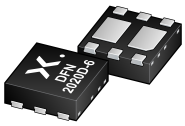


NCR320PAS / NCR321PAS

250 mA LED driver in DFN2020D-6

Rev. 1 — 13 May 2020 **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 leadless medium power DFN2020D-6 (SOT1118D) Surface-Mounted Device (SMD) plastic package with visible and solderable side pads.

Table 1. Product overview

Type number	Package	
	Name	Version
NCR320PAS	DFN2020D-6	SOT1118D
NCR321PAS		

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 530 mW
- Supply voltage up to 16 V
- Digital PWM input up to 10 kHz frequency for NCR321PAS
- 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

2. Quick reference data

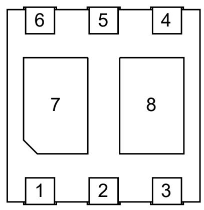
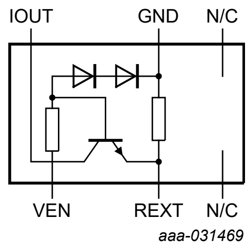
Table 2. Quick reference data

Symbol	Parameter	Conditions		Min	Typ	Max	Unit
V_{EN}	enable voltage						
	NCR320PAS			-	-	25	V
	NCR321PAS			-	-	4.5	V
V_{out}	output voltage			-	-	16	V
I_{out}	stabilized output current						
	NCR320PAS	V_{out} = 1.4 V; V_{EN} = 12 V	[1]	9	10	11	mA
	NCR321PAS	V_{out} = 1.4 V; V_{EN} = 3.3 V	[1]	9	10	11	mA

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

3. Pinning information

Table 3. Pinning

Pin	Symbol	Description	Simplified outline	Symbol
1	VEN	enable voltage	 Transparent top view DFN2020D-6 (SOT1118D)	
2	REXT	external resistor		
3	N/C	not connected		
4	N/C	not connected		
5	GND	ground		
6	IOUT	output current		
7	IOUT	output current		
8	N/C	not connected		

4. Ordering information

Table 4. Ordering information

Type number	Package		
	Name	Description	Version
NCR320PAS	DFN2020D-6	plastic, thermally enhanced ultra thin and small outline package; no leads; 6 terminals; body 2 x 2 x 0.65 mm	SOT1118D
NCR321PAS			

5. Marking

Table 5. Marking codes

Type number	Marking code
NCR320PAS	8A
NCR321PAS	8B

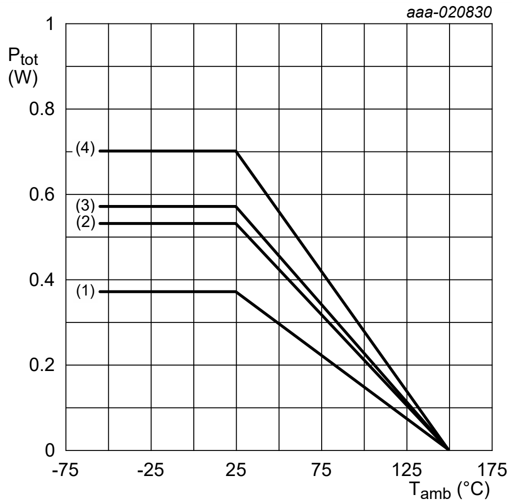
6. Limiting values

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					
	NCR320PAS			-	25	V
	NCR321PAS			-	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]	-	370	mW
			[3]	-	570	mW
			[4]	-	530	mW
			[5]	-	700	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, tin-plated and standard footprint.
[3] Device mounted on an FR4 Printed-Circuit Board (PCB), single-side copper, 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, single-sided copper, standard footprint
(2) FR4 PCB, 4-layer copper, standard footprint
(3) FR4 PCB, single-sided copper, 1 cm^2
(4) FR4 PCB, 4-layer copper, 1 cm^2

