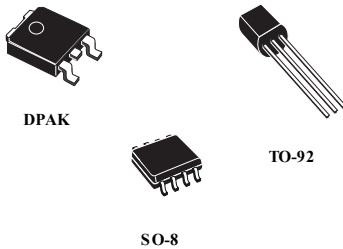




**THE DATASHEET OF
LM2931AD33R**



Very low drop voltage regulators with inhibit function



Features

- AEC-Q100 qualified (DPAK only)
- Very low dropout voltage (90 mV typ. at 10 mA load)
- Low quiescent current (typ. 2.5 mA, at 100 mA load)
- Output current up to 100 mA
- Adjustable (from $V_{OUT} = 2.5$ V only SO-8) and fixed (3.3 V and 5 V) output voltage version
- Internal current and thermal limit
- Load dump protection up to 60 V
- Reverse transient protection up to - 50 V
- Temperature range: - 40 to 125 °C
- Package available: TO-92, DPAK, SO-8 (with inhibit control)

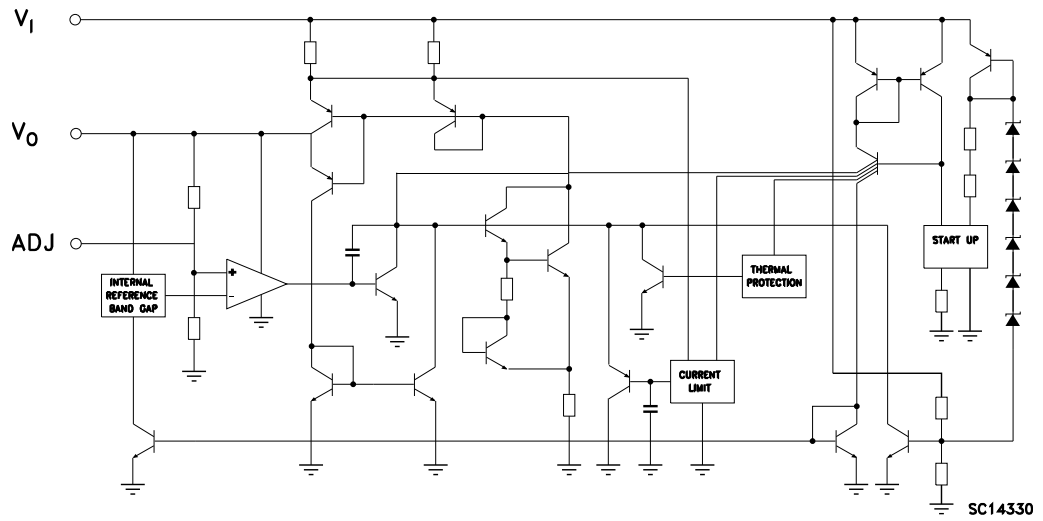
Description

The LM2931 are very low drop regulators. The very low drop voltage and the low quiescent current make them particularly suitable for low noise, low power applications and in battery-powered systems. In the 8-pin configuration (SO-8), fully compatible with the older L78L family, a shutdown logic control function is available. This means that when the device is used as a local regulator it is possible to put a part of the board in standby, decreasing total power consumption. Ideal for automotive applications, LM2931 is protected from reverse battery installations or 2 battery jumps. During the transient, such as a 60 V load dump, when the input voltage can exceed the specified maximum operating input voltage of 26 V, the regulator automatically shuts down to protect both internal circuitry and the load.

Maturity status link

[LM2931](#)

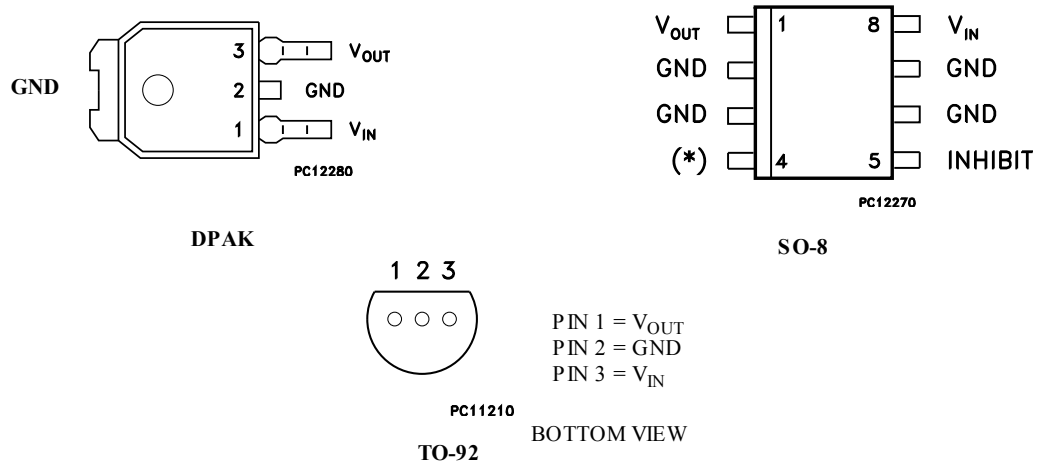
1 Diagram

Figure 2. Schematic diagram


AMG110720161100MT

2 Pin configuration

Figure 3. Pin connections (top view)



AMG110720161101MT

Note: (*) ADJ pin on the adjustable version, not connected in the fixed output version.

3 Maximum ratings

Table 1. Absolute maximum ratings

| Symbol | Parameter | Value | Unit |
|-----------|---|--------------------|------|
| V_I | DC positive input voltage | 40 | V |
| V_I | DC reverse input voltage | -15 | V |
| V_I | Transient input voltage ($T < 100$ ms) | 60 | V |
| V_I | Transient reverse input voltage ($T < 100$ ms) | -50 | V |
| V_{INH} | Inhibit input voltage | 40 | V |
| I_O | Output current | Internally limited | |
| T_{STG} | Storage temperature range | -65 to 150 | °C |
| T_{OP} | Operating junction temperature range | -40 to 125 | °C |

Note: Absolute maximum ratings are those values beyond which damage to the device may occur. Functional operation under these condition is not implied.

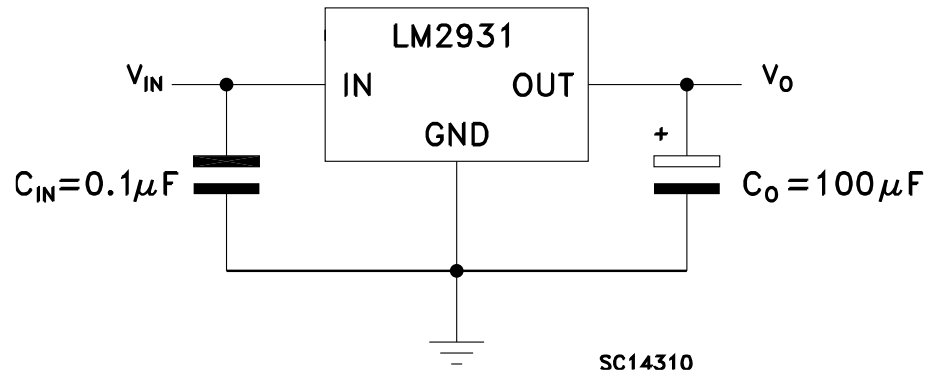
Table 2. Thermal data

| Symbol | Parameter | SO-8 | DPAK | TO-92 | Unit |
|------------|-------------------------------------|-------------------|------|-------|------|
| R_{thJC} | Thermal resistance junction-case | 20 | 8 | 57 | °C/W |
| R_{thJA} | Thermal resistance junction-ambient | 55 ⁽¹⁾ | 100 | 200 | °C/W |

