

# Device Modeling Report

COMPONENTS: TRANSISTOR  
PART NUMBER: 2SA1037AKT146R  
MANUFACTURER: ROHM



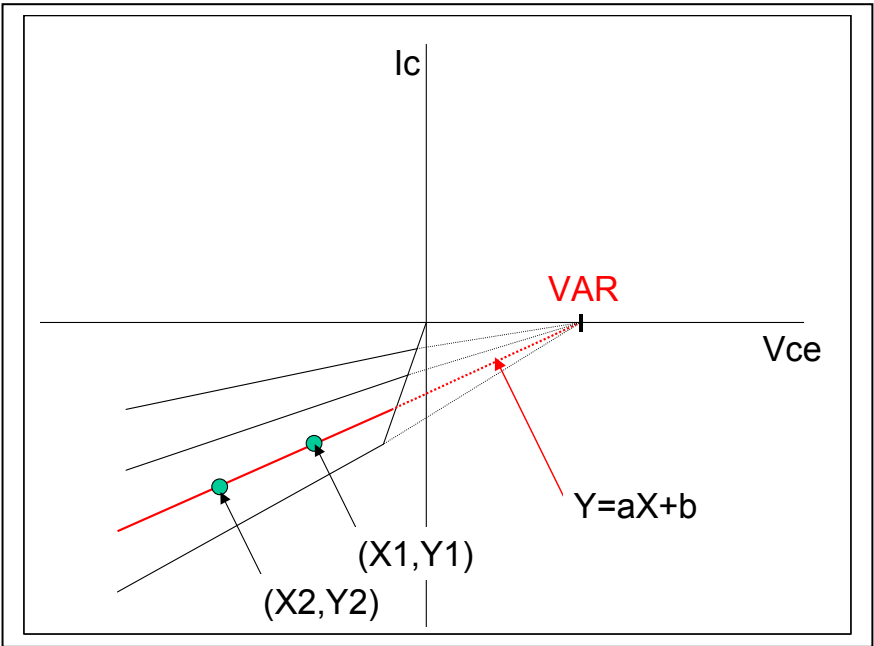
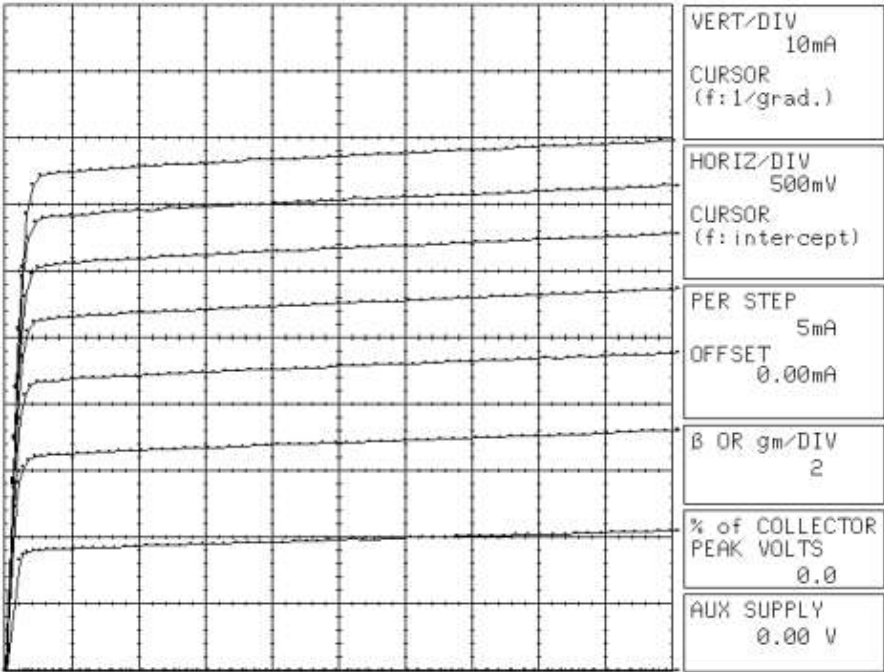
**Bee Technologies Inc.**

