

## 500 mA very low drop voltage regulator

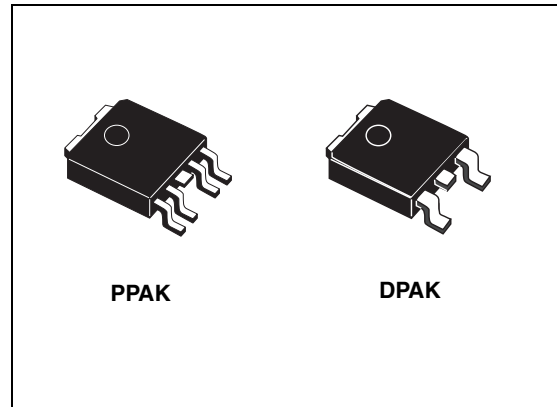
Datasheet – production data

### Features

- Input voltage from 2.5 to 16 V
- Very low dropout voltage (300 mV max. at 500 mA load)
- Low quiescent current (200  $\mu$ A typ. @ 500 mA load)
- Output voltage tolerance:  $\pm$  2% at 25 °C
- 500 mA 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 (PPAK)
- Power Good (on fixed versions in PPAK package)
- Fast dynamic response to line and load changes
- Internal current and thermal protection
- Temperature range: - 40 °C to 125 °C

### Applications

- PCs and laptop computers
- Battery-powered equipment
- Industrial and medical equipment
- Portable equipment



### Description

The LDFM is a fast, very low drop linear regulator which operates from an input supply voltage in the range of 2.5 V to 16 V.

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

The LDFM features 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 the PPAK package.

Current and thermal protection are provided.

**Table 1. Device summary**

Part numbers	Order codes	Packages	Output voltages
LDFM50	LDFM50DT-TR	DPAK	5 V
LDFM50	LDFM50PT-TR	PPAK	5 V
LDFM	LDFMPT-TR	PPAK	Adjustable from 0.8 V

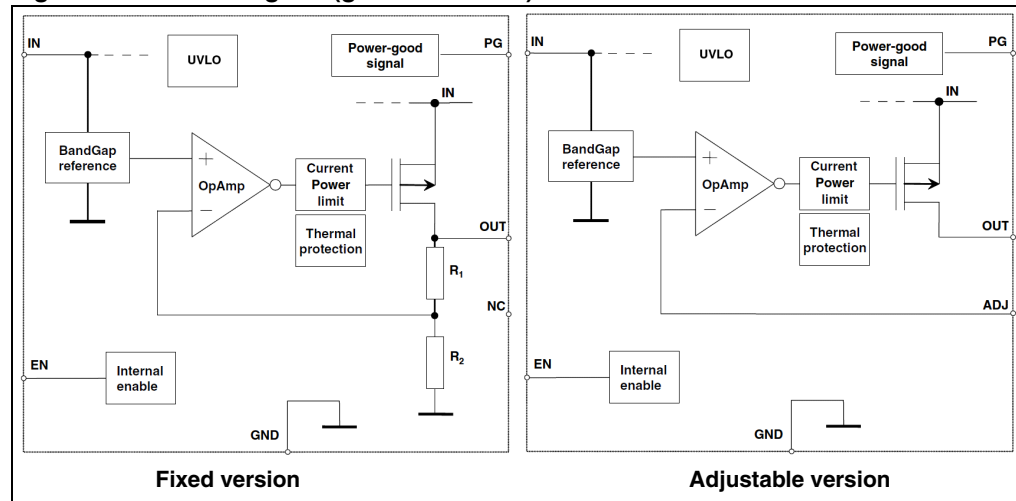
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# 1 Block diagram

Figure 1. Block diagram (generic version)



## 2 Pin configuration

Figure 2. Pin connection (top view)

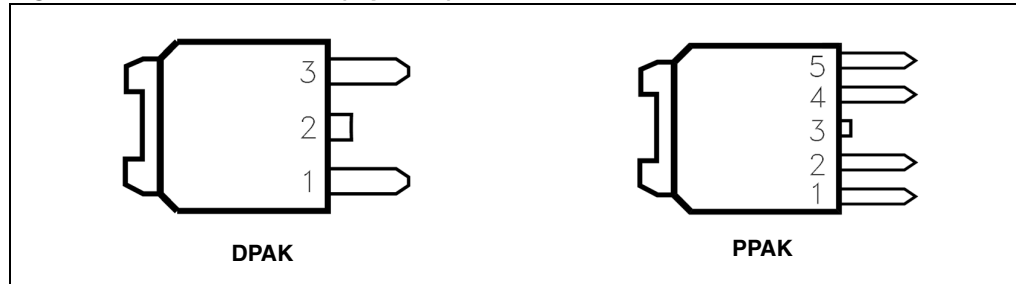
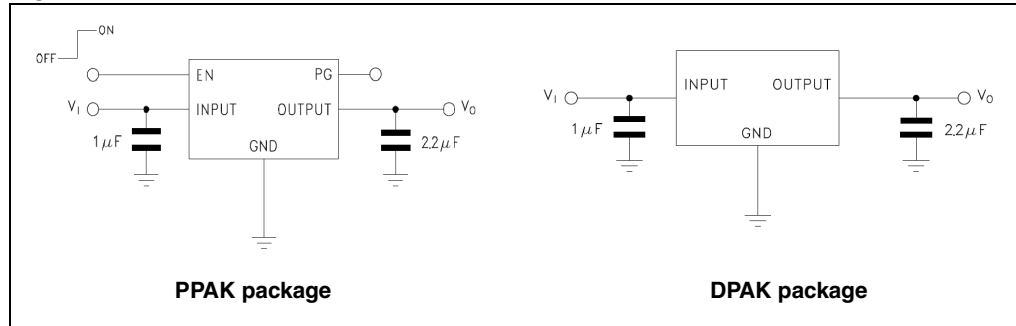


