3A Step-Down Voltage Regulator LM2576BM

DESCRIPTION

The LM2576BM series of regulators are monolithic integrated circuits that provide all the active functions for a step-down (buck) switching regulator, capable of driving 3A load with excellent line and load regulation. These devices are available in fixed output voltages of 3.3V, 5V, 12V and an ADJ output version.

Requiring a minimum number of external components, these regulators are simple to use and include internal frequency compensation and a fixed-frequency oscillator.

The LM2576BM series offers a high-efficiency replacement for popular three-terminal linear regulators. It substantially reduces the size of the heat sink, and in some cases no heat sink is required. A standard series of inductors optimized for use with the LM2576BM are available from several different manufacturers. This feature greatly simplifies the design of switch-mode power supplies.

Other features include a guaranteed ±4% tolerance on output voltage within specified input voltages and output load conditions, and ±10% on the oscillator frequency. External shutdown is included, featuring 50 μA (typical) standby current. The output switch includes cycle-by-cycle current limiting, as well as thermal shutdown for full protection under fault conditions.

FEATURES

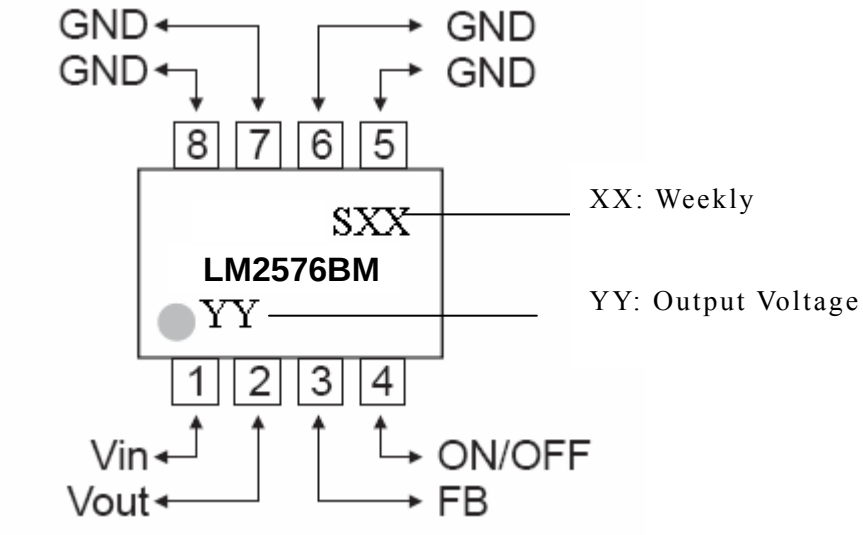
- 3.3V, 5V, 12V and adjustable output versions
- Guaranteed 3A output current
- Adjustable version output voltage range,1.23V to 37V±4% max over line and load conditions
- 52 kHz fixed frequency internal oscillator
- TTL shutdown capability, low power standby mode
- High efficiency
- Uses readily available standard inductors
- Thermal shutdown and current limit protection
- Wide input voltage range up to 40V
- Requires only 4 external components

APPLICATIONS

- Simple high-efficiency step-down (buck) regulator
- Efficient pre-regulator for linear regulators
- On-card switching regulators
- Positive to negative converter (Buck-Boost)

