

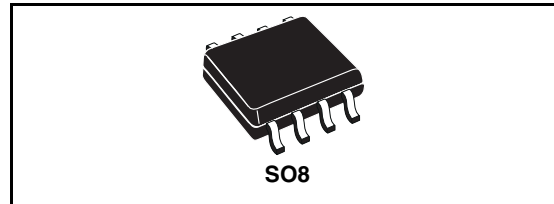
Up to 1A step down switching regulator

General features

- 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
- Synchronization
- 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: changers, 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.

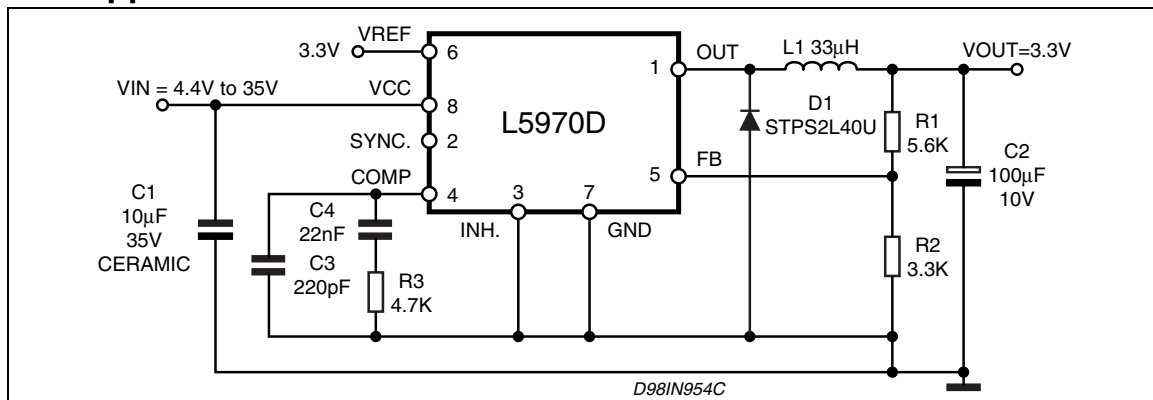
The device uses an internal P-Channel D-MOS transistor (with a typical R_{dson} of 250m Ω) as switching element to minimize the size of the external components.

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



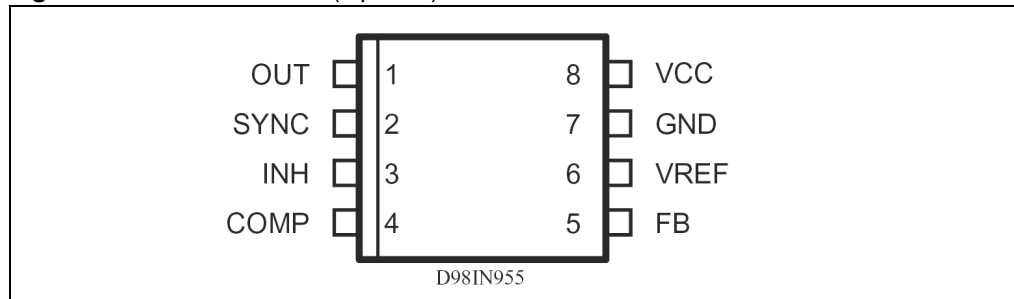
Contents

| | | |
|----------|---|-----------|
| 1 | Pin settings | 3 |
| | 1.1 Pin connection | 3 |
| | 1.2 Pin description | 3 |
| 2 | Electrical data | 4 |
| | 2.1 Maximum ratings | 4 |
| | 2.2 Thermal data | 4 |
| 3 | Electrical characteristics | 5 |
| 4 | Typical characteristics | 7 |
| 5 | Application circuit | 9 |
| 6 | Application ideas | 11 |
| 7 | Package mechanical data | 12 |
| 8 | Order code | 14 |
| 9 | Revision history | 15 |

1 Pin settings

1.1 Pin connection

Figure 1. Pin connection (top view)



1.2 Pin description

Table 1. Pin description

| N° | Type | 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 | VREF | 3.3V V_{REF} No cap is requested for stability. |
| 7 | GND | Ground. |
| 8 | VCC | Unregulated DC input voltage. |

