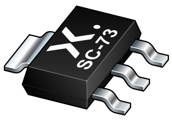



# NCR420Z / NCR421Z

**150 mA LED driver in SOT223**

**Rev. 1 — 4 February 2019** **Product data sheet**

## 1. Product profile

### 1.1. General description

LED driver consisting of resistor-equipped NPN transistor with two diodes on one chip in a medium power SOT223 (SC73) plastic package.

**Table 1. Product overview**

| Type number | Package | |
|---|---|---|
| | Nexperia | JEITA |
| NCR420Z | SOT223 | SC-73 |
| NCR421Z | SOT223 | SC-73 |

### 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 1250 mW
- Supply voltage up to 40 V
- Digital PWM input up to 10 kHz frequency for NCR421Z
- 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

nexperia

### 1.4. Quick reference data

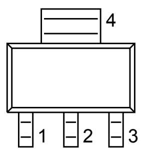
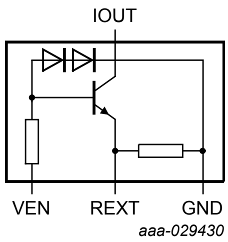
**Table 2. Quick reference data**

| Symbol | Parameter | Conditions | | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|---|
| $V_{EN}$ | enable voltage | | | | | | |
| | NCR420Z | | | - | - | 40 | V |
| | NCR421Z | | | - | - | 4.5 | V |
| $V_{out}$ | output voltage | | | - | - | 40 | V |
| $I_{out}$ | stabilized output current | | | | | | |
| | NCR420Z | $V_{out}$= 1.4 V; $V_{EN}$= 24 V | [1] | 9 | 10 | 11 | mA |
| | NCR421Z | $V_{out}$= 1.4 V; $V_{EN}$= 3.3 V | [1] | 9 | 10 | 11 | mA |

[1] Pulse test: $t_p \leq 300$ μs; $\delta \leq 0.02$

## 2. Pinning information

**Table 3. Pinning**

| Pin | Symbol | Description | Simplified outline | Symbol |
|---|---|---|---|---|
| 1 | VEN | enable voltage |   |   |
| 2 | REXT | external resistor | | |
| 3 | GND | ground | | |
| 4 | IOUT | output current | | |

## 3. Ordering information

**Table 4. Ordering information**

| Type number | Package | | |
|---|---|---|---|
| | Name | Description | Version |
| NCR420Z | SC-73 | plastic surface-mounted package with increased heatsink; 4 leads | SOT223 |
| NCR421Z | SC-73 | plastic surface-mounted package with increased heatsink; 4 leads | SOT223 |

## 4. Marking

**Table 5. Marking codes**

| Type number | Marking code |
|---|---|
| NCR420Z | CR420Z |
| NCR421Z | CR421Z |

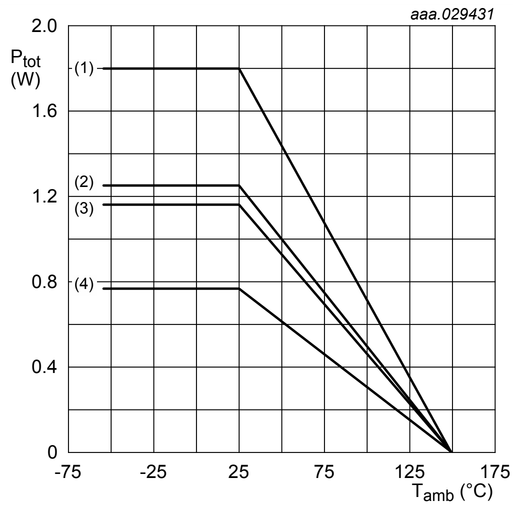
# 5. Limiting values

**Table 6. Limiting values**

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

| Symbol | Parameter | Conditions | | Min | Max | Unit |
|---|---|---|---|---|---|---|
| $I_{out}$ | stabilized output current if external resistor is used | | | - | 200 | mA |
| $V_{EN}$ | enable voltage | | | | | |
| | NCR420Z | | | - | 40 | V |
| | NCR421Z | | | - | 4.5 | V |
| $V_{out}$ | output voltage | | | - | 40 | V |
| $V_R$ | reverse voltage | | [1] | - | 0.5 | V |
| $P_{tot}$ | total power dissipation | $T_{amb} \leq 25$ °C | [2] | - | 765 | mW |
| | | | [3] | - | 1160 | mW |
| | | | [4] | - | 1250 | mW |
| | | | [5] | - | 1800 | mW |
| $T_j$ | junction temperature | | | - | 150 | °C |
| $T_{amb}$ | ambient temperature | | | -55 | 150 | °C |
| $T_{stg}$ | storage temperature | | | -65 | 150 | °C |

[1] Between all terminals.
[2] Device mounted on an FR4 Printed-Circuit Board (PCB), single-side copper (70 µm), tin-plated and standard footprint.
[3] Device mounted on an FR4 Printed-Circuit Board (PCB), single-side copper (70 µm), tin-plated; mounting pad for collector 1 cm$^2$.
[4] Device mounted on an FR4 Printed-Circuit Board (PCB), 4-layer copper, tin-plated and standard footprint.
[5] Device mounted on an FR4 Printed-Circuit Board (PCB), 4-layer copper, tin-plated; mounting pad for collector 1 cm$^2$.




(1) FR4 PCB, 4-layer copper, 1 cm$^2$
(2) FR4 PCB, 4-layer copper, standard footprint
(3) FR4 PCB, single sided copper (70 µm), 1 cm$^2$
(4) FR4 PCB, single-sided copper (70 µm), standard footprint

