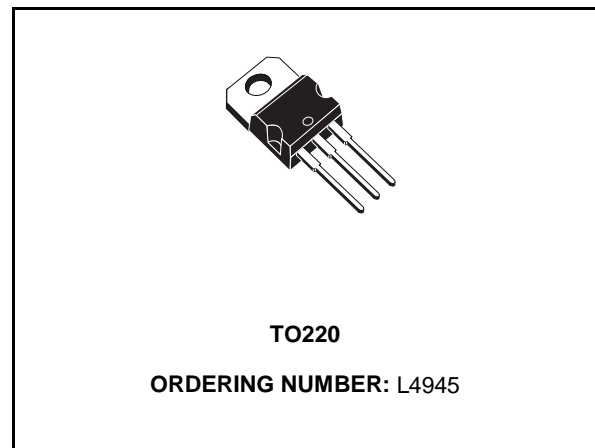


## 5V VERY LOW DROP VOLTAGE REGULATOR

- 5V ± 4% PRECISE OUTPUT VOLTAGE OVER FULL TEMPERATURE RANGE (- 40 / 125 °C)
- VERY LOW VOLTAGE DROP (0.75Vmax) OVER FULL TEMPERATURE RANGE
- OUTPUT CURRENT UP TO 500mA
- OVERVOLTAGE AND REVERSE VOLTAGE PROTECTIONS
- REVERSE VOLTAGE PROTECTION
- SHORT CIRCUIT PROTECTION AND THERMAL SHUT-DOWN (with hysteresis)
- LOW START UP CURRENT