1. Considering 6 cm² of copper board heat-sink.

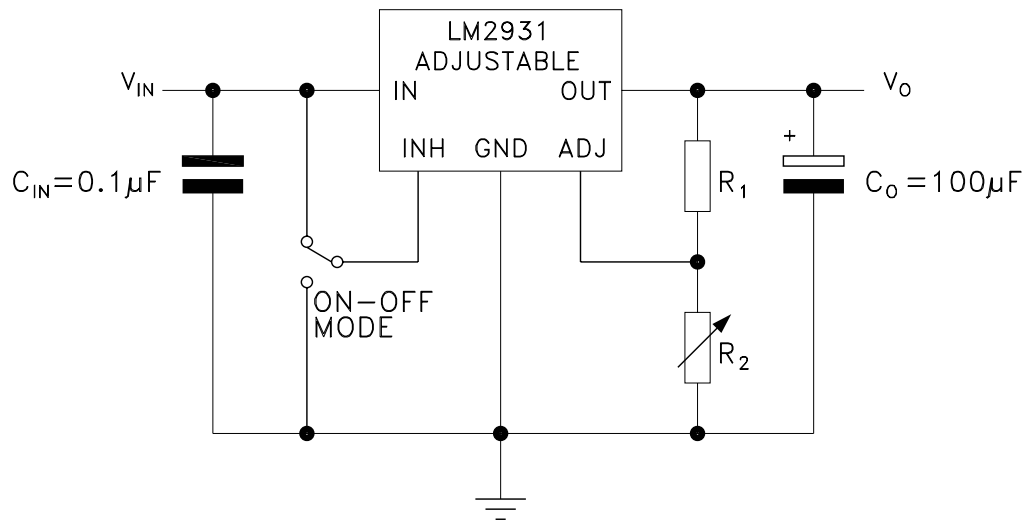
4 Application circuits

Figure 4. Application circuit for fixed output



AMG110720161102MT

Figure 5. Application circuit for adjustable output



Note: R_1 suggested value = 27 k Ω
 $V_O = V_{REF} (R_1 + R_2)/R_1$
 Inhibit pin: regulator is enabled when $V_{INH} < 1.2$ V , disabled when $V_{INH} > 3.25$ V

5 Electrical characteristics

Refer to the application circuit [Figure 4. Application circuit for fixed output](#), $T_J = 25\text{ °C}$, $C_I = 0.1\text{ }\mu\text{F}$, $C_O = 100\text{ }\mu\text{F}$, $V_I = 14\text{ V}$, $I_O = 10\text{ mA}$, $V_{INH} = 0\text{ V}$, unless otherwise specified.

Table 3. Electrical characteristics of LM2931A33/LM2931A33Y

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|-----------|--|---|-------|------|-------|---------------------|
| V_I | Maximum operating input voltage | $I_O = 10\text{ mA}$, $T_J = -40\text{ to }125\text{ °C}$ | 26 | | | V |
| V_O | Output voltage | | 3.175 | 3.3 | 3.425 | V |
| V_O | Output voltage | $I_O = 100\text{ mA}$, $V_I = 6\text{ to }26\text{ V}$, $T_J = -40\text{ to }125\text{ °C}$ | 3.135 | 3.3 | 3.465 | V |
| DV_O | Line regulation | $V_I = 9\text{ to }16\text{ V}$ | | 2 | 10 | mV |
| | | $V_I = 6\text{ to }26\text{ V}$ | | 4 | 33 | |
| DV_O | Load regulation | $I_O = 5\text{ to }100\text{ mA}$ | | 10 | 33 | mV |
| V_d | Dropout voltage ⁽¹⁾ | $I_O = 10\text{ mA}$ | | 90 | 250 | mV |
| | | $I_O = 100\text{ mA}$ | | 250 | 600 | |
| I_d | Quiescent current ON MODE | $I_O = 100\text{ mA}$ | | 2.5 | 30 | mA |
| | OFF MODE | $V_{INH} = 2.5\text{ V}$, $R_{LOAD} = 330\text{ }\Omega$ | | 0.3 | 1 | |
| I_{SC} | Short circuit current | | 100 | 300 | | mA |
| SVR | Supply voltage rejection | $I_O = 100\text{ mA}$, $V_I = 14 \pm 2\text{ V}$, $f = 120\text{ Hz}$ | 55 | 78 | | dB |
| V_{IL} | Control input voltage low | $T_J = -40\text{ to }125\text{ °C}$ | | 2 | 1.2 | V |
| V_{IH} | Control input voltage high | $T_J = -40\text{ to }125\text{ °C}$ | 3.25 | 2 | | V |
| I_{INH} | Inhibit input current | $V_{INH} = 2.5\text{ V}$ | | 22 | 50 | μA |
| V_I | Transient input voltage | $R_{LOAD} = 330\text{ }\Omega$, $T < 100\text{ ms}$ | 60 | 70 | | V |
| V_I | Reverse polarity input voltage | $V_O = \pm 0.3\text{ V}$, $R_{LOAD} = 330\text{ }\Omega$ | -15 | -50 | | V |
| V_I | Reverse polarity input voltage transient | $R_{LOAD} = 330\text{ }\Omega$, $T < 100\text{ ms}$ | -50 | | | V |
| eN | Output noise voltage | $B = 10\text{ Hz to }100\text{ kHz}$ | | 330 | | μV_{RMS} |

1. V_d measured when the output voltage has dropped 100 mV from the nominal value obtained at 14 V.

Refer to the application circuit [Figure 4. Application circuit for fixed output](#), $T_J = 25\text{ °C}$, $C_I = 0.1\text{ }\mu\text{F}$, $C_O = 100\text{ }\mu\text{F}$, $V_I = 14\text{ V}$, $I_O = 10\text{ mA}$, $V_{INH} = 0\text{ V}$, unless otherwise specified.

Table 4. Electrical characteristics of LM2931A50/ LM2931A50Y

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|--------|---------------------------------|---|------|------|------|------|
| V_I | Maximum operating input voltage | $I_O = 10\text{ mA}$, $T_J = -40\text{ to }125\text{ °C}$ | 26 | | | V |
| V_O | Output voltage | | 4.81 | 5 | 5.19 | V |
| V_O | Output voltage | $I_O = 100\text{ mA}$, $V_I = 6\text{ to }26\text{ V}$, $T_J = -40\text{ to }125\text{ °C}$ | 4.75 | 5 | 5.25 | V |
| DV_O | Line regulation | $V_I = 9\text{ to }16\text{ V}$ | | 2 | 10 | mV |
| | | $V_I = 6\text{ to }26\text{ V}$ | | 4 | 30 | |
| DV_O | Load regulation | $I_O = 5\text{ to }100\text{ mA}$ | | 15 | 50 | mV |
| V_d | Dropout voltage ⁽¹⁾ | $I_O = 10\text{ mA}$ | | 90 | 200 | mV |
| | | $I_O = 100\text{ mA}$ | | 250 | 600 | |