2 Electrical data

2.1 Maximum ratings

Table 2. Absolute maximum ratings

| Symbol | Parameter | Value | Unit |
|---------------------------------|---|--------------------------|--------|
| V ₈ | Input voltage | 40 | V |
| V ₁ | Output DC voltage Output peak voltage at t = 0.1μs | -1 to 40 -5 to 40 | V V |
| I ₁ | Maximum output current | int. limit. | |
| V ₄ , V ₅ | Analog pins | 4 | V |
| V ₃ | INH | -0.3V to V _{CC} | |
| V ₂ | SYNC | -0.3 to 4 | V |
| P _{TOT} | Power dissipation at T _A ≤ 60°C | 0.75 | W |
| T _J | Operating junction temperature range | -40 to 150 | °C |
| T _{STG} | Storage temperature range | -55 to 150 | °C |

2.2 Thermal data

Table 3. Thermal data

| Symbol | Parameter | SO8 | Unit |
|-------------------|---|--------------------|------|
| R _{thJA} | Maximum thermal resistance junction-ambient | 120 ⁽¹⁾ | °C/W |

1. Package mounted on board

3 Electrical characteristics

Table 4. Electrical characteristics ($T_J = 25^\circ\text{C}$, $V_{CC} = 12\text{V}$, unless otherwise specified)

| Symbol | Parameter | Test condition | | Min | Typ | Max | Unit |
|---|-----------------------------------|--|-----|-------|-------|-------|---------------|
| V_{CC} | Operating input voltage range | $V_o = 1.235\text{V}$; $I_o = 2\text{A}$ | (1) | 4.4 | | 36 | V |
| $R_{DS(on)}$ | Mosfet on Resistance | | (1) | | 0.250 | 0.5 | Ω |
| I_l | Maximum limiting current | $V_{CC} = 4.4\text{V}$ to 36V | | 1.5 | 1.87 | 2.25 | A |
| f_s | Switching frequency | | (1) | 212 | 250 | 280 | KHz |
| | | | | 225 | 250 | 275 | KHz |
| | Duty cycle | | | 0 | | 100 | % |
| Dynamic characteristics (see test circuit). | | | | | | | |
| V_5 | Voltage feedback | $4.4\text{V} < V_{CC} < 36\text{V}$, $20\text{mA} < I_o < 2\text{A}$ | | 1.220 | 1.235 | 1.25 | V |
| | | | (1) | 1.198 | 1.235 | 1.272 | V |
| h | Efficiency | $V_o = 5\text{V}$, $V_{CC} = 12\text{V}$ | | | 90 | | % |
| DC characteristics | | | | | | | |
| I_{qop} | Total operating quiescent current | | (1) | | 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 | $V_{inh} > 2.2\text{V}$ | (1) | | 50 | 100 | μA |
| | | $V_{CC} = 36\text{V}$; $V_{inh} > 2.2\text{V}$ | (1) | | 80 | 150 | μA |
| Inhibit | | | | | | | |
| | INH threshold voltage | Device ON | | | | 0.8 | V |
| | | Device OFF | | 2.2 | | | V |
| Error amplifier | | | | | | | |
| 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 | | μA |
| $I_{o\ sink}$ | Sink output current | $V_{COMP} = 1.9\text{V}$; $V_{FB} = 1.5\text{V}$ | | 1 | 1.5 | | mA |

Table 4. Electrical characteristics ($T_J = 25^\circ\text{C}$, $V_{CC} = 12\text{V}$, unless otherwise specified)

