MIC2940/MIC2940K

Low-Dropout Voltage Regulators

June 2007 – revised September 2014

General Description

The MIC2940 are high current, high accuracy, low-dropout voltage regulators. Using process with a PNP pass element, these regulators feature 400mV (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 MIC2940 are fully protected against over current faults, reversed input polarity, reversed lead insertion, over temperature operation and negative transient voltage spikes.

On the MIC2940-Adj the ENABLE pin may be tied to V_{IN} if it is not required for ON/OFF control. The MIC2940 are available in 3- pin (fixed version, 3.3V, 5V, others) and 5- pin (adjustable version) TO-220 and surface mount TO-263 packages.

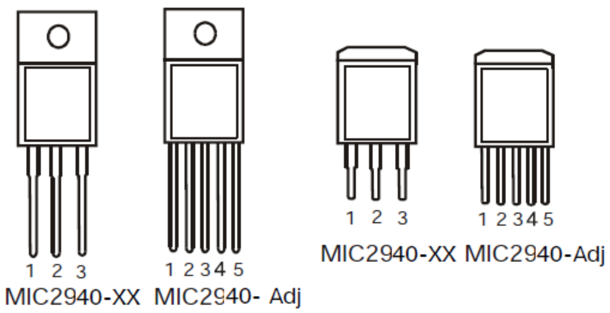
Features

- High Current Capability.........................1A
- Low-Dropout Voltage 400mV
- Low Ground Current
- Accurate 1% Guaranteed Tolerance
- Extremely Fast Transient Response
- Reverse-battery Protection
- Zero-Current Shutdown Mode (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



Pinout

On all devices, the Tab is grounded.
MIC2940-XX Three Terminal Devices:
Pin 1 = Input, 2 = Ground, 3 = Output
MIC2940-Adj Adjustable with ON/OFF Control
Pin 1 = Enable, 2 = Input, 3 = Ground, 4 = Output, 5 = Adjust

Absolute Maximum Ratings

Power Dissipation .... Internally Limited
Lead Temperature (Soldering, 5 seconds). ... 260^{0}C
Storage Temperature Range .... –65^{0}C to +150^{0}C
Input Supply Voltage……….............. –20V to +30V

Operating Ratings

Operating Junction Temperature ... –40^{0}C to +125^{0}C
Maximum Operating Input Voltage.................. 26V

Electrical Characteristics

All measurements at T_J = 25^{0}C, I_O = 5mA, V_{IN} = V_{OUT} + 1V, V_{EN} = 2.3V, unless otherwise noted. **Bold** values are guaranteed across the operating temperature range.
Adjustable versions are programmed to 5.0V.

Parameter	Condition	Min	Typ	Max	Units
Output Voltage	I_O=5mA	-1		1	%
	5mA≤I_O≤1A, (V_{OUT}+1V)≤V_{IN}≤26V	**-2**		**2**	%
Line Regulation	I_O=5mA, (V_{OUT}+1V)≤V_{IN}≤26V		0.06	0.5	%
Load Regulation	V_{IN}=V_{OUT}+V, 5mA≤I_{OUT}≤1A		0.2	1	%
Output Voltage (Note 1) Temperature Coef				**100**	ppm/^{0}C
Dropout Voltage	ΔV_{OUT}=-1%, (Note 2) I_O=5mA I_O=100mA I_O=1A		 60 170 400	 **180** **630**	 mV
Ground Current (Note 3)	V_{IN}=V_{OUT} +1V I_O=5mA I_O=1A		250 16	**500** **25**	µA mA
I_{GNDDO} Ground Pin Current at Dropout	V_{IN}=0.5V less than specified $V_{OUT.}$ I_{OUT}=5mA		1		mA
Current Limit	V_{OUT}=0V (Note 4)		1.5	**2.5**	A
Reference MIC2940-Adj					
Reference Voltage		1.228 **1.215**	1.240	1.252 **1.265**	V V
Reference Voltage	(Note 5)	**1.203**		**1.277**	V
Adjust Pin Bias Current			20	40 **60**	nA
Adjust Pin Bias Current Temperature Coefficient			0.1		nA/^{0}C
ENABLE Input MIC2940-Adj					
Input Logic Voltage Low (OFF) High (ON)		 **2.3**		 **0.8**	 V
Enable Pin Input Current	V_{EN}=26V		20	60 **75**	µA
	V_{EN}=0.8V			2.5 **5**	µA
Regulator Output Current Shutdown	(Note 6)		10	 **500**	µA

Notes

Note 1: Output voltage temperature coefficient is defined as the worst case voltage change divided by the total temperature range.

