

## 1.5 A very low drop voltage regulator IC

Datasheet - production data

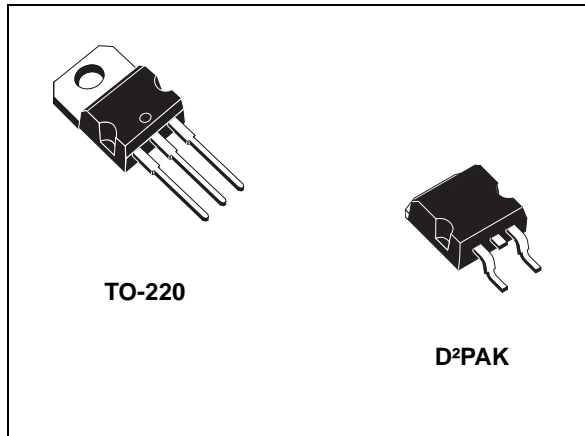


Table 1. Device summary

Order code		Output voltages
TO-220	D²PAK	
L4940V5	L4940D2T5-TR	5 V
L4940V85		8.5 V
	L4940D2T12-TR	12 V

### Features

- Precise 5, 8.5, 12 V outputs
- Low dropout voltage (450 mV typ. at 1 A)
- Very low quiescent current
- Thermal shutdown
- Short-circuit protection
- Reverse polarity protection

### Description

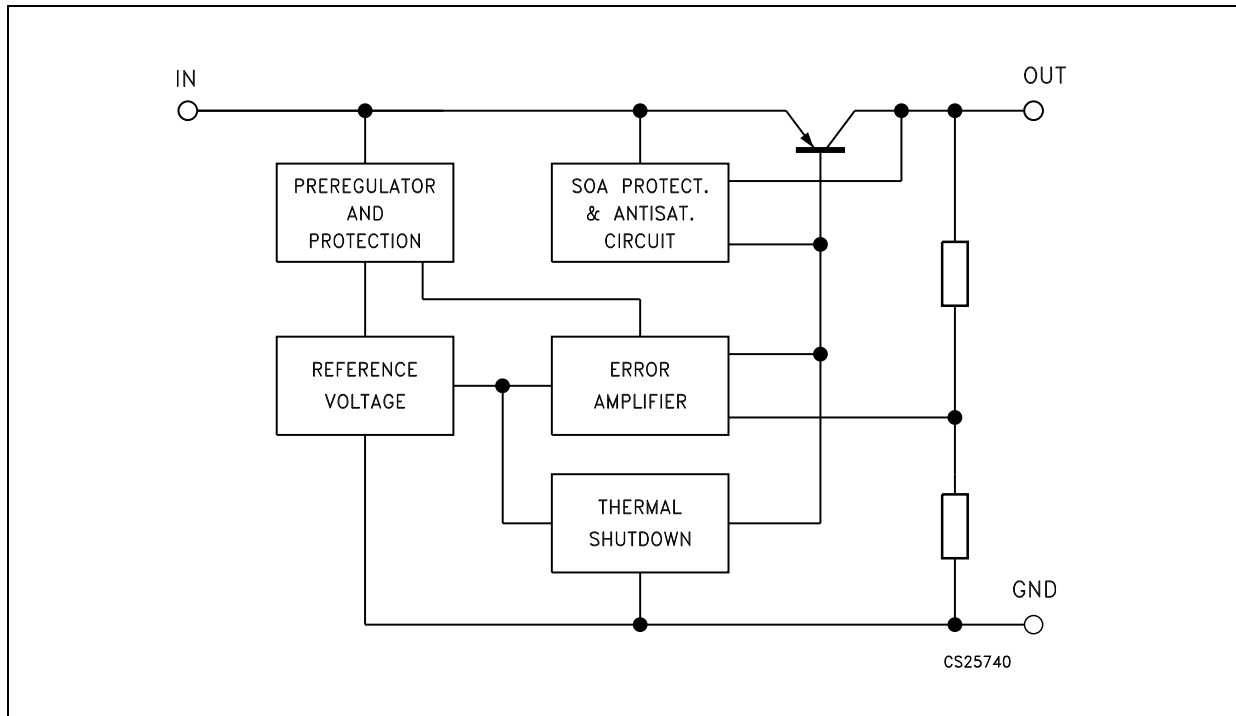
The L4940 series of three-terminal positive regulators is available in TO-220 and D²PAK packages and with several fixed output voltages, making it useful in a wide range of industrial and consumer applications. Thanks to their very low input/output voltage drop, these devices are particularly suitable for battery-powered equipment, reducing consumption and prolonging battery-life. Each type employs internal current limiting, anti-saturation circuit, thermal shutdown and safe area protection.

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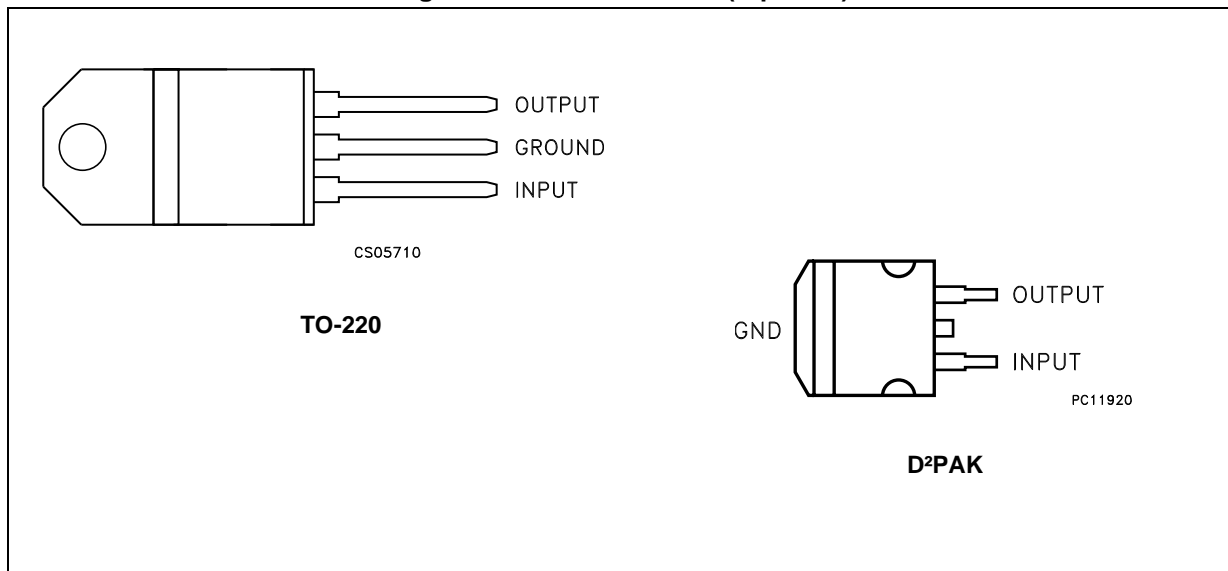
# 1 Block diagram

Figure 1. Block diagram



## 2 Pin configuration

Figure 2. Pin connections (top view)



### 3 Maximum ratings

**Table 2. Absolute maximum ratings**

Symbol	Parameter	Value	Unit	
$V_I$	Forward input voltage	30	V	
$V_{IR}$	Reverse input voltage	$V_O = 5\text{ V}, R_O = 100\ \Omega$	-15	V
		$V_O = 8.5\text{ V}, R_O = 180\ \Omega$	-15	V
		$V_O = 12\text{ V}, R_O = 240\ \Omega$	-15	V
$I_O$	Output current	Internally limited	mA	
$P_D$	Power dissipation	Internally limited	mW	
$T_{stg}$	Storage temperature range	-40 to +150	°C	
$T_{op}$	Operating junction temperature range	-40 to +150	°C	

