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.

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
- Guaranteed 3A output current
- Wide input voltage range:
  - 4V to 40V
- Wide output voltage range
  - 1.23V to 37V
- Requires only 4 external components
- 52kHz fixed frequency internal oscillator
- Low power standby mode I_{OQ} typically < 200μA
- 80% efficiency (adjustable version typically > 80%)
- Uses readily available standard inductors
- Thermal shutdown and current limit 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 number of external components
- Negative Boost Converter

Typical Applications

**Fixed Regulator in Typical Application**

```
+V_IN
+ 7V–40V Unregulated DC Input
  1
  LM2575-5.0
  +
  +5V, 1A Regulated Output
  2
  L1 330μH
  3
  C_{IN} 100μF
  4
  Feedback
  5
  On/Off
  6
  Output
  7
  C_{OUT} 330μF

Note: Pin numbers are for TO-220 Package
```

**Adjustable Regulator in Fixed Output Application**

```
+V_IN
+ 7V–40V Unregulated DC Input
  1
  LM2575
  +
  +5V, 1A Regulated Output
  2
  L1 330μH
  3
  C_{IN} 100μF
  4
  Feedback
  5
  On/Off
  6
  Output
  7
  C_{OUT} 330μF

Note: Pin numbers are for TO-220 Package
```

V_{OUT} = 1.23 \left(1 + \frac{R_2}{R_1}\right)
Ordering Information

<table>
<thead>
<tr>
<th>Part Number</th>
<th>RoHS Compliant</th>
<th>Range</th>
<th>Temperature Package</th>
</tr>
</thead>
<tbody>
<tr>
<td>LM2576BT**†</td>
<td>LM2576WT**†</td>
<td>-40°C to +85°C</td>
<td>TO-220-5</td>
</tr>
<tr>
<td>LM2576-3.3BT†</td>
<td>LM2576-3.3WT†</td>
<td>-40°C to +85°C</td>
<td>TO-220-5</td>
</tr>
<tr>
<td>LM2576-5.0BT†</td>
<td>LM2576-5.0WT†</td>
<td>-40°C to +85°C</td>
<td>TO-220-5</td>
</tr>
<tr>
<td>LM2576-12BT†</td>
<td>LM2576-12WT†</td>
<td>-40°C to +85°C</td>
<td>TO-220-5</td>
</tr>
<tr>
<td>LM2576BU*</td>
<td>LM2576WU*</td>
<td>-40°C to +85°C</td>
<td>TO-263-5</td>
</tr>
<tr>
<td>LM2576-3.3BU</td>
<td>LM2576-3.3WU</td>
<td>-40°C to +85°C</td>
<td>TO-263-5</td>
</tr>
<tr>
<td>LM2576-5.0BU</td>
<td>LM2576-5.0WU</td>
<td>-40°C to +85°C</td>
<td>TO-263-5</td>
</tr>
<tr>
<td>LM2576-12BU</td>
<td>LM2576-12WU</td>
<td>-40°C to +85°C</td>
<td>TO-263-5</td>
</tr>
</tbody>
</table>

* Adjustable output regulators.
**RoHS compliant with "hot-melting solder" exemption.
† Contact factory for bent or staggered leads option.

Pin Configurations

5-LEAD TO-220 (T)

```
GND 5- ON/OFF
4- FEEDBACK
3- GROUND
2- OUTPUT
1- VIN
```

5-LEAD TO-263 (U)

```
GND 5- ON/OFF
4- FEEDBACK
3- GROUND
2- OUTPUT
1- VIN
```
### Absolute Maximum Ratings (Note 1)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Conditions</th>
<th>Typ</th>
<th>Limit (Note 2)</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum Supply Voltage</td>
<td>45V</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ON/OFF Pin Input Voltage</td>
<td>$-0.3V \leq V \leq +40V$</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Output Voltage to Ground (Steady State)</td>
<td>$-1V$</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Power Dissipation</td>
<td>Internally Limited</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Storage Temperature Range</td>
<td>$-65^\circ C$ to $+150^\circ C$</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Minimum ESD Rating</td>
<td>$C = 100pF, R = 1.5k\Omega$</td>
<td>2 kV</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>FB Pin</td>
<td>1 kV</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lead Temperature (soldering, 10 sec.)</td>
<td>$260^\circ C$</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maximum Junction Temperature</td>
<td>$150^\circ C$</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Operating Ratings

