

1.5 A, very low drop voltage regulators

Features

- Very low dropout voltage (typ. 0.4 at 1.5 A)
- Guaranteed output current up to 1.5 A
- Fixed and adjustable output voltage ($\pm 1\%$ at 25 °C)
- Internal current and thermal limit
- Logic controlled electronic shutdown available in PPAK and P²PAK

Description

The LD29150 is a high current, high accuracy, low-dropout voltage regulator series. These regulators feature 400 mV dropout voltage and very low ground current. Designed for high current loads, these devices are also used in lower current, extremely low dropout-critical systems, where their tiny dropout voltage and ground current values are important attributes.

Typical applications are in Power supply switching post regulation, Series power supply for monitors, Series power supply for VCRs and TVs, Computer Systems and Battery powered systems.

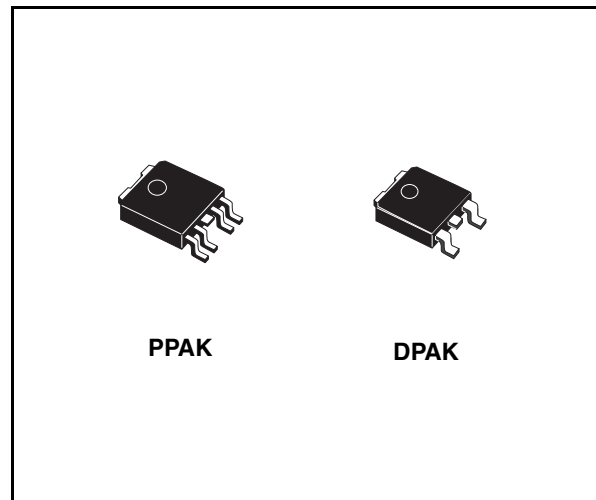


Table 1. Device summary

Part numbers	Order codes		Output voltage
	DPAK	PPAK	
LD29150XX15	LD29150DT15R	LD29150PT15R	1.5 V
LD29150XX18	LD29150DT18R	LD29150PT18R	1.8 V
LD29150XX25	LD29150DT25R	LD29150PT25R	2.5 V
LD29150XX33	LD29150DT33R	LD29150PT33R	3.3 V
LD29150XX50	LD29150DT50R	LD29150PT50R	5.0 V
LD29150XX		LD29150PTR	ADJ

Contents

1	Diagram	3
2	Pin configuration	4
3	Typical application	5
4	Maximum ratings	6
5	Electrical characteristics	7
6	Typical characteristics	13
7	Package mechanical data	16
8	Revision history	20

1 Diagram

Figure 1. Schematic diagram for adjustable version

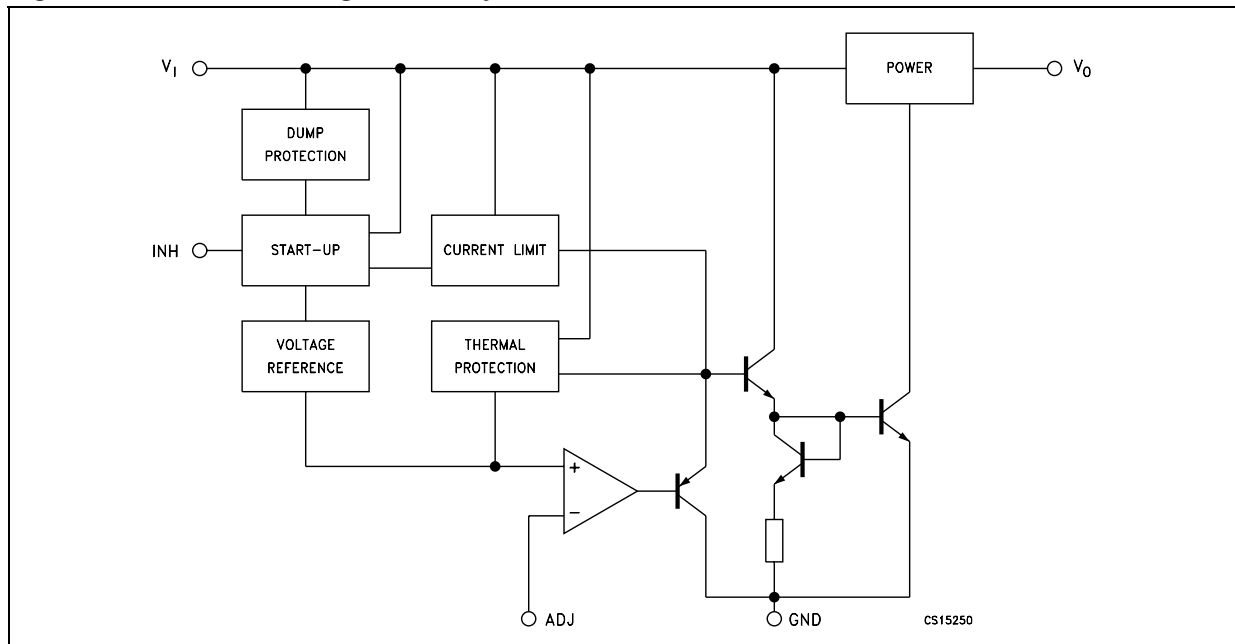
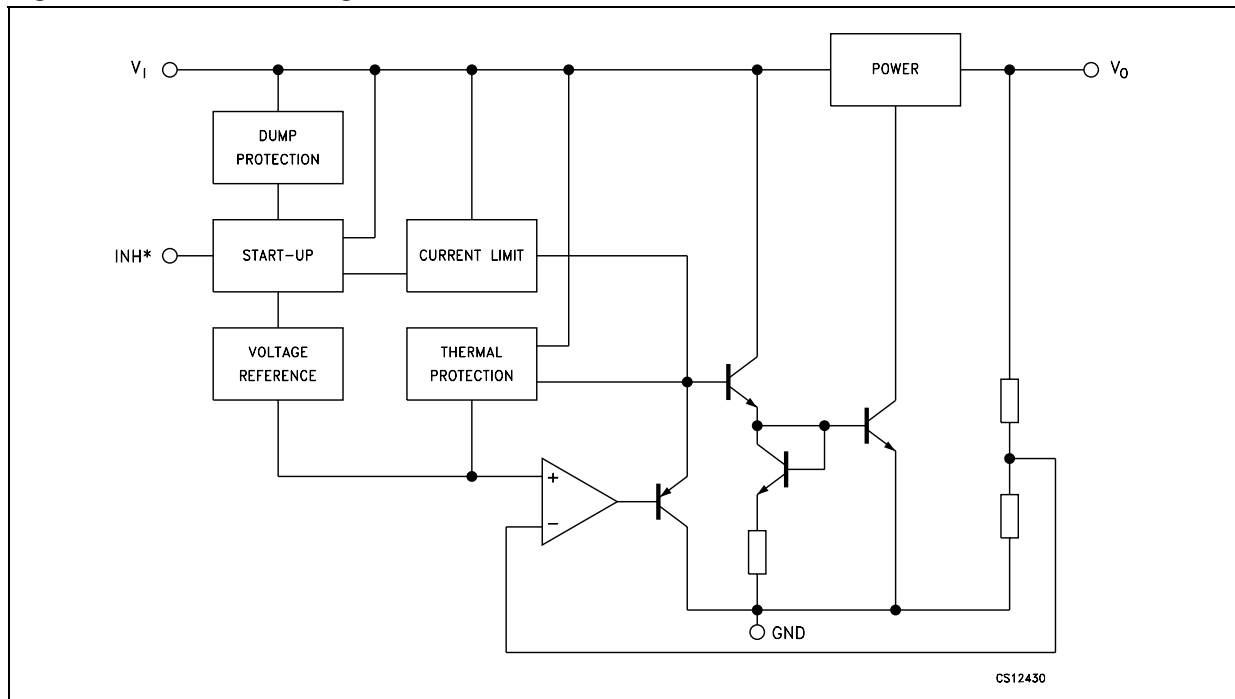