## TRANSISTOR MODEL

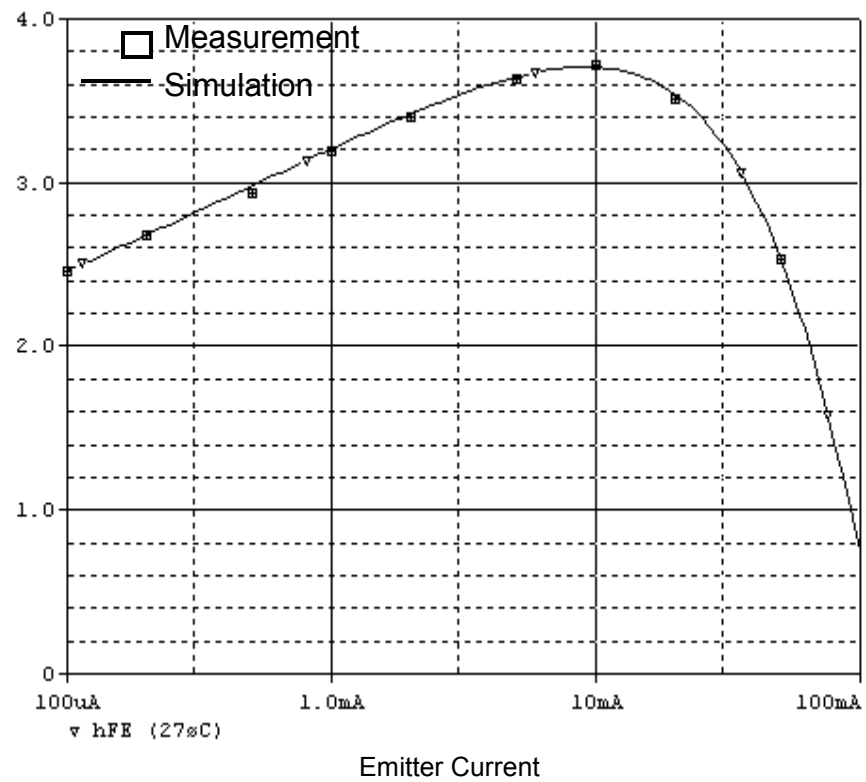
| PSpice model parameter | Model description                                           |
|------------------------|-------------------------------------------------------------|
| IS                     | Saturation Current                                          |
| BF                     | Ideal Maximum Forward Beta                                  |
| NF                     | Forward Current Emission Coefficient                        |
| VAF                    | Forward Early Voltage                                       |
| IKF                    | Forward Beta Roll-off Knee Current                          |
| ISE                    | Non-ideal Base-Emitter Diode Saturation Current             |
| NE                     | Non-ideal Base-Emitter Diode Emission Coefficient           |
| BR                     | Ideal Maximum Reverse Beta                                  |
| NR                     | Reverse Emission Coefficient                                |
| VAR                    | Reverse Early Voltage                                       |
| IKR                    | Reverse Beta Roll-off Knee Current                          |
| ISC                    | Non-ideal Base-Collector Diode Saturation Current           |
| NC                     | Non-ideal Base-Collector Diode Emission Coefficient         |
| NK                     | Forward Beta Roll-off Slope Exponent                        |
| RE                     | Emitter Resistance                                          |
| RB                     | Base Resistance                                             |
| RC                     | Series Collector Resistance                                 |
| CJE                    | Zero-bias Emitter-Base Junction Capacitance                 |
| VJE                    | Emitter-Base Junction Potential                             |
| MJE                    | Emitter-Base Junction Grading Coefficient                   |
| CJC                    | Zero-bias Collector-Base Junction Capacitance               |
| VJC                    | Collector-base Junction Potential                           |
| MJC                    | Collector-base Junction Grading Coefficient                 |
| FC                     | Coefficient for Onset of Forward-bias Depletion Capacitance |
| TF                     | Forward Transit Time                                        |
| XTF                    | Coefficient for TF Dependency on Vce                        |
| VTF                    | Voltage for TF Dependency on Vce                            |
| ITF                    | Current for TF Dependency on Ic                             |
| PTF                    | Excess Phase at $f=1/2\pi*TF$                               |
| TR                     | Reverse Transit Time                                        |
| EG                     | Activation Energy                                           |
| XTB                    | Forward Beta Temperature Coefficient                        |
| XTI                    | Temperature Coefficient for IS                              |

Reverse

Reverse Early Voltage Characteristic

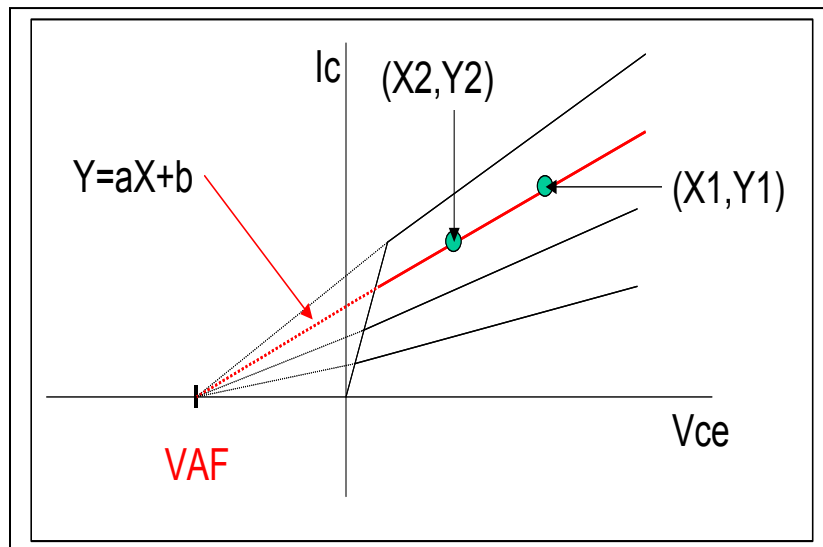
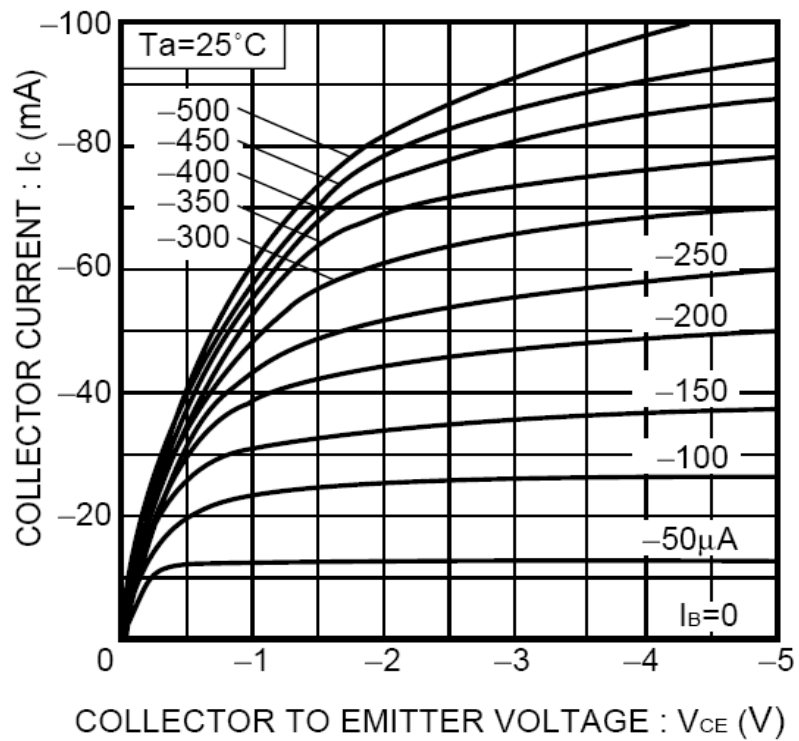