*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	TO-220	D <sup>2</sup> PAK	Unit
$R_{thJC}$	Thermal resistance junction-case	3	3	°C/W
$R_{thJA}$	Thermal resistance junction-ambient	50	62.5	°C/W

# 4 Test circuits

Figure 3. DC parameters

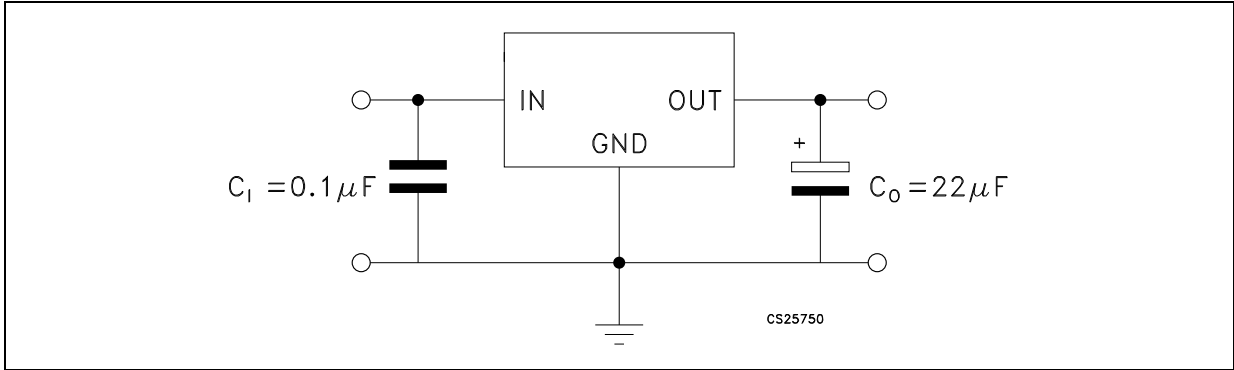


Figure 4. Load regulation

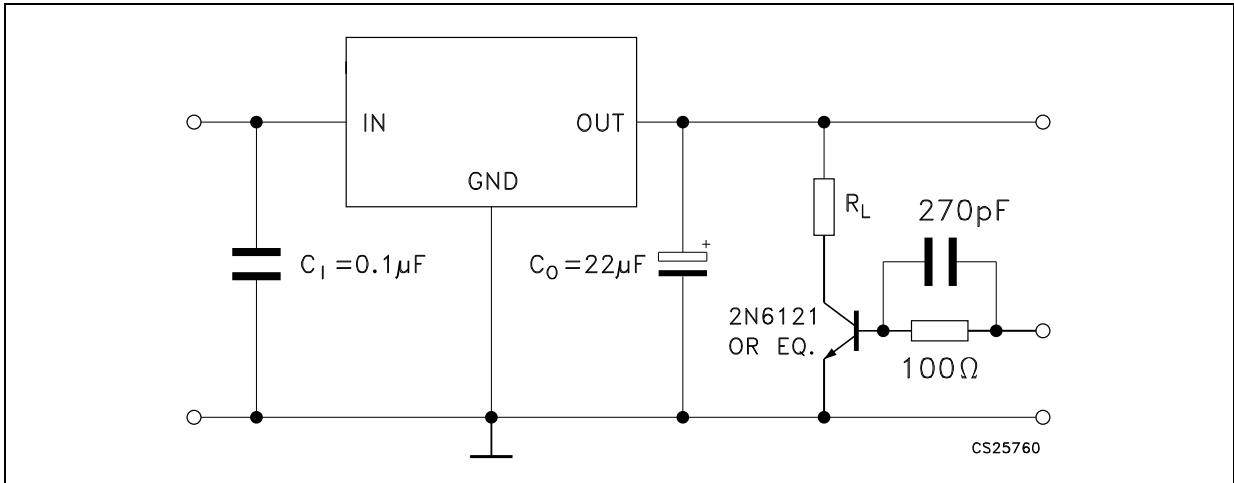
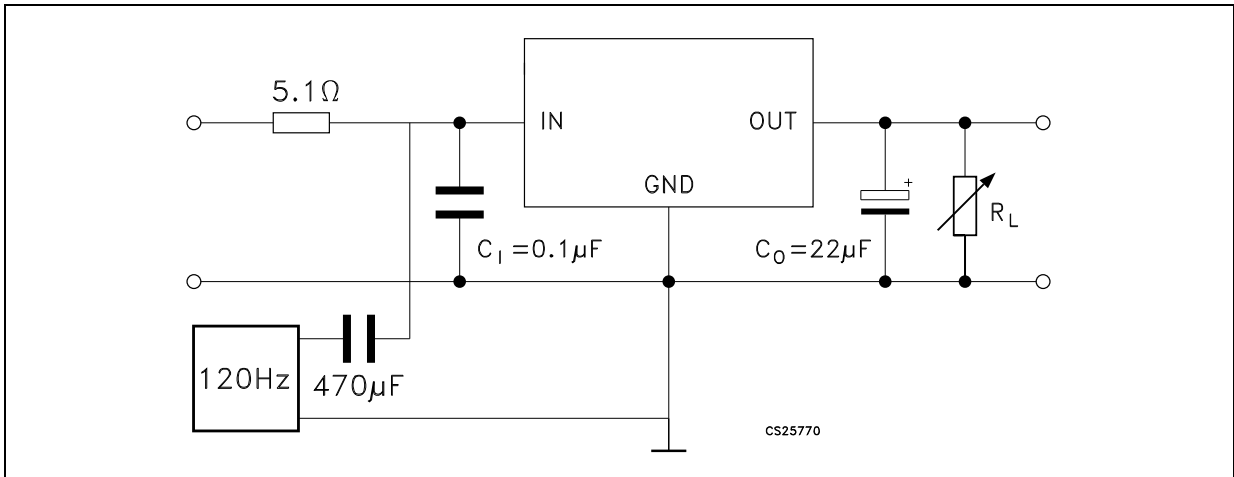


Figure 5. Ripple rejection



## 5 Electrical characteristics

Refer to test circuit,  $V_I = 7\text{ V}$ ,  $C_I = 0.1\ \mu\text{F}$ ,  $C_O = 22\ \mu\text{F}$ ,  $T_J = 25\ ^\circ\text{C}$ , unless otherwise specified.

**Table 4. L4940#5 electrical characteristics**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$V_O$	Output voltage	$I_O = 500\text{ mA}$	4.9	5	5.1	V
$V_O$	Output voltage	$I_O = 5\text{ mA to }1.5\text{ A}$ , $V_I = 6.5\text{ to }15\text{ V}$	4.8	5	5.2	V
$V_I$	Maximum input voltage	$I_O = 5\text{ mA}$			17	V
$\Delta V_O$	Line regulation	$V_I = 6\text{ to }17\text{ V}$ , $I_O = 5\text{ mA}$		4	10	mV
$\Delta V_O$	Load regulation	$I_O = 5\text{ mA to }1.5\text{ A}$		8	25	mV
		$I_O = 0.5\text{ A to }1\text{ A}$		5	15	mV
$I_q$	Quiescent current	$I_O = 5\text{ mA}$		5	8	mA
		$I_O = 1.5\text{ A}$ , $V_I = 6.5\text{ V}$		30	50	mA
$\Delta I_q$	Quiescent current change	$I_O = 5\text{ mA}$			3	mA
		$I_O = 1.5\text{ A}$ , $V_I = 6.5\text{ to }16\text{ V}$			15	mA
$\Delta V_O / \Delta T$	Output voltage drift			0.5		mV/ $^\circ\text{C}$
SVR	Supply voltage rejection	$f = 120\text{ Hz}$ , $I_O = 1\text{ A}$	58	68		dB
$V_d$	Dropout voltage	$I_O = 0.5\text{ A}$		200	400	mV
		$I_O = 1.5\text{ A}$		500	900	mV
$I_{sc}$	Short-circuit current	$V_I = 14\text{ V}$		2	2.7	A
		$V_I = 6.5\text{ V}$		2.2	2.9	

Refer to test circuit,  $V_I = 10.5\text{ V}$ ,  $C_I = 0.1\ \mu\text{F}$ ,  $C_O = 22\ \mu\text{F}$ ,  $T_J = 25\ ^\circ\text{C}$ , unless otherwise specified.

