MIC4575

1A, 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 1A 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 LM2575 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)
- Battery Charger
- Negative Boost Converter
- Step-Down 6V to 3.3V for Intel Pentium and Similar Microprocessors

General Description

The MIC4575 is a series of easy to use fixed and adjustable BiCMOS step-down (buck) switch-mode voltage regulators. The 200 kHz MIC4575 duplicates the pinout and function of the 52 kHz LM2575. The higher switching frequency may allow up to a 2:1 reduction in output filter inductor size.

The MIC4575 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 1A 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%.

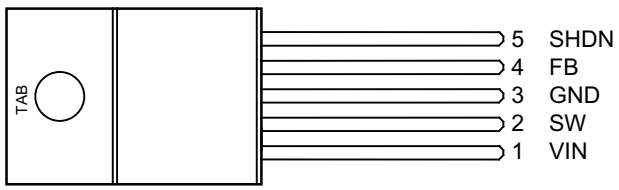
In shutdown mode, the regulator draws less than 200 µA standby current. The regulator performs cycle-by-cycle current limiting and thermal shutdown for protection under fault conditions.

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.

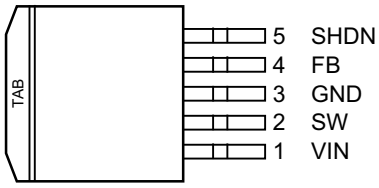
The MIC4575 is available in TO-220 (T) and DDPAK (U) packages for the industrial temperature range.

Package Types

MIC4575
5-Lead TO-220 (T)
(Top View)

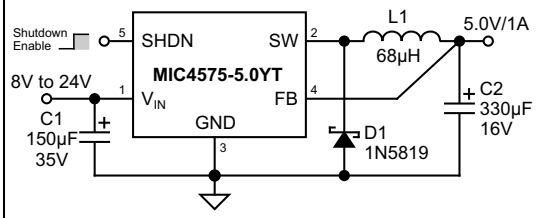


MIC4575
5-Lead DDPAK (U)
(Top View)

