MIC4574

0.5A, 200 kHz Buck Regulator

Features

- Fixed 200 kHz Operation
- 3.3V, 5V, and Adjustable Output Versions
- Voltage over Specified Line and Load Conditions:
  - Fixed Version: ±3% Max. Output Voltage
  - Adjustable Version: ±2% Max. Feedback Voltage
- Guaranteed 0.5A Switch Current
- Wide 4V to 24V Input Voltage Range
- Wide 1.23V to 20V Output Voltage Range
- Requires Minimum External Components
- <200 µA Typical Shutdown Mode
- 75% Efficiency (Adjustable Version >75% typ.)
- Standard Inductors and Capacitors are 25% of Typical LM2574 Values
- Thermal Shutdown
- Overcurrent Protection
- 100% Electrical Thermal Limit Burn-In

Applications

- Simple High-Efficiency Step-Down (Buck) Regulator
- Efficient Pre-Regulator for Linear Regulators
- On-Card Switching Regulators
- Positive-to-Negative Converter (Inverting Buck-Boost)
- Isolated Flyback Converter using Minimum External Components
- Negative Boost Converter

General Description

The MIC4574 is a series of easy to use fixed and adjustable BiCMOS step-down (buck) switch-mode voltage regulators. The 200 kHz MIC4574 duplicates the pinout and function of the 52 kHz LM2574. The higher switching frequency may allow up to a 2:1 reduction in output filter inductor size.

The MIC4574 is available in 3.3V and 5V fixed output versions or a 1.23V to 20V adjustable output version. Both versions are capable of driving a 0.5A load with excellent line and load regulation.

The feedback voltage is guaranteed to ±2% tolerance for adjustable versions, and the output voltage is guaranteed to ±3% for fixed versions, within specified voltages and load conditions. The oscillator frequency is guaranteed to ±10%.

In shutdown mode, the regulator draws less than 200 µA standby current. The regulator performs cycle-by-cycle current limiting and thermal shutdown for protection under fault conditions.

This series of simple switch-mode regulators requires a minimum number of external components and can operate using a standard series of inductors. Frequency compensation is provided internally.

The MIC4574 is available in the DIP (N) package and is rated over the industrial temperature range.

Package Type

MIC4574
8-Lead PDIP (N)
(Top View)

Pin	Name	Pin	Name
1	FB	8	NC
2	SGND	7	SW
3	SHDN	6	NC
4	PGND	5	V_{IN}
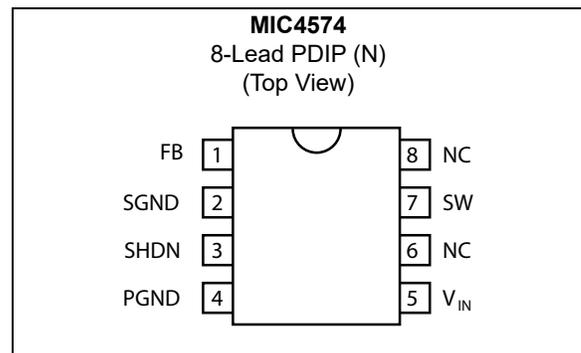
MIC4574

