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).

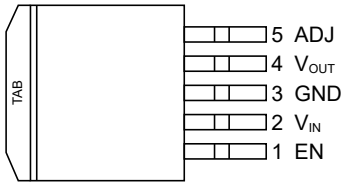
2.Features

- 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

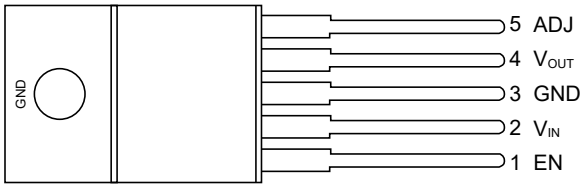
3.Applications

- 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)	θ_{JC}	3	°C/W
Thermal Resistance (JA)	θ_{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, θ_{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	ΔV_{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}≤V_{OUT}≤ (V_{IN}-1V), 3V≤V_{IN}≤26V, 10mA<I_L≤ I_{FL}, T_J≤$T_{J(MAX)}$.

* 5: V_{EN}≤0.8V, V_{IN}≤26V and V_{OUT}=0.

8.1 Typical characteristic

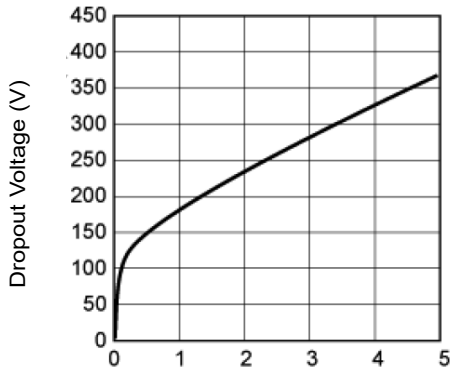


Figure 1: MIC29502 Dropout Voltage vs. Output Current

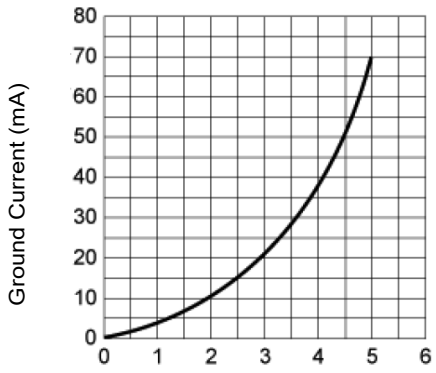


Figure 2: MIC29502 Ground Current vs. Output Current

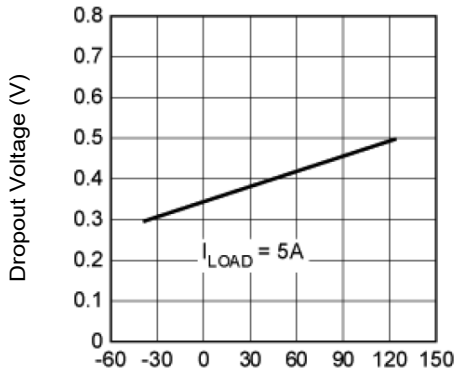


Figure 3: MIC29502 Dropout Voltage vs. Temperature

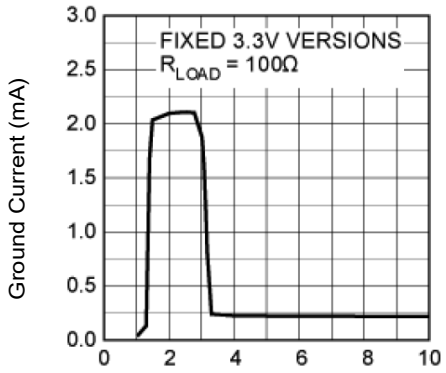


Figure 4: MIC29502 Ground Current vs. Supply Voltage

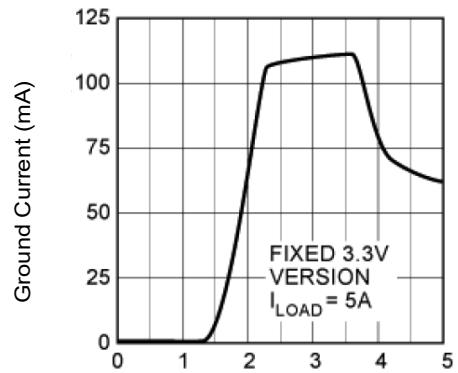


Figure 5: MIC29502 Ground Current vs. Supply Voltage

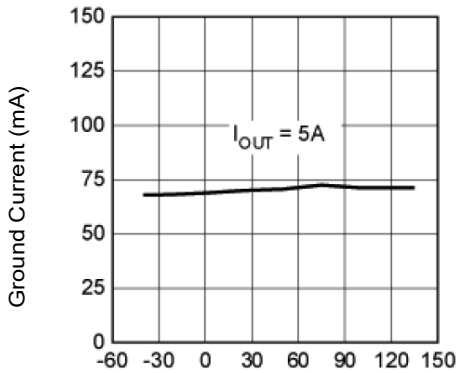


Figure 6: MIC29502 Ground Current vs. Temperature

8.2 Typical characteristic

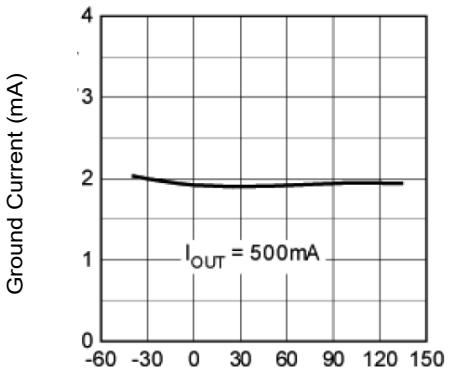