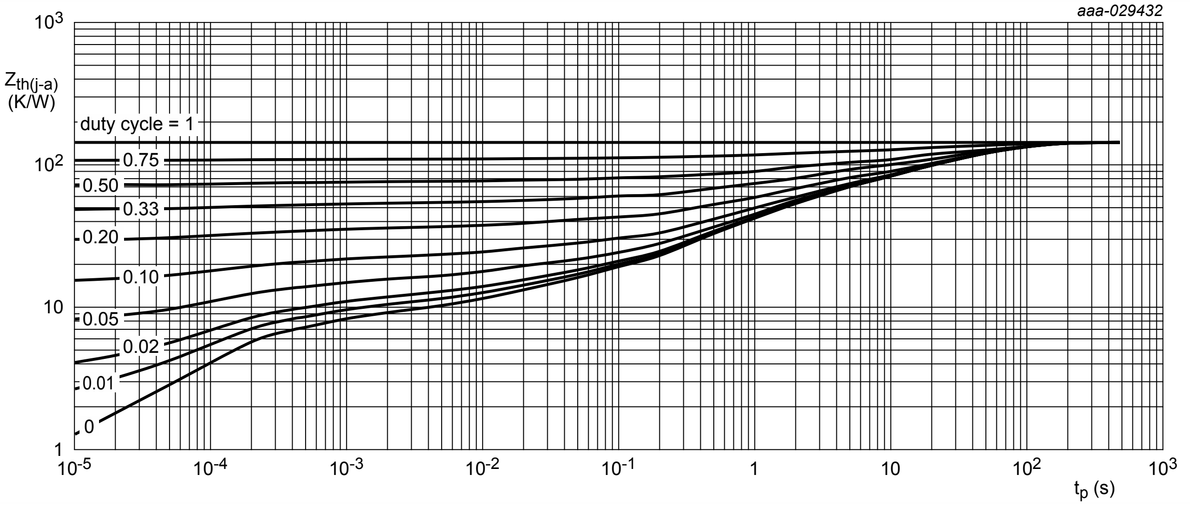
**Fig. 1. Power derating curve**

# 6. Thermal characteristics

**Table 7. Thermal characteristics**

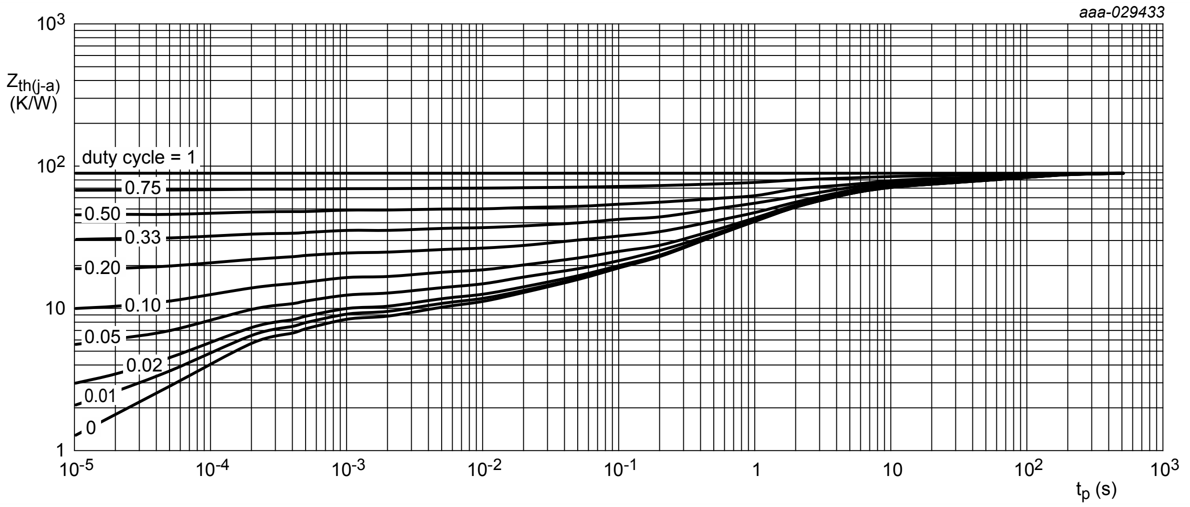
| Symbol | Parameter | Conditions | | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|---|
| $R_{th(j-a)}$ | thermal resistance from junction to ambient | in free air | [1] | - | - | 164 | K/W |
| | | | [2] | - | - | 108 | K/W |
| | | | [3] | - | - | 100 | K/W |
| | | | [4] | - | - | 70 | K/W |
| $R_{th(j-sp)}$ | thermal resistance from junction to solder point | | | - | - | 27 | K/W |

[1] Device mounted on an FR4 PCB, single-sided copper (70 µm), tin-plated and standard footprint.
[2] Device mounted on an FR4 PCB, single-sided copper (70 µm), tin-plated; mounting pad for collector 1 cm$^2$.
[3] Device mounted on an FR4 PCB, 4-layer copper, tin-plated and standard footprint.
[4] Device mounted on an FR4 PCB, 4-layer copper, tin-plated; mounting pad for collector 1 cm$^2$.



