



# NHUMD10/13/9 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 Transistors (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:
	kΩ	kΩ	Nexperia	JEITA		
NHUMD10	2.2	47	SOT363	SC-88	NHUMH10	NHUMB10
NHUMD13	4.7	47			NHUMH13	NHUMB13
NHUMD9	10	47			NHUMH9	NHUMB9

## 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

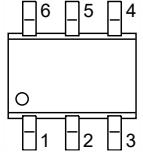
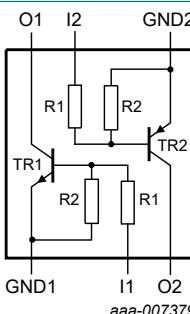
$T_{amb} = 25^\circ\text{C}$  unless otherwise specified.

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

**nexperia**

## 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		Version
	Name	Description	
NHUMD10	SC-88	plastic surface-mounted package; 6 leads	SOT363
NHUMD13			
NHUMD9			

## 7. Marking

Table 5. Marking

Type number	Marking code [1]
NHUMD10	6P%
NHUMD13	6R%
NHUMD9	6N%

[1] % = placeholder for manufacturing site code

## 8. Limiting values

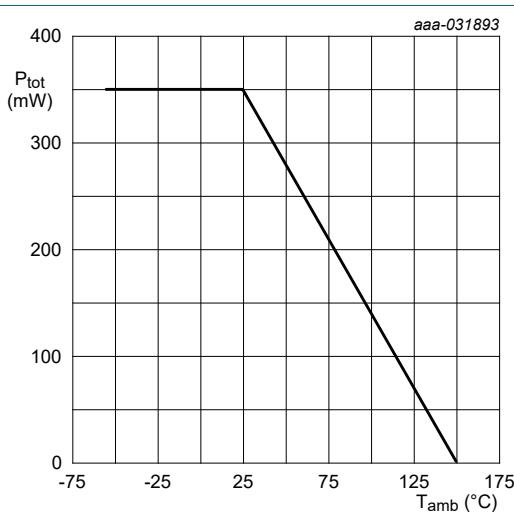
**Table 6. Limiting values**

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

$T_{amb} = 25^\circ\text{C}$  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	-	7	V
$V_I$	input voltage				
	NHUMD10, TR1 (NPN)		-7	+20	V
	NHUMD10, TR2 (PNP)		-20	+7	
	NHUMD13, TR1 (NPN)		-7	+30	V
	NHUMD13, TR2 (PNP)		-30	+7	V
	NHUMD9, TR1 (NPN)		-7	+40	V
	NHUMD9, TR2 (PNP)		-40	+7	V
$I_O$	output current		-	100	mA
$P_{tot}$	total power dissipation	$T_{amb} \leq 25^\circ\text{C}$	[1]	-	235 mW
<b>Per device</b>					
$P_{tot}$	total power dissipation	$T_{amb} \leq 25^\circ\text{C}$	[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.



