Application Note No. 003

The VCEO-Mystery or How to Use Low-VCE0-Transistors with High Operating Voltages

RF & Protection Devices

Never stop thinking

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The VCEO-Mystery or How to Use Low-VCE0-Transistors with High Operating Voltages Revision History: 2006-11-14, Rev. 2.0	
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Page	**Subjects (major changes since last revision)**
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1 The VCEO-Mystery or How to Use Low-VCEO-Transistors with High Operating Voltages

Mobile communications in particular has forced the operating voltages of handheld equipment to a very lowlevel. In order to achieve high gain and high f_T, the V_{CE0} of modern transistors is much lower than in previous generations. The typical V_{CE0} of SIEMENS 3rd generation transistors was 14 V, the new SIEGET® Grounded Emitter Transistors have typical values of 5 V.

Although these low V_{CE0} values present no problems in new handheld applications, in other areas a closer inspection of the limits of low V_{CE0} is required. This is particularly the case in power applications and applications where higher operating voltages are used.

The output characteristics a the BFP450 (**Figure 1**) exhibit a break-through mechanism above 5 V collector-emitter voltage. This mechanism is only destructive if the current and power dissipation exceeds the absolute maximum ratings. Nevertheless, for linear and small signal applications the maximum collector-emitter voltage should not exceed 4.5 V. Because of the outstanding performance of the SiEMENS Grounded Emitter Transistors at low voltages, a V_{CE} of 2 V - 3 V is recommended.