Table 2. Pin description

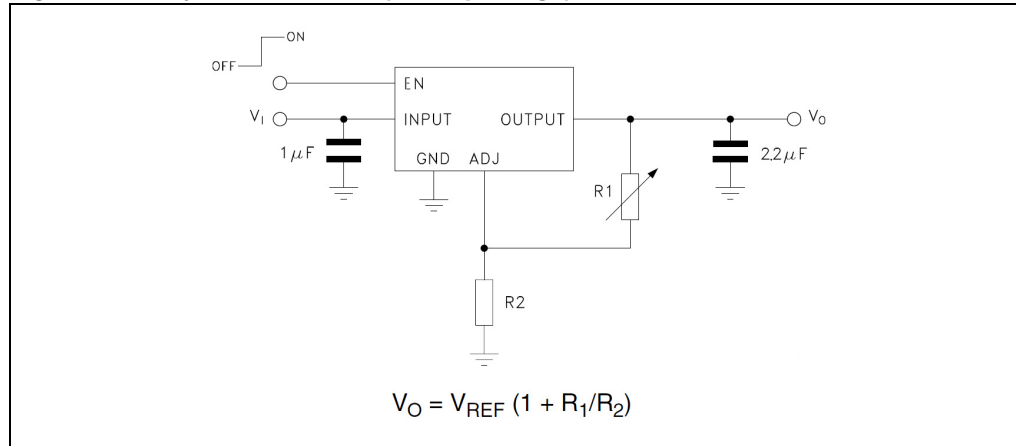
Pin n°		Symbol	Function
PPAK	DPAK		
5	-	ADJ/PG	For adjustable versions: Error amplifier input pin. For fixed version: Power Good output
2	1	$V_{IN}$	Input voltage
4	3	$V_{OUT}$	Output voltage
1	-	EN	Enable pin logic input: Low = shutdown, High = active
3	2	GND	Ground
TAB	TAB	GND	Ground

### 3 Typical application

**Figure 3. Fixed versions**



**Figure 4. Adjustable version (PPAK package)**



## 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
$V_{ADJ}$	Adjust pin voltage	- 0.3 to 2	V
$V_{PG}$	Power Good 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

*Note: 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	
$R_{thJA}$	Thermal resistance junction-ambient	100	100	°C/W
$R_{thJC}$	Thermal resistance junction-case	8	8	°C/W

## 5 Electrical characteristics

$T_J = 25\text{ °C}$ ,  $V_{IN} = V_{OUT(NOM)} + 1\text{ V}$  <sup>(1)</sup>,  $C_{IN} = 1\text{ }\mu\text{F}$ ,  $C_{OUT} = 2.2\text{ }\mu\text{F}$ ,  $I_{LOAD} = 10\text{ mA}$ ,  $V_{EN} = 2\text{ V}$ , unless otherwise specified.

**Table 5. Electrical characteristics for LDFM50 (fixed versions)**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$V_{IN}$	Operating input voltage		2.5		16	V
$V_{OUT}$	$V_{OUT}$ accuracy	$V_{OUT} + 1\text{ V}^{(1)} \leq V_{IN} \leq 16\text{ V}$ $I_{LOAD} = 10\text{ mA}$	-2		2	%
		$10\text{ mA} \leq I_{LOAD} \leq 500\text{ mA}$ $T_J = -40\text{ to }125\text{ °C}$	-3		3	%
$\Delta V_{OUT}$	Static line regulation	$V_{OUT} + 1\text{ V}^{(1)} \leq V_{IN} \leq 16\text{ V}$		0.01		% / V
		$V_{OUT} + 1\text{ V}^{(1)} \leq V_{IN} \leq 16\text{ V}$ , $T_J = -40\text{ to }125\text{ °C}$			0.04	
$\Delta V_{OUT}$	Static load regulation	$10\text{ mA} \leq I_{LOAD} \leq 500\text{ mA}$		0.1		% / A
		$10\text{ mA} \leq I_{LOAD} \leq 500\text{ mA}$ , $T_J = -40\text{ to }125\text{ °C}$		0.15	0.4	
$V_{DROP}$	Dropout voltage <sup>(2)</sup>	$I_{LOAD} = 500\text{ mA}$ , $-40\text{ °C} < T_J < 125\text{ °C}$		125	300	mV
$I_Q$	Quiescent current	ON mode: $V_{EN} = 2\text{ V}$ $I_{LOAD} = 10\text{ mA to }500\text{ mA}$ , $T_J = -40\text{ to }125\text{ °C}$		200	800	$\mu\text{A}$
		OFF mode: $V_{EN} = \text{GND}$ , PPAK version		50		$\mu\text{A}$
		OFF mode: $V_{EN} = \text{GND}$ , PPAK version $-40\text{ °C} < T_J < 125\text{ °C}$			300	
$I_{SC}$	Short-circuit current			0.8		A
$V_{EN}$	Enable input logic low	$V_{IN} = 2.5\text{ V to }16\text{ V}$ , $-40\text{ °C} < T_J < 125\text{ °C}$			0.8	V
	Enable input logic high		2			
$I_{EN}$	Enable pin input current	$V_{EN} = V_{IN}$		5	10	$\mu\text{A}$
PG	Power Good output threshold	Rising edge		0.92*		V
		Falling edge		0.8*		
	Power Good output voltage low	$I_{SINK} = 6\text{ mA}$ , open drain output		0.4		
SVR	Supply voltage rejection	$V_{IN} = 6\text{ V} \pm 0.5 V_{RIPPLE}$ Freq. = 120 Hz, $V_{OUT} = 5\text{ V}$		60		dB
		$V_{IN} = 6\text{ V} \pm 0.5 V_{RIPPLE}$ Freq. = 10 kHz, $V_{OUT} = 5\text{ V}$		52		