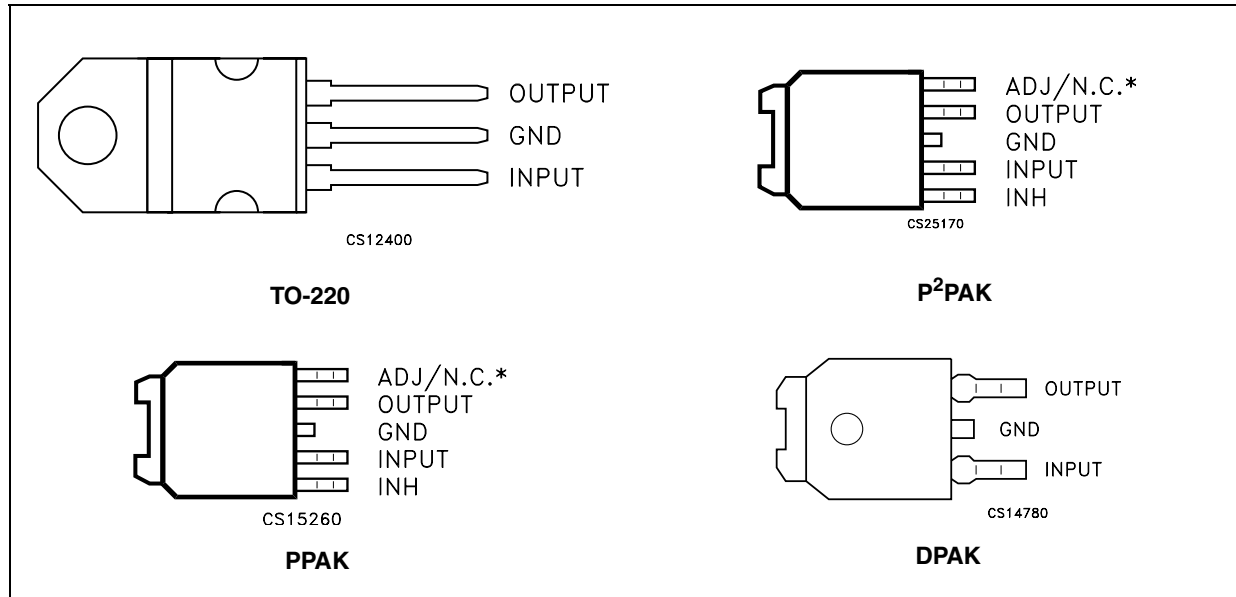
Figure 2. Schematic diagram for fixed version



* Only for version with inhibit function.

2 Pin configuration

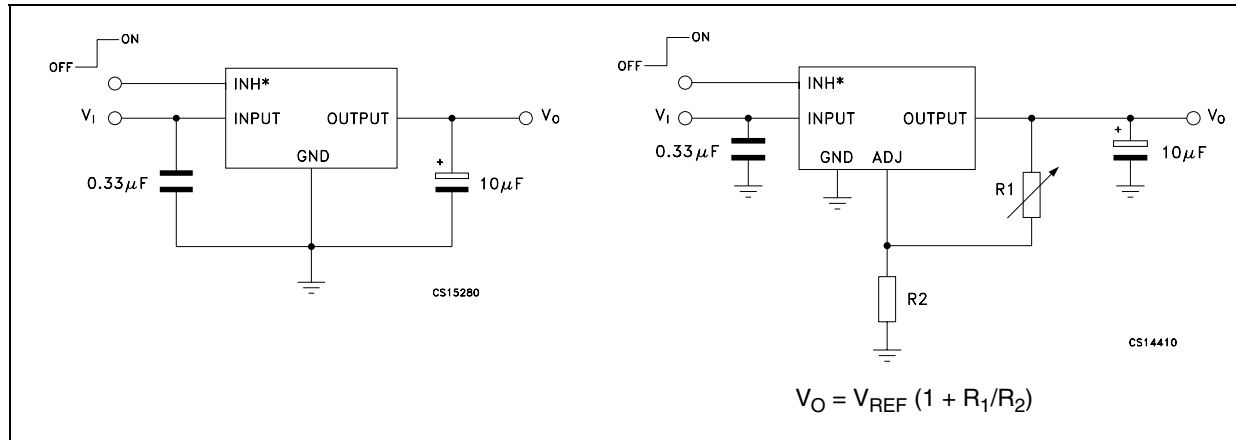
Figure 3. Pin connections (top view)



* Not connected for fixed version.

3 Typical application

Figure 4. Application circuit



* Only for version with inhibit function.

4 Maximum ratings

Table 2. Absolute maximum ratings

Symbol	Parameter	Value	Unit
V_I	DC input voltage	30 ⁽¹⁾	V
V_O	DC output voltage	-0.3 to 20	V
V_{INH}	Inhibit input voltage	-0.3 to 20	V
I_O	Output current	Internally limited	mA
P_D	Power dissipation	Internally limited	mW
T_{STG}	Storage temperature range	-55 to 150	°C
T_{OP}	Operating junction temperature range	-40 to 125	°C

1. Above 14 V the device is automatically in shut-down.

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

Table 3. Thermal data

Symbol	Parameter	DPAK	PPAK	P ² PAK	TO-220	Unit
R_{thJA}	Thermal resistance junction-ambient	100	100	60	50	°C/W
R_{thJC}	Thermal resistance junction-case	8	8	3	3	°C/W

5 Electrical characteristics

Table 4. Electrical characteristics of LD29150#15

($I_O = 10\text{ mA}$, $T_J = 25\text{ °C}$, $V_I = 3.5\text{ V}$, $V_{INH} = 2\text{ V}$ (*Note 2*), $C_I = 330\text{ nF}$, $C_O = 10\text{ }\mu\text{F}$, unless otherwise specified)

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
V_I	Minimum operating input voltage	$I_O = 10\text{ mA}$ to 1.5 A , $T_J = -40$ to 125 °C	2.5			V
V_O	Output voltage	$I_O = 10\text{ mA}$ to 1.5 A , $V_I = 3$ to 7 V $T_J = -40$ to 125 °C	1.485 1.47	1.5	1.515 1.53	V
ΔV_O	Load regulation	$I_O = 10\text{ mA}$ to 1.5 A		0.2	1.0	%
ΔV_O	Line regulation	$V_I = 3$ to 13 V		0.06	0.5	%
SVR	Supply voltage rejection	$f = 120\text{ Hz}$, $V_I = 3.5 \pm 1\text{ V}$, $I_O = 0.75\text{ A}$ (<i>Note 1</i>)	65	75		dB
I_q	Quiescent current	$I_O = 0.75\text{ A}$, $T_J = -40$ to 125 °C		15	40	mA
		$I_O = 1.5\text{ A}$, $T_J = -40$ to 125 °C		30	80	
		$V_I = 13\text{ V}$, $V_{INH} = \text{GND}$, $T_J = -40$ to 125 °C		130	180	μA
I_{sc}	Short circuit current	$V_I - V_O = 5.5\text{ V}$		2.2		A
V_{IL}	Control input logic low	OFF MODE, (<i>Note 2</i>), $T_J = -40$ to 125 °C			0.8	V
V_{IH}	Control input logic high	ON MODE, (<i>Note 2</i>), $T_J = -40$ to 125 °C	2			V
I_{INH}	Control input current	$T_J = -40$ to 125 °C , $V_{INH} = 13\text{ V}$		5	10	μA
eN	Output noise voltage	$B_P = 10\text{ Hz}$ to 100 kHz , $I_O = 100\text{ mA}$		60		μV_{RMS}
T_{SHDN}	Thermal shutdown			150		°C

Note: 1 Guaranteed by design.
2 Only for version with Inhibit function.

