

## VERY LOW DROP 1.5A REGULATORS

- PRECISE 5, 8.5, 10, 12V OUTPUTS
- LOW DROPOUT VOLTAGE  
(500mV Typ. at 1.5A)
- 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 D<sup>2</sup>PAK 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.

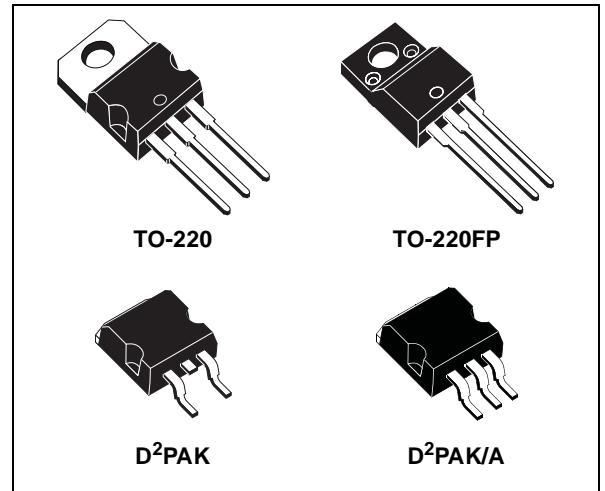
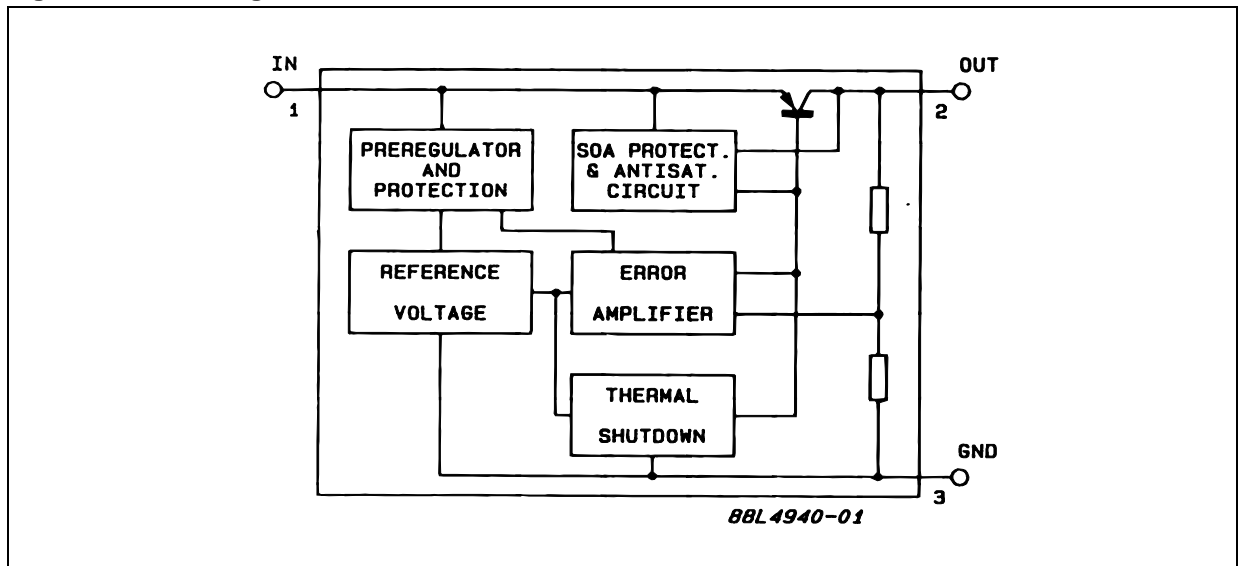


Figure 1: Block Diagram



**Table 1: Absolute Maximum Ratings**

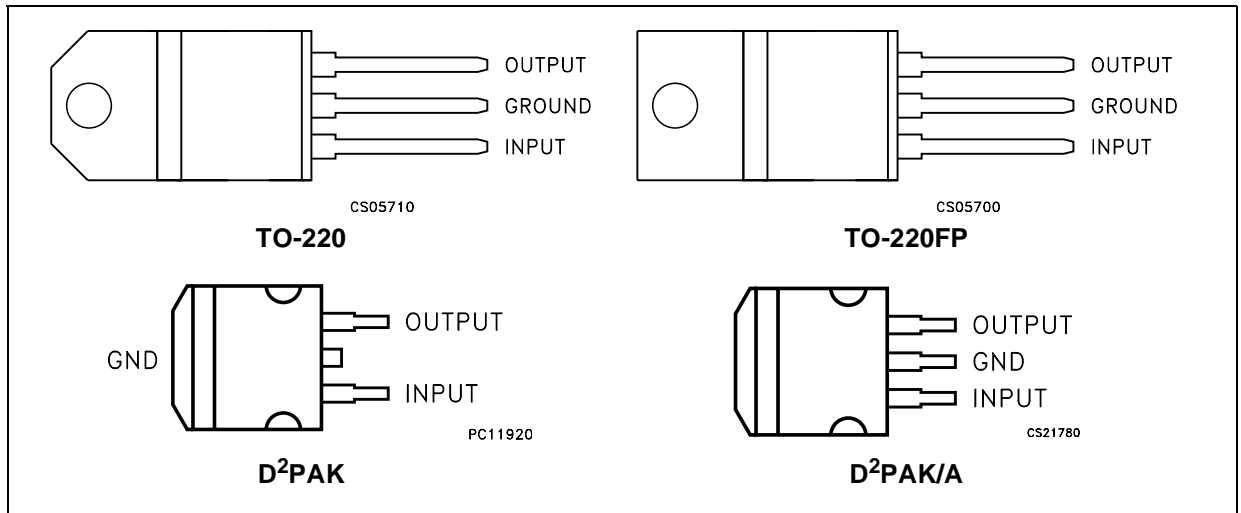
Symbol	Parameter	Value	Unit	
$V_I$	Forward Input Voltage	30	V	
$V_{IR}$	Reverse Input Voltage	$V_O=5V$ $R_O=100\Omega$	-15	V
		$V_O=8.5V$ $R_O=180\Omega$	-15	V
		$V_O=10V$ $R_O=200\Omega$	-15	V
		$V_O=12V$ $R_O=240\Omega$	-15	V
$I_O$	Output Current	Internally Limited	mA	
$P_D$	Power Dissipation	Internally Limited	mW	
$T_{stg}$	Storage Temperature Range	-40 to +150	°C	
$T_{op}$	Operating Junction Temperature Range	-40 to +150	°C	

Absolute Maximum Ratings are those values beyond which damage to the device may occur. Functional operation under these condition is not implied.

