



# L4940XX5, L4940XX85 L4940XX10, L4940XX12

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 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.

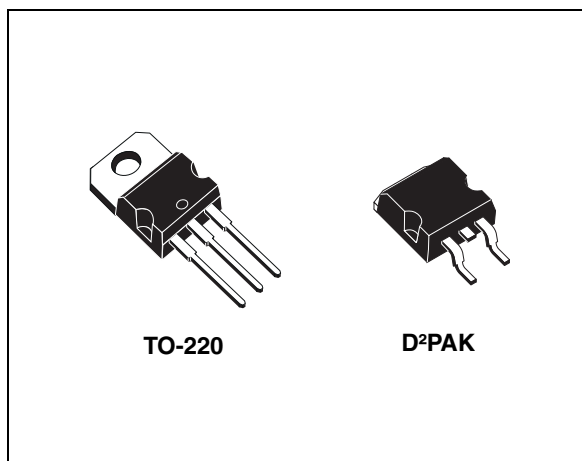


Table 1. Device summary

| Part numbers | Order codes |                    | Output voltages |
|--------------|-------------|--------------------|-----------------|
|              | TO-220      | D <sup>2</sup> PAK |                 |
| L4940XX5     | L4940V5     | L4940D2T5-TR       | 5 V             |
| L4940XX85    | L4940V85    |                    | 8.5 V           |
| L4940XX10    |             | L4940D2T10-TR      | 10 V            |
| L4940XX12    |             | L4940D2T12-TR      | 12 V            |

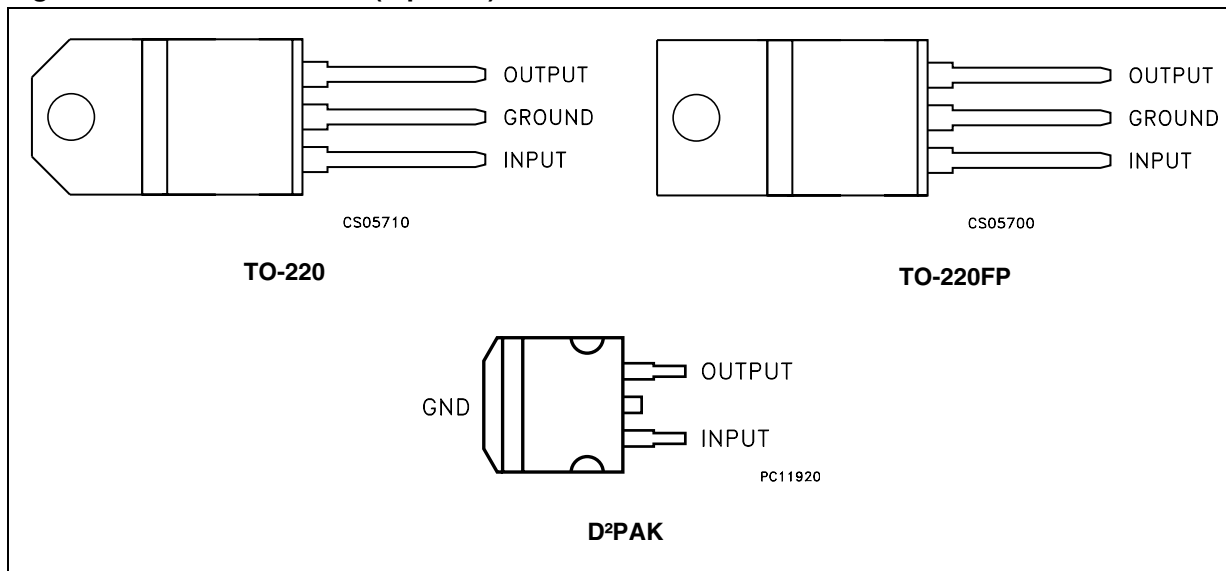
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## 2 Pin configuration

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 <sup>2</sup> 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

