

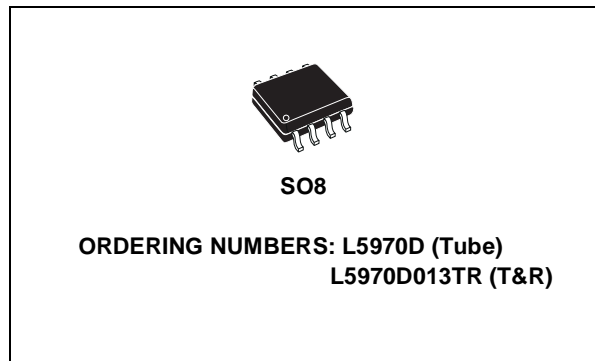


## UP TO 1A STEP DOWN SWITCHING REGULATOR

- UP TO 1A OUTPUT CURRENT
- OPERATING INPUT VOLTAGE FROM 4.4V TO 36V
- 3.3V / ( $\pm 2\%$ ) / REFERENCE VOLTAGE
- OUTPUT VOLTAGE ADJUSTABLE FROM 1.2V TO 35V
- LOW DROPOUT OPERATION: 100% DUTY CYCLE
- 250KHz INTERNALLY FIXED FREQUENCY
- VOLTAGE FEEDFORWARD
- ZERO LOAD CURRENT OPERATION
- INTERNAL CURRENT LIMITING
- INHIBIT FOR ZERO CURRENT CONSUMPTION
- SINCHRONIZATION
- PROTECTION AGAINST FEEDBACK DISCONNECTION
- THERMAL SHUTDOWN

### APPLICATIONS:

- CONSUMER: STB, DVD, TV, VCR, CAR RADIO, LCD MONITORS
- NETWORKING: XDSL, MODEMS, DC-DC MODULES
- COMPUTER: PRINTERS, AUDIO/GRAPHIC CARDS, OPTICAL STORAGE, HARD DISK DRIVE
- INDUSTRIAL: CHARGERS, CAR BATTERY DC-DC CONVERTERS



### DESCRIPTION

The L5970D is a step down monolithic power switching regulator capable to deliver up to 1A at output voltages from 1.2V to 35V.

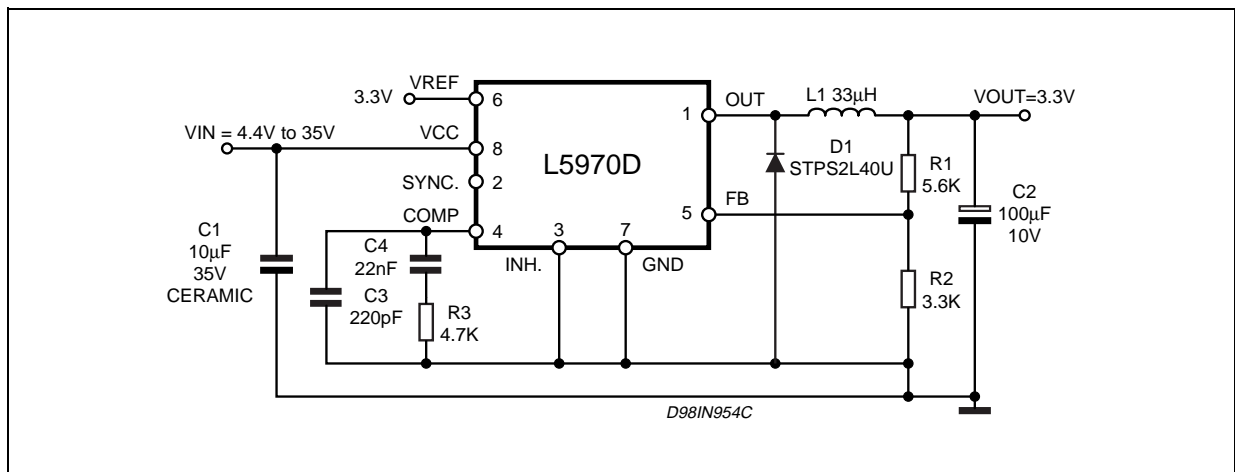
The device uses an internal P-Channel D-MOS transistor (with a typical  $R_{ds(on)}$  of 250m $\Omega$ ) as switching element to minimize the size of the external components.

An internal oscillator fixes the switching frequency at 250KHz.

Having a minimum input voltage of 4.4V only, it is particularly suitable for 5V bus, available in all computer related applications.

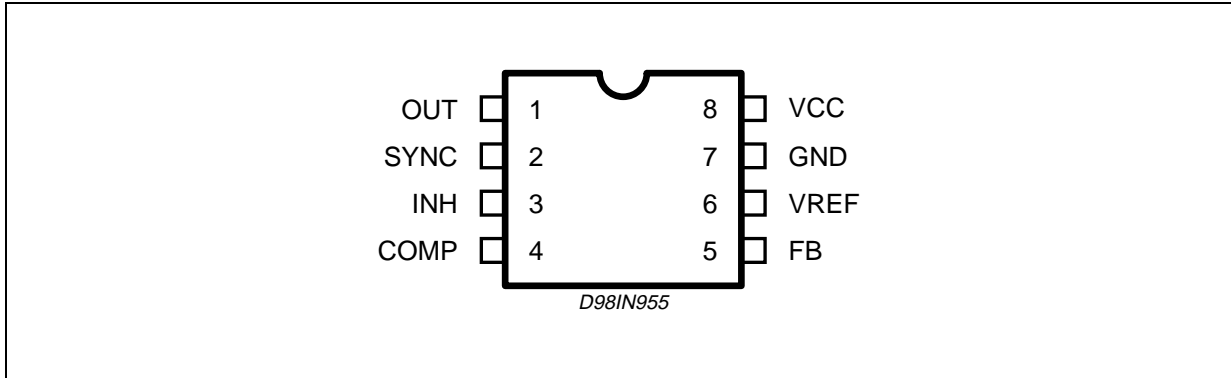
Pulse by pulse current limit with the internal frequency modulation offers an effective constant current short circuit protection.

