



# NHDTC123JU/143ZU/114YU series

80 V, 100 mA NPN resistor-equipped transistors

Rev. 1 — 17 July 2020

Product data sheet

## 1. General description

NPN Resistor-Equipped Transistor (RET) family in a very small SOT323 (SC-70) Surface-Mounted Device (SMD) plastic package.

Table 1. Product overview

| Type number | R1         | R2         | Package  |       | PNP complement: |
|-------------|------------|------------|----------|-------|-----------------|
|             | k $\Omega$ | k $\Omega$ | Nexperia | JEITA |                 |
| NHDTC123JU  | 2.2        | 47         | SOT323   | SC-70 | NHDTA123JU      |
| NHDTC143ZU  | 4.7        | 47         |          |       | NHDTA143ZU      |
| NHDTC114YU  | 10         | 47         |          |       | NHDTA114YU      |

## 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

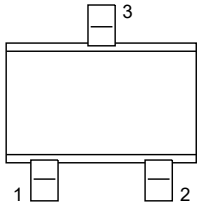
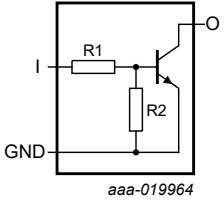
Table 2. Quick reference data

$T_{amb} = 25\text{ }^{\circ}\text{C}$  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 |
| NHDTC123JU  | SC-70   | plastic surface-mounted package; 3 leads | SOT323  |
| NHDTC143ZU  |         |                                          |         |
| NHDTC114YU  |         |                                          |         |

7. Marking

Table 5. Marking

| Type number | Marking code [1] |
|-------------|------------------|
| NHDTC123JU  | 5P%              |
| NHDTC143ZU  | 5R%              |
| NHDTC114YU  | 5N%              |

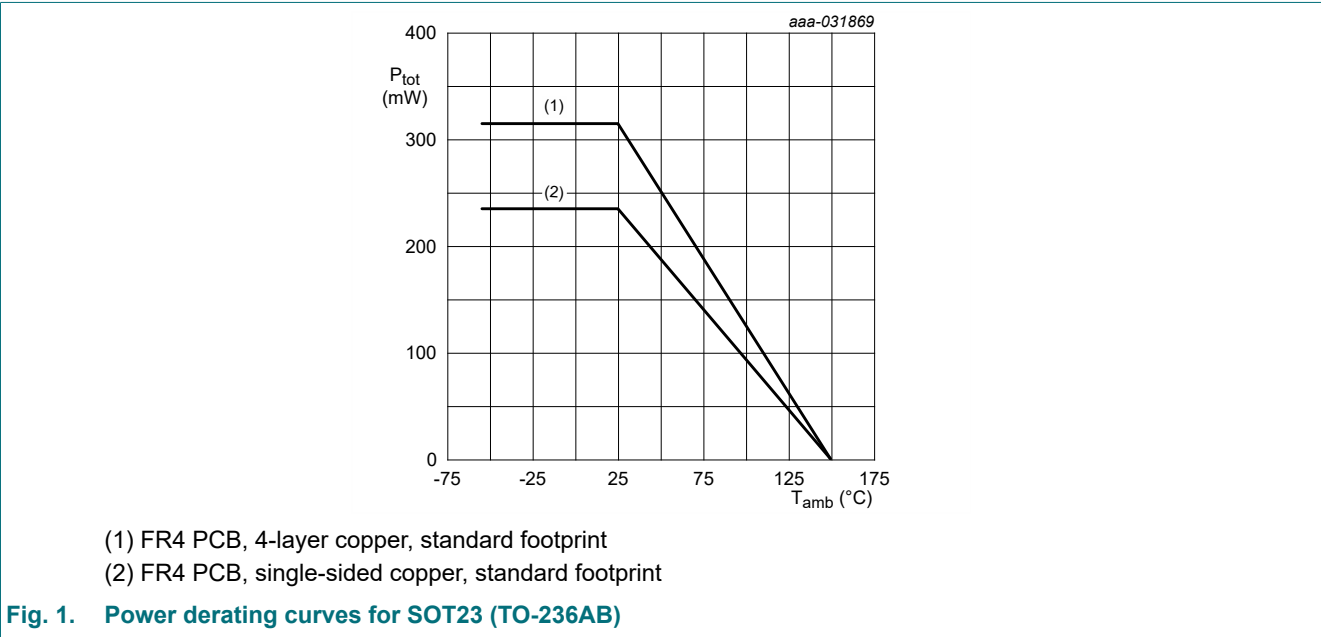
[1] % = placeholder for manufacturing site code

8. Limiting values

Table 6. Limiting values  
In accordance with the Absolute Maximum Rating System (IEC 60134).  
 $T_{amb} = 25\text{ }^{\circ}\text{C}$  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                                | -   | 7   | V                  |
| $V_I$     | input voltage             |                                               |     |     |                    |
|           | NHDTC123JU                |                                               | -7  | +20 | V                  |
|           | NHDTC143ZU                |                                               | -7  | +30 | V                  |
|           | NHDTC114YU                |                                               | -7  | +40 | V                  |
| $I_O$     | output current            |                                               | -   | 100 | mA                 |
| $P_{tot}$ | total power dissipation   | $T_{amb} \leq 25\text{ }^{\circ}\text{C}$ [1] | -   | 235 | mW                 |
|           |                           | [2]                                           | -   | 315 | mW                 |
| $T_j$     | junction temperature      |                                               | -   | 150 | $^{\circ}\text{C}$ |
| $T_{amb}$ | ambient temperature       |                                               | -55 | 150 | $^{\circ}\text{C}$ |
| $T_{stg}$ | storage temperature       |                                               | -65 | 150 | $^{\circ}\text{C}$ |

- [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.