## Reverse DC Beta Characteristic ( $I_e$ vs. $h_{FE}$ )

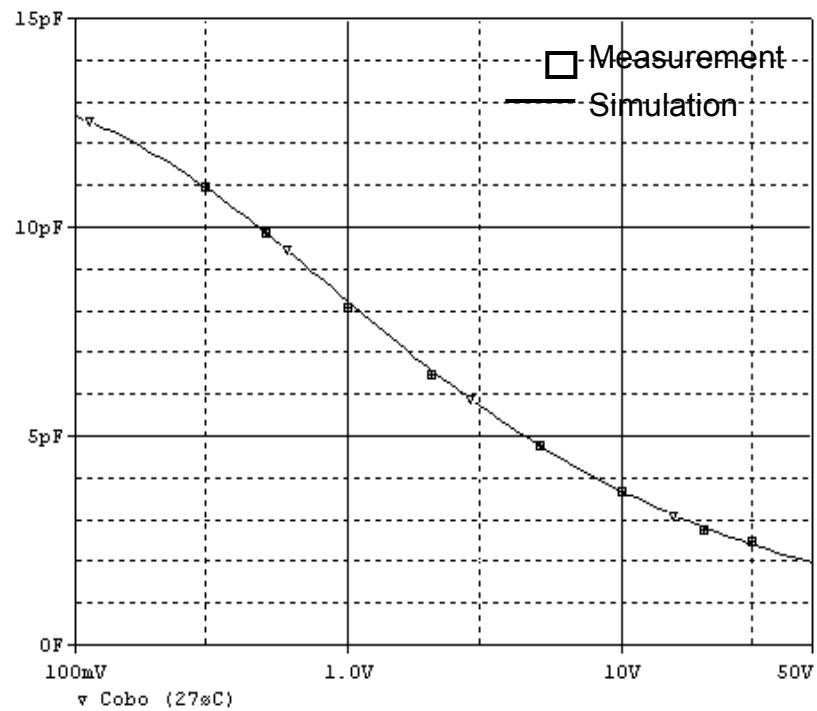


Forward

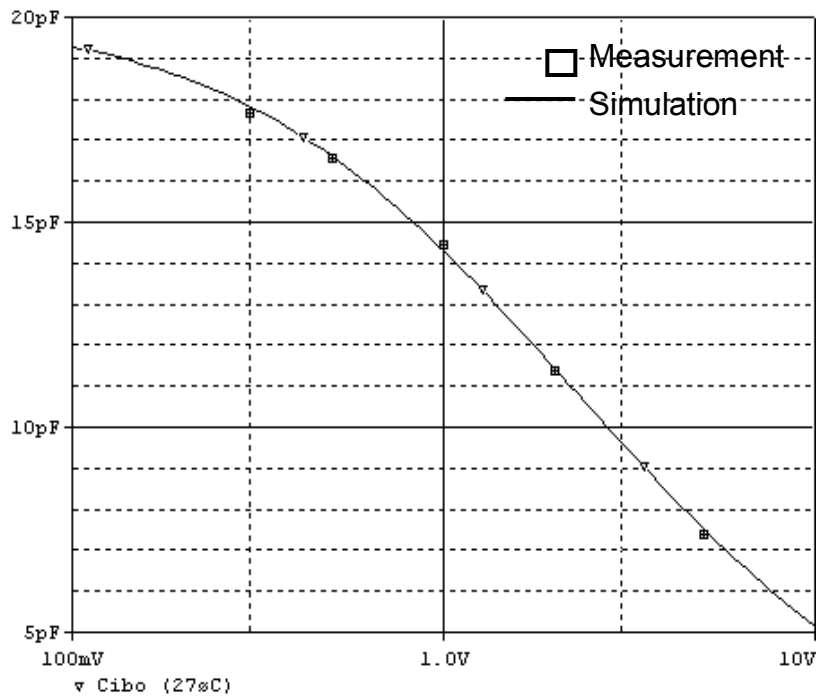
## Forward Early Voltage Characteristic



## C-B Capacitance Characteristics

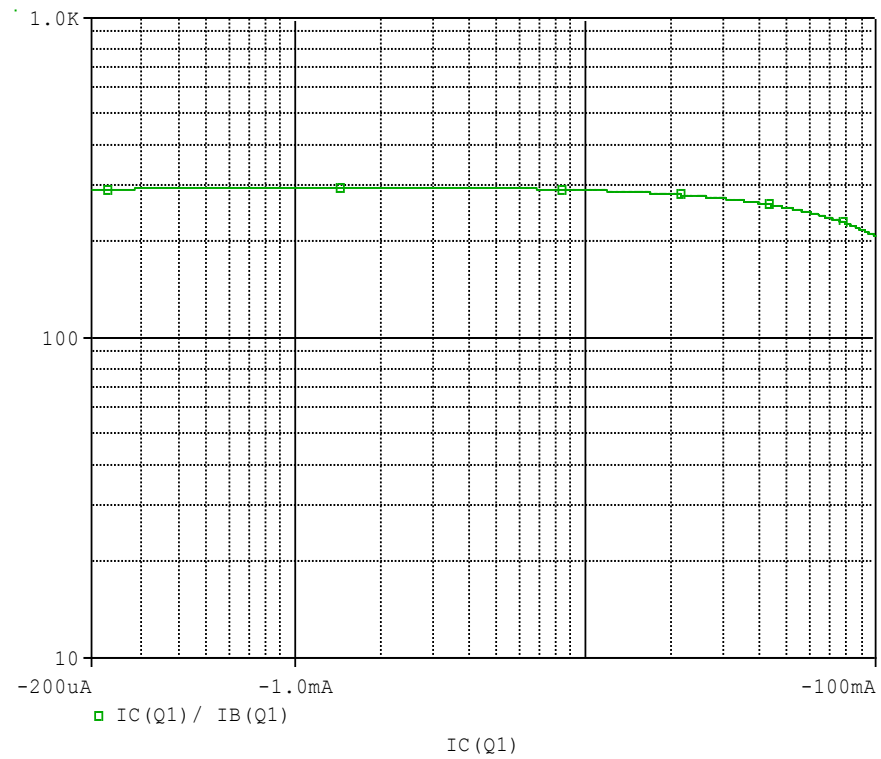


## E-B Capacitance Characteristics

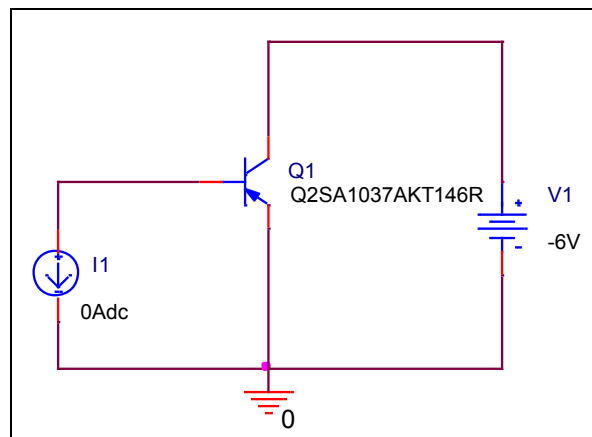


## Transistor $h_{FE}$ - $I_C$ Characteristics

### Circuit Simulation Result

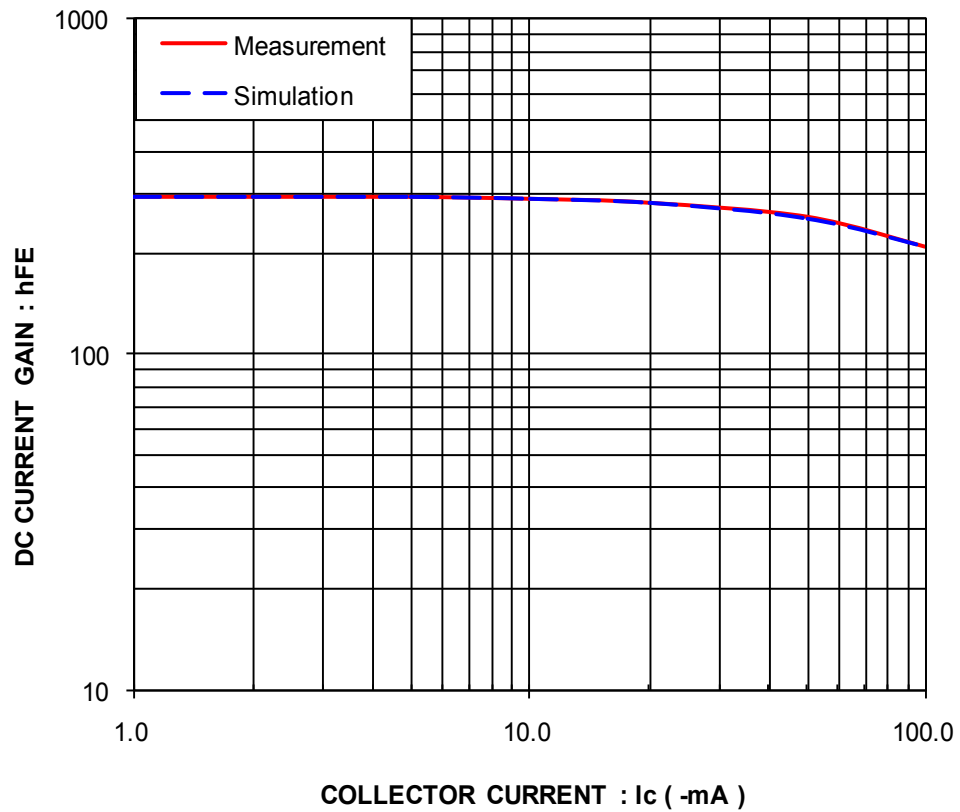


### Evaluation Circuit



## Comparison Graph

### Circuit Simulation Result

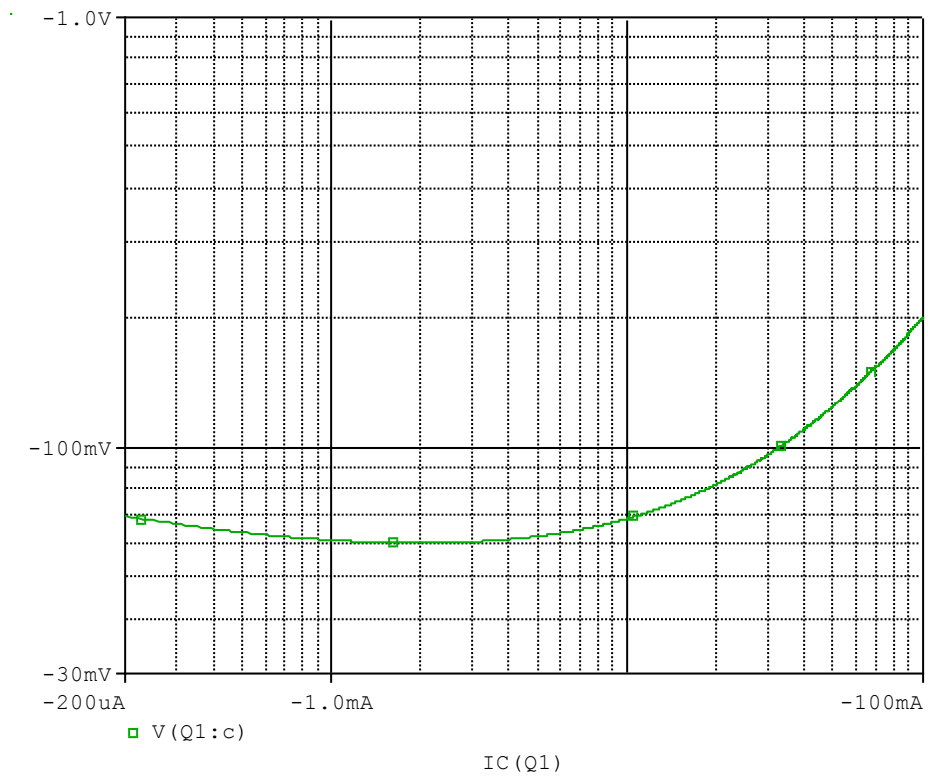


### Simulation Result

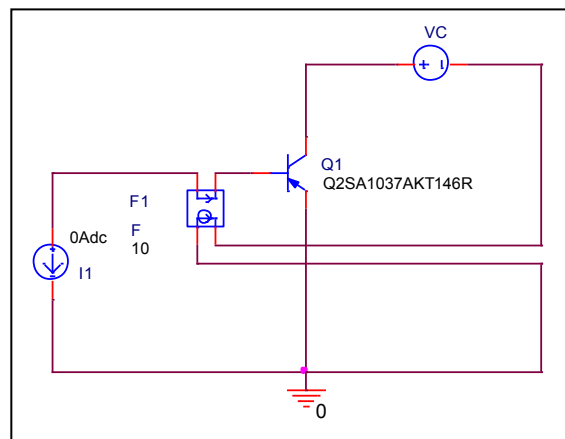
| Ic(mA)   | hFE         |            | Error(%) |
|----------|-------------|------------|----------|
|          | Measurement | Simulation |          |
| -0.200   | 288.000     | 287.083    | -0.318   |
| -0.500   | 294.000     | 293.905    | -0.032   |
| -1.000   | 295.000     | 295.117    | 0.040    |
| -2.000   | 295.000     | 295.330    | 0.112    |
| -5.000   | 294.000     | 293.563    | -0.149   |
| -10.000  | 290.000     | 289.581    | -0.144   |
| -20.000  | 283.000     | 281.114    | -0.666   |
| -50.000  | 257.000     | 254.769    | -0.868   |
| -100.000 | 210.000     | 207.905    | -0.998   |