| Symbol | Parameter | Test condition | Min | Typ | Max | Unit | |
|--------------------------|-------------------------|---|--------------|------|------------------|---------------|---|
| I_b | Source bias current | | | 2.5 | 4 | μA | |
| | DC open loop gain | $R_L = \infty$ | 50 | 65 | | dB | |
| g_m | Transconductance | $I_{\text{comp}} = -0.1\text{mA to } 0.1\text{mA}$ $V_{\text{COMP}} = 1.9\text{V}$ | | 2.3 | | mS | |
| Sync function | | | | | | | |
| | 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 | $V_{\text{sync}} = 0.74\text{V}^{(2)}$ $V_{\text{sync}} = 2.33\text{V}$ | 0.11 0.21 | | 0.25 0.45 | mA mA | |
| | Master output amplitude | $I_{\text{source}} = 3\text{mA}$ | 2.75 | 3 | | V | |
| | Output pulse width | no load, $V_{\text{sync}} = 1.65\text{V}$ | 0.20 | 0.35 | | μs | |
| Reference section | | | | | | | |
| | Reference voltage | | 3.234 | 3.3 | 3.366 | V | |
| | | $I_{\text{REF}} = 0 \text{ to } 5\text{mA}$ $V_{CC} = 4.4\text{V to } 36\text{V}$ | (1) | 3.2 | 3.3 | 3.399 | V |
| | Line regulation | $I_{\text{REF}} = 0\text{mA}$ $V_{CC} = 4.4\text{V to } 36\text{V}$ | | 5 | 10 | mV | |
| | Load regulation | $I_{\text{REF}} = 0 \text{ to } 5\text{mA}$ | | 8 | 15 | mV | |
| | Short circuit current | | 10 | 18 | 30 | mA | |

1. Specification Referred to T_J from -40 to 125°C . Specification over the -40 to $+125$ T_J Temperature range are assured by design, characterization and statistical correlation.
2. Guaranteed by design.