FR4 PCB, single-sided copper, standard footprint

**Fig. 1. Per device: Power derating curves for SOT363 (SC-88)**

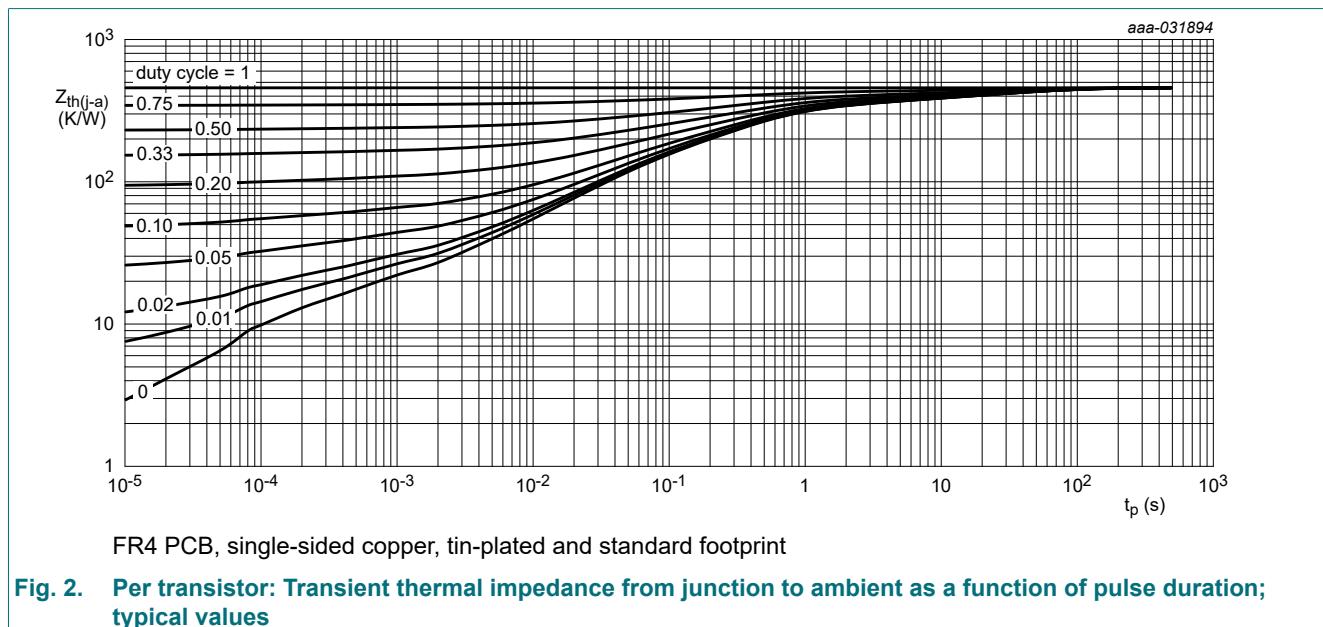
## 9. Thermal characteristics

**Table 7. Thermal characteristics**

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

$T_{amb} = 25^\circ\text{C}$  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	$I_C = 100 \mu\text{A}; I_E = 0 \text{ A}$	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	
		$V_{CE} = 60 \text{ V}; I_B = 0 \text{ A}; T_j = 150^\circ\text{C}$	-	-	5	$\mu\text{A}$	
$I_{EBO}$	emitter-base cut-off current						
	NHUMD10	$V_{EB} = 7 \text{ V}; I_C = 0 \text{ A}$	-	-	270	$\mu\text{A}$	
	NHUMD13		-	-	260	$\mu\text{A}$	
	NHUMD9		-	-	230	$\mu\text{A}$	
$h_{FE}$	DC current gain	$V_{CE} = 5 \text{ V}; I_C = 10 \text{ mA}$	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						
	NHUMD10	$V_{CE} = 5 \text{ V}; I_C = 100 \mu\text{A}$	-	595	500	mV	
	NHUMD13		-	625	500	mV	
	NHUMD9		-	690	500	mV	
$V_{I(on)}$	on-state input voltage						
	NHUMD10	$V_{CE} = 0.3 \text{ V}; I_C = 10 \text{ mA}$	1.2	0.81	-	V	
	NHUMD13		1.4	0.95	-	V	
	NHUMD9		1.6	1.22	-	V	
R1	bias resistor 1 (input)						
	NHUMD10		[1]	1.54	2.2	2.86	k $\Omega$
	NHUMD13			3.3	4.7	6.1	k $\Omega$
	NHUMD9			7	10	13	k $\Omega$
R2/R1	bias resistor ratio						
	NHUMD10		[1]	17	21	26	
	NHUMD13			8	10	12	
	NHUMD9			3.7	4.7	5.7	
$f_T$	transition frequency	$V_{CE} = 5 \text{ V}; I_C = 10 \text{ mA}; f = 100 \text{ MHz}$	[2]				
	TR1 (NPN)			-	170	-	MHz
	TR2 (PNP)			-	150	-	MHz
$C_c$	collector capacitance	$V_{CB} = 10 \text{ V}; I_E = i_e = 0 \text{ A}; f = 1 \text{ MHz}$					
	TR1 (NPN)			-	-	2.5	pF
	TR2 (PNP)			-	-	3	pF

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

[2] Characteristics of built-in transistor

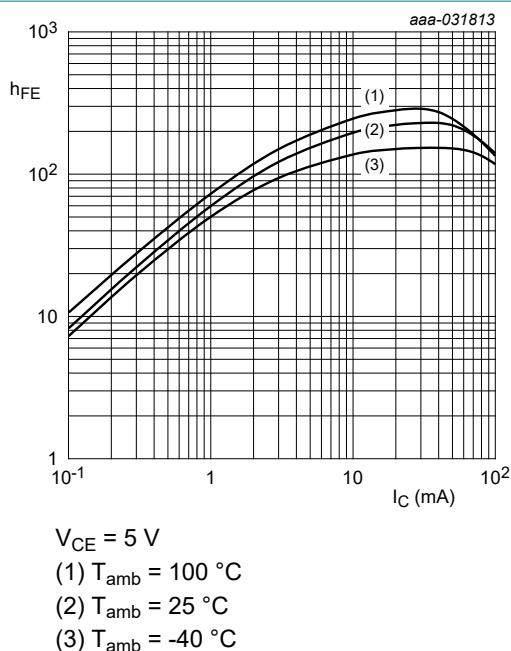


Fig. 3. NHUMD10, TR1 (NPN): DC current gain as a function of collector current; typical values

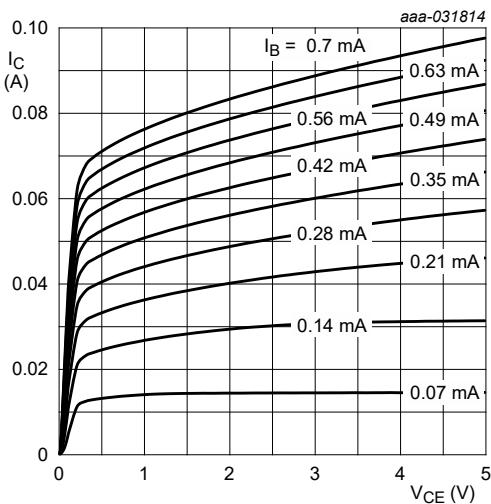


Fig. 4. NHUMD10, TR1 (NPN): Collector current as a function of collector-emitter voltage; typical values

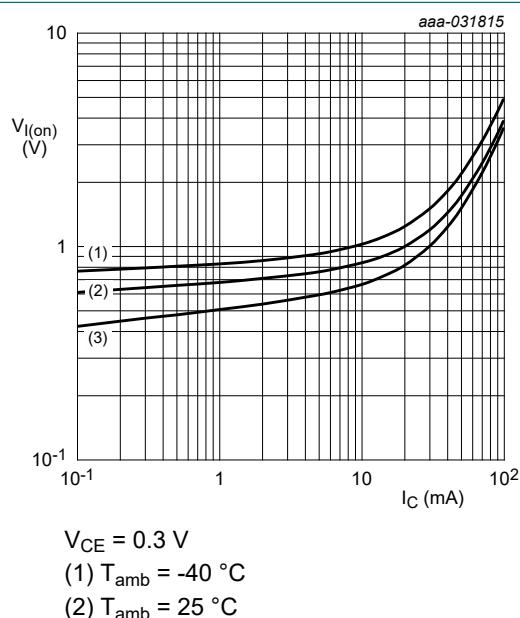


Fig. 5. NHUMD10, TR1 (NPN): On-state input voltage as a function of collector current; typical values

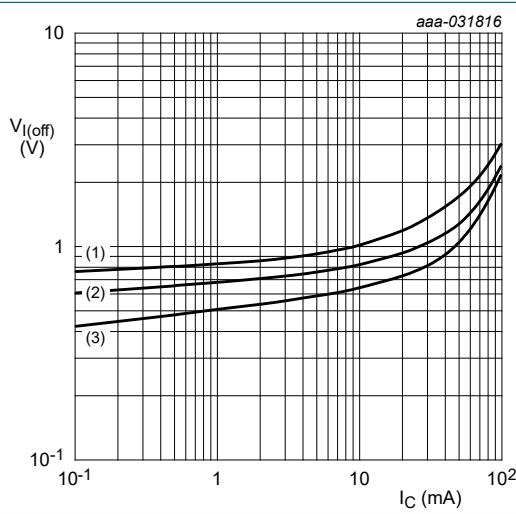
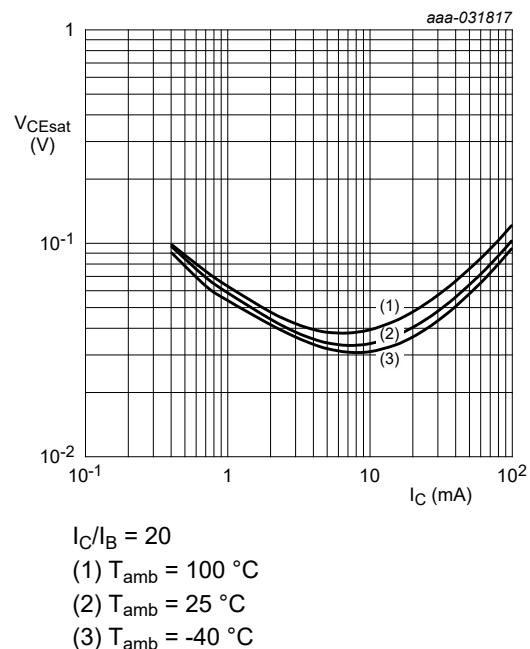
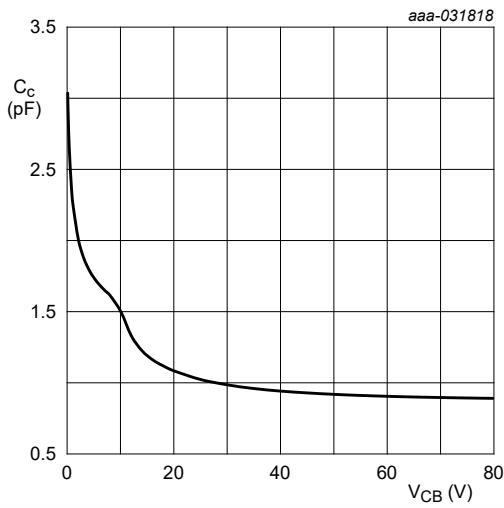


