UMW MIC29302

3A Fast-Response LDO Regulator

1.Description

The MIC29302 is a high-current, low-cost, low-dropout voltage regulator which uses Micrel's proprietary Super βeta PNP® process with a PNP pass element. The 3A LDO regulator features 450mV (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 voltage and ground current values are important attributes

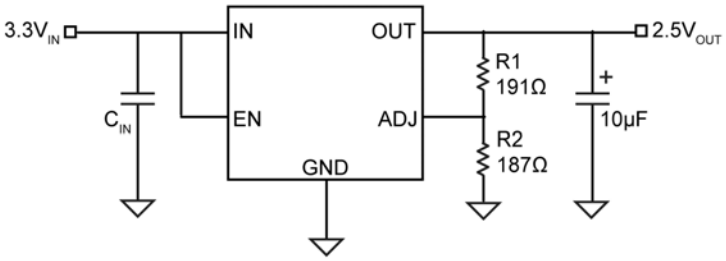
2.Features

- High-current capability
- − 3A over full temperature range
- Low-dropout voltage of 450mV at full load
- Low ground current
- Accurate 2% guaranteed tolerance
- Extremely-fast transient response
- Zero-current shutdown mode
- Error flag signals output out-of-regulation
- Adjustable output voltage
- Packages: TO263-5 and TO220-5

3.Applications

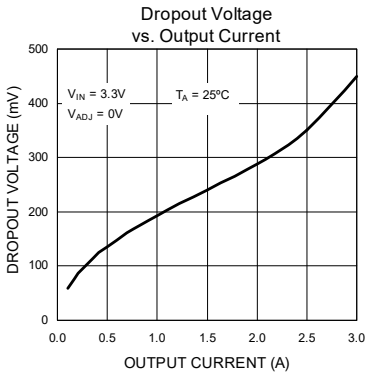
- Processor peripheral and I/O supplies
- High-efficiency “Green” computer systems
- Automotive electronics
- High-efficiency linear lower supplies
- Battery-powered equipment
- PC add-in cards
- High-efficiency lost-regulator for
- switching supply

4.Typical Application

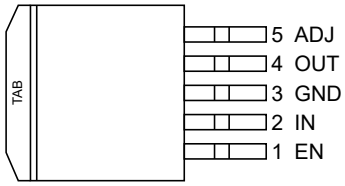


$$V_{OUT} = 1.242 \times \left(\frac{R1}{R2} + 1\right)$$

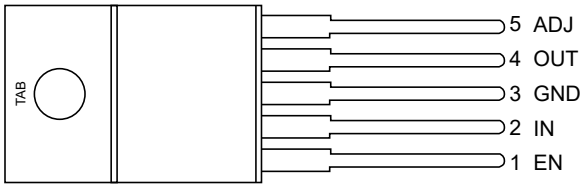
MIC29302 Adjustable Output Regulator



5.Pinning information



5-Pin TO-263 Adjustable Voltage(U)



5-Pin TO-220 Adjustable Voltage (T)

6.Pin Description

TO-263	TO-220	Pin Name	Function Description
1	1	EN	Enable (Input): Active-high CMOS compatible control input. Do not float.
2	2	IN	INPUT: Unregulated input, +2.8V to +16V maximum
3, TAB	3, TAB	GND	GND: TAB is also connected internally to the IC's ground on both packages.
4	4	OUT	OUTPUT: The regulator output voltage
5	5	ADJ	Feedback Voltage: 1.24V feedback from external resistor divider.

7.Absolute Maximum Ratings(1)

Parameter	Symbol	Value	Units
Input Supply Voltage	V_{IN}(1)	26	V
Enable Input Voltage	V_{EN}	–0.3V to V_{IN}	V
Lead Temperature (soldering, 5sec.)		260	°C
Power Dissipation		Internally Limited	
Storage Temperature Range		-65 to +150	°C
Operating Junction Temperature		−40 to +125	°C
Package Thermal Resistance			
TO-263	θ_{JC}	3	°C/W
TO-220	θ_{JC}	2	°C/W

9.1Electrical characteristics(4)

V_{IN}=4.2V; I_{OUT}=100mA; T_A=25°C, bold values indicate −40°C≤T_J≤+125°C, unless noted.

Parameter	Conditions	Min	Typ	Max	Units
Output Voltage					
Output Voltage Accuracy	100mA≤I_{OUT}≤3A, (V_{OUT}+1V)≤V_{IN}≤16V	-2		2	%
Line Regulation	I_{OUT}=100mA, (V_{OUT}+1V) ≤V_{IN}≤16V		0.1	0.5	%
Load Regulation	V_{IN}=V_{OUT}+1V, 100mA≤ I_{OUT}≤3A		0.2	1	%
Dropout Voltage	ΔV_{OUT}=−1%(6)				
	I_{OUT}=100mA		80	200	mV
	I_{OUT}=750mA		220		mV
	I_{OUT}=1.5A		275		mV
	I_{OUT}=3A		450	800	mV
Ground Current					
Ground Current	I_{OUT}=750mA, V_{IN}=V_{OUT}+1V		5	20	mA
	I_{OUT}=1.5A		15		mA
	I_{OUT}=3A		60	150	mA
I_{GRNDDO} Ground Pin Current @ Dropout	V_{IN}=0.5V less than specified V_{OUT}×I_{OUT}=10mA		2		mA
Current Limit	V_{OUT}= 0V(7)		4.5		A
e_n,Output Noise Voltage (10Hz to 100kHz)	C_L=10μF		400		μV (rms)
I_L=100mA	C_L=33μF		260		
Ground Pin Current in Shutdown	Input Voltage V_{IN}=16V		32		μA

9.2Electrical characteristics(4)(Continued)

V_{IN}=4.2V; I_{OUT}=10mA; T_A=25°C, bold values indicate −40°C≤T_J≤+125°C, unless noted.

