

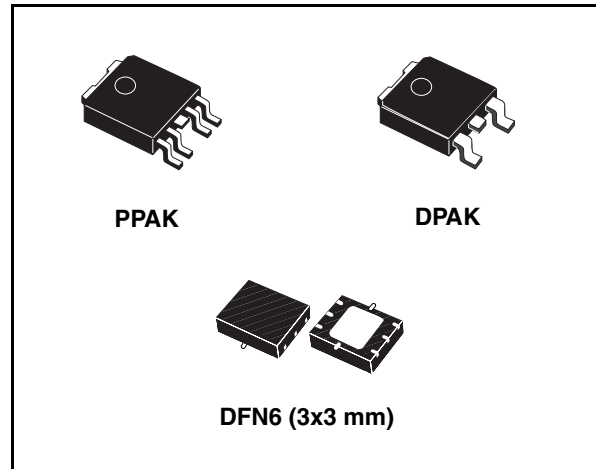
## Ultra low drop BiCMOS voltage regulator

### Features

- 1.5 A guaranteed output current
- Ultra low dropout voltage (200 mV typ. @ 1.5 A load, 40 mV typ. @ 300 mA load)
- Very low quiescent current (1 mA typ. @ 1.5 A load, 1 µA max @ 25 °C in off mode)
- Logic-controlled electronic shutdown
- Current and thermal internal limit
- ± 1.5 % output voltage tolerance @ 25 °C
- Fixed and ADJ output voltages: 1.22 V, 1.8 V, 2.5 V, 3.3 V, ADJ. (see [Table 1](#))
- Temperature range: -40 to 125 °C
- Fast dynamic response to line and load changes
- Stable with ceramic capacitor (see [Section 7.1](#), [Section 7.2](#) and [Section 7.3](#))
- Available in PPAK, DPAK and DFN6 (3x3 mm)

### Typical application

- Microprocessor power supply
- DSPs power supply
- Post regulators for switching suppliers
- High efficiency linear regulator



### Description

The LD39150xx is a fast ultra low drop linear regulator which operates from 2.5 V to 6 V input supply.

A wide range of output options are available. The low drop voltage, low noise, and ultra low quiescent current make it suitable for low voltage microprocessor and memory applications. The device is developed on a BiCMOS process which allows low quiescent current operation independently of output load current.

**Table 1. Device summary**

Part numbers	Order codes			Output voltages
	DPAK (T&R)	PPAK (T&R)	DFN <sup>(1)</sup>	
LD39150XX12	LD39150DT12-R		LD39150PU12R	1.22 V
LD39150XX18	LD39150DT18-R	LD39150PT18-R	LD39150PU18R	1.8 V
LD39150XX25	LD39150DT25-R	LD39150PT25-R	LD39150PU25R	2.5 V
LD39150XX33	LD39150DT33-R	LD39150PT33-R	LD39150PU33R	3.3 V
LD39150XX		LD39150PT-R	LD39150PU-R	ADJ from 1.22 to 5.0 V

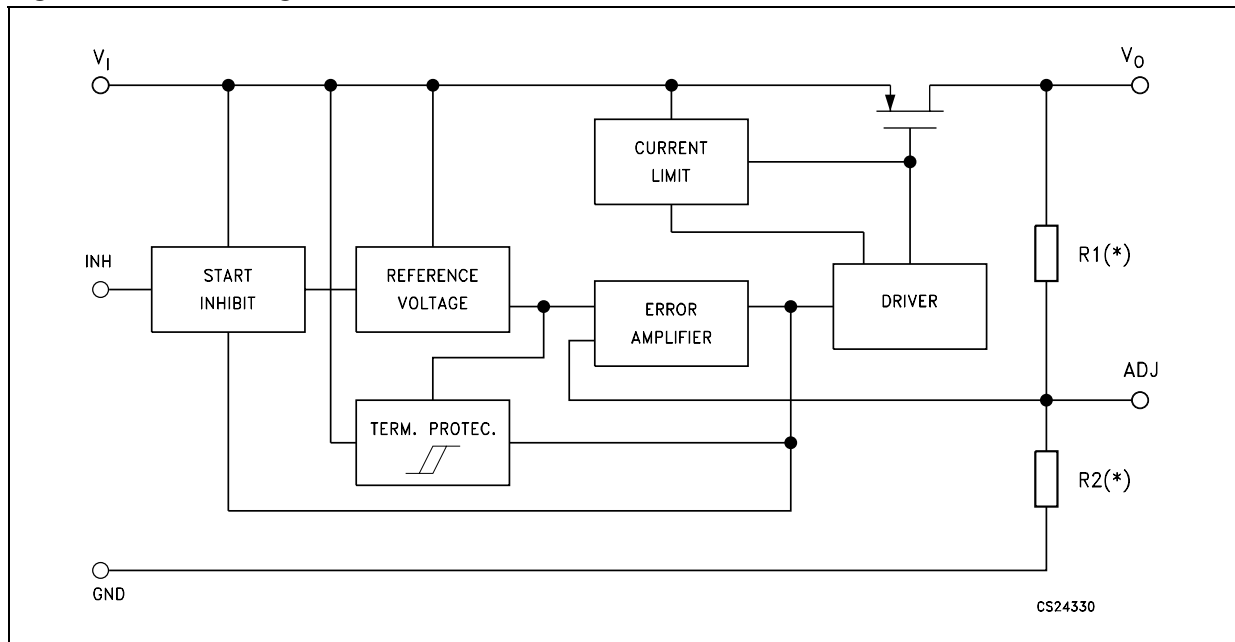
1. Available on request.

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# 1 Diagram

Figure 1. Block diagram



(\*) Not present on ADJ versions.

## 2 Pin configuration

Figure 2. Pin connections (top view for DPAK and PPAK, bottom view for DFN)