**Table 5. L4940#85 electrical characteristics**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$V_O$	Output voltage	$I_O = 500\text{ mA}$	8.3	8.5	8.7	V
$V_O$	Output voltage	$I_O = 5\text{ mA to }1.5\text{ A}$ , $V_I = 10.2\text{ to }15\text{ V}$	8.15	8.5	8.85	V
$V_I$	Maximum input voltage	$I_O = 5\text{ mA}$			17	V
$\Delta V_O$	Line regulation	$V_I = 9.5\text{ to }17\text{ V}$ , $I_O = 5\text{ mA}$		4	9	mV
$\Delta V_O$	Load regulation	$I_O = 5\text{ mA to }1.5\text{ A}$		12	30	mV
		$I_O = 0.5\text{ A to }1\text{ A}$		8	16	mV
$I_q$	Quiescent current	$I_O = 5\text{ mA}$		4	8	mA
		$I_O = 1.5\text{ A}$ , $V_I = 10.2\text{ V}$		30	50	mA
$\Delta I_q$	Quiescent current change	$I_O = 5\text{ mA}$			2.5	mA
		$I_O = 1.5\text{ A}$ , $V_I = 10.2\text{ to }16\text{ V}$			15	mA

Table 5. L4940#85 electrical characteristics (continued)

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$\Delta V_O / \Delta T$	Output voltage drift			0.8		mV/°C
SVR	Supply voltage rejection	f = 120 Hz, I <sub>O</sub> = 1 A	58	66		dB
V <sub>d</sub>	Dropout voltage	I <sub>O</sub> = 0.5 A		200	400	mV
		I <sub>O</sub> = 1.5 A		500	900	mV
I <sub>sc</sub>	Short-circuit current	V <sub>I</sub> = 14 V		2	2.7	A
		V <sub>I</sub> = 10.2 V		2.2	2.9	

Refer to test circuit, V<sub>I</sub> = 14 V, C<sub>I</sub> = 0.1 μF, C<sub>O</sub> = 22 μF, T<sub>J</sub> = 25 °C, unless otherwise specified.

Table 6. L4940#12 electrical characteristics

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
V <sub>O</sub>	Output voltage	I <sub>O</sub> = 500 mA	11.75	12	12.25	V
V <sub>O</sub>	Output voltage	I <sub>O</sub> = 5 mA to 1.5 A, V <sub>I</sub> = 13.8 to 15 V	11.5	12	12.5	V
V <sub>I</sub>	Maximum input voltage	I <sub>O</sub> = 5 mA			17	V
$\Delta V_O$	Line regulation	V <sub>I</sub> = 13 to 17 V, I <sub>O</sub> = 5 mA		3	7	mV
$\Delta V_O$	Load regulation	I <sub>O</sub> = 5 mA to 1.5 A		15	35	mV
		I <sub>O</sub> = 0.5 A to 1 A		10	25	mV
I <sub>q</sub>	Quiescent current	I <sub>O</sub> = 5 mA		4	8	mA
		I <sub>O</sub> = 1.5 A, V <sub>I</sub> = 13.8 V		30	50	mA
$\Delta I_q$	Quiescent current change	I <sub>O</sub> = 5 mA			1.5	mA
		I <sub>O</sub> = 1.5 A, V <sub>I</sub> = 13.8 to 16 V			10	mA
$\Delta V_O / \Delta T$	Output voltage drift			1.2		mV/°C
SVR	Supply voltage rejection	f = 120 Hz, I <sub>O</sub> = 1 A	55	61		dB
V <sub>d</sub>	Dropout voltage	I <sub>O</sub> = 0.5 A		200	400	mV
		I <sub>O</sub> = 1.5 A		500	900	mV
I <sub>sc</sub>	Short-circuit current	V <sub>I</sub> = 14 V		2	2.7	A
Z <sub>O</sub>	Output impedance	f = 120 Hz, I <sub>O</sub> = 0.5 A		40		mΩ



## 6 Performance characteristics

Figure 6. Dropout voltage vs. output current

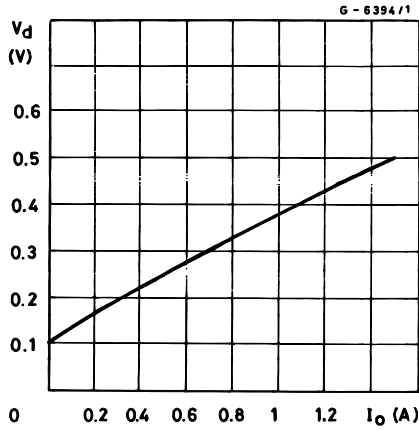


Figure 7. Dropout voltage vs. temperature

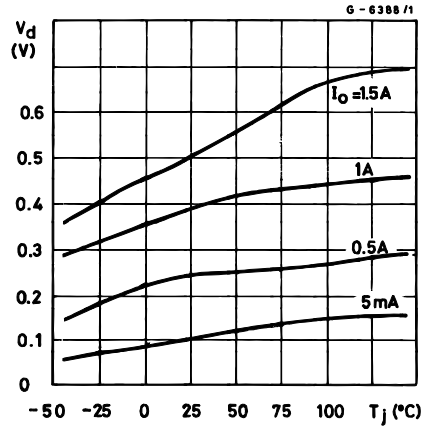


Figure 8. Output voltage vs. temperature (L4940V5)

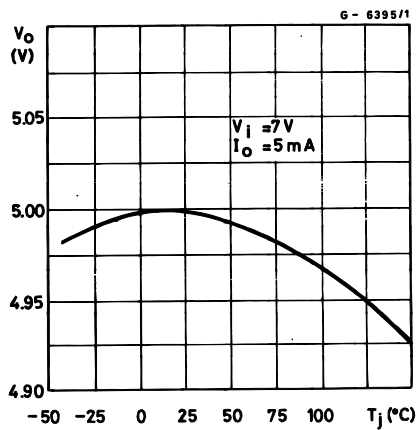


Figure 9. Output voltage vs. temperature (L4940V85)

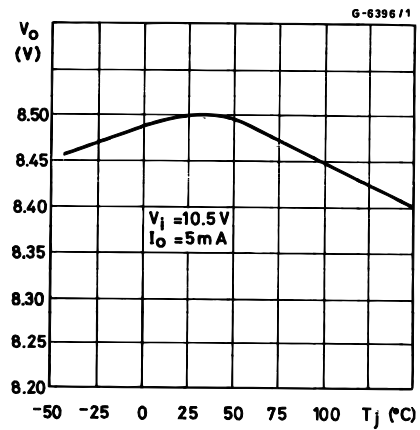


Figure 10. Output voltage vs. temperature (L4940V12)

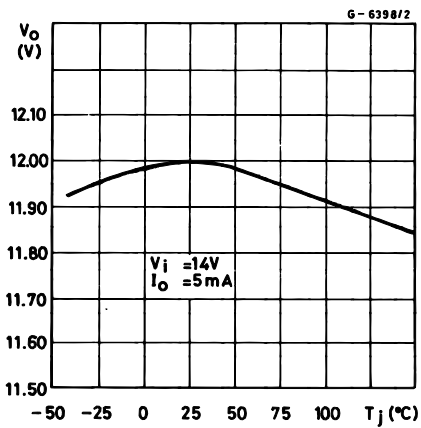


Figure 11. Quiescent current vs. temperature (L4940V5)

