

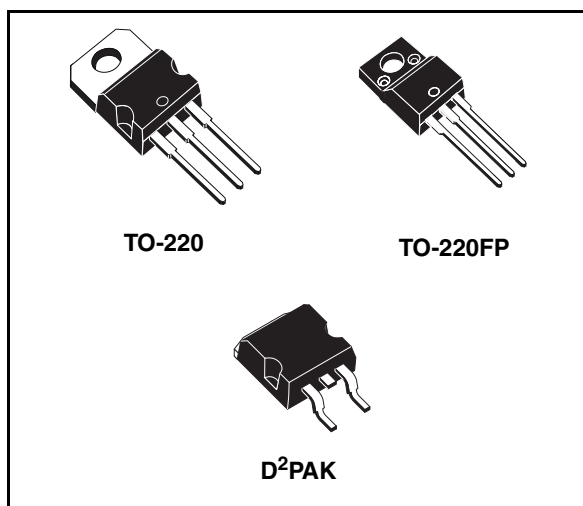
## Very low drop 1.5 A regulator

### 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 number | Order code |          |                    | Output voltage |
|-------------|------------|----------|--------------------|----------------|
|             | TO-220     | TO-220FP | D <sup>2</sup> PAK |                |
| L4940xx5    | L4940V5    |          | L4940D2T5-TR       | 5 V            |
| L4940xx85   | L4940V85   | L4940P85 | L4940D2T85-TR      | 8.5 V          |
| L4940xx10   | L4940V10   |          | L4940D2T10-TR      | 10 V           |
| L4940xx12   | L4940V12   |          | L4940D2T12-TR      | 12 V           |

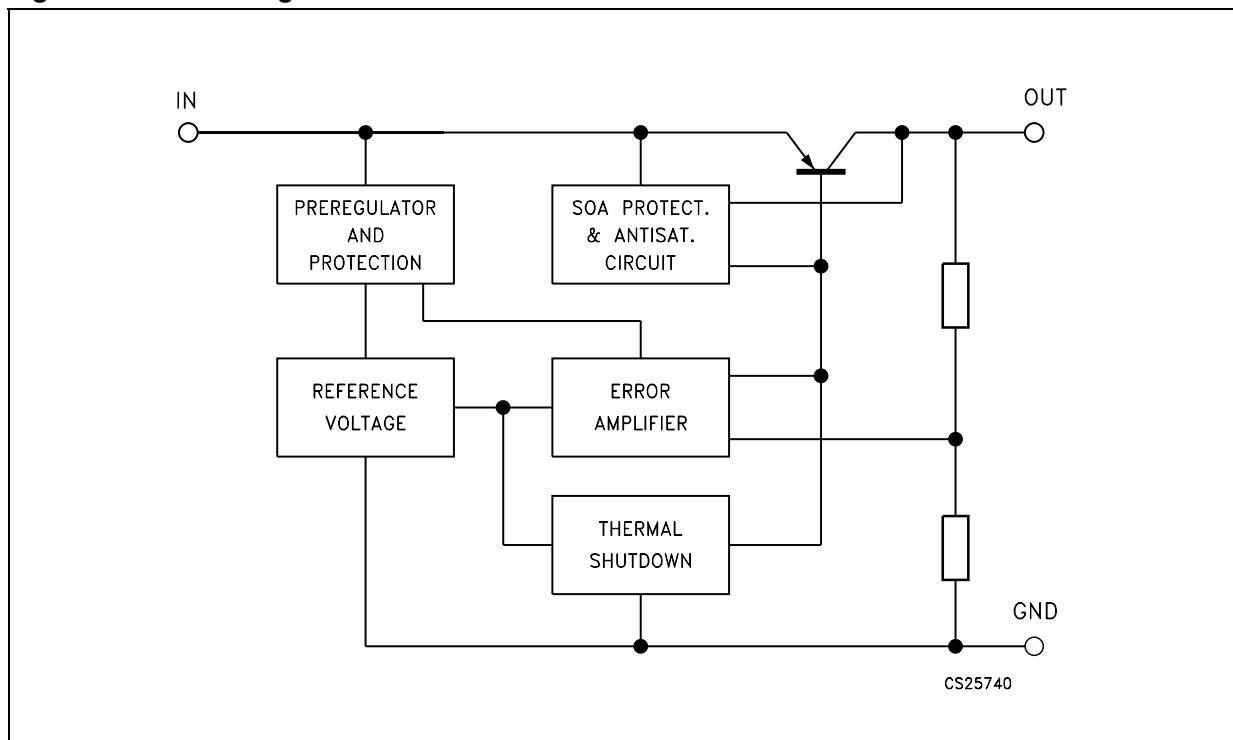
---

## Contents

|          |                                         |           |
|----------|-----------------------------------------|-----------|
| <b>1</b> | <b>Block diagram .....</b>              | <b>3</b>  |
| <b>2</b> | <b>Pin configuration .....</b>          | <b>4</b>  |
| <b>3</b> | <b>Maximum ratings .....</b>            | <b>5</b>  |
| <b>4</b> | <b>Test circuits .....</b>              | <b>6</b>  |
| <b>5</b> | <b>Electrical characteristics .....</b> | <b>7</b>  |
| <b>6</b> | <b>Typical application .....</b>        | <b>11</b> |
| <b>7</b> | <b>Schematic application .....</b>      | <b>15</b> |
| <b>8</b> | <b>Package mechanical data .....</b>    | <b>17</b> |
| <b>9</b> | <b>Revision history .....</b>           | <b>22</b> |

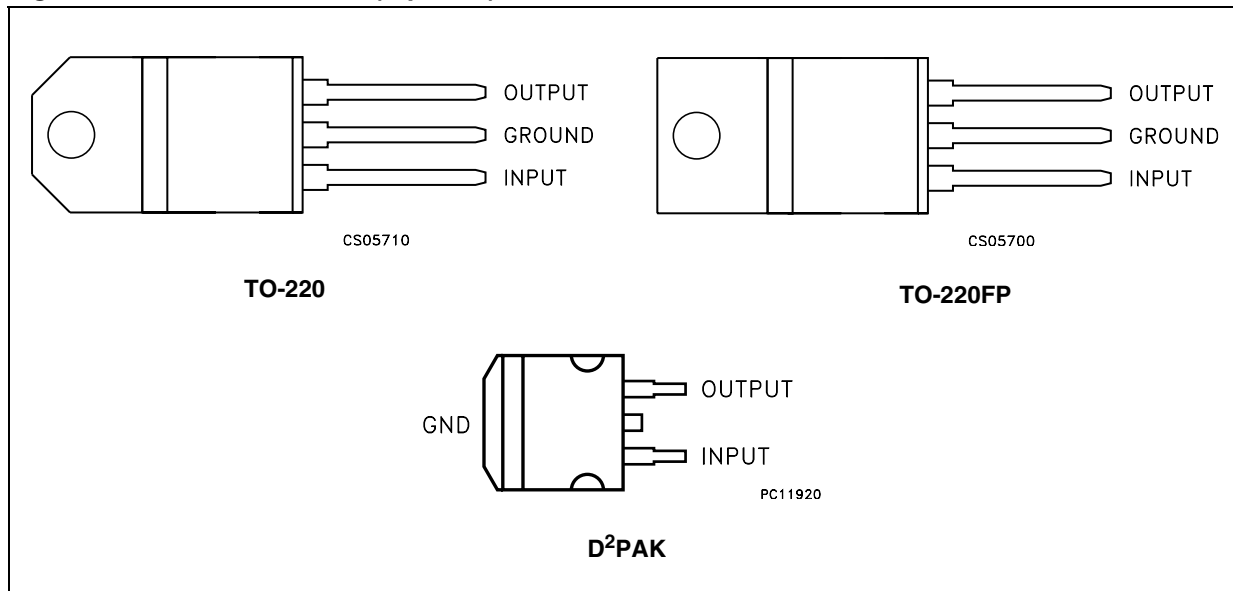
# 1 Block diagram

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 <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

