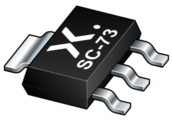


NCR320Z / NCR321Z

250 mA LED driver in SOT223

Rev. 1 — 4 February 2019 | Product data sheet

1. Product profile

1.1. General description

LED driver consisting of a resistor-equipped NPN transistor with two diodes on one chip in a medium power SOT223 (SC-73) Surface-Mounted Device (SMD) plastic package.

Table 1. Product overview

Type number	Package	
	Nexperia	JEITA
NCR320Z	SOT223	SC-73
NCR321Z	SOT223	SC-73

1.2. Features and benefits

- Stabilized output current of 10 mA without external resistor
- Stabilized output current adjustable up to 250 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 16 V
- Digital PWM input up to 10 kHz frequency for NCR321Z
- 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

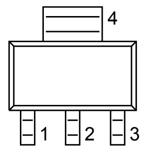
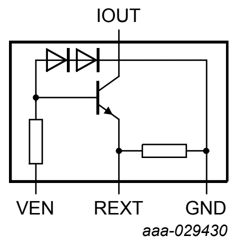
Table 2. Quick reference data

Symbol	Parameter	Conditions		Min	Typ	Max	Unit
V_{EN}	enable voltage						
	NCR320Z			-	-	25	V
	NCR321Z			-	-	4.5	V
V_{out}	output voltage			-	-	16	V
I_{out}	stabilized output current						
	NCR320Z	V_{out}= 1.4 V; V_{EN}= 12 V	[1]	9	10	11	mA
	NCR321Z	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
NCR320Z	SC-73	plastic surface-mounted package with increased heatsink; 4 leads	SOT223
NCR321Z	SC-73	plastic surface-mounted package with increased heatsink; 4 leads	SOT223

4. Marking

Table 5. Marking codes

Type number	Marking code
NCR320Z	CR320Z
NCR321Z	CR321Z

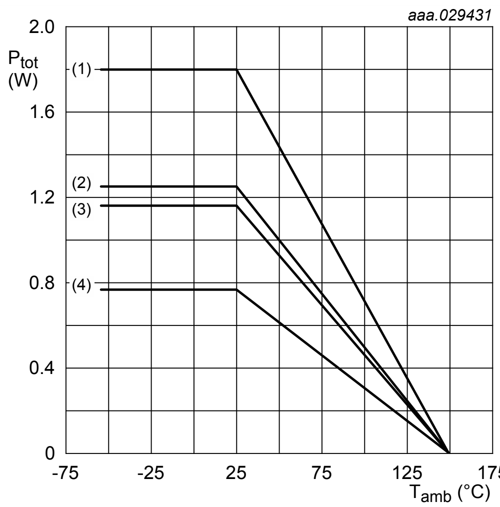
5. Limiting values

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			-	300	mA
V_{EN}	enable voltage					
	NCR320Z			-	25	V
	NCR321Z			-	4.5	V
V_{out}	output voltage			-	16	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