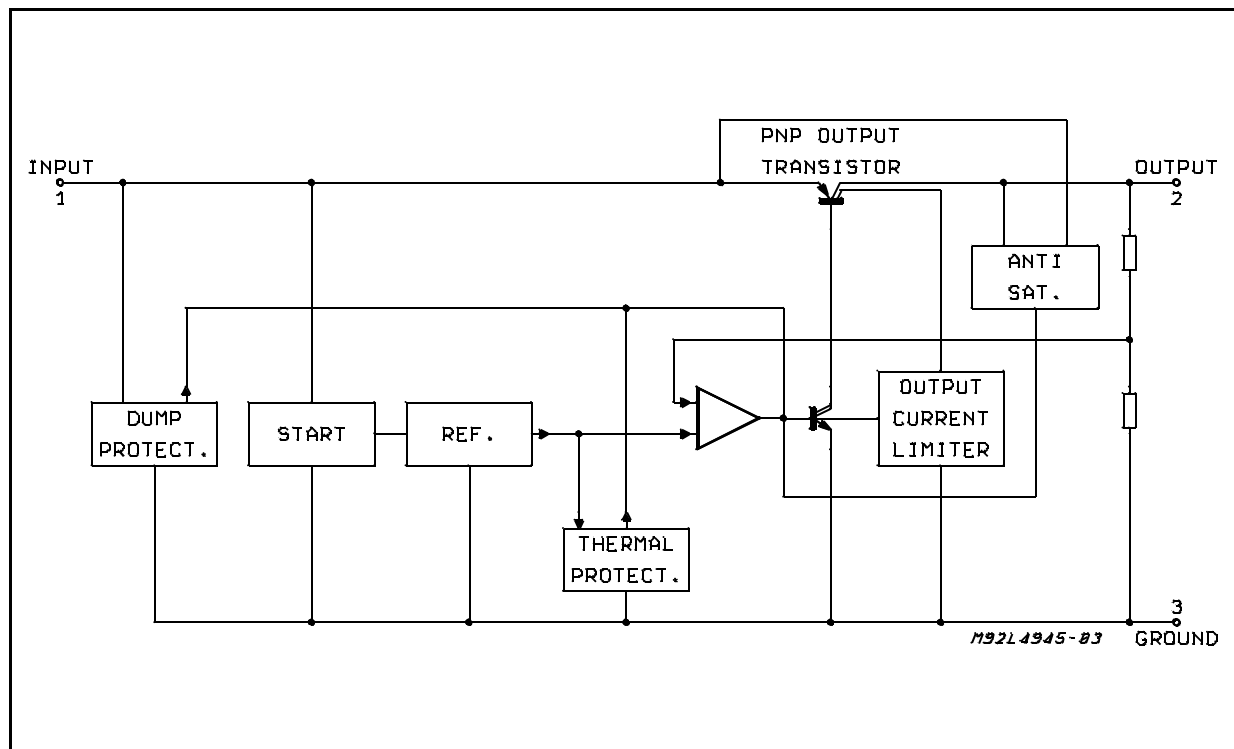
### DESCRIPTION

The L4945 is a monolithic integrated circuit in Versawatt package specially designed to provide a stabilized supply voltage for automotive and industrial electronic systems. Thanks to their very low voltage drop, in automotive applications the devices can work correctly even during the crank-



ing phase, when the battery voltage could fall as low as 6V. Furthermore, they incorporate a complete range of protection circuits against the dangerous overvoltages always present on the battery rail of the car.

### BLOCK DIAGRAM

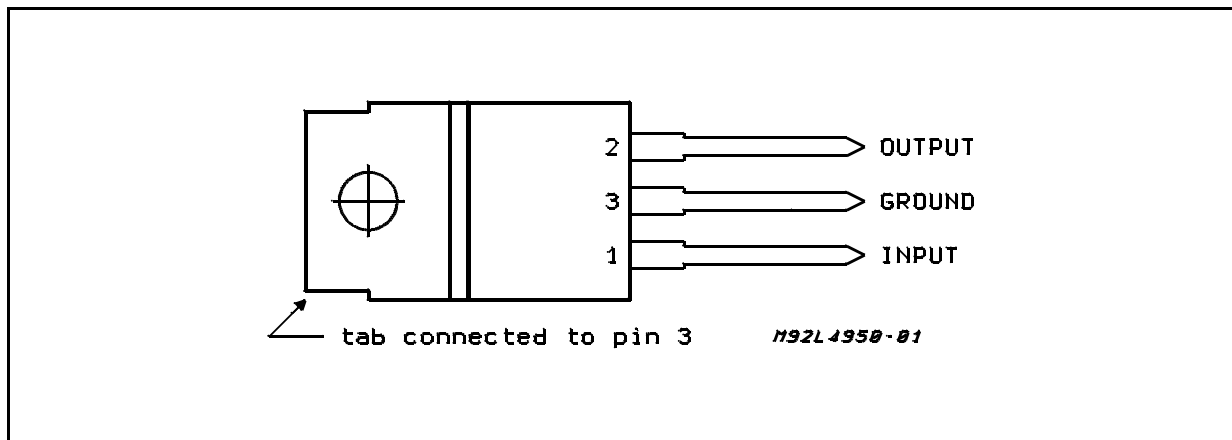


## ABSOLUTE MAXIMUM RATINGS

| Symbol    | Parameter                                                                                                                                                           | Value       | Unit |
|-----------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|------|
| $V_i$     | DC Input Voltage                                                                                                                                                    | 35          | V    |
|           | DC Reverse Input Voltage                                                                                                                                            | - 18        | V    |
|           | Transient Input Overvoltages :<br>Load Dump :                                                                                                                       | 80          | V    |
|           | $5\text{ms} \leq t_{\text{rise}} \leq 10\text{ms}$<br>$\tau_f$ Fall Time Constant = 100ms<br>$R_{\text{SOURCE}} \geq 0.5\Omega$                                     | - 80        | V    |
|           | Field Decay :<br>$5\text{ms} \leq t_{\text{fall}} \leq 10\text{ms}$ , $R_{\text{SOURCE}} \geq 10\Omega$<br>$\tau_r$ Rise Time Constant = 33ms                       | $\pm 100$   | V    |
|           | Low Energy Spike :<br>$t_{\text{rise}} = 1\mu\text{s}$ , $t_{\text{fall}} = 500\mu\text{s}$ , $R_{\text{SOURCE}} \geq 10\Omega$<br>$f_r$ Repetition Frequency = 5Hz |             |      |
| $T_J$     | Junction Temperature Range                                                                                                                                          | - 40 to 150 | °C   |
| $T_{OP}$  | Operating Temperature Range                                                                                                                                         | - 40 to 125 | °C   |
| $T_{stg}$ | Storage Temperature Range                                                                                                                                           | - 55 to 150 | °C   |

Note: The circuit is ESD protected according to MIL-STD-883C.

