LM2576

52 kHz Simple 3A Buck Regulator

Features

- 3.3V, 5V, 12V, and Adjustable Output Versions
- Voltage over Specified Line and Load Conditions:
  - Fixed Version: ±3% Max. Output Voltage
  - Adjustable Version: ±2% Max. Feedback Voltage
- Specified 3A Output Current
- Wide Input Voltage Range of 4V to 40V
- Wide Output Voltage Range of 1.23V to 37V
- Requires Only Four External Components
- 52 kHz Fixed-Frequency Internal Oscillator
- Low Power Standby Mode I_Q Typically <200 µA
- 80% Efficiency (Adjustable Version Typically >80%)
- Uses Readily Available Standard Inductors
- Thermal Shutdown and Current Limit Protection
- 100% Electrical Thermal Limit Built-In

Applications

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

General Description

The LM2576 series of monolithic integrated circuits provide all the active functions for a step-down (buck) switching regulator. Fixed versions are available with a 3.3V, 5V, or 12V fixed output. Adjustable versions have an output voltage range from 1.23V to 37V. Both versions are capable of driving a 3A load with excellent line and load regulation.

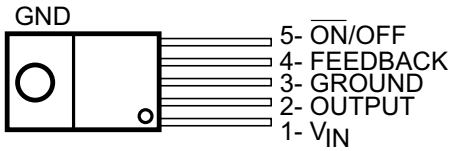
These regulators are simple to use because they require a minimum number of external components and include internal frequency compensation and a fixed-frequency oscillator. The LM2576 series offers a high efficiency replacement for popular three-terminal adjustable linear regulators. It substantially reduces the size of the heat sink, and in many cases no heat sink is required.

A standard series of inductors available from several different manufacturers are ideal for use with the LM2576 series. This feature greatly simplifies the design of switch-mode power supplies.

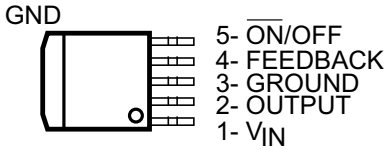
The feedback voltage is guaranteed to ±2% tolerance for adjustable versions, and the output voltage is guaranteed to ±3% for fixed versions, within specified input voltages and output load conditions. The oscillator frequency is guaranteed to ±10%. External shutdown is included, featuring less than 200µA standby current. The output switch includes cycle-by-cycle current limiting and thermal shutdown for full protection under fault conditions.

Package Types

LM2576
TO-220 (T)
(Top View)

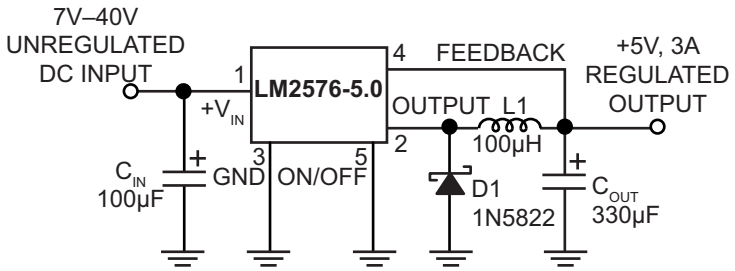


LM2576
TO-263 (U)
(Top View)