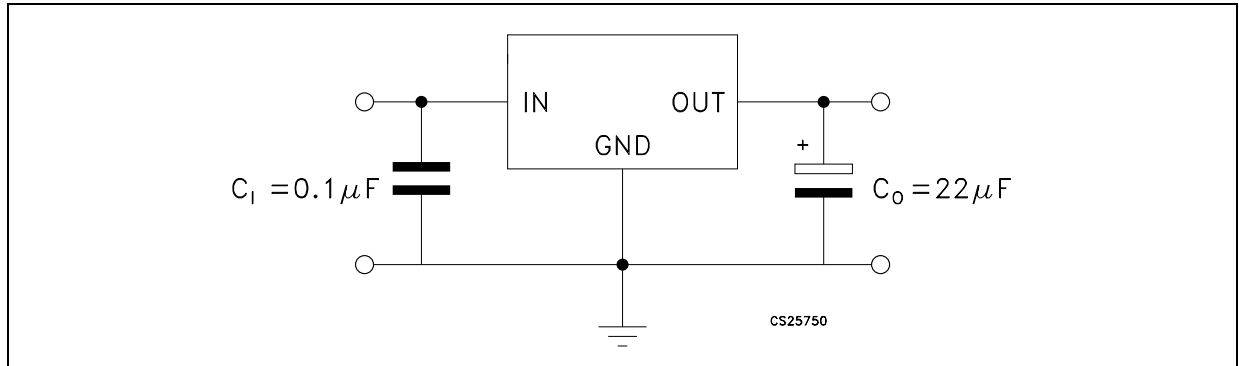


Figure 4. Load rejection

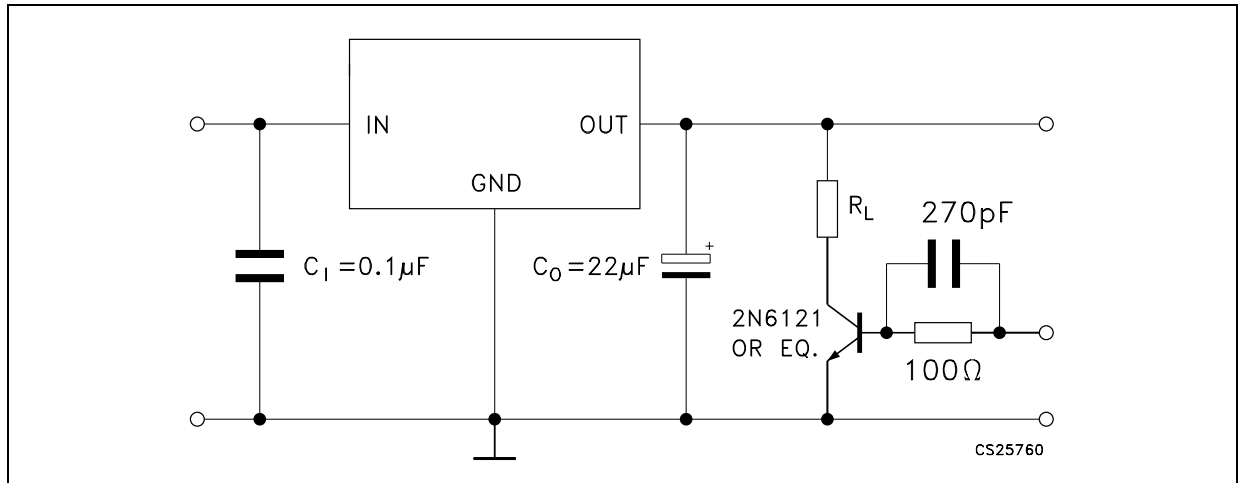
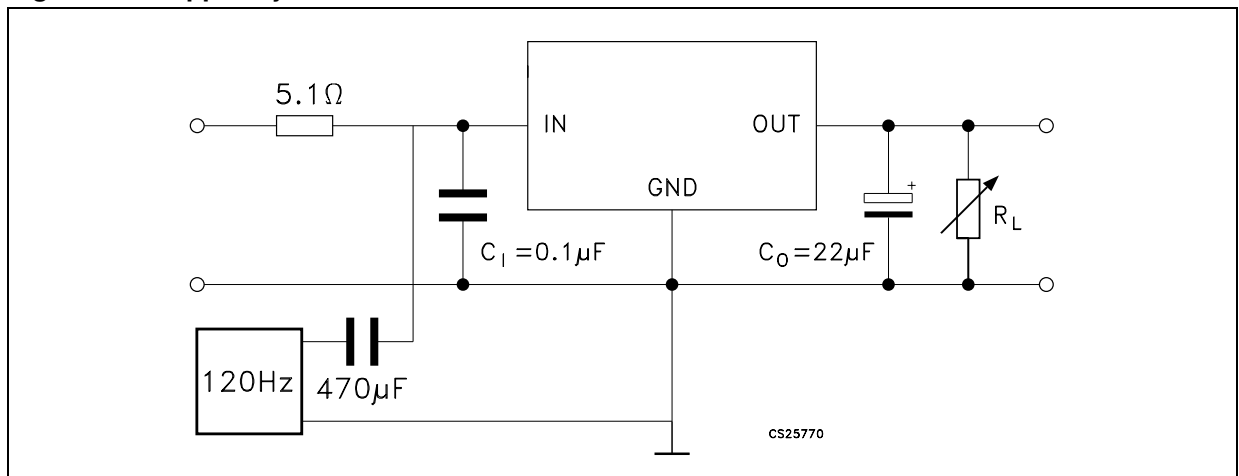


Figure 5. Ripple rejection



## 5 Electrical characteristics

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.

**Table 4. Electrical characteristics of L4940XX5**

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

**Table 5. Electrical characteristics of L4940XX85**

| 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                    |
| $\Delta V_O$          | 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/ $^\circ\text{C}$ |
| 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  |                      |

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.

**Table 6. Electrical characteristics of L4940XX10**

| 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/ $^\circ\text{C}$ |
| 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  |                      |

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.

**Table 7. Electrical characteristics of L4940XX12**

| 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/ $^\circ\text{C}$ |
| 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   |       | m $\Omega$           |

## 6 Typical application

Figure 6. Dropout voltage vs. output current

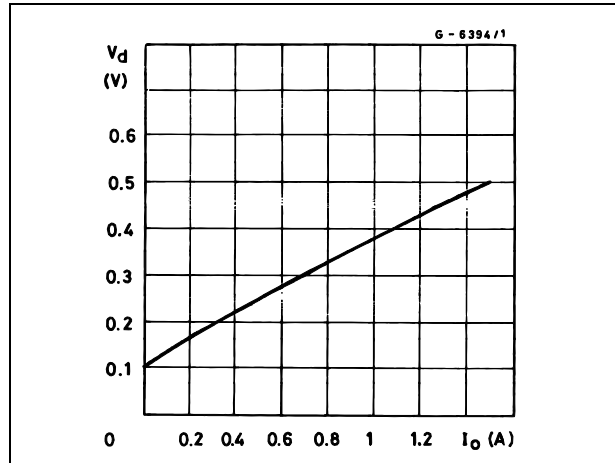


Figure 7. Dropout voltage vs. temperature

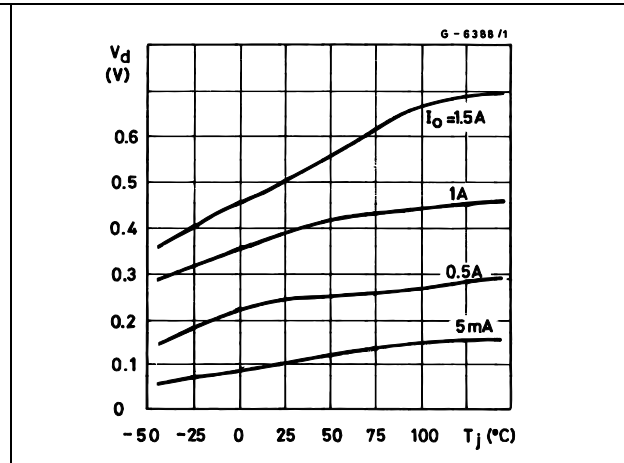


Figure 8. Output voltage vs. temperature (L4940V5)

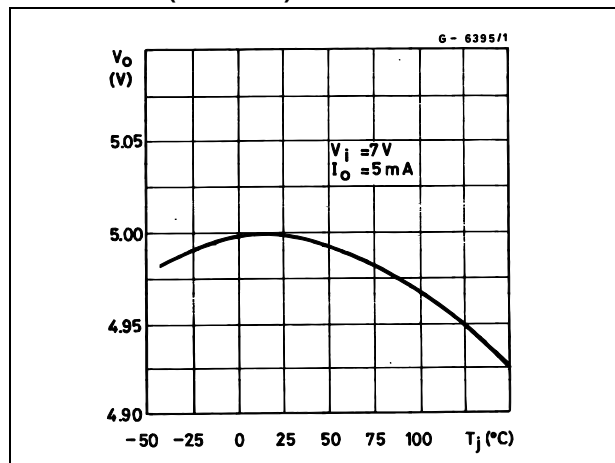


Figure 9. Output voltage vs. temperature (L4940V85)