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|-----------|--|--|------|------|------|---------------------|
| I_d | Quiescent current ON MODE | $I_O = 100 \text{ mA}$ | | 2.5 | 30 | mA |
| | OFF MODE | $V_{INH} = 2.5 \text{ V}, R_{LOAD} = 500 \Omega$ | | 0.3 | 1 | mA |
| I_{SC} | Short circuit current | | 100 | 300 | | mA |
| SVR | Supply voltage rejection | $I_O = 100 \text{ mA}, V_I = 14 \pm 2 \text{ V } f = 120 \text{ Hz}$ | 55 | 75 | | dB |
| V_{IL} | Control input voltage low | $T_J = -40 \text{ to } 125 \text{ }^\circ\text{C}$ | | 2 | 1.2 | V |
| V_{IH} | Control input voltage high | $T_J = -40 \text{ to } 125 \text{ }^\circ\text{C}$ | 3.25 | 2 | | V |
| I_{INH} | Inhibit input current | $V_{INH} = 2.5 \text{ V}$ | | 22 | 50 | μA |
| V_I | Transient input voltage | $R_{LOAD} = 500 \Omega, T < 100 \text{ ms}$ | 60 | 70 | | V |
| V_I | Reverse polarity input voltage | $V_O = \pm 0.3 \text{ V}, R_{LOAD} = 500 \Omega$ | -15 | -50 | | V |
| V_I | Reverse polarity input voltage transient | $R_{LOAD} = 500 \Omega, T < 100 \text{ ms}$ | -50 | | | V |
| eN | Output noise voltage | $B = 10 \text{ Hz to } 100 \text{ kHz}$ | | 500 | | μV_{RMS} |

1. V_d measured when the output voltage has dropped 100 mV from the nominal value obtained at 14 V.

Refer to the application circuit [Figure 5. Application circuit for adjustable output](#) with $R_1 = 27 \text{ k}\Omega$ and $R_2 = 40.5 \text{ k}\Omega$, $T_J = 25 \text{ }^\circ\text{C}$, $C_I = 0.1 \text{ }\mu\text{F}$, $C_O = 100 \text{ }\mu\text{F}$, $V_I = 14 \text{ V}$, $I_O = 10 \text{ mA}$, $V_{INH} = 0 \text{ V}$, unless otherwise specified.

Table 5. Electrical characteristics of LM2931 (adjustable version)

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|-----------|--|--|------|------|------|---------------------|
| V_I | Maximum operating input voltage | $I_O = 10 \text{ mA}, T_J = -40 \text{ to } 125 \text{ }^\circ\text{C}$ | 26 | | | V |
| V_{REF} | Reference voltage ⁽¹⁾ | | 1.14 | 1.2 | 1.26 | V |
| V_{REF} | Reference voltage ⁽¹⁾ | $I_O = 100 \text{ mA}, T_J = -40 \text{ to } 125 \text{ }^\circ\text{C}$ | 1.08 | 1.2 | 1.32 | V |
| DV_O | Line regulation | $V_I = 3.6 \text{ to } 26 \text{ V}$ | | 0.6 | 4.5 | mV |
| DV_O | Load regulation | $I_O = 5 \text{ to } 100 \text{ mA}$ | | 9 | 30 | mV |
| V_d | Dropout voltage ⁽²⁾ | $I_O = 10 \text{ mA}$ | | 90 | 200 | mV |
| | | $I_O = 100 \text{ mA}$ | | 250 | 600 | |
| I_d | Quiescent current ON MODE | $I_O = 100 \text{ mA}$ | | 2.5 | 30 | mA |
| | OFF MODE | $V_{INH} = 2.5 \text{ V}, R_{LOAD} = 300 \Omega$ | | 0.3 | 1 | mA |
| I_{SC} | Short circuit current | | 100 | 300 | | mA |
| SVR | Supply voltage rejection | $I_O = 100 \text{ mA}, V_I = 14 \pm 2 \text{ V } f = 120 \text{ Hz}$ | 55 | 80 | | dB |
| V_{IL} | Control input voltage low | $T_J = -40 \text{ to } 125 \text{ }^\circ\text{C}$ | | 2 | 1.2 | V |
| V_{IH} | Control input voltage high | $T_J = -40 \text{ to } 125 \text{ }^\circ\text{C}$ | 3.25 | 2 | | V |
| I_{INH} | Inhibit input current | $V_{INH} = 2.5 \text{ V}$ | | 22 | 50 | μA |
| V_I | Transient input voltage | $R_{LOAD} = 300 \Omega, T < 100 \text{ ms}$ | 60 | 70 | | V |
| V_I | Reverse polarity input voltage | $V_O = \pm 0.3 \text{ V}, R_{LOAD} = 300 \Omega$ | -15 | -50 | | V |
| V_I | Reverse polarity input voltage transient | $R_{LOAD} = 300 \Omega, T < 100 \text{ ms}$ | -50 | | | V |
| eN | Output noise voltage | $B = 10 \text{ Hz to } 100 \text{ kHz}$ | | 330 | | μV_{RMS} |

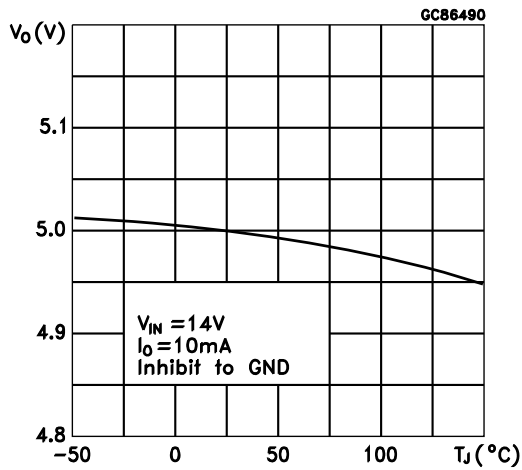
1. Reference voltage is measured from V_{OUT} to ADJ pin.

2. V_d measured when the output voltage has dropped 100 mV from the nominal value obtained at 14 V.

6 Typical characteristics

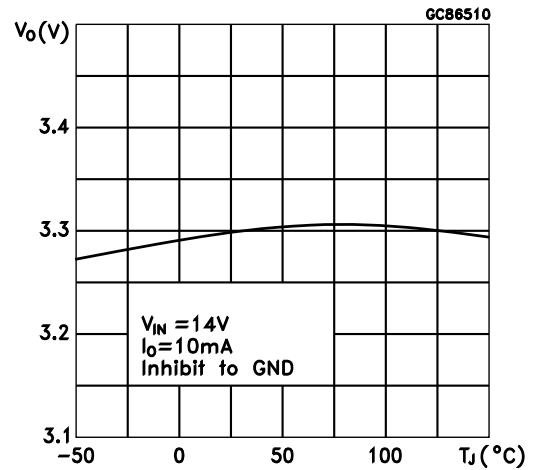
Unless otherwise specified $C_I = 0.1 \mu\text{F}$, $C_O = 100 \mu\text{F}$.