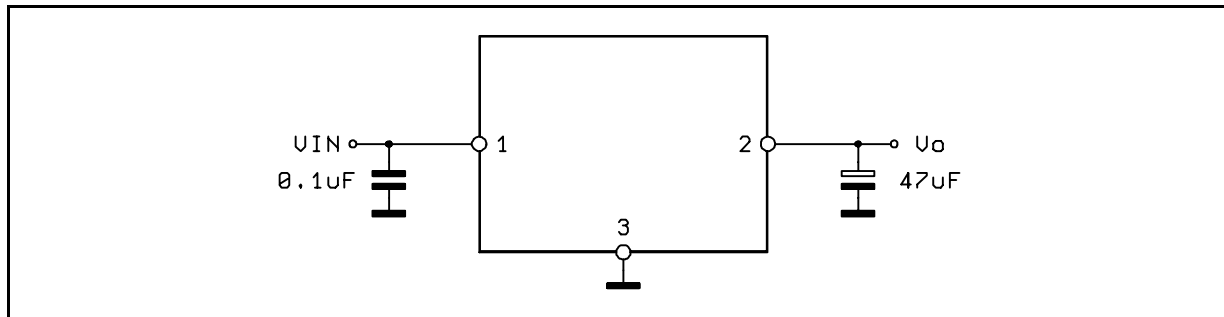
## PIN CONNECTION (Top view)



## THERMAL DATA

| Symbol           | Parameter                        | Value | Unit |
|------------------|----------------------------------|-------|------|
| $R_{th\ j-case}$ | Thermal Resistance Junction-case | Max 3 | °C/W |

## TEST CIRCUIT



**ELECTRICAL CHARACTERISTICS** (refer to the test circuit,  $V_i = 14.4\text{V}$ ,  $C_o = 47\mu\text{F}$ ,  $\text{ESR} < 10\Omega$ ,  $R_p = 1\text{K}\Omega$ ,  $R_L = 1\text{K}\Omega$ ,  $-40^\circ\text{C} \leq T_J \leq 125^\circ\text{C}$ , unless otherwise specified)

| Symbol                 | Parameter                        | Test Conditions                                                                                                | Min. | Typ. | Max. | Unit                 |
|------------------------|----------------------------------|----------------------------------------------------------------------------------------------------------------|------|------|------|----------------------|
| $V_o$                  | Output Voltage                   | $I_o = 0\text{mA}$ to $500\text{mA}$<br>Over Full T Range                                                      | 4.80 | 5.00 | 5.20 | V                    |
|                        |                                  | $T_J = 25^\circ\text{C}$                                                                                       | 4.90 | 5.00 | 5.10 | V                    |
| $V_i$                  | Operating Input Voltage          | $I_o = 0\text{mA}$ to (*) $500\text{mA}$                                                                       | 6    |      | 26   | V                    |
| $\Delta V_o$           | Line Regulation                  | $V_i = 6\text{V}$ to $26\text{V}$ ;<br>$I_o = 5\text{mA}$                                                      |      | 2    | 10   | mV                   |
| $\Delta V_o$           | Load Regulation                  | $I_o = 5\text{mA}$ to $500\text{mA}$                                                                           |      | 15   | 60   | mV                   |
| $V_i - V_o$            | Dropout Voltage                  | $I_o = 500\text{mA}$ , $T_J = 25^\circ\text{C}$<br>Over Full T Range                                           |      | 0.40 | 0.55 | V                    |
|                        |                                  |                                                                                                                |      |      | 0.75 | V                    |
| $I_q$                  | Quiescent Current                | $I_o = 0\text{mA}$ , $T_J = 25^\circ\text{C}$                                                                  |      | 5    | 10   | mA                   |
|                        |                                  | $I_o = 0\text{mA}$ Over Full T                                                                                 |      | 6.5  | 13   | mA                   |
|                        |                                  | $I_o = 500\text{mA}$ Over Full T                                                                               |      | 110  | 180  | mA                   |
| $\frac{\Delta V_o}{T}$ | Temperature Output Voltage Drift |                                                                                                                |      | -0.5 |      | mV/ $^\circ\text{C}$ |
| SVR                    | Supply Volt. Rej.                | $I_o = 350\text{mA}$ ; $f = 120\text{Hz}$<br>$C_o = 100\mu\text{F}$ ;<br>$V_i = 12\text{V} \pm 5\text{V}_{pp}$ | 50   | 60   |      | dB                   |
| $I_{sc}$               | Output Short Circuit Current     |                                                                                                                | 0.50 | 0.80 | 1.50 | A                    |