4 Typical characteristics

Figure 2. Junction temperature vs. output current

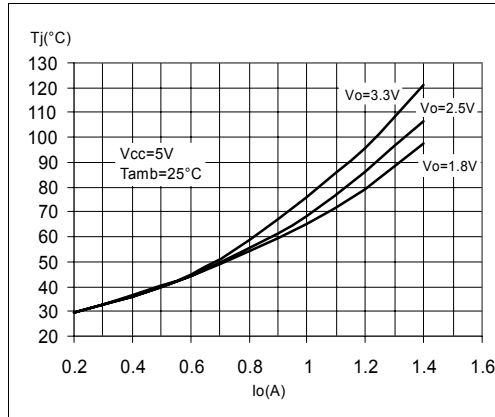


Figure 3. Load regulator

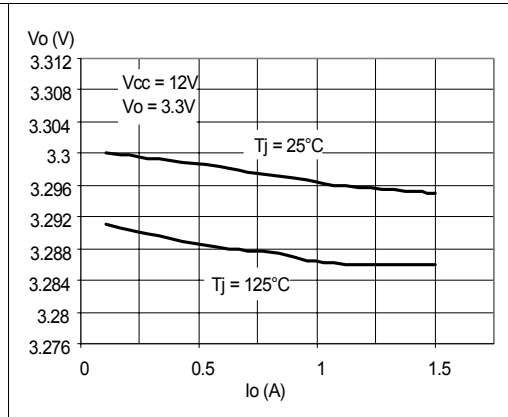


Figure 4. Junction temperature vs. output current

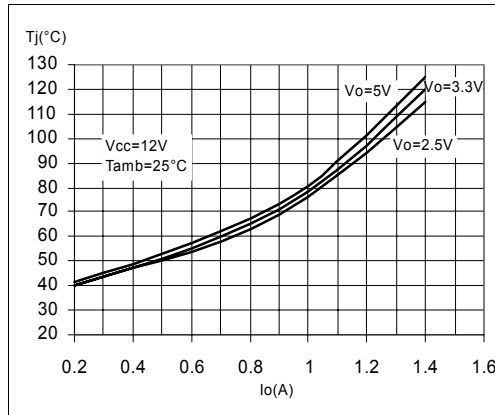


Figure 5. Line regulator

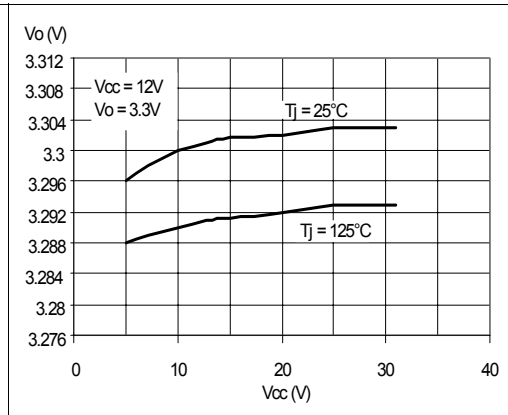


Figure 6. Junction temperature vs. output current

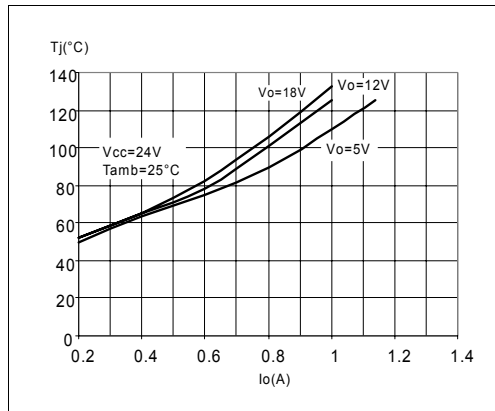


Figure 7. Output voltage vs. junction temperature

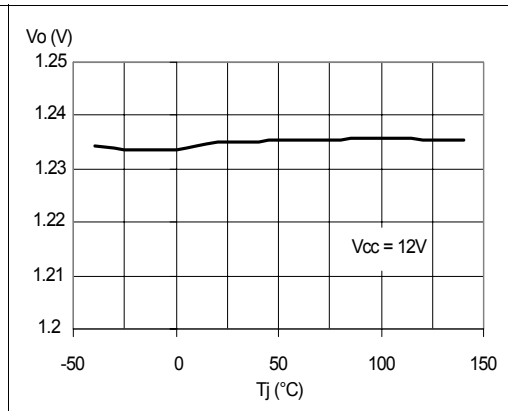


Figure 8. Quiescent current vs. junction temperature

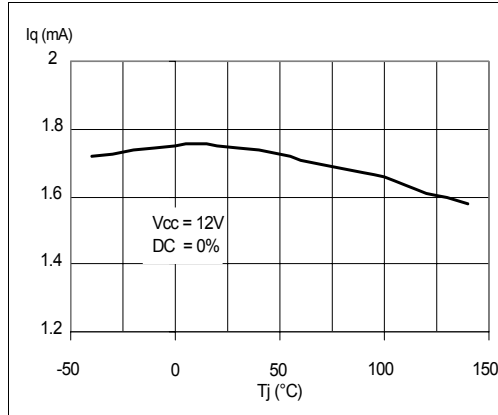


Figure 9. Switching frequency vs. junction temperature

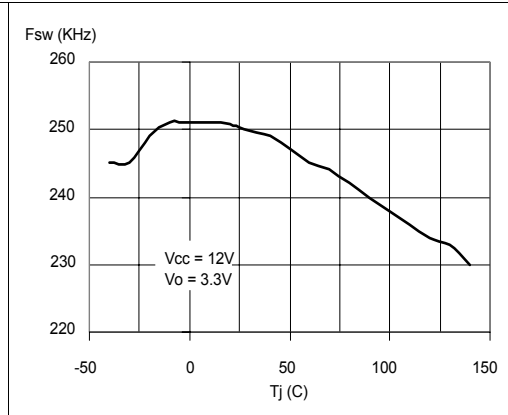