Figure 6. Output voltage vs temperature



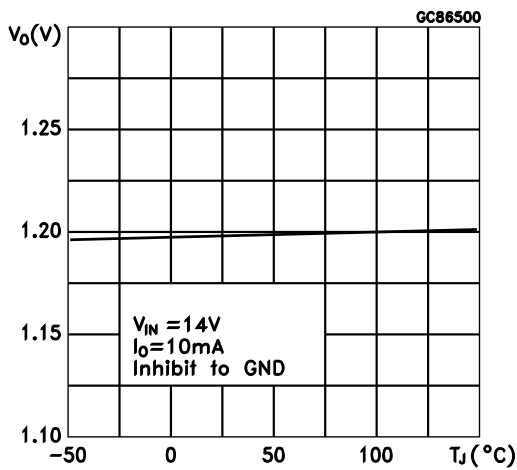
AMG110720161200MT

Figure 7. Output voltage vs temperature



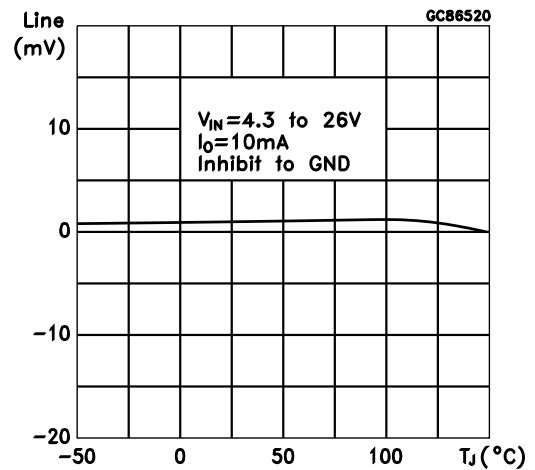
AMG110720161201MT

Figure 8. Reference voltage vs temperature

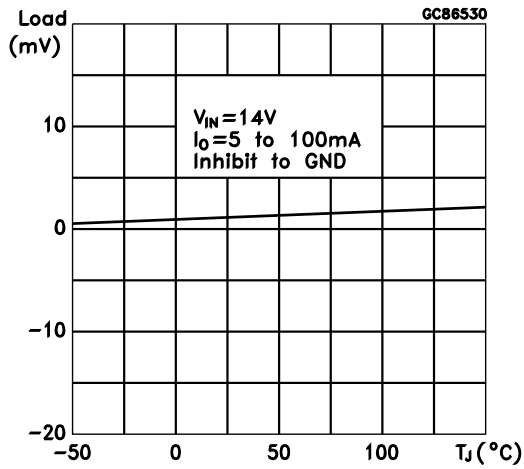


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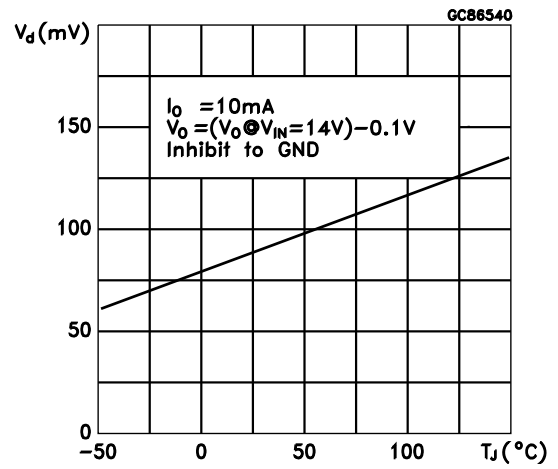
Figure 9. Line regulation vs temperature



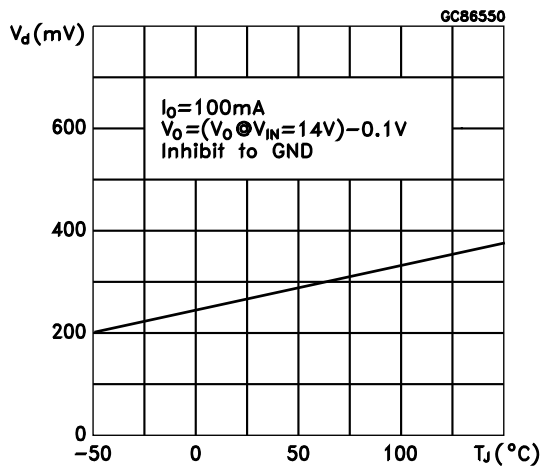
AMG110720161203MT

Figure 10. Load regulation vs temperature


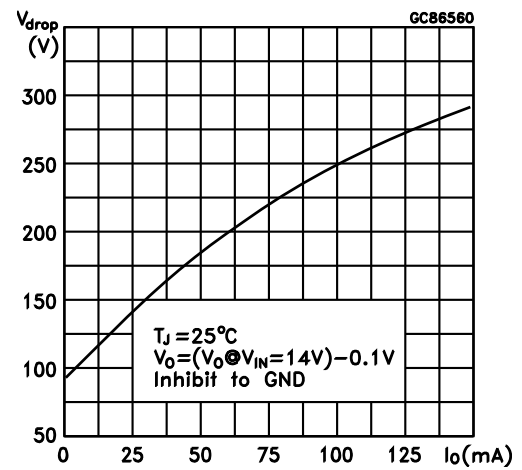
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Figure 11. Dropout voltage vs temperature