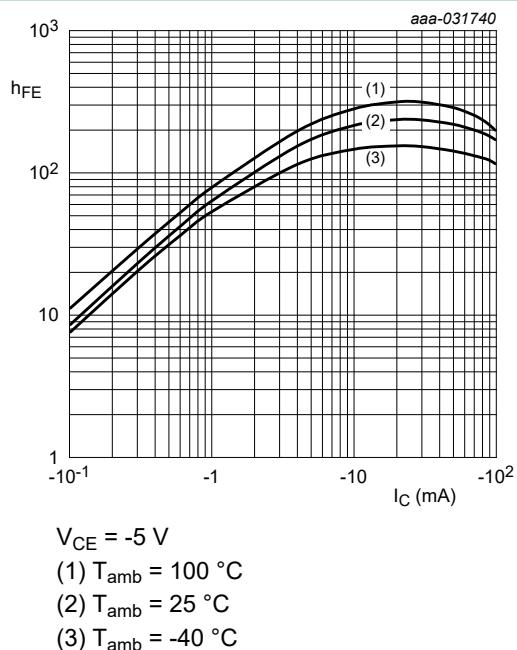
Fig. 6. NHUMD10, TR1 (NPN): Off-state input voltage as a function of collector current; typical values



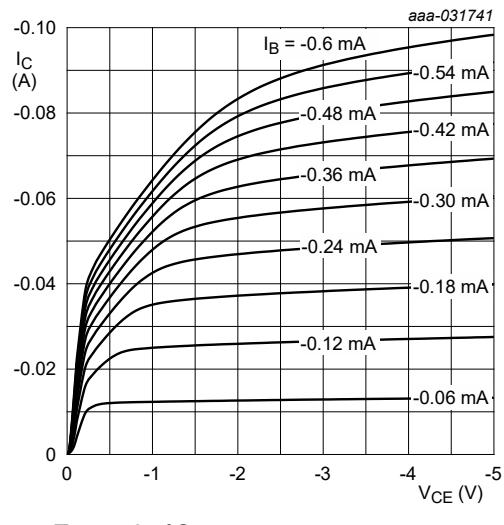
**Fig. 7. NHUMD10, TR1 (NPN): Collector-emitter saturation voltage as a function of collector current; typical values**



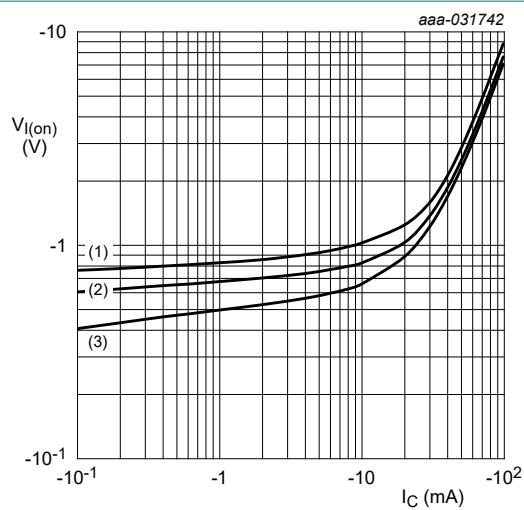
**Fig. 8. NHUMD10, TR1 (NPN): Collector capacitance as a function of collector-base voltage; typical values**



**Fig. 9. NHUMD10, TR2 (PNP): DC current gain as a function of collector current; typical values**

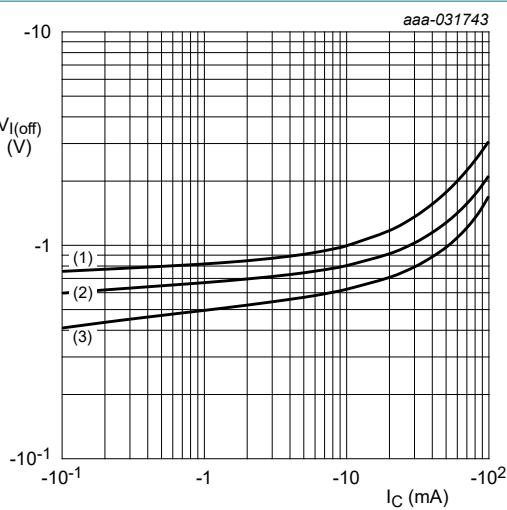


**Fig. 10. NHUMD10, TR2 (PNP): Collector current as a function of collector-emitter voltage; typical values**



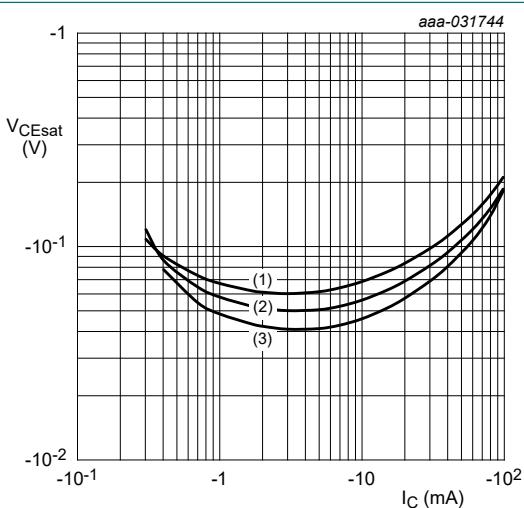
$V_{CE} = -0.3 \text{ V}$   
 (1)  $T_{amb} = -40 \text{ }^{\circ}\text{C}$   
 (2)  $T_{amb} = 25 \text{ }^{\circ}\text{C}$   
 (3)  $T_{amb} = 100 \text{ }^{\circ}\text{C}$

Fig. 11. NHUMD10, TR2 (PNP): On-state input voltage as a function of collector current; typical values



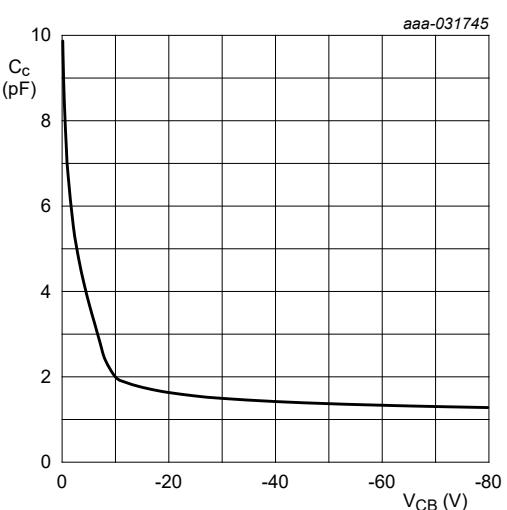
$V_{CE} = -5 \text{ V}$   
 (1)  $T_{amb} = -40 \text{ }^{\circ}\text{C}$   
 (2)  $T_{amb} = 25 \text{ }^{\circ}\text{C}$   
 (3)  $T_{amb} = 100 \text{ }^{\circ}\text{C}$

