

## 5V Step-Down Switching Regulator

### FEATURES

- Fixed 5V Output
- 2A On-Board Switch
- 100kHz Switching Frequency
- 2% Output Voltage Tolerance Over Temperature
- Greatly Improved Dynamic Behavior
- Available in Low Cost 5-Lead Package
- Only 9.5mA Quiescent Current
- Operates Up to 60V Input

### APPLICATIONS

- 5V Output Buck Converter
- Tapped Inductor Buck Converter with 4A Output at 5V
- Positive-to-Negative Converter

### DESCRIPTION

The LT1076-5 is a 2A fixed 5V output monolithic bipolar switching regulator which requires only a few external parts for normal operation. The power switch, all oscillator and control circuitry, all current limit components, and an output monitor are included on the chip. The topology is a classic positive “buck” configuration but several design innovations allow this device to be used as a positive-to-negative converter, a negative boost converter, and as a flyback converter. The switch output is specified to swing 40V below ground, allowing the LT1076-5 to drive a tapped inductor in the buck mode with output currents up to 4A.

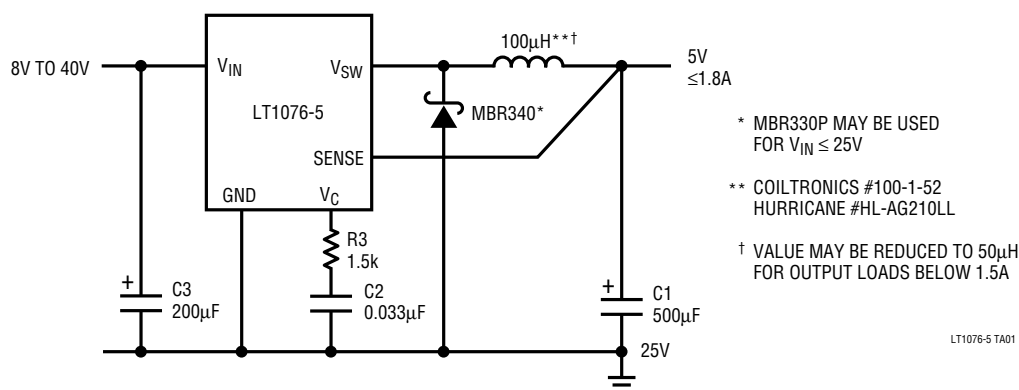
The LT1076-5 uses a true analog multiplier in the feedback loop. This makes the device respond nearly instantaneously to input voltage fluctuations and makes loop gain independent of input voltage. As a result, dynamic behavior of the regulator is significantly improved over previous designs.

On-chip pulse by pulse current limiting makes the LT1076-5 nearly bust-proof for output overloads or shorts. The input voltage range as a buck converter is 8V to 60V, but a self-boot feature allows input voltages as low as 5V in the inverting and boost configurations.

The LT1076-5 is available in a low cost 5-lead TO-220 package with frequency pre-set at 100kHz and current limit at 2.6A. See Application Note 44 for design details.

### TYPICAL APPLICATION

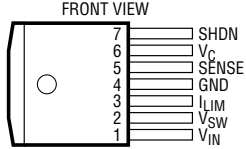
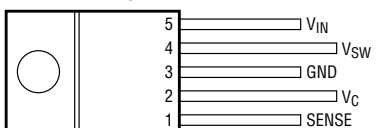
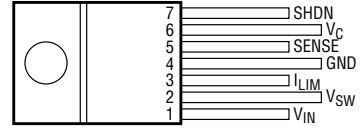
Basic Positive Buck Converter