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Conditions</th>
<th>Typ</th>
<th>Limit (Note 2)</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature Range</td>
<td>$-40^\circ C \leq T_J \leq +125^\circ C$</td>
<td>40V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Supply Voltage</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Electrical Characteristics

Specifications with standard typeface are for $T_J = 25^\circ C$, and those with **boldface type** apply over full Operating Temperature Range. Unless otherwise specified, $V_{IN} = 12V$, and $I_{LOAD} = 500mA$.

#### SYSTEM PARAMETERS, ADJUSTABLE REGULATORS (Note 3) Test Circuit *Figure 1*

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Conditions</th>
<th>Typ</th>
<th>Limit (Note 2)</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>$V_{OUT}$</td>
<td>Feedback Voltage</td>
<td>$V_{IN} = 12V \cdot I_{LOAD} = 0.5A$ $V_{OUT} = 5V$</td>
<td>1.230</td>
<td>1.217/1.243</td>
<td>V(min) / V(max)</td>
</tr>
<tr>
<td>$V_{OUT}$</td>
<td>Feedback Voltage</td>
<td>$LM2576$ $0.5A \leq I_{LOAD} \leq 3A$ $8V \leq V_{IN} \leq 40V$ $V_{OUT} = 5V$</td>
<td>1.230</td>
<td>1.193/1.180/1.267/1.280</td>
<td>V(min) / V(max)</td>
</tr>
<tr>
<td>$\eta$</td>
<td>Efficiency</td>
<td>$V_{IN} = 12V$, $I_{LOAD} = 3A$, $V_{OUT} = 5V$</td>
<td>82%</td>
<td></td>
<td>%</td>
</tr>
</tbody>
</table>

#### SYSTEM PARAMETERS, 3.3V REGULATORS (Note 3) Test Circuit *Figure 1*

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Conditions</th>
<th>Typ</th>
<th>Limit (Note 2)</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>$V_{OUT}$</td>
<td>Output Voltage</td>
<td>$V_{IN} = 12V \cdot I_{LOAD} = 0.5A$ $V_{OUT} = 3.3V$</td>
<td>3.3</td>
<td>3.234/3.366</td>
<td>V(min) / V(max)</td>
</tr>
<tr>
<td>$V_{OUT}$</td>
<td>Output Voltage</td>
<td>$LM2576$ $3.3$ $0.5A \leq I_{LOAD} \leq 3A$ $6V \leq V_{IN} \leq 40V$ $V_{OUT} = 3.3V$</td>
<td>3.3</td>
<td>3.168/3.135/3.432/3.465</td>
<td>V(min) / V(max)</td>
</tr>
<tr>
<td>$\eta$</td>
<td>Efficiency</td>
<td>$V_{IN} = 12V$, $I_{LOAD} = 3A$</td>
<td>75%</td>
<td></td>
<td>%</td>
</tr>
</tbody>
</table>

