

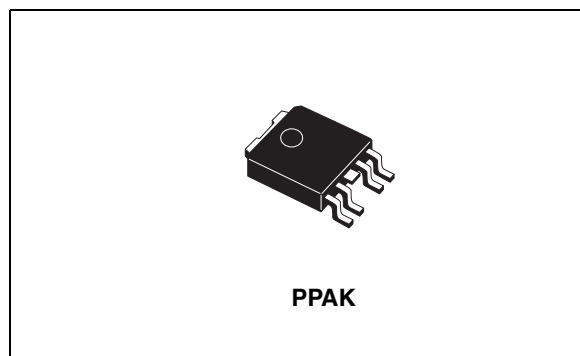
1.5A Very low drop for low output voltage regulator

Feature summary

- Input voltage range:
 $V_I = 1.4V$ to $5.5V$
 $V_{BIAS} = 3V$ to $6V$
- Stable with ceramic capacitor
- $\pm 1.5\%$ initial tolerance
- Maximum dropout voltage ($V_I - V_O$) of $200mV$ over temperature
- Adjustable output voltage down to $0.8V$
- Ultra fast transient response (up to $10MHz$ bandwidth)
- Excellent line and load regulation specifications
- Logic controlled shutdown option
- Thermal shutdown and current limit protection
- Junction temperature range: $-25^{\circ}C$ to $125^{\circ}C$

Description

The LD49150 is a high-bandwidth, low-dropout, 1.5A voltage regulator, ideal for powering core voltages of low-power microprocessors. The LD49150 implements a dual supply configuration allowing for very low output impedance and very fast transient response. The LD49150 requires a bias input supply and a main input supply, allowing for ultra-low input voltages on the main supply rail. The input supply operates from 1.4V to



5.5V and the bias supply requires between 3V and 6V for proper operation. The LD49150 offers fixed output voltages from 0.8V to 1.8V and adjustable output voltages down to 0.8V.

The LD49150 requires a minimum output capacitance for stability, and work optimally with small ceramic capacitors.

Applications

- Graphics processors
- PC Add-In Cards
- Microprocessor core voltage supply
- Low voltage digital ICs
- High Efficiency Linear power supplies
- SMPS post regulators

Order codes

| Part number | Package | Packaging |
|-----------------------------|------------------|---------------------|
| LD49150PT08R ⁽¹⁾ | PPAK (Tape&Reel) | 2500 parts per reel |
| LD49150PT10R | PPAK (Tape&Reel) | 2500 parts per reel |
| LD49150PT12R | PPAK (Tape&Reel) | 2500 parts per reel |

1. Adjustable Version.

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1 Typical application circuits

Figure 1. Adjustable version

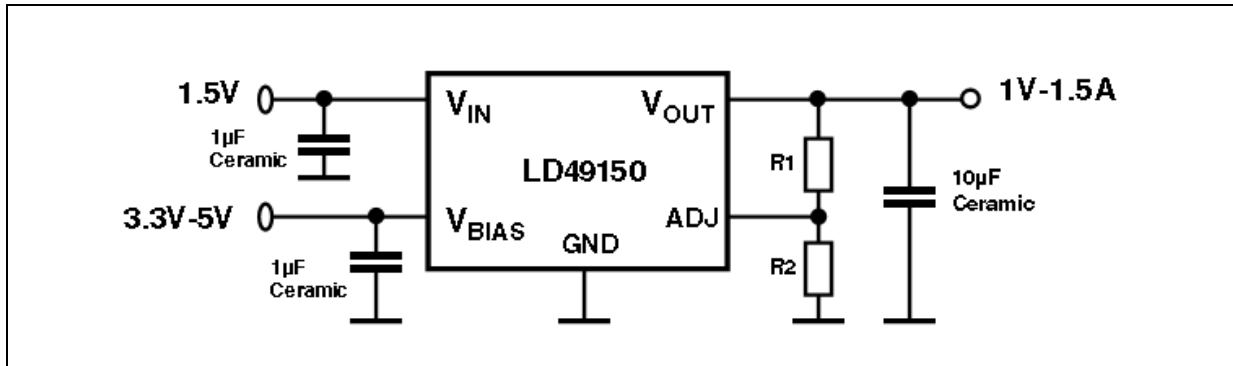
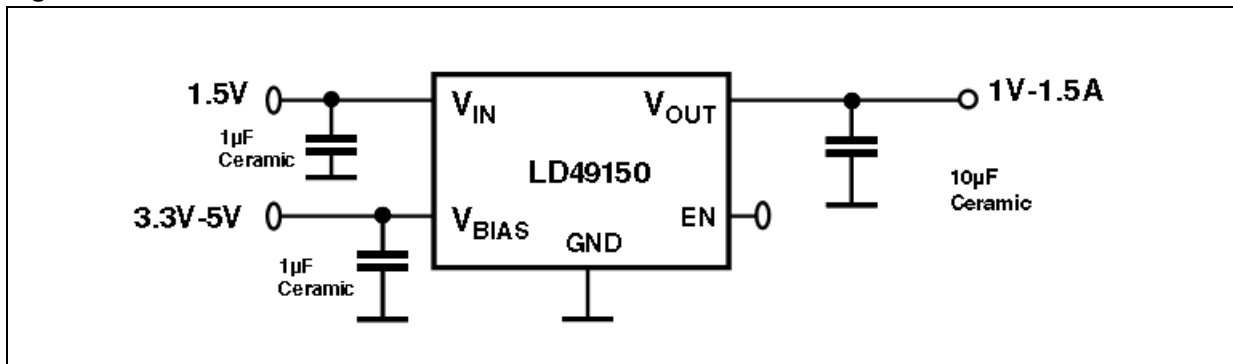


