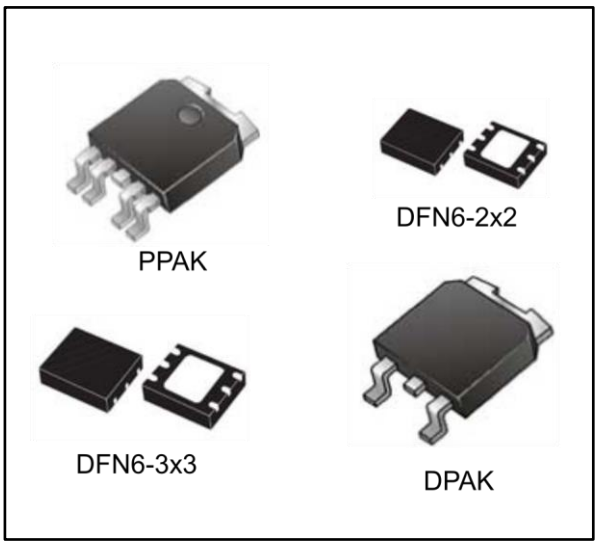
LDF

1 A very low drop voltage regulator

Datasheet - production data



Features

- Input voltage from 2.6 to 16 V
- Very low-dropout voltage (500 mV max. at 1 A load)
- Low quiescent current (200 µA typ. @ 1 A load)
- Available in 1% precision in PPAK and DFN6 packages, 2% in DPAK
- 1 A guaranteed output current
- Wide range of output voltages available on request: adjustable from 0.8 V, fixed up to 12 V in 100 mV steps
- Logic-controlled electronic shutdown
- Power Good (PPAK and DFN packages)
- Fast dynamic response to line and load changes
- Internal current and thermal protections
- Temperature range: -40 °C to 125 °C

Applications

- Computer and laptop
- Battery-powered equipments
- Industrial and medical equipment
- Consumer and set-top box

Description

The LDF is a fast, very low drop linear regulator which operates from an input supply voltage in the range of 2.6 V to 16 V.

It is available in fixed and adjustable output voltage versions, from 0.8 V to 12 V.

The LDF features are: high output precision, very low-dropout voltage, low noise, and low quiescent current, therefore suitable for low voltage microprocessors and memory applications.

Enable logic control pin and power-good output are featured on PPAK/DFN packages.

Current and thermal protection are provided.

This is information on a product in full production.

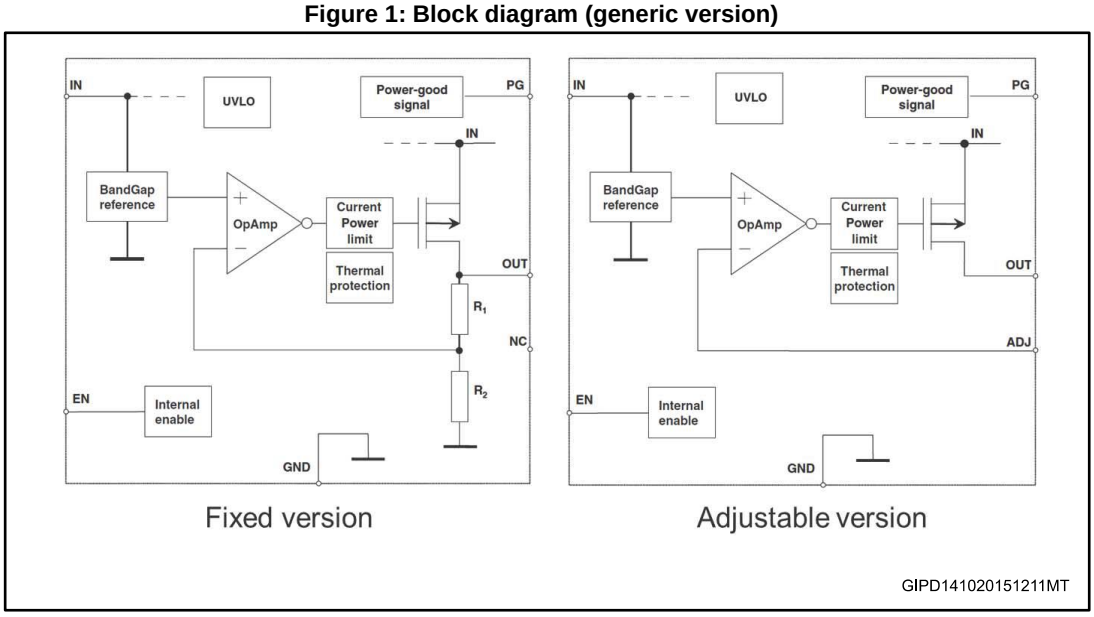
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1 Block diagram

Figure 1: Block diagram (generic version)



2 Pin configuration

Figure 2: Pin connection (top view)

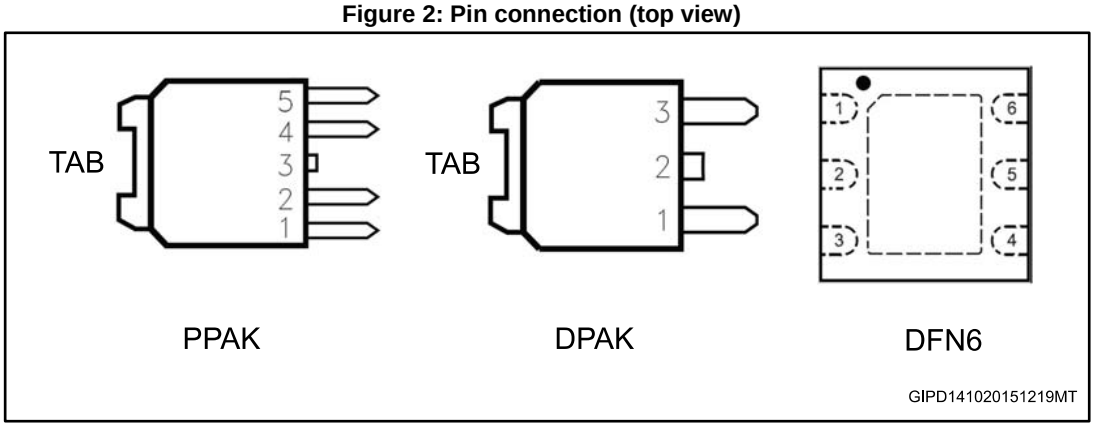


Table 1: DPAK, PPAK pin description

Pin n°		Symbol	Function
PPAK	DPAK		
5	-	ADJ/PG	For adjustable versions: error amplifier input pin For fixed versions: power-good output
2	1	V_{IN}	Input voltage
4	3	V_{OUT}	Output voltage
1	-	EN	Enable pin logic input: low = shutdown, high = active
3	2	GND	Ground
TAB	TAB	GND	Ground

Table 2: DFN6-2x2 and 3x3 pin description

Pin n°	Symbol	Function
2	ADJ/NC	For adjustable versions: error amplifier input pin For fixed versions: not connected
6	V_{IN}	Input voltage
1	V_{OUT}	Output voltage
5	EN	Enable pin logic input: low = shutdown, high = active
3	PG	Power-good output
4	GND	Ground
Exposed pad	GND	Ground

3 Typical application

Figure 3: Fixed versions

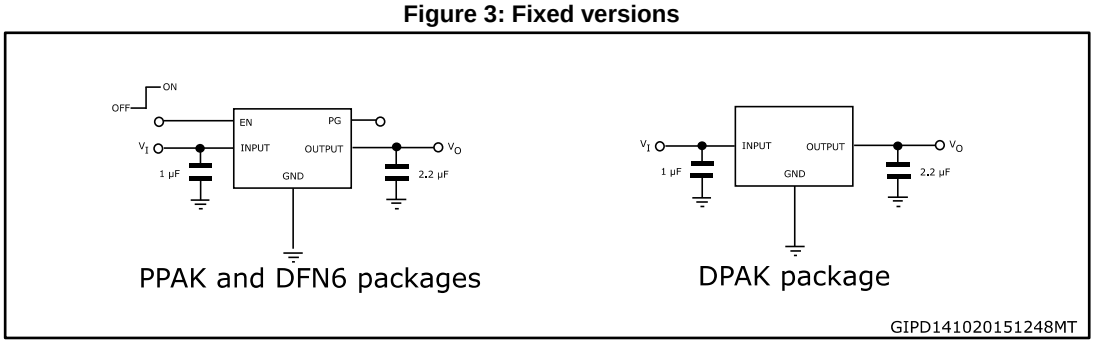
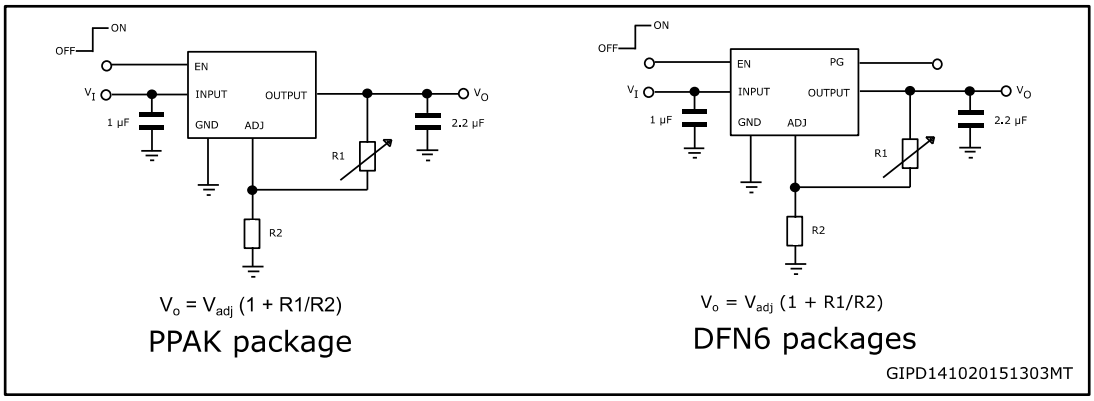


Figure 4: Adjustable versions (PPAK and DFN6 packages only)



4 Absolute maximum ratings

Table 3: Absolute maximum ratings

Symbol	Parameter	Value	Unit
V_{IN}	DC input voltage	- 0.3 to 20	V
V_{OUT}	DC output voltage	- 0.3 to V_{IN} + 0.3	V
V_{EN}	Enable input voltage	- 0.3 to V_{IN} + 0.3	V
V_{ADJ}	ADJ pin voltage	-0.3 to 2	V
V_{PG}	PG pin voltage	- 0.3 to V_{IN} + 0.3	V
I_{LOAD}	Output current	Internally limited	mA
P_D	Power dissipation	Internally limited	mW
T_{STG}	Storage temperature range	- 65 to 150	°C
T_{OP}	Operating junction temperature range	- 40 to 125	°C

Absolute maximum ratings are those values beyond which damage to the device may occur. Functional operation under these conditions is not implied. All values are referred to GND.

