

# 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- and 7-Lead Packages
- 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 LT<sup>®</sup>1076-5 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.

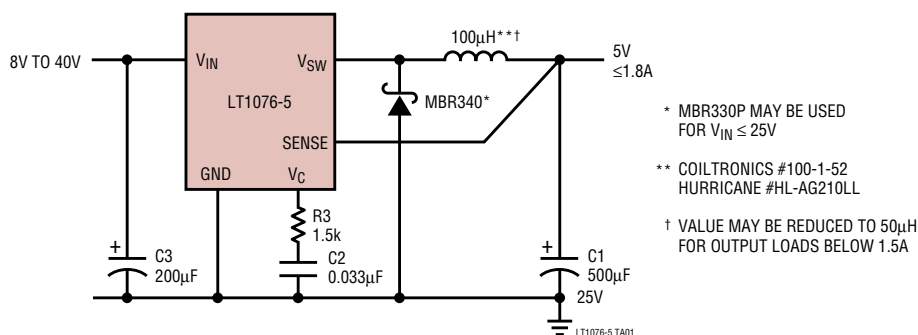
On-chip pulse by pulse current limiting makes the LT1076-5 nearly bust-proof for output overloads or shorts. The input voltage range as a buck converter is 8V to 60V, but a self-boot feature allows input voltages as low as 5V in the inverting and boost configurations.

The LT1076-5 is available in a low cost 5- and 7-lead TO-220 packages with frequency pre-set at 100kHz and current limit at 2.6A. See Application Note 44 for design details.

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## TYPICAL APPLICATION

**Basic Positive Buck Converter**



10765fc

# LT1076-5

## ABSOLUTE MAXIMUM RATINGS (Note 1)

|                                              |          |                                              |                      |
|----------------------------------------------|----------|----------------------------------------------|----------------------|
| Input Voltage                                |          | Sense Pin Voltage                            | ..... -2V, 10V       |
| LT1076-5                                     | .....45V | Maximum Operating Ambient Temperature Range  |                      |
| LT1076HV-5                                   | .....64V | LT1076C-5, LT1076HVC-5                       | ..... 0°C to 70°C    |
| Switch Voltage with Respect to Input Voltage |          | LT1076I-5, LT1076HVI-5                       | ..... -40°C to 85°C  |
| LT1076-5                                     | .....64V | Maximum Operating Junction Temperature Range |                      |
| LT1076HV-5                                   | .....75V | LT1076C-5, LT1076HVC-5                       | ..... 0°C to 125°C   |
| Switch Voltage with Respect to Ground Pin    |          | LT1076I-5, LT1076HVI-5                       | ..... -40°C to 125°C |
| (V <sub>SW</sub> Negative)                   |          | Maximum Storage Temperature                  | ..... -65°C to 150°C |
| LT1076-5 (Note 6)                            | .....35V | Lead Temperature (Soldering, 10 sec)         | ..... 300°C          |
| LT1076HV-5 (Note 6)                          | .....45V |                                              |                      |

## PACKAGE/ORDER INFORMATION

|                                                                                                                                                                                                                |                                                                                                                                                 |                                                          |                   |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------|-------------------|
| <p>Q PACKAGE<br/>5-LEAD PLASTIC DD<br/><math>\theta_{JC} = 4^{\circ}\text{C/W}</math>, <math>\theta_{JA} = 30^{\circ}\text{C/W}</math></p>                                                                     | <p>R PACKAGE<br/>7-LEAD PLASTIC DD<br/><math>\theta_{JC} = 4^{\circ}\text{C/W}</math>, <math>\theta_{JA} = 30^{\circ}\text{C/W}</math></p>      | ORDER PART NUMBER                                        | ORDER PART NUMBER |
|                                                                                                                                                                                                                |                                                                                                                                                 | LT1076CQ-5                                               | LT1076CR-5        |
| <p>T PACKAGE<br/>5-LEAD PLASTIC TO-220<br/>LEADS ARE FORMED STANDARD FOR STRAIGHT LEADS, ORDER FLOW 06<br/><math>\theta_{JC} = 4^{\circ}\text{C/W}</math>, <math>\theta_{JA} = 50^{\circ}\text{C/W}</math></p> | <p>T7 PACKAGE<br/>7-LEAD PLASTIC TO-220<br/><math>\theta_{JC} = 4^{\circ}\text{C/W}</math>, <math>\theta_{JA} = 50^{\circ}\text{C/W}</math></p> | ORDER PART NUMBER                                        | ORDER PART NUMBER |
|                                                                                                                                                                                                                |                                                                                                                                                 | LT1076CT-5<br>LT1076HVCT-5<br>LT1076IT-5<br>LT1076HVIT-5 | LT1076CT7-5       |
| Order Options Tape and Reel: Add #TR<br>Lead Free: Add #PBF Lead Free Tape and Reel: Add #TRPBF<br>Lead Free Part Marking: <a href="http://www.linear.com/leadfree/">http://www.linear.com/leadfree/</a>       |                                                                                                                                                 |                                                          |                   |

