## 1.Description

The MIC29502 is a high current, high accuracy and low-dropout voltage regulator.The 5A LDO regulator features 560mV (full load) dropout voltage and very low ground current. Designed for high-current loads, these devices also find applications in lower current, low-dropout critical systems, where their dropout voltages and ground current values are important attributes. Along with a total accuracy of ±2% (over temperature, line, and load regulation) the regulator features very fast transient recovery from input voltage surges and output load current changes.The MIC29502 has an adjustable output that can be set by two external resistors to a voltage between 1.24V and 15V. In addition, the device is fully protected against over current faults, reversed input polarity, reversed lead insertion, and over temperature operation. A TTL/CMOS logic enable (EN) pin is available in the MIC29502 to shutdown the regulator. When not used, the device can be set to continuous operation by connecting EN to the input (IN).

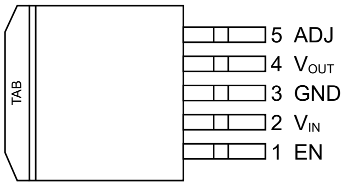
## 2.Features

- High Current Capability
- Low-Dropout Voltage
- Low Ground Current
- Accurate 2% Guaranteed Tolerance
- Fast Transient Response
- Operating Input Voltage Range: 3V to 26V
- 1.24V to 15V Adjustable Output Voltage
- Zero-Current Shutdown Mode
- Adjustable Version
- Packages: TO-263 and TO-220

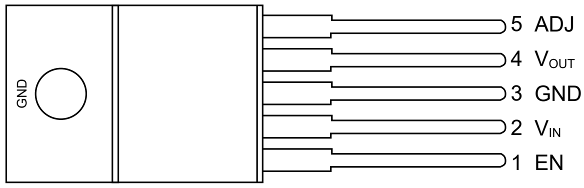
## 3.Applications

- Processor peripheral and I/O supplies
- High-efficiency “Green” computer systems
- Automotive electronics
- High-efficiency linear lower supplies
- Battery-powered equipment
- PC add-in cards
- High-efficiency lost-regulator for Switching supply

## 4.Pinning information




MIC29502 (TO-263)




MIC29502 (TO-220)

Pin Description

| Pin Number | Pin Name | Function Description |
|---|---|---|
| 1 | EN | Enable pin, Active high TTL/CMOS compatible control input Logic-high=enable Logic-low=shutdown. Do not float |
| 2 | $V_{IN}$ | Supplies the current to the output power device |
| 3,TAB | GND | Ground TAB is also connected internally to the IC's ground on both Packages |
| 4 | $V_{OUT}$ | The regulator output voltage |
| 5 | ADJ | Adjustable regulator feedback input that connects to the resistor voltage divider that is placed from $V_{OUT}$ to GND in order to set the output voltage |

## 5.Absolute Maximum Ratings

| Parameter | Symbol | Value | Units |
|---|---|---|---|
| Power Dissipation | $P_D$ | Internally Limited | |
| Input Supply Voltage (Note 1) | $V_{IN}$ | -20 to +50 | V |
| Maximum Operating Input Voltage | | 26 | V |
| Enable Input Voltage | $V_{EN}$ | -0.3V to $V_{IN}$ | V |
| Operating Junction Temperature | $T_J$ | -40 to +125 | °C |
| Lead Temperature (soldering, 5 seconds) | $T_{LEAD}$ | 260 | °C |
| Storage Temperature Range | $T_{STG}$ | -55 to +150 | °C |
| Thermal Resistance (JC) | $\theta_{JC}$ | 3 | °C/W |
| Thermal Resistance (JA) | $\theta_{JA}$ | 28 | °C/W |

Notice:
The maximum allowable power dissipation is a function of ambient temperature, the maximum allowable junction temperature and the thermal resistance from junction to air (i.e., $T_A$, $T_J$, $\theta_{JA}$). Exceeding the maximum allowable power dissipation will cause the device operating junction temperature to exceed the maximum +125°C rating. Sustained junction temperatures above +125°C can impact the device reliability.
Note1:
Maximum positive supply voltage of 50V must be of limited duration(<100ms) and duty cycle(<1%).The maximum continuous supply voltage is 26V. Exceeding the absolute maximum rating may damage the device.