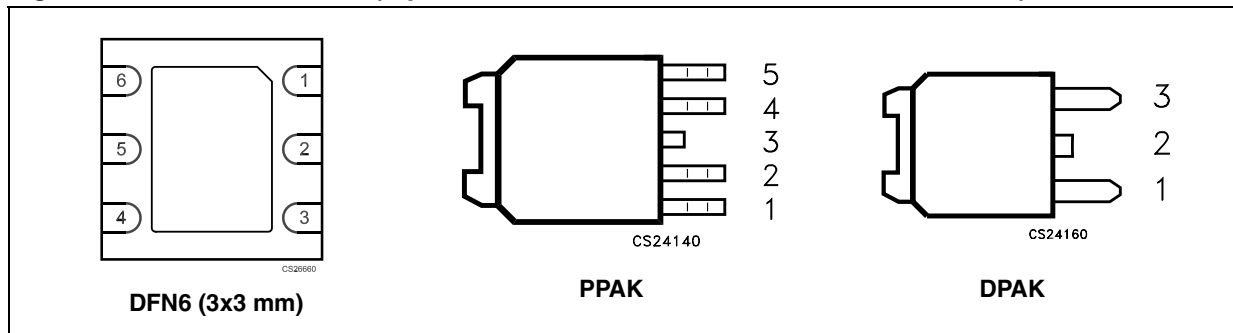


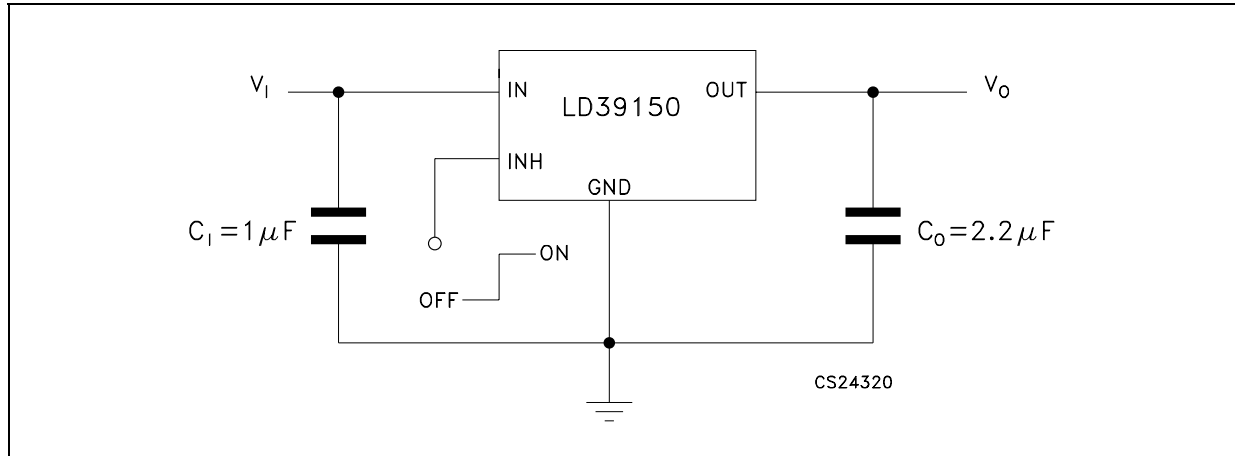
Table 2. Pin description

Pin n°			SYMBOL	NOTE
DFN	PPAK	DPAK		
5	5		$V_{SENSE}/N.C.$	For fixed versions: to be connected with LDO output voltage pins for DFN package and not connected on PPAK
			ADJ	For adjustable version: Error amplifier input pin for $V_O$ from 1.22 to 5.0 V
3	2	1	$V_I$	LDO input voltage; $V_I$ from 2.5 V to 6 V, $C_I = 1 \mu F$ must be located at a distance of not more than 0.5" from input pin.
4	4	3	$V_O$	LDO output voltage pins, with minimum $C_O = 2.2 \mu F$ needed for stability (also refer to $C_O$ vs ESR stability chart)
2	1		$V_{INH}$	Inhibit input voltage: ON MODE when $V_{INH} \geq 2 V$ , OFF MODE when $V_{INH} \leq 0.3 V$ (Do not leave floating, not internally pulled down/up)
1	3	2	GND	Common ground
6			N.C.	Not connected

### 3 Typical application circuits

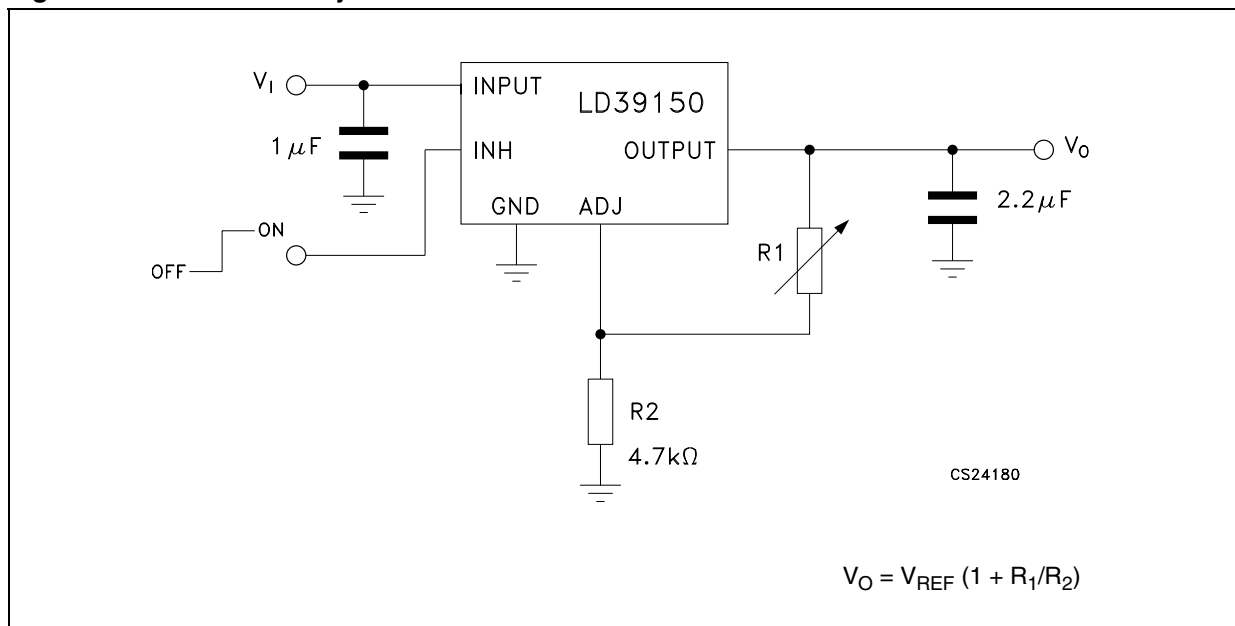
( $C_1$  and  $C_0$  capacitors must be placed as close as possible to the IC pins)

**Figure 3. LD39150xx fixed version with inhibit**



**Note:** *Inhibit pin is not internally pulled down/up then it must not be left floating. Disable the device when connected to GND or to a positive voltage less than 0.3 V.*

