NHDT123JT/143ZT/114YT series
80 V, 100 mA NPN resistor-equipped transistors
Rev. 1 — 7 July 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>
<thead>
<tr>
<th>Type number</th>
<th>R1 (kΩ)</th>
<th>R2 (kΩ)</th>
<th>Package</th>
<th>PNP complement:</th>
</tr>
</thead>
<tbody>
<tr>
<td>NHDTC123JT</td>
<td>2.2</td>
<td>47</td>
<td>SOT23</td>
<td>NHDTA123JT</td>
</tr>
<tr>
<td>NHDTC143ZT</td>
<td>4.7</td>
<td>47</td>
<td>TO-236AB</td>
<td>NHDTA143ZT</td>
</tr>
<tr>
<td>NHDTC114YT</td>
<td>10</td>
<td>47</td>
<td></td>
<td>NHDTA114YT</td>
</tr>
</tbody>
</table>

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>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Conditions</th>
<th>Min</th>
<th>Typ</th>
<th>Max</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>V_{CEO}</td>
<td>collector-emitter voltage</td>
<td>open base</td>
<td>-</td>
<td>-</td>
<td>80</td>
<td>V</td>
</tr>
<tr>
<td>I_O</td>
<td>output current</td>
<td></td>
<td>-</td>
<td>-</td>
<td>100</td>
<td>mA</td>
</tr>
</tbody>
</table>

\( T_{amb} = 25 \degree C \) unless otherwise specified.
5. Pinning information

Table 3. Pinning

<table>
<thead>
<tr>
<th>Pin</th>
<th>Symbol</th>
<th>Description</th>
<th>Simplified outline</th>
<th>Graphic symbol</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>I</td>
<td>input (base)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>GND</td>
<td>GND (emitter)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>O</td>
<td>output (collector)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

6. Ordering information

Table 4. Ordering information

<table>
<thead>
<tr>
<th>Type number</th>
<th>Package</th>
<th>Description</th>
<th>Version</th>
</tr>
</thead>
<tbody>
<tr>
<td>NHDT123JT</td>
<td>TO-236AB</td>
<td>plastic surface-mounted package; 3 leads</td>
<td>SOT23</td>
</tr>
<tr>
<td>NHDT143ZT</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NHDT114YT</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

7. Marking

Table 5. Marking

<table>
<thead>
<tr>
<th>Type number</th>
<th>Marking code [1]</th>
</tr>
</thead>
<tbody>
<tr>
<td>NHDT123JT</td>
<td>QJ%</td>
</tr>
<tr>
<td>NHDT143ZT</td>
<td>QL%</td>
</tr>
<tr>
<td>NHDT114YT</td>
<td>QH%</td>
</tr>
</tbody>
</table>

[1] % = placeholder for manufacturing site code
8. Limiting values

Table 6. Limiting values
In accordance with the Absolute Maximum Rating System (IEC 60134).

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Conditions</th>
<th>Min</th>
<th>Max</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$V_{CBO}$</td>
<td>collector-base voltage</td>
<td>open emitter</td>
<td>-</td>
<td>80</td>
<td>V</td>
</tr>
<tr>
<td>$V_{CED}$</td>
<td>collector-emitter voltage</td>
<td>open base</td>
<td>-</td>
<td>80</td>
<td>V</td>
</tr>
<tr>
<td>$V_{EBO}$</td>
<td>emitter-base voltage</td>
<td>open collector</td>
<td>-</td>
<td>7</td>
<td>V</td>
</tr>
<tr>
<td>$V_i$</td>
<td>input voltage</td>
<td>NHDT213JT</td>
<td>-7</td>
<td>+20</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>NHDT2143ZT</td>
<td>-7</td>
<td>+30</td>
<td>V</td>
</tr>
<tr>
<td>$I_O$</td>
<td>output current</td>
<td>NHDT2114YT</td>
<td>-7</td>
<td>+40</td>
<td>mA</td>
</tr>
<tr>
<td>$P_{tot}$</td>
<td>total power dissipation</td>
<td>$T_{amb} \leq 25 \degree C$</td>
<td>[1]</td>
<td>-</td>
<td>250</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>[2]</td>
<td>-</td>
<td>350</td>
</tr>
<tr>
<td>$T_j$</td>
<td>junction temperature</td>
<td></td>
<td>-</td>
<td>150</td>
<td>°C</td>
</tr>
<tr>
<td>$T_{amb}$</td>
<td>ambient temperature</td>
<td></td>
<td>-55</td>
<td>150</td>
<td>°C</td>
</tr>
<tr>
<td>$T_{stg}$</td>
<td>storage temperature</td>
<td></td>
<td>-65</td>
<td>150</td>
<td>°C</td>
</tr>
</tbody>
</table>