Figure 10. Shutdown current vs. junction temperature

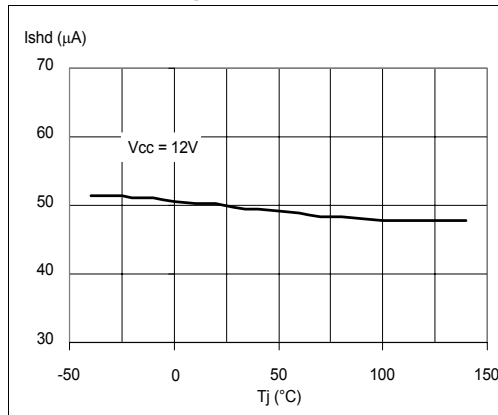


Figure 11. Efficiency vs. output current

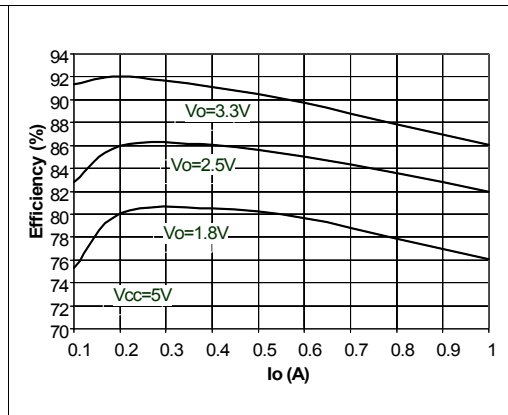
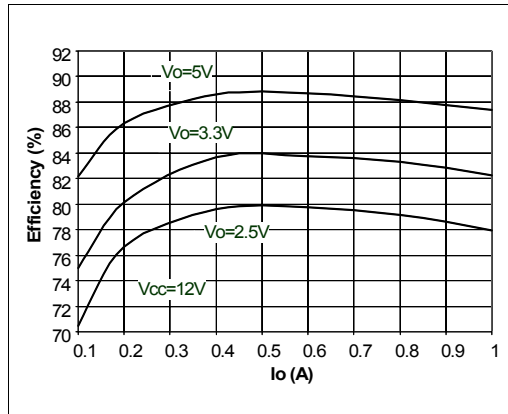


Figure 12. Efficiency vs. output current



5 Application circuit

Figure 13. Demo board application circuit

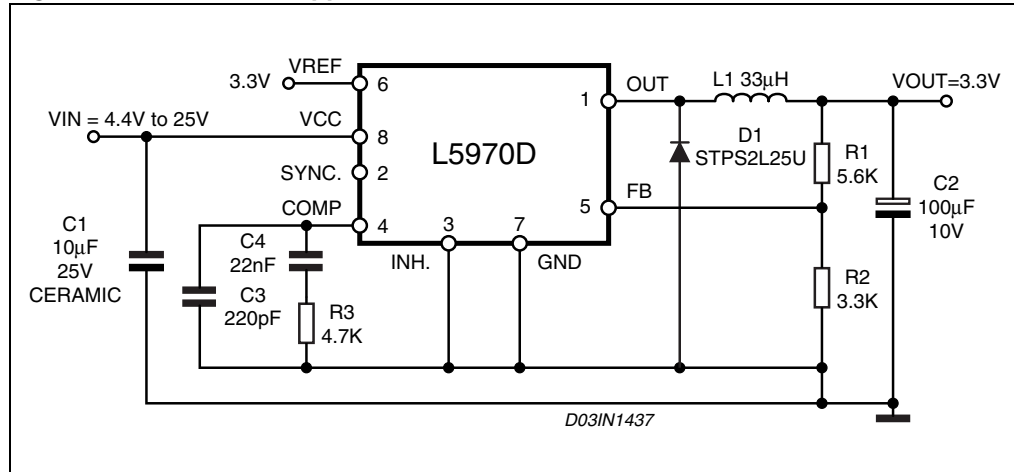


Table 5. Component list

| Reference | Part number | Description | Manufacturer |
|-----------|------------------|---------------------|--------------------|
| C1 | C3225X5R1E106M | 10µF, 25V | TDK |
| 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 14. PCB layout (component side)

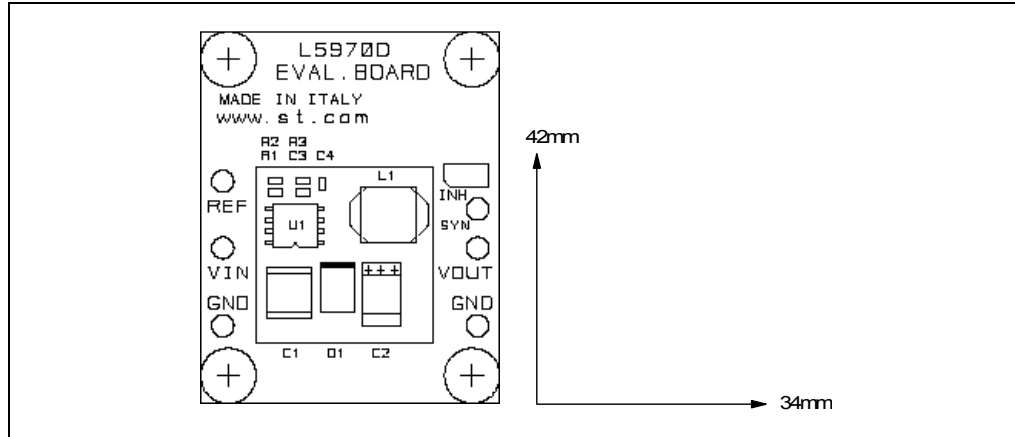


Figure 15. PCB layout (bottom side)