## 6.Recommended Operating Conditions

| Parameter | Symbol | Value | Units |
|---|---|---|---|
| Operating Input Voltage | $V_{IN}$ | 3 to 26 | V |

## 7.Electrical characteristics

All measurements at $T_J$=25°C unless otherwise noted. $V_{IN}$=$V_{OUT}$+1V, $I_{OUT}$=100mA, Bold values indicate -40°C≤$T_J$≤+125°C.

| Parameter | Symbol | Conditions | | Min | Typ | Max | Units |
|---|---|---|---|---|---|---|---|
| **Output Voltage** | | | | | | | |
| Output Voltage Accuracy | $V_{OUT}$ | 100mA≤$I_{OUT}$≤5A, ($V_{OUT}$+1V) ≤$V_{IN}$≤26V | | -2 | | 2 | % |
| Line Regulation | $\Delta V_{OUT}/V_{IN}$ | $I_O$=100mA, ($V_{OUT}$+1V) ≤$V_{IN}$≤26V | | | 0.1 | 0.5 | % |
| Load Regulation | $\Delta V_{OUT}/I_{OUT}$ | $V_{IN}$=$V_{OUT}$+1V, 100mA≤$I_{OUT}$≤5A | | | 0.2 | 1 | % |
| Dropout Voltage | $V_{DO}$ | $I_O$=100mA | $\Delta V_{OUT}$=-1% (*1) | | 100 | 200 | mV |
| | | $I_O$=750mA | | | 220 | | mV |
| | | $I_O$=2.5A | | | 300 | | mV |
| | | $I_O$=5A | | | 560 | 800 | mV |
| **Ground Current** | | | | | | | |
| Ground Current | $I_{GND}$ | $I_O$=750mA | $V_{IN}$=$V_{OUT}$+1V (*2) | | 5 | 20 | mA |
| | | $I_O$=2.5A | | | 15 | | mA |
| | | $I_O$=5A | | | 60 | 150 | mA |
| Ground Pin Current at Dropout | $I_{GND\_DO}$ | $V_{IN}$=0.5V less than specified $V_{OUT}$, $I_{OUT}$=10mA | | | 2 | | mA |
| Current Limit | $I_{LIMIT}$ | $V_{OUT}$=0V (*3) | | 5 | 7 | | A |
| Output Noise Voltage (10Hz to 100kHz) $I_L$=100mA | $e_N$ | $C_L$=10μF | | | 400 | | μV (rms) |
| | | $C_L$=33μF | | | 260 | | |
| Ground Pin Current in Shutdown | $I_{SHDN}$ | $V_{IN}$=26V | | | 32 | | μA |
| **Reference** | | | | | | | |
| Reference Voltage | $V_{REF}$ | (*4) | | 1.215 | | 1.267 | V |
| Adjust Pin Bias Current | $I_{ADJ}$ | | | | 40 | 80 | nA |
| | | | | | | 120 | nA |

| Parameter | Symbol | Conditions | Min | Typ | Max | Units |
|---|---|---|---|---|---|---|
| **Enable Input** | | | | | | |
| Input Logic Voltage | $V_{ENABLE}$ | Low (OFF) | | | 0.8 | V |
| | | High (ON) | 2.4 | | | V |
| Enable Pin Input Current | $I_{EABLE}$ | $V_{EN}$=4.2V | | 15 | 30 | μA |
| | | | | | 75 | μA |
| | | $V_{EN}$=0.8V | | | 2 | μA |
| | | | | | 4 | μA |
| Regulator Output Current in Shutdown | $I_{OUT-SHDN}$ | (*5) | | 10 | | μA |
| | | | | | 20 | μA |

Notes:

* 1: Dropout voltage is defined as the input-to-output differential when the output voltage drops to 99% of its nominal value with $V_{OUT}$+1V applied to $V_{IN}$.
* 2: Ground pin current is the regulator quiescent current. The total current drawn from the source is the sum of the load current plus the ground pin current.
* 3: $V_{IN}$=$V_{OUT}$(nominal) + 1V. For example, use $V_{IN}$=4.3V for a 3.3V regulator or use 6V for a 5V regulator. Employ pulse-testing procedures to minimize temperature rise.
* 4: $V_{REF} \le V_{OUT} \le (V_{IN}-1V)$, $3V \le V_{IN} \le 26V$, $10mA < I_L \le I_{FL}$, $T_J \le T_{J(MAX)}$.
* 5: $V_{EN} \le 0.8V$, $V_{IN} \le 26V$ and $V_{OUT}=0$.