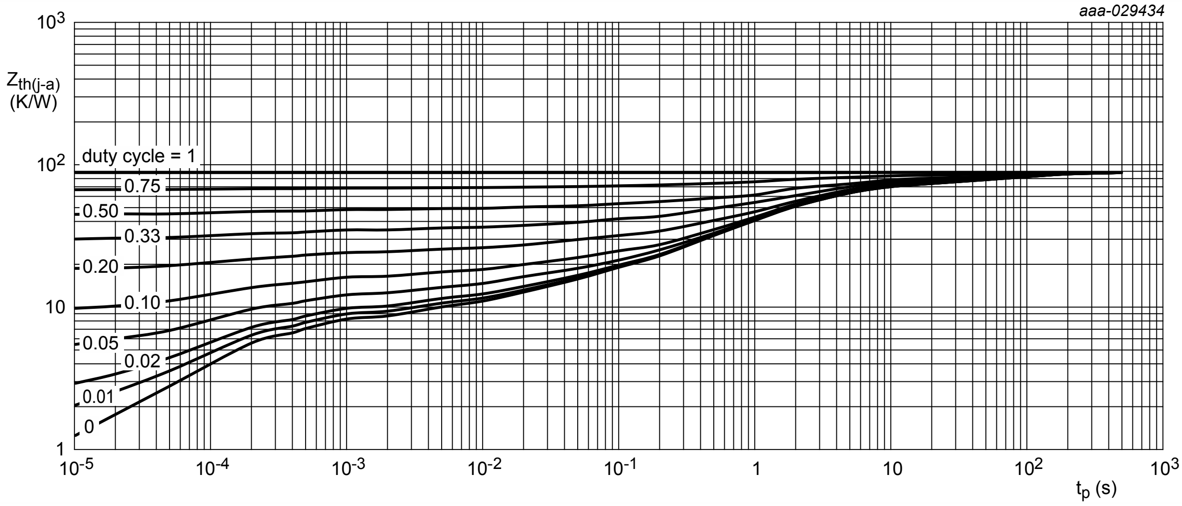

FR4 PCB; single-sided copper; tin-plated and standard footprint

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



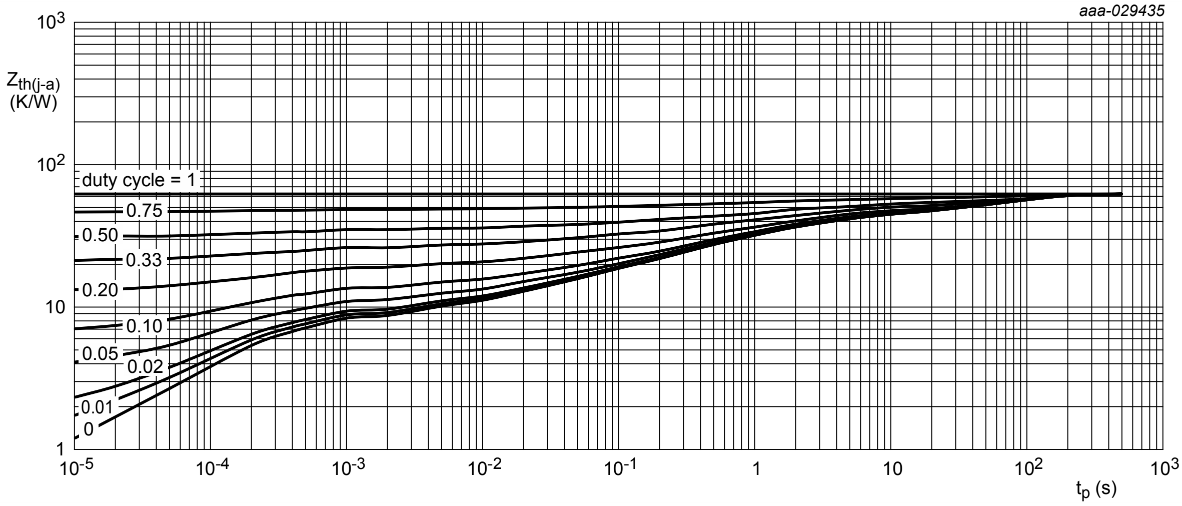

FR4 PCB; single-sided copper, tin-plated; mounting pad for collector 1 cm$^2$

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




FR4 PCB; 4-layer copper; tin-plated and standard footprint

**Fig. 4. Transient thermal impedance from junction to ambient as a function of pulse duration; typical values**




FR4 PCB; 4-layer copper, tin-plated; mounting pad for collector 1 $cm^2$

**Fig. 5. Transient thermal impedance from junction to ambient as a function of pulse duration; typical values**

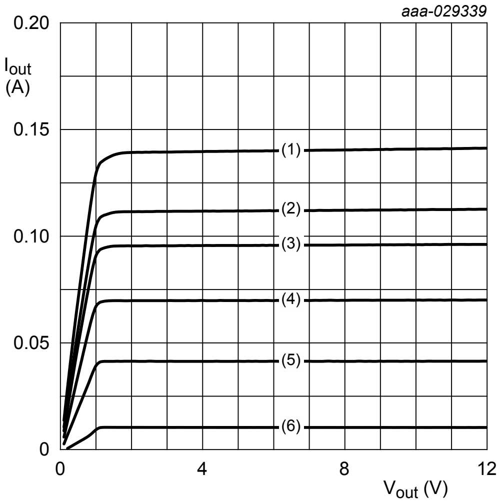
# 7. Characteristics

**Table 8. Characteristics**

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

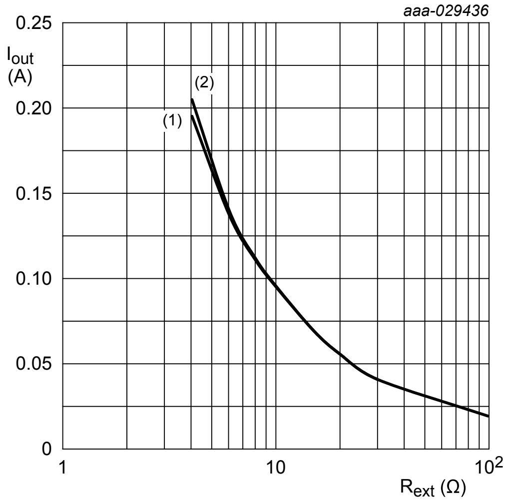
| Symbol | Parameter | Conditions | | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|---|
| $V_{(BR)CEO}$ | collector-emitter breakdown voltage | $I_C$ = 1 mA; $I_B$ = 0 A | | 40 | - | - | V |
| $h_{FE}$ | DC current gain | $V_{CE}$ =1 V; $I_C$ = 50 mA | [1] | 200 | 350 | - | |
| $R_{int}$ | internal resistor | $I_{Rint}$ = 10 mA | | 85 | 95 | 105 | Ω |
| $V_{Rint}$ | voltage drop at internal resistor $R_{int}$ | $I_{out}$ = 10 mA | [1] | 0.85 | 0.95 | 1.05 | V |
| $I_{EN}$ | enable current | | | | | | |
| | NCR420Z | $V_{EN}$ = 24 V | [1] | - | 1.2 | - | mA |
| | NCR421Z | $V_{EN}$ =3.3 V | [1] | - | 1.2 | - | mA |
| $R_B$ | bias resistor | | | | | | |
| | NCR420Z | | | - | 20 | - | kΩ |
| | NCR421Z | | | - | 1.5 | - | kΩ |
| $I_{out}$ | stabilized output current | | | | | | |
| | NCR420Z | $V_{EN}$ = 24 V; $V_{out}$ = 1.4 V | [1] | 9 | 10 | 11 | mA |
| | NCR421Z | $V_{EN}$ = 3.3 V; $V_{out}$ = 1.4 V | [1] | 9 | 10 | 11 | mA |
| $I_{out}$ | stabilized output current | | | | | | |
| | NCR420Z at $R_{ext}$ = 5.1 Ω | $V_{EN}$ = 24 V; $V_{out}$ > 2 V | [1] | - | 150 | - | mA |
| | NCR421Z at $R_{ext}$ = 5.1 Ω | $V_{EN}$ = 3.3 V; $V_{out}$ > 2 V | [1] | - | 150 | - | mA |
| $V_{out, min}$ | lowest sufficient output voltage overhead: $V_{out} = V_{CC} - V_{LED}$ | $I_{out}$> 10 mA | | - | 1.4 | - | V |
| $\Delta I_{out}/(I_{out} \times \Delta T_{amb})$ | stabilized output current change over ambient temperature | | | | | | |
| | NCR420Z | $V_{EN}$ = 24 V; $V_{out}$ > 2 V | [1] | - | -0.27 | - | %/K |
| | NCR421Z | $V_{EN}$ = 3.3 V; $V_{out}$ > 2 V | [1] | - | -0.27 | - | %/K |
| $\Delta I_{out}/(I_{out} \times \Delta V_{CC})$ | stabilized output current change over supply voltage | | | | | | |
| | NCR420Z | $V_{EN}$ = 24 V; $V_{out}$ > 2 V | [1] | - | 1 | - | %/V |
| | NCR421Z | $V_{EN}$ = 3.3 V; $V_{out}$ > 2 V | [1] | - | 1 | - | %/V |

[1] Pulse test: $t_p \leq 300$ µs; $\delta \leq 0.02$.