Table 4: Thermal data

Symbol	Parameter	Value				Unit
		PPAK	DPAK	DFN6-2x2	DFN6-3x3	
R_{thJA}	Thermal resistance junction-ambient	100	100	65	55	°C/W
R_{thJC}	Thermal resistance junction-case	8	8	6.5	10	°C/W

5 Electrical characteristics

T_J = 25 °C, V_{IN} = $V_{OUT(NOM)}$ + 1 V, C_{IN} = 1 µF, C_{OUT} = 2.2 µF, I_{LOAD} = 10 mA, V_{EN} = 2 V, unless otherwise specified.

Table 5: LDF (fixed versions) electrical characteristics

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
V_{IN}	Operating input voltage		2.6		16	V
V_{OUT}	V_{OUT} accuracy, PPAK and DFN6 versions	V_{OUT} +1 V (1) ≤ V_{IN} ≤ 16 V I_{LOAD} = 10 mA	-1		1	%
		10 mA ≤ I_{LOAD} ≤ 1 A T_J = -40 to 125 °C	-1.5		1.5	%
V_{OUT}	V_{OUT} accuracy, DPAK version	V_{OUT} +1 V (1) ≤ V_{IN} ≤ 16 V I_{LOAD} = 10 mA	-2		2	%
		10 mA ≤ I_{LOAD} ≤ 1 A T_J = -40 to 125 °C	-3		3	%
ΔV_{OUT}	Static line regulation	V_{OUT} +1 V (1) ≤ V_{IN} ≤ 16 V		0.01		%V
		V_{OUT} +1 V (1) ≤ V_{IN} ≤ 16 V T_J = -40 to 125 °C			0.04	
ΔV_{OUT}	Static load regulation	10 mA ≤ I_{LOAD} ≤ 1 A		0.2		%/A
		10 mA ≤ I_{LOAD} ≤ 1 A T_J = -40 to 125 °C			0.6	
V_{DROP}	Dropout voltage (2)	I_{LOAD} = 1 A -40 °C < T_J < 125 °C		200	500	mV
I_q	Quiescent current	ON mode: V_{EN} = 2 V I_{LOAD} = 10 mA to 1 A T_J = -40 to 125 °C		200	800	µA
		OFF mode: V_{EN} = GND, PPAK and DFN versions		30		
		OFF mode: V_{EN} = GND, PPAK and DFN versions -40 °C < T_J < 125 °C			120	
I_{SC}	Short-circuit current	V_{IN} > 3 V		1.5		A
V_{EN}	Enable input logic low	V_{IN} = 2.6 V to 16 V -40 °C < T_J < 125 °C			0.8	V
	Enable input logic high		2			
I_{EN}	Enable pin input current	V_{EN} = V_{IN}		5	10	µA
PG	Power-good output threshold	Rising edge		0.92*V_{OUT}		V
		Falling edge		0.8*V_{OUT}		
	Power-good output voltage low	I_{SINK} = 6 mA open drain output		0.4		

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
SVR	Supply voltage rejection	V_{IN} = 4.5 V +/- 0.5 V_{RIPPLE} f = 120 Hz V_{OUT} = 3.3 V		60		dB
		V_{IN} = 4.5 V +/- 0.5 V_{RIPPLE} f = 120 Hz to 100 kHz V_{OUT} = 3.3 V		45		
e_N	Output noise voltage	Bw = 10 Hz to 100 kHz, I_{LOAD} = 100 mA C_{OUT} = 2.2 µF		45		μV_{RMS} /V_{OUT}
T_{SHDN}	Thermal shutdown			170		°C
	Hysteresis			10		

Notes:

(1) For V_{OUT} < 1.6 V; V_{IN} = 2.6 V.

(2) Dropout voltage is the input-to-output voltage difference at which the output voltage is 100 mV below its nominal value. This specification does not apply to output voltages below 1.6 V.

T_J = 25 °C, V_{IN} = $V_{OUT(NOM)}$ + 1 V, C_{IN} = 1 µF, C_{OUT} = 2.2 µF, I_{LOAD} = 10 mA, V_{EN} = 2 V, unless otherwise specified.

Table 6: LDF (adjustable version) electrical characteristics

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
V_{IN}	Operating input voltage		2.6		16	V
V_{ADJ}	Reference voltage	V_{IN} = V_{OUT} +1 V (1)		0.8		V
	Reference voltage tolerance	V_{OUT} + 1 V (1) ≤ V_{IN} ≤ 16 V I_{LOAD} = 10 mA	-1		1	%
		10 mA ≤ I_{LOAD} ≤ 1 A T_J = -40 to 125 °C	-1.5		1.5	
ΔV_{OUT}	Static line regulation	V_{OUT} +1 V (1) ≤ V_{IN} ≤ 16 V		0.01		%V
		V_{OUT}+1 V (1) ≤ V_{IN} ≤ 16 V T_J = -40 to 125 °C			0.04	
ΔV_{OUT}	Static load regulation	10 mA ≤ I_{LOAD} ≤ 1 A		0.2		%/A
		10 mA ≤ I_{LOAD} ≤ 1 A T_J = -40 to 125 °C		0.2	0.6	
V_{DROP}	Dropout voltage (2)	V_{OUT} fixed to 2.5 V, I_{LOAD} = 1 A -40 °C < T_J < 125 °C		200	500	mV
I_q	Quiescent current	ON mode: V_{EN} = 2 V I_{LOAD} = 10 mA to 1 A T_J = -40 to 125 °C		200	800	µA
		OFF mode: V_{EN} = GND PPAK and DFN versions		30		
		OFF mode: V_{EN} = GND PPAK and DFN versions -40 °C < T_J < 125 °C			120	
I_{SC}	Short-circuit current	V_{IN} > 3 V		1.5		A
V_{EN}	Enable input logic low	V_{IN} = 2.6 V to 16 V -40 °C < T_J < 125 °C			0.8	V
	Enable input logic high		2			
I_{EN}	Enable pin input current	V_{EN} = V_{IN}		5	10	µA
PG	Power-good output threshold	Rising edge		0.92*V_{ADJ}		V
		Falling edge		0.8*V_{ADJ}		
	Power-good output voltage low	I_{SINK} = 6 mA open drain output		0.4		

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
SVR	Supply voltage rejection	V_{IN} = 3 V +/- 0.5 V_{RIPPLE} f = 120 Hz V_{OUT} = 0.8 V		62		dB
		V_{IN} = 3 V +/- 0.5 V_{RIPPLE} f = 120 Hz to 100 kHz V_{OUT} = 0.8 V		55		
e_N	Output noise voltage	B_w = 10 Hz to 100 kHz I_{LOAD} = 100 mA C_{OUT} = 2.2 µF		50		μV_{RMS} /V_{OUT}
T_{SHDN}	Thermal shutdown			170		°C
	Hysteresis			10		

Notes:

(1) For V_{OUT} < 1.6 V; V_{IN} = 2.6 V.

(2) Dropout voltage is the input-to-output voltage difference at which the output voltage is 100 mV below its nominal value. This specification does not apply to output voltages below 1.6 V.

6 Application information

6.1 External capacitors

The LDF voltage regulator requires external ceramic capacitors to assure the control loop stability. These capacitors must be selected to meet the requirements of minimum capacitance and equivalent series resistance (see *Figure 25: "Stability plane ADJ (C_{OUT}, ESR)"* and *Figure 26: "Stability plane 3.3 V (C_{OUT}, ESR)"*. Input/output capacitors should be located as closer as possible to the relative pins.

6.1.1 Input capacitor

An input capacitor, whose minimum value is 1 µF, must not be located farther than 0.5" from the input pin of the device and returned to a clean analog ground.

6.1.2 Output capacitor

Ceramic capacitors could be used on the output, provided that they must meet the minimum amount of capacitance and E.S.R. (equivalent series resistance) value required. 2.2 µF is suggested as minimum capacitance to guarantee the stability of the regulator. Anyway, other COUT values can be used according to the *Figure 25: "Stability plane ADJ (C_{OUT}, ESR)"* and *Figure 26: "Stability plane 3.3 V (C_{OUT}, ESR)"* showing the allowable ESR range as a function of the output capacitance. The output capacitor must maintain its ESR in the stable region over the full operating temperature range to assure stability. Besides, capacitor tolerance and temperature variation must be taken into account to assure the minimum amount of capacitance.

6.2 Output voltage setting for ADJ version

In the adjustable version, the output voltage can be set from 0.8 V up to the input voltage minus the voltage drop across the pass transistor (dropout voltage), by connecting a resistor divider between the ADJ pin and the output, thus allowing remote voltage sensing.

The resistor divider could be selected by the following equation:

$$V_{OUT} = V_{ADJ}\left(1 + {}^{R1}/_{R2}\right) \qquad with\ V_{ADJ} = 0.8\,V(typ.)$$

It is recommended to use resistors with values in the range of 10 kΩ to 100 kΩ. Lower values can also be suitable, but current consumption increases.

6.3 Enable pin operation

This pin can be used to turn OFF the regulator when it is pulled down, so to drastically reduce the current consumption. When the enable feature is not used, this pin must be tied to V_{IN} to keep the regulator output in ON state every time. To assure the proper operation, the signal source, used to drive the EN pin, must be able to swing above and below the specified thresholds listed in the electrical characteristics (V_{EN}). The EN pin must not be left floating because it is not internally pulled down/up.

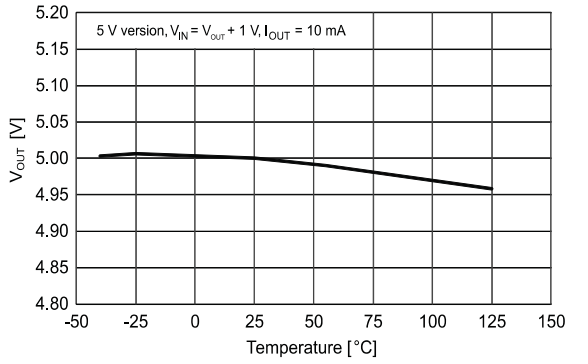
6.4 Power Good

The LDF features an open drain PG pin to sequence either external supplies or loads and to provide fault detection. This pin requires an external resistor (R_{PG}) to pull Power Good high when the output is within the power-good tolerance window. Typical values for this resistor range from 10 kΩ to 100 kΩ.