**Figure 4. LD39150xx adjustable version**



**Note:** *Set  $R_2$  as close as possible to 4.7 kΩ*

Figure 5. LD39150xx DPAK

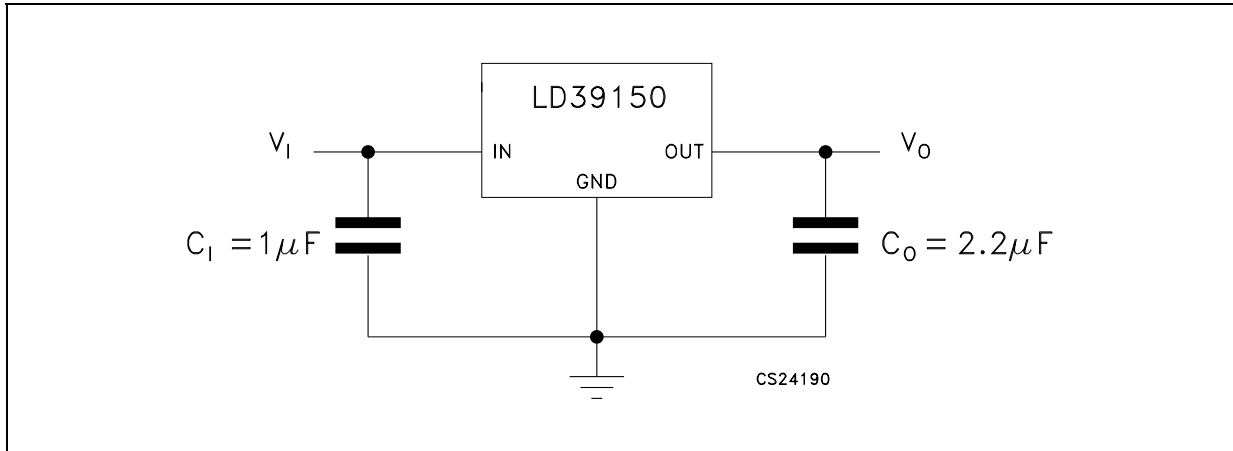
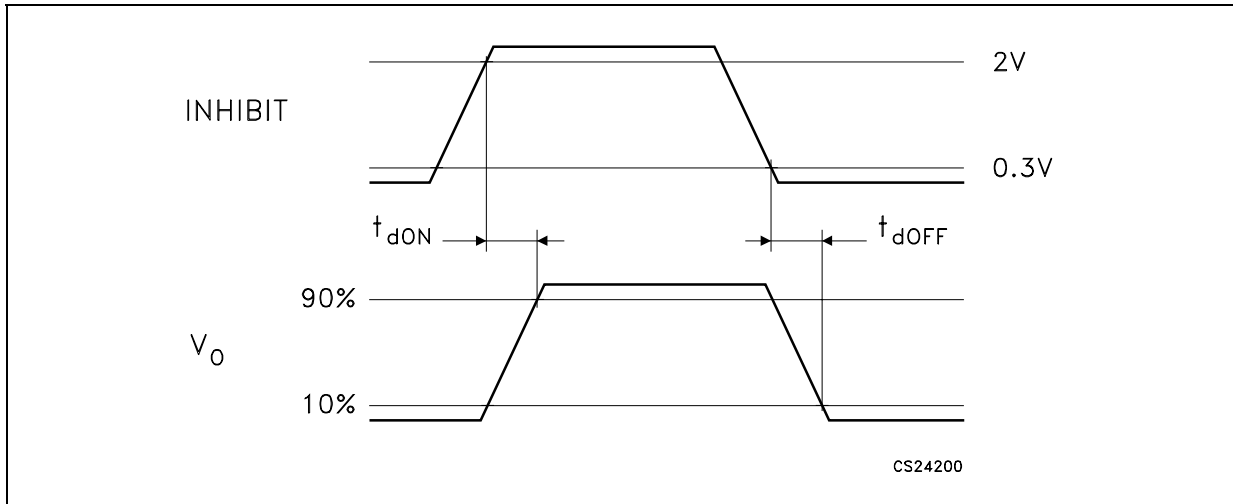


Figure 6. Timing diagram



## 4 Maximum ratings

**Table 3. Absolute maximum ratings**

Symbol	Parameter	Value	Unit
$V_I$	DC input voltage	-0.3 to 6.5	V
$V_{INH}$	INHIBIT input voltage	-0.3 to $V_I + 0.3$ (6.5 V max)	V
$V_O$	DC output voltage	-0.3 to $V_I + 0.3$ (6.5 V max)	V
$V_{ADJ}$	ADJ pin voltage	-0.3 to $V_I + 0.3$ (6.5 V max)	V
$I_O$	Output current	Internally limited	mA
$P_D$	Power dissipation	Internally limited	mW
$T_{STG}$	Storage temperature range	-50 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	PPAK	DPAK	DFN (1)	Unit
$R_{thJA}$	Thermal resistance junction-ambient	100	100	40	°C/W
$R_{thJC}$	Thermal resistance junction-case	8	8	10	°C/W

1. With PCB ground plane heatsink.

## 5 Electrical characteristics

**Table 5. Electrical characteristics**

( $T_J = 25\text{ }^\circ\text{C}$ ,  $V_I = V_O + 1\text{ V}$ ,  $C_I = 1\text{ }\mu\text{F}$ ,  $C_O = 2.2\text{ }\mu\text{F}$ ,  $I_{LOAD} = 10\text{ mA}$ ,  $V_{INH} = 2\text{ V}$ , unless otherwise specified)

Symbol	Parameter	Parameter	Min.	Typ.	Max.	Unit
$V_I$	Operating input voltage		2.5		6	V
$V_O$	Output voltage tolerance	$V_I = V_O + 1\text{V}$ , $I_{LOAD} = 10\text{mA to } 1.5\text{A}$	-1.5		1.5	% of $V_{O(NOM)}$
		$V_I = V_O + 1\text{V to } 6\text{V}$ , $I_{LOAD} = 10\text{mA to } 1.5\text{A}$ $T_J = -40\text{ to } 125^\circ\text{C}$	-3		3	
$V_{REF}$	Reference voltage			1.22		V
$\Delta V_O$	Output voltage LINE regulation	$V_I = V_O + 1\text{V to } 6\text{V}$		0.04		%
		$V_I = V_O + 1\text{V to } 6\text{V}$ , $T_J = -40\text{ to } 125^\circ\text{C}$		0.1	0.2	%
$\Delta V_O / \Delta I_{LOAD}$	Output voltage LOAD regulation	$I_{LOAD} = 10\text{mA to } 1.5\text{A}$		0.06		% / A
		$I_{LOAD} = 10\text{mA to } 1.5\text{A}$ , $T_J = -40\text{ to } 125^\circ\text{C}$		0.2	0.4	
$V_{DROP}$	Dropout voltage ( $V_I - V_O$ )	$I_{LOAD} = 300\text{mA}$ , $T_J = -40\text{ to } 125^\circ\text{C}$		40	80	mV
		$I_{LOAD} = 1.5\text{A}$ , $T_J = -40\text{ to } 125^\circ\text{C}$		200	400	
$I_Q$	Quiescent current: ON MODE	$I_{LOAD} = 10\text{mA to } 1.5\text{A}$ , $V_{INH} = 2\text{V}$ $T_J = -40\text{ to } 125^\circ\text{C}$		1	2.5	mA
	Quiescent current: OFF MODE	$V_{INH} = 0.3\text{V}$			1	$\mu\text{A}$
		$V_{INH} = 0.3\text{V}$ , $T_J = -40\text{ to } 125^\circ\text{C}$			5	
<b>Short circuit protection</b>						
$I_{SC}$	Short circuit protection	$R_L = 0$		3		A
<b>Inhibit input</b>						
$V_{INH}$	Inhibit threshold LOW	$V_I = 2.5\text{ to } 6\text{V OFF}$ $T_J = -40\text{ to } 125^\circ\text{C}$			0.3	V
	Inhibit threshold HIGH		2			
$T_{D-OFF}$	Current limit	$I_{LOAD} = 1.5\text{A}$ , $V_O = 3.3\text{V}$		15		$\mu\text{s}$
$T_{D-ON}$	Current limit	$I_{LOAD} = 1.5\text{A}$ , $V_O = 3.3\text{V}$		15		
$I_{INH}$	Inhibit input current <sup>(1)</sup>	$V_I = 6\text{V}$ , $V_{INH} = 0\text{ to } 6\text{V}$		$\pm 0.1$	$\pm 1$	$\mu\text{A}$
<b>AC parameters</b>						
SVR	Supply voltage rejection	$V_I = 4.5 \pm 1\text{V}$ , $V_O = 3.3\text{V}$ , $I_{LOAD} = 10\text{mA}$ ,	$f = 120\text{Hz}$		65	dB
			$f = 1\text{kHz}$		55	
$e_N$	Output noise voltage	$B_W = 10\text{Hz to } 100\text{kHz}$ , $C_O = 2.2\mu\text{F}$ , $V_O = 2.5\text{V}$		100		$\mu\text{V}_{RMS}$
$T_{SHDN}$	Thermal shutdown OFF			170		$^\circ\text{C}$
	Hysteresis			10		