Consult LTC Marketing for parts specified with wider operating temperature ranges. \*The temperature grade is identified by a label on the shipping container.

## ELECTRICAL CHARACTERISTICS The ● denotes the specifications which apply over the full operating temperature range, otherwise specifications are at T<sub>J</sub> = 25°C. V<sub>IN</sub> = 25V, unless otherwise noted.

| SYMBOL                       | CONDITIONS                                                                               | MIN | TYP | MAX        | UNITS    |
|------------------------------|------------------------------------------------------------------------------------------|-----|-----|------------|----------|
| Switch "On" Voltage (Note 2) | I <sub>SW</sub> = 0.5A<br>I <sub>SW</sub> = 2A                                           | ●   |     | 1.2<br>1.7 | V<br>V   |
| Switch "Off" Leakage         | V <sub>IN</sub> = 25V, V <sub>SW</sub> = 0<br>V <sub>IN</sub> = 25V, V <sub>SW</sub> = 0 |     |     | 150<br>250 | μA<br>μA |

# ELECTRICAL CHARACTERISTICS

The ● denotes the specifications which apply over the full operating temperature range, otherwise specifications are at  $T_J = 25^\circ\text{C}$ .  $V_{IN} = 25\text{V}$ , unless otherwise noted.

| SYMBOL                                    | CONDITIONS                                                                                                   |   | MIN  | TYP       | MAX     | UNITS                |
|-------------------------------------------|--------------------------------------------------------------------------------------------------------------|---|------|-----------|---------|----------------------|
| Supply Current (Note 3)                   | $V_{OUT} = 5.5\text{V}$ , $V_{IN} \leq 40\text{V}$                                                           | ● |      | 8.5       | 11      | mA                   |
|                                           | $40\text{V} < V_{IN} < 60\text{V}$                                                                           | ● |      | 9.0       | 12      | mA                   |
|                                           | $V_{SHDN} = 0.1\text{V}$ (Device Shutdown) (Note 9)                                                          |   |      | 140       | 300     | $\mu\text{A}$        |
| Minimum Supply Voltage                    | Normal Mode                                                                                                  | ● |      | 7.3       | 8.0     | V                    |
|                                           | Start-Up Mode (Note 4)                                                                                       | ● |      | 3.5       | 4.8     | V                    |
| Switch Current Limit (Note 5)             | $I_{LIM} = \text{Open}$                                                                                      | ● | 2    | 2.6       | 3.2     | A                    |
|                                           | $R_{LIM} = 10\text{k}$ (Note 10)                                                                             |   |      | 1.8       |         | A                    |
|                                           | $R_{LIM} = 7\text{k}$ (Note 10)                                                                              |   |      | 1.2       |         | A                    |
| Maximum Duty Cycle                        |                                                                                                              | ● | 85   | 90        |         | %                    |
| Switching Frequency                       | $T_J \leq 125^\circ\text{C}$<br>$V_{OUT} = V_{SENSE} = 0\text{V}$ (Note 5)                                   | ● | 90   | 100       | 110     | kHz                  |
|                                           |                                                                                                              | ● | 85   |           | 120     | kHz                  |
|                                           |                                                                                                              |   |      | 20        |         | kHz                  |
| Switching Frequency Line Regulation       | $8\text{V} \leq V_{IN} \leq V_{MAX}$ (Note 8)                                                                | ● |      | 0.03      | 0.1     | %/V                  |
| Error Amplifier Voltage Gain (Note 8)     | $1\text{V} \leq V_C \leq 4\text{V}$                                                                          |   |      | 2000      |         | V/V                  |
| Error Amplifier Transconductance (Note 8) |                                                                                                              |   | 3700 | 5000      | 8000    | $\mu\text{mho}$      |
| Error Amplifier Source and Sink Current   | Source ( $V_{SENSE} = 4.5\text{V}$ )                                                                         |   | 100  | 140       | 225     | $\mu\text{A}$        |
|                                           | Sink ( $V_{SENSE} = 5.5\text{V}$ )                                                                           |   | 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 7)                                                                | ● |      | 0.005     | 0.02    | %/V                  |
| VC Voltage at 0% Duty Cycle               | Over Temperature                                                                                             | ● |      | 1.5       |         | V                    |
|                                           |                                                                                                              | ● |      | -4.0      |         | mV/ $^\circ\text{C}$ |
| Multiplier Reference Voltage              |                                                                                                              |   |      | 24        |         | V                    |
| Shutdown Pin Current                      | $V_{SHDN} = 5\text{V}$                                                                                       |   | 5    | 10        | 20      | $\mu\text{A}$        |
|                                           | $V_{SHDN} \leq V_{THRESHOLD} (\approx 2.5\text{V})$                                                          |   |      |           | 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       | $^\circ\text{C/W}$   |