CONNECTION DIAGRAMS

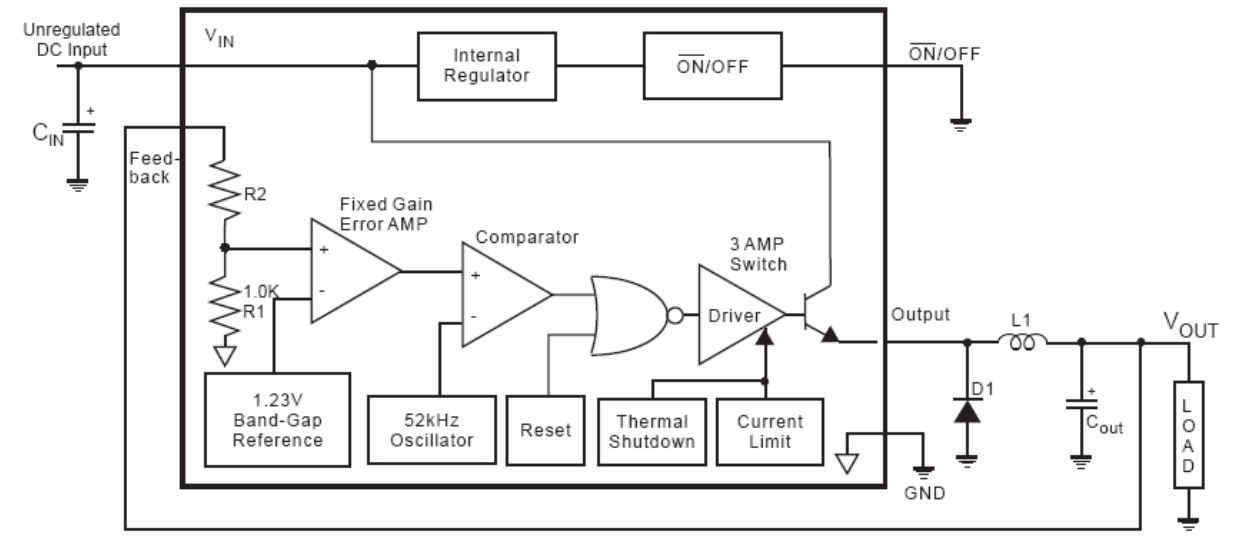
ESOP-8L



ORDERING INFORMATION

Ordering	Output Voltage	Package
LM2576BM-ADJ	Adj.	ESOP-8L
LM2576BM-3.3	3.3V	ESOP-8L
LM2576BM-5.0	5.0V	ESOP-8L
LM2576BM-12	12V	ESOP - 8L

BLOCK DIAGRAM



3.3V R2=1.7K 5V R2=3.1K

For ADJ Version R1=open, R2=0Ω

PIN FUNCTIONS

+VIN —This is the positive input supply for the IC switching regulator. A suitable input bypass capacitor must be present at this pin to minimize voltage transients and to supply the switching currents needed by the regulator.

Ground —Circuit ground.

Output —Internal switch, the voltage at this pin switches between (+VIN VSAT) and approximately -0.5V. To minimize coupling to sensitive circuitry, the PC board copper area connected to this pin should be kept to a minimum.

FeedBack —Senses the regulated output voltage to complete the feedback loop**.**

—Allows the switching regulator circuit to be shut down using logic level signals. Pulling this pin below a threshold voltage of approximately 1.5V turns the regulator on, and shutdown feature is not needed, the $\overline{ON}$/OFF pin can be wired to the ground pin or it can be left open, in either case the regulator will be in the ON condition.

ABSOLUTE MAXIMUM RATINGS (Ta=25°C) *

Characteristic	Value	Unit
Maximum supply voltage	45	V
$\overline{ON}$ /OFF pin input voltage	$-0.3V \leq V \leq +V_{IN}$	V
Output voltage to ground(steady state)	-1	V
Power dissipation	Internally limited	
Storage temperature range	-65~+150	°C
Maximum junction temperature	2	kV
ESD susceptibility (Human Body Model)	150	°C

RECOMMENDED OPERATING CONDITIONS

Characteristic	Symbol	Value	Unit
Supply Voltage	V_{CC}	6～40	V
Operating temperature range		-40～+125	°C

ELECTRICAL CHARACTERISTICS

(Specifications with standard type face are for T_J = 25°C,)