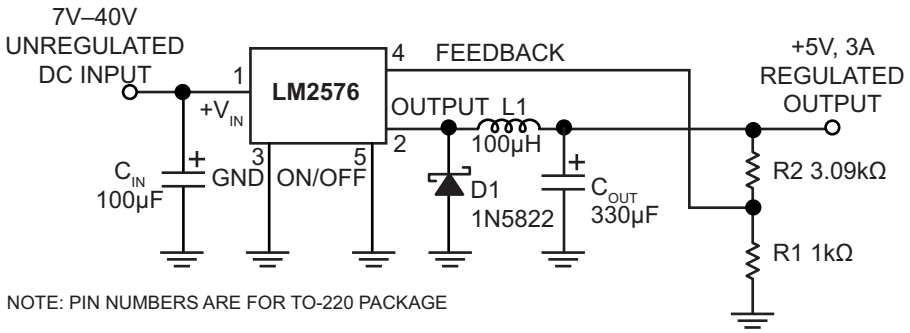
Typical Application Circuits

LM2576
Fixed Regulator Version



NOTE: PIN NUMBERS ARE FOR TO-220 PACKAGE

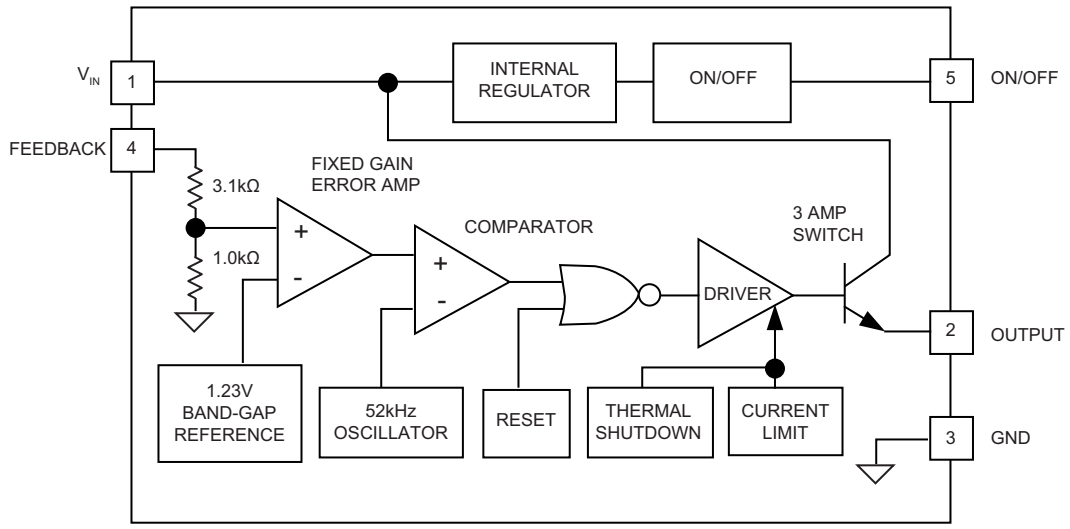
LM2576
Adjustable Regulator Version



NOTE: PIN NUMBERS ARE FOR TO-220 PACKAGE

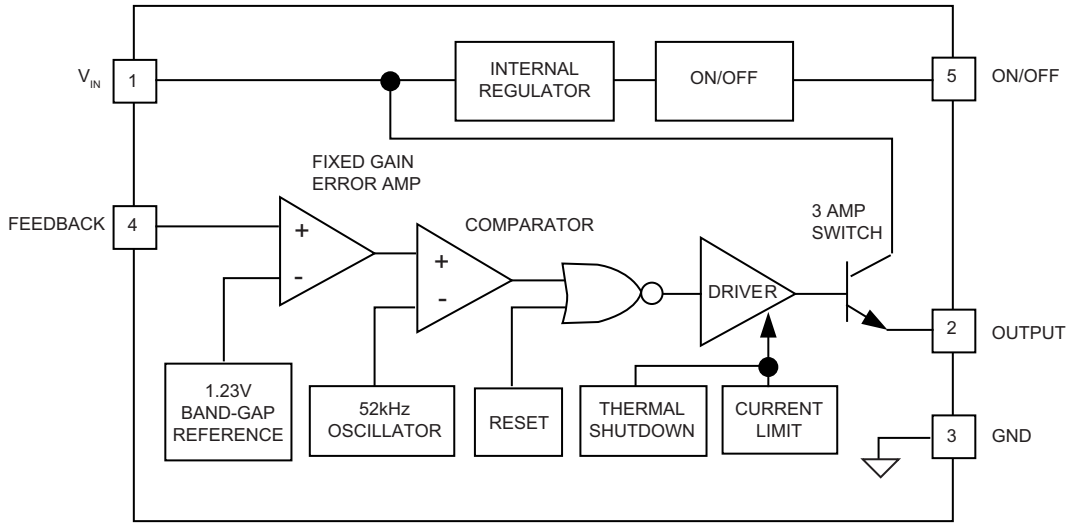
Functional Block Diagrams

LM2576
Fixed Regulator Version



Note: Pin numbers are for the TO-220 package.

LM2576
Adjustable Regulator Version



1.0 ELECTRICAL CHARACTERISTICS

Absolute Maximum Ratings †

Maximum Supply Voltage ..... +45V
ON/OFF Pin Input Voltage ..... –0.3V ≤ V ≤ +40V
Output Voltage to Ground ..... –1V
Power Dissipation ..... Internally Limited
ESD Rating (Note 1)
C = 100 pF, R = 1.5 kΩ ..... 2 kV
FB Pin ..... 1 kV

Operating Ratings ††

Supply Voltage (V_{IN}) ..... +40V

† 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: Devices are ESD sensitive. Handling precautions recommended. Human body model, 1.5 kΩ in series with 100 pF.

ELECTRICAL CHARACTERISTICS

Specifications with standard typeface are for T_J = +25°C, **bold** values are valid for –40°C ≤ T_J ≤ +125°C. Unless otherwise specified, V_{IN} = 12V, and I_{LOAD} = 500 mA. Note 1

Parameter	Sym.	Min.	Typ.	Max.	Units	Conditions
System Parameters, Adjustable Regulators (Note 2) Test Circuit Figure 4-1						
Feedback Voltage	V_{OUT}	1.217	1.230	1.243	V	V_{IN} = 12V, I_{LOAD} = 0.5A, V_{OUT} = 5V
Feedback Voltage LM2576	V_{OUT}	1.193	1.230	1.267	V	0.5A ≤ I_{LOAD} ≤ 3A, 8V ≤ V_{IN} ≤ 40V, V_{OUT} = 5V
		1.180	—	**1.280**		
Efficiency	η	—	82	—	%	V_{IN} = 12V, I_{LOAD} = 3A, V_{OUT} = 5V
System Parameters, 3.3V Regulators (Note 2) Test Circuit Figure 4-1						
Output Voltage	V_{OUT}	3.234	3.3	3.363	V	V_{IN} = 12V, I_{LOAD} = 0.5A, V_{OUT} = 3.3V
Output voltage LM2576-3.3	V_{OUT}	3.168	3.3	3.432	V	0.5A ≤ I_{LOAD} ≤ 3A, 6V ≤ V_{IN} ≤ 40V, V_{OUT} = 3.3V
		3.135	—	**3.465**		
Efficiency	η	—	75	—	%	V_{IN} = 12V, I_{LOAD} = 3A
System Parameters, 5V Regulators (Note 2) Test Circuit Figure 4-1						
Output Voltage	V_{OUT}	4.900	5.0	5.100	V	V_{IN} = 12V, I_{LOAD} = 0.5A, V_{OUT} = 5.0V
Output voltage LM2576-5.0	V_{OUT}	4.800	5.0	5.200	V	0.5A ≤ I_{LOAD} ≤ 3A, 8V ≤ V_{IN} ≤ 40V, V_{OUT} = 5.0V
		4.750	—	**5.250**		

Note 1: Specification for packaged product only.

2: External components such as the catch diode, inductor, input and output capacitors can affect switching regulator system performance. When the LM2576/LM1576 is used as shown in Figure 4-1 test circuit, system performance will be shown in system parameters section of Electrical Characteristics.

3: Output (pin 2) sourcing current. No diode, inductor or capacitor connected to output.