## 8.1 Typical characteristic

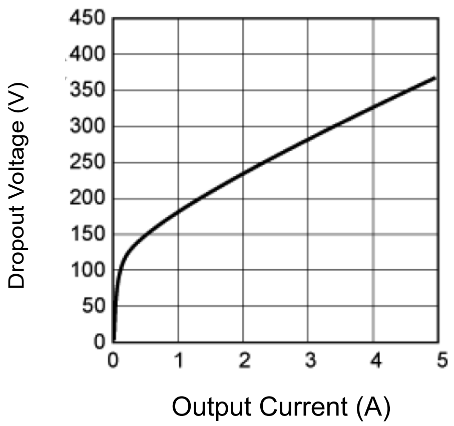



Figure 1: MIC29502 Dropout Voltage vs. Output Current

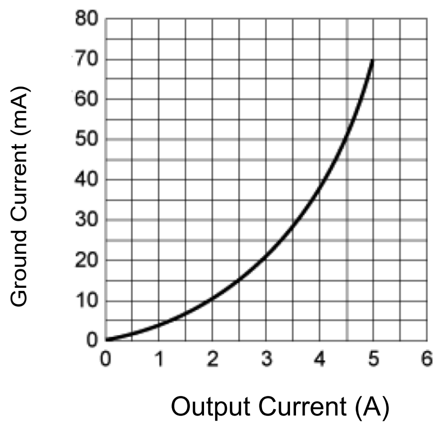



Figure 2: MIC29502 Ground Current vs. Output Current

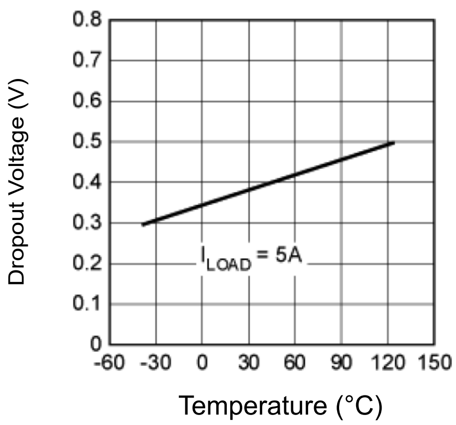



Figure 3: MIC29502 Dropout Voltage vs. Temperature

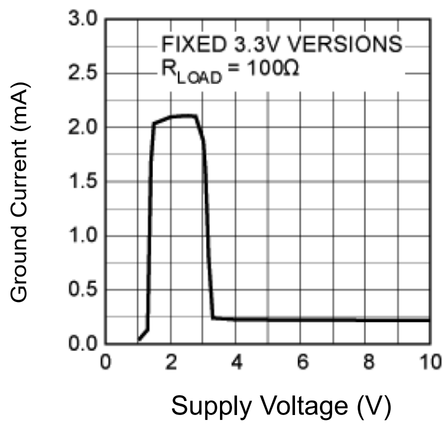



Figure 4: MIC29502 Ground Current vs. Supply Voltage

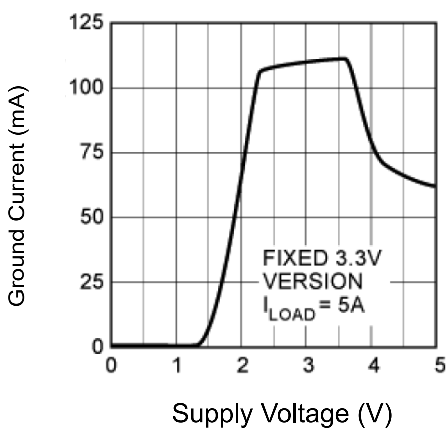