**Table 2: Thermal Data**

Symbol	Parameter	TO-220	TO-220FP	D <sup>2</sup> PAK	Unit
$R_{thj-case}$	Thermal Resistance Junction-case	3	5	3	°C/W
$R_{thj-amb}$	Thermal Resistance Junction-ambient	50	60	62.5	°C/W

**Figure 2: Connection Diagram (top view)**



**Table 3: Order Codes**

TO-220	TO-220FP	D <sup>2</sup> PAK (*)	D <sup>2</sup> PAK/A (**)	OUTPUT VOLTAGE
L4940V5	L4940P5	L4940D2T5	L4940D2M5	5 V
L4940V85	L4940P85	L4940D2T85	L4940D2M85	8.5 V
L4940V10	L4940P10	L4940D2T10	L4940D2M10	10 V
L4940V12	L4940P12	L4940D2T12	L4940D2M12	12 V

(\*) Available in Tape & Reel with the suffix "-TR".

(\*\*) Available on Request.

## TEST CIRCUITS

Figure 3: DC Parameter

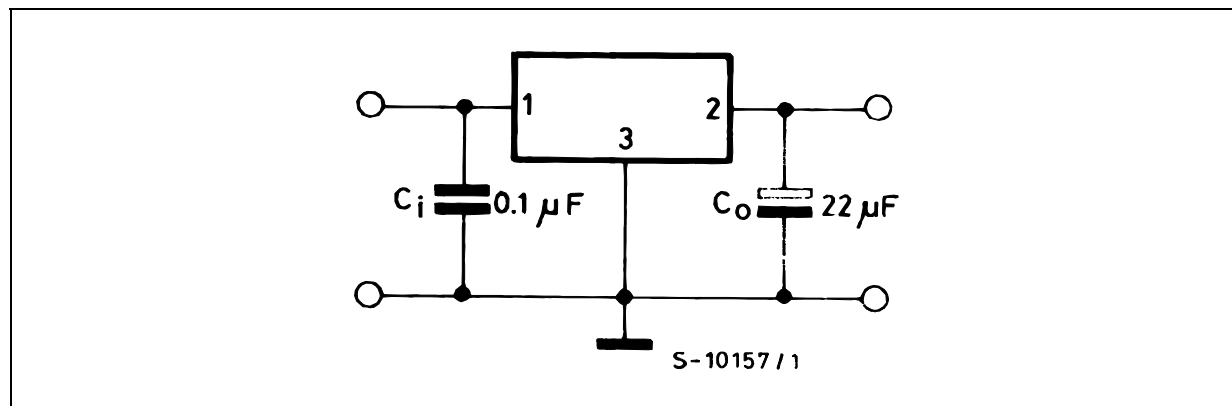


Figure 4: Load Rejection

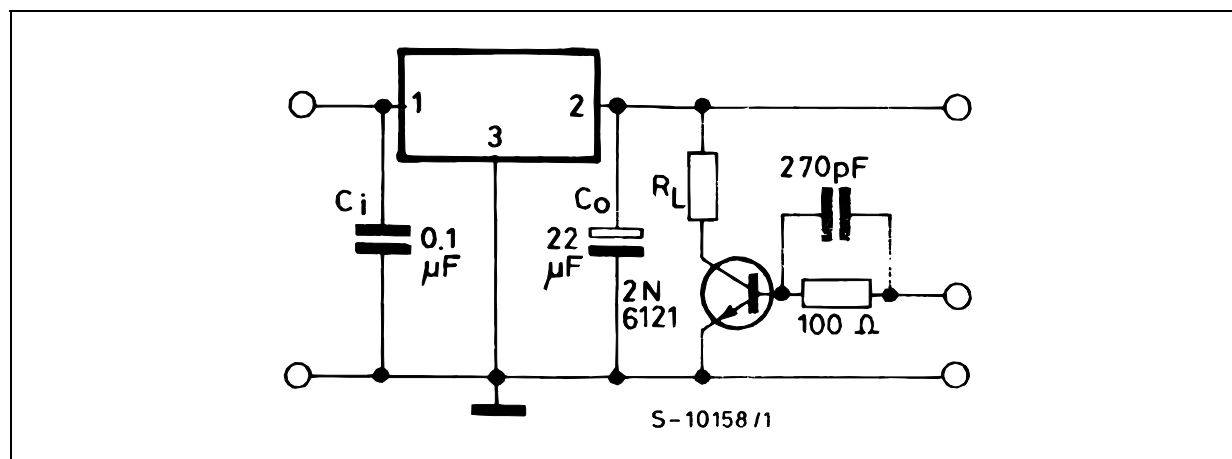
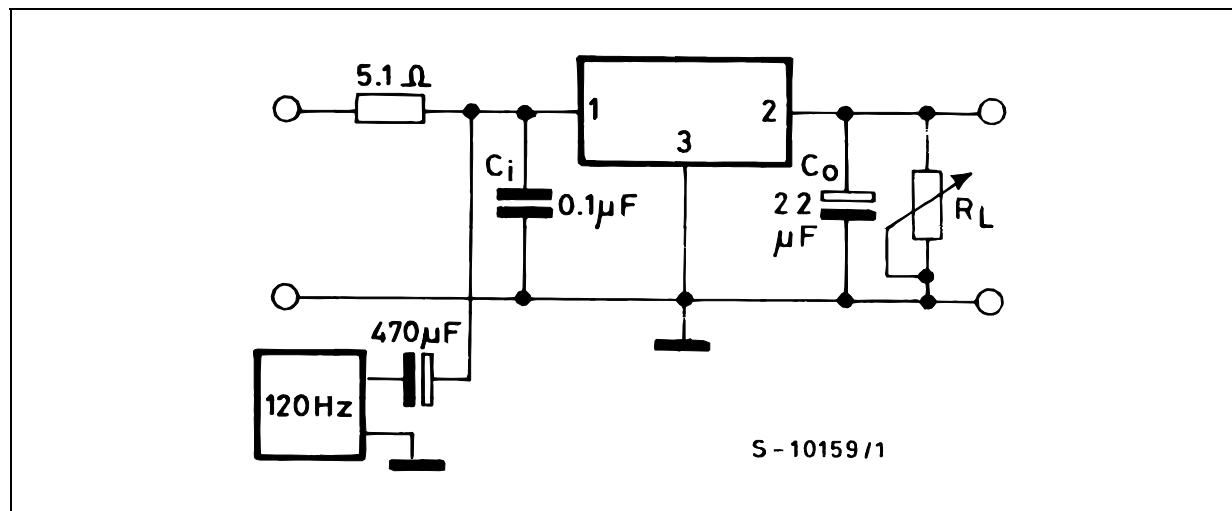