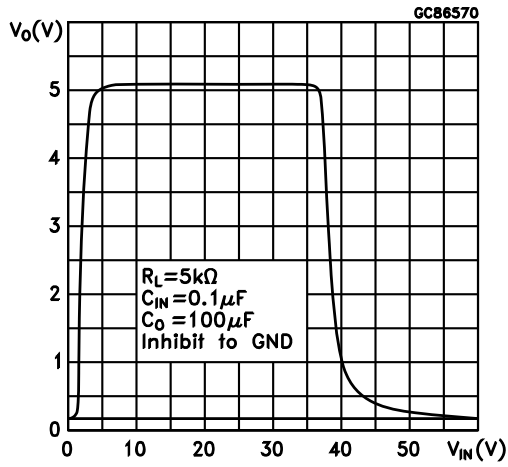
AMG110720161205MT

Figure 12. Dropout voltage vs temperature


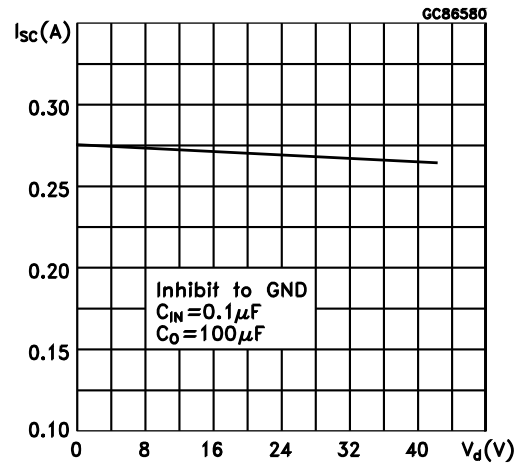
AMG110720161206MT

Figure 13. Dropout voltage vs output current


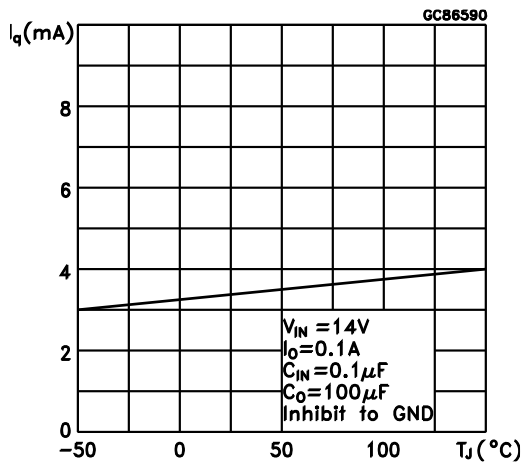
AMG110720161207MT

Figure 14. Output voltage vs input voltage


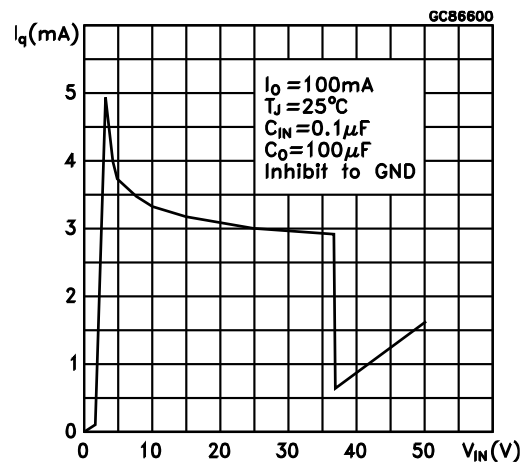
AMG110720161208MT

Figure 15. Short circuit current vs drop voltage


AMG110720161209MT

Figure 16. Quiescent current vs temperature


AMG110720161210MT

Figure 17. Quiescent current vs input voltage


AMG110720161211MT

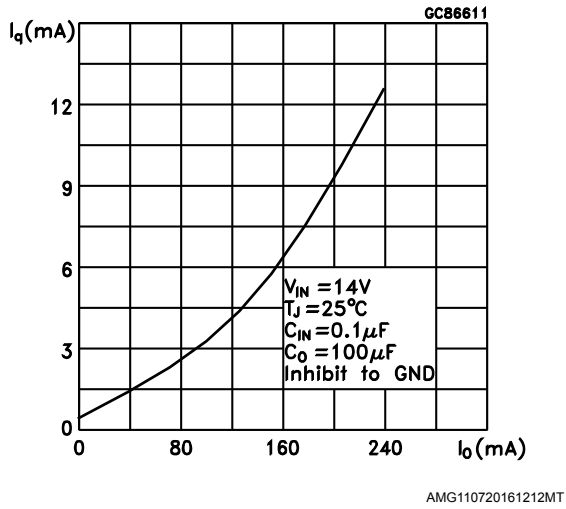
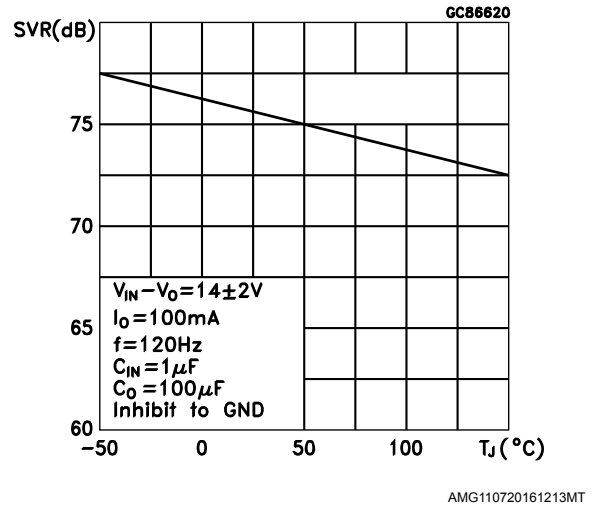
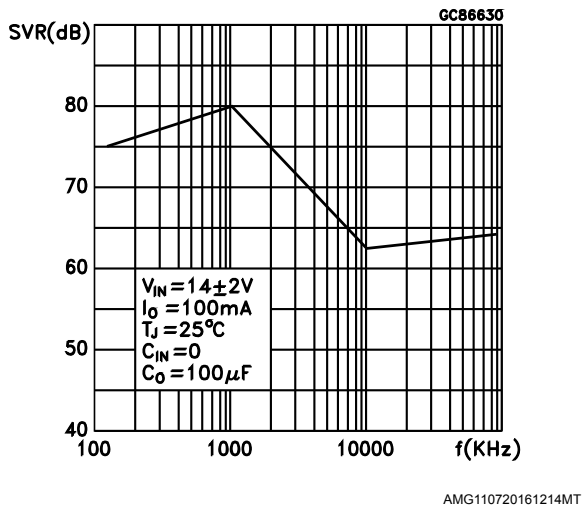
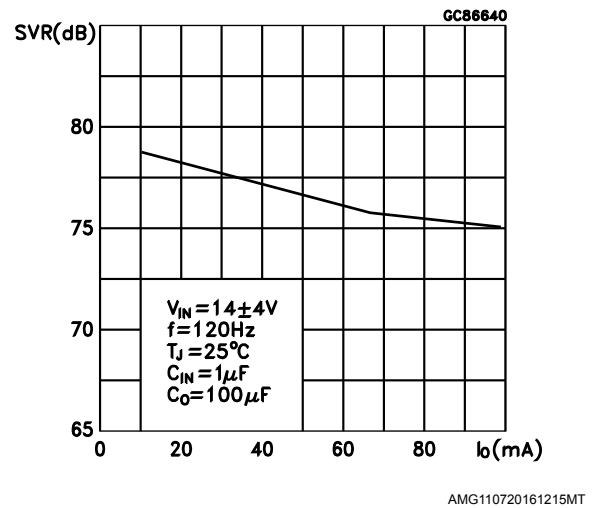
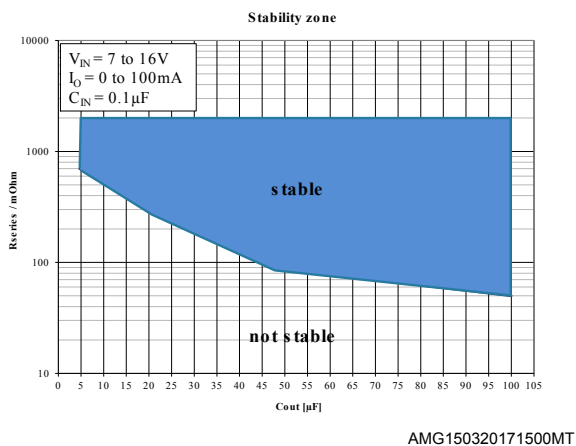
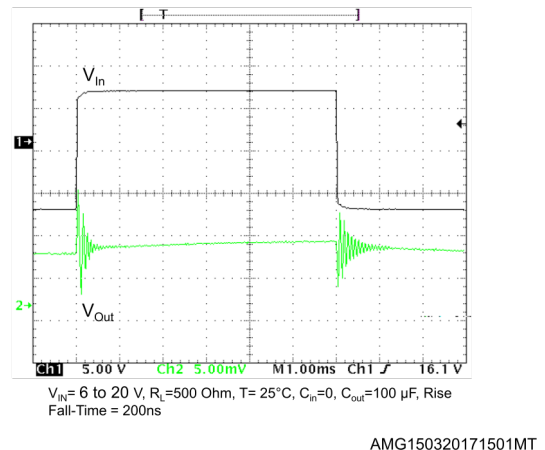
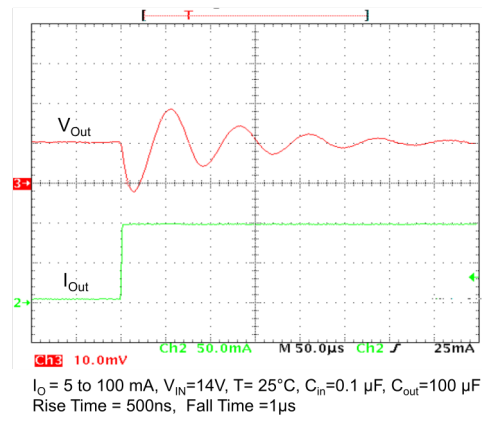
Figure 18. Quiescent current vs output current