Figure 2. Fixed version with Enable



2 Alternative application circuits

Figure 3. Single supply voltage solution

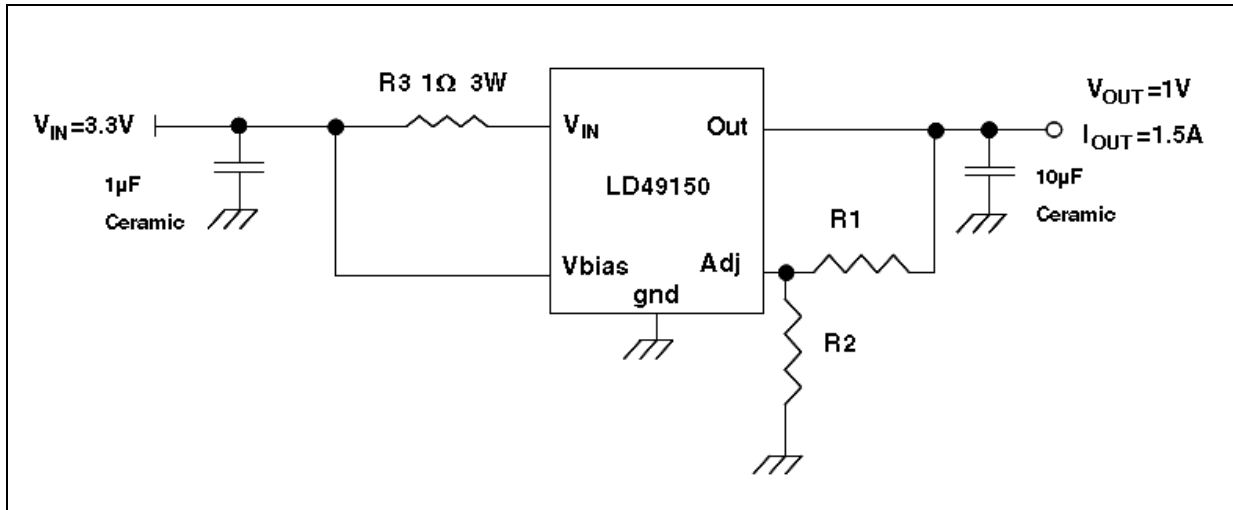
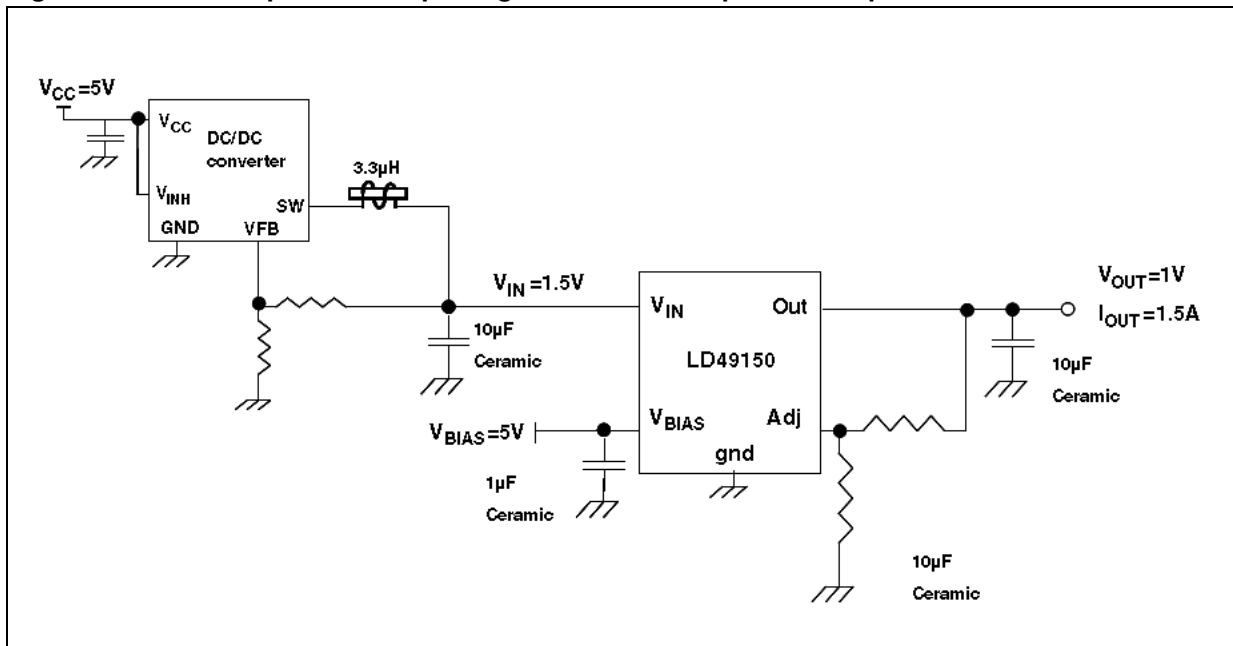


Figure 4. LD49150 plus DC/DC pre-regulator to reduce power dissipation



3 Pin configuration

Figure 5. Pin connections (top view)

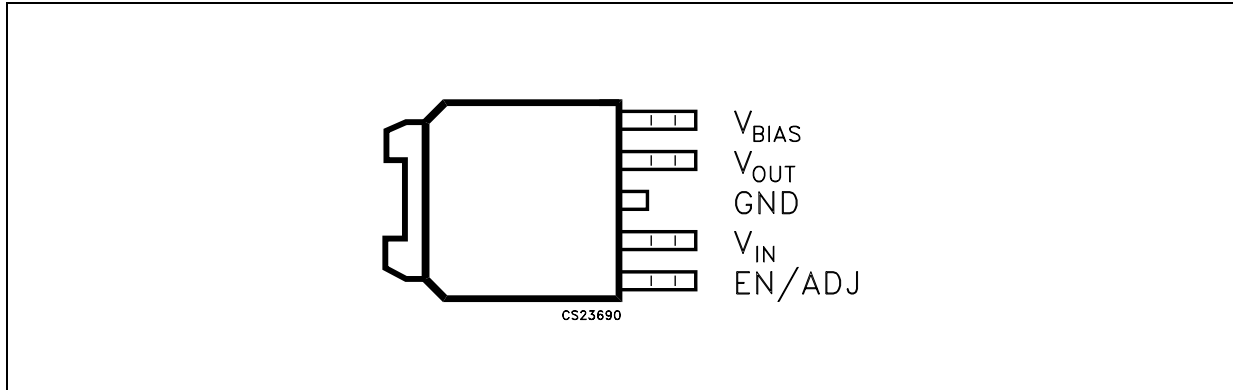
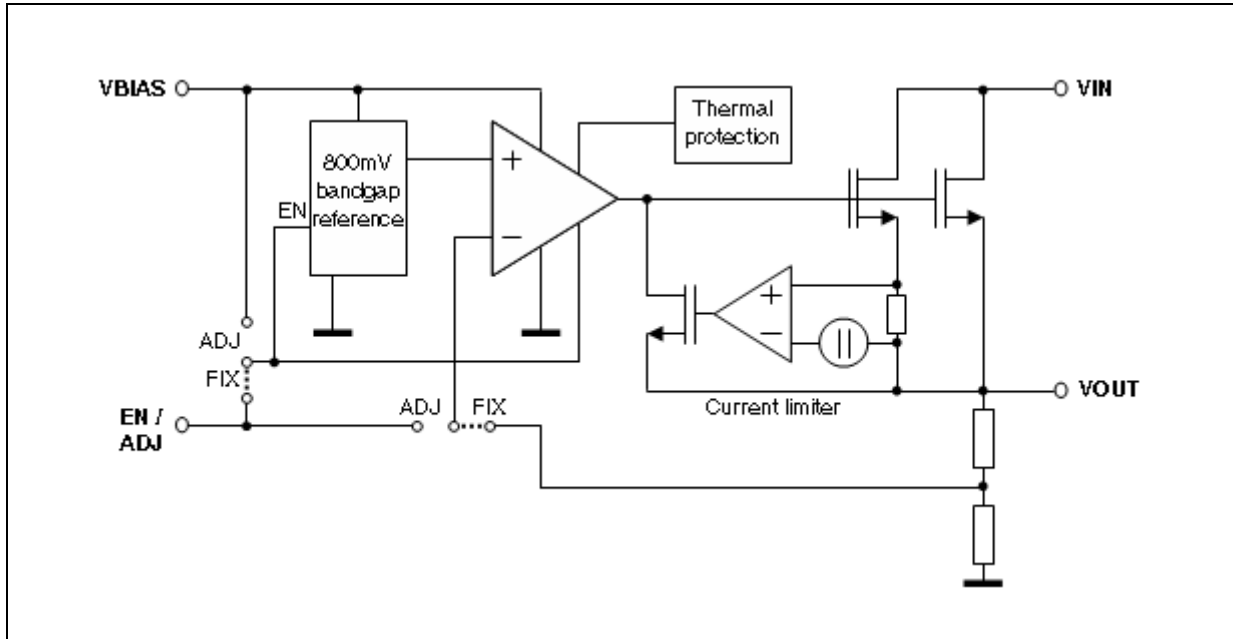