Figure 7: MIC29502 Ground Current vs. Temperature

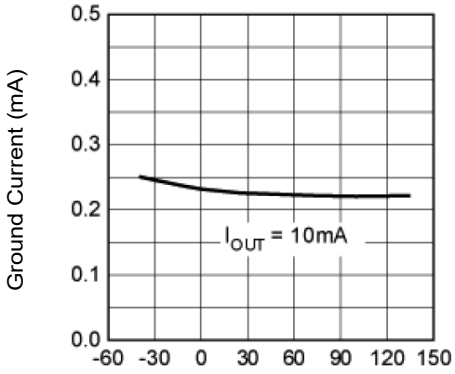


Figure 8: MIC29502 Ground Current vs. Temperature

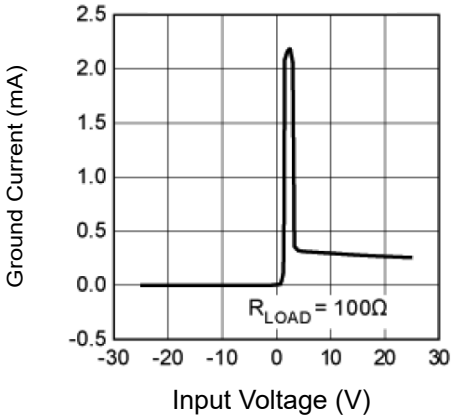


Figure 9: MIC29502 Ground Current vs. Input Voltage

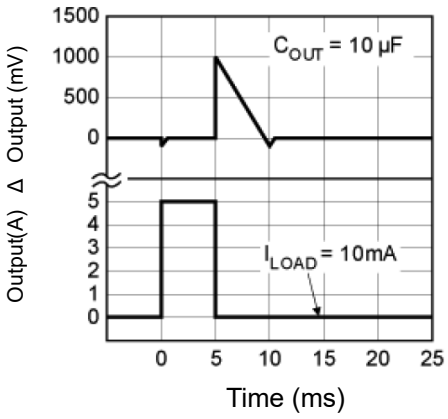


Figure 10: MIC29502 Load Transient

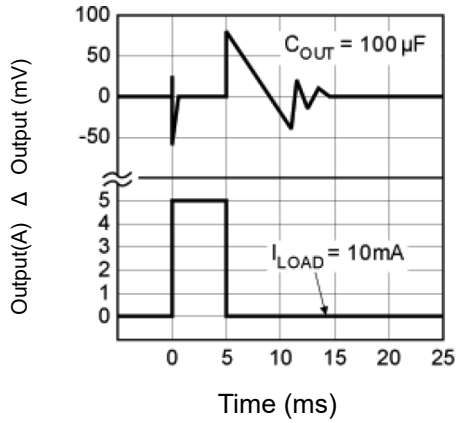


Figure 11: MIC29502 Load Transient

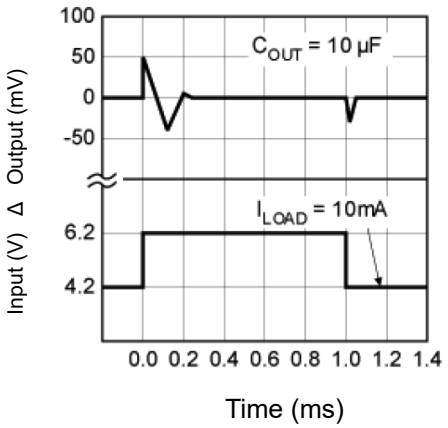
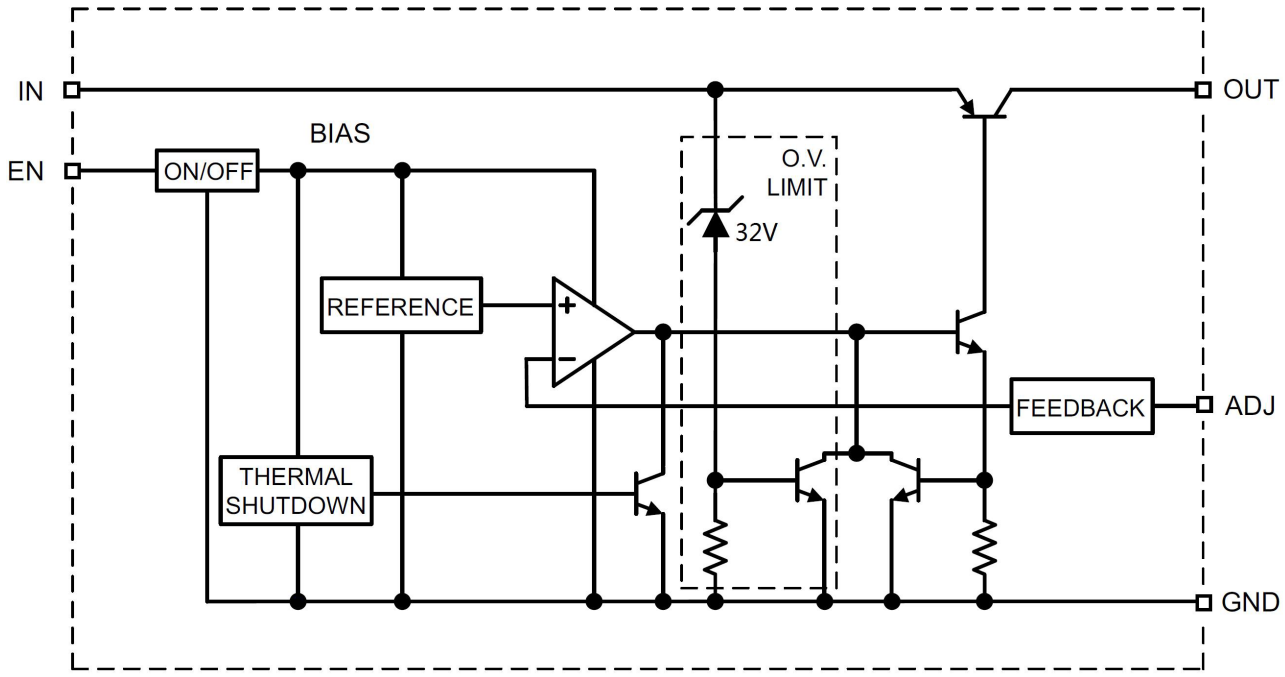


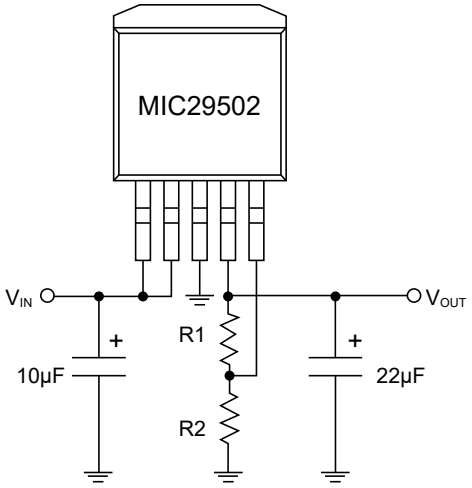
Figure 12: MIC29502 Line Transient

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.

