

# Device Modeling Report

COMPONENTS: PHOTOCOUPLER  
PART NUMBER: PS2501-4  
MANUFACTURER: NEC



**Bee Technologies Inc.**

## DIODE MODEL

| Pspice model Parameter | Model description                           |
|------------------------|---------------------------------------------|
| IS                     | Saturation Current                          |
| N                      | Emission Coefficient                        |
| RS                     | Series Resistance                           |
| IKF                    | High-injection Knee Current                 |
| CJO                    | Zero-bias Junction Capacitance              |
| M                      | Junction Grading Coefficient                |
| VJ                     | Junction Potential                          |
| ISR                    | Recombination Current Saturation Value      |
| BV                     | Reverse Breakdown Voltage(a positive value) |
| IBV                    | Reverse Breakdown Current(a positive value) |
| TT                     | Transit Time                                |

## BIPOLAR JUNCTION TRANSISTOR MODEL

| Pspice model parameter | Model description                             |
|------------------------|-----------------------------------------------|
| NR                     | Reverse Emission Coefficient                  |
| RB                     | Base Resistance                               |
| RC                     | Series Collector Resistance                   |
| CJE                    | Zero-bias Emitter-Base Junction Capacitance   |
| CJC                    | Zero-bias Collector-Base Junction Capacitance |
| TF                     | Forward Transit Time                          |
| TR                     | Reverse Transit Time                          |

## VOLTAGE CONTROLLED VOLTAGE SOURCE MODEL(VCVS)

E<Name><(+)Node><( - )Node>VALUE={Expression}

E<Name><(+)Node><( - )Node>TABLE={Expression}

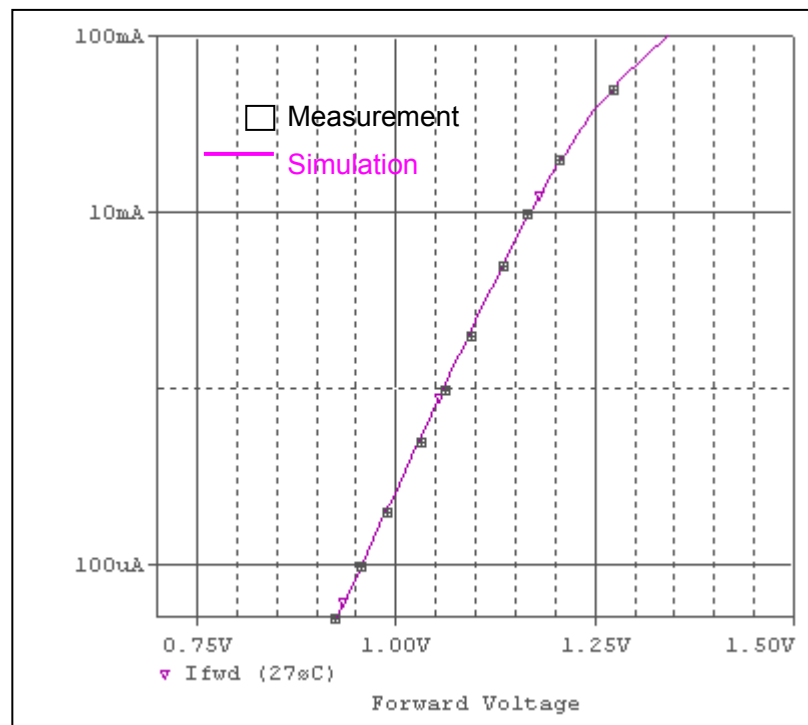
## **VOLTAGE CONTROLLED CURRENT SOURCE MODEL(VCCS)**