Figure 5: MIC29502 Ground Current vs. Supply Voltage

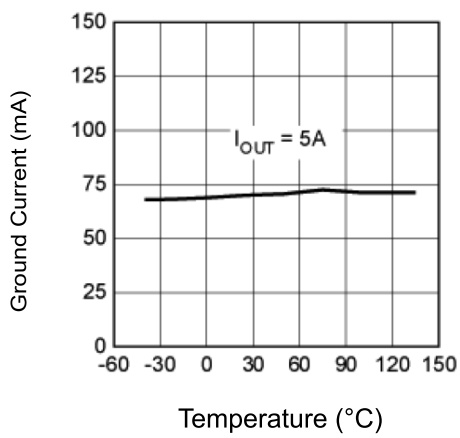



Figure 6: MIC29502 Ground Current vs. Temperature

## 8.2 Typical characteristic

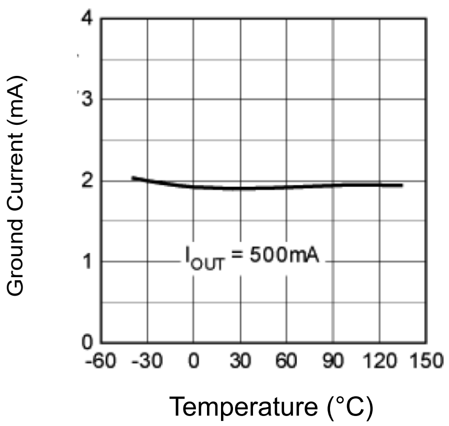



Figure 7: MIC29502 Ground Current vs. Temperature

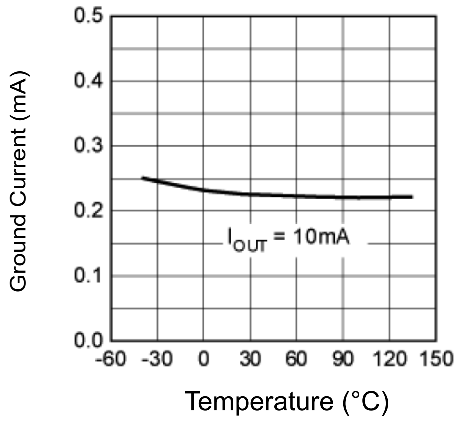



Figure 8: MIC29502 Ground Current vs. Temperature

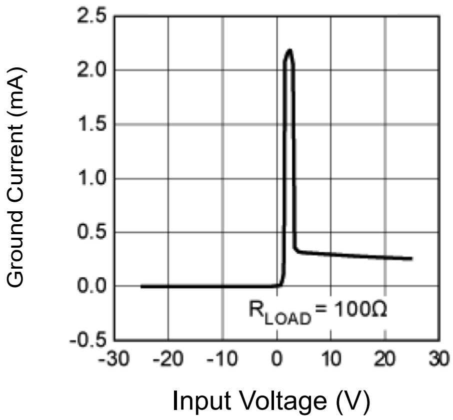



Figure 9: MIC29502 Ground Current vs. Input Voltage

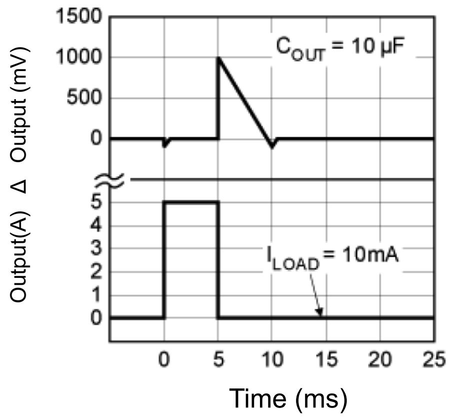