7 Typical characteristics

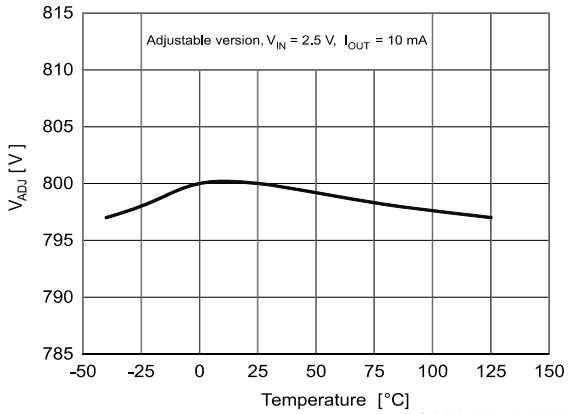
C_{IN} = C_{OUT} = 1 µF, V_{IN} = V_{OUT} +1 V, V_{EN} to V_{IN}, I_{OUT} = 10 mA, unless otherwise specified.

Figure 5: Output voltage vs. temperature, fixed version



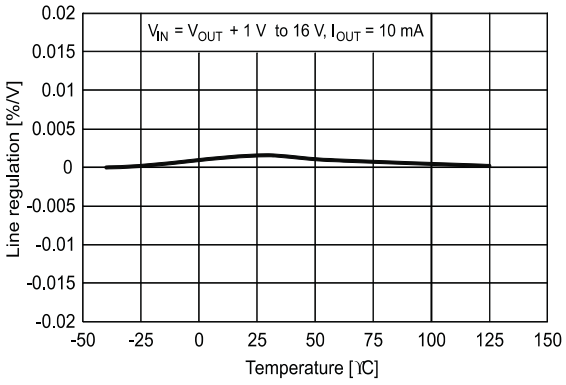
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Figure 6: Output voltage vs. temperature, adjustable version



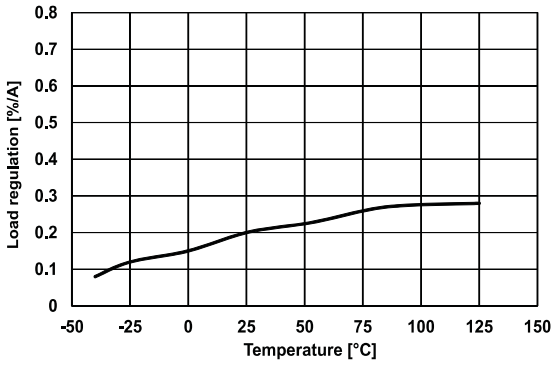
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Figure 7: Line regulation vs. temperature



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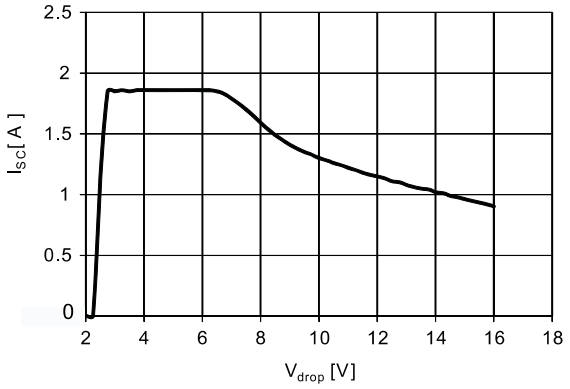
Figure 8: Load regulation vs. temperature



V_{IN} =V_{OUT}+1V, I_{OUT} = 10mA to 1A

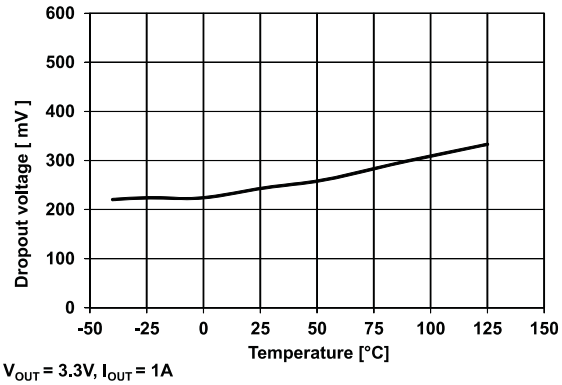
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Figure 9: Short-circuit current vs. dropout



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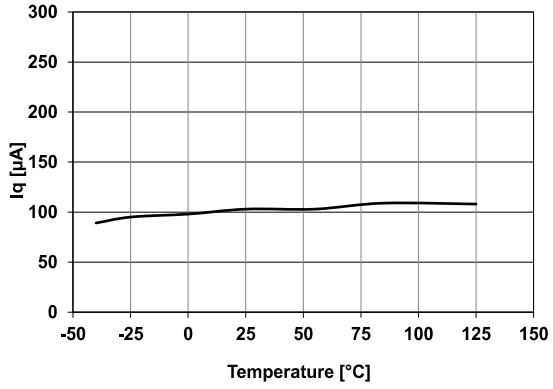
Figure 10: Dropout voltage vs. temperature



V_{OUT} = 3.3V, I_{OUT} = 1A

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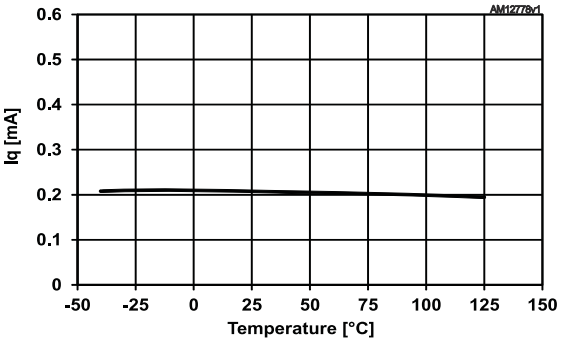
Figure 11: Quiescent current vs. temperature, I_{OUT} = 10 mA



I_{OUT}=10mA

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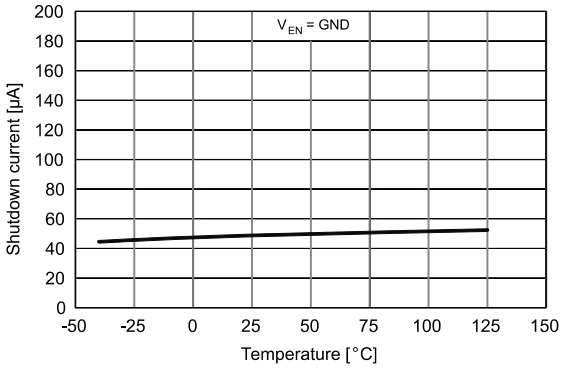
Figure 12: Quiescent current vs. temperature, I_{OUT} = 1 A



I_{OUT} = 1000mA

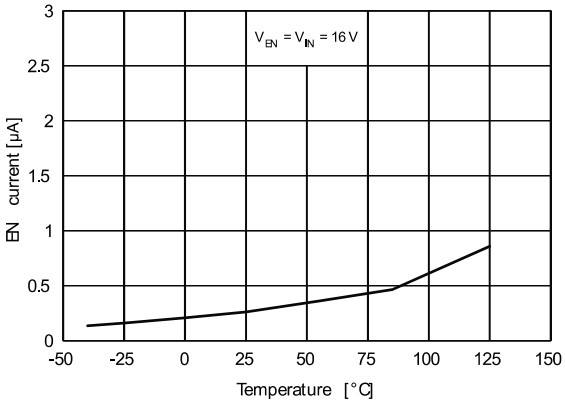
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Figure 13: Shutdown current vs. temperature



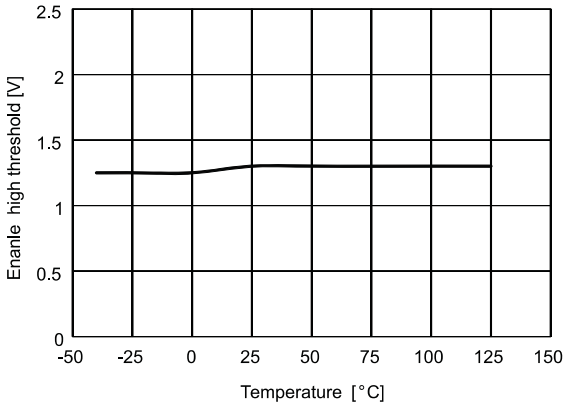
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Figure 14: Enable pin current vs. temperature



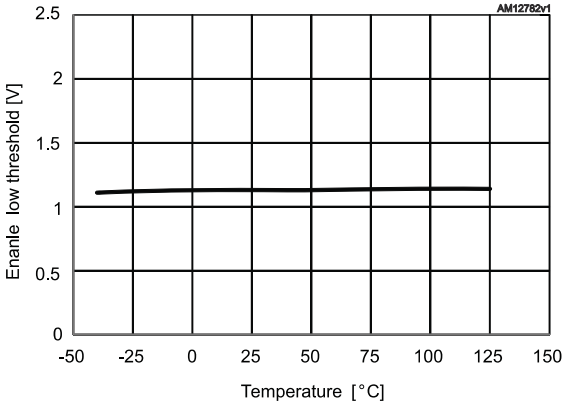
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Figure 15: Enable high threshold vs. temperature



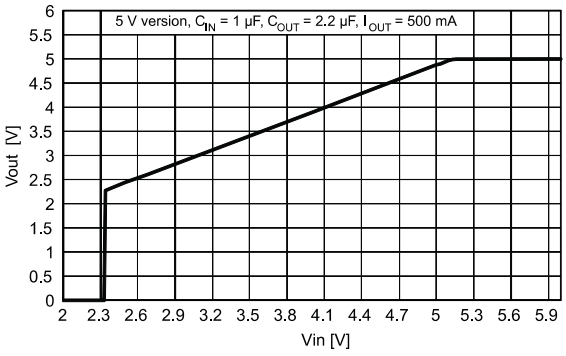
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Figure 16: Enable low threshold vs. temperature



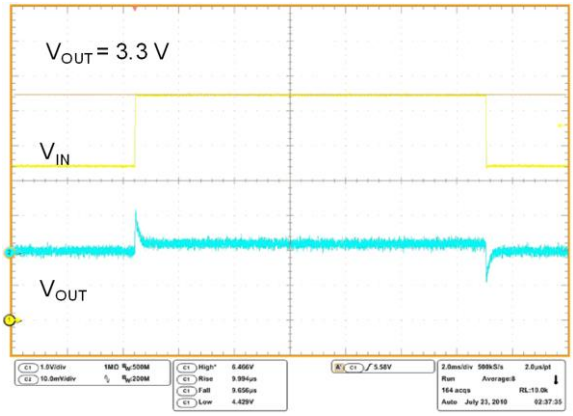
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Figure 17: Output voltage vs. input voltage