### TEST APPLICATION CIRCUIT



## L5970D

### PINS CONNECTION (Top View)



### PINS FUNCTION

| N. | Name             | Description  |
|----|------------------|--|
| 1  | OUT              | Regulator Output.  |
| 2  | SYNC             | Master/slave synchronization.  |
| 3  | INH              | A logical signal (active high) disables the device. If INH not used the pin must be grounded. When it is open an internal pull-up disable the device.        |
| 4  | COMP             | E/A output for frequency compensation.   |
| 5  | FB               | Feedback input. Connecting directly to this pin results in an output voltage of 1.23V. An external resistive divider is required for higher output voltages. |
| 6  | V <sub>REF</sub> | 3.3V V <sub>REF</sub> . No cap is requested for stability.   |
| 7  | GND              | Ground.  |
| 8  | V <sub>CC</sub>  | Unregulated DC input voltage.  |

### THERMAL DATA

| Symbol                 | Parameter                                   | Value   | Unit |
|------------------------|---|---------|------|
| R <sub>th(j-amb)</sub> | Thermal Resistance Junction to ambient Max. | 120 (*) | °C/W |

(\*) Package mounted on board

### ABSOLUTE MAXIMUM RATINGS

| Symbol             | Parameter                                    | Value                    | Unit |
|--------------------|--|--------------------------|------|
| V <sub>8</sub>     | Input Voltage                                | 40                       | V    |
| V <sub>1</sub>     | Output DC voltage                            | -1 to 40                 | V    |
|                    | Output peak voltage at t = 0.1μs             | -5 to 40                 | V    |
| I <sub>1</sub>     | Maximum output current                       | int. limit.              |      |
| V <sub>4, V5</sub> | Analog pins                                  | 4                        | V    |
| V <sub>3</sub>     | INH  | -0.3V to V <sub>CC</sub> |      |
| V <sub>2</sub>     | SYNC   | -0.3 to 4                | V    |
| P <sub>tot</sub>   | Power dissipation at T <sub>amb</sub> ≤ 60°C | 0.75                     | W    |
| T <sub>j</sub>     | Operating junction temperature range         | -40 to 150               | °C   |
| T <sub>stg</sub>   | Storage temperature range                    | -55 to 150               | °C   |

**ELECTRICAL CHARACTERISTICS** ( $T_j = 25^\circ\text{C}$ ,  $V_{CC} = 12\text{V}$ , unless otherwise specified.)(\*) Specification Referred to  $T_j$  from  $-40$  to  $+125^\circ\text{C}$  (1).

