1. Product profile

1.1. General description
LED driver consisting of resistor-equipped NPN transistor with two diodes on one chip in an SOT457 (SC-74; TSOP6) plastic package.

Table 1. Product overview

<table>
<thead>
<tr>
<th>Type number</th>
<th>Package</th>
<th>JEITA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nexperia</td>
<td>SOT457</td>
<td>SC-74; TSOP6</td>
</tr>
<tr>
<td>NCR420U</td>
<td>SOT457</td>
<td>SC-74; TSOP6</td>
</tr>
<tr>
<td>NCR421U</td>
<td>SOT457</td>
<td>SC-74; TSOP6</td>
</tr>
</tbody>
</table>

1.2. Features and benefits
- Stabilized output current of 10 mA without external resistor
- Stabilized output current adjustable up to 150 mA when an external resistor is used
- High current accuracy at supply voltage variation
- Low voltage overhead of 1.4 V
- Reduces component count and board space
- High power dissipation of 750 mW
- Supply voltage up to 40 V
- Digital PWM input up to 10 kHz frequency for NCR421U
- AEC-Q101 qualified

1.3. Applications
- Constant current LED driver
- Generic constant current source
- Automotive applications (for example: interior lighting, dash board, instrumentation, number plate light)
- Increase stabilized output current by paralleling drivers
1.4. Quick reference data

Table 2. 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_{EN}</td>
<td>enable voltage</td>
<td></td>
<td>-</td>
<td>-</td>
<td>40</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td>NCR420U</td>
<td></td>
<td>-</td>
<td>-</td>
<td>4.5</td>
<td>V</td>
</tr>
<tr>
<td>V_{out}</td>
<td>output voltage</td>
<td></td>
<td>-</td>
<td>-</td>
<td>40</td>
<td>V</td>
</tr>
<tr>
<td>I_{out}</td>
<td>stabilized output current</td>
<td>V_{out} = 1.4 V; V_{EN} = 24 V</td>
<td>9</td>
<td>10</td>
<td>11</td>
<td>mA</td>
</tr>
<tr>
<td></td>
<td>NCR421U</td>
<td>V_{out} = 1.4 V; V_{EN} = 3.3 V</td>
<td>9</td>
<td>10</td>
<td>11</td>
<td>mA</td>
</tr>
</tbody>
</table>

[1] Pulse test: \( t_p \leq 300 \mu s; \delta \leq 0.02 \)

2. Pinning information

Table 3. Pinning

<table>
<thead>
<tr>
<th>Pin</th>
<th>Symbol</th>
<th>Description</th>
<th>Simplified outline</th>
<th>Symbol</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>VEN</td>
<td>enable voltage</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>IOUT</td>
<td>output current</td>
<td>SC-74; TSOP6</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>IOUT</td>
<td>output current</td>
<td>(SOT457)</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>GND</td>
<td>ground</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>IOUT</td>
<td>output current</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>REXT</td>
<td>external resistor</td>
<td>SC-74; TSOP6</td>
<td>aaa-029361</td>
</tr>
</tbody>
</table>

3. Ordering information

Table 4. Ordering information

<table>
<thead>
<tr>
<th>Type number</th>
<th>Package Name</th>
<th>Description</th>
<th>Version</th>
</tr>
</thead>
<tbody>
<tr>
<td>NCR420U</td>
<td>SC-74; TSOP6</td>
<td>plastic surface-mounted package; 6 leads</td>
<td>SOT457</td>
</tr>
<tr>
<td>NCR421U</td>
<td>SC-74; TSOP6</td>
<td>plastic surface-mounted package; 6 leads</td>
<td>SOT457</td>
</tr>
</tbody>
</table>