#### SYSTEM PARAMETERS, 5V REGULATORS (Note 3) Test Circuit *Figure 1*

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Conditions</th>
<th>Typ</th>
<th>Limit (Note 2)</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>$V_{OUT}$</td>
<td>Output Voltage</td>
<td>$V_{IN} = 12V \cdot I_{LOAD} = 0.5A$ $V_{OUT} = 5V$</td>
<td>5.0</td>
<td>4.900/5.100</td>
<td>V(min) / V(max)</td>
</tr>
<tr>
<td>$V_{OUT}$</td>
<td>Output Voltage</td>
<td>$LM2576$ $5.0$ $0.5A \leq I_{LOAD} \leq 3A$ $8V \leq V_{IN} \leq 40V$ $V_{OUT} = 5V$</td>
<td>5.0</td>
<td>4.800/4.750/5.200/5.250</td>
<td>V(min) / V(max)</td>
</tr>
<tr>
<td>$\eta$</td>
<td>Efficiency</td>
<td>$V_{IN} = 12V$, $I_{LOAD} = 3A$</td>
<td>82%</td>
<td></td>
<td>%</td>
</tr>
</tbody>
</table>

#### SYSTEM PARAMETERS, 12V REGULATORS (Note 3) Test Circuit *Figure 1*

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Conditions</th>
<th>Typ</th>
<th>Limit (Note 2)</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>$V_{OUT}$</td>
<td>Output Voltage</td>
<td>$V_{IN} = 25V \cdot I_{LOAD} = 0.5A$ $V_{OUT} = 12V$</td>
<td>12</td>
<td>11.760/12.240</td>
<td>V(min) / V(max)</td>
</tr>
<tr>
<td>$V_{OUT}$</td>
<td>Output Voltage</td>
<td>$LMLM2576$ $12$ $0.5A \leq I_{LOAD} \leq 3A$ $15V \leq V_{IN} \leq 40V$ $V_{OUT} = 12V$</td>
<td>12</td>
<td>11.520/11.400/12.480/12.600</td>
<td>V(min) / V(max)</td>
</tr>
<tr>
<td>$\eta$</td>
<td>Efficiency</td>
<td>$V_{IN} = 25V$, $I_{LOAD} = 3A$</td>
<td>88%</td>
<td></td>
<td>%</td>
</tr>
</tbody>
</table>
## Electrical Characteristics (continued)

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Conditions</th>
<th>Typ</th>
<th>LM2576 Limit (Note 2)</th>
<th>Units (Limits)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>DEVICE PARAMETERS, ADJUSTABLE REGULATOR</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$I_B$</td>
<td>Feedback Bias Current</td>
<td>$V_{OUT} = 5V$</td>
<td>50</td>
<td>100/500</td>
<td>nA</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>DEVICE PARAMETERS, FIXED and ADJUSTABLE REGULATORS</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$f_O$</td>
<td>Oscillator Frequency</td>
<td></td>
<td>52</td>
<td>47/42 58/63</td>
<td>kHz kHz (min) kHz (max)</td>
</tr>
<tr>
<td>$V_{SAT}$</td>
<td>Saturation Voltage</td>
<td>$I_{OUT} = 3A$ (Note 4)</td>
<td>1.4</td>
<td>1.8/2.0</td>
<td>V V(max)</td>
</tr>
<tr>
<td>DC</td>
<td>Max Duty Cycle (ON)</td>
<td>(Note 5)</td>
<td>98</td>
<td>93</td>
<td>% %(%(min))</td>
</tr>
<tr>
<td>$I_{CL}$</td>
<td>Current Limit</td>
<td>Peak Current, $t_{ON} \leq 3\mu s$ (Note 4)</td>
<td>5.8</td>
<td>4.2/3.5 6.9/7.5</td>
<td>A A(min) A(max)</td>
</tr>
<tr>
<td>$I_L$</td>
<td>Output Leakage Current</td>
<td>$V_{IN} = 40V$, (Note 6), Output = 0V (Note 6) Output = −1V Output = −1V</td>
<td>7.5</td>
<td>2 30</td>
<td>mA(max) mA mA(max)</td>
</tr>
<tr>
<td>$I_Q$</td>
<td>Quiescent Current</td>
<td>(Note 6)</td>
<td>5</td>
<td>10</td>
<td>mA mA(max)</td>
</tr>
<tr>
<td>$I_{STBY}$</td>
<td>Standby Quiescent Current</td>
<td>ON/OFF Pin = 5V (OFF)</td>
<td>50</td>
<td>200</td>
<td>μA μA(max)</td>
</tr>
<tr>
<td>$\theta_{JA}$</td>
<td>Thermal Resistance</td>
<td>T,U Package, Junction to Ambient (Note 7) T,U Package, Junction to Ambient (Note 8) T,U Package, Junction to Case</td>
<td>65</td>
<td>45 2</td>
<td>°C/W</td>
</tr>
</tbody>
</table>
Electrical Characteristics (continued)