Parameter	Symbol	Condition	Min. *2	Typ.	Max.	Unit
Device Parameters						
Feedback bias current	Ib	Adjustable version only, V_{OUT}=5V		50	100	nA
Oscillator frequency	fo	*8	47	52	58	kHz
V_{SAT} saturation voltage	V_{SAT}	I_{OUT}=3A *4		1.4	1.8	V
Max. duty cycle(ON)	DC	*5	93	98		%
Current limit	I_{CL}	*4,8	4.2	5.8	6.9	A
Output leakage current	I_L	Output=0V *6,7		7.5	2.3	mA
		Output=-1VV *10			30	mA
Quiescent current	I_Q	*6		5	10	mA
Standby quiescent current	I_{STBY}	$\overline{ON}$/OFF $_{PIN}$=5V		50	200	μA
$\overline{ON}$/OFF Control						
$\overline{ON}$/OFF pin logic input level	V_{IH}	V_{OUT}=0V	2.0			V
	V_{IL}	V_{OUT}=nominal output voltage			0.8	V
$\overline{ON}$/OFF pin input current	I_{IH}	ON/OFF pin=5V(OFF)		4	30	μA
	I_{IL}	ON/OFF pin=0V(ON)		0.01	10	μA
LM2576BM 3.3V System Parameters *3						
Output voltagde	V_{OUT}	6V≤V_{IN}≤40V 0.5A≤I_{LOAD}≤3A	3.234	3.3	3.366	V
Efficiency	η	V_{IN}=12V,I_{LOAD}=3A		73		%
LM2576BM 5.0V System Parameters *3						
Output voltagde	V_{OUT}	8V≤V_{IN}≤40V 0.5A≤I_{LOAD}≤3A	4.8	5.0	5.2	V
Efficiency	η	V_{IN}=12V,I_{LOAD}=3A		77		%
LM2576BM 12V System Parameters *3						
Output voltagde	V_{OUT}	15V≤V_{IN}≤40V 0.5A≤I_{LOAD}≤3A	11.52	12.0	12.48	V
Efficiency	η	V_{IN}=15V,I_{LOAD}=3A		88		%
LM2576BM ADJ System Parameters *3						
Output voltagde	V_{OUT}	8V≤V_{IN}≤40V 0.5A≤I_{LOAD}≤3A V_{OUT}=5V	1.193	1.230	1.267	V
Efficiency	η	V_{IN}=12V,I_{LOAD}=3A V_{OUT}=5V		77		%

*** 1** Absolute Maximum Ratings indicates limits beyond which damage to the device may occur. Operating Ratings indicate conditions for which the device is intended to be

functional, but specific performance is not guaranteed. For guaranteed specifications and the best conditions, see the Electrical Characteristics.

*** 2** All limits guaranteed at room temperature (standard type face) and at temperature extremes(bold type face). All room temperature limits are 100% production tested. All limits at temperature extremes are guaranteed via correlation using standard Statistical Quality Control (SQC) methods.

*** 3** External components such as the catch diode, inductor, input and output capacitors, and voltage programming resistors can affect switching regulator system performance.

*** 4** Output pin sourcing current. No diode, inductor or capacitor connected to output pin.

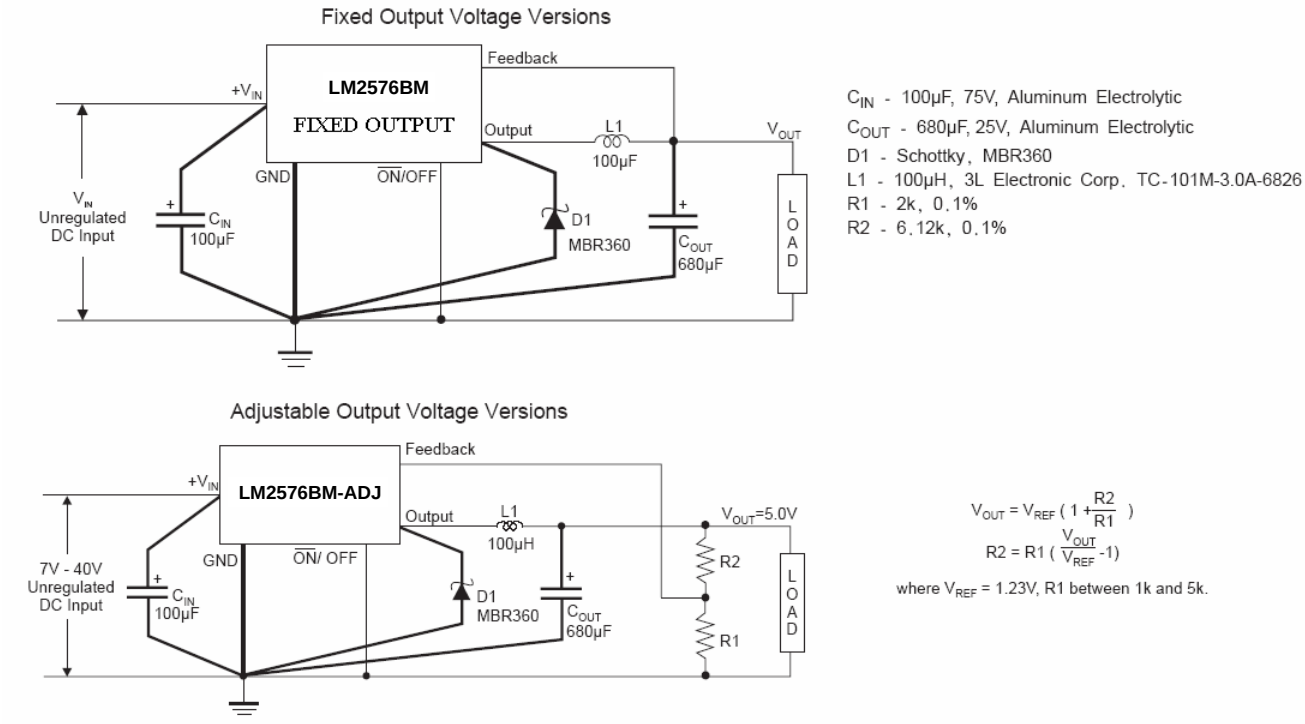
*** 5** Feedback pin removed from output and connected to 0V.