Typical Application Circuit

Functional Block Diagrams

Fixed Step-Down Regulator with External Components

Adjustable Step-Down Regulator with External Components

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

$$R1 = R2 \left(\frac{V_{OUT}}{V_{REF}} - 1 \right)$$
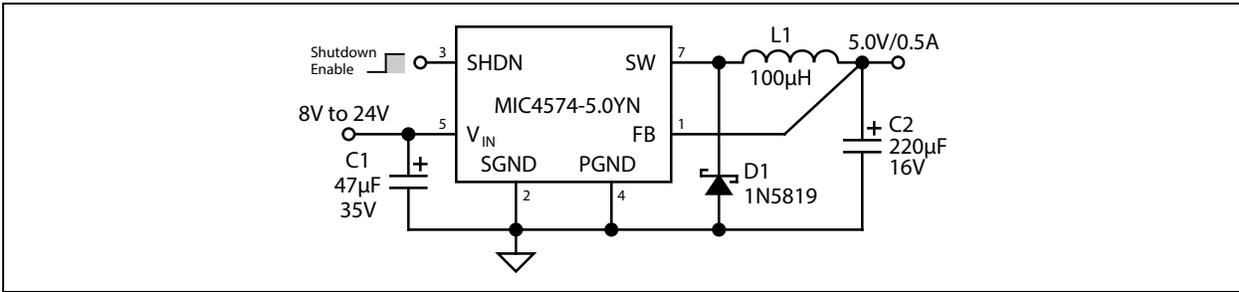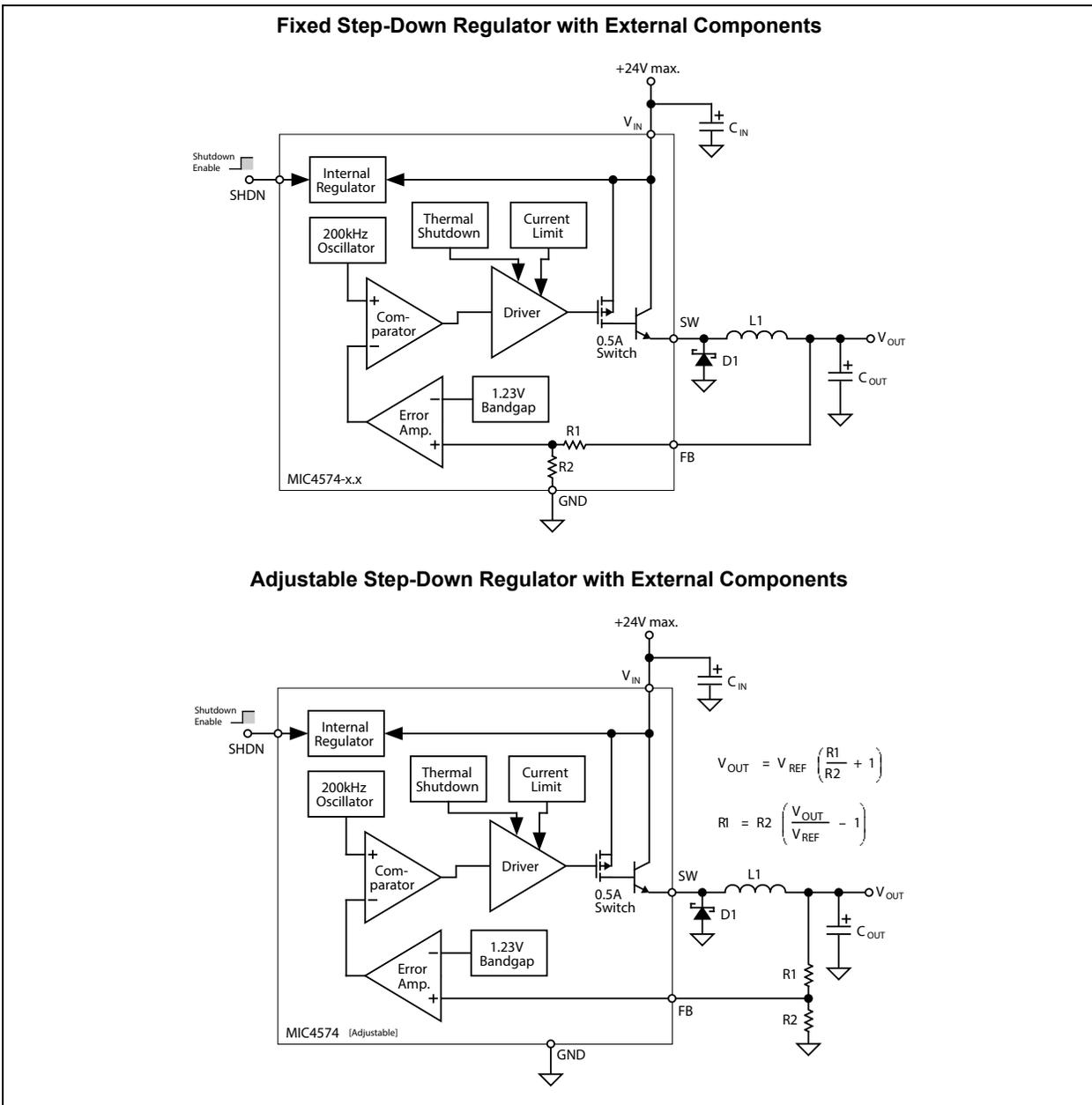
1.0   ELECTRICAL CHARACTERISTICS

Absolute Maximum Ratings †

Supply Voltage (V_{IN}, Note 1)..+40V
Shutdown Voltage (V_{SHDN}) .... −0.3V to +36V
Output Switch (V_{SW}, Steady State)..−1V
Junction Temperature (T_J).. +150°C
Storage Temperature .... −65°C to +150°C
ESD Rating ....Note 2

Operating Ratings ††

Supply Voltage (V_{IN}) ....+24V
Package Thermal Resistance
8-Lead Plastic DIP (θ_{JA})...130°C/W

† 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:   The MIC4574 is not guaranteed to survive a short-circuit to ground for input voltages above 24V.