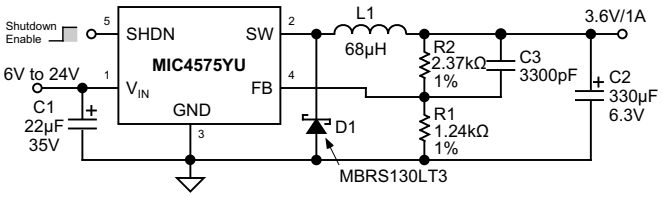


Typical Application Circuits

Fixed Regulator

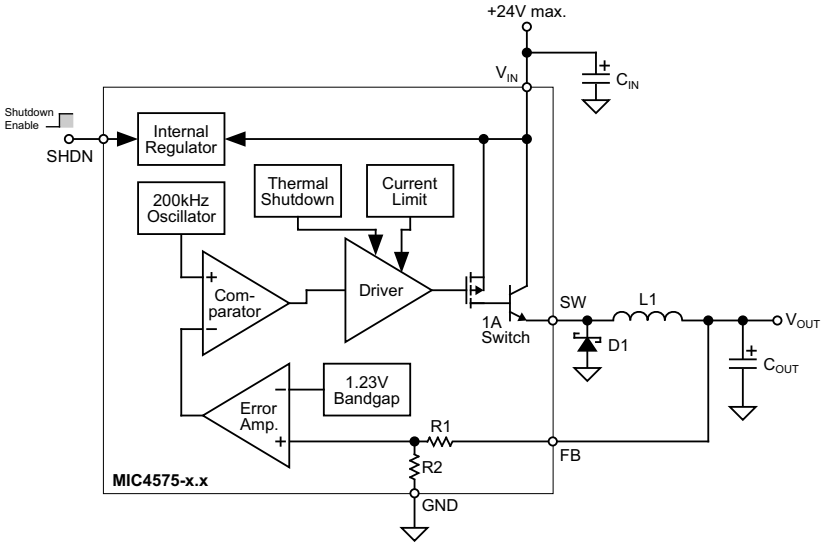


Adjustable Regulator

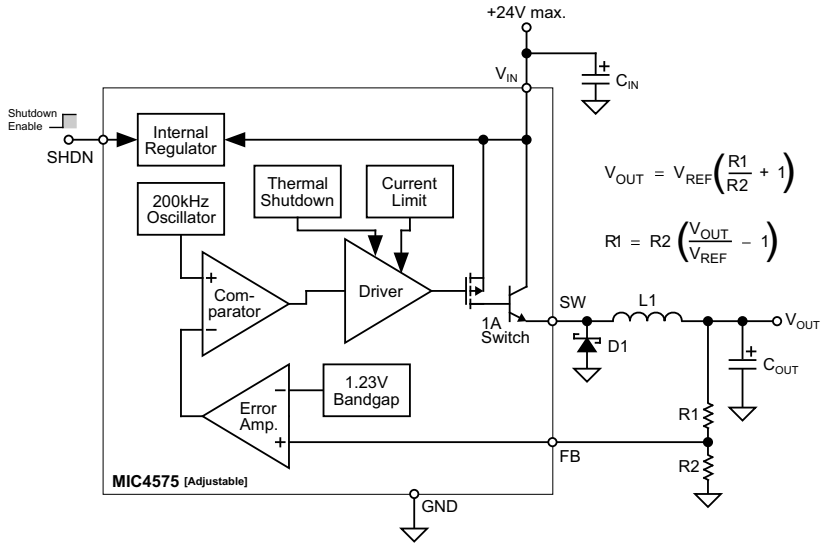


Functional Block Diagrams

Fixed Step-Down Regulator with External Components



Adjustable Step-Down Regulator with External Components



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
Storage Temperature ..... –65°C to +150°C
ESD Rating ..... Note 2

Operating Ratings ††

Supply Voltage (V_{IN}) ..... +24V
Junction Temperature (T_J) ..... +150°C
Package Thermal Resistance
TO-220, DDPAK (θ_{JA}) ..... 65°C/W
TO-220, DDPAK (θ_{JC}) ..... 2°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 MIC4575 is not guaranteed to survive a short-circuit to ground for input voltages above 24V.

2: Device is ESD sensitive. Handling precautions recommended.

ELECTRICAL CHARACTERISTICS

Electrical Characteristics: V_{IN} = 12V; I_{LOAD} = 200 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
MIC4575 (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, 0.2A ≤ I_{LOAD} ≤ 1A
		1.180	—	**1.280**		
Efficiency		—	77	—	%	I_{LOAD} = 1A, V_{OUT} = 5V
Feedback Bias Current	I_{BIAS}	—	50	100	nA	—
		—	—	**500**		
MIC4575-3.3						
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, 0.2A ≤ I_{LOAD} ≤ 1A
		3.135	—	**3.465**		
Efficiency		—	72	—	%	I_{LOAD} = 1A
MIC4575-5.0						
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	—	%	I_{LOAD} = 1A
MIC4575/-3.3/-5.0						
Oscillator Frequency	f_O	180	200	220	kHz	—
Saturation Voltage	V_{SAT}	—	1	1.3	V	I_{OUT} = 1A
		—	—	**1.5**		
Maximum Duty Cycle (On)	D_{MAX}	90	95	—	%	FB connected to 0V
Current Limit	I_{LIM}	1.7	2.2	3.0	A	Peak Current, t_{ON} ≤ 3 µs
		1.3	—	**3.2**		
Output Leakage Current	I_{OUT}	—	0	2	mA	Output = 0V, V_{IN} = 24V, FB connected to 0V
		—	7.5	35		Output = –1V, V_{IN} = 24V, FB connected to 0V
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						
Junction Temperature	T_J	—	—	+150	°C	—
Storage Temperature Range	T_S	–65	—	+150	°C	—
Package Thermal Resistances						
Thermal Resistance, TO-220, TO-263	θ_{JA}	—	65	—	°C/W	—
Thermal Resistance, TO-220, TO-263	θ_{JC}	—	2	—	°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.