**Table 5. Electrical characteristics for LDFM50 (fixed versions)**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$e_N$	Output noise voltage	Bw = 10 Hz to 100 kHz, $I_{LOAD} = 100$ mA, $C_{OUT} = 2.2 \mu F$		45		$\mu V_{RMS}/V_{OUT}$
$T_{SHDN}$	Thermal shutdown			170		°C
	Hysteresis			10		

- For  $V_{OUT} < 1.5$  V;  $V_{IN} = 2.5$  V.
- 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 for output voltages below 1.5 V.

$T_J = 25$  °C,  $V_{IN} = V_{OUT(NOM)} + 1$  V<sup>(1)</sup>,  $C_{IN} = 1 \mu F$ ,  $C_{OUT} = 2.2 \mu F$ ,  $I_{LOAD} = 10$  mA,  $V_{EN} = 2$  V, unless otherwise specified.

**Table 6. Electrical characteristics for LDFM (adjustable version)**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$V_{IN}$	Operating input voltage		2.5		16	V
$V_{ADJ}$	Reference voltage	$V_{IN} = V_{OUT} + 1$ V <sup>(1)</sup>		0.8		V
	Reference voltage tolerance	$V_{OUT} + 1$ V <sup>(1)</sup> $\leq V_{IN} \leq 16$ V $I_{LOAD} = 10$ mA	-2		2	%
		$10$ mA $\leq I_{LOAD} \leq 500$ mA $T_J = -40$ to $125$ °C	-3		3	
$\Delta V_{OUT}$	Static line regulation	$V_{OUT} + 1$ V <sup>(1)</sup> $\leq V_{IN} \leq 16$ V		0.01		% / V
		$V_{OUT} + 1$ V <sup>(1)</sup> $\leq V_{IN} \leq 16$ V, $T_J = -40$ to $125$ °C			0.04	
$\Delta V_{OUT}$	Static load regulation	$10$ mA $\leq I_{LOAD} \leq 500$ mA		0.06		% / A
		$10$ mA $\leq I_{LOAD} \leq 500$ mA, $T_J = -40$ to $125$ °C		0.2	0.4	
$V_{DROP}$	Dropout voltage <sup>(2)</sup>	$V_{OUT}$ fixed to 2.5 V, $I_{LOAD} = 500$ mA, $-40$ °C $< T_J < 125$ °C		125	300	mV
$I_Q$	Quiescent current	ON mode: $V_{EN} = 2$ V $I_{LOAD} = 10$ mA to 500 mA, $T_J = -40$ to $125$ °C		200	800	$\mu A$
		OFF mode: $V_{EN} = GND$ , PPAK version		50		
		OFF mode: $V_{EN} = GND$ , PPAK version $-40$ °C $< T_J < 125$ °C			200	$\mu A$
$I_{SC}$	Short-circuit current			0.8		A
$V_{EN}$	Enable input logic low	$V_{IN} = 2.5$ 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	$\mu A$



Table 6. Electrical characteristics for LDFM (adjustable version)

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
PG	Power Good output threshold	Rising edge		0.92* $V_{ADJ}$		V
		Falling edge		0.8* $V_{ADJ}$		
	Power Good output voltage low	$I_{SINK} = 6 \text{ mA}$ , open drain output		0.4		
SVR	Supply voltage rejection	$V_{IN} = V_{OUT} + 1 \text{ V} \pm 0.5 V_{RIPPLE}$ Freq. = 120 Hz, $V_{OUT} = 0.8 \text{ V}$		62		dB
		$V_{IN} = V_{OUT} + 1 \text{ V} \pm 0.5 V_{RIPPLE}$ Freq. = 10 kHz, $V_{OUT} = 0.8 \text{ V}$		55		
$e_N$	Output noise voltage	Bw = 10 Hz to 100 kHz, $I_{LOAD} = 100 \text{ mA}$ , $C_{OUT} = 2.2 \mu\text{F}$		50		$\mu\text{V}_{RMS} / V_{OUT}$
$T_{SHDN}$	Thermal shutdown			170		°C
	Hysteresis			10		

1. For  $V_{OUT} < 1.5 \text{ V}$ ;  $V_{IN} = 2.5 \text{ V}$ .

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 for output voltages below 1.5 V.

## 6 Application information

### 6.1 External capacitors

The LDFM requires external capacitors for regulator stability. These capacitors must be selected to meet the requirements of minimum capacitance and equivalent series resistance (see [Figure 26 and 27](#)). It is advisable to locate the input/output capacitors as close as possible to the relative pins.

#### 6.1.1 Input capacitor

An input capacitor with a minimum value of 1  $\mu\text{F}$  is required with the LDFM. This capacitor must be located a distance of not more than 0.5" from the input pin of the device and returned to a clean analog ground. Any good quality ceramic capacitors can be used for this capacitor.