Table 5. Electrical characteristics of LD29150#18

($I_O = 10\text{ mA}$, $T_J = 25\text{ °C}$, $V_I = 3.8\text{ V}$, $V_{INH} = 2\text{ V}$ (*Note 3*), $C_I = 330\text{ nF}$, $C_O = 10\text{ }\mu\text{F}$, unless otherwise specified)

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
V_O	Output voltage	$I_O = 10\text{mA to } 1.5\text{A}$, $V_I = 3\text{ to } 7.3\text{V}$ $T_J = -40\text{ to } 125\text{°C}$	1.782	1.8	1.818	V
			1.764		1.836	
ΔV_O	Load regulation	$I_O = 10\text{mA to } 1.5\text{A}$		0.2	1.0	%
ΔV_O	Line regulation	$V_I = 3\text{ to } 13\text{V}$		0.06	0.5	%
SVR	Supply voltage rejection	$f = 120\text{ Hz}$, $V_I = 3.8 \pm 1\text{V}$, $I_O = 0.75\text{A}$ (<i>Note 1</i>)	62	72		dB
V_{DROPP}	Dropout voltage	$I_O = 250\text{mA}$, $T_J = -40\text{ to } 125\text{°C}$ (<i>Note 2</i>)		0.1		V
		$I_O = 0.75\text{A}$, $T_J = -40\text{ to } 125\text{°C}$ (<i>Note 2</i>)		0.2		
		$I_O = 1.5\text{A}$, $T_J = -40\text{ to } 125\text{°C}$ (<i>Note 2</i>)		0.4	0.7	
I_q	Quiescent current	$I_O = 0.75\text{A}$, $T_J = -40\text{ to } 125\text{°C}$		15	40	mA
		$I_O = 1.5\text{A}$, $T_J = -40\text{ to } 125\text{°C}$		30	80	
		$V_I = 13\text{V}$, $V_{INH} = \text{GND}$, $T_J = -40\text{ to } 125\text{°C}$		130	180	μA
I_{sc}	Short circuit current	$V_I - V_O = 5.5\text{V}$		2.2		A
V_{IL}	Control input logic low	OFF MODE, (<i>Note 3</i>), $T_J = -40\text{ to } 125\text{°C}$			0.8	V
V_{IH}	Control input logic high	ON MODE, (<i>Note 3</i>), $T_J = -40\text{ to } 125\text{°C}$	2			V
I_{INH}	Control input current	$T_J = -40\text{ to } 125\text{°C}$, $V_{INH} = 13\text{V}$		5	10	μA
eN	Output noise voltage	$B_P = 10\text{Hz to } 100\text{kHz}$, $I_O = 100\text{mA}$		72		μV_{RMS}
T_{SHDN}	Thermal shutdown			150		$^{\circ}\text{C}$

Note: 1 Guaranteed by design.

2 Dropout voltage is defined as the input-to-output differential when the output voltage drops to 99 % of its nominal value with $V_O + 1\text{ V}$ applied to V_I .

3 Only for version with Inhibit function.

Table 6. Electrical characteristics of LD29150#25

($I_O = 10\text{ mA}$, $T_J = 25\text{ °C}$, $V_I = 4.5\text{ V}$, $V_{INH} = 2\text{ V}$ (*Note 3*), $C_I = 330\text{ nF}$, $C_O = 10\text{ }\mu\text{F}$, unless otherwise specified)

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
V_O	Output voltage	$I_O = 10\text{mA to } 1.5\text{A}$, $V_I = 3.5\text{ to } 8\text{V}$ $T_J = -40\text{ to } 125\text{°C}$	2.475	2.5	2.525	V
			2.45		2.55	
ΔV_O	Load regulation	$I_O = 10\text{mA to } 1.5\text{A}$		0.2	1.0	%
ΔV_O	Line regulation	$V_I = 3.5\text{ to } 13\text{V}$		0.06	0.5	%
SVR	Supply voltage rejection	$f = 120\text{ Hz}$, $V_I = 4.5 \pm 1\text{V}$, $I_O = 0.75\text{A}$ (<i>Note 1</i>)	55	70		dB
V_{DROPP}	Dropout voltage	$I_O = 250\text{mA}$, $T_J = -40\text{ to } 125\text{°C}$ (<i>Note 2</i>)		0.1		V
		$I_O = 0.75\text{A}$, $T_J = -40\text{ to } 125\text{°C}$ (<i>Note 2</i>)		0.2		
		$I_O = 1.5\text{A}$, $T_J = -40\text{ to } 125\text{°C}$ (<i>Note 2</i>)		0.4	0.7	
I_q	Quiescent current	$I_O = 0.75\text{A}$, $T_J = -40\text{ to } 125\text{°C}$		15	40	mA
		$I_O = 1.5\text{A}$, $T_J = -40\text{ to } 125\text{°C}$		30	80	
		$V_I = 13\text{V}$, $V_{INH} = \text{GND}$, $T_J = -40\text{ to } 125\text{°C}$		130	180	μA
I_{sc}	Short circuit current	$V_I - V_O = 5.5\text{V}$		2.2		A
V_{IL}	Control input logic low	OFF MODE, (<i>Note 3</i>), $T_J = -40\text{ to } 125\text{°C}$			0.8	V
V_{IH}	Control input logic high	ON MODE, (<i>Note 3</i>), $T_J = -40\text{ to } 125\text{°C}$	2			V
I_{INH}	Control input current	$T_J = -40\text{ to } 125\text{°C}$, $V_{INH} = 13\text{V}$		5	10	μA
eN	Output noise voltage	$B_P = 10\text{Hz to } 100\text{kHz}$, $I_O = 100\text{mA}$		100		μV_{RMS}
T_{SHDN}	Thermal shutdown			150		$^{\circ}\text{C}$

Note: 1 Guaranteed by design.

2 Dropout voltage is defined as the input-to-output differential when the output voltage drops to 99 % of its nominal value with $V_O + 1\text{ V}$ applied to V_I .

3 Only for version with Inhibit function.

Table 7. Electrical characteristics of LD29150#33

($I_O = 10\text{ mA}$, $T_J = 25\text{ °C}$, $V_I = 5.3\text{ V}$, $V_{INH} = 2\text{ V}$ (*Note 3*), $C_I = 330\text{ nF}$, $C_O = 10\text{ }\mu\text{F}$, unless otherwise specified)

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
V_O	Output voltage	$I_O = 10\text{mA to } 1.5\text{A}$, $V_I = 4.3\text{ to } 8.8\text{V}$ $T_J = -40\text{ to } 125\text{°C}$	3.267	3.3	3.333	V
			3.234		3.366	
ΔV_O	Load regulation	$I_O = 10\text{mA to } 1.5\text{A}$		0.2	1.0	%
ΔV_O	Line regulation	$V_I = 4.3\text{ to } 13\text{V}$		0.06	0.5	%
SVR	Supply voltage rejection	$f = 120\text{ Hz}$, $V_I = 5.3 \pm 1\text{V}$, $I_O = 0.75\text{A}$ (<i>Note 1</i>)	52	67		dB
V_{DROPP}	Dropout voltage	$I_O = 250\text{mA}$, $T_J = -40\text{ to } 125\text{°C}$ (<i>Note 2</i>)		0.1		V
		$I_O = 0.75\text{A}$, $T_J = -40\text{ to } 125\text{°C}$ (<i>Note 2</i>)		0.2		
		$I_O = 1.5\text{A}$, $T_J = -40\text{ to } 125\text{°C}$ (<i>Note 2</i>)		0.4	0.7	
I_q	Quiescent current	$I_O = 0.75\text{A}$, $T_J = -40\text{ to } 125\text{°C}$		15	40	mA
		$I_O = 1.5\text{A}$, $T_J = -40\text{ to } 125\text{°C}$		30	80	
		$V_I = 13\text{V}$, $V_{INH} = \text{GND}$, $T_J = -40\text{ to } 125\text{°C}$		130	180	μA
I_{sc}	Short circuit current	$V_I - V_O = 5.5\text{V}$		2.2		A
V_{IL}	Control input logic low	OFF MODE, (<i>Note 3</i>), $T_J = -40\text{ to } 125\text{°C}$			0.8	V
V_{IH}	Control input logic high	ON MODE, (<i>Note 3</i>), $T_J = -40\text{ to } 125\text{°C}$	2			V
I_{INH}	Control input current	$T_J = -40\text{ to } 125\text{°C}$, $V_{INH} = 13\text{V}$		5	10	μA
eN	Output noise voltage	$B_P = 10\text{Hz to } 100\text{kHz}$, $I_O = 100\text{mA}$		132		μV_{RMS}
T_{SHDN}	Thermal shutdown			150		$^{\circ}\text{C}$

Note: 1 Guaranteed by design.

