



# NHUMD3/2/12 series

80 V, 100 mA NPN/PNP resistor-equipped double transistors

Rev. 1 — 24 July 2020

Product data sheet

## 1. General description

NPN/PNP Resistor-Equipped double Transistor (RET) family in a very small SOT363 (SC-88) Surface-Mounted Device (SMD) plastic package.

Table 1. Product overview

Type number	R1	R2	Package		NPN/NPN complement:	PNP/PNP complement:
	k $\Omega$	k $\Omega$	Nexperia	JEITA		
NHUMD3	10	10	SOT363	SC-88	NHUMH11	NHUMB11
NHUMD2	22	22			NHUMH1	NHUMB1
NHUMD12	47	47			NHUMH2	NHUMB2

## 2. Features and benefits

- 100 mA output current capability
- High breakdown voltage
- Built-in resistors
- Simplifies circuit design
- Reduces component count
- Reduces pick and place costs
- AEC-Q101 qualified

## 3. Applications

- Digital applications
- Cost saving alternative for BC846 / BC856 series in digital applications
- Controlling IC inputs
- Switching loads

## 4. Quick reference data

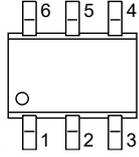
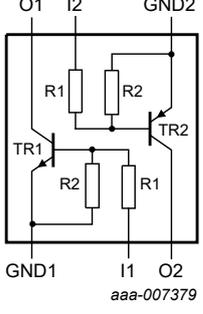
Table 2. Quick reference data

$T_{amb} = 25\text{ }^{\circ}\text{C}$  unless otherwise specified.

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
<b>Per transistor, for the PNP transistor with negative polarity</b>						
$V_{CEO}$	collector-emitter voltage	open base	-	-	80	V
$I_O$	output current		-	-	100	mA

## 5. Pinning information

Table 3. Pinning

Pin	Symbol	Description	Simplified outline	Graphic symbol
1	GND1	GND (emitter) TR1		
2	I1	input (base) TR1		
3	O2	output (collector) TR2		
4	GND2	GND (emitter) TR2		
5	I2	input (base) TR2		
6	O1	output (collector) TR1		

## 6. Ordering information

Table 4. Ordering information

Type number	Package		
	Name	Description	Version
NHUMD3	SC-88	plastic surface-mounted package; 6 leads	SOT363
NHUMD2			
NHUMD12			

## 7. Marking

Table 5. Marking

Type number	Marking code [1]
NHUMD3	6M%
NHUMD2	6Q%
NHUMD12	6S%

[1] % = placeholder for manufacturing site code

## 8. Limiting values

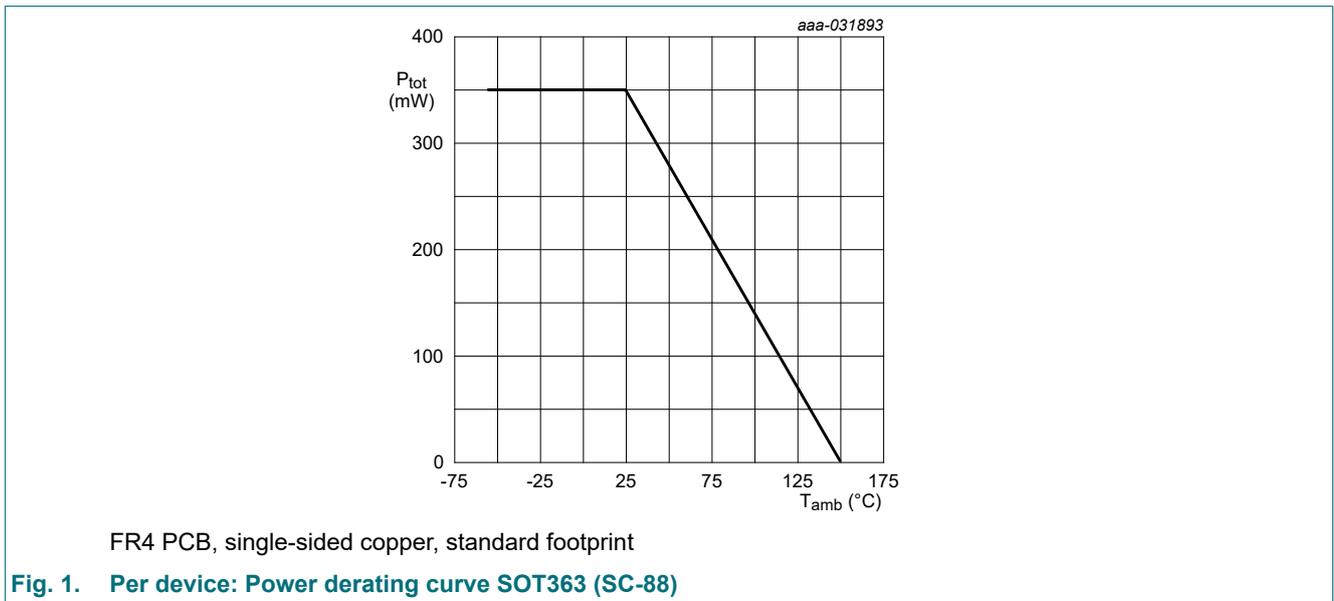
**Table 6. Limiting values**

In accordance with the Absolute Maximum Rating System (IEC 60134).

$T_{amb} = 25\text{ °C}$  unless otherwise specified.

Symbol	Parameter	Conditions	Min	Max	Unit
<b>Per transistor, for the PNP transistor with negative polarity</b>					
$V_{CBO}$	collector-base voltage	open emitter	-	80	V
$V_{CEO}$	collector-emitter voltage	open base	-	80	V
$V_{EBO}$	emitter-base voltage	open collector	-	10	V
$V_I$	input voltage				
	NHUMD3, TR1 (NPN)		-10	+40	V
	NHUMD3, TR2 (PNP)		-40	+10	V
	NHUMD2, TR1 (NPN)		-10	+60	V
	NHUMD2, TR2 (PNP)		-60	+10	V
	NHUMD12, TR1 (NPN)		-10	+80	V
	NHUMD12, TR2 (PNP)		-80	+10	V
$I_O$	output current		-	100	mA
$P_{tot}$	total power dissipation	$T_{amb} \leq 25\text{ °C}$	[1]	235	mW
<b>Per device</b>					
$P_{tot}$	total power dissipation	$T_{amb} \leq 25\text{ °C}$	[1]	350	mW
$T_j$	junction temperature		-	150	°C
$T_{amb}$	ambient temperature		-55	150	°C
$T_{stg}$	storage temperature		-65	150	°C

[1] Device mounted on an FR4 Printed-Circuit-Board (PCB); single-sided copper; tin-plated and standard footprint.



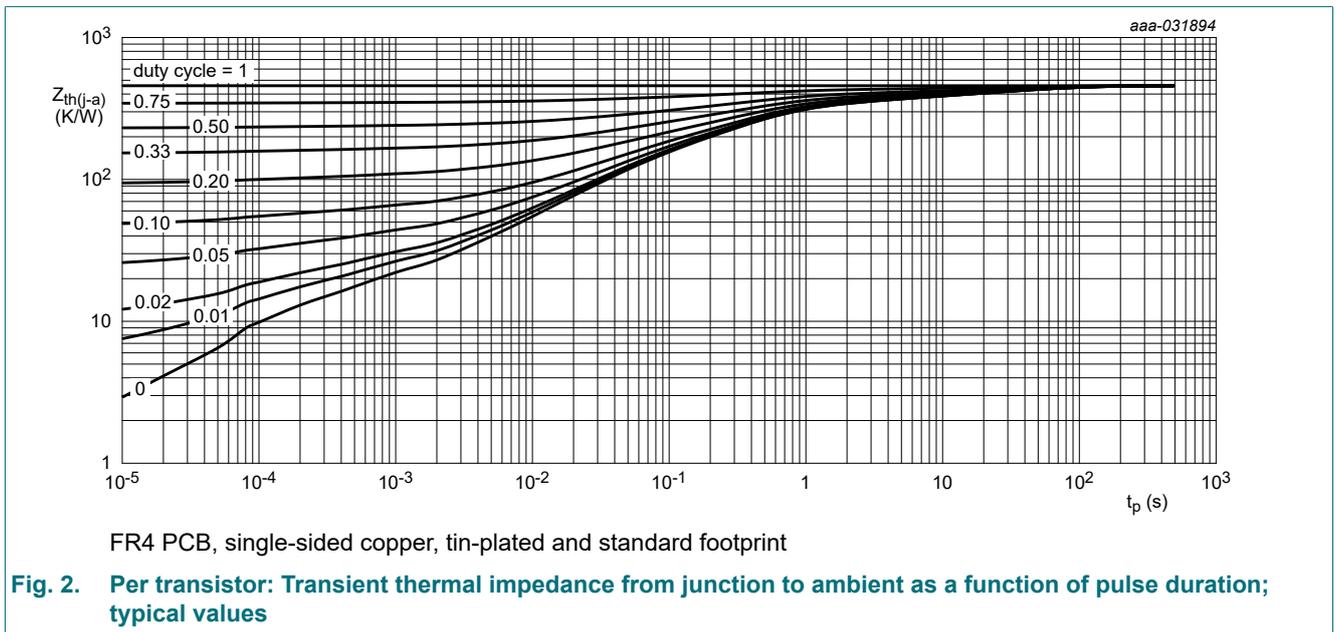
## 9. Thermal characteristics

**Table 7. Thermal characteristics**

$T_{amb} = 25\text{ °C}$  unless otherwise specified.