Fig. 12. NHUMD10, 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. 13. NHUMD10, 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. 14. NHUMD10, TR2 (PNP): Collector capacitance as a function of collector-base voltage; typical values

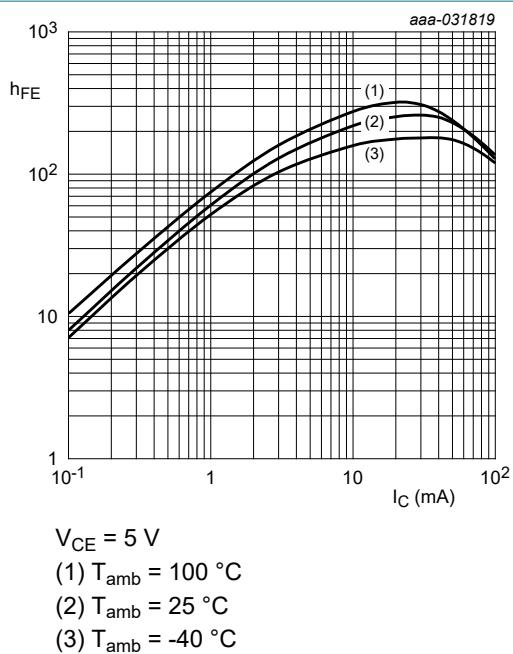


Fig. 15. NHUMD13, TR1 (NPN): DC current gain as a function of collector current; typical values

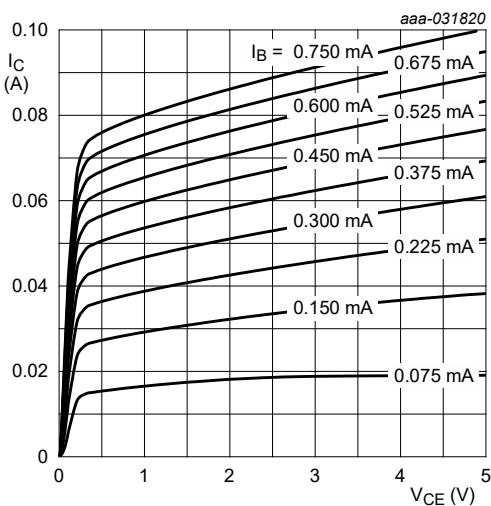


Fig. 16. NHUMD13, TR1 (NPN): Collector current as a function of collector-emitter voltage; typical values

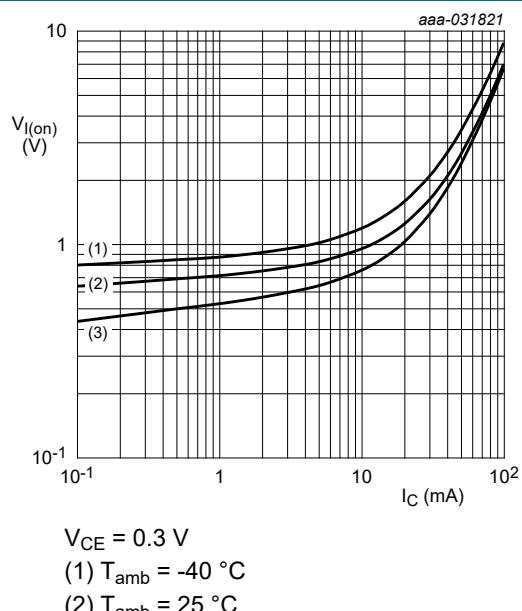


Fig. 17. NHUMD13, TR1 (NPN): On-state input voltage as a function of collector current; typical values

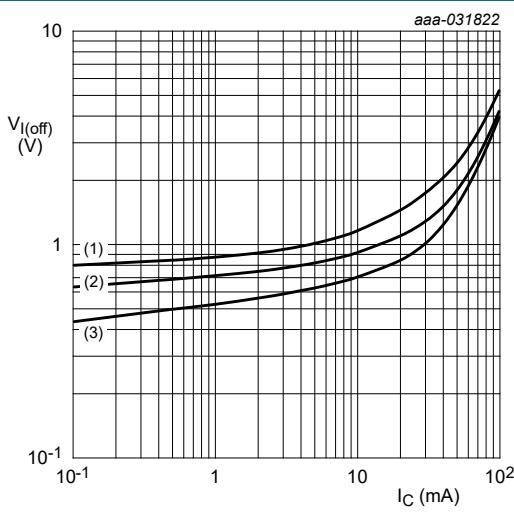


Fig. 18. NHUMD13, TR1 (NPN): Off-state input voltage as a function of collector current; typical values

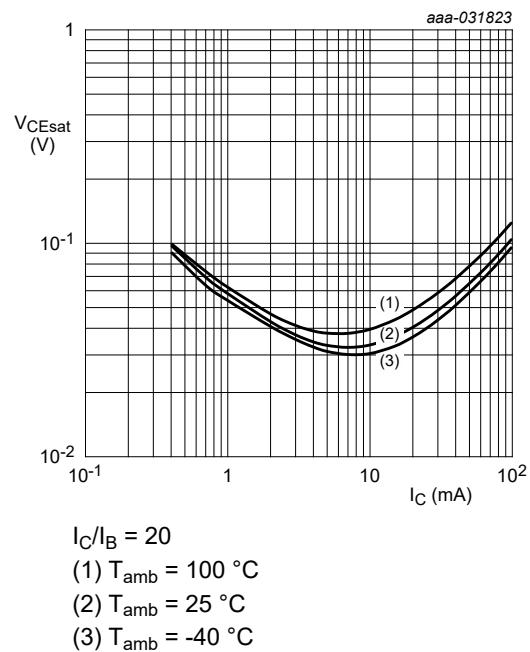


Fig. 19. NHUMD13, TR1 (NPN): Collector-emitter saturation voltage as a function of collector current; typical values

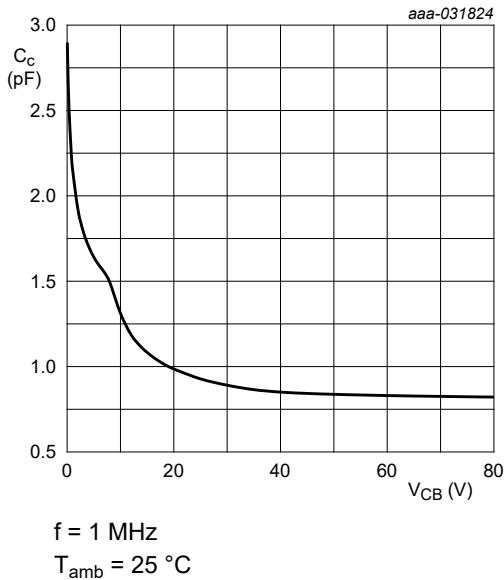


Fig. 20. NHUMD13, TR1 (NPN): Collector capacitance as a function of collector-base voltage; typical values