Figure 5: Ripple Rejection



**Table 4: Electrical Characteristics Of L4940V5** (Refer to test circuit,  $V_I=7V$ ,  $C_I = 0.1\mu F$ ,  $C_O = 22\mu F$ ,  $T_J = 25^\circ C$ , 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
$\Delta V_O$	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/ $^\circ C$
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 L4940V85** (Refer to test circuit,  $V_I=10.5V$ ,  $C_I = 0.1\mu F$ ,  $C_O = 22\mu F$ ,  $T_J = 25^\circ C$ , 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	$I_O = 5\text{mA to } 1.5\text{A}$ $V_I = 10.2\text{ to } 16\text{V}$	8.15	8.5	8.85	V
$V_I$	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
$\Delta V_O/\Delta T$	Output Voltage Drift			0.8		mv/ $^\circ C$
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 L4940V10** (Refer to test circuit,  $V_I=12V$ ,  $C_I = 0.1\mu F$ ,  $C_O = 22\mu F$ ,  $T_J = 25^\circ C$ , 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
$\Delta V_O$	Line Regulation	$V_I = 11\text{ to } 17\text{V}$ $I_O = 5\text{ mA}$		3	8	mV
$\Delta V_O$	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
$\Delta I_q$	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/°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 L4940V12** (Refer to test circuit,  $V_I=14V$ ,  $C_I = 0.1\mu F$ ,  $C_O = 22\mu F$ ,  $T_J = 25^\circ C$ , 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	$I_O = 5\text{mA to } 1.5\text{A}$ $V_I = 13.8\text{ to } 15\text{V}$	11.5	12	12.5	V
$V_I$	Input Voltage	$I_O = 5\text{ mA}$			17	V
$\Delta V_O$	Line Regulation	$V_I = 13\text{ to } 17\text{V}$ $I_O = 5\text{ mA}$		3	7	mV
$\Delta V_O$	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
		$I_O = 1.5\text{A}$ $V_I = 13.8\text{V}$		30	50	mA
$\Delta I_q$	Quiescent Current Change	$I_O = 5\text{ mA}$			1.5	mA
		$I_O = 1.5\text{A}$ $V_I = 13.8\text{ to } 16\text{V}$			10	mA
$\Delta V_O/\Delta T$	Output Voltage Drift			1.2		mv/°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		mΩ

TYPICAL CHARACTERISTICS

Figure 6: Dropout Voltage vs Output Current

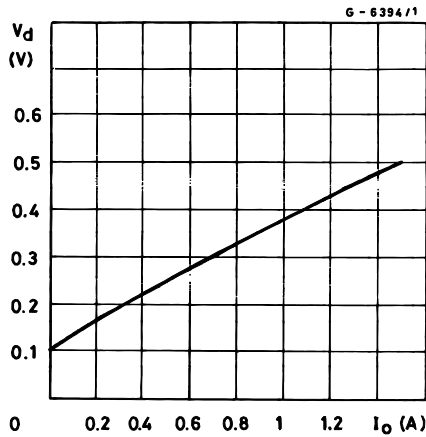


Figure 9: Output Voltage vs Temperature (L4940V85)

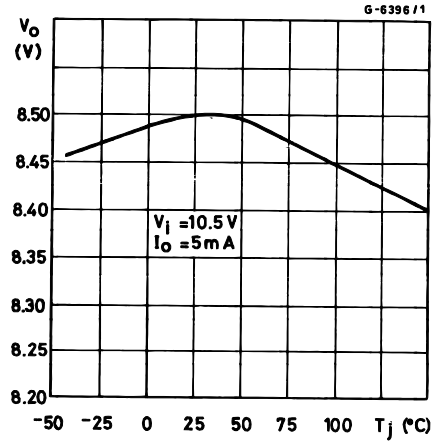


Figure 7: Dropout Voltage vs Temperature

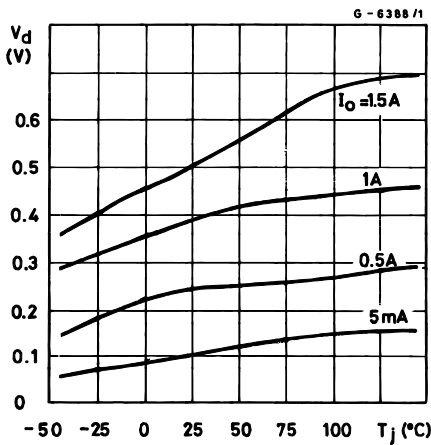


Figure 10: Output Voltage vs Temperature (L4940V10)

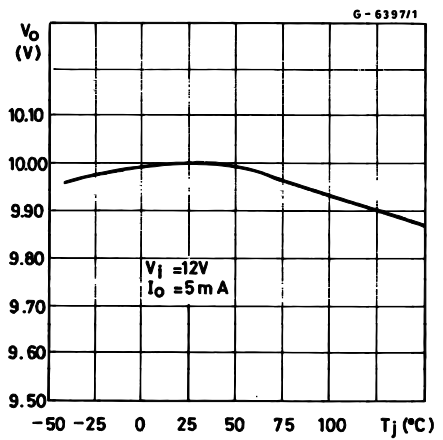


Figure 8: Output Voltage vs Temperature (L4940V5)