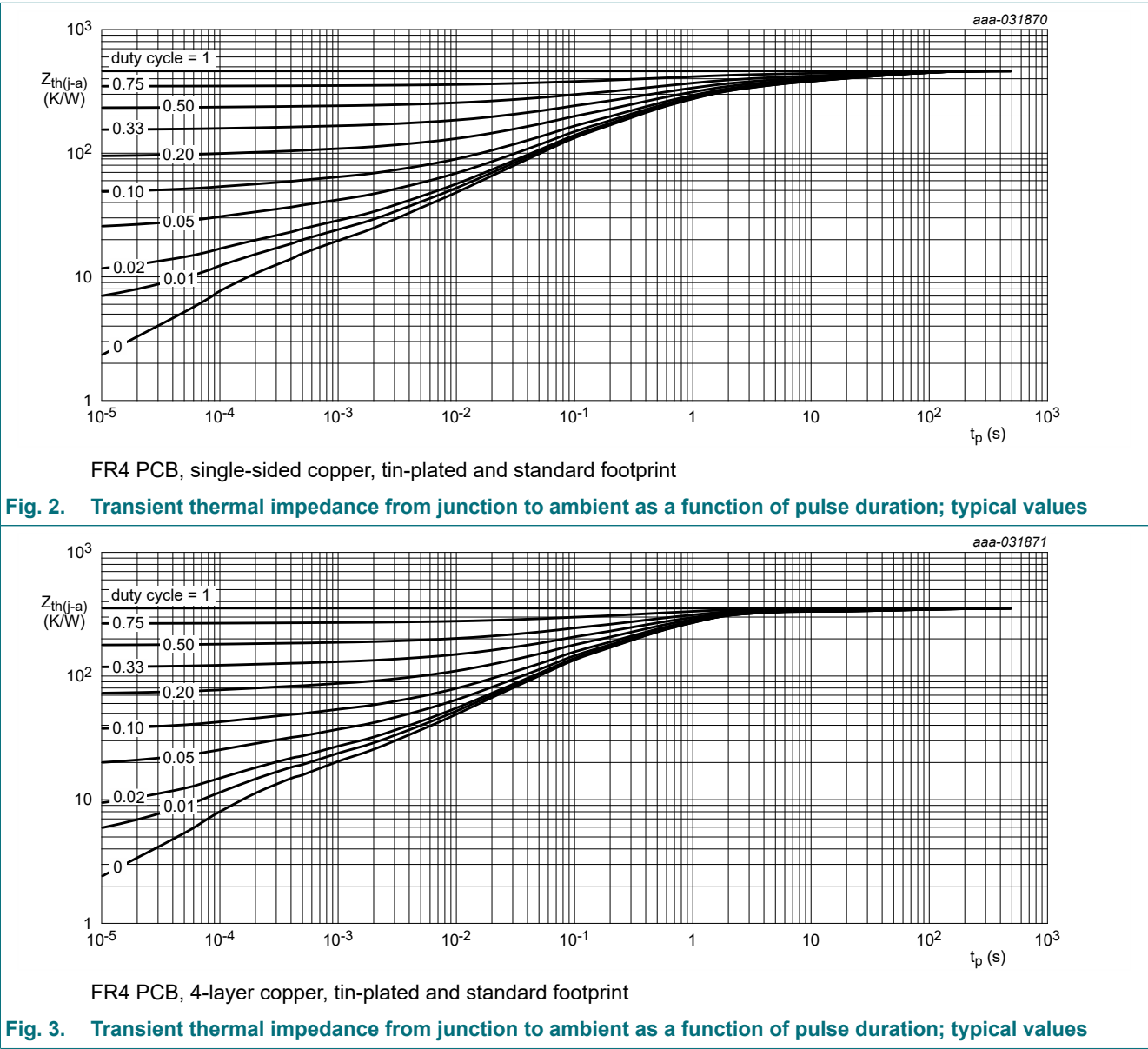
9. Thermal characteristics

Table 7. Thermal characteristics

T<sub>amb</sub> = 25 °C unless otherwise specified.

| Symbol                | Parameter                                        | Conditions  |     | Min | Typ | Max | Unit |
|-----------------------|--------------------------------------------------|-------------|-----|-----|-----|-----|------|
| R <sub>th(j-a)</sub>  | thermal resistance from junction to ambient      | in free air | [1] | -   | -   | 532 | K/W  |
|                       |                                                  |             | [2] | -   | -   | 397 | K/W  |
| R <sub>th(j-sp)</sub> | thermal resistance from junction to solder point |             |     | -   | -   | 150 | 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.



10. Characteristics

Table 8. Characteristics

T<sub>amb</sub> = 25 °C unless otherwise specified.