**Note 1:** Stresses beyond those listed under Absolute Maximum Ratings may cause permanent damage to the device. Exposure to any Absolute Maximum Rating condition for extended periods may affect device reliability and lifetime.

**Note 2:** To calculate maximum switch "on" voltage at currents between low and high conditions, a linear interpolation may be used.

**Note 3:** A sense pin voltage ( $V_{SENSE}$ ) of 5.5V forces the VC 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 4:** 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 5:** 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 1ms.

**Note 6:** Switch to input voltage limitation must also be observed.

**Note 7:**  $V_{MAX} = 40\text{V}$  for the LT1076-5 and 60V for the LT1076HV-5.

**Note 8:** 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.

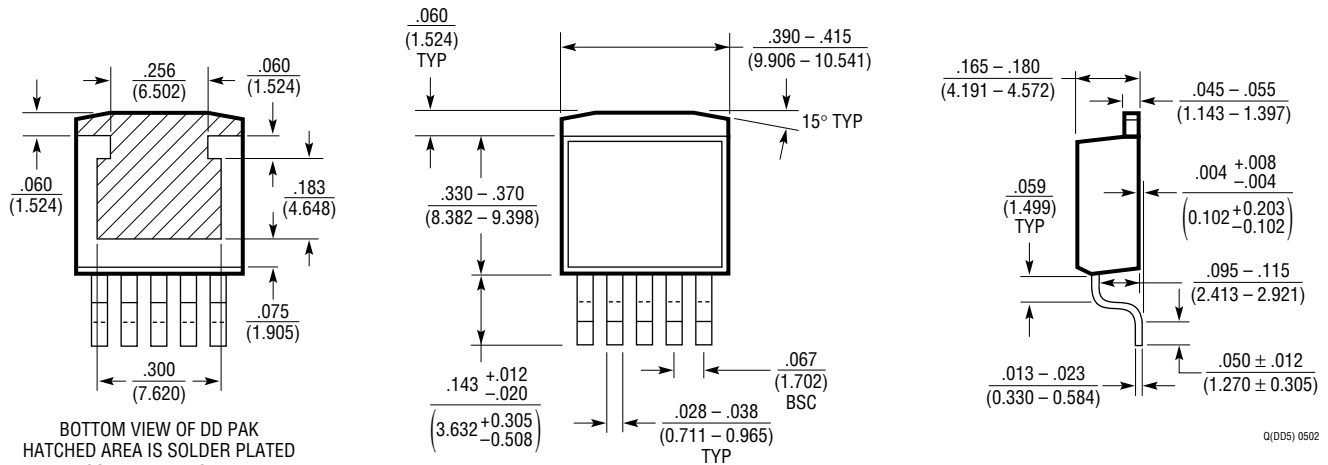
**Note 9:** Does not include switch leakage.