*** 6** Feedback pin removed from output and connected to +12V for the 3.3V, 5V, and the ADJ version, to force the output transistor switch OFF.

*** 7** V_{IN} = 40V

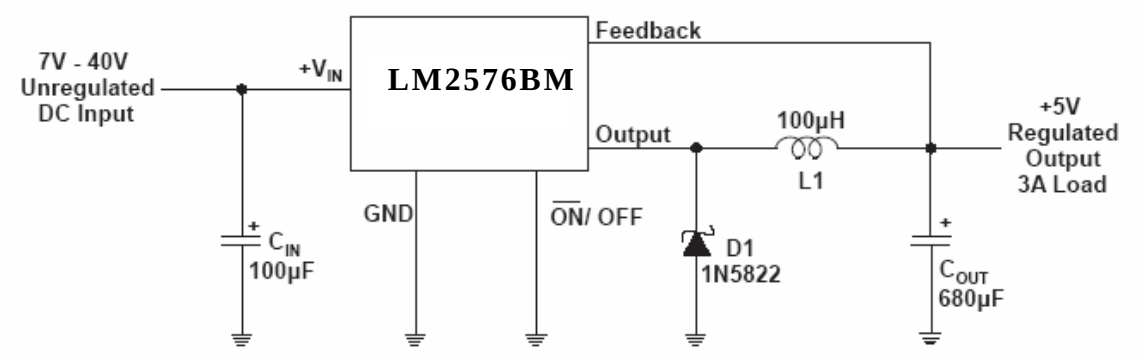
*** 8** The oscillator frequency reduces to approximately 11 KHz in the event of an output short or an overload which causes the regulated output voltage to drop approximately 40% from the nominal output voltage. The self-protection feature lowers the average power dissipation of the minimum duty cycle from 5% down to approximately 2%.