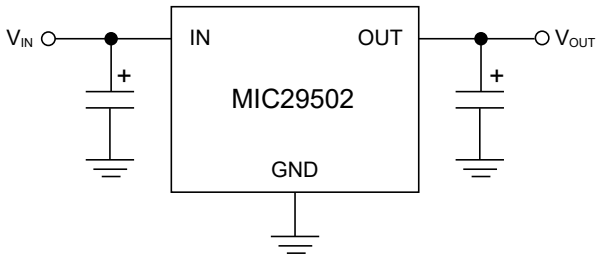


Fig. Linear Regulators Require Only Two Capacitors for Operation

13.Minimum Load Current

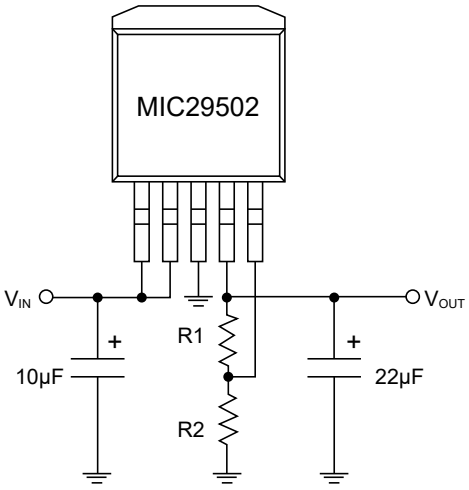
The MIC29502 regulator operates within a specified loads. If the output current is too small, leakage currents dominate and the output voltage rises. A minimum load current of 10 mA is necessary for proper regulation and to swamp any expected leakage current across the operating temperature range.

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.

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

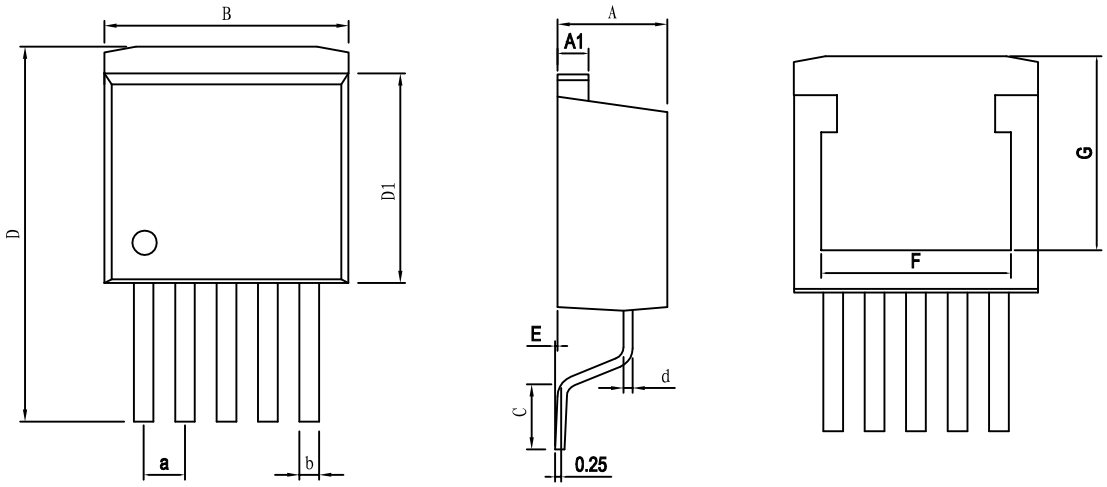
Where the ground current is approximated by 5% of I_{OUT}. Then the heat sink thermal resistance is determined with this formula:

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

Where $T_{J(MAX)}\leq 125°C$ and θ_{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.