$$I_{LIM} \approx \frac{R_{LIM} - 1\text{k}}{5\text{k}}$$

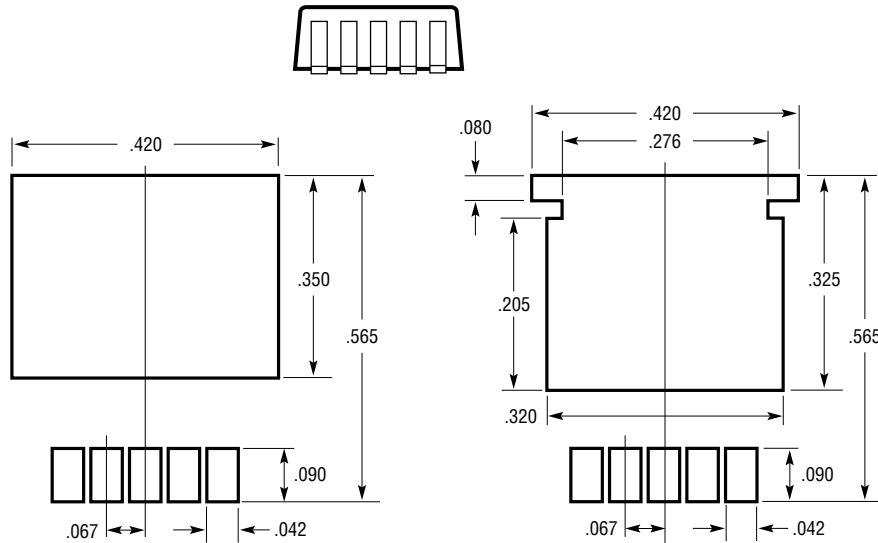
**Note 10:**

# PACKAGE DESCRIPTION

**Q Package**  
**5-Lead Plastic DD Pak**  
 (Reference LTC DWG # 05-08-1461)



Q(DD5) 0502

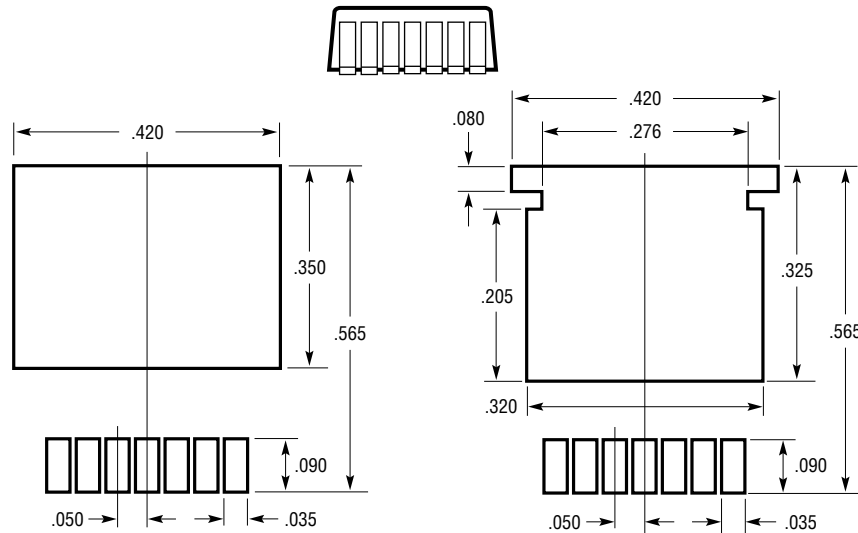
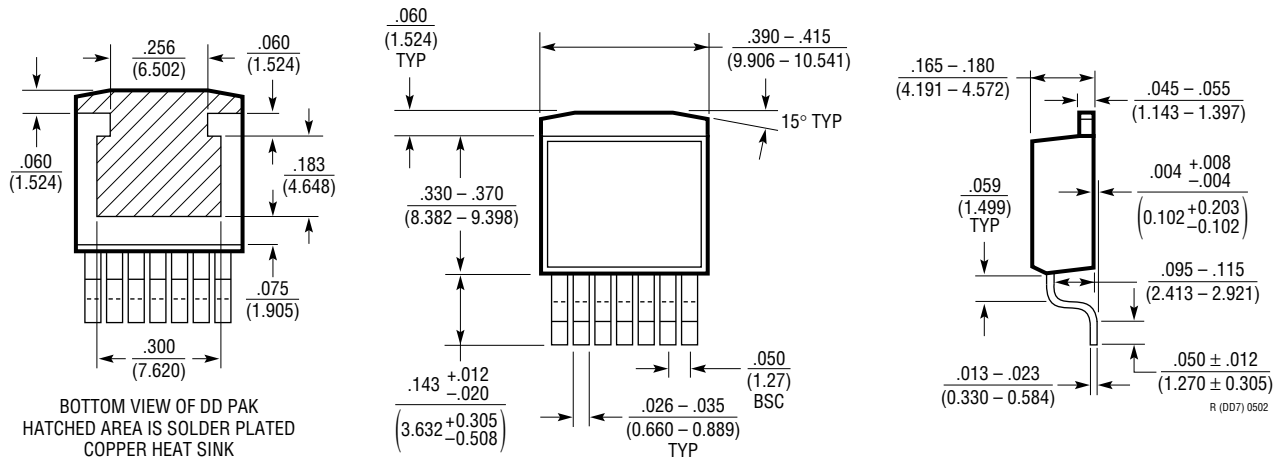