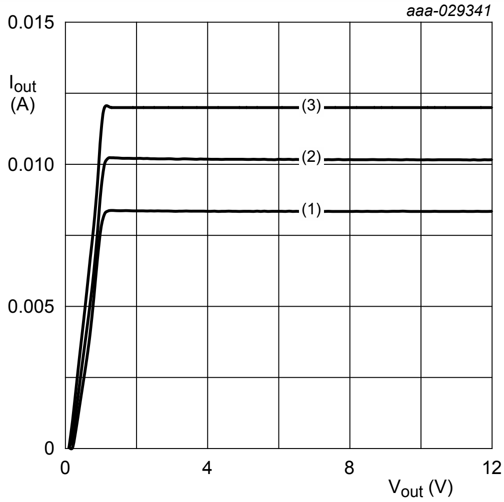

$V_{EN}$ = 40 V; $T_{amb}$ = 25 °C
(1) $R_{ext}$ = 6 Ω
(2) $R_{ext}$ = 8 Ω
(3) $R_{ext}$ = 10 Ω
(4) $R_{ext}$ = 15 Ω
(5) $R_{ext}$ = 30 Ω
(6) $R_{ext}$ = open

**Fig. 6. NCR420Z: Output current as a function of output voltage; typical values**



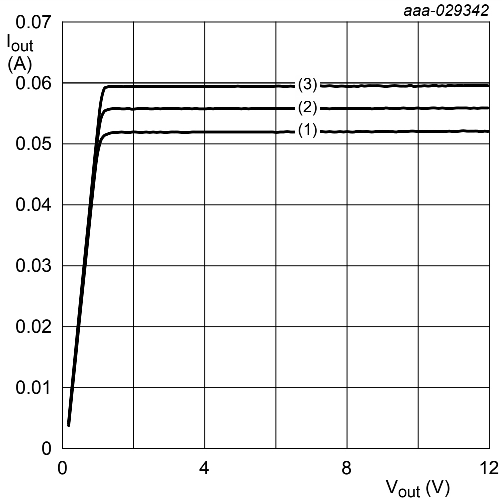

$V_{EN}$ = 40 V; $T_{amb}$ = 25 °C
(1) $V_{out}$ = 1.4 V
(2) $V_{out}$ = 5.4 V

**Fig. 7. NCR420Z: Output current as a function of external resistor; typical values**



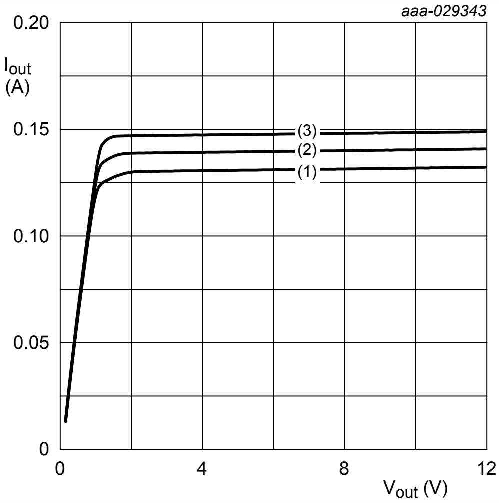

$V_{EN}$ = 40 V; $R_{ext}$ = open
(1) $T_{amb}$ = 85 °C
(2) $T_{amb}$ = 25 °C
(3) $T_{amb}$ = -40 °C

**Fig. 8. NCR420Z: Output current as a function of output voltage; typical values**



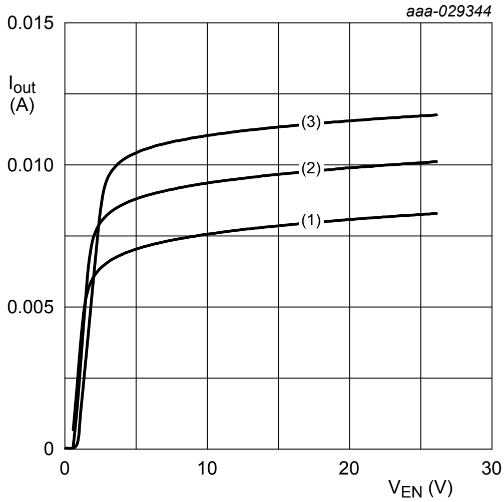

$V_{EN}$ = 40 V; $R_{ext}$ = 20 Ω
(1) $T_{amb}$ = 85 °C
(2) $T_{amb}$ = 25 °C
(3) $T_{amb}$ = -40 °C

**Fig. 9. NCR420Z: Output current as a function of output voltage; typical values**



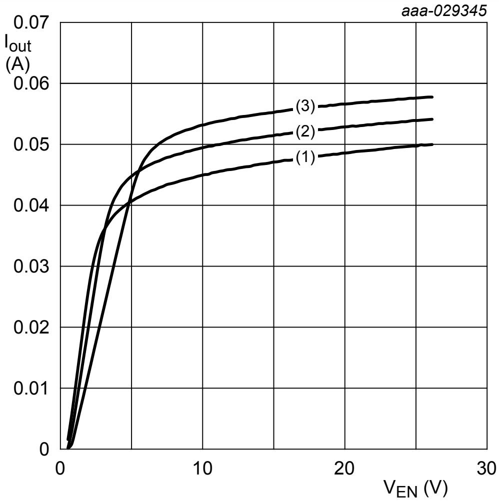

$V_{EN}$ = 40 V; $R_{ext}$ = 6 Ω
(1) $T_{amb}$ = 85 °C
(2) $T_{amb}$ = 25 °C
(3) $T_{amb}$ = -40 °C

**Fig. 10. NCR420Z: Output current as a function of output voltage; typical values**



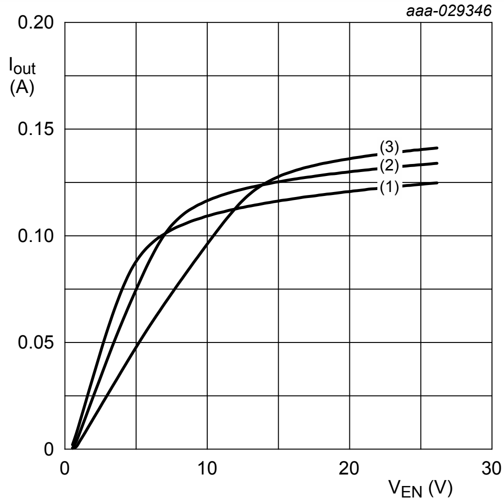

$V_{out}$ = 2 V; $R_{ext}$ = open
(1) $T_{amb}$ = 85 °C
(2) $T_{amb}$ = 25 °C
(3) $T_{amb}$ = -40 °C

