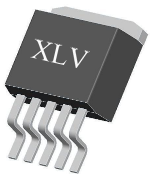
3A Low-Dropout Adjustable Regulator



TO263-5

TO220-5

General Description

The MIC29302WT/WU is high current, high accuracy, low dropout voltage regulato This regulators feature 300mV to 370mV (full load) typical dropout voltages and very low ground current. Designed for high current loads, these devices also find applications in lower current, extremely low dropout-critical systems,where their tiny dropout voltage and ground current values are important attributes.

The MIC29302WT/WU is fully protected against over current faults, reversed polarity,reversed lead insertion, over temperature operation, and positive and negative transient voltage spikes.

On the MIC29302WT/WU, the ENABLE pin may be tied to VIN if it is not required for ON/OFF control.

The MIC29302WT is available in TO220-5 package.

The MIC29302WU is available in TO263-5 package

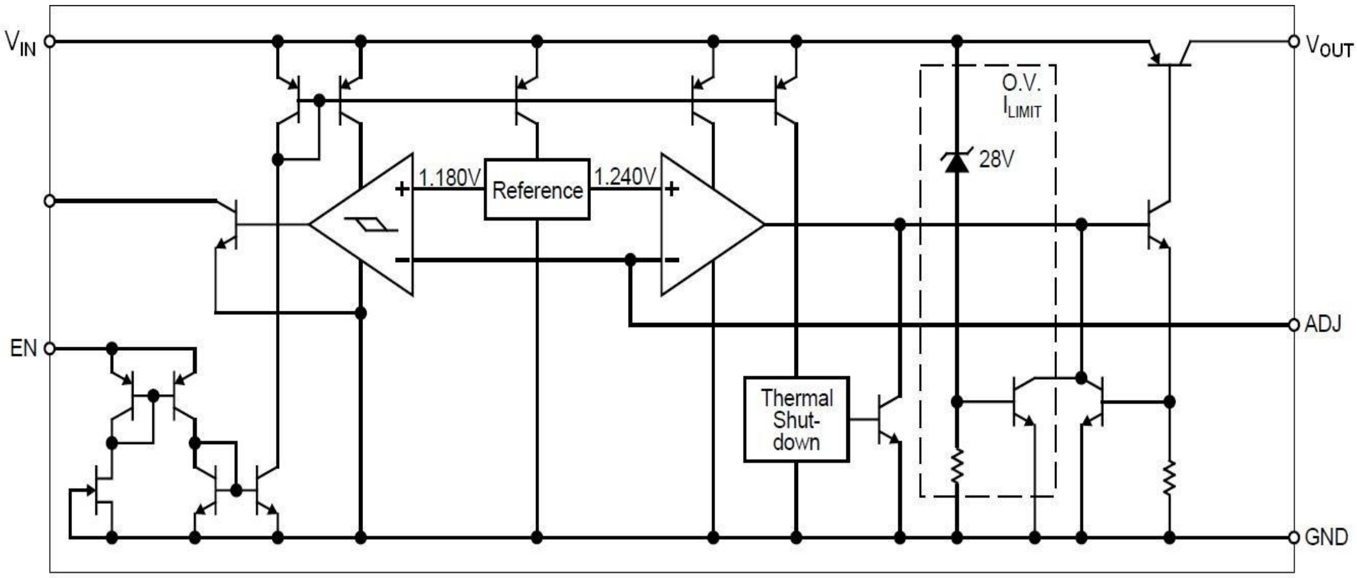
Features

- High Current Capability of 3A
- Low Dropout Voltage
- Low Ground Current
- Accurate 1% Guaranteed Tolerance
- Extremely Fast Transient Response
- Reverse-Battery and “Load Dump” Protection
- Zero-Current Shutdown Mode
- Also Characterized for Smaller Loads with Industry-Leading Performance Specifications
- Adjustable Versions