RECOMMENDED SOLDER PAD LAYOUT

NOTE:  
 1. DIMENSIONS IN INCH/(MILLIMETER)  
 2. DRAWING NOT TO SCALE

RECOMMENDED SOLDER PAD LAYOUT  
 FOR THICKER SOLDER PASTE APPLICATIONS

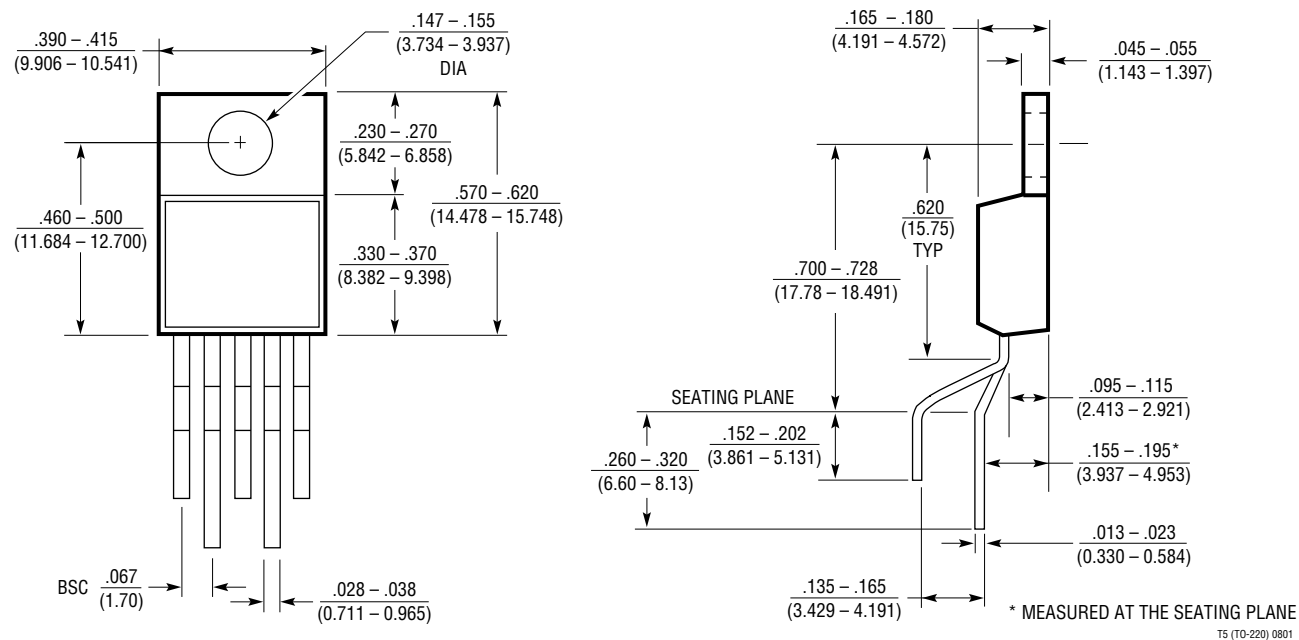
**R Package**  
**7-Lead Plastic DD Pak**  
 (Reference LTC DWG # 05-08-1462)