Figure 10: MIC29502 Load Transient

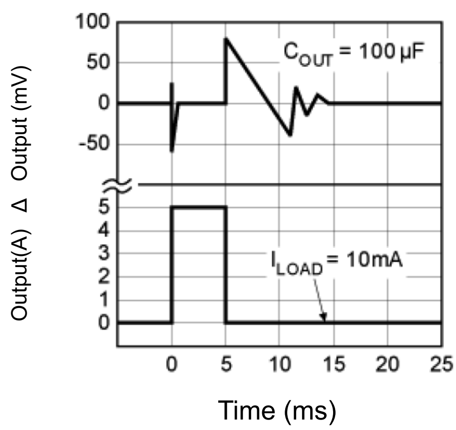



Figure 11: MIC29502 Load Transient

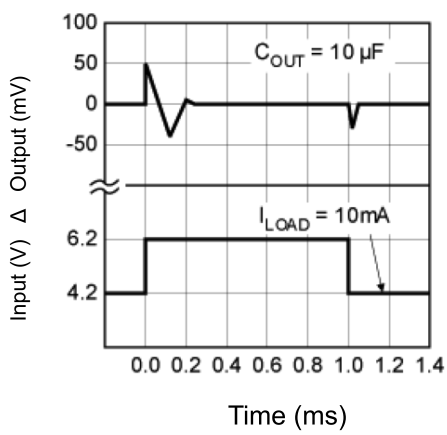
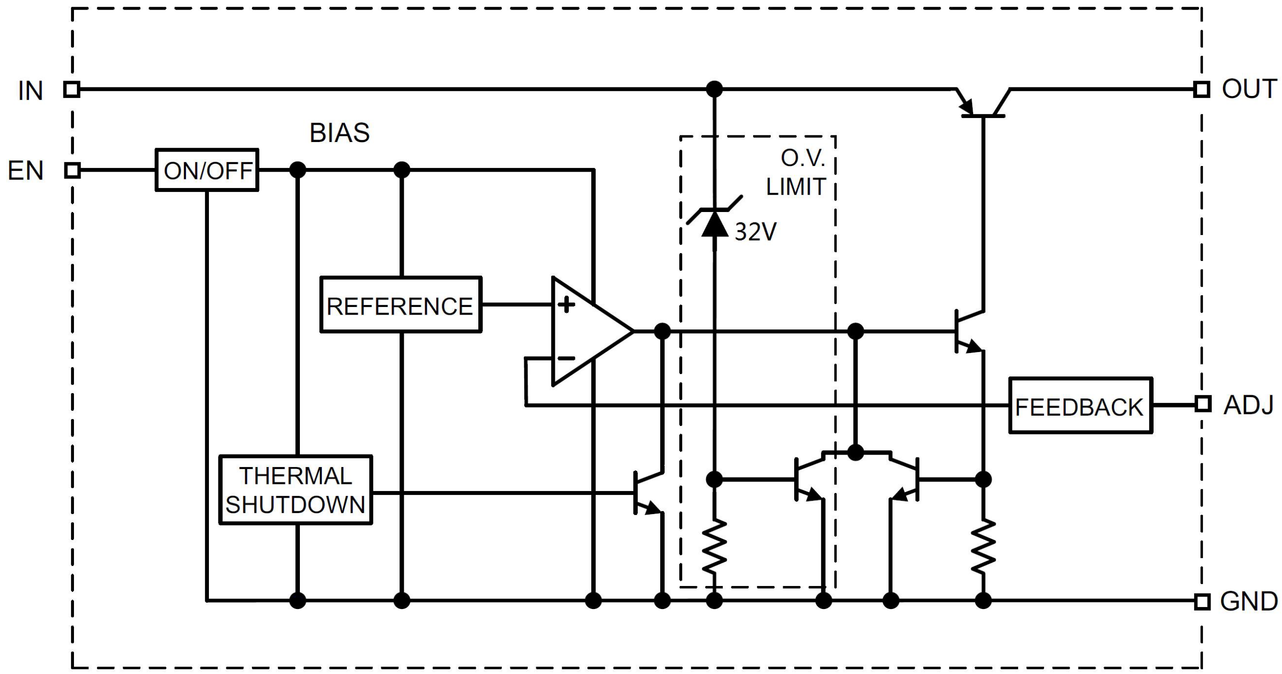


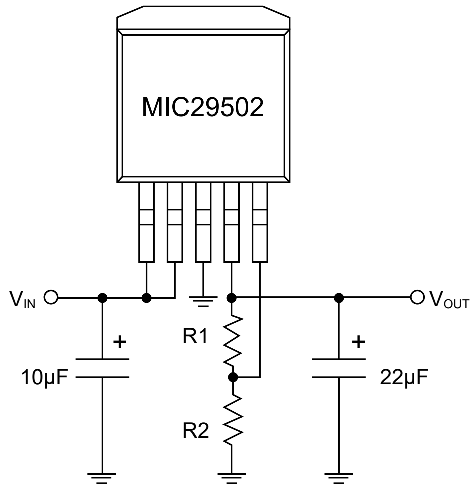

Figure 12: MIC29502 Line Transient

## 9.Functional Diagram



## 10.Typical Application

Below is adjustable output voltage configuration.For best results, the total series resistance should be small enough to pass the minimum regulator load current.




