

# Device Modeling Report

COMPONENTS: TRANSISTOR  
PART NUMBER: 2SA1577T106Q  
MANUFACTURER: ROHM



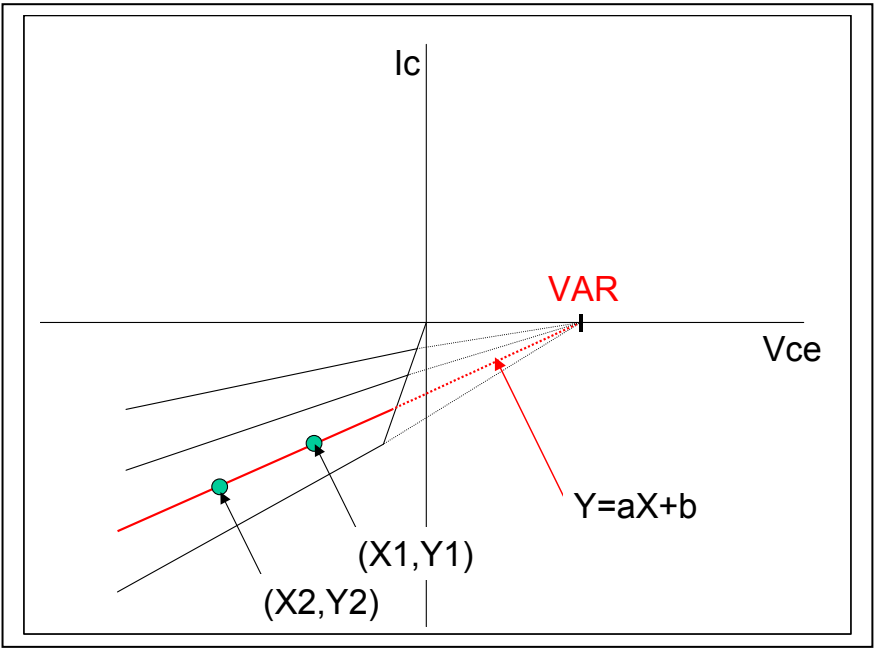
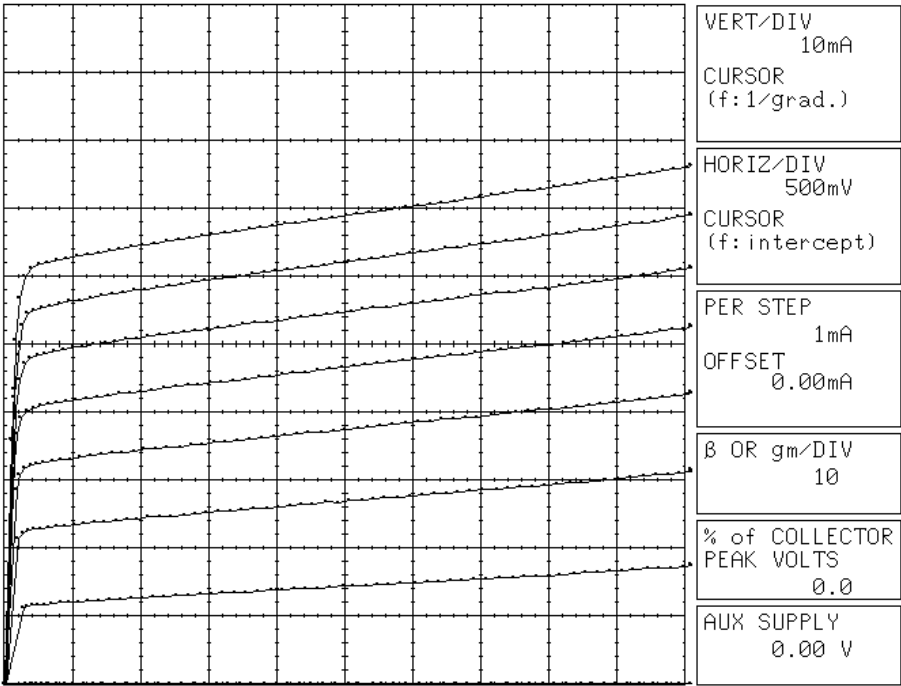
**Bee Technologies Inc.**

## TRANSISTOR MODEL

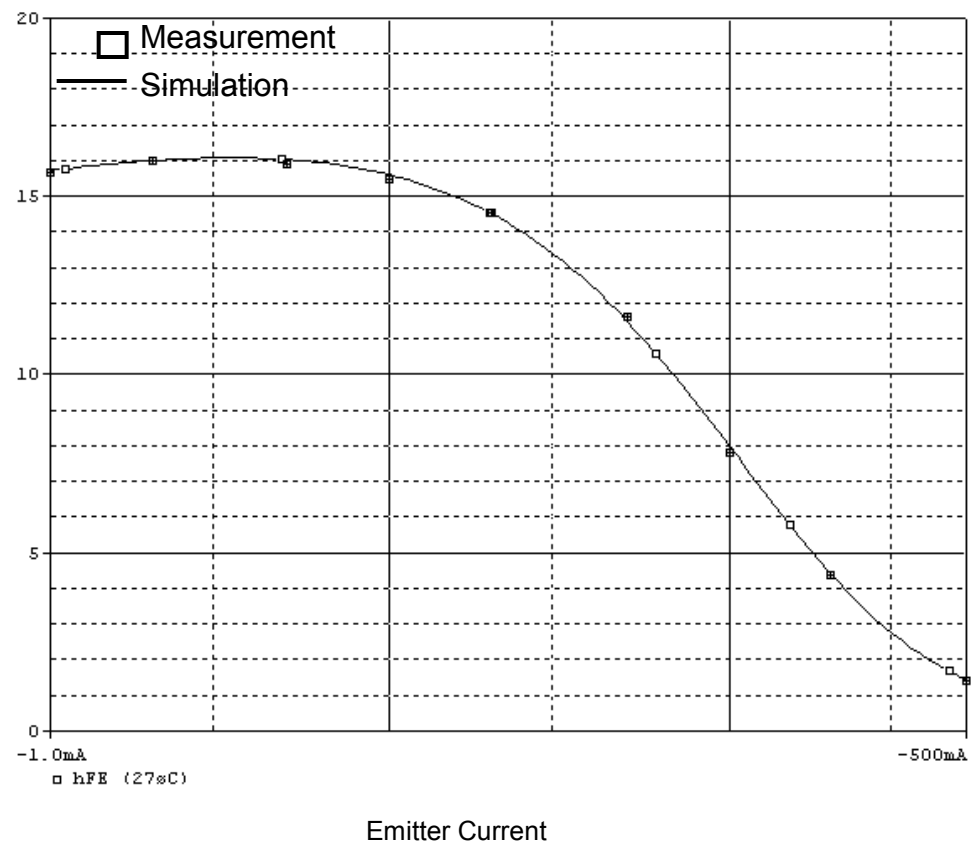
| PSpice model parameter | Model description                                           |
|------------------------|-------------------------------------------------------------|
| IS                     | Saturation Current                                          |
| BF                     | Ideal Maximum 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