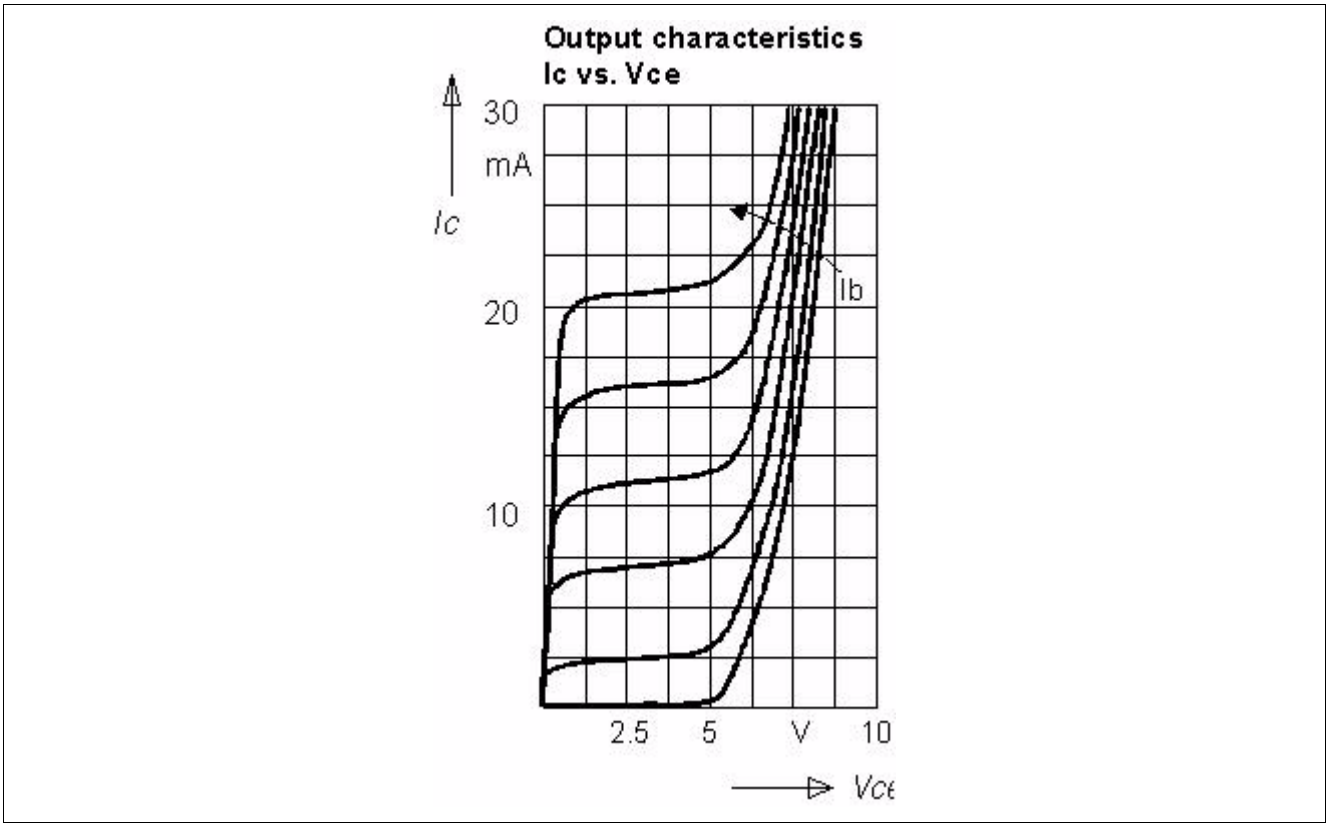

Figure 1 Output characteristics of the BFP450

Especially in power applications, a high operating voltage is essential for high output power.

To demonstrate the situation in a power application, the output characteristics for constant base voltage are shown in **Figure 2**. Due to the fixed base-emitter voltage the break-through effect is shifted to an V_{CE} of about 8 V. For all applications which use a bipolar transistor in an RF power stage, a constant voltage base supply with low input resistance is highly recommended. To avoid self destruction by thermal runaway, temperature sensing of the power transistor must be used.