2 Dropout voltage is defined as the input-to-output differential when the output voltage drops to 99 % of its nominal value with $V_O + 1\text{ V}$ applied to V_I .

3 Only for version with Inhibit function.

Table 8. Electrical characteristics of LD29150#50

($I_O = 10 \text{ mA}$, $T_J = 25 \text{ °C}$, $V_I = 7 \text{ V}$, $V_{INH} = 2 \text{ V}$ (*Note 3*), $C_I = 330 \text{ nF}$, $C_O = 10 \text{ μF}$, unless otherwise specified)

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
V_O	Output voltage	$I_O = 10\text{mA to } 1.5\text{A}$, $V_I = 6 \text{ to } 10.5\text{V}$ $T_J = -40 \text{ to } 125\text{°C}$	4.95	5	5.05	V
			4.9		5.1	
ΔV_O	Load regulation	$I_O = 10\text{mA to } 1.5\text{A}$		0.2	1.0	%
ΔV_O	Line regulation	$V_I = 6 \text{ to } 13\text{V}$		0.06	0.5	%
SVR	Supply voltage rejection	$f = 120 \text{ Hz}$, $V_I = 7 \pm 1\text{V}$, $I_O = 0.75\text{A}$ (<i>Note 1</i>)	49	64		dB
V_{DROPP}	Dropout voltage	$I_O = 250\text{mA}$, $T_J = -40 \text{ to } 125\text{°C}$ (<i>Note 2</i>)		0.1		V
		$I_O = 0.75\text{A}$, $T_J = -40 \text{ to } 125\text{°C}$ (<i>Note 2</i>)		0.2		
		$I_O = 1.5\text{A}$, $T_J = -40 \text{ to } 125\text{°C}$ (<i>Note 2</i>)		0.4	0.7	
I_q	Quiescent current	$I_O = 0.75\text{A}$, $T_J = -40 \text{ to } 125\text{°C}$		15	40	mA
		$I_O = 1.5\text{A}$, $T_J = -40 \text{ to } 125\text{°C}$		30	80	
		$V_I = 13\text{V}$, $V_{INH} = \text{GND}$, $T_J = -40 \text{ to } 125\text{°C}$		130	180	μA
I_{sc}	Short circuit current	$V_I - V_O = 5.5\text{V}$		2.2		A
V_{IL}	Control input logic low	OFF MODE, (<i>Note 3</i>), $T_J = -40 \text{ to } 125\text{°C}$			0.8	V
V_{IH}	Control input logic high	ON MODE, (<i>Note 3</i>), $T_J = -40 \text{ to } 125\text{°C}$	2			V
I_{INH}	Control input current	$T_J = -40 \text{ to } 125\text{°C}$, $V_{INH} = 13\text{V}$		5	10	μA
eN	Output noise voltage	$B_P = 10\text{Hz to } 100\text{kHz}$, $I_O = 100\text{mA}$		200		μV_{RMS}
T_{SHDN}	Thermal shutdown			150		$^{\circ}\text{C}$

Note: 1 Guaranteed by design.

2 Dropout voltage is defined as the input-to-output differential when the output voltage drops to 99 % of its nominal value with $V_O + 1 \text{ V}$ applied to V_I .

3 Only for version with Inhibit function.

Table 9. Electrical characteristics of LD29150#ADJ

($I_O = 10\text{ mA}$, $T_J = 25\text{ °C}$, $V_I = 3.23\text{ V}$, $V_{INH} = 2\text{ V}$ (*Note 3*), $C_I = 330\text{ nF}$, $C_O = 10\text{ }\mu\text{F}$ adjust pin tied to output pin)

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
V_I	Minimum operating input voltage	$I_O = 10\text{mA}$ to 1.5A , $T_J = -40$ to 125°C	2.5			V
ΔV_O	Load regulation	$I_O = 10\text{mA}$ to 1.5A		0.2	1.0	%
ΔV_O	Line regulation	$V_I = 2.5\text{ V}$ to 13V , $I_O = 10\text{mA}$		0.06	0.5	%
V_{REF}	Reference voltage	$I_O = 10\text{mA}$ to 1.5A , $V_I = 2.5$ to 4.5V $T_J = -40$ to 125°C (<i>Note 2</i>)	-1%	1.23	+1%	V
			-2%		+2%	
SVR	Supply voltage rejection	$f = 120\text{ Hz}$, $V_I = 3.23 \pm 1\text{V}$, $I_O = 0.75\text{A}$ (<i>Note 1</i>)	45	75		dB
I_q	Quiescent current	$I_O = 0.75\text{A}$, $T_J = -40$ to 125°C		15	40	mA
		$I_O = 1.5\text{A}$, $T_J = -40$ to 125°C		30	80	
		$V_I = 13\text{V}$, $V_{INH} = \text{GND}$, $T_J = -40$ to 125°C		130	180	μA
I_{ADJ}	Adjust pin current	$T_J = -40$ to 125°C (<i>Note 1</i>)			1	μA
I_{sc}	Short circuit current	$V_I - V_O = 5.5\text{V}$		2.2		A
V_{IL}	Control input logic low	OFF MODE, (<i>Note 3</i>), $T_J = -40$ to 125°C			0.8	V
V_{IH}	Control input logic high	ON MODE, (<i>Note 3</i>), $T_J = -40$ to 125°C	2			V
I_{INH}	Control input current	$T_J = -40$ to 125°C , $V_{INH} = 13\text{V}$		5	10	μA
eN	Output noise voltage	$B_P = 10\text{Hz}$ to 100kHz , $I_O = 100\text{mA}$		50		μV_{RMS}
T_{SHDN}	Thermal shutdown			150		$^{\circ}\text{C}$

Note: 1 Guaranteed by design.