4. Marking

Table 5. Marking codes

<table>
<thead>
<tr>
<th>Type number</th>
<th>Marking code</th>
</tr>
</thead>
<tbody>
<tr>
<td>NCR420U</td>
<td>L6</td>
</tr>
<tr>
<td>NCR421U</td>
<td>L7</td>
</tr>
</tbody>
</table>
5. 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>$I_{\text{out}}$</td>
<td>stabilized output current if external resistor is used</td>
<td>-</td>
<td>200</td>
<td>mA</td>
<td></td>
</tr>
<tr>
<td>$V_{\text{EN}}$</td>
<td>enable voltage</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NCR420U</td>
<td>-</td>
<td>40</td>
<td>V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>NCR421U</td>
<td>-</td>
<td>4.5</td>
<td>V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$V_{\text{out}}$</td>
<td>output voltage</td>
<td>-</td>
<td>40</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>$V_{R}$</td>
<td>reverse voltage</td>
<td>[1]</td>
<td>0.5</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>$P_{\text{tot}}$</td>
<td>total power dissipation</td>
<td>$T_{\text{amb}} \leq 25 ^\circ C$</td>
<td>[2]</td>
<td>475</td>
<td>mW</td>
</tr>
<tr>
<td>&amp;</td>
<td>&amp;</td>
<td>[3]</td>
<td>650</td>
<td>mW</td>
<td></td>
</tr>
<tr>
<td>&amp;</td>
<td>&amp;</td>
<td>[4]</td>
<td>750</td>
<td>mW</td>
<td></td>
</tr>
<tr>
<td>&amp;</td>
<td>&amp;</td>
<td>[5]</td>
<td>1100</td>
<td>mW</td>
<td></td>
</tr>
<tr>
<td>$T_{J}$</td>
<td>junction temperature</td>
<td>-</td>
<td>150</td>
<td>°C</td>
<td></td>
</tr>
<tr>
<td>$T_{\text{amb}}$</td>
<td>ambient temperature</td>
<td>-55</td>
<td>150</td>
<td>°C</td>
<td></td>
</tr>
<tr>
<td>$T_{\text{stg}}$</td>
<td>storage temperature</td>
<td>-65</td>
<td>150</td>
<td>°C</td>
<td></td>
</tr>
</tbody>
</table>

[1] Between all terminals.
[3] Device mounted on an FR4 Printed-Circuit Board (PCB), single-side copper (35 µm), tin-plated; mounting pad for collector 1 cm².
[5] Device mounted on an FR4 Printed-Circuit Board (PCB), 4-layer copper, tin-plated; mounting pad for collector 1 cm².

![Power derating curve](aaa-029338)

(1) FR4 PCB, 4-layer copper, 1 cm²
(2) FR4 PCB, 4-layer copper, standard footprint
(3) FR4 PCB, single sided copper (35 µm), 1 cm²
(4) FR4 PCB, single-sided copper (35 µm), standard footprint

Fig. 1. Power derating curve
6. Thermal characteristics

Table 7. Thermal characteristics

<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>-</td>
<td>-</td>
<td>265 K/W</td>
</tr>
<tr>
<td>R(_{\text{th(j-sp)}})</td>
<td>thermal resistance from junction to solder point</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>50 K/W</td>
<td></td>
</tr>
</tbody>
</table>

[2] Device mounted on an FR4 PCB, single-sided copper (35 µm), tin-plated; mounting pad for collector 1 cm\(^2\).
[4] Device mounted on an FR4 PCB, 4-layer copper, tin-plated; mounting pad for collector 1 cm\(^2\).

