

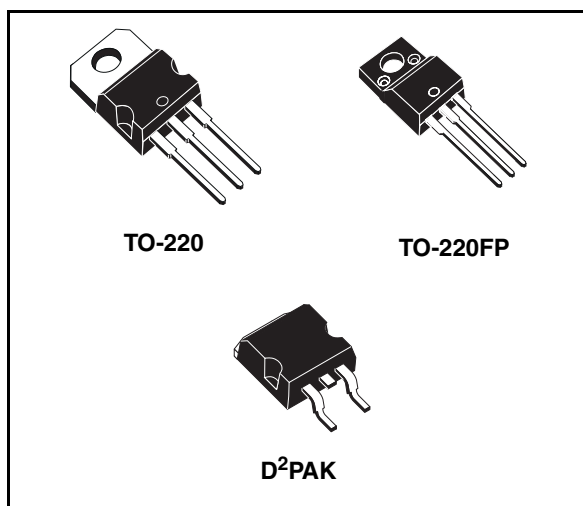
Very low drop 1.5 A regulator

Features

- Precise 5, 8.5, 10, 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, TO-220FP and D²PAK packages and with several fixed output voltages, making it useful in a wide range of industrial and consumer applications. Thanks to its very low input/output voltage drop, these devices are particularly suitable for batteries powered equipment, reducing consumption and



prolonging battery life. Each type employs internal current limiting, antisaturation circuit, thermal shut-down and safe area protection.

Table 1. Device summary

Part number	Order code			Output voltage
	TO-220	TO-220FP	D ² PAK	
L4940xx5	L4940V5		L4940D2T5-TR	5 V
L4940xx85	L4940V85	L4940P85	L4940D2T85-TR	8.5 V
L4940xx10			L4940D2T10-TR	10 V
L4940xx12			L4940D2T12-TR	12 V

Contents

1 **Block diagram** 3

2 **Pin configuration** 4

3 **Maximum ratings** 5

4 **Test circuits** 6

5 **Electrical characteristics** 7

6 **Typical application** 11

7 **Schematic application** 15

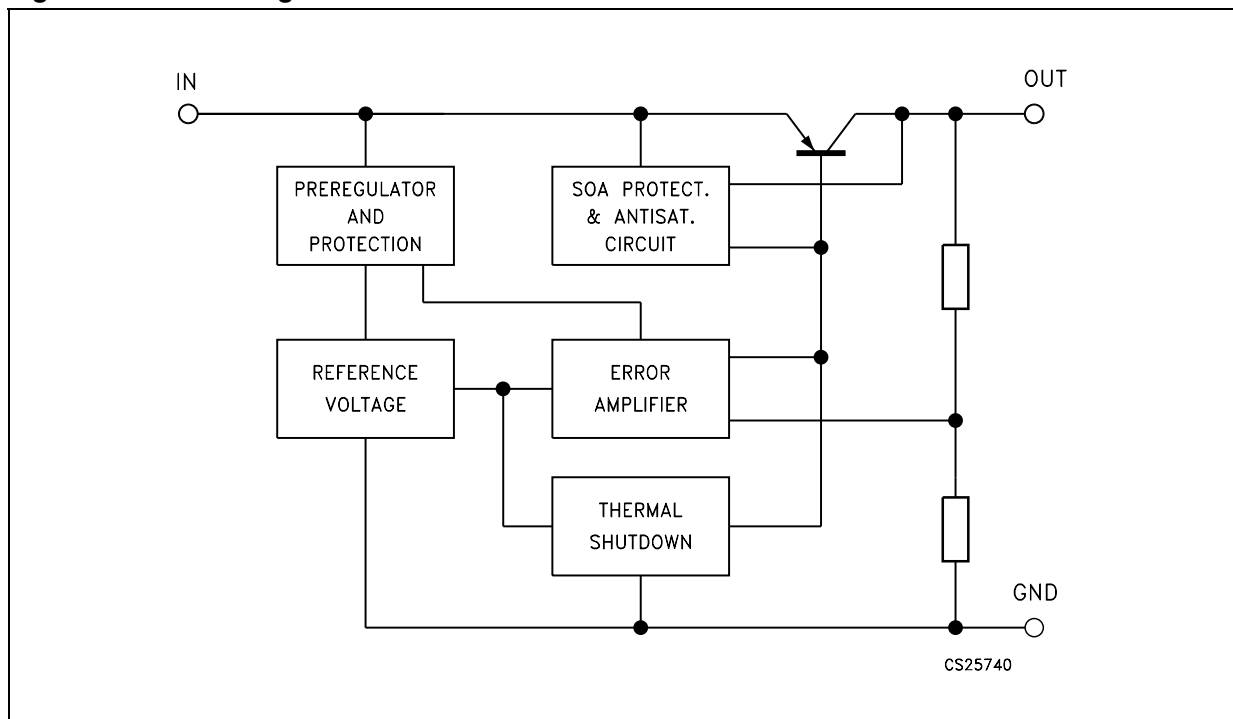
8 **Package mechanical data** 17

9 **Revision history** 22



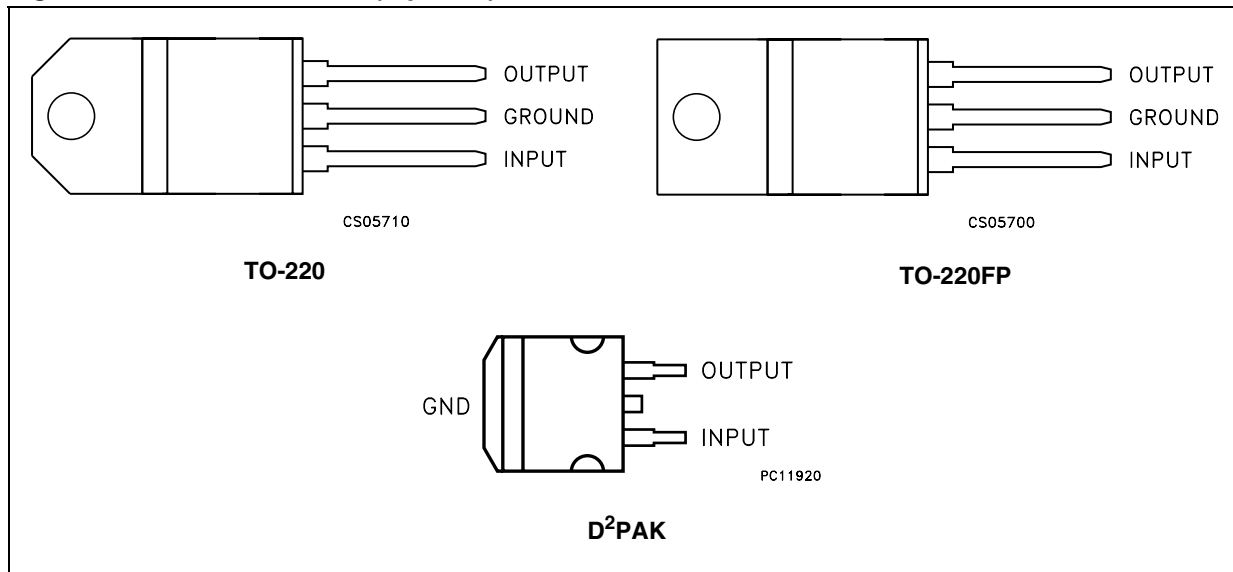
1 Block diagram

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	$V_O = 5V, R_O = 100\Omega$	-15	V
		$V_O = 8.5V, R_O = 180\Omega$	-15	V
		$V_O = 10V, R_O = 200\Omega$	-15	V
		$V_O = 12V, R_O = 240\Omega$	-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 condition is not implied.