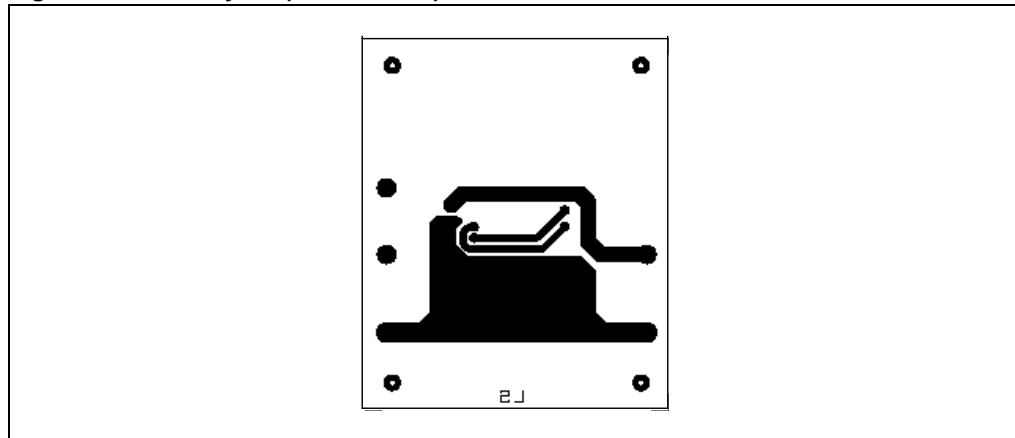
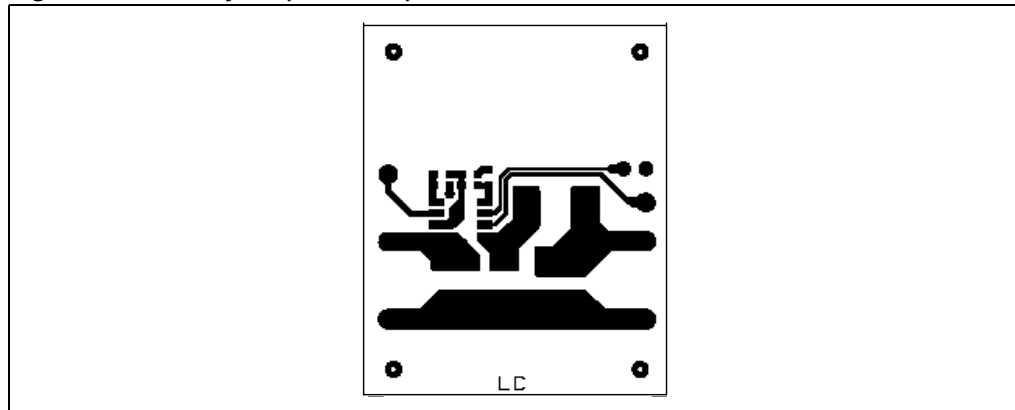


Figure 16. PCB layout (front side)



