

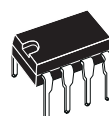
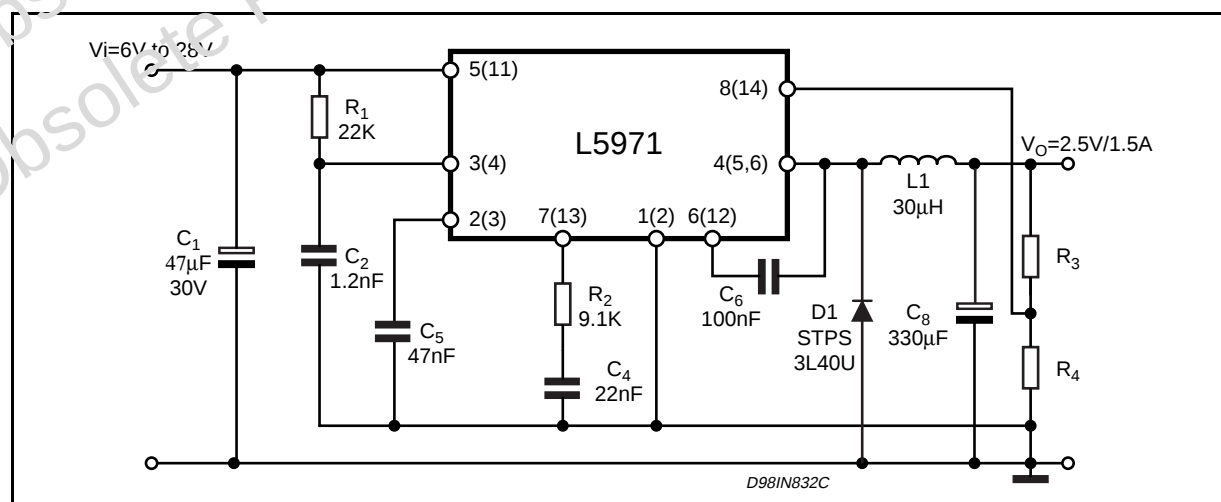
## 1.5A STEP DOWN SWITCHING REGULATOR

- UP TO 1.5A STEP DOWN CONVERTER
- OPERATING INPUT VOLTAGE FROM 6.5V TO 28V
- PRECISE 1.26V ( $\pm 1\%$ ) INTERNAL REFERENCE VOLTAGE
- OUTPUT VOLTAGE ADJUSTABLE FROM 1.26V TO 20V
- SWITCHING FREQUENCY ADJUSTABLE UP TO 300KHz
- VOLTAGE FEEDFORWARD
- ZERO LOAD CURRENT OPERATION
- INTERNAL CURRENT LIMITING (PULSE-BY-PULSE AND HICCUP MODE)
- INHIBIT FOR ZERO CURRENT CONSUMPTION
- PROTECTION AGAINST FEEDBACK DISCONNECTION
- THERMAL SHUTDOWN
- SOFT START FUNCTION

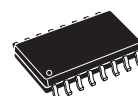
### DESCRIPTION

The L5971 is a step down monolithic power switching regulator delivering 1.5A at a voltage between 1.26V and 20V (selected by a simple external divider). Realized in BCD mixed technology, the device uses an internal power D-MOS transistor (with a typical  $R_{DS(on)}$  of  $0.25\Omega$ ) to obtain very high efficiency and high switching speed.

### TYPICAL APPLICATION CIRCUIT



Minidip



SO16V

ORDERING NUMBERS: L5971 (Minidip)  
L5971D (SO16)

A switching frequency up to 300KHz is achievable (the maximum power dissipation of the packages must be observed).