2 Reference voltage is measured between output and GND pin, with ADJ PIN tied to V_{OUT} .

3 Only for version with Inhibit function.

6 Typical characteristics

Figure 5. Output voltage vs temperature

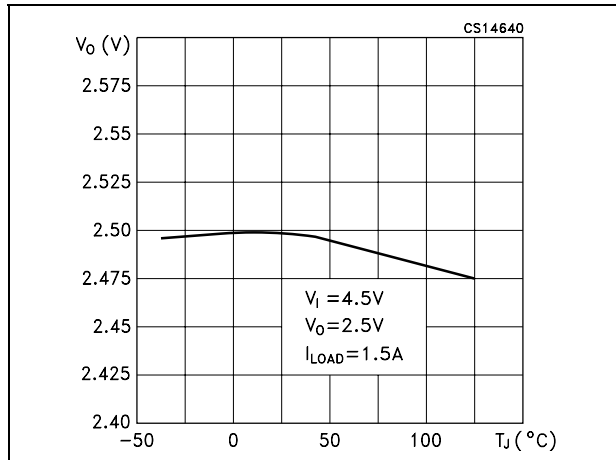


Figure 6. Reference voltage vs temperature

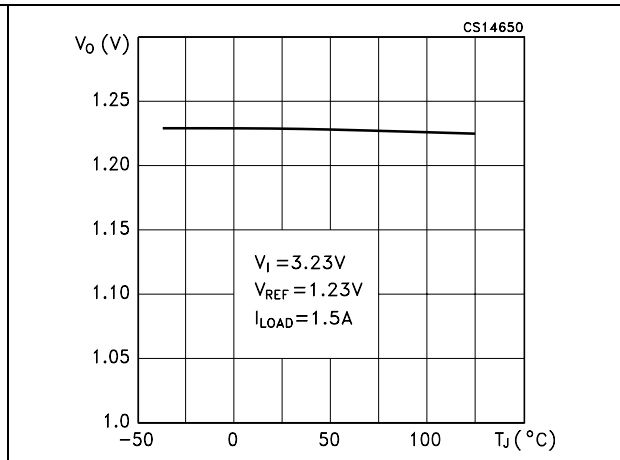


Figure 7. Dropout voltage vs temperature

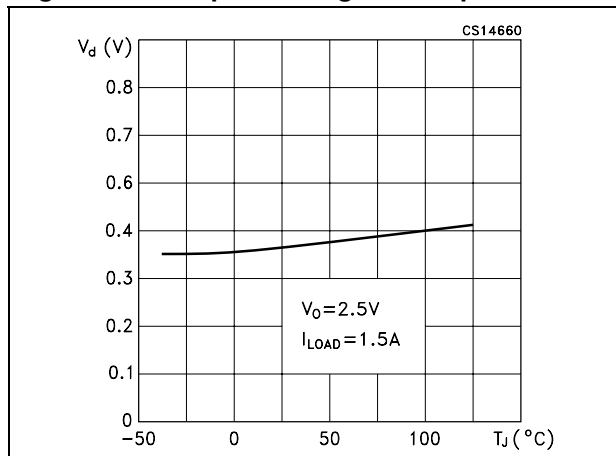


Figure 8. Dropout voltage vs output current

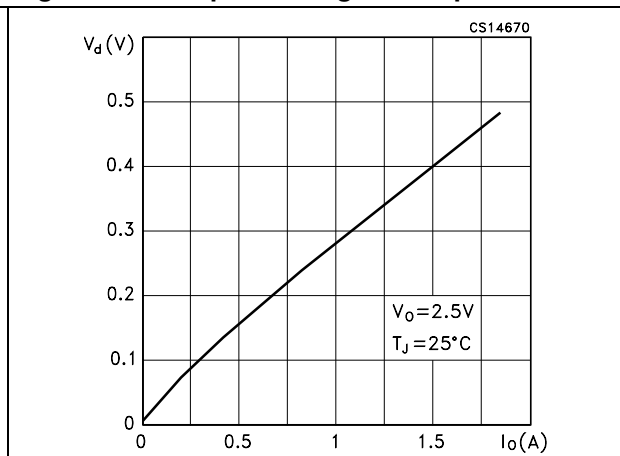


Figure 9. Quiescent current vs output current

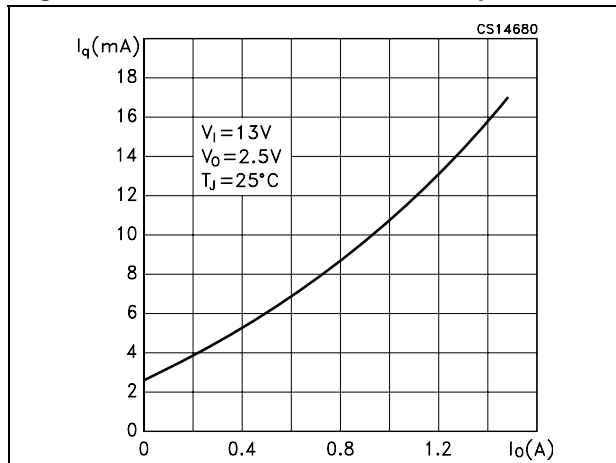


Figure 10. Quiescent current vs output current

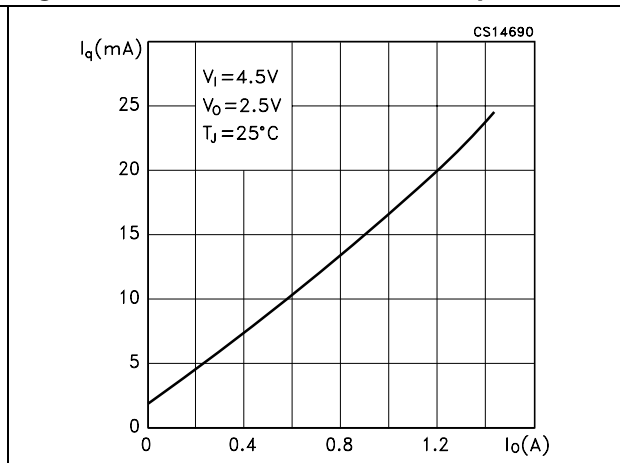


Figure 11. Quiescent current vs supply voltage

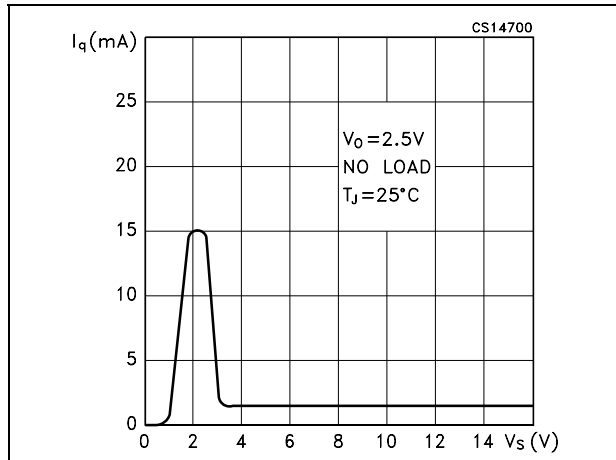


Figure 12. Quiescent current vs temperature