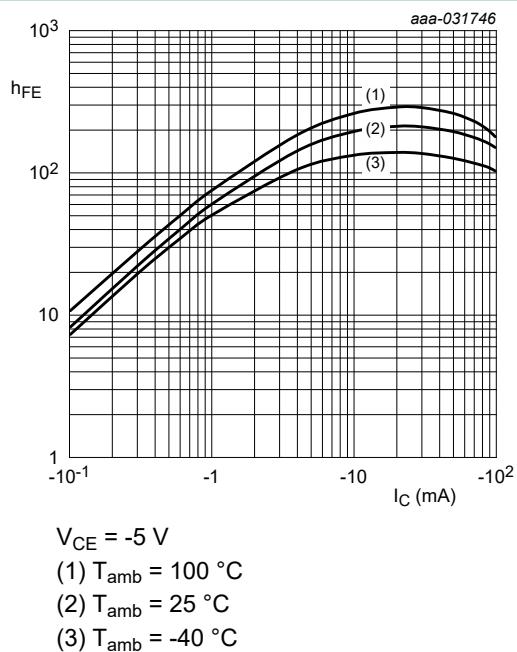


Fig. 21. NHUMD13, TR2 (PNP): DC current gain as a function of collector current; typical values

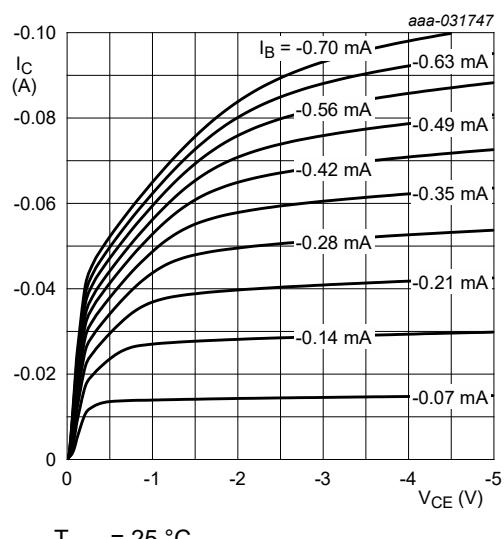
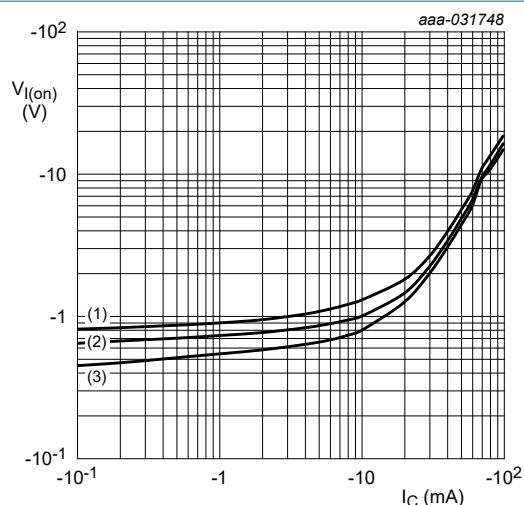
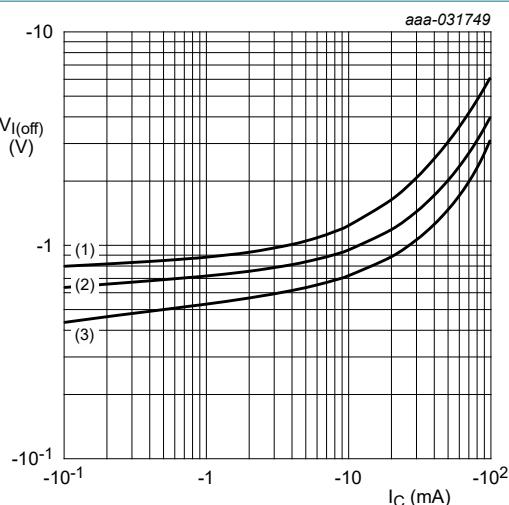


Fig. 22. NHUMD13, TR2 (PNP): Collector current as a function of collector-emitter voltage; typical values



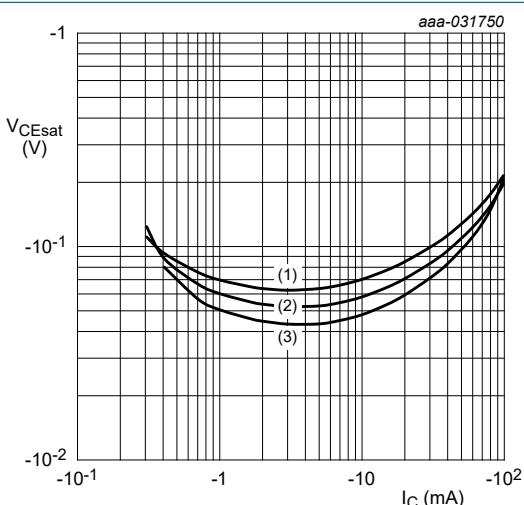
$V_{CE} = -0.3 \text{ V}$   
 (1)  $T_{amb} = -40 \text{ }^{\circ}\text{C}$   
 (2)  $T_{amb} = 25 \text{ }^{\circ}\text{C}$   
 (3)  $T_{amb} = 100 \text{ }^{\circ}\text{C}$

Fig. 23. NHUMD13, 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. 24. NHUMD13, 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. 25. NHUMD13, TR2 (PNP): Collector-emitter saturation voltage as a function of collector current; typical values

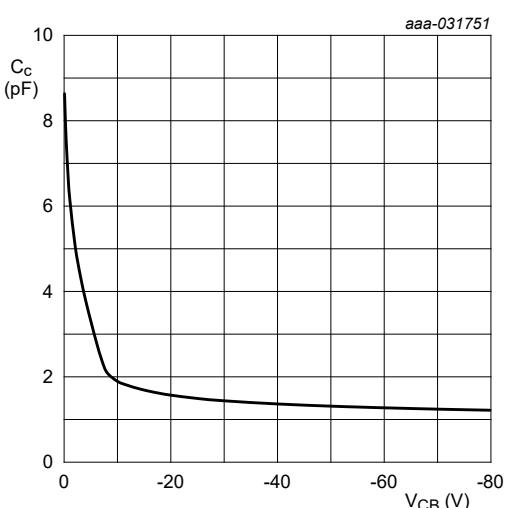


Fig. 26. NHUMD13, TR2 (PNP): Collector capacitance as a function of collector-base voltage; typical values