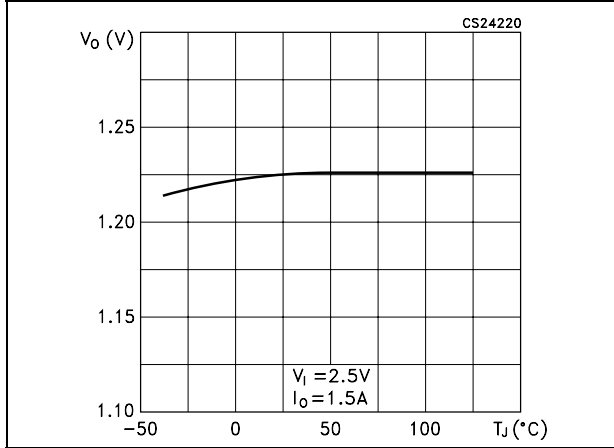
1. Guaranteed by design



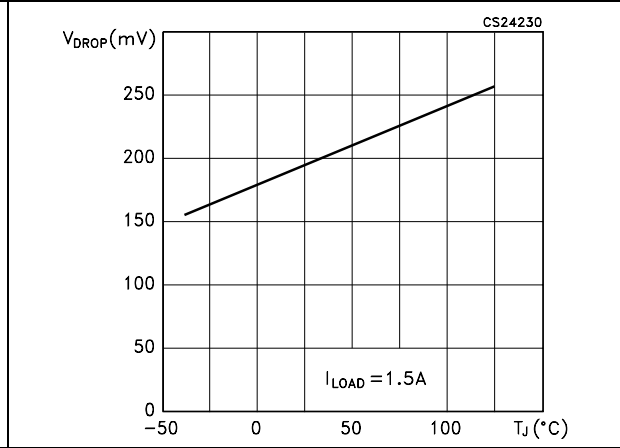
## 6 Typical performance characteristics

( $T_J = 25\text{ }^\circ\text{C}$ ,  $V_I = V_O + 1\text{ V}$ ,  $C_I = 1\text{ }\mu\text{F}$ ,  $C_O = 2.2\text{ }\mu\text{F}$ ,  $I_{LOAD} = 10\text{ mA}$ ,  $V_{INH} = V_I$ , unless otherwise specified)

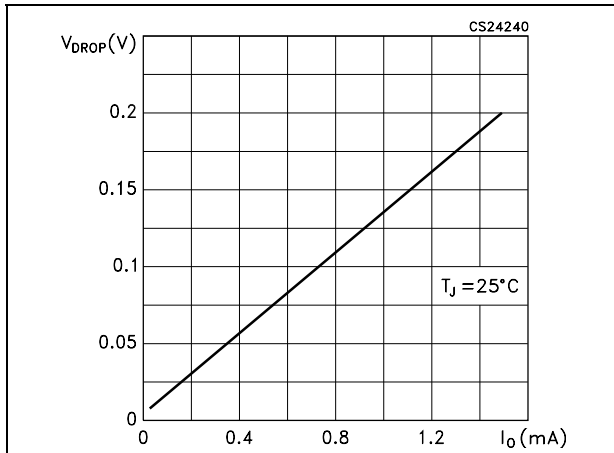
**Figure 7. Output voltage vs temperature**



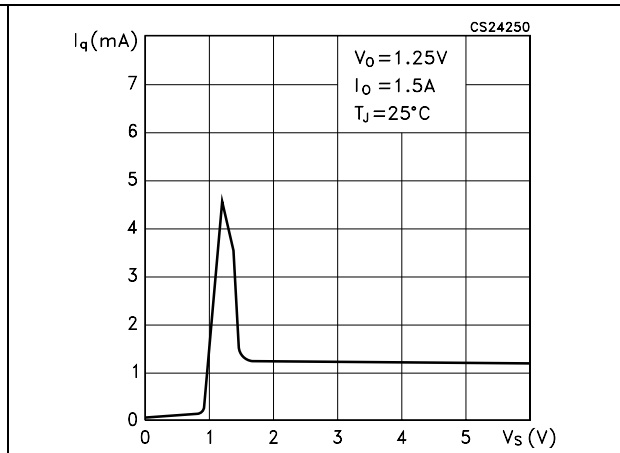
**Figure 8. Dropout voltage vs temperature**



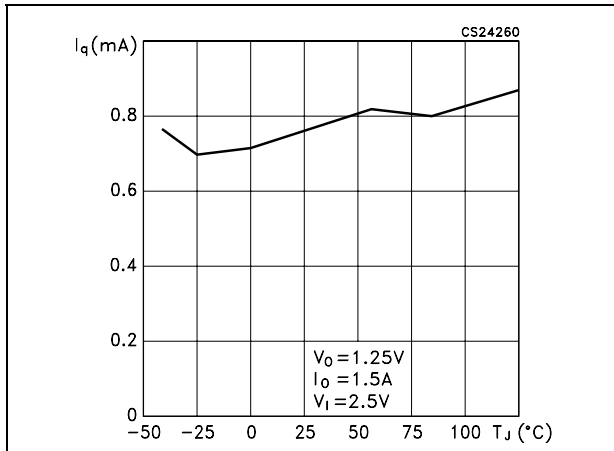
**Figure 9. Dropout voltage vs output current**



**Figure 10. Quiescent current vs supply voltage**



**Figure 11. Quiescent current vs temperature**



**Figure 12. Quiescent current vs temperature**

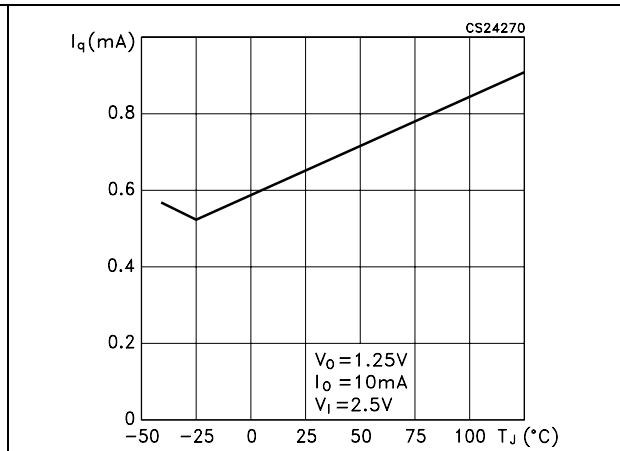


Figure 13. Short circuit current vs temperature Figure 14. Output voltage vs input voltage