4: Feedback (pin 4) removed from output and connected to 0V.

5: Feedback (pin 4) removed from output and connected to 12V to force the output transistor OFF.

ELECTRICAL CHARACTERISTICS (CONTINUED)

Specifications with standard typeface are for T_J = +25°C, **bold** values are valid for –40°C ≤ T_J ≤ +125°C. Unless otherwise specified, V_{IN} = 12V, and I_{LOAD} = 500 mA. Note 1

Parameter	Sym.	Min.	Typ.	Max.	Units	Conditions
Efficiency	η	—	82	—	%	V_{IN} = 12V, I_{LOAD} = 3A
System Parameters, 12V Regulators (Note 2) Test Circuit Figure 4-1						
Output Voltage	V_{OUT}	11.760	12.0	12.240	V	V_{IN} = 25V, I_{LOAD} = 0.5A, V_{OUT} = 12V
Output voltage LM2576-12	V_{OUT}	11.520	12.0	12.480	V	0.5A ≤ I_{LOAD} ≤ 3A, 15V ≤ V_{IN} ≤ 40V, V_{OUT} = 12V
		11.400	—	**12.600**		
Efficiency	η	—	88	—	%	V_{IN} = 25V, I_{LOAD} = 3A
Device Parameters, Adjustable Regulator						
Feedback Bias Current	I_B	100	50	**500**	nA	V_{OUT} = 5V
Device Parameters, Fixed and Adjustable Regulators						
Oscillator Frequency	f_O	47	52	58	kHz	—
		42	—	**63**		
Saturation Voltage	V_{SAT}	—	1.4	1.8	V	I_{OUT} = 3A, Note 3
		—	—	**2.0**		
Max. Duty Cycle (ON)	DC	93	98	—	%	Note 4
Current Limit	I_{LIM}	4.2	5.8	6.9	A	Peak current, t_{ON} ≤ 3 µs, Note 3
		3.5	—	**7.5**		
Output Leakage Current	I_L	—	—	2	mA	V_{IN} = 40V, Note 5, Output = 0V
		—	7.5	—		Output = –1V
		—	—	30		Note 5, Output = –1V
Quiescent Current	I_Q	—	5	10	mA	Note 5
Standby Quiescent Current	I_{STBY}	—	50	200	µA	ON/OFF Pin = 5V (OFF)
On/Off Control, Fixed and Adjustable Regulators, Test Circuit Figure 4-1						
ON/OFF Pin Logic Input Level	V_{IH}	2.2	1.4	**2.4**	V	V_{OUT} = 0V
	V_{IL}	1.0	1.2	**0.8**		V_{OUT} = 5V
ON/OFF Pin Logic Current	I_{IH}	—	4	30	µA	ON/OFF Pin = 5V (OFF)
	I_{IL}	—	0.01	10		ON/OFF Pin = 0V (ON)

Note 1: Specification for packaged product only.

2: External components such as the catch diode, inductor, input and output capacitors can affect switching regulator system performance. When the LM2576/LM1576 is used as shown in Figure 4-1 test circuit, system performance will be shown in system parameters section of Electrical Characteristics.

3: Output (pin 2) sourcing current. No diode, inductor or capacitor connected to output.

4: Feedback (pin 4) removed from output and connected to 0V.

5: Feedback (pin 4) removed from output and connected to 12V to force the output transistor OFF.

TEMPERATURE SPECIFICATIONS

Parameters	Sym.	Min.	Typ.	Max.	Units	Conditions
Temperature Ranges						
Maximum Junction Temperature	T_J	—	—	+150	°C	—
Storage Temperature Range	T_S	–65	—	+150	°C	—
Lead Temperature	—	—	—	+260	°C	Soldering, 10 sec.
Operating Temperature Range	T_A	–40	—	+125	°C	—
Package Thermal Resistance						
Thermal Resistance, TO-220, TO-263	θ_{JA}	—	65	—	°C/W	Junction-to-Ambient, Note 2
Thermal Resistance, TO-220, TO-263	θ_{JA}	—	45	—	°C/W	Junction-to-Ambient, Note 3
Thermal Resistance, TO-220, TO-263	θ_{JC}	—	2	—	°C/W	Junction-to-Case

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: Junction to ambient thermal resistance (no external heat sink) for the 5-lead TO-220 package mounted vertically, with 1/2" leads in a socket, or on PC board with minimum copper area.

3: Junction to ambient thermal resistance (no external heat sink) for the 5-lead TO-220 package mounted vertically, with 1/4" leads soldered to PC board containing approximately 4 square inches of copper area surrounding the leads.

4: Junction to ambient thermal resistance with approximately 1 square inch of PC board copper surrounding the leads. Additional copper will lower thermal resistance further.

2.0 TYPICAL PERFORMANCE CURVES

Note: The graphs and tables provided following this note are a statistical summary based on a limited number of samples and are provided for informational purposes only. The performance characteristics listed herein are not tested or guaranteed. In some graphs or tables, the data presented may be outside the specified operating range (e.g., outside specified power supply range) and therefore outside the warranted range.