Note 2: 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 3: 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.

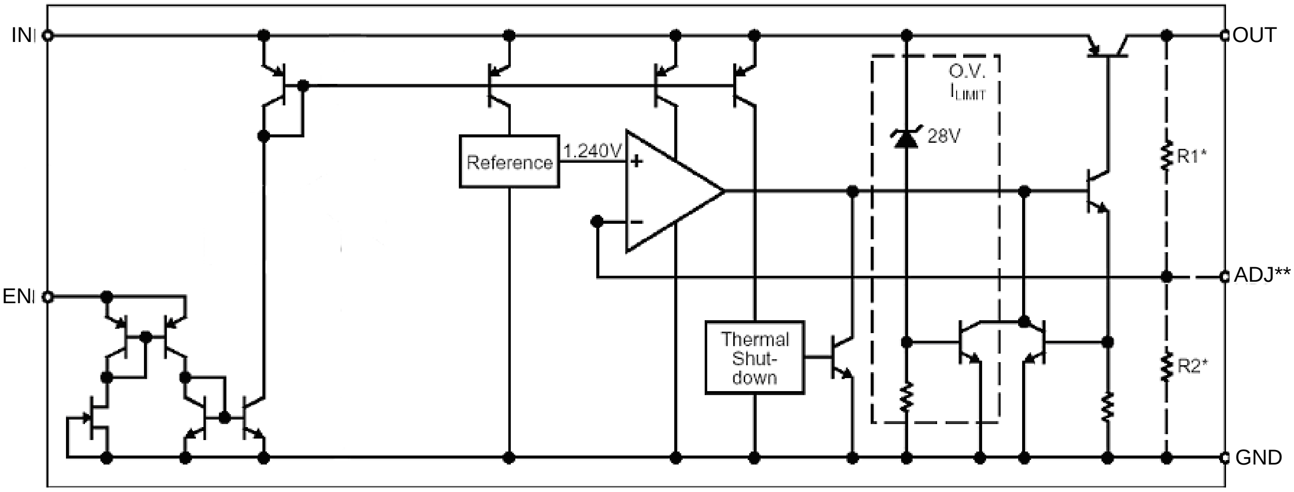
Note 4: V_{IN} = $V_{OUT\ (nominal)}$ + 1V. For example, use V_{IN} = 4.3V for a 3.3V regulator or use 6V for a 5V regulator. Employ pulse-testing procedures to minimize temperature rise.

Note 5: $V_{REF} \le V_{OUT} \le (V_{IN}\text{-1V})$, 2.3V ≤ V_{IN} ≤ 26V, 5mA ≤ I_L≤1A, $T_J \le T_J$ MAX.

Note 6: V_{EN} ≤0.8V and V_{IN} ≤26V, V_{OUT}=0

Note 7: 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

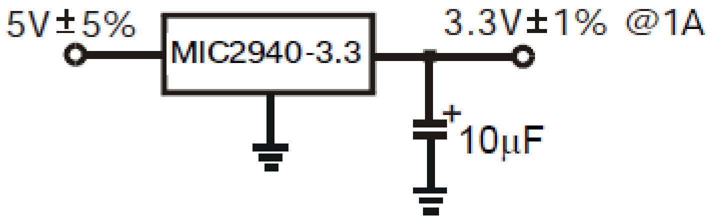
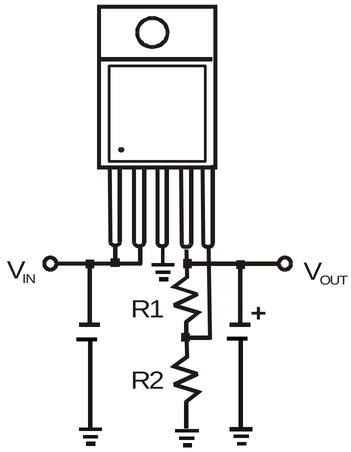


Figure1. Fixed output voltage



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

Figure2. Adjustable output voltage configuration. For best results, the total series resistance should be small enough to pass the minimum regulator load current.