Parameter	Conditions	Min	Typ	Max	Units
Reference					
Reference Voltage	(8)	1.215		1.267	V
Adjust Pin Bias Current			40		nA
				120	nA
ENABLE Input					
Input Logic Voltage	Low (OFF)			0.8	V
	High (ON)	2.4			V
Enable Pin Input Current	V_{EN}=8V		15	30	μA
				75	μA
	V_{EN}=0.8V			2	μA
				4	μA
Regulator Output Current in Shutdown	(10)		10		μA
				20	μA

Notes:

1. Exceeding the absolute maximum rating may damage the device.

2. The device is not guaranteed to function outside its operating rating.

3. Devices are ESD sensitive. Handling precautions recommended. Human body model, 1.5k in series with 100pF.

4. Specification for packaged product only.

5. Output voltage temperature coefficient is defined as the worst case voltage change divided by the total temperature change.

6. Dropout voltage is defined as the input-to-output differential when output voltage drops to 99% of its normal value with V_{OUT}+ 1V applied to V_{IN}.

7. V_{IN}=V_{OUT}(nominal) + 1V. For example, use V_{IN}= 4.3V for a 3.3Vregulator or use 6V for a 5V regulator. Employ pulse testing procedure for current limit.

8. V_{REF}≤V_{OUT}≤ V_{IN}-1, 3V≤V_{OUT}≤16V, 10mA ≤ I_L ≤ I_{FL}, T_J≤T_{Jmax}.

9. Thermal regulation is defined as the change in the output voltage at a time T after a change in power dissipation is applied, excluding load or line regulation effects. Specifications are for a 250mA load pulse at V_{IN}=16V (a 4W pulse) for T=10ms.