## $V_{CE(Sat)}$ - $I_C$ Characteristics

### Circuit Simulation Result

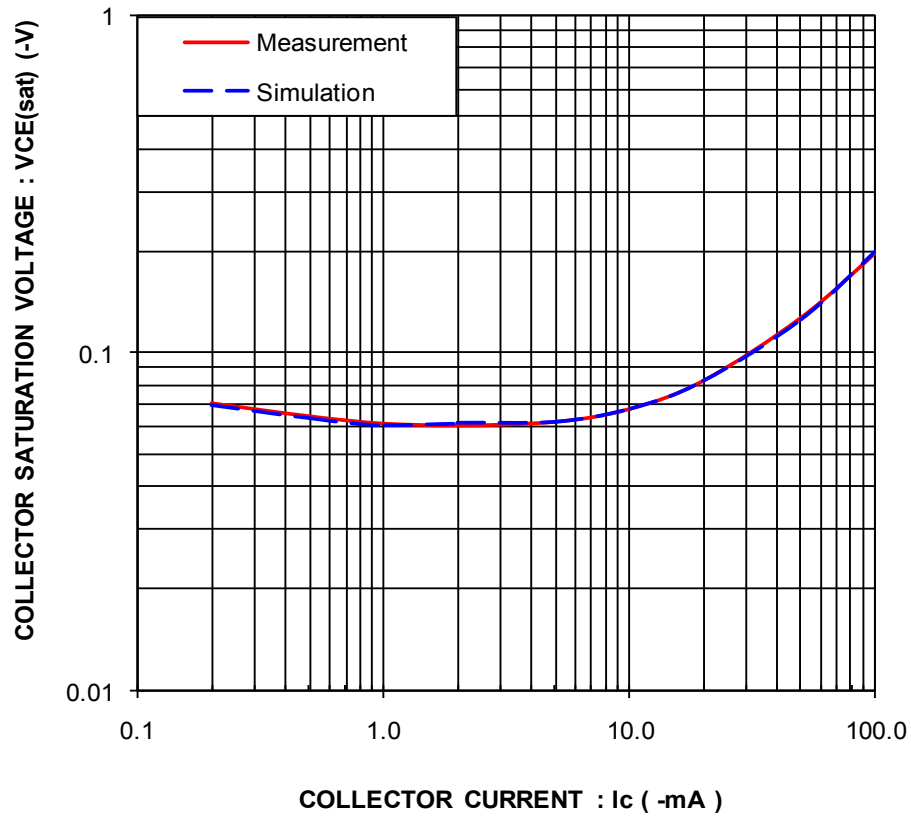


### Evaluation Circuit



## Comparison Graph

### Circuit Simulation Result

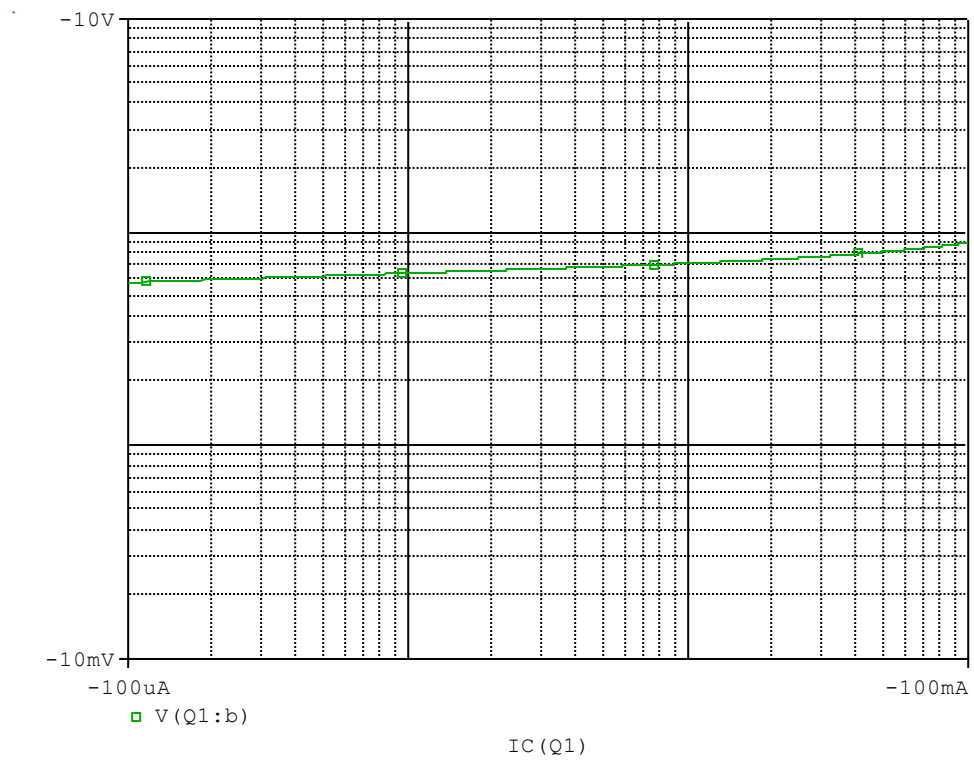


### Simulation Result

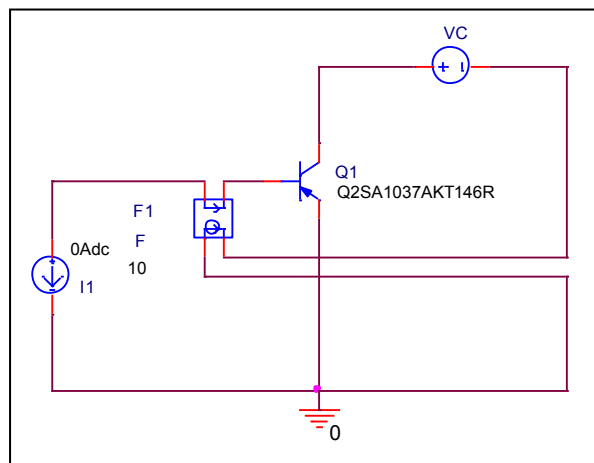
| IC(mA)   | VCE(sat)(V) |            | Error(%) |
|----------|-------------|------------|----------|
|          | Measurement | Simulation |          |
| -0.200   | -0.0710     | -0.0697    | -1.8310  |
| -0.500   | -0.0650     | -0.0638    | -1.8462  |
| -1.000   | -0.0620     | -0.0612    | -1.2903  |
| -2.000   | -0.0610     | -0.0620    | 1.6393   |
| -5.000   | -0.0626     | -0.0625    | -0.1597  |
| -10.000  | -0.0680     | -0.0687    | 1.0294   |
| -20.000  | -0.0825     | -0.0824    | -0.1212  |
| -50.000  | -0.1270     | -0.1258    | -0.9449  |
| -100.000 | -0.1990     | -0.2001    | 0.5528   |