| Symbol               | Parameter                            | Conditions                                                               | Min  | Typ  | Max  | Unit |
|----------------------|--------------------------------------|--------------------------------------------------------------------------|------|------|------|------|
| V <sub>(BR)CBO</sub> | collector-base breakdown voltage     | I <sub>C</sub> = 100 μA; I <sub>E</sub> = 0 A                            | 80   | -    | -    | V    |
| V <sub>(BR)CEO</sub> | collector-emitter breakdown voltage  | I <sub>C</sub> = 2 mA; I <sub>B</sub> = 0 A                              | 80   | -    | -    | V    |
| I <sub>CBO</sub>     | collector-base cut-off current       | V <sub>CB</sub> = 80 V; I <sub>E</sub> = 0 A                             | -    | -    | 100  | nA   |
| I <sub>CEO</sub>     | collector-emitter cut-off current    | V <sub>CE</sub> = 60 V; I <sub>B</sub> = 0 A                             | -    | -    | 100  | nA   |
|                      |                                      | V <sub>CE</sub> = 60 V; I <sub>B</sub> = 0 A; T <sub>J</sub> = 150 °C    | -    | -    | 5    | μA   |
| I <sub>EBO</sub>     | emitter-base cut-off current         |                                                                          |      |      |      |      |
|                      | NHDTC123JU                           | V <sub>EB</sub> = 7 V; I <sub>C</sub> = 0 A                              | -    | -    | 270  | μA   |
|                      | NHDTC143ZU                           |                                                                          | -    | -    | 260  | μA   |
|                      | NHDTC114YU                           |                                                                          | -    | -    | 230  | μA   |
| h <sub>FE</sub>      | DC current gain                      | V <sub>CE</sub> = 5 V; I <sub>C</sub> =10 mA                             | 100  | -    | -    |      |
| V <sub>CEsat</sub>   | collector-emitter saturation voltage | I <sub>C</sub> = 10 mA; I <sub>B</sub> = 0.5 mA                          | -    | -    | 100  | mV   |
| V <sub>I(off)</sub>  | off-state input voltage              |                                                                          |      |      |      |      |
|                      | NHDTC123JU                           | V <sub>CE</sub> = 5 V ; I <sub>C</sub> = 100 μA                          | -    | 595  | 500  | mV   |
|                      | NHDTC143ZU                           |                                                                          | -    | 625  | 500  | mV   |
|                      | NHDTC114YU                           |                                                                          | -    | 690  | 500  | mV   |
| V <sub>I(on)</sub>   | on-state input voltage               |                                                                          |      |      |      |      |
|                      | NHDTC123JU                           | V <sub>CE</sub> = 0.3 V ; I <sub>C</sub> = 10 mA                         | 1.2  | 0.81 | -    | V    |
|                      | NHDTC143ZU                           |                                                                          | 1.4  | 0.95 | -    | V    |
|                      | NHDTC114YU                           |                                                                          | 1.6  | 1.22 | -    | V    |
| R1                   | bias resistor 1 (input)              |                                                                          |      |      |      |      |
|                      | NHDTC123JU                           | [1]                                                                      | 1.54 | 2.2  | 2.86 | kΩ   |
|                      | NHDTC143ZU                           |                                                                          | 3.3  | 4.7  | 6.1  | kΩ   |
|                      | NHDTC114YU                           |                                                                          | 7    | 10   | 13   | kΩ   |
| R2/R1                | bias resistor ratio                  |                                                                          |      |      |      |      |
|                      | NHDTC123JU                           | [1]                                                                      | 17   | 21   | 26   |      |
|                      | NHDTC143ZU                           |                                                                          | 8    | 10   | 12   |      |
|                      | NHDTC114YU                           |                                                                          | 3.7  | 4.7  | 5.7  |      |
| f <sub>T</sub>       | transition frequency                 | V <sub>CE</sub> = 5 V; I <sub>C</sub> = 10 mA; f = 100 MHz               | [2]  | 170  | -    | MHz  |
| C <sub>c</sub>       | collector capacitance                | V <sub>CB</sub> = 10 V; I <sub>E</sub> = i <sub>e</sub> = 0 A; f = 1 MHz | -    | -    | 2.5  | pF   |

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

[2] Characteristics of built-in transistor

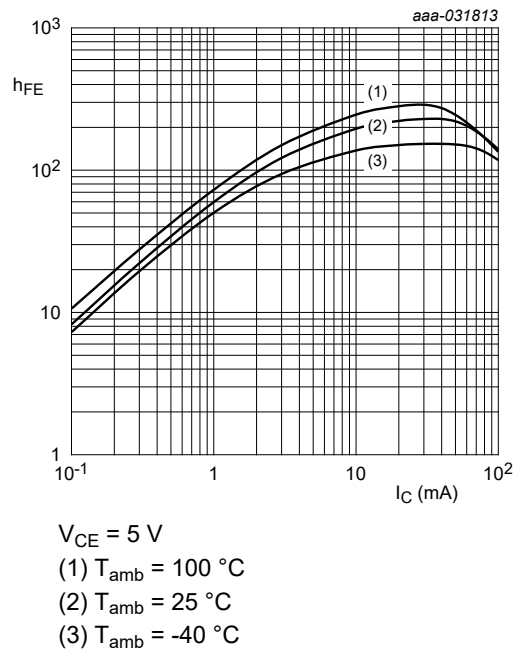


Fig. 4. NHDTC123JU: DC current gain as a function of collector current; typical values

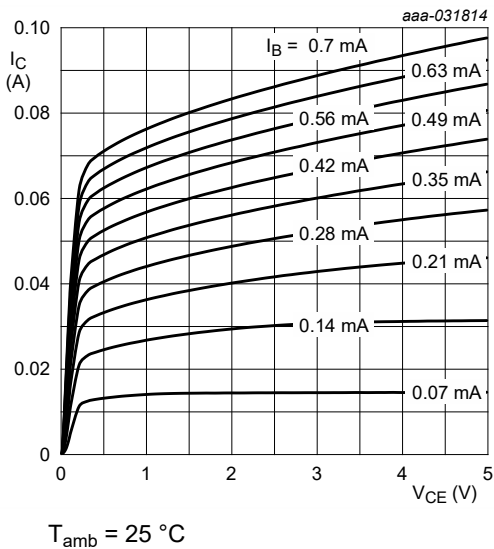


Fig. 5. NHDTC123JU: Collector current as a function of collector-emitter voltage; typical values

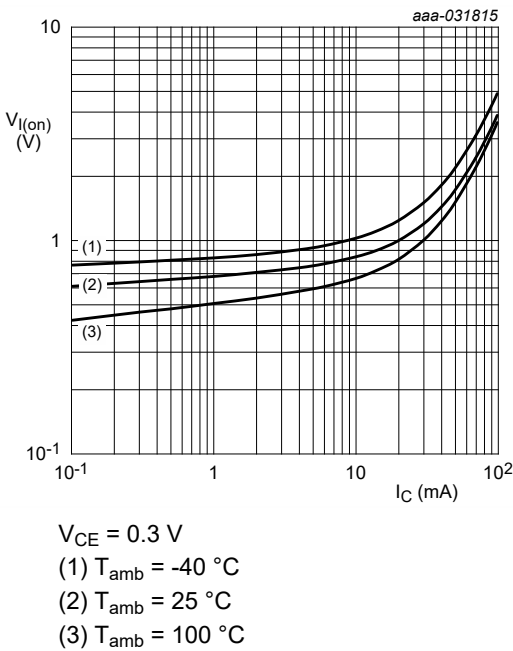


Fig. 6. NHDTC123JU: On-state input voltage as a function of collector current; typical values