| Symbol   | Parameter                         | Test Condition   |   | Min.  | Typ.  | Max.      | Unit          |
|--|-----------------------------------|--|---|-------|-------|-----------|---------------|
| $V_{CC}$   | Operating input voltage range     | $V_o = 1.235\text{V}; I_o = 1\text{A}$                                   | * | 4.4   |       | 36        | V             |
| $R_{DSON}$   | Mosfet on Resistance              |  | * |       | 0.250 | 0.5       | $\Omega$      |
| $I_l$  | Maximum limiting current          | $V_{CC} = 4.4\text{V}$ to $36\text{V}$                                   | * | 1.5   | 1.87  | 2.25      | A             |
| fs   | Switching frequency               |  | * | 212   | 250   | 280       | KHz           |
|  |                                   |  |   | 225   | 250   | 275       | KHz           |
|  | Duty cycle                        |  |   | 0     |       | 100       | %             |
| <b>DYNAMIC CHARACTERISTICS</b> (see test circuit). |                                   |  |   |       |       |           |               |
| $V_5$  | Voltage feedback                  | $4.4\text{V} < V_{CC} < 36\text{V}$ ,<br>$20\text{mA} < I_o < 1\text{A}$ |   | 1.220 | 1.235 | 1.25      | V             |
|  |                                   |  | * | 1.198 | 1.235 | 1.272     | V             |
| $\eta$   | Efficiency                        | $V_o = 5\text{V}, V_{CC} = 12\text{V}$                                   |   |       | 90    |           | %             |
| <b>DC CHARACTERISTICS</b>                          |                                   |  |   |       |       |           |               |
| $I_{qop}$  | Total operating quiescent current |  | * |       | 3     | 5         | mA            |
| $I_q$  | Quiescent current                 | Duty Cycle = 0; $V_{FB} = 1.5\text{V}$                                   |   |       |       | 2.5       | mA            |
| $I_{qst-by}$                                       | Total stand-by quiescent current  | $V_{inh} > 2.2\text{V}$<br>$V_{CC} = 36\text{V}; V_{inh} > 2.2\text{V}$  | * |       | 50    | 100       | $\mu\text{A}$ |
|  |                                   |  | * |       | 80    | 150       | $\mu\text{A}$ |
| <b>INHIBIT</b>                                     |                                   |  |   |       |       |           |               |
|  | INH Threshold voltage             | Device ON  |   |       |       | 0.8       | V             |
|  |                                   | Device OFF   |   | 2.2   |       |           | V             |
| <b>ERROR AMPLIFIER</b>                             |                                   |  |   |       |       |           |               |
| $V_{OH}$   | High level output voltage         | $V_{FB} = 1\text{V}$   |   | 3.5   |       |           | V             |
| $V_{OL}$   | Low level output voltage          | $V_{FB} = 1.5\text{V}$   |   |       |       | 0.4       | V             |
| $I_{o\ source}$                                    | Source output current             | $V_{COMP} = 1.9\text{V}; V_{FB} = 1\text{V}$                             |   | 200   | 300   |           | $\mu\text{A}$ |
| $I_{o\ sink}$                                      | Sink output current               | $V_{comp} = 1.9\text{V}; V_{FB} = 1.5\text{V}$                           |   | 1     | 1.5   |           | mA            |
| $I_b$  | Source bias current               |  |   |       | 2.5   | 4         | $\mu\text{A}$ |
|  | DC open loop gain                 | $R_L = \infty$   |   | 50    | 65    |           | dB            |
| gm   | Transconductance                  | $I_{comp} = -0.1\text{mA}$ to $0.1\text{mA}$<br>$V_{comp} = 1.9\text{V}$ |   |       | 2.3   |           | mS            |
| <b>SYNC FUNCTION</b>                               |                                   |  |   |       |       |           |               |
|  | High Input Voltage                | $V_{CC} = 4.4\text{V}$ to $36\text{V}$                                   |   | 2.5   |       | $V_{REF}$ | V             |
|  | Low Input Voltage                 | $V_{CC} = 4.4\text{V}$ to $36\text{V}$                                   |   |       |       | 0.74      | V             |
|  | Slave Sink Current                | $V_{sync} = 0.74\text{V}$ (2)<br>$V_{sync} = 2.33\text{V}$               |   | 0.11  |       | 0.25      | mA            |
|  |                                   |  |   | 0.21  |       | 0.45      | mA            |
|  | Master Output Amplitude           | $I_{source} = 3\text{mA}$  |   | 2.75  | 3     |           | V             |
|  | Output Pulse Width                | no load, $V_{sync} = 1.65\text{V}$                                       |   | 0.20  | 0.35  |           | $\mu\text{s}$ |
| <b>REFERENCE SECTION</b>                           |                                   |  |   |       |       |           |               |
|  | Reference Voltage                 | $I_{REF} = 0$ to $5\text{mA}$<br>$V_{CC} = 4.4\text{V}$ to $36\text{V}$  |   | 3.234 | 3.3   | 3.366     | V             |
|  |                                   |  | * | 3.2   | 3.3   | 3.399     | V             |
|  | Line Regulation                   | $I_{REF} = 0\text{mA}$<br>$V_{CC} = 4.4\text{V}$ to $36\text{V}$         |   |       | 5     | 10        | mV            |
|  | Load Regulation                   | $I_{REF} = 0$ to $5\text{mA}$  |   |       | 8     | 15        | mV            |
|  | Short Circuit Current             |  |   | 10    | 18    | 30        | mA            |

Note (1): Specification over the  $-40$  to  $+125^\circ\text{C}$   $T_j$  Temperature range are assured by design, characterization and statistical correlation.

Note (2): Guaranteed by design.