Table 3. Thermal data

Symbol	Parameter	TO-220	TO-220FP	D ² PAK	Unit
R_{thJC}	Thermal resistance junction-case	3	5	3	°C/W
R_{thJA}	Thermal resistance junction-ambient	50	60	62.5	°C/W

4 Test circuits

Figure 3. DC parameters

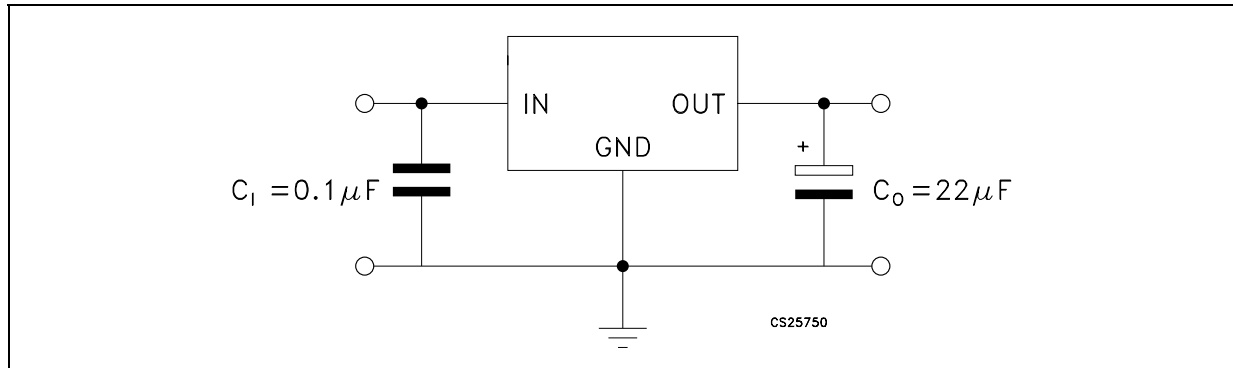


Figure 4. Load rejection

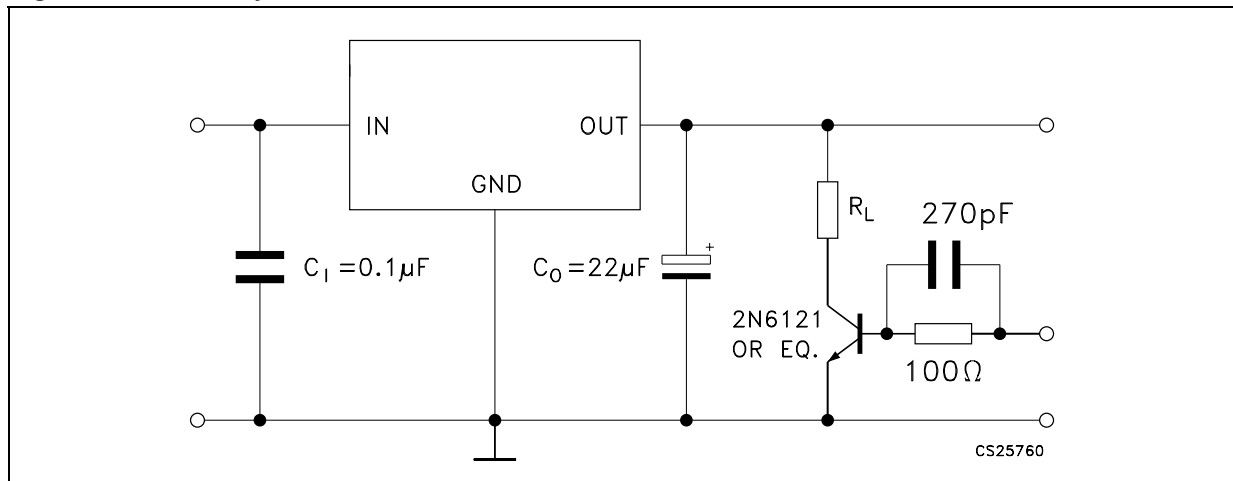
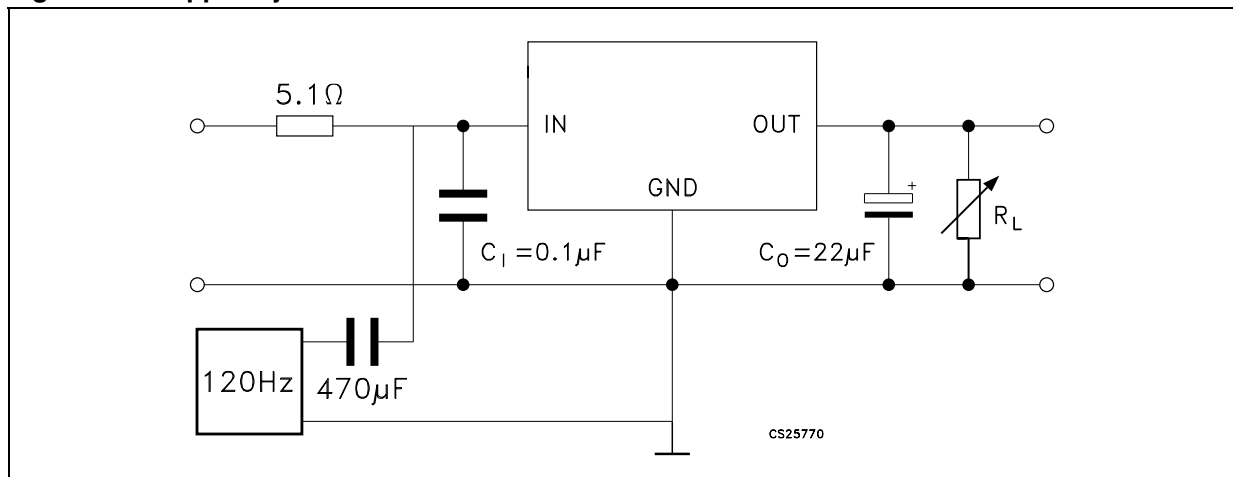


Figure 5. Ripple rejection



5 Electrical characteristics

Table 4. Electrical characteristics of L4940xx5 (Refer to test circuit, $V_I = 7\text{ V}$, $C_I = 0.1\text{ }\mu\text{F}$, $C_O = 22\text{ }\mu\text{F}$, $T_J = 25^\circ\text{C}$, unless otherwise specified.)

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	Input voltage	$I_O = 5\text{ mA}$			17	V
ΔV_O	Line regulation	$V_I = 6\text{ to }17\text{ V}$, $I_O = 5\text{ mA}$		4	10	mV
ΔV_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
ΔI_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	

Table 5. Electrical characteristics of L4940xx85 (Refer to test circuit, $V_I = 10.5\text{ V}$, $C_I = 0.1\text{ }\mu\text{F}$, $C_O = 22\text{ }\mu\text{F}$, $T_J = 25^\circ\text{C}$, unless otherwise specified.)

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	Input voltage	$I_O = 5\text{ mA}$			17	V
ΔV_O	Line regulation	$V_I = 9.5\text{ to }17\text{ V}$, $I_O = 5\text{ mA}$		4	9	mV
ΔV_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
ΔI_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
$\Delta V_O/\Delta T$	Output voltage drift			0.8		mV/ $^\circ\text{C}$
SVR	Supply voltage rejection	$f = 120\text{ Hz}$, $I_O = 1\text{ A}$	58	66		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
		$V_I = 10.2\text{ V}$		2.2	2.9	

Table 6. Electrical characteristics of L4940xx10 (Refer to test circuit, $V_I = 12\text{V}$, $C_I = 0.1\text{ }\mu\text{F}$, $C_O = 22\text{ }\mu\text{F}$, $T_J = 25^\circ\text{C}$, unless otherwise specified.)