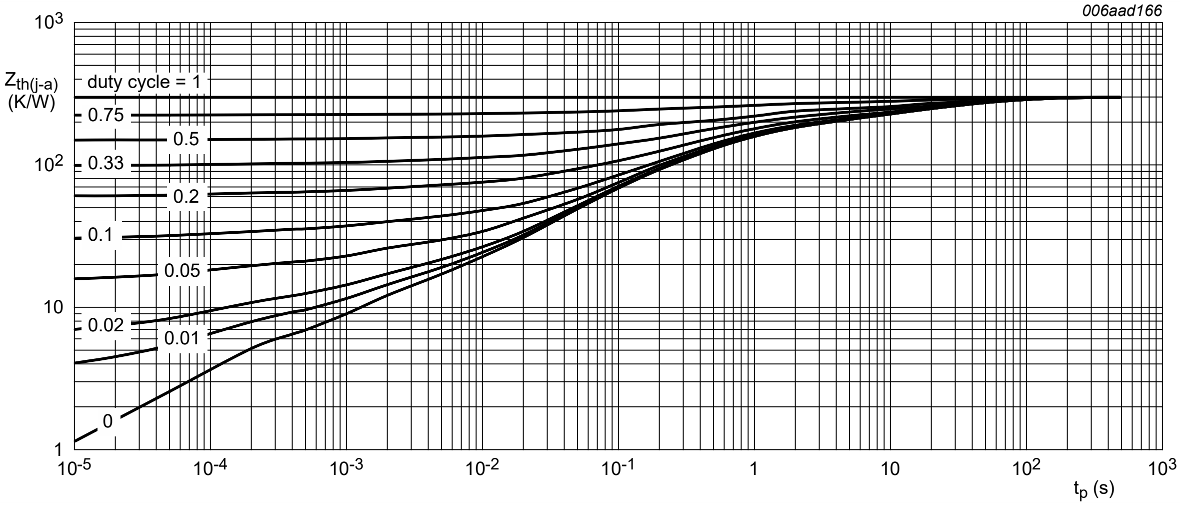
Fig. 1. Power derating curve

7. Thermal characteristics

Table 7. Thermal characteristics

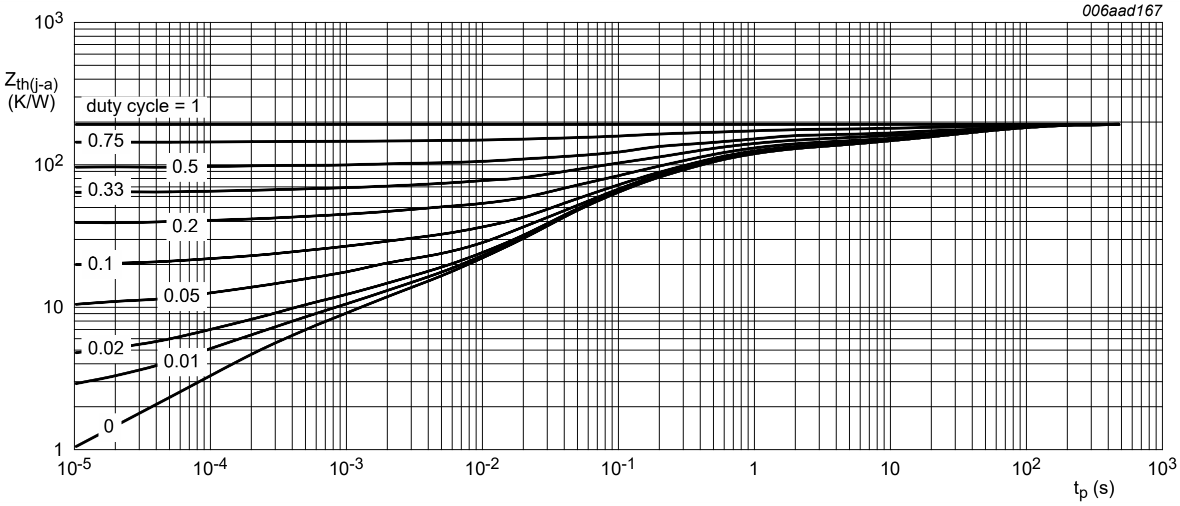
Symbol	Parameter	Conditions		Min	Typ	Max	Unit
$R_{th(j-a)}$	thermal resistance from junction to ambient	in free air	[1]	-	-	338	K/W
			[2]	-	-	219	K/W
			[3]	-	-	236	K/W
			[4]	-	-	179	K/W

[1] Device mounted on an FR4 PCB, single-sided copper, tin-plated and standard footprint.
[2] Device mounted on an FR4 PCB, single-sided copper, 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.



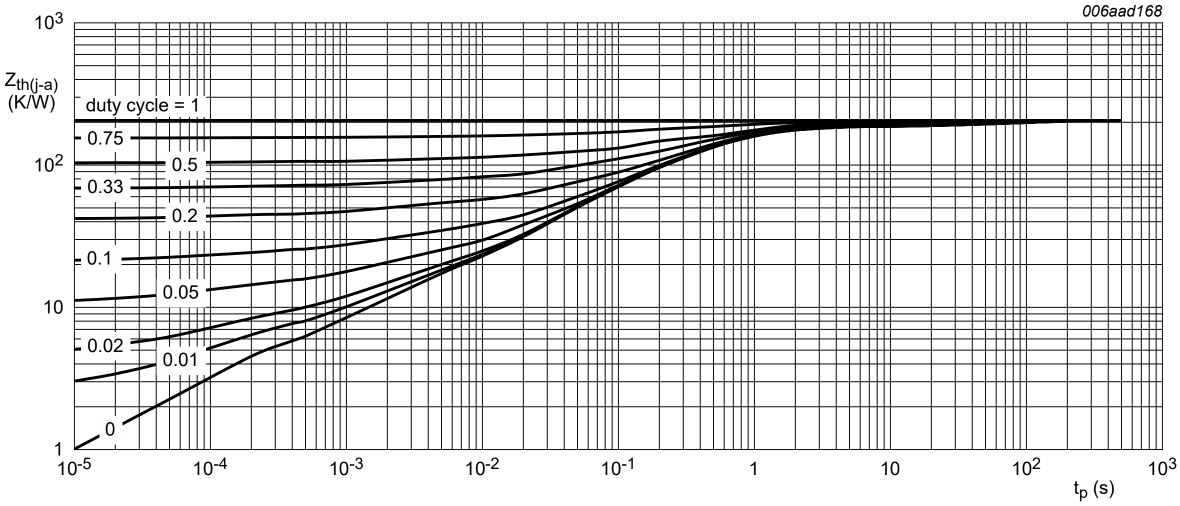
FR4 PCB; single-sided copper; tin-plated and standard footprint