**Fig. 11. NCR420Z: Output current as a function of enable voltage; typical values**



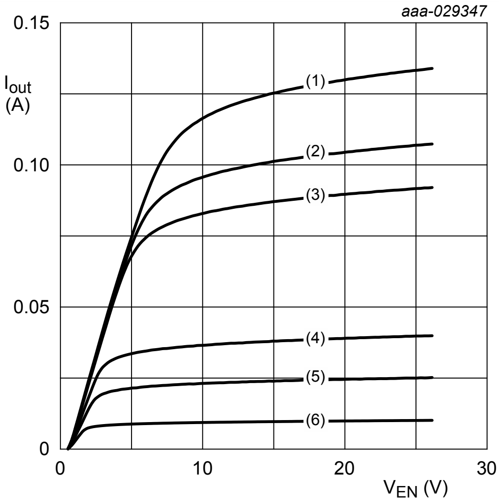

$V_{out}$ = 2 V; $R_{ext}$ = 20 Ω
(1) $T_{amb}$ = 85 °C
(2) $T_{amb}$ = 25 °C
(3) $T_{amb}$ = -40 °C

**Fig. 12. NCR420Z: Output current as a function of enable voltage; typical values**



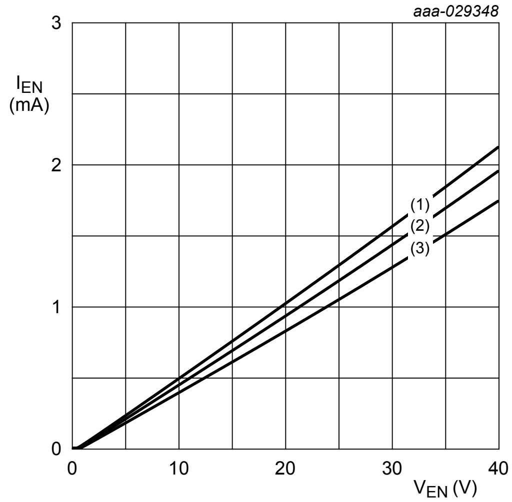

$V_{out}$ = 2 V; $R_{ext}$ = 6 Ω
(1) $T_{amb}$ = 85 °C
(2) $T_{amb}$ = 25 °C
(3) $T_{amb}$ = -40 °C

**Fig. 13. NCR420Z: Output current as a function of enable voltage; typical values**



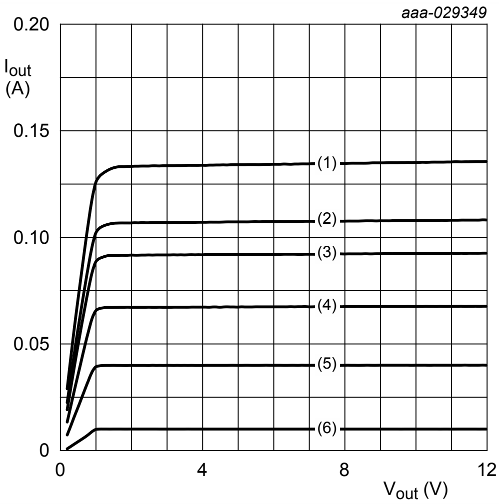

$V_{out}$ = 2 V; $T_{amb}$ = 25 °C
(1) $R_{ext}$ = 6 Ω
(2) $R_{ext}$ = 8 Ω
(3) $R_{ext}$ = 10 Ω
(4) $R_{ext}$ = 30 Ω
(5) $R_{ext}$ = 60 Ω
(6) $R_{ext}$ = open

**Fig. 14. NCR420Z: Output current as a function of enable voltage; typical values**



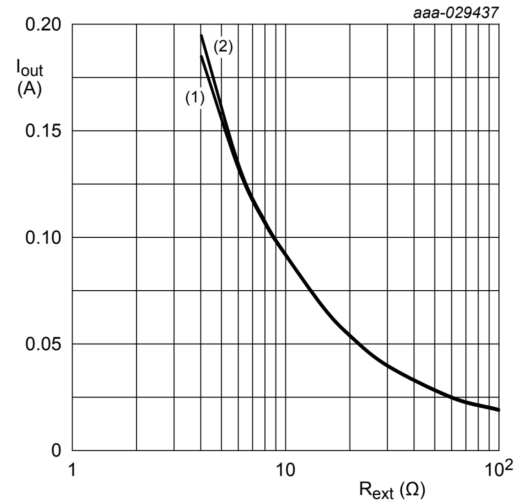

$I_{out}$ = 0 A; $R_{ext}$ = open
(1) $T_{amb}$ = 85 °C
(2) $T_{amb}$ = 25 °C
(3) $T_{amb}$ = -40 °C

**Fig. 15. NCR420Z: Enable current as a function of enable voltage; typical values**



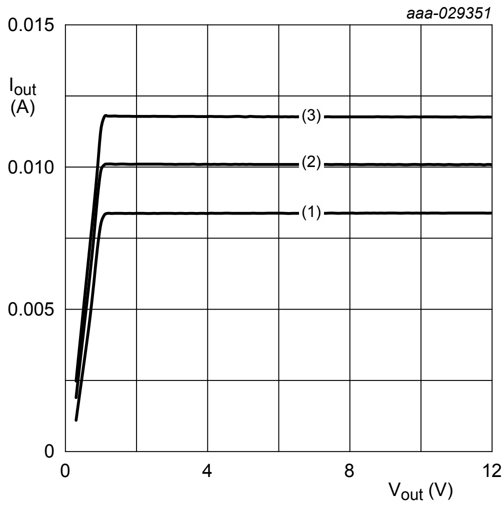

$V_{EN}$ = 3.3 V; $T_{amb}$ = 25 °C
(1) $R_{ext}$ = 6 Ω
(2) $R_{ext}$ = 8 Ω
(3) $R_{ext}$ = 10 Ω
(4) $R_{ext}$ = 15 Ω
(5) $R_{ext}$ = 30 Ω
(6) $R_{ext}$ = open