Applications Information

The MIC2940 are high performance low-dropout voltage regulators suitable for all moderate to high-current voltage regulator applications. Their 350mV 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, dropout performance of the PNP output of these devices is limited merely by the low V_{CE} saturation voltage.

The MIC2940 family of regulators is fully protected from 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 125^0C maximum safe operating temperature. Transient protection allows device survival even when the input voltage spikes between –20V and +30V.

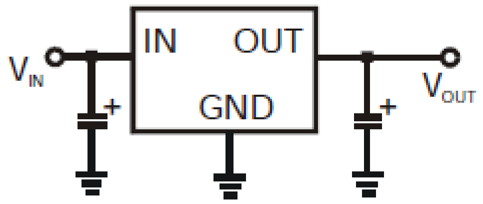


Figure 3. Linear regulators require only two capacitors for operation.

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:

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

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

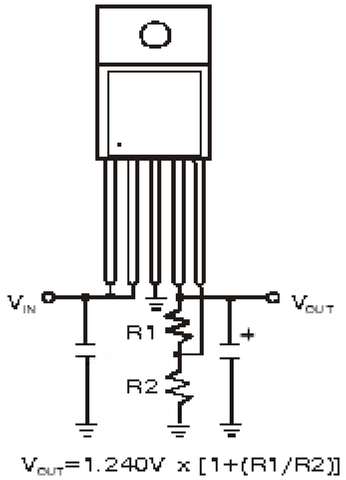
Capacitor Requirements

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. MIC2940 regulators are stable with the 10µF minimum capacitor values at 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.

Minimum Load Current

The MIC2940 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.



Adjustable Regulator Design

Figure 4. Adjustable Regulator with Resistors

The adjustable regulator version, MIC2940-Adj, allow 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:

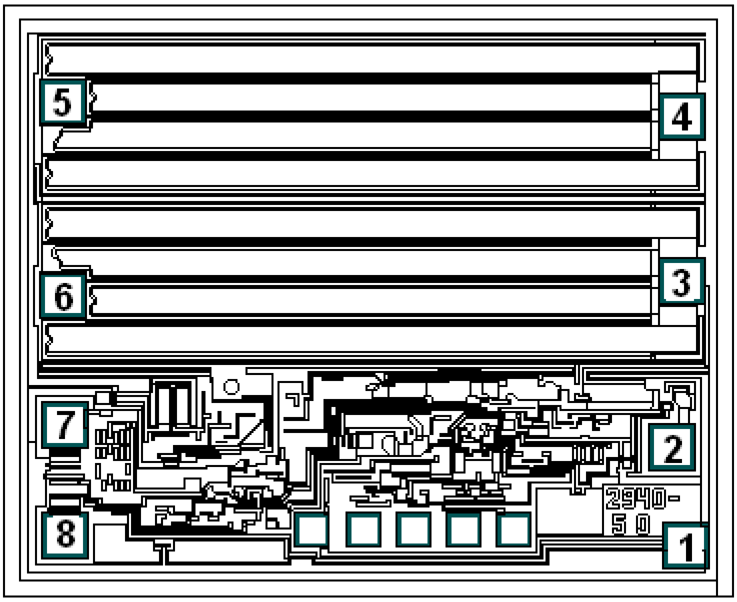
$$R_1=R_2\left(\frac{V_{OUT}}{1.240}-1\right)$$

Where is V_O 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.

Enable Input

MIC2940-Adj version 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.