Table 1. Pin description

| Pin n° | Symbol | Note |
|--------|------------|---|
| 1 | EN | Enable (Input): Logic High = Enable, Logic Low = Shutdown. |
| | ADJ | Adjustable regulator feedback input. Connect to resistor voltage divider. |
| 2 | V_{IN} | Input voltage which supplies current to the output power device. |
| 3 | GND | Ground (TAB is connected to ground). |
| 4 | V_{OUT} | Regulator output. |
| 5 | V_{BIAS} | Input bias voltage for powering all circuitry on the regulator with the exception of the output power device. |

4 Diagram

Figure 6. Block diagram



5 Maximum ratings

Table 2. Absolute maximum ratings

| Symbol | Parameter | Value | Unit |
|------------|---------------------------|--|------|
| V_{IN} | Supply voltage | -0.3 to 7 | V |
| V_{OUT} | Output voltage | -0.3 to $V_{IN} + 0.3$ -0.3 to $V_{BIAS} + 0.3$ | V |
| V_{BIAS} | BIAS Supply voltage | -0.3 to 7 | V |
| V_{EN} | Enable input voltage | -0.3 to 7 | V |
| P_D | Power dissipation | Internally Limited | |
| T_{STG} | Storage temperature range | -50 to 150 | °C |

Note: 1 Absolute Maximum Ratings are those values beyond which damage to the device may occur. Functional Operation under these conditions is not implied.

2 All the values are referred to ground.

Table 3. Operating ratings

| Symbol | Parameter | Value | Unit |
|------------|----------------------------|-----------------|------|
| V_{IN} | Supply voltage | 1.4 to 5.5 | V |
| V_{OUT} | Output voltage | 0.8 to 4.5 | V |
| V_{BIAS} | BIAS Supply voltage | 3 to 6 | V |
| V_{EN} | Enable input voltage | 0 to V_{BIAS} | V |
| T_J | Junction temperature range | -25 to 125 | °C |

6 Electrical characteristics

Table 4. Electrical characteristics

($T_J = -25^{\circ}\text{C}$ to 125°C , $V_{\text{BIAS}} = V_O + 2.1\text{V}$ ⁽¹⁾; $V_I = V_O + 1\text{V}$; $V_{\text{EN}} = V_{\text{BIAS}}$ ⁽²⁾, $I_O = 10\text{mA}$; $C_I = 1\mu\text{F}$; $C_O = 10\mu\text{F}$; $C_{\text{BIAS}} = 1\mu\text{F}$; unless otherwise specified. Typical values are referred to $T_J = 25^{\circ}\text{C}$).

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|------------------------------------|---|---|-------|------|-------|---------------|
| V_O | Output voltage accuracy | $T_J = 25^{\circ}\text{C}$, fixed voltage options | -1.5 | | 1.5 | % |
| | | Over temperature range | -3 | | 3 | |
| V_{LINE} | Line regulation | $V_I = V_O + 1\text{V}$ to 5.5V | -0.1 | | 0.1 | %/V |
| V_{LOAD} | Load regulation | $I_L = 0\text{mA}$ to 3A , $V_{\text{BIAS}} \geq 3\text{V}$ | | | 1 | % |
| V_{DROP} | Dropout voltage ($V_I - V_O$) | $I_L = 1.5\text{A}$ | | | 200 | mV |
| V_{DROP} | Dropout voltage ($V_{\text{BIAS}} - V_O$) | $I_L = 1.5\text{A}$ ⁽¹⁾ | | 1.5 | 2.1 | V |
| I_{GND} | Ground pin current | $I_L = 0\text{mA}$ | | 4 | 6 | mA |
| | | $I_L = 1.5\text{A}$ | | 4 | 6 | |
| $I_{\text{GND_SHD}}$ | Ground pin current in shutdown | $V_{\text{EN}} \leq 0.4\text{V}$ ⁽²⁾ | | | 5 | μA |
| I_{VBIAS} | Current through V_{BIAS} | $I_L = 0\text{mA}$ | | 3 | 5 | mA |
| | | $I_L = 1.5\text{A}$ | | 3 | 5 | |
| I_L | Current limit | $V_O = 0\text{V}$ | 2.5 | | | A |
| Enable Input ⁽²⁾ | | | | | | |
| V_{EN} | Enable input threshold (fixed voltage only) | Regulator Enable | 1.4 | | | V |
| | | Regulator Shutdown | | | 0.4 | |
| I_{EN} | Enable pin input current | | | 0.1 | 1 | μA |
| Reference | | | | | | |
| V_{REF} | Reference voltage | $T_J = 25^{\circ}\text{C}$ | 0.788 | 0.8 | 0.812 | V |
| | | Over temperature range | 0.776 | 0.8 | 0.824 | |
| SVR | Supply voltage rejection | $V_I = 2.5\text{V} \pm 0.5\text{V}$, $V_O = 1\text{V}$, $F = 120\text{Hz}$, $V_{\text{BIAS}} = 3.3\text{V}$ | | 68 | | dB |

1. For $V_O \leq 1\text{V}$, V_{BIAS} dropout specification does not apply due to a minimum 3V V_{BIAS} input.
2. Fixed output voltage version only.