10. V_{EN}≤0.8V, V_{IN}≤16V and V_{OUT}=0V.

10.1Typical characteristic

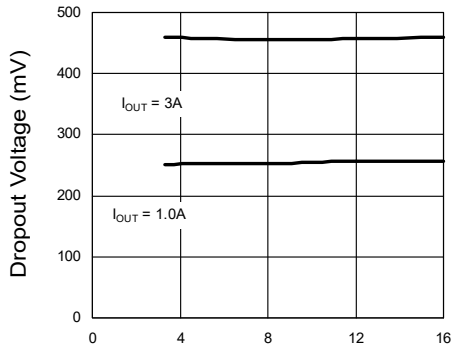


Figure 1: Dropout Voltage vs. Input Voltage

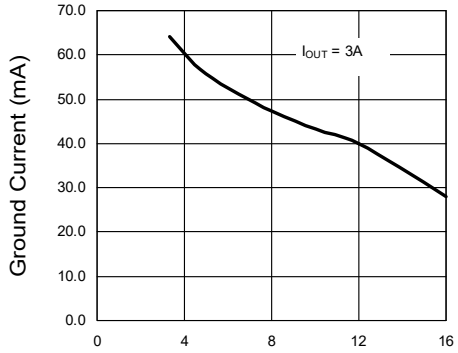


Figure 2: GND Pin Current vs. Input Voltage

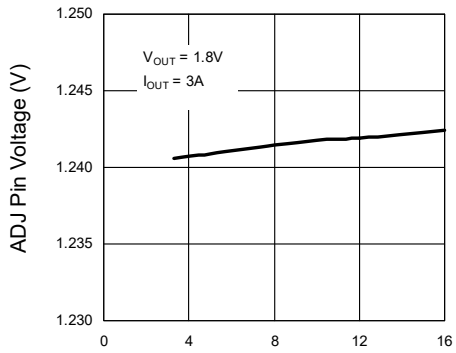


Figure 3: Adjust Pin Voltagevs. Input Voltage

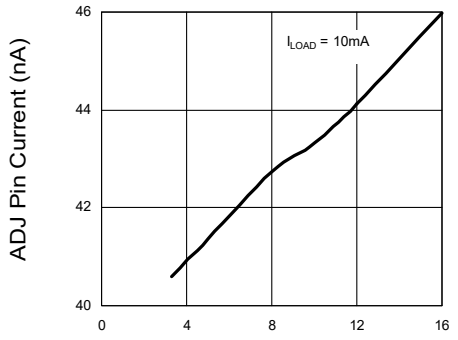


Figure 4: Adjust Pin Current vs. Input Voltage

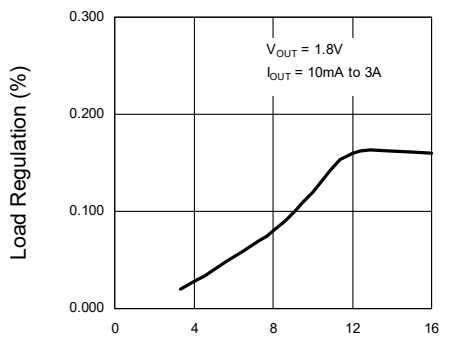


Figure 5: Load Regulation vs. Input Voltage

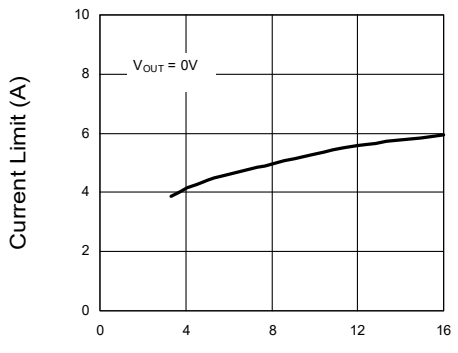


Figure 6: Short-Circuit Current vs. Input Voltage

10.2Typical characteristic

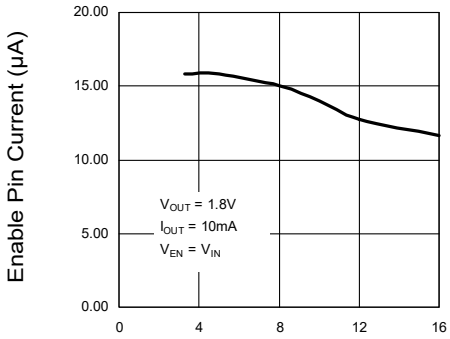


Figure 7: Enable Pin Current vs. Input Voltage

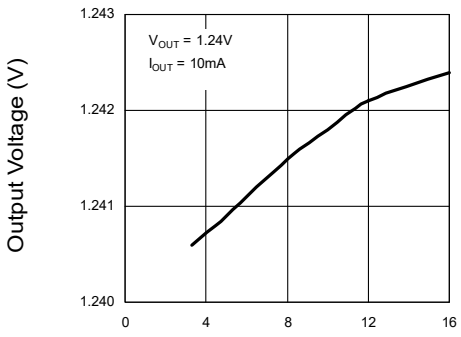


Figure 8: Output Voltage vs. Input Voltage

10.3Typical characteristic (Continued)

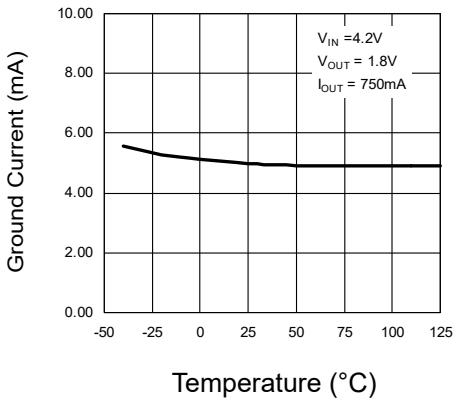


Figure 1: GND Pin Current vs. Temperature

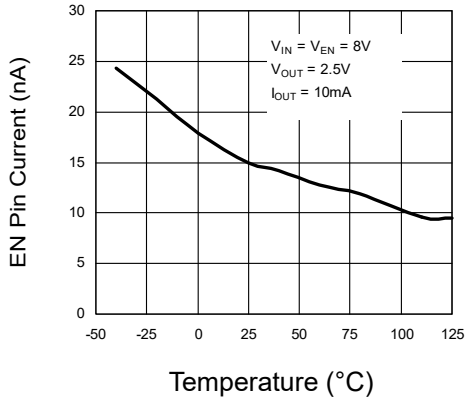


Figure 2: Enable Bias Current vs. Temperature (B06)