$V_{OUT}$=1.240V x [1+(R1/R2)]

## 11.Application Information

The MIC29502 is a high performance low-dropout voltage adjustable regulator suitable for all moderate to high-current voltage regulator application. It 560mV typical dropout voltage at full load make it especially valuable in battery-powered systems and as high efficiency noise filters in post-regulator applications. Unlike older NPN-pass transistor designs, where the minimum dropout voltage is limited by the base-emitter voltage drop and collector-emitter saturation voltage, dropout performance of the PNP output of this device is limited merely by the low $V_{CE}$ saturation voltage.

A trade-off for the low dropout voltage is a varying base drive requirement. The MIC29502 is a fully protected from damage due to fault condition. Current limiting is provided. This limiting is linear; output current under over-load conditions is constant. Thermal shutdown disables the device when the die temperature exceeds the 125°C maximum safe operating temperature. The output structure of this regulator allows voltages in excess of the desired output voltage to be applied without reverse current flow. MIC29502 offers a logic level ON/OFF control: when disabled, the device draws 32µA at maximum 26V input.

## 12.Capacitor Requirements

For stability and minimum output noise, a capacitor on the regulator output is necessary. The value of this capacitor is dependent upon the output current; lower currents allow smaller capacitors. MIC29502 regulator is stable with the following minimum capacitor values at full load: 10μF. This capacitor need not be an expensive low ESR type: aluminum electrolytics are adequate. In fact, extremely low ESR capacitors may contribute to instability. Tantalum capacitors are recommended for systems where fast load transient response is important.
Where the regulator is powered from a source with a high AC impedance, a 0.1μF capacitor connected between Input and GND is recommended.

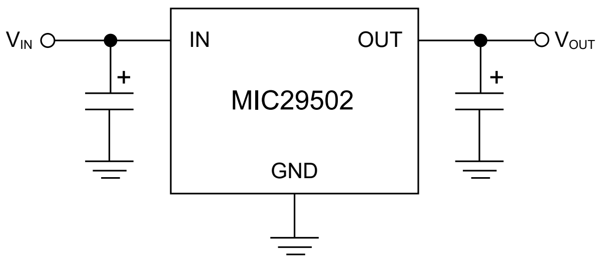



Fig. Linear Regulators Require Only Two Capacitors for Operation

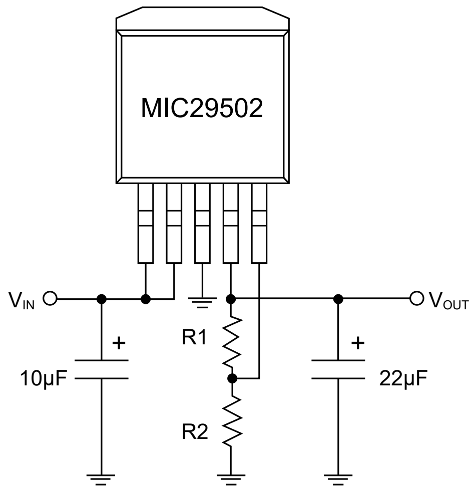
## 13.Minimum Load Current

The MIC29502 regulator operates within a specified loads. If the output current is too small, leakage currents dominate and the output voltage rises. A minimum load current of 10 mA is necessary for proper regulation and to swamp any expected leakage current across the operating temperature range.
For best performance the total resistance (R1+R2) should be small enough to pass the minimum regulator load current of 10 mA.

## 14.Adjustable Regulator Design

The output voltage can be programmed anywhere between 1.25V and the 15V.Two resistors are used. The resistor values are calculated by:

$$R_1=R_2\left(\frac{V_{OUT}}{1.240}-1\right)$$




$V_{OUT}$=1.240V x [1+(R1/R2)]

Fig. Adjustable Regulator with Resistors

Where $V_{OUT}$ is the desired output voltage. Figure shows component definition. Applications with widely varying load currents may scale the resistors to draw the minimum load current required for proper operation.