Figure 1. Junction Temperature vs. Output Current

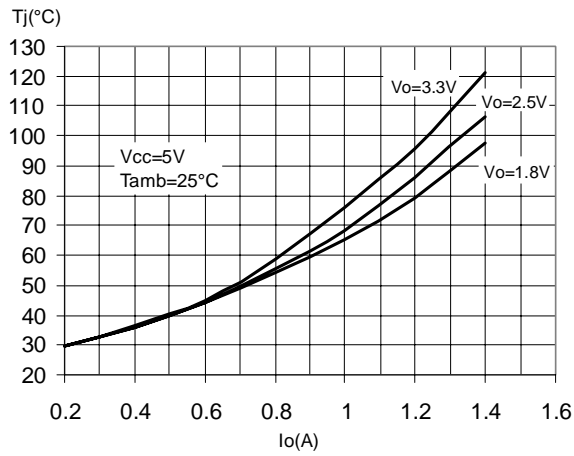


Figure 4. Load Regulation

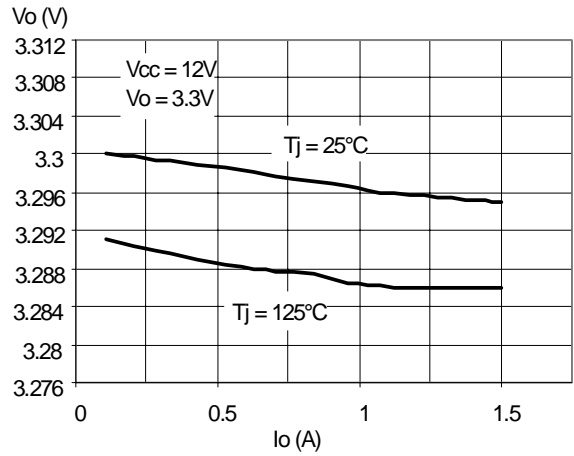


Figure 2. Junction Temperature vs. Output Current

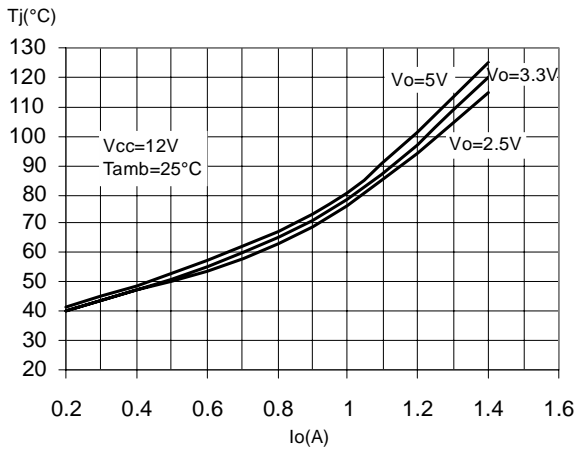


Figure 5. Line Regulation

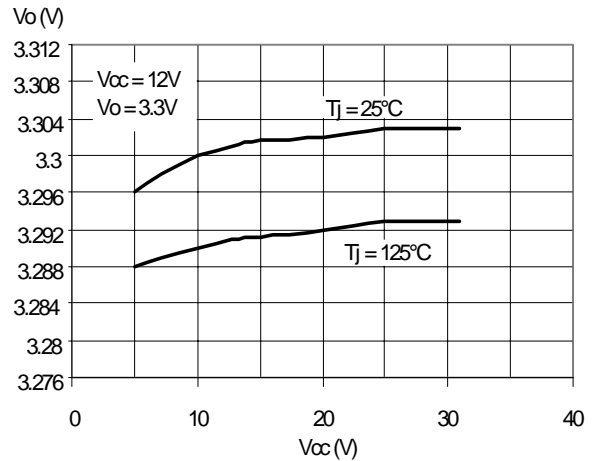


Figure 3. Junction Temperature vs. Output Current

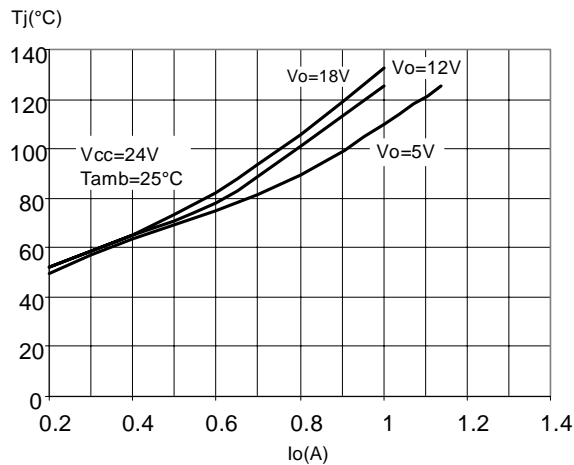
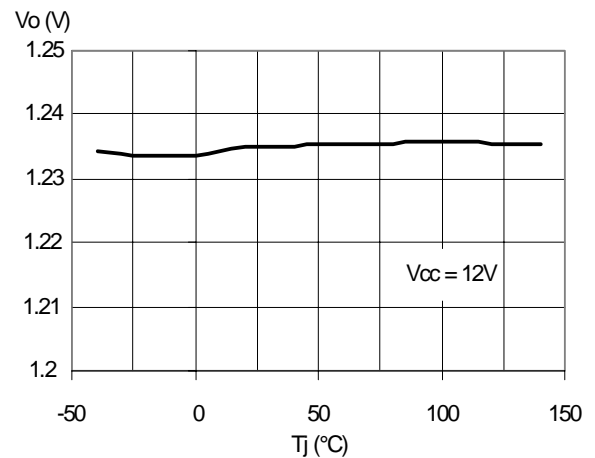
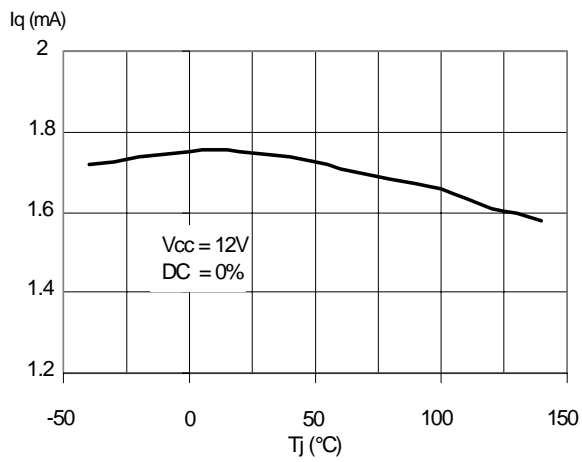


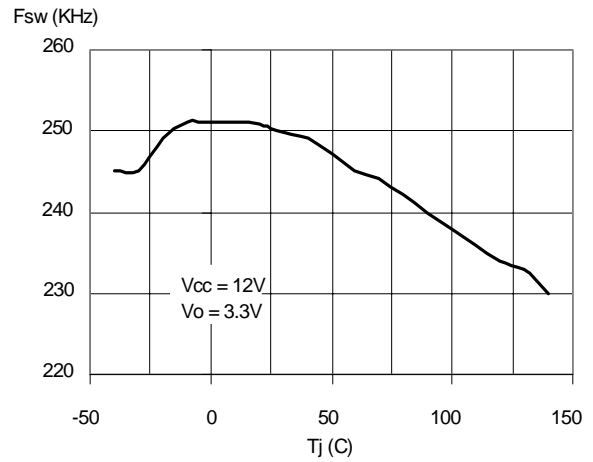
Figure 6. Output Voltage vs. Junction Temperature