## ABSOLUTE MAXIMUM RATINGS

|                                              |                |
|----------------------------------------------|----------------|
| Input Voltage                                |                |
| LT1076-5 .....                               | 45V            |
| LT1076HV-5 .....                             | 64V            |
| Switch Voltage with Respect to Input Voltage |                |
| LT1076-5 .....                               | 64V            |
| LT1076HV-5 .....                             | 75V            |
| Switch Voltage with Respect to Ground Pin    |                |
| ( $V_{SW}$ <b>Negative</b> )                 |                |
| LT1076-5 (Note 5) .....                      | 35V            |
| LT1076HV-5 (Note 5) .....                    | 45V            |
| Sense Pin Voltage .....                      | -2V, 10V       |
| Maximum Operating Ambient Temperature Range  |                |
| LT1076C-5, LT1076HVC-5 .....                 | 0°C to 70°C    |
| LT1076I-5, LT1076HVI-5 .....                 | -40°C to 85°C  |
| Maximum Operating Junction Temperature Range |                |
| LT1076C-5, LT1076HVC-5 .....                 | 0°C to 125°C   |
| LT1076I-5, LT1076HVI-5 .....                 | -40°C to 125°C |
| Maximum Storage Temperature .....            | -65°C to 150°C |
| Lead Temperature (Soldering, 10 sec) .....   | 300°C          |

## PACKAGE/ORDER INFORMATION

|                                                                                                                                                                                                                                                                                                                               |                                                         |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------|
|  <p>R PACKAGE<br/>7-LEAD PLASTIC DD<br/><math>T_{JMAX} = 110^{\circ}\text{C}</math><br/><math>\theta</math> WILL VARY FROM APPROXIMATELY 30°C/W WITH 2.8IN<sup>2</sup> OF 1 OZ COPPER TO 70°C/W WITH 0.20IN<sup>2</sup> OF 1 OZ COPPER.</p> | ORDER PART NUMBER                                       |
|                                                                                                                                                                                                                                                                                                                               | LT1076CR-5                                              |
|  <p>T PACKAGE<br/>5-LEAD TO-220<br/>FOR STRAIGHT LEADS, ORDER FLOW 06<br/><math>T_{JMAX} = 110^{\circ}\text{C}</math>, <math>\theta_{JA} = 130^{\circ}\text{C/W}</math></p>                                                                 | LT1076CT-5<br>LT1076HVCT-5<br>LT1076IT-5<br>LT1076HVI-5 |
|  <p>Y PACKAGE<br/>7-LEAD TO-220<br/><math>T_{JMAX} = 110^{\circ}\text{C}</math>, <math>\theta_{JA} = 130^{\circ}\text{C/W}</math></p>                                                                                                      | LT1076CY-5                                              |

Consult factory for Military grade parts.

## ELECTRICAL CHARACTERISTICS $T_J = 25^{\circ}\text{C}$ , $V_{IN} = 25\text{V}$ , unless otherwise noted.

| PARAMETER                     | CONDITIONS                                                                                                                                      | MIN    | TYP                    | MAX             | UNITS                                       |
|-------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------|--------|------------------------|-----------------|---------------------------------------------|
| Switch "On" Voltage (Note 1)  | $I_{SW} = 0.5\text{A}$<br>$I_{SW} = 2\text{A}$                                                                                                  | ●      |                        | 1.2<br>1.7      | V<br>V                                      |
| Switch "Off" Leakage          | $V_{IN} = 25\text{V}$ , $V_{SW} = 0$<br>$V_{IN} = V_{MAX}$ , $V_{SW} = 0$ (Note 6)                                                              |        |                        | 150<br>250      | $\mu\text{A}$<br>$\mu\text{A}$              |
| Supply Current (Note 2)       | $V_{OUT} = 5.5\text{V}$ , $V_{IN} \leq 40\text{V}$<br>$40\text{V} < V_{IN} < 60\text{V}$<br>$V_{SHDN} = 0.1\text{V}$ (Device Shutdown) (Note 8) | ●<br>● | 8.5<br>9.0<br>140      | 11<br>12<br>300 | $\text{mA}$<br>$\text{mA}$<br>$\mu\text{A}$ |
| Minimum Supply Voltage        | Normal Mode<br>Start-Up Mode (Note 3)                                                                                                           | ●<br>● | 7.3<br>3.5             | 8.0<br>4.8      | V<br>V                                      |
| Switch Current Limit (Note 4) | $I_{LIM} = \text{Open}$<br>$R_{LIM} = 10\text{k}$ (Note 9)<br>$R_{LIM} = 7\text{k}$ (Note 9)                                                    | ●      | 2<br>2.6<br>1.8<br>1.2 | 3.2             | A<br>A<br>A<br>A                            |
| Maximum Duty Cycle            |                                                                                                                                                 | ●      | 85                     | 90              | %                                           |