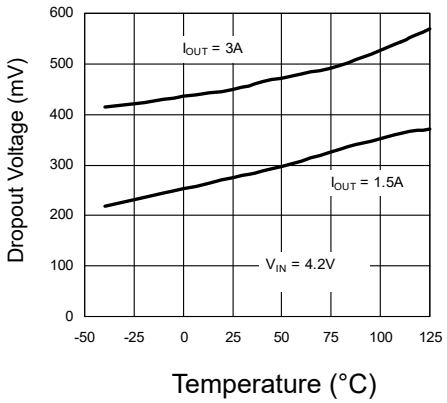


Figure 3: Dropout Voltage vs. Temperature

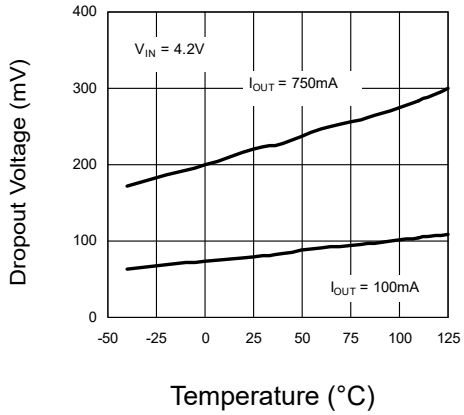


Figure 4: Dropout Voltage vs. Temperature

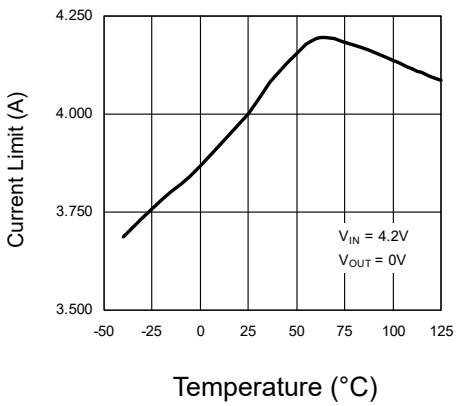


Figure 5: Short-Circuit Current vs. Temperature

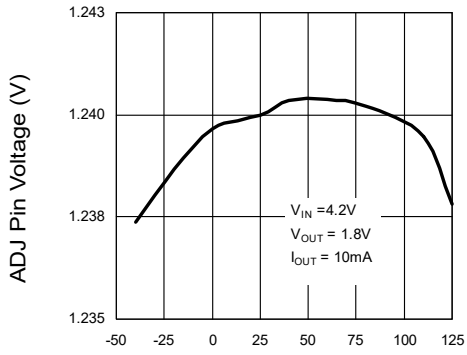


Figure 6: Adjust Pin Voltage vs. Temperature

10.4Typical characteristic (Continued)

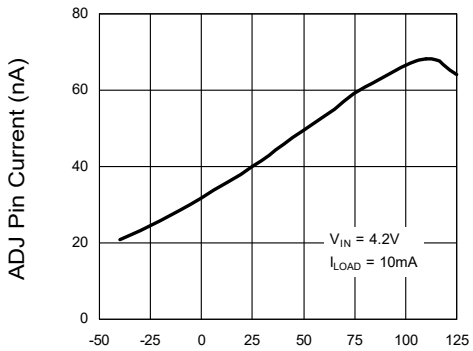


Figure 7: Adjust Pin Current vs. Temperature

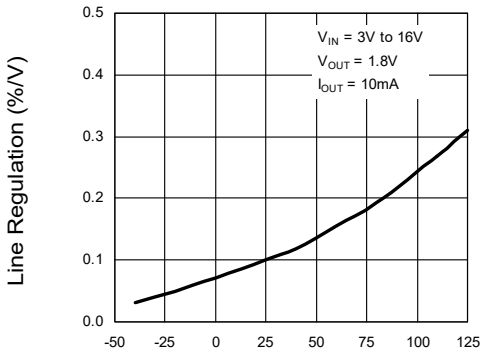


Figure 8: Line Regulation vs. Temperature

10.5Typical characteristic (Continued)