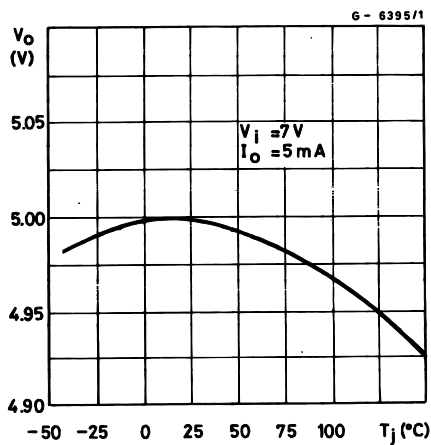
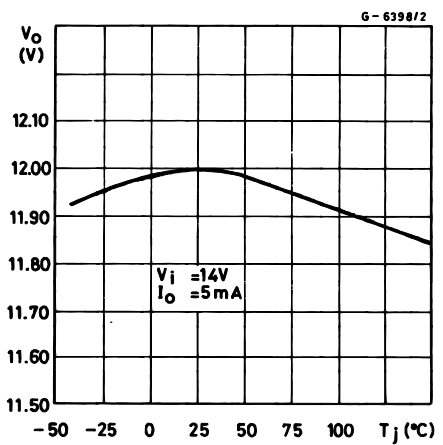
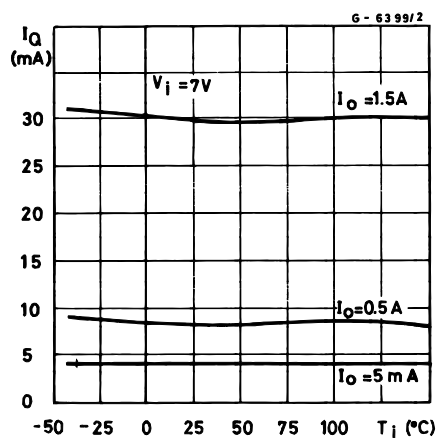


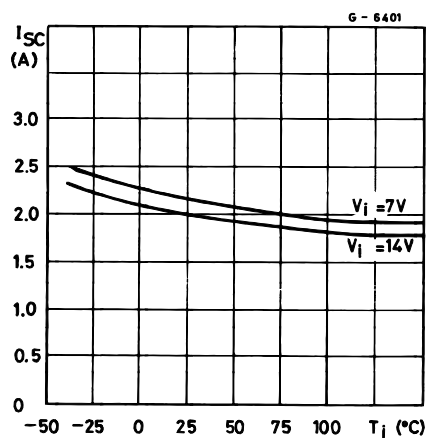
Figure 11: Output Voltage vs Temperature (L4940V12)



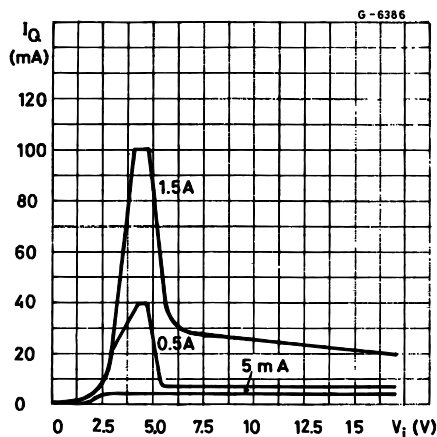
**Figure 12:** Quiescent Current vs Temperature (L4940V5)



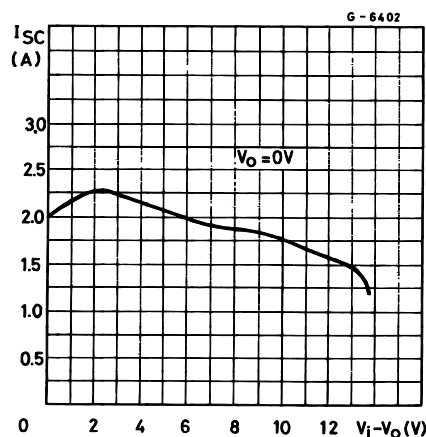
**Figure 15:** Short Circuit Current vs Temperature (L4940V5)



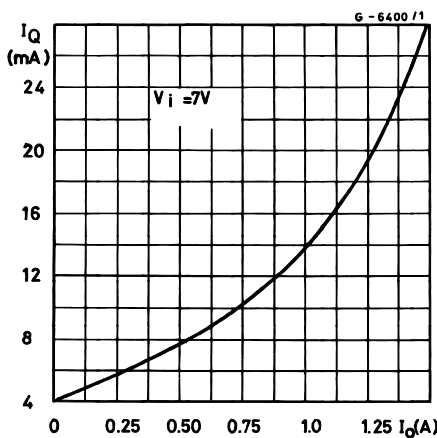
**Figure 13:** Quiescent Current vs Input Voltage (L4940V5)



**Figure 16:** Peak Output Current vs Input/Output Differential Voltage (L4940V5)



**Figure 14:** Quiescent Current vs Output Current (L4940V5)



**Figure 17:** Low Voltage Behavior (L4940V5)

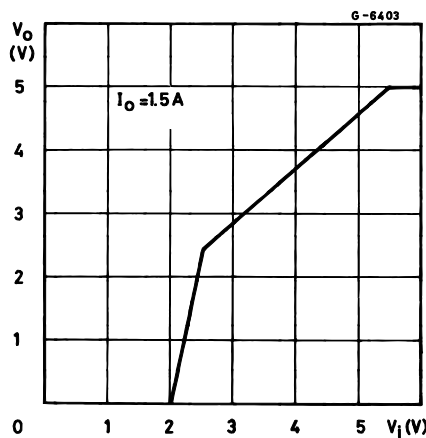


Figure 18: Low Voltage Behavior (L4940V85)

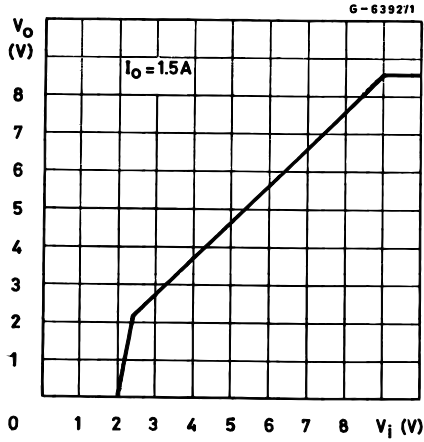


Figure 19: Low Voltage Behavior (L4940V10)

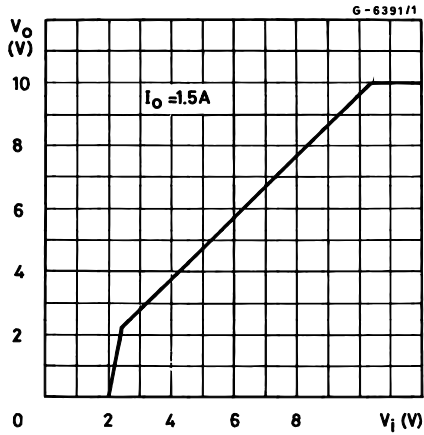


Figure 20: Low Voltage Behavior (L4940V12)