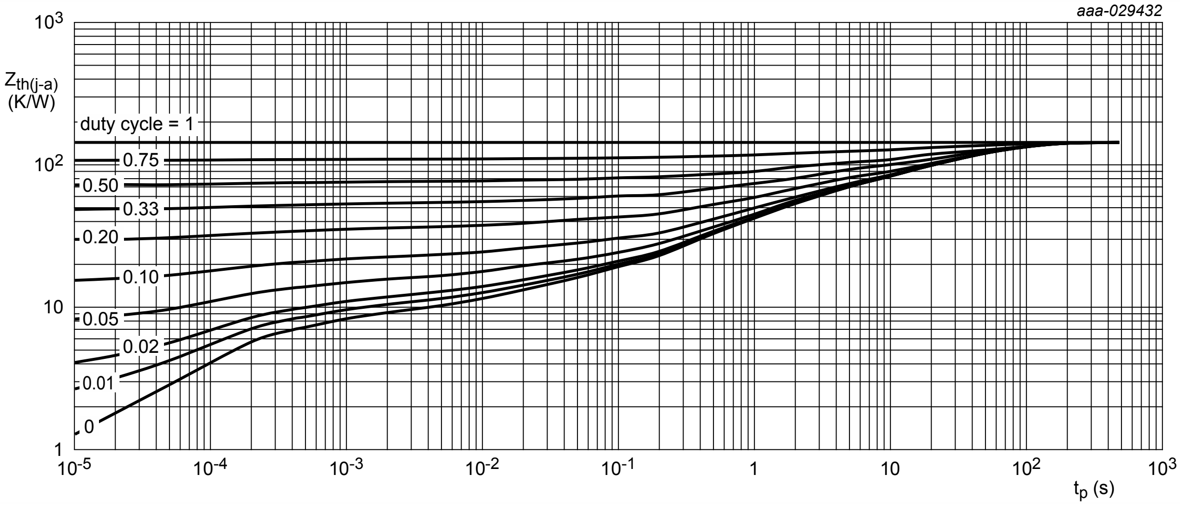
Fig. 1. Power derating curve

6. Thermal characteristics

Table 7. Thermal characteristics

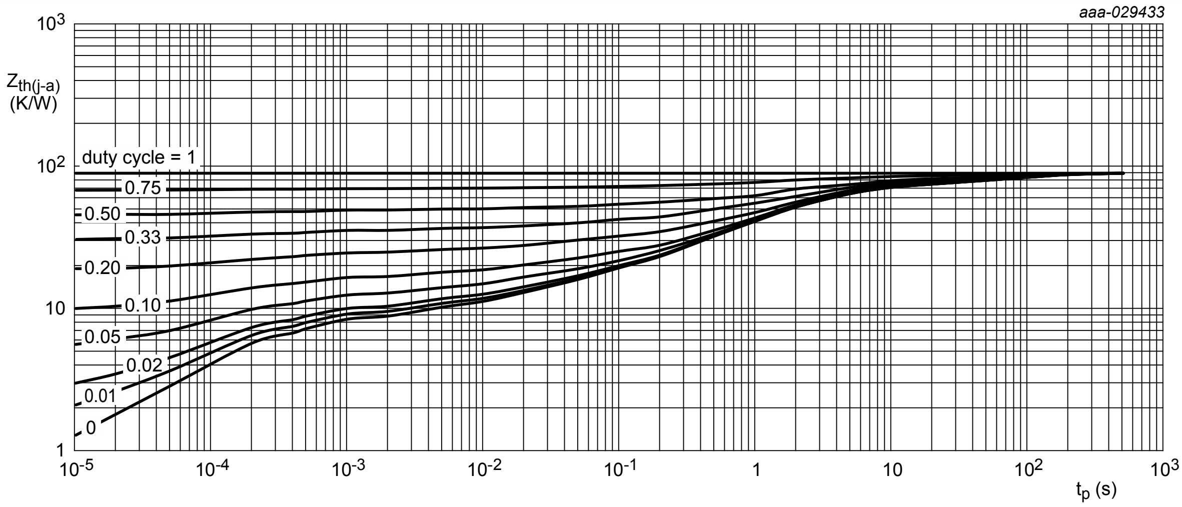
Symbol	Parameter	Conditions		Min	Typ	Max	Unit
$R_{th(j-a)}$	thermal resistance from junction to ambient	in free air	[1]	-	-	164	K/W
			[2]	-	-	108	K/W
			[3]	-	-	100	K/W
			[4]	-	-	70	K/W
$R_{th(j-sp)}$	thermal resistance from junction to solder point			-	-	27	K/W

[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.



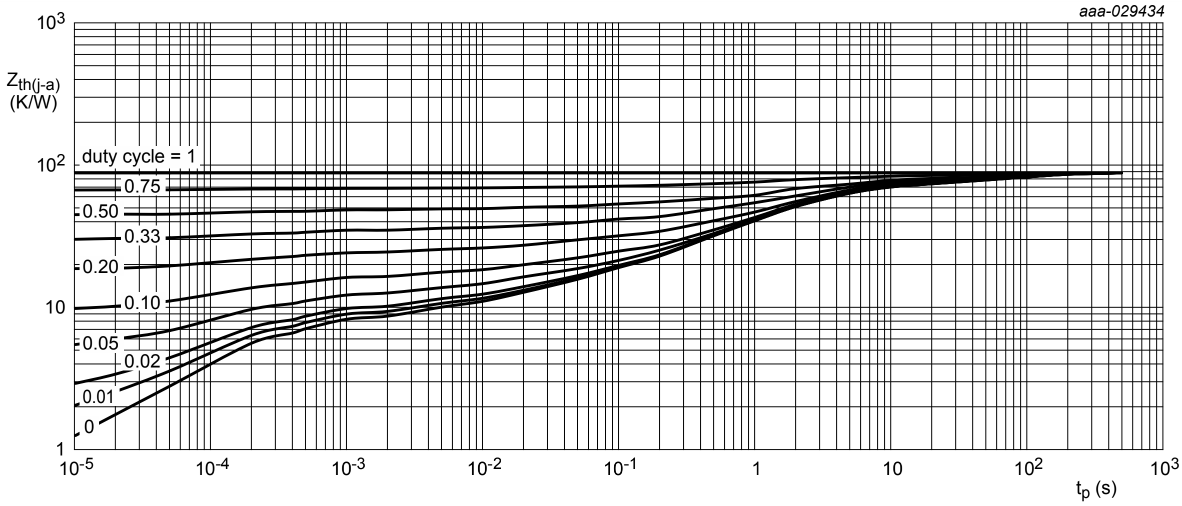
FR4 PCB; single-sided copper; tin-plated and standard footprint

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



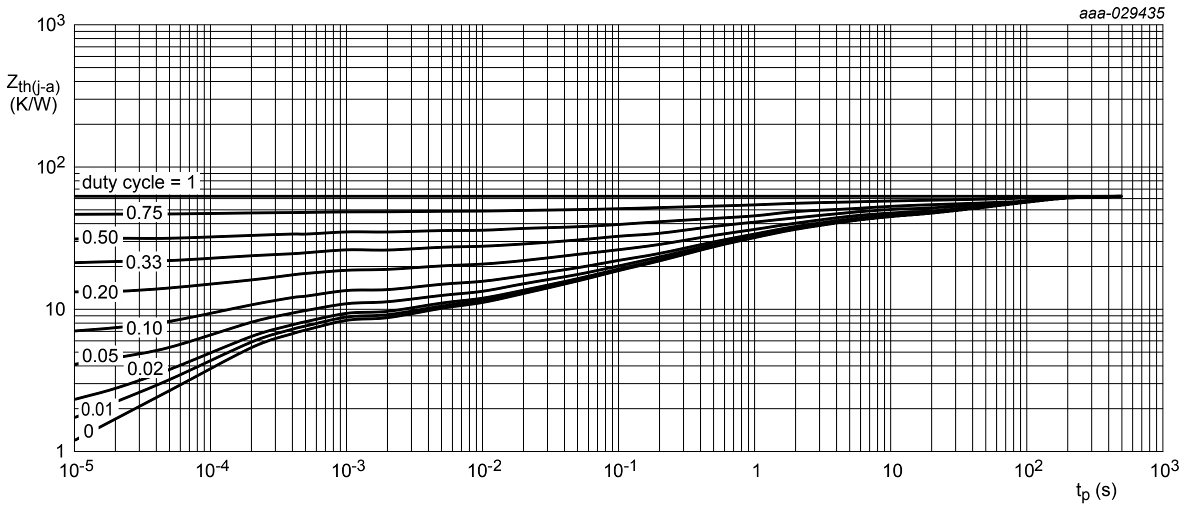
FR4 PCB; single-sided copper, tin-plated; mounting pad for collector 1 cm ^{2}