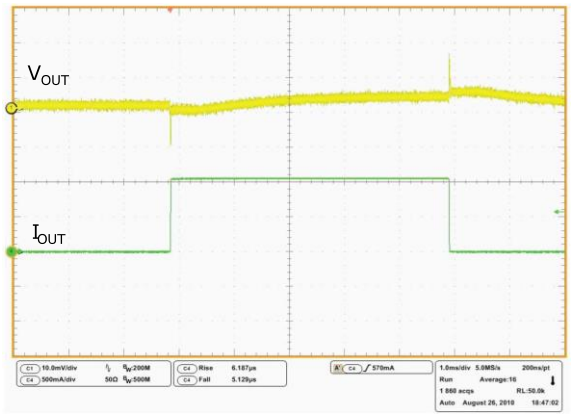
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Figure 18: Line transient



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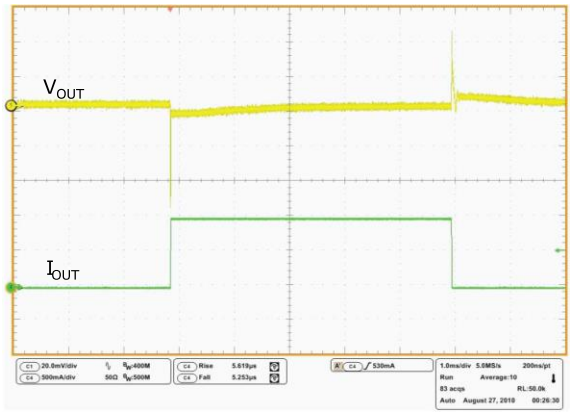
Figure 19: Load transient (V_{OUT} = 3.3 V)



$V_{EN} = V_{IN} = 4.5V$; I_{OUT} = from 1mA to 1A, $t_{rise} = t_{fall} = 5\mu s$, $C_{OUT} = 2.2\mu F$, $V_{OUT} = V_{ADJ}$

GIPD151020151015MT

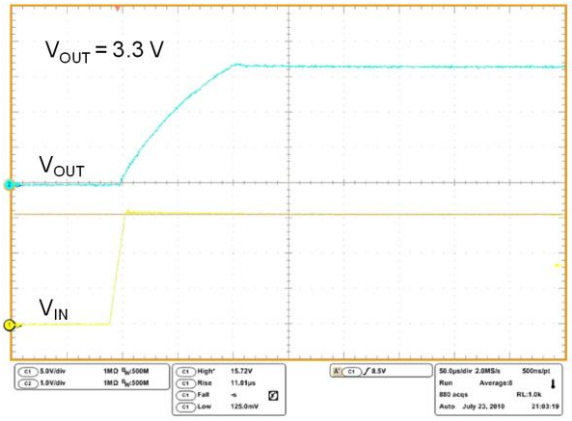
Figure 20: Load transient (V_{OUT} = V_{ADJ})



$V_{EN} = V_{IN} = 4.5V$; I_{OUT} = from 1mA to 1A, $t_{rise} = t_{fall} = 5\mu s$, $C_{OUT} = 2.2\mu F$, $V_{OUT} = 3.3V$

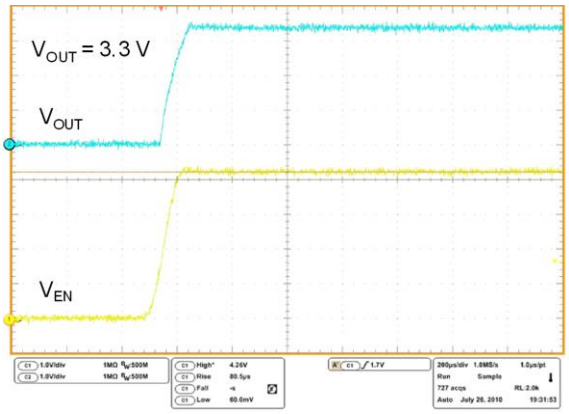
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Figure 21: Start-up transient



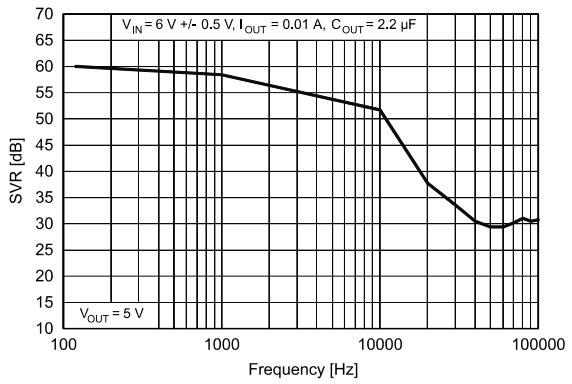
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Figure 22: Enable transient



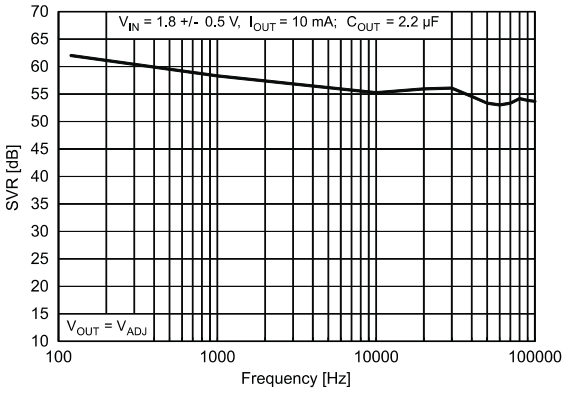
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Figure 23: SVR vs. frequency (V_{OUT} = 5 V)



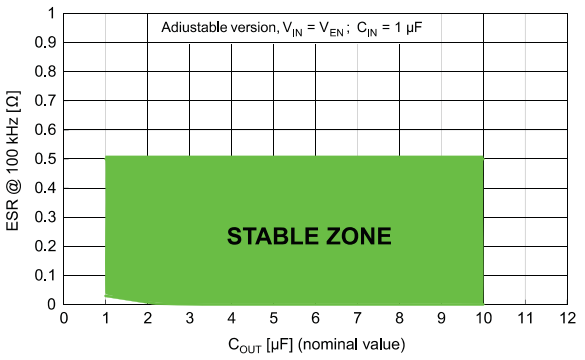
GIPD151020151029MT

Figure 24: SVR vs. frequency (V_{OUT} = V_{ADJ})



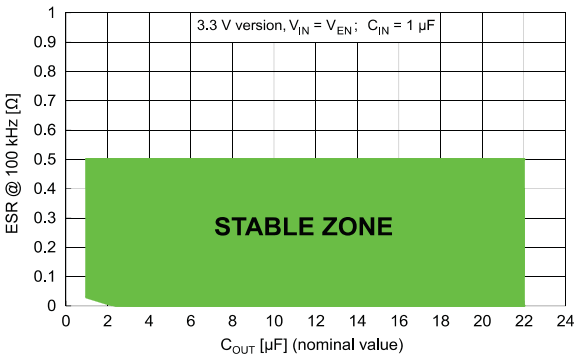
GIPD151020151031MT

Figure 25: Stability plane ADJ (C_{OUT}, ESR)



GIPD151020151034MT

Figure 26: Stability plane 3.3 V (C_{OUT}, ESR)



GIPD151020151035MT

8 Package information

In order to meet environmental requirements, ST offers these devices in different grades of ECOPACK® packages, depending on their level of environmental compliance. ECOPACK® specifications, grade definitions and product status are available at: ***www.st.com***. ECOPACK® is an ST trademark.

