



# NHDTC114/124/144ET series

80 V, 100 mA NPN resistor-equipped transistors

Rev. 1 — 26 June 2020

Product data sheet

## 1. General description

NPN Resistor-Equipped Transistor (RET) family in a small SOT23 (TO-236AB) Surface-Mounted Device (SMD) plastic package.

Table 1. Product overview

Type number	R1	R2	Package		PNP complement:
	k $\Omega$	k $\Omega$	Nexperia	JEDEC	
NHDTC114ET	10	10	SOT23	TO-236AB	NHDTA114ET
NHDTC124ET	22	22			NHDTA124ET
NHDTC144ET	47	47			NHDTA144ET

## 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 series in digital applications
- Controlling IC inputs
- Switching loads

## 4. Quick reference data

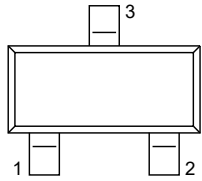
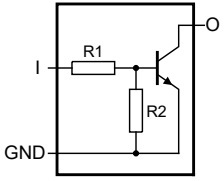
Table 2. Quick reference data

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

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
$V_{CEO}$	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	I	input (base)		
2	GND	GND (emitter)		
3	O	output (collector)		

## 6. Ordering information

Table 4. Ordering information

Type number	Package		
	Name	Description	Version
NHDTC114ET	TO-236AB	plastic surface-mounted package; 3 leads	SOT23
NHDTC124ET			
NHDTC144ET			

## 7. Marking

Table 5. Marking

Type number	Marking code [1]
NHDTC114ET	QG%
NHDTC124ET	QK%
NHDTC144ET	QM%

[1] % = placeholder for manufacturing site code

## 8. Limiting values

**Table 6. Limiting values**

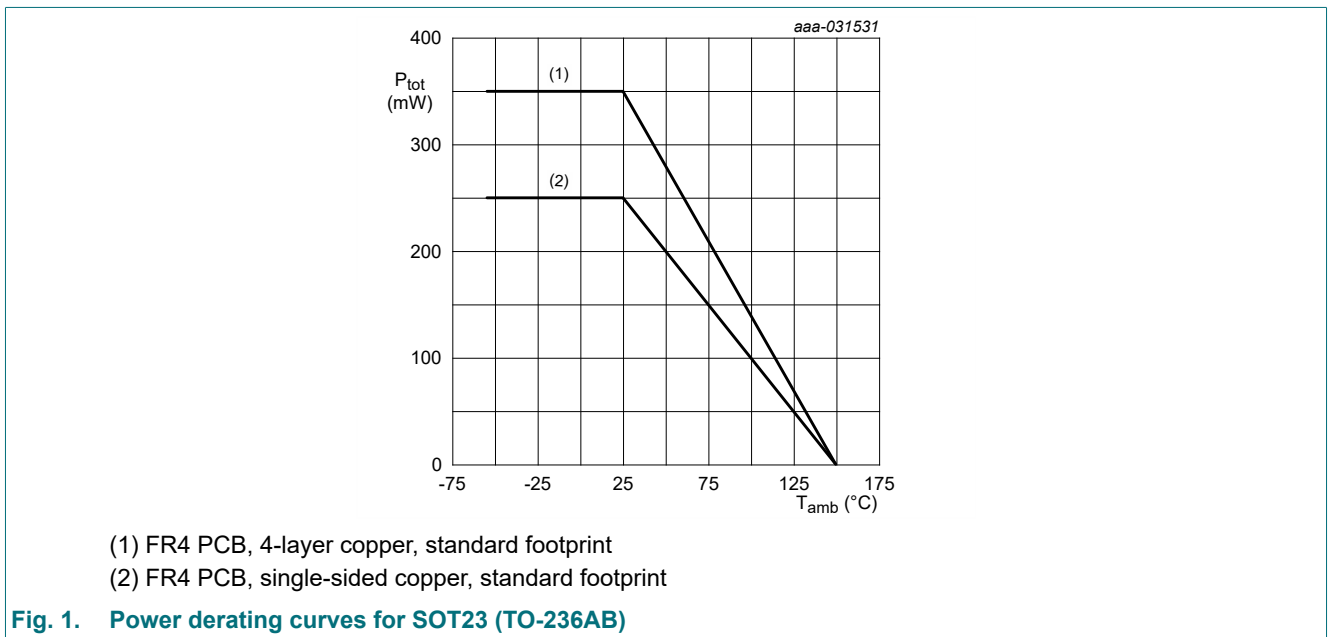
In accordance with the Absolute Maximum Rating System (IEC 60134).

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

Symbol	Parameter	Conditions	Min	Max	Unit	
$V_{CBO}$	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					
	NHDTC114ET		-10	+40	V	
	NHDTC124ET		-10	+60	V	
	NHDTC144ET		-10	+80	V	
$I_O$	output current		-	100	mA	
$P_{tot}$	total power dissipation	$T_{amb} \leq 25\text{ °C}$	[1]	-	250	mW
			[2]	-	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.

[2] Device mounted on an FR4 Printed-Circuit-Board (PCB); 4-layer copper; tin-plated and standard footprint.