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



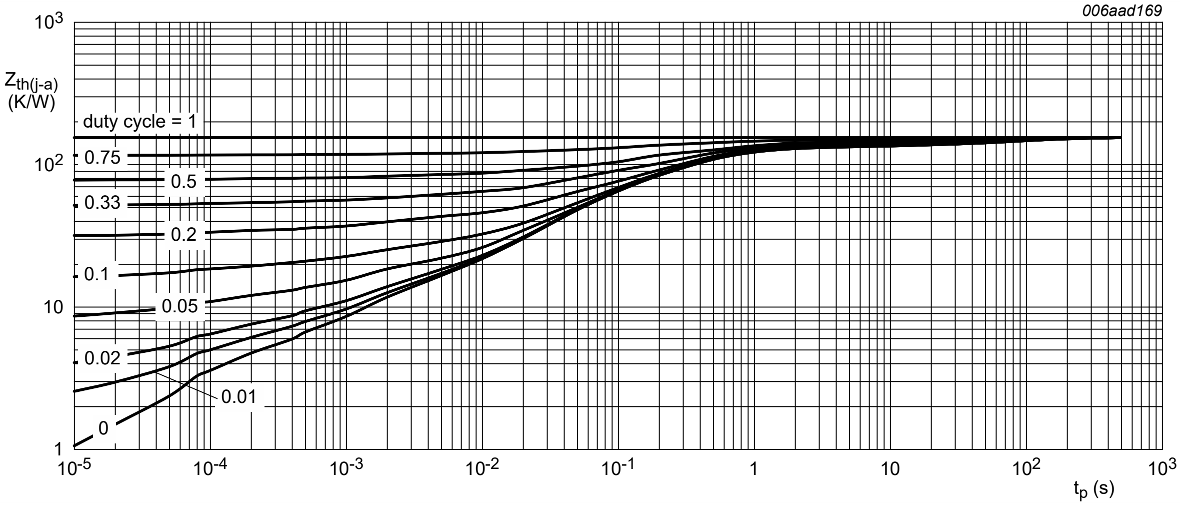
FR4 PCB; mounting pad for collector 1 cm^2

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; mounting pad for collector 1 cm^2

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

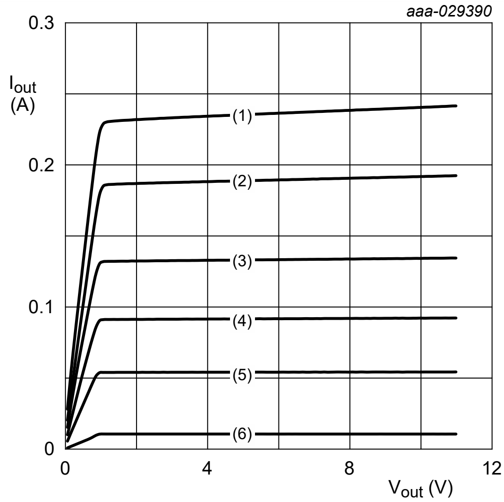
8. Characteristics

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						
	NCR320PAS	V_{EN} = 12 V	[1]	-	1.2	-	mA
	NCR321PAS	V_{EN} = 3.3 V	[1]	-	1.2	-	mA
R_B	bias resistor						
	NCR320PAS			-	10	-	kΩ
	NCR321PAS			-	1.5	-	kΩ
I_{out}	stabilized output current						
	NCR320PAS	V_{EN} = 12 V; V_{out} = 1.4 V	[1]	9	10	11	mA
	NCR321PAS	V_{EN} = 3.3 V; V_{out} = 1.4 V	[1]	9	10	11	mA
I_{out}	stabilized output current						
	NCR320PAS at R_{ext} = 3 Ω	V_{EN} = 12 V; V_{out} > 1.4 V	[1]	-	250	-	mA
	NCR321PAS 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						
	NCR320PAS	V_{EN} = 12 V; V_{out} > 2 V	[1]	-	-0.27	-	%/K
	NCR321PAS	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						
	NCR320PAS	V_{EN} = 12 V; V_{out} > 2 V	[1]	-	1	-	%/V
	NCR321PAS	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

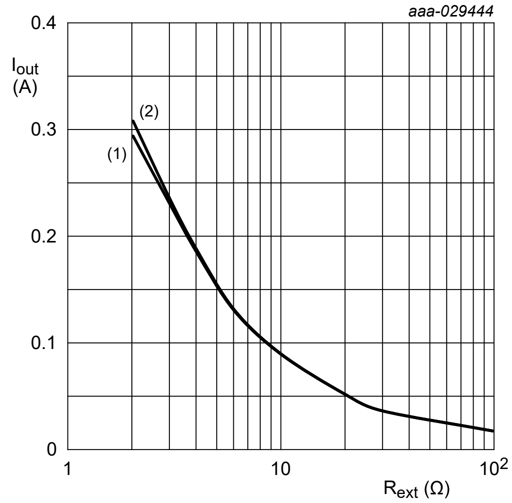
(3) R_{ext} = 6 Ω

(4) R_{ext} = 10 Ω

(5) R_{ext} = 20 Ω

(6) R_{ext} = open

Fig. 6. NCR320PAS: Output current as a function of output voltage; typical values

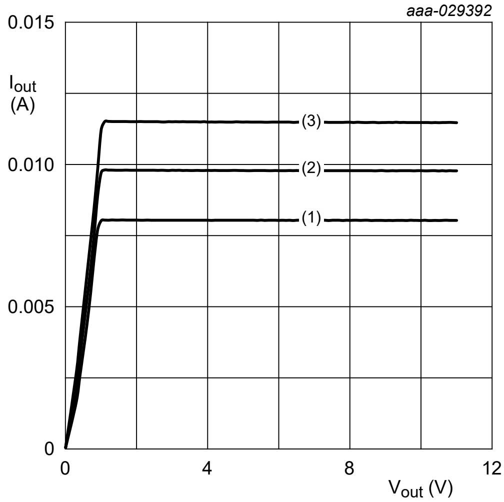


V_{EN} = 12 V; T_{amb} = 25 °C

(1) V_{out} = 1.4 V

(2) V_{out} = 5.4 V

Fig. 7. NCR320PAS: Output current as a function of external resistor; typical values



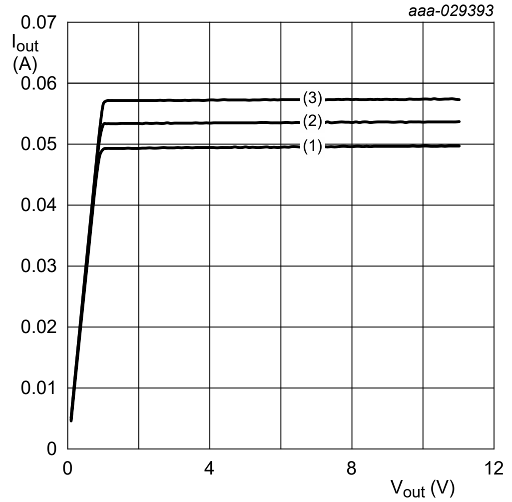
V_{EN} = 12 V; R_{ext} = open

(1) T_{amb} = 85 °C

(2) T_{amb} = 25 °C

(3) T_{amb} = -40 °C

Fig. 8. NCR320PAS: Output current as a function of output voltage; typical values