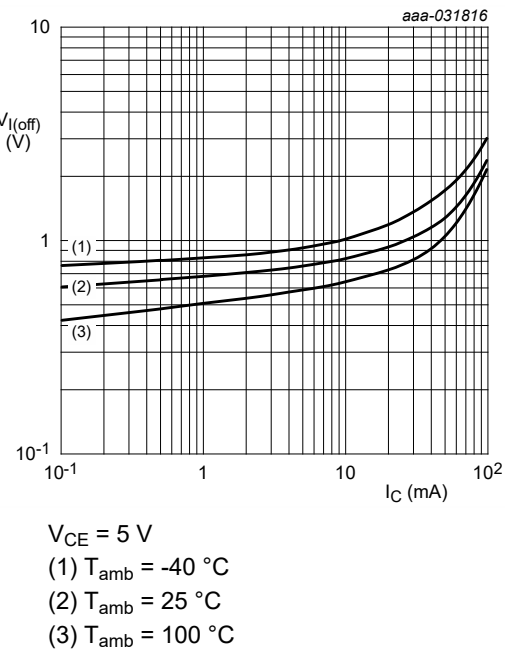


Fig. 7. NHDTC123JU: Off-state input voltage as a function of collector current; typical values

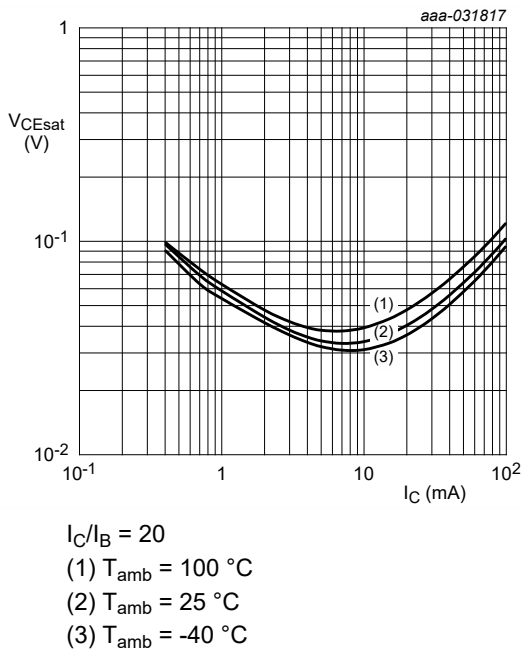


Fig. 8. NHDTC123JU: Collector-emitter saturation voltage as a function of collector current; typical values

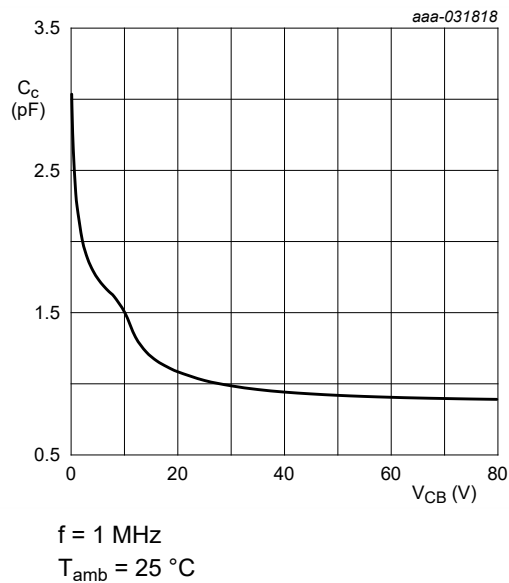


Fig. 9. NHDTC123JU: Collector capacitance as a function of collector-base voltage; typical values

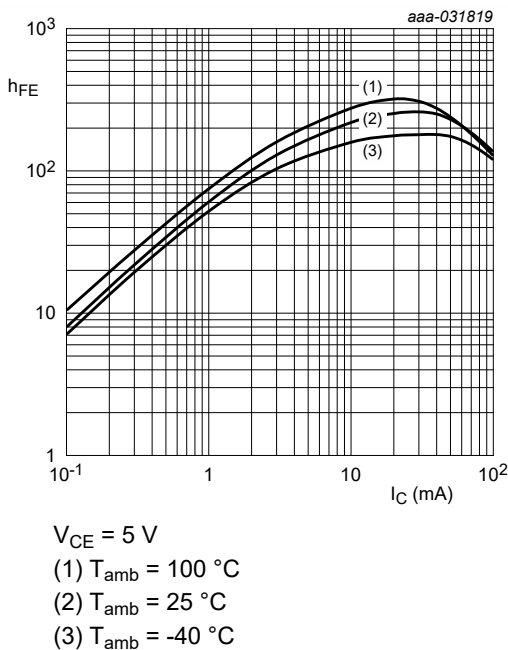


Fig. 10. NHDTC143ZU: DC current gain as a function of collector current; typical values