## $V_{BE(Sat)}-I_C$ Characteristics

### Circuit Simulation Result

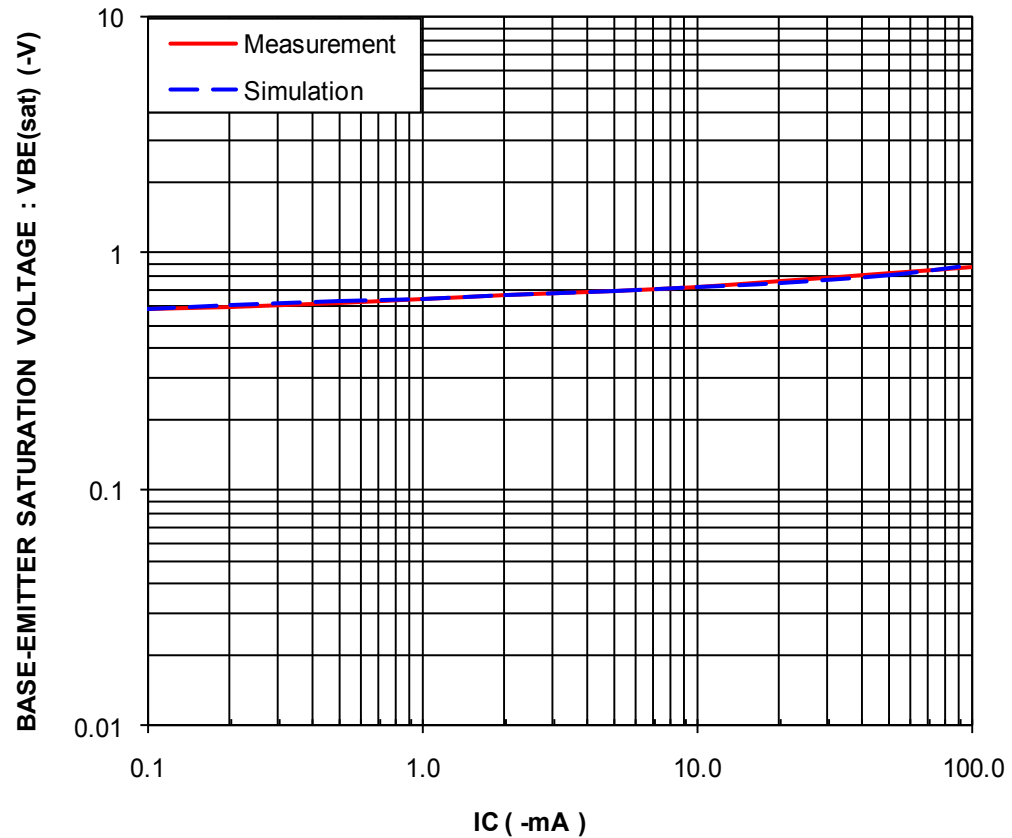


### Evaluation Circuit



## Comparison Graph

### Circuit Simulation Result

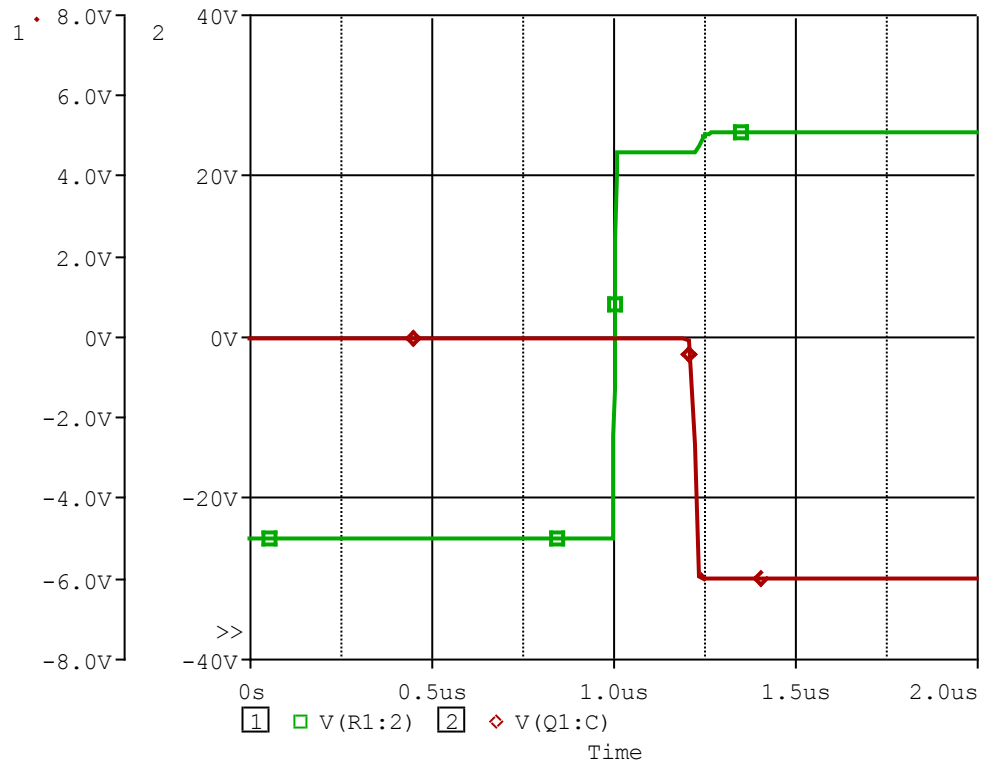


### Simulation Result

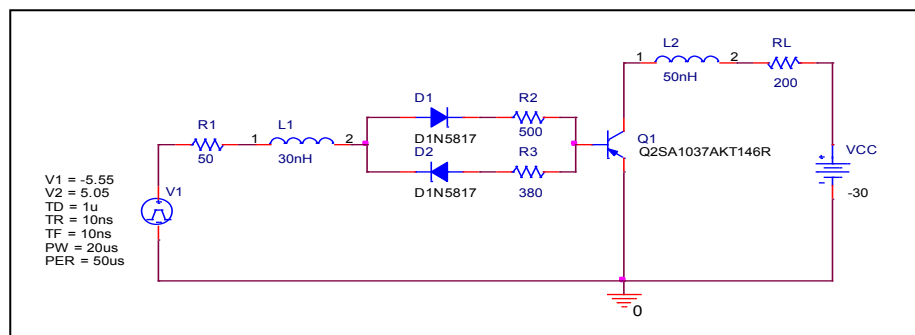
| IC(mA)   | VBE(sat)(V) |            | Error(%) |
|----------|-------------|------------|----------|
|          | Measurement | Simulation |          |
| -0.100   | -0.577      | -0.581     | 0.693    |
| -0.200   | -0.596      | -0.599     | 0.503    |
| -0.500   | -0.620      | -0.624     | 0.645    |
| -1.000   | -0.639      | -0.643     | 0.626    |