Figure 19. Supply voltage rejection vs temperature

Figure 20. Supply voltage rejection vs frequency

Figure 21. Supply voltage rejection vs output current

Figure 22. Stability vs CO

Figure 23. Line transient


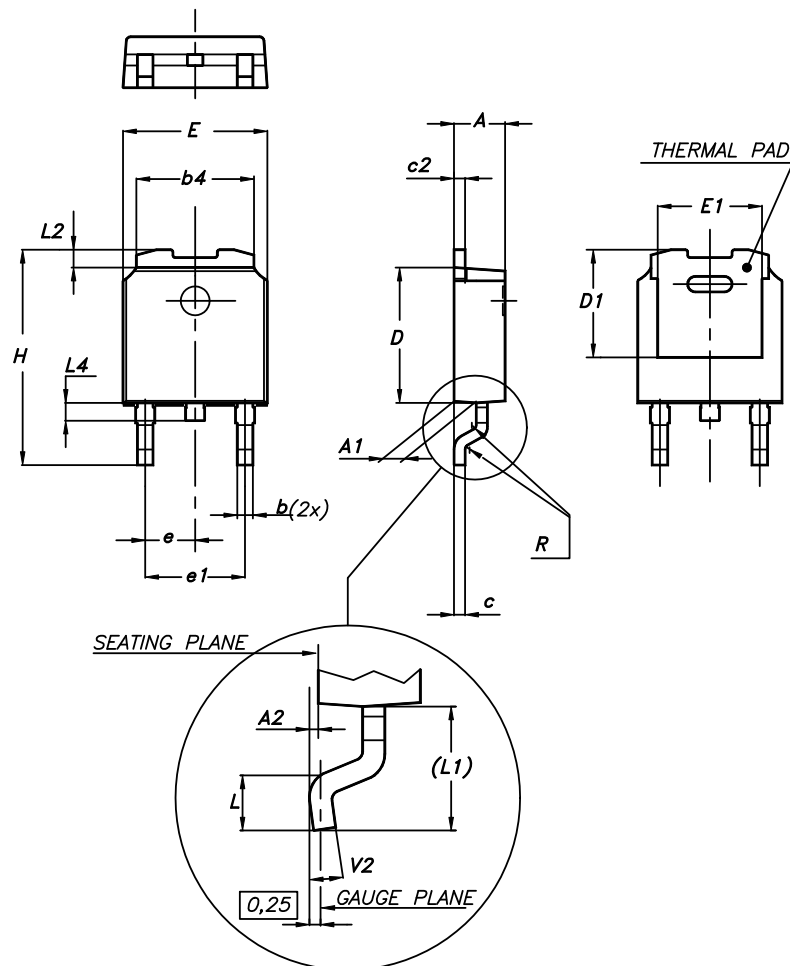
Figure 24. Load transient


AMG150320171502MT

7 Package information

In order to meet environmental requirements, ST offers these devices in different grades of ECOPACK® packages, depending on their level of environmental compliance. ECOPACK® specifications, grade definitions and product status are available at: www.st.com. ECOPACK® is an ST trademark.

7.1 DPAK package information

Figure 25. DPAK package outline


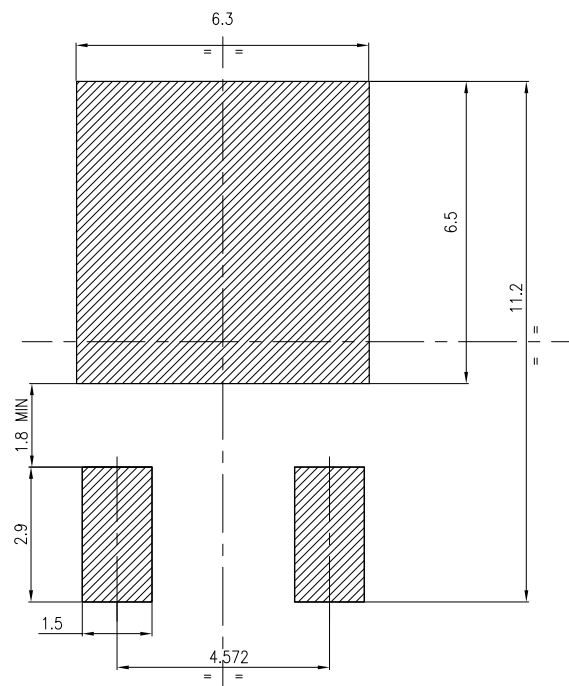
0068772_A_21

Table 6. DPAK mechanical data

| Dim. | mm | | |
|------|------|------|------|
| | Min. | Typ. | Max. |
| A | 2.20 | | 2.40 |
| A1 | 0.90 | | 1.10 |
| A2 | 0.03 | | 0.23 |
| b | 0.64 | | 0.90 |
| b4 | 5.20 | | 5.40 |
| c | 0.45 | | 0.60 |
| c2 | 0.48 | | 0.60 |
| D | 6.00 | | 6.20 |

| Dim. | mm | | |
|------|------|------|-------|
| | Min. | Typ. | Max. |
| D1 | | 5.10 | |
| E | 6.40 | | 6.60 |
| E1 | | 4.70 | |
| e | | 2.28 | |
| e1 | 4.40 | | 4.60 |
| H | 9.35 | | 10.10 |
| L | 1.00 | | 1.50 |
| (L1) | | 2.80 | |
| L2 | | 0.80 | |
| L4 | 0.60 | | 1.00 |
| R | | 0.20 | |
| V2 | 0° | | 8° |

Figure 26. DPAK recommended footprint (dimensions are in mm)