       2:   Device is ESD sensitive. Handling precautions recommended.

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ELECTRICAL CHARACTERISTICS

Electrical Characteristics: V_{IN} = 12V; I_{LOAD} = 100 mA; T_A = +25°C, **bold** values indicate –40°C ≤ T_A ≤ +85°C; unless noted. Note 1

Parameter	Sym.	Min.	Typ.	Max.	Units	Conditions
MIC4574 (Adjustable)						
Feedback Voltage	V_{FB}	1.217	1.230	1.243	V	—
Feedback Voltage	V_{FB}	1.193	1.230	1.267	V	8V ≤ V_{IN} ≤ 24V, 0.1A ≤ I_{LOAD} ≤ 0.5A
		1.180	—	**1.280**		
Efficiency		—	77	—	%	I_{LOAD} = 0.5A, V_{OUT} = 5V
Feedback Bias Current	I_{BIAS}	—	50	100	nA	—
		—	—	**500**		
MIC4574-3.3						
Output Voltage	V_{OUT}	3.234	3.3	3.366	V	—
Output Voltage	V_{OUT}	3.168	3.3	3.432	V	6V ≤ V_{IN} ≤ 24V, 0.1A ≤ I_{LOAD} ≤ 0.5A
		3.135	—	**3.465**		
Efficiency		—	72	—	%	—
MIC4574-5.0						
Output Voltage	V_{OUT}	4.9	5.0	5.1	V	—
Output Voltage	V_{OUT}	4.8	5.0	5.2	V	8V ≤ V_{IN} ≤ 24V, 0.1A ≤ I_{LOAD} ≤ 0.5A
		4.75	—	**5.25**		
Efficiency		—	77	—	%	—
MIC4574/-3.3/-5.0						
Oscillator Frequency	f_O	180	200	220	kHz	—
Saturation Voltage	V_{SAT}	—	1	1.3	V	I_{OUT} = 0.5A
		—	—	**1.5**		
Maximum Duty Cycle (On)	D_{MAX}	90	95	—	%	FB connected to 0V
Current Limit	I_{LIM}	0.7	1.0	1.6	A	Peak Current, t_{ON} ≤ 3 µs
		0.65	—	**1.8**		
Output Leakage Current	I_{OUT}	—	0	2	mA	Output = 0V, V_{IN} = 24V, FB connected to 6V
		—	7.5	35		Output = –1V, V_{IN} = 24V, FB connected to 6V
Quiescent Current	I_Q	—	5	10	mA	—
Standby Quiescent Current	$I_{Q(STBY)}$	—	50	200	µA	SHDN = 5V (regulator off)
SHDN Input Logic Level		2.2	1.4	—	V	V_{OUT} = 0V (regulator off)
		2.4	—	—		
		—	1.2	1.0		V_{OUT} = 3.3V or 5V (regulator on)
		—	—	**0.8**		
SHDN Input Cuurent		—	4	30	µA	SHDN = 5V (regulator off)
		–10	0.01	10		SHDN = 0V (regulator on)

Note 1: Specification for packaged product only.

TEMPERATURE SPECIFICATIONS

Parameters	Sym.	Min.	Typ.	Max.	Units	Conditions
Temperature Ranges						
Maximum Junction Temperature	$T_{J(MAX)}$	—	—	+125	°C	—
Storage Temperature Range	T_S	−65	—	+150	°C	—
Package Thermal Resistances						
Thermal Resistance, PDIP 8-Ld	θ_{JA}	—	130	—	°C/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.

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2.0   PIN DESCRIPTIONS

The descriptions of the pins are listed in Table 2-1.

TABLE 2-1:   PIN FUNCTION TABLE

Pin Number	Pin Name	Description
1	FB	Feedback (Input): Output voltage feedback to regulator. Connect to output of supply for fixed versions. Connect to 1.23V tap of resistive divider for adjustable versions.
2	SGND	Signal ground.
3	SHDN	Shutdown (Input): Logic low enables regulator. Logic high (> 2.4V) shuts down regulator.
4	PGND	Power ground.
5	VIN	Supply Voltage (Input): Unregulated +4V to +24V supply voltage.
7	SW	Switch (Output): Emitter of NPN output switch. Connect to external storage inductor and Schottky diode.
6, 8	NC	Not internally connected. Solder to printed circuit for maximum heat transfer.

3.0 FUNCTIONAL DESCRIPTION

The MIC4574 is a variable duty cycle switch-mode regulator with an internal power switch. Refer to the Functional Block Diagrams.

3.1 Supply Voltage

The MIC4574 operates from a +4V to +24V unregulated input. Highest efficiency operation is from a supply voltage below +15V.