## 9. Thermal characteristics

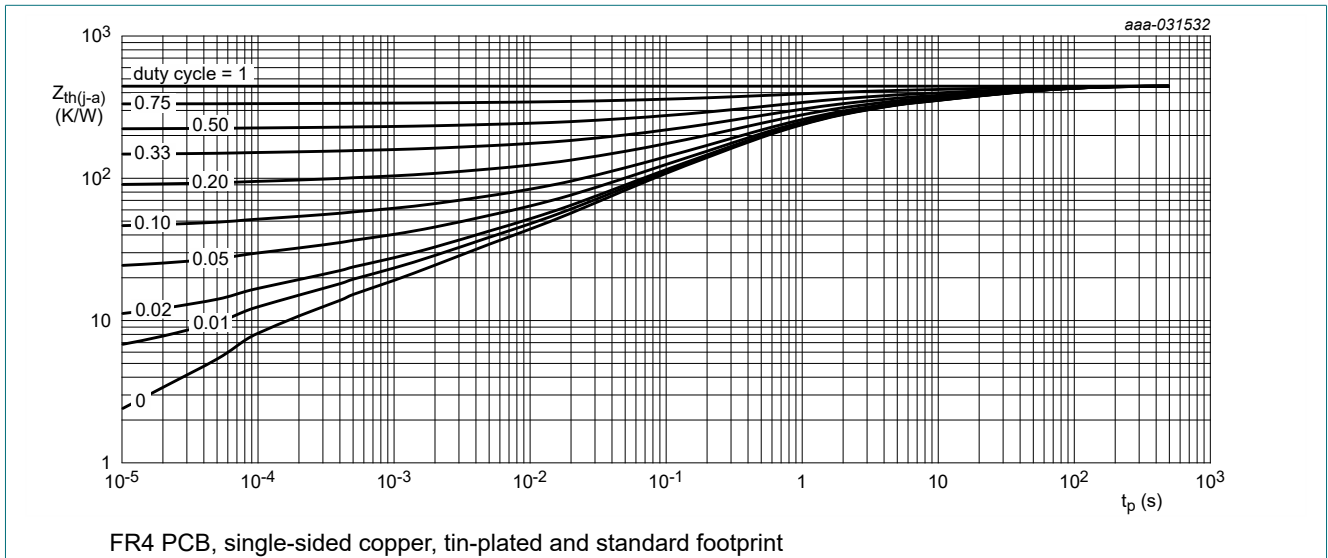
**Table 7. Thermal characteristics**

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

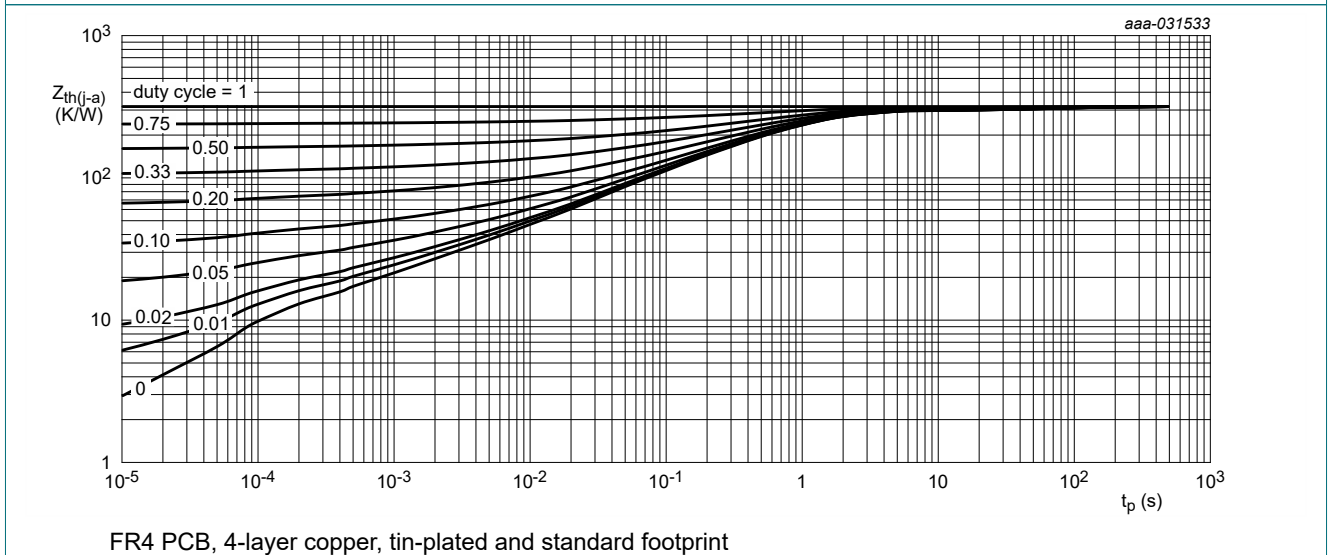
Symbol	Parameter	Conditions		Min	Typ	Max	Unit
$R_{th(j-a)}$	thermal resistance from junction to ambient	in free air	[1]	-	-	500	K/W
			[2]	-	-	358	K/W
$R_{th(j-sp)}$	thermal resistance from junction to solder point			-	-	130	K/W

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

[2] Device mounted on an FR4 Printed-Circuit Board (PCB), 4-layer copper, tin-plated and standard footprint.