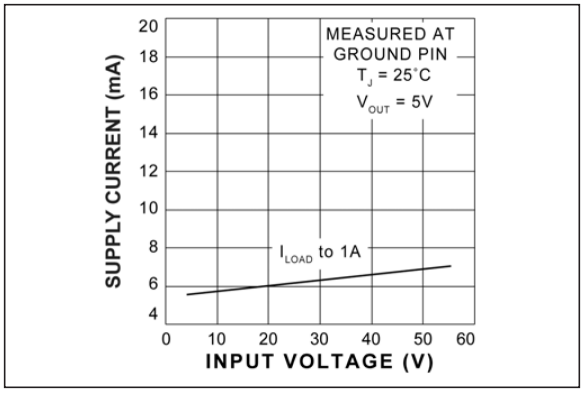


FIGURE 2-1: *Supply Current.*

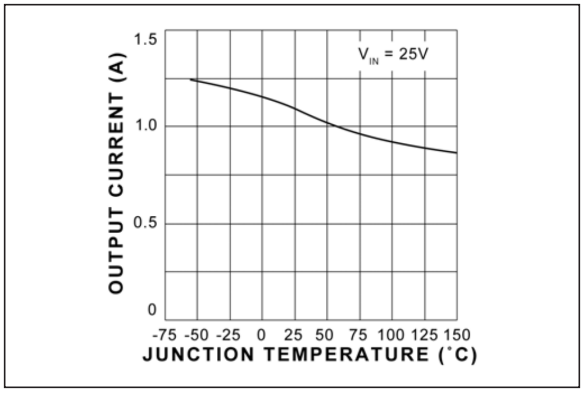


FIGURE 2-4: *Current Limit.*

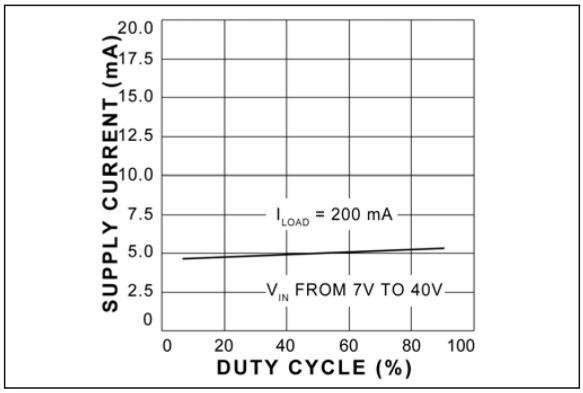


FIGURE 2-2: *Supply Current vs. Duty Cycle.*

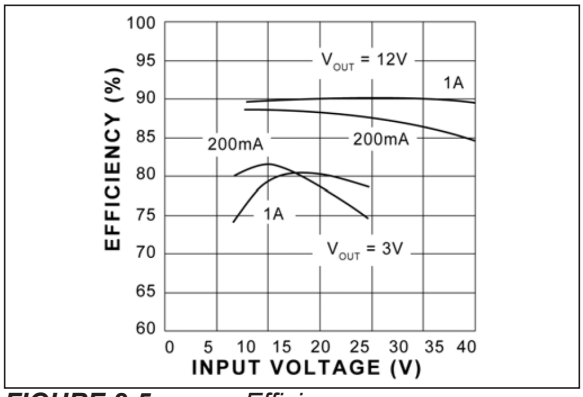


FIGURE 2-5: *Efficiency.*

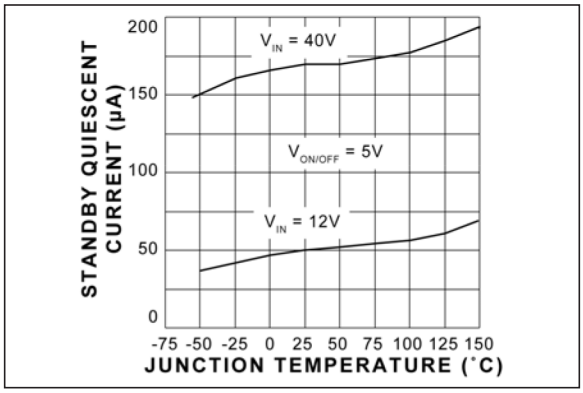


FIGURE 2-3: *Standby Quiescent Current.*

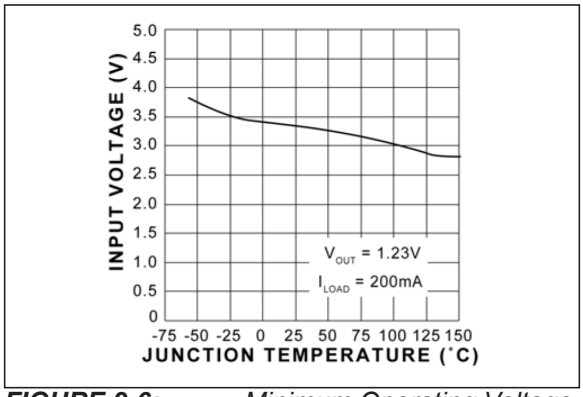


FIGURE 2-6: *Minimum Operating Voltage.*

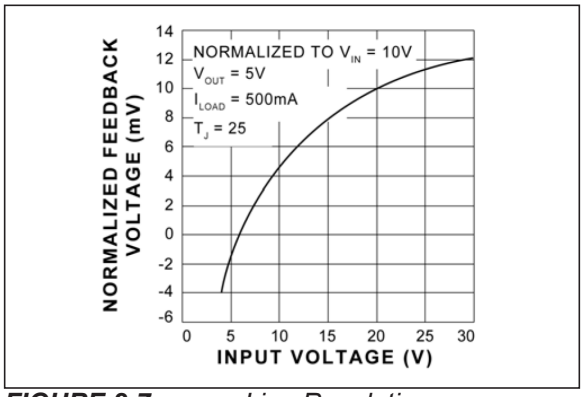


FIGURE 2-7: *Line Regulation.*

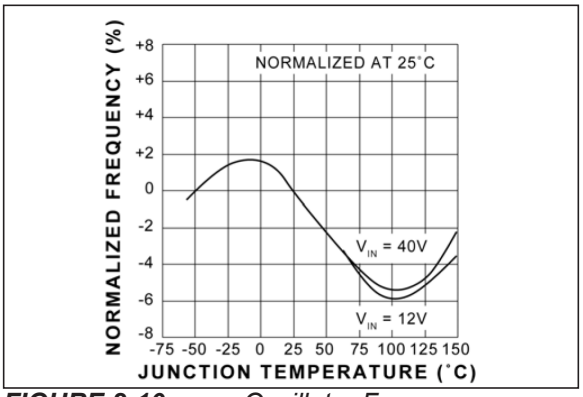


FIGURE 2-10: *Oscillator Frequency.*

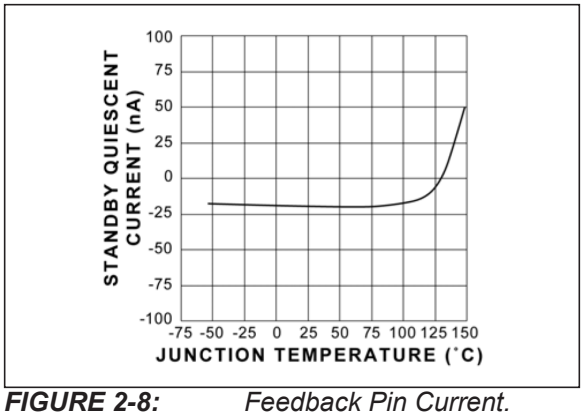