3.2 Enable/Shutdown

The shutdown (SHDN) input is TTL-compatible. Ground the input if unused. A logic low enables the regulator. A logic high shuts down the internal regulator, which reduces the current to typically 50 µA.

3.3 Feedback

Fixed versions of the regulator have an internal resistive divider from the feedback (FB) pin. Connect FB directly to the output line.

Adjustable versions require an external resistive voltage divider from the output voltage to ground, connected from the 1.23V tap to FB.

3.4 Duty Cycle Control

A fixed-gain error amplifier compares the feedback signal with a 1.23V bandgap voltage reference. The resulting error amplifier output voltage is compared to a 200 kHz sawtooth waveform to produce a voltage controlled variable duty cycle output.

A higher feedback voltage increases the error amplifier output voltage. A higher error amplifier voltage (comparator inverting input) causes the comparator to detect only the peaks of the sawtooth, reducing the duty cycle of the comparator output. A lower feedback voltage increases the duty cycle.

3.5 Output Switching

When the internal switch is on, an increasing current flows from the supply V_{IN}, through external storage inductor L1, to output capacitor C_{OUT} and the load. Energy is stored in the inductor as the current increases with time.

When the internal switch is turned off, the collapse of the magnetic field in L1 forces current to flow through fast recovery diode D1, charging C_{OUT}.

3.6 Output Capacitor

External output capacitor C_{OUT} provides stabilization and reduces ripple.

3.7 Return Paths

During the on portion of the cycle, the output capacitor and load currents return to the supply ground. During the off portion of the cycle, current is being supplied to the output capacitor and load by storage inductor L1, which means that D1 is part of the high-current return path.

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4.0   APPLICATION INFORMATION

The applications circuits that follow have been constructed and tested. Refer to AN 15, *Practical Switching Regulator Circuits* for additional information, including efficiency graphs and manufacturer's addresses and telephone numbers for most circuits.

For a mathematical approach to component selection and circuit design, refer to AN 14, *200kHz MIC4574/5/6 Family Design Guide*.
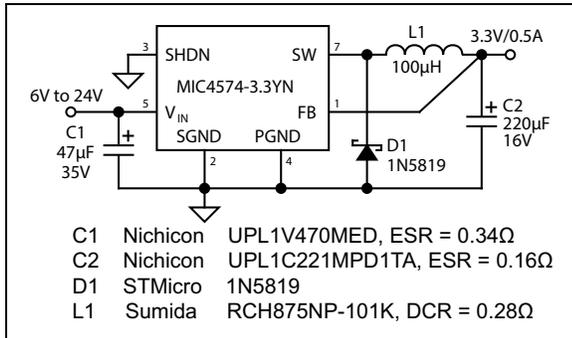

FIGURE 4-1: $6V_{IN}$ - $24V_{IN}$ to 3.3V/0.5A Buck Converter Through Hole.
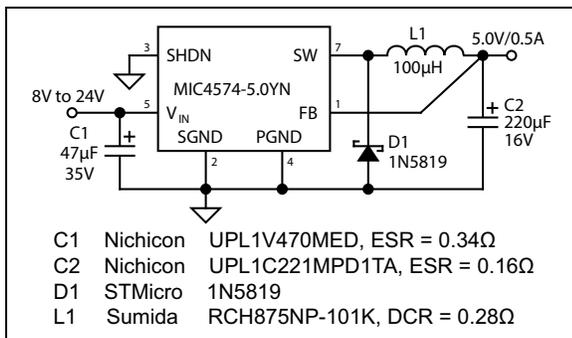
FIGURE 4-2: $8V_{IN}$ - $24V_{IN}$ to 5V/0.5A Buck Converter Through Hole.
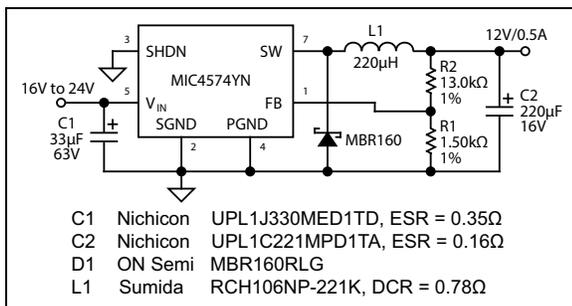
FIGURE 4-3: $16V_{IN}$ - $24V_{IN}$ to 12V/0.5A Buck Converter Through Hole.