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
**7. Characteristics**

Table 8. Characteristics

<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_{(BR)CEO}</td>
<td>collector-emitter breakdown voltage</td>
<td>I_C = 1 mA; I_B = 0 A</td>
<td>40</td>
<td>-</td>
<td>-</td>
<td>V</td>
</tr>
<tr>
<td>h_FE</td>
<td>DC current gain</td>
<td>V_{CE} = 1 V; I_C = 50 mA</td>
<td>200</td>
<td>350</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>R_{int}</td>
<td>internal resistor</td>
<td>I_{Rint} = 10 mA</td>
<td>85</td>
<td>95</td>
<td>105</td>
<td>Ω</td>
</tr>
<tr>
<td>V_{Rint}</td>
<td>voltage drop at internal resistor R_{int}</td>
<td>I_{out} = 10 mA</td>
<td>[1]</td>
<td>0.85</td>
<td>0.95</td>
<td>1.05</td>
</tr>
<tr>
<td>I_{EN}</td>
<td>enable current</td>
<td></td>
<td>[1]</td>
<td>-</td>
<td>1.2</td>
<td>mA</td>
</tr>
<tr>
<td></td>
<td>NCR420U</td>
<td>V_{EN} = 24 V</td>
<td>-</td>
<td>20</td>
<td>-</td>
<td>kΩ</td>
</tr>
<tr>
<td></td>
<td>NCR421U</td>
<td>V_{EN} = 3.3 V</td>
<td>-</td>
<td>1.5</td>
<td>-</td>
<td>kΩ</td>
</tr>
<tr>
<td>R_{B}</td>
<td>bias resistor</td>
<td></td>
<td>[1]</td>
<td>20</td>
<td>-</td>
<td>kΩ</td>
</tr>
<tr>
<td></td>
<td>NCR420U</td>
<td>V_{EN} = 24 V; V_{out} = 1.4 V</td>
<td>[1]</td>
<td>9</td>
<td>10</td>
<td>11</td>
</tr>
<tr>
<td></td>
<td>NCR421U</td>
<td>V_{EN} = 3.3 V; V_{out} = 1.4 V</td>
<td>[1]</td>
<td>9</td>
<td>10</td>
<td>11</td>
</tr>
<tr>
<td>I_{out}</td>
<td>stabilized output current</td>
<td></td>
<td>[1]</td>
<td>-</td>
<td>150</td>
<td>mA</td>
</tr>
<tr>
<td></td>
<td>NCR420U at R_{ext} = 5.1 Ω</td>
<td>V_{EN} = 24 V; V_{out} &gt; 2 V</td>
<td>[1]</td>
<td>-</td>
<td>150</td>
<td>mA</td>
</tr>
<tr>
<td></td>
<td>NCR421U at R_{ext} = 5.1 Ω</td>
<td>V_{EN} = 3.3 V; V_{out} &gt; 2 V</td>
<td>[1]</td>
<td>-</td>
<td>150</td>
<td>mA</td>
</tr>
<tr>
<td>V_{out, min}</td>
<td>lowest sufficient output voltage overhead: V_{out} = V_{CC} - V_{LED}</td>
<td>I_{out} &gt; 10 mA</td>
<td>-</td>
<td>1.4</td>
<td>-</td>
<td>V</td>
</tr>
<tr>
<td>ΔI_{out}/(I_{out} x ΔT_{amb})</td>
<td>stabilized output current change over ambient temperature</td>
<td></td>
<td>[1]</td>
<td>-0.27</td>
<td>-</td>
<td>%/K</td>
</tr>
<tr>
<td></td>
<td>NCR420U</td>
<td>V_{EN} = 24 V; V_{out} &gt; 2 V</td>
<td>-</td>
<td>-0.27</td>
<td>-</td>
<td>%/K</td>
</tr>
<tr>
<td></td>
<td>NCR421U</td>
<td>V_{EN} = 3.3 V; V_{out} &gt; 2 V</td>
<td>-</td>
<td>-0.27</td>
<td>-</td>
<td>%/K</td>
</tr>
<tr>
<td>ΔI_{out}/(I_{out} x ΔV_{CC})</td>
<td>stabilized output current change over supply voltage</td>
<td></td>
<td>[1]</td>
<td>1</td>
<td>-</td>
<td>%/V</td>
</tr>
<tr>
<td></td>
<td>NCR420U</td>
<td>V_{EN} = 24 V; V_{out} &gt; 2 V</td>
<td>-</td>
<td>1</td>
<td>-</td>
<td>%/V</td>
</tr>
<tr>
<td></td>
<td>NCR421U</td>
<td>V_{EN} = 3.3 V; V_{out} &gt; 2 V</td>
<td>-</td>
<td>1</td>
<td>-</td>
<td>%/V</td>
</tr>
</tbody>
</table>

[1] Pulse test: \( t_p \leq 300 \, \mu s; \delta \leq 0.02. \)
**Nexperia**

**NCR420U / NCR421U**

150 mA LED driver in SOT457

---

**Fig. 4.** NCR420U: Output current as a function of output voltage; typical values

- $V_{EN} = 40 \text{ V}$; $T_{amb} = 25 \degree \text{C}$
- (1) $R_{ext} = 6 \Omega$
- (2) $R_{ext} = 8 \Omega$
- (3) $R_{ext} = 10 \Omega$
- (4) $R_{ext} = 15 \Omega$
- (5) $R_{ext} = 30 \Omega$
- (6) $R_{ext} = \text{open}$

---

**Fig. 5.** NCR420U: Output current as a function of external resistor; typical values

- $V_{EN} = 40 \text{ V}$; $T_{amb} = 25 \degree \text{C}$
- (1) $V_{out} = 1.4 \text{ V}$
- (2) $V_{out} = 5.4 \text{ V}$

---

**Fig. 6.** NCR420U: Output current as a function of output voltage; typical values

- $V_{EN} = 40 \text{ V}$; $R_{ext} = \text{open}$
- (1) $T_{amb} = 85 \degree \text{C}$
- (2) $T_{amb} = 25 \degree \text{C}$
- (3) $T_{amb} = -40 \degree \text{C}$