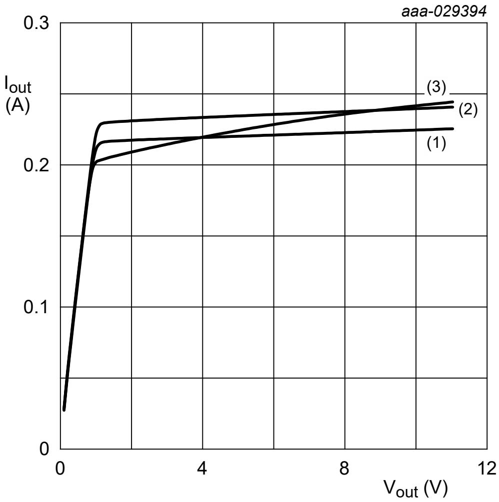
V_{EN} = 12 V; R_{ext} = 20 Ω

(1) T_{amb} = 85 °C

(2) T_{amb} = 25 °C

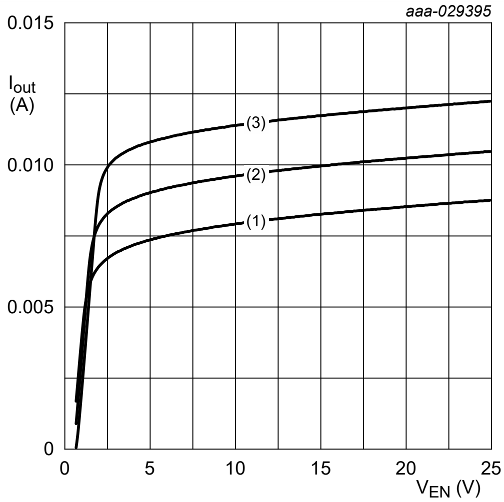
(3) T_{amb} = -40 °C

Fig. 9. NCR320PAS: Output current as a function of output voltage; typical values



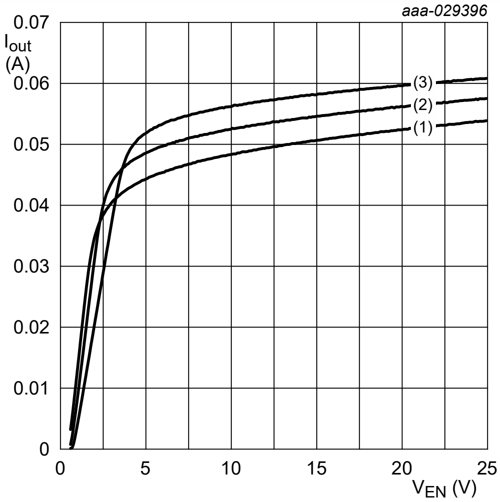
V_{EN} = 12 V; R_{ext} = 3 Ω
(1) T_{amb} = 85 °C
(2) T_{amb} = 25 °C
(3) T_{amb} = -40 °C

Fig. 10. NCR320PAS: Output current as a function of output voltage; typical values



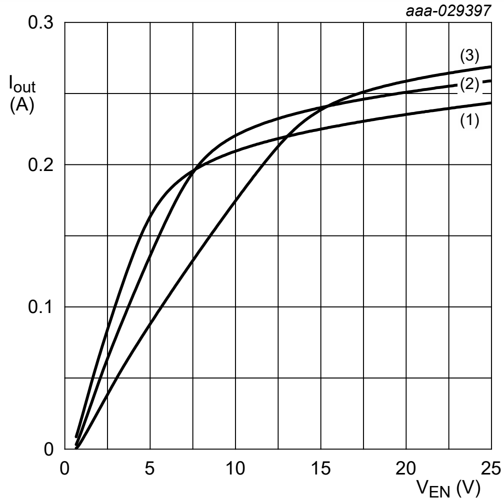
V_{out} = 2 V; R_{ext} = open
(1) T_{amb} = 85 °C
(2) T_{amb} = 25 °C
(3) T_{amb} = -40 °C

Fig. 11. NCR320PAS: Output current as a function of enable voltage; typical values



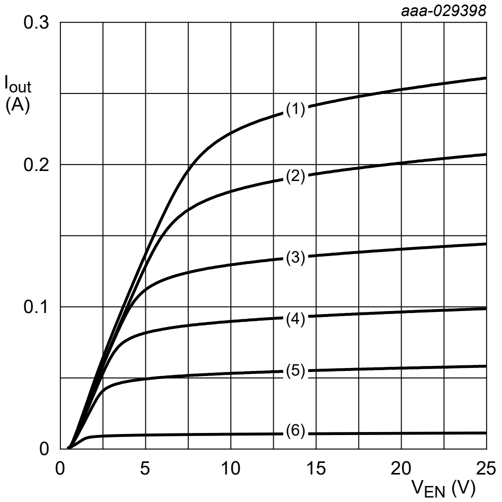
V_{out} = 2 V; R_{ext} = 20 Ω
(1) T_{amb} = 85 °C
(2) T_{amb} = 25 °C
(3) T_{amb} = -40 °C

Fig. 12. NCR320PAS: Output current as a function of enable voltage; typical values