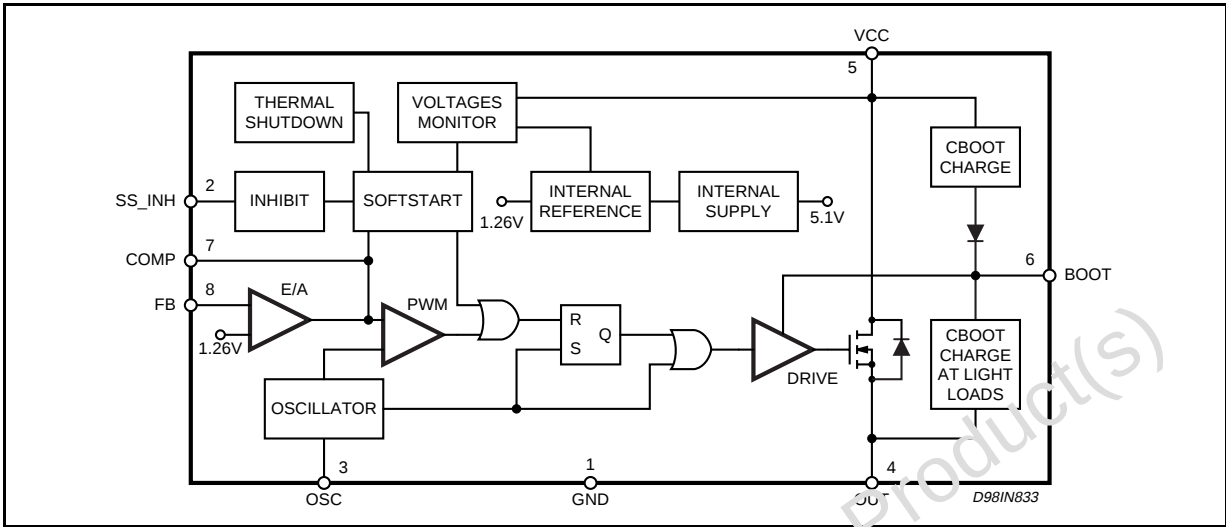
Features of this new generation of DC-DC converter include pulse-by-pulse current limit, hiccup mode for short circuit protection, voltage feedforward regulation, soft-start, protection against feedback loop disconnection, inhibit for zero current consumption and thermal shutdown.

The device is available in plastic dual in line, MINIDIP 8 for standard assembly, and SO16 for SMD assembly.

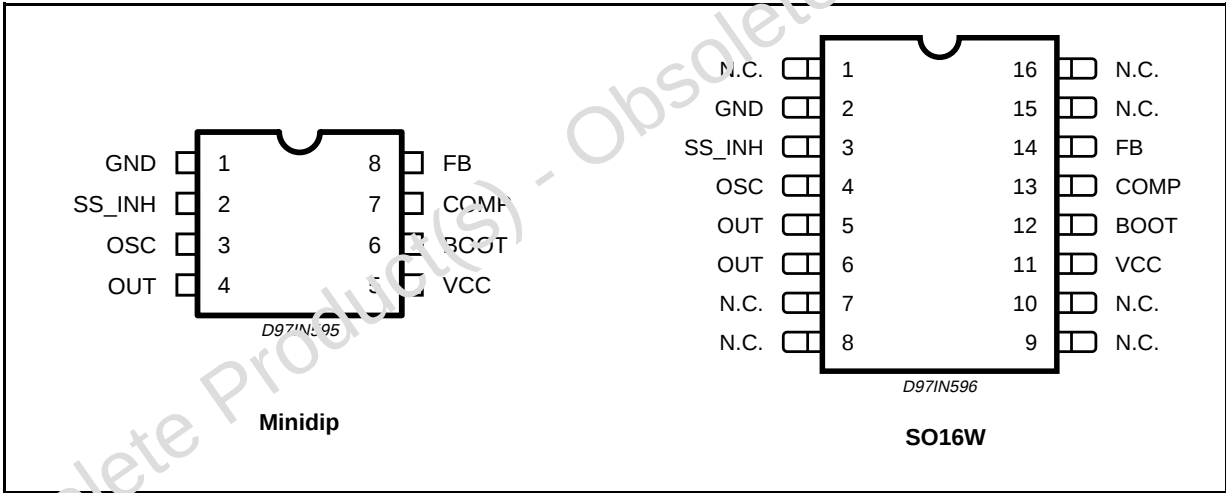
### Typical Applications:

- High efficiency step-down converter
- Portable computers
- Battery charger
- Distributed power
- PDAs and Mobile Communicators

BLOCK DIAGRAM



PIN CONNECTIONS



PIN FUNCTIONS

| DIP | SO (*) | Name   | Function                                                                                                                                                                                                                                  |
|-----|--------|--------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1   | 2      | GND    | Ground                                                                                                                                                                                                                                    |
| 2   | 3      | SS_INH | A logic signal (active low) disables the device (sleep mode operation). A capacitor connected between this pin and ground determines the soft start time. When this pin is grounded disables the device (driven by open collector/drain). |
| 3   | 4      | OSC    | An external resistor connected between the unregulated input voltage and this pin and a capacitor connected from this pin to ground fix the switching frequency. (Line feed forward is automatically obtained)                            |
| 4   | 5, 6   | OUT    | Stepdown regulator output                                                                                                                                                                                                                 |
| 5   | 11     | Vcc    | Not regulated DC input voltage                                                                                                                                                                                                            |
| 6   | 12     | BOOT   | A capacitor connected between this pin and OUT allows to drive the internal VDMOS                                                                                                                                                         |
| 7   | 13     | COMP   | E/A output to be used for frequency compensation                                                                                                                                                                                          |
| 8   | 14     | FB     | Stepdown feedback input. Connecting directly this pin to the output 1.26V is obtained; a voltage divider is requested for higher output voltages                                                                                          |

(\*) Pins 1, 7, 8, 9, 10, 15 and 16 are not internally, electrically connected to the die.

## THERMAL DATA

| Symbol          | Parameter                              | Minidip     | SO16    | Unit |
|-----------------|----------------------------------------|-------------|---------|------|
| $R_{th(j-amb)}$ | Thermal Resistance Junction to ambient | Max. 90 (*) | 110 (*) | °C/W |

(\*) Package mounted on board.

## ABSOLUTE MAXIMUM RATINGS

| Symbol                            |                                  | Parameter                                     | Value       | Unit |   |
|-----------------------------------|----------------------------------|-----------------------------------------------|-------------|------|---|
| Minidip                           | S016                             |                                               |             |      |   |
| V <sub>5</sub> , V <sub>3</sub>   | V <sub>11</sub> , V <sub>4</sub> | Input voltage                                 | 30          | V    |   |
| V <sub>4</sub>                    | V <sub>5</sub> , V <sub>6</sub>  | Output DC voltage                             | -1          | V    |   |
|                                   |                                  | Output peak voltage at t = 0.1μs f=200KHz     | 5           | V    |   |
| I <sub>4</sub>                    | I <sub>5</sub> , I <sub>6</sub>  | Maximum output current                        | Int. limit. |      |   |
| V <sub>6</sub> -V <sub>5</sub>    | V <sub>12</sub> -V <sub>11</sub> |                                               | 14          | V    |   |
| V <sub>6</sub>                    | V <sub>12</sub>                  | Bootstrap voltage                             | 45          | V    |   |
| V <sub>7</sub> , V <sub>2</sub>   | V <sub>13</sub> , V <sub>3</sub> | Analogs input voltage (V <sub>CC</sub> = 12V) | 10          | V    |   |
| V <sub>8</sub>                    | V <sub>14</sub>                  | (V <sub>CC</sub> = 20V)                       | 6           | V    |   |
|                                   |                                  |                                               | -0.3        | V    |   |
| P <sub>tot</sub>                  |                                  | Power dissipation a T <sub>amb</sub> ≤ 60°C   | Minidip     | 1    | W |
|                                   |                                  |                                               | S016        | 0.8  | W |
| T <sub>j</sub> , T <sub>stg</sub> |                                  | Junction and storage temperature              | -40 to 150  | °C   |   |