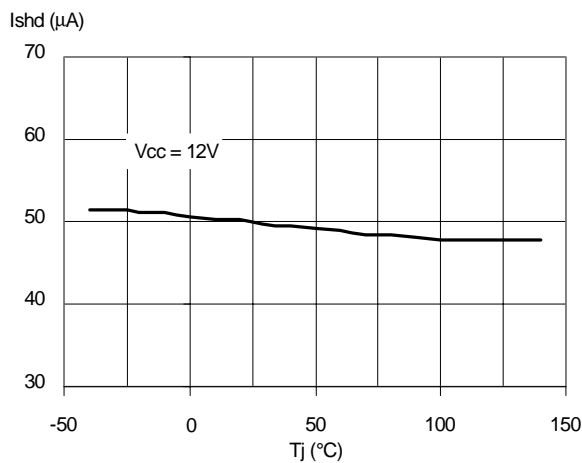
**Figure 7. Quiescent Current vs. Junction Temperature**



**Figure 9. Switching Frequency vs. Junction Temperature**

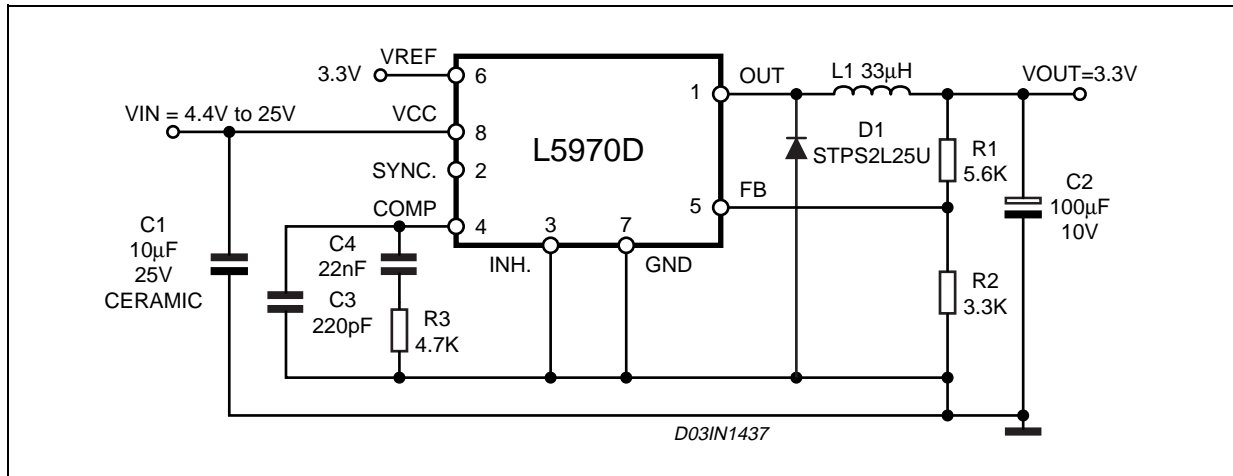


**Figure 8. Shutdown Current vs. Junction Temperature**



# L5970D

Figure 10. Demoboard schematic



## Part list demoboard

| Reference | Part Number      | Description         | Manufacturer       |
|-----------|------------------|---------------------|--------------------|
| C1        |                  | 10µF, 25V           | TOKIN              |
| C2        | POSCAP 10TPB100M | 100µF, 10V          | Sanyo              |
| C3        | C1206C221J5GAC   | 220pF, 5%, 50V      | KEMET              |
| C4        | C1206C223K5RAC   | 22nF, 10%, 50V      | KEMET              |
| R1        |                  | 5.6K, 1%, 0.1W 0603 | Neohm              |
| R2        |                  | 3.3K, 1%, 0.1W 0603 | Neohm              |
| R3        |                  | 4.7K, 1%, 0.1W 0603 | Neohm              |
| D1        | STPS2L25U        | 2A, 25V             | STMicroelectronics |
| L1        | DO3316P-333      | 33µH, 2A            | COILCRAFT          |

Figure 11. Efficiency vs. Output Current

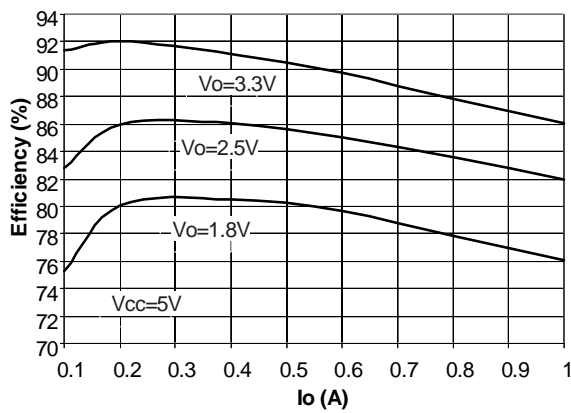


Figure 12. Efficiency vs. Output Current

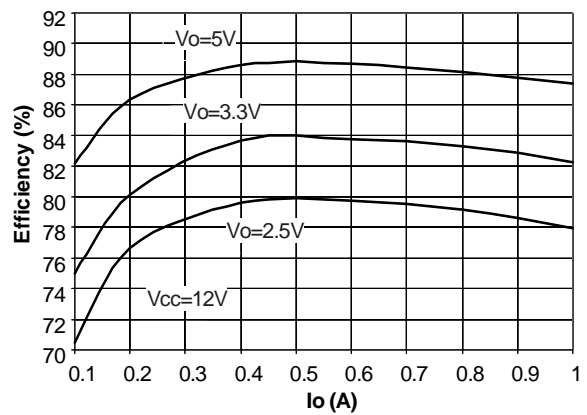


Figure 13. PCB layout (component side)

