

# Device Modeling Report

COMPONENTS: Power MOSFET (Professional)  
PART NUMBER: TPC8114  
MANUFACTURER: TOSHIBA  
Body Diode (Professional) / ESD Protection Diode

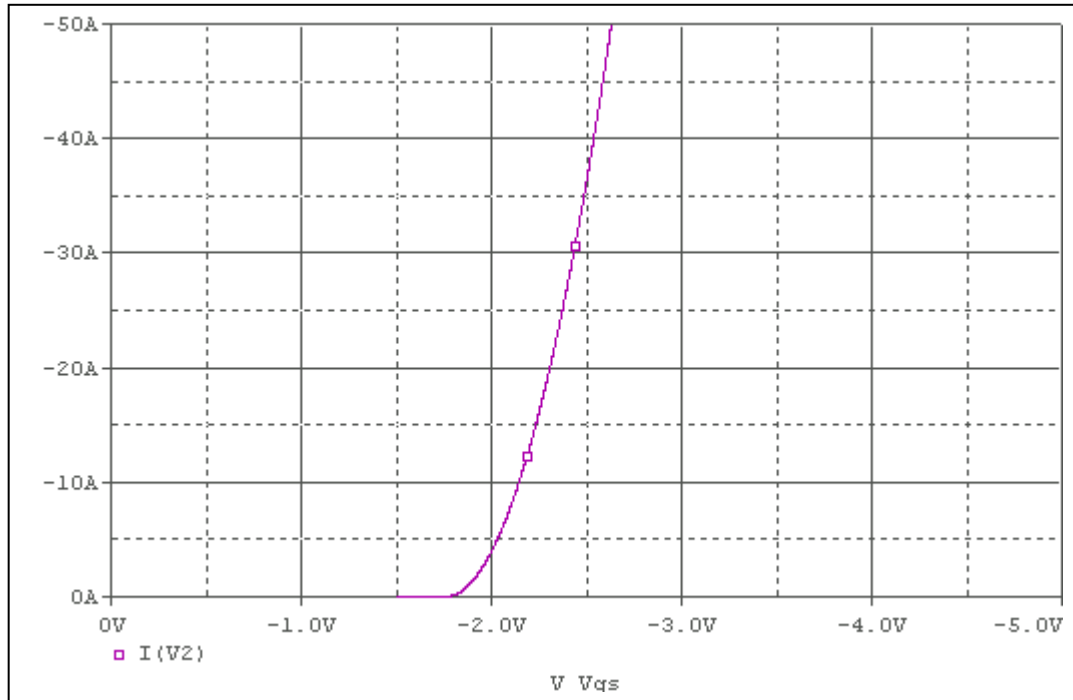


## MOSFET MODEL

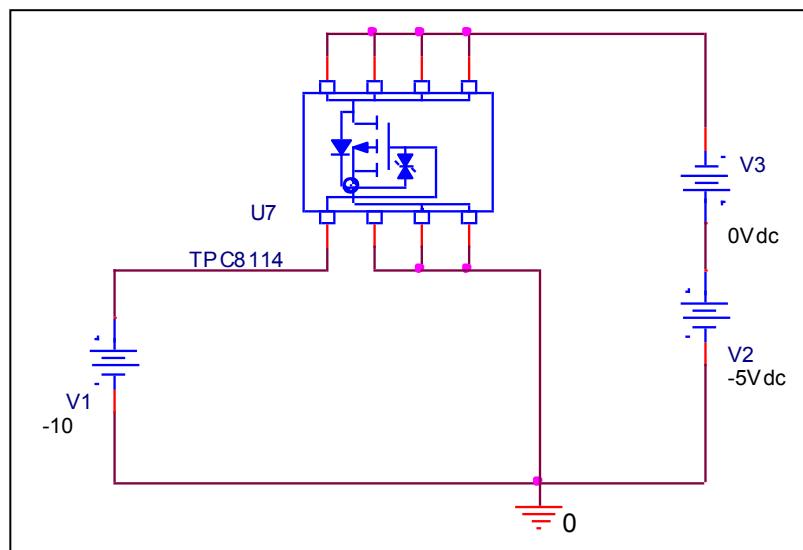
| Pspice model parameter | Model description                                  |
|------------------------|----------------------------------------------------|
| LEVEL                  |                                                    |
| L                      | Channel Length                                     |
| 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                                   |