6 Application ideas

Figure 17. Dual output voltage with auxiliary winding

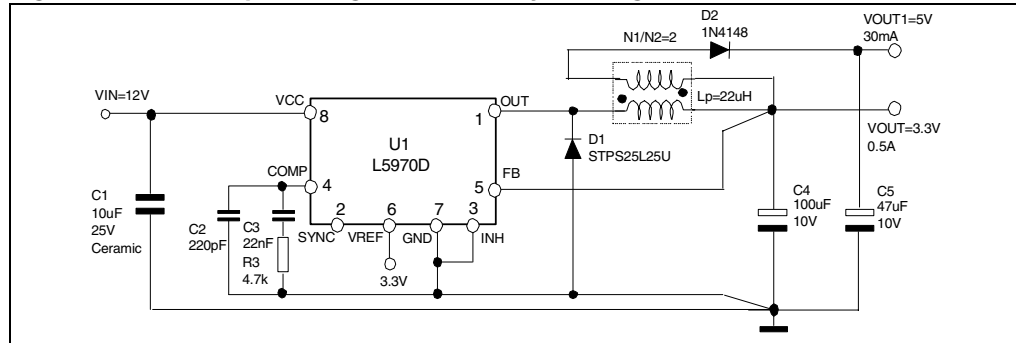


Figure 18. Buck-boost regulator

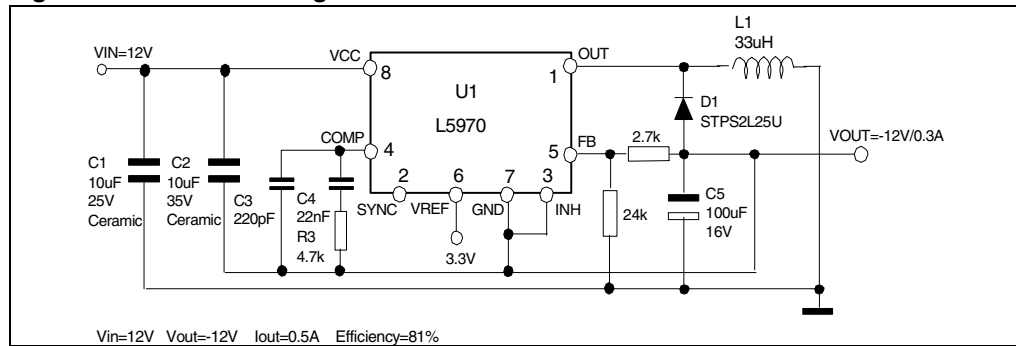


Figure 19. Positive Buck-Boost regulator

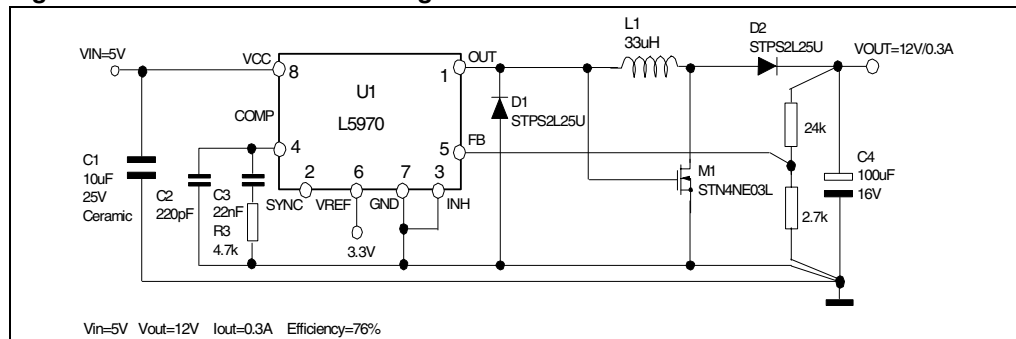
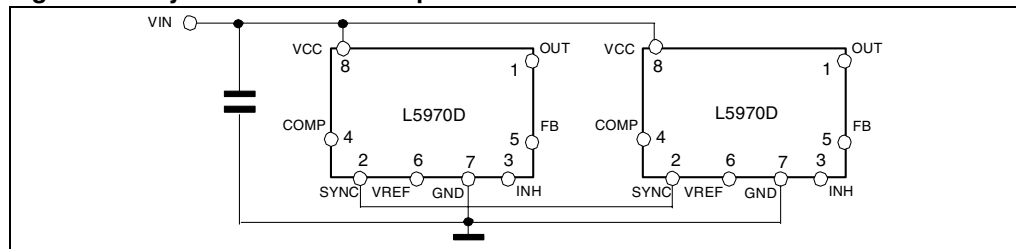