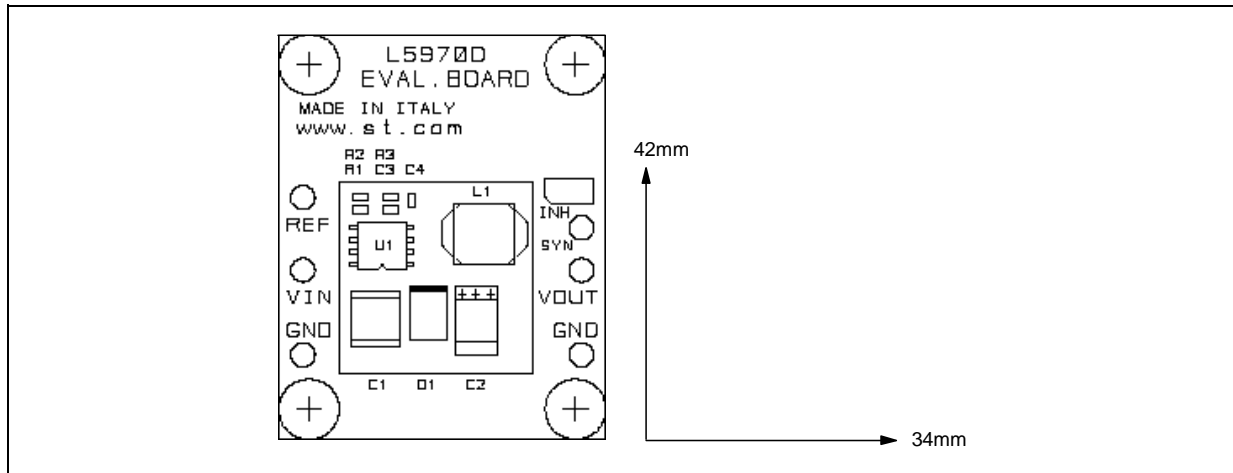


Figure 14. PCB layout (bottom side)

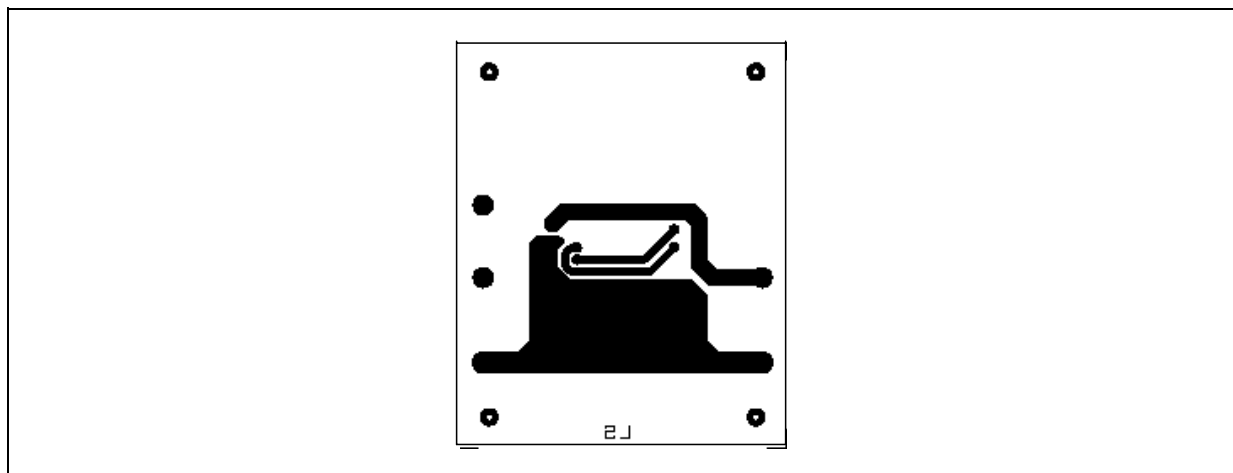
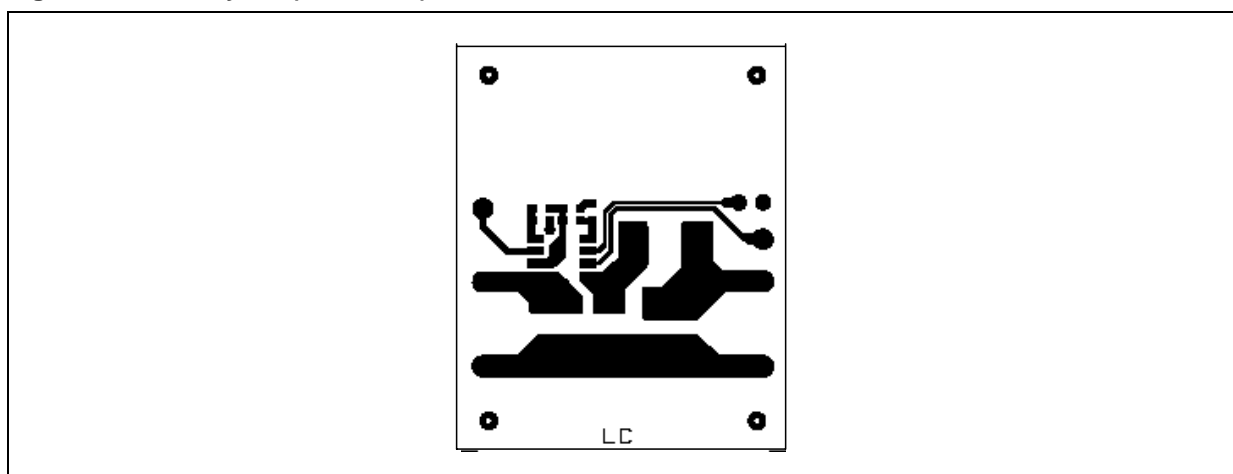