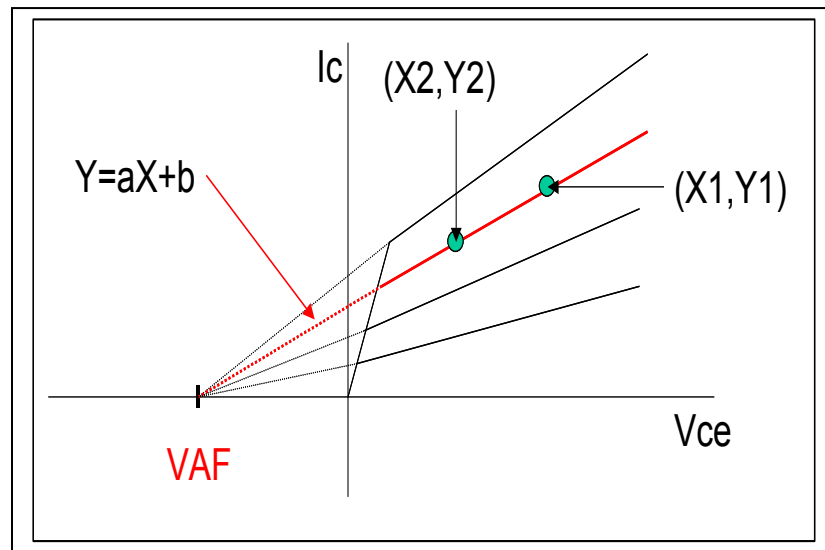
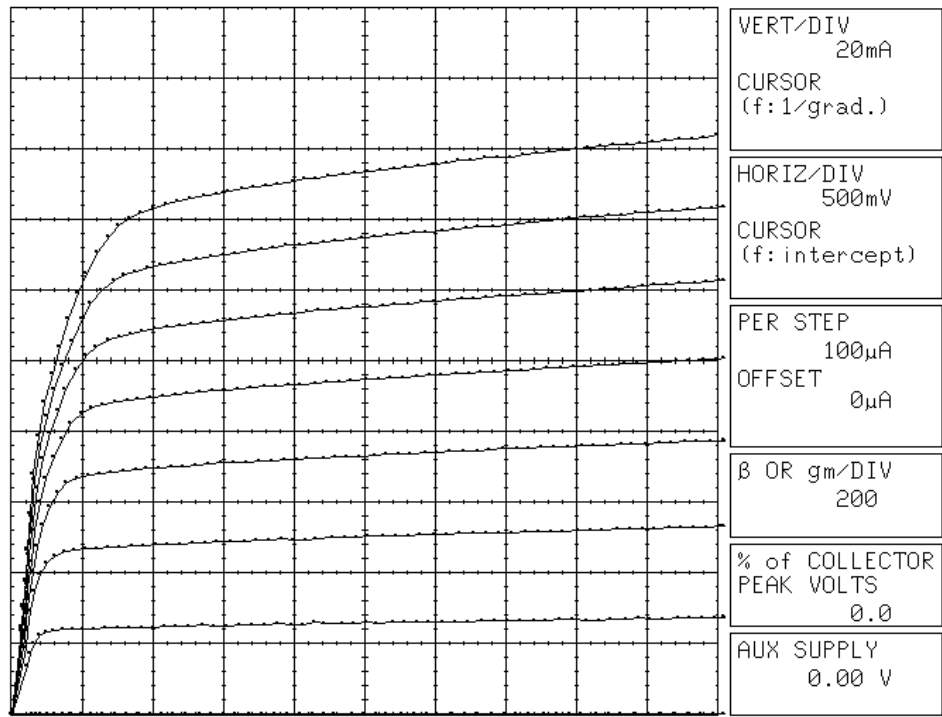