FP_0068772_24

7.2 DPAK packing information

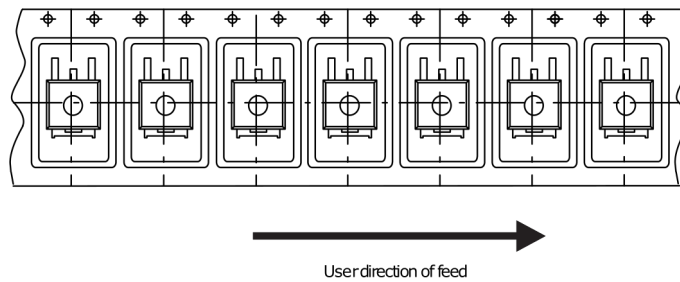
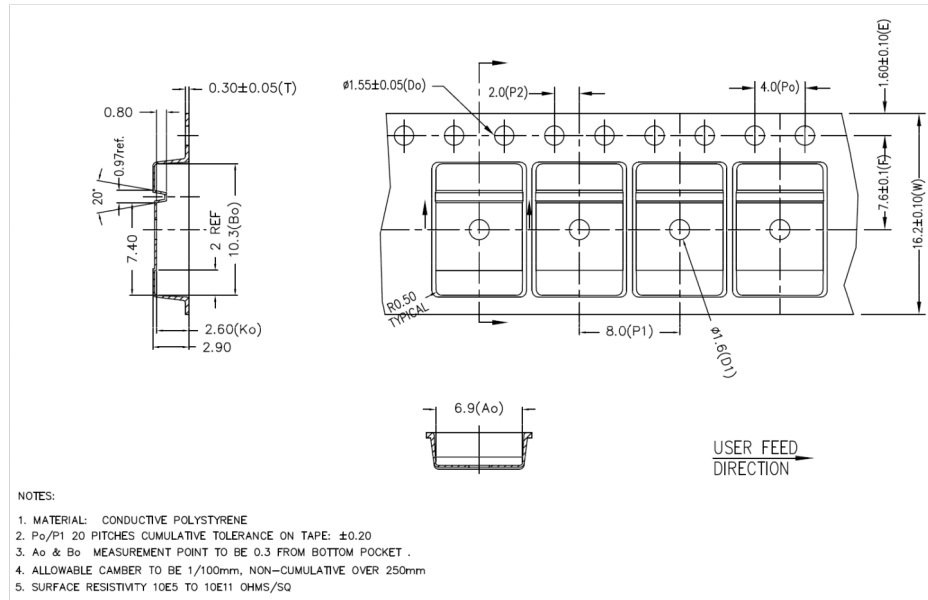
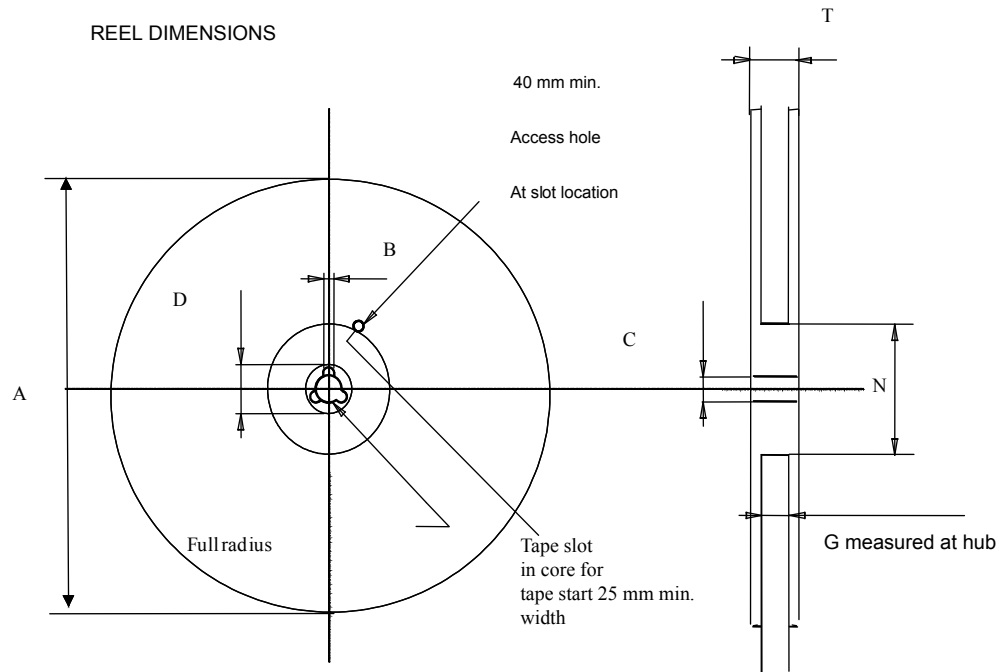
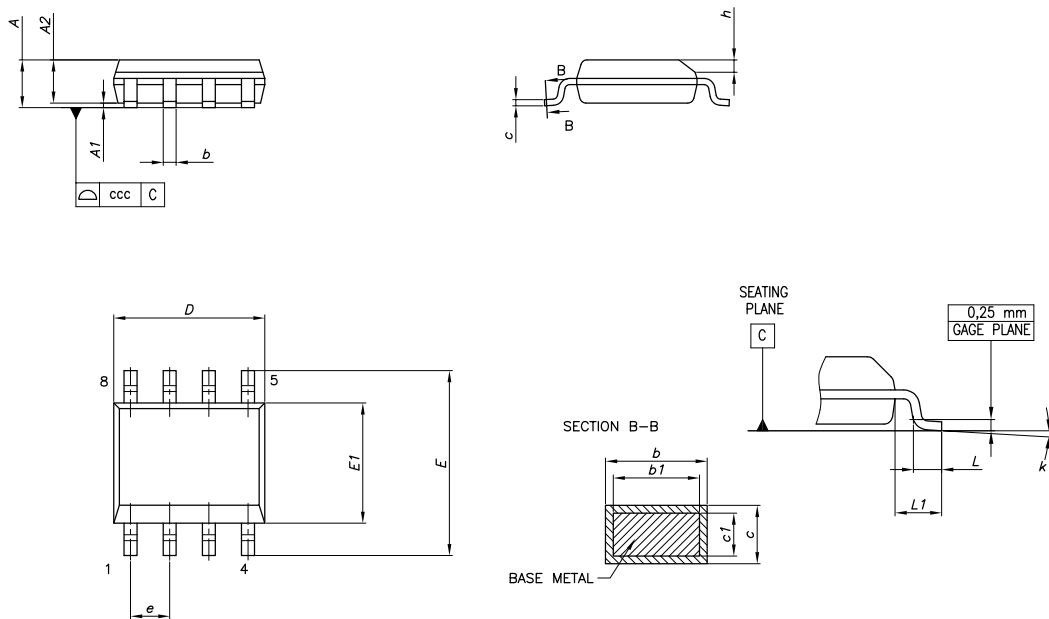
Figure 27. DPAK tape outline


Figure 28. DPAK reel outline



7.3 SO8 package information

Figure 29. SO-8 package outline

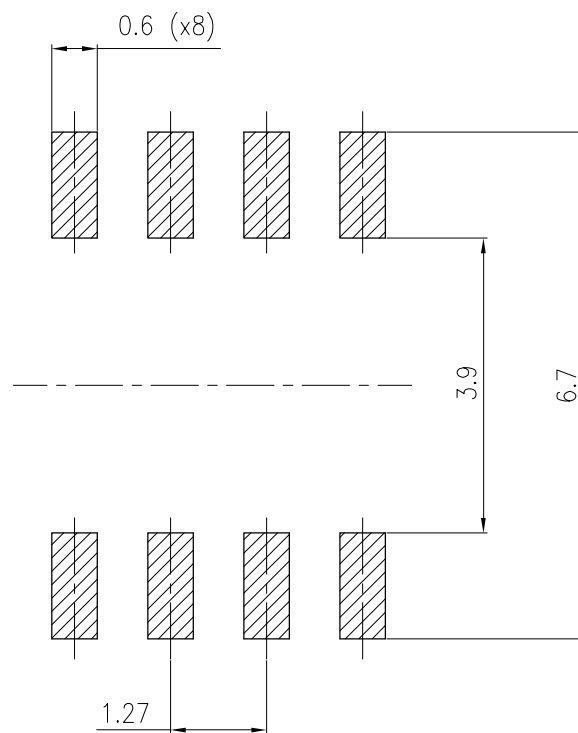


0016023_I

Table 7. SO-8 mechanical data

| Dim. | mm | | |
|------|------|------|------|
| | Min. | Typ. | Max. |
| A | | | 1.75 |
| A1 | 0.10 | | 0.25 |
| A2 | 1.25 | | |
| b | 0.28 | | 0.48 |
| c | 0.17 | | 0.23 |
| D | 4.80 | 4.90 | 5.00 |
| E | 5.80 | 6.00 | 6.20 |
| E1 | 3.80 | 3.90 | 4.00 |
| e | | 1.27 | |
| h | 0.25 | | 0.50 |
| L | 0.40 | | 1.27 |
| L1 | | 1.04 | |
| k | 0° | | 8° |
| ccc | | | 0.10 |