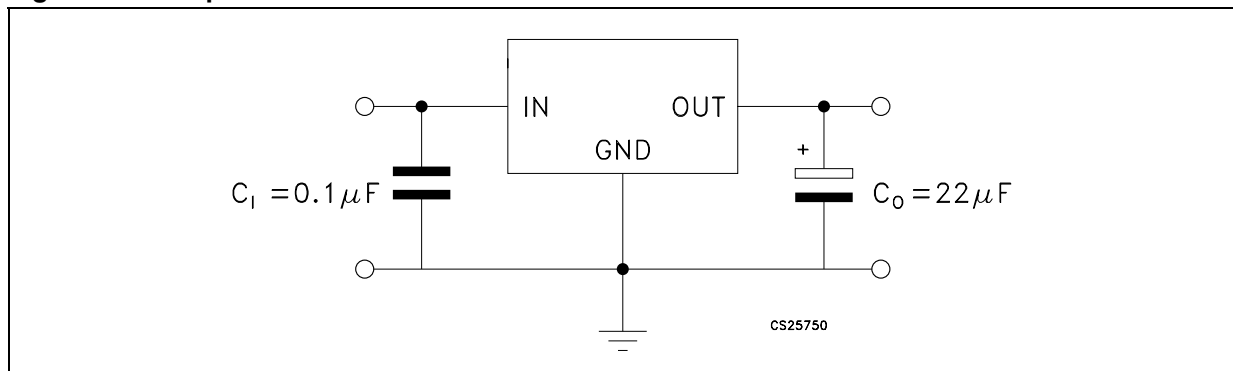


Figure 4. Load rejection

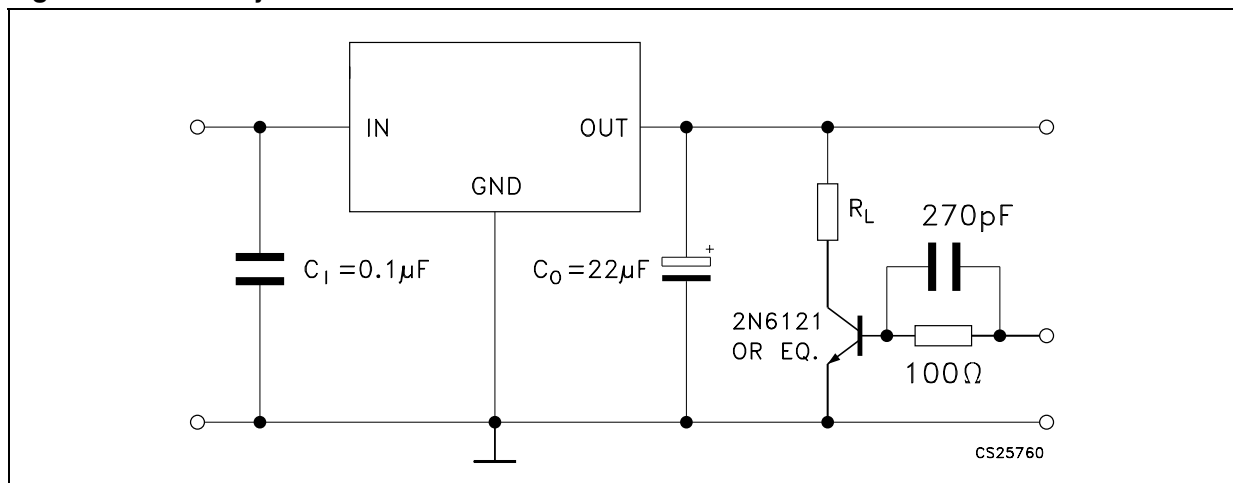
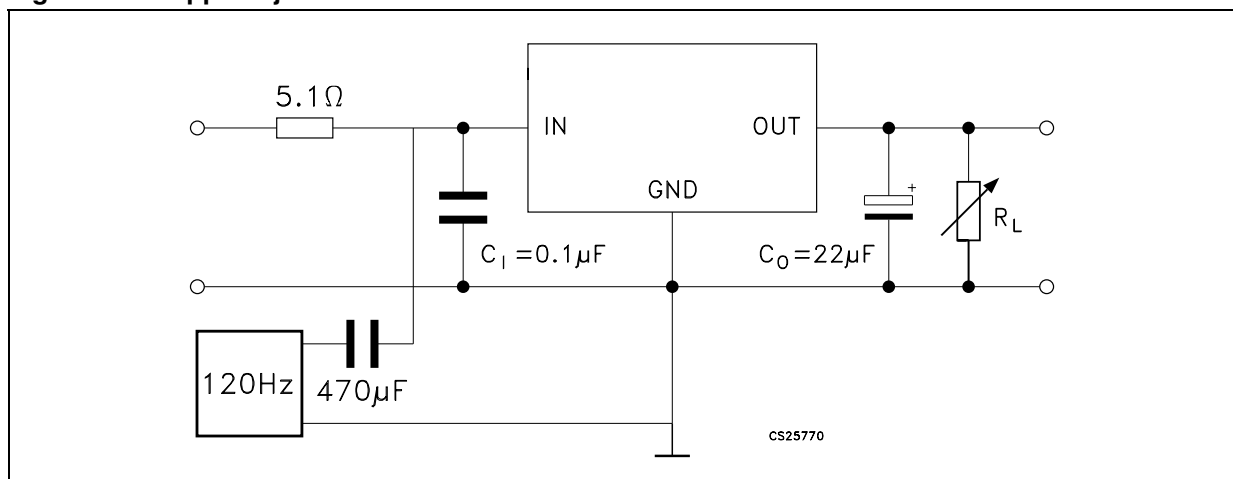


Figure 5. Ripple rejection



## 5 Electrical characteristics

**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                    |
| $\Delta V_O$          | 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  |                      |

**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                    |
| $\Delta V_O$          | 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  |                      |



**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                    |
| $\Delta V_O$          | 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  |                      |

**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                    |
| $\Delta V_O$          | Line regulation          | $V_I = 11\text{ to }17\text{ V}$ , $I_O = 5\text{ mA}$                   |       | 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                   |
|                       |                          | $I_O = 1.5\text{ A}$ , $V_I = 11.7\text{ V}$                             |       | 30   | 50    | mA                   |
| $\Delta I_q$          | Quiescent current change | $I_O = 5\text{ mA}$                                                      |       |      | 1.5   | mA                   |
|                       |                          | $I_O = 1.5\text{ A}$ , $V_I = 11.7\text{ to }16\text{ V}$                |       |      | 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   |       | m $\Omega$           |