| -2.000   | -0.662      | -0.663     | 0.151    |
| -5.000   | -0.698      | -0.692     | -0.860   |
| -10.000  | -0.725      | -0.715     | -1.379   |
| -20.000  | -0.765      | -0.746     | -2.484   |
| -50.000  | -0.820      | -0.809     | -1.341   |
| -100.000 | -0.875      | -0.894     | 2.171    |

## Switching Characteristics

### Circuit simulation result



### Evaluation circuit

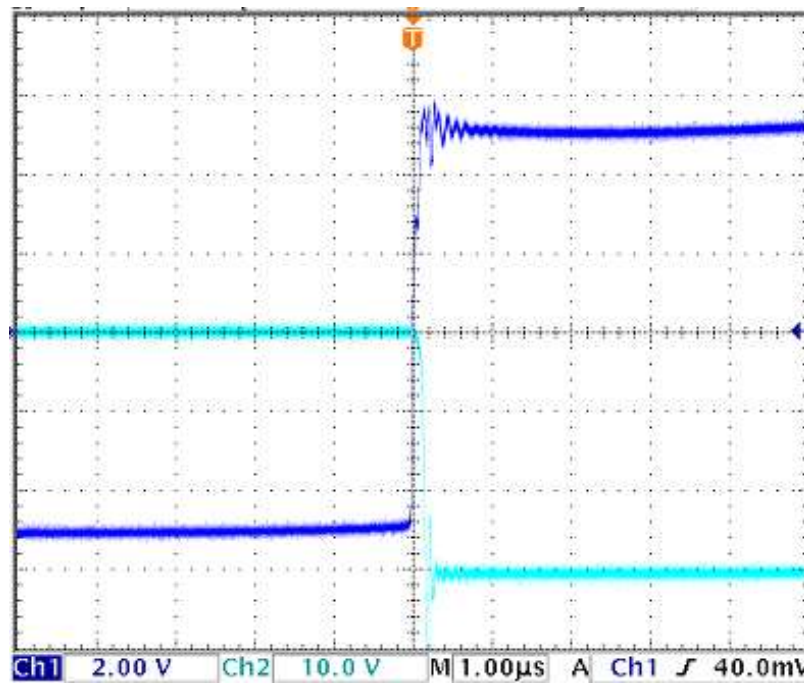


### Simulation result

|                | Measurement | Simulation | %Error |
|----------------|-------------|------------|--------|
| $t_f$ (ns)     | 25.000      | 24.395     | -2.420 |
| $t_{stg}$ (ns) | 210.000     | 210.919    | 0.438  |