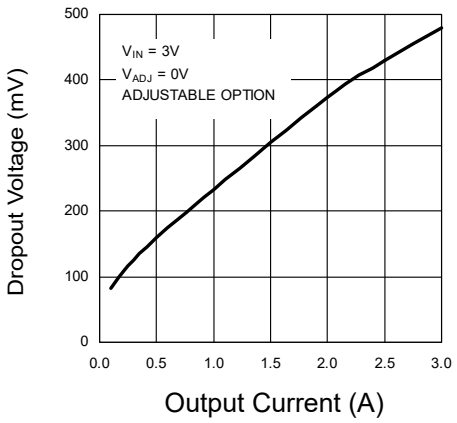


Figure 9: Dropout Voltage vs. Output Current

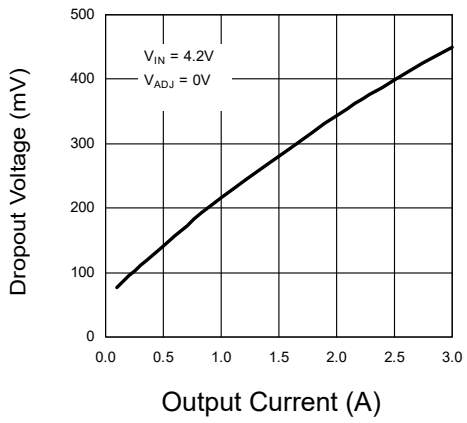


Figure 10: Dropout Voltage vs. Output Current

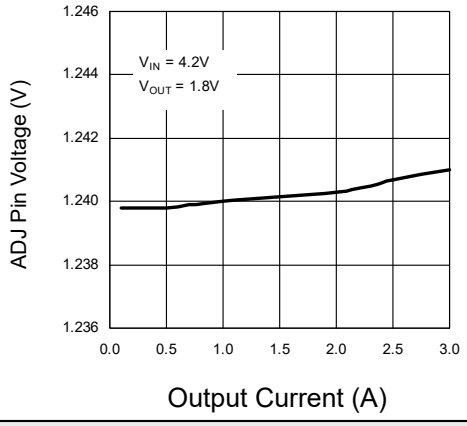


Figure 11: Adjust Pin Voltage vs. Output Current

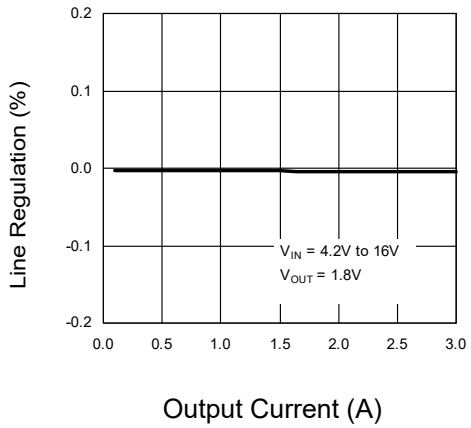


Figure 12: Line Regulation vs. Output Current

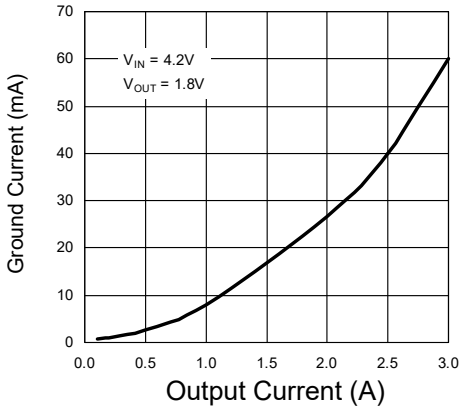


Figure 13: GND Pin Current vs. Output Current

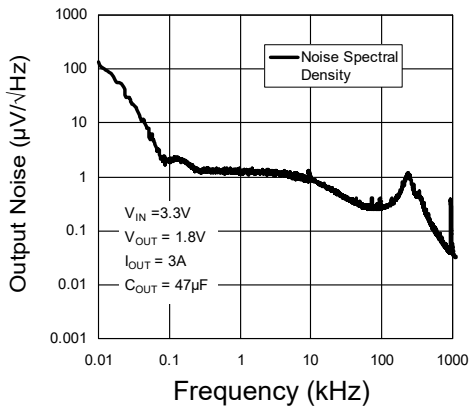


Figure 14: Output Noise vs. Frequency

10.6Typical characteristic (Continued)

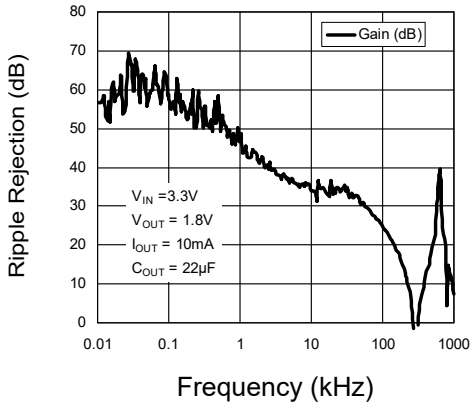


Figure 15: Ripple Rejection (I_{OUT}=10mA)vs. Frequency

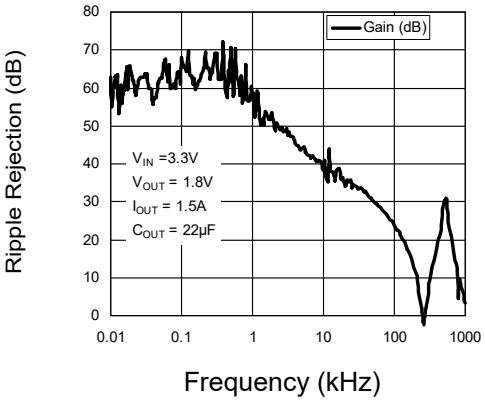


Figure 16: Ripple Rejection (I_{OUT}=1.5A) vs. Frequency

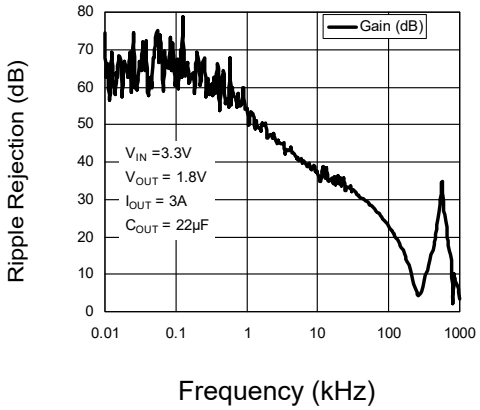
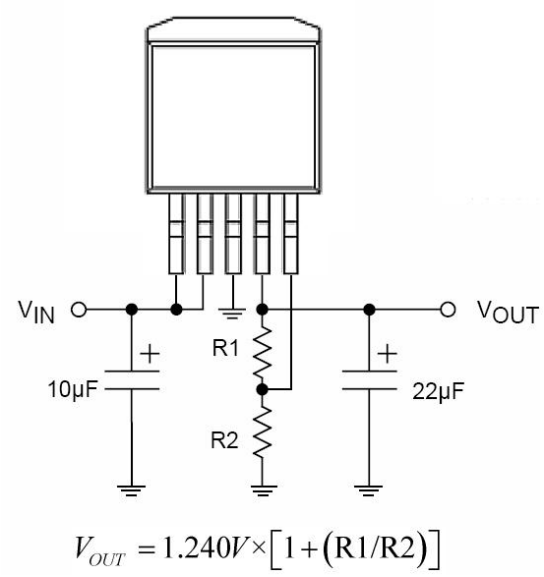