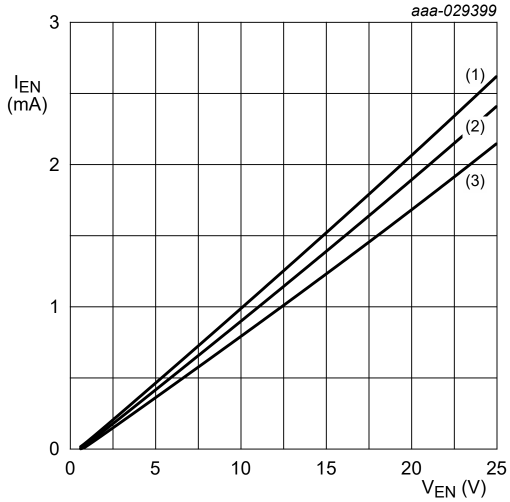
V_{out} = 2 V; R_{ext} = 3 Ω
(1) T_{amb} = 85 °C
(2) T_{amb} = 25 °C
(3) T_{amb} = -40 °C

Fig. 13. NCR320PAS: Output current as a function of enable voltage; typical values



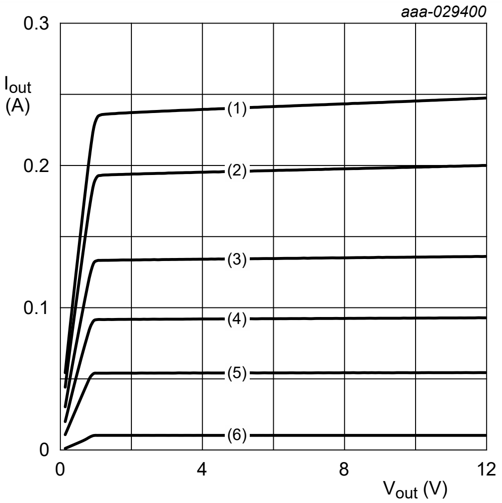
V_{out} = 2 V; T_{amb} = 25 °C
(1) R_{ext} = 3 Ω
(2) R_{ext} = 4 Ω
(3) R_{ext} = 6 Ω
(4) R_{ext} = 10 Ω
(5) R_{ext} = 20 Ω
(6) R_{ext} = open

Fig. 14. NCR320PAS: Output current as a function of enable voltage; typical values



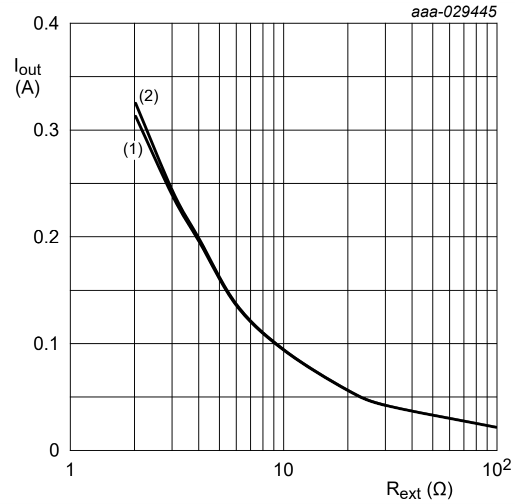
I_{out} = 0 A; R_{ext} = open
(1) T_{amb} = 85 °C
(2) T_{amb} = 25 °C
(3) T_{amb} = -40 °C

Fig. 15. NCR320PAS: Enable current as a function of enable voltage; typical values



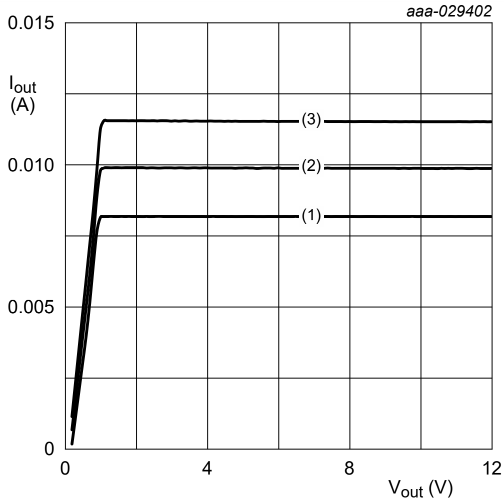
V_{EN} = 3.3 V; T_{amb} = 25 °C
(1) R_{ext} = 3 Ω
(2) R_{ext} = 4 Ω
(3) R_{ext} = 6 Ω
(4) R_{ext} = 10 Ω
(5) R_{ext} = 20 Ω
(6) R_{ext} = open

Fig. 16. NCR321PAS: Output current as a function of output voltage; typical values



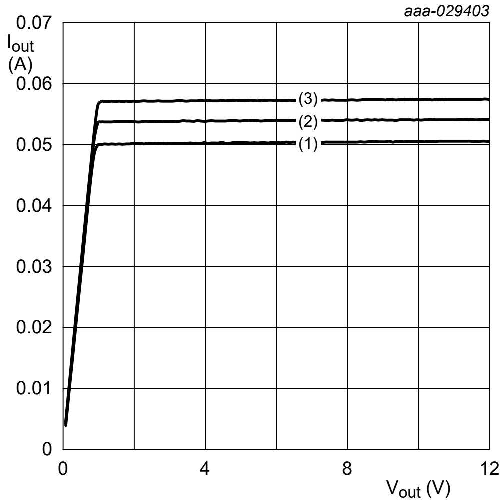
V_{EN} = 3.3 V; T_{amb} = 25 °C
(1) V_{out} = 1.4 V
(2) V_{out} = 5.4 V

Fig. 17. NCR321PAS: Output current as a function of external resistor; typical values