**ELECTRICAL CHARACTERISTICS** ( $T_j = 25^\circ C$ ,  $C_{osc} = 2.7nF$ ,  $R_{osc} = 20k\Omega$ ,  $V_{CC} = 12V$ , unless otherwise specified.) \* Specification Referred to  $T_j$  from 0 to  $125^\circ C$

| Symbol                         | Parameter                                | Test Condition                                                                    |   | Min.  | Typ. | Max.  | Unit    |
|--------------------------------|------------------------------------------|-----------------------------------------------------------------------------------|---|-------|------|-------|---------|
| <b>DYNAMIC CHARACTERISTICS</b> |                                          |                                                                                   |   |       |      |       |         |
| $V_i$                          | Operating input voltage range            |                                                                                   | * | 6.5   |      | 28    | V       |
| $V_o$                          | Output voltage                           | $I_o = 0.5A$                                                                      |   | 1.247 | 1.26 | 1.273 | V       |
|                                |                                          | $I_o = 0.2$ to $1.5A$                                                             |   | 1.235 | 1.26 | 1.285 | V       |
|                                |                                          | $V_{CC} = 6.5$ to $25V$                                                           | * | 1.21  | 1.26 | 1.31  | V       |
| $V_{dr}$                       | Dropout voltage                          | $V_{CC} = 10V$ ; $I_o = 1.5A$                                                     |   |       | 0.44 | 0.55  | V       |
|                                |                                          |                                                                                   | * |       |      | 0.88  | V       |
| $I_i$                          | Maximum limiting current                 | $V_{CC} = 6.5$ to $25V$                                                           | * | 2     | 2.5  | 3     | A       |
|                                | Efficiency                               | $V_o = 3.3V$ ; $I_o = 1.5A$                                                       |   |       | 85   |       | %       |
| $f_s$                          | Switching frequency                      |                                                                                   | * | 90    | 100  | 110   | KHz     |
| SVRR                           | Supply voltage ripple rejection          | $V_i = V_{CC} + 2V_{RMS}$ ; $V_o = V_{ref}$ ; $I_o = 1.5A$ ; $f_{ripple} = 100Hz$ |   | 60    |      |       | dB      |
|                                | Voltage stability of switching frequency | $V_{CC} = 6.5$ to $25V$                                                           |   |       | 3    | 6     | %       |
|                                | Temp. stability of switching frequency   | $T_j = 0$ to $125^\circ C$                                                        |   |       | 4    |       | %       |
| <b>Soft Start</b>              |                                          |                                                                                   |   |       |      |       |         |
|                                | Soft start charge current                |                                                                                   |   | 30    | 40   | 50    | $\mu A$ |
|                                | Soft start discharge current             |                                                                                   |   | 6     | 10   | 14    | $\mu A$ |
| <b>Inhibit</b>                 |                                          |                                                                                   |   |       |      |       |         |
| $V_{LL}$                       | Low level voltage                        |                                                                                   | * |       |      | 0.9   | V       |
| $I_{SLL}$                      | Source Low level                         |                                                                                   | * |       | 5    | 15    | $\mu A$ |