Symbol	Parameter	Conditions		Min	Typ	Max	Unit
<b>Per transistor</b>							
$R_{th(j-a)}$	thermal resistance from junction to ambient	in free air	[1]	-	-	532	K/W
$R_{th(j-sp)}$	thermal resistance from junction to solder point			-	-	150	K/W
<b>Per device</b>							
$R_{th(j-a)}$	thermal resistance from junction to ambient	in free air	[1]	-	-	358	K/W

[1] Device mounted on an FR4 Printed-Circuit-Board (PCB); single-sided copper; tin-plated and standard footprint.



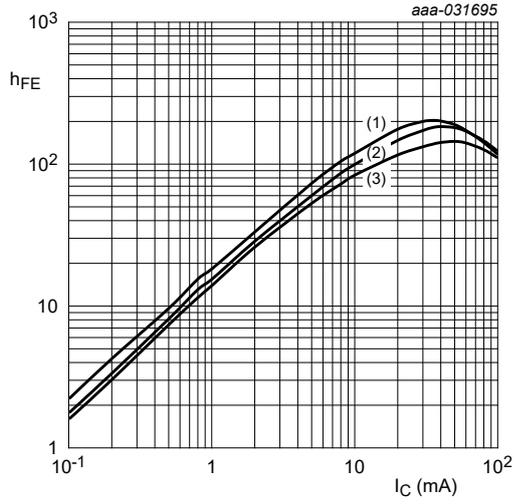
## 10. Characteristics

**Table 8. Characteristics**
 $T_{amb} = 25\text{ }^{\circ}\text{C}$  unless otherwise specified.

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
<b>Per transistor, for the PNP transistor with negative polarity</b>						
$V_{(BR)CBO}$	collector-base breakdown voltage	$I_C = 100\text{ }\mu\text{A}$ ; $I_E = 0\text{ A}$	80	-	-	V
$V_{(BR)CEO}$	collector-emitter breakdown voltage	$I_C = 2\text{ mA}$ ; $I_B = 0\text{ A}$	80	-	-	V
$I_{CBO}$	collector-base cut-off current	$V_{CB} = 80\text{ V}$ ; $I_E = 0\text{ A}$	-	-	100	nA
$I_{CEO}$	collector-emitter cut-off current	$V_{CE} = 60\text{ V}$ ; $I_B = 0\text{ A}$	-	-	100	nA
		$V_{CE} = 60\text{ V}$ ; $I_B = 0\text{ A}$ ; $T_J = 150\text{ }^{\circ}\text{C}$	-	-	5	$\mu\text{A}$
$I_{EBO}$	emitter-base cut-off current					
	NHUMD3	$V_{EB} = 7\text{ V}$ ; $I_C = 0\text{ A}$	-	-	600	$\mu\text{A}$
	NHUMD2		-	-	270	$\mu\text{A}$
	NHUMD12		-	-	130	$\mu\text{A}$
$h_{FE}$	DC current gain					
	NHUMD3	$V_{CE} = 5\text{ V}$ ; $I_C = 10\text{ mA}$	50	-	-	
	NHUMD2		70	-	-	
	NHUMD12		100	-	-	
$V_{CEsat}$	collector-emitter saturation voltage	$I_C = 10\text{ mA}$ ; $I_B = 0.5\text{ mA}$	-	-	100	mV
$V_{I(off)}$	off-state input voltage	$V_{CE} = 5\text{ V}$ ; $I_C = 100\text{ }\mu\text{A}$	-	1.15	0.8	V
$V_{I(on)}$	on-state input voltage					
	NHUMD3	$V_{CE} = 0.3\text{ V}$ ; $I_C = 10\text{ mA}$	2.5	1.8	-	V
	NHUMD2		3	2.3	-	V
	NHUMD12		5	3.3	-	V
R1	bias resistor 1 (input)					
	NHUMD3		7	10	13	k $\Omega$
	NHUMD2		15.4	22	28.6	k $\Omega$
	NHUMD12		33	47	61	k $\Omega$
R2/R1	bias resistor ratio					
$f_T$	transition frequency					
	TR1 (NPN)	$V_{CE} = 5\text{ V}$ ; $I_C = 10\text{ mA}$ ; $f = 100\text{ MHz}$	-	170	-	
	TR2 (PNP)		-	150	-	
$C_c$	collector capacitance					
	TR1 (NPN)	$V_{CB} = 10\text{ V}$ ; $I_E = I_e = 0\text{ A}$ ; $f = 1\text{ MHz}$	-	-	2.5	pF
	TR2 (PNP)		-	-	3	pF

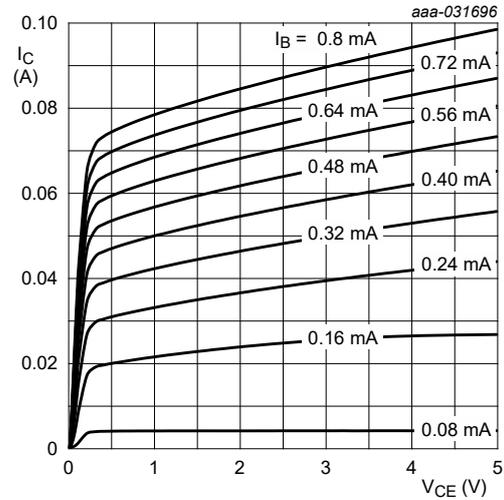
[1] See section "Test information" for resistor calculation and test conditions

[2] Characteristics of built-in transistor



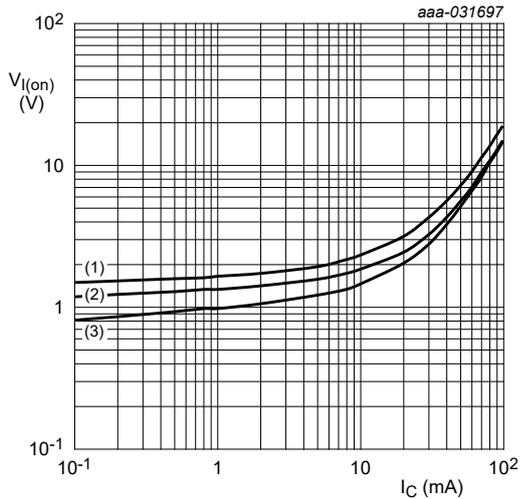
$V_{CE} = 5\text{ V}$   
 (1)  $T_{amb} = 100\text{ }^\circ\text{C}$   
 (2)  $T_{amb} = 25\text{ }^\circ\text{C}$   
 (3)  $T_{amb} = -40\text{ }^\circ\text{C}$

Fig. 3. NHUMD3, TR1 (NPN): DC current gain as a function of collector current; typical values



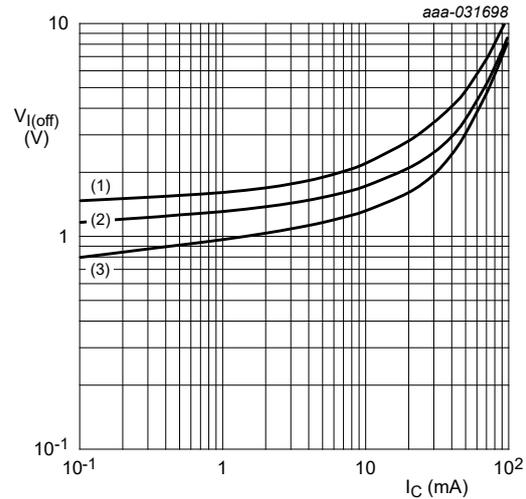
$T_{amb} = 25\text{ }^\circ\text{C}$

Fig. 4. NHUMD3, TR1 (NPN): Collector current as a function of collector-emitter voltage; typical values