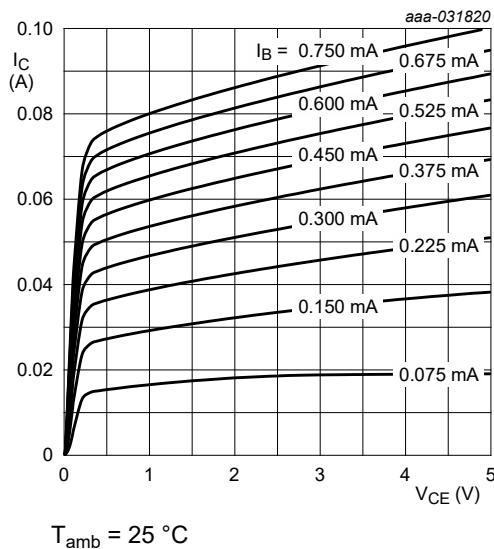


Fig. 11. NHDTC143ZU: Collector current as a function of collector-emitter voltage; typical values

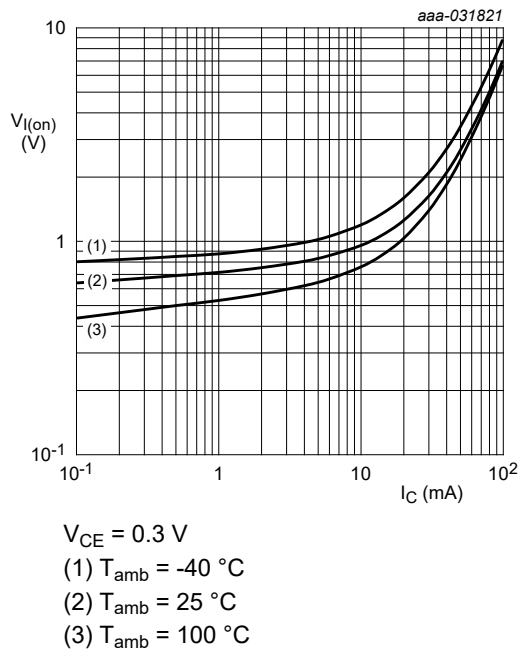


Fig. 12. NHDTC143ZU: On-state input voltage as a function of collector current; typical values

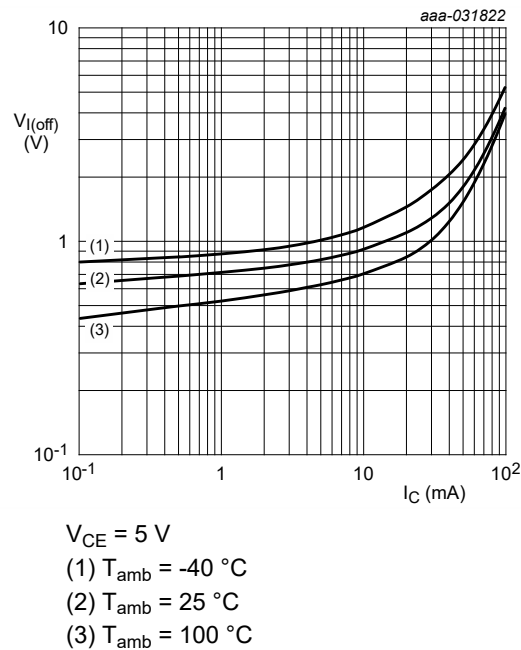


Fig. 13. NHDTC143ZU: Off-state input voltage as a function of collector current; typical values

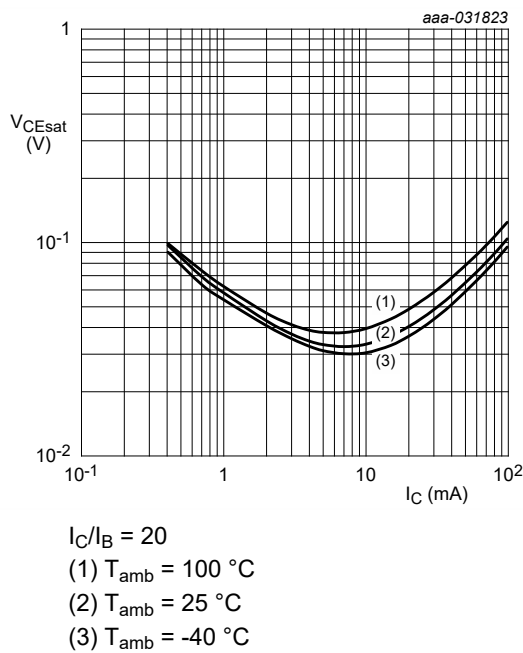


Fig. 14. NHDTC143ZU: Collector-emitter saturation voltage as a function of collector current; typical values

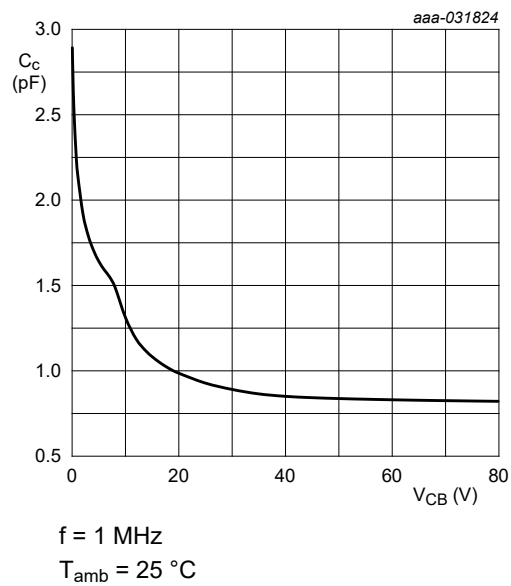


Fig. 15. NHDTC143ZU: Collector capacitance as a function of collector-base voltage; typical values