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

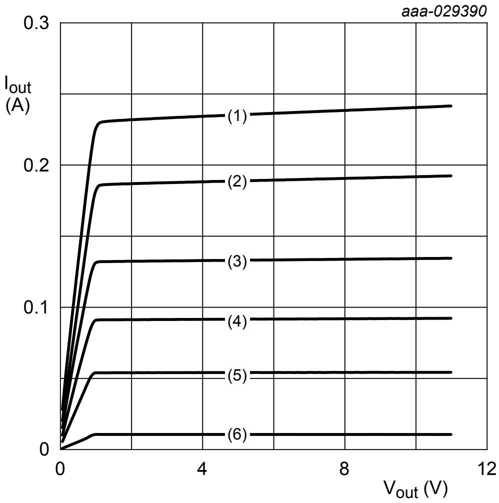
7. Characteristics

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		16	-	-	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						
	NCR320Z	V_{EN} = 12 V	[1]	-	1.2	-	mA
	NCR321Z	V_{EN} =3.3 V	[1]	-	1.2	-	mA
R_B	bias resistor						
	NCR320Z			-	10	-	kΩ
	NCR321Z			-	1.5	-	kΩ
I_{out}	stabilized output current						
	NCR320Z	V_{EN} = 12 V; V_{out} = 1.4 V	[1]	9	10	11	mA
	NCR321Z	V_{EN} = 3.3 V; V_{out} = 1.4 V	[1]	9	10	11	mA
I_{out}	stabilized output current						
	NCR320Z at R_{ext} = 3 Ω	V_{EN} = 12 V; V_{out} > 1.4 V	[1]	-	250	-	mA
	NCR321Z at R_{ext} = 3 Ω	V_{EN} = 3.3 V; V_{out} > 1.4 V	[1]	-	250	-	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						
	NCR320Z	V_{EN} = 12 V; V_{out} > 2 V	[1]	-	-0.27	-	%/K
	NCR321Z	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						
	NCR320Z	V_{EN} = 12 V; V_{out} > 2 V	[1]	-	1	-	%/V
	NCR321Z	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} = 12 V; T_{amb} = 25 °C

(1) R_{ext} = 3 Ω

(2) R_{ext} = 4 Ω

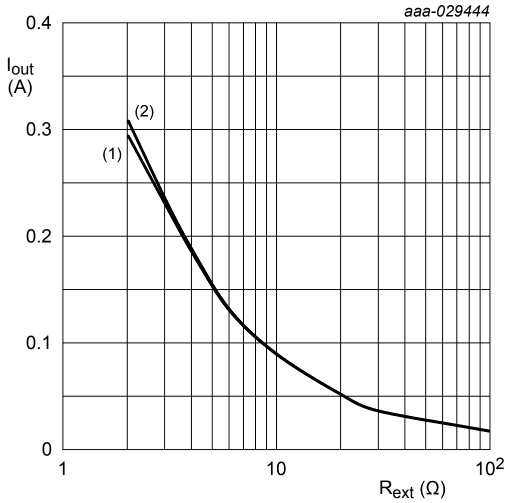
(3) R_{ext} = 6 Ω

(4) R_{ext} = 10 Ω

(5) R_{ext} = 20 Ω

(6) R_{ext} = open

Fig. 6. NCR320Z: Output current as a function of output voltage; typical values

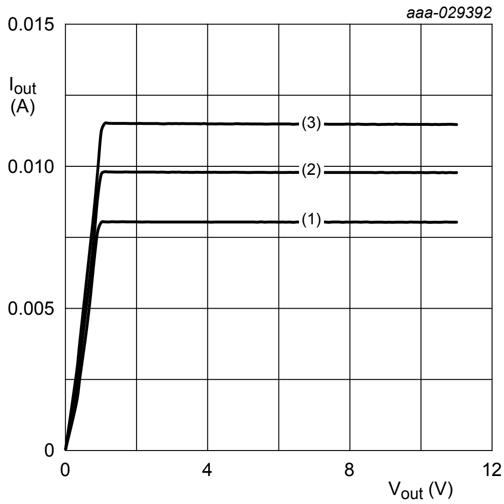


V_{EN} = 12 V; T_{amb} = 25 °C

(1) V_{out} = 1.4 V

(2) V_{out} = 5.4 V

Fig. 7. NCR320Z: Output current as a function of external resistor; typical values