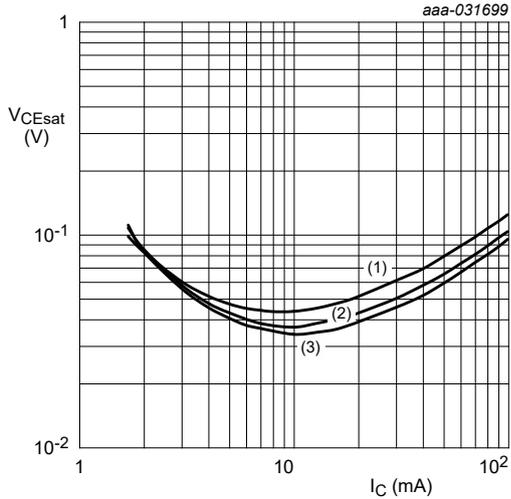
$V_{CE} = 0.3\text{ V}$   
 (1)  $T_{amb} = -40\text{ }^\circ\text{C}$   
 (2)  $T_{amb} = 25\text{ }^\circ\text{C}$   
 (3)  $T_{amb} = 100\text{ }^\circ\text{C}$

Fig. 5. NHUMD3, TR1 (NPN): On-state input voltage as a function of collector current; typical values



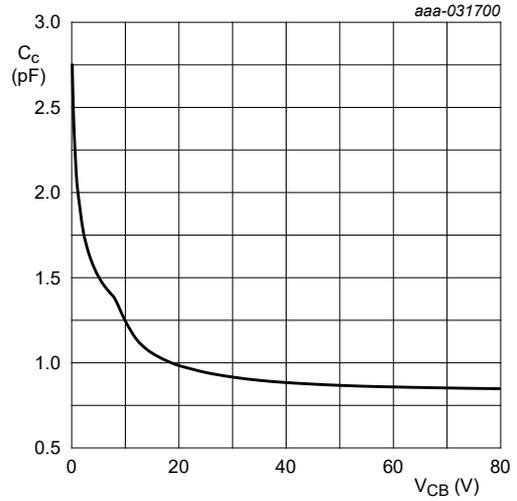
$V_{CE} = 5\text{ V}$   
 (1)  $T_{amb} = -40\text{ }^\circ\text{C}$   
 (2)  $T_{amb} = 25\text{ }^\circ\text{C}$   
 (3)  $T_{amb} = 100\text{ }^\circ\text{C}$

Fig. 6. NHUMD3, TR1 (NPN): Off-state input voltage as a function of collector current; typical values



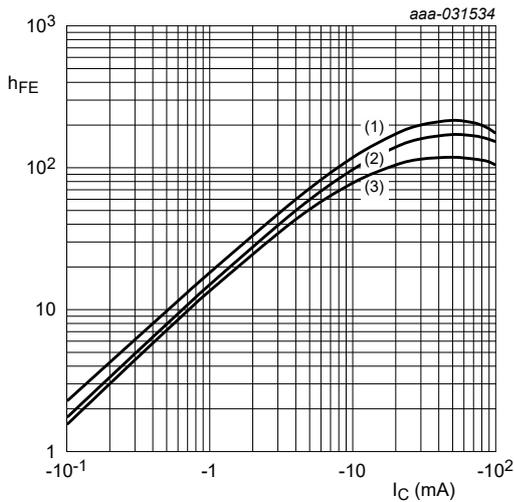
$I_C/I_B = 20$   
 (1)  $T_{amb} = 100\text{ °C}$   
 (2)  $T_{amb} = 25\text{ °C}$   
 (3)  $T_{amb} = -40\text{ °C}$

**Fig. 7. NHUMD3, TR1 (NPN): Collector-emitter saturation voltage as a function of collector current; typical values**



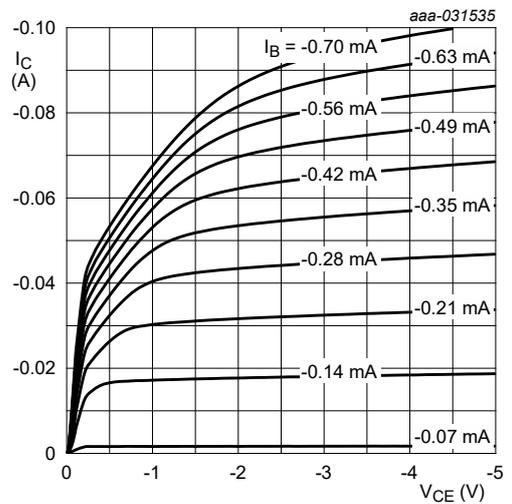
$f = 1\text{ MHz}$   
 $T_{amb} = 25\text{ °C}$

**Fig. 8. NHUMD3, TR1 (NPN): Collector capacitance as a function of collector-base voltage; typical values**



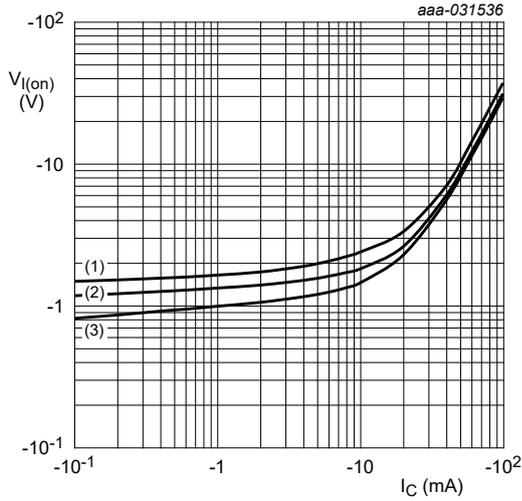
$V_{CE} = -5\text{ V}$   
 (1)  $T_{amb} = 100\text{ °C}$   
 (2)  $T_{amb} = 25\text{ °C}$   
 (3)  $T_{amb} = -40\text{ °C}$

**Fig. 9. NHUMD3, TR2 (PNP): DC current gain as a function of collector current; typical values**



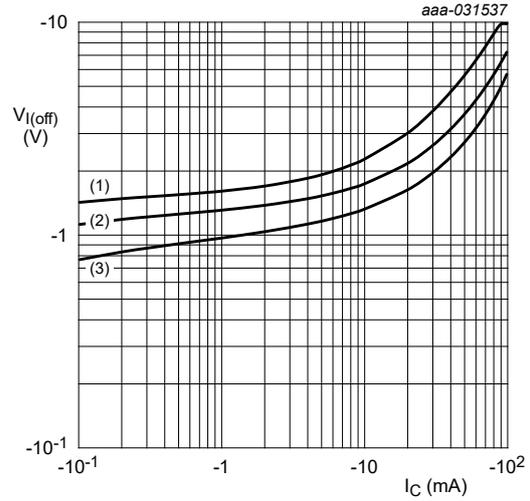
$T_{amb} = 25\text{ °C}$

**Fig. 10. NHUMD3, TR2 (PNP): Collector current as a function of collector-emitter voltage; typical values**



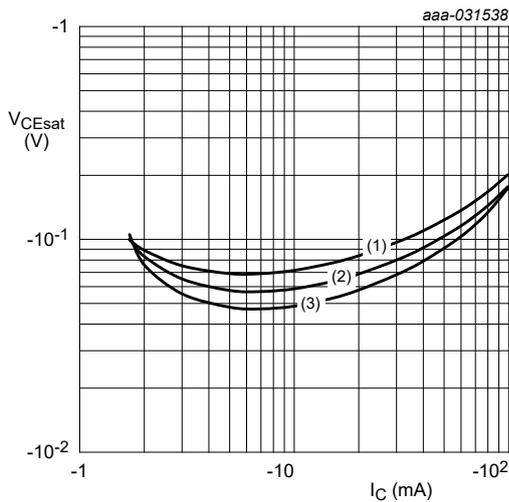
$V_{CE} = -0.3\text{ V}$   
 (1)  $T_{amb} = -40^\circ\text{C}$   
 (2)  $T_{amb} = 25^\circ\text{C}$   
 (3)  $T_{amb} = 100^\circ\text{C}$

Fig. 11. NHUMD3, TR2 (PNP): On-state input voltage as a function of collector current; typical values



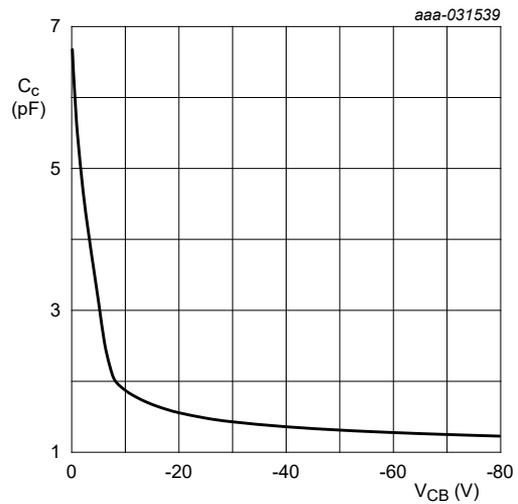
$V_{CE} = -5\text{ V}$   
 (1)  $T_{amb} = -40^\circ\text{C}$   
 (2)  $T_{amb} = 25^\circ\text{C}$   
 (3)  $T_{amb} = 100^\circ\text{C}$