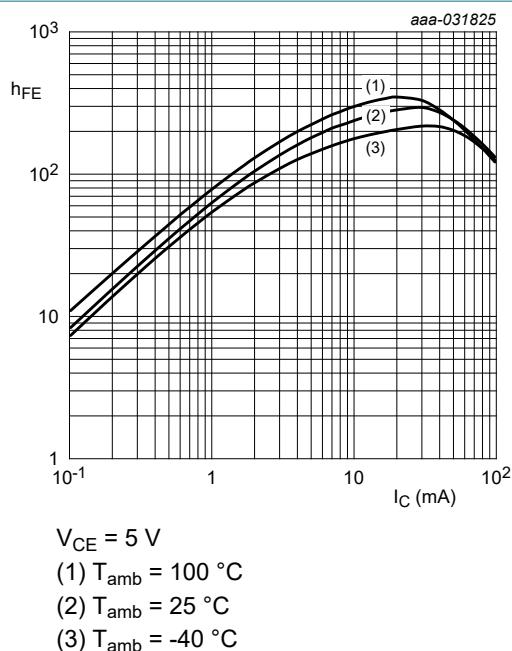


Fig. 27. NHUMD9, TR1 (NPN): DC current gain as a function of collector current; typical values

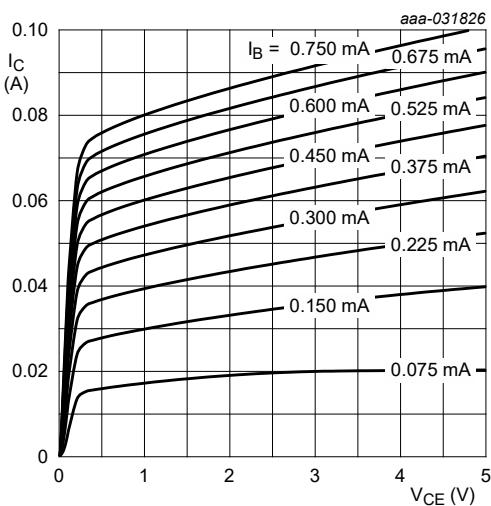


Fig. 28. NHUMD9, TR1 (NPN): Collector current as a function of collector-emitter voltage; typical values

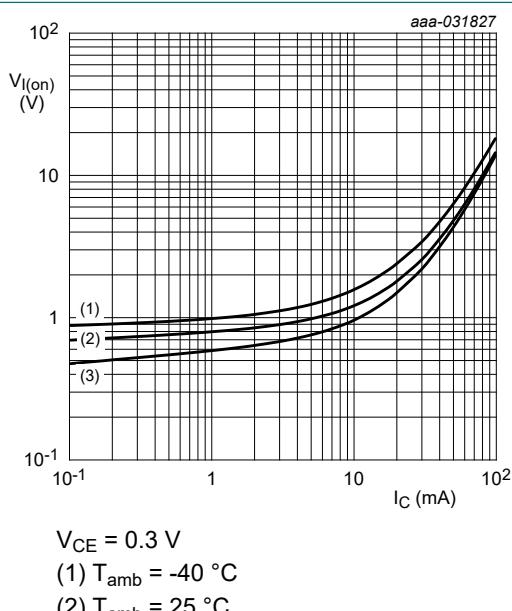


Fig. 29. NHUMD9, TR1 (NPN): On-state input voltage as a function of collector current; typical values

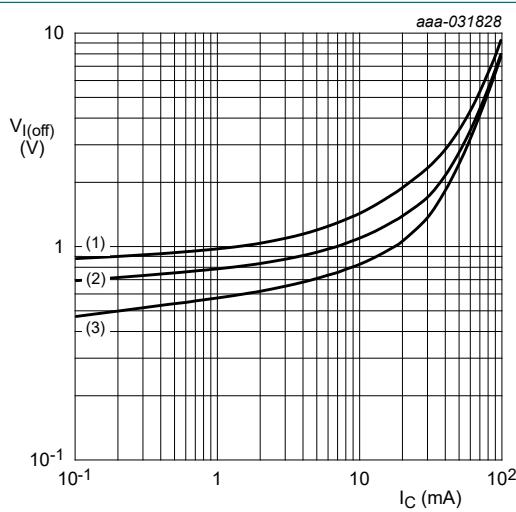


Fig. 30. NHUMD9, TR1 (NPN): Off-state input voltage as a function of collector current; typical values

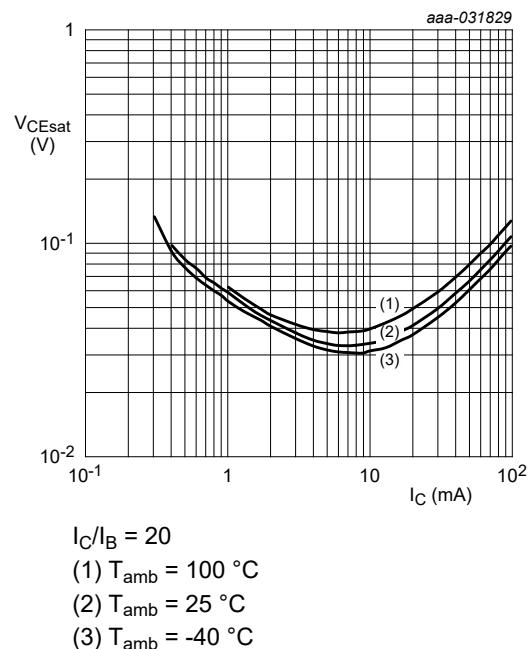


Fig. 31. NHUMD9, TR1 (NPN): Collector-emitter saturation voltage as a function of collector current; typical values

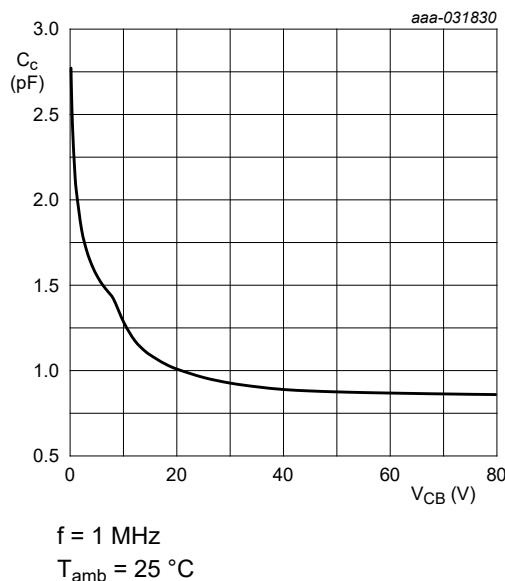


Fig. 32. NHUMD9, TR1 (NPN): Collector capacitance as a function of collector-base voltage; typical values