E<Name><(+)Node><(–)Node>VALUE={Expression}

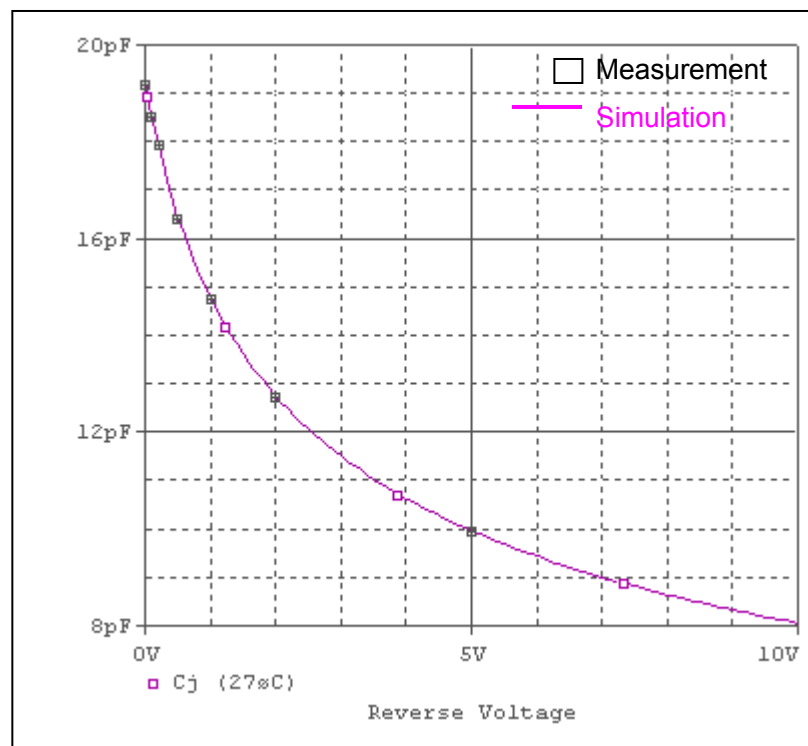
## **CURRENT CONTROLLED MODEL(W)**

| Pspice<br>model<br>parameter | Model description                |
|------------------------------|----------------------------------|
| IOFF                         | Controlling current to Off state |
| ION                          | Controlling current to On state  |
| ROFF                         | Off Resistance                   |
| RON                          | On Resistance                    |

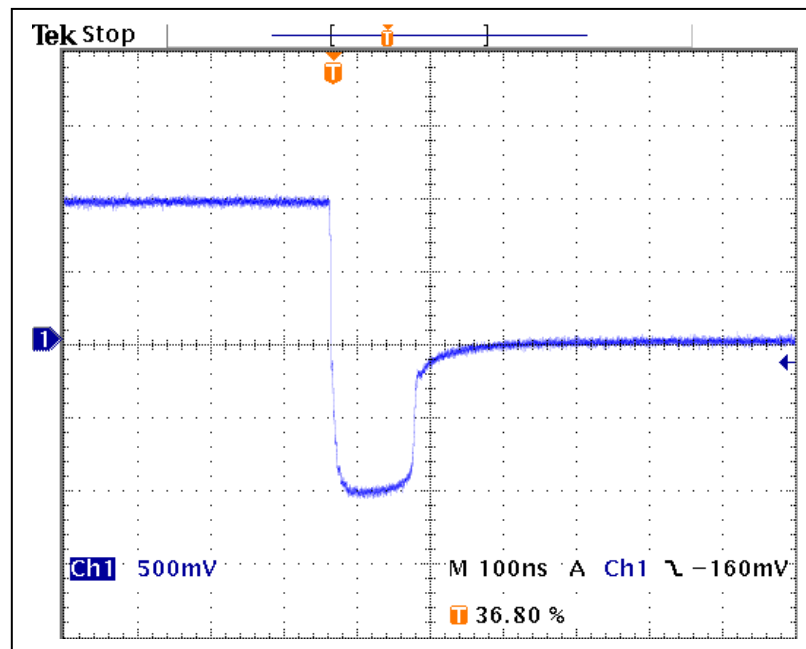
## Input Device Forward Current Characteristics