Fig. 12. NHUMD3, TR2 (PNP): Off-state input voltage as a function of collector current; typical values



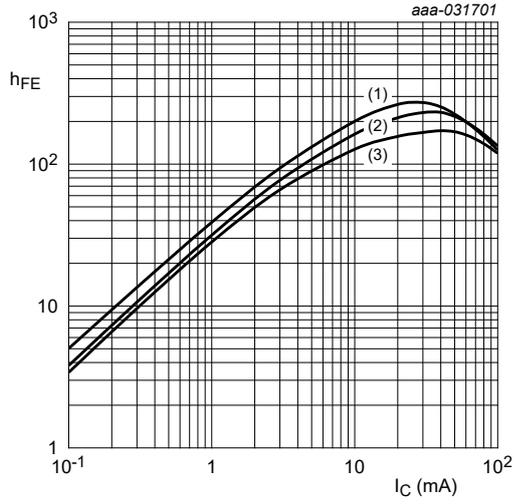
$I_C/I_B = 20$   
 (1)  $T_{amb} = 100^\circ\text{C}$   
 (2)  $T_{amb} = 25^\circ\text{C}$   
 (3)  $T_{amb} = -40^\circ\text{C}$

Fig. 13. NHUMD3, TR2 (PNP): Collector-emitter saturation voltage as a function of collector current; typical values



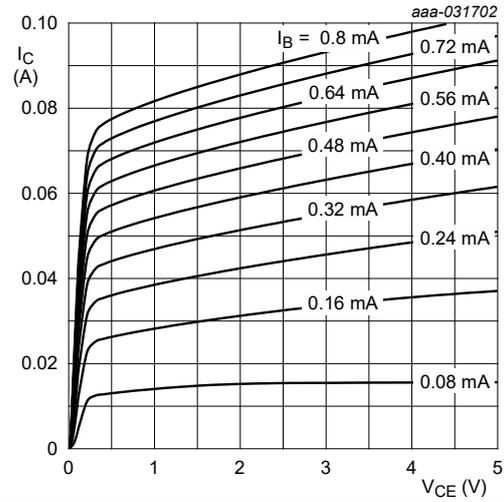
$f = 1\text{ MHz}$   
 $T_{amb} = 25^\circ\text{C}$

Fig. 14. NHUMD3, TR2 (PNP): Collector capacitance as a function of collector-base voltage; typical values



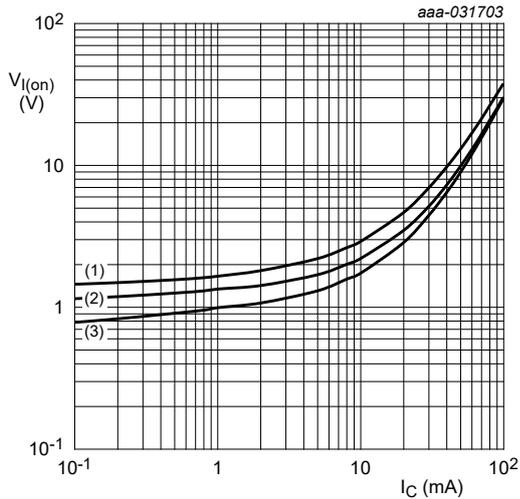
$V_{CE} = 5\text{ V}$   
 (1)  $T_{amb} = 100\text{ }^\circ\text{C}$   
 (2)  $T_{amb} = 25\text{ }^\circ\text{C}$   
 (3)  $T_{amb} = -40\text{ }^\circ\text{C}$

Fig. 15. NHUMD2, TR1 (NPN): DC current gain as a function of collector current; typical values



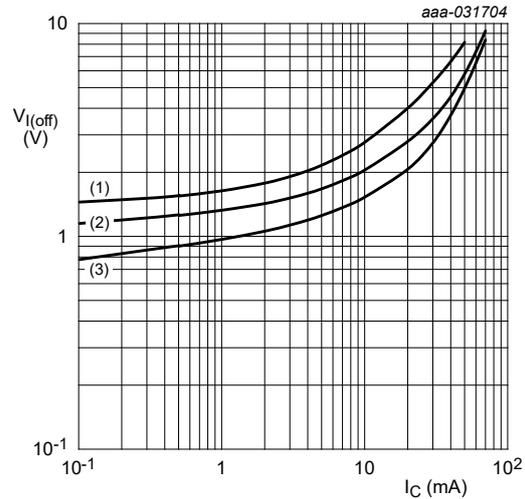
$T_{amb} = 25\text{ }^\circ\text{C}$

Fig. 16. NHUMD2, TR1 (NPN): Collector current as a function of collector-emitter voltage; typical values



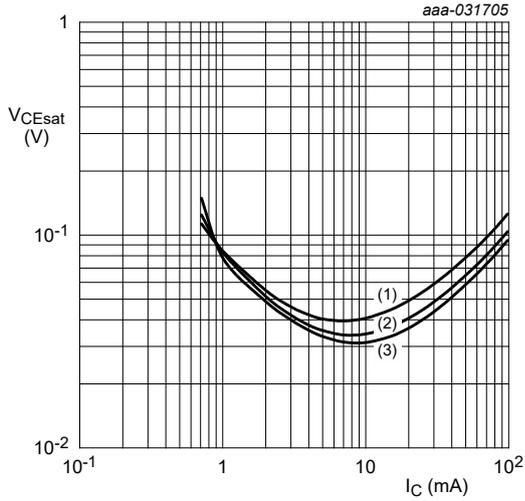
$V_{CE} = 0.3\text{ V}$   
 (1)  $T_{amb} = -40\text{ }^\circ\text{C}$   
 (2)  $T_{amb} = 25\text{ }^\circ\text{C}$   
 (3)  $T_{amb} = 100\text{ }^\circ\text{C}$

Fig. 17. NHUMD2, TR1 (NPN): On-state input voltage as a function of collector current; typical values



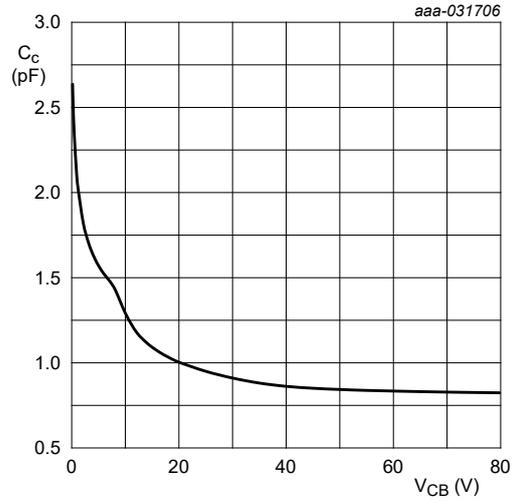
$V_{CE} = 5\text{ V}$   
 (1)  $T_{amb} = -40\text{ }^\circ\text{C}$   
 (2)  $T_{amb} = 25\text{ }^\circ\text{C}$   
 (3)  $T_{amb} = 100\text{ }^\circ\text{C}$

Fig. 18. NHUMD2, TR1 (NPN): Off-state input voltage as a function of collector current; typical values



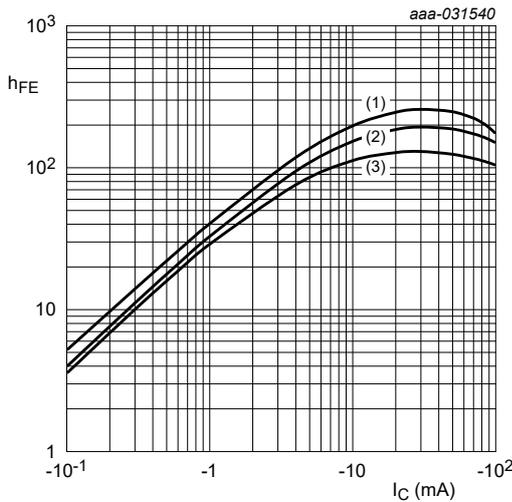
$I_C/I_B = 20$   
 (1)  $T_{amb} = 100\text{ °C}$   
 (2)  $T_{amb} = 25\text{ °C}$   
 (3)  $T_{amb} = -40\text{ °C}$