## 6 Typical application

Figure 6. Dropout voltage vs output current

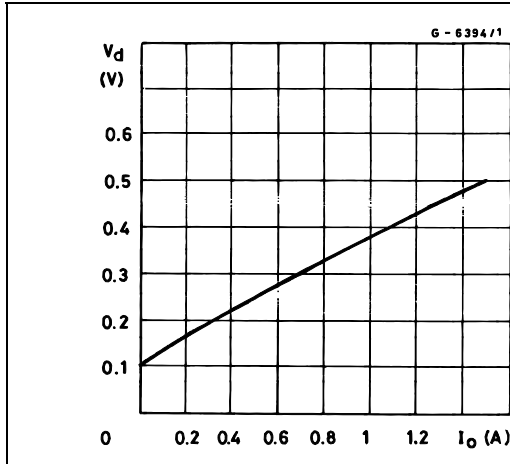


Figure 7. Dropout voltage vs temperature

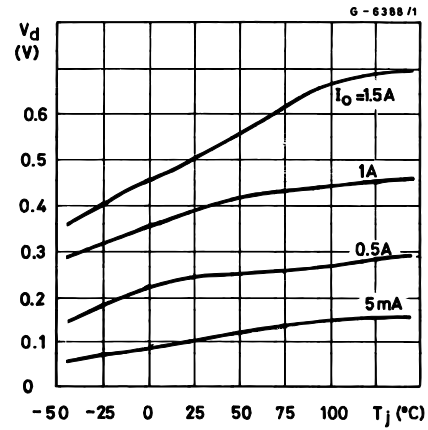


Figure 8. Output voltage vs temperature (L4940V5)

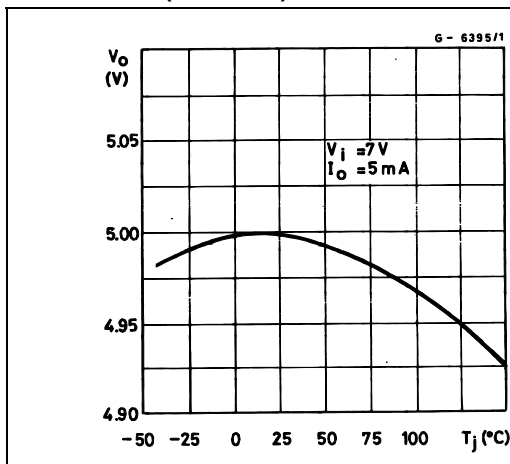


Figure 9. Output voltage vs temperature (L4940V85)

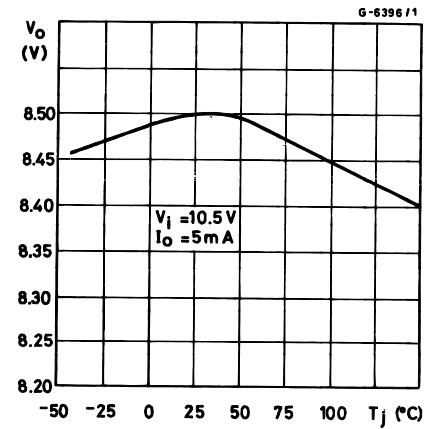


Figure 10. Output voltage vs temperature (L4940V10)

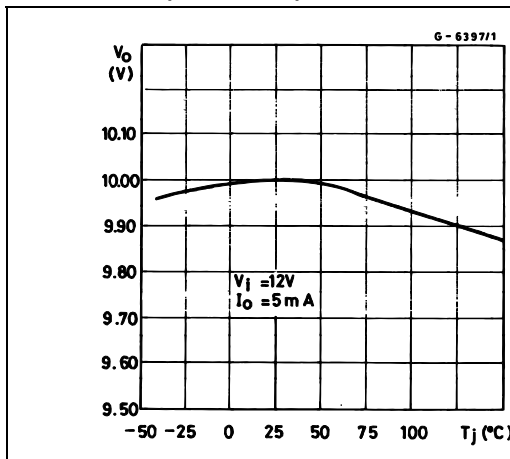


Figure 11. Output voltage vs temperature (L4940V12)

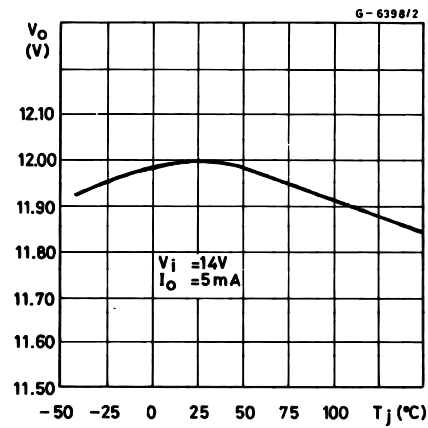


Figure 12. Quiescent current vs temperature (L4940V5)

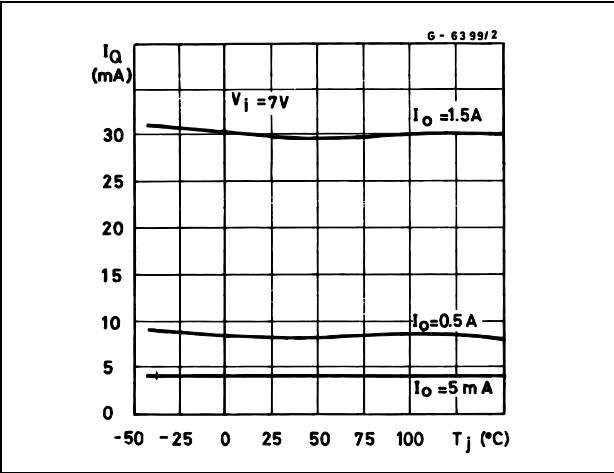


Figure 13. Quiescent current vs input voltage (L4940V5)

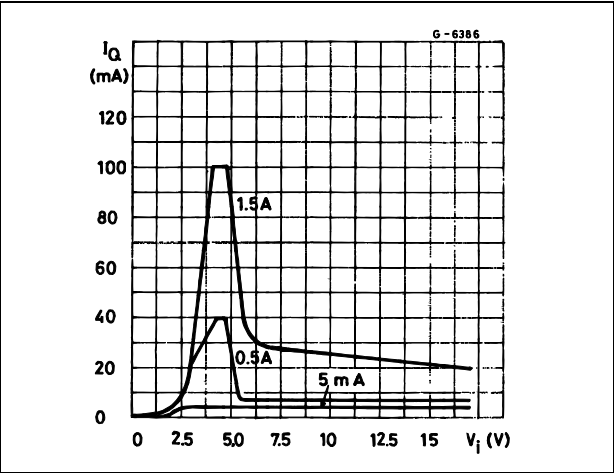


Figure 14. Quiescent current vs output current (L4940V5)

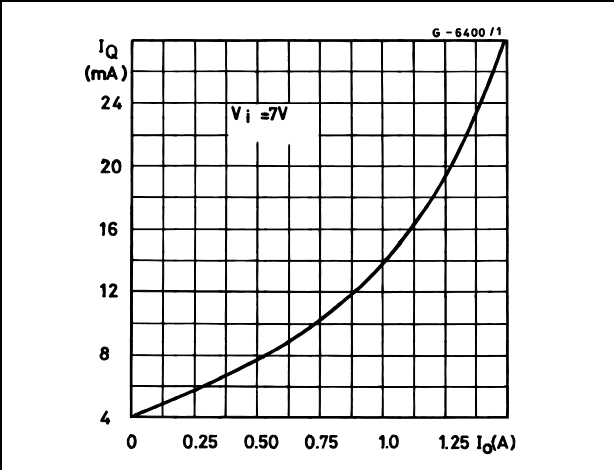


Figure 15. Short circuit current vs temperature (L4940V5)