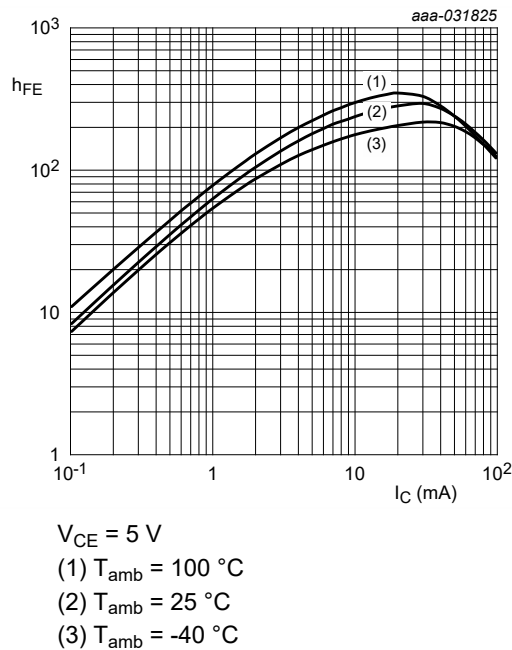


Fig. 16. NHDTC114YU: DC current gain as a function of collector current; typical values

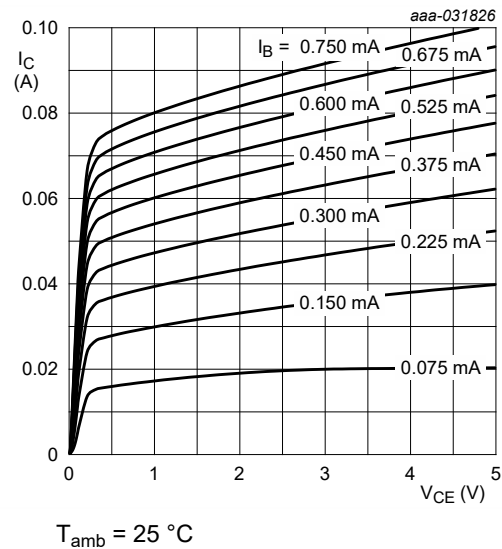


Fig. 17. NHDTC114YU: Collector current as a function of collector-emitter voltage; typical values

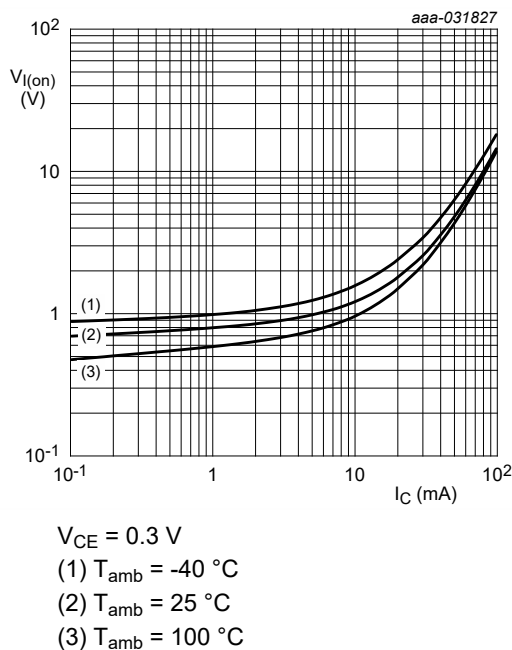


Fig. 18. NHDTC114YU: On-state input voltage as a function of collector current; typical values

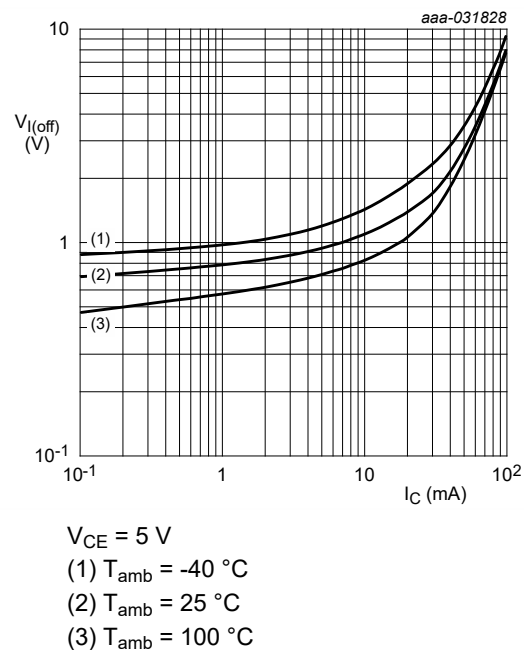


Fig. 19. NHDTC114YU: Off-state input voltage as a function of collector current; typical values

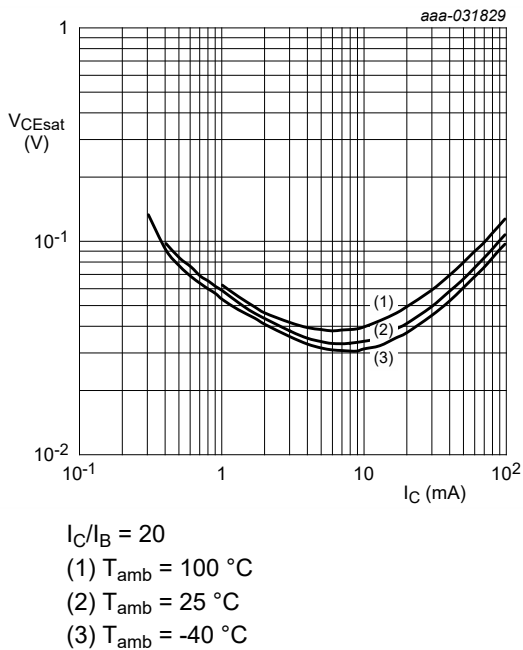


Fig. 20. NHDTC114YU: Collector-emitter saturation voltage as a function of collector current; typical values