**Fig. 19. NHUMD2, TR1 (NPN): Collector-emitter saturation voltage as a function of collector current; typical values**



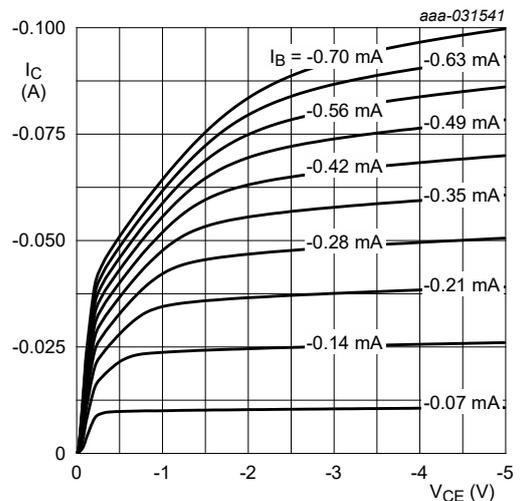
$f = 1\text{ MHz}$   
 $T_{amb} = 25\text{ °C}$

**Fig. 20. NHUMD2, TR1 (NPN): Collector capacitance as a function of collector-base voltage; typical values**



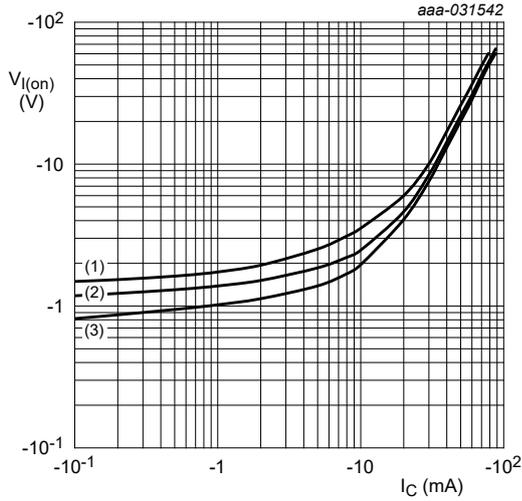
$V_{CE} = -5\text{ V}$   
 (1)  $T_{amb} = 100\text{ °C}$   
 (2)  $T_{amb} = 25\text{ °C}$   
 (3)  $T_{amb} = -40\text{ °C}$

**Fig. 21. NHUMD2, TR2 (PNP): DC current gain as a function of collector current; typical values**



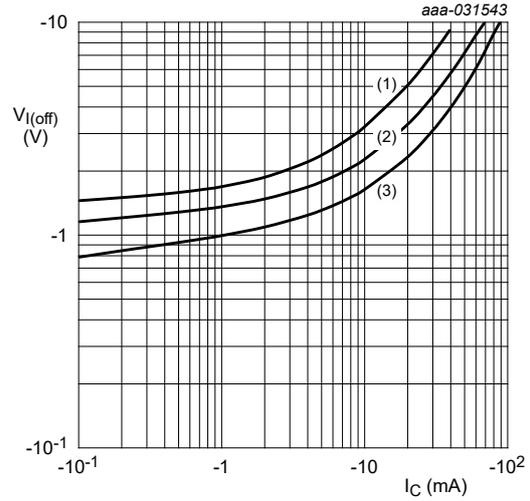
$T_{amb} = 25\text{ °C}$

**Fig. 22. NHUMD2, TR2 (PNP): Collector current as a function of collector-emitter voltage; typical values**



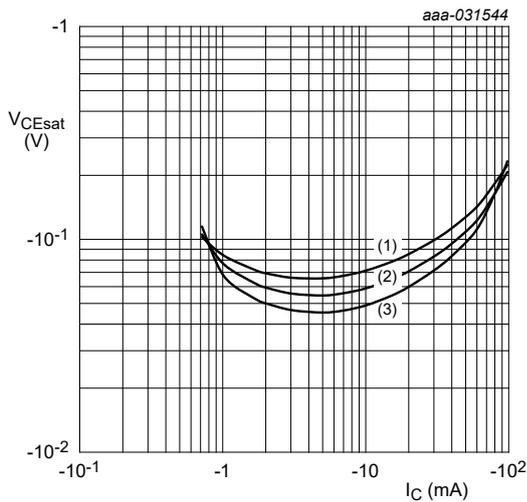
$V_{CE} = -0.3\text{ V}$   
 (1)  $T_{amb} = -40^\circ\text{C}$   
 (2)  $T_{amb} = 25^\circ\text{C}$   
 (3)  $T_{amb} = 100^\circ\text{C}$

Fig. 23. NHUMD2, TR2 (PNP): On-state input voltage as a function of collector current; typical values



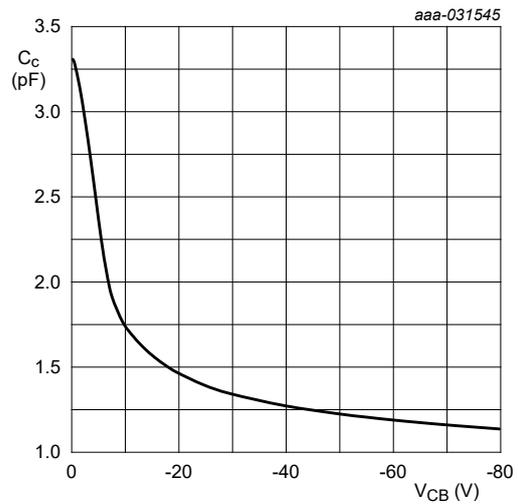
$V_{CE} = -5\text{ V}$   
 (1)  $T_{amb} = -40^\circ\text{C}$   
 (2)  $T_{amb} = 25^\circ\text{C}$   
 (3)  $T_{amb} = 100^\circ\text{C}$

Fig. 24. NHUMD2, TR2 (PNP): Off-state input voltage as a function of collector current; typical values



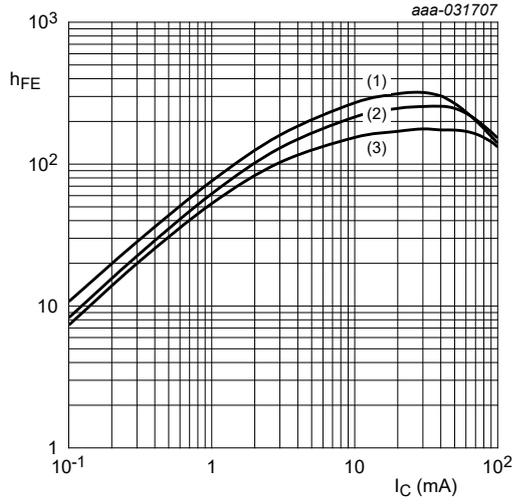
$I_C/I_B = 20$   
 (1)  $T_{amb} = 100^\circ\text{C}$   
 (2)  $T_{amb} = 25^\circ\text{C}$   
 (3)  $T_{amb} = -40^\circ\text{C}$

Fig. 25. NHUMD2, TR2 (PNP): Collector-emitter saturation voltage as a function of collector current; typical values



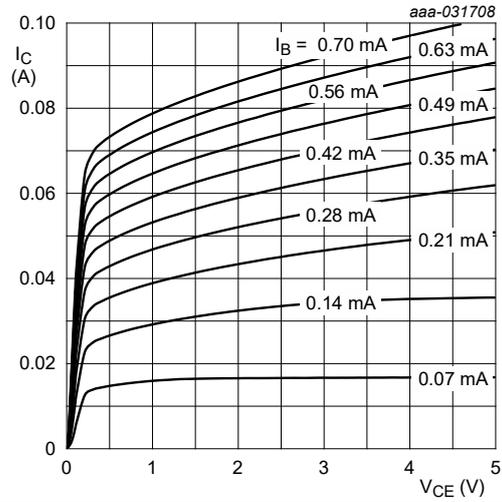
$f = 1\text{ MHz}$   
 $T_{amb} = 25^\circ\text{C}$

Fig. 26. NHUMD2, TR2 (PNP): Collector capacitance as a function of collector-base voltage; typical values



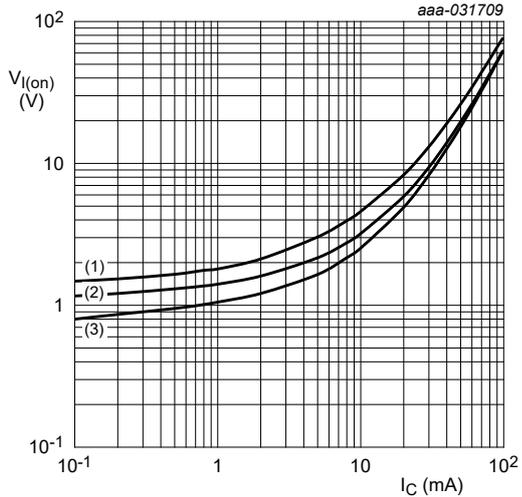
$V_{CE} = 5 \text{ V}$   
 (1)  $T_{amb} = 100 \text{ }^\circ\text{C}$   
 (2)  $T_{amb} = 25 \text{ }^\circ\text{C}$   
 (3)  $T_{amb} = -40 \text{ }^\circ\text{C}$