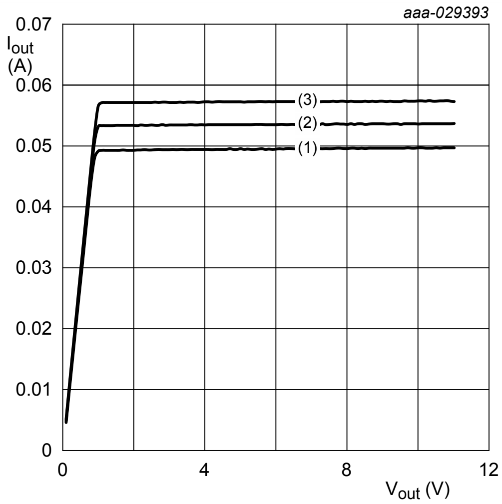
V_{EN} = 12 V; R_{ext} = open

(1) T_{amb} = 85 °C

(2) T_{amb} = 25 °C

(3) T_{amb} = -40 °C

Fig. 8. NCR320Z: Output current as a function of output voltage; typical values



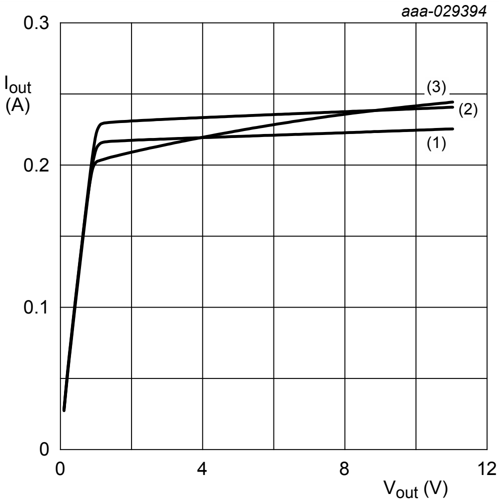
V_{EN} = 12 V; R_{ext} = 20 Ω

(1) T_{amb} = 85 °C

(2) T_{amb} = 25 °C

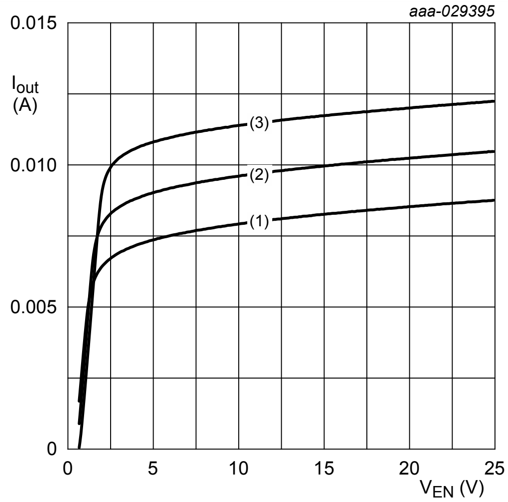
(3) T_{amb} = -40 °C

Fig. 9. NCR320Z: Output current as a function of output voltage; typical values



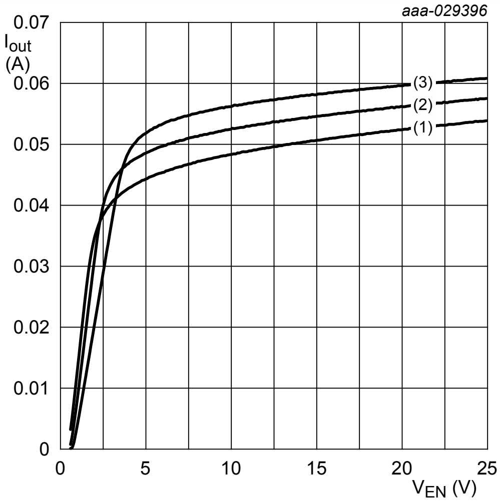
V_{EN} = 12 V; R_{ext} = 3 Ω
(1) T_{amb} = 85 °C
(2) T_{amb} = 25 °C
(3) T_{amb} = -40 °C

Fig. 10. NCR320Z: Output current as a function of output voltage; typical values



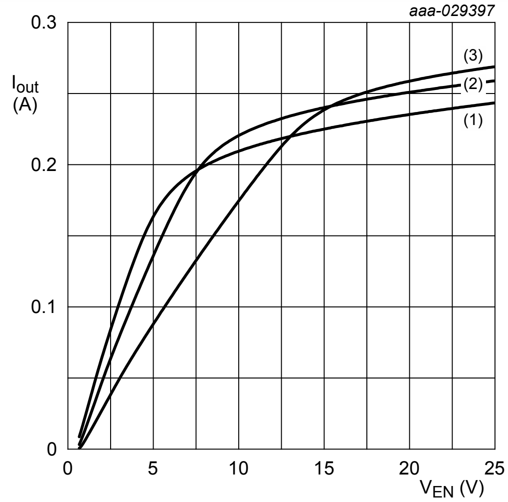
V_{out} = 2 V; R_{ext} = open
(1) T_{amb} = 85 °C
(2) T_{amb} = 25 °C
(3) T_{amb} = -40 °C

Fig. 11. NCR320Z: Output current as a function of enable voltage; typical values



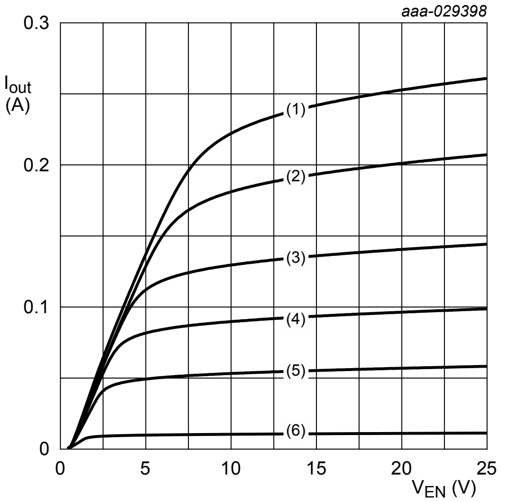
V_{out} = 2 V; R_{ext} = 20 Ω
(1) T_{amb} = 85 °C
(2) T_{amb} = 25 °C
(3) T_{amb} = -40 °C