NOTE:  
 1. DIMENSIONS IN INCH/(MILLIMETER)  
 2. DRAWING NOT TO SCALE

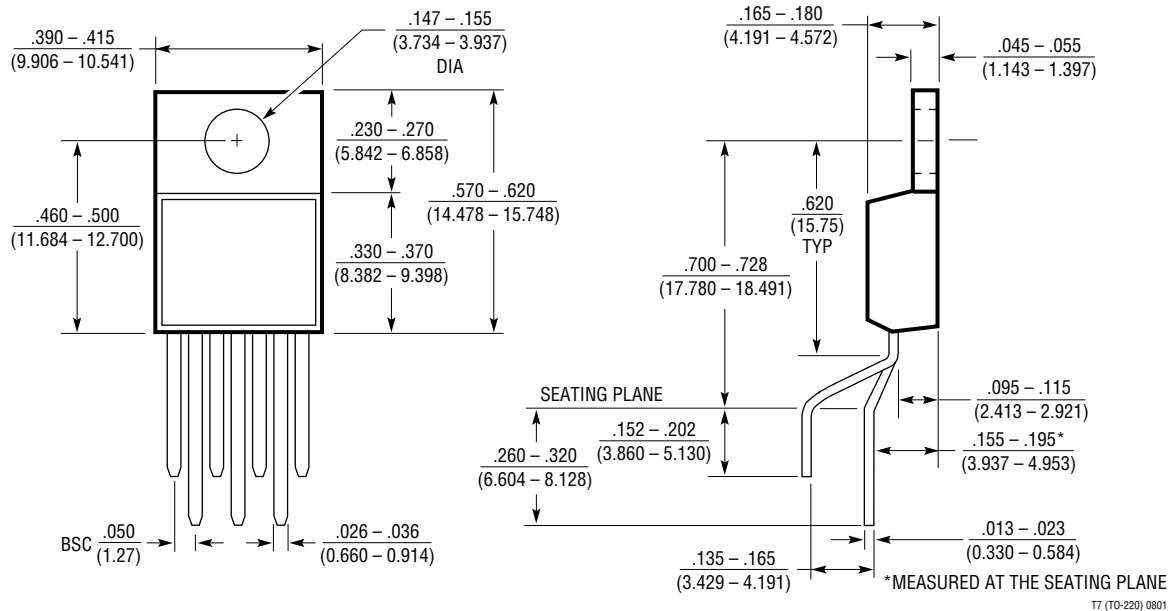
PACKAGE DESCRIPTION

T Package  
5-Lead Plastic TO-220 (Standard)  
(Reference LTC DWG # 05-08-1421)



## PACKAGE DESCRIPTION

**T7 Package**  
**7-Lead Plastic TO-220 (Standard)**  
 (Reference LTC DWG # 05-08-1422)



## RELATED PARTS

| PART NUMBER | DESCRIPTION                                                                | COMMENTS                                                                                                     |
|-------------|----------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------|
| LT1074/HV   | 4.4A ( $I_{OUT}$ ), 100kHz High Efficiency Step-Down DC/DC Converter       | $V_{IN}$ : 7.3V to 45V/64V, $V_{OUT(MIN)}$ : 2.21V, $I_Q$ : 8.5mA, $I_{SHDN}$ : 10 $\mu$ A, DD5/7, T0-2205/7 |
| LT3430      | 60V, 2.75A ( $I_{OUT}$ ), 200kHz High Efficiency Step-Down DC/DC Converter | $V_{IN}$ : 5.5V to 60V, $V_{OUT(MIN)}$ : 1.20V, $I_Q$ : 2.5mA, $I_{SHDN}$ : 25 $\mu$ A, TSSOP16E             |
| LT1956      | 60V, 1.2A ( $I_{OUT}$ ), 500kHz High Efficiency Step-Down DC/DC Converter  | $V_{IN}$ : 5.5V to 60V, $V_{OUT(MIN)}$ : 1.20V, $I_Q$ : 2.5mA, $I_{SHDN}$ : 25 $\mu$ A, TSSOP16E             |





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- Техническая поддержка проекта;
- Защита от снятия компонента с производства.



#### Как с нами связаться

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