Fig. 27. NHUMD12, TR1 (NPN): DC current gain as a function of collector current; typical values



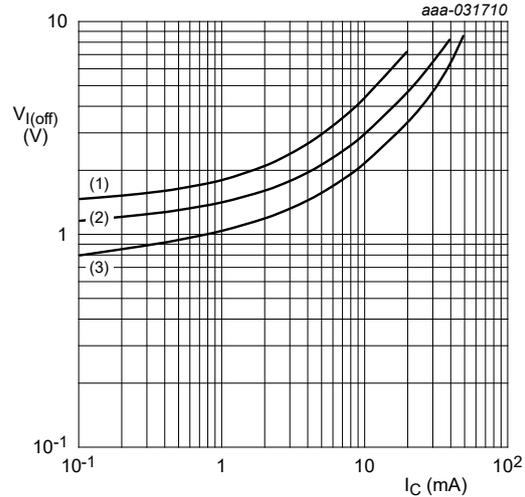
$T_{amb} = 25 \text{ }^\circ\text{C}$

Fig. 28. NHUMD12, TR1 (NPN): Collector current as a function of collector-emitter voltage; typical values



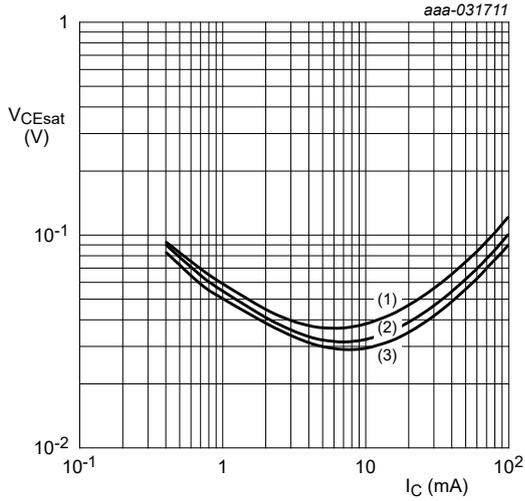
$V_{CE} = 0.3 \text{ V}$   
 (1)  $T_{amb} = -40 \text{ }^\circ\text{C}$   
 (2)  $T_{amb} = 25 \text{ }^\circ\text{C}$   
 (3)  $T_{amb} = 100 \text{ }^\circ\text{C}$

Fig. 29. NHUMD12, TR1 (NPN): On-state input voltage as a function of collector current; typical values



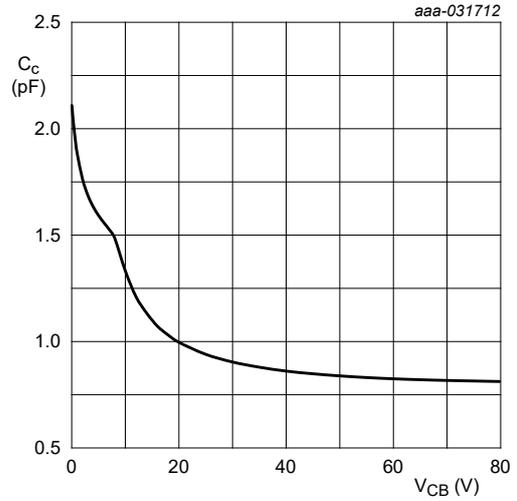
$V_{CE} = 5 \text{ V}$   
 (1)  $T_{amb} = -40 \text{ }^\circ\text{C}$   
 (2)  $T_{amb} = 25 \text{ }^\circ\text{C}$   
 (3)  $T_{amb} = 100 \text{ }^\circ\text{C}$

Fig. 30. NHUMD12, TR1 (NPN): Off-state input voltage as a function of collector current; typical values



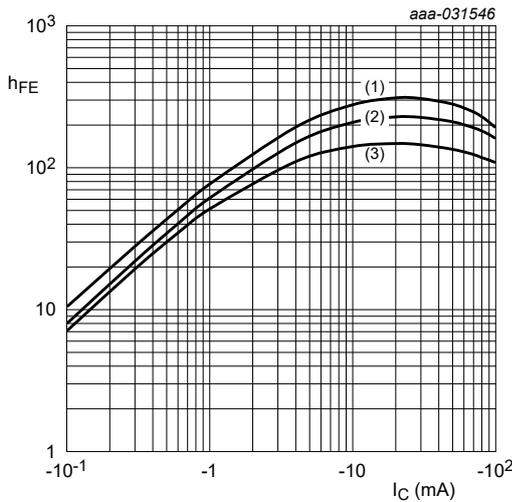
$I_C/I_B = 20$   
 (1)  $T_{amb} = 100\text{ °C}$   
 (2)  $T_{amb} = 25\text{ °C}$   
 (3)  $T_{amb} = -40\text{ °C}$

**Fig. 31. NHUMD12, TR1 (NPN): Collector-emitter saturation voltage as a function of collector current; typical values**



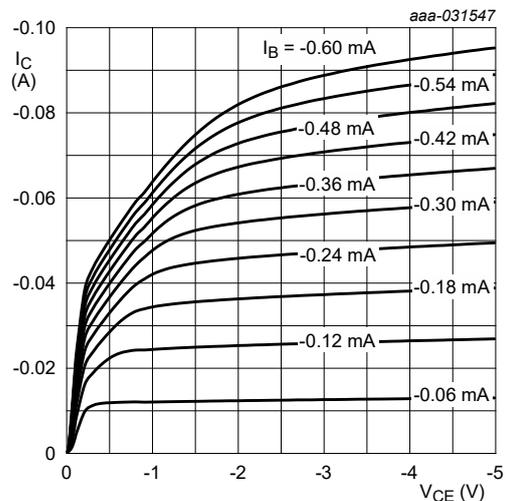
$f = 1\text{ MHz}$   
 $T_{amb} = 25\text{ °C}$

**Fig. 32. NHUMD12, TR1 (NPN): Collector capacitance as a function of collector-base voltage; typical values**



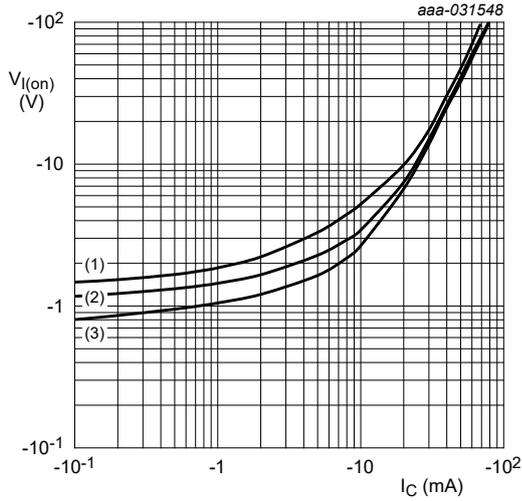
$V_{CE} = -5\text{ V}$   
 (1)  $T_{amb} = 100\text{ °C}$   
 (2)  $T_{amb} = 25\text{ °C}$   
 (3)  $T_{amb} = -40\text{ °C}$

**Fig. 33. NHUMD12, TR2 (PNP): DC current gain as a function of collector current; typical values**



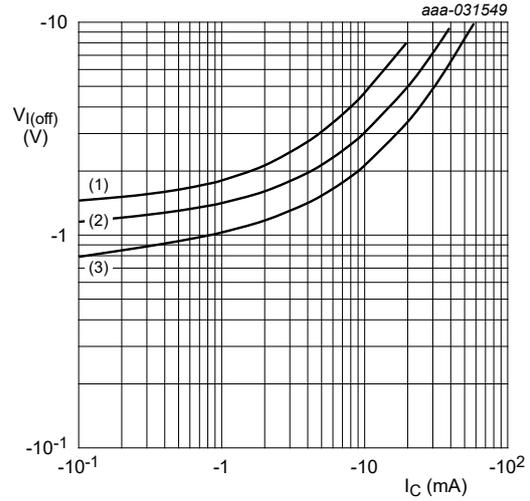
$T_{amb} = 25\text{ °C}$

**Fig. 34. NHUMD12, TR2 (PNP): Collector current as a function of collector-emitter voltage; typical values**



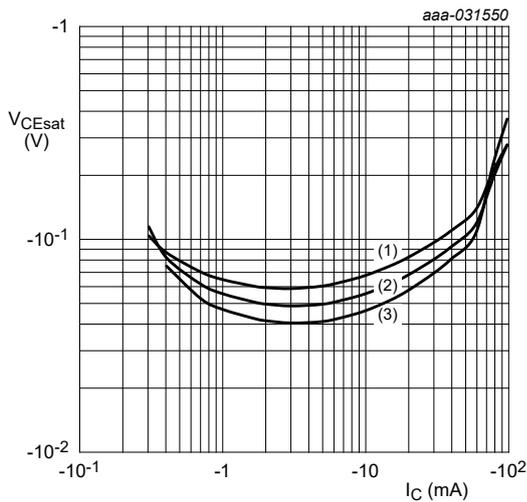
$V_{CE} = -0.3\text{ V}$   
 (1)  $T_{amb} = -40\text{ }^{\circ}\text{C}$   
 (2)  $T_{amb} = 25\text{ }^{\circ}\text{C}$   
 (3)  $T_{amb} = 100\text{ }^{\circ}\text{C}$