Fig. 12. NCR320Z: Output current as a function of enable voltage; typical values



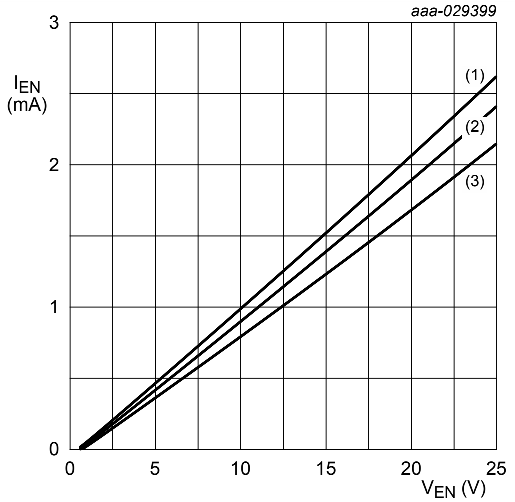
V_{out} = 2 V; R_{ext} = 3 Ω
(1) T_{amb} = 85 °C
(2) T_{amb} = 25 °C
(3) T_{amb} = -40 °C

Fig. 13. NCR320Z: Output current as a function of enable voltage; typical values



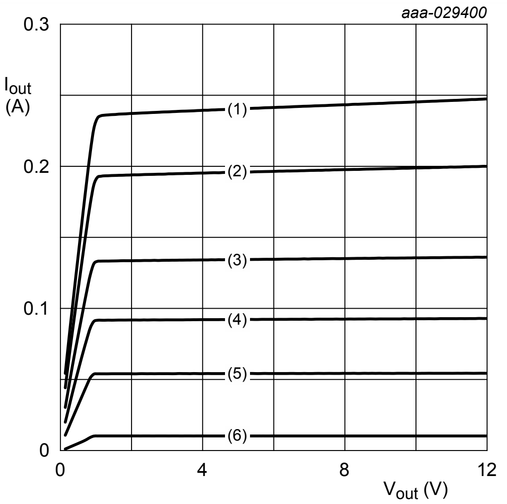
V_{out} = 2 V; T_{amb} = 25 °C
(1) R_{ext} = 3 Ω
(2) R_{ext} = 4 Ω
(3) R_{ext} = 6 Ω
(4) R_{ext} = 10 Ω
(5) R_{ext} = 20 Ω
(6) R_{ext} = open

Fig. 14. NCR320Z: Output current as a function of enable voltage; typical values



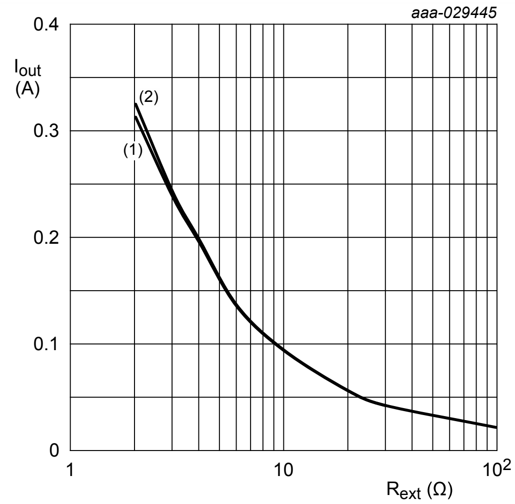
I_{out} = 0 A; R_{ext} = open
(1) T_{amb} = 85 °C
(2) T_{amb} = 25 °C
(3) T_{amb} = -40 °C

Fig. 15. NCR320Z: Enable current as a function of enable voltage; typical values



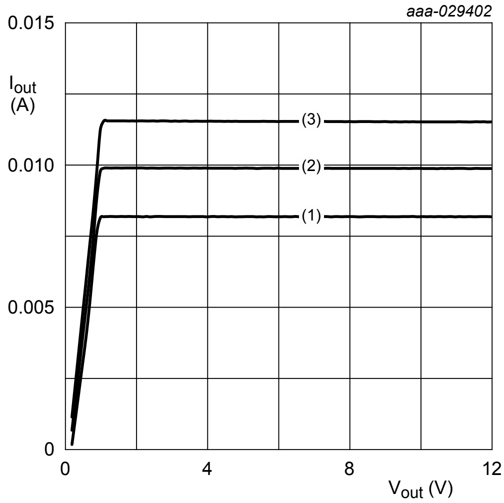
V_{EN} = 3.3 V; T_{amb} = 25 °C
(1) R_{ext} = 3 Ω
(2) R_{ext} = 4 Ω
(3) R_{ext} = 6 Ω
(4) R_{ext} = 10 Ω
(5) R_{ext} = 20 Ω
(6) R_{ext} = open

Fig. 16. NCR321Z: Output current as a function of output voltage; typical values



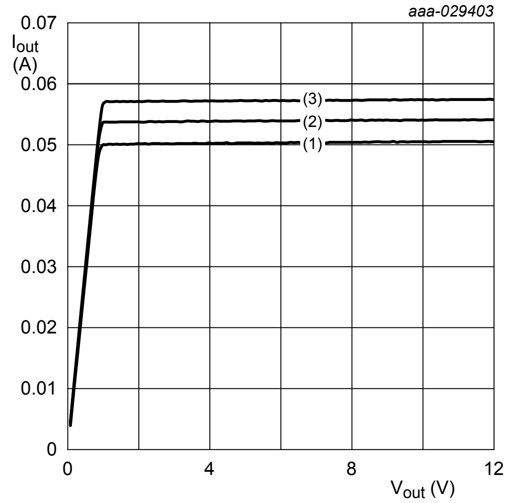
V_{EN} = 3.3 V; T_{amb} = 25 °C
(1) V_{out} = 1.4 V
(2) V_{out} = 5.4 V

Fig. 17. NCR321Z: Output current as a function of external resistor; typical values