## 15.Enable Input

MIC29502 features an enable (EN) input that allows ON/OFF control of the device. The EN input has TTL/CMOS compatible thresholds for simple interfacing with logic, or may be directly tied to $V_{IN}$. Enabling the regulator requires approximately 20µA of current into the EN pin.

## 16.Transient Response and 5V to 3.3V Conversion

The MIC29502 has excellent response to variations in input voltage and load current. By virtue of its low dropout voltage, the device does not saturate into dropout as readily as similar NPN-based designs. A 3.3V output LDO will maintain full speed and performance with an input supply as low as 4.2V, and will still provide some regulation with supplies down to 3.8V, unlike NPN devices that require 5.1V or more for good performance and become nothing more than a resistor under 4.6V of input. MIC29502 PNP regulators provide superior performance in “5V to 3.3V” conversion applications than NPN regulators, especially when all tolerances are considered.

## 17.Thermal Design

Linear regulators are simple to use.The most complicated design parameters to consider are thermal characteristics. Thermal design requires the following application-specific parameters:

- Maximum ambient temperature, $T_A$
- Output Current, $I_{OUT}$
- Output Voltage, $V_{OUT}$
- Input Voltage, $V_{IN}$

First, calculate the power dissipation of the regulator from these numbers and the device parameters from this datasheet.

$$P_D = I_{OUT}(1.05V_{IN} - V_{OUT})$$

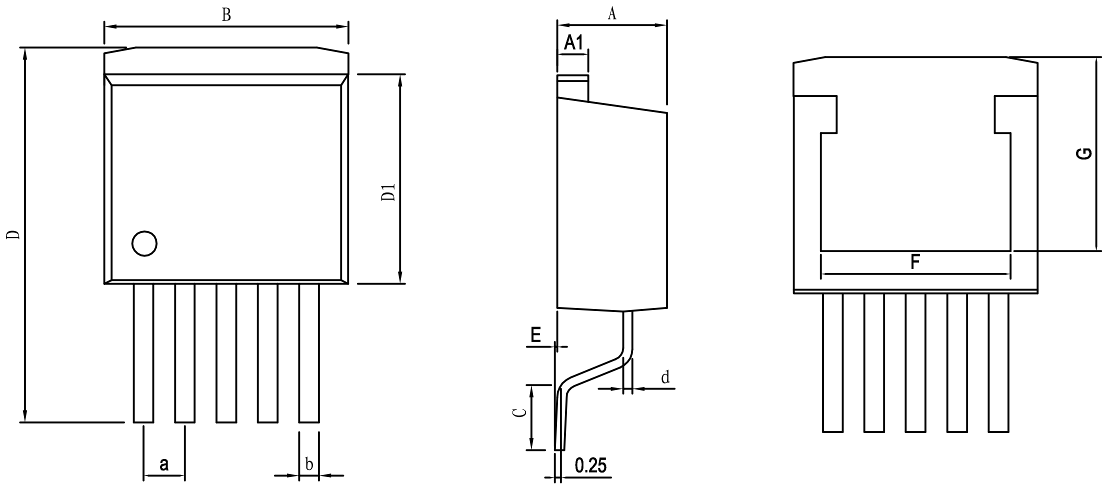
Where the ground current is approximated by 5% of $I_{OUT}$. Then the heat sink thermal resistance is determined with this formula:

$$\theta_{SA} = \frac{T_{JMAX} - T_A}{P_D} - (\theta_{JC} + \theta_{CS})$$

Where $T_{J(MAX)} \leq 125°C$ and $\theta_{CS}$ is between 0°C/W and 2°C/W.

The heat sink may be significantly reduced in applications where the minimum input voltage is known and is large compared with the dropout voltage. Use a series input resistor to drop excessive voltage and distribute the heat between this resistor and the regulator. The low dropout properties of regulators allow very significant reductions in regulator power dissipation and the associated heat sink without compromising performance. When this technique is employed, a capacitor of at least 0.1μF is needed directly between the input and regulator ground.

