Low-Dropout Regulators

General Description

The MIC2915X(-XX) are high-current, high-accuracy, low-dropout voltage regulators. Using the process with a PNP pass element, these regulators feature 350mV (full load) dropout voltages and very low ground current. These devices also find applications in lower current, low-dropout critical systems, where their tiny dropout voltage and ground current values are important attributes.

The MIC2915X(-XX) are fully protected against overcurrent faults, reversed input polarity, reversed lead insertion, over temperature operation, positive and negative transient voltage spikes. Five-pin fixed voltage versions feature a logic level ON/OFF control and an error flag, which signals whenever the output falls out of regulation.

On the MIC29151(-XX) and MIC29152 the EN (Enable) pin may be tied to V_{IN}, if it is not required for the ON/OFF control. The MIC2915X(-XX) are available in 3- and 5-pin TO-220, TO-263 and TO-252 packages.

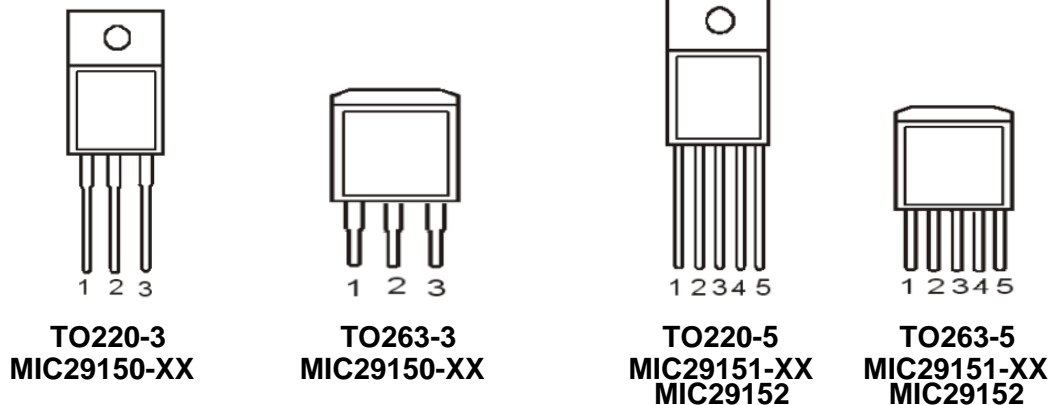The Output Voltage, (-XX), may be 1.5V, 1.8V, 2.5V, 2.85V, 3V, 3.3V, 5V, 8V, 9V, 12V.

Features

• High-current capability.........................1.5A
• Low dropout voltage 350mV
• Low ground current
• 1% initial accuracy
• Extremely fast transient response
• Reverse-battery and "load dump" protection
• Zero-current shutdown mode (5-pin versions)
• Error flag signals Output Out-of-Regulation (5-Pin versions)
• Fixed voltage and 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

PIN Configuration

TO220-3	**TO263-3**	**TO220-5**	**TO263-5**
MIC29150-XX	MIC29150-XX	MIC29151-XX	MIC29151-XX
		MIC29152	MIC29152

Pinout

On all the devices, the Tab is grounded.
MIC29150-XX, three-terminal devices:
Pin 1 = IN (Input), 2 = GND (Ground), 3 = OUT (Output)
MIC29151-XX, five-terminal fixed voltage devices
Pin 1 = EN (Enable), 2 = IN (Input), 3 = GND (Ground), 4 = OUT (Output), 5 = FLAG (Flag)
MIC29152 , adjustable version with ON/OFF control
Pin 1 = EN (Enable), 2 = IN (Input), 3 = GND (Ground), 4 = OUT (Output), 5 = ADJ (Adjust)

Absolute Maximum Ratings

Power Dissipation	internally-limited
Lead Temperature (soldering, 5 seconds)	260°C
Storage Temperature Range	–65°C to +150°C
Input Supply Voltage	–20V to +30V

Operating Ratings

Operating Junction Temperature	–40°C to +125°C
Operating Input Voltage	2.3V to 26V

Electrical Characteristics

All measurements at T_J=25°C, I_O=10mA, V_{IN}=V_{OUT}+1V, unless otherwise noted. **Bold** values are guaranteed across the operating temperature range. Adjustable versions are programmed to 5.0V.