**Fig. 2. Transient thermal impedance from junction to ambient as a function of pulse duration; typical values**



**Fig. 3. Transient thermal impedance from junction to ambient as a function of pulse duration; typical values**

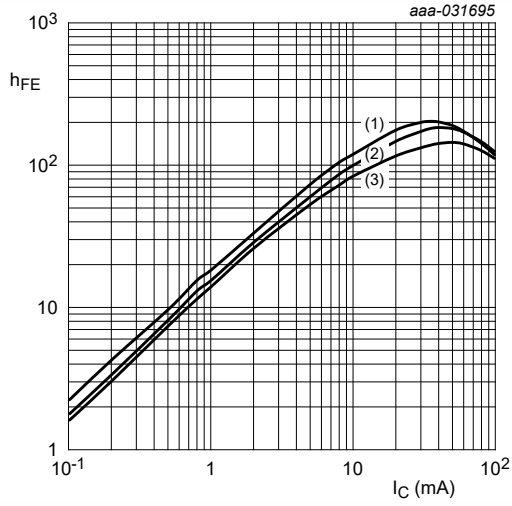
## 10. Characteristics

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

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
$V_{(BR)CBO}$	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
		$V_{CE} = 60\ \text{V}; I_B = 0\ \text{A}; T_J = 150\text{ °C}$	-	-	5	$\mu\text{A}$
$I_{EBO}$	emitter-base cut-off current					
	NHDTTC114ET	$V_{EB} = 7\ \text{V}; I_C = 0\ \text{A}$	-	-	600	$\mu\text{A}$
	NHDTTC124ET		-	-	270	$\mu\text{A}$
	NHDTTC144ET		-	-	130	$\mu\text{A}$
$h_{FE}$	DC current gain					
	NHDTTC114ET	$V_{CE} = 5\ \text{V}; I_C = 10\ \text{mA}$	50	-	-	
	NHDTTC124ET		70	-	-	
	NHDTTC144ET		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	$V_{CE} = 5\ \text{V}; I_C = 100\ \mu\text{A}$	-	1.15	0.8	V
$V_{I(on)}$	on-state input voltage					
	NHDTTC114ET	$V_{CE} = 0.3\ \text{V}; I_C = 10\ \text{mA}$	2.5	1.8	-	V
	NHDTTC124ET		3	2.3	-	V
	NHDTTC144ET		5	3.3	-	V
R1	bias resistor 1 (input)		[1]			
	NHDTTC114ET		7	10	13	k $\Omega$
	NHDTTC124ET		15.4	22	28.6	k $\Omega$
	NHDTTC144ET		33	47	61	k $\Omega$
R2/R1	bias resistor ratio	[1]	0.8	1	1.2	
$f_T$	transition frequency	$V_{CE} = 5\ \text{V}; I_C = 10\ \text{mA}; f = 100\ \text{MHz}$	[2]	-	170	MHz
$C_c$	collector capacitance	$V_{CB} = 10\ \text{V}; I_E = I_e = 0\ \text{A}; f = 1\ \text{MHz}$	-	-	2.5	pF

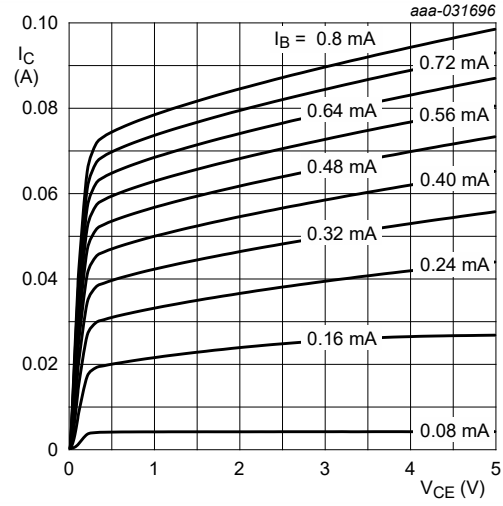
[1] See section "Test information" for resistor calculation and test conditions

[2] Characteristics of built-in transistor



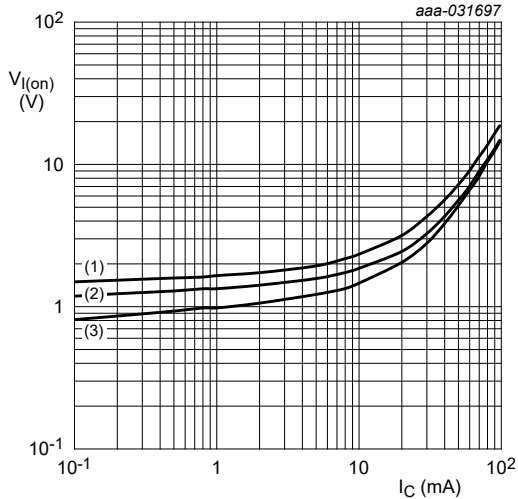
$V_{CE} = 5 \text{ V}$   
 (1)  $T_{amb} = 100 \text{ }^\circ\text{C}$   
 (2)  $T_{amb} = 25 \text{ }^\circ\text{C}$   
 (3)  $T_{amb} = -40 \text{ }^\circ\text{C}$

Fig. 4. NHDTTC114ET: DC current gain as a function of collector current; typical values



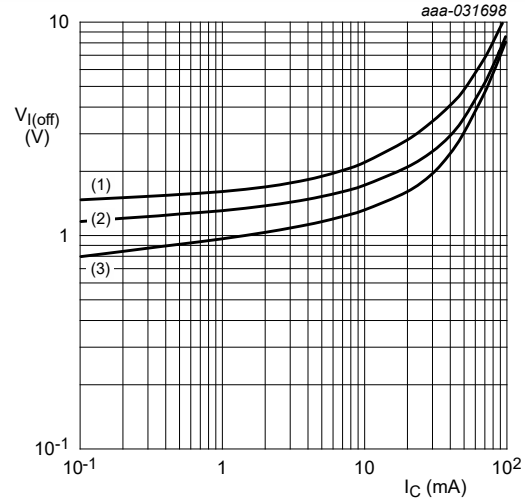
$T_{amb} = 25 \text{ }^\circ\text{C}$

Fig. 5. NHDTTC114ET: Collector current as a function of collector-emitter voltage; typical values