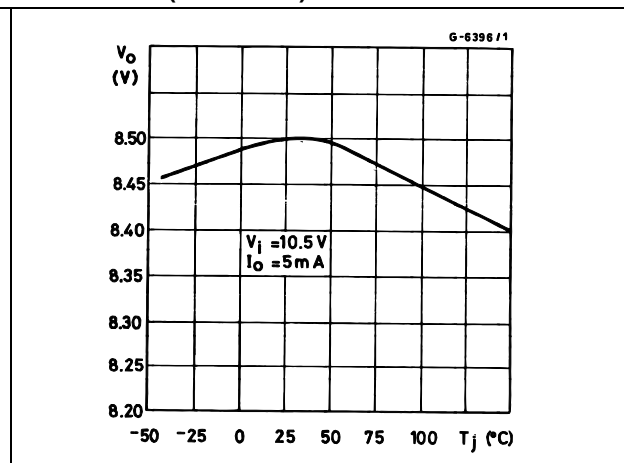


Figure 10. Output voltage vs. temperature (L4940V10)

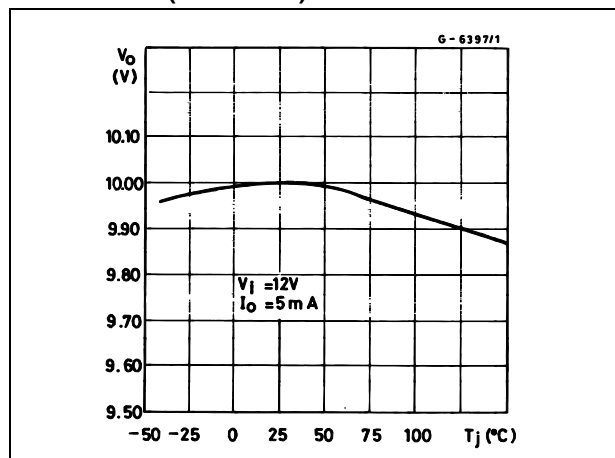


Figure 11. Output voltage vs. temperature (L4940V12)

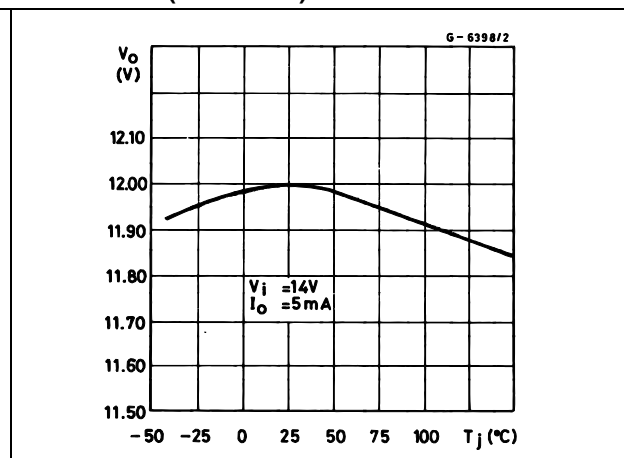


Figure 12. Quiescent current vs. temperature (L4940V5)

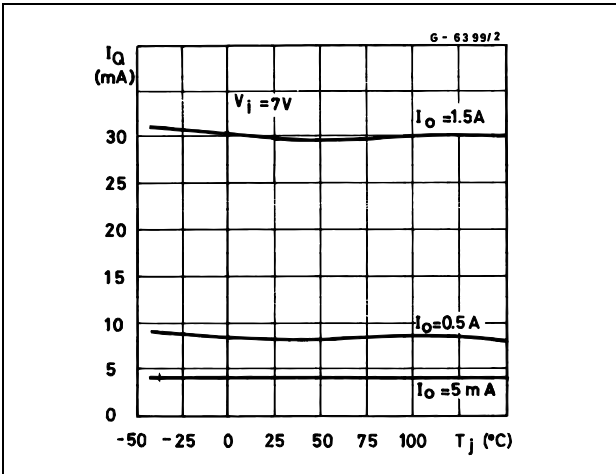


Figure 13. Quiescent current vs. input voltage (L4940V5)

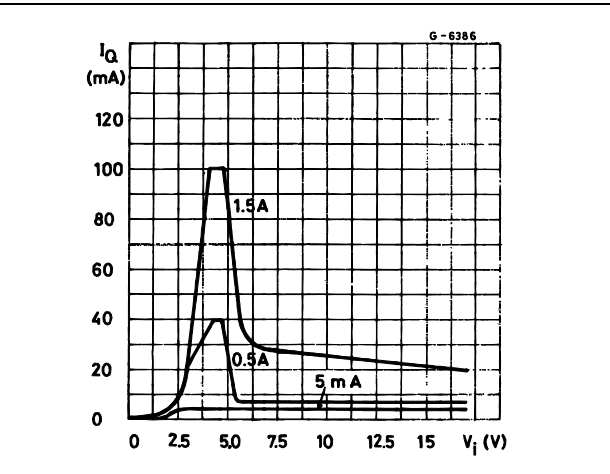


Figure 14. Quiescent current vs. output current (L4940V5)

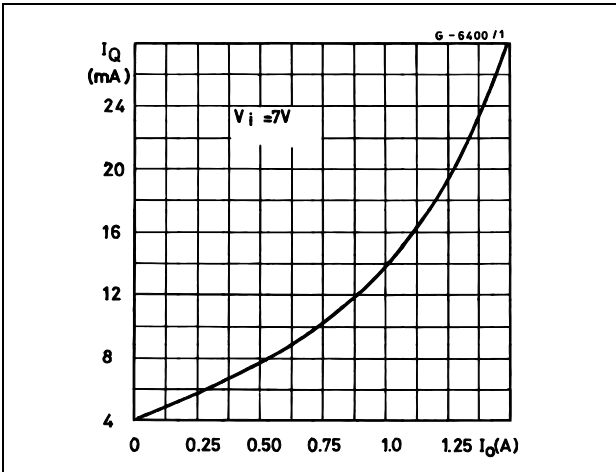


Figure 15. Short circuit current vs. temperature (L4940V5)

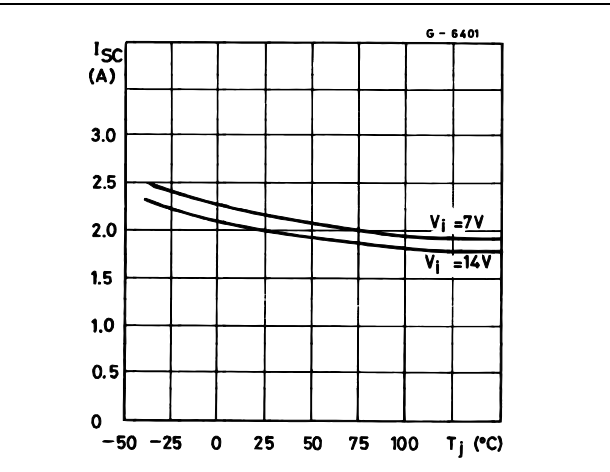


Figure 16. Peak output current vs. input/output differential voltage (L4940V5)