FIGURE 2-8: *Feedback Pin Current.*

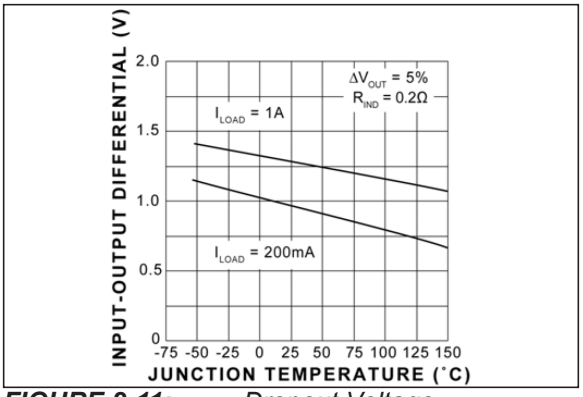


FIGURE 2-11: *Dropout Voltage.*

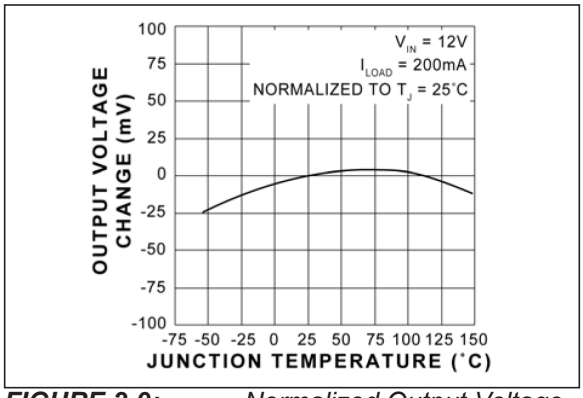


FIGURE 2-9: *Normalized Output Voltage.*

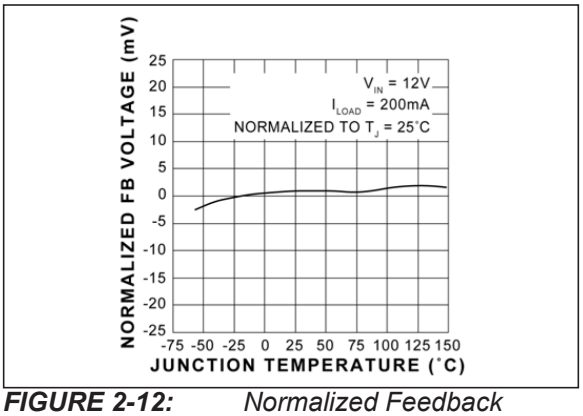


FIGURE 2-12: *Normalized Feedback Voltage (Adjustable Version Only).*

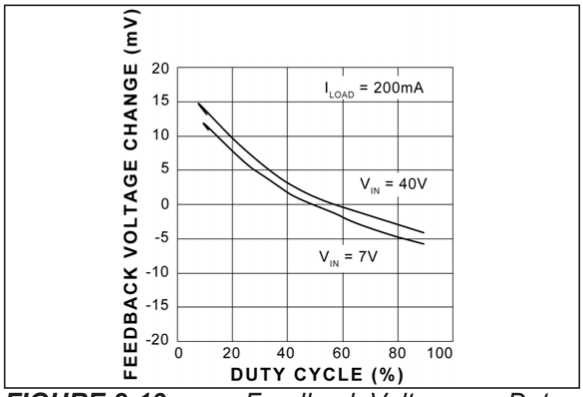


FIGURE 2-13: *Feedback Voltage vs. Duty Cycle (Adjustable Version Only).*

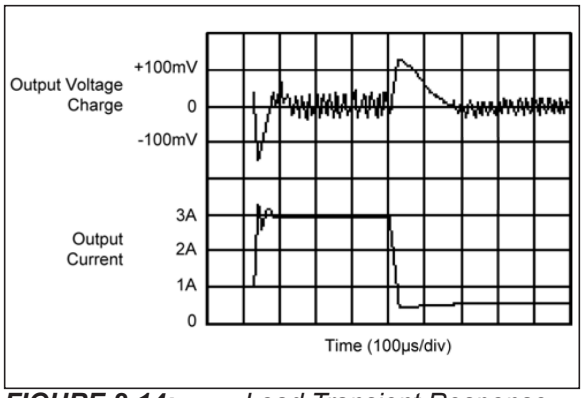


FIGURE 2-14: *Load Transient Response.*

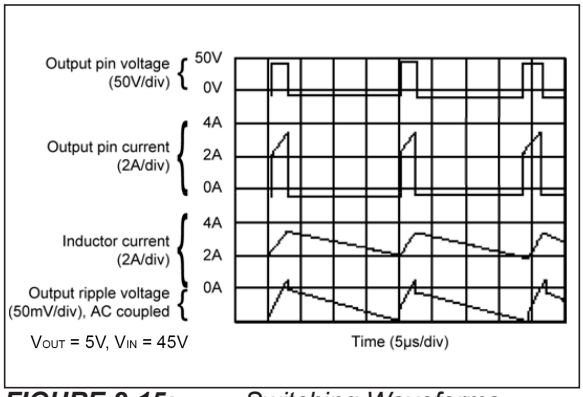


FIGURE 2-15: *Switching Waveforms.*

3.0 PIN DESCRIPTIONS

The descriptions of the pins are listed in Table 3-1.