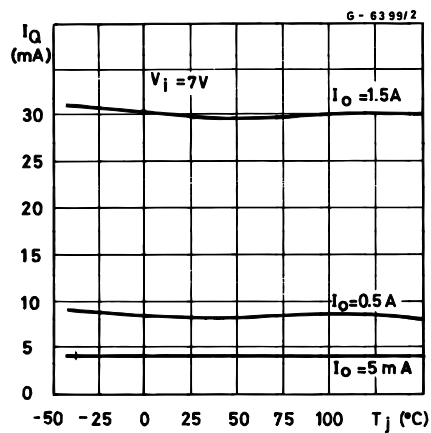


Figure 12. Quiescent current vs. input voltage (L4940V5)

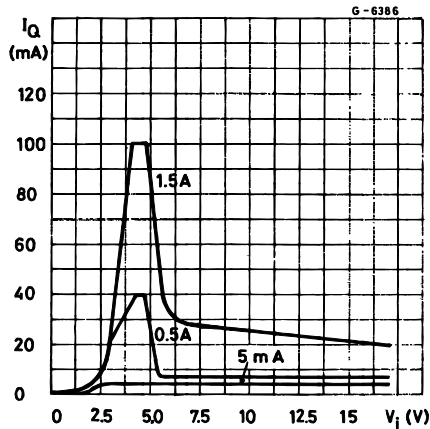


Figure 13. Quiescent current vs. output current (L4940V5)

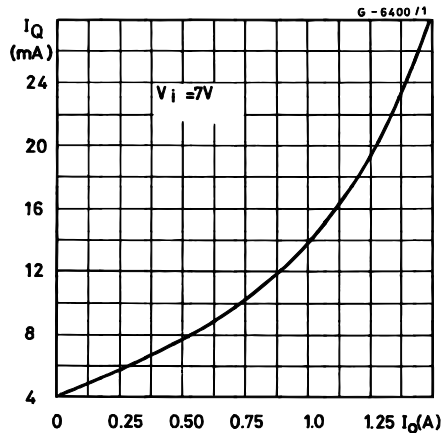


Figure 14. Short-circuit current vs. temperature (L4940V5)

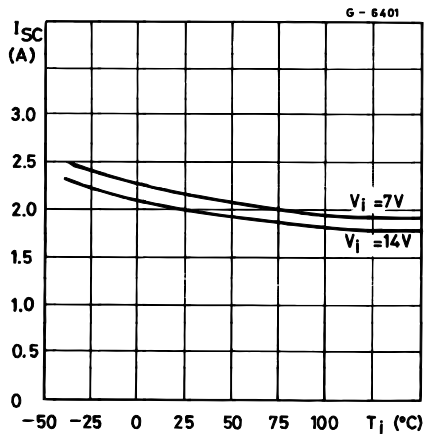


Figure 15. Peak output current vs. input/output differential voltage (L4940V5)

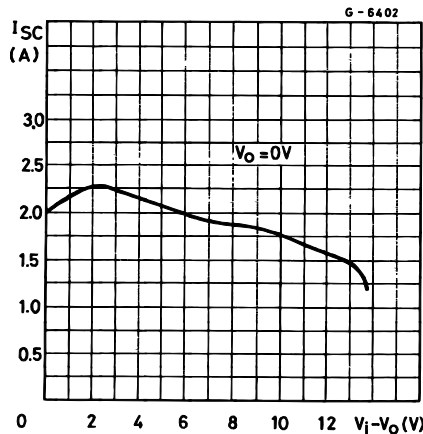


Figure 16. Low voltage behavior (L4940V5)

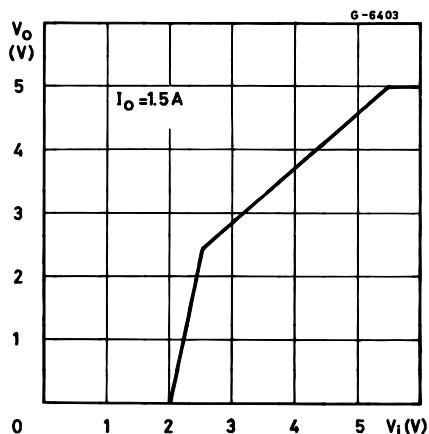


Figure 17. Low voltage behavior (L4940V85)

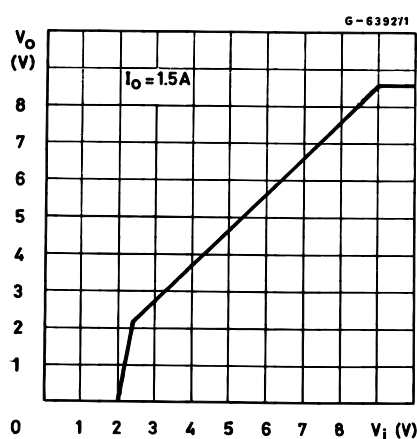


Figure 18. Low voltage behavior (L4940V12)

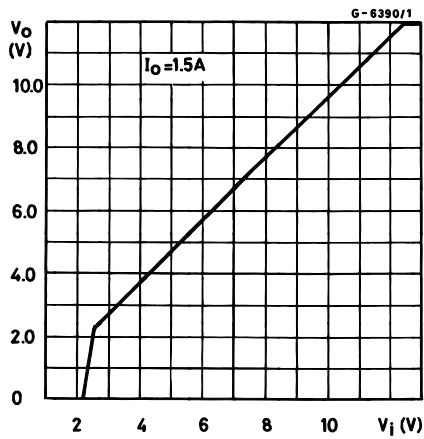


Figure 19. Supply voltage rejection vs. frequency (L4940V5)

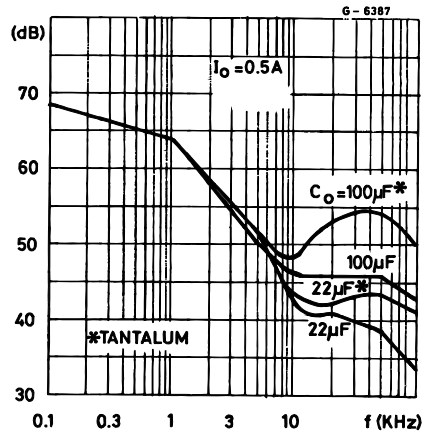


Figure 20. Supply voltage rejection vs. output current (L4940V5)

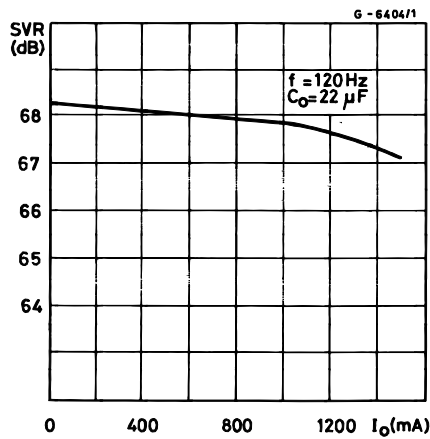


Figure 21. Load dump characteristics (L4940V5)

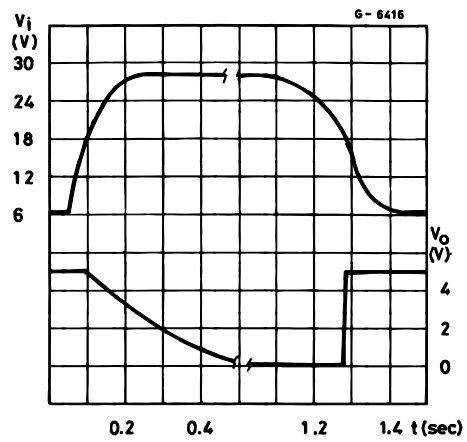


Figure 22. Line transient response (L4940V5)