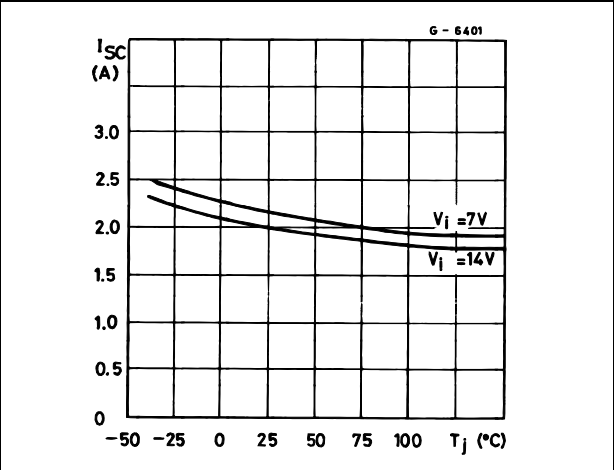


Figure 16. Peak output current vs input/output differential voltage (L4940V5)

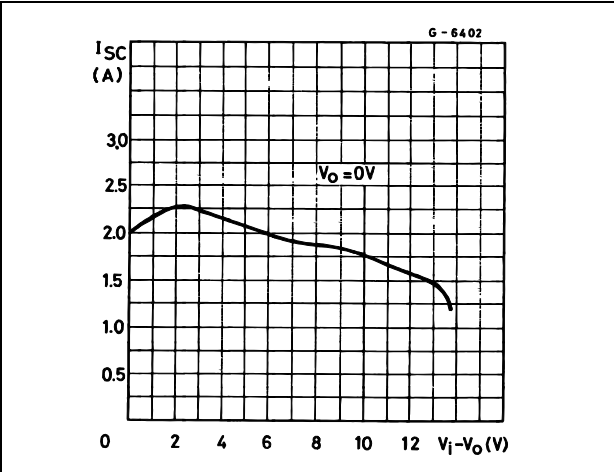


Figure 17. Low voltage behavior (L4940V5)

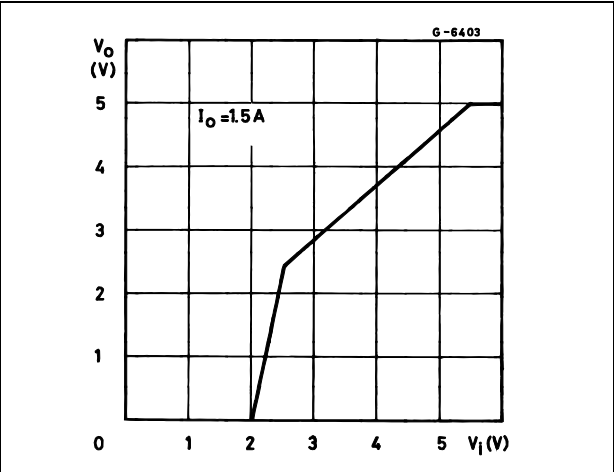


Figure 18. Low voltage behavior (L4940V85)

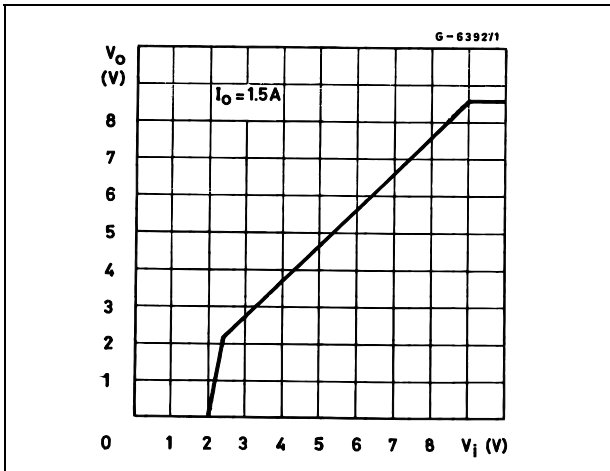


Figure 19. Low voltage behavior (L4940V10)

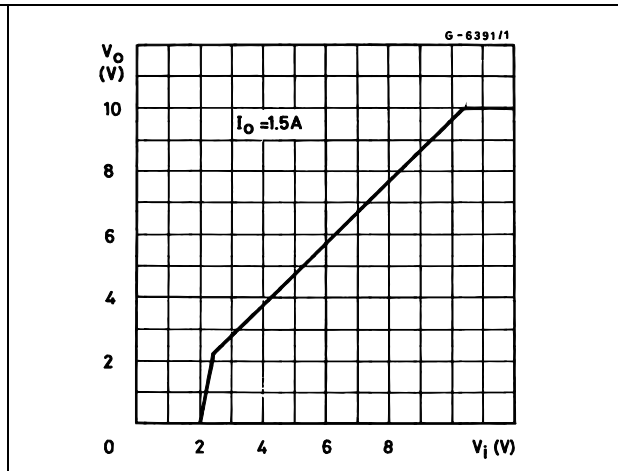


Figure 20. Low voltage behavior (L4940V12)

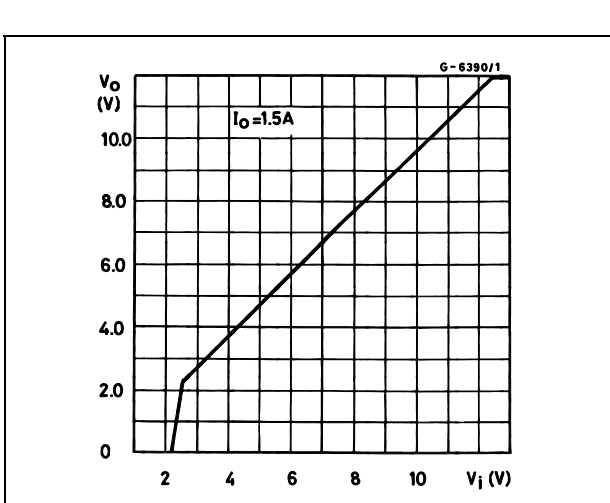


Figure 21. Supply voltage rejection vs frequency (L4940V5)

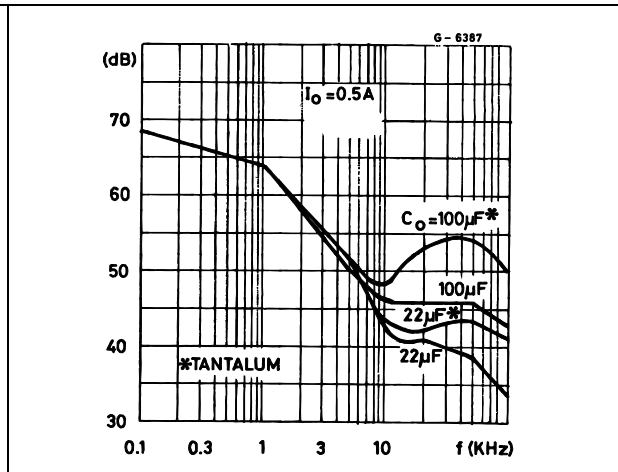


Figure 22. Supply voltage rejection vs output current (L4940V5)