## ELECTRICAL CHARACTERISTICS $T_J = 25^\circ\text{C}$ , $V_{IN} = 25\text{V}$ , unless otherwise noted.

| PARAMETER                                 | CONDITIONS                                                                                                   |   | MIN  | TYP       | MAX     | UNITS                     |
|-------------------------------------------|--------------------------------------------------------------------------------------------------------------|---|------|-----------|---------|---------------------------|
| Switching Frequency                       | $T_J \leq 125^\circ\text{C}$<br>$V_{OUT} = V_{SENSE} = 0\text{V}$ (Note 4)                                   | ● | 90   | 100       | 110     | kHz                       |
|                                           |                                                                                                              |   | 85   |           | 120     | kHz                       |
|                                           |                                                                                                              |   |      | 20        |         | kHz                       |
| Switching Frequency Line Regulation       | $8\text{V} \leq V_{IN} \leq V_{MAX}$ (Note 7)                                                                | ● |      | 0.03      | 0.1     | %/V                       |
| Error Amplifier Voltage Gain (Note 7)     | $1\text{V} \leq V_C \leq 4\text{V}$                                                                          |   |      | 2000      |         | V/V                       |
| Error Amplifier Transconductance (Note 7) |                                                                                                              |   | 3700 | 5000      | 8000    | $\mu\text{mho}$           |
| Error Amplifier Source and Sink Current   | Source ( $V_{SENSE} = 4.5\text{V}$ )<br>Sink ( $V_{SENSE} = 5.5\text{V}$ )                                   |   | 100  | 140       | 225     | $\mu\text{A}$             |
|                                           |                                                                                                              |   | 0.7  | 1.0       | 1.6     | mA                        |
| Sense Pin Divider Resistance              |                                                                                                              |   | 3    | 5         | 8       | k $\Omega$                |
| Sense Voltage                             | $V_C = 2\text{V}$                                                                                            | ● | 4.85 | 5         | 5.15    | V                         |
| Output Voltage Tolerance                  | $V_{OUT}$ (Nominal) = 5V<br>All Conditions of Input Voltage, Output Voltage,<br>Temperature and Load Current | ● |      | $\pm 0.5$ | $\pm 2$ | %                         |
|                                           |                                                                                                              |   |      | $\pm 1.0$ | $\pm 3$ | %                         |
| Output Voltage Line Regulation            | $8\text{V} \leq V_{IN} \leq V_{MAX}$ (Note 6)                                                                | ● |      | 0.005     | 0.02    | %/V                       |
| $V_C$ Voltage at 0% Duty Cycle            | Over Temperature                                                                                             | ● |      | 1.5       |         | V                         |
|                                           |                                                                                                              |   |      | -4.0      |         | mV/ $^\circ\text{C}$      |
| Multiplier Reference Voltage              |                                                                                                              |   |      | 24        |         | V                         |
| Shutdown Pin Current                      | $V_{SHDN} = 5\text{V}$<br>$V_{SHDN} \leq V_{THRESHOLD} (\cong 2.5\text{V})$                                  |   | 5    | 10        | 20      | $\mu\text{A}$             |
|                                           |                                                                                                              |   |      |           | 50      | $\mu\text{A}$             |
| Shutdown Thresholds                       | Switch Duty Cycle = 0<br>Fully Shut Down                                                                     |   | 2.2  | 2.45      | 2.7     | V                         |
|                                           |                                                                                                              |   | 0.1  | 0.30      | 0.5     | V                         |
| Thermal Resistance Junction to Case       |                                                                                                              |   |      |           | 4       | $^\circ\text{C}/\text{W}$ |

The ● denotes specifications which apply over the full operating temperature range.

**Note 1:** To calculate maximum switch “on” voltage at currents between low and high conditions, a linear interpolation may be used.

