Application Note No. 024

Parasitic Capacitance in Bipolar Junction Transistors

RF & Protection Devices

Never stop thinking

Edition 2006-11-14

Published by
Infineon Technologies AG
81726 München, Germany

LEGAL DISCLAIMER

THE INFORMATION GIVEN IN THIS APPLICATION NOTE IS GIVEN AS A HINT FOR THE IMPLEMENTATION OF THE INFINEON TECHNOLOGIES COMPONENT ONLY AND SHALL NOT BE REGARDED AS ANY DESCRIPTION OR WARRANTY OF A CERTAIN FUNCTIONALITY, CONDITION OR QUALITY OF THE INFINEON TECHNOLOGIES COMPONENT. THE RECIPIENT OF THIS APPLICATION NOTE MUST VERIFY ANY FUNCTION DESCRIBED HEREIN IN THE REAL APPLICATION. INFINEON TECHNOLOGIES HEREBY DISCLAIMS ANY AND ALL WARRANTIES AND LIABILITIES OF ANY KIND (INCLUDING WITHOUT LIMITATION WARRANTIES OF NON-INFRINGEMENT OF INTELLECTUAL PROPERTY RIGHTS OF ANY THIRD PARTY) WITH RESPECT TO ANY AND ALL INFORMATION GIVEN IN THIS APPLICATION NOTE.

Information

For further information on technology, delivery terms and conditions and prices please contact your nearest Infineon Technologies Office (**www.infineon.com**).

Warnings

Due to technical requirements components may contain dangerous substances. For information on the types in question please contact your nearest Infineon Technologies Office.

Infineon Technologies Components may only be used in life-support devices or systems with the express written approval of Infineon Technologies, if a failure of such components can reasonably be expected to cause the failure of that life-support device or system, or to affect the safety or effectiveness of that device or system. Life support devices or systems are intended to be implanted in the human body, or to support and/or maintain and sustain and/or protect human life. If they fail, it is reasonable to assume that the health of the user or other persons may be endangered.

Parasitic Capacitance in Bipolar Junction Transistors Revision History: 2006-11-14, Rev. 2.0	
Previous Version: 2000-07-28	
Page	**Subjects (major changes since last revision)**
All	Document layout change

1 Parasitic Capacitance in Bipolar Junction Transistors

The parasitic capacitance present in any bipolar junction transistor can be best modeled as three capacitors connected between each of the three ports of the transistor.

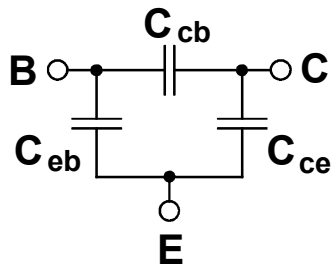
Historically, a number of different capacitance characterizations have been used and published. This application note shows the most popular of these different definitions.

Definition

C_{cb} **C**apacitance, **C**ollector-**B**ase

C_{ce} **C**apacitance, **C**ollector-**E**mitter

C_{eb} **C**apacitance, **E**mitter-**B**ase



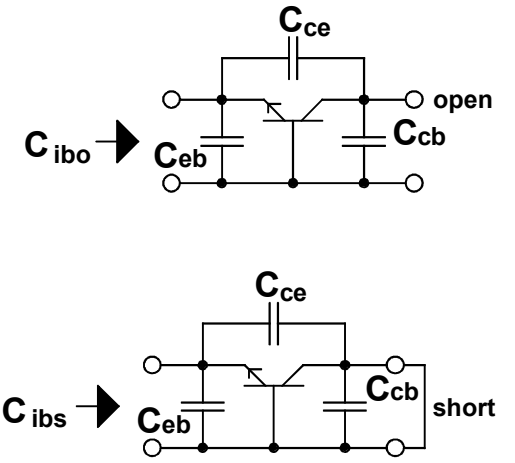
AN023_capacitance_definition.vsd

Figure 1 Capacitance definition

Measurement Related Definitions

C_{ibo} **C**apacitance, **I**nput,
Common-**B**ase, Output **o**pen
$C_{ibo} = C_{eb} + (C_{ce} \times C_{cb}) / (C_{ce} + C_{cb})$
also known as: C_{ib}, C_{ebo}, C_e