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	IN	Supply Voltage (Input): Unregulated +4V to +40V supply voltage.
2	SW	Switch (Output): Emitter of NPN output switch. Connect to external storage inductor and Schottky diode.
3, TAB	GND	Ground.
4	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.
5	SHDN	Shutdown (Input): Logic low enables regulator. Logic high (> 2.4V) shuts down regulator.

3.0 FUNCTIONAL DESCRIPTION

The MIC4575 is a variable duty cycle switch-mode regulator with an internal power switch. Refer to the Functional Block Diagrams.

3.1 Supply Voltage

The MIC4575 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.

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, *200 kHz MIC4574/5/6 Family Design Guide*.

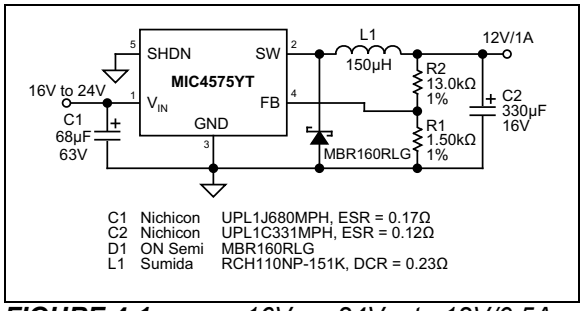


FIGURE 4-1: *$16V_{IN}$ - $24V_{IN}$ to 12V/0.5A Buck Converter Through Hole.*

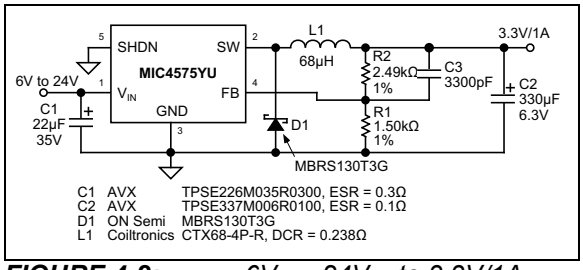


FIGURE 4-2: *$6V_{IN}$ - $24V_{IN}$ to 3.3V/1A Buck Converter Low-Profile Surface Mount.*

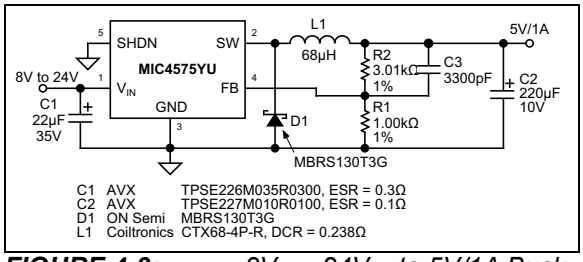


FIGURE 4-3: *$8V_{IN}$ - $24V_{IN}$ to 5V/1A Buck Converter Low-Profile Surface Mount.*

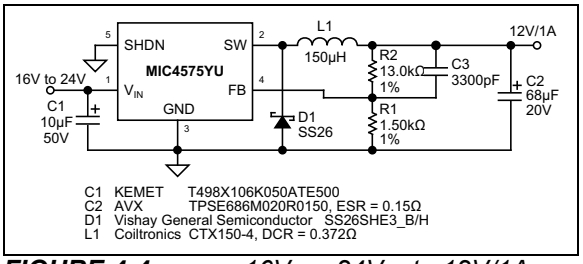


FIGURE 4-4: *$16V_{IN}$ - $24V_{IN}$ to 12V/1A Buck Converter Low-Profile Surface Mount.*