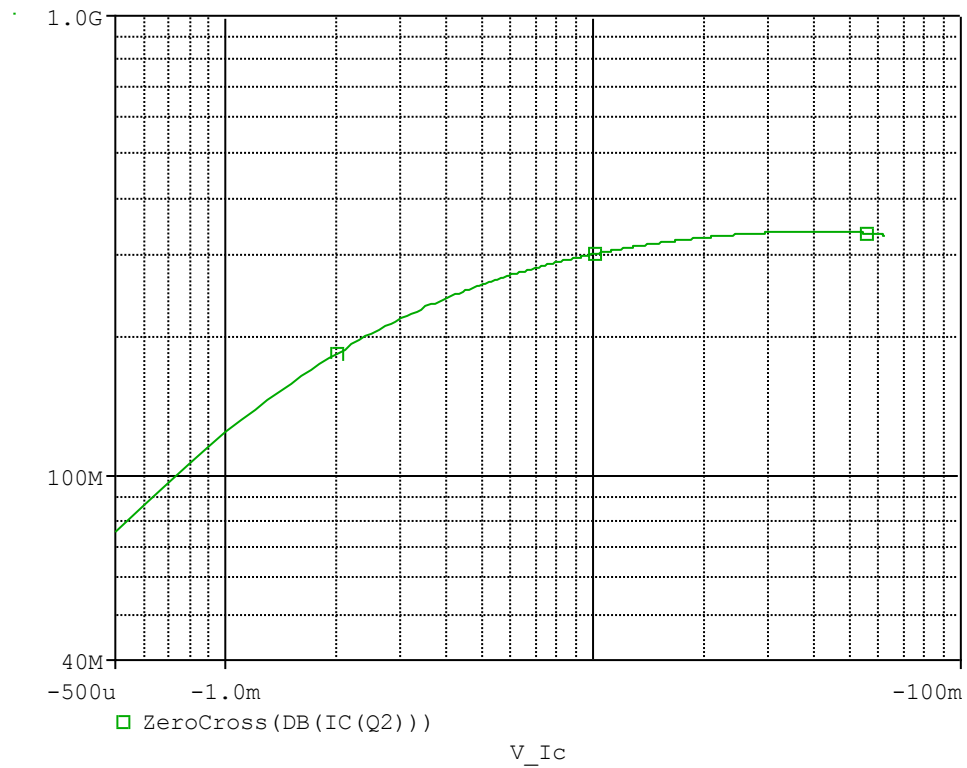
## Switching Characteristics

## Reference

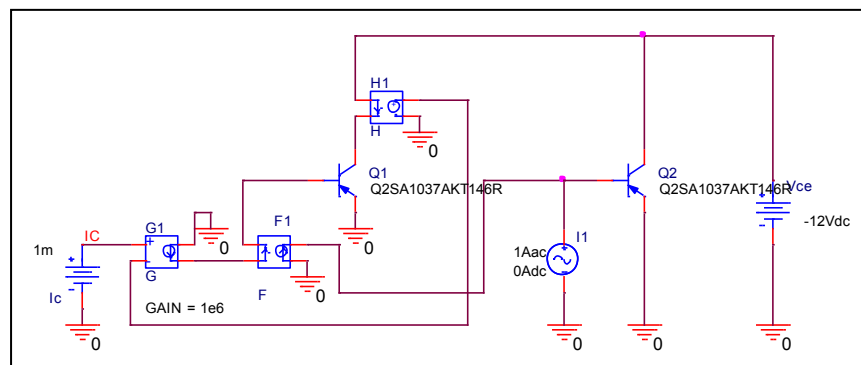


## F<sub>t</sub> - I<sub>C</sub> Characteristics

### Circuit Simulation Result



### Evaluation Circuit

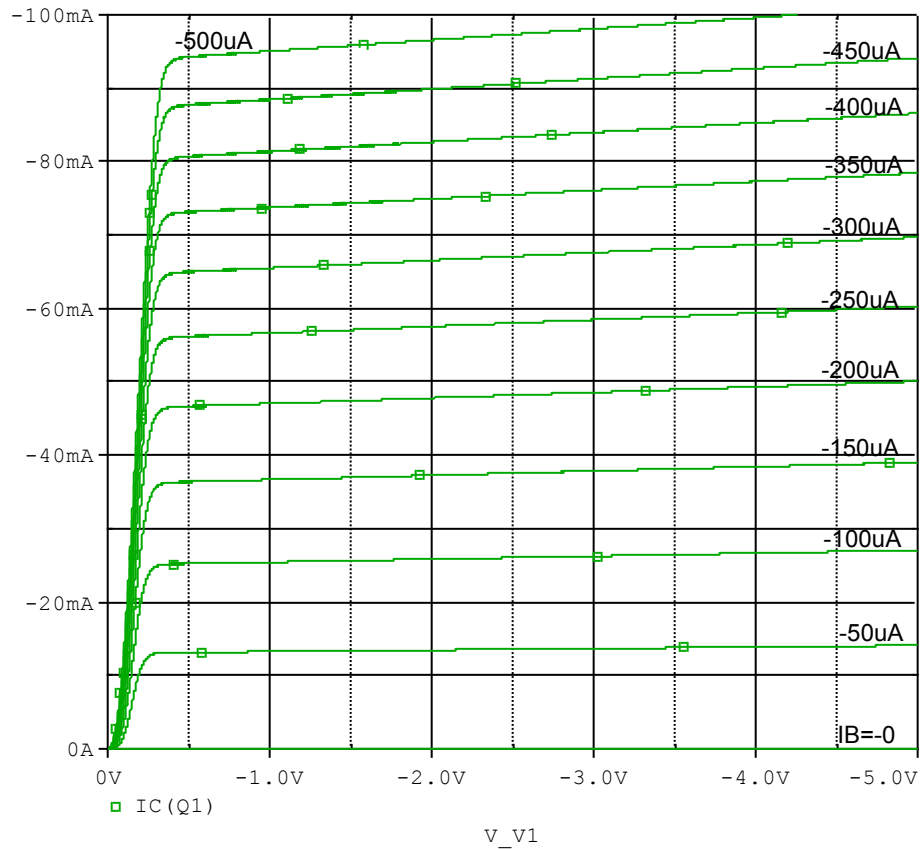


### Simulation Result

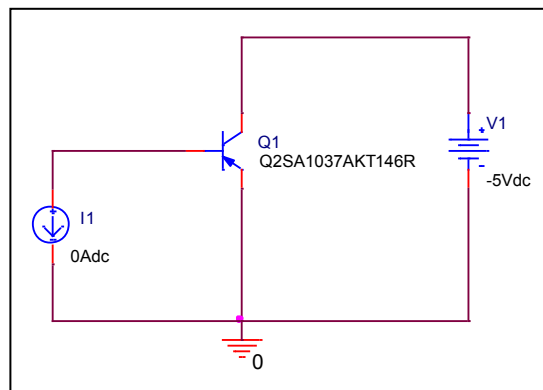
| -I <sub>C</sub> (mA) | F <sub>T</sub> (MHz) |            | Error(%) |
|----------------------|----------------------|------------|----------|
|                      | Measurement          | Simulation |          |
| 10.000               | 310.000              | 303.881    | -1.974   |

## Output Characteristics

### Circuit Simulation Result



### Evaluation Circuit



## Output Characteristics

## Reference