---

**Fig. 7.** NCR420U: Output current as a function of output voltage; typical values

- $V_{EN} = 40 \text{ V}$; $R_{ext} = 20 \Omega$
- (1) $T_{amb} = 85 \degree \text{C}$
- (2) $T_{amb} = 25 \degree \text{C}$
- (3) $T_{amb} = -40 \degree \text{C}$
Fig. 8. NCR420U: Output current as a function of output voltage; typical values

- $V_{EN} = 40\, \text{V}$; $R_{\text{ext}} = 6\, \Omega$
- (1) $T_{\text{amb}} = 85\, ^{\circ}\text{C}$
- (2) $T_{\text{amb}} = 25\, ^{\circ}\text{C}$
- (3) $T_{\text{amb}} = -40\, ^{\circ}\text{C}$

Fig. 9. NCR420U: Output current as a function of enable voltage; typical values

- $V_{\text{out}} = 2\, \text{V}$; $R_{\text{ext}} = \text{open}$
- (1) $T_{\text{amb}} = 85\, ^{\circ}\text{C}$
- (2) $T_{\text{amb}} = 25\, ^{\circ}\text{C}$
- (3) $T_{\text{amb}} = -40\, ^{\circ}\text{C}$

Fig. 10. NCR420U: Output current as a function of enable voltage; typical values

- $V_{\text{out}} = 2\, \text{V}$; $R_{\text{ext}} = 20\, \Omega$
- (1) $T_{\text{amb}} = 85\, ^{\circ}\text{C}$
- (2) $T_{\text{amb}} = 25\, ^{\circ}\text{C}$
- (3) $T_{\text{amb}} = -40\, ^{\circ}\text{C}$

Fig. 11. NCR420U: Output current as a function of enable voltage; typical values

- $V_{\text{out}} = 2\, \text{V}$; $R_{\text{ext}} = 6\, \Omega$
- (1) $T_{\text{amb}} = 85\, ^{\circ}\text{C}$
- (2) $T_{\text{amb}} = 25\, ^{\circ}\text{C}$
- (3) $T_{\text{amb}} = -40\, ^{\circ}\text{C}$
**Fig. 12. NCR420U: Output current as a function of enable voltage; typical values**

- $V_{out} = 2$ V; $T_{amb} = 25$ °C
- (1) $R_{ext} = 6$ Ω
- (2) $R_{ext} = 8$ Ω
- (3) $R_{ext} = 10$ Ω
- (4) $R_{ext} = 30$ Ω
- (5) $R_{ext} = 60$ Ω
- (6) $R_{ext} = \text{open}$

**Fig. 13. NCR420U: Enable current as a function of enable voltage; typical values**

- $I_{out} = 0$ A; $R_{ext} = \text{open}$
- (1) $T_{amb} = 85$ °C
- (2) $T_{amb} = 25$ °C
- (3) $T_{amb} = -40$ °C

**Fig. 14. NCR421U: Output current as a function of output voltage; typical values**

- $V_{EN} = 3.3$ V; $T_{amb} = 25$ °C
- (1) $R_{ext} = 6$ Ω
- (2) $R_{ext} = 8$ Ω
- (3) $R_{ext} = 10$ Ω
- (4) $R_{ext} = 15$ Ω
- (5) $R_{ext} = 30$ Ω
- (6) $R_{ext} = \text{open}$

**Fig. 15. NCR421U: Output current as a function of external resistor; typical values**

- $V_{EN} = 3.3$ V; $T_{amb} = 25$ °C
- (1) $V_{out} = 1.4$ V
- (2) $V_{out} = 5.4$ V

All information provided in this document is subject to legal disclaimers.
**Nexperia**

**NCR420U / NCR421U**

150 mA LED driver in SOT457

---

**Fig. 16.** NCR421U: Output current as a function of output voltage; typical values

V_{EN} = 3.3 V; R_{ext} = open
(1) R_{ext} = 85 °C
(2) R_{ext} = 25 °C
(3) R_{ext} = -40 °C

**Fig. 17.** NCR421U: Output current as a function of output voltage; typical values

V_{EN} = 3.3 V; R_{ext} = 20 Ω
(1) R_{ext} = 85 °C
(2) R_{ext} = 25 °C
(3) R_{ext} = -40 °C

**Fig. 18.** NCR421U: Output current as a function of output voltage; typical values

V_{EN} = 3.3 V; R_{ext} = 6 Ω
(1) R_{ext} = 85 °C
(2) R_{ext} = 25 °C
(3) R_{ext} = -40 °C

**Fig. 19.** NCR421U: Output current as a function of enable voltage; typical values

V_{out} = 2 V; R_{ext} = open
(1) R_{ext} = 85 °C
(2) R_{ext} = 25 °C
(3) R_{ext} = -40 °C

