MIC29150/300/500/750 Series

High Current Low Drop Out Regulators

General Description

The MIC29150/29300/29500/29750 are high current, high accuracy, low drop out voltage regulators. Using Micrel's proprietary Super ßeta PNP™ process with a PNP pass element, these regulators feature 300mV (full load) dropout voltages and very low ground currents. 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 MIC29150/29300/29500/29750 are fully protected against over-current faults, reversed input polarity, reversed lead insertion, over temperature operation, and positive and negative transient voltage spikes. Four and five pin fixed voltage versions feature logic level ON/OFF control and an error flag which signals whenever the output falls out of regulation. Flagged states include low input voltage (dropout), output current limit, overtemperature shutdown, and extremely high voltage spikes on the input.

On the MIC29xx1 and MIC29xx2, the ENABLE pin may be tied to V_{IN} if it is not required for ON/OFF control.
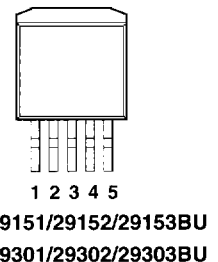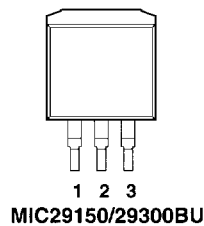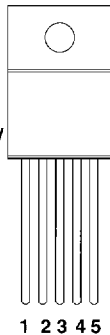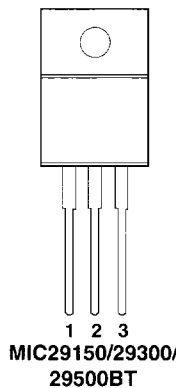
Features

- High Current Capability
  MIC29150/29151/29152/29153 .... 1.5A
  MIC29300/29301/29302/29303 .... 3A
  MIC29500/29501/29502/29503 .... 5A
  MIC29750/29751/29752/29753 .... 7.5A
- Low Drop Out Voltage .... <600mV at Full Load
- Low Ground Current
- Accurate 1% Guaranteed Tolerance
- Reverse-battery and "Load Dump" Protection
- Zero-Current Shutdown Mode (4 & 5 Pin versions)
- Error Flag Signals Output Out-of- Regulation
  (4 & 5 Pin versions)
- Also Characterized For Smaller Loads With Industry-Leading Performance Specifications
- 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

Case = Ground
(Bottom View)
MIC29500/29750BK

Case = Ground
(Bottom View)
MIC29501/29502/29503BK
MIC29751/29752/29753BK

1 2 3
MIC29150/29300/
29500BT

1 2 3 4 5
MIC29151/29152/29153BT
MIC29301/29302/29303BT
MIC29501/29502/29503BT

1 2 3
MIC29150/29300BU

1 2 3 4 5
MIC29151/29152/29153BU
MIC29301/29302/29303BU
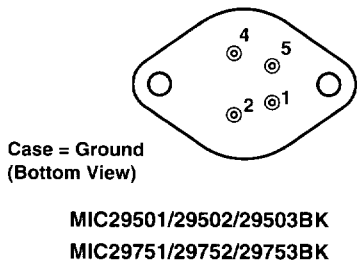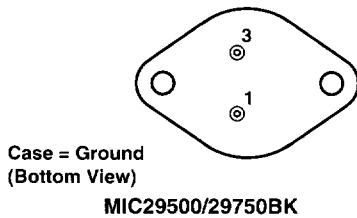
Pinout On all devices, the Tab is grounded.