## Input Device Junction Capacitance Characteristics



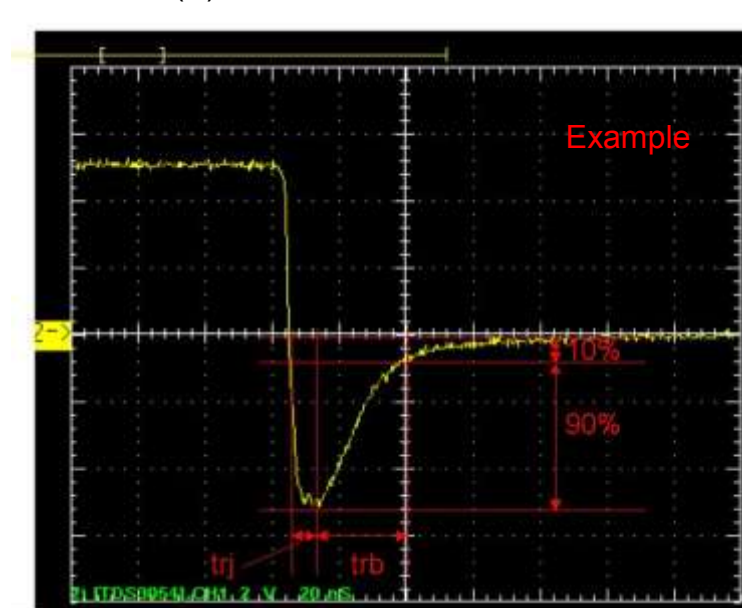
## Input Device Reverse Recovery Characteristics



$t_{rj}=102\text{n(s)}$

$t_{rb}=32\text{n(s)}$

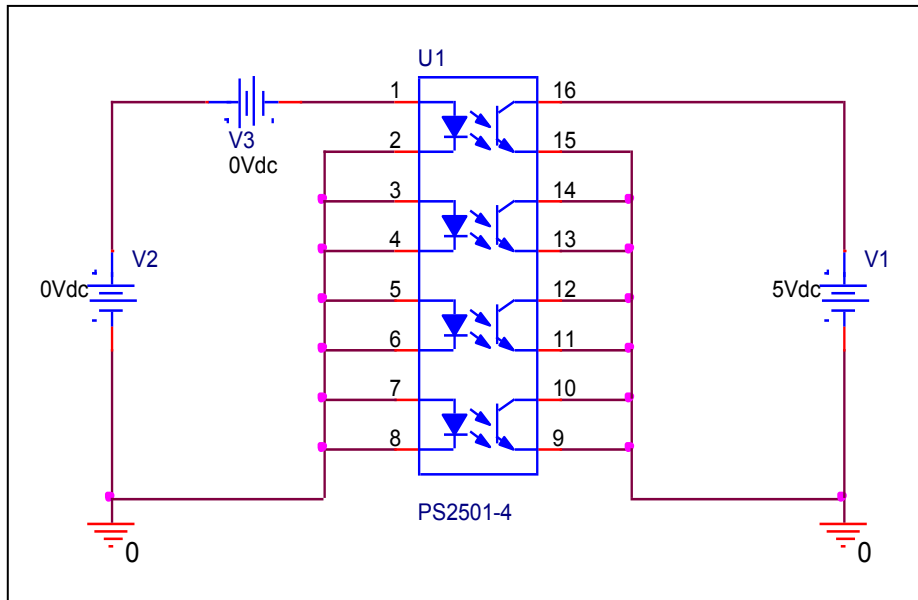
Conditions:  $I_{fwd}=I_{rev}=0.04\text{(A)}$ ,  $R_I=50$