Figure 15. PCB layout (front side)



# L5970D

## APPLICATION IDEAS

Figure 16. Dual output voltage with auxiliary winding

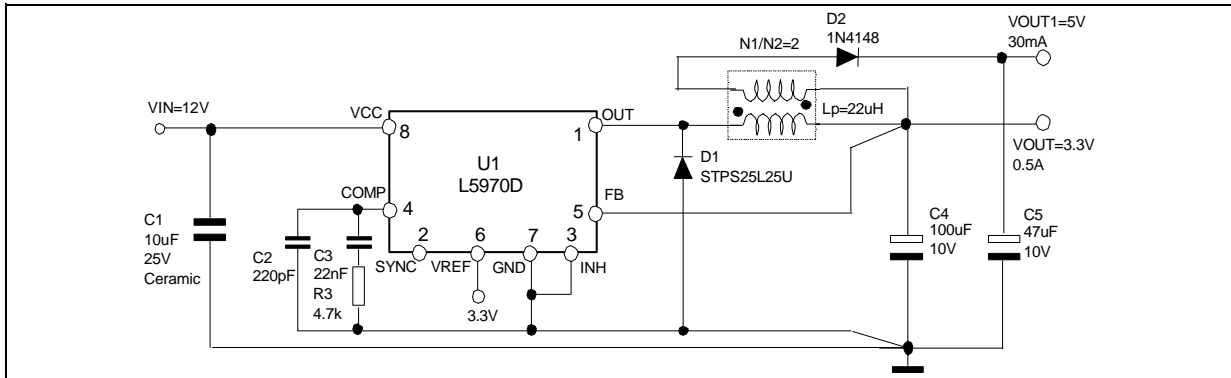


Figure 17. Buck-Boost regulator

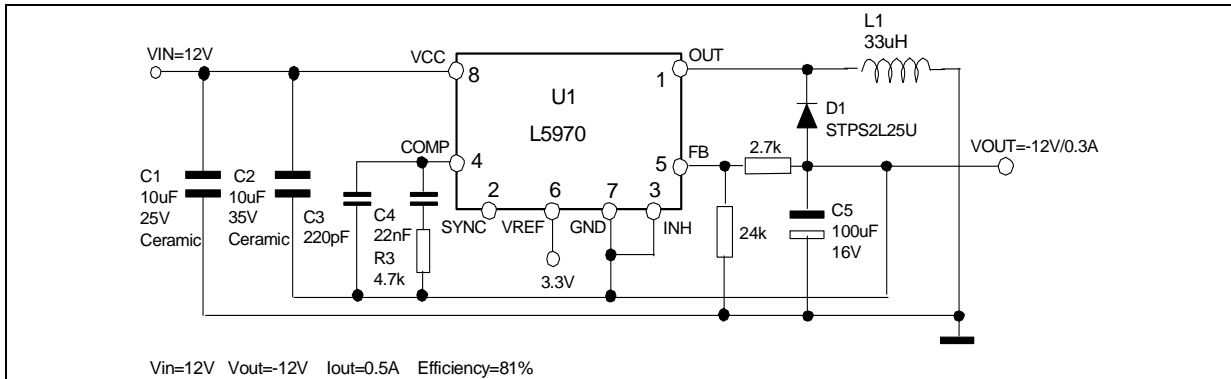


Figure 18. Positive Buck-Boost regulator

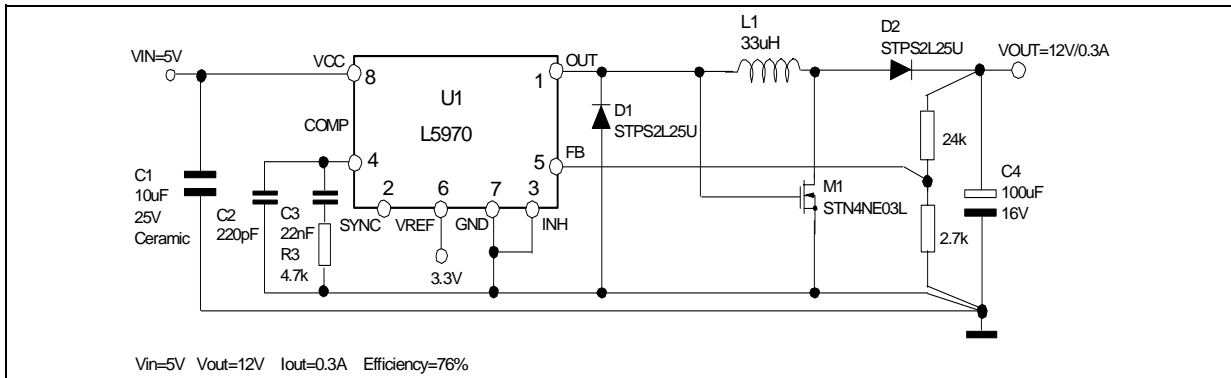
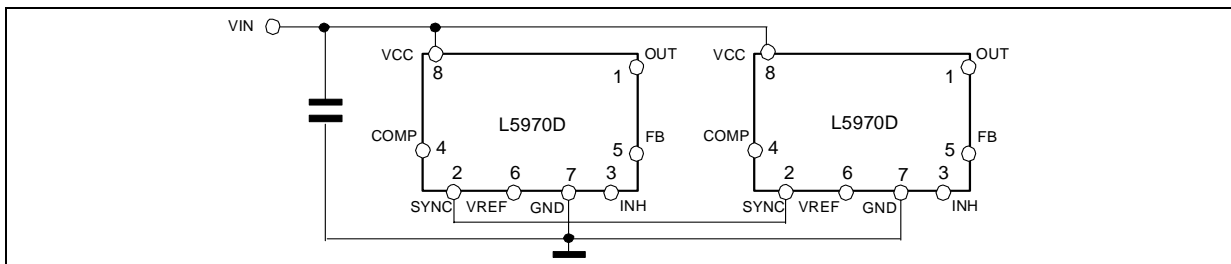