8.1 DFN6 (3x3) package information

Figure 27: DFN6 (3x3) package outline

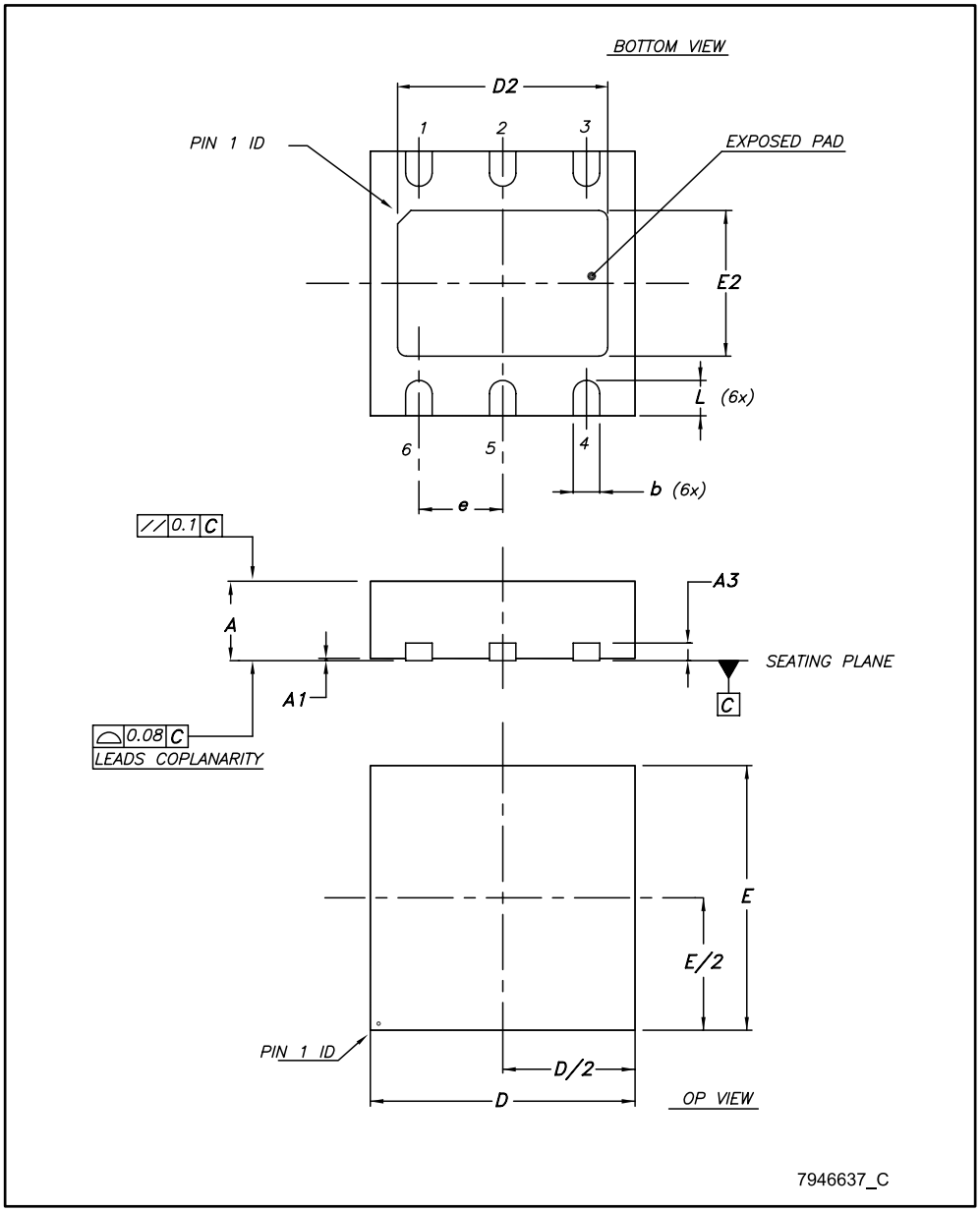
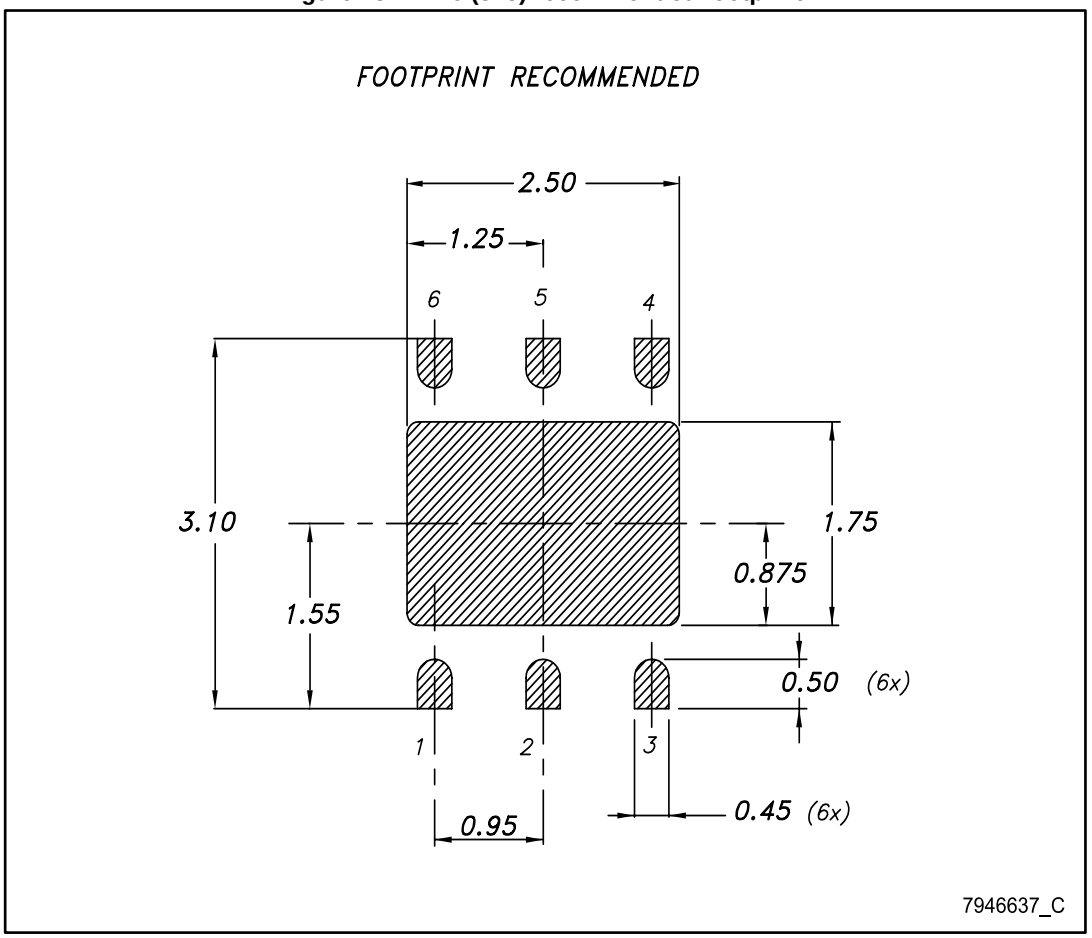


Table 7: DFN6 (3x3) mechanical data

Dim.	mm		
	Min.	Typ.	Max.
A	0.80		1
A1	0	0.02	0.05
A3		0.20	
b	0.23		0.45
D	2.90	3	3.10
D2	2.23		2.50
E	2.90	3	3.10
E2	1.50		1.75
e		0.95	
L	0.30	0.40	0.50