TABLE 3-1: PIN FUNCTION TABLE

Pin Number	Pin Name	Description
1	V_{IN}	Supply input. Requires bypass capacitor to GND.
2	OUTPUT	Switch output. Internal MOSFET switch output.
3	GND	Ground.
4	FB	Feedback. For fixed output versions, connect to the output. For adjustable versions, connect to external resistive divider to set output voltage.
5	ON/OFF	Enable. Logic low enables operation. Logic high shuts down the regulator. Do not leave floating.

4.0 TEST CIRCUIT

As in any switching regulator, layout is very important. Rapidly switching currents associated with wiring inductance generate voltage transients which can cause problems. For minimal stray inductance and ground loops, the length of the leads indicated by heavy lines should be kept as short as possible. Single point grounding (as indicated) or grounding plane construction should be used for best results.

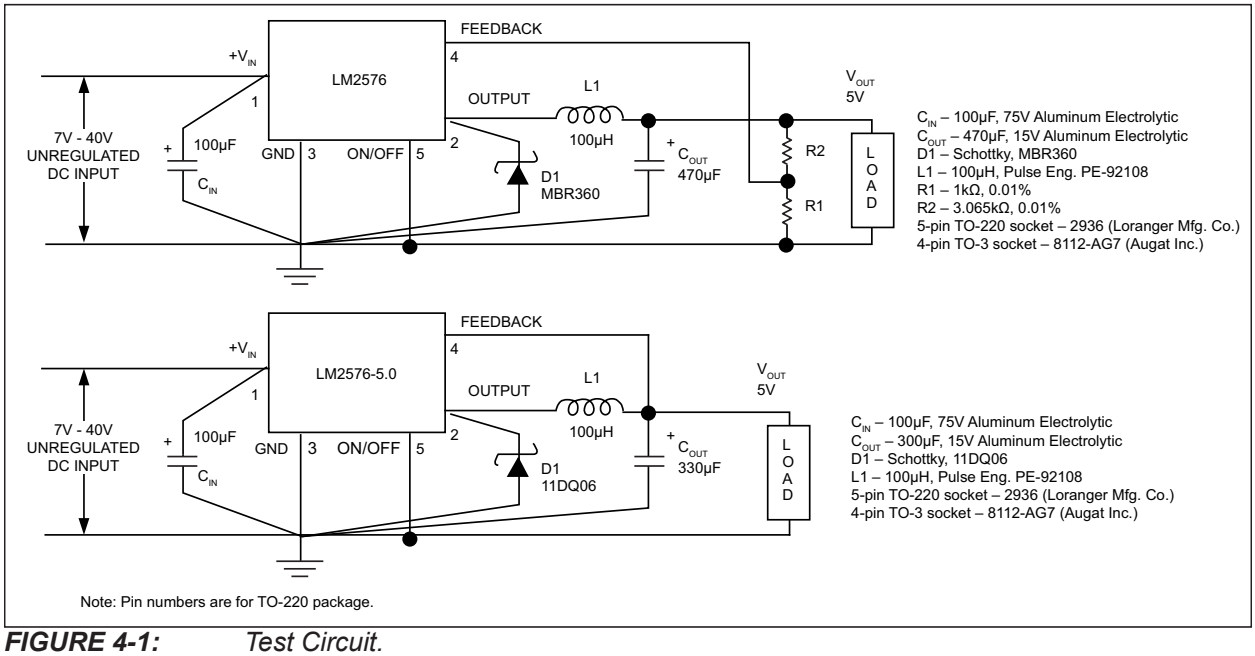


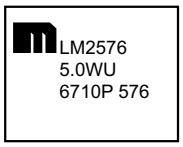
FIGURE 4-1: *Test Circuit.*

5.0 PACKAGING INFORMATION

5.1 Package Marking Information

5-Lead TO-220*
5-Lead TO-263*
(Fixed Versions)

Example



5-Lead TO-220*
5-Lead TO-263*
(Adj. Versions)