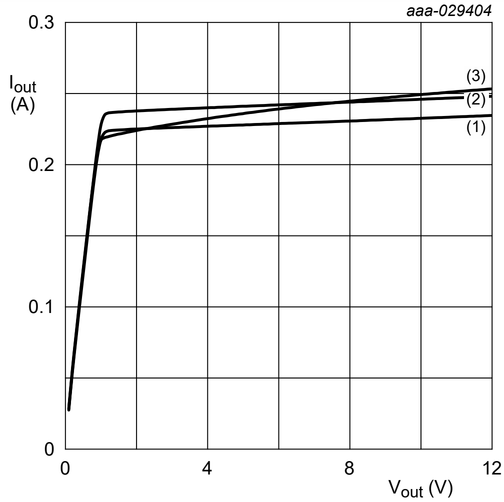
V_{EN} = 3.3 V; R_{ext} = open
(1) R_{ext} = 85 °C
(2) R_{ext} = 25 °C
(3) R_{ext} = -40 °C

Fig. 18. NCR321PAS: Output current as a function of output voltage; typical values



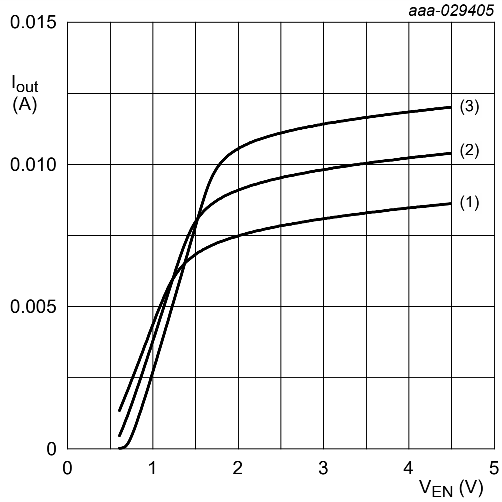
V_{EN} = 3.3 V; R_{ext} = 20 Ω
(1) R_{ext} = 85 °C
(2) R_{ext} = 25 °C
(3) R_{ext} = -40 °C

Fig. 19. NCR321PAS: Output current as a function of output voltage; typical values



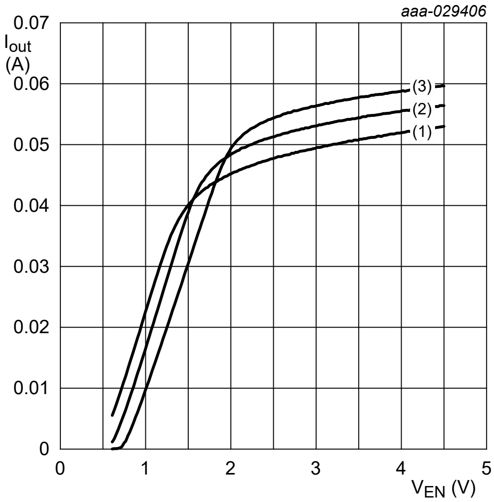
V_{EN} = 3.3 V; R_{ext} = 3 Ω
(1) R_{ext} = 85 °C
(2) R_{ext} = 25 °C
(3) R_{ext} = -40 °C

Fig. 20. NCR321PAS: Output current as a function of output voltage; typical values



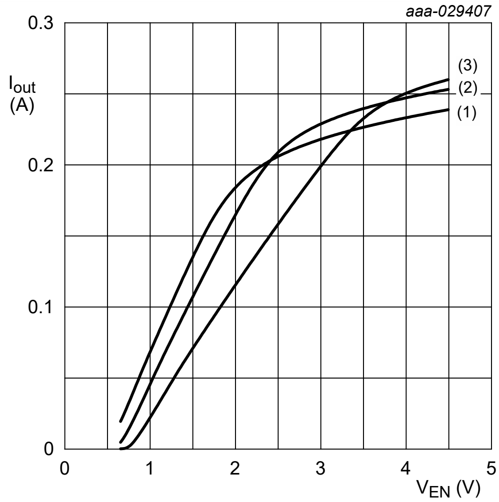
V_{out} = 2 V; R_{ext} = open
(1) R_{ext} = 85 °C
(2) R_{ext} = 25 °C
(3) R_{ext} = -40 °C

Fig. 21. NCR321PAS: Output current as a function of enable voltage; typical values



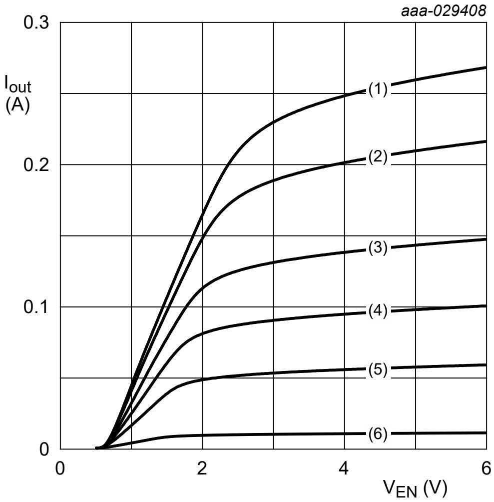
V_{out} = 2 V; R_{ext} = 20 Ω
(1) R_{ext} = 85 °C
(2) R_{ext} = 25 °C
(3) R_{ext} = -40 °C

Fig. 22. NCR321PAS: Output current as a function of enable voltage; typical values



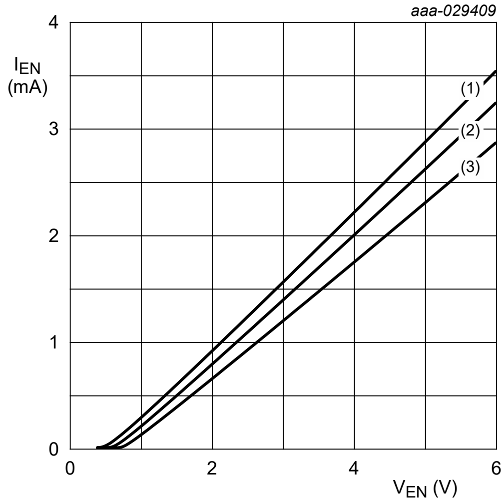
V_{out} = 2 V; R_{ext} = 3 Ω
(1) R_{ext} = 85 °C
(2) R_{ext} = 25 °C
(3) R_{ext} = -40 °C