## V<sub>gs</sub>-I<sub>d</sub> Characteristic

Circuit Simulation result

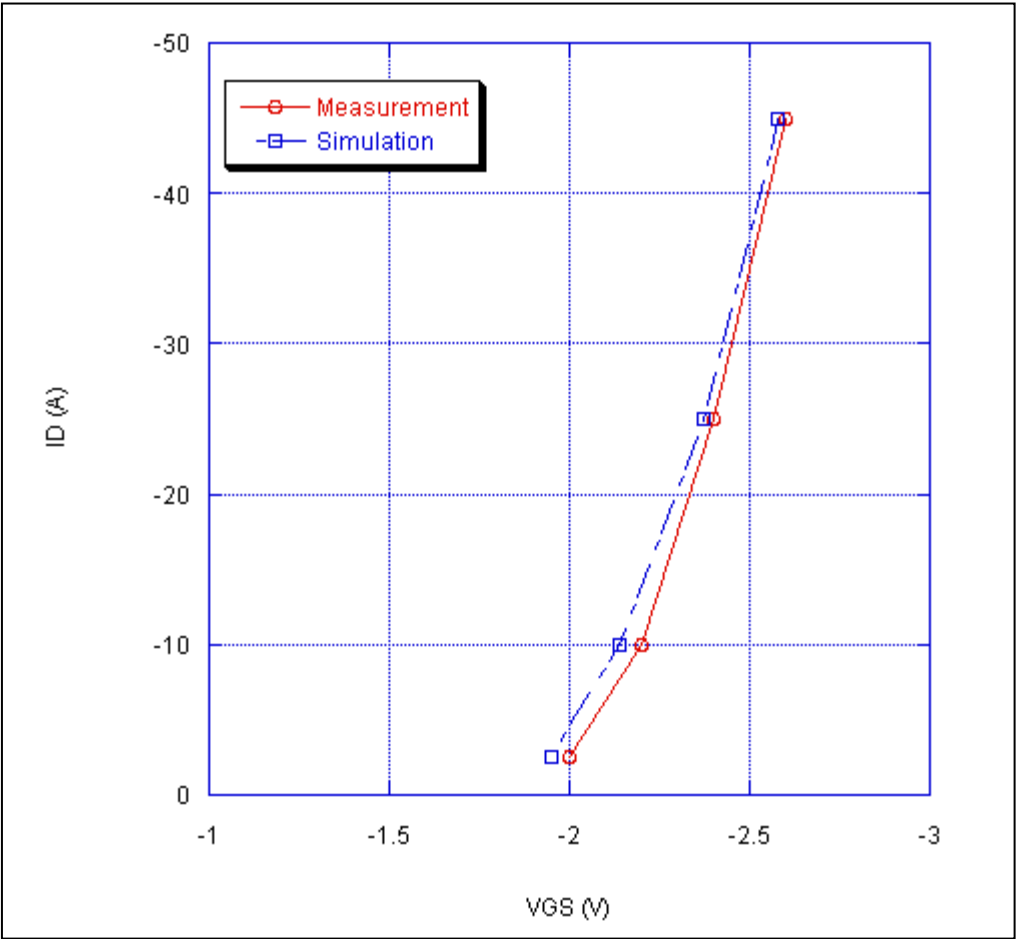


Evaluation circuit



# Comparison Graph

Circuit Simulation Result

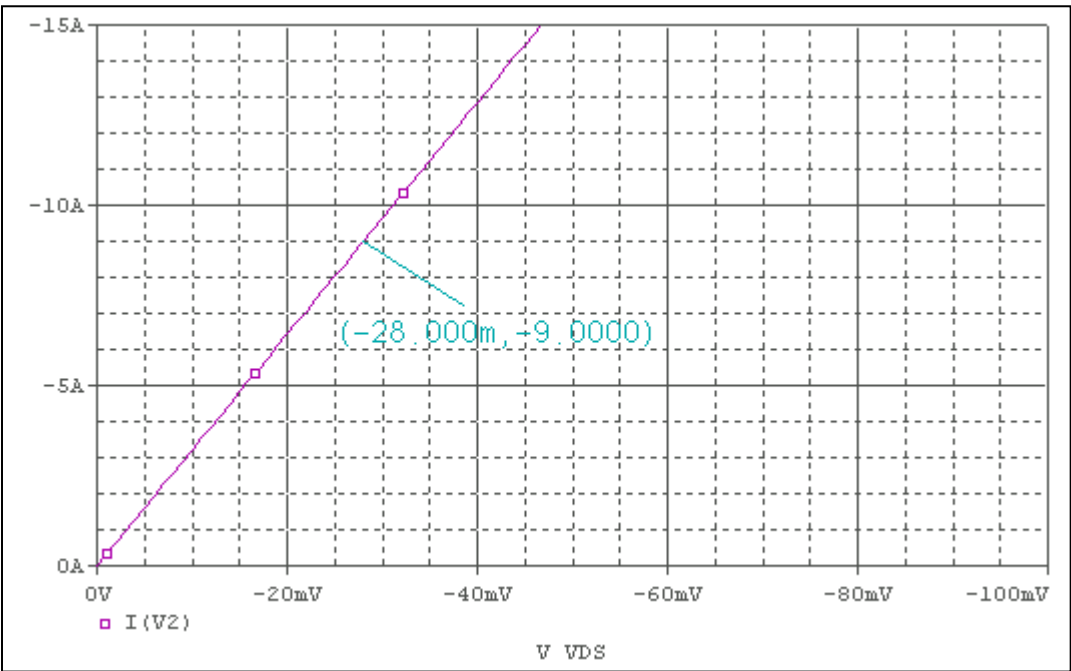


Simulation Result

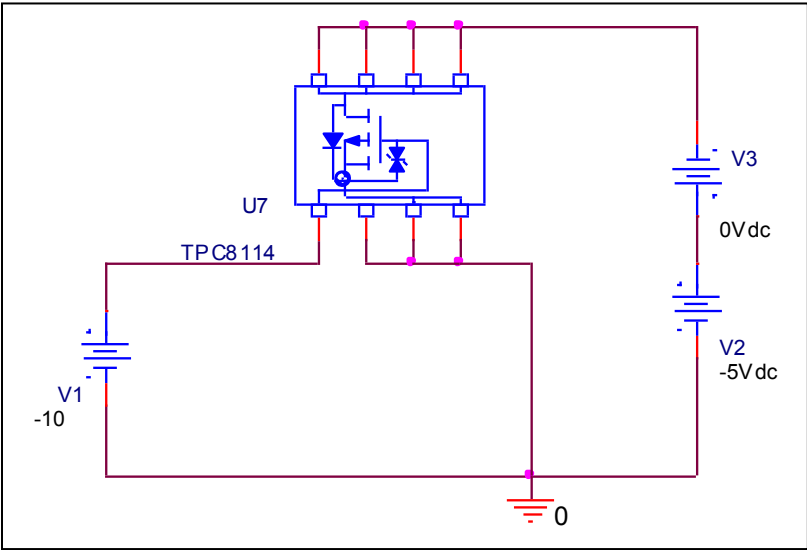
| $I_D$ (A) | $V_{GS}$ (V) |            | Error (%) |
|-----------|--------------|------------|-----------|
|           | Measurement  | Simulation |           |
| -2.50     | -2.00        | -1.95      | -2.50     |
| -10.00    | -2.20        | -2.14      | -2.73     |
| -25.00    | -2.40        | -2.37      | -1.25     |
| -45.00    | -2.60        | -2.58      | -0.77     |