Figure 28: DFN6 (3x3) recommended footprint



8.2 DFN6 (3x3) packing information

Figure 29: DFN6 (3x3) tape outline

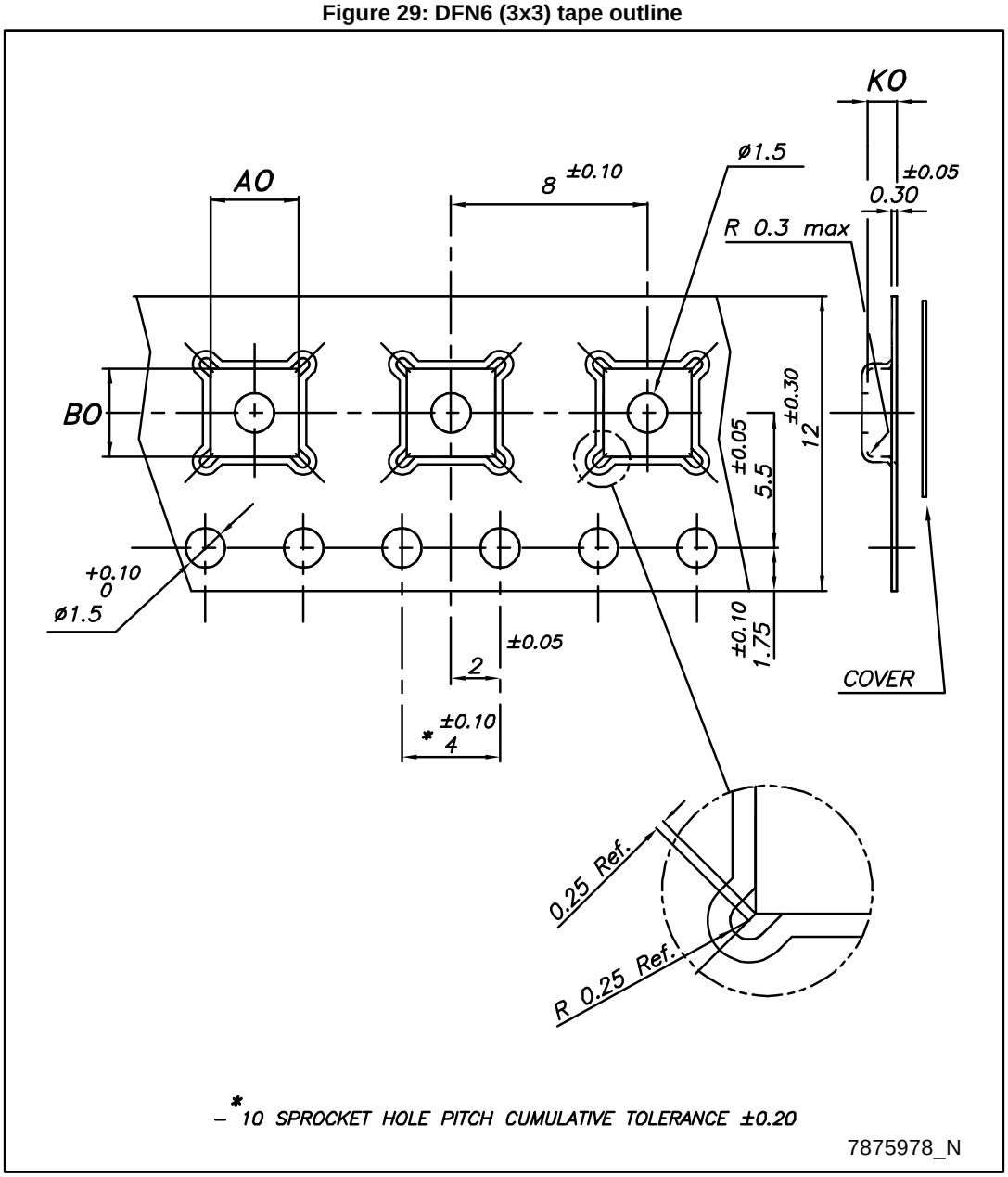


Figure 30: DFN6 (3x3) reel outline

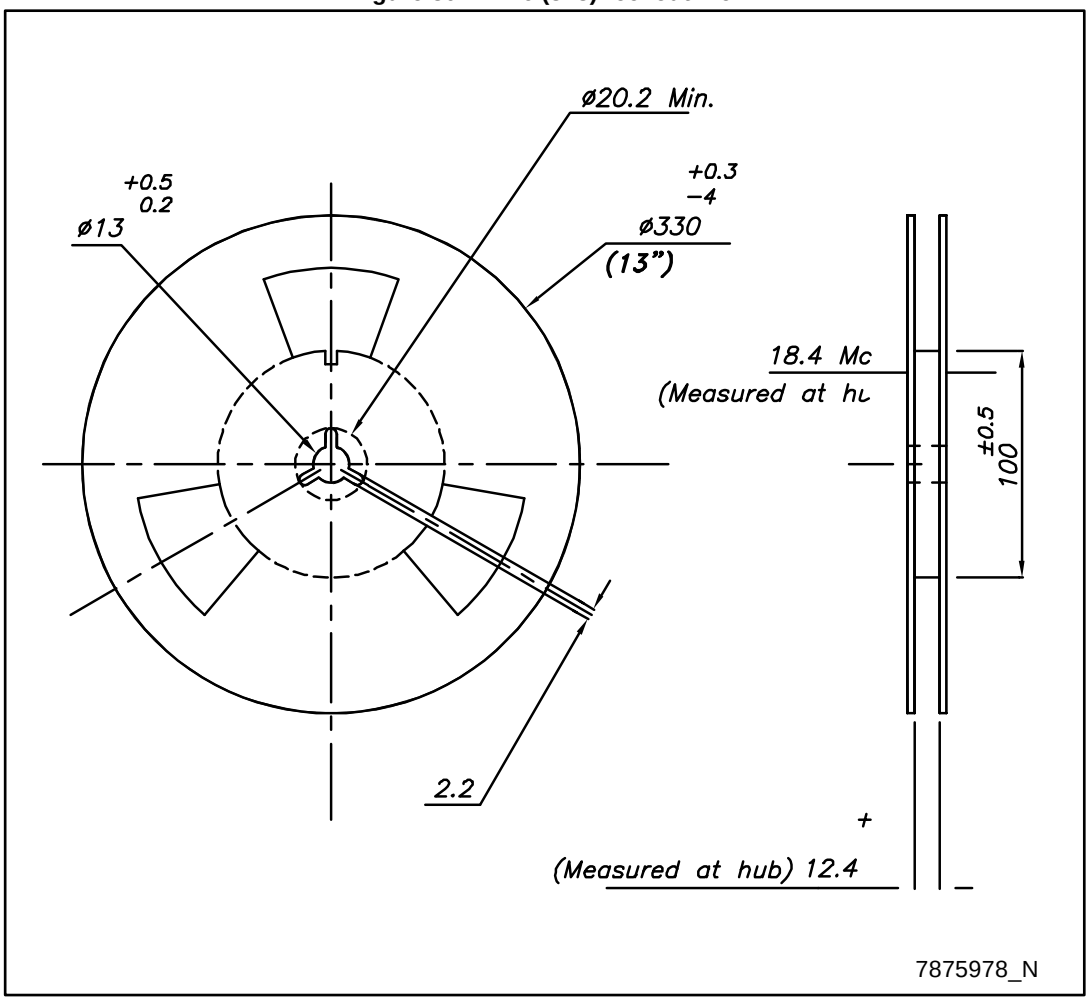


Table 8: DFN6 (3x3) tape and reel mechanical data

Dim.	mm		
	Min.	Typ.	Max.
A0	3.20	3.30	3.40
B0	3.20	3.30	3.40
K0	1	1.10	1.20

8.3 DFN6 (2x2) package information

Figure 31: DFN6 (2x2) package outline

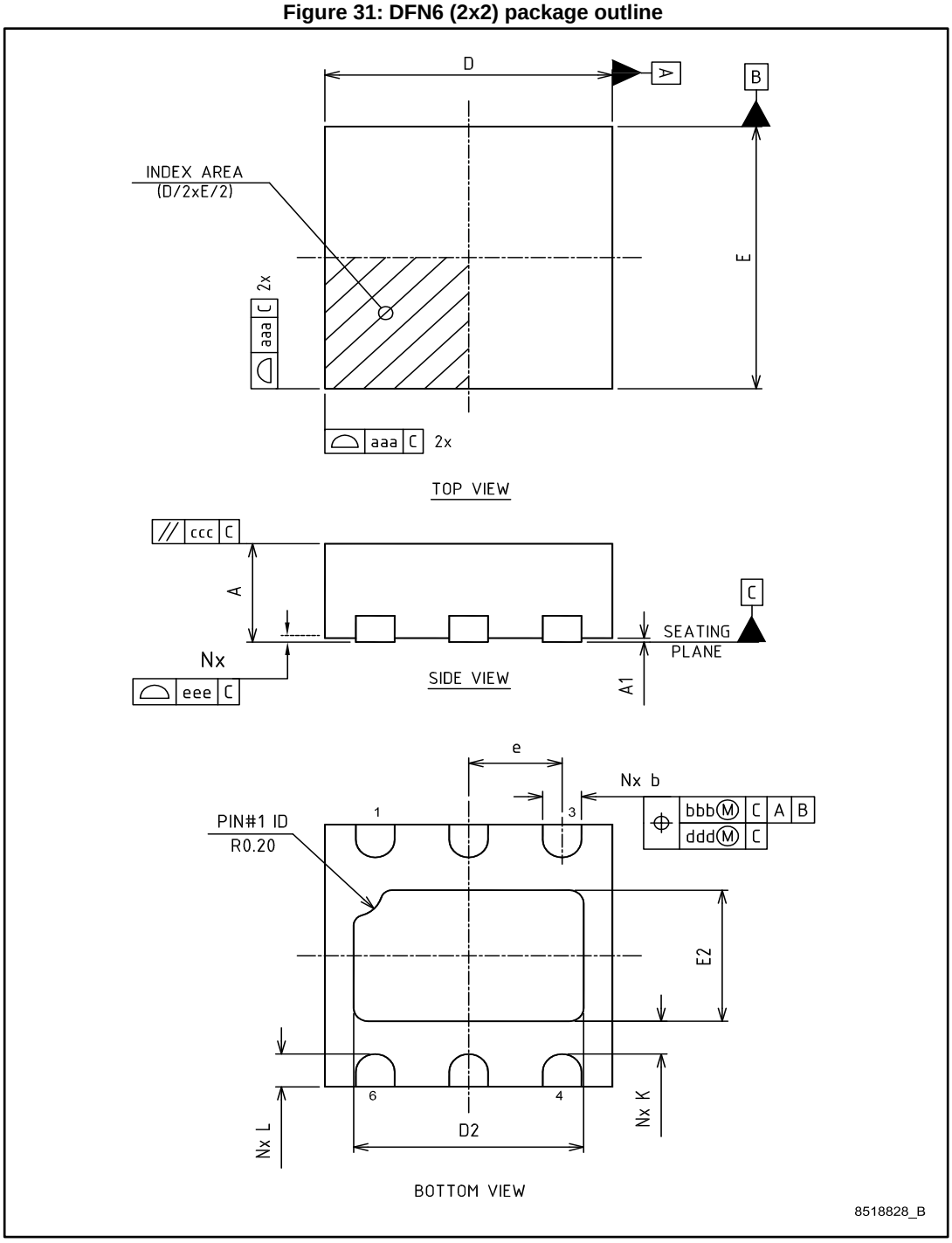
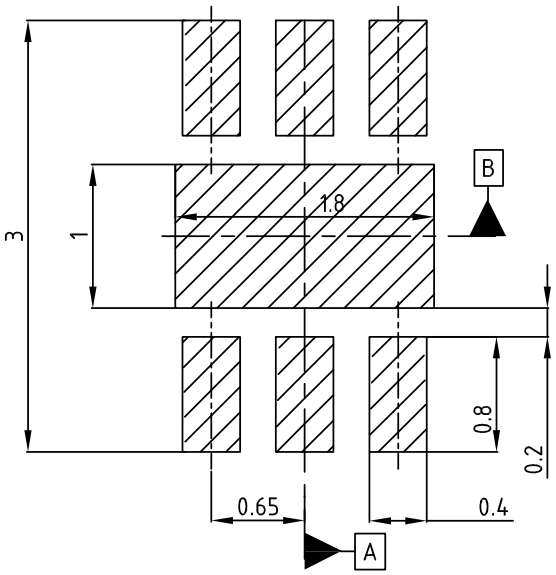


Table 9: DFN6 (2x2) mechanical data

Dim.	mm		
	Min.	Typ.	Max.
A	0.80	0.90	1.00
A1	0.00	0.02	0.05
b	0.25	0.30	0.35
D	2.00 BSC		
E	2.00 BSC		
e	0.65 BSC		
D2	1.45		1.70
E2	0.85		1.10
L	0.20		0.30
K	0.15		
aaa	0.05		
bbb	0.10		
ccc	0.10		
ddd	0.05		
eee	0.08		
N	6		

Figure 32: DFN6 (2x2) recommended footprint



Notes:

1) This footprint is able to ensure insulation up to 60 Vrms (according to CEI IEC 664-1)

2) The device must be positioned within ⌖ 0.02 A B

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8.4 DFN6 (2x2) packing information

Figure 33: DFN6 (2x2) reel outline

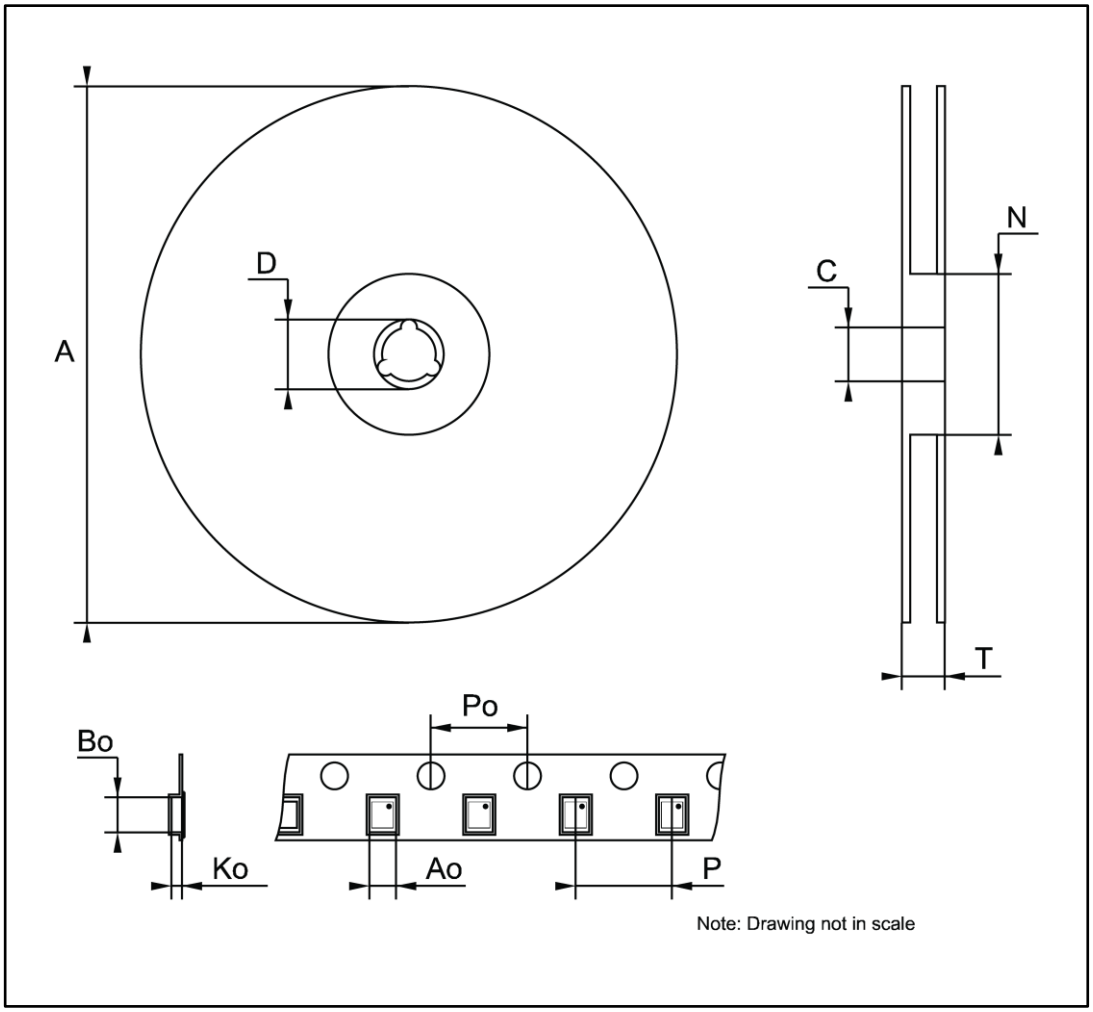


Table 10: DFN6 (2x2) tape and reel mechanical data

Dim.	mm		
	Min.	Typ.	Max.
A			180
C	12.8		13.2
D	20.2		
N	60		
T			14.4
A0		2.4	
B0		2.4	
K0		1.3	
P0		4	
P		4	