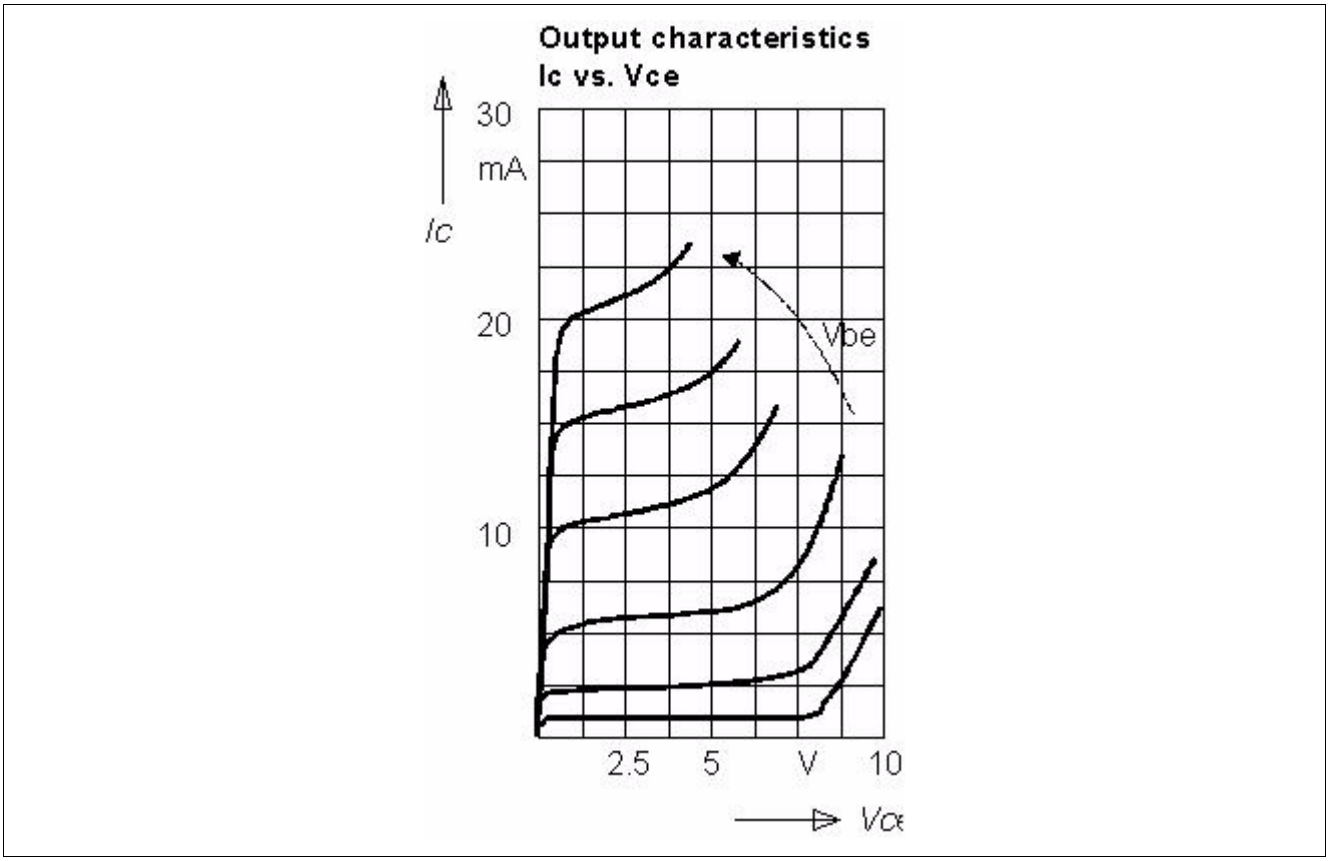

Figure 2 Output characteristics with fixed base-emitter voltage

When the output resistance of the base supply is increased in steps from 0 Ω to 10 kΩ (**Figure 3**), the maximum V_{CE} decreases to the value in the first diagram, because a 10 kΩ resistor in series with a constant voltage supply acts as an constant current source.

It is shown that even with a 100 Ω - 200 Ω resistor the maximum VCE stays above 7 V.

As the V_{CE} of the transistor must be at least twice the operating voltage for class A high power applications, the SIEMENS Grounded Emitter Transistors are safe at 3.8 V operating voltage in power amplifier stages.