MIC29150/29300/29500/29750 Three Terminal Devices:

Pin 1 = Input, 2 = Ground, 3 = Output

MIC29151/29301/29501/29751 Four & Five Terminal Fixed Voltage Devices:

Pin 1 = Enable, 2 = Input, 3 = Ground, 4 = Output, 5 = Flag

MIC29152/29302/29502/29752 Adjustable with ON/OFF Control

Pin 1 = Enable, 2 = Input, 3 = Ground, 4 = Output, 5 = Adjust

MIC29153/29303/29503/29753 Adjustable with Flag

Pin 1 = Flag, 2 = Input, 3 = Ground, 4 = Output, 5 = Adjust

Ordering Information

Part Number	Temp. Range*	Volts	Current	Package
MIC29150-3.3BK	−40 to +125°C	3.3	1.5A	TO-3
MIC29150-5.0BK	−40 to +125°C	5.0	1.5A	TO-3
MIC29150-12BK	−40 to +125°C	12	1.5A	TO-3
MIC29150-3.3BT	−40 to +125°C	3.3	1.5A	TO-220
MIC29150-3.6BT	−40 to +125°C	3.6	1.5A	TO-220
MIC29150-5.0BT	−40 to +125°C	5.0	1.5A	TO-220
MIC29150-12BT	−40 to +125°C	12	1.5A	TO-220
MIC29150-3.3BU	−40 to +125°C	3.3	1.5A	TO-263
MIC29150-5.0BU	−40 to +125°C	5.0	1.5A	TO-263
MIC29150-12BU	−40 to +125°C	12	1.5A	TO-263
MIC29151-3.3BK	−40 to +125°C	3.3	1.5A	TO-3-4
MIC29151-5.0BK	−40 to +125°C	5.0	1.5A	TO-3-4
MIC29151-12BK	−40 to +125°C	12	1.5A	TO-3-4
MIC29151-3.3BT	−40 to +125°C	3.3	1.5A	TO-220-5
MIC29151-3.6BT	−40 to +125°C	3.6	1.5A	TO-220-5
MIC29151-5.0BT	−40 to +125°C	5.0	1.5A	TO-220-5
MIC29151-12BT	−40 to +125°C	12	1.5A	TO-220-5
MIC29151-3.3BU	−40 to +125°C	3.3	1.5A	TO-263-5
MIC29151-5.0BU	−40 to +125°C	5.0	1.5A	TO-263-5
MIC29151-12BU	−40 to +125°C	12	1.5A	TO-263-5
MIC29152BT	−40 to +125°C	Adj	1.5A	TO-220-5
MIC29152BU	−40 to +125°C	Adj	1.5A	TO-263-5
MIC29153BT	−40 to +125°C	Adj	1.5A	TO-220-5
MIC29153BU	−40 to +125°C	Adj	1.5A	TO-263-5
MIC29300-3.3BK	−40 to +125°C	3.3	3.0A	TO-3
MIC29300-5.0BK	−40 to +125°C	5.0	3.0A	TO-3
MIC29300-12BK	−40 to +125°C	12	3.0A	TO-3
MIC29300-3.3BT	−40 to +125°C	3.3	3.0A	TO-220
MIC29300-5.0BT	−40 to +125°C	5.0	3.0A	TO-220
MIC29300-12BT	−40 to +125°C	12	3.0A	TO-220
MIC29300-3.3BU	−40 to +125°C	3.3	3.0A	TO-263
MIC29300-5.0BU	−40 to +125°C	5.0	3.0A	TO-263
MIC29300-12BU	−40 to +125°C	12	3.0A	TO-263
MIC29301-3.3BK	−40 to +125°C	3.3	3.0A	TO-3-4
MIC29301-5.0BK	−40 to +125°C	5.0	3.0A	TO-3-4
MIC29301-12BK	−40 to +125°C	12	3.0A	TO-3-4
MIC29301-3.3BT	−40 to +125°C	3.3	3.0A	TO-220-5
MIC29301-5.0BT	−40 to +125°C	5.0	3.0A	TO-220-5
MIC29301-12BT	−40 to +125°C	12	3.0A	TO-220-5
MIC29301-3.3BU	−40 to +125°C	3.3	3.0A	TO-263-5
MIC29301-5.0BU	−40 to +125°C	5.0	3.0A	TO-263-5
MIC29301-12BU	−40 to +125°C	12	3.0A	TO-263-5