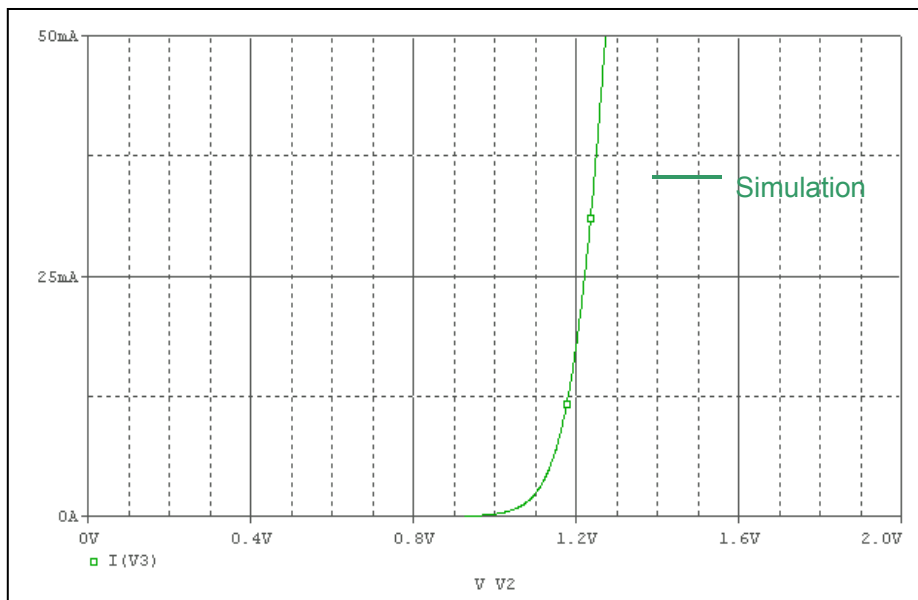
Relation between  $t_{rj}$  and  $t_{rb}$