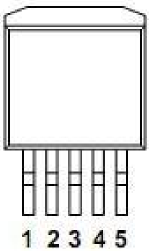
Applications

- Battery-Powered Equipment
- High-Efficiency Green Computer Systems
- Automotive Electronics
- High-Efficiency Linear Power Supplies
- High-Efficiency Post-Regulator for Switching Supply

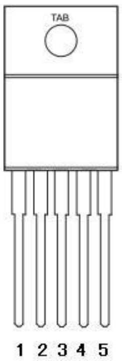
Functional Diagram



Pin Configuration



MIC29302WU(TO263-5)



MIC29302WT(TO220-5)

Pin Description

Pin Number	Pin Name	Function Description
1	EN	Enable pin.CMOS compatible control input. Logic-high =enable, logic-low = shutdown.
2	V_{IN}	Input Power Supply.
3	GND	Ground. TAB is also connected internally to the IC's ground.
4	V_{OUT}	Output
5	ADJ	Adjustable pin.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.

Absolute Maximum Ratings

Parameter Name		Symbol	Value	Unit
Power Dissipation		P_D	Internally Limited	
Input Supply Voltage （*1）		V_{IN}	-20～+50	V
Enable Input Voltage		V_{EN}	–0.3V ~V $_{IN}$	V
Lead Temperature (soldering, 5 seconds)		T_{LEAD}	260	℃
Operating Junction Temperature		T_{OPR}	-40～+125	℃
Storage Temperature Range		T_{STG}	-65～+150	℃
Thermal Resistance	TO263-5/TO220-5	θ_{JC}	2	℃/W
	TO263-5/TO220-5	θ_{JA}	28	℃/W

Note 1: 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.

Recommended Operating Conditions

Parameter Name	Symbol	Value	Unit
Maximum Operating Input Voltage	V_{IN}	26	V

Notice: Stresses above those listed under "Absolute Maximum Ratings" may cause permanent damage to the device.This is a stress rating only and functional operation of the device at those or any other conditions above those indicated in the operational sections of this specification is not intended. Exposure to maximum rating conditions for extended periods may affect device reliability.

Notice: The device is not guaranteed to function outside its operating ratings.

Note 1: Maximum positive supply voltage of 60V must be of limited duration (<100 ms) and duty cycle (≤1%). The maximum continuous supply voltage is 26V. Exceeding the absolute maximum rating may damage the device.

2: Devices are ESD sensitive. Handling precautions recommended.

Electrical Characteristics (Note 1, Note 2)

$V_{IN} = V_{OUT} + 1V$; $I_{OUT} = 10mA$; $T_J = +25°C$. Bold values indicate $-40°C \le T_J \le +125°C$, unless noted.

Parameter Name	Test Conditions		Min.	Typ.	Max.	Units
Output Voltage	I_O=10mA		-1		1	%
	10mA≤I_O≤I_{FL}, (V_{OUT}+1V) ≤V_{IN}≤26V (*2)		-2		2	%
Line Regulation	I_O=10mA, (V_{OUT}+1V) ≤V_{IN}≤26V			0.06	0.5	%
Load Regulation	V_{IN}=V_{OUT}+5V, 10mA≤I_{OUT}≤$I_{FULLLOAD}$ (*2,3)			0.2	1	%
$\frac{\Delta V_O}{\Delta T}$	Output Voltage (*3) Temperature Coefficient			20	100	ppm/°C
Dropout Voltage	I_O=100mA I_O=1.5A I_O=3A	Δ V_{OUT} = -1% (*4)		80 250 370	175 600	mV
Ground Current	I_O= 1.5A, I_O=3A	V_{IN}=V_{OUT}+1V (*5)		10 37	35	mA
Ground Pin Current at Dropout	V_{IN}=0.5V less than specified V_{OUT} I_{OUT}=10mA			1.7		mA
Current Limit	V_{OUT} =0V (*6)			4.5	5.0	A
Output Noise Voltage(10Hz to 100kHz) I_L=100mA	C_L=10μF C_L=33μF			400 260		μV(rms)
Reference						
Reference Voltage			1.228 1.215	1.240	1.252 1.265	V V
Reference Voltage	(*7)		1.203		1.277	V
Adjust Pin Bias Current				40	80 120	nA
Reference Voltage Temperature Coefficient	(*8)			20		ppm/°C
Adjust Pin Bias Current Temperature Coefficient				0.1		nA/°C
Enable Input						
Input Logic Voltage Low (OFF) High (ON)			 2.4		0.8	V
Enable Pin Input Current	V_{EN}=26V			100	600 750	μA
	V_{EN}=0.8V				1 2	μA
Regulator Output Current in Shutdown	(*9)			10	500	μA