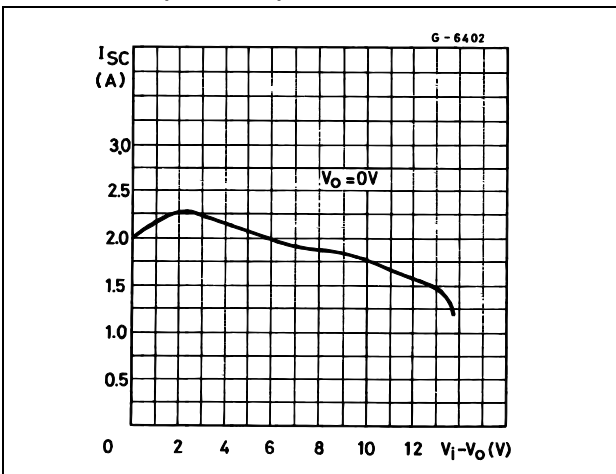


Figure 17. Low voltage behavior (L4940V5)

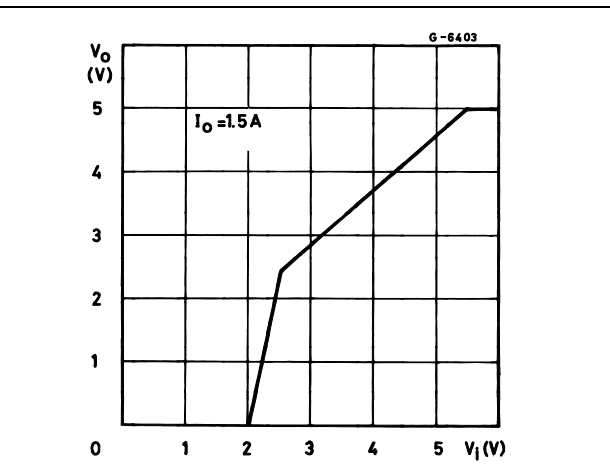


Figure 18. Low voltage behavior (L4940V85)

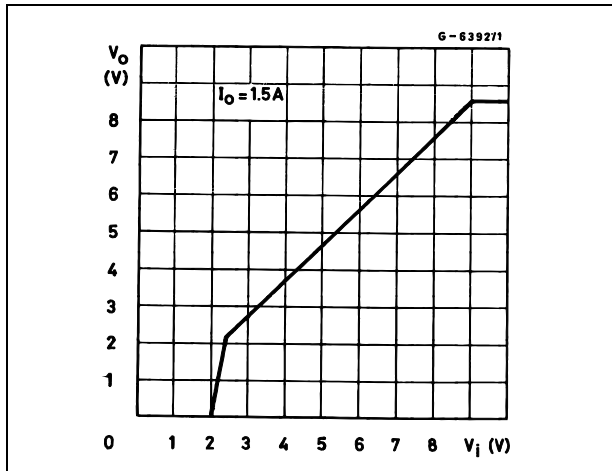


Figure 19. Low voltage behavior (L4940V10)

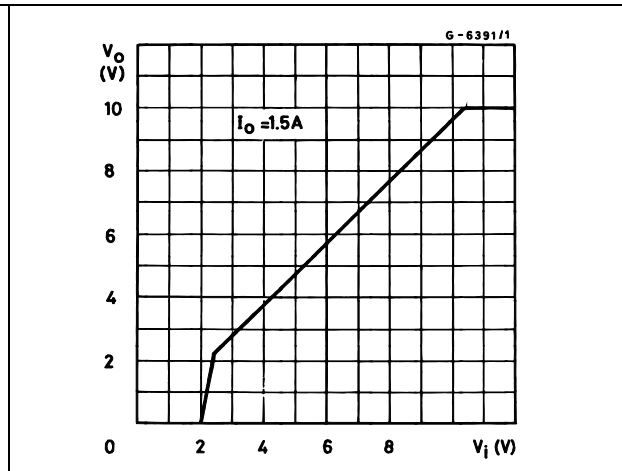


Figure 20. Low voltage behavior (L4940V12)

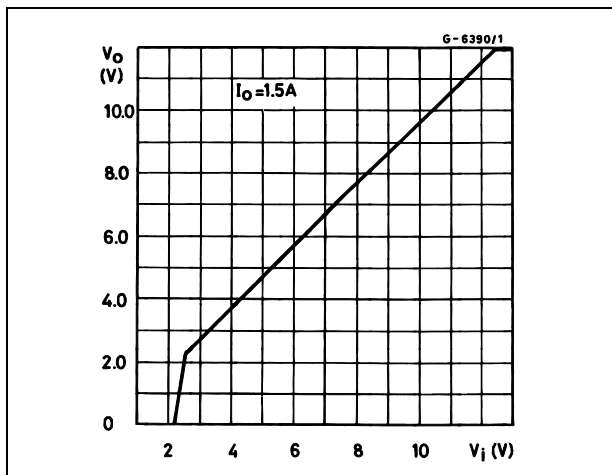


Figure 21. Supply voltage rejection vs. frequency (L4940V5)

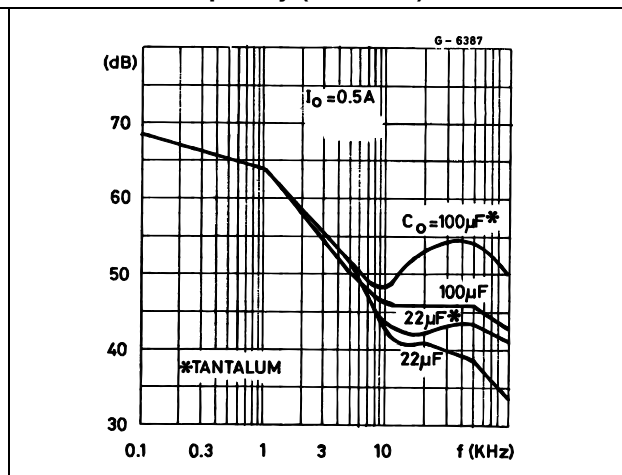


Figure 22. Supply voltage rejection vs. output current (L4940V5)

