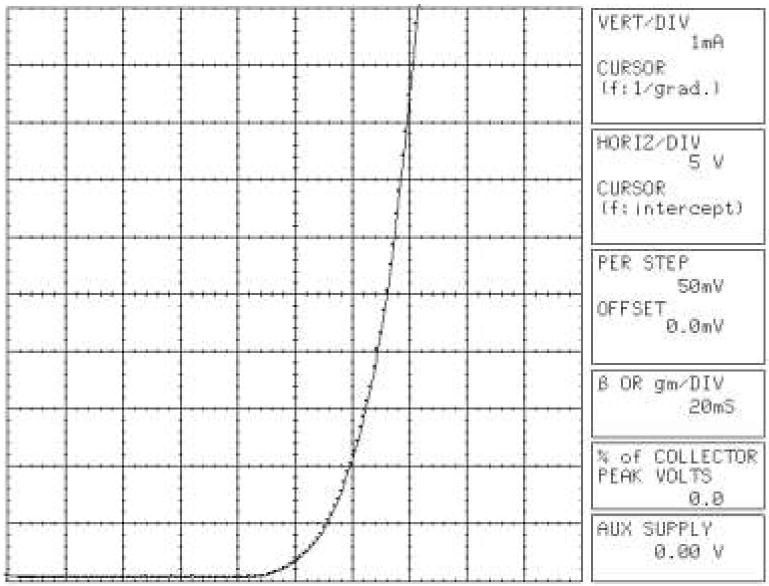
### Circuit Simulation Result



### Evaluation Circuit



## Zener Voltage Characteristic Reference



VERT/DIV
1mA
CURSOR
(f:1/grad.)

HORIZ/DIV
5 V
CURSOR
(f:intercept)

PER STEP
50mV
OFFSET
0.0mV

β OR gm/DIV
20mS

% of COLLECTOR
PEAK VOLTS
0.0

AUX SUPPLY
0.00 V