7 Typical characteristics

Figure 7. Reference voltage vs temperature

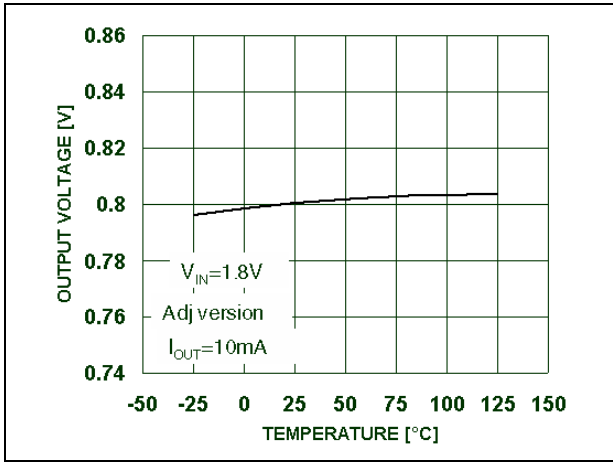


Figure 8. Output voltage vs temperature

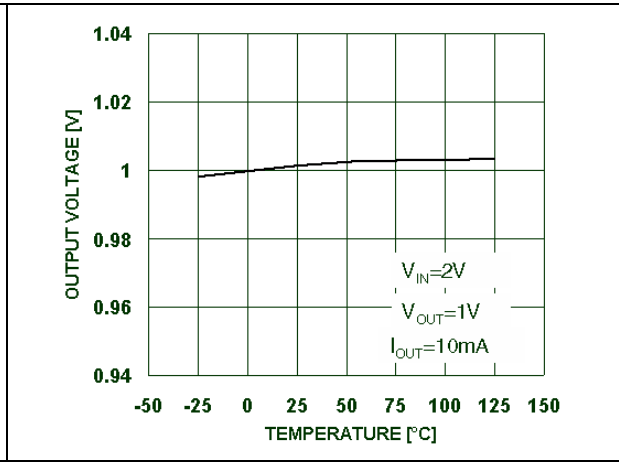


Figure 9. Load regulation vs temperature

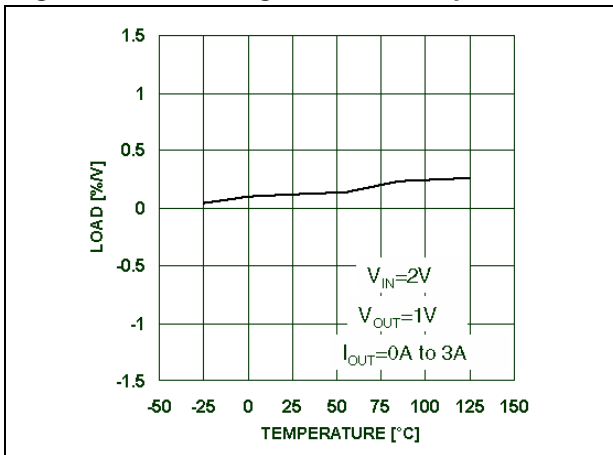


Figure 10. Line regulation vs temperature

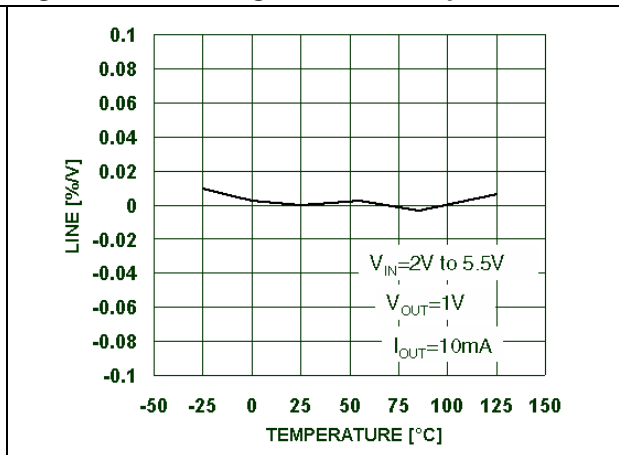


Figure 11. Output voltage vs input voltage

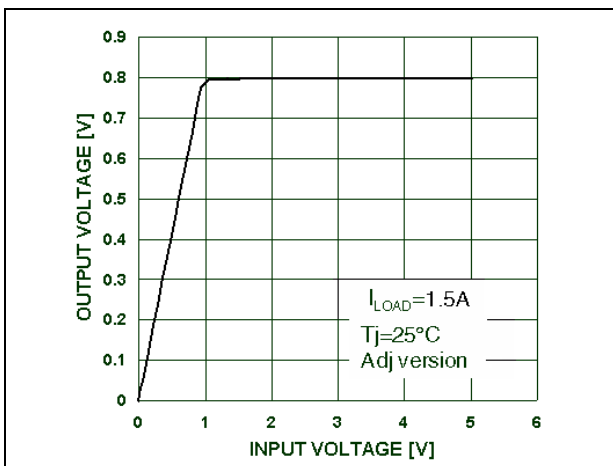


Figure 12. Dropout voltage ($V_{IN}-V_{OUT}$) vs temperature

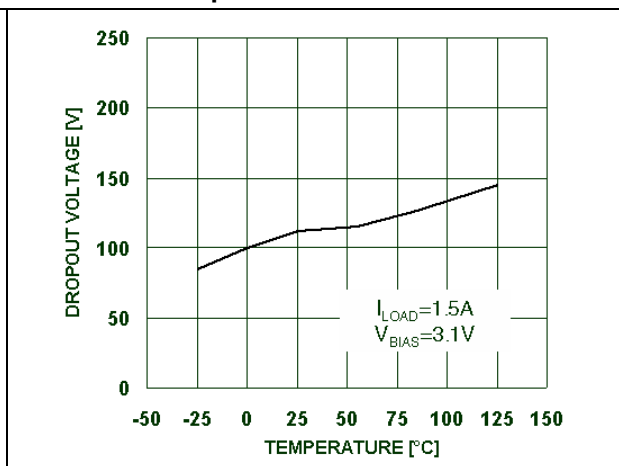


Figure 13. Dropout voltage ($V_{IN}-V_{OUT}$) vs temperature

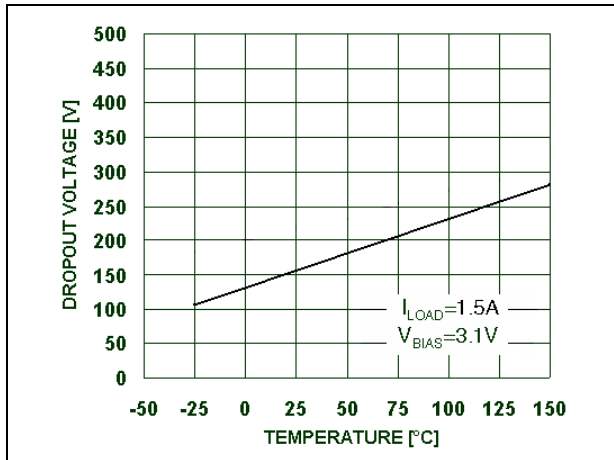


Figure 14. V_{BIAS} pin current vs temperature