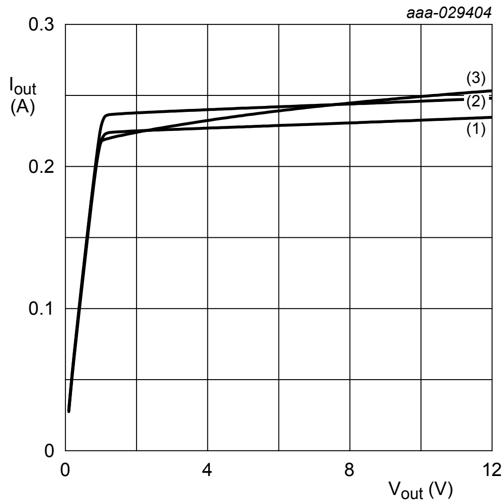
V_{EN} = 3.3 V; R_{ext} = open
(1) R_{ext} = 85 °C
(2) R_{ext} = 25 °C
(3) R_{ext} = -40 °C

Fig. 18. NCR321Z: Output current as a function of output voltage; typical values



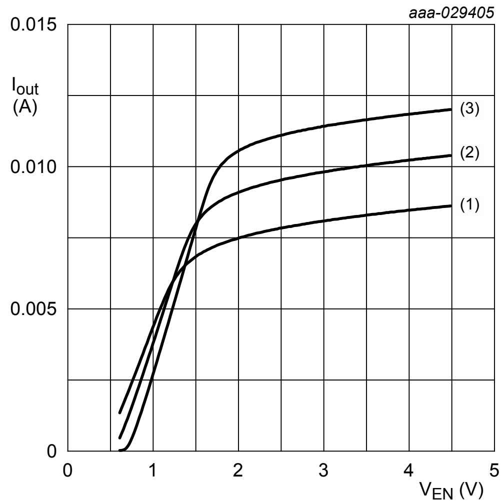
V_{EN} = 3.3 V; R_{ext} = 20 Ω
(1) R_{ext} = 85 °C
(2) R_{ext} = 25 °C
(3) R_{ext} = -40 °C

Fig. 19. NCR321Z: Output current as a function of output voltage; typical values



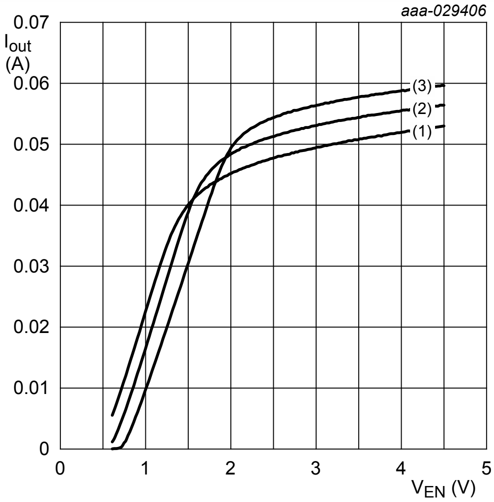
V_{EN} = 3.3 V; R_{ext} = 3 Ω
(1) R_{ext} = 85 °C
(2) R_{ext} = 25 °C
(3) R_{ext} = -40 °C

Fig. 20. NCR321Z: Output current as a function of output voltage; typical values



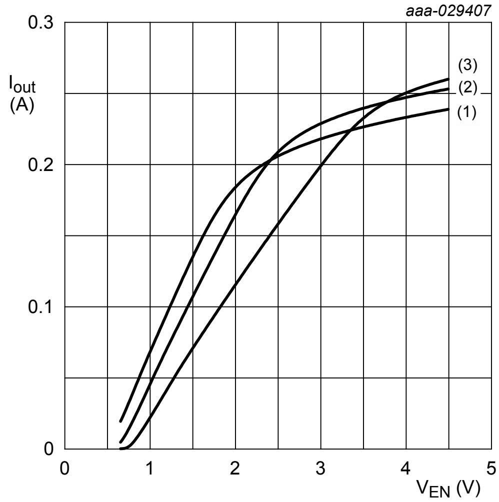
V_{out} = 2 V; R_{ext} = open
(1) R_{ext} = 85 °C
(2) R_{ext} = 25 °C
(3) R_{ext} = -40 °C

Fig. 21. NCR321Z: Output current as a function of enable voltage; typical values



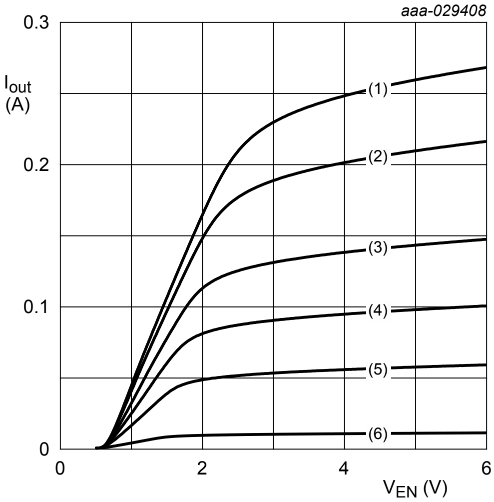
V_{out} = 2 V; R_{ext} = 20 Ω
(1) R_{ext} = 85 °C
(2) R_{ext} = 25 °C
(3) R_{ext} = -40 °C

Fig. 22. NCR321Z: Output current as a function of enable voltage; typical values



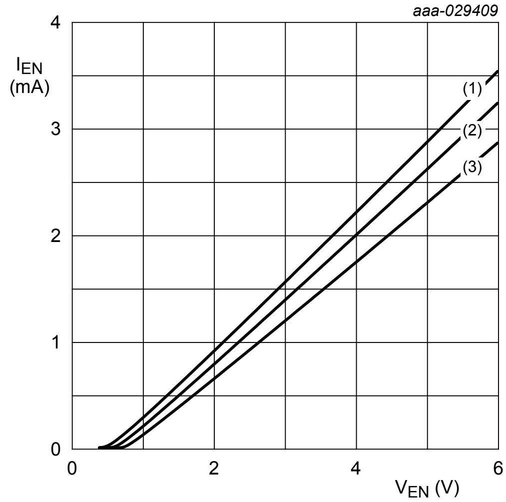
V_{out} = 2 V; R_{ext} = 3 Ω
(1) R_{ext} = 85 °C
(2) R_{ext} = 25 °C
(3) R_{ext} = -40 °C