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
V_O	Output voltage	$I_O = 500\text{ mA}$	9.8	10	10.2	V
V_O	Output voltage	$I_O = 5\text{ mA to }1.5\text{ A}$, $V_I = 11.7\text{ to }15\text{ V}$	9.6	10	10.4	V
V_I	Input voltage	$I_O = 5\text{ mA}$			17	V
ΔV_O	Line regulation	$V_I = 11\text{ to }17\text{ V}$, $I_O = 5\text{ mA}$		3	8	mV
ΔV_O	Load regulation	$I_O = 5\text{ mA to }1.5\text{ A}$		15	35	mV
		$I_O = 0.5\text{ A to }1\text{ A}$		10	20	mV
I_q	Quiescent current	$I_O = 5\text{ mA}$		5	8	mA
		$I_O = 1.5\text{ A}$, $V_I = 11.7\text{ V}$		30	50	mA
ΔI_q	Quiescent current change	$I_O = 5\text{ mA}$			2	mA
		$I_O = 1.5\text{ A}$, $V_I = 11.7\text{ to }16\text{ V}$			13	mA
$\Delta V_O/\Delta T$	Output voltage drift			1		mV/ $^\circ\text{C}$
SVR	Supply voltage rejection	$f = 120\text{ Hz}$, $I_O = 1\text{ A}$	56	62		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
		$V_I = 11.7\text{ V}$		2.2	2.9	

Table 7. Electrical characteristics of L4940xx12 (Refer to test circuit, $V_I = 14\text{ V}$, $C_I = 0.1\text{ }\mu\text{F}$, $C_O = 22\text{ }\mu\text{F}$, $T_J = 25^\circ\text{C}$, unless otherwise specified.)

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
V_O	Output voltage	$I_O = 500\text{ mA}$	11.75	12	12.25	V
V_O	Output voltage	$I_O = 5\text{ mA to }1.5\text{ A}$, $V_I = 11.7\text{ to }15\text{ V}$	11.5	12	12.5	V
V_I	Input voltage	$I_O = 5\text{ mA}$			17	V
ΔV_O	Line regulation	$V_I = 11\text{ to }17\text{ V}$, $I_O = 5\text{ mA}$		3	7	mV
ΔV_O	Load regulation	$I_O = 5\text{ mA to }1.5\text{ A}$		15	35	mV
		$I_O = 0.5\text{ A to }1\text{ A}$		10	25	mV
I_q	Quiescent current	$I_O = 5\text{ mA}$		4	8	mA
		$I_O = 1.5\text{ A}$, $V_I = 11.7\text{ V}$		30	50	mA
ΔI_q	Quiescent current change	$I_O = 5\text{ mA}$			1.5	mA
		$I_O = 1.5\text{ A}$, $V_I = 11.7\text{ to }16\text{ V}$			10	mA
$\Delta V_O/\Delta T$	Output voltage drift			1.2		mV/ $^\circ\text{C}$
SVR	Supply voltage rejection	$f = 120\text{ Hz}$, $I_O = 1\text{ A}$	55	61		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
Z_O	Output impedance	$f = 120\text{ Hz}$, $I_O = 0.5\text{ A}$		40		$\text{m}\Omega$

6 Typical application

Figure 6. Dropout voltage vs output current

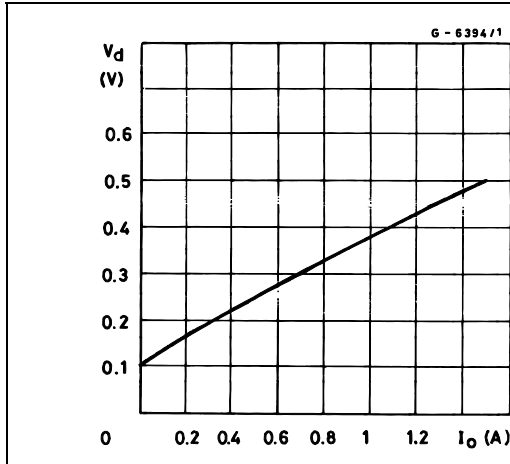


Figure 7. Dropout voltage vs temperature

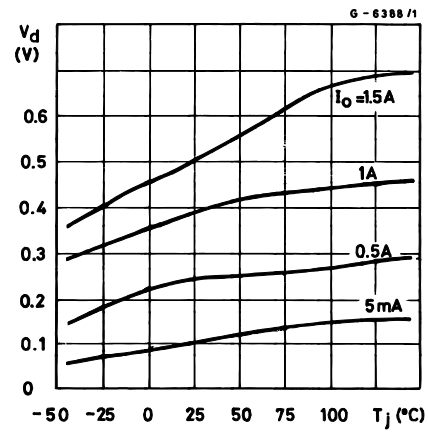


Figure 8. Output voltage vs temperature (L4940V5)

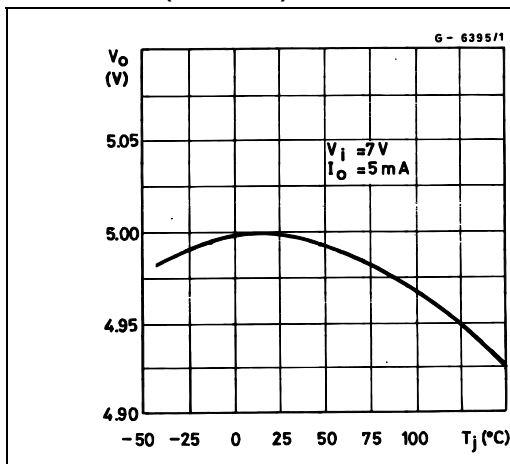


Figure 9. Output voltage vs temperature (L4940V85)

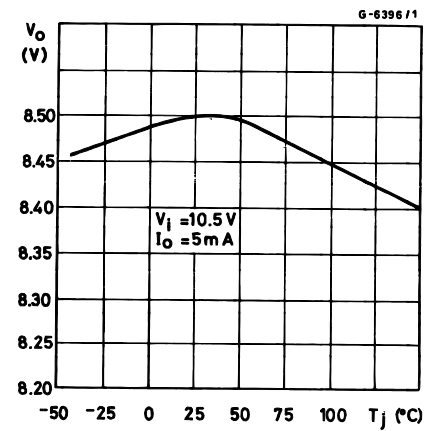


Figure 10. Output voltage vs temperature (L4940V10)

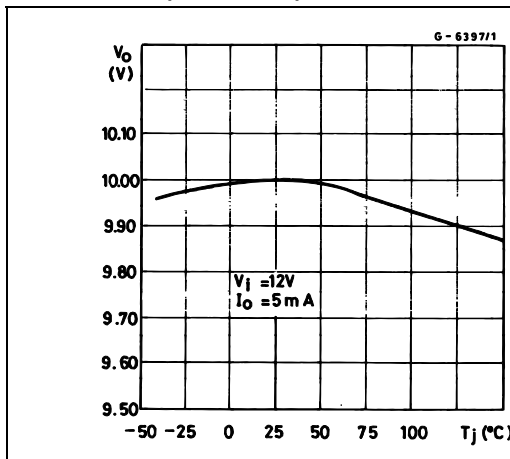


Figure 11. Output voltage vs temperature (L4940V12)