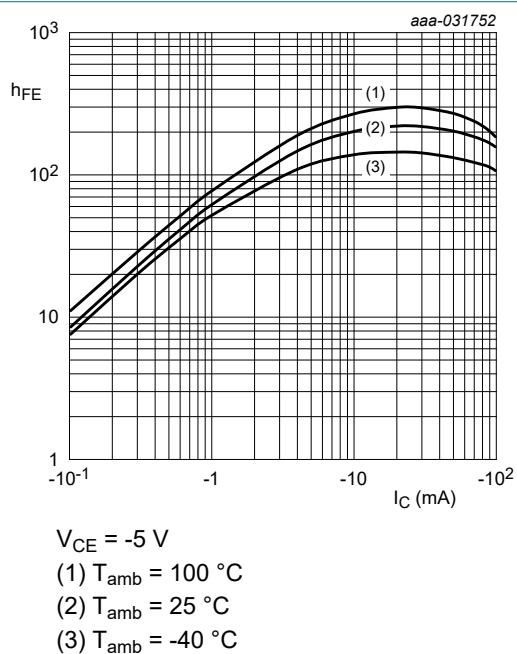


Fig. 33. NHUMD9, TR2 (PNP): DC current gain as a function of collector current; typical values

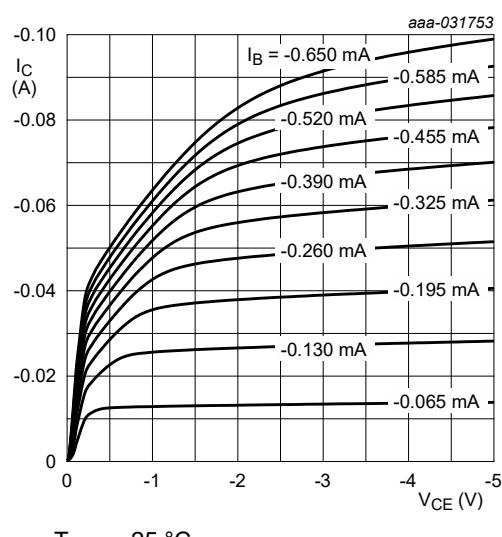
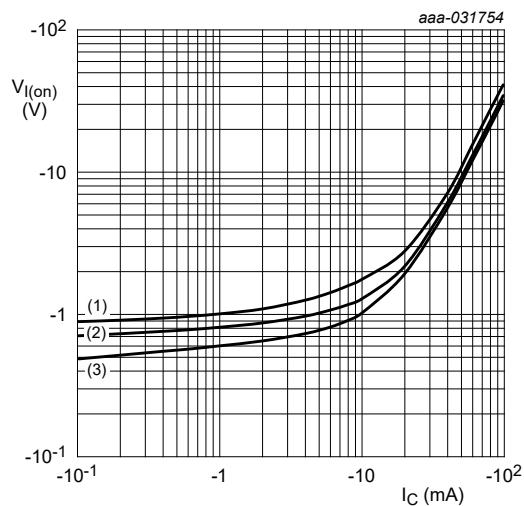
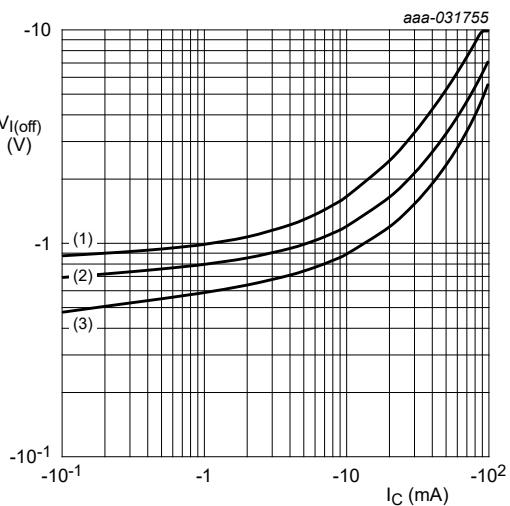


Fig. 34. NHUMD9, TR2 (PNP): Collector current as a function of collector-emitter voltage; typical values



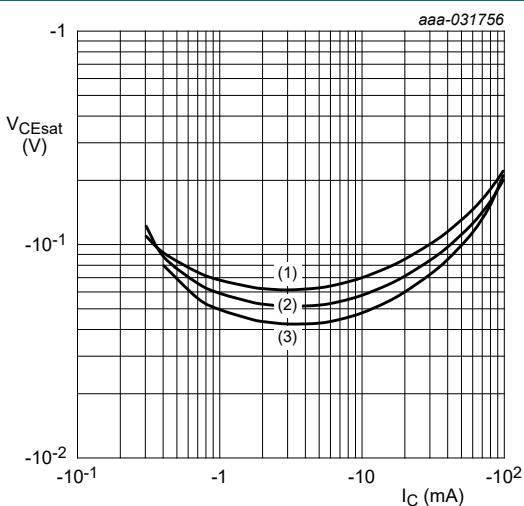
$V_{CE} = -0.3 \text{ V}$   
 (1)  $T_{amb} = -40 \text{ }^{\circ}\text{C}$   
 (2)  $T_{amb} = 25 \text{ }^{\circ}\text{C}$   
 (3)  $T_{amb} = 100 \text{ }^{\circ}\text{C}$

Fig. 35. NHUMD9, 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. NHUMD9, 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. NHUMD9, TR2 (PNP): Collector-emitter saturation voltage as a function of collector current; typical values

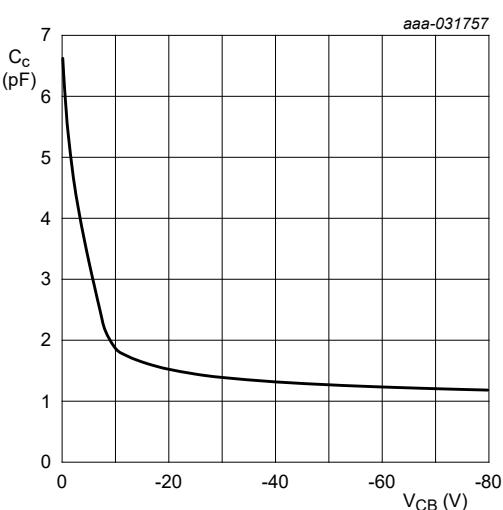
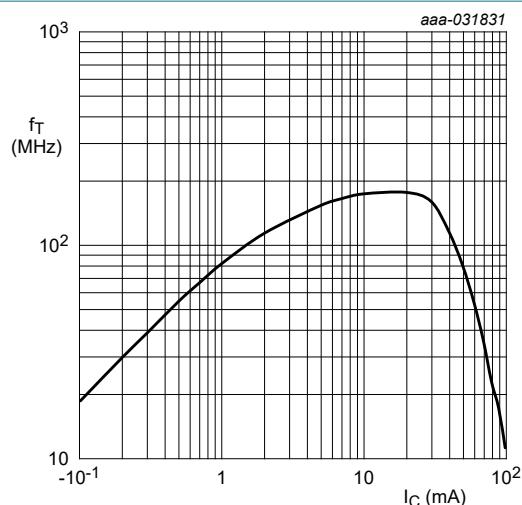