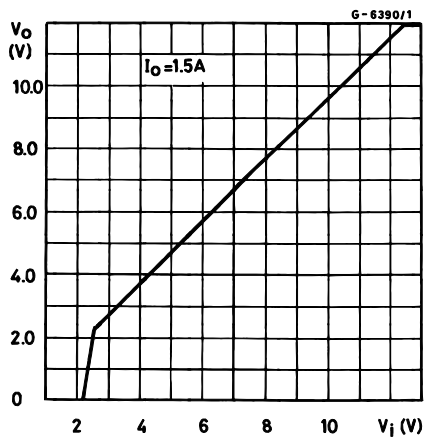


Figure 21: Supply Voltage Rejection vs Frequency (L4940V5)

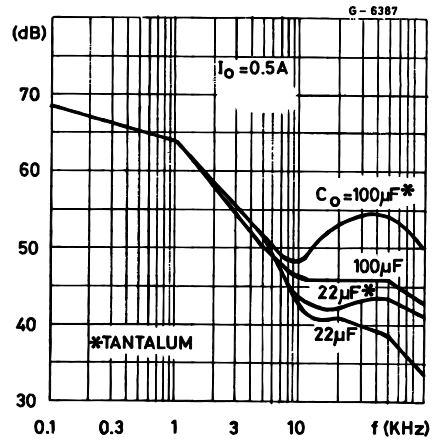


Figure 22: Supply Voltage Rejection vs Output Current (L4940V5)

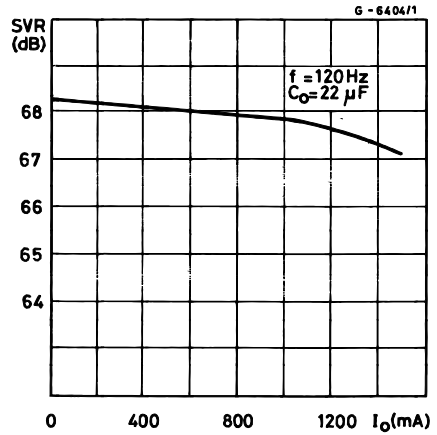


Figure 23: Lad Dump Characteristics (L4940V5)

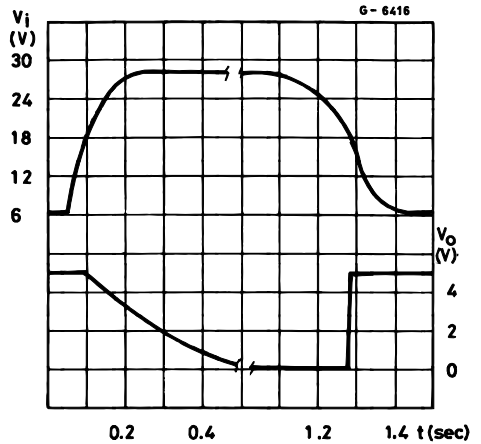
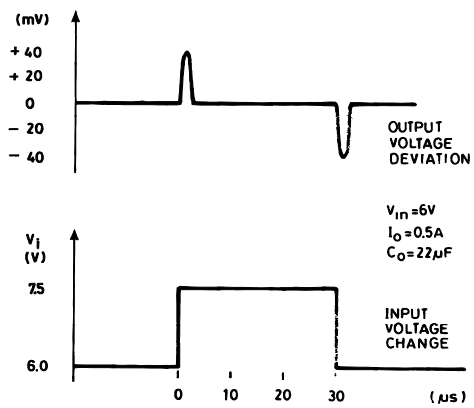




Figure 24: Line Transient Response (L4940V5)



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Figure 26: Load Transient Response