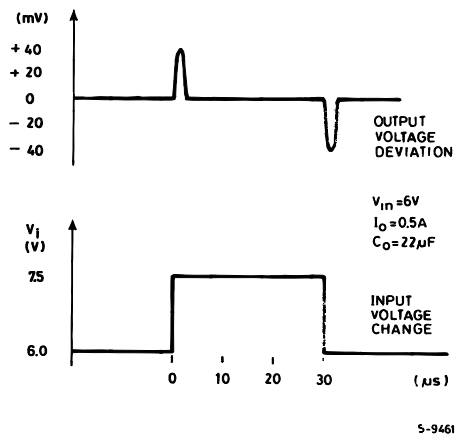
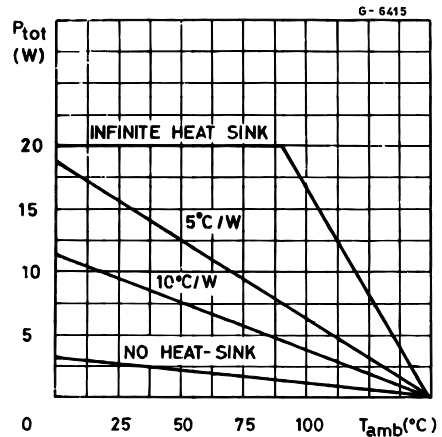
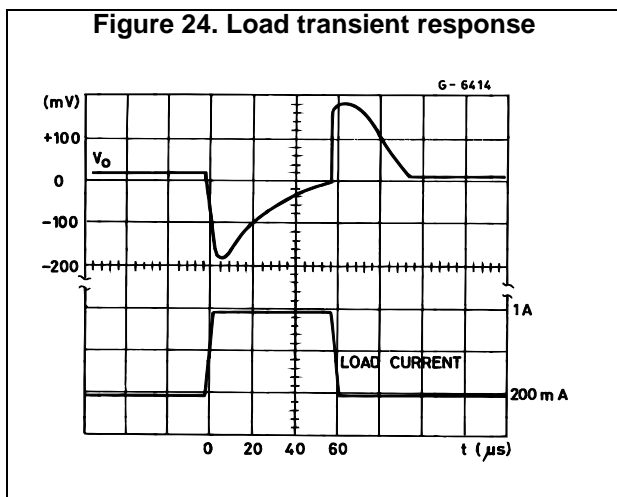


Figure 23. Total power dissipation





# 7 Application circuits

Figure 25. Distributed power supply with the L4960, L4940 and the L4941

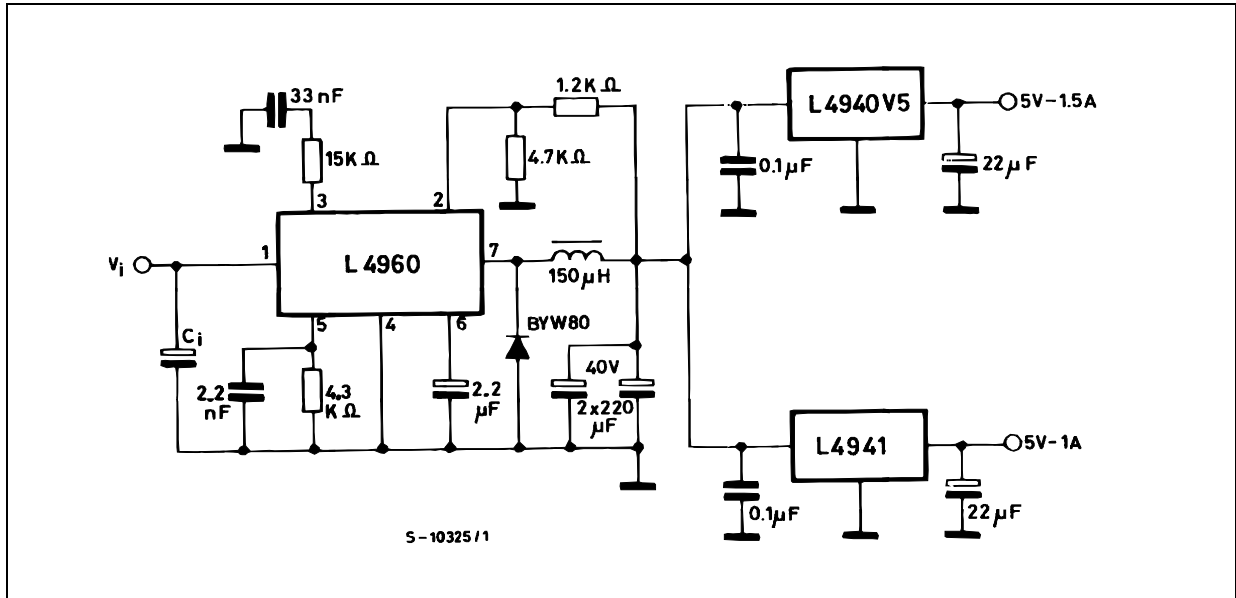
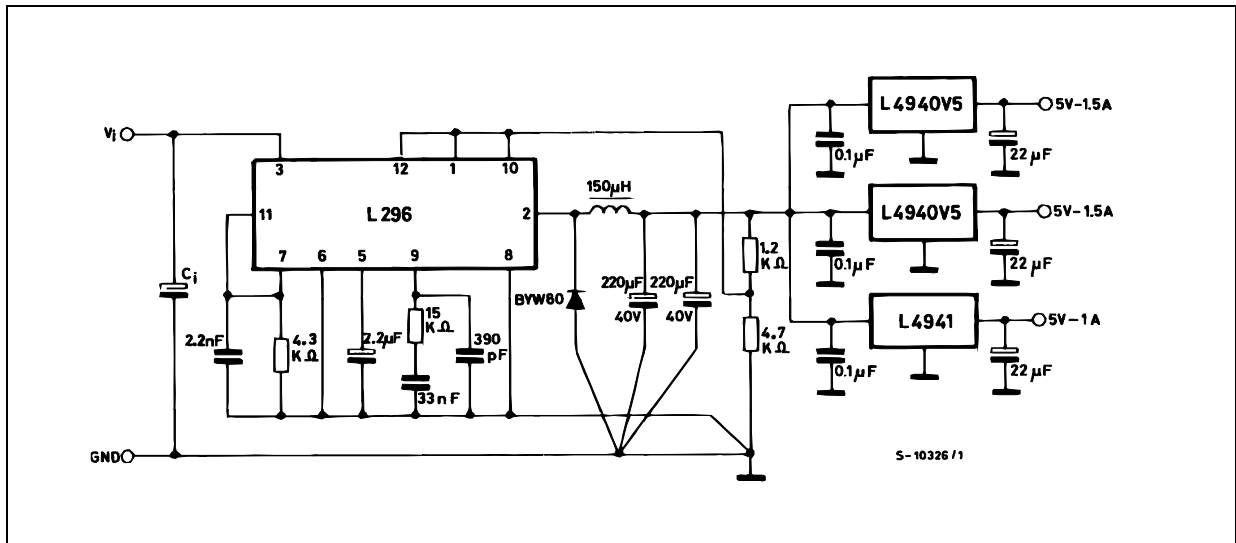
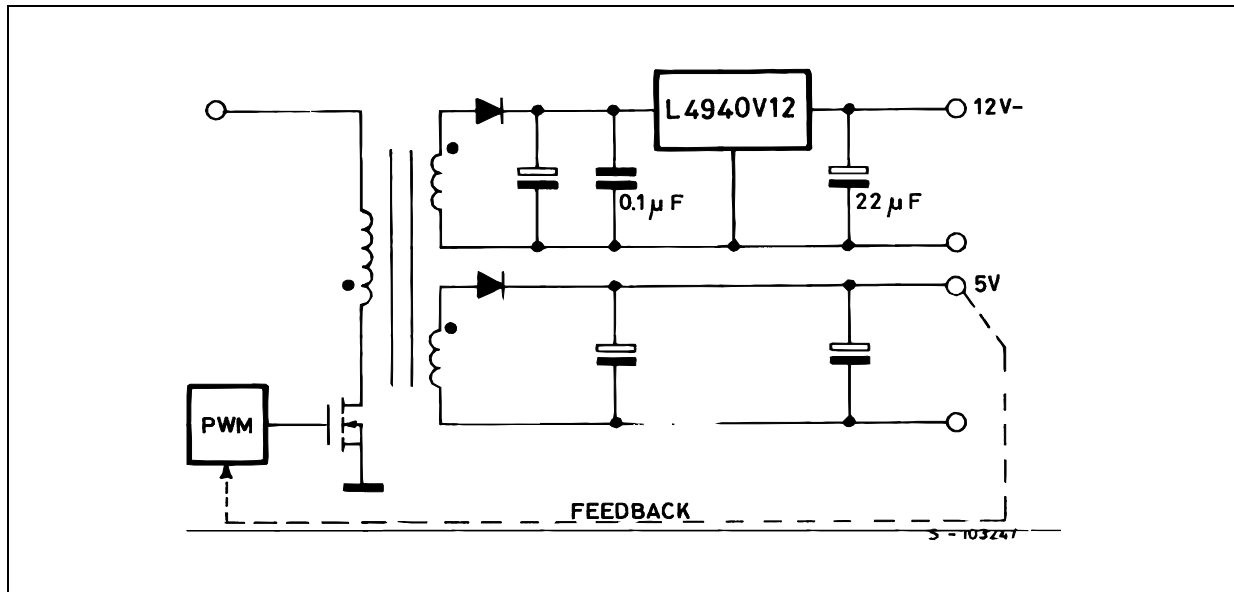