Fig. 23. NCR321Z: Output current as a function of enable voltage; typical values



V_{out} = 2 V; T_{amb} = 25 °C
(1) R_{ext} = 3 Ω
(2) R_{ext} = 4 Ω
(3) R_{ext} = 6 Ω
(4) R_{ext} = 10 Ω
(5) R_{ext} = 20 Ω
(6) R_{ext} = open

Fig. 24. NCR321Z: 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. NCR321Z: 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 250 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

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

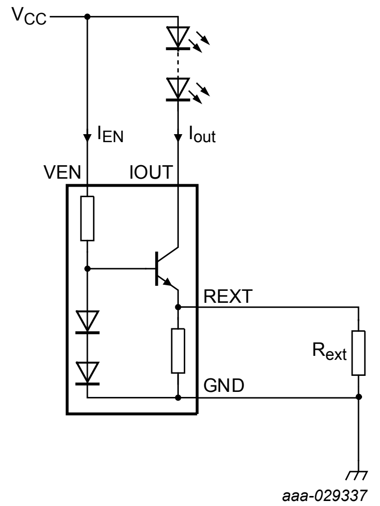


Fig. 26. LED driver application diagram

NCR321Z 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 NCR321Z devices by one microcontroller output, a shift register (for example 74AHC(T)594PW) can be used.

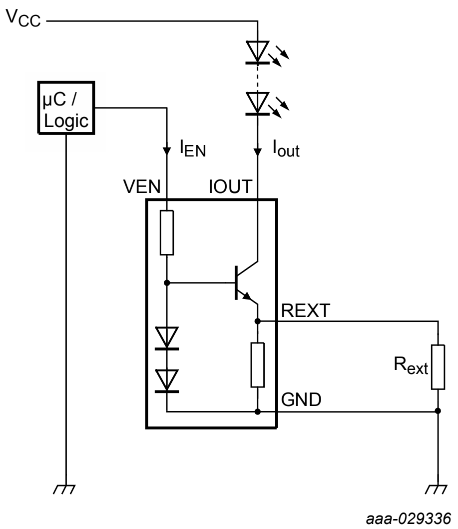


Fig. 27. Application diagram: PWM dimming function

To savely drive currents that are above the limits of the NCR32xZ, 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, NCR320Z and NCR321Z can be used in this configuration.

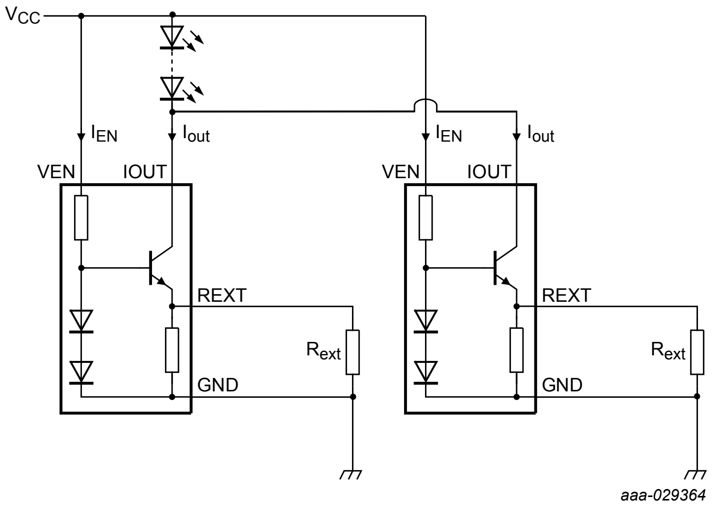
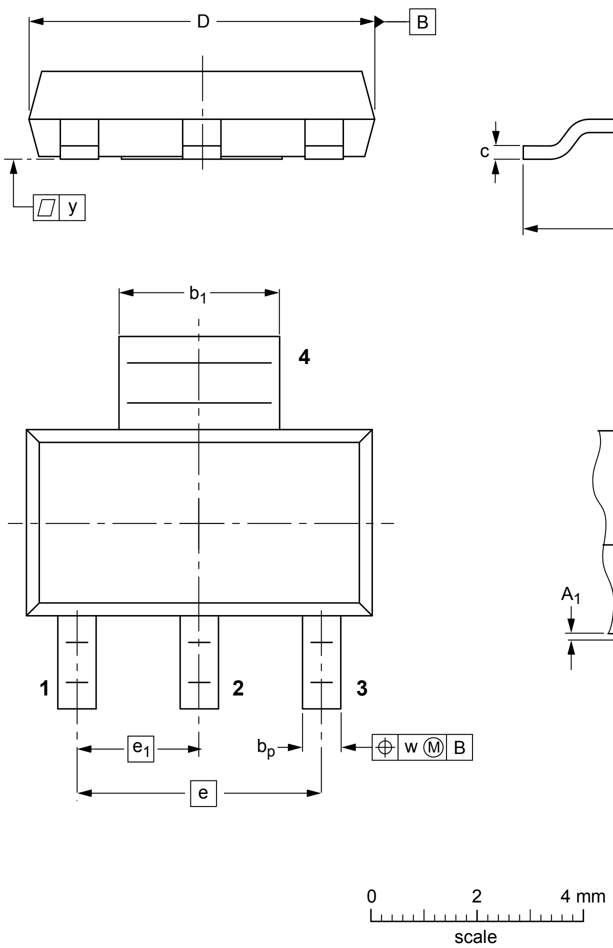