Figure 17: Ripple Rejection (I_{OUT}=3A) vs. Frequency

11.Functional Characteristics



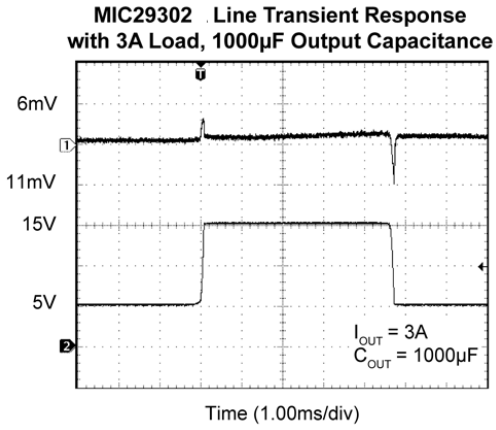
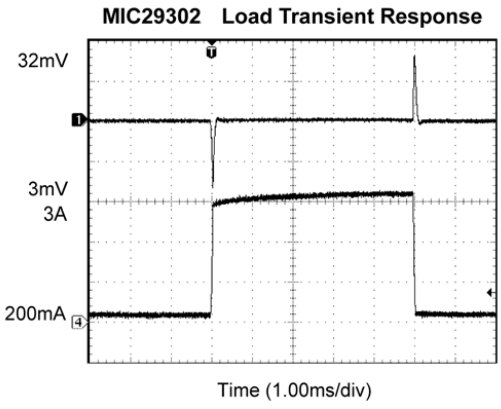
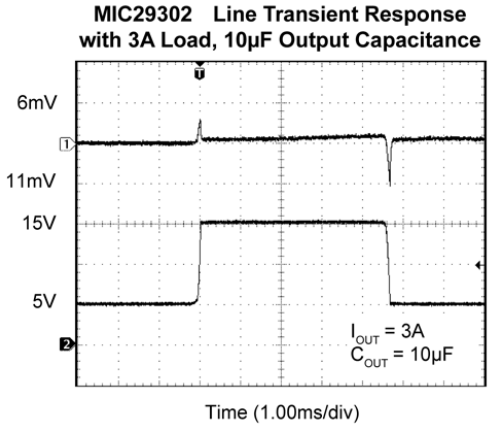
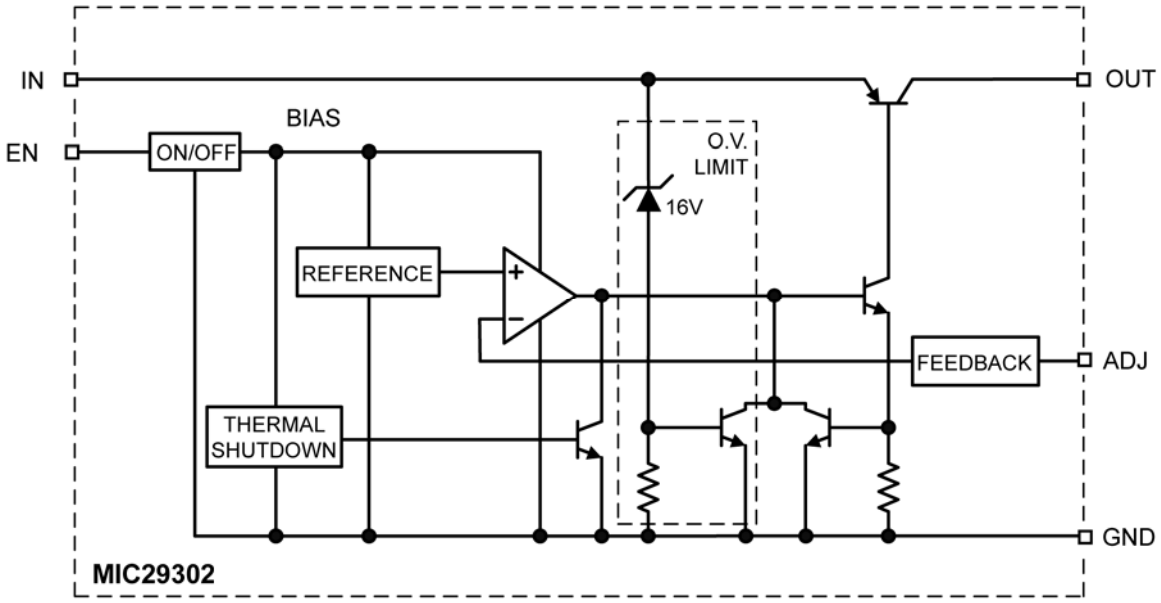


Figure 18. MIC29302 Load Transient Response Test Circuit





12.Functional Diagram



13.Application Information

The MIC29302 is a high-performance, low-dropout voltage regulator suitable for all moderate to high-current voltage regulation applications. Its 450mV typical dropout voltage at full load makes 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 is limited merely by the low VCE saturation voltage.

A trade-off for the low-dropout voltage is a varying base driver requirement. But Micrel’s Super ßeta PNP® process reduces this drive requirement to merely 1% of the load current.

The MIC29302 regulator is fully protected from damage due to fault conditions. Current limiting is linear; output current under overload conditions is constant. Thermal shutdown disables the device when the die temperature exceeds the 125°C maximum safe operating temperature. The output structure of the regulators allows voltages in excess of the desired output voltage to be applied without reverse current flow. The MIC29302 offer a logic level ON/OFF control: when disabled, the devices draw nearly zero current.