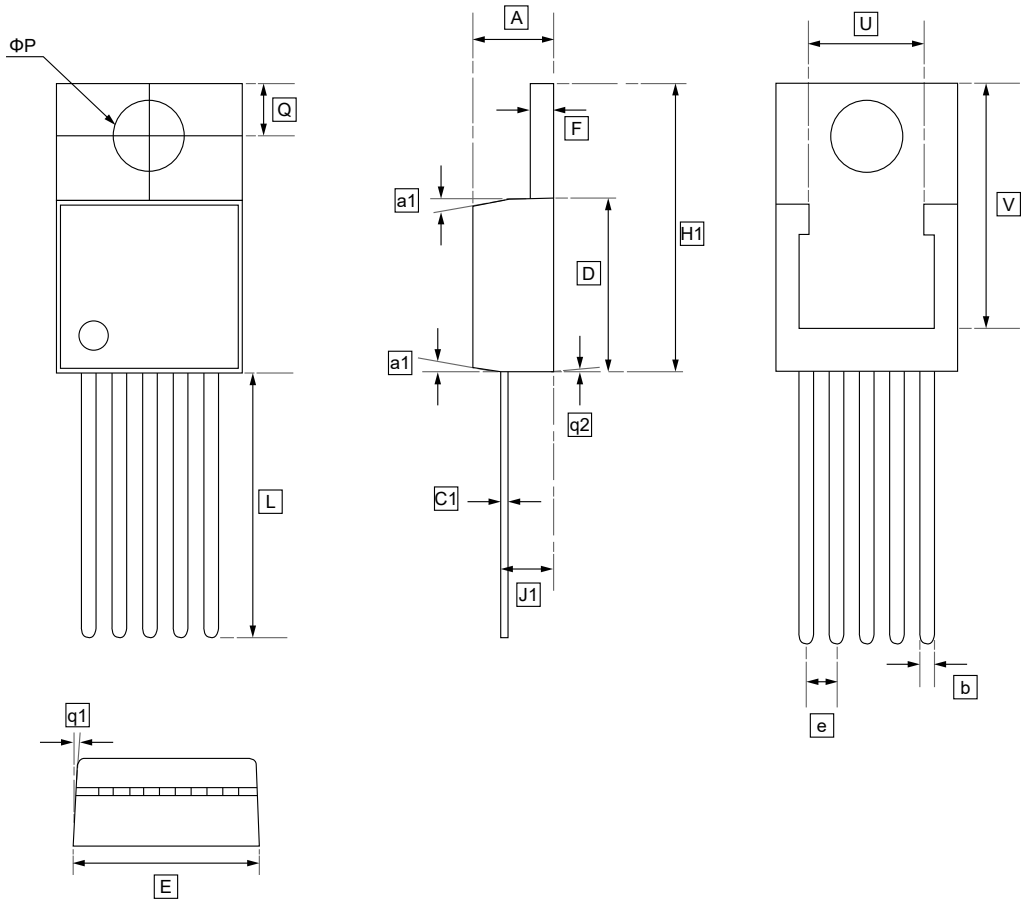
18.1 TO-263 Package Outline Dimensions



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	7.97	1.680	0.710
Max	4.600	1.300	10.41	2.600	15.340	8.950	0.305	TYP	TYP	1.720	0.910

18.2 TO220-5 Package Outline Dimensions

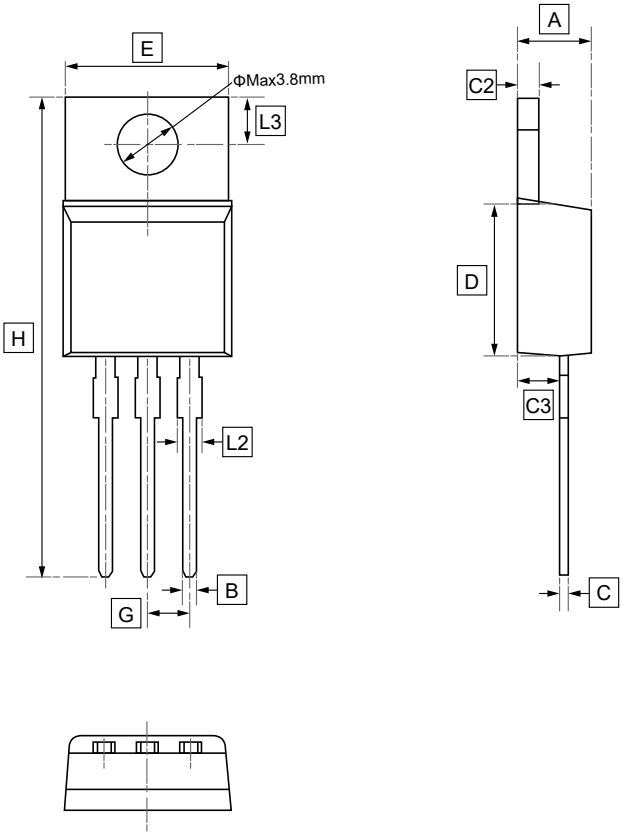


DIMENSIONS (mm are the original dimensions)

Symbol	A	b	C1	D	E	e	F	H1	J1	ΦP	Q	L	q1
Min	0.160	0.025	0.012	0.351	0.385	0.062	0.045	0.560	0.080	0.146	0.103	0.500	3°
Max	0.190	0.040	0.022	0.361	0.420	0.072	0.055	0.595	0.120	0.156	0.113	0.580	10°

Symbol	q2	U	V
Min	1°	0.256	0.486
Max	7°	REF	REF

18.3 TO-220 Package Outline Dimensions

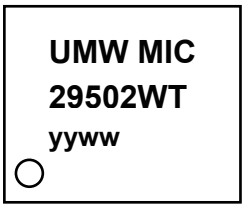


DIMENSIONS (mm are the original dimensions)

Symbol	A	B	C	C2	C3	D	E	G	H	L2	L3
Min	4.30	0.60	0.28	1.17	2.30	8.80	9.80	2.44	28.55	1.10	2.59
Max	4.70	1.00	0.48	1.37	2.70	9.20	10.20	2.64	29.15	1.50	2.89

19.Ordering Information

TO-220



TO-263

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

20.Disclaimer

UMW reserves the right to make changes to all products, specifications. Customers should obtain the latest version of product documentation and verify the completeness and currency of the information before placing an order.

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