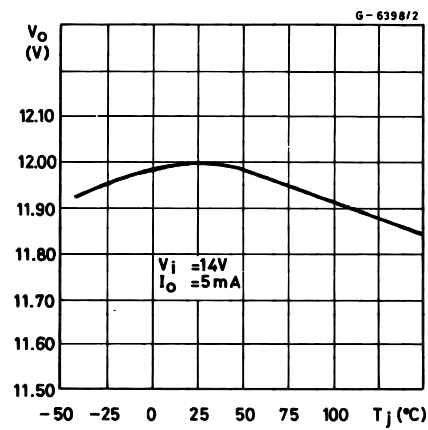


Figure 12. Quiescent current vs temperature (L4940V5)

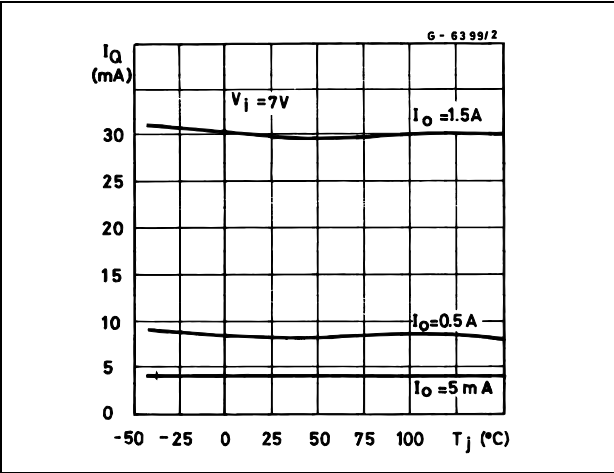


Figure 13. Quiescent current vs input voltage (L4940V5)

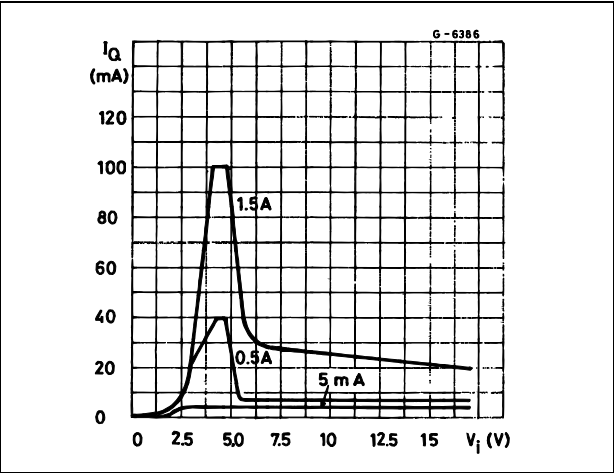


Figure 14. Quiescent current vs output current (L4940V5)

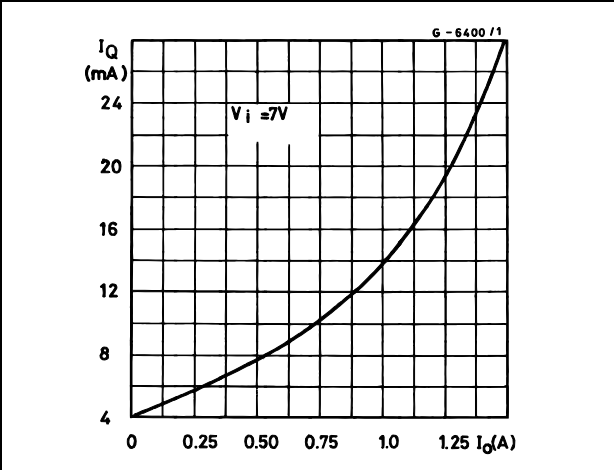


Figure 15. Short circuit current vs temperature (L4940V5)

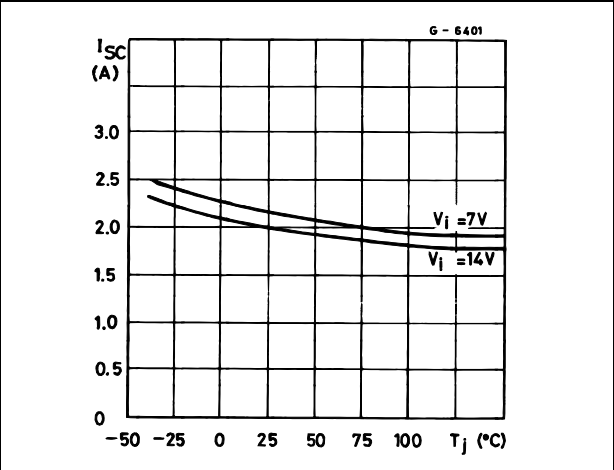


Figure 16. Peak output current vs input/output differential voltage (L4940V5)

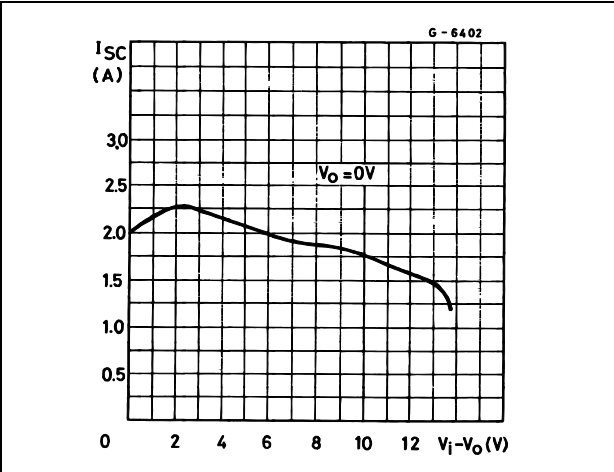


Figure 17. Low voltage behavior (L4940V5)

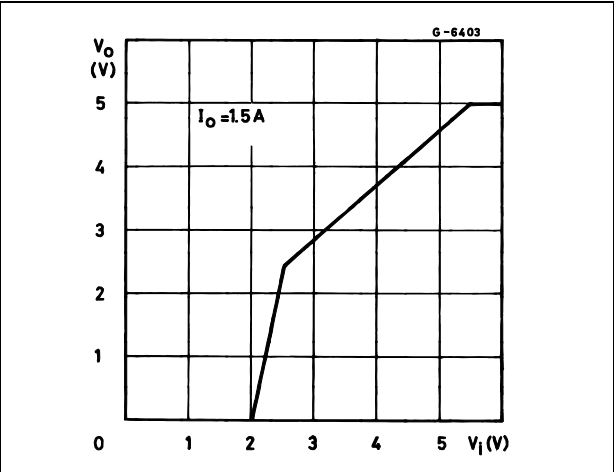


Figure 18. Low voltage behavior (L4940V85)

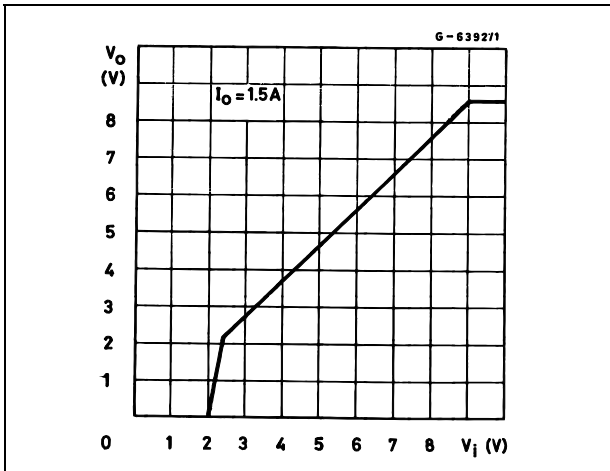


Figure 19. Low voltage behavior (L4940V10)