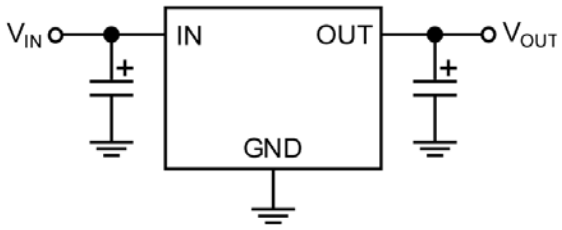


Figure 19. Linear Regulators Require Only Two Capacitors for Operation

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

$$P_D=I_{OUT}(1.02V_{IN}-V_{OUT})$$

Where the ground current is approximated by 2% of I_{OUT}. Then the heat sink thermal resistance is determined with this formula:

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

where:

T_{JMAX}≤125°C and θ_{CS} is between 0 and 2°C/W.

The heat sink may be significantly reduced in applications where the minimum input voltage is known and is large compared to the dropout voltage. A series input resistor can be used to drop excessive voltage and distribute the heat between this resistor and the regulator. The low-dropout properties of Micrel Super βeta PNP®

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.

With no heat sink in the application, calculate the junction temperature to determine the maximum power dissipation that will be allowed before exceeding the maximum junction temperature of the MIC29302.

Thermal Design

Linear regulators are simple to use. The most complicated set of 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}

Next, calcualte the junction temperature for the expected power dissipation:

$T_J=(\theta_{JA}\times P_D) + T_A=(35°C/W \times 2.3472W) +75°C= 157.15°C$

Now determine the maximum power dissipation allowed that would not exceed the IC's maximum junction temperature (125°C) without the use of a heat sink by:

$$P_{D(MAX)}=(T_{J(MAX)}-T_A) /\theta_{JA}$$
$$=(125°C-75°C) / (35°C/W)$$
$$=1.428W$$

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. The MIC29302 is stable with a 10µF capacitor at full load.

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.

When the regulator is powered from a source with high AC impedance, a 0.1µF capacitor connected between input and GND is recommended.

Transient Response and 5V to 3.3V Conversion

The MIC29302 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 Micrel 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. Micrel's PNP regulators provide superior performance in "5V to 3.3V" conversion applications than NPN regulators, especially when all tolerances are considered.

Minimum Load Current

The MIC29302 regulator operates within a specified load range. If the output current is too small, leakage currents dominate and the output voltage rises.

A minimum load current of 10mA 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 10mA.

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:

$$R_1=R_2x(\frac{V_{OUT}}{1.240}-1)$$

where V_{OUT} is the desired output voltage.

Figure 20 shows component definition. Applications with widely varying load currents may scale the resistors to draw the minimum load current required for proper operation (see “Minimum Load Current” section).

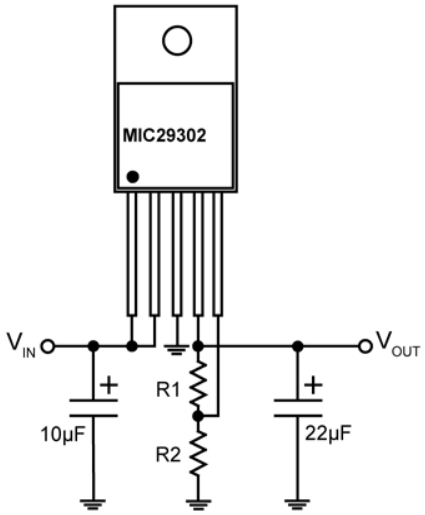
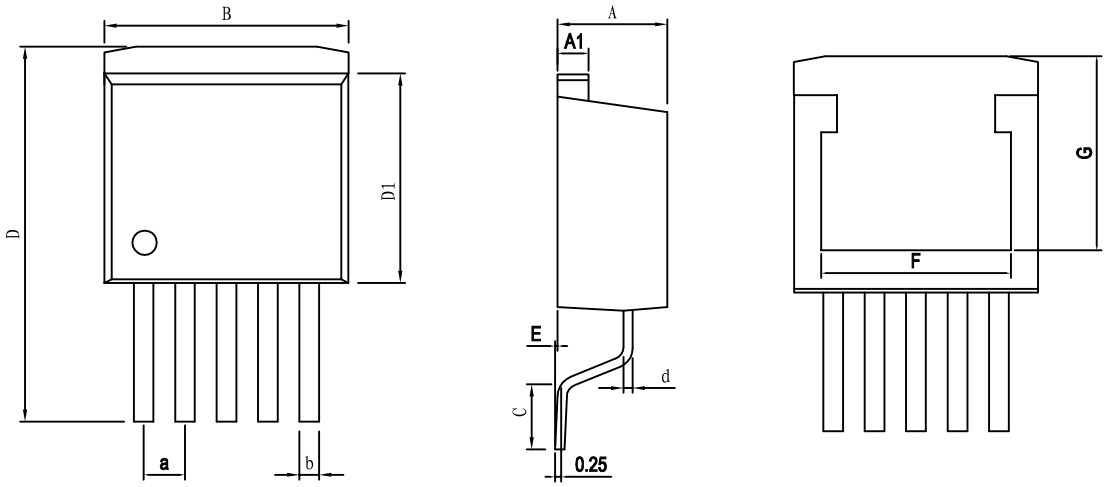


Figure 20. Adjustable Regulator with Resistors

Enable Input

MIC29302 features an enable (EN) input that allows ON/OFF control of the device. Special design allows “zero” current drain when the device is disabled—only microamperes of leakage current flows. The EN input has TTL/CMOS compatible thresholds for simple interfacing with logic, or may be directly tied to VIN. Enabling the regulator requires approximately 20µA of current into the EN pin.