Figure 26. Distributed power supply with the L296, L4940, and the L4941



Note: *Advantages of these applications are:  
On-card regulation with short-circuit and thermal protection on each output. Very high total system efficiency due to the switching pre-regulation and very low drop post-regulation.*

Figure 27. Secondary regulation for switch mode power supply with the L4940



Note: Advantages of this configuration are:  
Very high regulation (line and load on both the output voltage. 12 V output short-circuit and thermal protection. Very high efficiency on the 12 V output due to the low drop regulator.

## 8 Package information

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<sup>®</sup> specifications, grade definitions and product status are available at: [www.st.com](http://www.st.com). ECOPACK<sup>®</sup> is an ST trademark.

### 8.1 TO-220 (dual gauge) package information

Figure 28. TO-220 (dual gauge) package outline

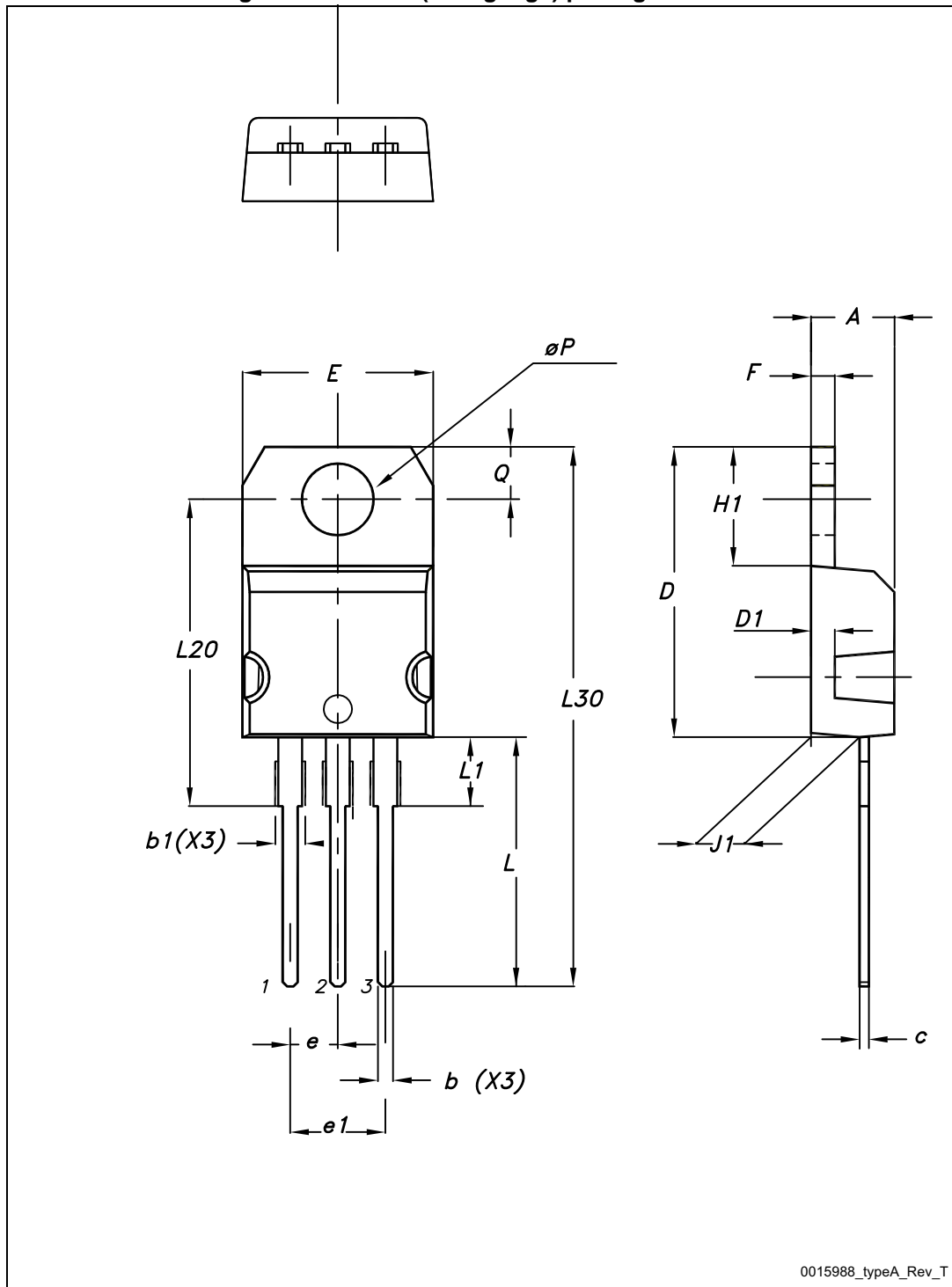


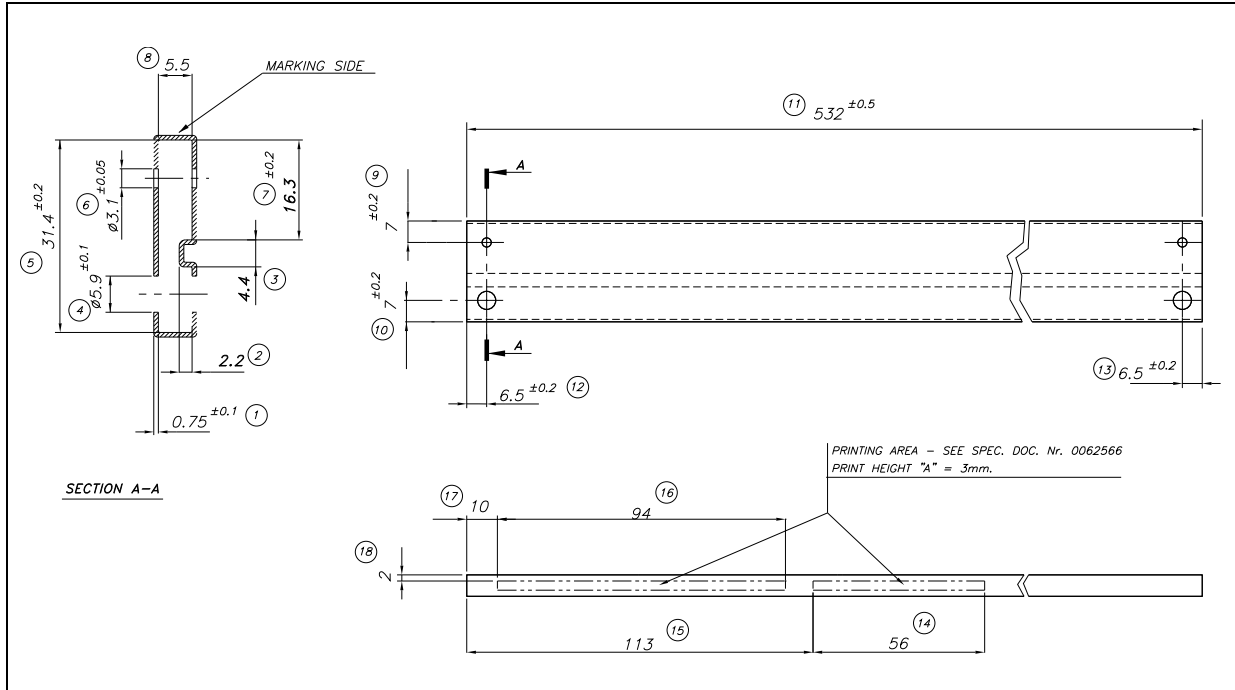