## ELECTRICAL CHARACTERISTICS (continued)

| Symbol                | Parameter                             | Test Condition                                                       |   | Min.  | Typ. | Max.  | Unit  |
|-----------------------|---------------------------------------|----------------------------------------------------------------------|---|-------|------|-------|-------|
| DC Characteristics    |                                       |                                                                      |   |       |      |       |       |
| I <sub>qop</sub>      | Total operating quiescent current     | Pin 5 (Pin 11)                                                       |   |       | 3    | 4.5   | mA    |
| I <sub>q</sub>        | Quiescent current                     | Duty Cycle = 0; V <sub>FB</sub> = 1.7V                               |   |       | 2.8  | 3.5   | mA    |
| I <sub>qst-by</sub>   | Total stand-by quiescent current      | V <sub>inh</sub> <0.9V                                               |   |       | 100  | 200   | μA    |
|                       |                                       | V <sub>cc</sub> = 25V; V <sub>inh</sub> <0.9V                        |   |       | 150  | 300   | μA    |
| Error Amplifier       |                                       |                                                                      |   |       |      |       |       |
| V <sub>FB</sub>       | Voltage Feedback Input                |                                                                      |   | 1.247 | 1.26 | 1.273 | V     |
| R <sub>L</sub>        | Line regulation                       | V <sub>cc</sub> = 6.5 to 25V                                         |   |       | 5    | 10    | mV    |
|                       | Ref. voltage stability vs temperature |                                                                      | * |       | 0.4  |       | mV/°C |
| V <sub>oH</sub>       | High level output voltage             | V <sub>FB</sub> = 0.8V                                               |   | 8.7   |      |       | V     |
| V <sub>oL</sub>       | Low level output voltage              | V <sub>FB</sub> = 1.7V                                               |   |       |      | 0.65  | V     |
| I <sub>o source</sub> | Source output current                 | V <sub>comp</sub> = 3V; V <sub>FB</sub> = 0.8V                       |   | 130   | 250  |       | μA    |
| I <sub>o sink</sub>   | Sink output current                   | V <sub>comp</sub> = 3V; V <sub>FB</sub> = 1.7V                       |   | 200   | 300  |       | μA    |
| I <sub>b</sub>        | Source bias current                   |                                                                      |   |       | 2    | 3     | μA    |
| SVRR E/A              | Supply voltage ripple rejection       | V <sub>comp</sub> = V <sub>fb</sub> ; V <sub>cc</sub> = 6.5 to 25V   |   | 60    | 80   |       | dB    |
|                       | DC open loop gain                     | R <sub>L</sub> = ∞                                                   |   | 50    | 57   |       | dB    |
| gm                    | Transconductance                      | I <sub>comp</sub> = -0.1 to 0.1mA<br>V <sub>comp</sub> = 6V          |   |       | 4.3  |       | mS    |
| Oscillator Section    |                                       |                                                                      |   |       |      |       |       |
|                       | Ramp Valley                           |                                                                      |   | 0.74  | 0.81 | 0.88  | V     |
|                       | Ramp peak                             | V <sub>cc</sub> = 6.5V                                               |   | 1.80  | 1.87 | 1.94  | V     |
|                       |                                       | V <sub>cc</sub> = 25V                                                |   | 4.72  | 4.79 | 4.86  | V     |
|                       | Maximum duty cycle                    |                                                                      |   | 95    | 97   |       | %     |
|                       | Maximum Frequency                     | Duty Cycle = 0%<br>R <sub>osc</sub> = 13kΩ, C <sub>osc</sub> = 820pF |   |       |      | 300   | kHz   |

Figure 1. Test and valuation board circuit.