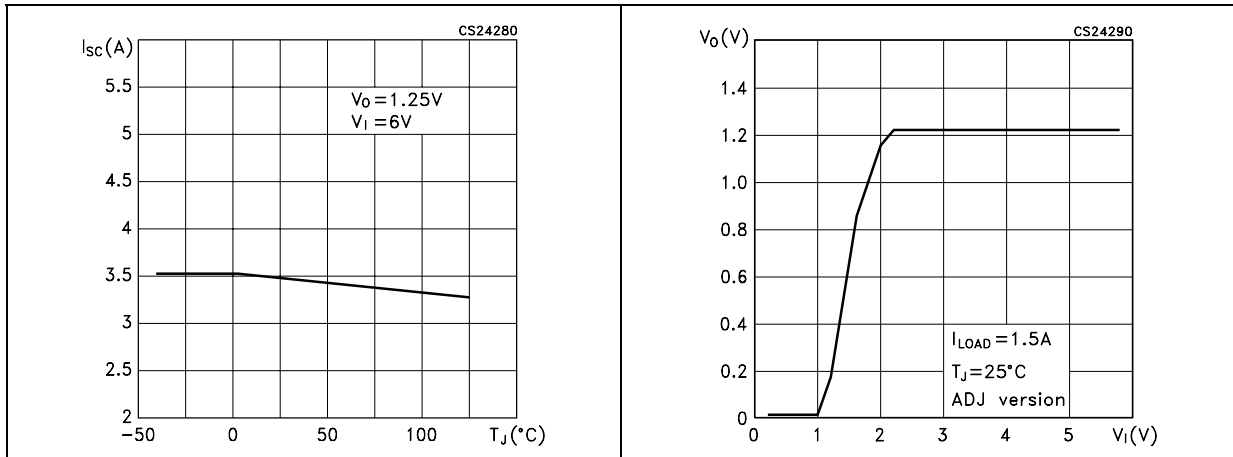


Figure 15. Stability region vs  $C_O$  & ESR (at 100 kHz) Figure 16. Stability region vs  $C_O$  & low ESR (at 100 kHz)

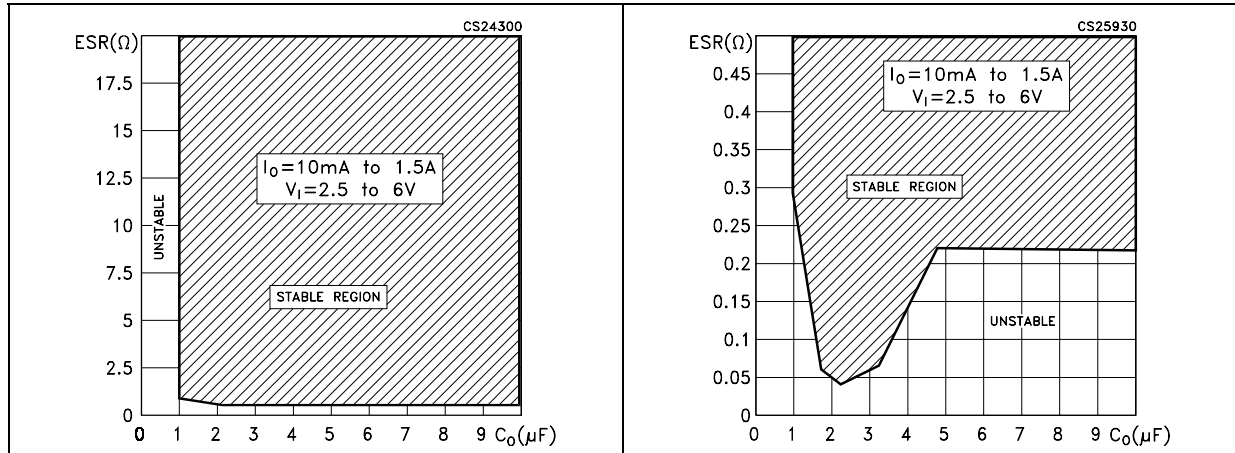


Figure 17. Load transient

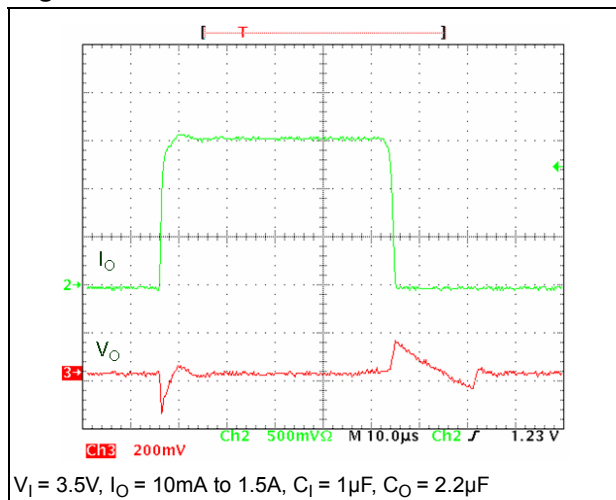
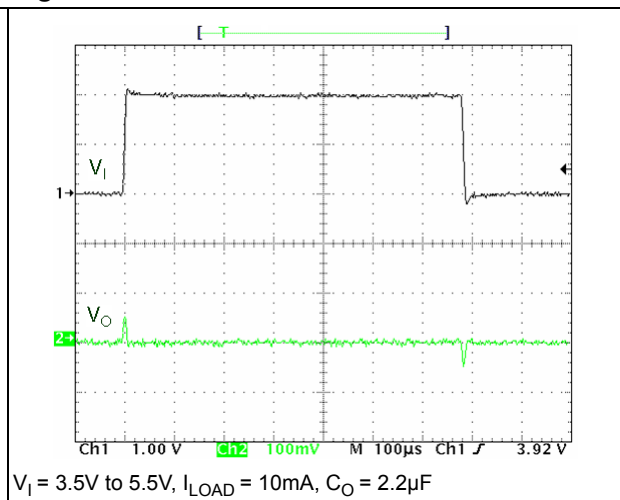


Figure 18. Line transient



## 7 Application notes

### 7.1 External capacitors

The LD39150xx requires external capacitors for regulator stability. These capacitors must be selected to meet the requirements of minimum capacitance and equivalent series resistance (see [Figure 15](#) and [Figure 16](#)). The input/output capacitors must be located less than 1cm from the relative pins and connected directly to the input/output ground pins using traces which have no other currents flowing through them. Any good quality of Ceramic or Electrolytic capacitors can be used.