Fig. 35. NHUMD12, TR2 (PNP): On-state input voltage as a function of collector current; typical values



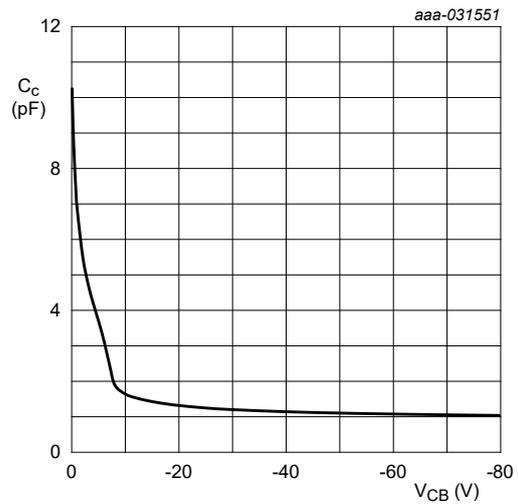
$V_{CE} = -5\text{ V}$   
 (1)  $T_{amb} = -40\text{ }^{\circ}\text{C}$   
 (2)  $T_{amb} = 25\text{ }^{\circ}\text{C}$   
 (3)  $T_{amb} = 100\text{ }^{\circ}\text{C}$

Fig. 36. NHUMD12, TR2 (PNP): Off-state input voltage as a function of collector current; typical values



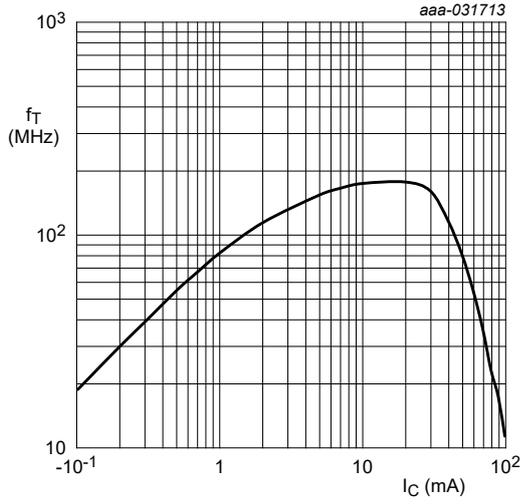
$I_C/I_B = 20$   
 (1)  $T_{amb} = 100\text{ }^{\circ}\text{C}$   
 (2)  $T_{amb} = 25\text{ }^{\circ}\text{C}$   
 (3)  $T_{amb} = -40\text{ }^{\circ}\text{C}$

Fig. 37. NHUMD12, TR2 (PNP): Collector-emitter saturation voltage as a function of collector current; typical values



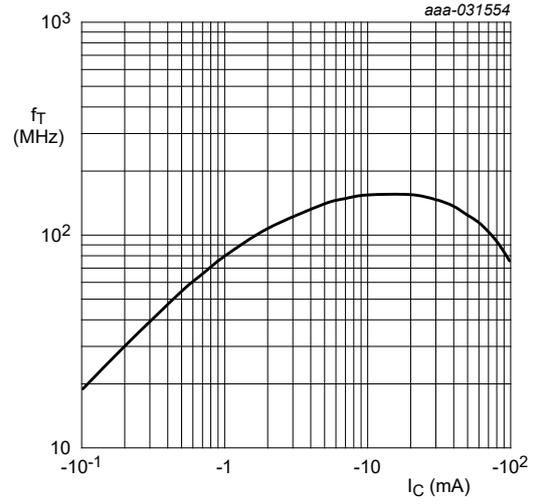
$f = 1\text{ MHz}$   
 $T_{amb} = 25\text{ }^{\circ}\text{C}$

Fig. 38. NHUMD12, TR2 (PNP): Collector capacitance as a function of collector-base voltage; typical values of built-in transistor



$f = 100 \text{ MHz}$   
 $V_{CE} = 5 \text{ V}$   
 $T_{amb} = 25 \text{ }^\circ\text{C}$

**Fig. 39. TR1 (NPN):** Transition frequency as a function of collector current; typical values of built-in transistor



$f = 100 \text{ MHz}$   
 $V_{CE} = -5 \text{ V}$   
 $T_{amb} = 25 \text{ }^\circ\text{C}$

**Fig. 40. TR2 (PNP):** Transition frequency as a function of collector current; typical values of built-in transistor

## 11. Test information

### Quality information

This product has been qualified in accordance with the Automotive Electronics Council (AEC) standard Q101 - Stress test qualification for discrete semiconductors, and is suitable for use in automotive applications.

### Resistor calculation

- Calculation of bias resistor 1 (R1)

$$R_1 = \frac{V(I_{I2}) - V(I_{I1})}{I_{I2} - I_{I1}}$$

- Calculation of bias resistor ratio (R2/R1)

$$\frac{R_2}{R_1} = \frac{V(I_{I4}) - V(I_{I3})}{R_1 \cdot (I_{I4} - I_{I3})} - 1$$

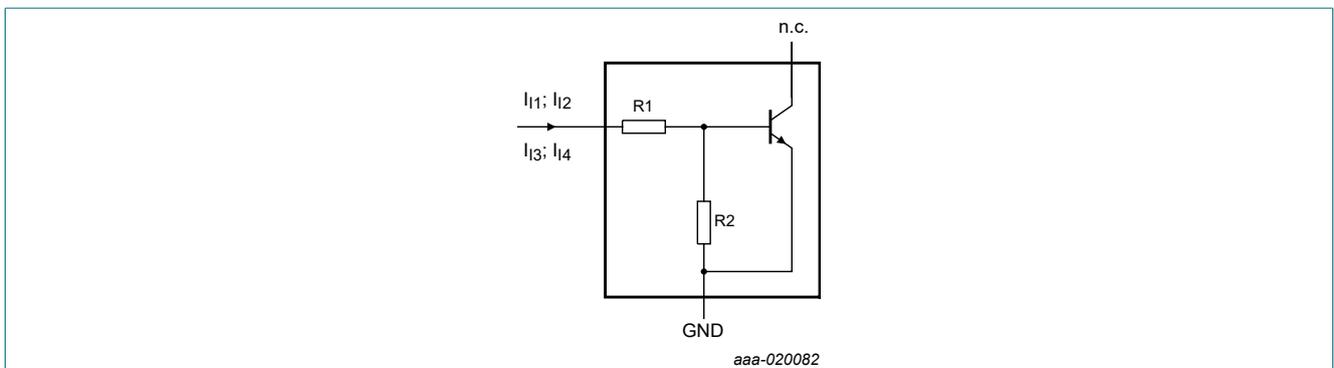


Fig. 41. TR1 (NPN): Resistor test circuit

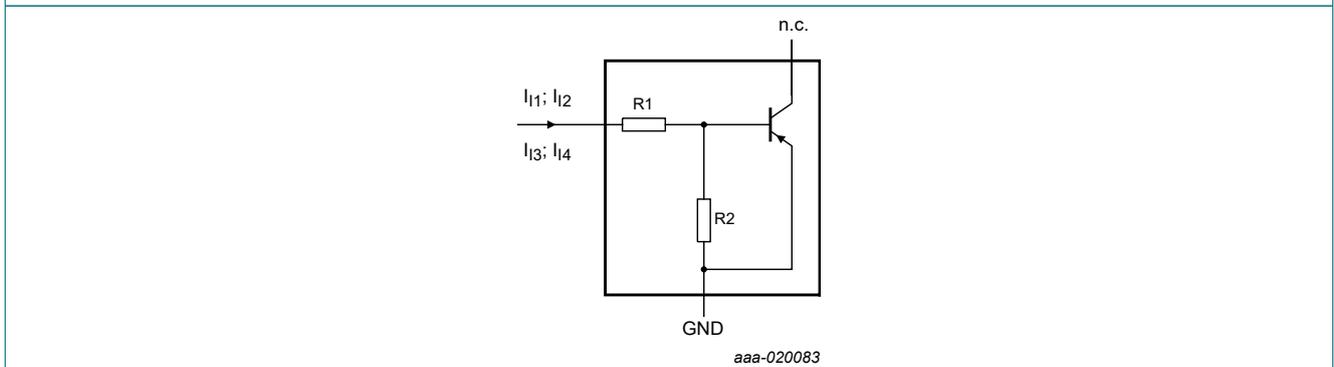


Fig. 42. TR2 (PNP): Resistor test circuit

### Resistor test conditions

Table 9. Resistor test conditions

Type number	R1 (kΩ)	R2 (kΩ)	Test conditions			
			I <sub>I1</sub>	I <sub>I2</sub>	I <sub>I3</sub>	I <sub>I4</sub>
<b>Per transistor; for the PNP transistor with negative polarity</b>						
NHUMD3	10	10	800 μA	1.1 mA	-350 μA	-450 μA
NHUMD2	22	22	550 μA	750 μA	-150 μA	-230 μA
NHUMD12	47	47	250 μA	350 μA	-55 μA	-105 μA