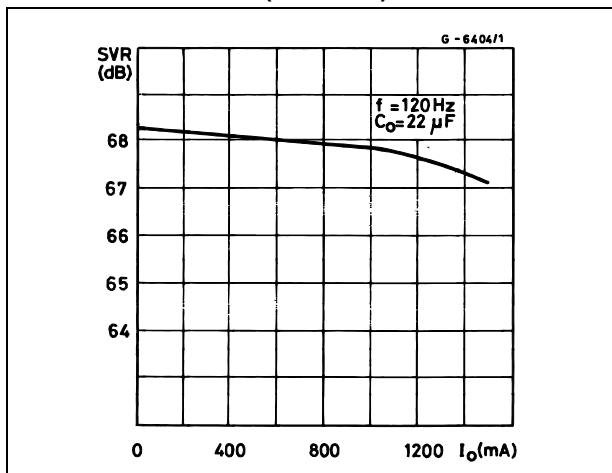


Figure 23. Load dump characteristics (L4940V5)

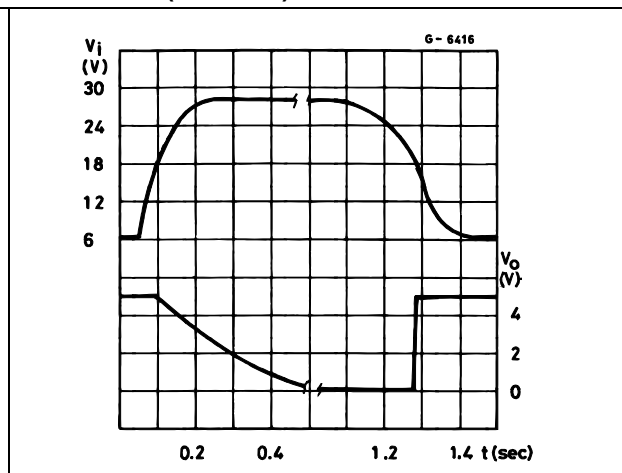


Figure 24. Line transient response (L4940V5)      Figure 25. Total power dissipation

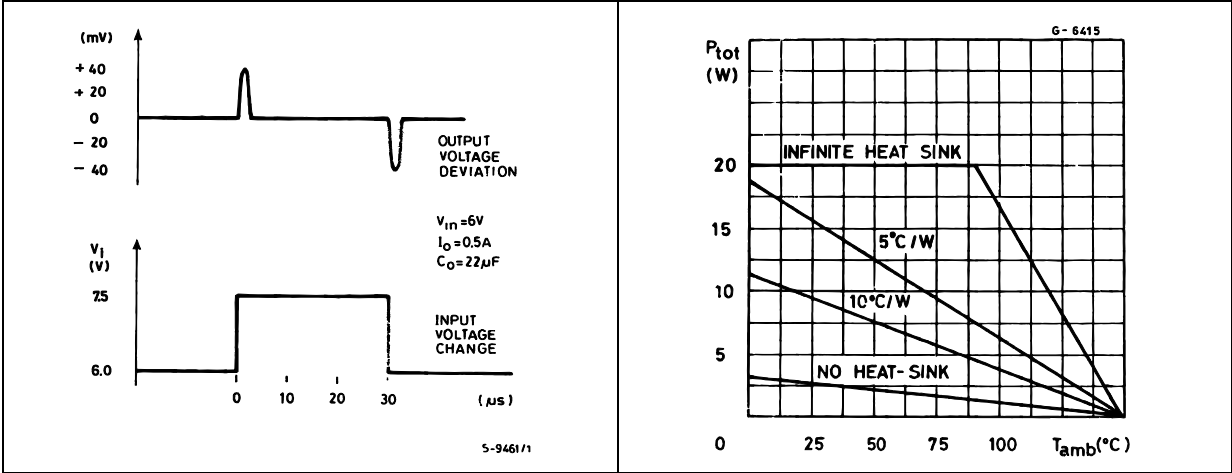
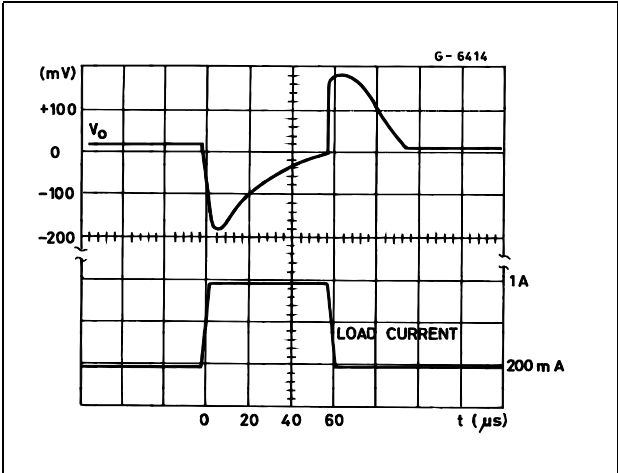