Fig. 23. NCR321PAS: 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. NCR321PAS: 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. NCR321PAS: Enable current as a function of enable voltage; typical values

9. 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

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

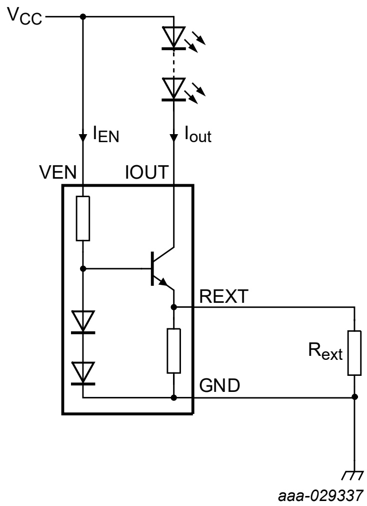


Fig. 26. LED driver application diagram

NCR321PAS 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 NCR321PAS devices by one microcontroller output, a shift register (for example 74AHC(T)594PW) can be used.

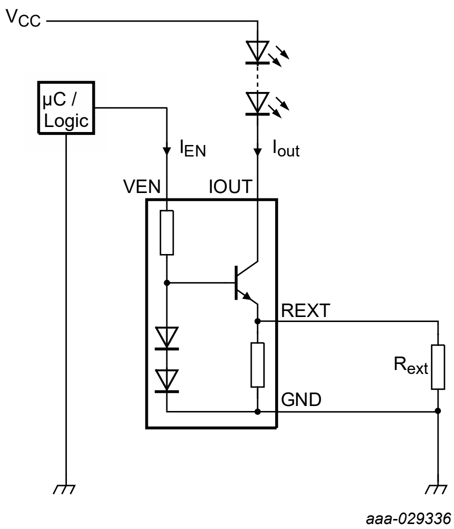


Fig. 27. Application diagram: PWM dimming function

To savely drive currents that are above the limits of the NCR32xPAS, 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, NCR320PAS and NCR321PAS can be used in this configuration.

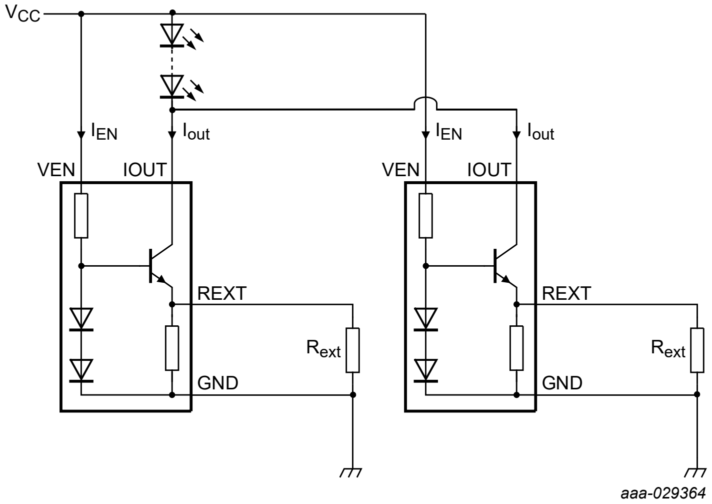
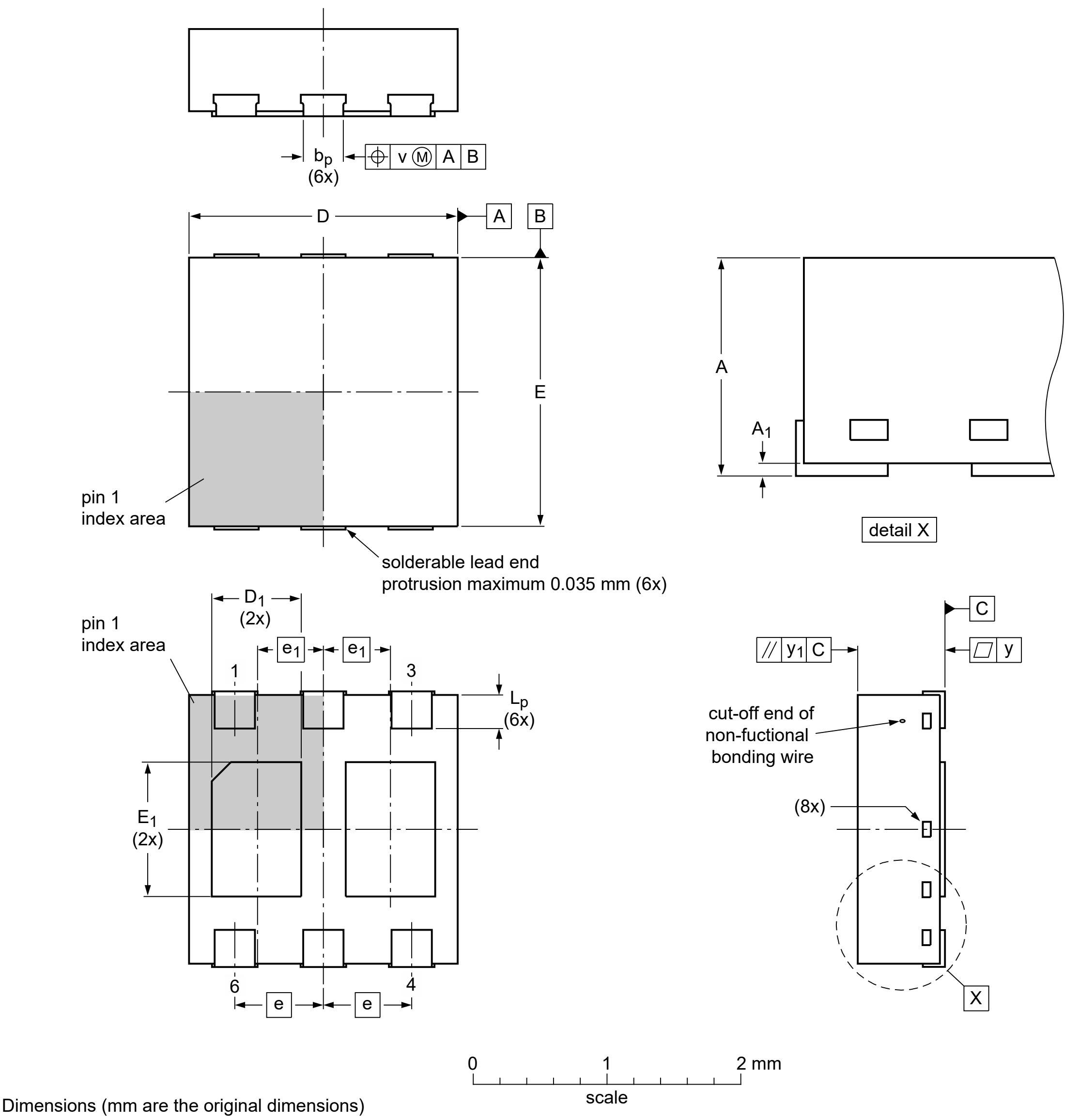