[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. 1. Power derating curves for SOT23 (TO-236AB)
9. Thermal characteristics

Table 7. Thermal characteristics

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

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Conditions</th>
<th>Min</th>
<th>Typ</th>
<th>Max</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$R_{\text{th(j-a)}}$</td>
<td>thermal resistance from junction to ambient</td>
<td>in free air</td>
<td>[1] - -</td>
<td>500</td>
<td>K/W</td>
<td></td>
</tr>
<tr>
<td>$R_{\text{th(j-sp)}}$</td>
<td>thermal resistance from junction to solder point</td>
<td>[2] - -</td>
<td>358</td>
<td>K/W</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>


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

\( T_{\text{amb}} = 25 \, ^{\circ}\text{C} \) unless otherwise specified.

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Conditions</th>
<th>Min</th>
<th>Typ</th>
<th>Max</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>( V_{\text{(BR)CBO}} )</td>
<td>collector-base breakdown voltage</td>
<td>( I_C = 100 , \mu A; I_E = 0 , A )</td>
<td>80</td>
<td>-</td>
<td>-</td>
<td>V</td>
</tr>
<tr>
<td>( V_{\text{(BR)CEO}} )</td>
<td>collector-emitter breakdown voltage</td>
<td>( I_C = 2 , mA; I_B = 0 , A )</td>
<td>80</td>
<td>-</td>
<td>-</td>
<td>V</td>
</tr>
<tr>
<td>( I_{\text{CBO}} )</td>
<td>collector-base cut-off current</td>
<td>( V_C = 80 , V; I_E = 0 , A )</td>
<td>-</td>
<td>-</td>
<td>100</td>
<td>nA</td>
</tr>
<tr>
<td>( I_{\text{CEO}} )</td>
<td>collector-emitter cut-off current</td>
<td>( V_C = 60 , V; I_B = 0 , A )</td>
<td>-</td>
<td>-</td>
<td>100</td>
<td>nA</td>
</tr>
<tr>
<td>( I_{\text{CEO}} )</td>
<td>collector-emitter cut-off current</td>
<td>( V_C = 60 , V; I_B = 0 , A; T_j = 150 , ^{\circ}\text{C} )</td>
<td>-</td>
<td>-</td>
<td>5</td>
<td>( \mu A )</td>
</tr>
<tr>
<td>( I_{\text{EBO}} )</td>
<td>emitter-base cut-off current</td>
<td>( V_E = 7 , V; I_C = 0 , A )</td>
<td>-</td>
<td>-</td>
<td>270</td>
<td>( \mu A )</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>-</td>
<td>-</td>
<td>260</td>
<td>( \mu A )</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>-</td>
<td>-</td>
<td>230</td>
<td>( \mu A )</td>
</tr>
<tr>
<td>( h_{\text{FE}} )</td>
<td>DC current gain</td>
<td>( V_C = 5 , V; I_C = 10 , mA )</td>
<td>100</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>( V_{\text{CEsat}} )</td>
<td>collector-emitter saturation voltage</td>
<td>( I_C = 10 , mA; I_E = 0.5 , mA )</td>
<td>-</td>
<td>-</td>
<td>100</td>
<td>mV</td>
</tr>
<tr>
<td>( V_{\text{i(off)}} )</td>
<td>off-state input voltage</td>
<td>( V_C = 5 , V; I_C = 100 , \mu A )</td>
<td>-</td>
<td>595</td>
<td>500</td>
<td>mV</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>-</td>
<td>625</td>
<td>500</td>
<td>mV</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>-</td>
<td>690</td>
<td>500</td>
<td>mV</td>
</tr>
<tr>
<td>( V_{\text{i(on)}} )</td>
<td>on-state input voltage</td>
<td>( V_C = 0.3 , V; I_C = 10 , mA )</td>
<td>1.2</td>
<td>0.81</td>
<td>-</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>1.4</td>
<td>0.95</td>
<td>-</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>1.6</td>
<td>1.22</td>
<td>-</td>
<td>V</td>
</tr>
<tr>
<td>( R_{1} )</td>
<td>bias resistor 1 (input)</td>
<td>( \text{NHDTC123JT} )</td>
<td>[1]</td>
<td>1.54</td>
<td>2.2</td>
<td>2.86</td>
</tr>
<tr>
<td></td>
<td></td>
<td>( \text{NHDTC143ZT} )</td>
<td>3.3</td>
<td>4.7</td>
<td>6.1</td>
<td>k( \Omega )</td>
</tr>
<tr>
<td></td>
<td></td>
<td>( \text{NHDTC114YT} )</td>
<td>7</td>
<td>10</td>
<td>13</td>
<td>k( \Omega )</td>
</tr>
<tr>
<td>( R_{2}/R_{1} )</td>
<td>bias resistor ratio</td>
<td>( \text{NHDTC123JT} )</td>
<td>[1]</td>
<td>17</td>
<td>21</td>
<td>26</td>
</tr>
<tr>
<td></td>
<td></td>
<td>( \text{NHDTC143ZT} )</td>
<td>8</td>
<td>10</td>
<td>12</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>( \text{NHDTC114YT} )</td>
<td>3.7</td>
<td>4.7</td>
<td>5.7</td>
<td></td>
</tr>
<tr>
<td>( f_{T} )</td>
<td>transition frequency</td>
<td>( V_C = 5 , V; I_C = 10 , mA; f = 100 , MHz )</td>
<td>[2]</td>
<td>-</td>
<td>170</td>
<td>MHz</td>
</tr>
<tr>
<td>( C_{c} )</td>
<td>collector capacitance</td>
<td>( V_C = 10 , V; I_E = I_E = 0 , A; f = 1 , MHz )</td>
<td>-</td>
<td>-</td>
<td>2.5</td>
<td>pF</td>
</tr>
</tbody>
</table>