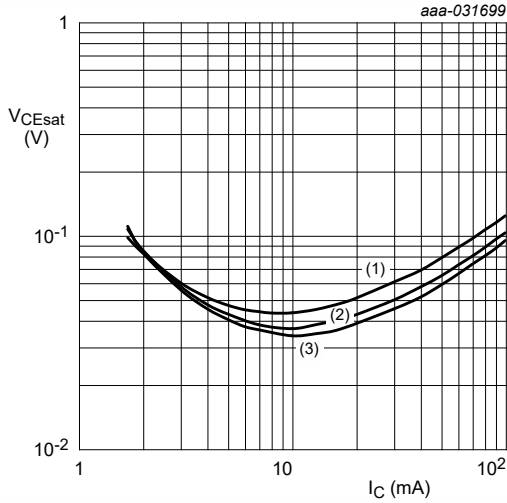
$V_{CE} = 0.3 \text{ V}$   
 (1)  $T_{amb} = -40 \text{ }^\circ\text{C}$   
 (2)  $T_{amb} = 25 \text{ }^\circ\text{C}$   
 (3)  $T_{amb} = 100 \text{ }^\circ\text{C}$

Fig. 6. NHDTTC114ET: On-state input voltage as a function of collector current; typical values



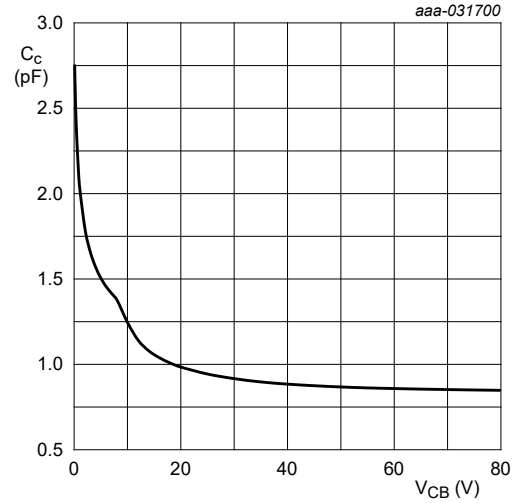
$V_{CE} = 5 \text{ V}$   
 (1)  $T_{amb} = -40 \text{ }^\circ\text{C}$   
 (2)  $T_{amb} = 25 \text{ }^\circ\text{C}$   
 (3)  $T_{amb} = 100 \text{ }^\circ\text{C}$

Fig. 7. NHDTTC114ET: Off-state input voltage as a function of collector current; typical values



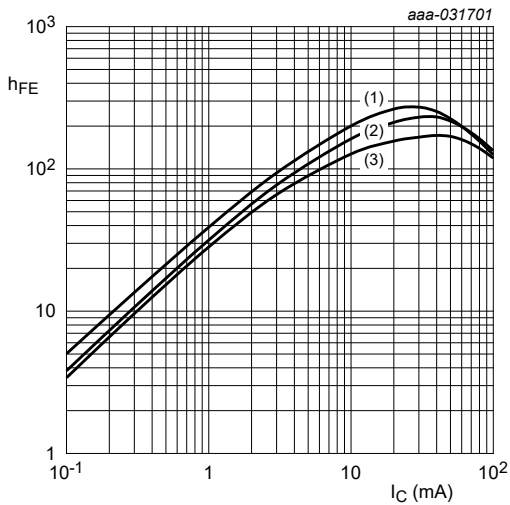
$I_C/I_B = 20$   
 (1)  $T_{amb} = 100\text{ °C}$   
 (2)  $T_{amb} = 25\text{ °C}$   
 (3)  $T_{amb} = -40\text{ °C}$

**Fig. 8. NHDTC114ET: Collector-emitter saturation voltage as a function of collector current; typical values**



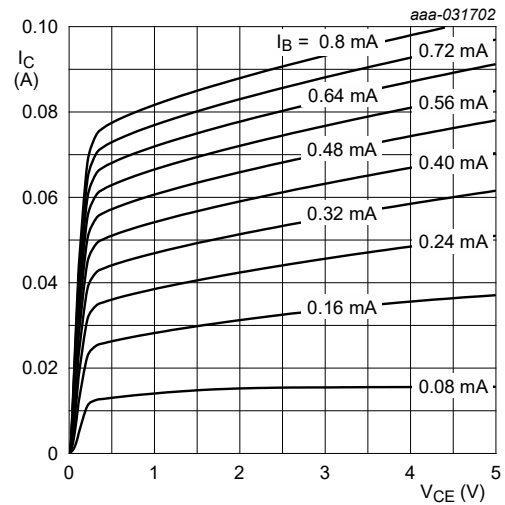
$f = 1\text{ MHz}$   
 $T_{amb} = 25\text{ °C}$

**Fig. 9. NHDTC114ET: Collector capacitance as a function of collector-base voltage; typical values**



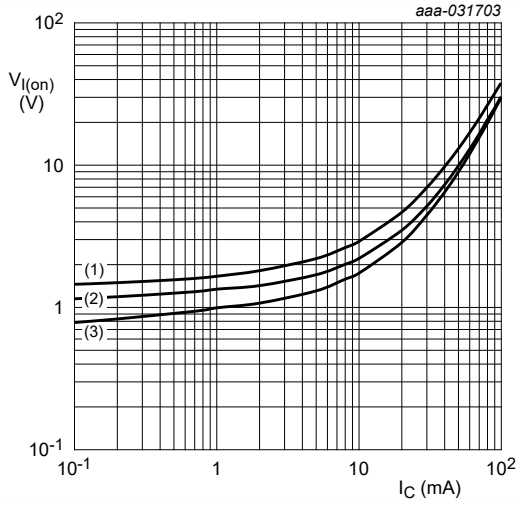
$V_{CE} = 5\text{ V}$   
 (1)  $T_{amb} = 100\text{ °C}$   
 (2)  $T_{amb} = 25\text{ °C}$   
 (3)  $T_{amb} = -40\text{ °C}$