## Reverse DC Beta Characteristic ( $I_e$ vs. $h_{FE}$ )

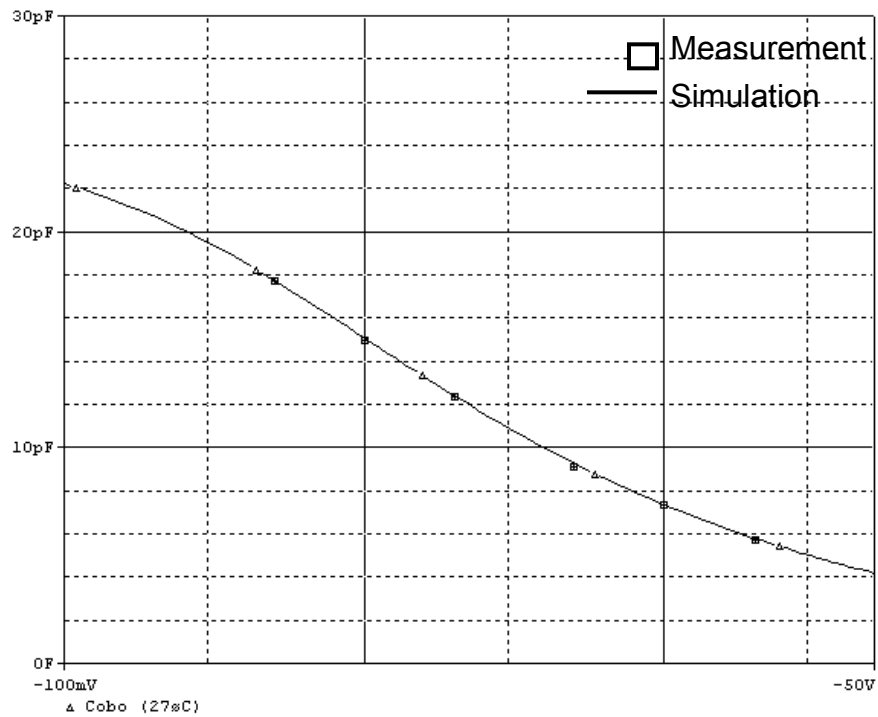


Forward

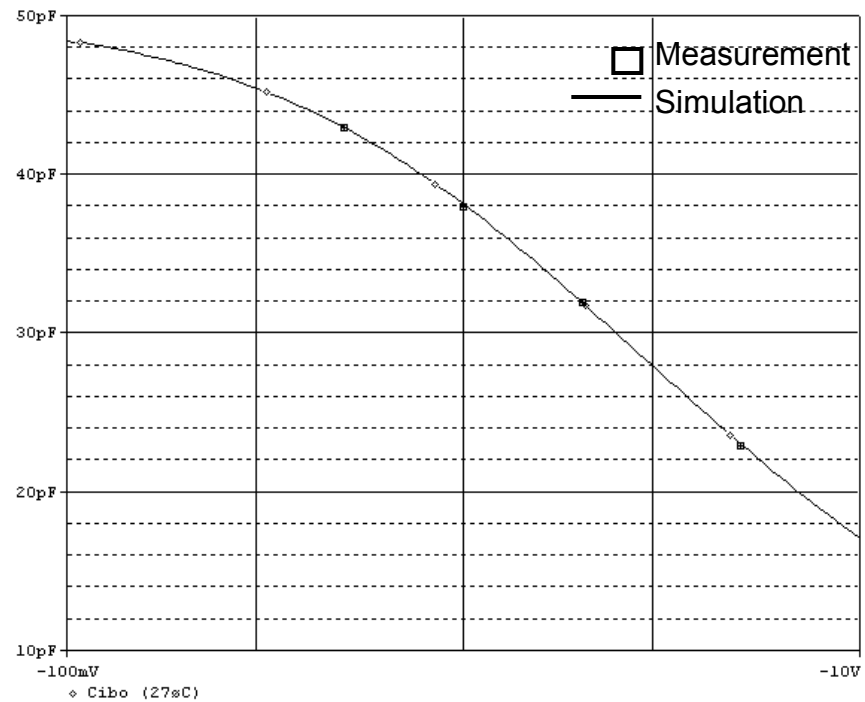
## Forward Early Voltage Characteristic



## C-B Capacitance Characteristics

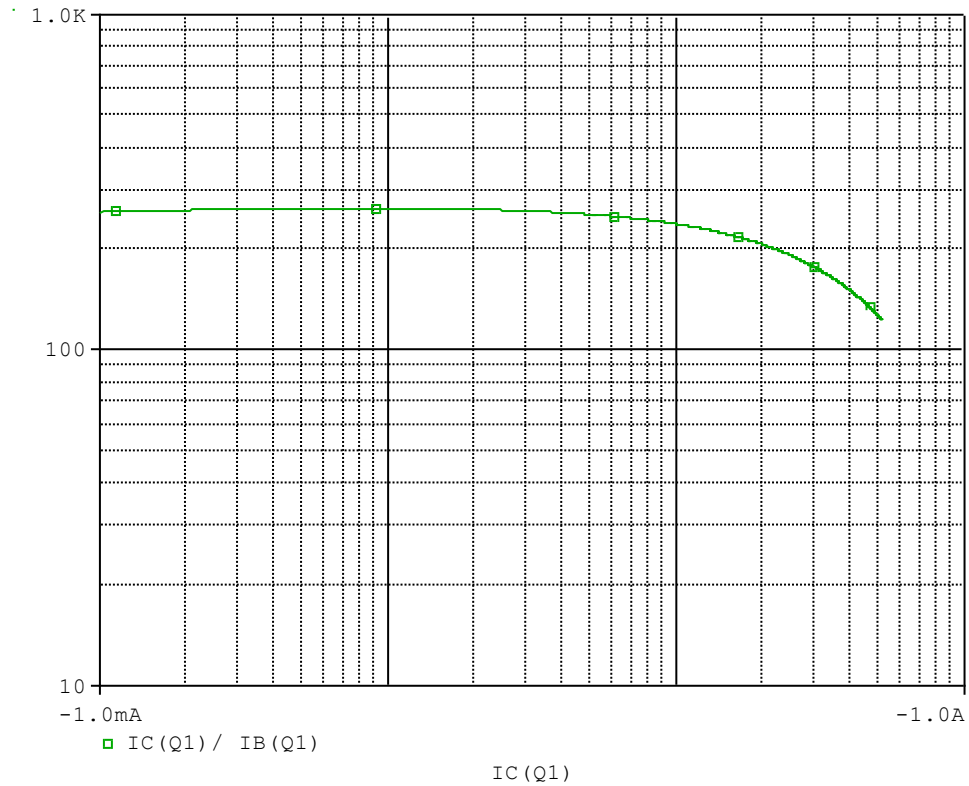


## E-B Capacitance Characteristics

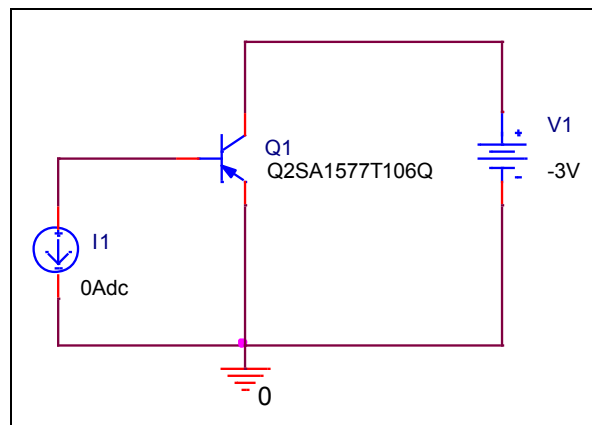


## Transistor $h_{FE}$ - $I_C$ Characteristics

### Circuit Simulation Result

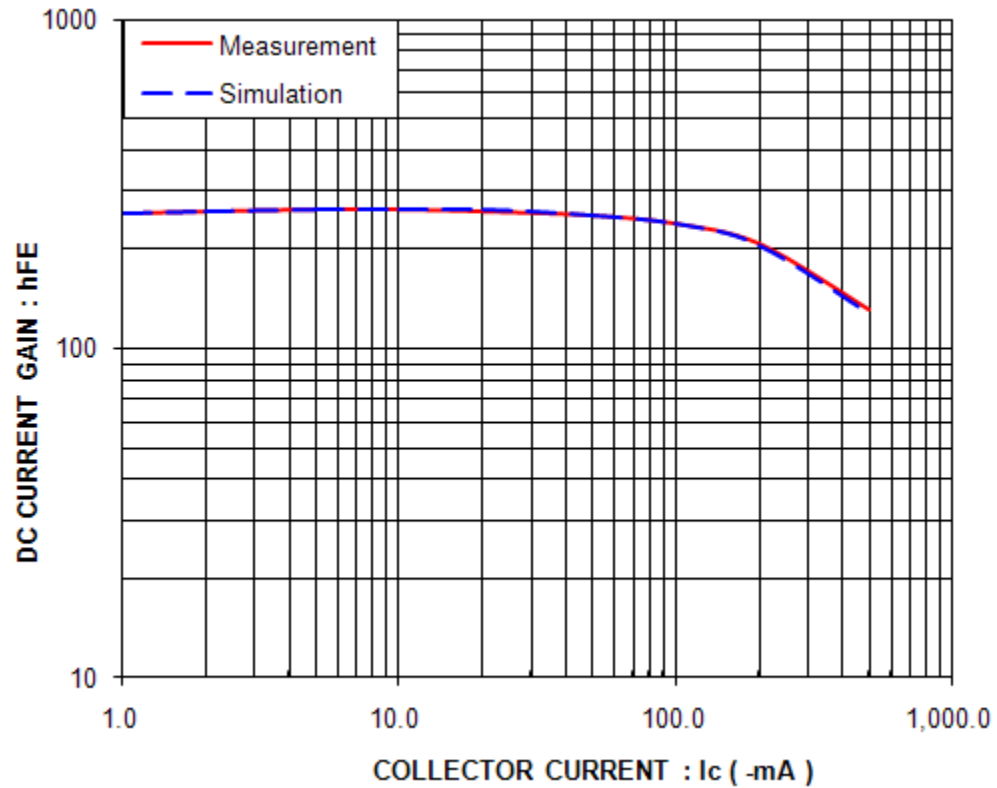


### Evaluation Circuit



## Comparison Graph

Circuit Simulation Result

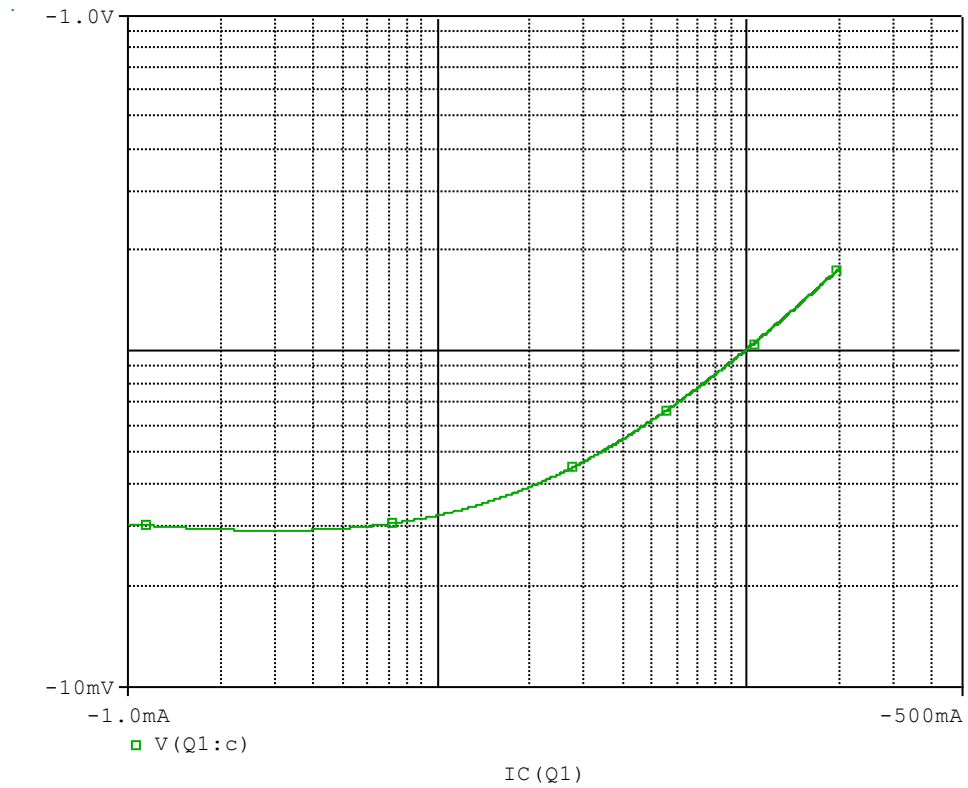


Simulation Result

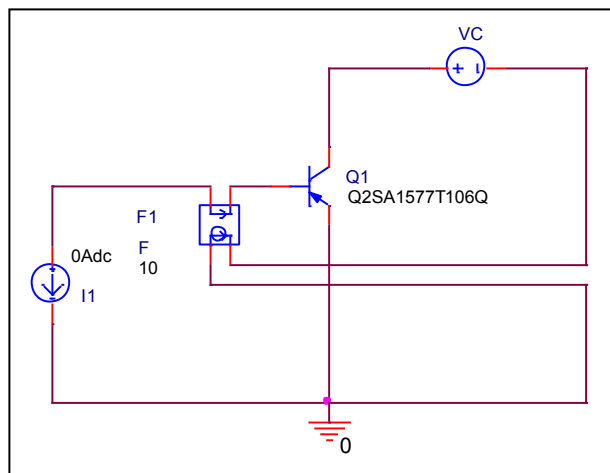
| Ic(mA)   | hFE         |            | Error(%) |
|----------|-------------|------------|----------|
|          | Measurement | Simulation |          |
| -1.000   | 257.500     | 258.039    | 0.209    |
| -2.000   | 261.000     | 261.600    | 0.230    |
| -5.000   | 265.000     | 264.465    | -0.202   |
| -10.000  | 264.780     | 264.877    | 0.037    |
| -20.000  | 262.000     | 262.995    | 0.380    |
| -50.000  | 255.000     | 254.068    | -0.365   |
| -100.000 | 240.000     | 237.907    | -0.872   |
| -200.000 | 207.680     | 206.500    | -0.568   |
| -500.000 | 130.890     | 127.316    | -2.731   |