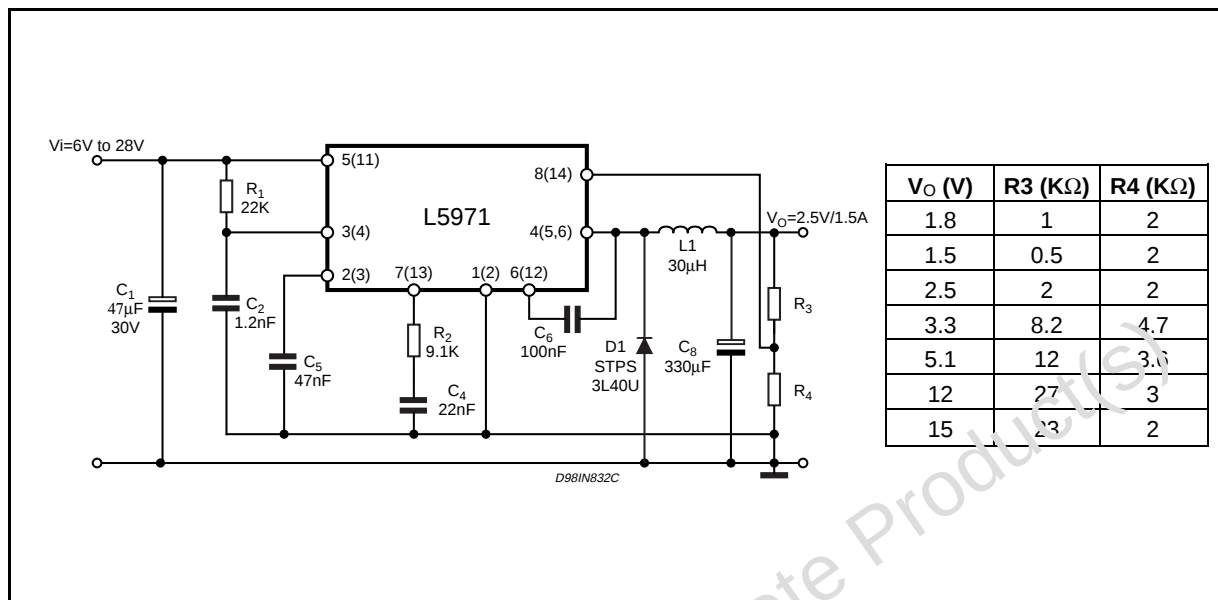


Figure 2. PCB and component layout of the figure 1.