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Conditions</th>
<th>Typ</th>
<th>Limit (Note 2)</th>
<th>Units (Limits)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>ON/OFF CONTROL, FIXED and ADJUSTABLE REGULATORS Test Circuit Figure 1</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$V_{IH}$</td>
<td>ON/OFF Pin Logic Input Level</td>
<td>$V_{OUT} = 0V$</td>
<td>1.4</td>
<td>2.2/2.4</td>
<td>V(min) V(max)</td>
</tr>
<tr>
<td>$V_{IL}$</td>
<td>ON/OFF Pin Logic Input Level</td>
<td>$V_{OUT} = 5V$</td>
<td>1.2</td>
<td>1.0/0.8</td>
<td></td>
</tr>
<tr>
<td>$I_{IH}$</td>
<td>ON/OFF Pin Logic Input Level</td>
<td>ON/OFF Pin = 5V (OFF)</td>
<td>4</td>
<td>30</td>
<td>µA (max)</td>
</tr>
<tr>
<td>$I_{IL}$</td>
<td>ON/OFF Pin Logic Input Level</td>
<td>ON/OFF Pin = 0V (ON)</td>
<td>0.01</td>
<td>10</td>
<td>µA (max)</td>
</tr>
</tbody>
</table>

Note 1: Absolute Maximum Rating indicate limits beyond which damage to the device may occur. Operating Ratings indicate conditions for which the device is intended to be functional, but do not guarantee specific performance limits. For guaranteed specifications and test conditions, see the Electrical Characteristics.

Note 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 testing.

Note 3: 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 1 test circuit, system performance will be shown in system parameters section of Electrical Characteristics.

Note 4: Output (pin 2) sourcing current. No diode, inductor or capacitor connected to output.

Note 5: Feedback (pin 4) removed from output and connected to 0V.

Note 6: Feedback (pin 4) removed from output and connected to 12V to force the output transistor OFF.

Note 7: 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.

Note 8: 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.

Note 9: Junction to ambient thermal resistance with approximately 1 square inch of pc board copper surrounding the leads. Additional copper will lower thermal resistance further.

Typical Performance Characteristics

![Normalized Feedback Voltage*](image1)

![Feedback Voltage vs Duty Cycle*](image2)

* Adjustable version only
Typical Performance Characteristics (continued) (Circuit of Figure 1)

Supply Current

![Supply Current vs. Duty Cycle](image)

Supply Current vs. Duty Cycle

![Standby Quiescent Current](image)

Standby Quiescent Current

Current Limit

Switch Saturation Voltage

Efficiency

Minimum Operating Voltage

Line Regulation

Feedback Pin Current

Normalized Output Voltage

Oscillator Frequency

Dropout Voltage
Typical Performance Characteristics (Circuit of Figure 1)

Load Transient Response

Output Voltage Change

Output Current

100 µS/div.

Switching Waveforms

\[ V_{OUT} = 5V \quad V_{IN} = 45V \]

A: Output pin voltage 50V/div
B: Output pin current 2A/div
C: Inductor current 2A/div
D: Output ripple voltage 50 mV/div., AC coupled

Horizontal Time Base: 5µS/div
Test Circuits and Layout Guidelines

Figure 1.

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 ground plane construction should be used for best results.

Block Diagrams

Fixed Regulator

Adjustable Regulator
Package Information

5-Lead TO-220 (T)

5-Lead TO-263 (U)

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