Pad Location



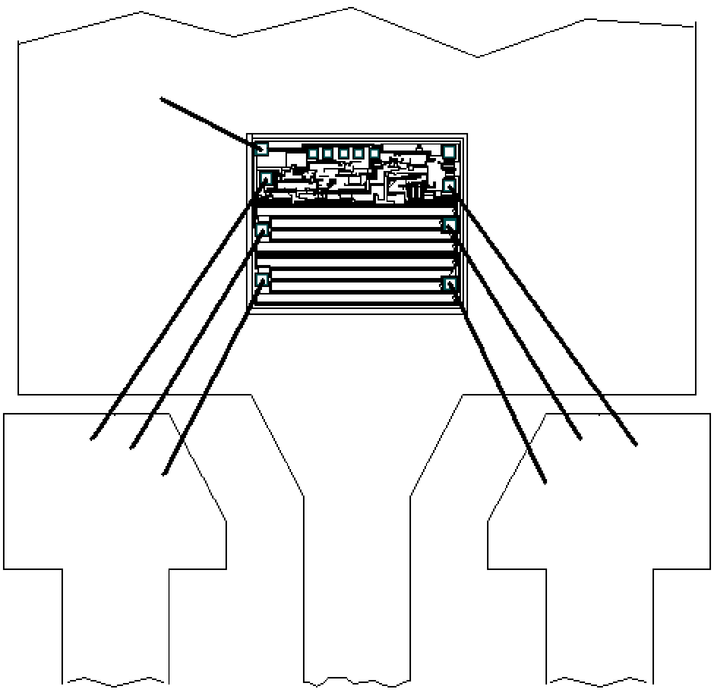
Chip size 1.87mm * 1.52mm
Pad size 110um * 110um

MIC2940 – for 4” wafers
MIC2940K – for 6” wafers

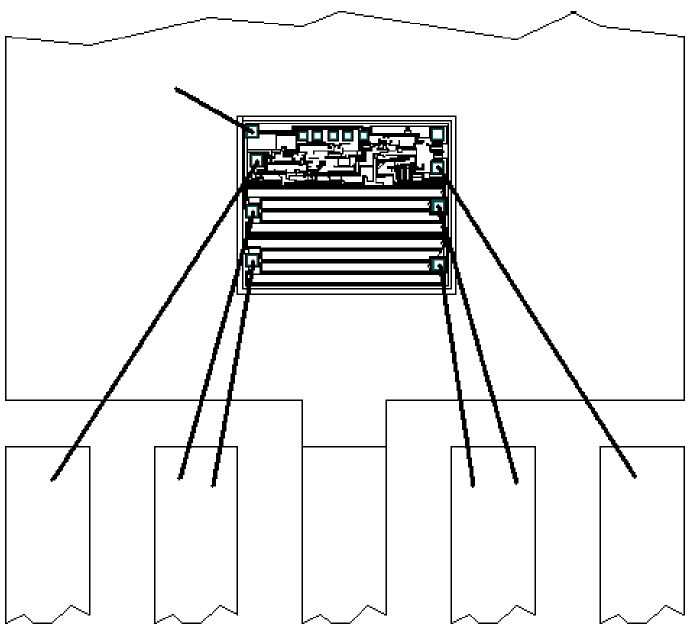
Pad Name and Coordinates

Pad N	Pad Name	Pad Center Coordinates (mm)	
		X	Y
1	GND	1.75	0.13
2	Input (for MIC2940-XX) Enable (for MIC2940-Adj)	1.71	0.38
3	Input	1.74	0.81
4	Input	1.74	1.235
5	Output	0.15	1.27
6	Output	0.15	0.77
7	Output (for MIC2940-XX) Adjust (for MIC2940-Adj)	0.155	0.44
8	NC	0.155	0.155

Drawing Assembly



MIC2940-XX



MIC2940-Adj

The appearance complies with the requirements of the company standards.

Assembling Information for MIC2940K

No.	Assembly Characteristics	Value
1	Wafer Size	6 Inch
2	Wafer Thickness before Grinding	675 +/-25 μm
3	Scribe Street Width	80 μm
4	Die Attach Material	Substrate is connected to GND
5	Quantity of Bond Pad Metal Layers	1
6	Me Pad Thickness	1.6 μm
7	Composition of Metal Layers	Al+Si(1.0%)+Ti(0.5%)
8	Min. Bond Pad Opening Size	110×110 μm
9	Min. Bond Pad Pitch	290 μm
10	Circuit Under Pad Design (CUP)	No

For your information

Pb-free products:
- RoHS compliant and compatible with the current requirements of IPC/JEDEC J-STD-020.

Green products:
- Lead-free (RoHS compliant)
- Halogen free (Br or Cl does not exceed 900ppm by weight in homogeneous material and total of Br and Cl does not exceed 1500ppm by weight).