# Id-Rds(on) Characteristic

## Circuit Simulation result



## Evaluation circuit

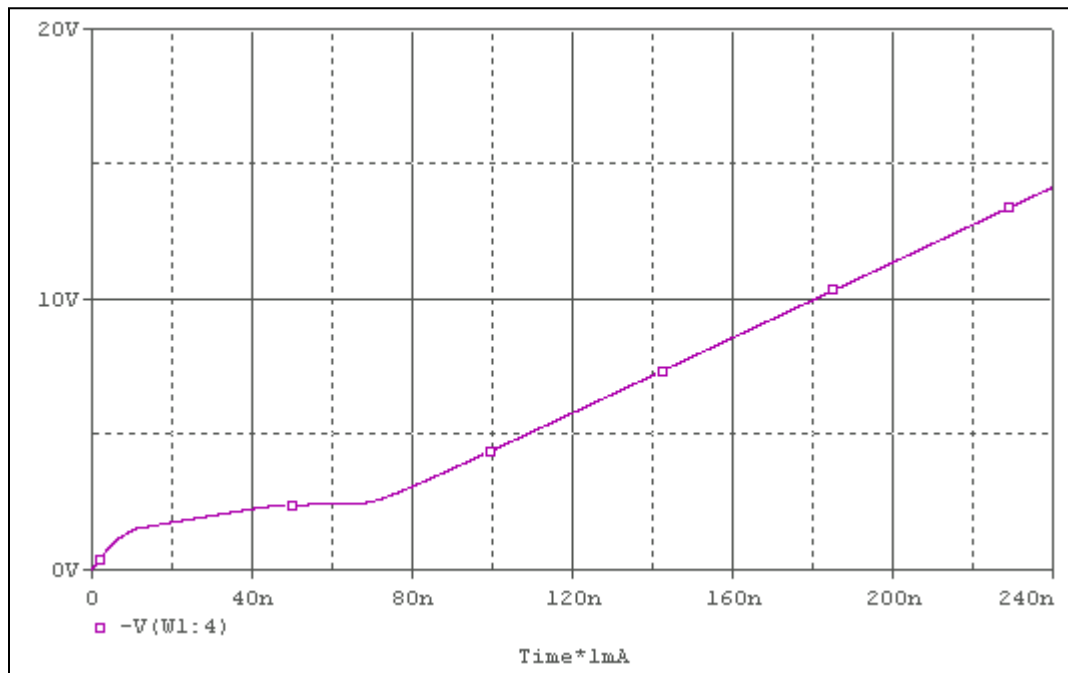


## Simulation Result

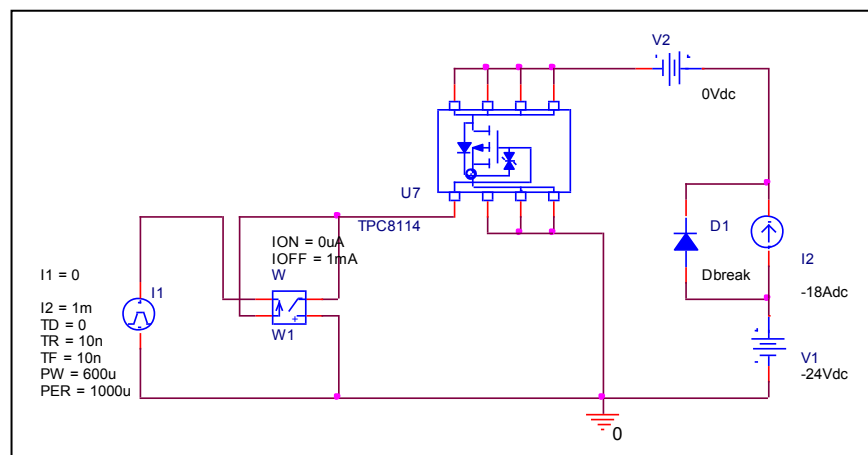
| $I_D = -9, V_{GS} = -10V$ | Measurement |    | Simulation |    | Error (%) |
|---------------------------|-------------|----|------------|----|-----------|
| $R_{DS} (on)$             | 3.1         | mΩ | 3.1        | mΩ | 0         |