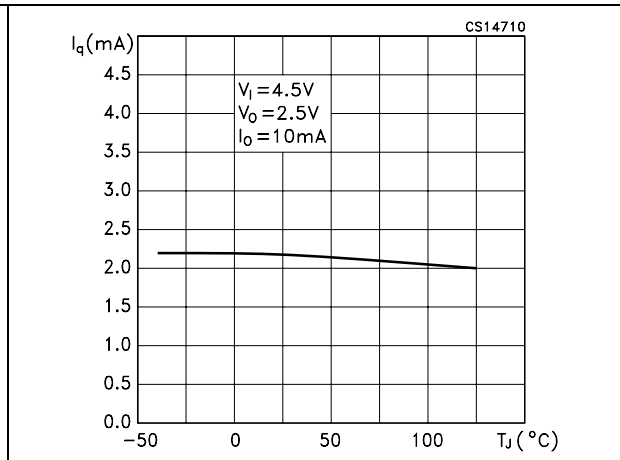


Figure 13. Quiescent current vs temperature

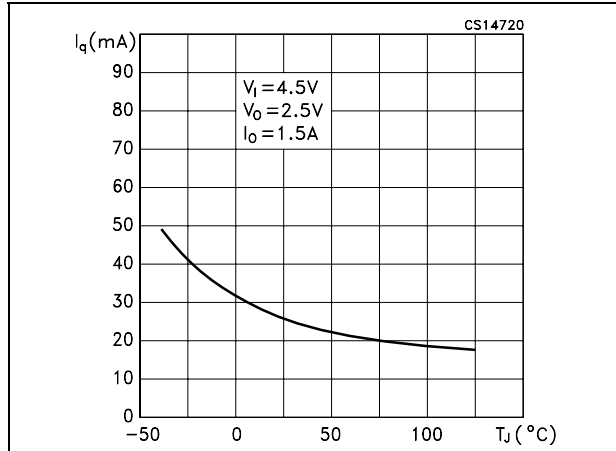


Figure 14. Short circuit current vs temperature

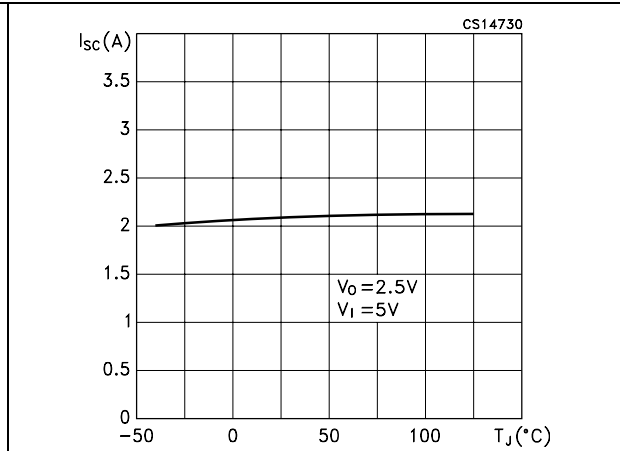


Figure 15. Adjust pin current vs temperature

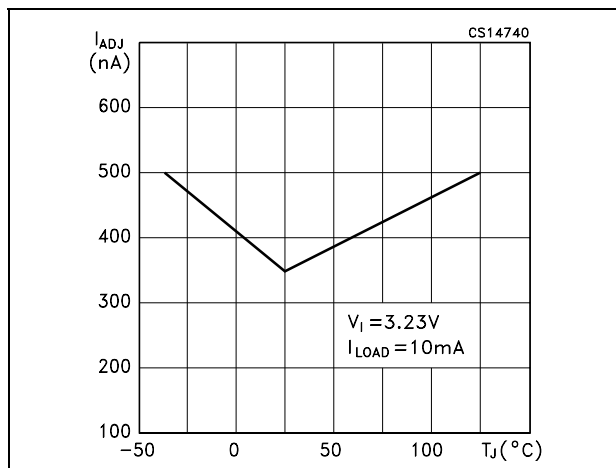


Figure 16. Supply voltage rejection vs temperature

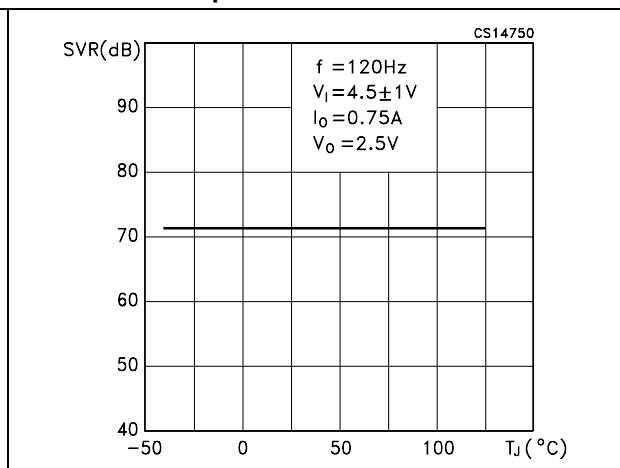


Figure 17. Output voltage vs input voltage

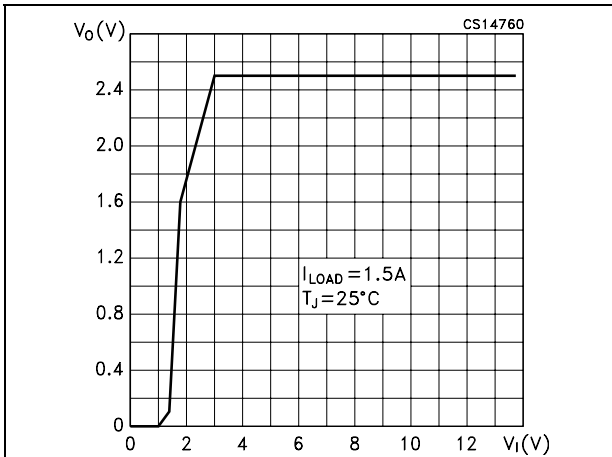


Figure 18. Stability vs C_O

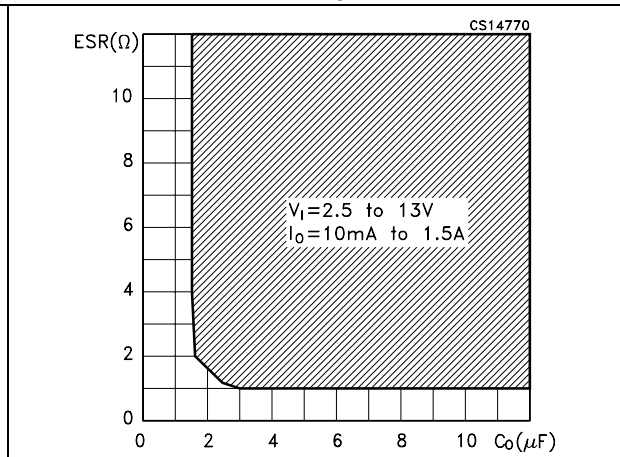


Figure 19. Line transient

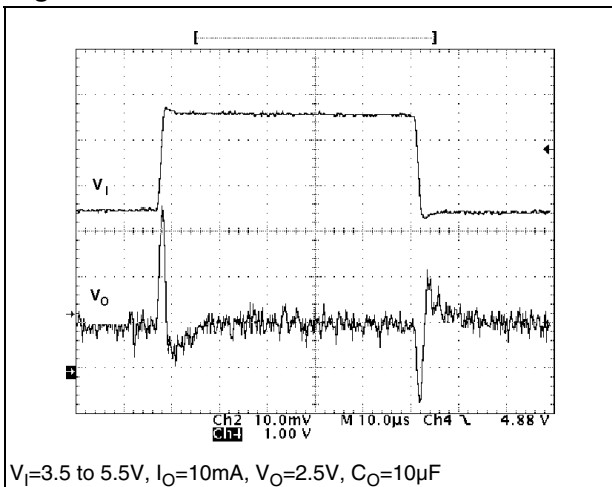


Figure 20. Load transient

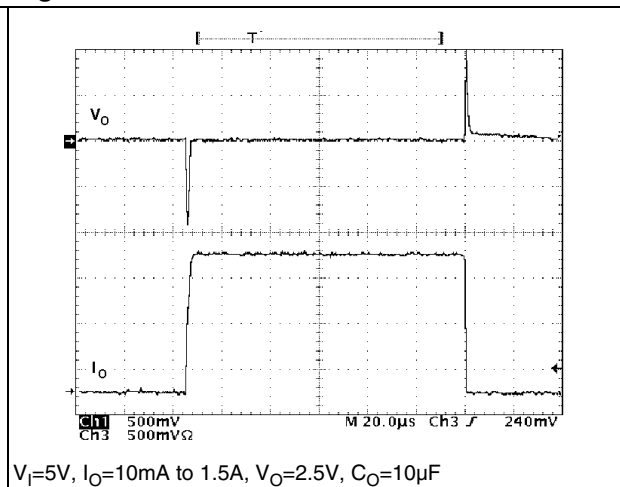


Figure 21. Start-up time 10mA

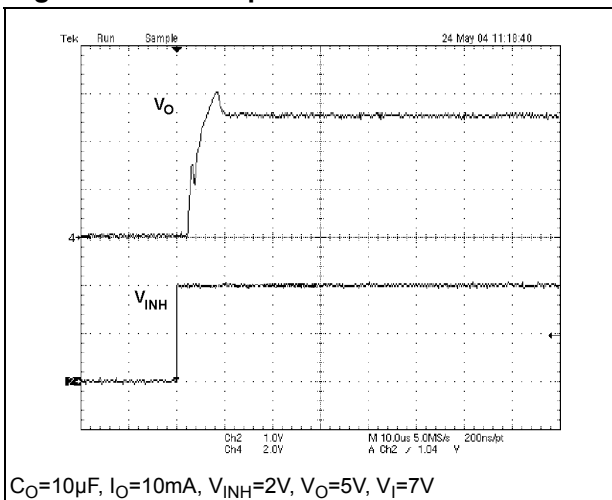
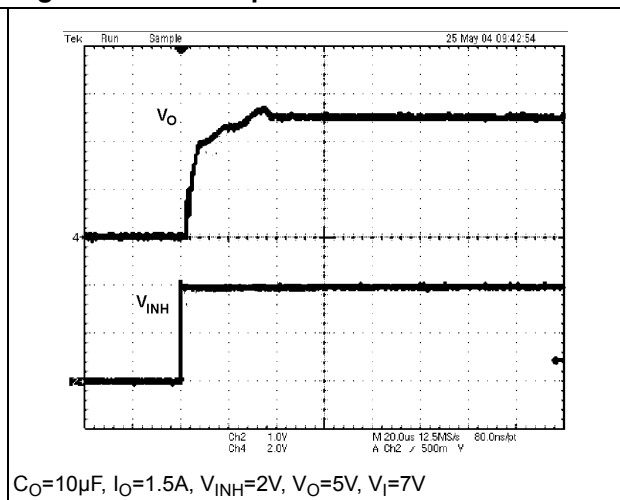