(\*) For a DC voltage  $26 < V_i < 37\text{V}$  the device is not operating

## FUNCTIONAL DESCRIPTION

The block diagram shows the basic structure of the devices : the reference, the error amplifier, the driver, the power PNP, the protection and reset functions.

The power stage is a Lateral PNP transistor which allows a very low dropout voltage (typ.  $400\text{mV}$  at  $T_J = 25^\circ\text{C}$ , max.  $750\text{mV}$  over the full temperature range @  $I_o = 500\text{mA}$ ). The typical curve of the dropout voltage as a function of the junction temperature is shown in Fig. 1 : that is the worst case, where  $I_o = 500\text{mA}$ .

The current consumption of the devices (quiescent current) are maximum  $10\text{mA}$  - over full T -

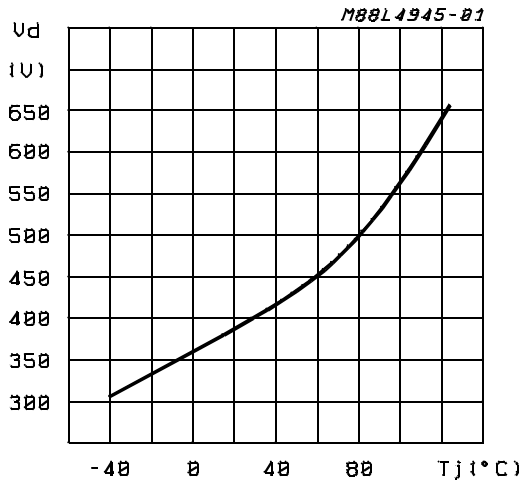
when no load current is required.

The internal antisaturation circuit allows a drastic reduction in the current peak which takes place during the start up.

The three gain stages (operational amplifier, driver and power PNP) require the external capacitor ( $C_{omin} = 20\mu\text{F}$ ) to guarantee the global stability of the system.

Load dump and field decay protections ( $\pm 80\text{V}$ ,  $t = 300\text{ms}$ ), reverse voltage ( $-18\text{V}$ ) and short circuit protection, thermal shutdown are the main features that make the devices specially suitable for applications in the automotive environment.

**Figure 1:** Typical Dropout Voltage vs.  $T_j$   
( $I_o = 500\text{mA}$ ).



**EXTERNAL COMPENSATION**

Since the purpose of a voltage regulator is to supply and load variations, the open loop gain of the regulators must be very high at low frequencies. This may cause instability as a result of the vari-

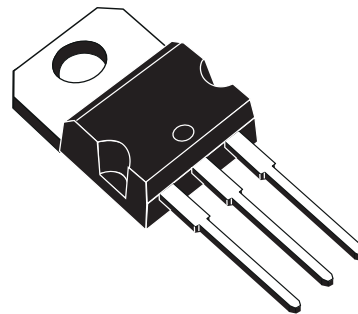
ous poles present in the loop. To avoid this instability dominant pole compensation is used to reduce phase shift due to other poles at the unity gain frequency. The lower the frequency of these other poles at the unity gain frequency, the greater must be capacitor used to create the dominant pole for the same DC gain.

Where the output transistor is a lateral PNP type there is a pole in the regulation loop at a frequency too low to be compensated by a capacitor which can be integrated. An external compensation is therefore necessary so a very high value capacitor must be connected from the output to ground.