## LED IV Curve Characteristics

### Evaluation Circuit



### Simulation result

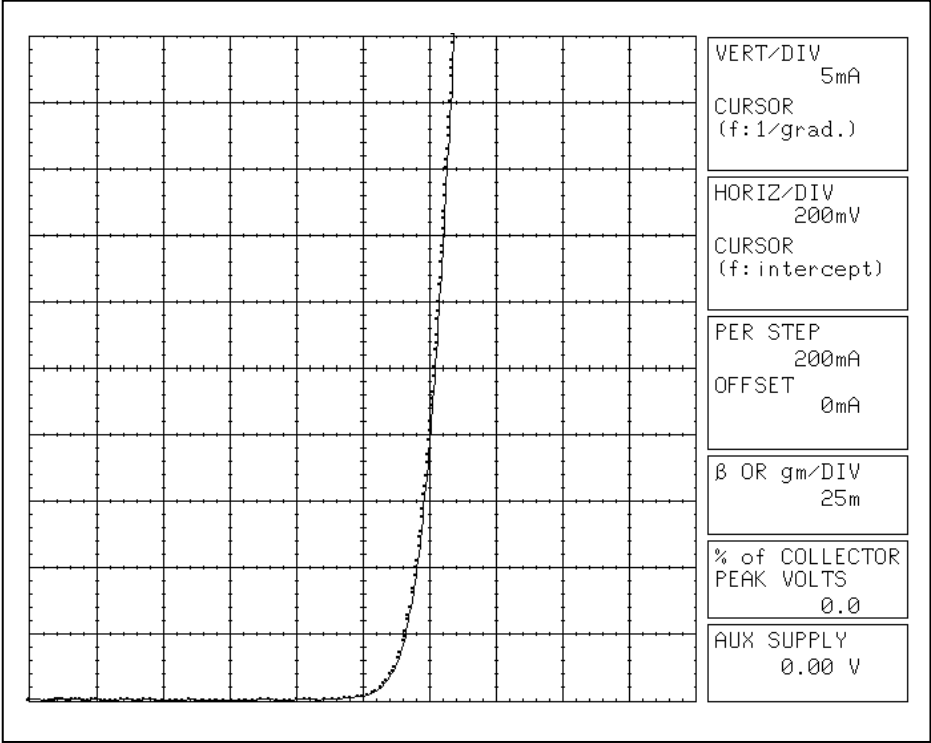


## Comparison Table

| Ifwd(mA) | Vfwd(V)     |            | % Error |
|----------|-------------|------------|---------|
|          | Measurement | Simulation |         |
| 0.05     | 0.924       | 0.927      | 0.325   |
| 0.10     | 0.956       | 0.958      | 0.209   |
| 0.20     | 0.990       | 0.988      | -0.202  |
| 0.50     | 1.032       | 1.029      | -0.291  |
| 1.00     | 1.062       | 1.060      | -0.188  |
| 2.00     | 1.094       | 1.092      | -0.183  |
| 5.00     | 1.134       | 1.135      | 0.088   |
| 10.00    | 1.166       | 1.169      | 0.257   |
| 20.00    | 1.206       | 1.208      | 0.166   |
| 50.00    | 1.274       | 1.273      | -0.078  |