5.0 PACKAGING INFORMATION

5.1 Package Marking Information

8-Lead PDIP*

```
XXXXXX
XXXXXXXXX
WNNN  XX
```

Example

```
MICREL
MIC4574YN
9287 R5
```

Legend:	XX...X	Product code or customer-specific information
	Y	Year code (last digit of calendar year)
	YY	Year code (last 2 digits of calendar year)
	WW	Week code (week of January 1 is week '01')
	NNN	Alphanumeric traceability code
	(e3)	Pb-free JEDEC® designator for Matte Tin (Sn)
	*	This package is Pb-free. The Pb-free JEDEC designator ((e3)) can be found on the outer packaging for this package.
	●, ▲, ▼	Pin one index is identified by a dot, delta up, or delta down (triangle mark).

Note:	In the event the full Microchip part number cannot be marked on one line, it will be carried over to the next line, thus limiting the number of available characters for customer-specific information. Package may or may not include the corporate logo.
	Underbar (_) and/or Overbar (‾) symbol may not be to scale.

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8-Lead PDIP Package Outline & Recommended Land Pattern

TITLE
8 LEAD PDIP PACKAGE OUTLINE & RECOMMENDED LAND PATTERN

DRAWING #	PDIP-8LD-PL-1	**UNIT**	INCH
Lead Frame	Copper	**Lead Finish**	Matte Tin
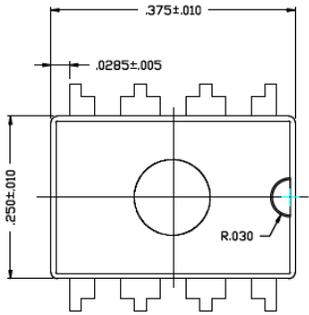
TOP VIEW
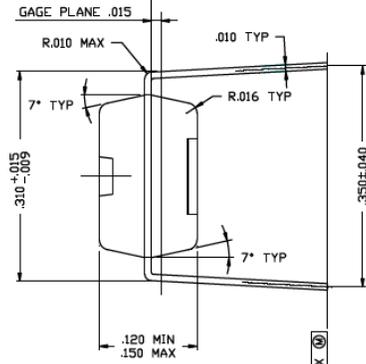
END VIEW
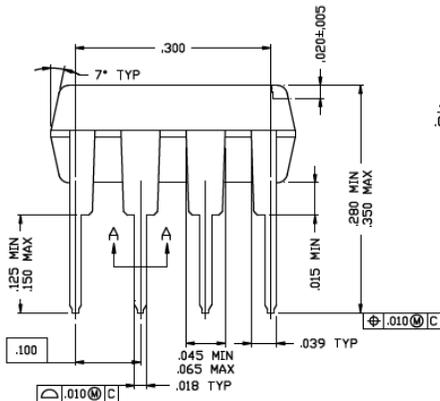
SECTION A-A

SIDE VIEW
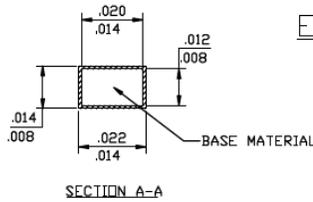
Note: For the most current package drawings, please see the Microchip Packaging Specification located at http://www.microchip.com/packaging.

APPENDIX A: REVISION HISTORY

Revision A (December 2020)

- Converted Micrel document MIC4574 to Microchip data sheet template DS20006472A.
- Minor grammatical text changes throughout.

NOTES:

PRODUCT IDENTIFICATION SYSTEM

To order or obtain information, e.g., on pricing or delivery, contact your local Microchip representative or sales office.

Device	-X.X	X	XX	-XX
Part No.	Output Voltage	Junction Temp. Range	Package	Media Type

Device:	MIC4574:	0.5A, 200 kHz Step-Down Regulator
Output Voltage:	3.3 = 3.3V Fixed 5.0 = 5.0V Fixed <blank> = Adjustable	
Junction Temperature Range:	Y =	–40°C to +85°C, RoHS-Compliant
Package:	N =	8-Lead Plastic DIP
Media Type:	<blank>= 50/Tube	

Examples:

a) MIC4574-3.3YN: MIC4574, 3.3V Fixed Output Voltage, –40°C to +85°C Temperature Range, 8-Lead PDIP, 50/Tube

b) MIC4574-5.0YN: MIC4574, 5.0V Fixed Output Voltage, –40°C to +85°C Temperature Range, 8-Lead PDIP, 50/Tube

c) MIC4574YN: MIC4574, Adjustable Output Voltage, –40°C to +85°C Temperature Range, 8-Lead PDIP, 50/Tube

NOTES:

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- Microchip products meet the specifications contained in their particular Microchip Data Sheet.

- Microchip believes that its family of products is secure when used in the intended manner and under normal conditions.

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