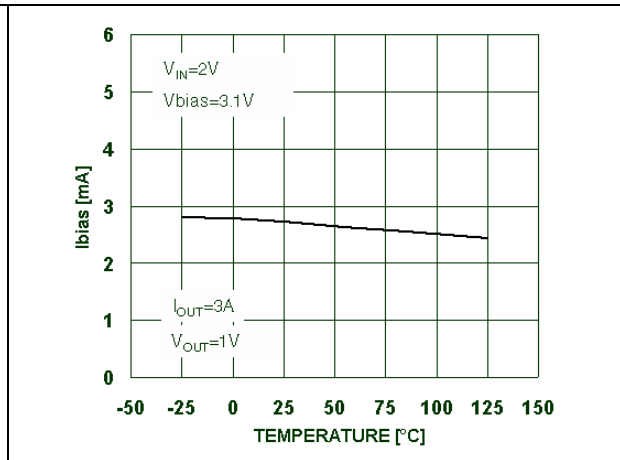


Figure 15. Noise vs frequency

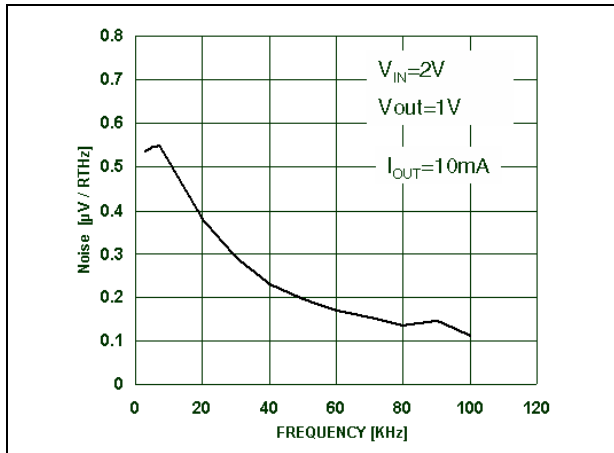


Figure 16. Quiescent current vs temperature

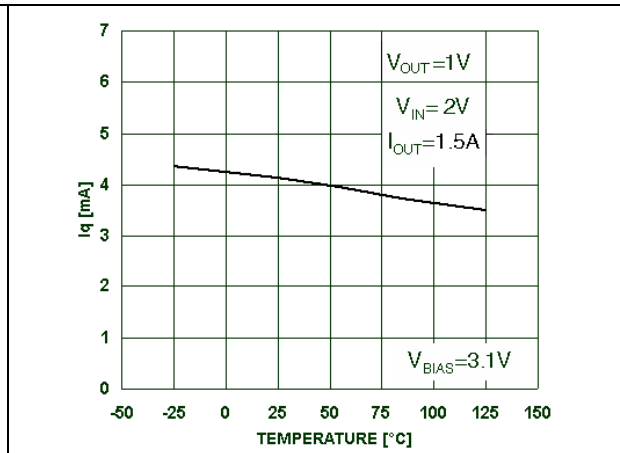


Figure 17. Supply voltage rejection vs output current

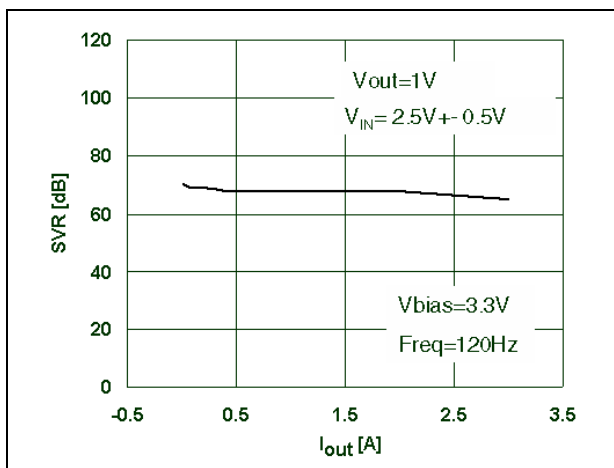


Figure 18. Stability region vs C_{OUT} & High ESR

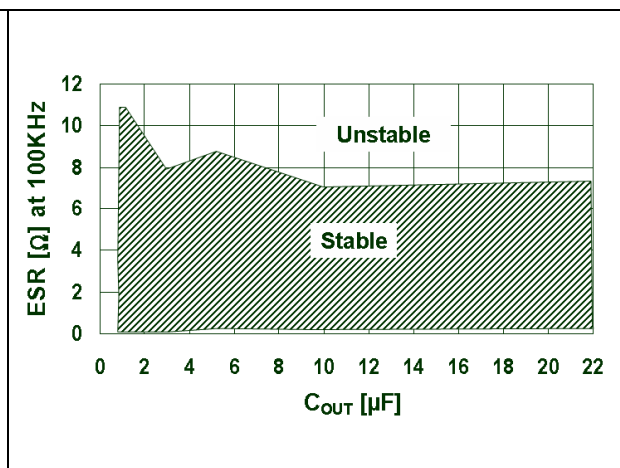


Figure 19. Stability region vs C_{OUT} & Low ESR Figure 20. V_{BIAS} & V_{IN} Start Up transient response (V_{IN} and V_{BIAS} Start Up at the same time)

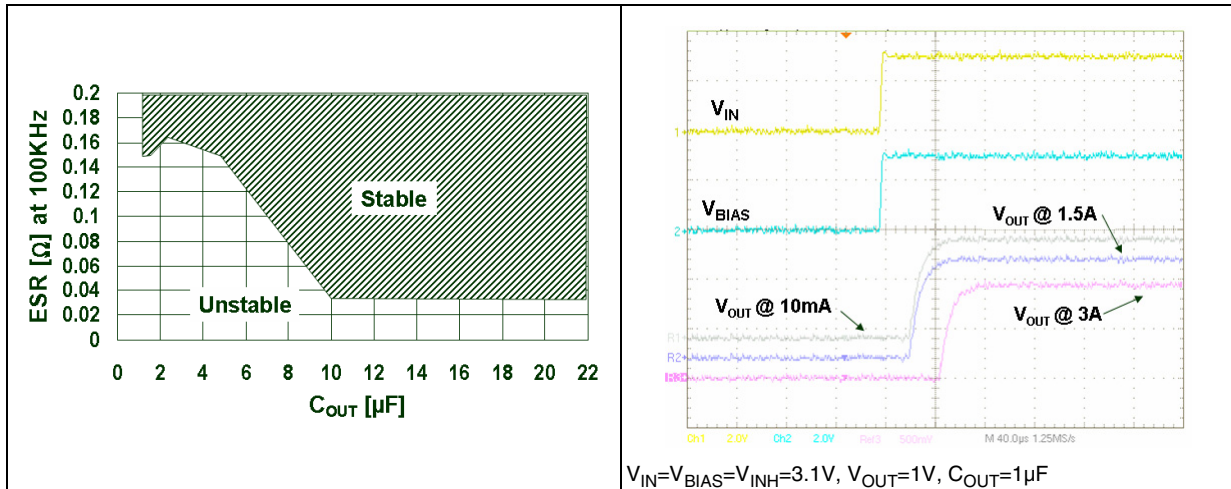


Figure 21. V_{IN} Start Up transient response (V_{BIAS} Start Up before V_{IN})