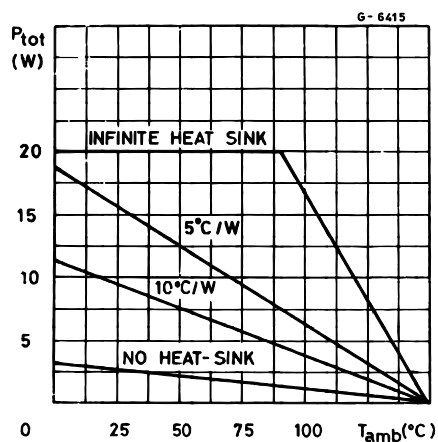


Figure 25: Total Power Dissipation

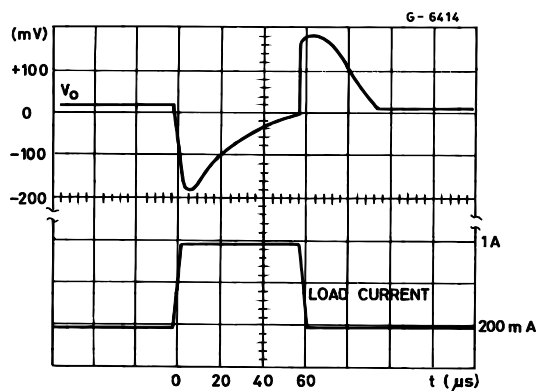


Figure 27: Distributed Supply with On-card L4940 and L4941 low drop regulator

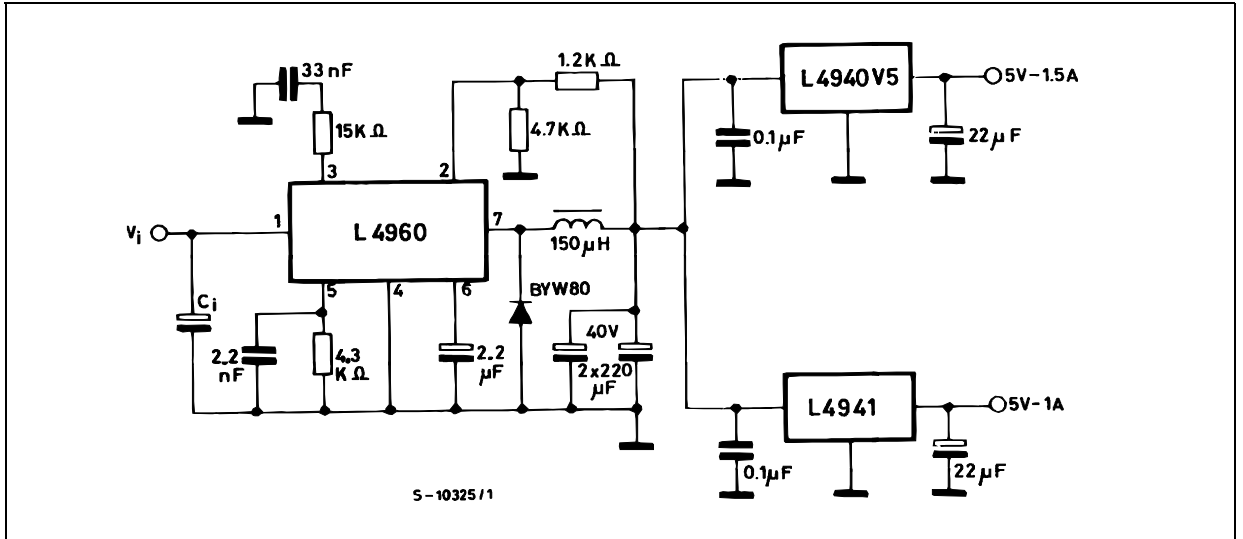
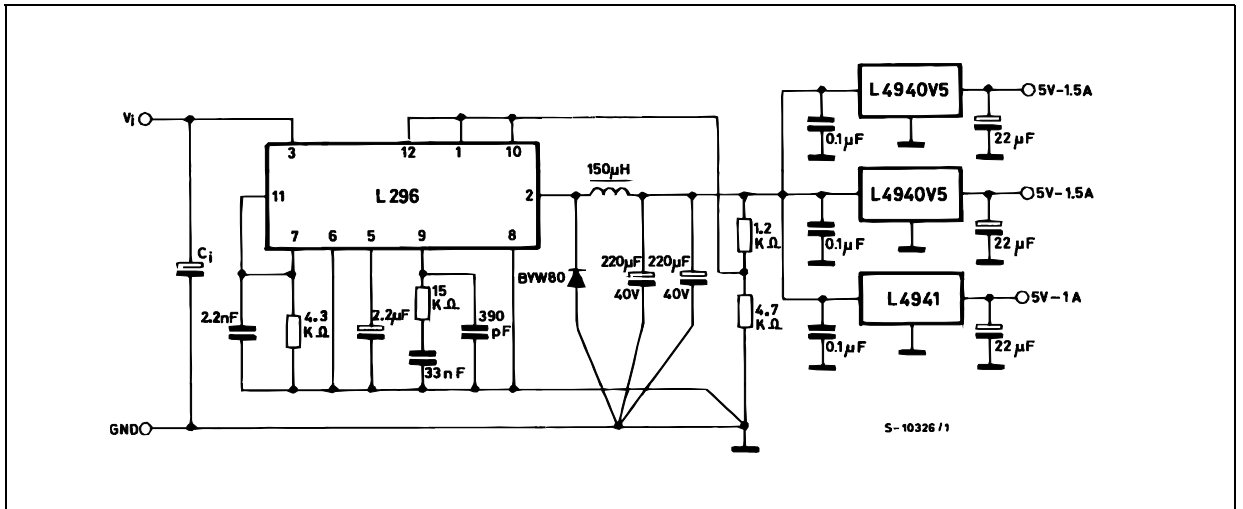


Figure 28: Distributed Supply with On-card L4940 and L4941 low drop regulator

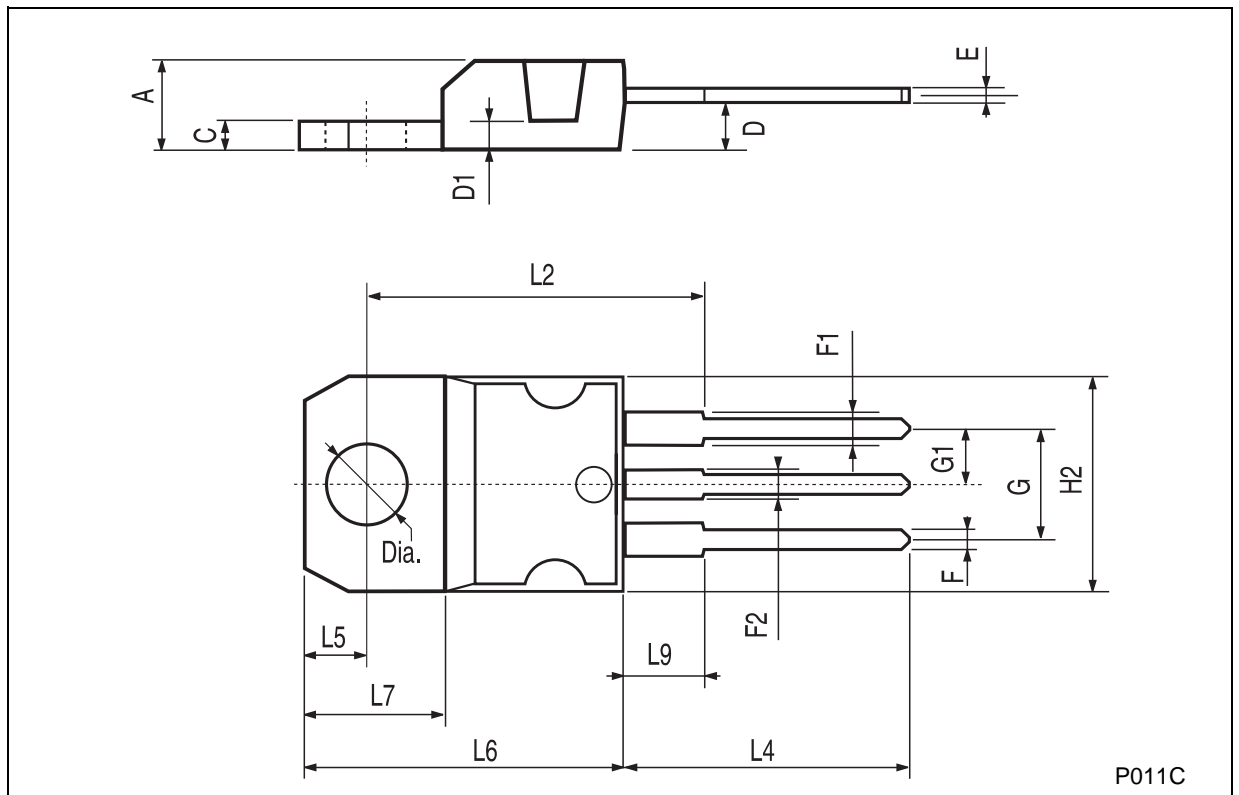


ADVANTAGES OF THESE APPLICATIONS ARE:  
 On card regulation with short-circuit and thermal protection on each output.  
 Very high total system efficiency due to the switching preregulation and very low-drop postregulation