Part Number	Temp. Range*	Volts	Current	Package
MIC29302BT	−40 to +125°C	Adj	3.0A	TO-220-5
MIC29302BU	−40 to +125°C	Adj	3.0A	TO-263-5
MIC29303BT	−40 to +125°C	Adj	3.0A	TO-220-5
MIC29303BU	−40 to +125°C	Adj	3.0A	TO-263-5
MIC29500-3.3BK	−40 to +125°C	3.3	5.0A	TO-3
MIC29500-5.0BK	−40 to +125°C	5.0	5.0A	TO-3
MIC29500-12BK	−40 to +125°C	12	5.0A	TO-3
MIC29500-3.3BT	−40 to +125°C	3.3	5.0A	TO-220
MIC29500-5.0BT	−40 to +125°C	5.0	5.0A	TO-220
MIC29500-12BT	−40 to +125°C	12	5.0A	TO-220
MIC29501-3.3BK	−40 to +125°C	3.3	5.0A	TO-3-4
MIC29501-5.0BK	−40 to +125°C	5.0	5.0A	TO-3-4
MIC29501-12BK	−40 to +125°C	12	5.0A	TO-3-4
MIC29501-3.3BT	−40 to +125°C	3.3	5.0A	TO-220-5
MIC29501-5.0BT	−40 to +125°C	5.0	5.0A	TO-220-5
MIC29501-12BT	−40 to +125°C	12	5.0A	TO-220-5
MIC29501-3.3BU	−40 to +125°C	3.3	5.0A	TO-263-5
MIC29501-5.0BU	−40 to +125°C	5.0	5.0A	TO-263-5
MIC29501-12BU	−40 to +125°C	12	5.0A	TO-263-5
MIC29502BT	−40 to +125°C	Adj	5.0A	TO-220-5
MIC29502BU	−40 to +125°C	Adj	5.0A	TO-263-5
MIC29503BT	−40 to +125°C	Adj	5.0A	TO-220-5
MIC29503BU	−40 to +125°C	Adj	5.0A	TO-263-5
MIC29750-3.3BK	−40 to +125°C	3.3	7.5A	TO-3
MIC29750-5.0BK	−40 to +125°C	5.0	7.5A	TO-3
MIC29750-12BK	−40 to +125°C	12	7.5A	TO-3
MIC29751-3.3BK	−40 to +125°C	3.3	7.5A	TO-3-4
MIC29751-5.0BK	−40 to +125°C	5.0	7.5A	TO-3-4
MIC29751-12BK	−40 to +125°C	12	7.5A	TO-3-4
MIC29752BK	−40 to +125°C	Adj	7.5A	TO-3-4
MIC29753BK	−40 to +125°C	Adj	7.5A	TO-3-4

* Junction Temperature

MIC29xx0 versions are three terminal fixed voltage devices. MIC29xx1 are fixed voltage devices with ENABLE and ERROR flag. MIC29xx2 are adjustable regulators with ENABLE control. MIC29xx3 are adjustables with an ERROR flag.

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 (Note 1) ....−20V to +60V

Operating Ratings

Operating Junction Temperature ....−40°C to +125°C

TO-220 θ_{JC} ....2 °C/W

TO-263 θ_{JC} ....2 °C/W

TO-247 θ_{JC} ....1.5 °C/W

TO-3 θ_{JC} ....1 °C/W

Electrical Characteristics

All measurements at T_J = 25°C unless otherwise noted. **Bold** values are guaranteed across the operating temperature range.