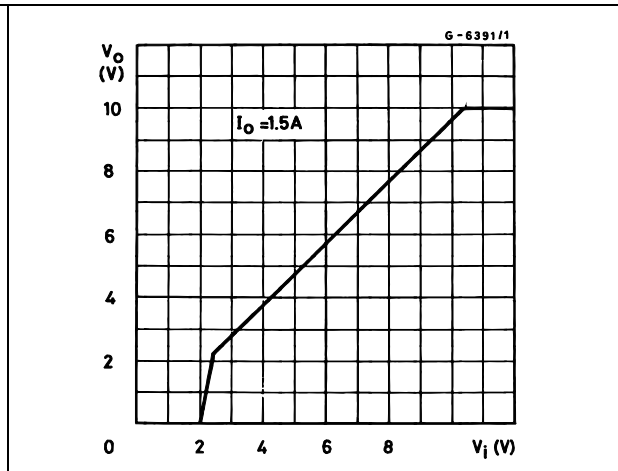


Figure 20. Low voltage behavior (L4940V12)

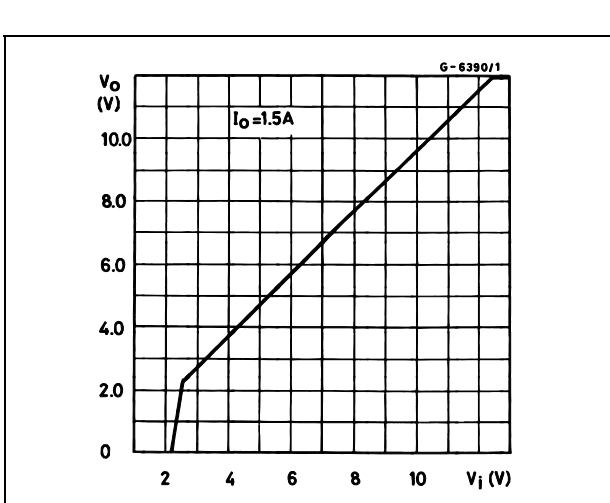


Figure 21. Supply voltage rejection vs frequency (L4940V5)

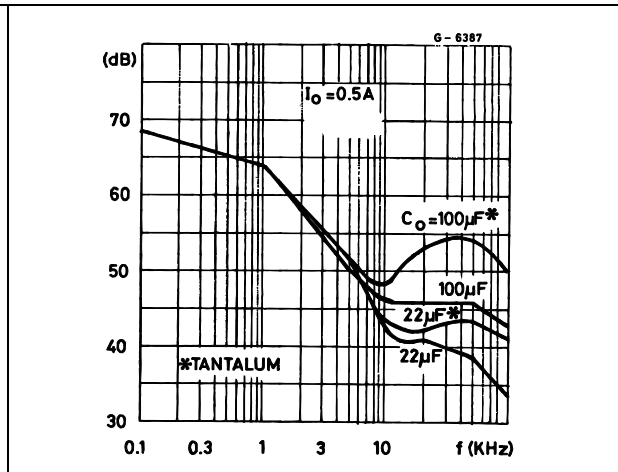


Figure 22. Supply voltage rejection vs output current (L4940V5)

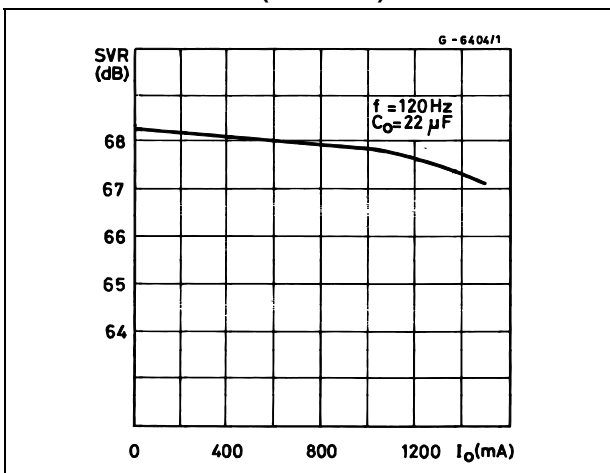


Figure 23. Load dump characteristics (L4940V5)

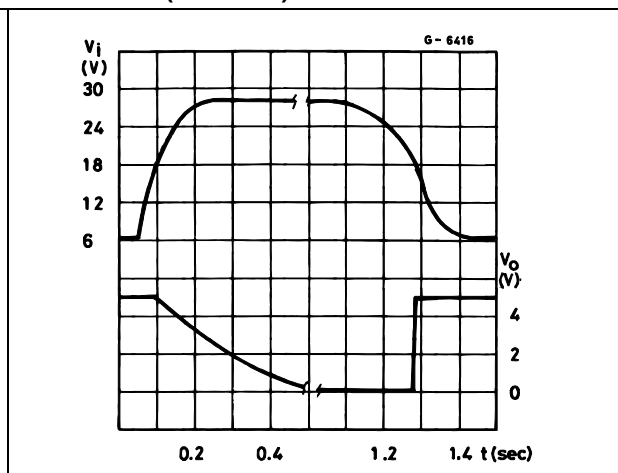


Figure 24. Line transient response (L4940V5) Figure 25. Total power dissipation

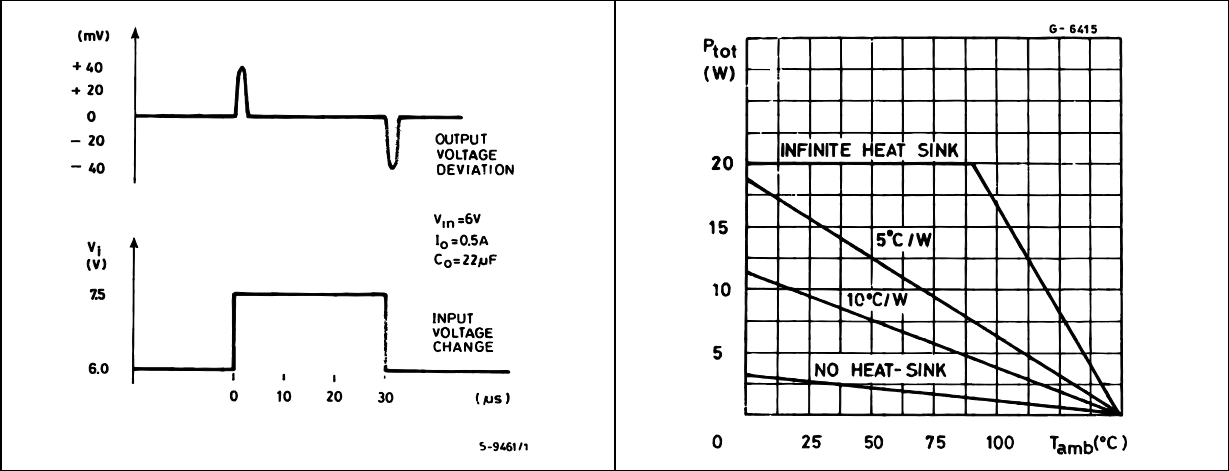
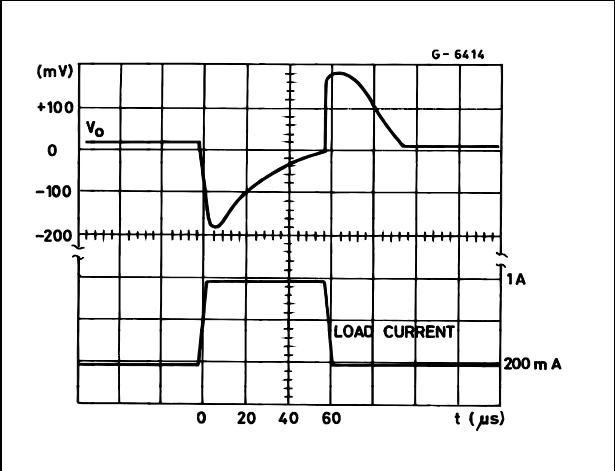