#### 6.1.2 Output capacitor

It is possible to use ceramic capacitors but the output capacitor must meet the requirements for minimum amount of capacitance and E.S.R. (equivalent series resistance) value.

A minimum capacitance of 2.2  $\mu\text{F}$  is a good choice to guarantee the stability of the regulator. However, other  $C_{\text{OUT}}$  values can be used according to [Figure 26 and 27](#), 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. Also, capacitor tolerance and variation with temperature must be kept in consideration in order to assure the minimum amount of capacitance at all times.

### 6.2 Enable pin operation

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

### 6.3 Power Good

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

## 7 Typical performance characteristics

$C_{IN} = C_{OUT} = 1 \mu\text{F}$ ,  $V_{IN} = V_{OUT} + 1 \text{ V}$ ,  $V_{EN}$  to  $V_{IN}$ ,  $I_{OUT} = 10 \text{ mA}$ , unless otherwise specified.

Figure 5. Output voltage vs. temperature

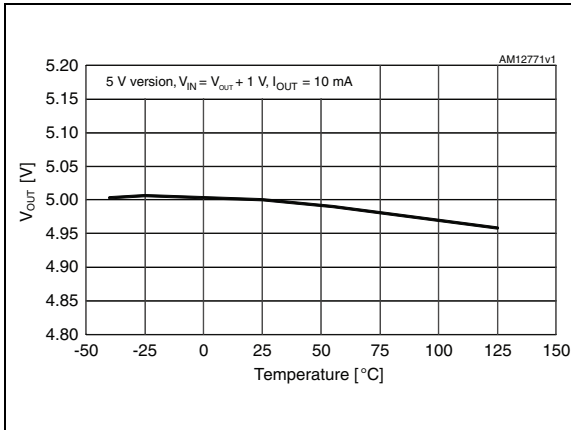


Figure 6. Output voltage vs. temperature for adjustable

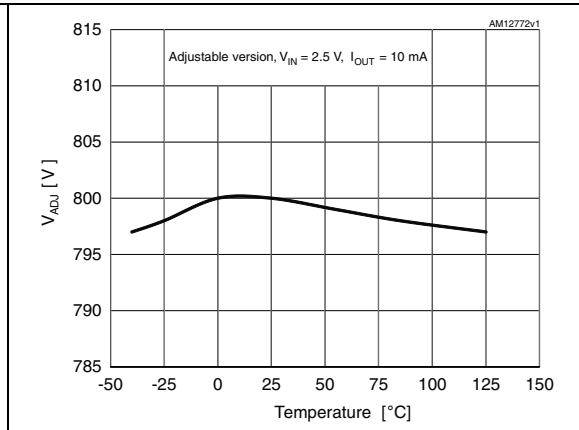


Figure 7. Line regulation vs. temperature

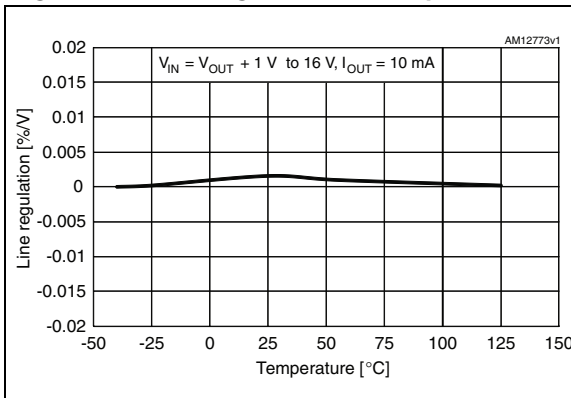


Figure 8. Load regulation vs. temperature

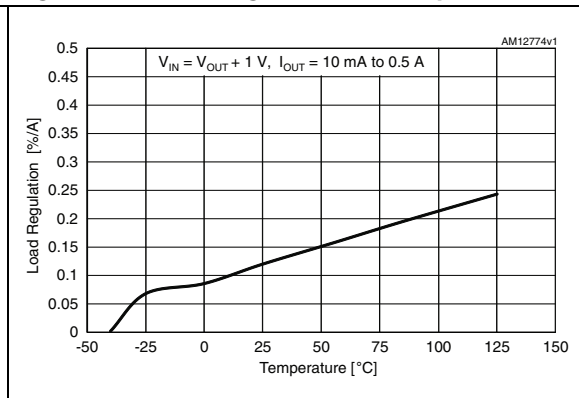


Figure 9. Short-circuit current vs. drop voltage

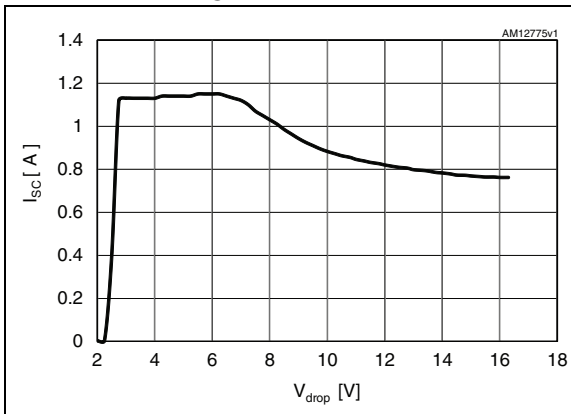


Figure 10. Dropout voltage vs. temperature

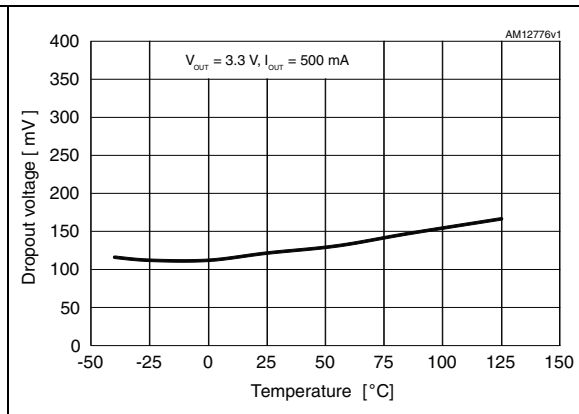


Figure 11. Quiescent current vs. temperature ( $I_{OUT} = 0 \text{ mA}$ )