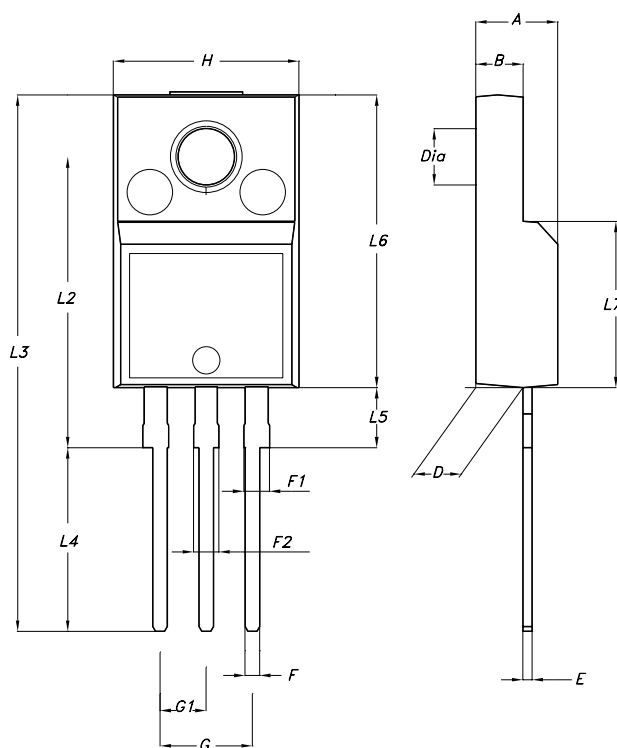
**TO-220 MECHANICAL DATA**

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

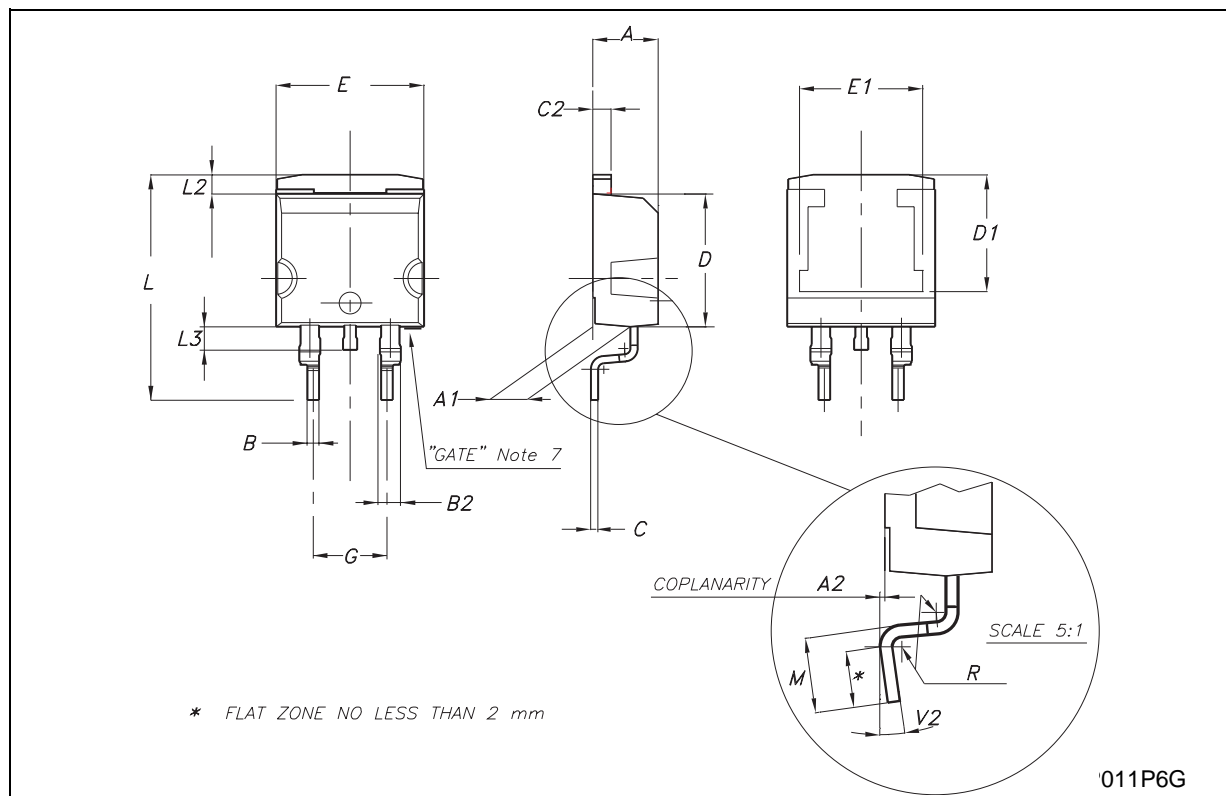
DIM.	mm.			inch		
	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.
A	4.40		4.60	0.173		0.181
B	2.5		2.7	0.098		0.106
D	2.5		2.75	0.098		0.108
E	0.45		0.70	0.017		0.027
F	0.75		1	0.030		0.039
F1	1.15		1.50	0.045		0.059
F2	1.15		1.50	0.045		0.059
G	4.95		5.2	0.194		0.204
G1	2.4		2.7	0.094		0.106
H	10.0		10.40	0.393		0.409
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