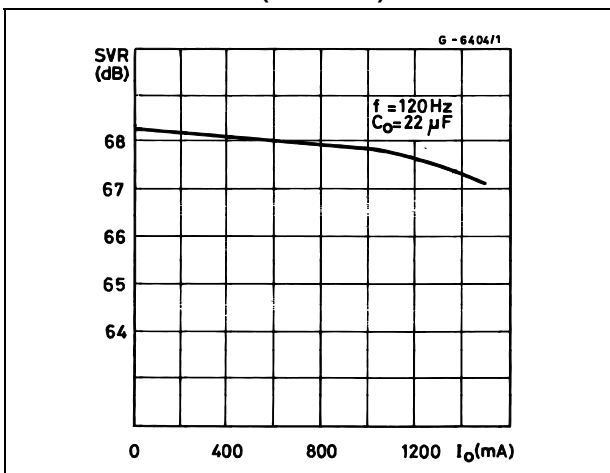


Figure 23. Load dump characteristics (L4940V5)

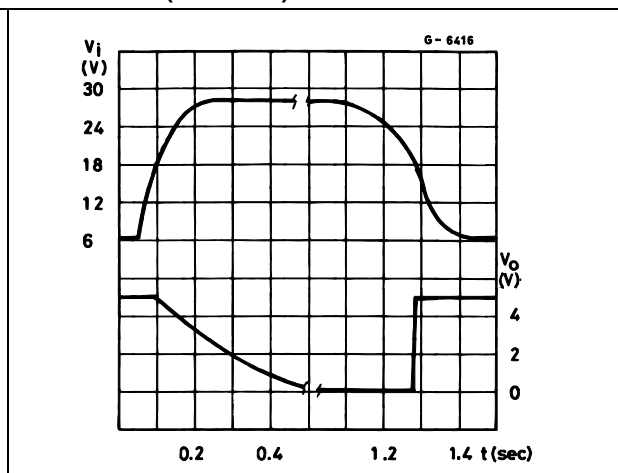


Figure 24. Line transient response (L4940V5)      Figure 25. Total power dissipation

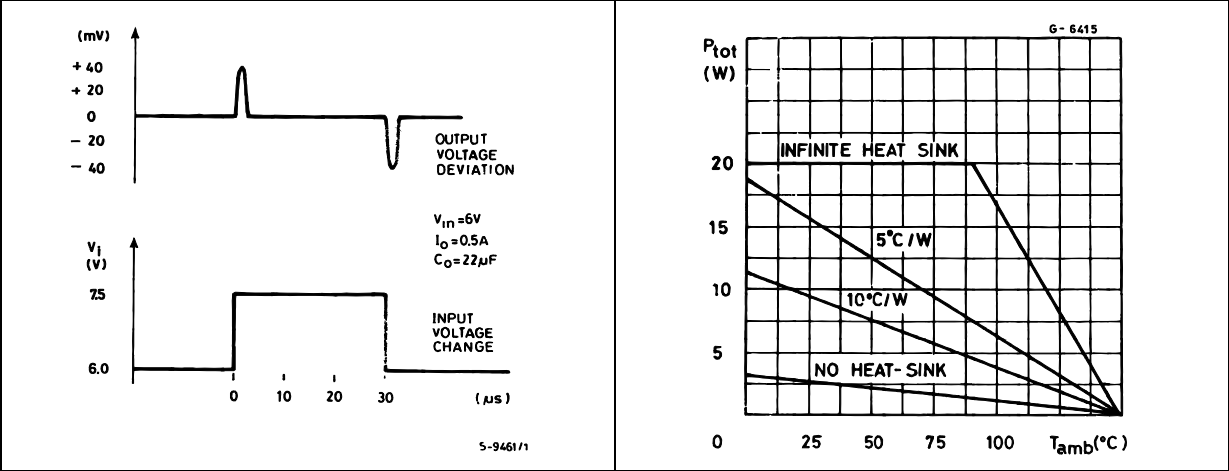
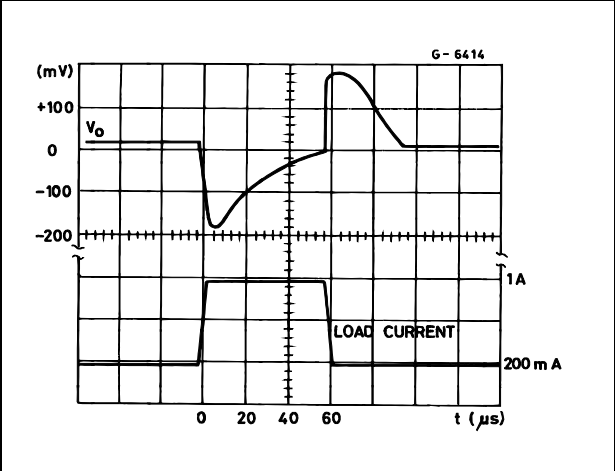