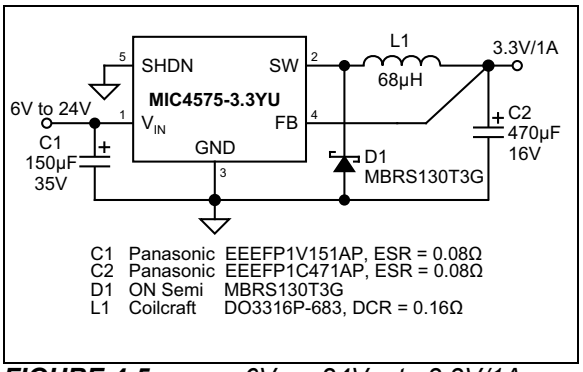


FIGURE 4-5: *$6V_{IN}$ - $24V_{IN}$ to 3.3V/1A Buck Converter Surface Mount.*

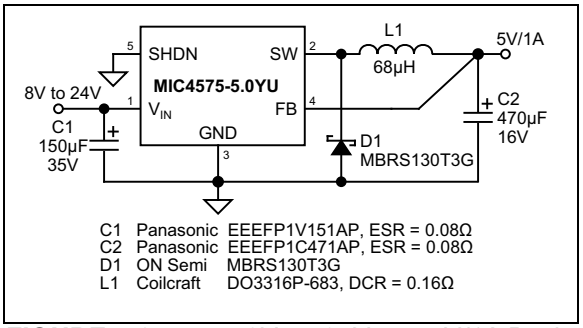


FIGURE 4-6: *$8V_{IN}$ - $24V_{IN}$ to 5V/1A Buck Converter Surface Mount.*

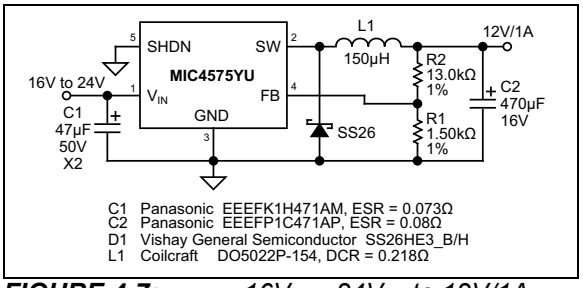


FIGURE 4-7: *$16V_{IN}$ - $24V_{IN}$ to 12V/1A Buck Converter Surface Mount.*

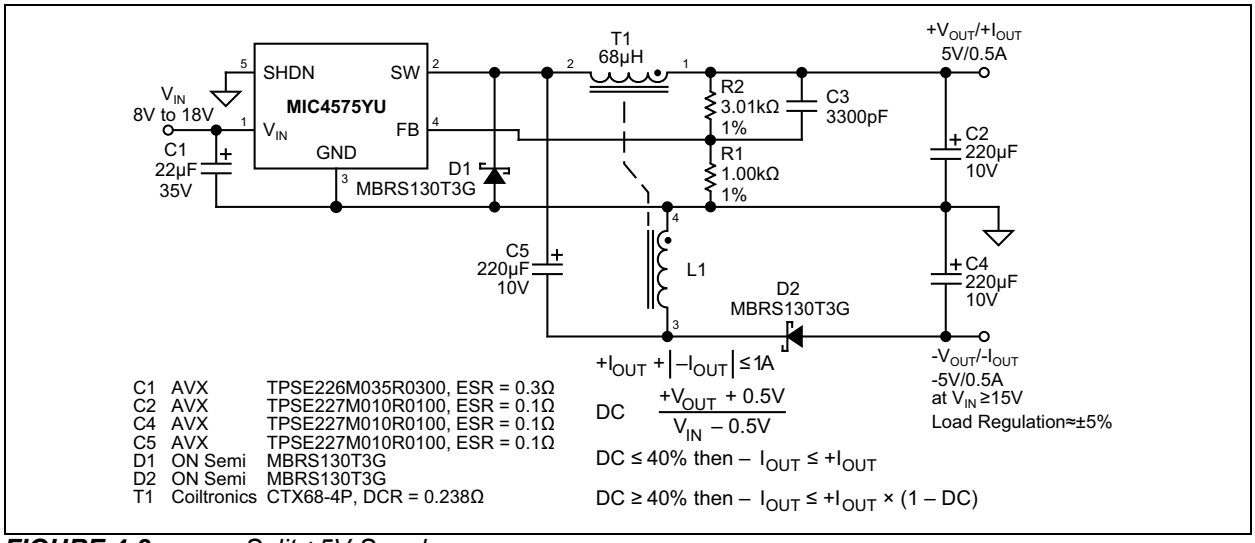


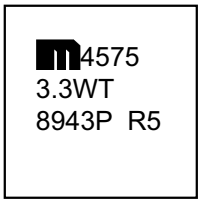
FIGURE 4-8: *Split ±5V Supply.*

5.0 PACKAGING INFORMATION

5.1 Package Marking Information

5-Lead TO-220*

Example