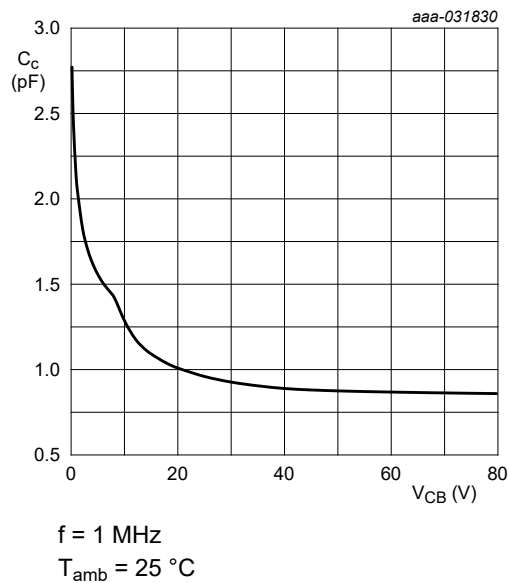
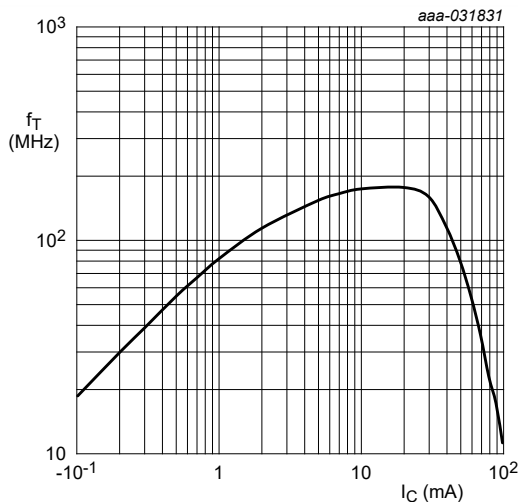


Fig. 21. NHDTC114YU: Collector capacitance as a function of collector-base voltage; typical values



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

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)
$$R1 = \frac{V(I_{I2}) - V(I_{I1})}{I_{I2} - I_{I1}}$$
- Calculation of bias resistor ratio (R2/R1)
$$\frac{R2}{R1} = \frac{V(I_{I4}) - V(I_{I3})}{R1 \cdot (I_{I4} - I_{I3})} - 1$$

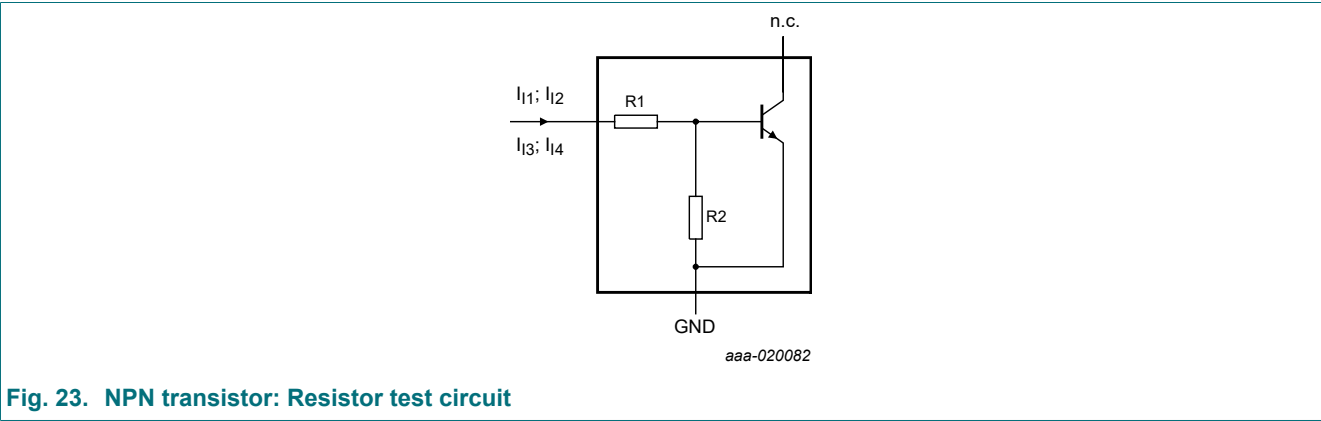


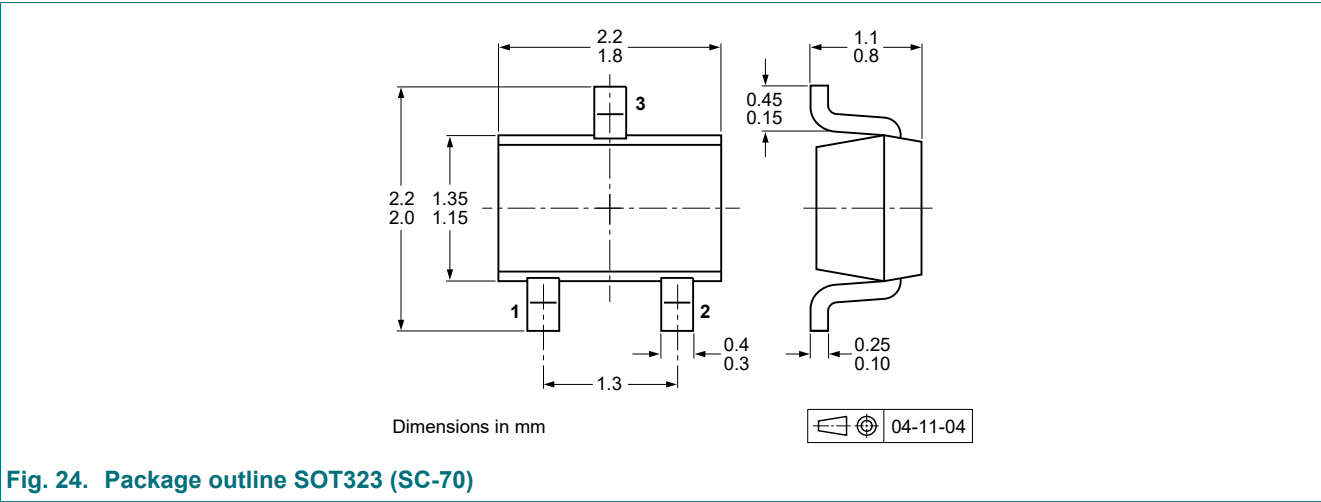
Fig. 23. NPN transistor: Resistor test circuit