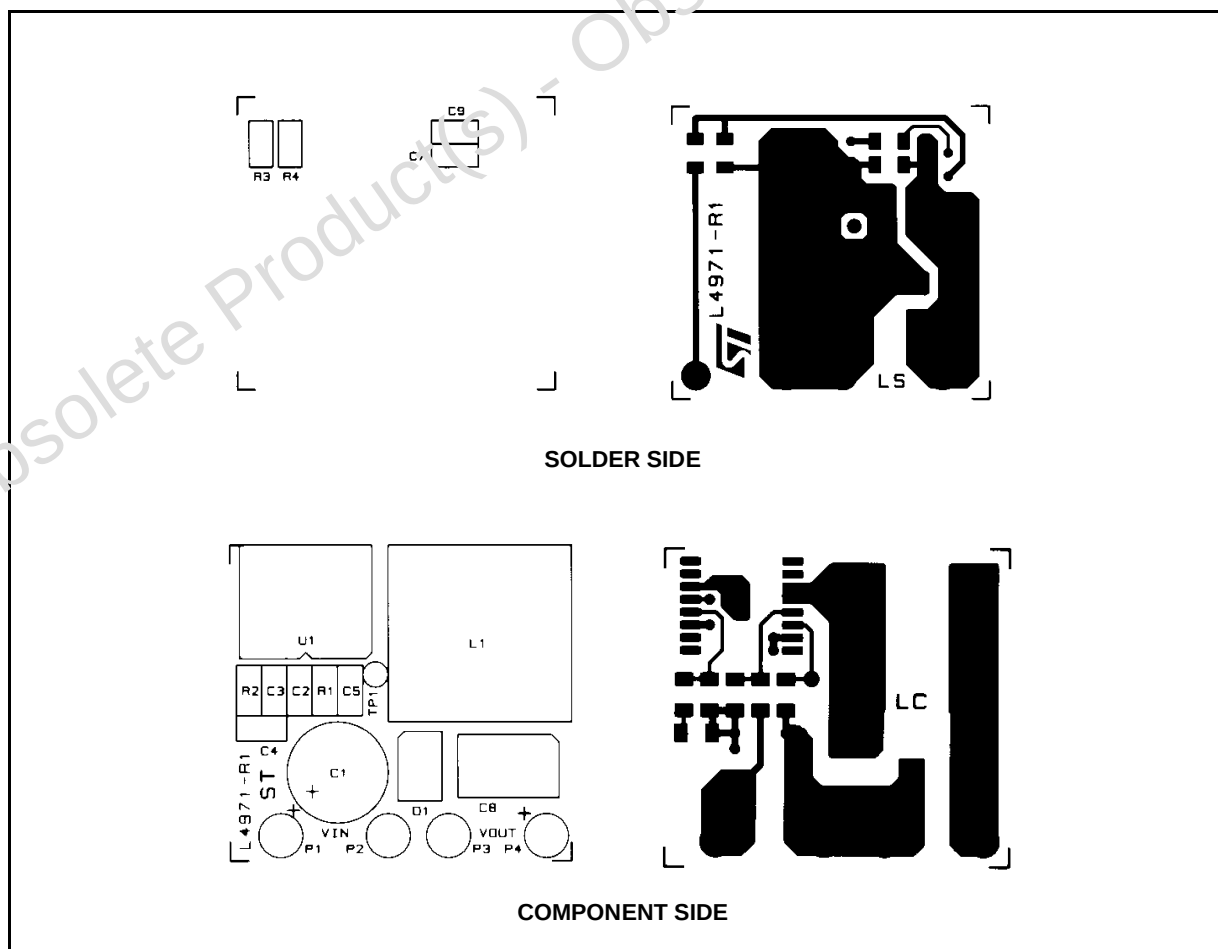


Figure 3. Quiescent drain current vs. input voltage.