5-Lead DDPAK*

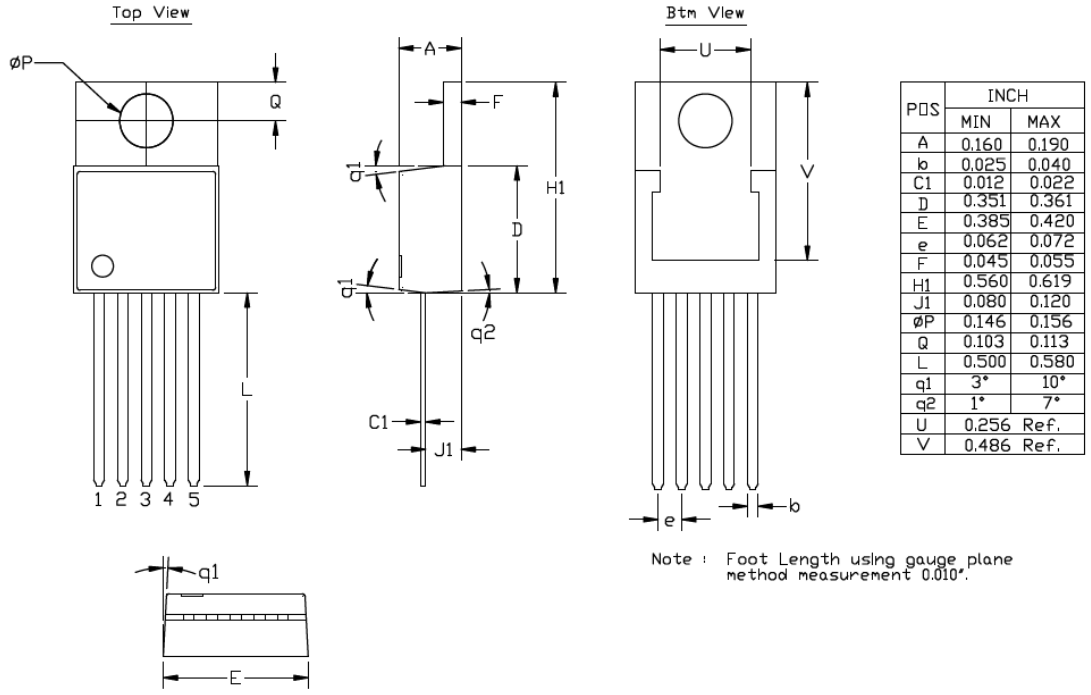
Example

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.	

5-Lead TO-220 Package Outline & Recommended Land Pattern

TITLE
5 LEAD TO220 PACKAGE OUTLINE & RECOMMENDED LAND PATTERN

DRAWING #	TO220-5LD-PL-1	**UNIT**	INCH
Lead Frame	Copper Alloy	**Lead Finish**	Matte Tin



POS	INCH	
	MIN	MAX
A	0.160	0.190
b	0.025	0.040
C1	0.012	0.022
D	0.351	0.361
E	0.385	0.420
e	0.062	0.072
F	0.045	0.055
H1	0.560	0.619
J1	0.080	0.120
øP	0.146	0.156
Q	0.103	0.113
L	0.500	0.580
q1	3°	10°
q2	1°	7°
U	0.256 Ref.	
V	0.486 Ref.	