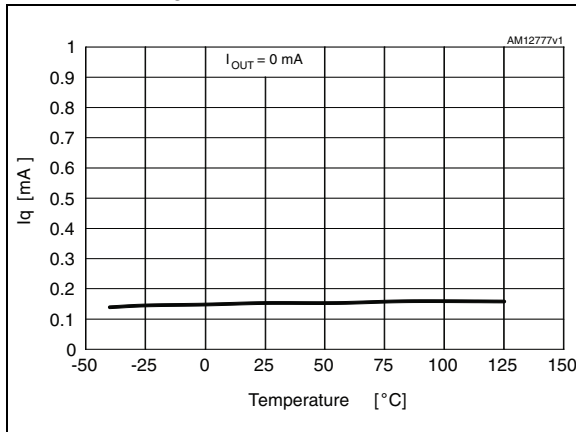


Figure 12. Quiescent current vs. temperature ( $I_{OUT} = 500 \text{ mA}$ )

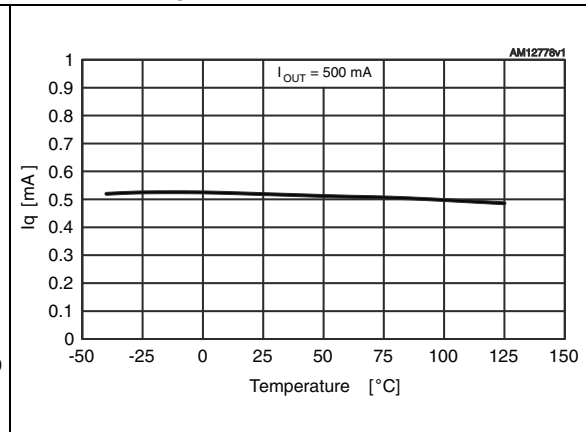


Figure 13. Shutdown current vs. temperature

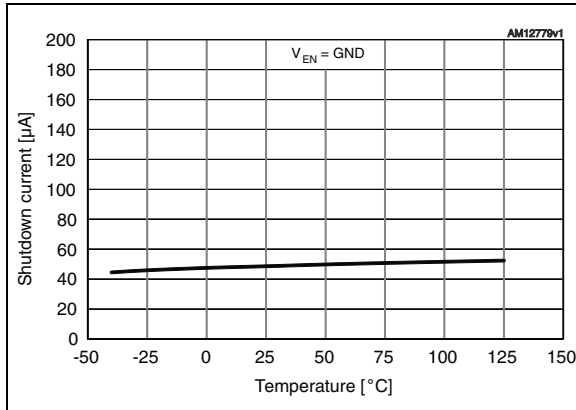


Figure 14. Enable pin current vs. temperature

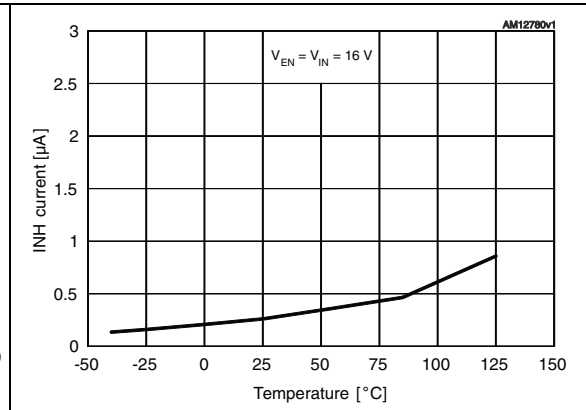


Figure 15. Enable high threshold vs. temperature

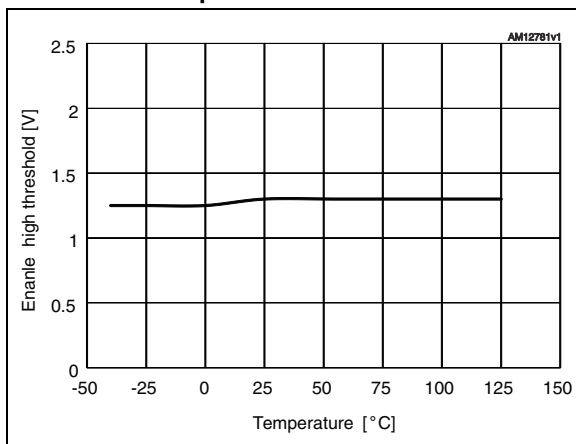


Figure 16. Enable low threshold vs. temperature

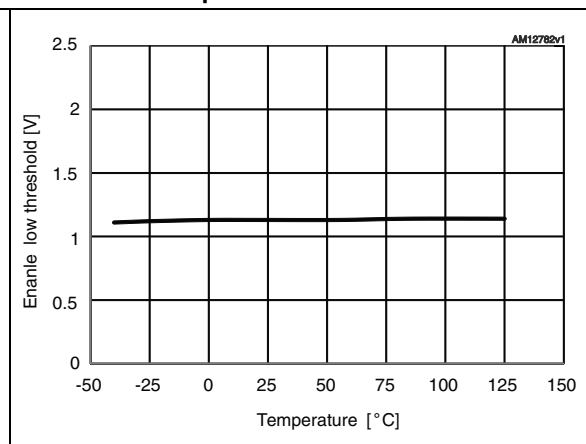