Figure 26. Load transient response



7 Schematic application

Figure 27. Distributed supply with On-card L4940 and L4941 low drop regulator

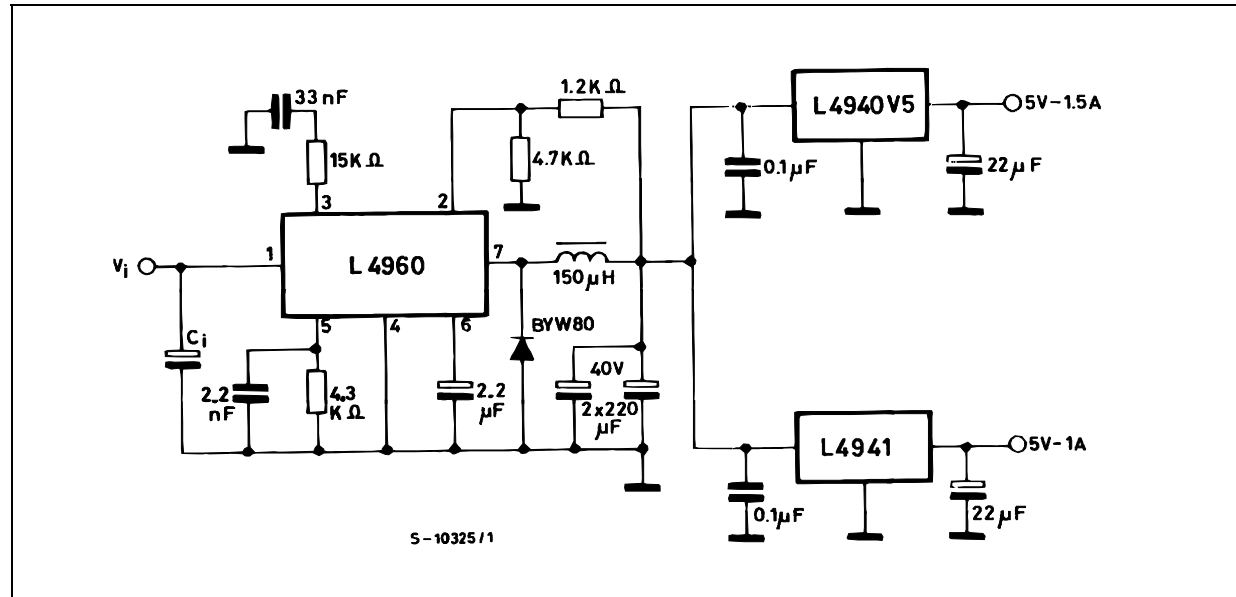
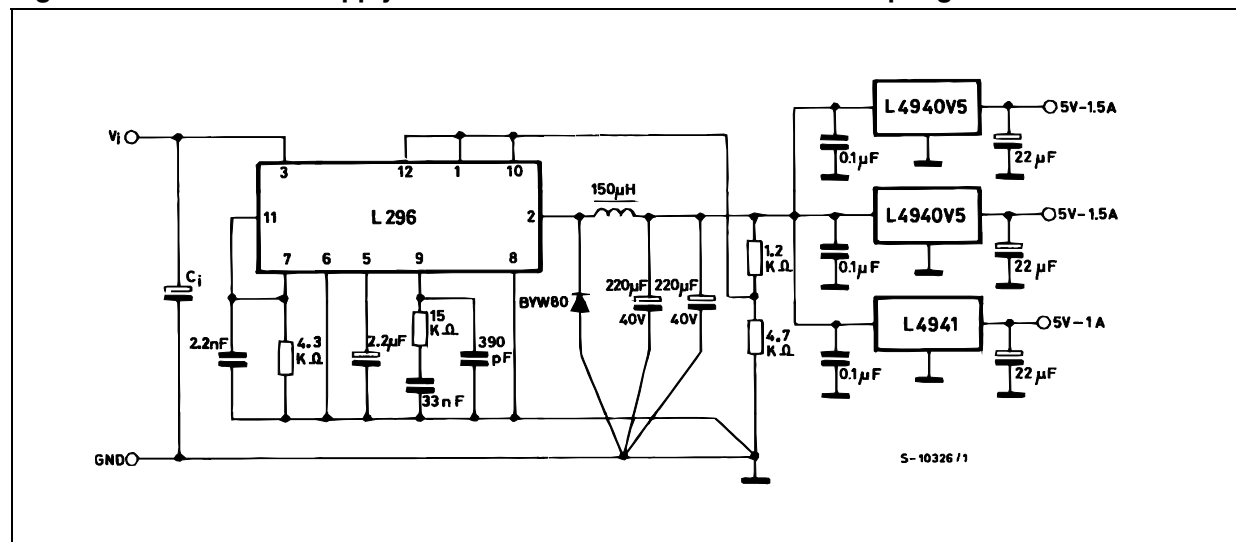


Figure 28. Distributed supply with On-card L4940 and L4941 low drop regulator



ADVANTAGES OF THESE APPLICATION ARE:

On card regulation with short-circuit and thermal protection on each output.

Vary high total system efficiency due to the switching pre-regulation and very low-drop post-regulation.

The diagram illustrates a switching power supply circuit. A PWM (Pulse Width Modulation) block is connected to the base of a transistor, which is also connected to ground. The collector of the transistor is connected to the primary winding of a transformer. The secondary winding of the transformer is connected to a full-bridge rectifier circuit. The rectifier consists of four diodes and two capacitors. The output of the rectifier is connected to a 12V output terminal. A feedback loop is shown, connecting the 12V output terminal back to the PWM block. The feedback signal is taken from the 12V output terminal and fed back to the PWM block. The output voltage is labeled 12V-.

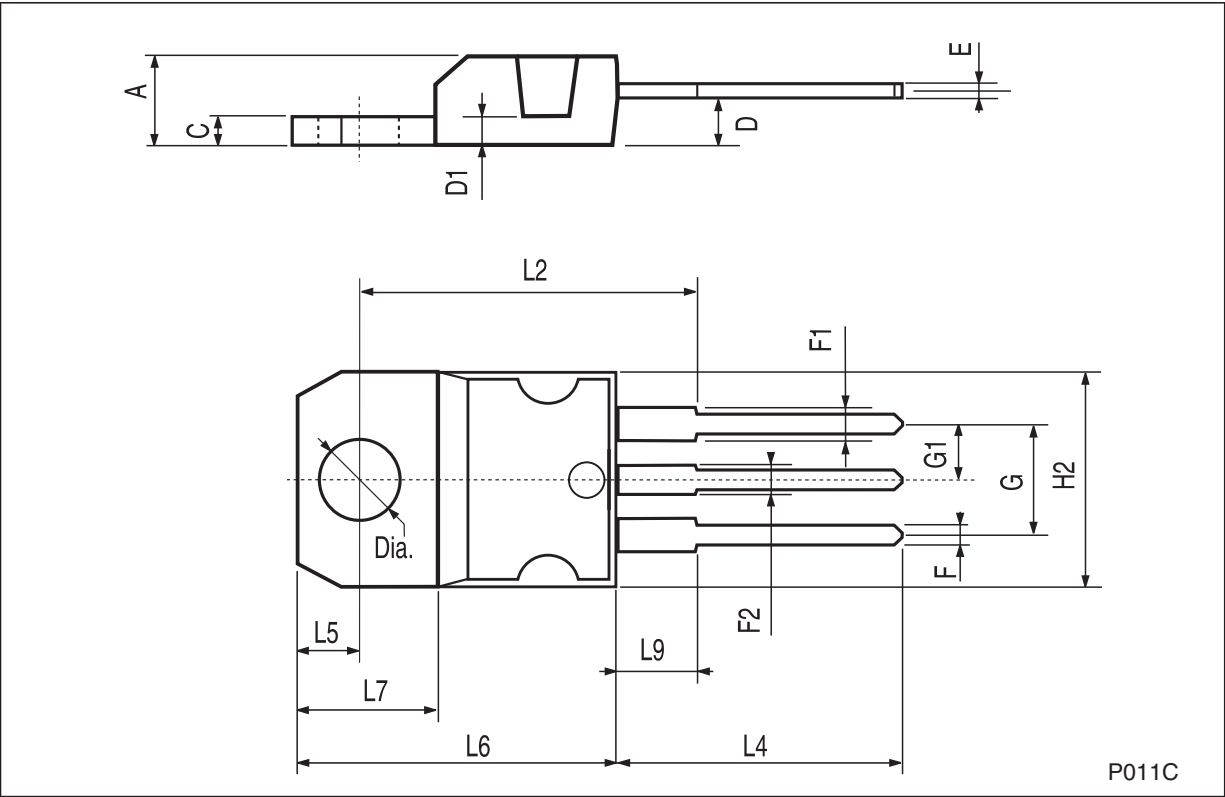
Very high efficiency on the 12 V output due to the low drop regulator