### 7.2 Input capacitor

An input capacitor whose minimum value is 1  $\mu\text{F}$  is required with the LD39150xx (amount of capacitance can be increased without limit). This capacitor must be located a distance of not more than 1cm from the input pin of the device and returned to a clean analog ground. Any good quality ceramic, tantalum or film capacitors can be used for this capacitor.

### 7.3 Output capacitor

It is possible to use ceramic or tantalum capacitors but the output capacitor must meet the requirement for minimum amount of capacitance and ESR (equivalent series resistance) value. A minimum capacitance of 2.2  $\mu\text{F}$  is a good choice to guarantee the stability of the regulator. Anyway, other  $C_O$  values can be used according to the ([Figure 15](#) and [Figure 16](#)) showing the allowable ESR range as a function of the output capacitance. This curve represents the stability region over the full temperature and  $I_O$  range.

### 7.4 Thermal note

The output capacitor must maintain its ESR in the stable region over the full operating temperature range to assure stability. Also, capacitors tolerance and variation with temperature must be kept in consideration in order to assure the minimum amount of capacitance at all times.

### 7.5 Inhibit input operation

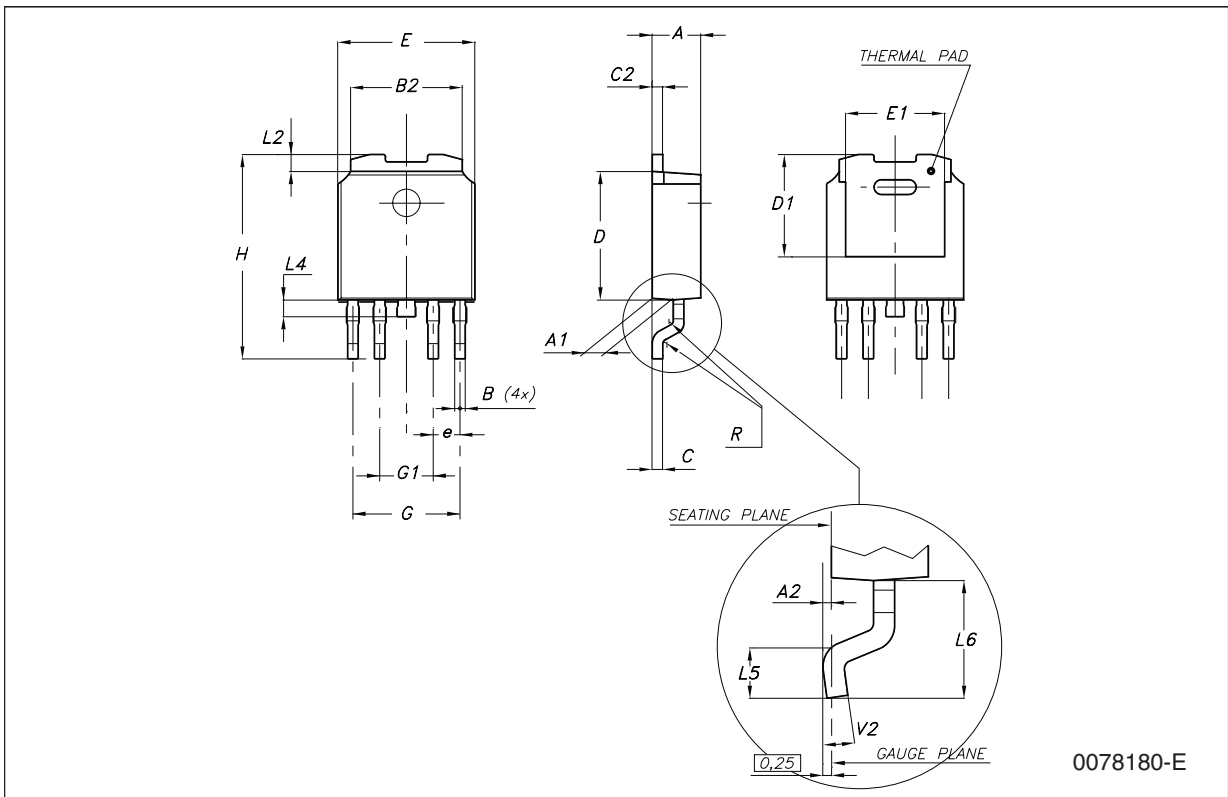
The inhibit pin can be used to turn OFF the regulator when pulled down, so drastically reducing the current consumption down to less than 1  $\mu\text{A}$ . When the inhibit feature is not used, this pin must be tied to  $V_I$  to keep the regulator output ON at all times. To assure proper operation, the signal source used to drive the inhibit pin must be able to swing above and below the specified thresholds listed in the electrical characteristics section ( $V_{IH}$   $V_{IL}$ ). The inhibit pin must not be left floating because it is not internally pulled down/up.

## 8 Package mechanical data

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](http://www.st.com). ECOPACK® is an ST trademark.