Figure 26. Load transient response



## 7 Schematic application

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

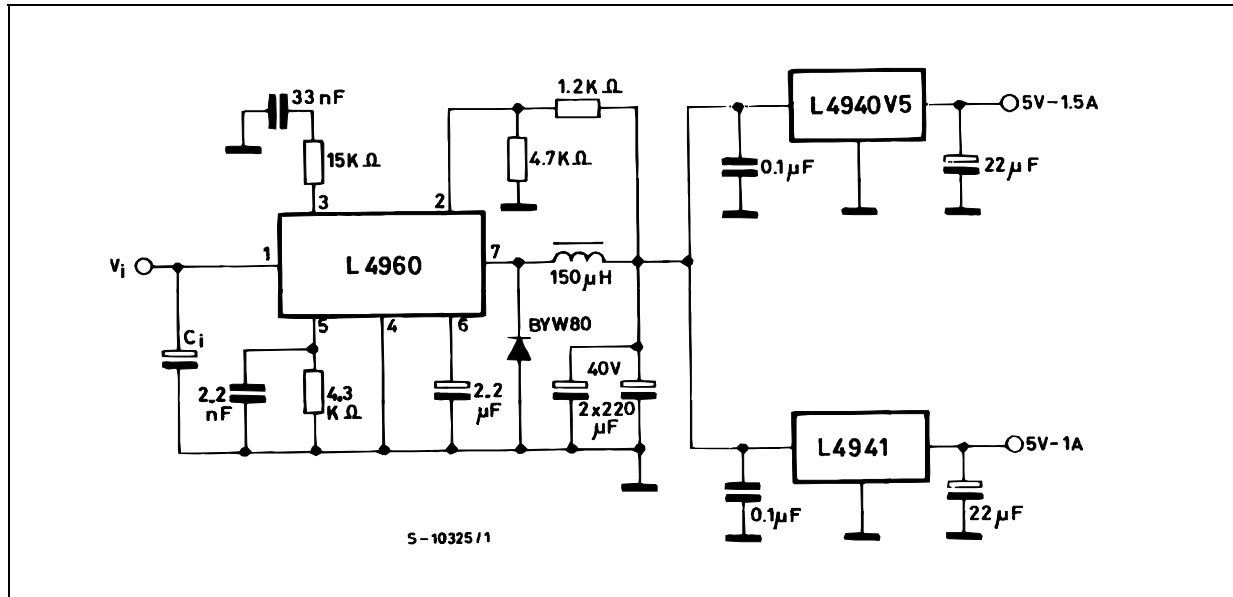
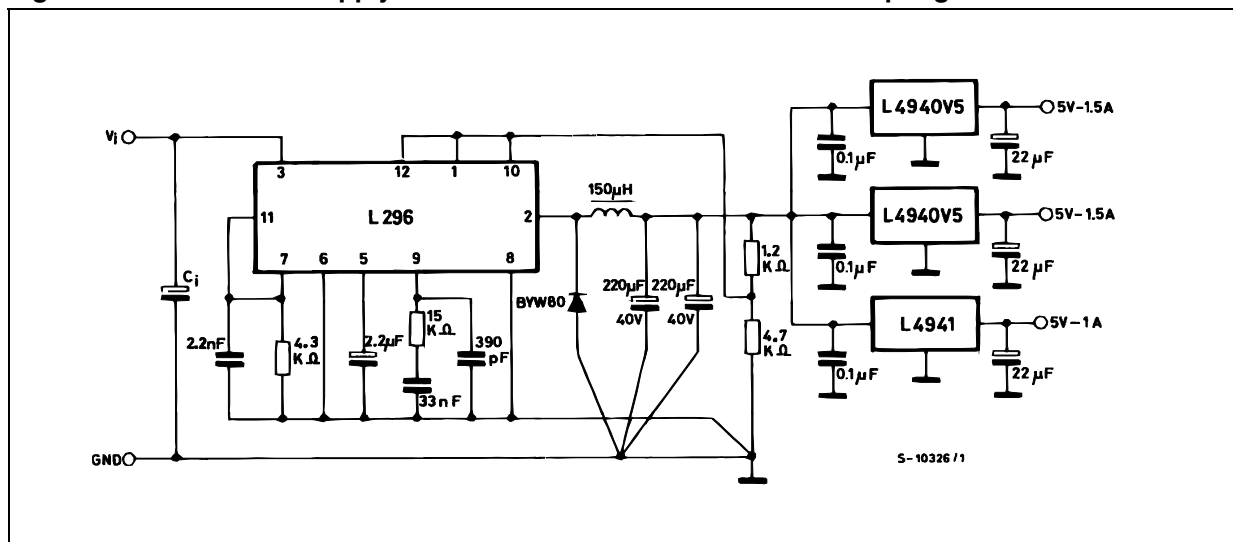


Figure 28. Distributed supply with On-card L4940 and L4941 low drop regulator

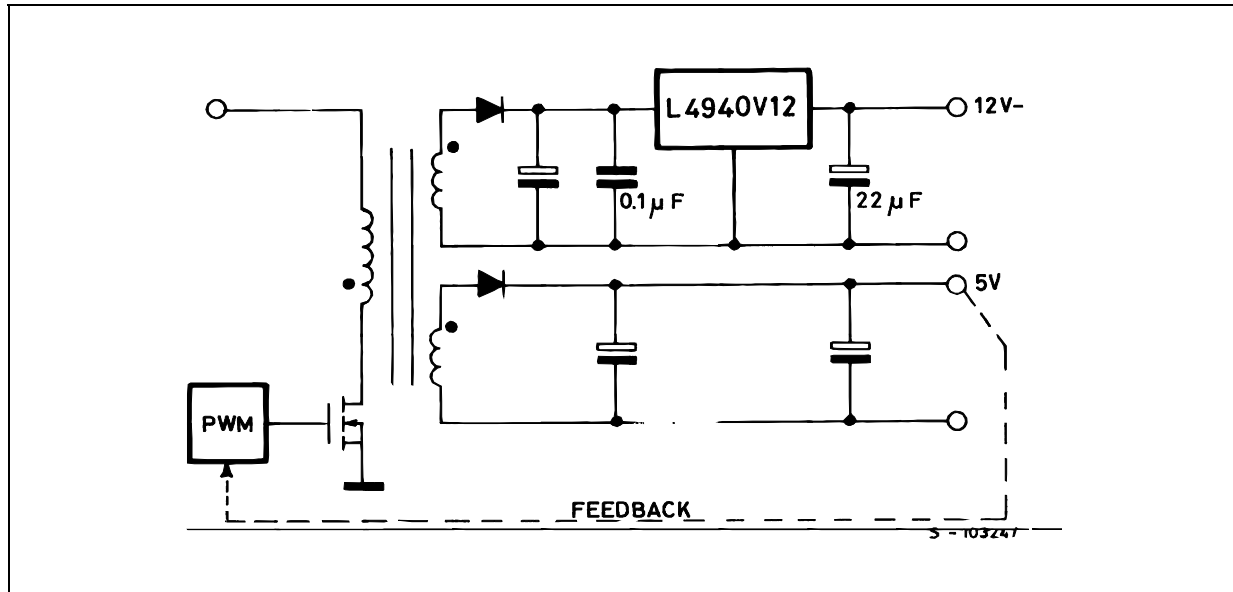


ADVANTAGES OF THESE APPLICATION ARE:

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.

Figure 29. Distributed supply with On-card L4940 and L4941 low drop regulator



ADVANTAGES OF THIS CONFIGURATION ARE:

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

12V output short circuit and thermally protected

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

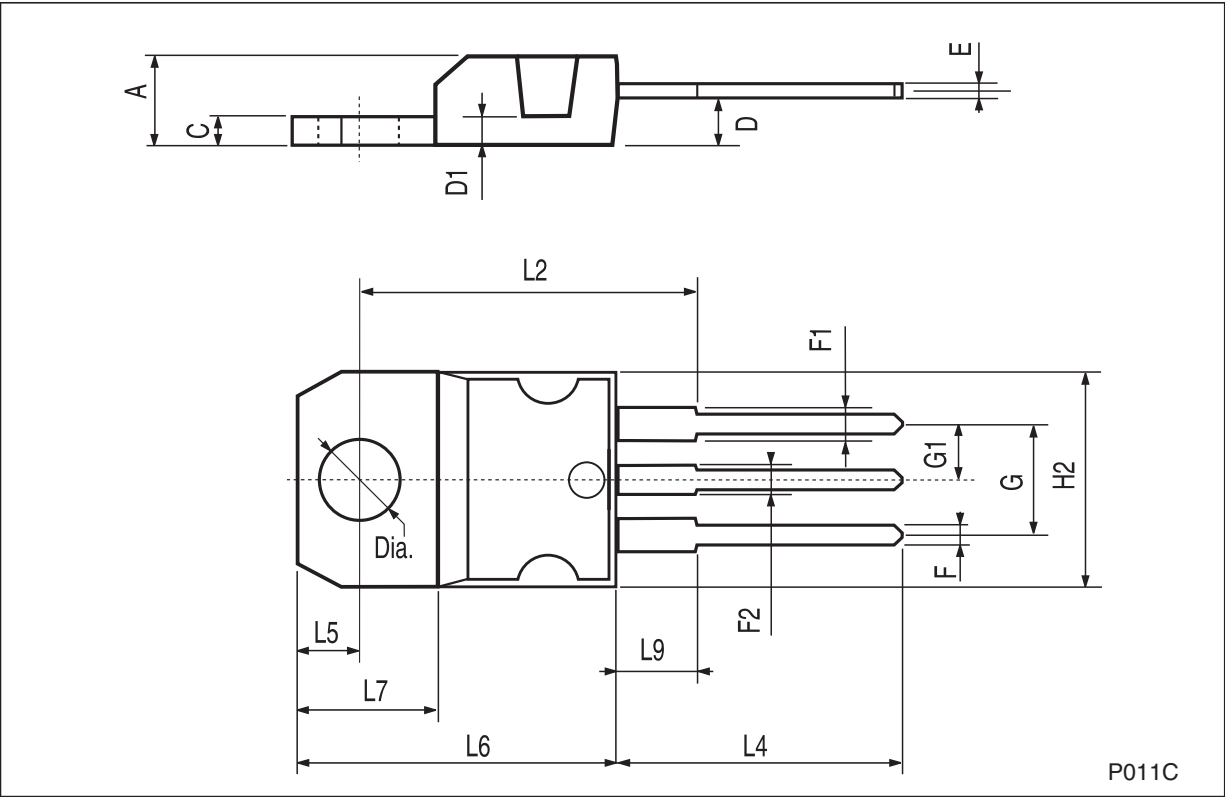


## 8 Package mechanical data

In order to meet environmental requirements, ST offers these devices in ECOPACK<sup>®</sup> 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](http://www.st.com).