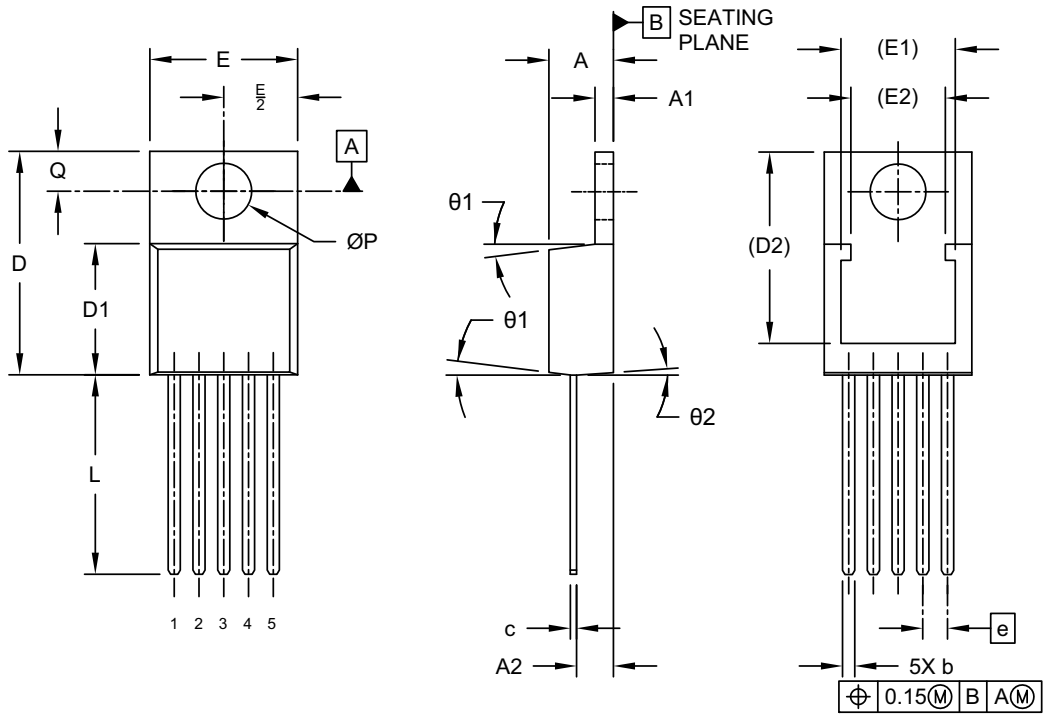
Example

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.	

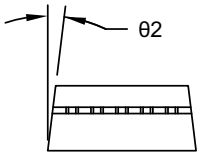
5-Lead TO-220 Package Outline and Recommended Land Pattern

5-Lead Transistor Outline Type LB03 (B8X) - [TO-220]
Micrel Legacy Package TO220-LB03-5LD-PL-1

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



TOP VIEW SIDE VIEW BOTTOM VIEW

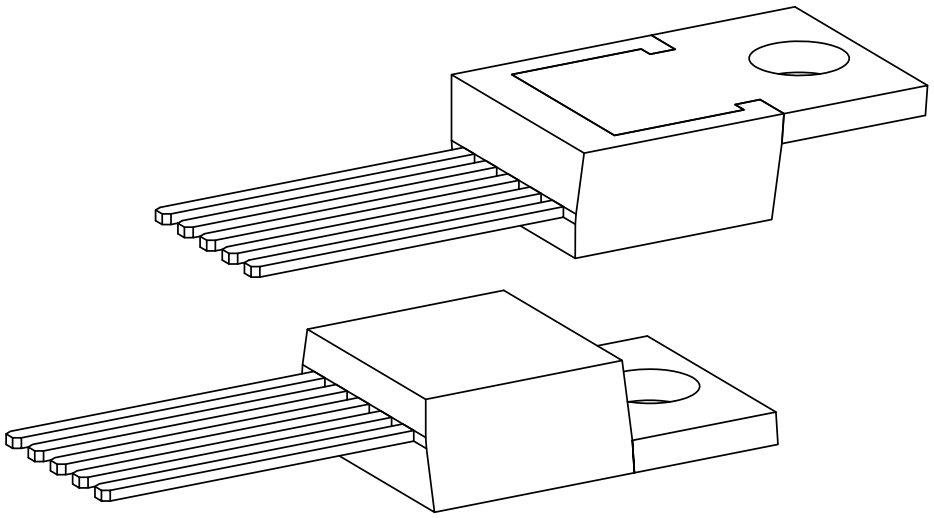


END VIEW

Microchip Technology Drawing C04-036 Rev C Sheet 1 of 2

5-Lead Transistor Outline Type LB03 (B8X) - [TO-220]
Micrel Legacy Package TO220-LB03-5LD-PL-1

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



		INCHES		
Dimension Limits		Min	Nom	Max
Number of Leads	N		5	
Pitch	e		.067 BSC	
Overall Height	A	.160	.175	.190
Tab Height	A1	.045	.050	.055
Seating Plane to Lead	A2	.080	.098	.115
Lead Width	b	.025	.033	.040
Lead Thickness	c	.012	.016	.020
Lead Length	L	.500	.540	.580
Total Body Length Including Tab	D	.542	.580	.619
Molded Body Length	D1	.348	.354	.360
Total Width	E	.380	.400	.420
Pad Width	E1		0.256 REF	
Pad Length	D2		0.486 REF	
Hole Diameter	ØP	.146	.151	.156
Hole Center to Tab Edge	Q	.103	.108	.113
Molded Body Draft Angle	θ2	3	7	10
Molded Body Draft Angle	θ2	1	4	7

Notes:

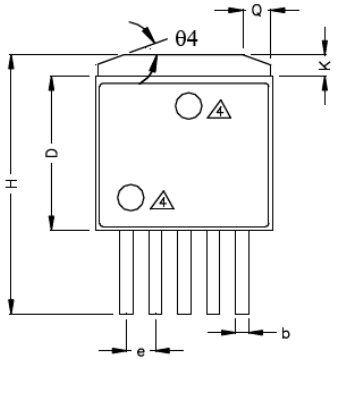
1. Pin 1 visual index feature may vary, but must be located within the hatched area.
2. Dimensioning and tolerancing per ASME Y14.5M
   BSC: Basic Dimension. Theoretically exact value shown without tolerances.
   REF: Reference Dimension, usually without tolerance, for information purposes only.