Table 7. TO-220 (dual gauge) mechanical data

Dim.	mm		
	Min.	Typ.	Max.
A	4.40		4.60
b	0.61		0.88
b1	1.14		1.70
c	0.48		0.70
D	15.25		15.75
D1		1.27	
E	10		10.40
e	2.40		2.70
e1	4.95		5.15
F	1.23		1.32
H1	6.20		6.60
J1	2.40		2.72
L	13		14
L1	3.50		3.93
L20		16.40	
L30		28.90	
ØP	3.75		3.85
Q	2.65		2.95

### 8.2 TO-220 (dual gauge) packing information

Figure 29. Tube for TO-220 (dual gauge) outline (mm.)



### 8.3 D<sup>2</sup>PAK package information

Figure 30. D<sup>2</sup>PAK package outline

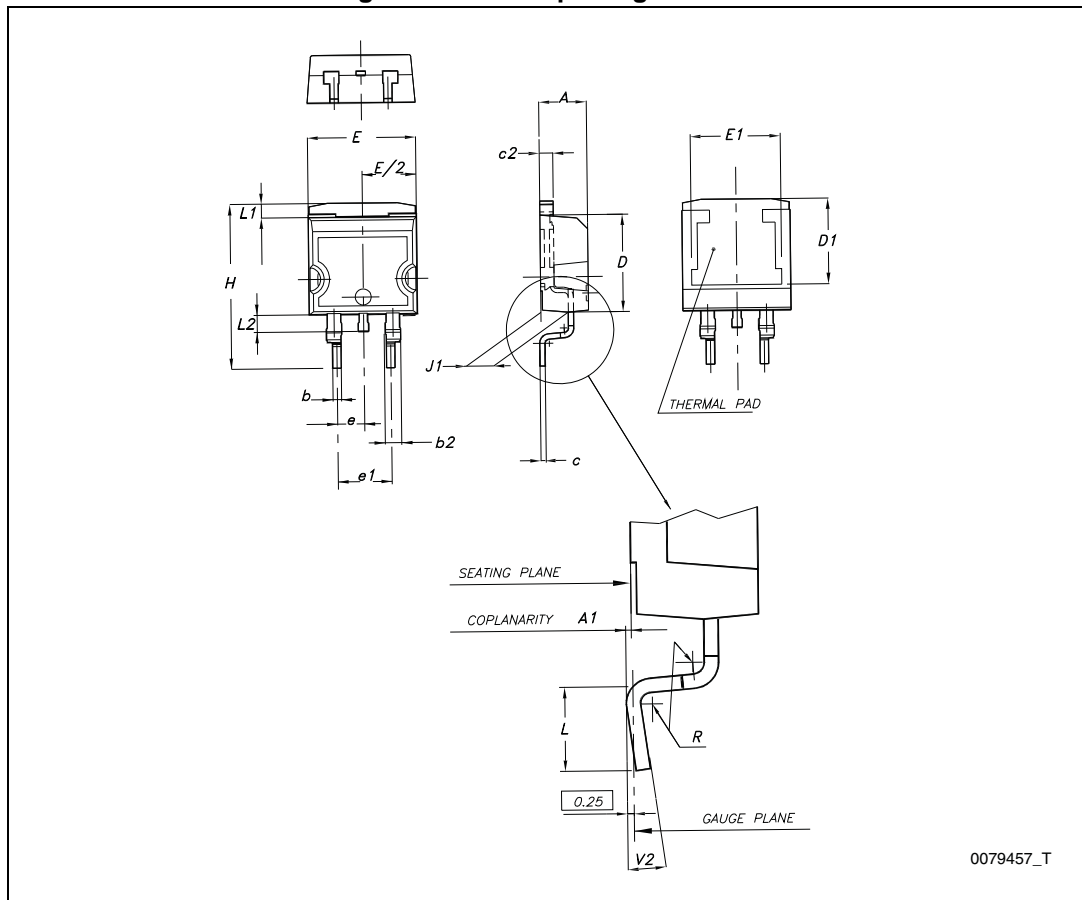
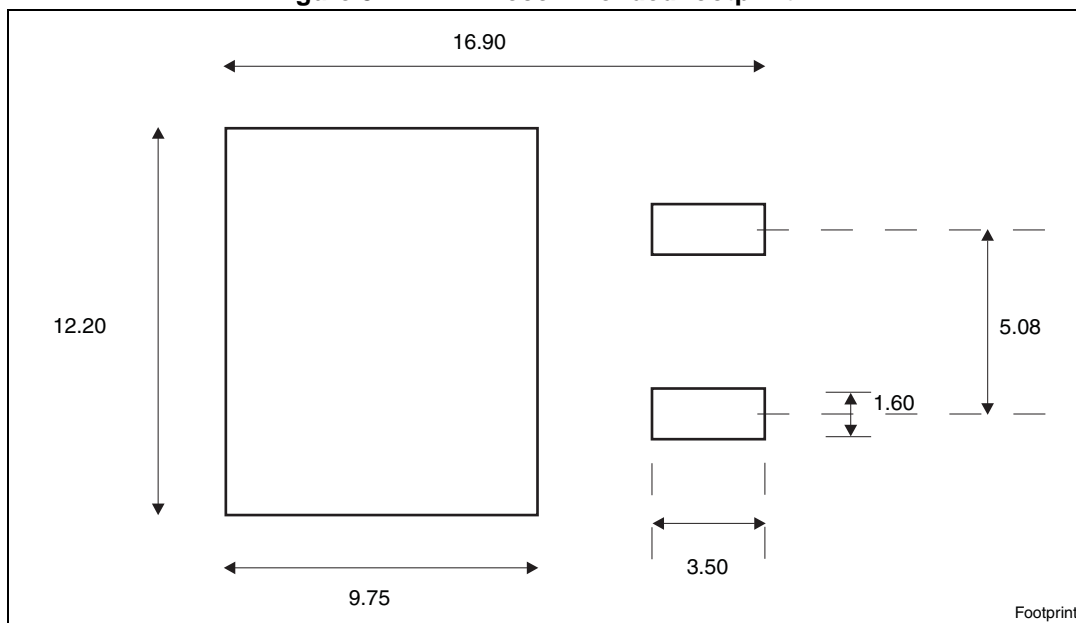


Table 8. D<sup>2</sup>PAK mechanical data

Dim.	mm		
	Min.	Typ.	Max.
A	4.40		4.60
A1	0.03		0.23
b	0.70		0.93
b2	1.14		1.70
c	0.45		0.60
c2	1.23		1.36
D	8.95		9.35
D1	7.50		
E	10		10.40
E1	8.50		
e		2.54	
e1	4.88		5.28
H	15		15.85
J1	2.49		2.69
L	2.29		2.79
L1	1.27		1.40
L2	1.30		1.75
R		0.4	
V2	0°		8°

Figure 31. D<sup>2</sup>PAK recommended footprint<sup>(a)</sup>



a. All dimensions are in millimeters.