Note 1: Specification for packaged product only.

2: When used in dual supply systems where the regulator load is returned to a negative supply, the output voltage must be diode clamped to ground.

3: Full load current (I_{FL}) is defined as 1.5A for the MIC29302WT/WU

4: Output voltage temperature coefficient is defined as the worst case voltage change divided by the total temperature range.

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

6: 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.

7: $V_{IN} = V_{OUT}$ (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 pin current.

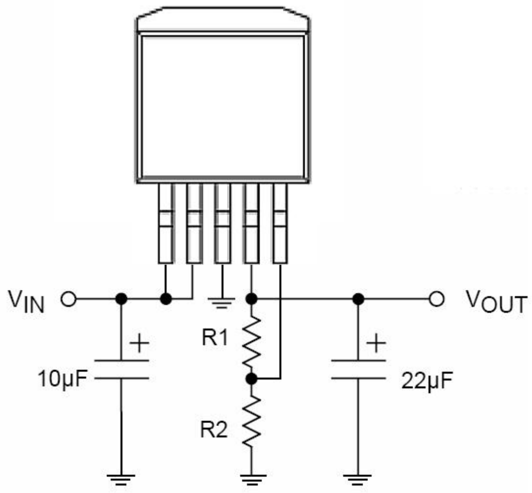
8: $V_{REF} \leq V_{OUT} \leq (V_{IN} – 1V)$, $2.3V \leq V_{IN} \leq 26V$, $10mA < I_L \leq I_{FL}$, $T_J \leq T_{JMAX}$.

9: Thermal regulation is defined as the change in output voltage at a time T after a change in power dissipation is applied, excluding load or line regulation effects. Specifications are for a 200 mA load pulse at V_{IN} =20V (a 4W pulse) for T = 10 ms.

10: Comparator thresholds are expressed in terms of a voltage differential at the adjust terminal below the nominal reference voltage measured at 6V input. To express these thresholds in terms of output voltage change, multiply by the error amplifier gain = V_{OUT} / V_{REF} = (R1 + R2)/R2. For example, at a programmed output voltage of 5V, the error output is guaranteed to go low when the output drops by 95mV×5V/1.240V = 384mV. Thresholds remain constant as a percent of V_{OUT} as V_{OUT} is varied, with the drop-out warning occurring at typically 5% below nominal, 7.7% guaranteed.

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.



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

Application Information

The MIC29302WT/WU is a high performance low-dropout voltage adjustable regulator suitable for all moderate to high-current voltage regulator application. Its 300mV to 400mV dropout voltage at full load make them 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 MIC29302WT/WU 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. Transient protection allows device (and load) survival even when the input voltage spikes between –20V and +50V. When the input voltage exceeds about 35V to 40V, the over-voltage sensor temporarily disables the regulator. The output structure of this regulator allows voltages in excess of the desired output voltage to be applied without reverse current flow. MIC29302WT/WU version offers a logic level ON/OFF control: when disabled, the devices draw nearly zero current.

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

$$P_D = I_{OUT}(1.01V_{IN} - V_{OUT})$$

Where the ground current is approximated by 1% 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 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.