C_{ibs} **C**apacitance, **I**nput,
Common-**B**ase, Output **s**hort
$C_{ibs} = C_{eb} + C_{ce}$
also known as: C_{ib}, C_{ebs}, C_{11b}, C_{11e}



AN023_capacitance_Cibo_Cibs.vsd

Figure 2 C_{ibo} and C_{ibs} definition

C_{obo} **C**apacitance, **O**utput, Common-**B**ase, Output **o**pen
$C_{obo} = C_{eb} + (C_{ce} \times C_{eb}) / (C_{ce} + C_{eb})$
also known as: C_{ob}, C_{cbo}, C_c

C_{obs} **C**apacitance, **O**utput, Common-**B**ase, Output **s**hort
$C_{obs} = C_{cb} + C_{ce}$
also known as: C_{ob}, C_{22e}, C_{22b}

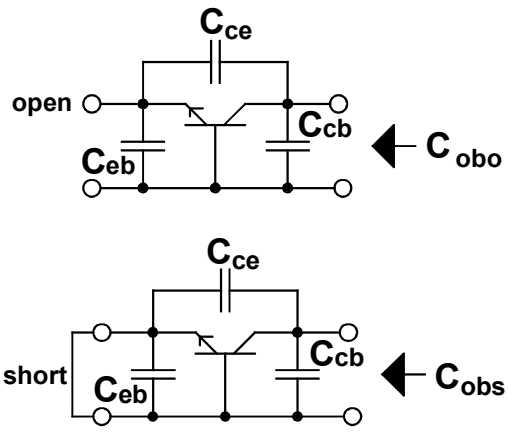


Figure 3 C_{obo} **and** C_{obs} **definition**

C_{re} **C**apacitance, **R**everse, Common-**E**mitter
$C_{re} = C_{cb}$
also known as: C_{12e}
C_{eb} and C_{ce} to ground do not affect C_{cb} measurement in a capacitance measurement bridge.

C_{rb} **C**apacitance, **R**everse, Common-**B**ase
$C_{rb} = C_{ce}$
also known as: C_{12b}
C_{eb} and C_{cb} to ground do not affect C_{ce} measurement in a capacitance measurement bridge.

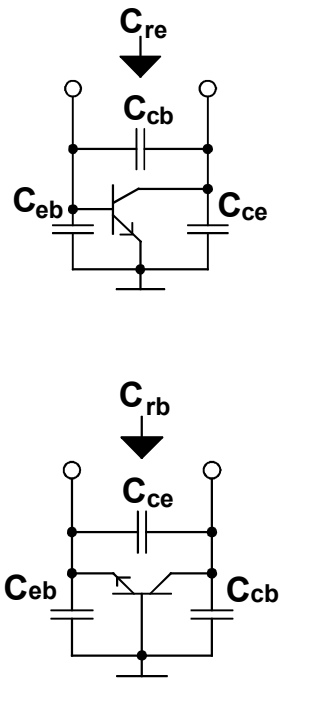


Figure 4 C_{re} **and** C_{rb} **definition**

How to measure C_{cb}, C_{ce} and C_{eb}

For simple measurements, the features of a capacitance bridge (e.g. HP4279A) can be used. This type of bridge can measure capacitances between two coax outputs and ignore capacitances from coax output to ground. They can also apply DC voltages to the ports for biasing.

- To measure C_{cb}, ground emitter and measure between collector and base.
- To measure C_{ce}, ground base and measure between collector and emitter.
- To measure C_{eb}, ground collector and measure between emitter and base.

The measurement strategy can be seen above in C_{re} and C_{rb} definition. When the third lead of the device is grounded, only the capacitance between the other two leads is measured.

Note: Some names of capacitances are used in industry with different meanings.