Microchip Technology Drawing C04-036 Rev C Sheet 2 of 2

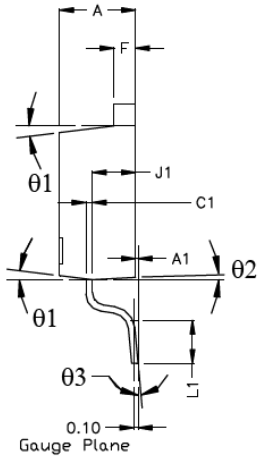
5-Lead TO-263 Package Outline and Recommended Land Pattern

TITLE
5 LEAD T0263 PACKAGE OUTLINE & RECOMMENDED LAND PATTERN

DRAWING #	T0263-5LD-PL-1	**UNIT**	INCH/MM

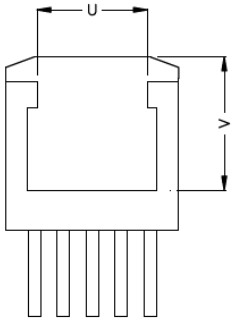


TOP VIEW

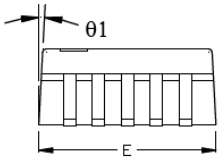


SIDE VIEW 1

POS	INCH		MM	
	MIN	MAX	MIN	MAX
A	0.170	0.181	4.318	4.597
A1	0.000	0.012	0.000	0.305
b	0.026	0.036	0.660	0.914
C1	0.012	0.023	0.305	0.584
D	0.330	0.361	8.392	9.169
E	0.396	0.420	10.058	10.668
e	0.062	0.072	1.575	1.829
F	0.045	0.055	1.143	1.397
H	0.575	0.625	14.605	15.875
J1	0.080	0.120	2.032	3.048
K	0.045	0.066	1.143	1.676
L1	0.090	0.110	2.286	2.794
θ1	3°	10°	3°	10°
θ2	1°	7°	1°	7°
θ3	0°	8°	0°	8°
θ4	18°	22°	18°	22°
Q	0.055	0.075	1.397	1.905
U	0.256 Ref.		6.502 Ref.	
V	0.305 Ref.		7.747 Ref.	

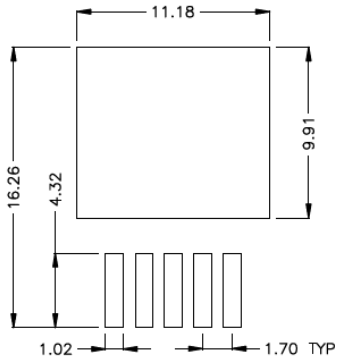


BOTTOM VIEW



SIDE VIEW 2

NOTE:
1. PACKAGE OUTLINE EXCLUSIVE OF MOLD FLASH & METAL BURR.
2. PACKAGE OUTLINE INCLUSIVE OF PLATING THICKNESS.
3. FOOT LENGTH USING GAUGE PLANE METHOD MEASUREMENT 0.010"
4. PACKAGE TOP MARK MAY BE IN TOP CENTER OR LOWER LEFT CORNER
5. ALL DIMENSIONS ARE IN INCHES/MILLIMETERS.



RECOMMENDED LAND PATTERN
(UNIT : mm)

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

NOTES:

APPENDIX A: REVISION HISTORY

Revision A (August 2019)

- Converted Micrel document LM2576 to Microchip data sheet template DS20006238A.
- 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	X	-XX
Part No.	Output Voltage	Junction Temp. Range	Package	Media Type

Device:	LM2576:	52 kHz Simple 3A Buck Regulator
Output Voltage:	<blank> = Adjustable 3.3 = 3.3V 5.0 = 5.0V 12 = 12V	
Junction Temperature Range:	W =	–40°C to +125°C, RoHS-Compliant
Package:	T = 5-Lead TO-220 U = 5-Lead TO-263	
Media Type:	<blank>= 50/Tube TR = 750/Reel	

Examples:

a) LM2576WT:	LM2576, Adj. Output Voltage, –40°C to +125°C Temp. Range, 5-Lead TO-220, 50/Tube
b) LM2576-3.3WT:	LM2576, 3.3V Output Voltage, –40°C to +125°C Temp. Range, 5-Lead TO-220, 50/Tube
c) LM2576-5.0WT:	LM2576, 5.0V Output Voltage, –40°C to +125°C Temp. Range, 5-Lead TO-220, 50/Tube
d) LM2576-12WT:	LM2576, 12V Output Voltage, –40°C to +125°C Temp. Range, 5-Lead TO-220, 50/Tube
e) LM2576WU:	LM2576, Adj. Output Voltage, –40°C to +125°C Temp. Range, 5-Lead TO-263, 50/Tube
f) LM2576-3.3WU:	LM2576, 3.3V Output Voltage, –40°C to +125°C Temp. Range, 5-Lead TO-263, 50/Tube
g) LM2576-5.0WU:	LM2576, 5.0V Output Voltage, –40°C to +125°C Temp. Range, 5-Lead TO-263, 50/Tube
h) LM2576-12WU:	LM2576, 12V Output Voltage, –40°C to +125°C Temp. Range, 5-Lead TO-263, 50/Tube
i) LM2576WU-TR:	LM2576, Adj. Output Voltage, –40°C to +125°C Temp. Range, 5-Lead TO-263, 750/Reel
j) LM2576-3.3WU-TR:	LM2576, 3.3V Output Voltage, –40°C to +125°C Temp. Range, 5-Lead TO-263, 750/Reel
k) LM2576-5.0WU-TR:	LM2576, 5.0V Output Voltage, –40°C to +125°C Temp. Range, 5-Lead TO-263, 750/Reel
l) LM2576-12WU-TR:	LM2576, 12V Output Voltage, –40°C to +125°C Temp. Range, 5-Lead TO-263, 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:

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- There are dishonest and possibly illegal methods used to breach the code protection feature. All of these methods, to our knowledge, require using the Microchip products in a manner outside the operating specifications contained in Microchip's Data Sheets. Most likely, the person doing so is engaged in theft of intellectual property.
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