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. MIC29302WT/WU 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. This capacitor should have good characteristics to above 250kHz.

Minimum Load Current

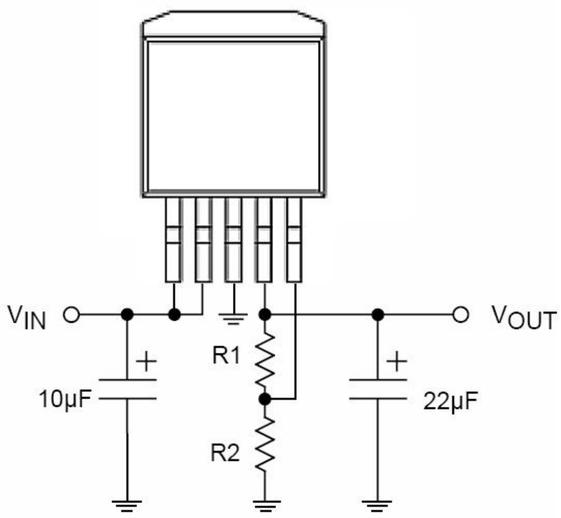
The MIC29302WT/WU regulator is specified between finite loads. If the output current is too small, leakage currents dominate and the output voltage rises. The following minimum load current swamps any expected leakage current across the operating temperature range:7mA

Adjustable Regulator Design

The adjustable regulator version, MIC29302WT/WU allows programming the output voltage anywhere between 1.25V and the 26V maximum operating rating of the family.

Two resistors are used. Resistors can be quite large, up to 1MΩ, because of the very high input impedance and low bias current of the sense comparator: The resistor values are calculated by:

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



$$V_{OUT} = 1.240V \times \left[1 + (R1/R2)\right]$$

Fig. Adjustable Regulator with Resistors

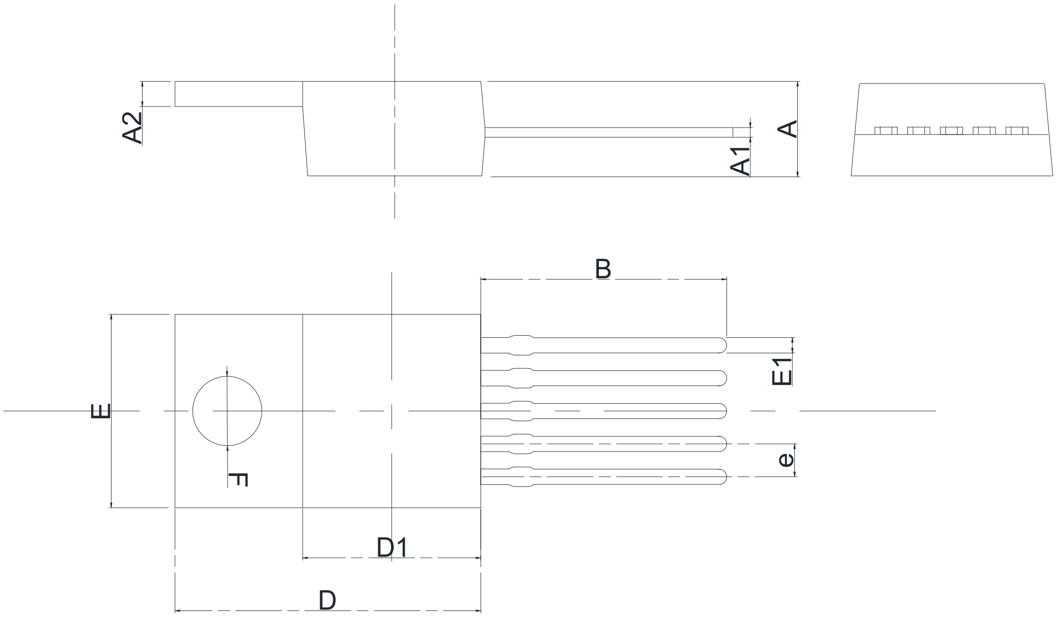
Where V_{OUT} is the desired output voltage. Figure right shows component definition. Applications with widely varying load currents may scale the resistors to draw the minimum load current required for proper operation (see above).