Fig. 38. NHUMD9, TR2 (PNP): Collector capacitance as a function of collector-base voltage; typical values

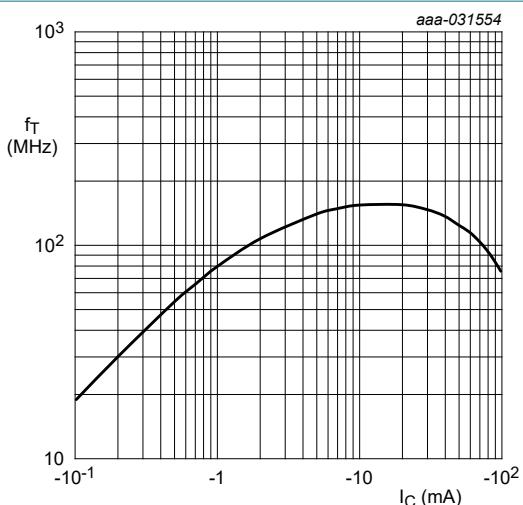


$f = 100$  MHz

$V_{CE} = 5$  V

$T_{amb} = 25$  °C

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



$f = 100$  MHz

$V_{CE} = -5$  V

$T_{amb} = 25$  °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)

$$R1 = \frac{V(I_{I2}) - V(I_{II})}{I_{I2} - I_{II}}$$

- Calculation of bias resistor ratio (R2/R1)

$$\frac{R2}{R1} = \frac{V(I_{I4}) - V(I_{I3})}{R1 \cdot (I_{I4} - I_{I3})} - 1$$

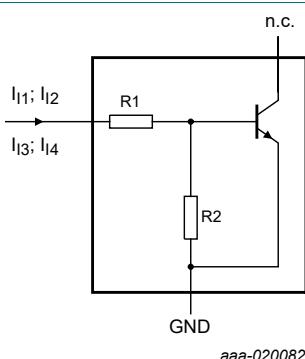
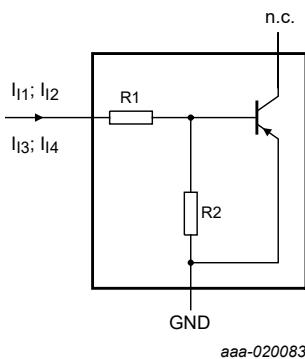


Fig. 41. TR1 (NPN): Resistor test circuit



**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>						
NHUMD10	2.2	47	1.6 mA	2.4 mA	-55 µA	-105 µA
NHUMD13	4.7	47	1.2 mA	1.8 mA	-55 µA	-105 µA
NHUMD9	10	47	0.8 mA	1.1 mA	-55 µA	-105 µA

## 12. Package outline

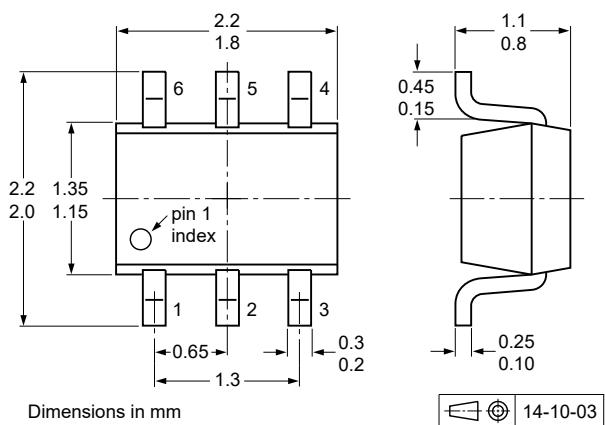


Fig. 43. Package outline SOT363 (SC-88)

## 13. Soldering

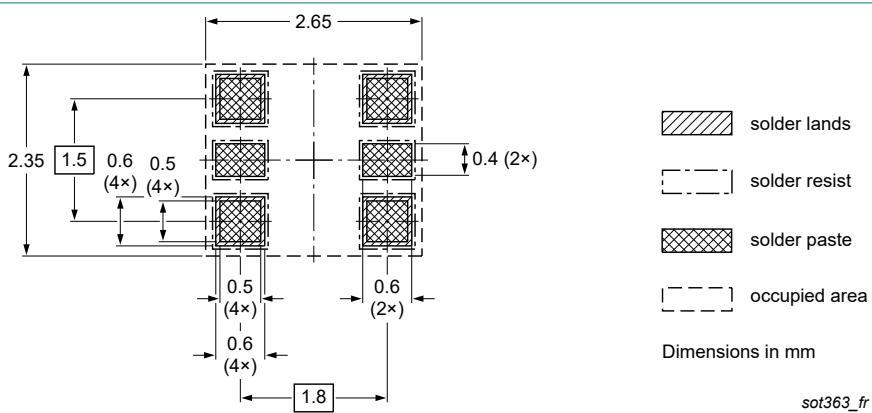


Fig. 44. Reflow soldering footprint for SOT363 (SC-88)

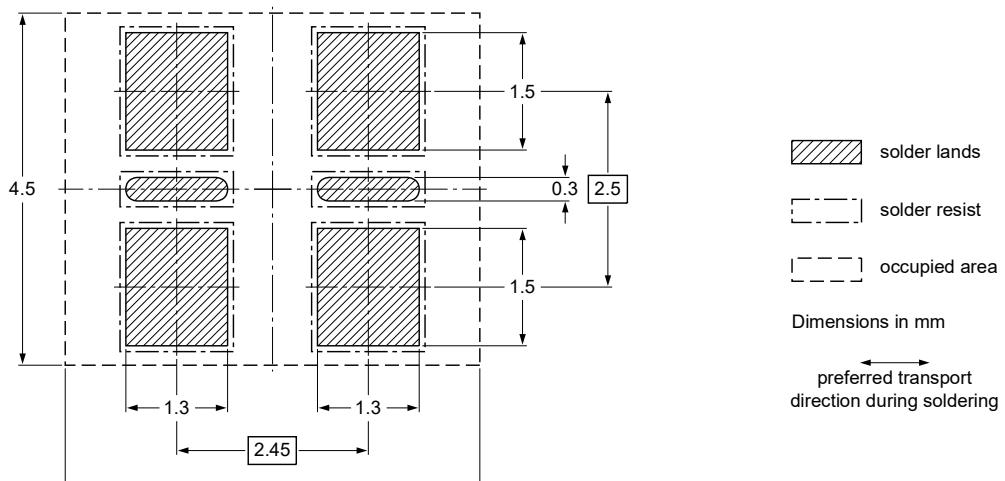


Fig. 45. Wave soldering footprint for SOT363 (SC-88)

## 14. Revision history

**Table 10. Revision history**

Data sheet ID	Release date	Data sheet status	Change notice	Supersedes
NHUMD10_13_9_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".
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For more information, please visit: <http://www.nexperia.com>

For sales office addresses, please send an email to: [salesaddresses@nexperia.com](mailto:salesaddresses@nexperia.com)

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