Figure 17. Output voltage vs. input voltage

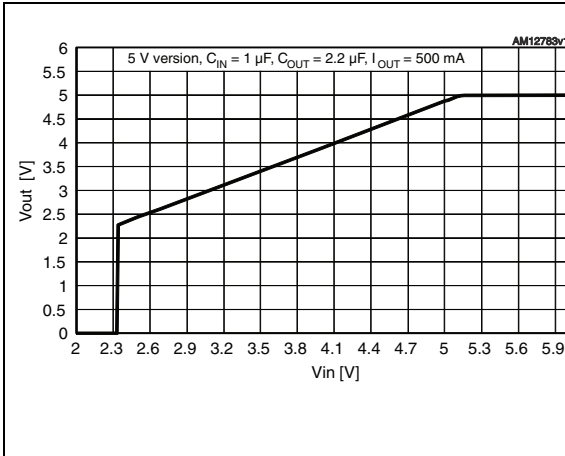


Figure 18. Line transient

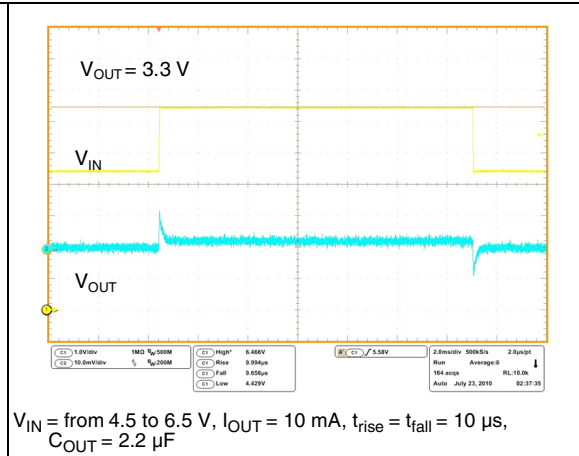


Figure 19. Load transient ( $V_{OUT} = 3.3 \text{ V}$ )

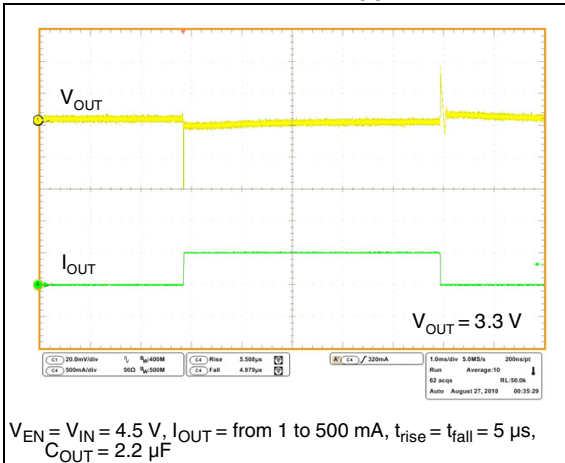


Figure 20. Load transient ( $V_{OUT} = V_{ADJ}$ )

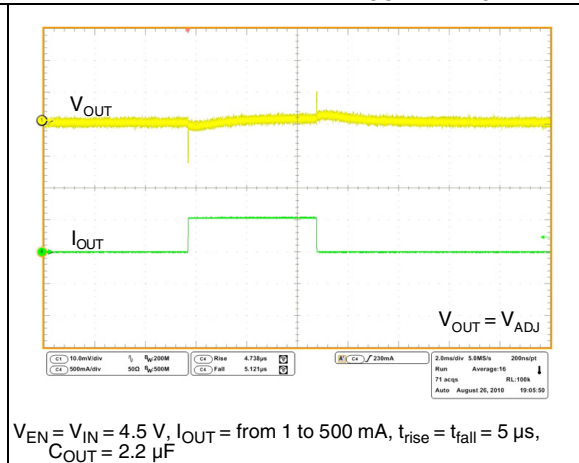


Figure 21. Startup transient

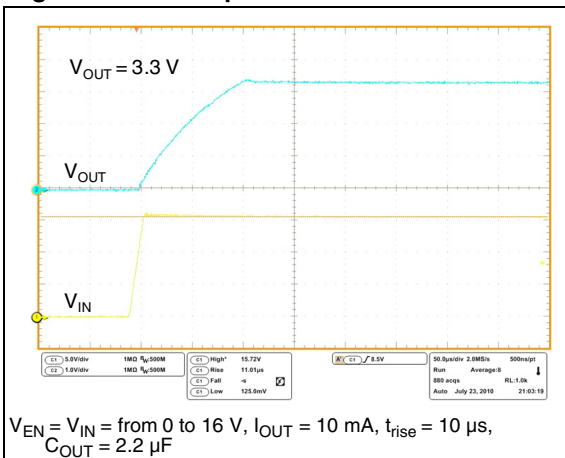


Figure 22. Enable transient

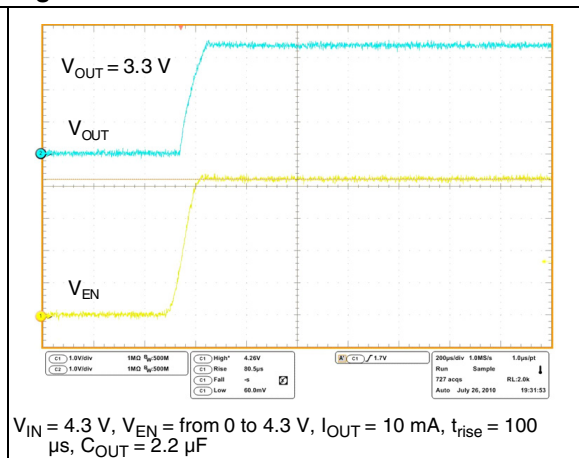


Figure 23. SVR vs. frequency ( $V_{OUT} = 5\text{ V}$ )