8.5 PPAK package information

Figure 34: PPAK package outline

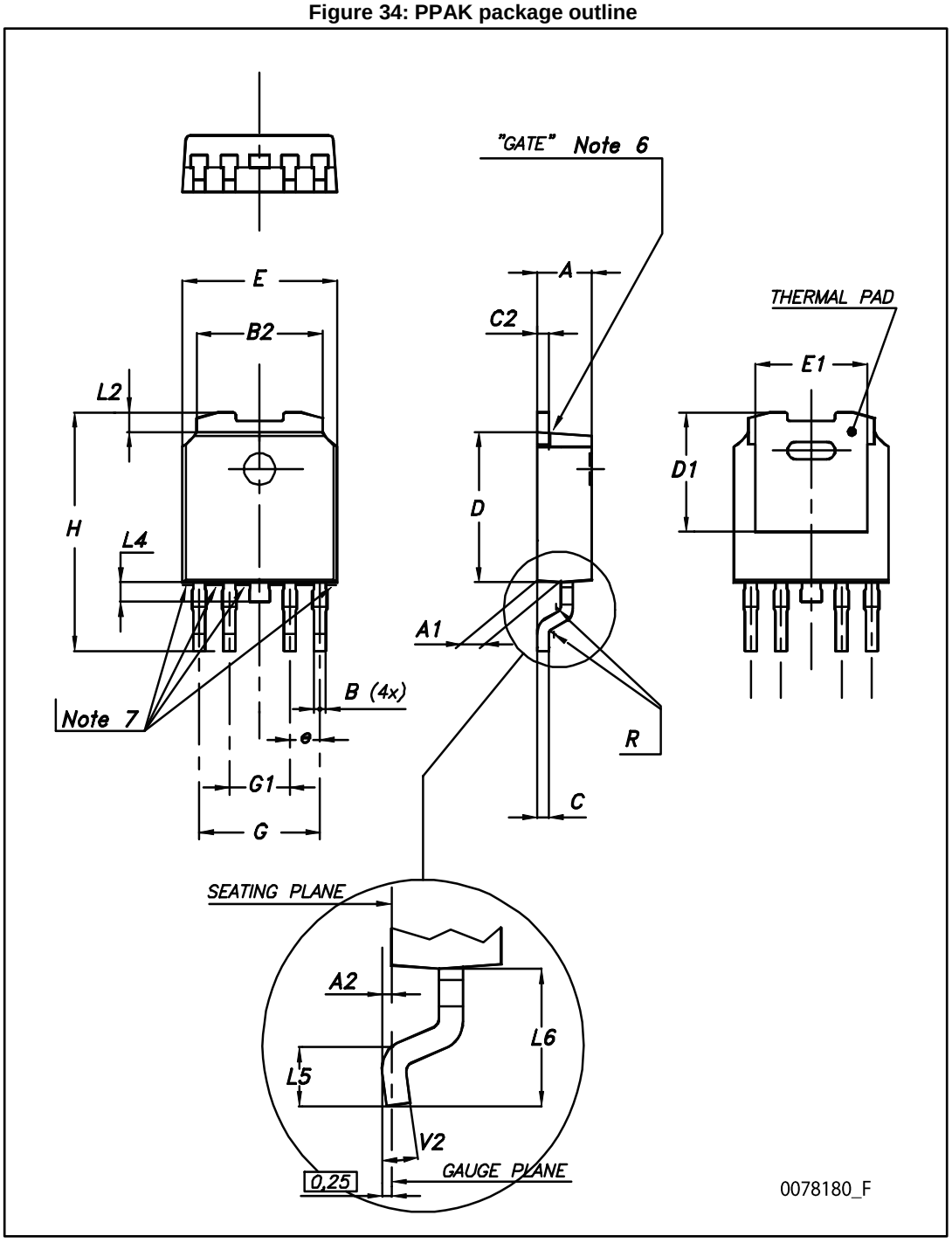


Table 11: PPAK mechanical data

Dim.	mm		
	Min.	Typ.	Max.
A	2.2		2.4
A1	0.9		1.1
A2	0.03		0.23
B	0.4		0.6
B2	5.2		5.4
C	0.45		0.6
C2	0.48		0.6
D	6		6.2
D1		5.1	
E	6.4		6.6
E1		4.7	
e		1.27	
G	4.9		5.25
G1	2.38		2.7
H	9.35		10.1
L2		0.8	1
L4	0.6		1
L5	1		
L6		2.8	
R		0.20	
V2	0°		8°

8.6 DPAK package information

Figure 35: DPAK package outline

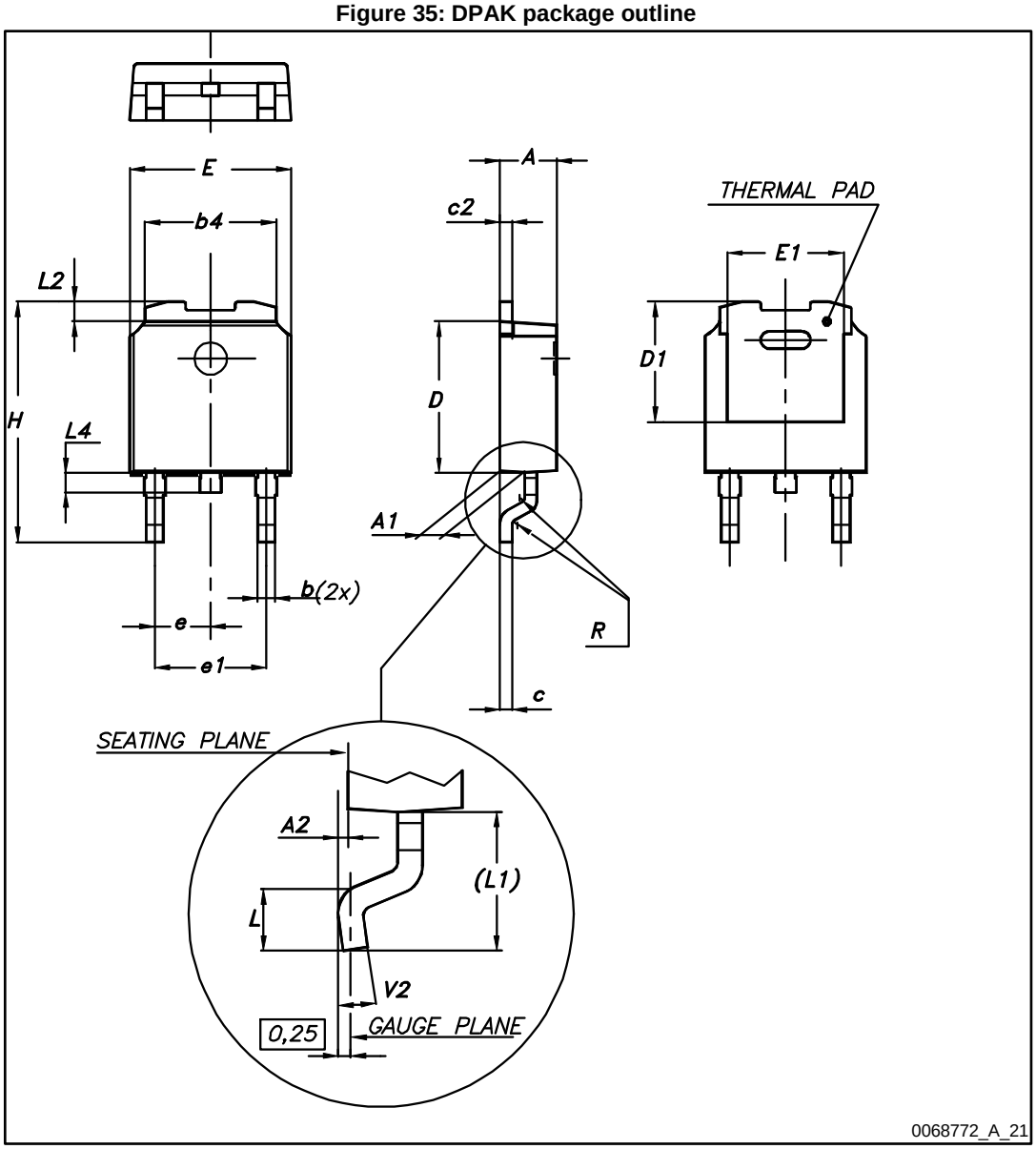
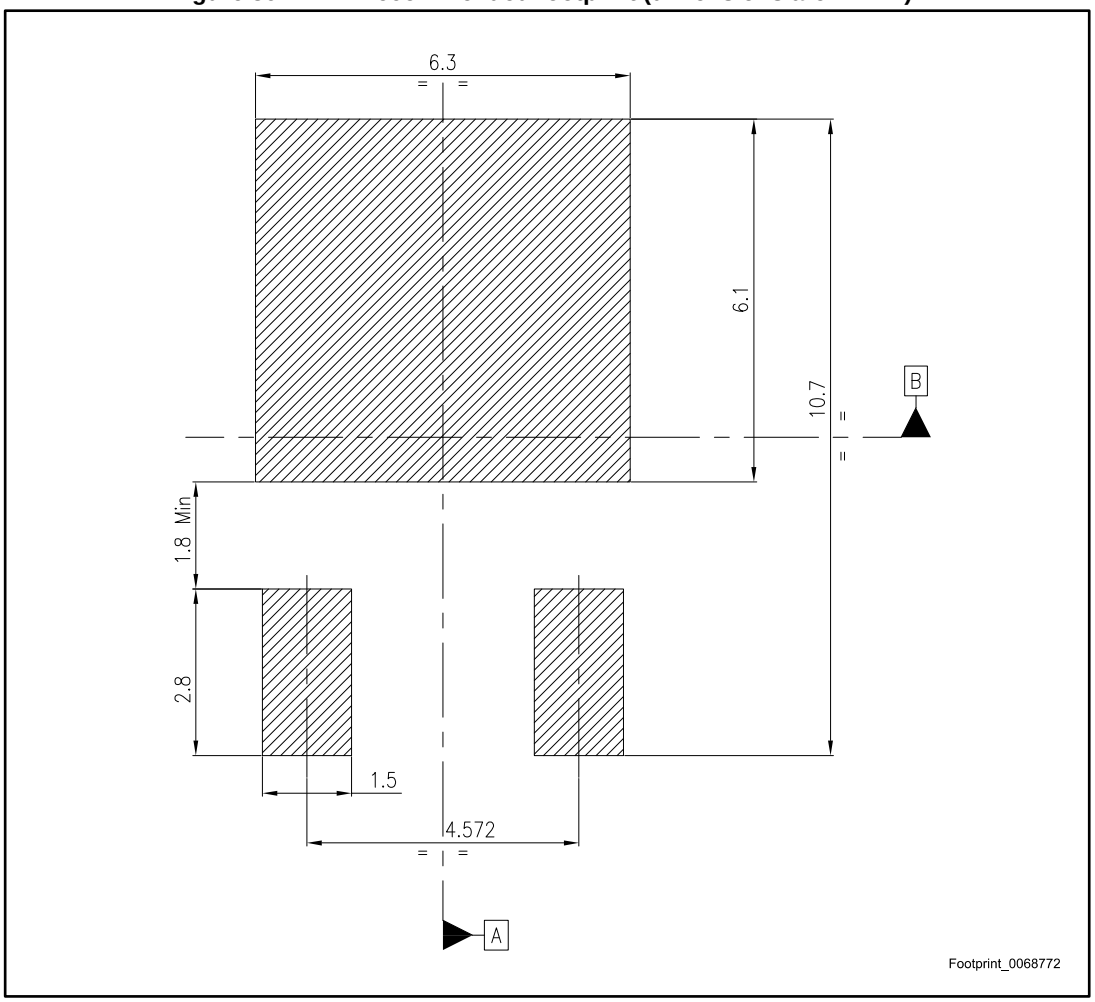