**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	

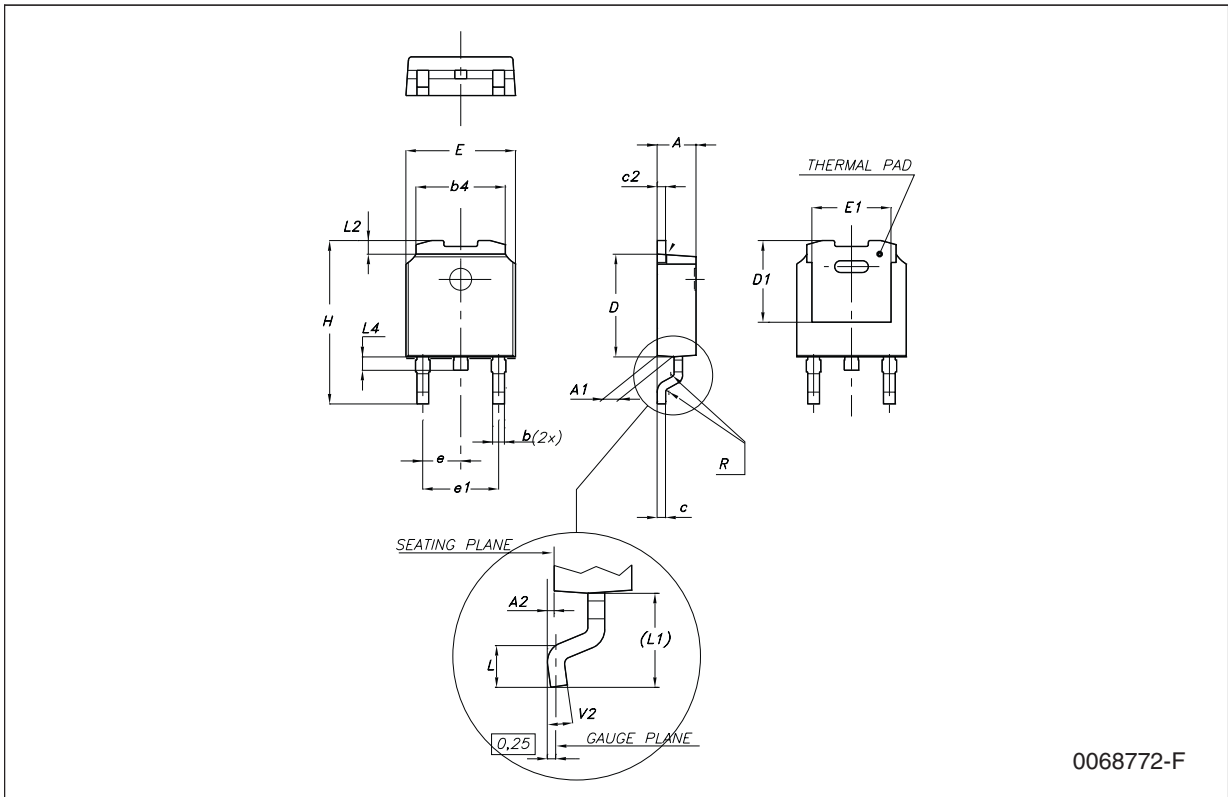


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**DPAK mechanical data**

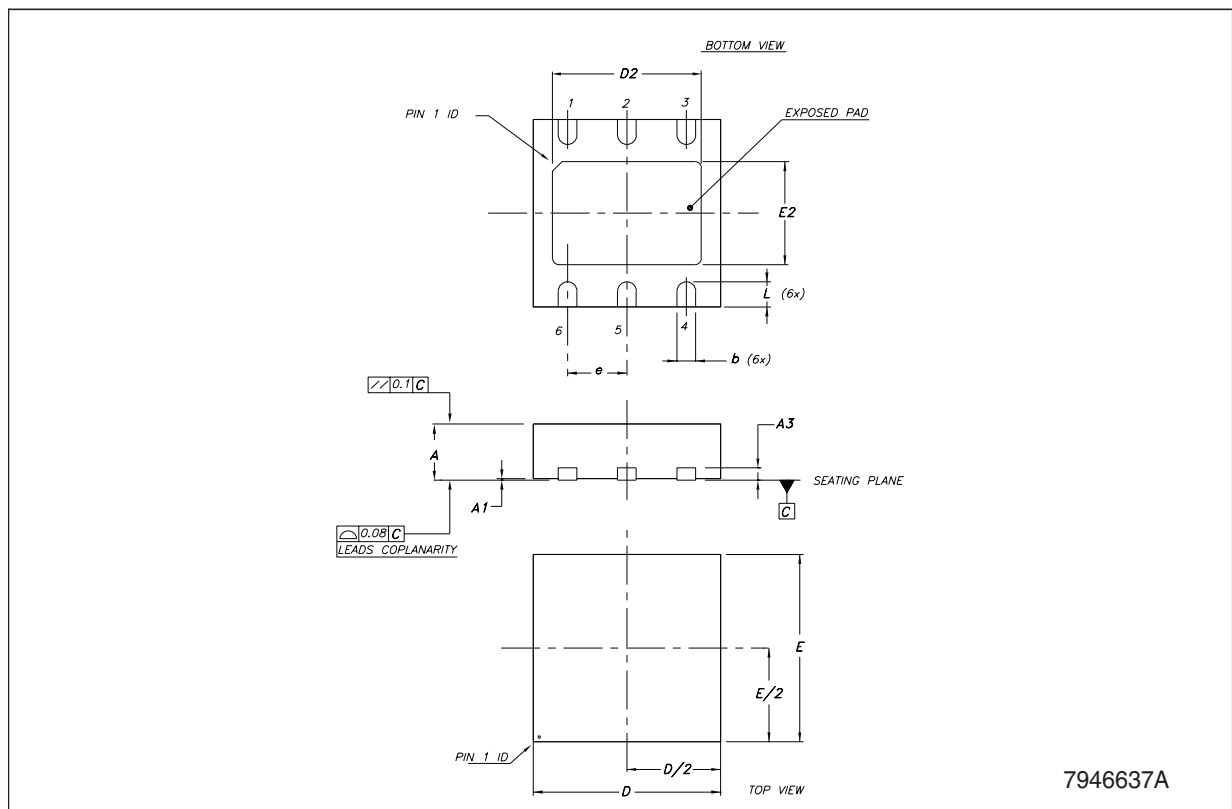
Dim.	mm.			inch.		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A	2.2		2.4	0.086		0.094
A1	0.9		1.1	0.035		0.043
A2	0.03		0.23	0.001		0.009
B	0.64		0.9	0.025		0.035
b4	5.2		5.4	0.204		0.212
C	0.45		0.6	0.017		0.023
C2	0.48		0.6	0.019		0.023
D	6		6.2	0.236		0.244
D1		5.1			0.200	
E	6.4		6.6	0.252		0.260
E1		4.7			0.185	
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°



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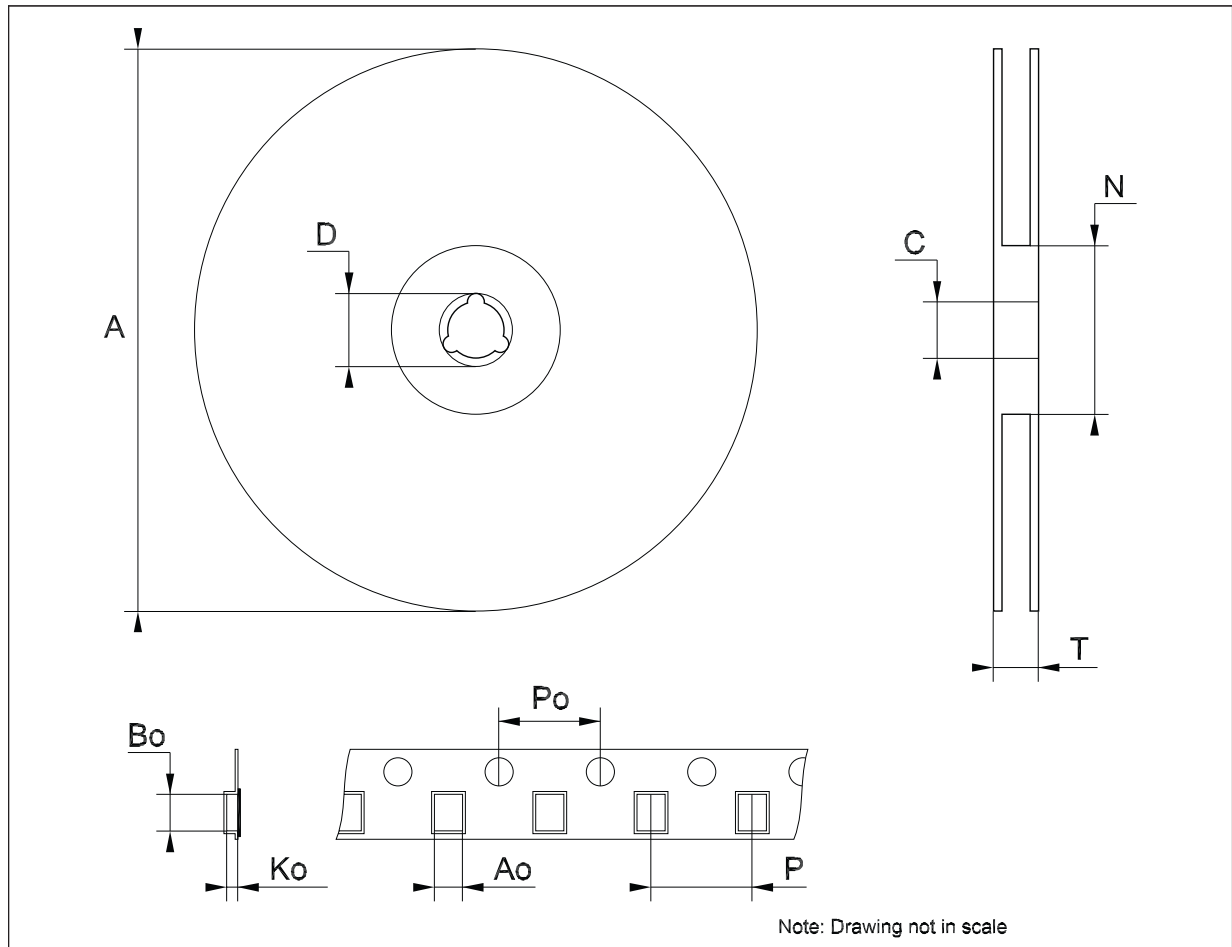
**DFN6 (3x3 mm) mechanical data**