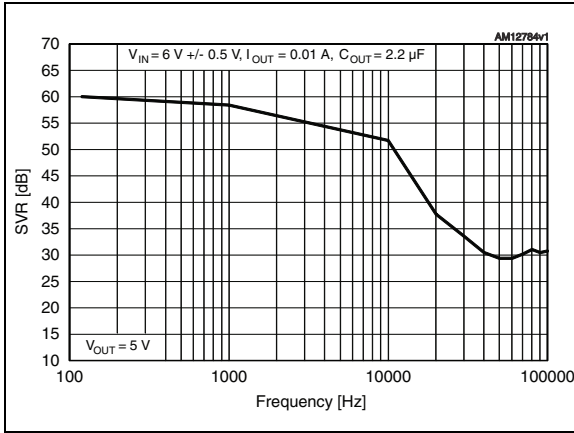


Figure 24. SVR vs. frequency ( $V_{OUT} = V_{ADJ}$ )

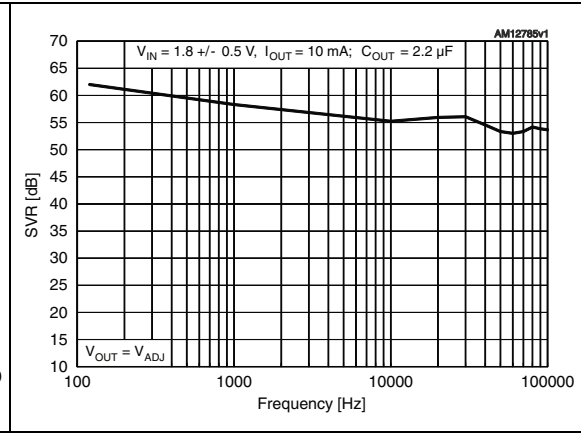


Figure 25. Stability plane adj ( $C_{OUT}$ , ESR)

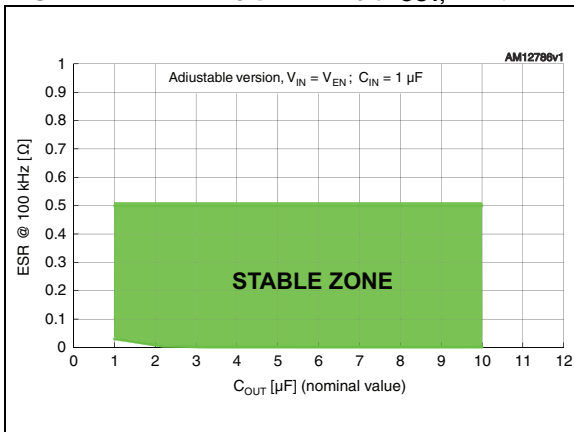
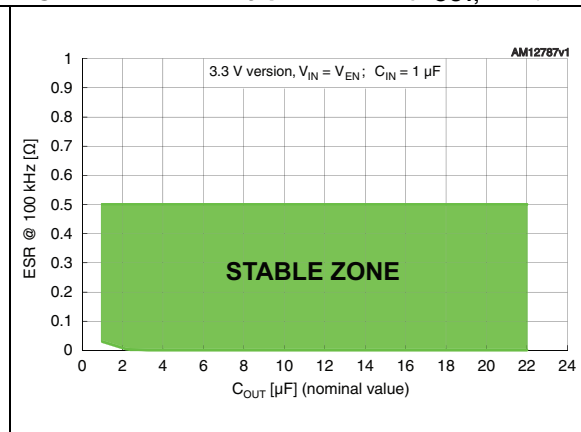


Figure 26. Stability plane 3.3 V ( $C_{OUT}$ , ESR)



## 8 Package mechanical data

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

**Table 7. 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		1.50
L1		2.80	
L2		0.80	
L4	0.60		1.00
R		0.20	
V2	0°		8°