**Fig. 10. NHDTC124ET: DC current gain as a function of collector current; typical values**



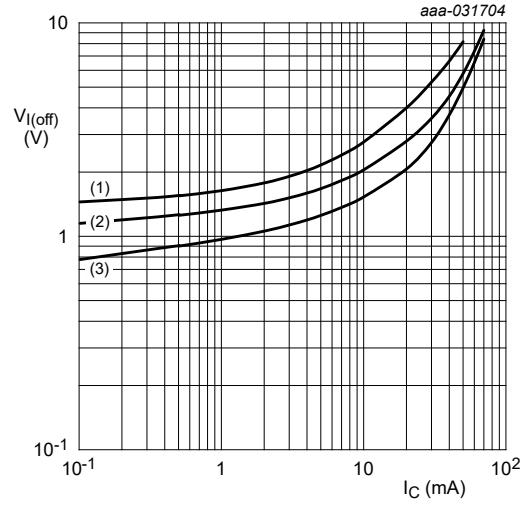
$T_{amb} = 25\text{ °C}$

**Fig. 11. NHDTC124ET: Collector current as a function of collector-emitter voltage; typical values**



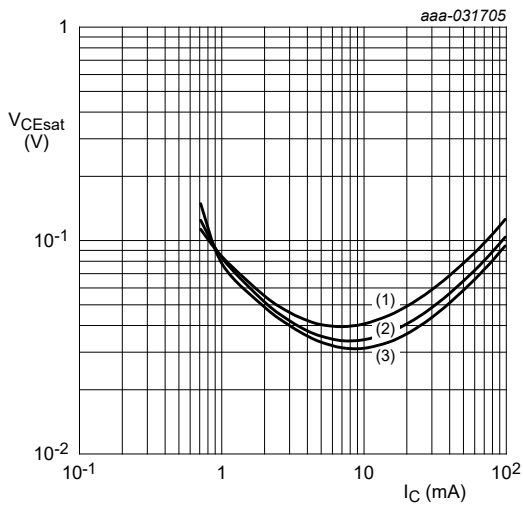
$V_{CE} = 0.3 \text{ V}$   
 (1)  $T_{amb} = -40 \text{ }^\circ\text{C}$   
 (2)  $T_{amb} = 25 \text{ }^\circ\text{C}$   
 (3)  $T_{amb} = 100 \text{ }^\circ\text{C}$

**Fig. 12. NHDTC124ET: On-state input voltage as a function of collector current; typical values**



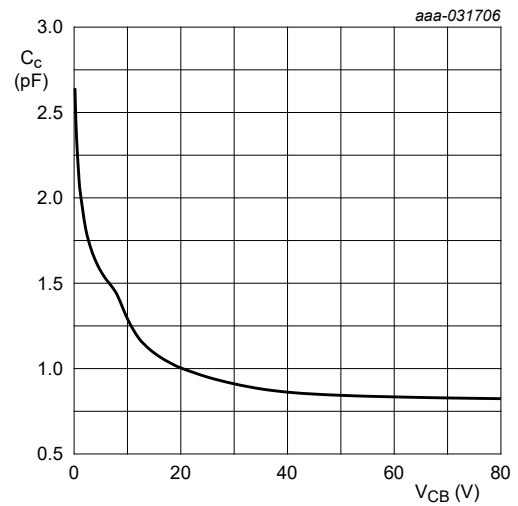
$V_{CE} = 5 \text{ V}$   
 (1)  $T_{amb} = -40 \text{ }^\circ\text{C}$   
 (2)  $T_{amb} = 25 \text{ }^\circ\text{C}$   
 (3)  $T_{amb} = 100 \text{ }^\circ\text{C}$

**Fig. 13. NHDTC124ET: 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)  $T_{amb} = -40 \text{ }^\circ\text{C}$

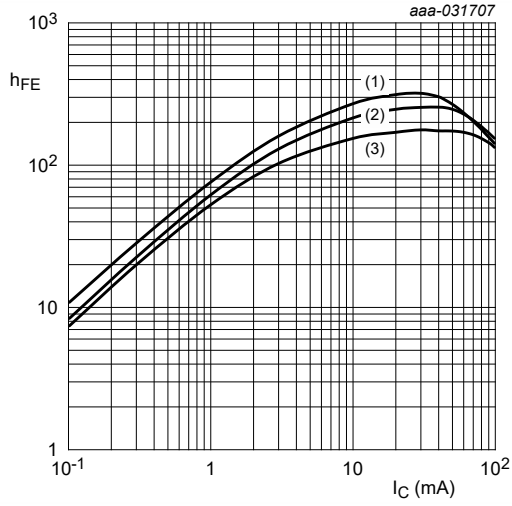
**Fig. 14. NHDTC124ET: Collector-emitter saturation voltage as a function of collector current; typical values**



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

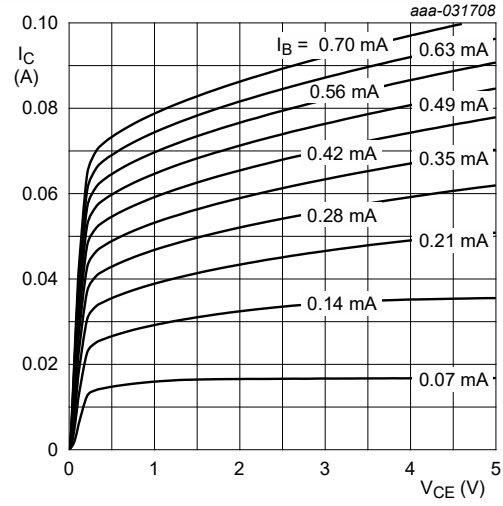
**Fig. 15. NHDTC124ET: Collector capacitance as a function of collector-base voltage; typical values**