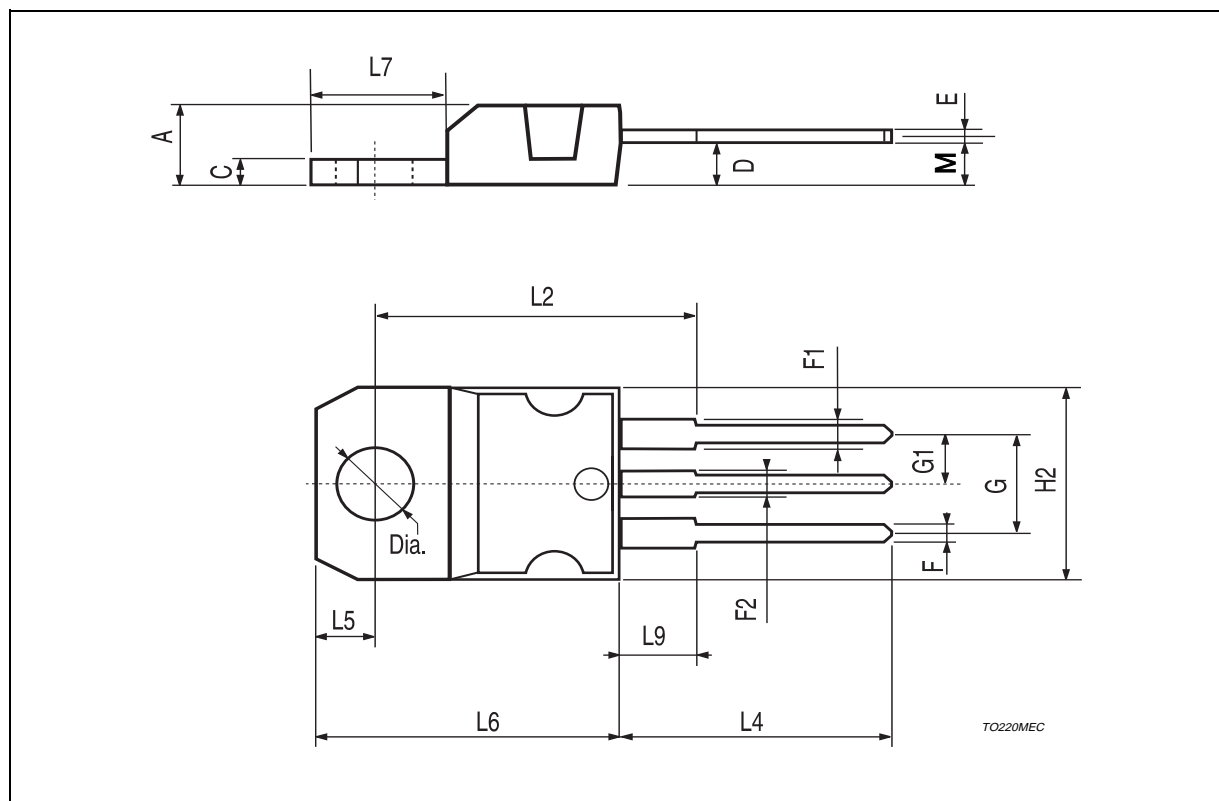
The parasitic equivalent series resistance of the capacitor used adds a zero to the regulation loop. This zero may compromise the stability of the system since its effect tends to cancel the effect of the pole added. In regulators this ESR must be less than  $3\Omega$  and the minimum capacitor value is  $47\mu\text{F}$ .

| 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 |
| 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   | 2.40  |      | 2.70  | 0.094 |       | 0.106 |
| H2   | 10.0  |      | 10.4  | 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   | 6.20  |      | 6.60  | 0.244 |       | 0.260 |
| L9   | 3.50  |      | 3.93  | 0.137 |       | 0.154 |
| M    |       | 2.6  |       |       | 0.102 |       |
| Dia  | 3.75  |      | 3.85  | 0.147 |       | 0.151 |

## OUTLINE AND MECHANICAL DATA



## Versawatt (TO220)



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