Figure 27. DPAK drawing

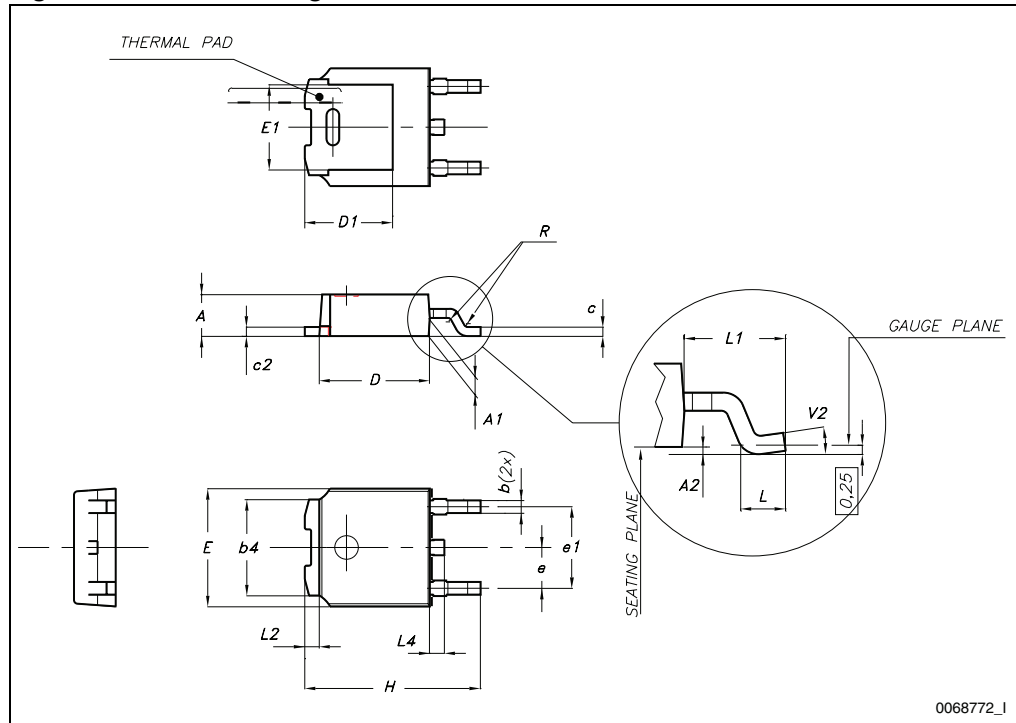
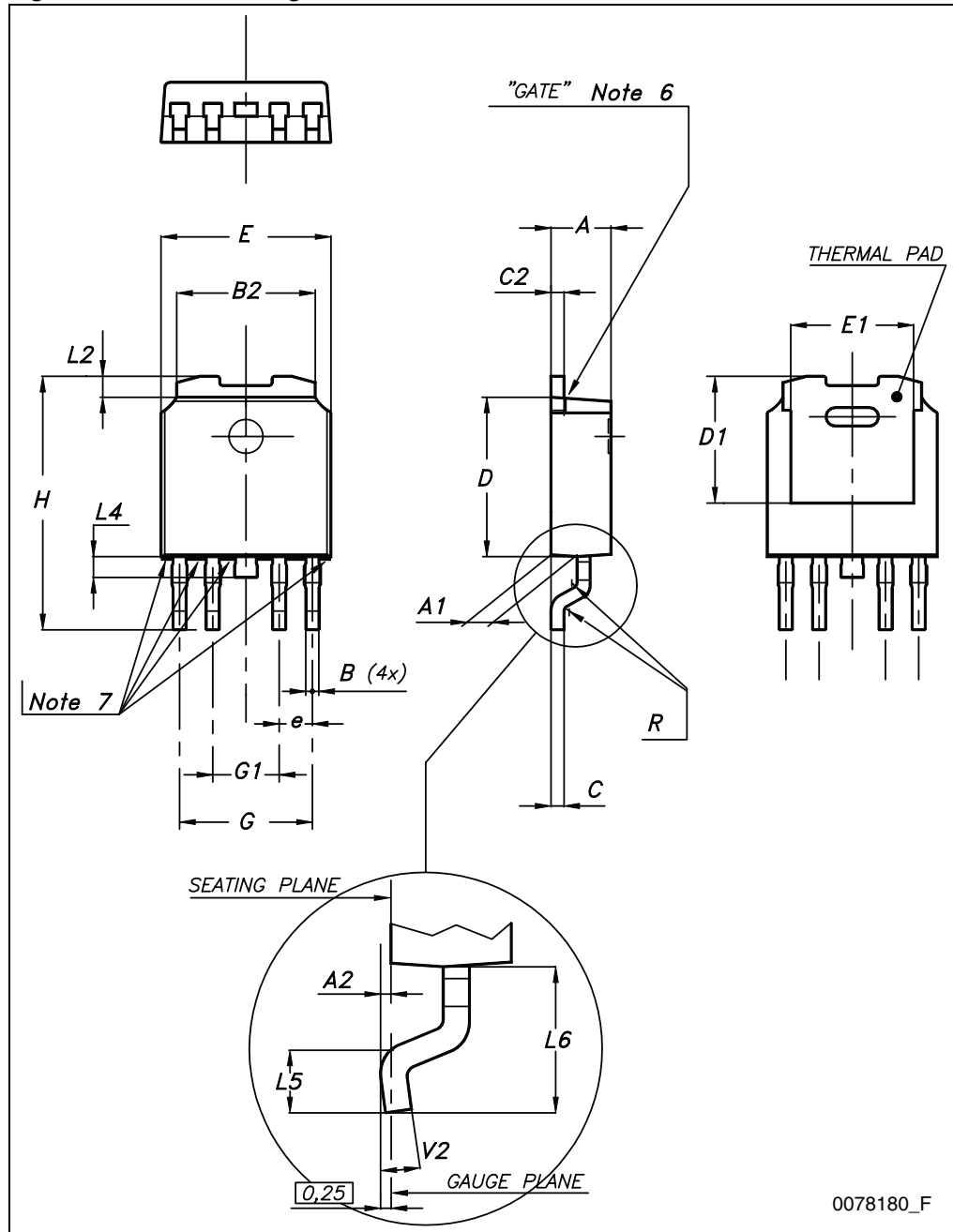




Table 8. PPAK mechanical data

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°

Figure 28. PPAK drawing



0078180\_F

## 9 Revision history

**Table 9. Document revision history**

Date	Revision	Changes
28-Aug-2012	1	Initial release.

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