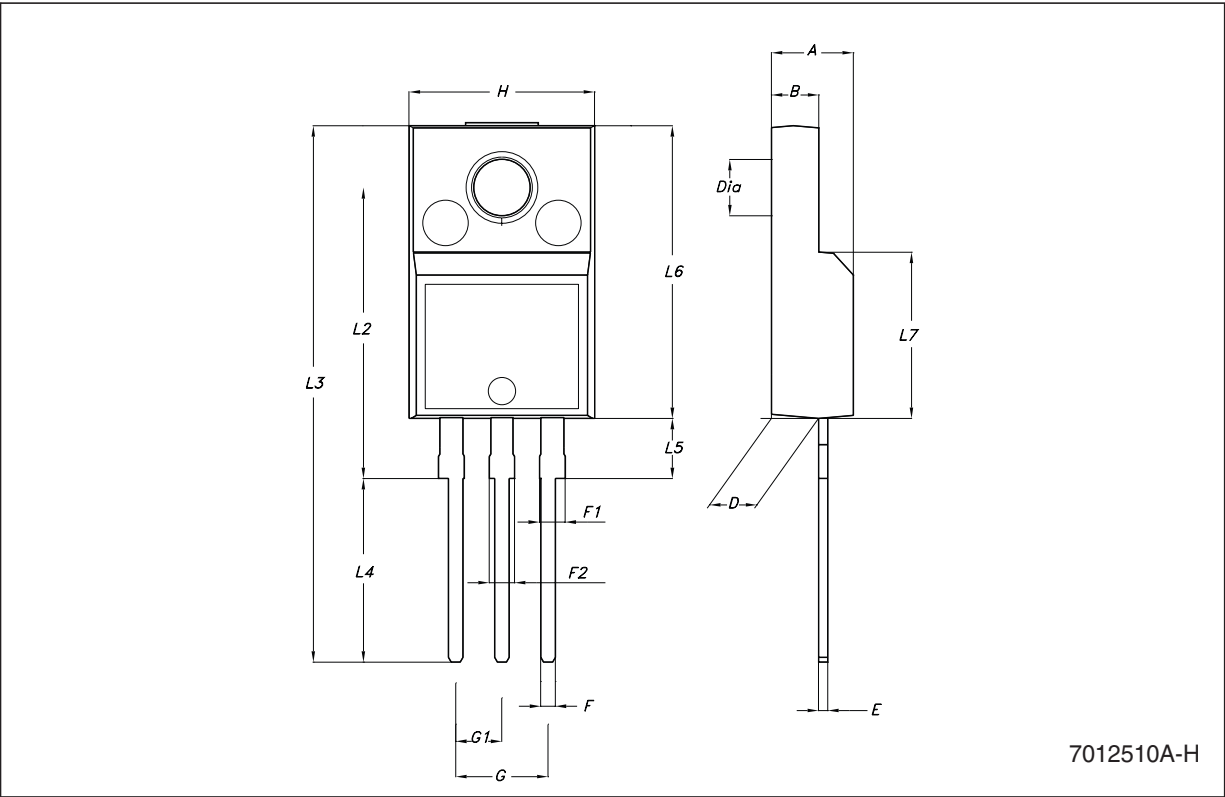
TO-220 mechanical data

| 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 |



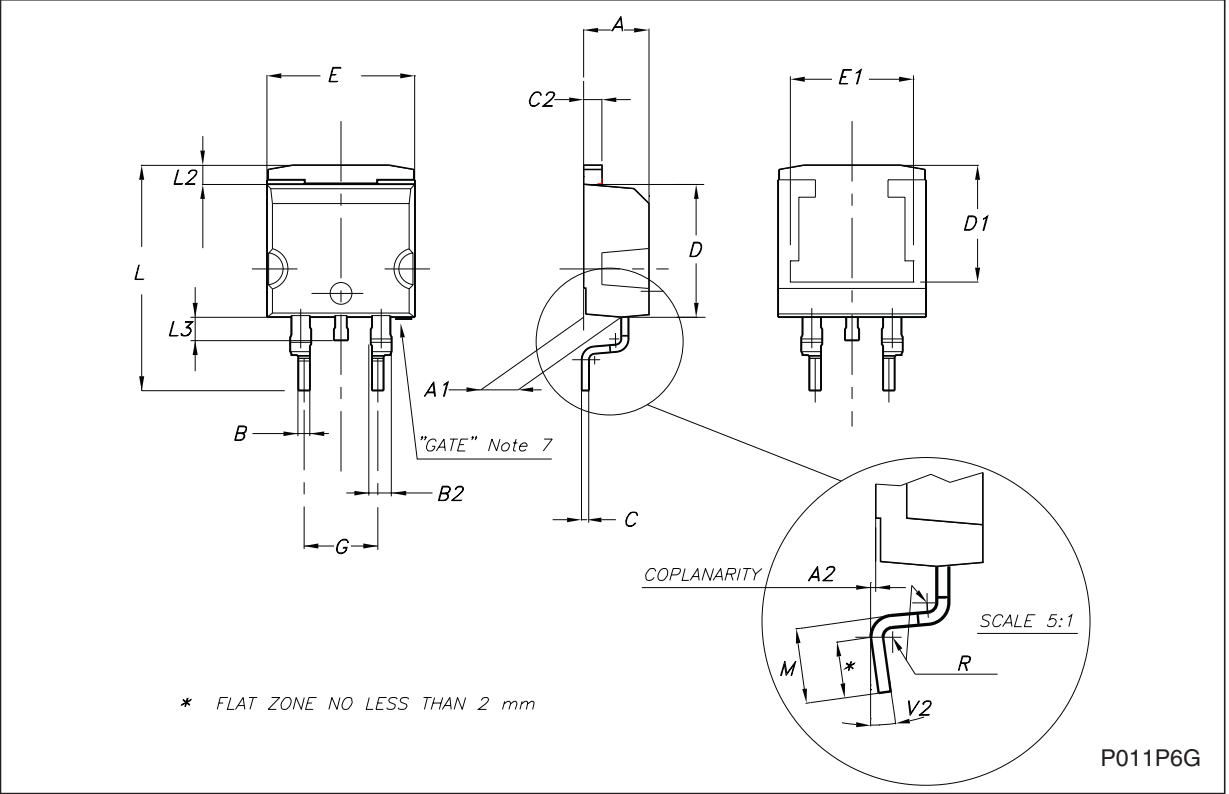
TO-220FP mechanical data

| 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 |



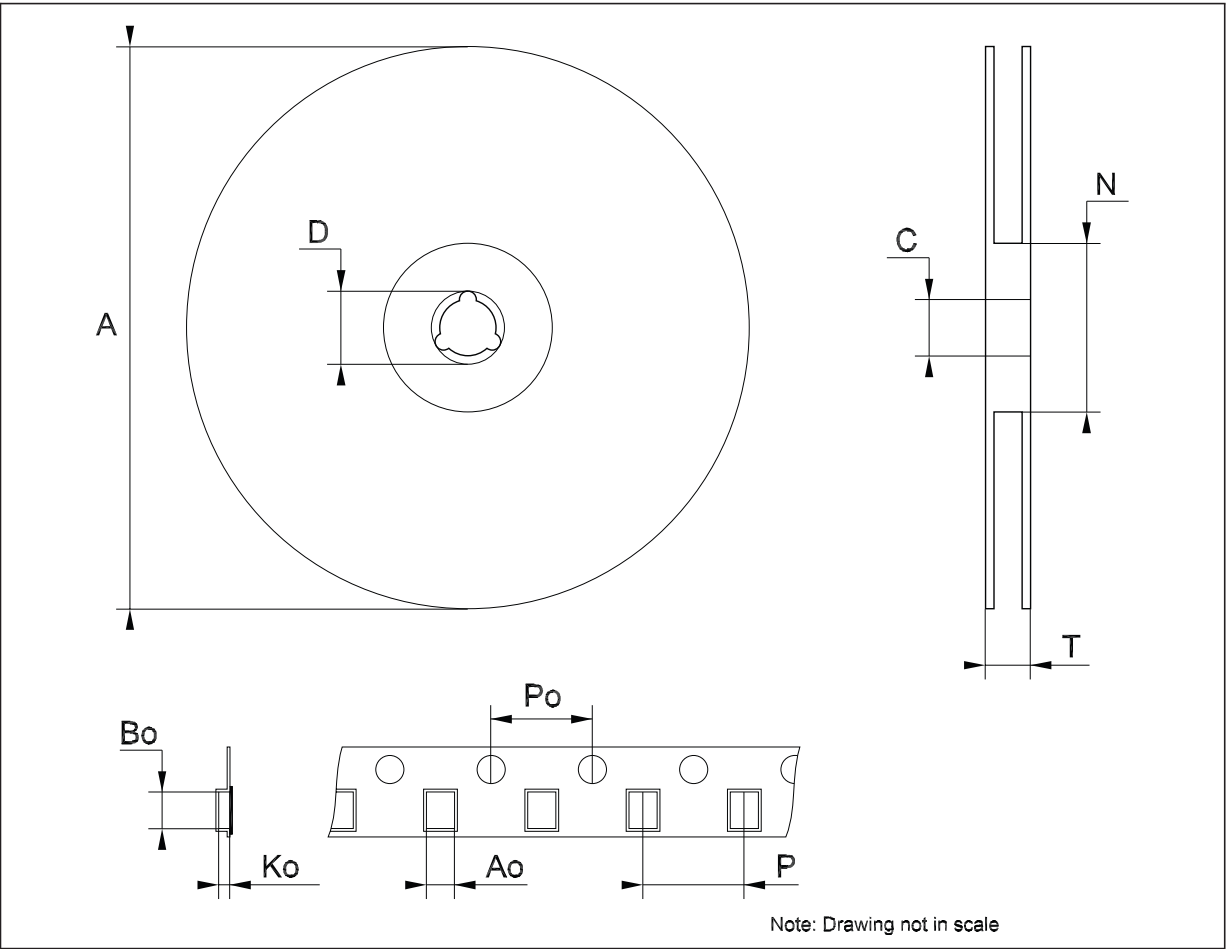
D<sup>2</sup>PAK mechanical data

| 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.   |

**Please Read Carefully:**

Information in this document is provided solely in connection with ST products. STMicroelectronics NV and its subsidiaries ("ST") reserve the right to make changes, corrections, modifications or improvements, to this document, and the products and services described herein at any time, without notice.

All ST products are sold pursuant to ST's terms and conditions of sale.

Purchasers are solely responsible for the choice, selection and use of the ST products and services described herein, and ST assumes no liability whatsoever relating to the choice, selection or use of the ST products and services described herein.

No license, express or implied, by estoppel or otherwise, to any intellectual property rights is granted under this document. If any part of this document refers to any third party products or services it shall not be deemed a license grant by ST for the use of such third party products or services, or any intellectual property contained therein or considered as a warranty covering the use in any manner whatsoever of such third party products or services or any intellectual property contained therein.

**UNLESS OTHERWISE SET FORTH IN ST'S TERMS AND CONDITIONS OF SALE ST DISCLAIMS ANY EXPRESS OR IMPLIED WARRANTY WITH RESPECT TO THE USE AND/OR SALE OF ST PRODUCTS INCLUDING WITHOUT LIMITATION IMPLIED WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE (AND THEIR EQUIVALENTS UNDER THE LAWS OF ANY JURISDICTION), OR INFRINGEMENT OF ANY PATENT, COPYRIGHT OR OTHER INTELLECTUAL PROPERTY RIGHT.**

**UNLESS EXPRESSLY APPROVED IN WRITING BY AN AUTHORIZED ST REPRESENTATIVE, ST PRODUCTS ARE NOT RECOMMENDED, AUTHORIZED OR WARRANTED FOR USE IN MILITARY, AIR CRAFT, SPACE, LIFE SAVING, OR LIFE SUSTAINING APPLICATIONS, NOR IN PRODUCTS OR SYSTEMS WHERE FAILURE OR MALFUNCTION MAY RESULT IN PERSONAL INJURY, DEATH, OR SEVERE PROPERTY OR ENVIRONMENTAL DAMAGE. ST PRODUCTS WHICH ARE NOT SPECIFIED AS "AUTOMOTIVE GRADE" MAY ONLY BE USED IN AUTOMOTIVE APPLICATIONS AT USER'S OWN RISK.**

Resale of ST products with provisions different from the statements and/or technical features set forth in this document shall immediately void any warranty granted by ST for the ST product or service described herein and shall not create or extend in any manner whatsoever, any liability of ST.

ST and the ST logo are trademarks or registered trademarks of ST in various countries.

Information in this document supersedes and replaces all information previously supplied.

The ST logo is a registered trademark of STMicroelectronics. All other names are the property of their respective owners.

© 2007 STMicroelectronics - All rights reserved

STMicroelectronics group of companies

Australia - Belgium - Brazil - Canada - China - Czech Republic - Finland - France - Germany - Hong Kong - India - Israel - Italy - Japan - Malaysia - Malta - Morocco - Singapore - Spain - Sweden - Switzerland - United Kingdom - United States of America

[www.st.com](http://www.st.com)