Figure 26. Load transient response



## 7 Schematic application

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

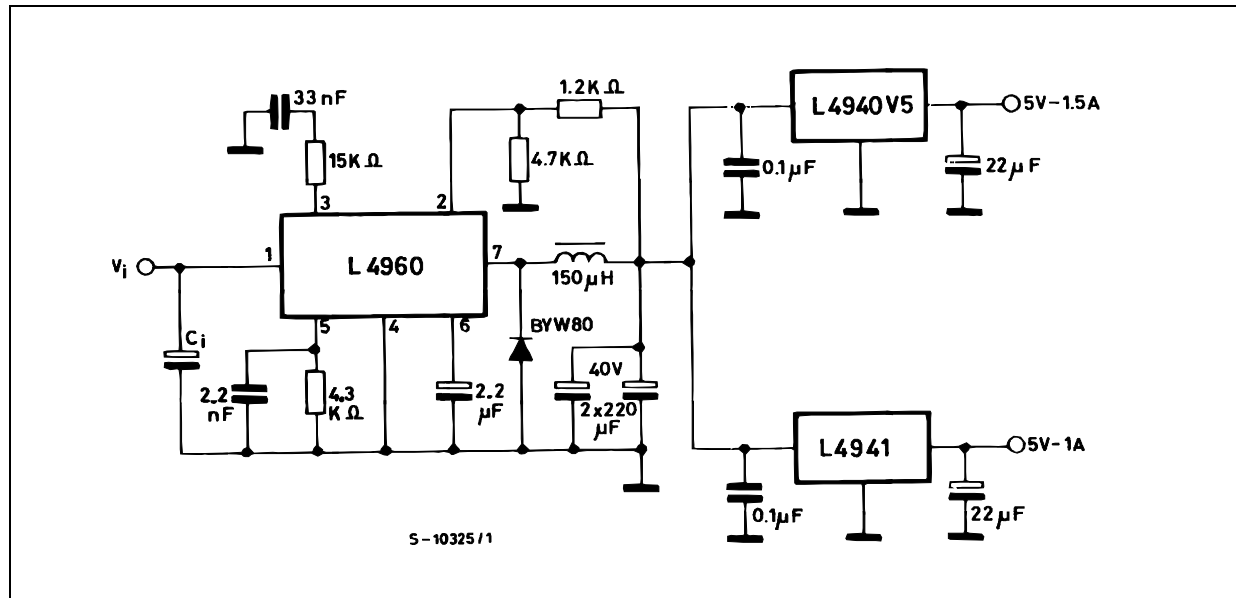
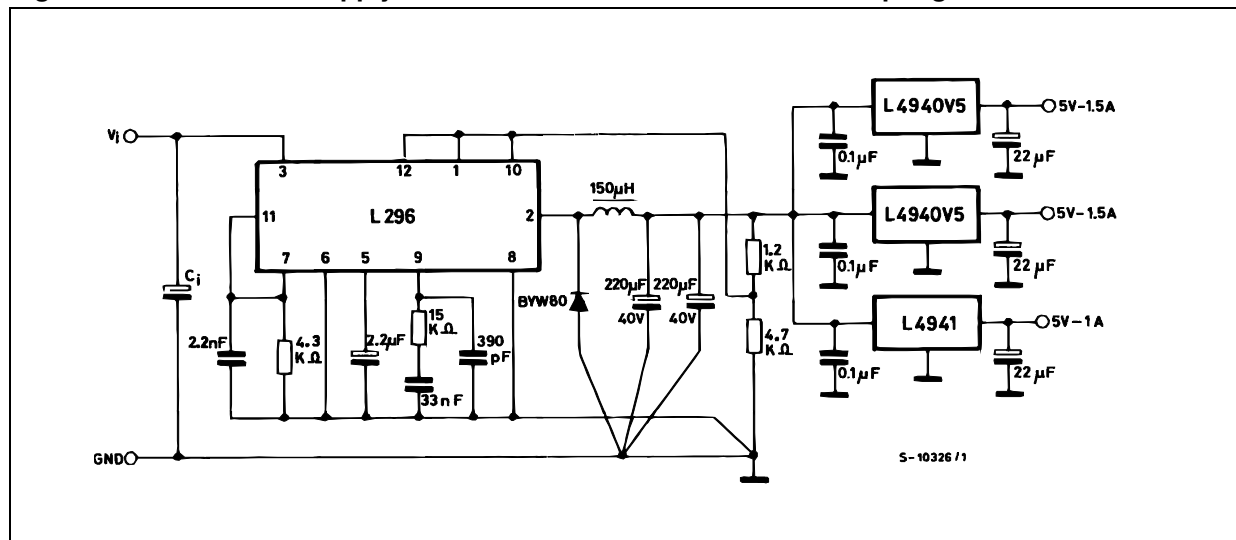
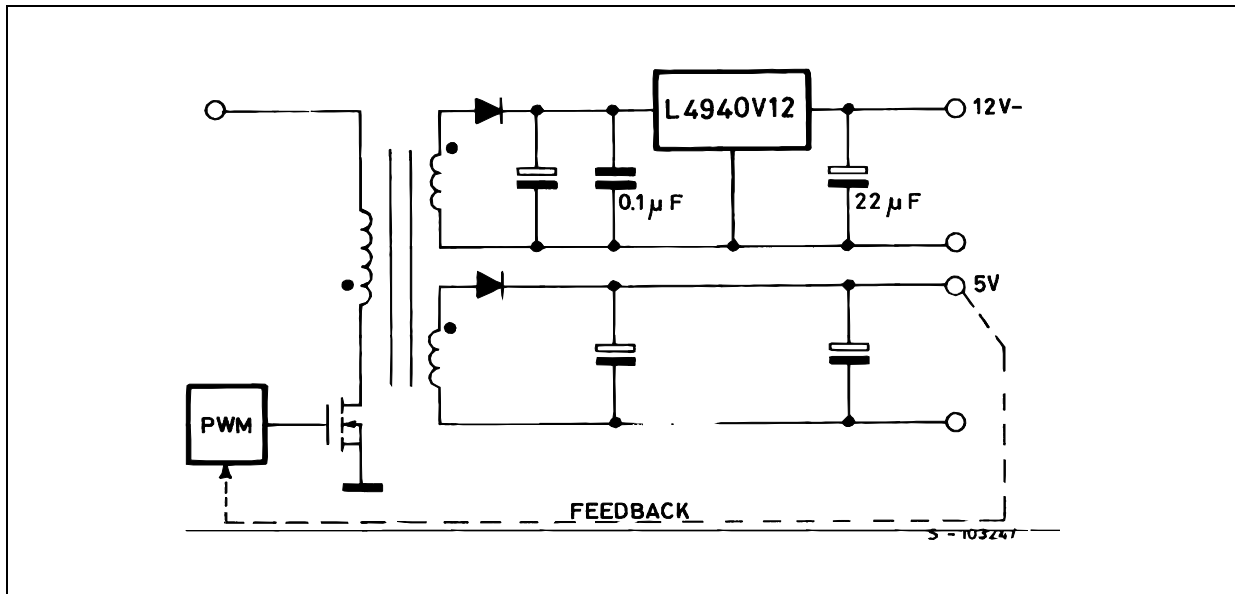


Figure 28. Distributed supply with on-card L4940 and L4941 low drop regulator



**Note:** Advantages of these application 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 29. Distributed supply with on-card L4940 and L4941 low drop regulator



Note:

Advantages of this configuration are:

Very high regulation (line and load on both the output voltage).