## Gate Charge Characteristic

### Circuit Simulation result



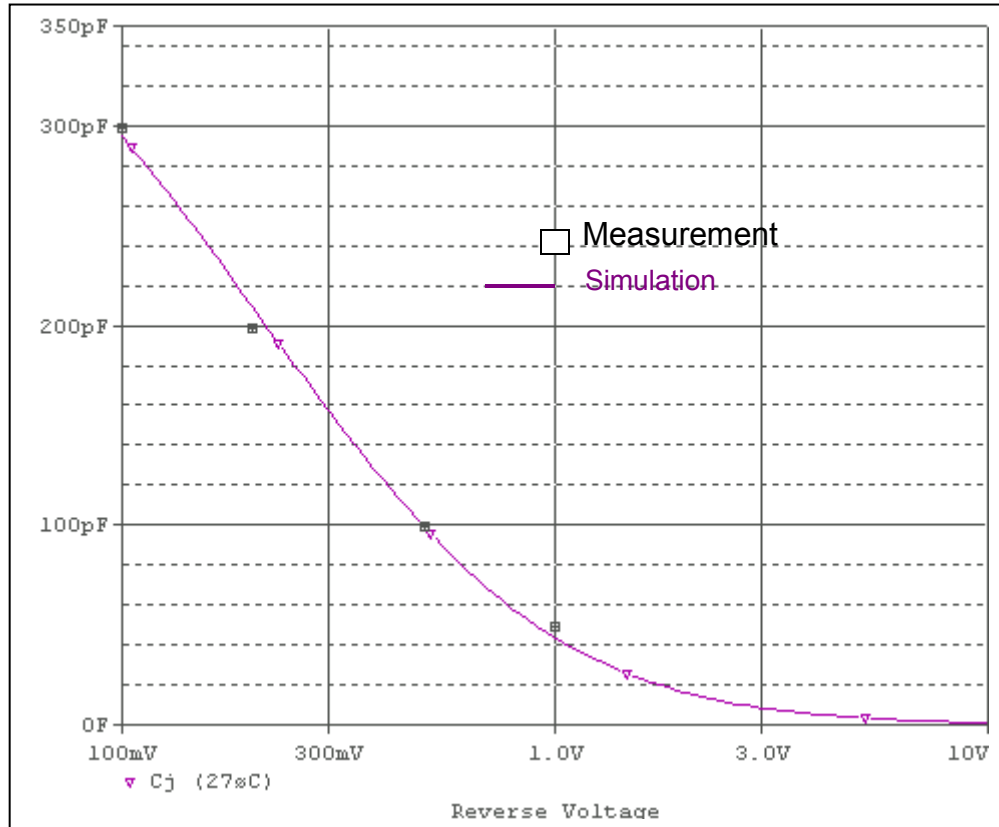
### Evaluation circuit



### Simulation Result

| $V_{DD} = -24V, I_D = -18A, V_{GS} = -10V$ | Measurement |    | Simulation |    | Error (%) |
|--------------------------------------------|-------------|----|------------|----|-----------|
| <b>Qgs</b>                                 | 10          | nC | 9.86       | nC | - 1.4     |
| <b>Qgd</b>                                 | 60          | nC | 59.659     | nC | - 0.568   |
| <b>Qg</b>                                  | 180         | nC | 180.39     | nC | 0.216     |

## Capacitance Characteristic

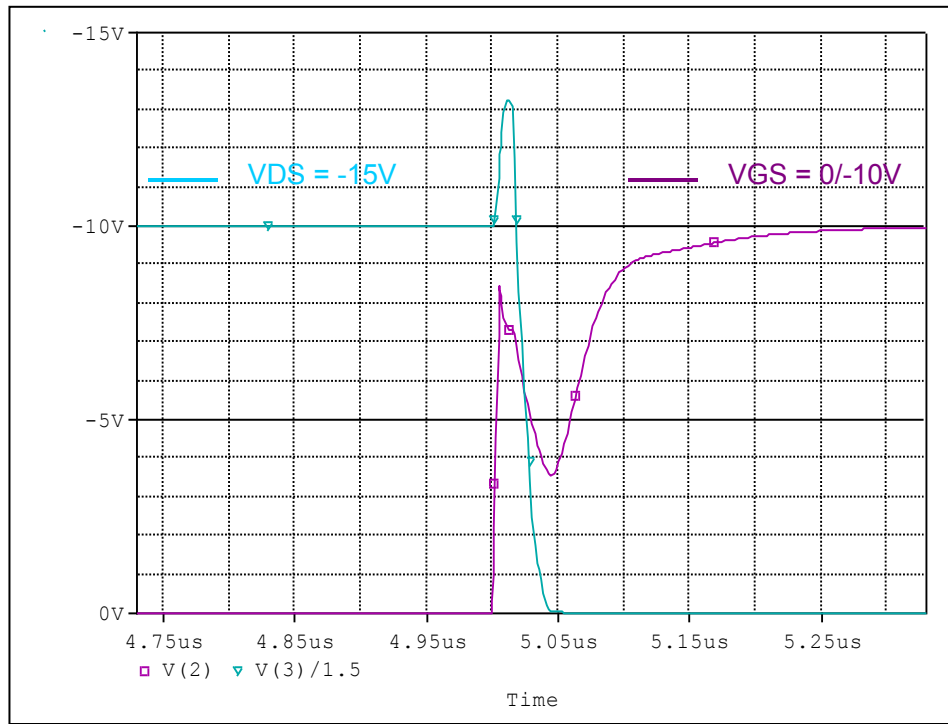


### Simulation Result

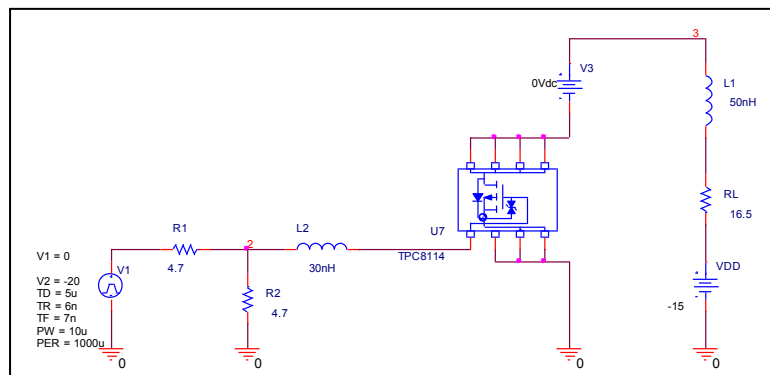
| $V_{DS}(V)$ | Cbd(pF)     |            | Error(%) |
|-------------|-------------|------------|----------|
|             | Measurement | Simulation |          |
| 0.1         | 300.0       | 297.0      | - 1.0    |
| 0.2         | 200.0       | 204.0      | 2.0      |
| 0.5         | 100.0       | 101.0      | 1.0      |
| 1.0         | 50.0        | 48.0       | - 4.0    |