---
**Fig. 20.** NCR421U: Output current as a function of enable voltage; typical values

\[ V_{\text{out}} = 2 \text{ V}; \ R_{\text{ext}} = 20 \ \Omega \]

(1) \( R_{\text{ext}} = 85 \ ^\circ\text{C} \)
(2) \( R_{\text{ext}} = 25 \ ^\circ\text{C} \)
(3) \( R_{\text{ext}} = -40 \ ^\circ\text{C} \)

**Fig. 21.** NCR421U: Output current as a function of enable voltage; typical values

\[ V_{\text{out}} = 2 \text{ V}; \ R_{\text{ext}} = 6 \ \Omega \]

(1) \( R_{\text{ext}} = 85 \ ^\circ\text{C} \)
(2) \( R_{\text{ext}} = 25 \ ^\circ\text{C} \)
(3) \( R_{\text{ext}} = -40 \ ^\circ\text{C} \)

**Fig. 22.** NCR421U: Output current as a function of enable voltage; typical values

\[ V_{\text{out}} = 2 \text{ V}; \ T_{\text{amb}} = 25 \ ^\circ\text{C} \]

(1) \( R_{\text{ext}} = 6 \ \Omega \)
(2) \( R_{\text{ext}} = 8 \ \Omega \)
(3) \( R_{\text{ext}} = 10 \ \Omega \)
(4) \( R_{\text{ext}} = 30 \ \Omega \)
(5) \( R_{\text{ext}} = 60 \ \Omega \)
(6) \( R_{\text{ext}} = \text{open} \)

**Fig. 23.** NCR421U: Enable current as a function of enable voltage; typical values

\[ I_{\text{out}} = 0 \text{ A}; \ R_{\text{ext}} = \text{open} \]

(1) \( T_{\text{amb}} = 85 \ ^\circ\text{C} \)
(2) \( T_{\text{amb}} = 25 \ ^\circ\text{C} \)
(3) \( T_{\text{amb}} = -40 \ ^\circ\text{C} \)
8. Application information

Figure 24 shows a typical application circuit for an LED driver. The constant current ensures a constant brightness in all LEDs. The output current can be adjusted between 10 mA and 150 mA by connecting resistor $R_{ext}$. Figures 5 and 15 give a first indication for choosing the external resistor $R_{ext}$. The minimum input voltage is given by voltage drop at the LED's $V_{LED}$ and the maximum is governed by the maximum power dissipation

$$V_{LED} + V_{out, \min} < V_{CC} < \frac{P_{tot}}{I_{out}} + V_{LED}$$

![LED driver application diagram](aaa-029337)

Fig. 24. LED driver application diagram

NCR421U can be used for PWM dimming or on/off function by driving the VEN pin. The enable voltage depends on the drive current, see Figure 21. Figure 25 shows a typical application where VEN is driven via a micro directly. To control more than one NCR421U devices by one microcontroller output, a shift register (for example 74AHC(T)594PW) can be used.

![Application diagram: PWM dimming function](aaa-029336)

Fig. 25. Application diagram: PWM dimming function
To safely drive currents that are above the limits of the NCR42xU, two or more devices can be parallel connected as illustrated in Figure 26. When choosing the same values for the external resistors, the drive current splits equally and the capability of handling excess power is doubled. Both, NCR420U and NCR421U can be used in this configuration.

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**Fig. 26. Application diagram: Parallelization**

---
9. Package outline

Table 9. Package outline

| Plastic surface-mounted package (TSOP6); 6 leads | SOT457 |

![Diagram of package outline](image)

**DIMENSIONS (mm are the original dimensions)**

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<th>UNIT</th>
<th>A</th>
<th>A₁</th>
<th>bₚ</th>
<th>c</th>
<th>D</th>
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<th>e</th>
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<td>0.26</td>
<td>3.1</td>
<td>1.7</td>
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<td>3.0</td>
<td>0.6</td>
<td>0.33</td>
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**OUTLINE VERSION**

| SOT457 |

**REFERENCES**

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**EUROPEAN PROJECTION**

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Fig. 27. Package outline SC-74; TSOP6 (SOT457)
10. Soldering

Table 10. Soldering

Fig. 28. Reflow soldering footprint for SC-74; TSOP6 (SOT457)

Fig. 29. Wave soldering footprint for SC-74; TSOP6 (SOT457)
11. Revision history

Table 11. Revision history

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Data sheet status

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[2] The term "short data sheet" is explained in section "Definitions".
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