8 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.

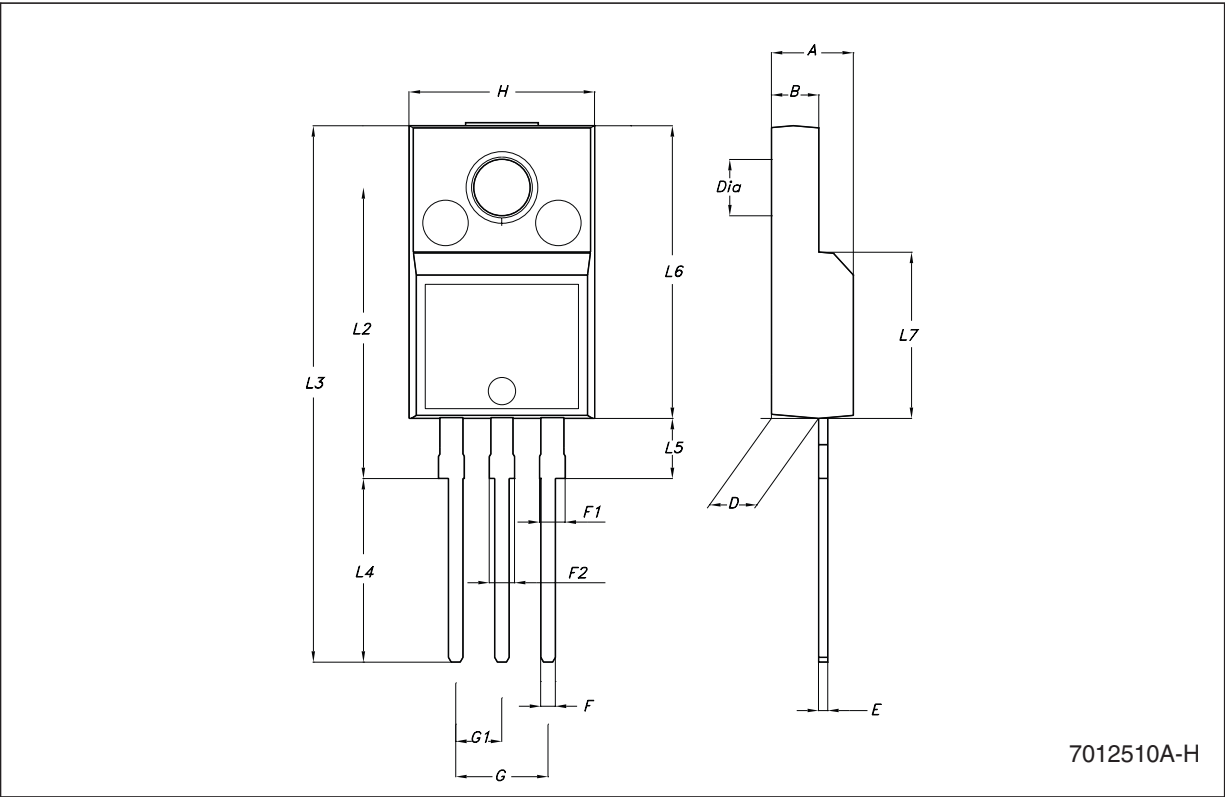
TO-220 mechanical data

Dim.	mm.			inch.		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A	4.40		4.60	0.173		0.181
C	1.23		1.32	0.048		0.051
D	2.40		2.72	0.094		0.107
D1		1.27			0.050	
E	0.49		0.70	0.019		0.027
F	0.61		0.88	0.024		0.034
F1	1.14		1.70	0.044		0.067
F2	1.14		1.70	0.044		0.067
G	4.95		5.15	0.194		0.203
G1	2.4		2.7	0.094		0.106
H2	10.0		10.40	0.393		0.409
L2		16.4			0.645	
L4	13.0		14.0	0.511		0.551
L5	2.65		2.95	0.104		0.116
L6	15.25		15.75	0.600		0.620
L7	6.2		6.6	0.244		0.260
L9	3.5		3.93	0.137		0.154
DIA.	3.75		3.85	0.147		0.151