Figure 30. SO-8 recommended footprint



0016023_I

7.4 SO-8 packing information

Figure 31. SO-8 tape and reel outline

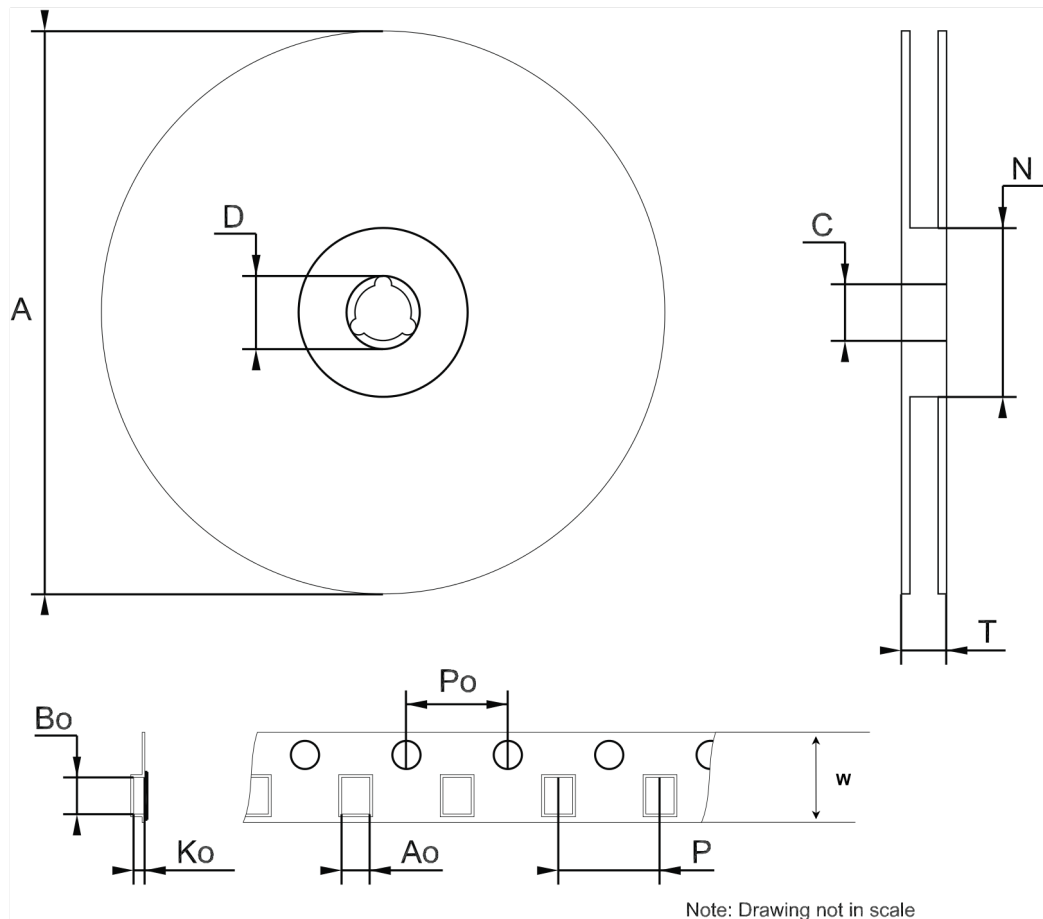
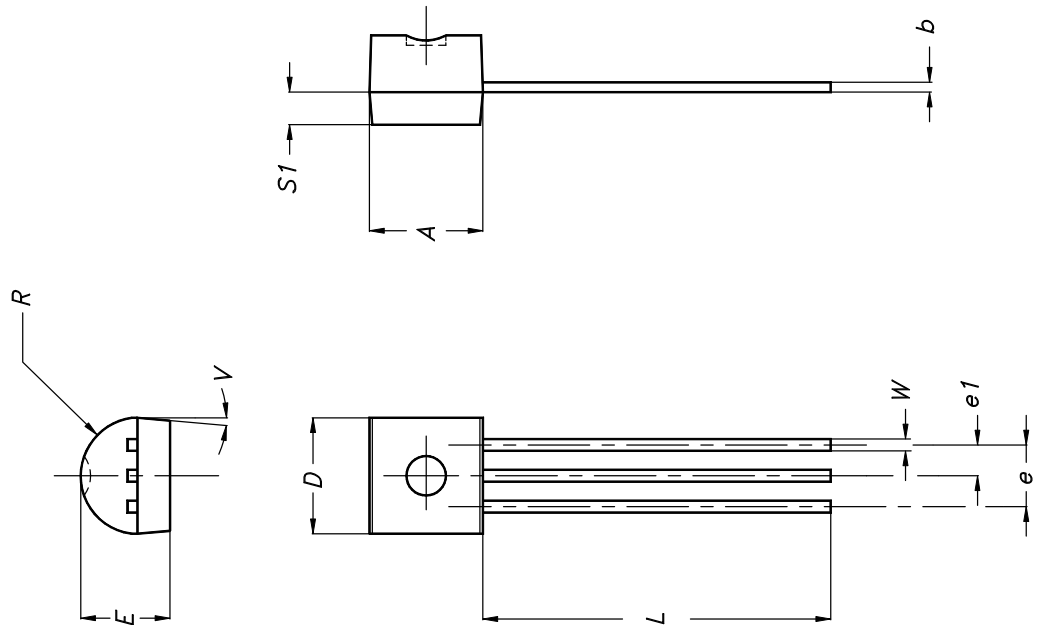


Table 8. SO-8 mechanical data

| Dim. | mm | | |
|------|------|------|------|
| | Min. | Typ. | Max. |
| A | | | 330 |
| C | 12.8 | | 13.2 |
| D | 20.2 | | |
| N | 50 | | |
| T | | | 22.4 |
| Ao | 6.4 | 6.5 | 6.6 |
| Bo | 5.2 | | 5.4 |
| Ko | 2.1 | | 2.3 |
| Po | 3.9 | | 4.1 |
| P | 7.9 | | 8.1 |
| W | 11.7 | 12.0 | 12.3 |

7.5 TO-92 package information
Figure 32. TO-92 package outline


0102782_E

Table 9. TO-92 mechanical data

| Dim. | mm | | |
|------|-------|------|-------|
| | Min. | Typ. | Max. |
| A | 4.32 | | 4.95 |
| b | 0.36 | | 0.51 |
| D | 4.45 | | 4.95 |
| E | 3.30 | | 3.94 |
| e | 2.41 | | 2.67 |
| e1 | 1.14 | | 1.40 |
| L | 12.70 | | 15.49 |
| R | 2.16 | | 2.41 |
| S1 | 0.92 | | 1.52 |
| W | 0.41 | | 0.56 |
| V | | 5° | |

8 Ordering informations

Table 10. Order code

| DPAK | | TO-92 (bag) | SO-8 | Output voltages |
|------------------------------|--------------|-------------|-------------|-----------------|
| AG | Standard | | | |
| LM2931ADT33RY ⁽¹⁾ | | | LM2931AD33R | 3.3 V |
| LM2931ADT50RY ⁽¹⁾ | LM2931ADT50R | LM2931AZ50R | LM2931AD50R | 5.0 V |
| | | | LM2931D-R | 2.5 to 26 V |

1. Qualified and characterized according to AEC Q100 and Q003 or equivalent, advanced screening according to AEC Q001 and Q002 or equivalent .

Revision history

Table 11. Document revision history

| Date | Revision | Changes |
|-------------|----------|---|
| 21-Jun-2004 | 12 | Document updated. |
| 16-Jun-2006 | 13 | Order codes updated. |
| 27-Jul-2007 | 14 | Added Table 1 in cover page. |
| 21-Aug-2007 | 15 | Added root part number - (see Table 1). |
| 22-Nov-2007 | 16 | Modified: Table 1. |
| 11-Feb-2008 | 17 | Modified: Table 1 on page 1. |
| 10-Jul-2008 | 18 | Removed package TO-220, modified Table 1 on page 1. |
| 26-May-2010 | 19 | Modified: V_I values Table 4 on page 6, Table 5 on page 7 and Table 6 on page 8. |
| 02-Nov-2011 | 20 | Modified: Figure 4 on page 6. Added: (*) ADJ pin on the Adjustable version, Not Connected in the fixed output version. on page 4 and Inhibit pin: regulator is enabled when $V_{INH} < 1.2$ V , disabled when $V_{INH} > 3.25$ V on page 6. |
| 09-Apr-2014 | 21 | Part numbers LM2931XX, LM2931AXX33 and LM2931AXX50 changed to LM2931. Updated the description in cover page Section 2: Pin configuration and Section 7: Package information. Added Section 8: Revision history. Minor text changes. |
| 16-Mar-2017 | 22 | Updated features in cover page, removed Table 1. Device summary from cover page, Table 3: "Electrical characteristics of LM2931A33/LM2931A33Y" , Table 4: "Electrical characteristics of LM2931A50/ LM2931A50Y" and Table 5: "Electrical characteristics of LM2931 (adjustable version)". Updated Section 7: "Package information". Added Section 8: "Ordering information". Minor text changes. |
| 23-Feb-2018 | 23 | Updated Figure 5. Application circuit for adjustable output. |

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