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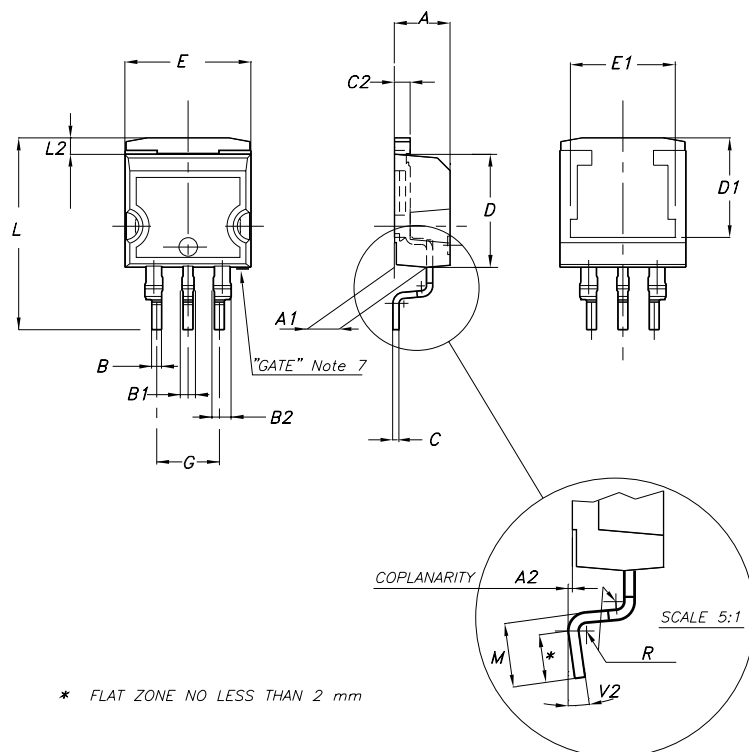
D<sup>2</sup>PAK MECHANICAL DATA

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°



D<sup>2</sup>PAK/A MECHANICAL DATA

DIM.	mm.			inch		
	MIN.	TYP	MAX.	MIN.	TYP.	MAX.
A	4.40		4.60	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	0.028		0.037
B1	0.8		1.3	0.031		0.051
B2	1.14		1.7	0.045		0.067
C	0.45		0.60	0.018		0.024
C2	1.23		1.36	0.048		0.054
D	8.95		9.35	0.352		0.368
D1		8			0.315	
E	10		10.4	0.394		0.409
E1		8.5			0.335	
G	4.88		5.28	0.192		0.208
L	15		15.85	0.591		0.624
L2	1.27		1.4	0.050		0.055
M	2.4		3.2	0.094		0.126
R		0.4			0.016	
V2	0°		8°	0°		8°



7106164/D

**Tape & Reel D<sup>2</sup>PAK-P<sup>2</sup>PAK-D<sup>2</sup>PAK/A-P<sup>2</sup>PAK/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

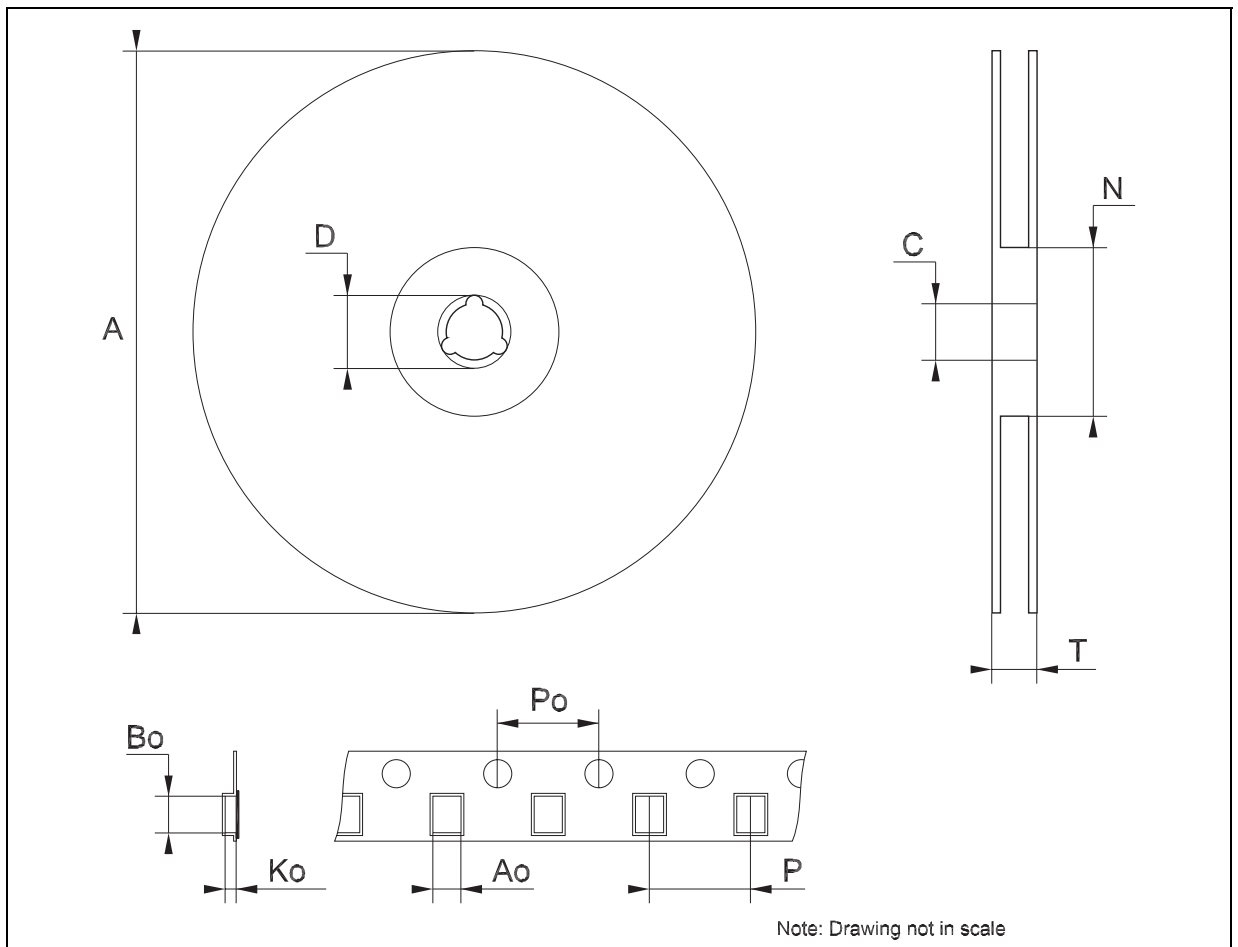




Table 8: Revision History

Date	Revision	Description of Changes
04-Feb-2005	6	Add new package D <sup>2</sup> PAK/A.

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