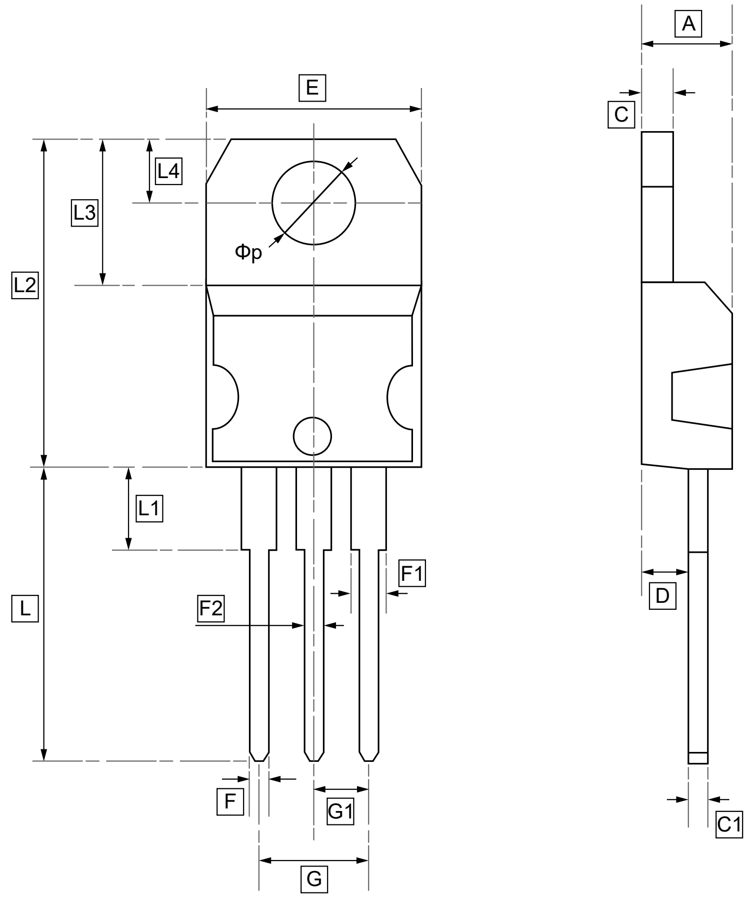
## 18.1 TO-263 Package Outline Dimensions




**DIMENSIONS (mm are the original dimensions)**

| Symbol | A | A1 | B | C | D | D1 | E | F | G | a | b |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Min | 4.400 | 1.250 | 9.800 | 2.100 | 14.440 | 8.450 | 0 | 7.80 TYP | 7.97 TYP | 1.680 | 0.710 |
| Max | 4.600 | 1.300 | 10.41 | 2.600 | 15.340 | 8.950 | 0.305 | | | 1.720 | 0.910 |

## 18.2 TO-220 Package Outline Dimensions

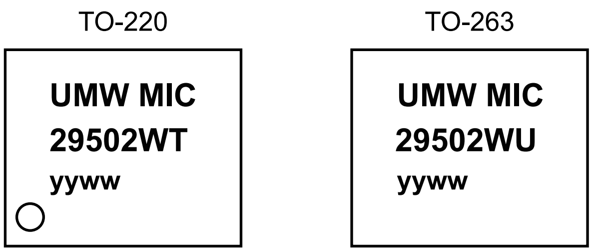



**DIMENSIONS (mm are the original dimensions)**

| Symbol | A | C | C1 | D | E | F | F1 | F2 | G | G1 | L | L1 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Min** | 4.4 | 1.2 | 0.38 | 2.4 | 9.85 | 0.6 | 1.22 | 1.22 | 4.93 | 2.39 | 13.1 | 3.75 |
| **Max** | 4.6 | 1.32 | 0.55 | 2.65 | 10.85 | 0.85 | 1.4 | 1.4 | 5.23 | 2.69 | 13.9 | 4.75 |

| Symbol | L2 | L3 | L4 | Φp |
|---|---|---|---|---|
| **Min** | 15.25 | 6.25 | 2.65 | 3.75 |
| **Max** | 15.75 | 6.75 | 2.85 | 3.95 |

## 19.Ordering Information




yy: Year Code
ww: Week Code

| Order Code | Marking | Package | Base QTY | Delivery Mode |
|---|---|---|---|---|
| UMW MIC29502WT | MIC29502WT | TO-220 | 1000 | Tube and box |
| UMW MIC29502WU | MIC29502WU | TO-263 | 800 | Tape and reel |

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