Enable Input

MIC29302WT/WU versions feature 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 ≤ 30V. Enabling the regulator requires approximately 20μA of current.

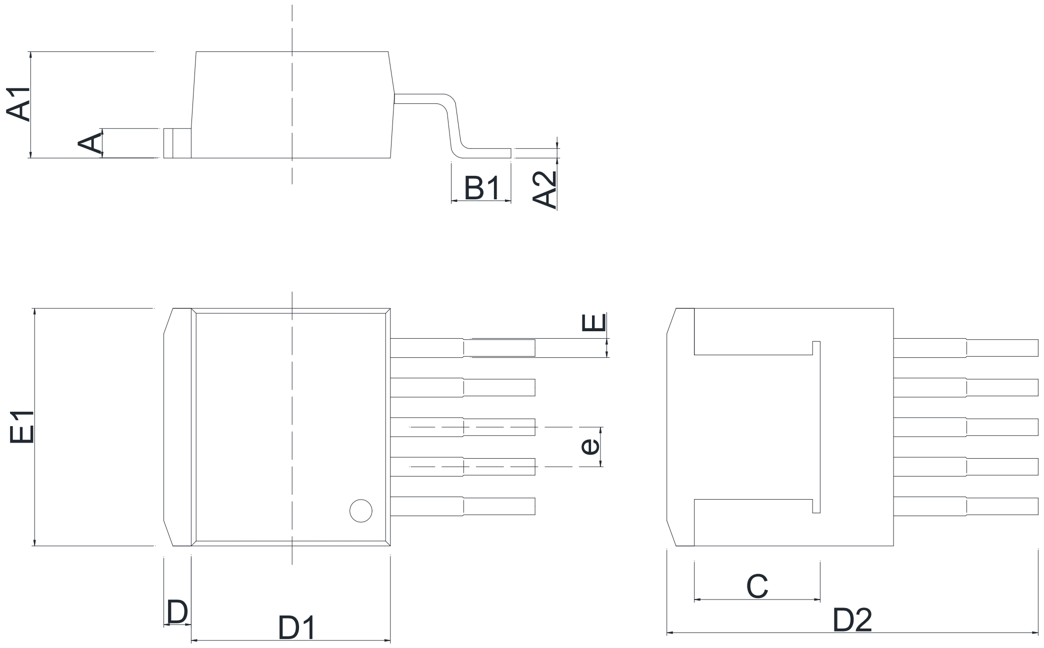
Outline Dimensions

TO220-5



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	4.300	4.700	0.169	0.185
A1	0.450	0.600	0.017	0.023
A2	1.250	1.400	0.049	0.055
B	12.880	13.380	0.507	0.527
D	15.500	15.900	0.610	0.626
D1	9.000	9.400	0.354	0.370
E	9.700	10.100	0.381	0.398
E1	0.660	0.914	0.025	0.036
e	1.702（BSC）		0.670（BSC）	
F	Φ3.500	Φ3.700	Φ0.137	Φ0.146

TO263-5



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	1.150	1.400	0.045	0.055
A1	4.350	4.750	0.171	0.187
A2	0.310	0.530	0.012	0.021
B1	1.300	2.740	0.051	0.108
C	5.080 REF		0.200 REF	
D	0.900	1.700	0.035	0.067
D1	8.100	8.900	0.318	0.350
D2	13.900	15.550	0.547	0.612
E	0.660	0.970	0.025	0.038
E1	9.800	10.400	0.385	0.409
e	1.700（BSC）		0.067（BSC）	

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