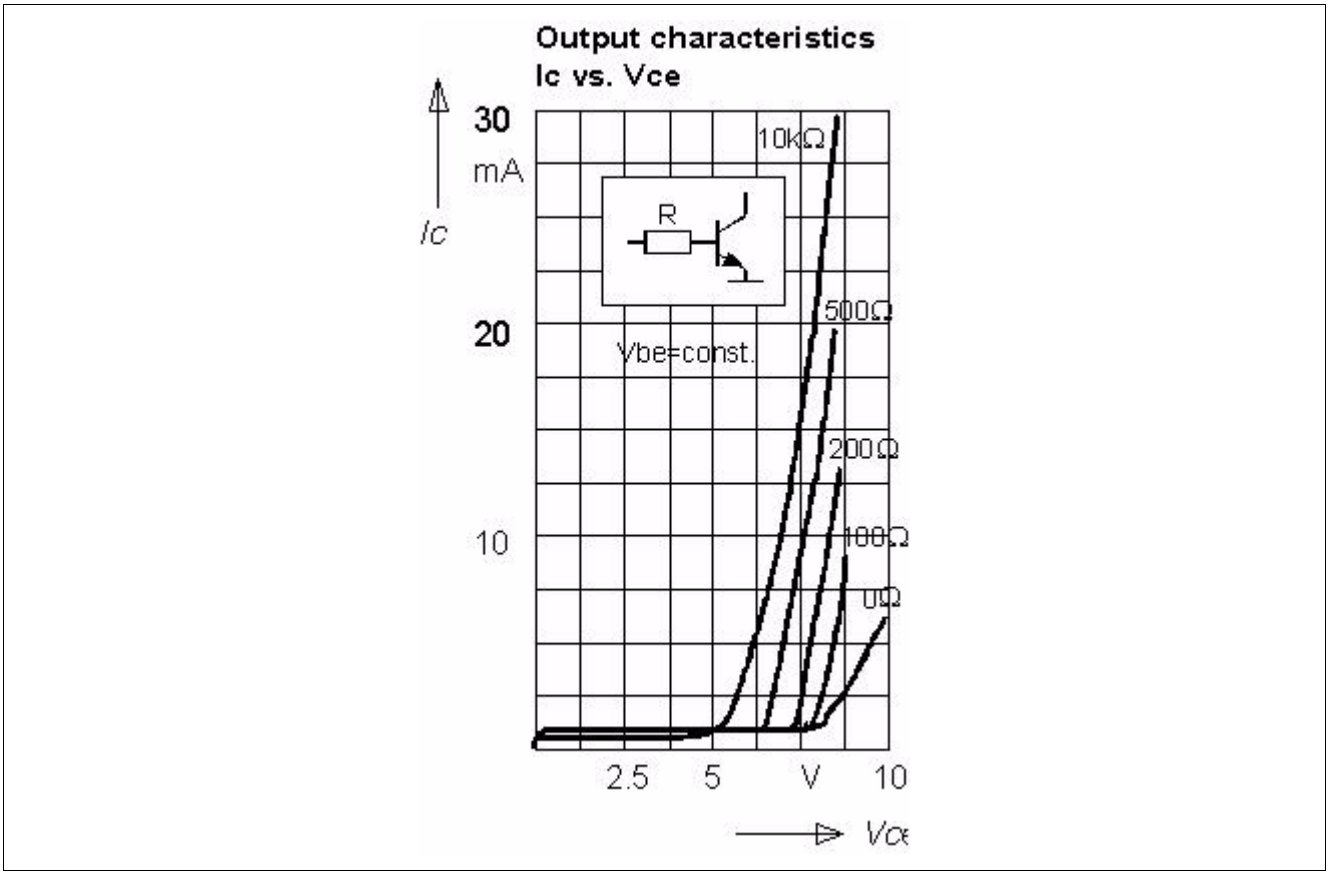

Figure 3 Output characteristics, resistor increase from 0 Ω to 10 kΩ

Using SIEMENS Grounded Emitter Transistors is very simple at higher operating voltages in small signal applications. A collector resistor can reduce the V_{CE} of the transistor to safe limits. It is recommended to use a V_{CE} between 2 V and 3 V for optimum performance.

To reduce temperature sensitivity, a BCR400W active bias controller can be used.

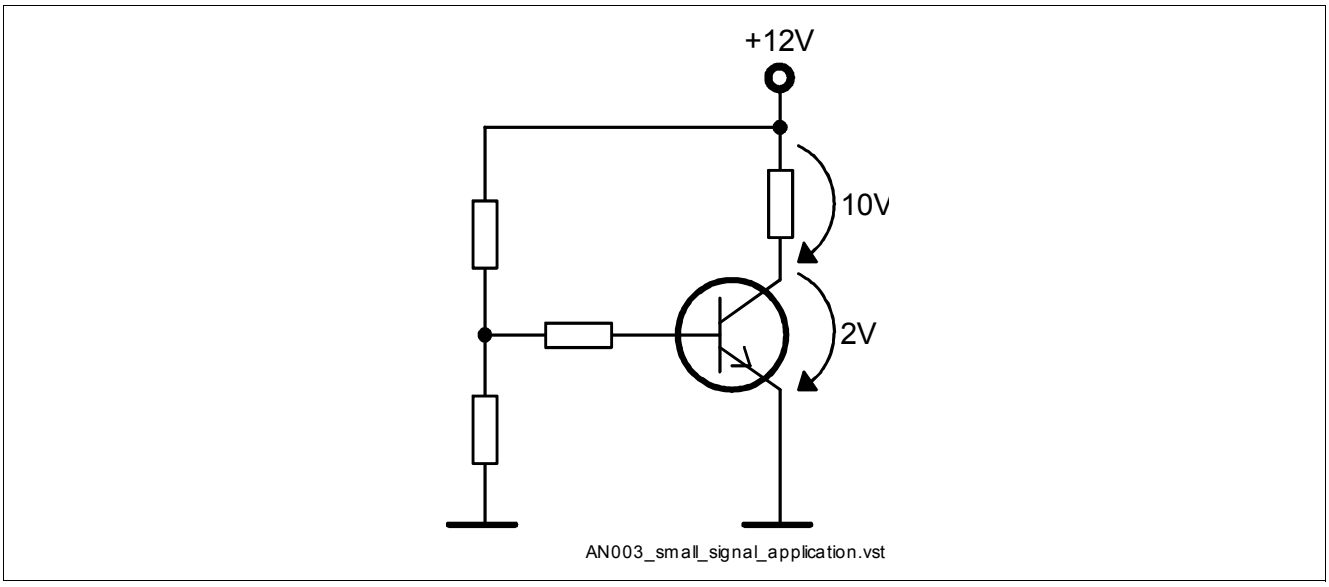

Figure 4 Small signal application