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

### Circuit Simulation Result

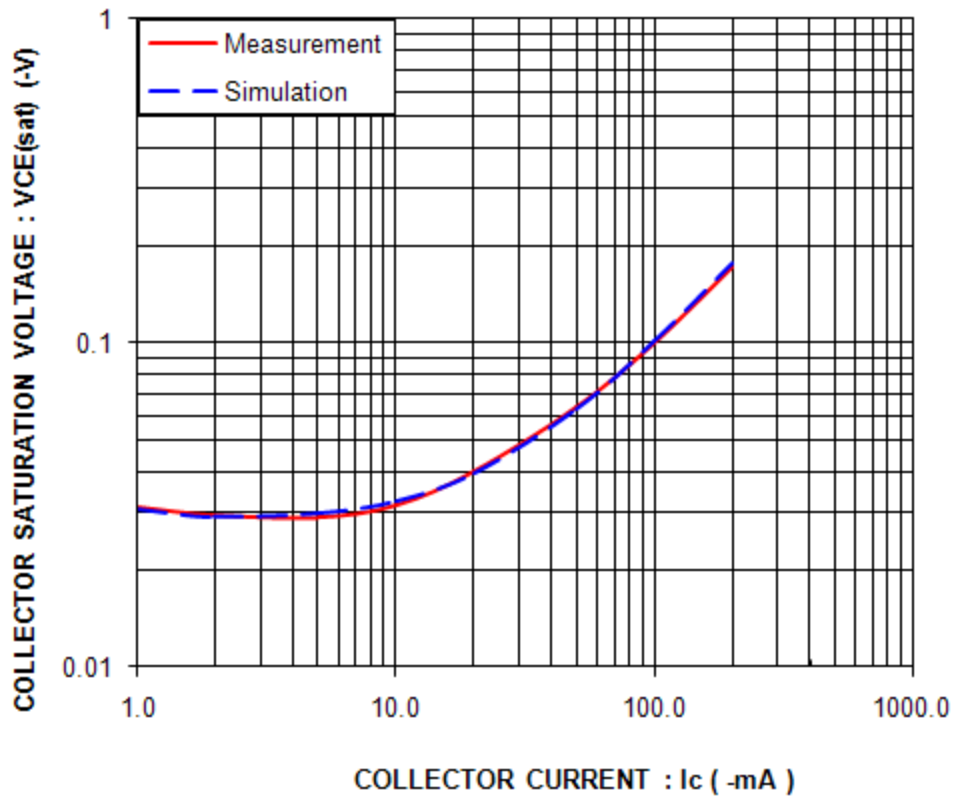


### Evaluation Circuit



## Comparison Graph

Circuit Simulation Result

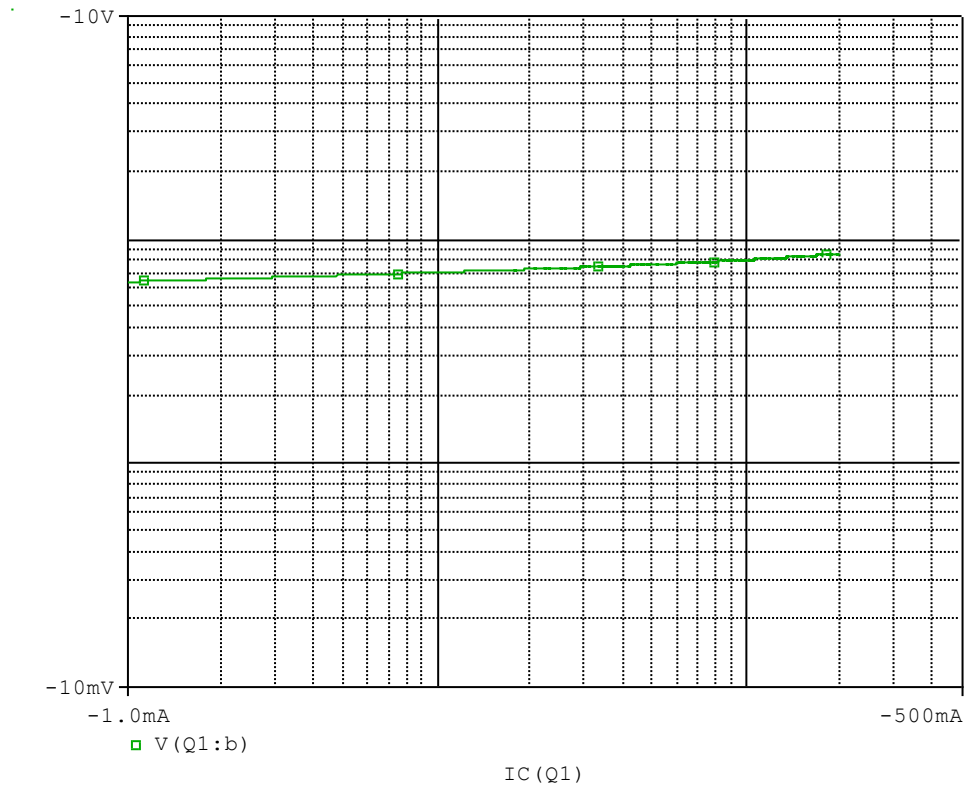


Simulation Result

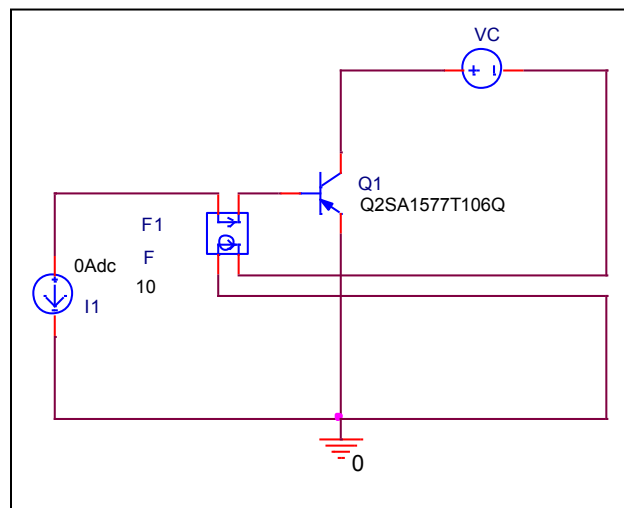
| IC(mA)   | VCE(sat)(V) |            | Error(%) |
|----------|-------------|------------|----------|
|          | Measurement | Simulation |          |
| -1.000   | -0.0310     | -0.0306    | -1.3355  |
| -2.000   | -0.0295     | -0.0291    | -1.5017  |
| -5.000   | -0.0290     | -0.0297    | 2.5828   |
| -10.000  | -0.0315     | -0.0325    | 3.0667   |
| -20.000  | -0.0400     | -0.0395    | -1.1675  |
| -50.000  | -0.0630     | -0.0627    | -0.4460  |
| -100.000 | -0.1000     | -0.1015    | 1.4800   |
| -200.000 | -0.1700     | -0.1771    | 4.1918   |