## Switching Time Characteristic

### Circuit Simulation result



Evaluation circuit



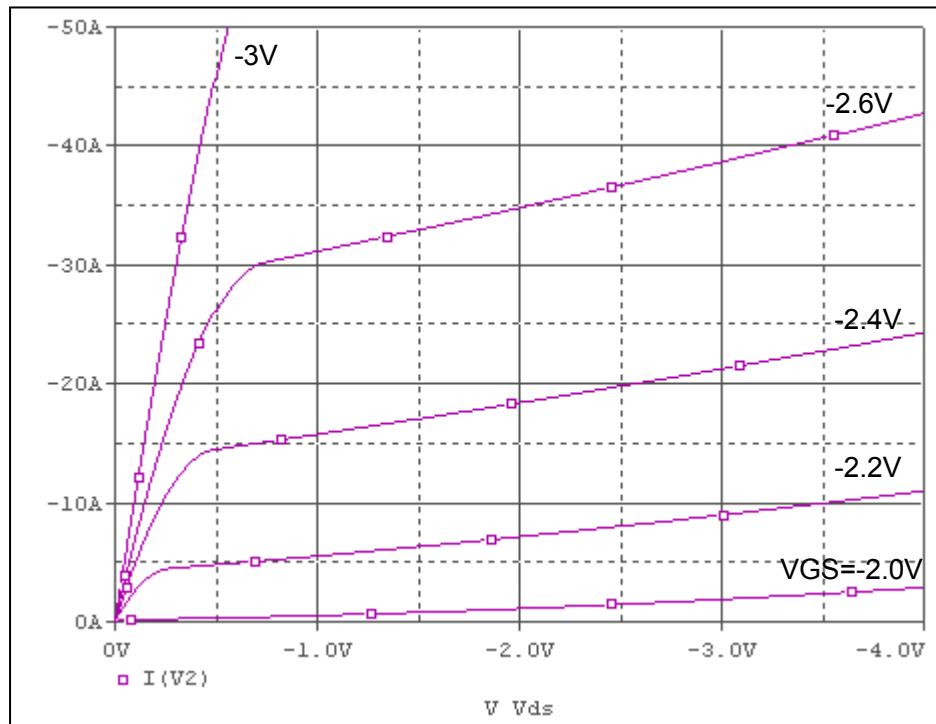
## Simulation Result

| <b>I<sub>D</sub>=-9A, V<sub>DD</sub>=-15V<br/>V<sub>GS</sub>=0/-10V</b> | <b>Measurement</b> |           | <b>Simulation</b> |           | <b>Error(%)</b> |
|-------------------------------------------------------------------------|--------------------|-----------|-------------------|-----------|-----------------|
| <b>ton</b>                                                              | <b>36.00</b>       | <b>ns</b> | <b>35.90</b>      | <b>ns</b> | <b>-0.29</b>    |