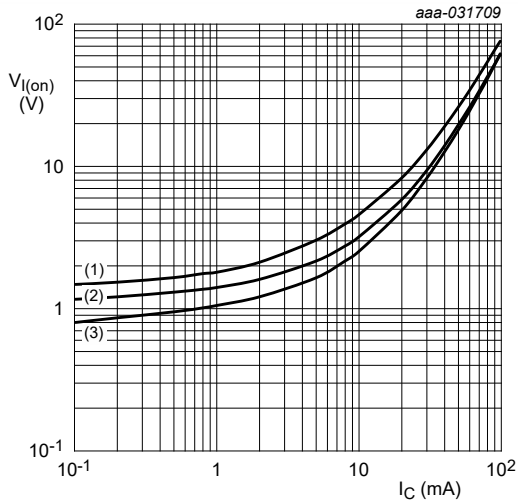
$V_{CE} = 5 \text{ V}$   
 (1)  $T_{amb} = 100 \text{ }^\circ\text{C}$   
 (2)  $T_{amb} = 25 \text{ }^\circ\text{C}$   
 (3)  $T_{amb} = -40 \text{ }^\circ\text{C}$

Fig. 16. NHDTC144ET: DC current gain as a function of collector current; typical values



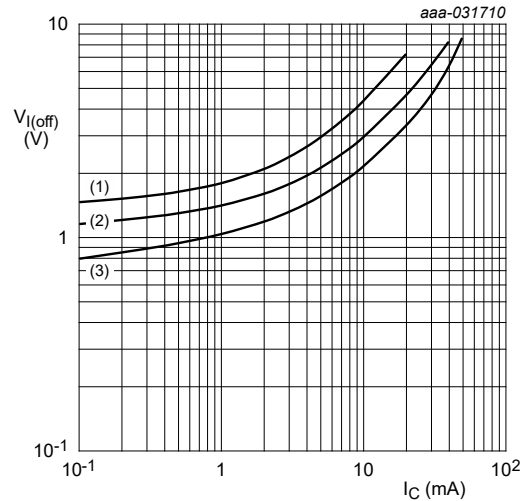
$T_{amb} = 25 \text{ }^\circ\text{C}$

Fig. 17. NHDTC144ET: Collector current as a function of collector-emitter voltage; typical values



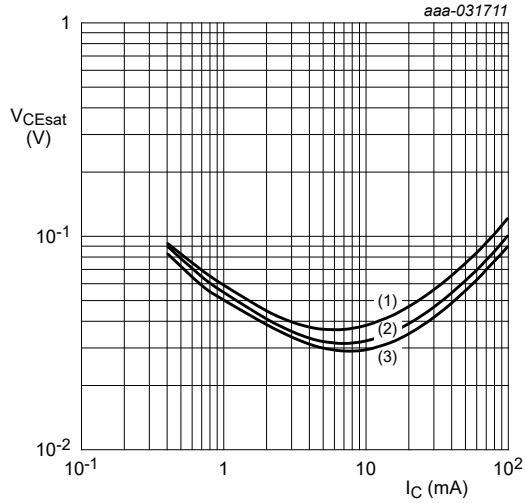
$V_{CE} = 0.3 \text{ V}$   
 (1)  $T_{amb} = -40 \text{ }^\circ\text{C}$   
 (2)  $T_{amb} = 25 \text{ }^\circ\text{C}$   
 (3)  $T_{amb} = 100 \text{ }^\circ\text{C}$

Fig. 18. NHDTC144ET: On-state input voltage as a function of collector current; typical values



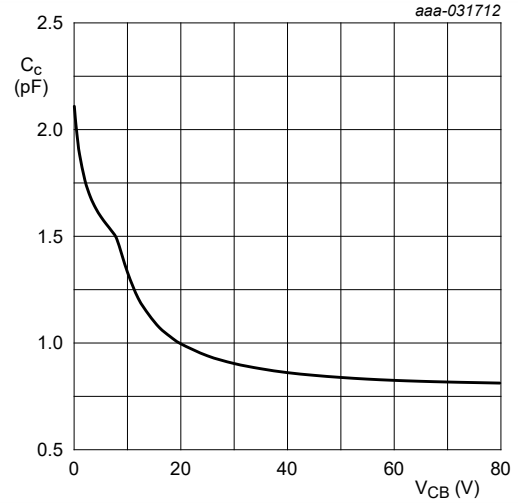
$V_{CE} = 5 \text{ V}$   
 (1)  $T_{amb} = -40 \text{ }^\circ\text{C}$   
 (2)  $T_{amb} = 25 \text{ }^\circ\text{C}$   
 (3)  $T_{amb} = 100 \text{ }^\circ\text{C}$

Fig. 19. NHDTC144ET: Off-state input voltage as a function of collector current; typical values



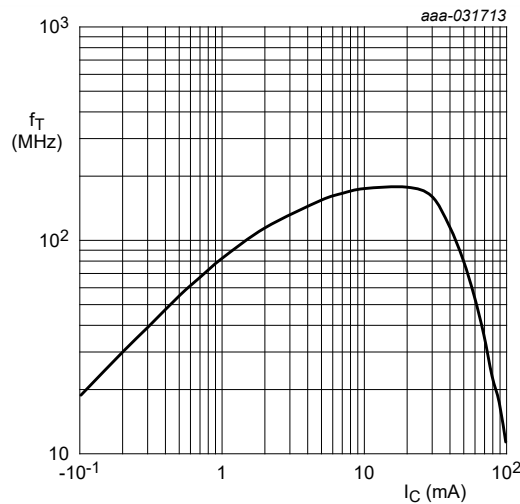
$I_C/I_B = 20$   
 (1)  $T_{amb} = 100\text{ }^\circ\text{C}$   
 (2)  $T_{amb} = 25\text{ }^\circ\text{C}$   
 (3)  $T_{amb} = -40\text{ }^\circ\text{C}$