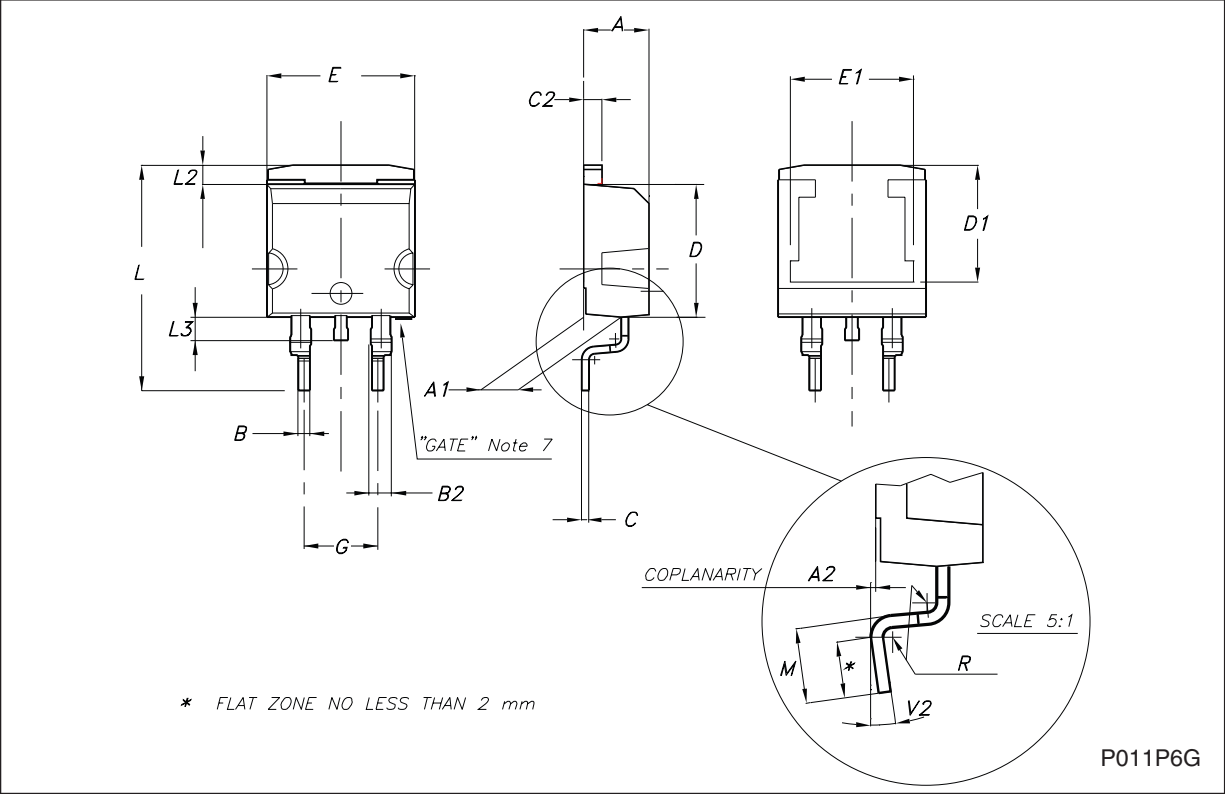
TO-220FP mechanical data

Dim.	mm.			inch.		
	Min.	Typ	Max.	Min.	Typ.	Max.
A	4.40		4.60	0.173		0.181
B	2.5		2.7	0.098		0.106
D	2.5		2.75	0.098		0.108
E	0.45		0.70	0.017		0.027
F	0.75		1	0.030		0.039
F1	1.15		1.50	0.045		0.059
F2	1.15		1.50	0.045		0.059
G	4.95		5.2	0.194		0.204
G1	2.4		2.7	0.094		0.106
H	10.0		10.40	0.393		0.409
L2		16			0.630	
L3	28.6		30.6	1.126		1.204
L4	9.8		10.6	0.385		0.417
L5	2.9		3.6	0.114		0.142
L6	15.9		16.4	0.626		0.645
L7	9		9.3	0.354		0.366
DIA.	3		3.2	0.118		0.126



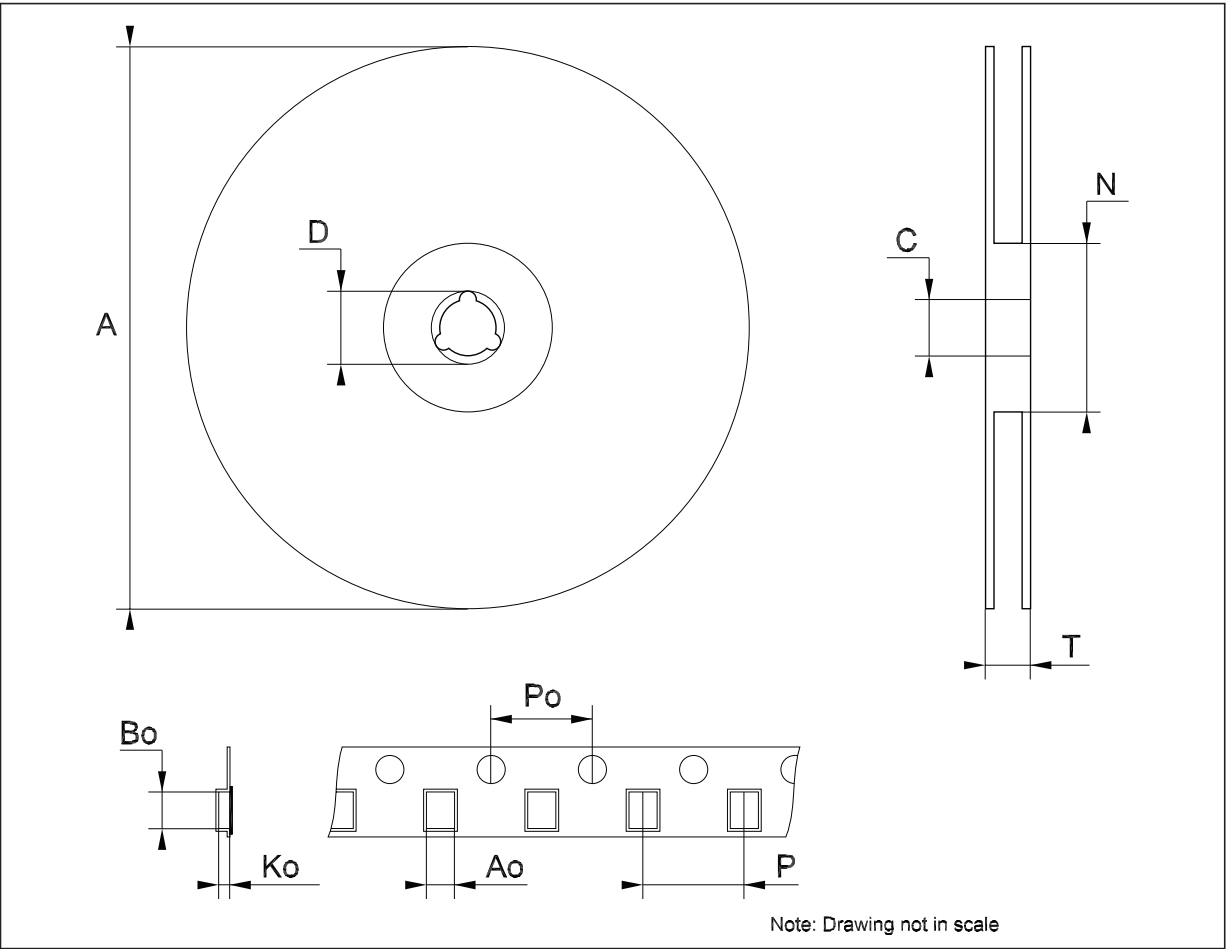
D²PAK mechanical data

Dim.	mm.			inch.		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A	4.4		4.6	0.173		0.181
A1	2.49		2.69	0.098		0.106
A2	0.03		0.23	0.001		0.009
B	0.7		0.93	0.027		0.036
B2	1.14		1.7	0.044		0.067
C	0.45		0.6	0.017		0.023
C2	1.23		1.36	0.048		0.053
D	8.95		9.35	0.352		0.368
D1		8			0.315	
E	10		10.4	0.393		0.409
E1		8.5			0.335	
G	4.88		5.28	0.192		0.208
L	15		15.85	0.590		0.624
L2	1.27		1.4	0.050		0.055
L3	1.4		1.75	0.055		0.068
M	2.4		3.2	0.094		0.126
R		0.4			0.016	
V2	0°		8°	0°		8°



Tape & reel D²PAK-P²PAK-D²PAK/A-P²PAK/A mechanical data

Dim.	mm.			inch.		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A			180			7.086
C	12.8	13.0	13.2	0.504	0.512	0.519
D	20.2			0.795		
N	60			2.362		
T			14.4			0.567
Ao	10.50	10.6	10.70	0.413	0.417	0.421
Bo	15.70	15.80	15.90	0.618	0.622	0.626
Ko	4.80	4.90	5.00	0.189	0.193	0.197
Po	3.9	4.0	4.1	0.153	0.157	0.161
P	11.9	12.0	12.1	0.468	0.472	0.476



9 Revision history

Table 8. Document revision history

Date	Revision	Changes
04-Feb-2005	6	Add new package D ² PAK/A.
18-Sep-2006	7	Order codes has been updated and new template.
31-May-2007	8	Order codes has been updated.
19-Sep-2007	9	Add Table 1 in cover page.
20-Feb-2008	10	Modified: Table 1 on page 1 .

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