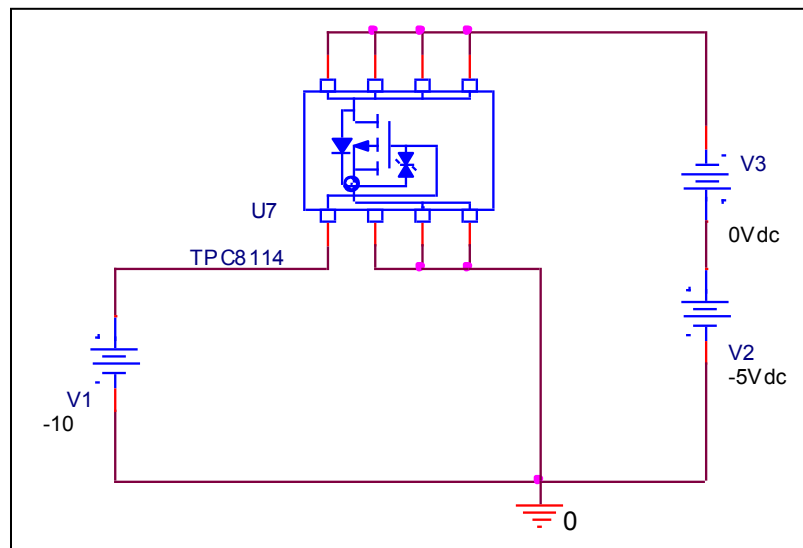


## Output Characteristic

Circuit Simulation result

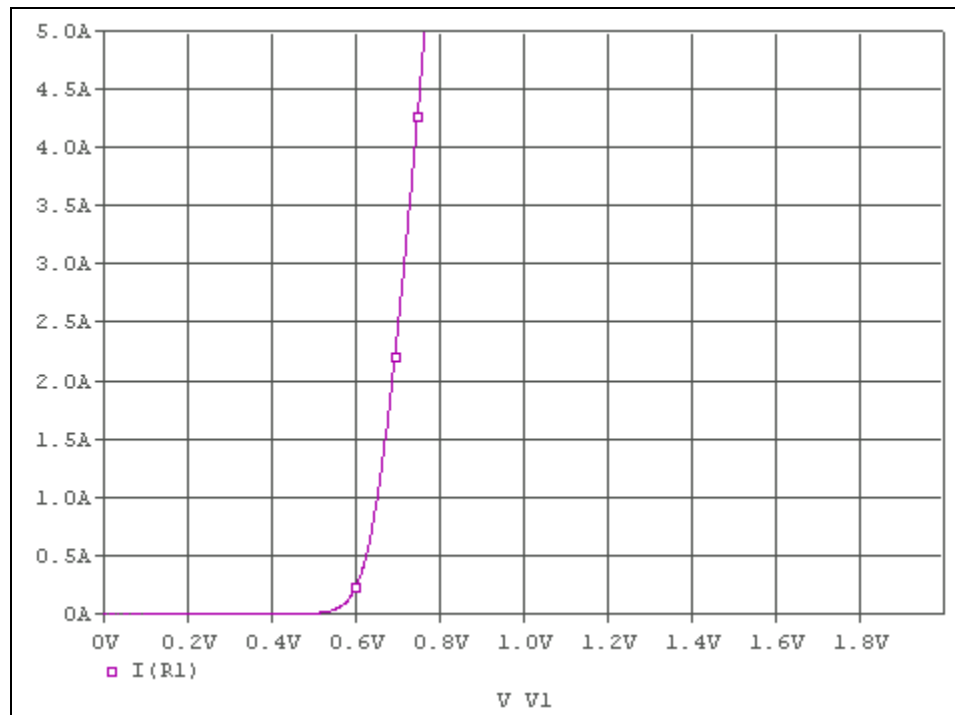


Evaluation circuit

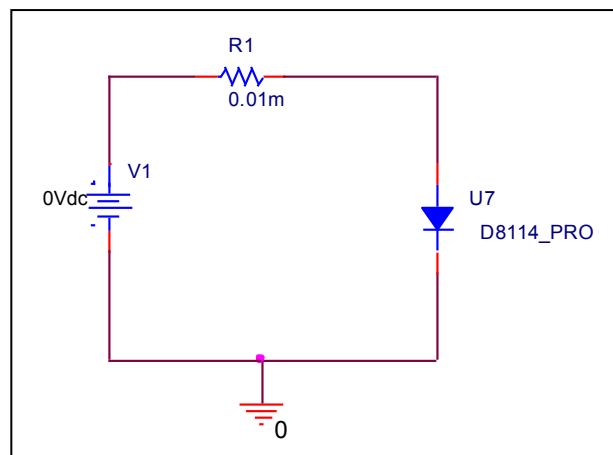


## Forward Current Characteristic

### Circuit Simulation Result

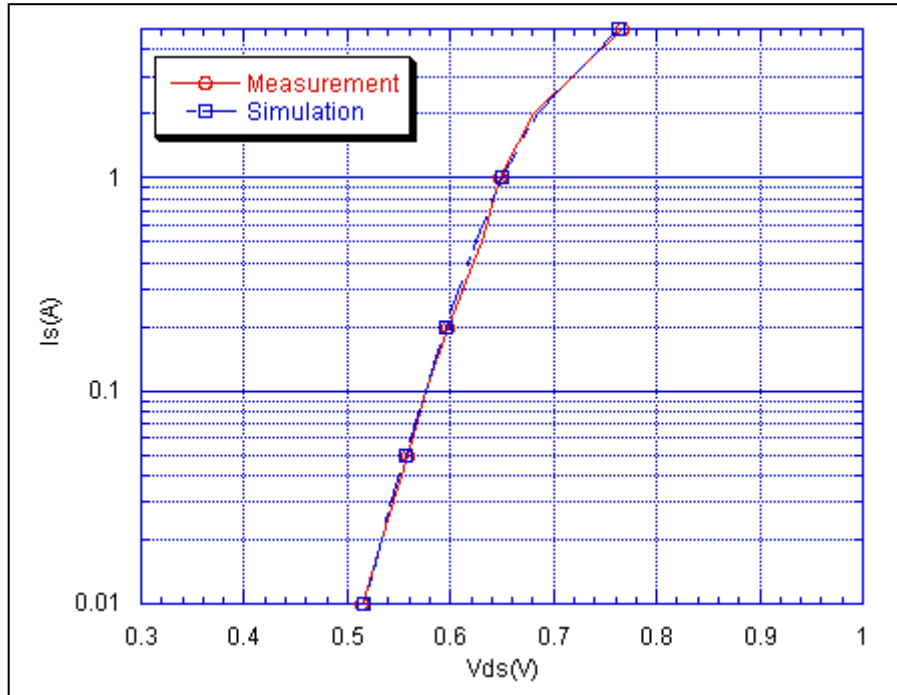


### Evaluation Circuit



## Comparison Graph

### Circuit Simulation Result

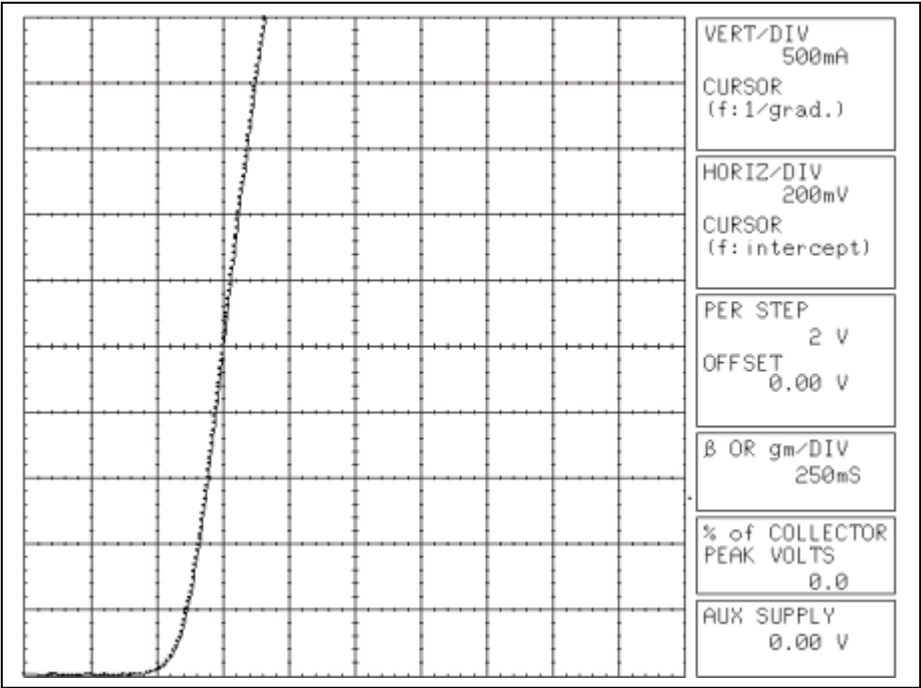


### Simulation Result

| Ifwd(A) | Vfwd(V)<br>Measurement | Vfwd(V)<br>Simulation | %Error |
|---------|------------------------|-----------------------|--------|
| 0.010   | 0.514                  | 0.515                 | 0.195  |
| 0.020   | 0.534                  | 0.533                 | -0.187 |
| 0.050   | 0.558                  | 0.557                 | -0.179 |
| 0.100   | 0.576                  | 0.576                 | 0.000  |
| 0.200   | 0.598                  | 0.596                 | -0.334 |
| 0.500   | 0.630                  | 0.624                 | -0.952 |
| 1.000   | 0.648                  | 0.651                 | 0.463  |
| 2.000   | 0.682                  | 0.686                 | 0.587  |
| 5.000   | 0.766                  | 0.763                 | -0.392 |