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

### Circuit Simulation Result

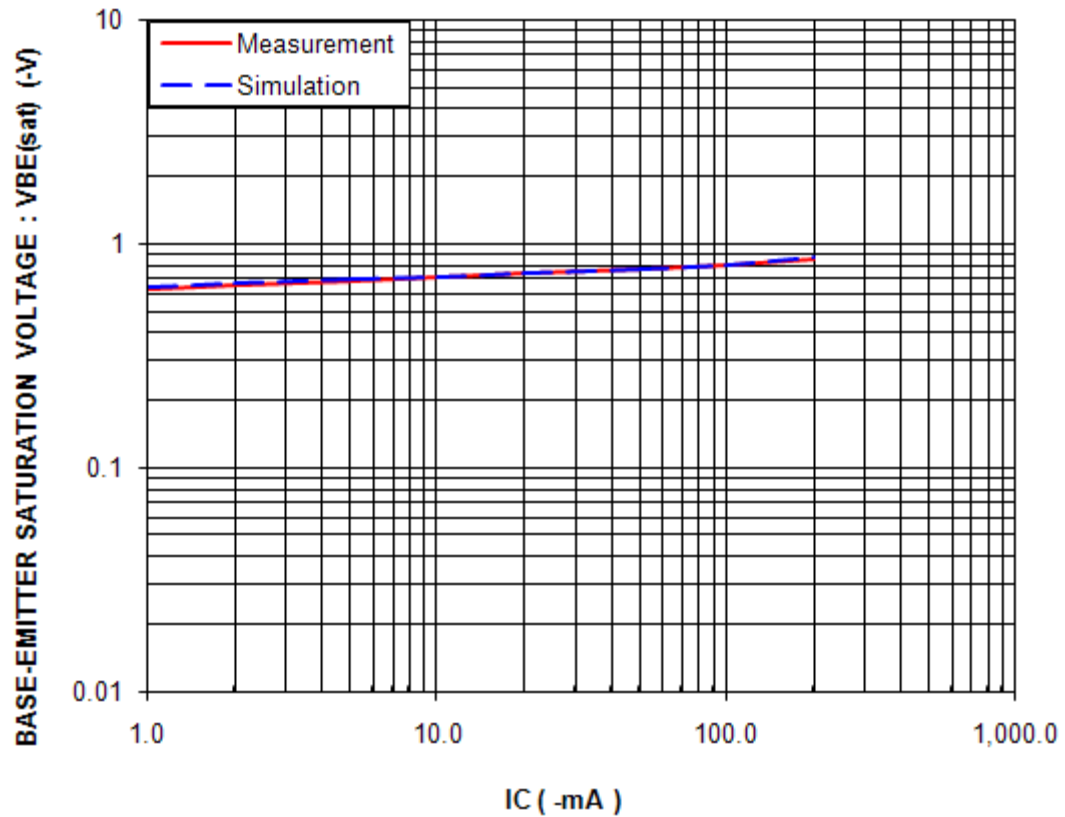


### Evaluation Circuit



## Comparison Graph

### Circuit Simulation Result

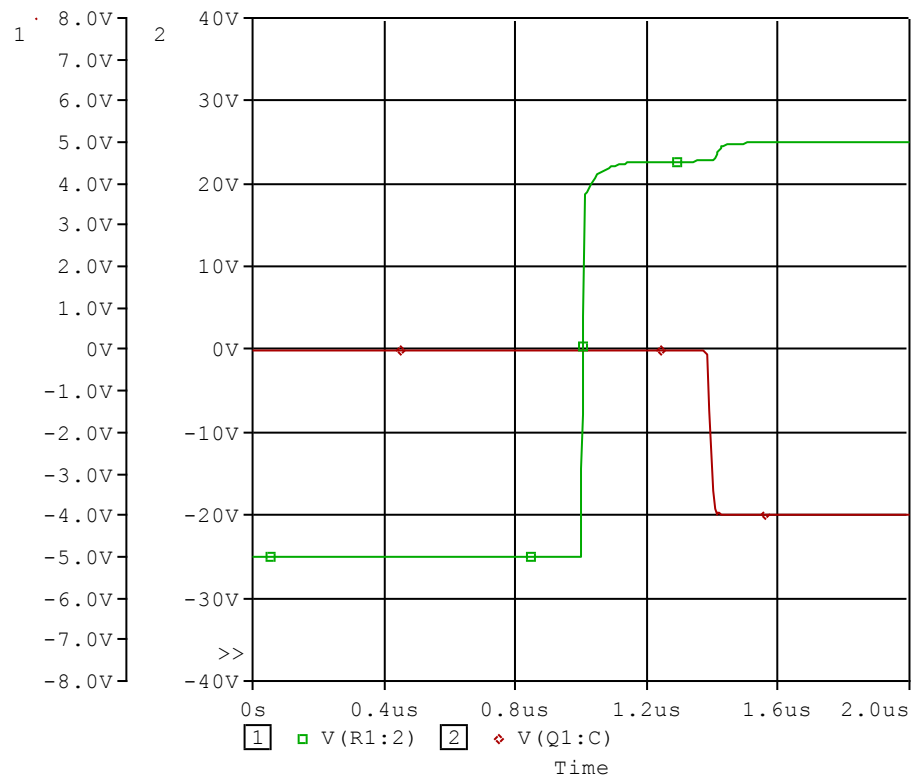


### Simulation Result

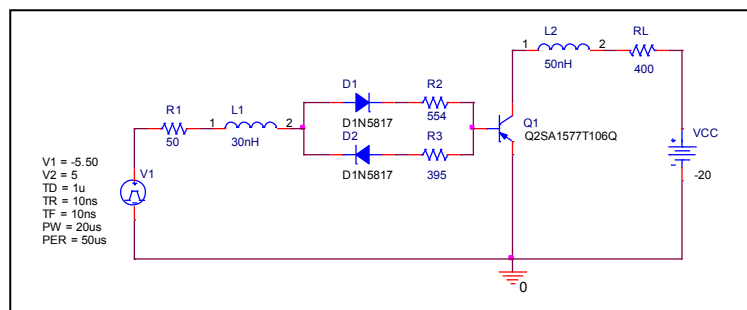
| IC(mA)   | VBE(sat)(V) |            | Error(%) |
|----------|-------------|------------|----------|
|          | Measurement | Simulation |          |
| -1.000   | -0.630      | -0.648     | 2.882    |
| -2.000   | -0.650      | -0.668     | 2.695    |
| -5.000   | -0.685      | -0.694     | 1.253    |