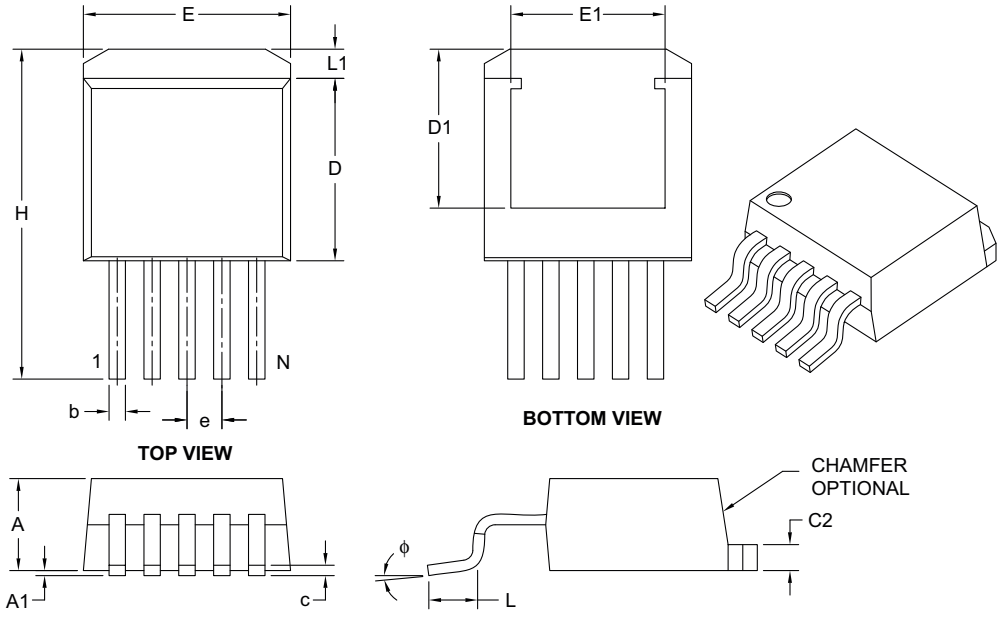
Note : Foot Length using gauge plane method measurement 0.010".

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

5-Lead DDPAK Package Outline and Recommended Land Pattern

5-Lead Plastic (ET) [DDPAK]

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



Units		INCHES		
Dimension Limits		MIN	NOM	MAX
Number of Pins	N		5	
Pitch	e		.067 BSC	
Overall Height	A	.160	–	.190
Standoff §	A1	.000	–	.010
Overall Width	E	.380	–	.420
Exposed Pad Width	E1	.245	–	–
Molded Package Length	D	.330	–	.380
Overall Length	H	.549	–	.625
Exposed Pad Length	D1	.270	–	–
Lead Thickness	c	.014	–	.029
Pad Thickness	C2	.045	–	.065
Lead Width	b	.020	–	.039
Foot Length	L	.068	–	.110
Pad Length	L1	–	–	.067
Foot Angle	ϕ	0°	–	8°

Notes:

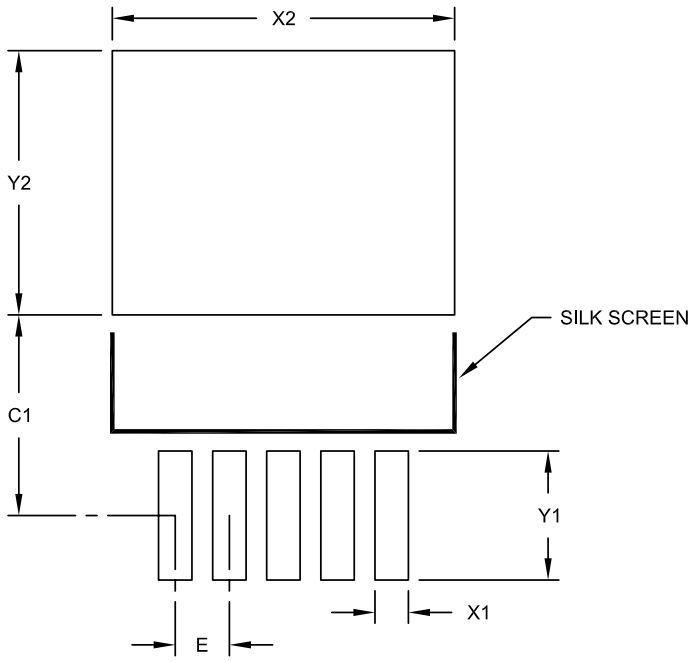
1. § Significant Characteristic.
2. Dimensions D and E do not include mold flash or protrusions. Mold flash or protrusions shall not exceed .005" per side.
3. Dimensioning and tolerancing per ASME Y14.5M.

BSC: Basic Dimension. Theoretically exact value shown without tolerances.

Microchip Technology Drawing C04-012B

5-Lead Plastic (ET) [DDPAK]

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



RECOMMENDED LAND PATTERN

Units		INCHES		
Dimension Limits		MIN	NOM	MAX
Contact Pitch	E	.067 BSC		
Optional Center Pad Width	X2			.423
Optional Center Pad Length	Y2			.327
Contact Pad Spacing	C1		.248	
Contact Pad Width (X5)	X1			.041
Contact Pad Length (X5)	Y1			.159

Notes:

1. Dimensioning and tolerancing per ASME Y14.5M

BSC: Basic Dimension. Theoretically exact value shown without tolerances.

Microchip Technology Drawing No. C04-2012A

NOTES:

APPENDIX A: REVISION HISTORY

Revision A (December 2020)

- Converted Micrel document MIC4575 to Microchip data sheet template DS20006464A.
- 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:	MIC4575:	1A, 200 kHz Step-Down Regulator
Output Voltage:	3.3 =	3.3V Fixed
	5.0 =	5.0V Fixed
	<blank> =	Adjustable
Junction Temperature Range:	W =	–40°C to +85°C, RoHS-Compliant with High Melting Solder Exemption
Package:	T =	5-Lead TO-220
	U =	5-Lead DDPAK
Media Type:	<blank>=	50/Tube (both package options)
	TR =	750/Reel (DDPAK package option only)

Examples:

a) MIC4575WT: MIC4575, Adjustable Output Voltage, –40°C to +85°C Temperature Range, 5-Lead TO-220, 50/Tube

b) MIC4575-3.3WU: MIC4575, 3.3V Fixed Output Voltage, –40°C to +85°C Temperature Range, 5-Lead DDPAK, 50/Tube

c) MIC4575-3.3WU-TR: MIC4575, 3.3V Fixed Output Voltage, –40°C to +85°C Temperature Range, 5-Lead DDPAK, 750/Reel

d) MIC4575-5.0WT: MIC4575, 5.0V Fixed Output Voltage, –40°C to +85°C Temperature Range, 5-Lead TO-220, 50/Tube

e) MIC4575-5.0WU-TR: MIC4575, 5.0V Fixed Output Voltage, –40°C to +85°C Temperature Range, 5-Lead DDPAK, 750/Reel

Note 1: Tape and Reel identifier only appears in the catalog part number description. This identifier is used for ordering purposes and is not printed on the device package. Check with your Microchip Sales Office for package availability with the Tape and Reel option.

NOTES:

Note the following details of the code protection feature on Microchip devices:

- 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.
- There are dishonest and possibly illegal methods being used in attempts to breach the code protection features of the Microchip devices. We believe that these methods require using the Microchip products in a manner outside the operating specifications contained in Microchip's Data Sheets. Attempts to breach these code protection features, most likely, cannot be accomplished without violating Microchip's intellectual property rights.
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ISBN: 978-1-5224-7356-5

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