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


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Fig. 4. **NHDTC123JT**: DC current gain as a function of collector current; typical values

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

Fig. 5. **NHDTC123JT**: Collector current as a function of collector-emitter voltage; typical values

- $T_{amb} = 25 \degree \text{C}$

Fig. 6. **NHDTC123JT**: On-state input voltage as a function of collector current; typical values

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

Fig. 7. **NHDTC123JT**: Off-state input voltage as a function of collector current; typical values

- $V_{CE} = 5 \text{ V}$
- (1) $T_{amb} = -40 \degree \text{C}$
- (2) $T_{amb} = 25 \degree \text{C}$
- (3) $T_{amb} = 100 \degree \text{C}$
Fig. 8. NHDTC123JT: Collector-emitter saturation voltage as a function of collector current; typical values

\[
\begin{array}{c|c|c}
I_C (mA) & V_{CE_{sat}} (V) \\
\hline
10^{-1} & 10 \to 1 \to 10 \to 10^2 \\
1 & 10 \to 1 \to 10 \to 10^2 \\
10^{-1} & 10 \to 1 \to 10 \to 10^2 \\
\end{array}
\]

\(I_C/I_B = 20\)

(1) \(T_{amb} = 100 \degree C\)
(2) \(T_{amb} = 25 \degree C\)
(3) \(T_{amb} = -40 \degree C\)

Fig. 9. NHDTC123JT: Collector capacitance as a function of collector-base voltage; typical values

\(f = 1 \, MHz\)
\(T_{amb} = 25 \degree C\)

Fig. 10. NHDTC143ZT: DC current gain as a function of collector current; typical values

\[
\begin{array}{c|c|c|c|c|c}
V_{CE} (V) & h_FE \\
\hline
5 & 10^3 \to 10^2 \to 10 \to 1 \to 10^{-1} \\
& 10 \to 1 \to 10 \to 10^2 \\
& 10^{-1} \to 1 \to 10 \to 10^2 \\
& 10^{-2} \to 1 \to 10 \to 10^2 \\
& 10^{-3} \to 1 \to 10 \to 10^2 \\
\end{array}
\]

\(V_{CE} = 5 \, V\)

(1) \(T_{amb} = 100 \degree C\)
(2) \(T_{amb} = 25 \degree C\)
(3) \(T_{amb} = -40 \degree C\)

Fig. 11. NHDTC143ZT: Collector current as a function of collector-emitter voltage; typical values

\(
I_B = 0.750 \, mA
0.600 \, mA
0.525 \, mA
0.450 \, mA
0.375 \, mA
0.300 \, mA
0.225 \, mA
0.150 \, mA
0.075 \, mA
\)