**LED IV Curve Characteristics**

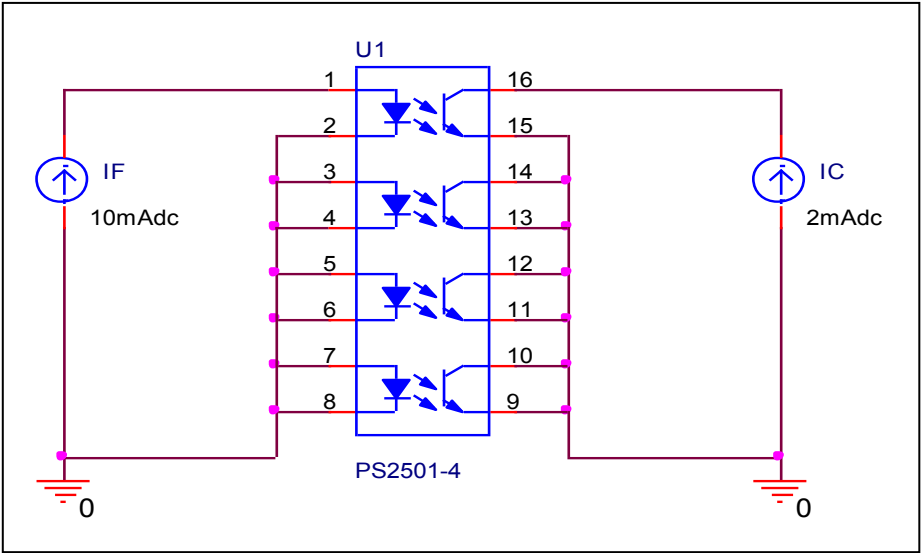
**Reference**



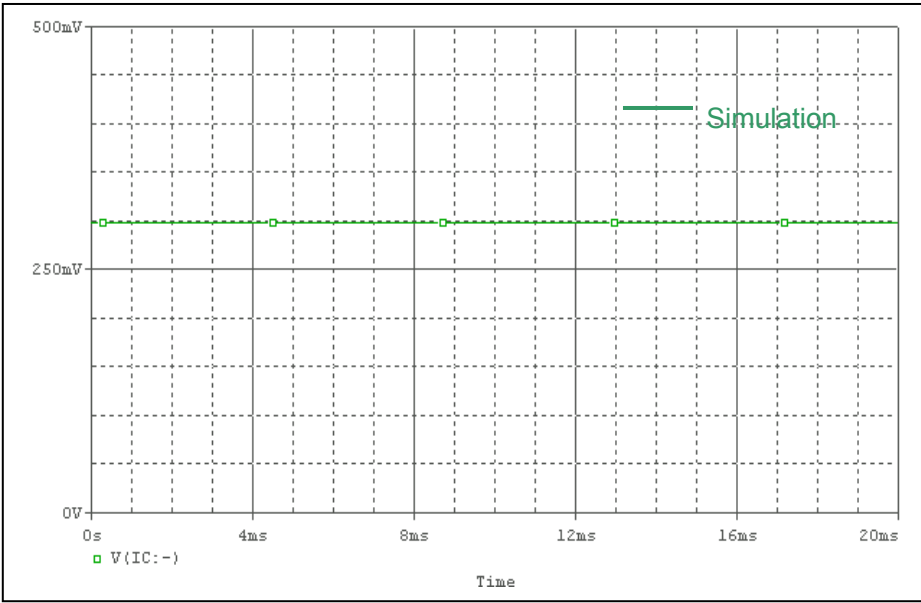


# Transistor Saturation Characteristics

## Evaluation Circuit



## Simulation result

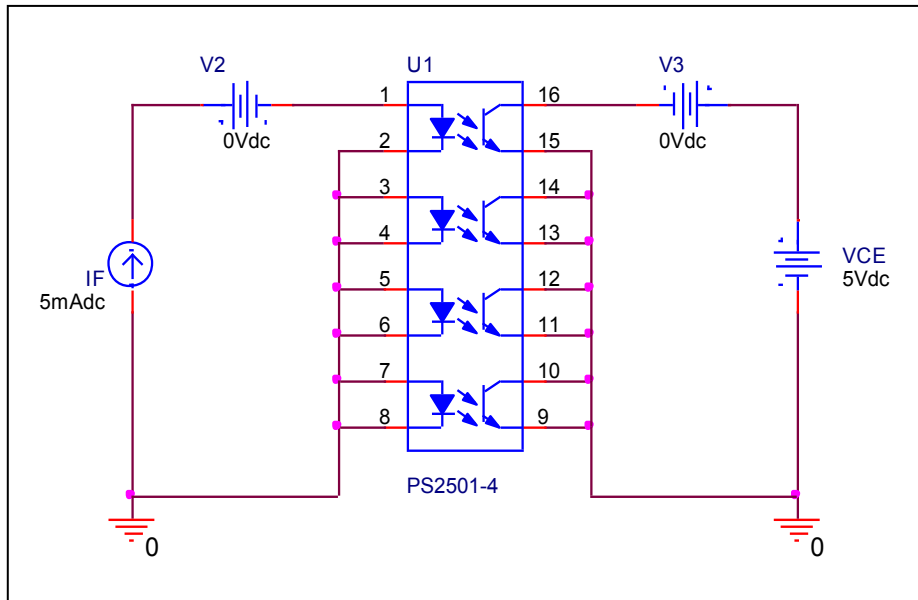


## Comparison Table

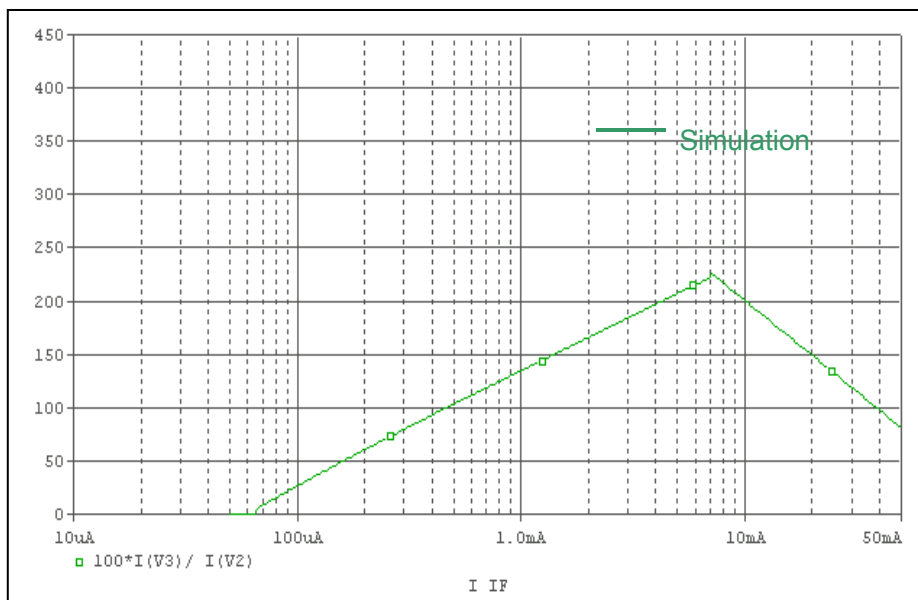
|              | Measurement | Simulation | % Error |
|--------------|-------------|------------|---------|
| Vce(sat) (V) | 0.3         | 0.299      | -0.333  |