**Fig. 20. NHDTC144ET: Collector-emitter saturation voltage as a function of collector current; typical values**



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

**Fig. 21. NHDTC144ET: Collector capacitance as a function of collector-base voltage; typical values**



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

**Fig. 22. 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)

$$R1 = \frac{V(I12) - V(I11)}{I12 - I11}$$

- Calculation of bias resistor ratio (R2/R1)

$$\frac{R2}{R1} = \frac{V(I14) - V(I13)}{R1 \cdot (I14 - I13)} - 1$$

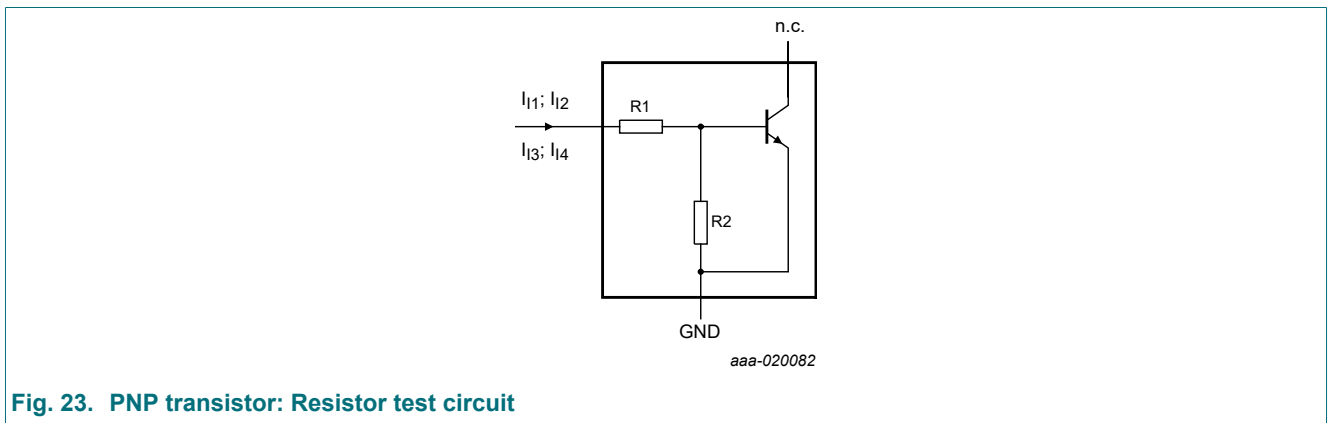


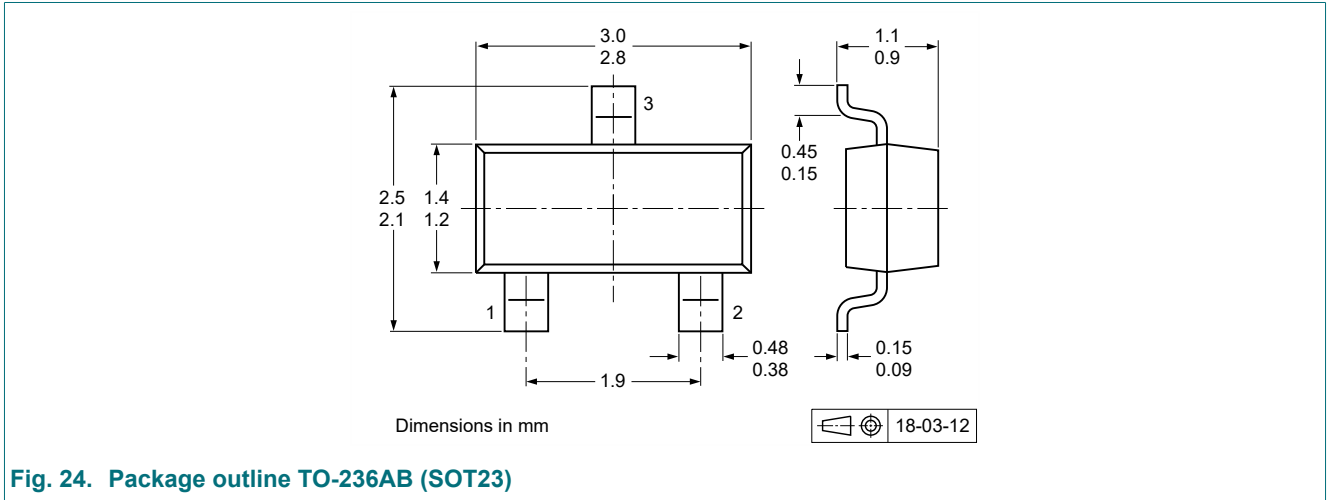
Fig. 23. PNP transistor: Resistor test circuit

### Resistor test conditions

Table 9. Resistor test conditions

Type number	R1 (kΩ)	R2 (kΩ)	Test conditions			
			I <sub>11</sub>	I <sub>12</sub>	I <sub>13</sub>	I <sub>14</sub>
NHDTC114ET	10	10	800 μA	1.1 mA	-350 μA	-450 μA
NHDTC124ET	22	22	550 μA	750 μA	-150 μA	-230 μA
NHDTC144ET	47	47	250 μA	350 μA	-55 μA	-105 μA