| -10.000  | -0.710      | -0.715     | 0.697    |
| -20.000  | -0.735      | -0.738     | 0.420    |
| -50.000  | -0.775      | -0.775     | 0.028    |
| -100.000 | -0.810      | -0.813     | 0.346    |
| -200.000 | -0.850      | -0.866     | 1.891    |

## Switching Characteristics

### Circuit simulation result



### Evaluation circuit

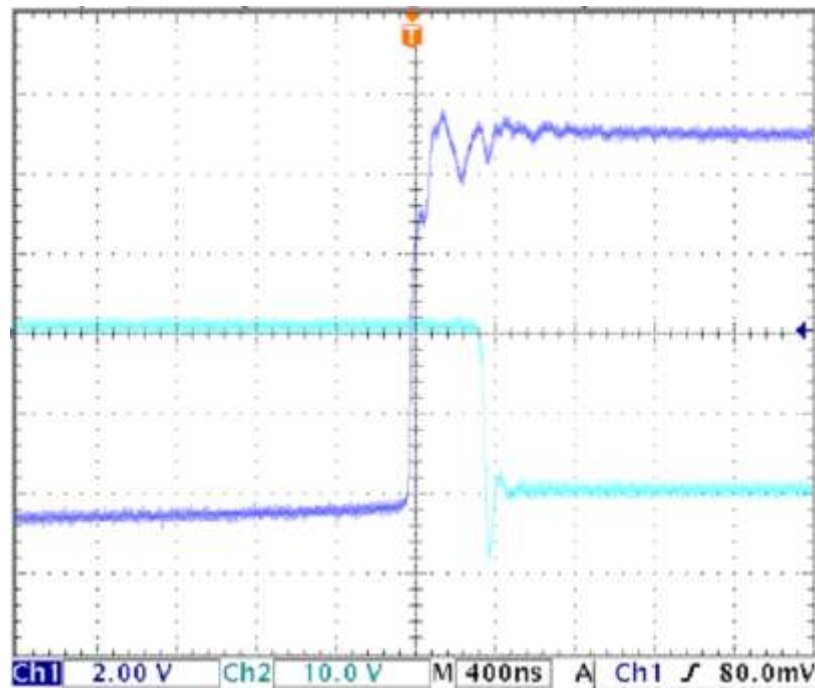


### Simulation result

|                | Measurement | Simulation | %Error |
|----------------|-------------|------------|--------|
| $t_f$ (ns)     | 20.000      | 20.301     | 1.505  |
| $t_{stg}$ (ns) | 380.000     | 385.000    | 1.316  |