12 V output short circuit and thermally protected.

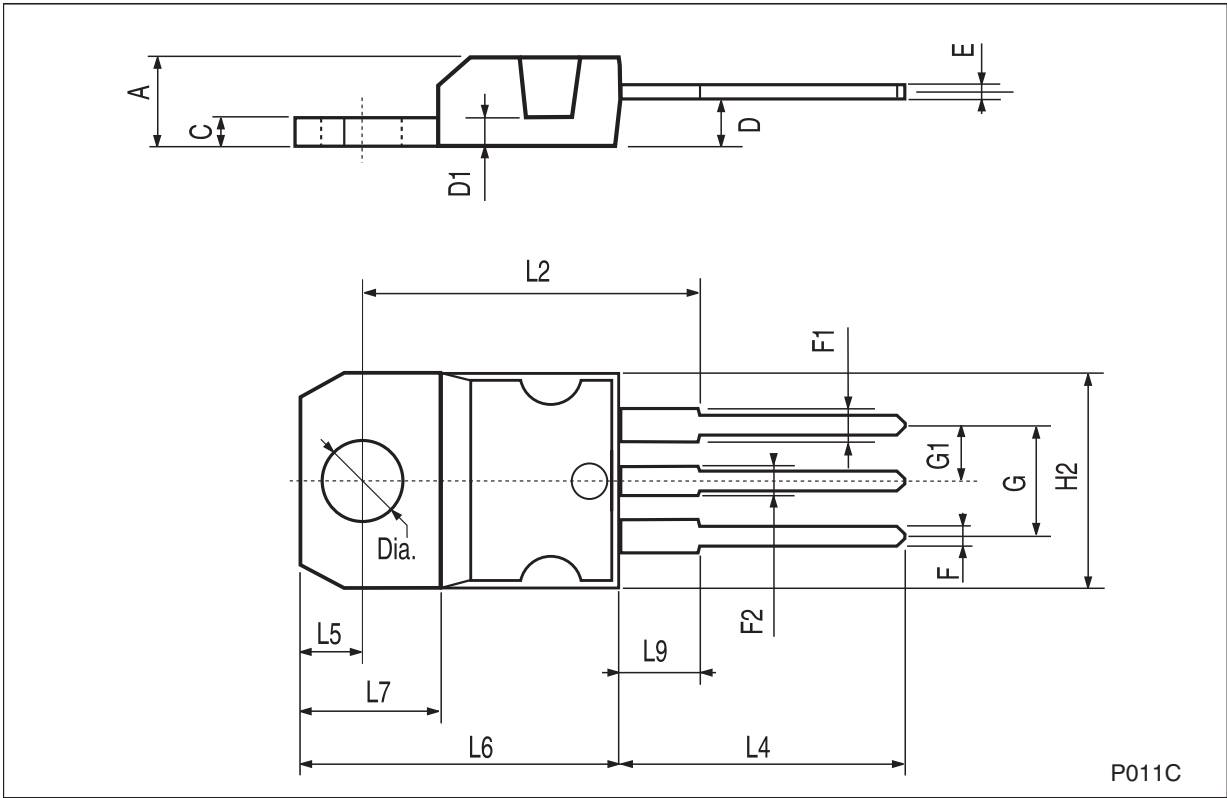
Very high efficiency on the 12 V output due to the low drop regulator.

## 8 Package mechanical data

In order to meet environmental requirements, ST offers these devices in 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.