Parameter	Conditions	Min	Typ	Max	Units
Output Voltage	I_O=10mA	-1		1	%
	10mA≤I_O≤1.5A, (V_{OUT}+1V)≤V_{IN}≤26V	**-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}≤1.5A (Note 1)		0.2	1	%
$\dfrac{\Delta Vo}{\Delta T}$	Output Voltage Temperature Coefficient (Note 2)		**20**	**100**	ppm/^{o}C
Dropout Voltage	ΔV_{OUT}=-1%, (Note 1, 3)				mV
	I_O=100mA		100	**200**	
	I_O=750mA		250		
	I_O=1.5A		350	**600**	
Ground Current	(Note 1, 4)　　　I_O=750mA, V_{IN}=V_{OUT}+1V		8	**20**	mA
	I_O=1.5A		22		
I_{GNDDO}, GND Pin Current at Dropout	V_{IN}=0.5V less than specified V_{OUT}, I_{OUT}=10mA (Note 5)		2		mA
Current Limit	MIC29150　　　V_{OUT}=0V (Note 1)		2.1	**3.5**	A
Reference, MIC29152					
Reference Voltage		1.228 **1.215**	1.240	1.252 **1.265**	V
Reference Voltage	(Note 6)	**1.203**		**1.277**	V
ADJ Pin Bias Current			20	80 **120**	nA
Reference Voltage Temperature Coefficient	(Note 2)		20		ppm/^{o}C
ADJ Pin Bias Current Temperature Coefficient			0.1		nA/^{o}C
Flag Output (Error Comparator), MIC29151-XX					
Output Leakage Current	V_{OH}=26V		0.01	1.00 **2.00**	μA
Output Low Voltage	V_{IN}=0.5V less than specified V_{OUT}, I_{OL}=250μA (Note 5)		220	300 **400**	mV
Upper Threshold Voltage	(Note 5)			99.2	% of V_{OUT}
Lower Threshold Voltage	(Note 5)	93			% of V_{OUT}
Hysteresis	(Note 5)		1		% of V_{OUT}
EN Input, MIC29151-XX, MIC29152					
Input Logic Voltage Low (OFF) High (ON)		**2.4**		**0.8**	V
EN Pin Input Current	V_{EN}=26V		30	600 **750**	μA
	V_{EN}=0.8V			2.5 **5**	μA
Regulator Output Current Shutdown	(Note 7)		10	**500**	μA

Notes:

Note 1: Employ pulse-testing procedures to minimize temperature rise.

Note 2: Output Voltage temperature coefficient is defined as the worst case voltage change divided by the total temperature range.

Note 3: 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}. For Output Voltages below 2.3V the Dropout Voltage is the input-to-output voltage differential with the minimum input voltage being 2.3V. The minimum input operation voltage is 2.3V.

Note 4: GND pin current is the regulator quiescent current. The total current drawn from the source is a sum of the load current plus the GND pin current.
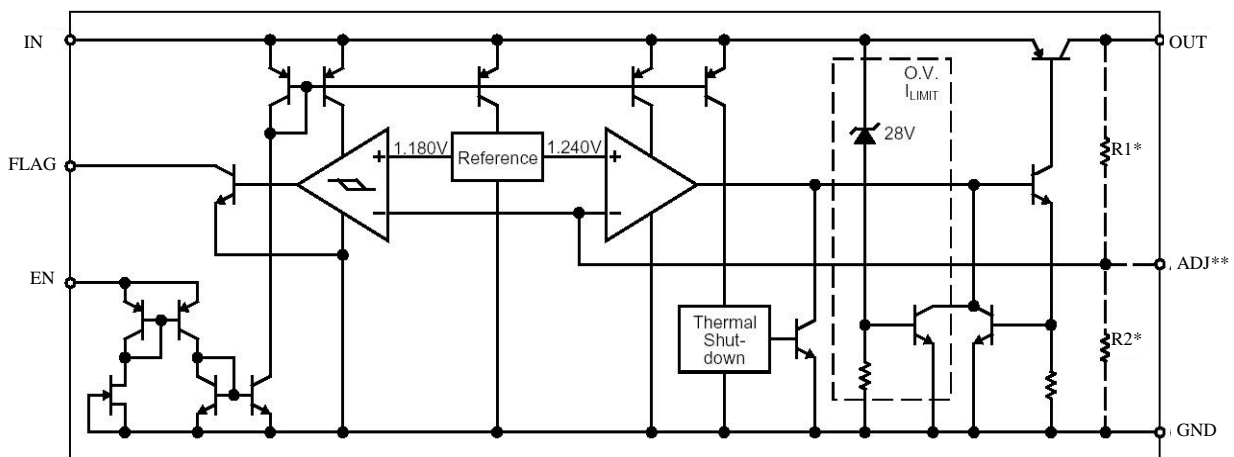
Note 5: For specified V_{OUT} ≥2.5V.

Note 6: $V_{REF} \leq V_{OUT} \leq (V_{IN}-1V)$, 2.3V≤$V_{IN}$≤26V, 10mA≤$I_L$≤1.5A, T_J<T_J MAX.