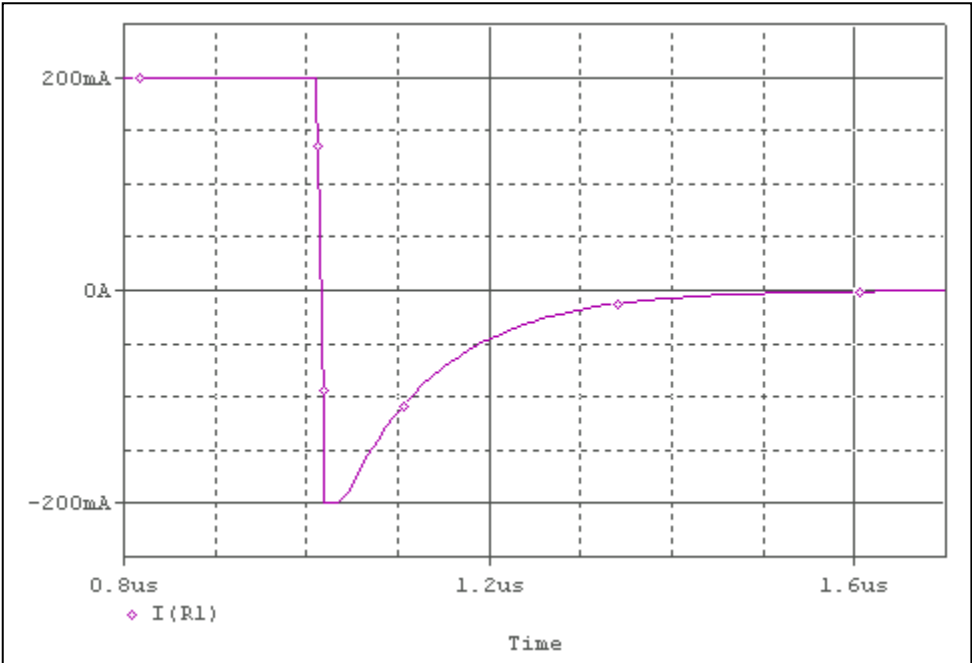
Forward Current Characteristic

Reference

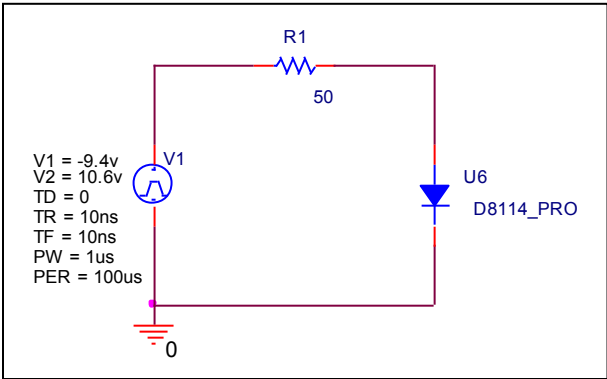


# Reverse Recovery Characteristic

## Circuit Simulation Result



## Evaluation Circuit

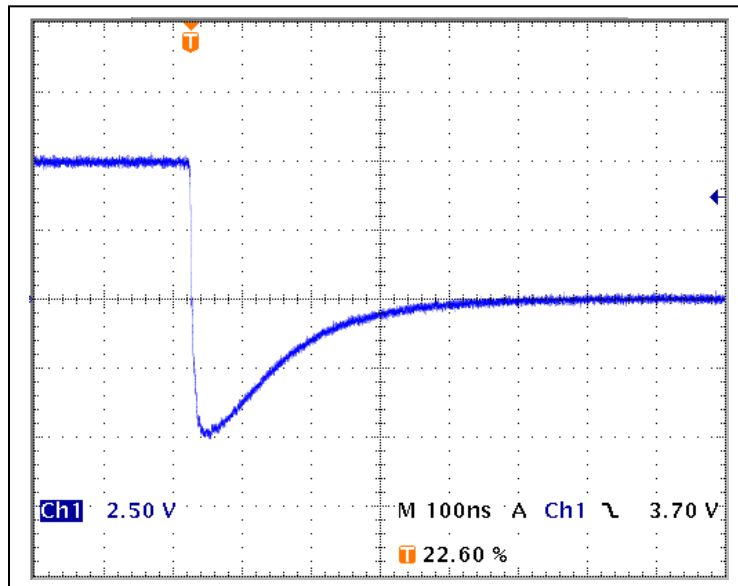


## Compare Measurement vs. Simulation

|            | Measurement    |           | Simulation     |           | Error(%)       |
|------------|----------------|-----------|----------------|-----------|----------------|
| <b>trj</b> | <b>22.000</b>  | <b>ns</b> | <b>21.178</b>  | <b>ns</b> | <b>- 3.736</b> |
| <b>trb</b> | <b>250.000</b> | <b>ns</b> | <b>250.394</b> | <b>ns</b> | <b>0.157</b>   |

## Reverse Recovery Characteristic

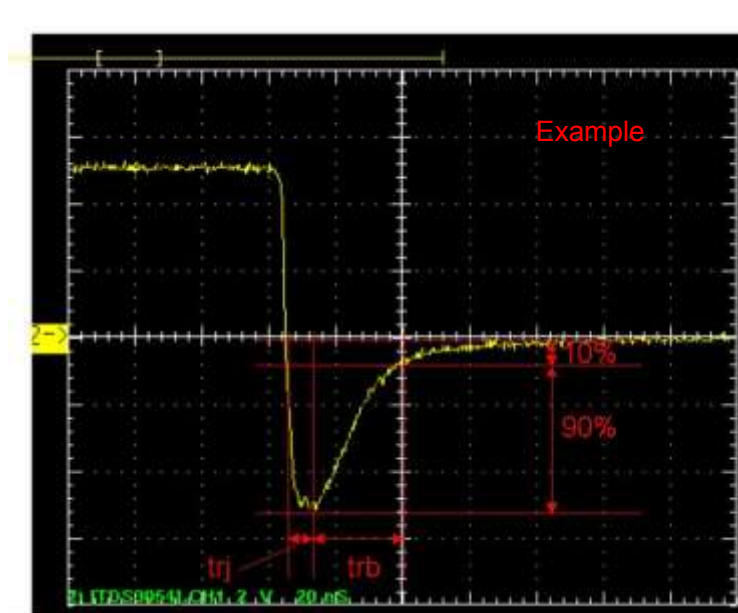
## Reference



$T_{rj}=22(\text{ns})$

$T_{rb}=250(\text{ns})$

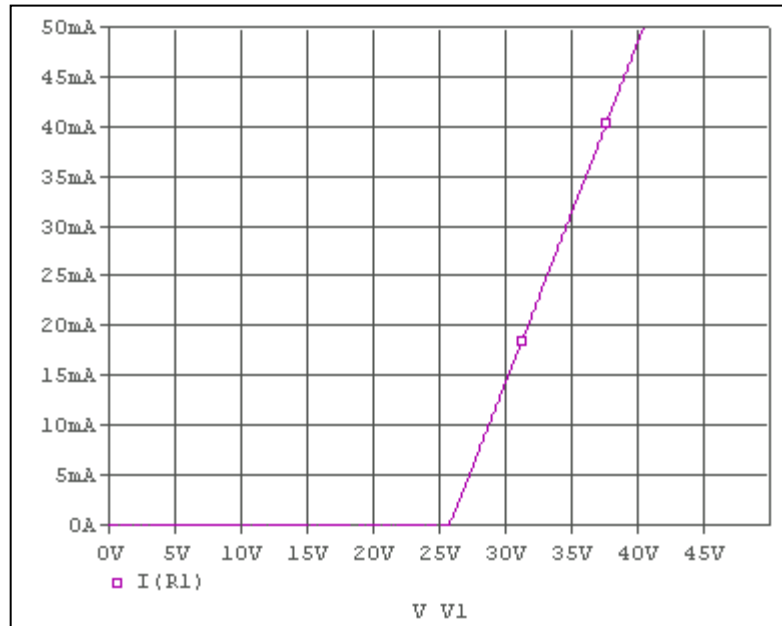
Conditions:  $I_{fwd}=I_{rev}=0.2(\text{A})$ ,  $R_I=50$



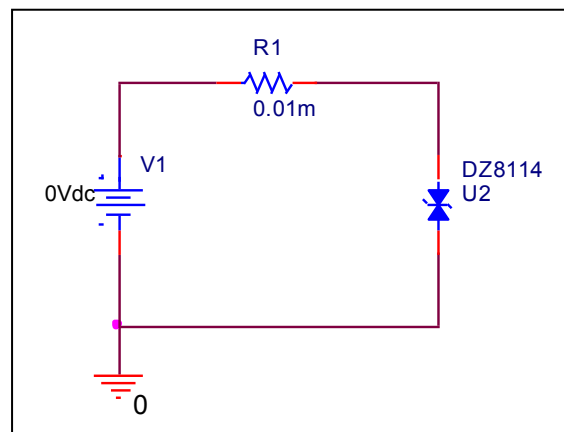
Relation between  $t_{rj}$  and  $t_{rb}$

## Zener Voltage Characteristic

### Circuit Simulation Result



### Evaluation Circuit



## Zener Voltage Characteristic

## Reference