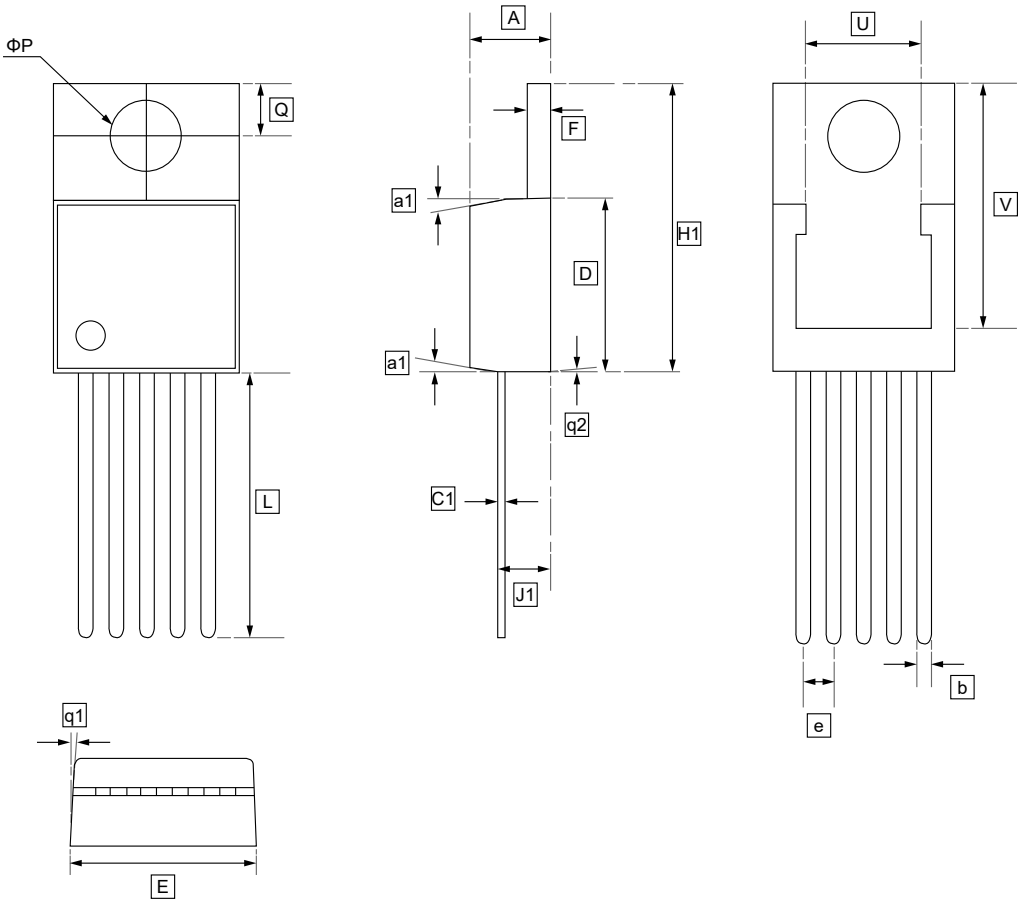
14.1 TO-263 Package Outline Dimensions



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

14.2 TO220-5 Package Outline Dimensions



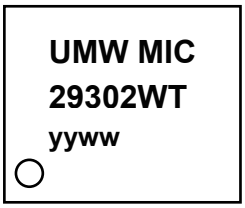
DIMENSIONS (mm are the original dimensions)

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

15.Ordering information

TO-220



TO-263

yy: Year Code
ww: Week Code

Order Code	Marking	Package	Base QTY	Delivery Mode
UMW MIC29302WT	MIC29302WT	TO-220	1000	Tube and box
UMW MIC29302WU	MIC29302WU	TO-263	800	Tape and reel

16.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.

When applying our products, please do not exceed the maximum rated values, as this may affect the reliability of the entire system. Under certain conditions, any semiconductor product may experience faults or failures. Buyers are responsible for adhering to safety standards and implementing safety measures during system design, prototyping, and manufacturing when using our products to prevent potential failure risks that could lead to personal injury or property damage.

Unless explicitly stated in writing, UMW products are not intended for use in medical, life-saving, or life-sustaining applications, nor for any other applications where product failure could result in personal injury or death. If customers use or sell the product for such applications without explicit authorization, they assume all associated risks.

When reselling, applying, or exporting, please comply with export control laws and regulations of China, the United States, the United Kingdom, the European Union, and other relevant countries, regions, and international organizations.

This document and any actions by UMW do not grant any intellectual property rights, whether express or implied, by estoppel or otherwise. The product names and marks mentioned herein may be trademarks of their respective owners.