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> |
| NHDTC123JU  | 2.2     | 47      | 1.6 mA          | 2.4 mA          | -55 μA          | -105 μA         |
| NHDTC143ZU  | 4.7     | 47      | 1.2 mA          | 1.8 mA          | -55 μA          | -105 μA         |
| NHDTC114YU  | 10      | 47      | 0.8 mA          | 1.1 mA          | -55 μA          | -105 μA         |

12. Package outline



13. Soldering

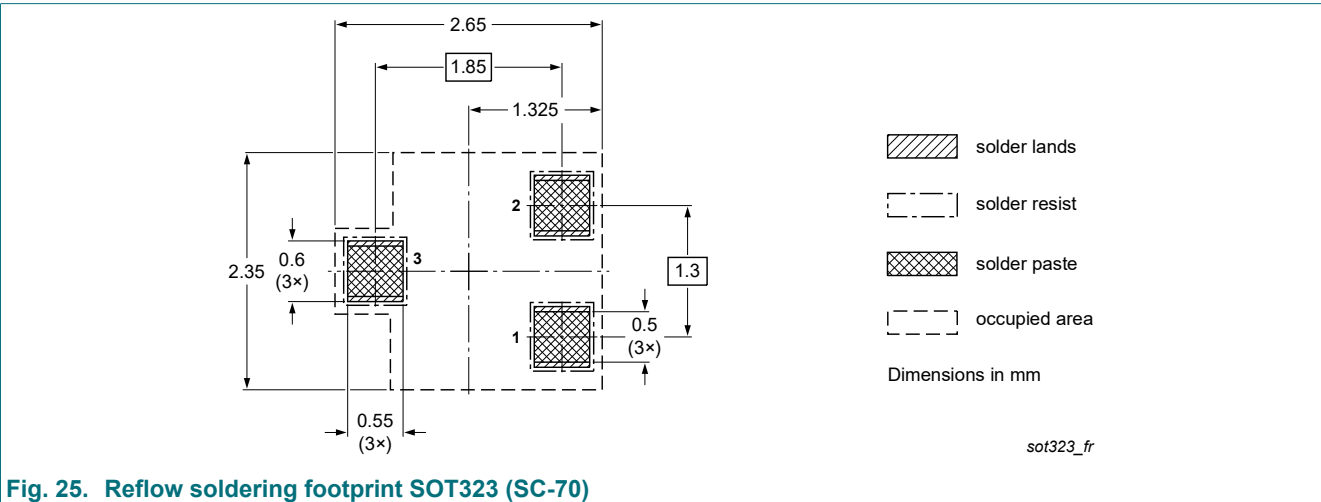


Fig. 25. Reflow soldering footprint SOT323 (SC-70)

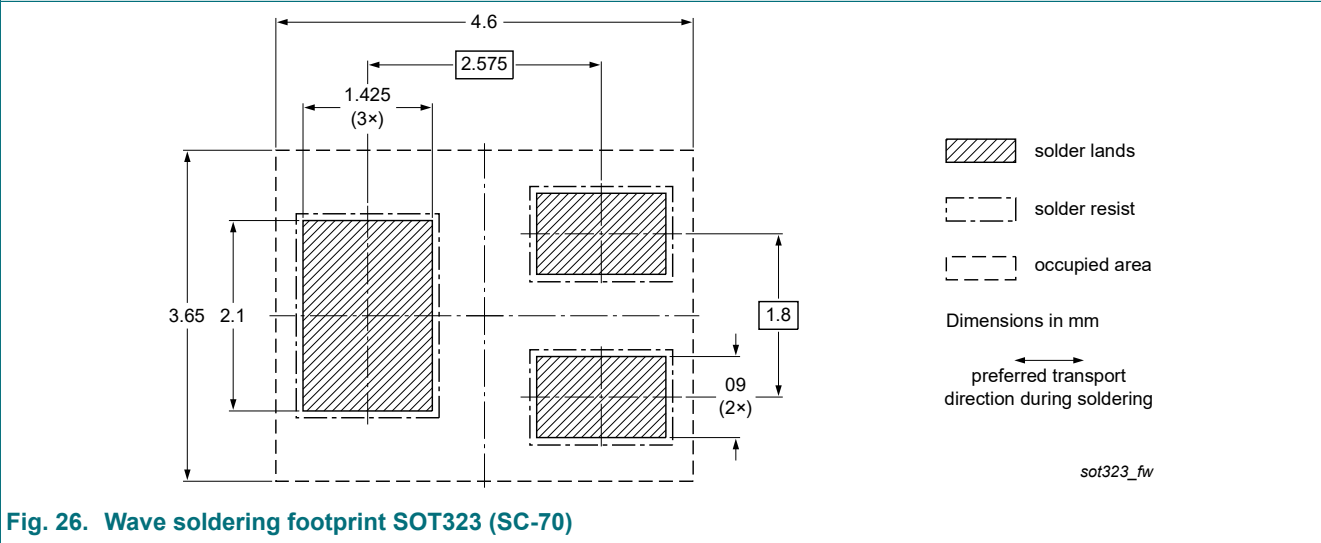


Fig. 26. Wave soldering footprint SOT323 (SC-70)

14. Revision history

Table 10. Revision history

| Data sheet ID                  | Release date | Data sheet status  | Change notice | Supersedes |
|--------------------------------|--------------|--------------------|---------------|------------|
| NHDTC123JU_143ZU_114YU_SER v.1 | 20200717     | 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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Date of release: 17 July 2020

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