Parameter	Condition	Min	Typ	Max	Units
Output Voltage	I_O = 10mA	−1		1	%
	$10mA \leq I_O \leq I_{FL}$, $(V_{OUT} + 1V) \leq V_{IN} \leq 25V$	**−2**		**2**	%
Line Regulation	I_O = 10mA, $(V_{OUT} + 1V) \leq V_{IN} \leq 26V$		0.06	0.5	%
Load Regulation	$V_{IN} = V_{OUT} + 5V$, $10mA \leq I_{OUT} \leq I_{FULL\ LOAD}$ (Note 6)		0.2	1	%
$\dfrac{\Delta V_o}{\Delta T}$	Output Voltage (Note 6) Temperature Coef.		**20**	**100**	ppm/°C
Dropout Voltage	$\Delta V_{OUT} = -1\%$, (Note 3)				mV
	MIC29150 I_O = 100mA		80	**200**	
	I_O = 750mA		220		
	I_O = 1.5A			**600**	
	MIC29300 I_O = 100mA		80	**175**	
	I_O = 1.5A		250		
	I_O = 3A		370	**600**	
	MIC29500 I_O = 250mA		125	**250**	
	I_O = 2.5A		220		
	I_O = 5A		370	**600**	
	MIC29750 I_O = 250mA		80	**200**	
	I_O = 4A		240		
	I_O = 7.5A		350	**600**	
Ground Current	MIC29150 I_O = 750mA, $V_{IN} = V_{OUT} + 1V$		8	**20**	mA
	I_O = 1.5A		25		
	MIC29300 I_O = 1.5A, $V_{IN} = V_{OUT} + 1V$		10	**35**	mA
	I_O = 3A		37		
	MIC29500 I_O = 2.5A, $V_{IN} = V_{OUT} + 1V$		15	**50**	mA
	I_O = 5A		70	**85**	
	MIC29750 I_O = 4A, $V_{IN} = V_{OUT} + 1V$		28	**75**	mA
	I_O = 7.5A		70		
I_{GNDDO} Ground Pin Current at Dropout	V_{IN} = 0.5V less than specified V_{OUT}. I_{OUT} = 10mA		180	**300**	μA
Current Limit	MIC29150 V_{OUT} = 0V (Note 4)	1.5	2.1		A
	MIC29300 V_{OUT} = 0V (Note 4)	3.0	4.5		A
	MIC29500 V_{OUT} = 0V (Note 4)	5.0	7.5		A
	MIC29750 V_{OUT} = 0V (Note 4)	7.5	9.5		A
e_n, Output Noise Voltage (10Hz to 100kHz) I_L = 100mA	C_L = 10μF		400		μV RMS
	C_L = 33μF		260		

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Electrical Characteristics (Continued)

Reference MIC29xx2/MIC29xx3

Parameter	Conditions	Min	Typical	Max	Units
Reference Voltage		1.210 **1.200**	1.235	1.260 **1.270**	V V max
Reference Voltage	(Note 8)	**1.185**		**1.285**	V
Adjust Pin Bias Current			20	40 **60**	nA
Reference Voltage Temperature Coefficient	(Note 7)		20		ppm/°C
Adjust Pin Bias Current Temperature Coefficient			0.1		nA/°C

Error Comparator MIC29xx1/29xx3

| Parameter	Conditions	Min	Typical	Max	Units
Output Leakage Current	$V_{OH} = 26V$		0.01	1.00 **2.00**	μA
Output Low Voltage	Deviceset for 5V. $V_{IN} = 4.5V$ $I_{OL} = 250\mu A$		220	300 **400**	mV
Upper Threshold Voltage	Deviceset for 5V (Note 9)	40 **25**	60		mV
Lower Threshold Voltage	Deviceset for 5V (Note 9)		75	95 **140**	mV
Hysteresis	Deviceset for 5V (Note 9)		15		mV

ENABLE Input MIC29xx1/MIC29xx2

Parameter	Conditions	Min	Typical	Max	Units
Input Logic Voltage Low (OFF) High (ON)		**2.4**		**0.8**	V
ENABLE Pin Input Current	$V_{SHUTDOWN} = 26V$		15	30 **75**	μA
	$V_{SHUTDOWN} = 0.8V$		–	1 **2**	μA
Regulator Output Current in Shutdown	(Note 10)		10	**20**	μA

Notes

Note1: Maximum positive supply voltage of 60V must be of limited duration (<100msec) and duty cycle (≤1%). The maximum continuous supply voltage is 26V.