**Fig. 16. NCR421Z: Output current as a function of output voltage; typical values**



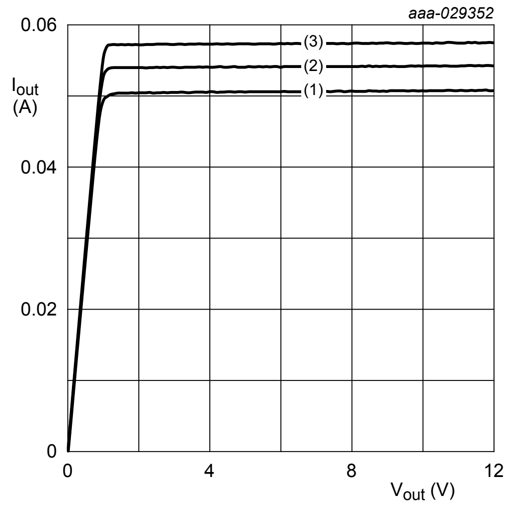

$V_{EN}$ = 3.3 V; $T_{amb}$ = 25 °C
(1) $V_{out}$ = 1.4 V
(2) $V_{out}$ = 5.4 V

**Fig. 17. NCR421Z: Output current as a function of external resistor; typical values**



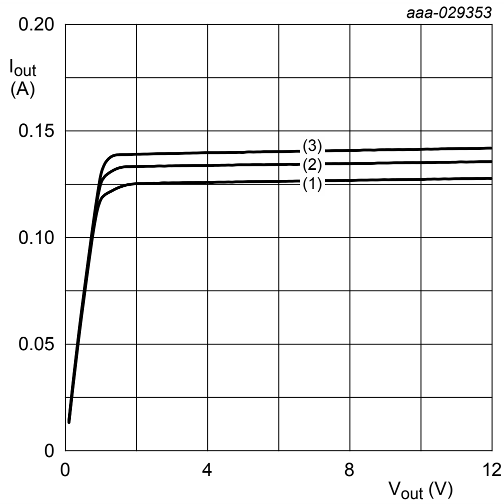

$V_{EN}$ = 3.3 V; $R_{ext}$ = open
(1) $R_{ext}$ = 85 °C
(2) $R_{ext}$ = 25 °C
(3) $R_{ext}$ = -40 °C

**Fig. 18. NCR421Z: Output current as a function of output voltage; typical values**



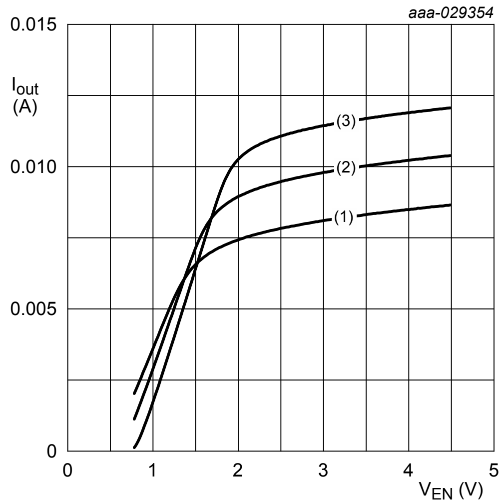

$V_{EN}$ = 3.3 V; $R_{ext}$ = 20 Ω
(1) $R_{ext}$ = 85 °C
(2) $R_{ext}$ = 25 °C
(3) $R_{ext}$ = -40 °C

**Fig. 19. NCR421Z: Output current as a function of output voltage; typical values**



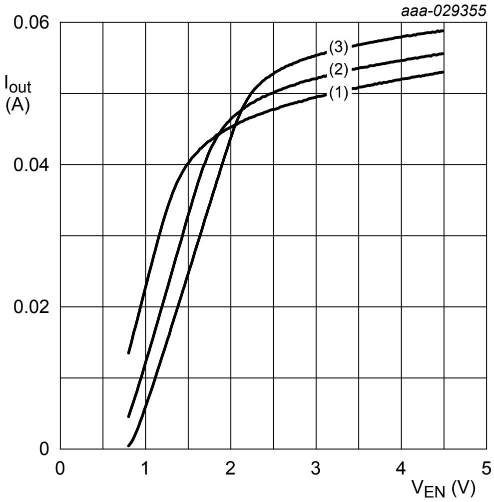

$V_{EN}$ = 3.3 V; $R_{ext}$ = 6 Ω
(1) $R_{ext}$ = 85 °C
(2) $R_{ext}$ = 25 °C
(3) $R_{ext}$ = -40 °C

**Fig. 20. NCR421Z: Output current as a function of output voltage; typical values**



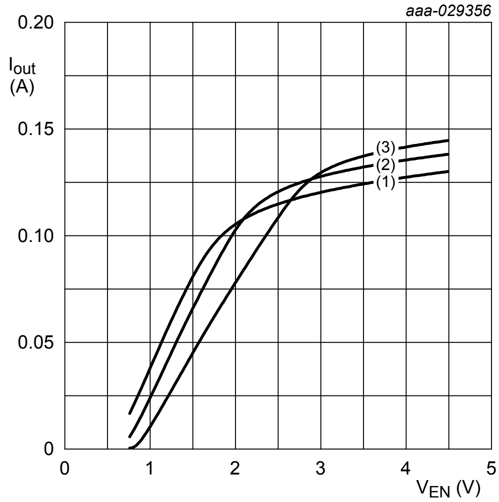

$V_{out}$ = 2 V; $R_{ext}$ = open
(1) $R_{ext}$ = 85 °C
(2) $R_{ext}$ = 25 °C
(3) $R_{ext}$ = -40 °C

**Fig. 21. NCR421Z: Output current as a function of enable voltage; typical values**



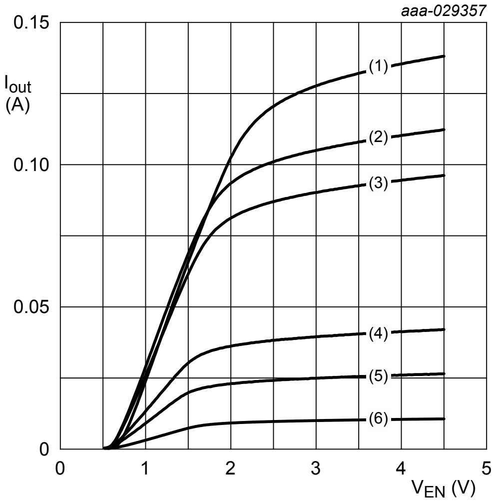

$V_{out}$ = 2 V; $R_{ext}$ = 20 Ω
(1) $R_{ext}$ = 85 °C
(2) $R_{ext}$ = 25 °C
(3) $R_{ext}$ = -40 °C

**Fig. 22. NCR421Z: Output current as a function of enable voltage; typical values**



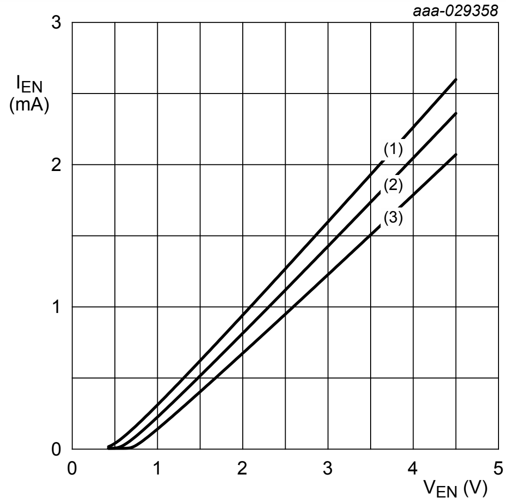

$V_{out}$ = 2 V; $R_{ext}$ = 6 Ω
(1) $R_{ext}$ = 85 °C
(2) $R_{ext}$ = 25 °C
(3) $R_{ext}$ = -40 °C