Dim.	mm.			inch.		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A	0.80	0.90	1.00	0.031	0.035	0.039
A1	0	0.02	0.05	0	0.001	0.002
A3		0.20			0.008	
b	0.23	0.30	0.38	0.009	0.012	0.015
D	2.90	3.00	3.10	0.114	0.118	0.122
D2	2.23	2.38	2.48	0.088	0.094	0.098
E	2.90	3.00	3.10	0.114	0.118	0.122
E2	1.50	1.65	1.75	0.059	0.065	0.069
e		0.95			0.037	
L	0.30	0.40	0.50	0.012	0.016	0.020



**Tape & reel DPAK-PPAK mechanical data**

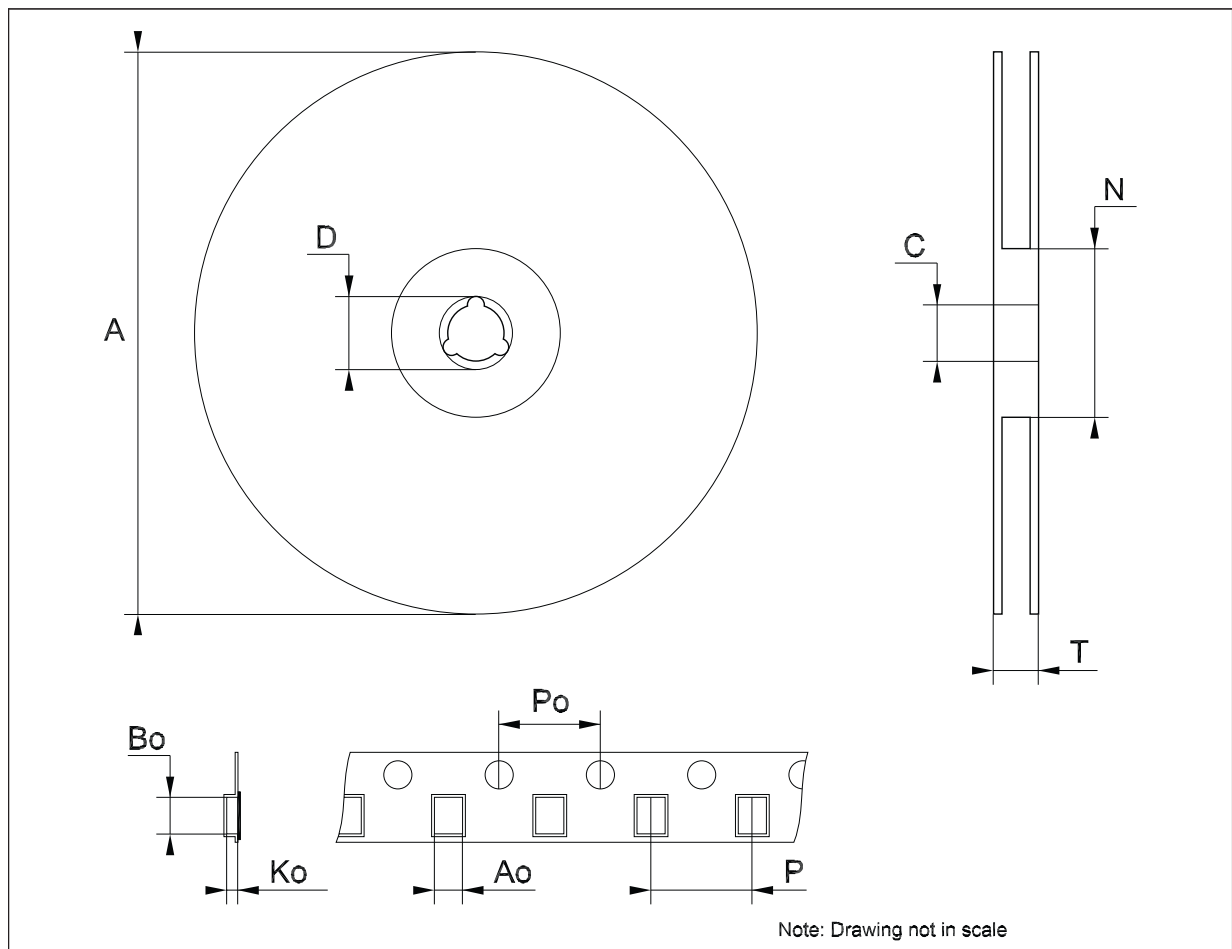
Dim.	mm.			inch.		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A			330			12.992
C	12.8	13.0	13.2	0.504	0.512	0.519
D	20.2			0.795		
N	60			2.362		
T			22.4			0.882
Ao	6.80	6.90	7.00	0.268	0.272	0.276
Bo	10.40	10.50	10.60	0.409	0.413	0.417
Ko	2.55	2.65	2.75	0.100	0.104	0.105
Po	3.9	4.0	4.1	0.153	0.157	0.161
P	7.9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





**Tape & reel QFNxx/DFNxx (3x3) mechanical data**

Dim.	mm.			inch.		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A			180			7.087
C	12.8		13.2	0.504		0.519
D	20.2			0.795		
N	60			2.362		
T			14.4			0.567
Ao		3.3			0.130	
Bo		3.3			0.130	
Ko		1.1			0.043	
Po		4			0.157	
P		8			0.315	



## 9 Revision history

**Table 6. Document revision history**

Date	Revision	Changes
26-Jan-2007	1	Initial release.
12-Jan-2009	2	Removed: package DFN8 (4x4 mm) and added package DFN6 (3x3 mm).

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