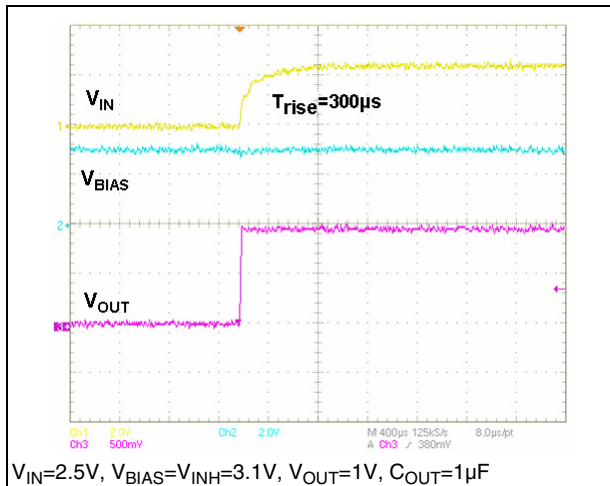


Figure 22. V_{IN} Start Up transient response (V_{BIAS} Start Up before V_{IN})

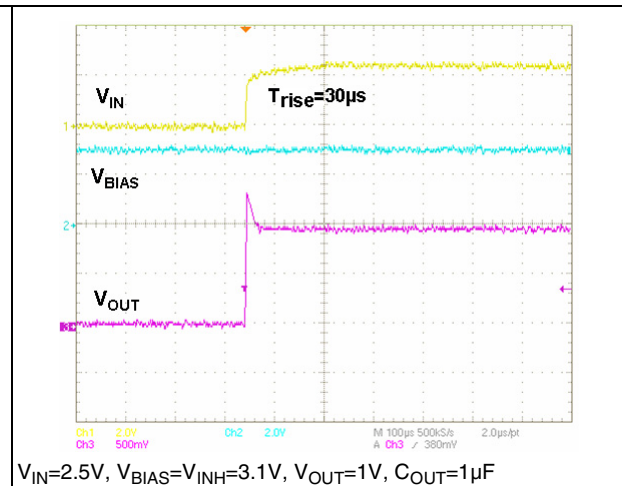
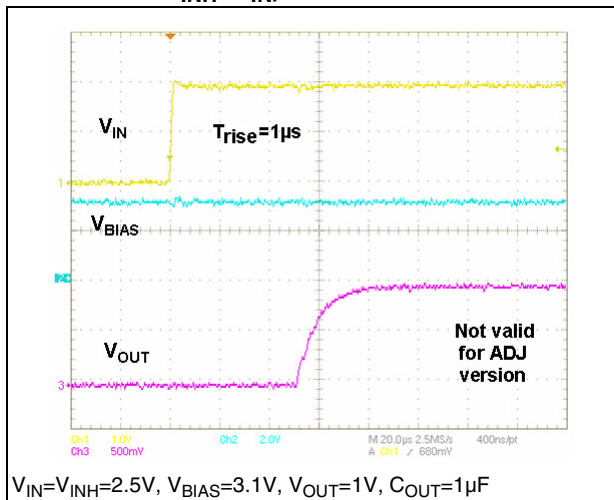


Figure 23. V_{IN} Start Up transient response
(V_{BIAS} Start Up before V_{IN} and
 $V_{INH}=V_{IN}$)



8 Application hints

The LD49150 is an ultra-high performance, low dropout linear regulator, designed for high current application that requires fast transient response. The LD49150 operates from two input voltages, to reduce dropout voltage. The LD49150 is designed so that a minimum of external component are necessary.

8.1 Input supply voltage (V_{IN})

V_{IN} provides the power input current to the LD49150. The minimum input voltage can be as low as 1.4V, allowing conversion from very low voltage supplies to achieve low output voltage levels with very low power dissipation.

8.2 Bias supply voltage (V_{BIAS})

The LD49150 control circuitry is supplied the V_{BIAS} pin which requires a very low bias current (3mA typ.) even at the maximum output current level (1.5A). A bypass capacitor on the bias pin is recommended to improve the performance of the LD49150 during line and load transient. The small ceramic capacitor from V_{BIAS} to ground reduces high frequency noise that could be injected into the control circuitry from the bias rail. In typical applications a 1 μ F ceramic chip capacitor may be used. The V_{BIAS} input voltage must be 2.1V above the output voltage, with a minimum V_{BIAS} input voltage of 3V.

8.3 External capacitors

To assure regulator stability, input and output capacitors are required as shown in the typical application circuit.

8.4 Output capacitor

The LD49150 requires a minimum output capacitance to maintain stability. A ceramic chip capacitor of at least 1 μ F is required. However, specific capacitor selection could be needed to ensure the transient response. A 1 μ F ceramic chip capacitor satisfies most applications but 10 μ F is recommended to ensure better transient performances. In applications where the V_{IN} level is close to the maximum operating voltage ($V_{IN}>4V$), it is strongly recommended to use an output capacitors of, at least, 10 μ F in order to avoid over-voltage stress on the Input/output power pins during short circuit conditions due to parasitic inductive effect. The output capacitor must be located as close as possible to the output pin of the LD49150. The ESR (equivalent series resistance) of the output capacitor must be within the "STABLE" region as shown in the typical characteristics figures. Both ceramic and tantalum capacitors are suitable.

8.5 Minimum load current

The LD49150 does not require a minimum load to maintain output voltage regulation.

8.6 V_{IN} and V_{BIAS} power sequencing

In common applications where the power on transient of V_{IN} and V_{BIAS} voltages are not particularly fast ($T_r > 100\mu s$), no power sequencing is required. Where voltage transient input ($T_r < 100\mu s$) is very fast, it is recommended to have the V_{IN} voltage present before or, at least, at the same time as the V_{BIAS} voltage in order to avoid overvoltage spikes during the power on transient (refer to the figures in the typical characteristics). Where V_{IN} transient input ($T_r \ll 100\mu s$) is very fast for the fixed V_{OUT} versions, it is possible to avoid start-up overvoltage spikes by pulling the V_{INH} pin up to V_{IN} voltage (refer to relative typical characteristics figures at pages 11 and 12).

8.7 Power dissipation/heatsinking

A heatsink may be required depending on the maximum power dissipation and maximum ambient temperature of the application. Under all possible conditions, the junction temperature must be within the range specified under operating conditions. The total power dissipation of the device is given by:

$$P_D = V_{IN} \times I_{IN} + V_{BIAS} \times I_{BIAS} - V_{OUT} \times I_{OUT}$$

Where:

- V_{IN} , Input supply voltage
- V_{BIAS} , Bias supply voltage
- V_{OUT} , Output voltage
- I_{OUT} , Load current

From this data, we can calculate the thermal resistance (θ_{SA}) required for the heat sink using the following formula:

$$\theta_{SA} = (T_J - T_A/P_D) - (\theta_{JC} + \theta_{CS})$$

The maximum allowed temperature rise (T_{Rmax}) depends on the maximum ambient temperature (T_{Amax}) of the application, and the maximum allowable junction temperature (T_{Jmax}):

$$T_{Rmax} = T_{Jmax} - T_{Amax}$$

The maximum allowable value for junction to ambient thermal resistance, θ_{JA} , can be calculated using the formula:

$$\theta_{JAmax} = T_{Rmax} / P_D$$

This part is available for the PPAK package.