Table 12: DPAK mechanical data

Dim.	mm		
	Min.	Typ.	Max.
A	2.20		2.40
A1	0.90		1.10
A2	0.03		0.23
b	0.64		0.90
b4	5.20		5.40
c	0.45		0.60
c2	0.48		0.60
D	6.00		6.20
D1		5.10	
E	6.40		6.60
E1		4.70	
e		2.28	
e1	4.40		4.60
H	9.35		10.10
L	1.00		1.50
(L1)		2.80	
L2		0.80	
L4	0.60		1.00
R		0.20	
V2	0°		8°

Figure 36: DPAK recommended footprint (dimensions are in mm)



8.7 PPAK and DPAK packing information

Figure 37: PPAK and DPAK tape

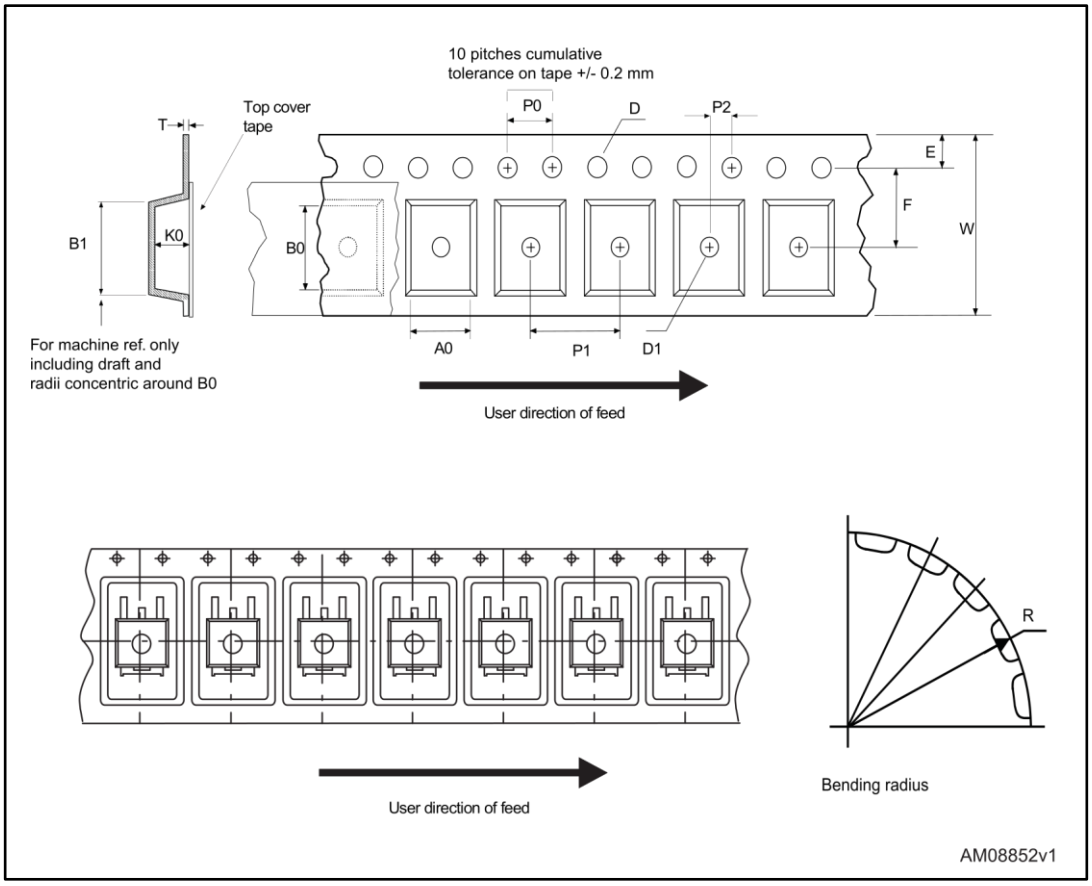


Figure 38: PPAK and DPAK reel

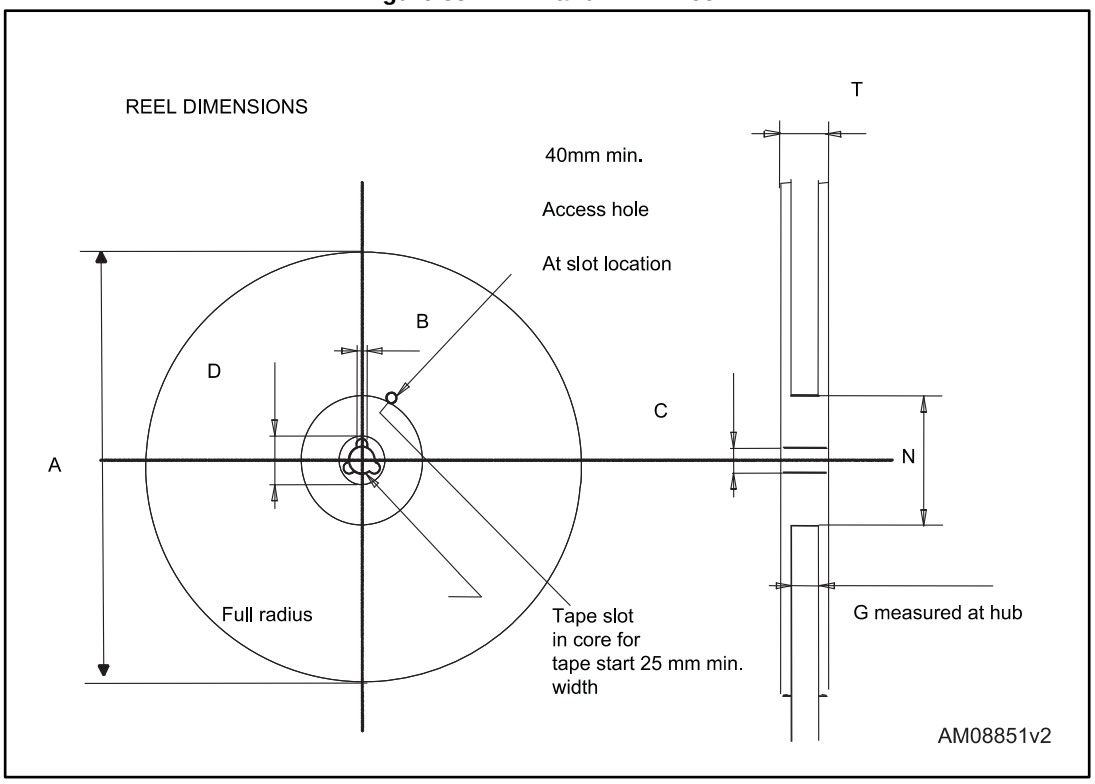


Table 13: PPAK and DPAK tape and reel mechanical data

Tape			Reel		
Dim.	mm		Dim.	mm	
	Min.	Max.		Min.	Max.
A0	6.8	7	A		330
B0	10.4	10.6	B	1.5	
B1		12.1	C	12.8	13.2
D	1.5	1.6	D	20.2	
D1	1.5		G	16.4	18.4
E	1.65	1.85	N	50	
F	7.4	7.6	T		22.4
K0	2.55	2.75			
P0	3.9	4.1	Base qty.		2500
P1	7.9	8.1	Bulk qty.		2500
P2	1.9	2.1			
R	40				
T	0.25	0.35			
W	15.7	16.3			

9 Ordering information

Different output voltage versions of the LDF available on request:

Table 14: Order code

Package				Output voltage (V)
PPAK	DPAK	DFN6-3x3	DFN6-2x2	
LDF18PT-TR				1.8
LDF25PT-TR				2.5
LDF33PT-TR	LDF33DT-TR			3.3
LDFPT-TR		LDFPUR	LDFPVR	ADJ

10 Revision history

Table 15: Document revision history

Date	Revision	Changes
05-Dec-2013	1	Initial release.
12-Apr-2017	2	Updated *Figure 14: "Enable pin current vs. temperature"* and *Section 8: "Package information"*. Added *Section 6.2: "Output voltage setting for ADJ version"*. Minor text changes.

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