**Note 2:** A sense pin voltage ( $V_{SENSE}$ ) of 5.5V forces the  $V_C$  pin to its low clamp level and the switch duty cycle to zero. This approximates the zero load condition where duty cycle approaches zero.

**Note 3:** Total voltage from  $V_{IN}$  pin to ground pin must be  $\geq 8\text{V}$  after start-up for proper regulation. For  $T_A < 25^\circ\text{C}$ , limit = 5V.

**Note 4:** Switch frequency is internally scaled down when the sense pin voltage is less than 2.6V to avoid extremely short switch on times. During current limit testing,  $V_{SENSE}$  is adjusted to give a minimum switch on time of 1 $\mu\text{s}$ .

**Note 5:** Switch to input voltage limitation must also be observed.

**Note 6:**  $V_{MAX} = 40\text{V}$  for the LT1076-5 and 60V for the LT1076HV-5.

**Note 7:** Error amplifier voltage gain and transconductance are specified relative to the internal feedback node. To calculate gain and transconductance from the Sense pin (Output) to the  $V_C$  pin, multiply by 0.44.

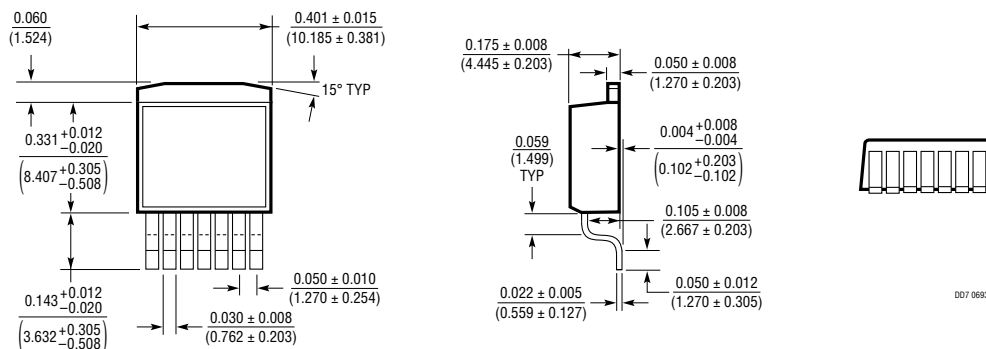
**Note 8:** Does not include switch leakage.

**Note 9:**  $I_{LIM} \approx \frac{R_{LIM} - 1\text{k}}{5\text{k}}$

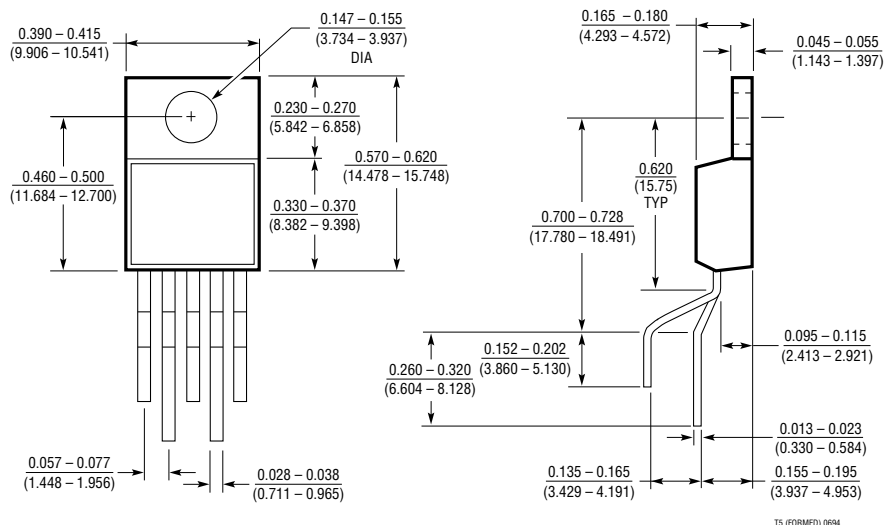
# PACKAGE DESCRIPTION

Dimensions in inches (millimeters) unless otherwise noted.

## R Package, 7-Lead Plastic DD



## T Package, 5-Lead TO-220



## Y Package, 7-Lead TO-220