## CTR(Current Transfer Ratio) Characteristics

### Evaluation Circuit



### Simulation result

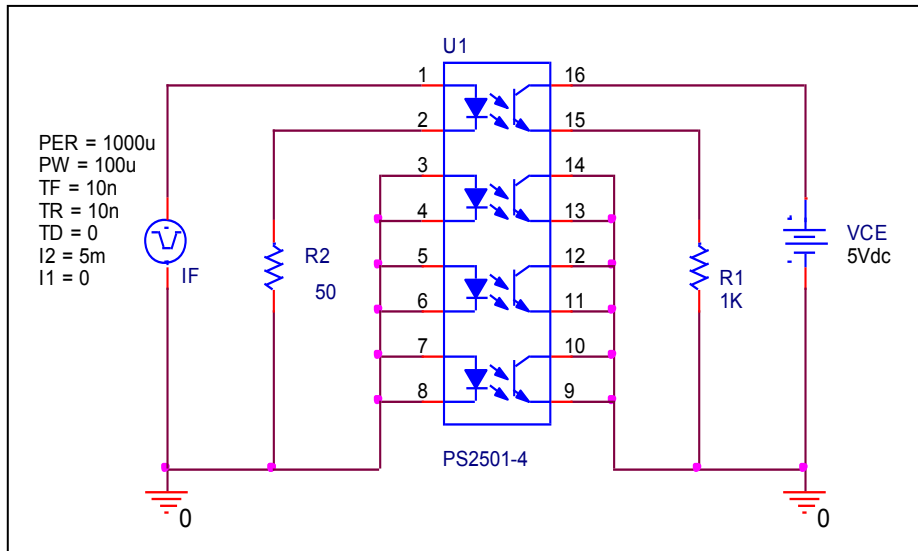


## Comparison Table

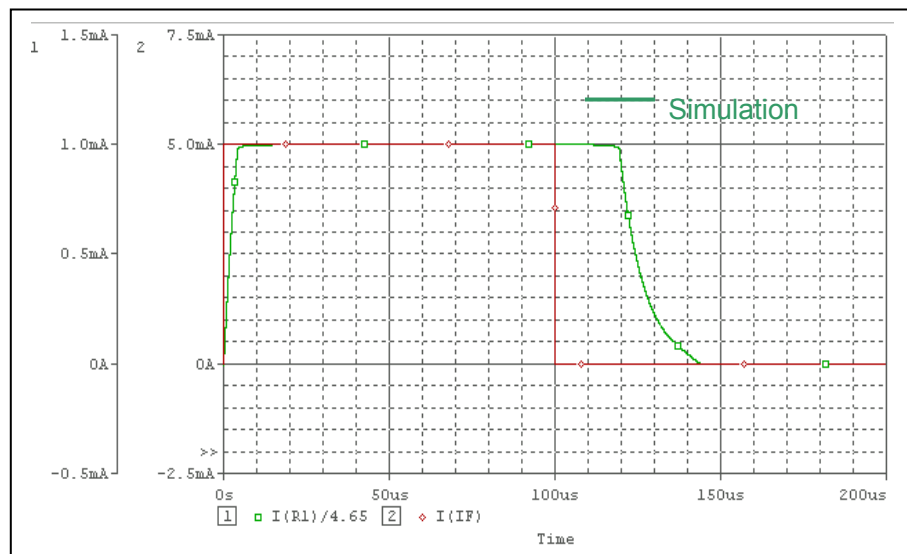
| If(mA) | CTR(%)      |            | % Error |
|--------|-------------|------------|---------|
|        | Measurement | Simulation |         |
| 0.1    | 27.0        | 26.467     | -1.974  |
| 0.2    | 59.0        | 60.415     | 2.398   |
| 0.5    | 98.2        | 103.219    | 5.111   |
| 1.0    | 129.0       | 134.764    | 4.468   |
| 2.0    | 158.0       | 165.336    | 4.643   |
| 5.0    | 207.0       | 206.938    | -0.030  |
| 10.0   | 205.0       | 200.280    | -2.302  |
| 20.0   | 150.0       | 148.833    | -0.778  |
| 50.0   | 80.0        | 80.794     | 0.992   |