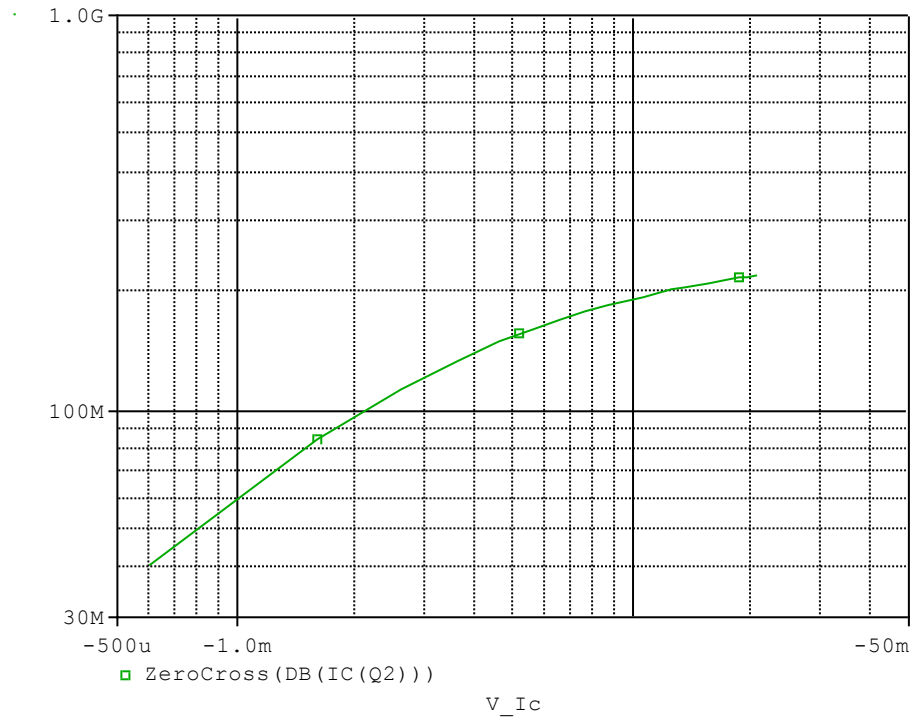
## Switching Characteristics

## Reference

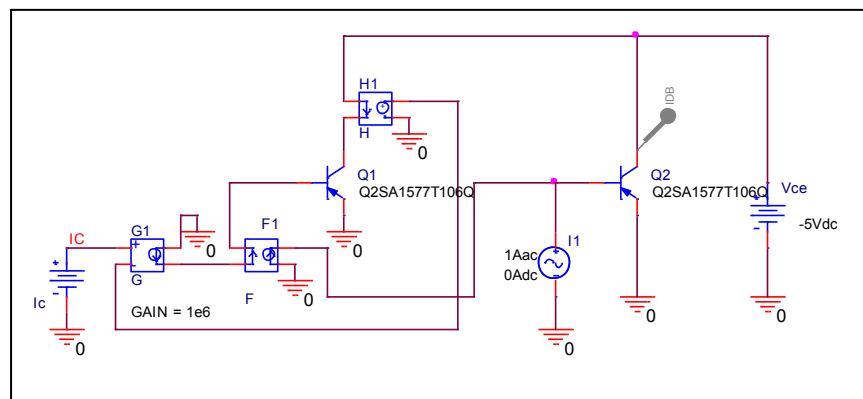


## F<sub>t</sub> - I<sub>C</sub> Characteristics

### Circuit Simulation Result



### Evaluation Circuit

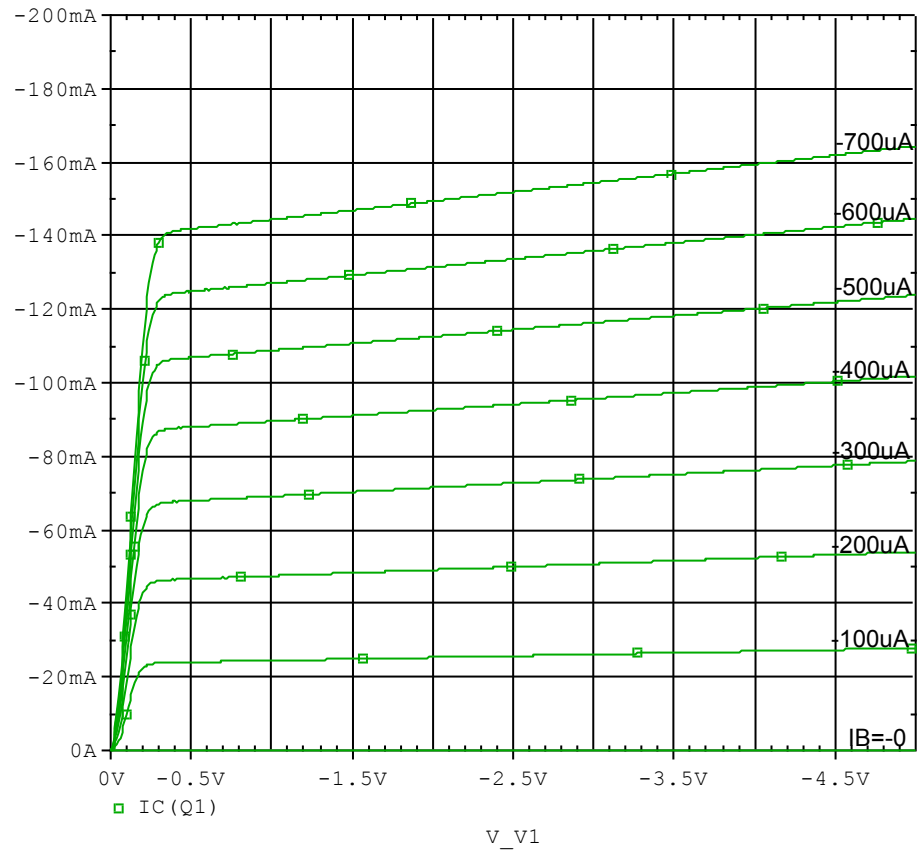


### Simulation Result

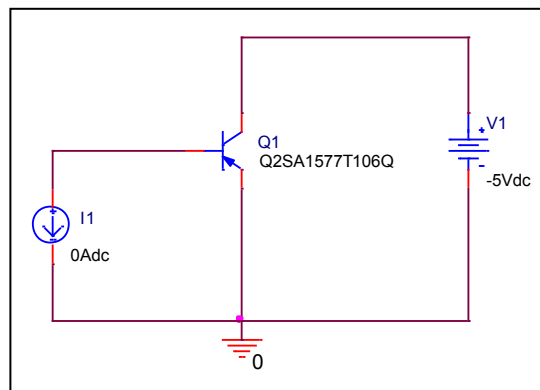
| -I <sub>C</sub> (mA) | F <sub>t</sub> (MHz) |            | Error(%) |
|----------------------|----------------------|------------|----------|
|                      | Measurement          | Simulation |          |
| 20.000               | 220.000              | 218.488    | -0.687   |

## Output Characteristics

### Circuit Simulation Result



### Evaluation Circuit



## Output Characteristics

## Reference