Note 2: Full Load current is defined as 1.5A for the MIC29150, 3A for the MIC29300, 5A for the MIC29500, and 7.5A for the MIC29750 families.

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}

Note 4: V_{IN} is the larger of 8V or V_{OUT} + 3V

Note 5: 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.

Note 6: Output voltage temperature coefficient is defined as the worst case voltage change divided by the total temperature range.

Note 7: 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 200mA load pulse at V_{IN} = 20V (a 4W pulse) for T = 10ms.

Note 8: $V_{REF} \leq V_{OUT} \leq (V_{IN} - 1\ V)$, 2.3V ≤ V_{IN} ≤ 26V, 5mA < I_L ≤ 1.25A, $T_J \leq T_{J\ MAX}$.

Note 9: 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 95 mV x 5V/1.235 V = 384 mV. Thresholds remain constant as a percent of V_{OUT} as V_{OUT} is varied, with the dropout warning occurring at typically 5% below nominal, 7.5% guaranteed.

Note 10: V_{ENABLE} ≤ 0.8V and V_{IN} ≤ 26V, V_{OUT} = 0.

Note 11: 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.
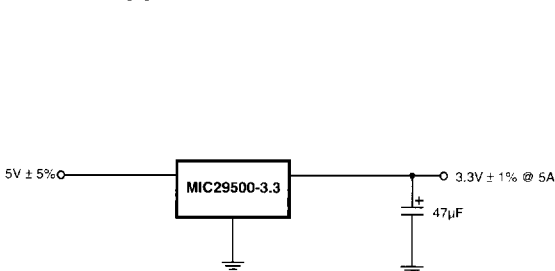
Block Diagram
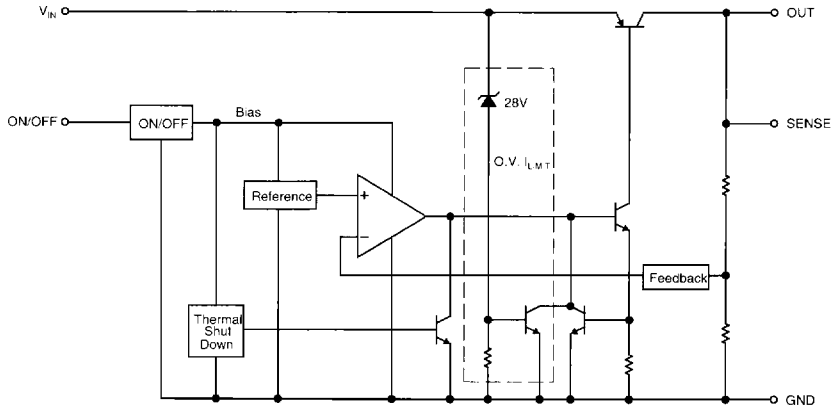
Typical Applications

Figure 1. Fixed output voltage.
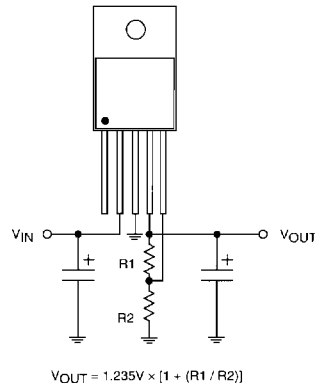

$V_{OUT} = 1.235V \times [1 + (R1 / R2)]$

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

Typical Characteristics

MIC29150 Dropout Voltage vs. Output Current

MIC29300 Dropout Voltage vs. Output Current

MI29500 Dropout Voltage vs. Output Current

MIC29150 Ground Current vs. Output Current

MIC29300 Ground Current vs. Output Current

MIC29500 Ground Current vs. Output Current

MIC29750 Dropout Voltage vs. Output Current

MIC29750 Ground Current vs. Output Current