# Switching Time Characteristics

## Evaluation Circuit



## Simulation result

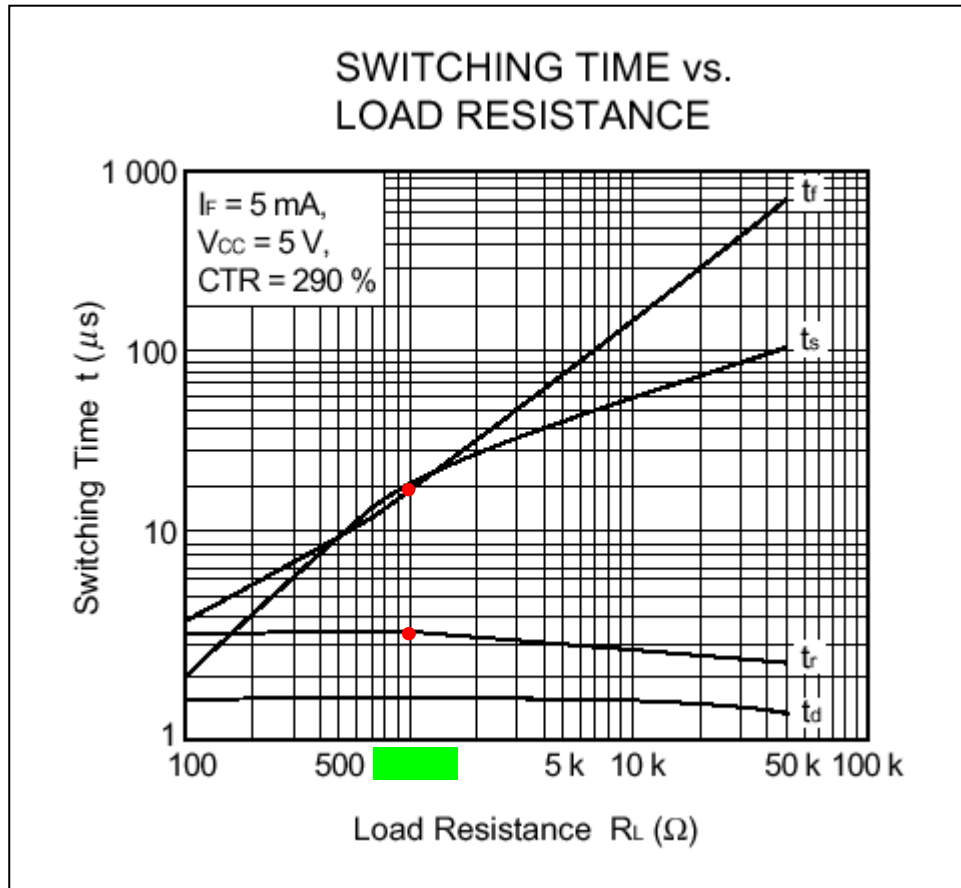


## Comparison Table

| IF=5mA, Vcc=5V,RL=1K | Measurement | Simulation | % Error |
|----------------------|-------------|------------|---------|
| tr(us)               | 3.4         | 3.405      | 0.147   |
| tf (us)              | 17.0        | 16.277     | -4.253  |
| ts (us)              | 20.0        | 19.954     | -0.230  |

## Switching Time Characteristics

## Reference



$t_r = 3.4(\mu\text{s})$

$t_f = 17(\mu\text{s})$

$t_s = 20(\mu\text{s})$

Conditions:  $I_F = 5\text{mA}$ ,  $V_{CC} = 5\text{V}$