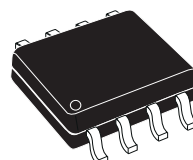
Figure 19. Synchronization example





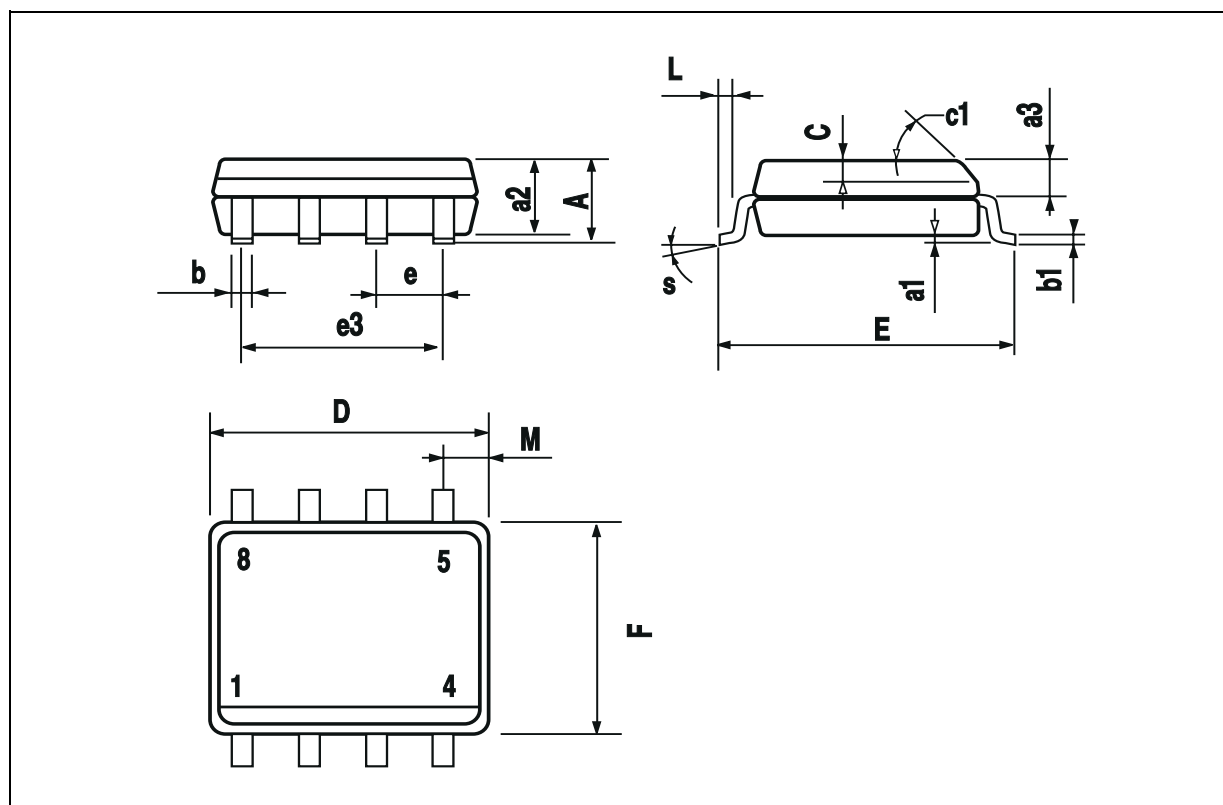
| DIM.  | mm         |      |      | inch  |       |       |
|-------|------------|------|------|-------|-------|-------|
|       | MIN.       | TYP. | MAX. | MIN.  | TYP.  | MAX.  |
| A     |            |      | 1.75 |       |       | 0.069 |
| a1    | 0.1        |      | 0.25 | 0.004 |       | 0.010 |
| a2    |            |      | 1.65 |       |       | 0.065 |
| a3    | 0.65       |      | 0.85 | 0.026 |       | 0.033 |
| b     | 0.35       |      | 0.48 | 0.014 |       | 0.019 |
| b1    | 0.19       |      | 0.25 | 0.007 |       | 0.010 |
| C     | 0.25       |      | 0.5  | 0.010 |       | 0.020 |
| c1    | 45° (typ.) |      |      |       |       |       |
| D (1) | 4.8        |      | 5.0  | 0.189 |       | 0.197 |
| E     | 5.8        |      | 6.2  | 0.228 |       | 0.244 |
| e     |            | 1.27 |      |       | 0.050 |       |
| e3    |            | 3.81 |      |       | 0.150 |       |
| F (1) | 3.8        |      | 4.0  | 0.15  |       | 0.157 |
| L     | 0.4        |      | 1.27 | 0.016 |       | 0.050 |
| M     |            |      | 0.6  |       |       | 0.024 |
| S     | 8° (max.)  |      |      |       |       |       |

## OUTLINE AND MECHANICAL DATA



### SO8

(1) D and F do not include mold flash or protrusions. Mold flash or protrusions shall not exceed 0.15mm (.006inch).



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