### 8.4 D<sup>2</sup>PAK packing information

Figure 32. D<sup>2</sup>PAK tape outline

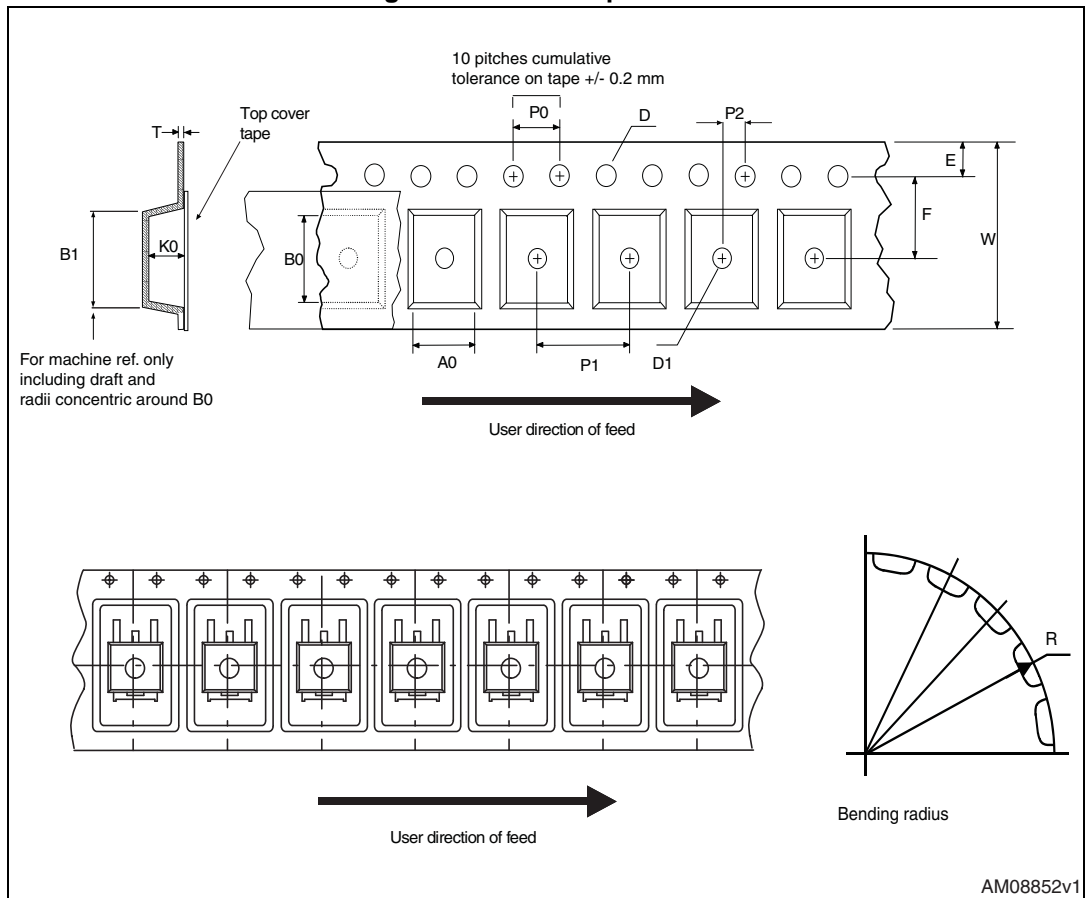


Figure 33. D<sup>2</sup>PAK reel outline

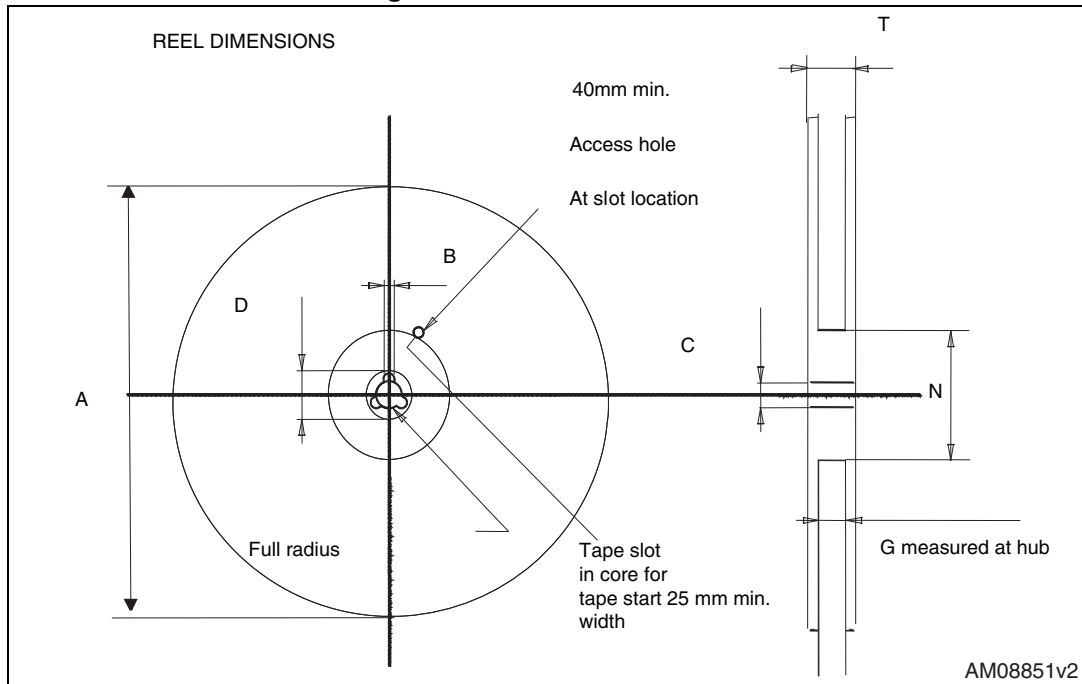


Table 9. D<sup>2</sup>PAK tape and reel mechanical data

Tape			Reel		
Dim.	mm		Dim.	mm	
	Min.	Max.		Min.	Max.
A0	10.5	10.7	A		330
B0	15.7	15.9	B	1.5	
D	1.5	1.6	C	12.8	13.2
D1	1.59	1.61	D	20.2	
E	1.65	1.85	G	24.4	26.4
F	11.4	11.6	N	100	
K0	4.8	5.0	T		30.4
P0	3.9	4.1			
P1	11.9	12.1	Base qty		1000
P2	1.9	2.1	Bulk qty		1000
R	50				
T	0.25	0.35			
W	23.7	24.3			

## 9 Revision history

**Table 10. Document revision history**

Date	Revision	Changes
04-Feb-2005	6	Added new package D <sup>2</sup> PAK/A.
18-Sep-2006	7	Order codes and new template have been updated.
31-May-2007	8	Order codes have been updated.
19-Sep-2007	9	Added <a href="#">Table 1</a> to cover page.
20-Feb-2008	10	Modified: <a href="#">Table 1 on page 1</a> .
29-Jul-2009	11	Modified: <a href="#">Table 1 on page 1</a> .
16-Dec-2009	12	Modified: <a href="#">Table 6 on page 8</a> .
04-Nov-2013	13	<p>The L4940XX5, L4940XX85, L4940XX10, L4940XX12 have been changed into the L4940.</p> <p>Updated: the title and the description in cover page.</p> <p>Updated <a href="#">Section 4: Test circuits</a>, <a href="#">Section 5: Electrical characteristics</a>, <a href="#">Section 6: Performance characteristics</a> and <a href="#">Section 8: Package information</a>.</p> <p>Added <a href="#">Section 8.4: D<sup>2</sup>PAK packing information</a>.</p> <p>Minor text changes.</p>
08-Apr-2015	14	<p>Updated title in <a href="#">Table 1: Device summary</a>.</p> <p>Updated <a href="#">Section 8: Package information</a>.</p> <p>Minor text changes.</p>



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