Figure 20. Synchronization example



7 Package mechanical data

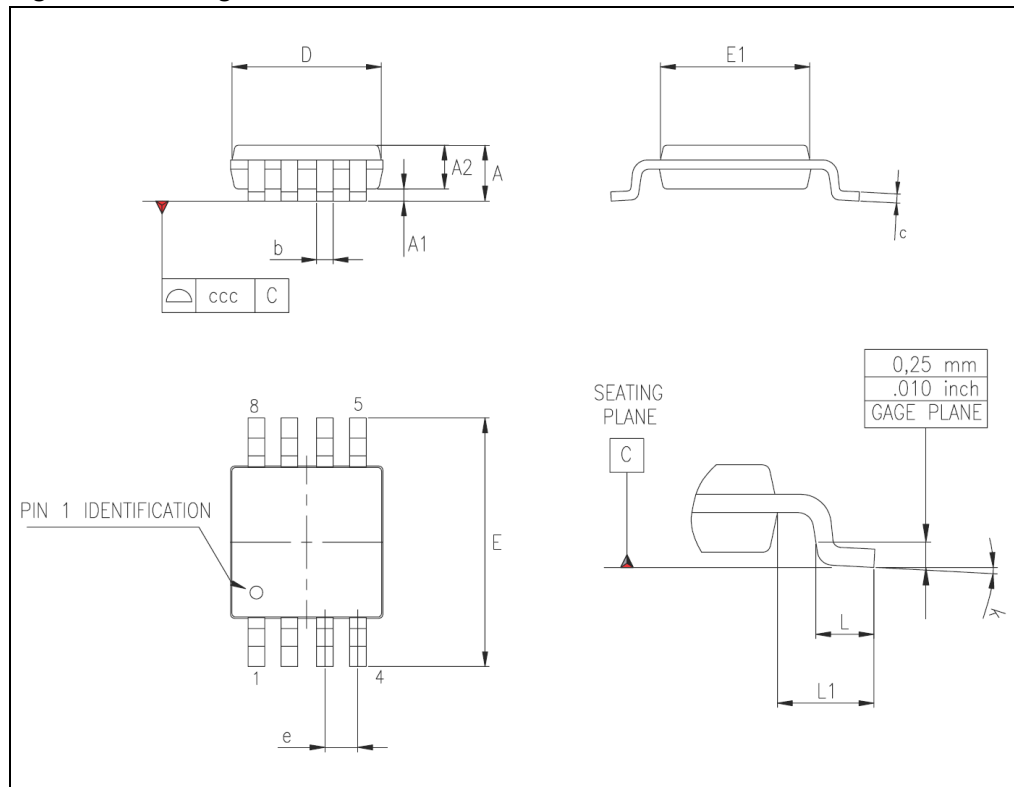
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Table 6. MSOP8 Mechanical data

| Dim. | mm. | | | inch | | |
|--------|---------------------|-------|-------|-------|-------|-------|
| | Min | Typ | Max | Min | Typ | Max |
| A | | | 1.10 | | | 0.043 |
| A1 | 0.050 | | 0.150 | 0.002 | | 0.006 |
| A2 | 0.750 | 0.850 | 0.950 | 0.03 | 0.033 | 0.037 |
| b | 0.250 | | 0.400 | 0.010 | | 0.016 |
| c | 0.130 | | 0.230 | 0.005 | | 0.009 |
| D (1) | 2.900 | 3.000 | 3.100 | 0.114 | 0.118 | 0.122 |
| E | 4.650 | 4.900 | 5.150 | 0.183 | 0.193 | 0.20 |
| E1 (1) | 2.900 | 3.000 | 3.100 | 0.114 | 0.118 | 0.122 |
| e | | 0.650 | | | 0.026 | |
| L | 0.400 | 0.550 | 0.700 | 0.016 | 0.022 | 0.028 |
| L1 | | 0.950 | | | 0.037 | |
| k | 0° (min.) 6° (max.) | | | | | |
| aaa | | | 0.100 | | | 0.004 |

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

Figure 21. Package dimensions



8 Order code

Table 7. Order code

| Part number | Package | Packaging |
|-------------|---------|---------------|
| L5970D | SO8 | Tube |
| L5970D013TR | SO8 | Tape and reel |

9 Revision history

Table 8. Revision history

| Date | Revision | Changes |
|-------------|----------|---|
| 26-Jan-2007 | 14 | Updated Table 5 on page 9 |

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