Figure 22. Start-up time 1.5A

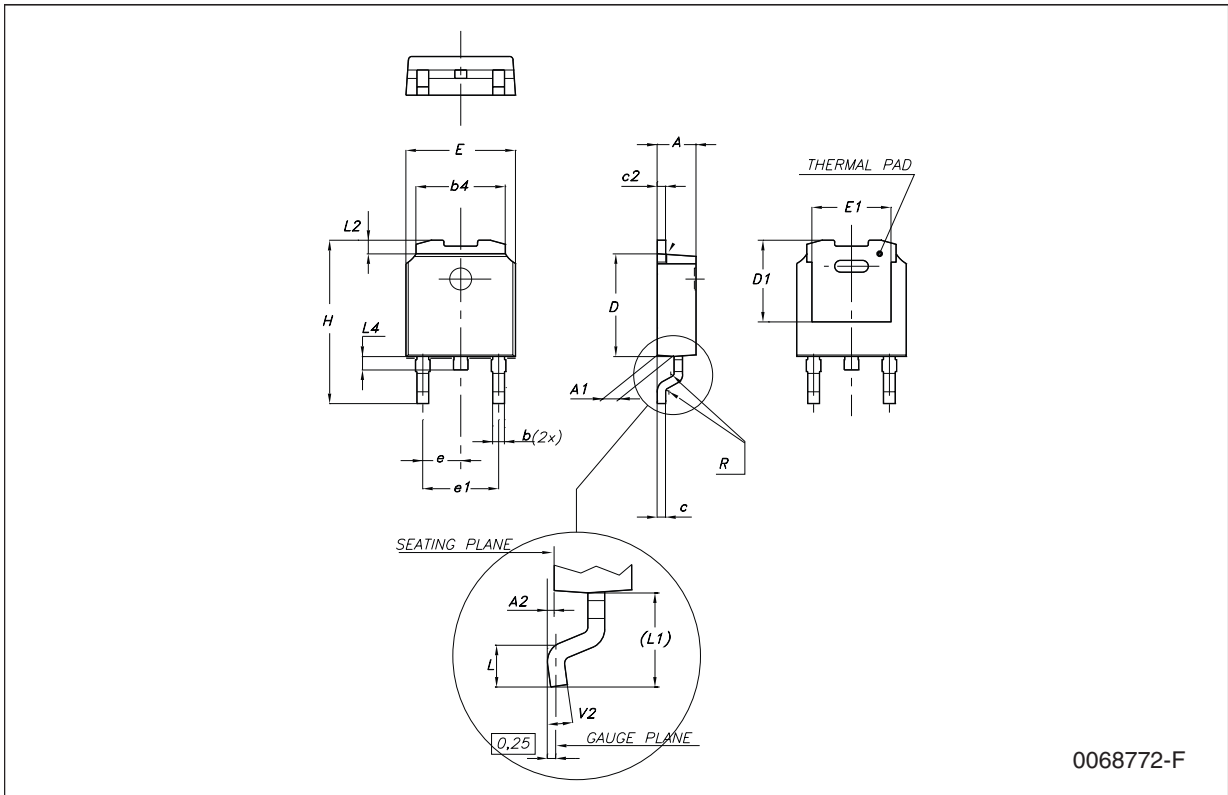


7 Package mechanical data

In order to meet environmental requirements, ST offers these devices in ECOPACK® packages. These packages have a lead-free second level interconnect. The category of second Level Interconnect is marked on the package and on the inner box label, in compliance with JEDEC Standard JESD97. The maximum ratings related to soldering conditions are also marked on the inner box label. ECOPACK is an ST trademark. ECOPACK specifications are available at: www.st.com.

DPAK mechanical data

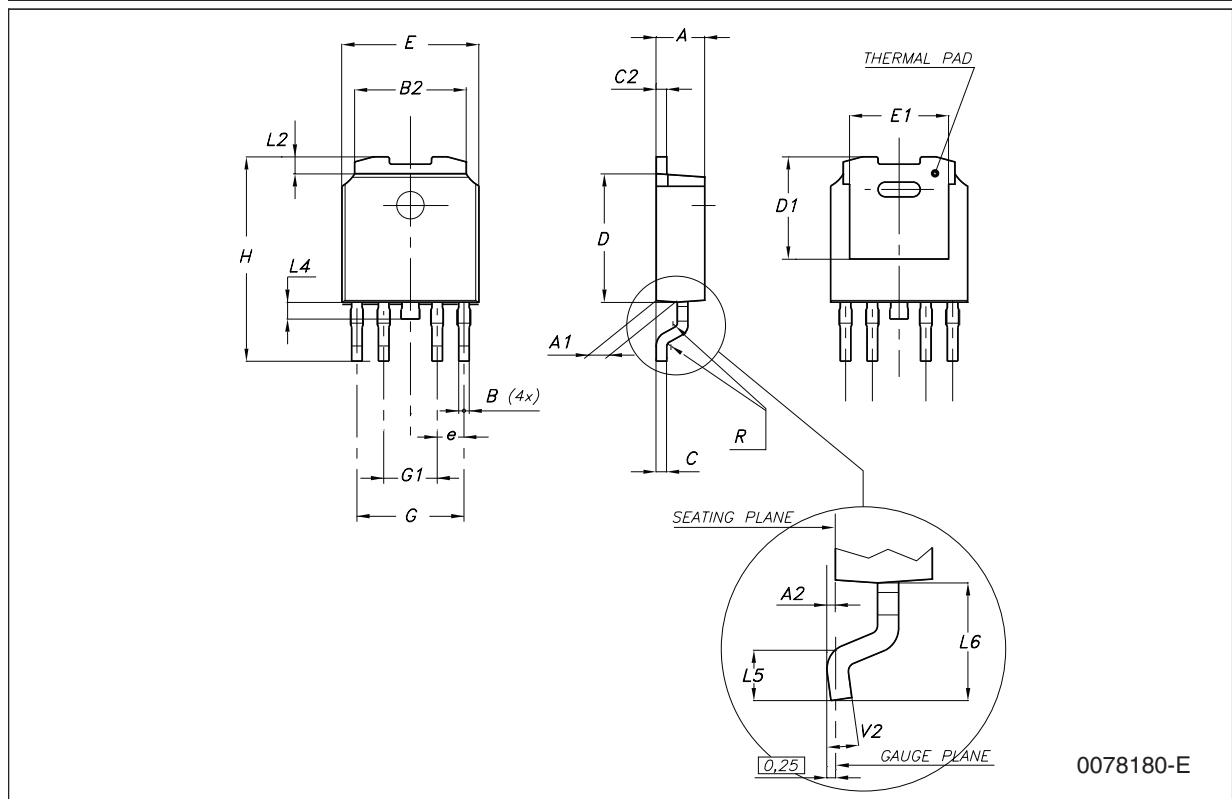
Dim.	mm.			inch.		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A	2.2		2.4	0.086		0.094
A1	0.9		1.1	0.035		0.043
A2	0.03		0.23	0.001		0.009
B	0.64		0.9	0.025		0.035
b4	5.2		5.4	0.204		0.212
C	0.45		0.6	0.017		0.023
C2	0.48		0.6	0.019		0.023
D	6		6.2	0.236		0.244
D1		5.1			0.200	
E	6.4		6.6	0.252		0.260
E1		4.7			0.185	
e		2.28			0.090	
e1	4.4		4.6	0.173		0.181
H	9.35		10.1	0.368		0.397
L	1			0.039		
(L1)		2.8			0.110	
L2		0.8			0.031	
L4	0.6		1	0.023		0.039
R		0.2			0.008	
V2	0°		8°	0°		8°