Note 7: V_{EN} ≤0.8V and V_{IN} ≤26V, V_{OUT}=0

Note 8: 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.

Block Diagram

*Feedback network in fixed versions only.
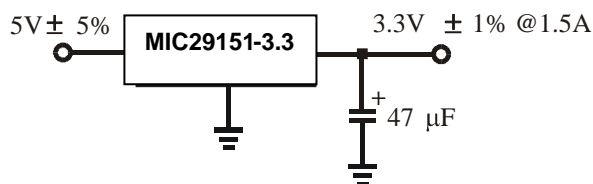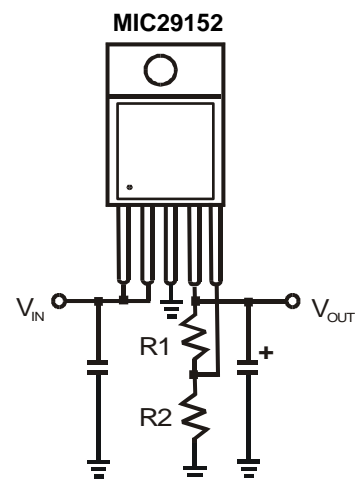**Adjustable version only.

Typical Applications

Fig.1. Fixed output voltage

MIC29152

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

Fig.2. Adjustable output voltage configuration. For best results, the total series resistance should be small enough to pass the minimum regulator load current

Application information

The MIC2915X(-XX) are high performance low-dropout voltage regulators suitable for all moderate to high-current voltage regulator applications. Their 350mV dropout voltage at full load makes them especially valuable in battery-powered systems and as high-efficiency noise filters in post-regulator applications. Unlike older NPN-pass transistor designs, dropout performance of the PNP output of these devices is limited merely by the low V_{CE} saturation voltage.

The MIC2915X (-XX) family of regulators is fully protected from the damage due to fault conditions. Current limiting is provided. This 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 Transients protection allows the device survival even when the input voltage spikes between −20V and +30V. When the input voltage exceeds about 28V to 33V, the overvoltage sensor temporarily disables the regulator.
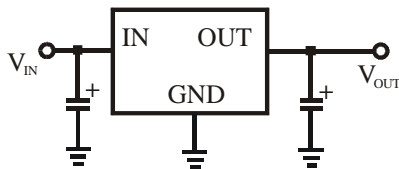

Fig.3. Linear regulators require only two capacitors for operation.

Thermal Design

The 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.

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

where the ground current is approximated by 1% of I_{OUT}. Then the heat sink thermal resistance is determined with this formula:

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

where $T_{J\ MAX} \leq 125^O$C and θ_{CS} is between 0 and 2^{O}C/W.

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. MIC2915X(-XX) regulators are stable with the 10μF minimum capacitor values at a full load.

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.

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Minimum Load Current

The MIC29150 regulators are specified between finite loads. If the output current is too small, leakage currents dominate and the output voltage rises. The 5mA minimum load current swamps any expected leakage current across the operating temperature range.
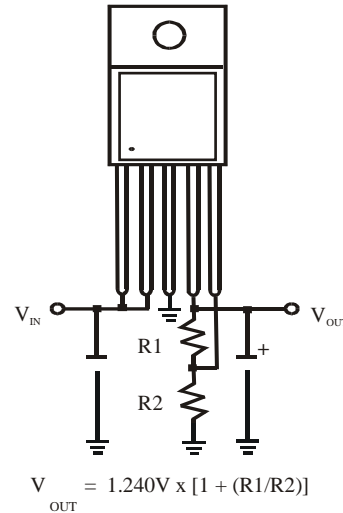

$$V_{OUT} = 1.240V \times [1 + (R1/R2)]$$

Fig.4. Adjustable Regulator with Resistors

Adjustable Regulator Design

The adjustable regulator version, MIC29152, allows one to program the output voltage anywhere between 1.25V and 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:

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

where V_{OUT} is the desired output voltage. Figure 4 shows component definition. Applications with widely varying load currents may scale the resistors to draw the minimum load current required for proper operation.

Error Flag

The MIC29151-XX version features an Error Flag, which looks at the output voltage and signals an error condition when this voltage drops 5% below its expected value. The error flag is an open-collector output that pulls low under fault conditions. It may sink 10mA. Low output voltage signifies a number of possible problems, including an overcurrent fault (the device is in current limit) and a low input voltage. The flag output is inoperative during overtemperature shutdown conditions.

Enable Input

MIC29151-XX and MIC29152 versions feature an enable (EN) input that allows ON/OFF control of the device. A special design allows "zero" current drain when the device is disabled - only microamperes of leakage current flow. 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.

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