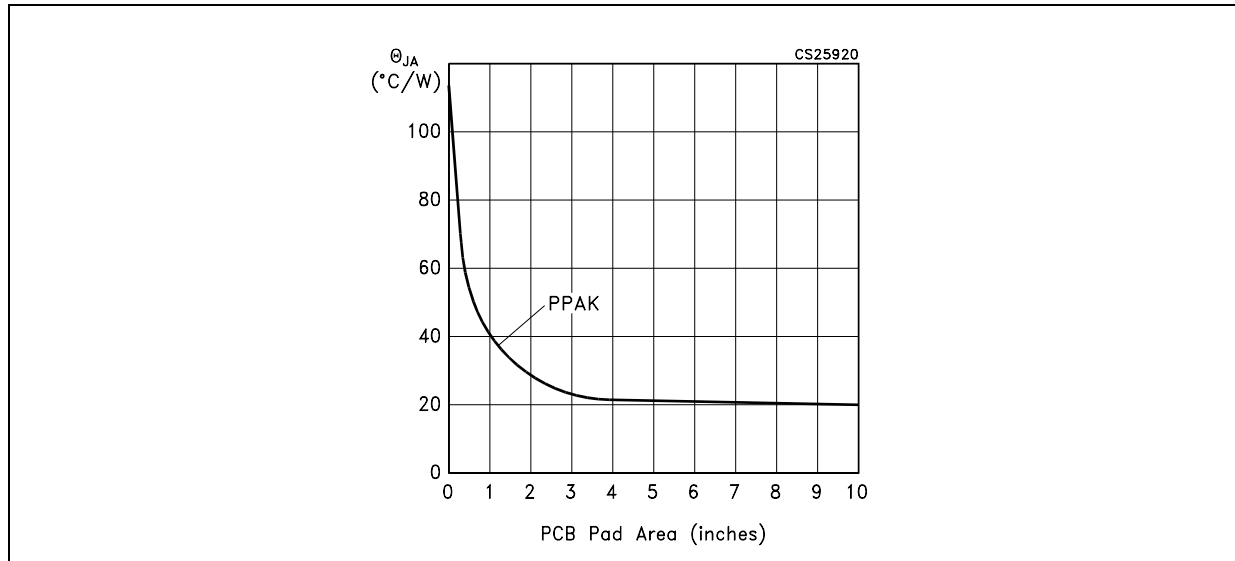
The thermal resistance depends on the amount of copper area or heat sink, and on air flow. If the maximum allowable value of θ_{JA} calculated above is ≥ 100 °C/W for the PPAK package, no heatsink is needed since the package can dissipate enough heat to satisfy these requirements. If the value for allowable θ_{JA} falls below these limits, a heat sink is required as described below.

8.8 Heatsinking PPAK package

The PPAK package uses the copper plane on the PCB as a heatsink. The tab of these packages is soldered to the copper plane for heat sinking. It is also possible to use the PCB ground plane as a heatsink. This area can be the inner GND layer of a multi-layer PCB, or, in a dual layer PCB, it can be an unbroken GND area on the opposite side where the IC is situated with a dissipating area thermally connected through vias holes, filled by solder.

Figure 26 shows a curve for θ_{JA} of the PPAK package for different copper area sizes, using a typical PCB with 1/16 in thick G10/FR4.

Figure 24. θ_{JA} vs Copper Area for PPAK package



8.9 Adjustable regulator design

The LD49150 adjustable version allows fixing output voltage anywhere between 0.8V and 4.5V using two resistors as shown in the typical application circuit. For example, to fix the R1 resistor value between V_{OUT} and the ADJ pin, the resistor value between ADJ and GND (R2) is calculated by:

$$R2 = R1 [0.8/(V_{OUT} - 0.8)]$$

Where V_{OUT} is the desired output voltage.

It is suggested to use R1 values lower than 10K Ω to obtain better load transient performances. Even, higher values up to 100K Ω are suitable.

8.10 Enable

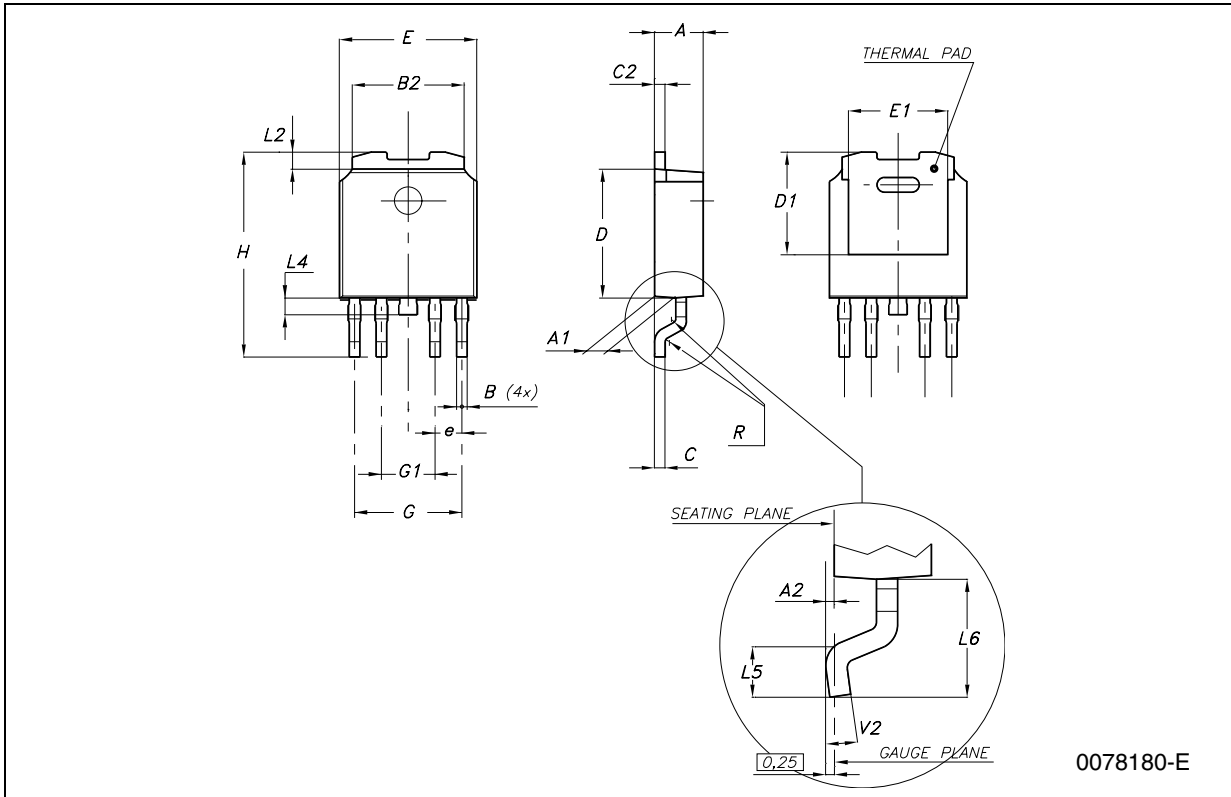
The fixed output voltage versions of LD49150 feature an active high Enable input (EN) that allows on-off control of the regulator. The EN input threshold is guaranteed between 0.4V and 1.4V, for simple logic interfacing. The regulator is set in shut down mode when $V_{EN} < 0.4\text{V}$ and it is in operating mode (V_{OUT} activated) when $V_{EN} > 1.4\text{V}$. If not in use, the EN pin must be tied directly to the V_{IN} to keep the regulator continuously activated. The En pin must not be left at high impedance.