0068772-F

PPAK mechanical data

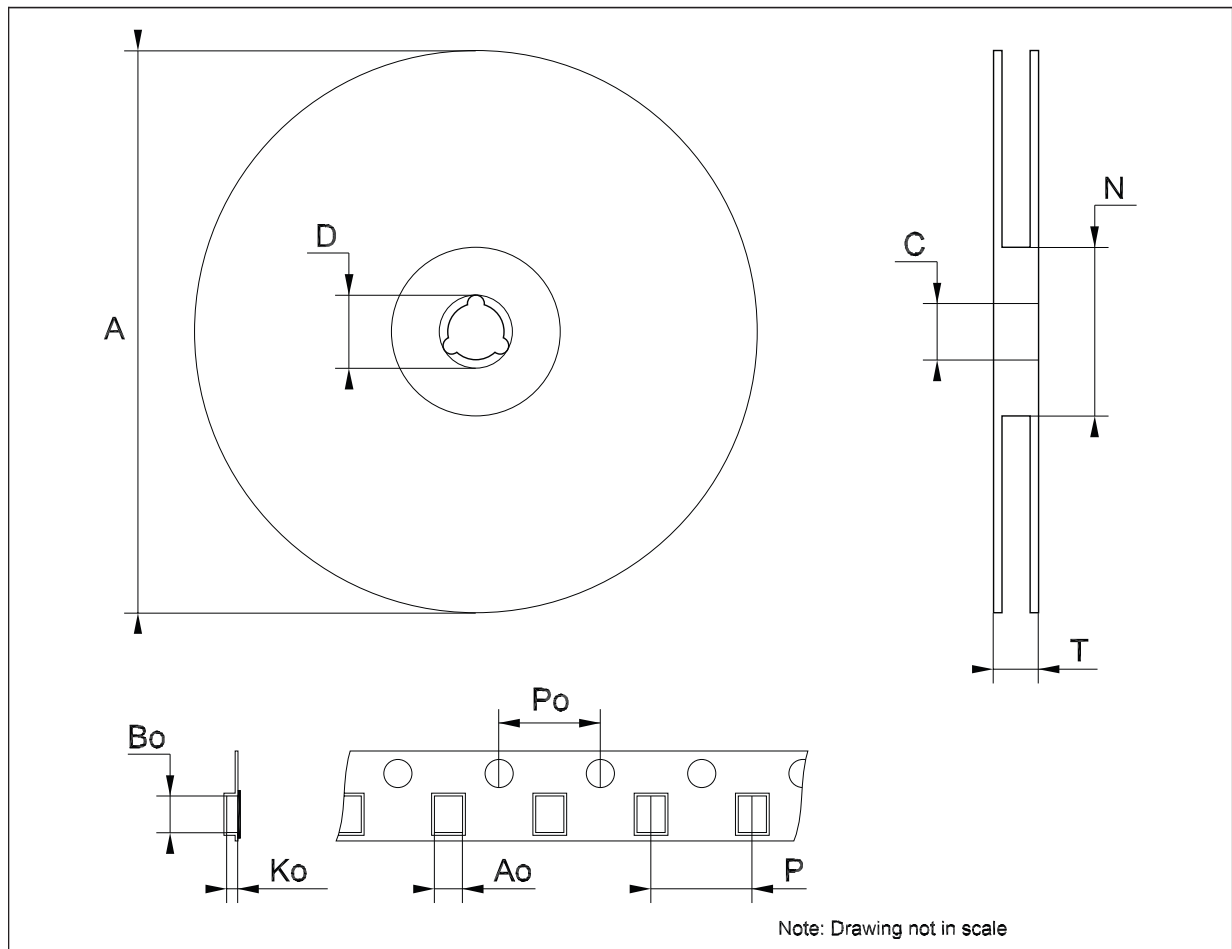
Dim.	mm.			inch.		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A	2.2		2.4	0.086		0.094
A1	0.9		1.1	0.035		0.043
A2	0.03		0.23	0.001		0.009
B	0.4		0.6	0.015		0.023
B2	5.2		5.4	0.204		0.212
C	0.45		0.6	0.017		0.023
C2	0.48		0.6	0.019		0.023
D	6		6.2	0.236		0.244
D1		5.1			0.201	
E	6.4		6.6	0.252		0.260
E1		4.7			0.185	
e		1.27			0.050	
G	4.9		5.25	0.193		0.206
G1	2.38		2.7	0.093		0.106
H	9.35		10.1	0.368		0.397
L2		0.8	1		0.031	0.039
L4	0.6		1	0.023		0.039
L5	1			0.039		
L6		2.8			0.110	



0078180-E

Tape & reel DPAK-PPAK mechanical data

Dim.	mm.			inch.		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A			330			12.992
C	12.8	13.0	13.2	0.504	0.512	0.519
D	20.2			0.795		
N	60			2.362		
T			22.4			0.882
Ao	6.80	6.90	7.00	0.268	0.272	0.276
Bo	10.40	10.50	10.60	0.409	0.413	0.417
Ko	2.55	2.65	2.75	0.100	0.104	0.105
Po	3.9	4.0	4.1	0.153	0.157	0.161
P	7.9	8.0	8.1	0.311	0.315	0.319



8 Revision history

Table 10. Document revision history

Date	Revision	Changes
17-Jun-2004	5	Add figures 20 and 21, PPAK, TO-220 and TO-220FP mechanical data updated.
19-Jul-2004	6	Remove Package TO-220FP4.
08-Nov-2004	7	Mistake Figure 7.
21-Mar-2005	8	Add V_O and V_{INH} on Table 2.
21-Oct-2005	9	Order Codes Has Been Updated.
17-Oct-2006	10	Add new package P ² PAK.
13-Nov-2006	11	Add row T_{SHDN} on tables of the electrical characteristics.
11-May-2007	12	Order codes updated.
15-Feb-2008	13	Added: Table 1 on page 1 .

Please Read Carefully:

Information in this document is provided solely in connection with ST products. STMicroelectronics NV and its subsidiaries ("ST") reserve the right to make changes, corrections, modifications or improvements, to this document, and the products and services described herein at any time, without notice.

All ST products are sold pursuant to ST's terms and conditions of sale.

Purchasers are solely responsible for the choice, selection and use of the ST products and services described herein, and ST assumes no liability whatsoever relating to the choice, selection or use of the ST products and services described herein.

No license, express or implied, by estoppel or otherwise, to any intellectual property rights is granted under this document. If any part of this document refers to any third party products or services it shall not be deemed a license grant by ST for the use of such third party products or services, or any intellectual property contained therein or considered as a warranty covering the use in any manner whatsoever of such third party products or services or any intellectual property contained therein.

UNLESS OTHERWISE SET FORTH IN ST'S TERMS AND CONDITIONS OF SALE ST DISCLAIMS ANY EXPRESS OR IMPLIED WARRANTY WITH RESPECT TO THE USE AND/OR SALE OF ST PRODUCTS INCLUDING WITHOUT LIMITATION IMPLIED WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE (AND THEIR EQUIVALENTS UNDER THE LAWS OF ANY JURISDICTION), OR INFRINGEMENT OF ANY PATENT, COPYRIGHT OR OTHER INTELLECTUAL PROPERTY RIGHT.

UNLESS EXPRESSLY APPROVED IN WRITING BY AN AUTHORIZED ST REPRESENTATIVE, ST PRODUCTS ARE NOT RECOMMENDED, AUTHORIZED OR WARRANTED FOR USE IN MILITARY, AIR CRAFT, SPACE, LIFE SAVING, OR LIFE SUSTAINING APPLICATIONS, NOR IN PRODUCTS OR SYSTEMS WHERE FAILURE OR MALFUNCTION MAY RESULT IN PERSONAL INJURY, DEATH, OR SEVERE PROPERTY OR ENVIRONMENTAL DAMAGE. ST PRODUCTS WHICH ARE NOT SPECIFIED AS "AUTOMOTIVE GRADE" MAY ONLY BE USED IN AUTOMOTIVE APPLICATIONS AT USER'S OWN RISK.

Resale of ST products with provisions different from the statements and/or technical features set forth in this document shall immediately void any warranty granted by ST for the ST product or service described herein and shall not create or extend in any manner whatsoever, any liability of ST.

ST and the ST logo are trademarks or registered trademarks of ST in various countries.

Information in this document supersedes and replaces all information previously supplied.

The ST logo is a registered trademark of STMicroelectronics. All other names are the property of their respective owners.

© 2008 STMicroelectronics - All rights reserved

STMicroelectronics group of companies

Australia - Belgium - Brazil - Canada - China - Czech Republic - Finland - France - Germany - Hong Kong - India - Israel - Italy - Japan - Malaysia - Malta - Morocco - Singapore - Spain - Sweden - Switzerland - United Kingdom - United States of America

www.st.com