TEST CIRCUIT

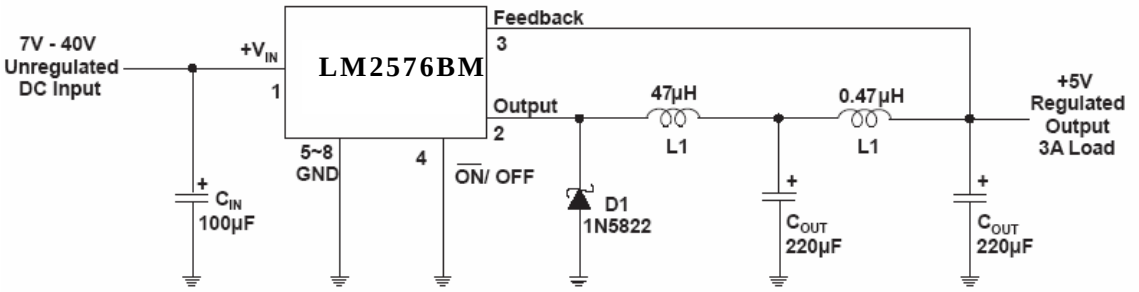


APPLICATION CIRCUIT

Typical



Low Noise



APPLICATION INFORMATION

Careful layout is important with any switching regulator. Rapidly switching currents associated with wiring inductance generate voltage transients which can cause problems. To minimize inductance and ground loops, the lengths of the leads indicated by heavy lines in Figure 1 below should be kept as short as possible. Single point grounding or ground plane construction should be used for best results. When using the Adjustable version, place the programming resistors as close as possible to LM2576BM, to keep the sensitive feedback wiring short.

INPUT CAPACITOR C_{IN}

A low ESR aluminum or tantalum bypass capacitor is needed between the input pin and ground pin**.** It must be located near the regulator using short leads. This capacitor prevents large voltage transients from appearing at the input, and provides the instantaneous current needed each time the switch turns on. Selecting an input capacitor requires consulting the manufacturers data sheet for maximum allowable RMS ripple current. For a maximum ambient temperature of 40°C, a general guideline would be to select a capacitor with a ripple current rating of approximately 50% of the DC load current. For ambient

temperatures up to 70°C, a current rating of 75% of the DC load current would be a good choice for a conservative design. The capacitor voltage rating must be at least 1.25 times greater than the maximum input voltage, and often a much higher voltage capacitor is needed to satisfy the RMS current requirements.

OUTPUT CAPACITOR C_{OUT}

An output capacitor is required to filter the output and provide regulator loop stability. Low impedance or low ESR Electrolytic or solid tantalum capacitors designed for switching regulator applications must be used. When selecting an output capacitor, the important capacitor parameters are; the 100 kHz Equivalent Series resistance (ESR), the RMS ripples current rating, voltage rating, and capacitance value. For the output capacitor, the ESR value is the most important parameter. The output capacitor requires an ESR value that has an upper and lower limit. For low output ripple voltage, a low ESR value is needed. This value is determined by the maximum allow able output ripple voltage, typically 1% to 2% of the output voltage. But if the selected capacitor's ESR is extremely low, there is a possibility of an unstable feedback loop, resulting in an oscillation at the output.

CATCH DIODE *D1*

Buck regulators require a diode to provide a return path for the inductor current when the switch turns off. This must be a fast diode and must be located close to the LM2576BM using short leads and short printed circuit traces. Because of their very fast switching speed and low forward voltage drop, Schottky diodes provide the best performance, especially in low output voltage applications (5V and lower). Ultra fast recovery, or High-Efficiency rectifiers are also a good choice, but some types with an abrupt turnoff characteristic may cause instability or EMI problems.

INDUCTOR SELECTION *L*

All switching regulators have two basic modes of operation; continuous and discontinuous. The difference between the two types relates to the inductor current, whether it is flowing continuously, or if it drops to zero for a period of time in the normal switching cycle. Each mode has distinctively different operating characteristics, which can affect the regulators performance and requirements. Most switcher designs will operate in the discontinuous mode when the load current is low.

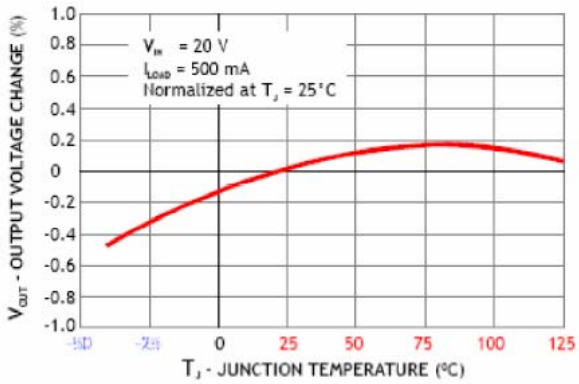
The LM2576BM (or any of the Simple Switcher family) can be used for both continuous and discontinuous modes of operation. There is a formula for general applications:

$$L=(5\sim10)\ \frac{V_o}{100I_o}\left(1-\frac{V_o}{V_{IN}}\right)\text{mH}$$

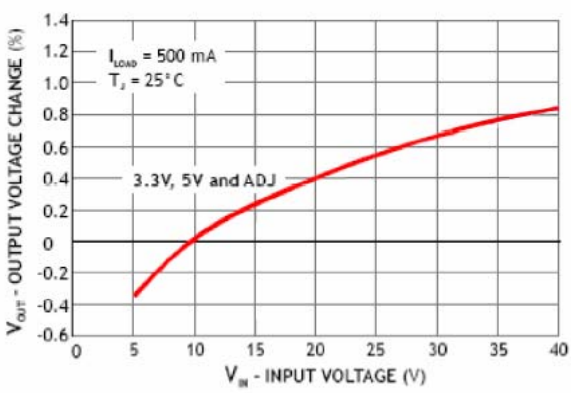
(Note The unit of voltage is V, the unit of current is A)

CHARACTERISTICS CURVE

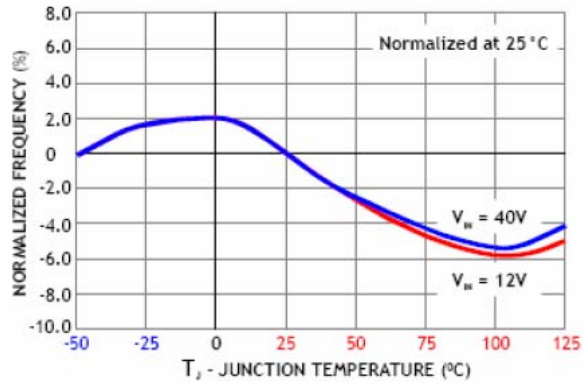
NORMALIZED OUTPUT VOLTAGE



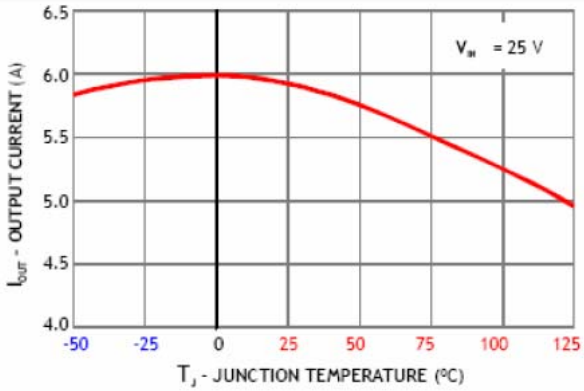
LINE REGULATION



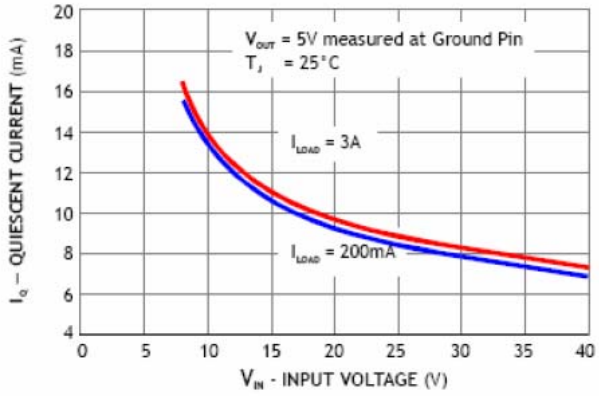
OSCILLATOR FREQUENCY



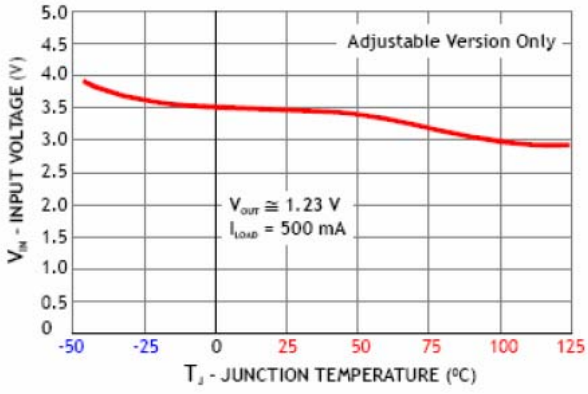
CURRENT LIMIT



QUIESCENT CURRENT



MINIMUM OPERATING VOLTAGE



OUTLINE DRAWING

ESOP-8L Unit:mm