9 Package mechanical data

In order to meet environmental requirements, ST offers these devices in ECOPACK[®] 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.

PPAK MECHANICAL DATA

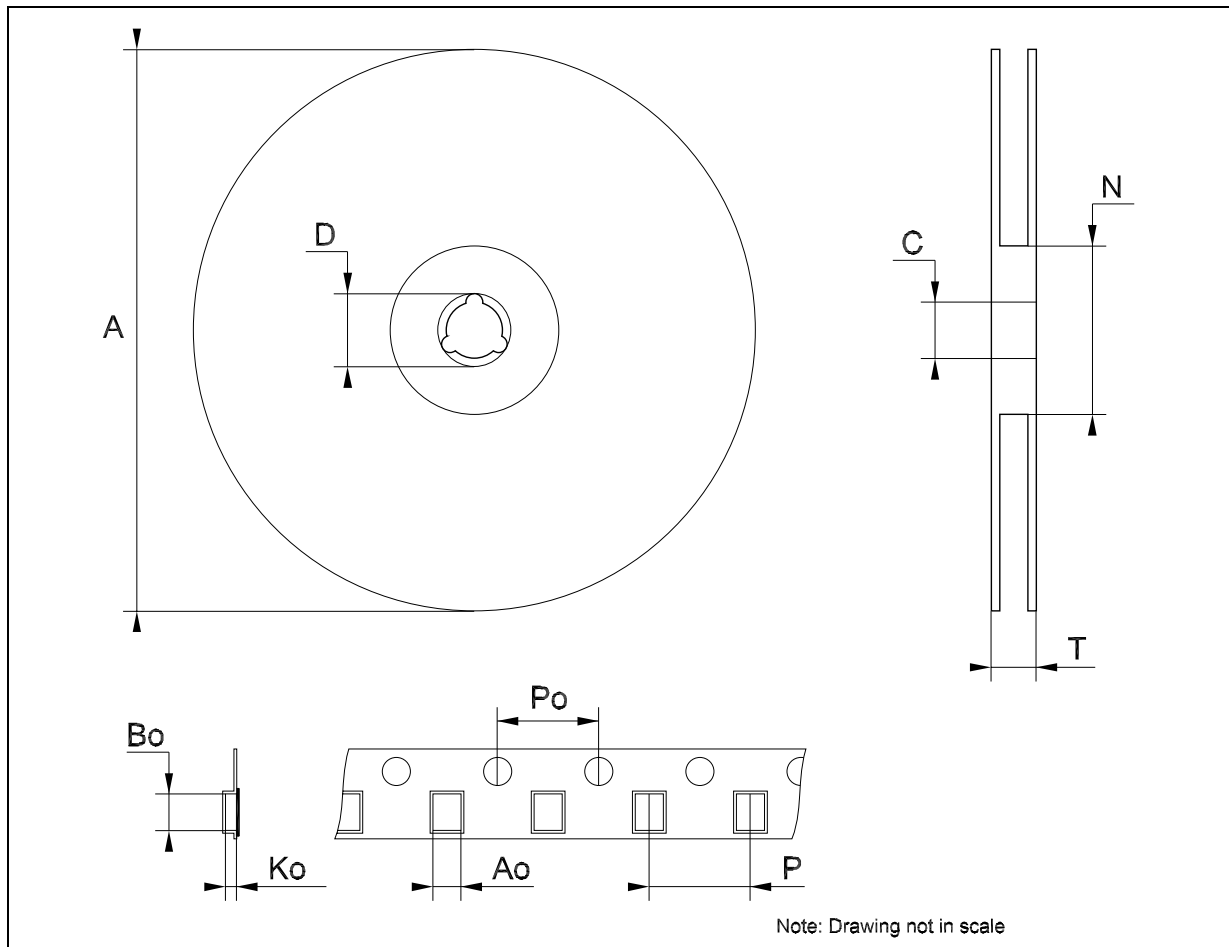
| DIM. | mm. | | | inch | | |
|------|------|------|------|-------|-------|-------|
| | MIN. | TYP | MAX. | MIN. | TYP. | MAX. |
| A | 2.2 | | 2.4 | 0.086 | | 0.094 |
| A1 | 0.9 | | 1.1 | 0.035 | | 0.043 |
| A2 | 0.03 | | 0.23 | 0.001 | | 0.009 |
| B | 0.4 | | 0.6 | 0.015 | | 0.023 |
| B2 | 5.2 | | 5.4 | 0.204 | | 0.212 |
| C | 0.45 | | 0.6 | 0.017 | | 0.023 |
| C2 | 0.48 | | 0.6 | 0.019 | | 0.023 |
| D | 6 | | 6.2 | 0.236 | | 0.244 |
| D1 | | 5.1 | | | 0.201 | |
| E | 6.4 | | 6.6 | 0.252 | | 0.260 |
| E1 | | 4.7 | | | 0.185 | |
| e | | 1.27 | | | 0.050 | |
| G | 4.9 | | 5.25 | 0.193 | | 0.206 |
| G1 | 2.38 | | 2.7 | 0.093 | | 0.106 |
| H | 9.35 | | 10.1 | 0.368 | | 0.397 |
| L2 | | 0.8 | 1 | | 0.031 | 0.039 |
| L4 | 0.6 | | 1 | 0.023 | | 0.039 |
| L5 | 1 | | | 0.039 | | |
| L6 | | 2.8 | | | 0.110 | |



0078180-E

Tape & Reel DPAK-PPAK MECHANICAL DATA

| DIM. | mm. | | | inch | | |
|------|-------|-------|-------|-------|-------|--------|
| | MIN. | TYP | MAX. | MIN. | TYP. | MAX. |
| A | | | 330 | | | 12.992 |
| C | 12.8 | 13.0 | 13.2 | 0.504 | 0.512 | 0.519 |
| D | 20.2 | | | 0.795 | | |
| N | 60 | | | 2.362 | | |
| T | | | 22.4 | | | 0.882 |
| Ao | 6.80 | 6.90 | 7.00 | 0.268 | 0.272 | 0.276 |
| Bo | 10.40 | 10.50 | 10.60 | 0.409 | 0.413 | 0.417 |
| Ko | 2.55 | 2.65 | 2.75 | 0.100 | 0.104 | 0.105 |
| Po | 3.9 | 4.0 | 4.1 | 0.153 | 0.157 | 0.161 |
| P | 7.9 | 8.0 | 8.1 | 0.311 | 0.315 | 0.319 |



10 Revision history

Table 5. Revision history

| Date | Revision | Changes |
|-------------|----------|------------------|
| 18-Apr-2007 | 1 | Initial release. |

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