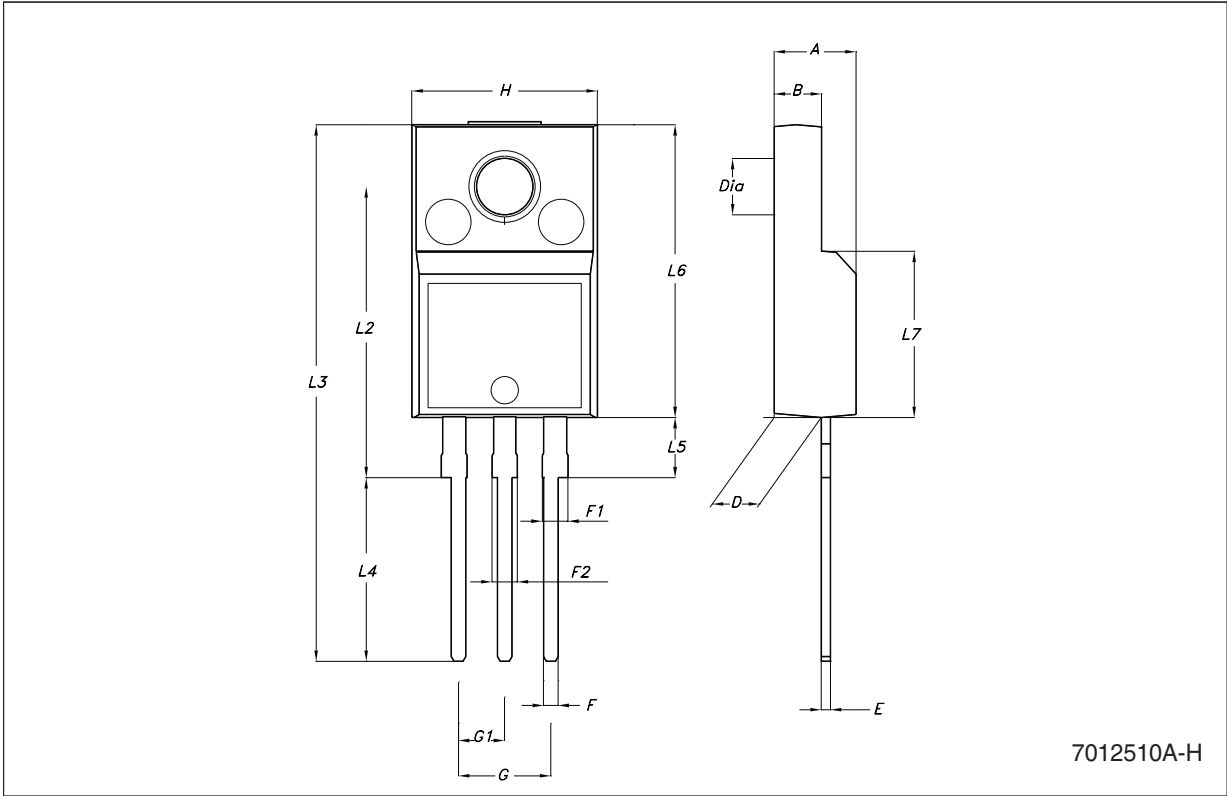
TO-220 mechanical data

| 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

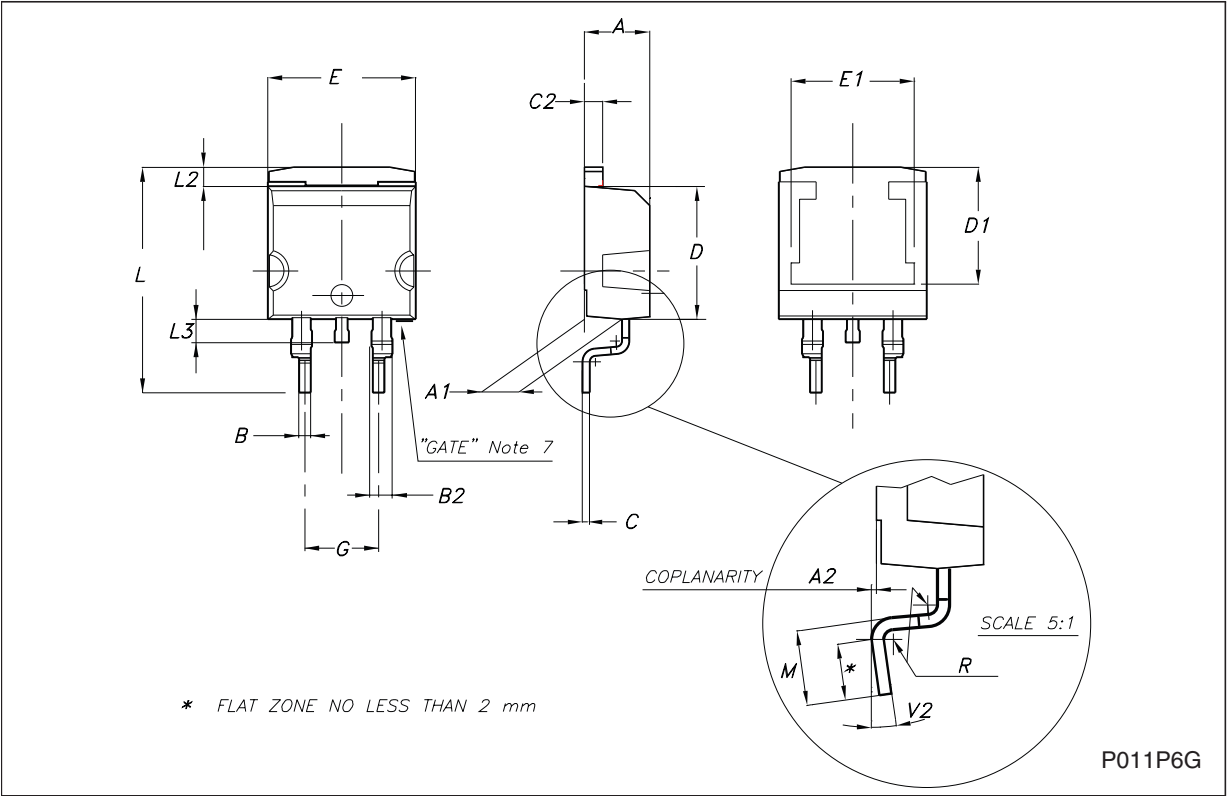
| Dim. | mm.  |     |       | inch. |       |       |
|------|------|-----|-------|-------|-------|-------|
|      | Min. | Typ | Max.  | Min.  | Typ.  | Max.  |
| A    | 4.40 |     | 4.60  | 0.173 |       | 0.181 |
| B    | 2.5  |     | 2.7   | 0.098 |       | 0.106 |
| D    | 2.5  |     | 2.75  | 0.098 |       | 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 |



7012510A-H

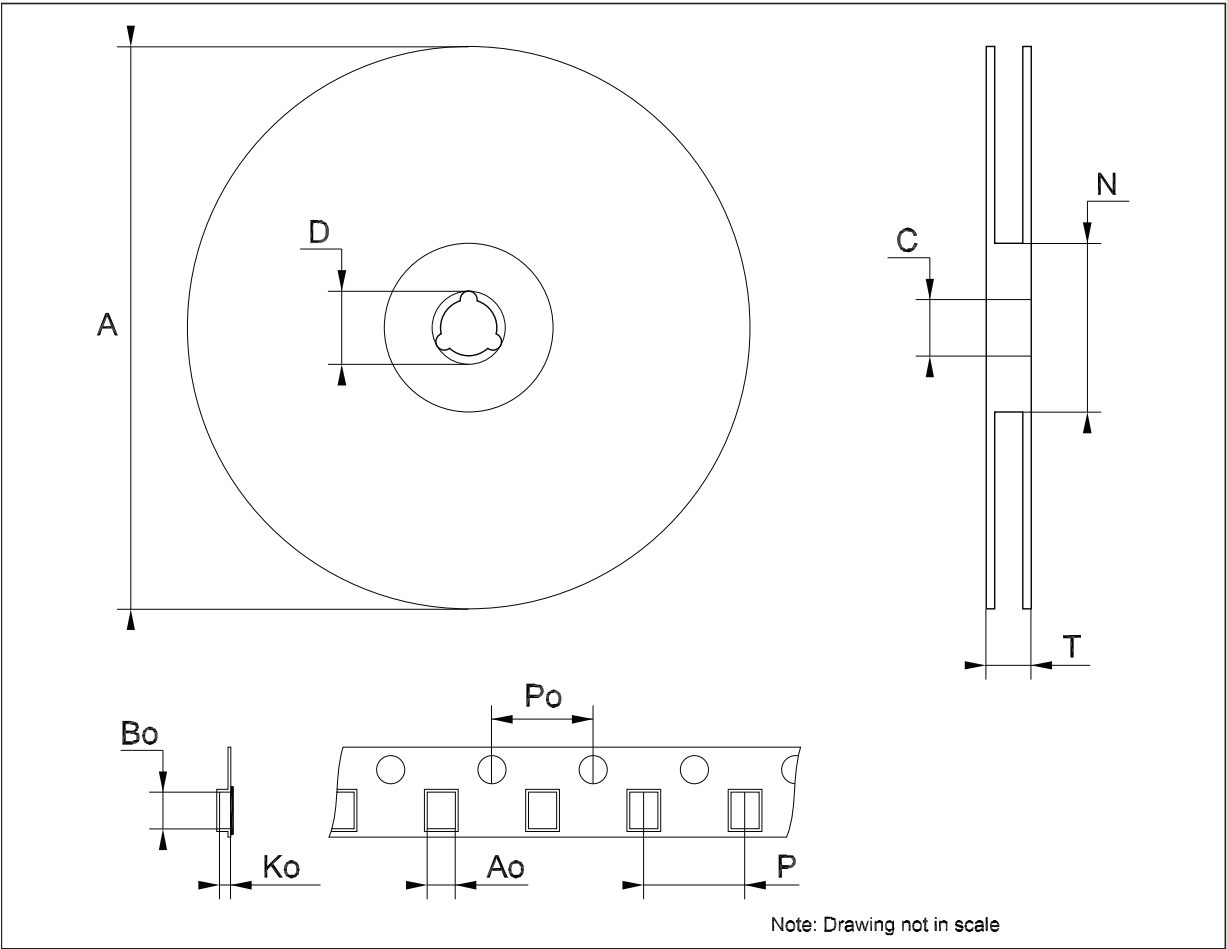
D<sup>2</sup>PAK mechanical data

| 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°    |



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 |



## 9 Revision history

**Table 8. Document revision history**

| Date        | Revision | Changes                                        |
|-------------|----------|------------------------------------------------|
| 04-Feb-2005 | 6        | Add new package D <sup>2</sup> 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 <a href="#">Table 1</a> in 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 7 on page 10</a> . |

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