**Fig. 23. NCR421Z: 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) $R_{ext}$ = open

**Fig. 24. NCR421Z: Output current as a function of enable voltage; typical values**




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

**Fig. 25. NCR421Z: Enable current as a function of enable voltage; typical values**

# 8. Application information

Figure 26 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 7 and 17 give a first indication for choosing the external resitor $R_{ext}$. 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

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

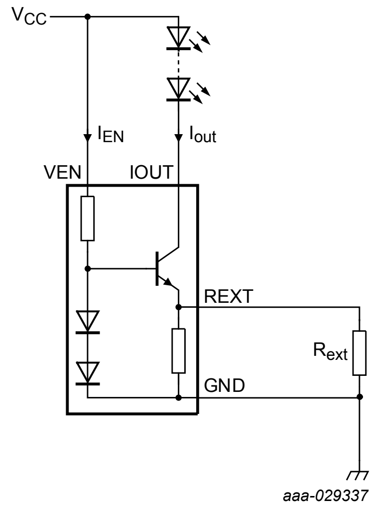



**Fig. 26. LED driver application diagram**

NCR421Z 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 23. Figure 27 shows a typical application where VEN is driven via a micro directly. To control more than one NCR421Z devices by one microcontroller output, a shift register (for example 74AHC(T)594PW) can be used.

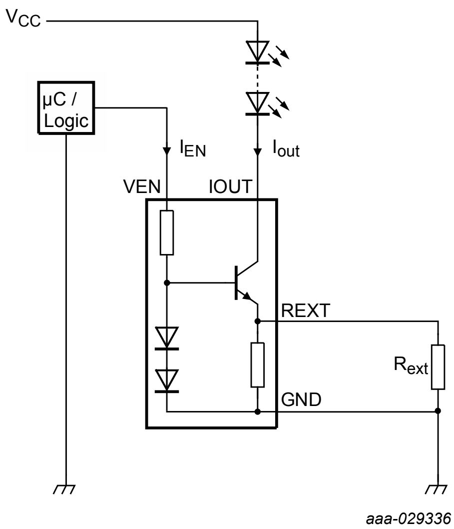



**Fig. 27. Application diagram: PWM dimming function**

To savely drive currents that are above the limits of the NCR42xZ, two or more devices can be parallel connected as illustrated in Figure 28. When choosing the same values for the external resistors, the drive current splits equally and the capability of handling excess power is doubled. Both, NCR420Z and NCR421Z can be used in this configuration.

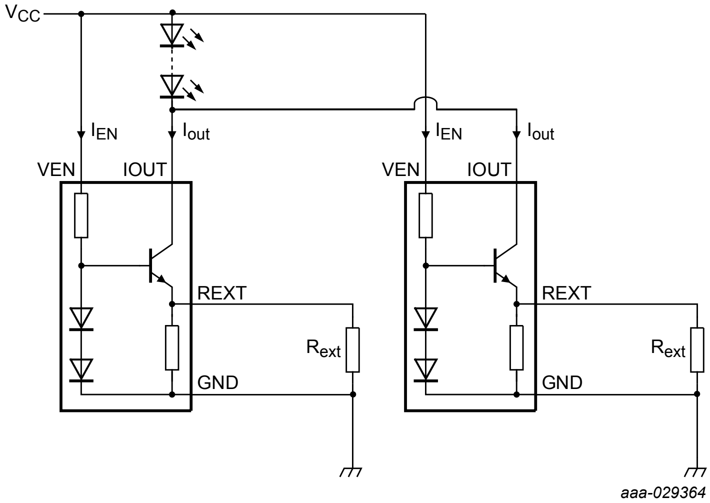
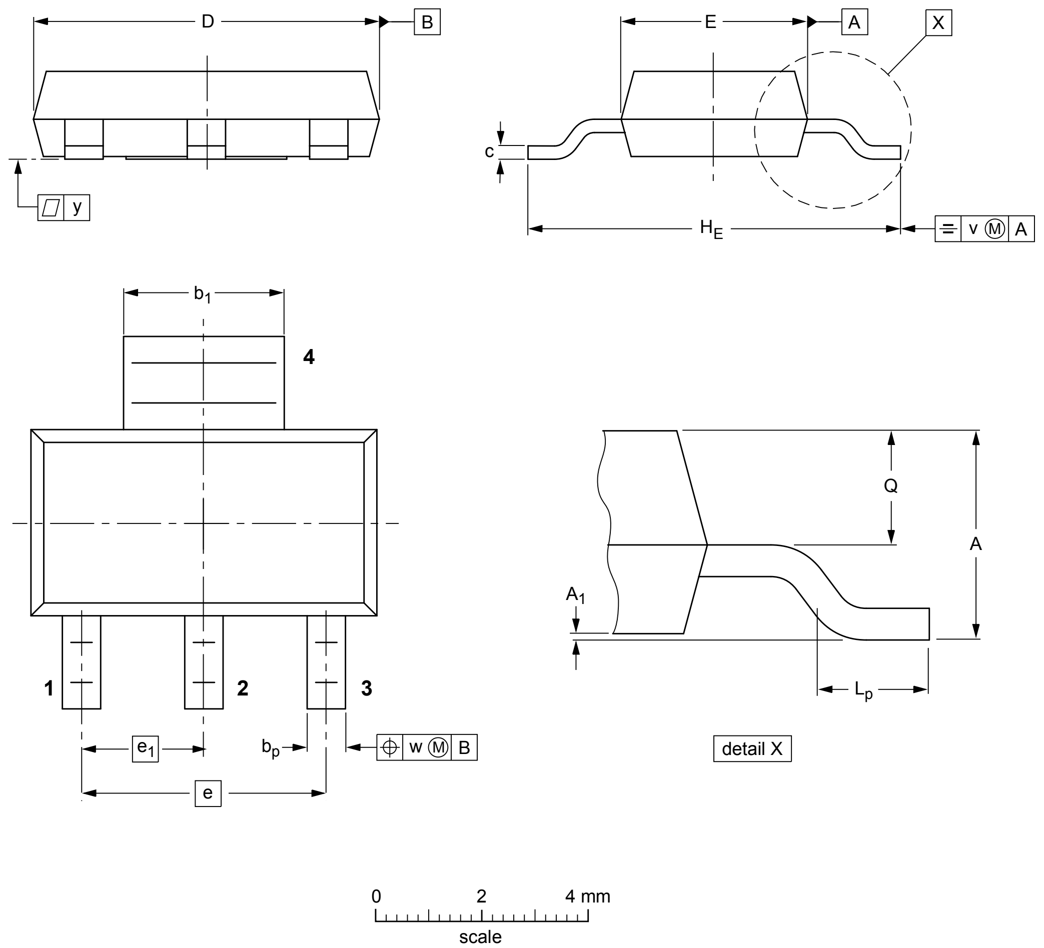