Fig. 28. Application diagram: Parallelization

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 1.5	0.10 0.01	0.80 0.60	3.1 2.9	0.32 0.22	6.7 6.3	3.7 3.3	4.6	2.3	7.3 6.7	1.1 0.7	0.95 0.85	0.2	0.1	0.1

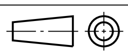
OUTLINE VERSION	REFERENCES				EUROPEAN PROJECTION	ISSUE DATE
	IEC	JEDEC	JEITA			
SOT223			SC-73			~~04-11-10~~ 06-03-16

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

10. Soldering

Table 10. Soldering

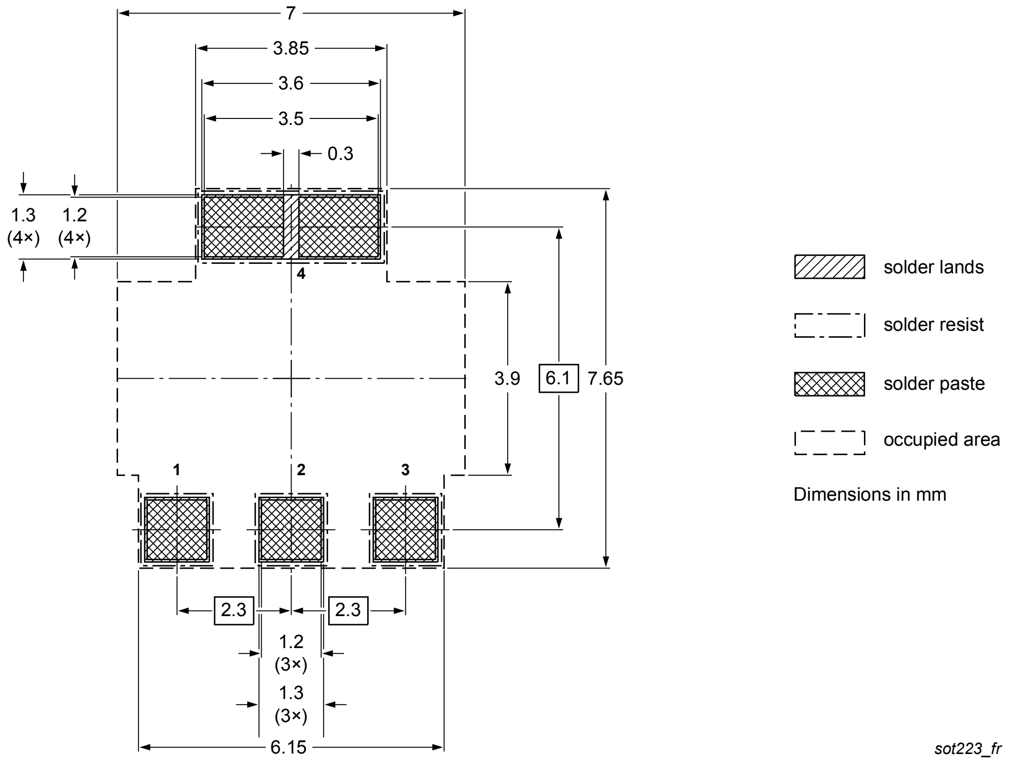


Fig. 30. Reflow soldering footprint for SC-73 (SOT223)

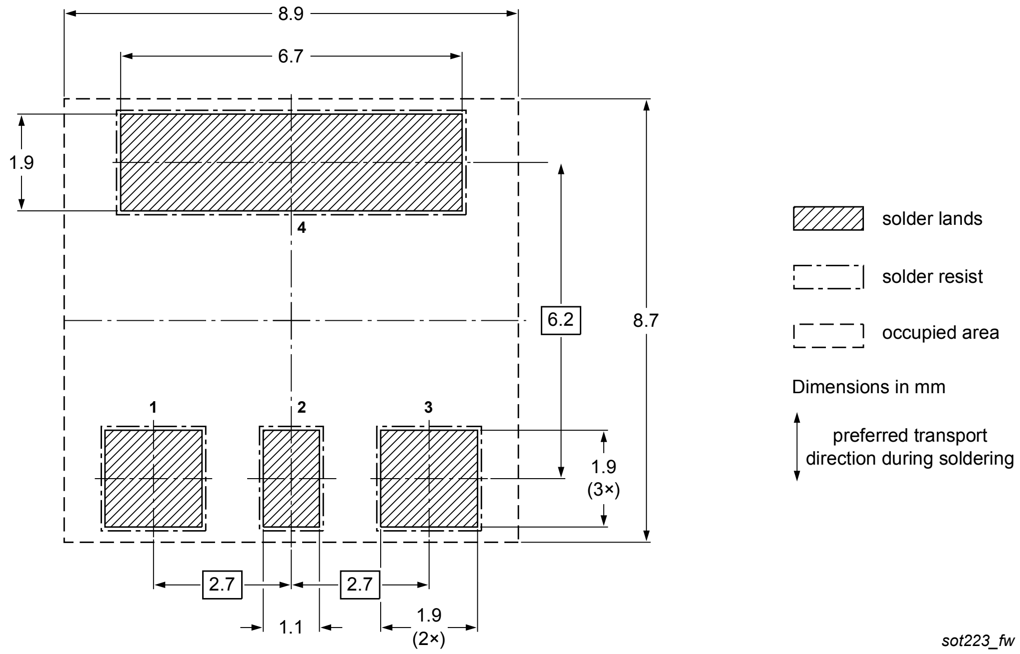


Fig. 31. Wave soldering footprint for SC-73 (SOT223)

11. Revision history

Table 11. Revision history

Document ID	Release date	Data sheet status	Change notice	Supersedes
NCR320Z_NCR321Z 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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