**12. Package outline**



**Fig. 24. Package outline TO-236AB (SOT23)**

13. Soldering

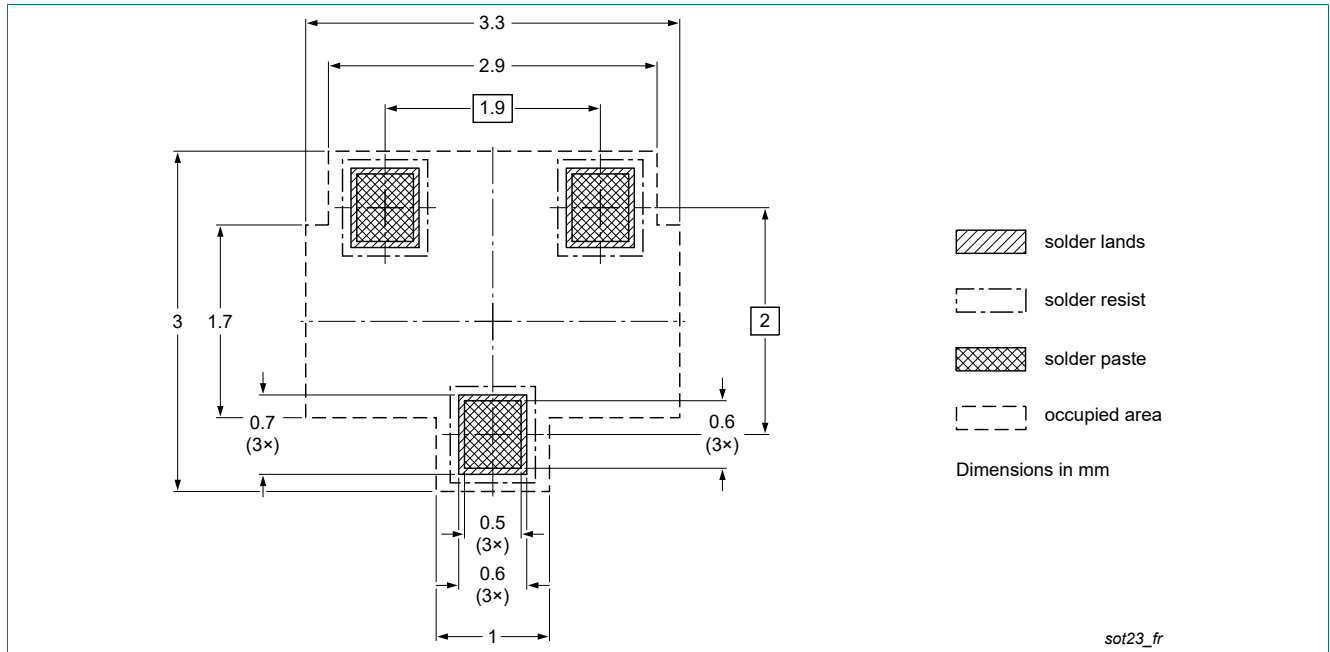


Fig. 25. Reflow soldering footprint for TO-236AB (SOT23)

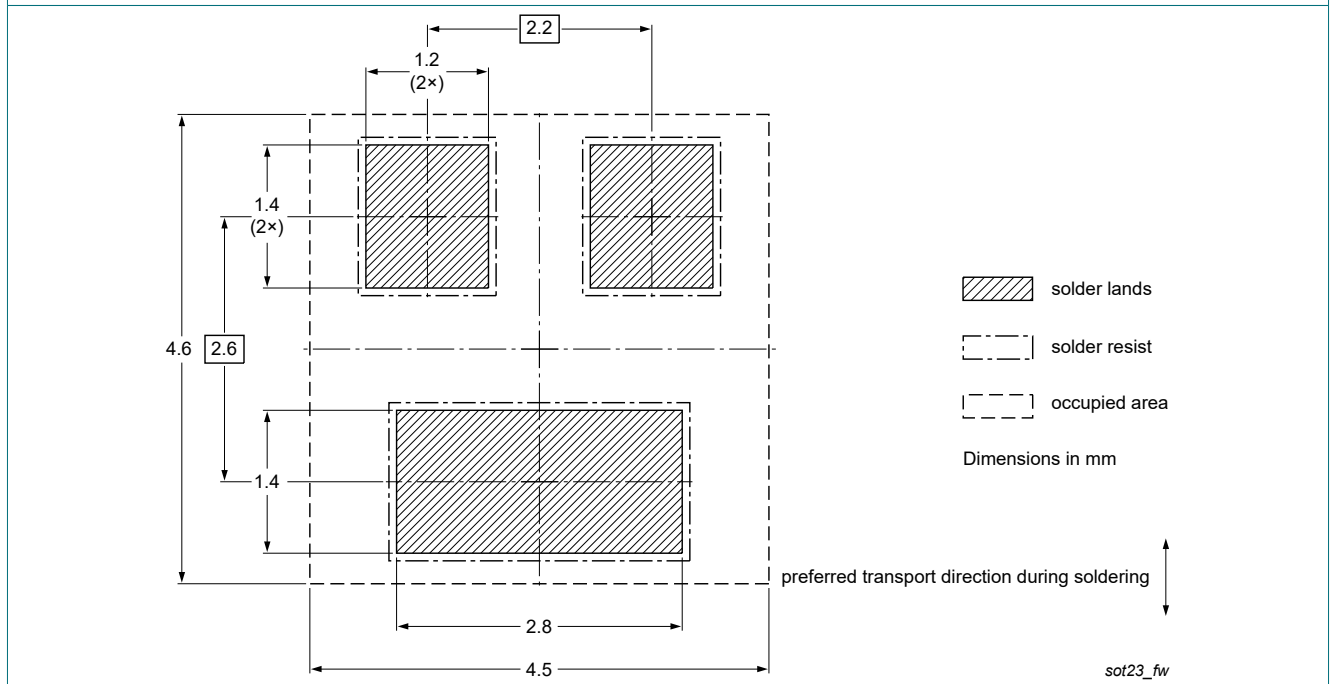


Fig. 26. Wave soldering footprint for TO-236AB (SOT23)

## 14. Revision history

Table 10. Revision history

Data sheet ID	Release date	Data sheet status	Change notice	Supersedes
NHDTTC114_124_144ET_SER v.1	20200626	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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