\(T_{amb} = 25 \degree C\)
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NHDTC123JT/143ZT/114YT series

80 V, 100 mA NPN resistor-equipped transistors

**Fig. 12.** NHDTC143ZT: On-state input voltage as a function of collector current; typical values

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

**Fig. 13.** NHDTC143ZT: Off-state input voltage as a function of collector current; typical values

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

**Fig. 14.** NHDTC143ZT: Collector-emitter saturation voltage as a function of collector current; typical values

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

**Fig. 15.** NHDTC143ZT: Collector capacitance as a function of collector-base voltage; typical values

- $f = 1 \, MHz$
- $T_{amb} = 25 \, °C$
NHDTC123JT/143ZT/114YT series
80 V, 100 mA NPN resistor-equipped transistors

Fig. 16. NHDTC114YT: DC current gain as a function of collector current; typical values

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

Fig. 17. NHDTC114YT: Collector current as a function of collector-emitter voltage; typical values

\[ I_C = 0.750 \text{ mA} \]
\[ V_{CE} = 0.3 \text{ V} \]
(1) \( T_{amb} = -40 ^\circ \text{C} \)
(2) \( T_{amb} = 25 ^\circ \text{C} \)
(3) \( T_{amb} = 100 ^\circ \text{C} \)

Fig. 18. NHDTC114YT: 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. 19. NHDTC114YT: Off-state input voltage as a function of collector current; typical values
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NHDTC123JT/143ZT/114YT series

80 V, 100 mA NPN resistor-equipped transistors

**Fig. 20.** NHDTC114YT: Collector-emitter saturation voltage as a function of collector current; typical values

$I_C/I_B = 20$

(1) $T_{amb} = 100 \, ^\circ\!C$

(2) $T_{amb} = 25 \, ^\circ\!C$

(3) $T_{amb} = -40 \, ^\circ\!C$

**Fig. 21.** NHDTC114YT: Collector capacitance as a function of collector-base voltage; typical values

$f = 1 \text{ MHz}$

$T_{amb} = 25 \, ^\circ\!C$

**Fig. 22.** Transition frequency as a function of collector current; typical values of built-in transistor

$f = 100 \text{ MHz}$

$V_{CE} = 5 \text{ V}$

$T_{amb} = 25 \, ^\circ\!C$
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)
  \[ \frac{R_2}{R_1} = \frac{V(I_{I4}) - V(I_{I3})}{R_1 \cdot (I_{I4} - I_{I3}) - 1} \]

![Resistor test circuit diagram](image)

Fig. 23. PNP transistor: Resistor test circuit

Resistor test conditions

<table>
<thead>
<tr>
<th>Type number</th>
<th>R1 (kΩ)</th>
<th>R2 (kΩ)</th>
<th>Test conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>I_{I1}</td>
<td>I_{I2}</td>
<td>I_{I3}</td>
</tr>
<tr>
<td>NHDTC123JT</td>
<td>2.2</td>
<td>47</td>
<td>1.6 mA</td>
</tr>
<tr>
<td>NHDTC143ZT</td>
<td>4.7</td>
<td>47</td>
<td>1.2 mA</td>
</tr>
<tr>
<td>NHDTC114YT</td>
<td>10</td>
<td>47</td>
<td>800 μA</td>
</tr>
</tbody>
</table>
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>
<thead>
<tr>
<th>Data sheet ID</th>
<th>Release date</th>
<th>Data sheet status</th>
<th>Change notice</th>
<th>Supersedes</th>
</tr>
</thead>
<tbody>
<tr>
<td>NHDT123JT_143ZT_114YT_SER v.1</td>
<td>20200707</td>
<td>Product data sheet</td>
<td>-</td>
<td>-</td>
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</table>
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NHDTC123JT/143ZT/114YT series

15. Legal information

Data sheet status

<table>
<thead>
<tr>
<th>Document status</th>
<th>Product status</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preliminary</td>
<td>Development</td>
<td>This document contains data from the objective specification for product development.</td>
</tr>
<tr>
<td>Objective</td>
<td>Qualification</td>
<td>This document contains data from the preliminary specification.</td>
</tr>
<tr>
<td>Product</td>
<td>Production</td>
<td>This document contains the product specification.</td>
</tr>
</tbody>
</table>

[1] Please consult the most recently issued document before initiating or completing a design.
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80 V, 100 mA NPN resistor-equipped transistors

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