## 12. Package outline

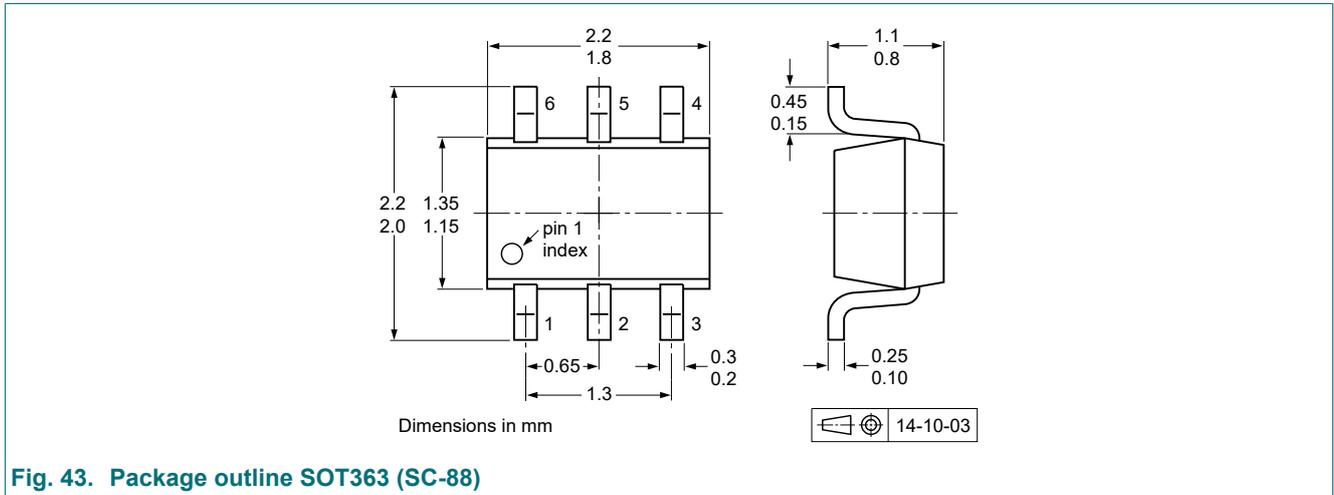


Fig. 43. Package outline SOT363 (SC-88)

## 13. Soldering

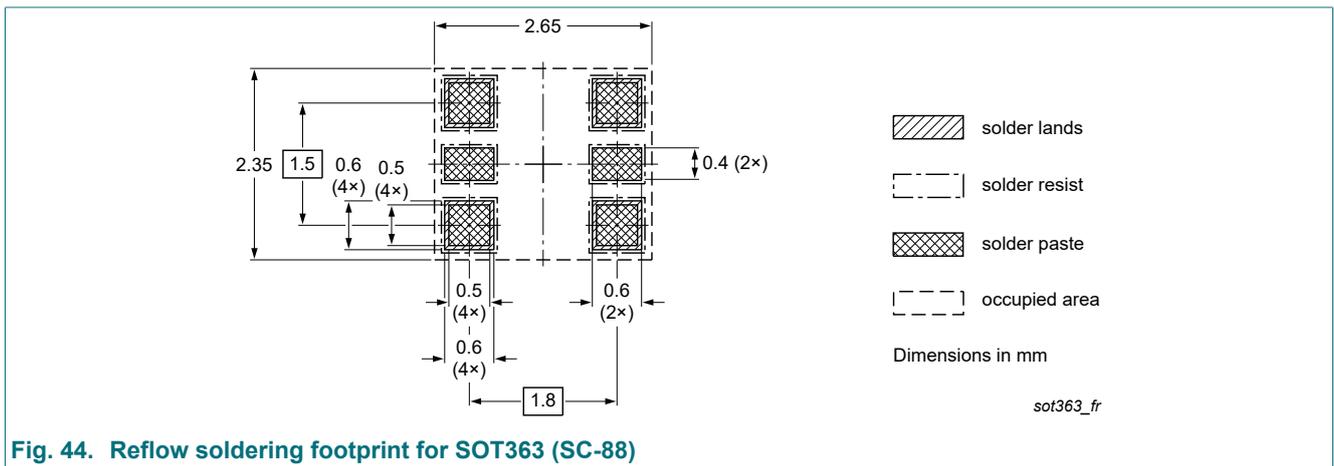


Fig. 44. Reflow soldering footprint for SOT363 (SC-88)

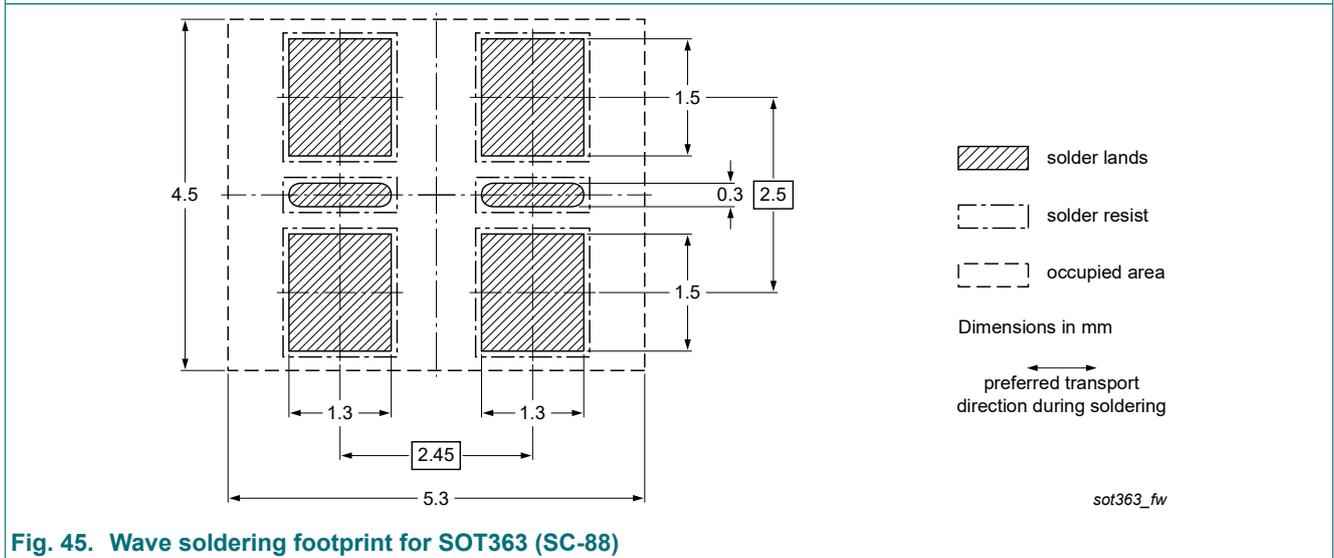


Fig. 45. Wave soldering footprint for SOT363 (SC-88)

## 14. Revision history

Table 10. Revision history

Data sheet ID	Release date	Data sheet status	Change notice	Supersedes
NHUMD3_2_12_SER v.1	20200724	Product data sheet	-	-

## 15. Legal information

### Data sheet status

Document status [1][2]	Product status [3]	Definition
Objective [short] data sheet	Development	This document contains data from the objective specification for product development.
Preliminary [short] data sheet	Qualification	This document contains data from the preliminary specification.
Product [short] data sheet	Production	This document contains the product specification.

- [1] Please consult the most recently issued document before initiating or completing a design.
- [2] The term 'short data sheet' is explained in section "Definitions".
- [3] The product status of device(s) described in this document may have changed since this document was published and may differ in case of multiple devices. The latest product status information is available on the internet at <https://www.nexperia.com>.

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