Fig. 28. Application diagram: Parallelization

10. Package outline

Table 9. Package outline

DFN2020D-6: plastic, thermally enhanced ultra thin and small outline package; no leads; 6 terminals; body 2 x 2 x 0.65 mm **SOT1118D**



Dimensions (mm are the original dimensions)

Unit		A	A_1	b_p	D	D_1	E	E_1	e	e_1	L_p	v	y	y_1
	max	0.65	0.04	0.35	2.1	0.77	2.1	1.0		0.54	0.30			
mm	nom	0.62		0.30	2.0	0.67	2.0	0.9	0.65	0.49	0.25	0.1	0.05	0.05
	min	0.59		0.25	1.9	0.57	1.9	0.8		0.44	0.20			

Note
1. Dimension A is including plating thickness.

sot1118d_po

Outline version	References				European projection	Issue date
	IEC	JEDEC	JEITA			
SOT1118D	- - -					~~14-07-16~~ 14-10-16

Fig. 29. Package outline DFN2020D-6 (SOT1118D)

11. Soldering

Table 10. Soldering

SOT1118D

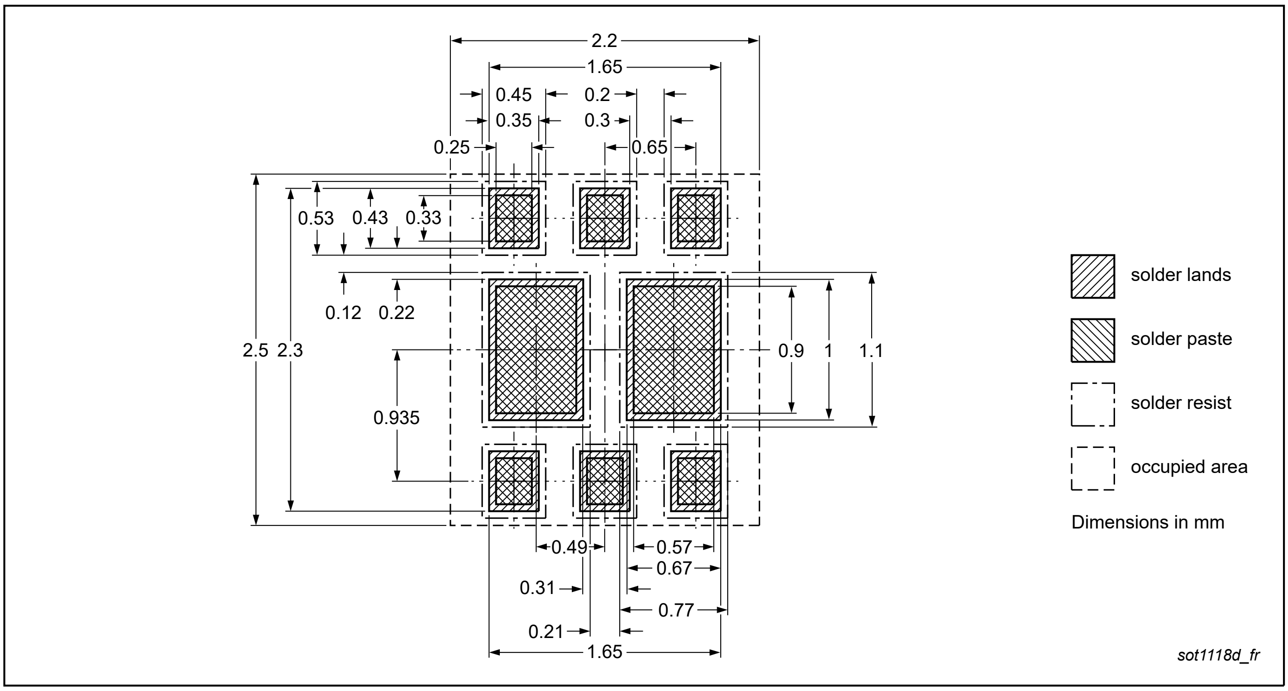


Fig. 30. Reflow soldering footprint for DFN2020D-6 (SOT1118D)

12. Revision history

Table 11. Revision history

Document ID	Release date	Data sheet status	Change notice	Supersedes
NCR320PAS_NCR321PAS v.1	20200513	Product data sheet	-	-

13. 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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