**Fig. 28. Application diagram: Parallelization**

# 9. Package outline

**Table 9. Package outline**

**Plastic surface-mounted package with increased heatsink; 4 leads** **SOT223**




DIMENSIONS (mm are the original dimensions)

| UNIT | A | $A_1$ | $b_p$ | $b_1$ | c | D | E | e | $e_1$ | $H_E$ | $L_p$ | Q | v | w | y |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| mm | 1.8<br>1.5 | 0.10<br>0.01 | 0.80<br>0.60 | 3.1<br>2.9 | 0.32<br>0.22 | 6.7<br>6.3 | 3.7<br>3.3 | 4.6 | 2.3 | 7.3<br>6.7 | 1.1<br>0.7 | 0.95<br>0.85 | 0.2 | 0.1 | 0.1 |

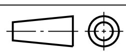
| OUTLINE VERSION | REFERENCES | | | | EUROPEAN PROJECTION | ISSUE DATE |
|---|---|---|---|---|---|---|
| | IEC | JEDEC | JEITA | | | |
| SOT223 | | | SC-73 | |  | ~~04-11-10~~<br>06-03-16 |

**Fig. 29. Package outline SC-73 (SOT223)**

# 10. Soldering

Table 10. Soldering

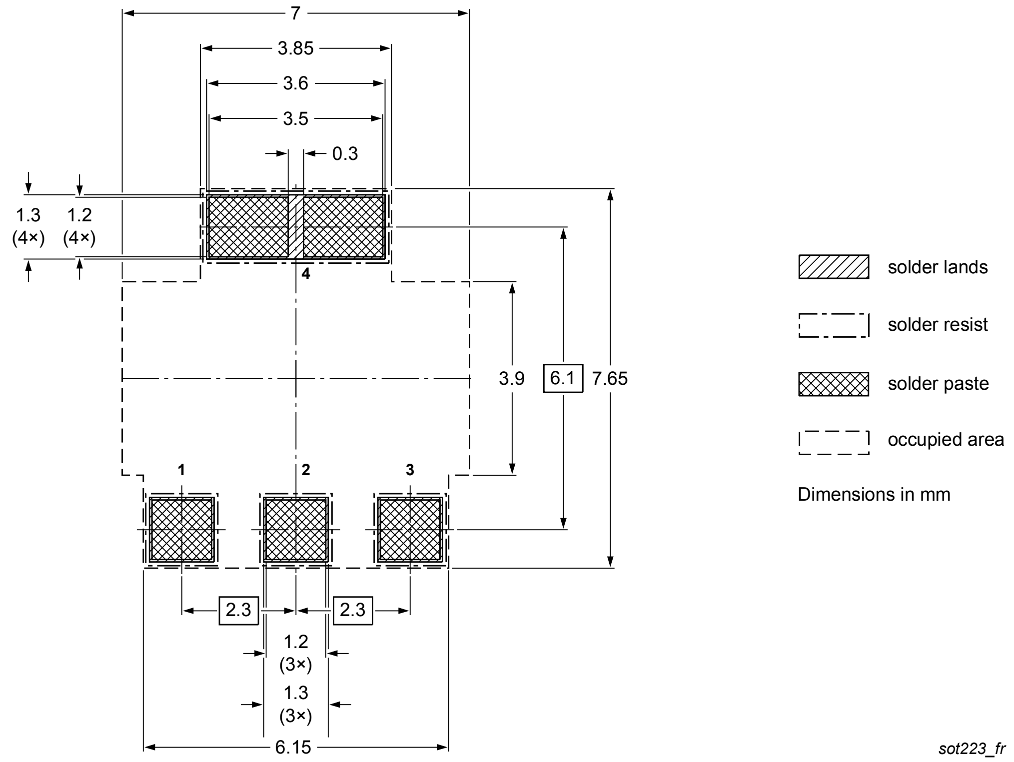



Fig. 30. Reflow soldering footprint for SC-73 (SOT223)

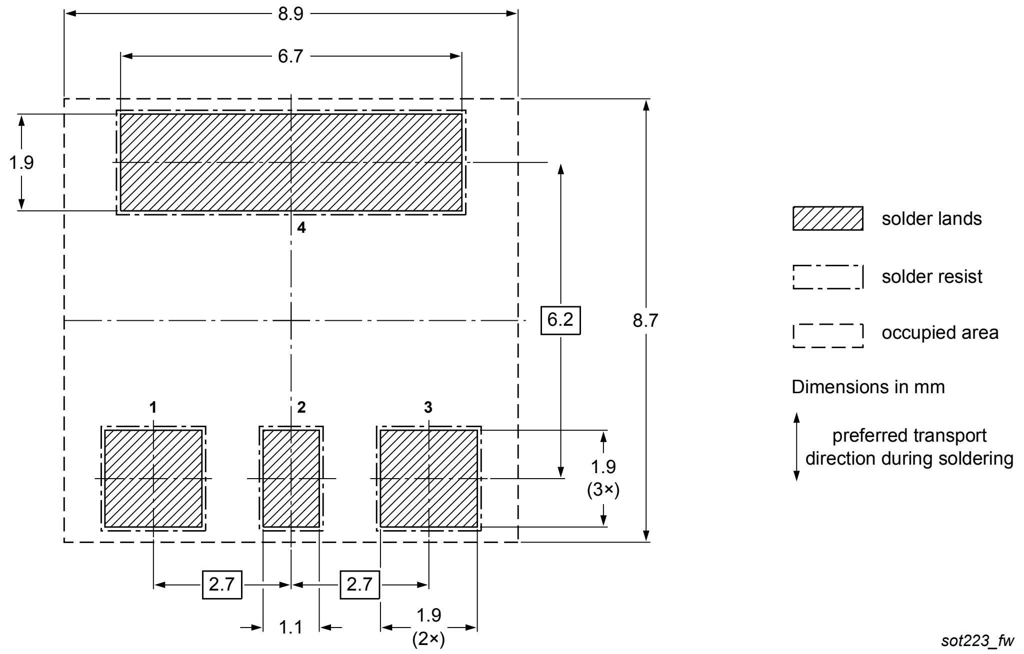



Fig. 31. Wave soldering footprint for SC-73 (SOT223)

## 11. Revision history

**Table 11. Revision history**

| Document ID | Release date | Data sheet status | Change notice | Supersedes |
|---|---|---|---|---|
| NCR420Z_NCR421Z v.1 | 20190204 | Product data sheet | - | - |

# 12. 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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**Date of release: 4 February 2019**