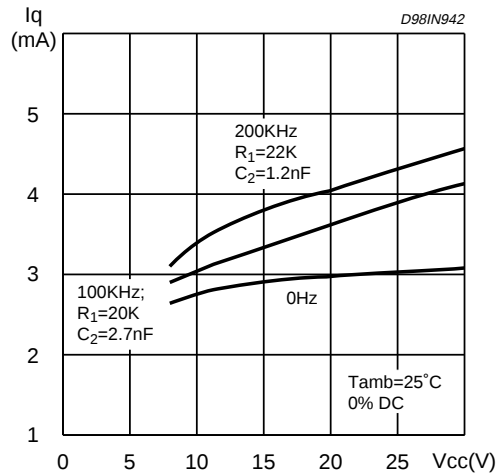


Figure 4. Quiescent current vs. junction temperature

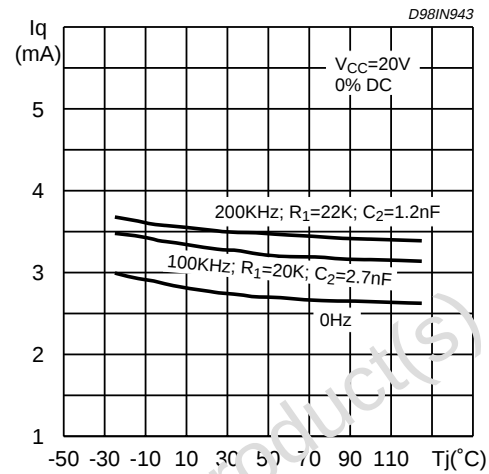


Figure 5. Stand-by drain current vs. input voltage

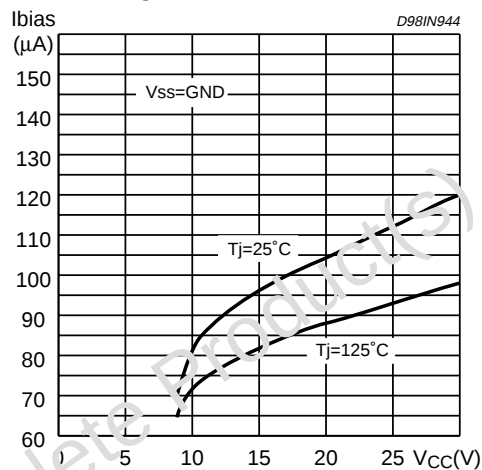


Figure 6. Line Regulation

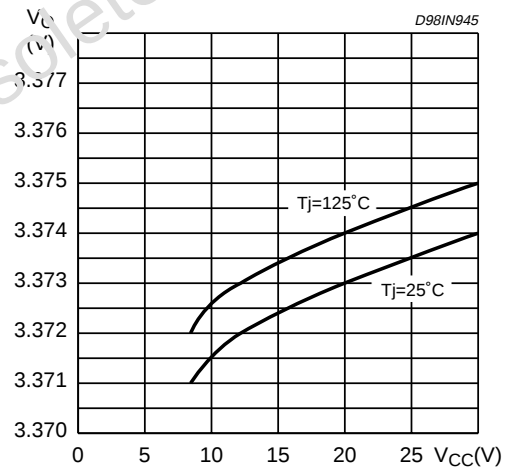


Figure 7. Switching frequency vs. R1 and C2

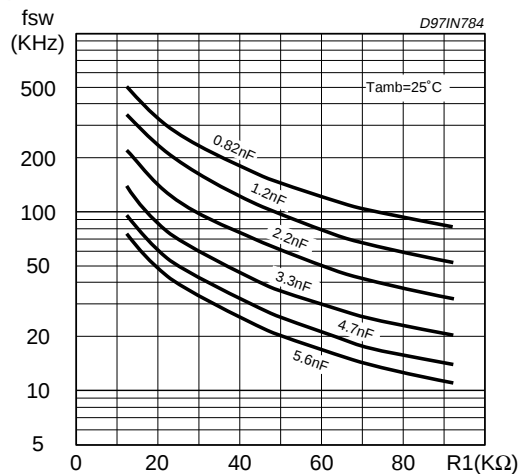
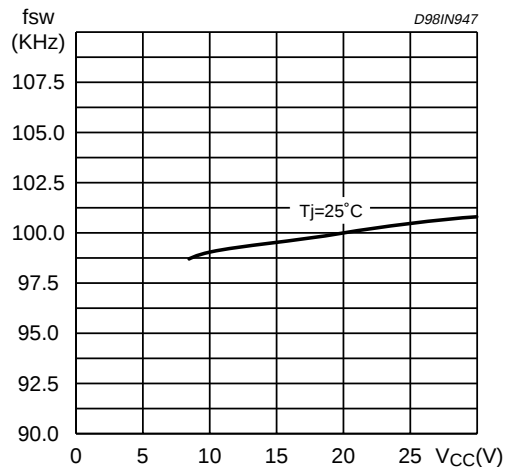
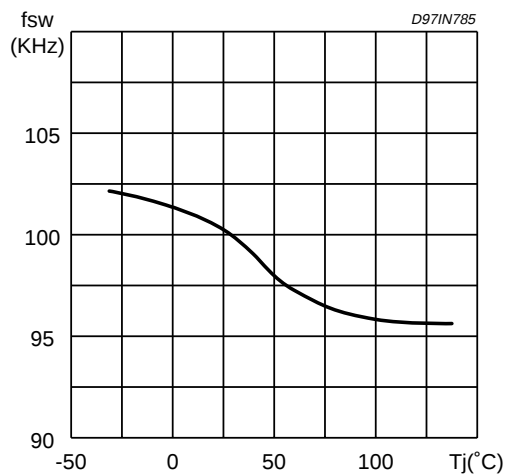


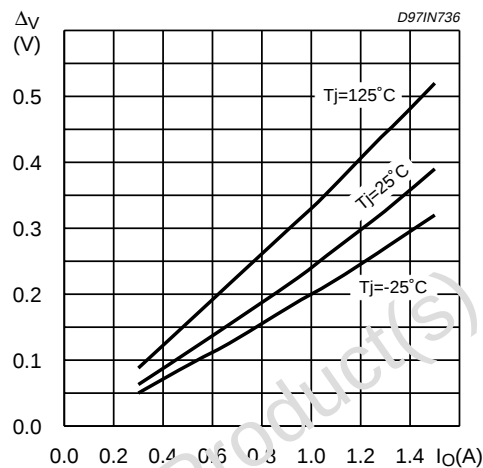
Figure 8. Switching Frequency vs. input voltage.



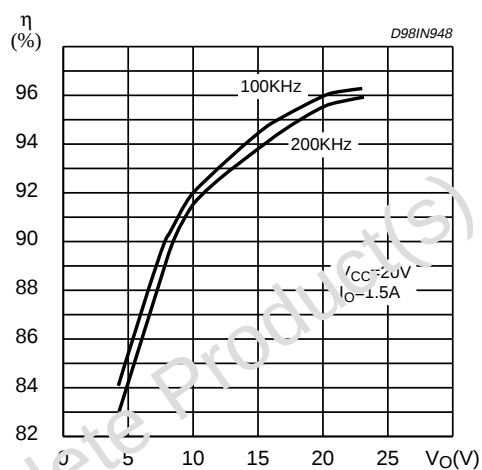
**Figure 9. Switching frequency vs. junction temperature.**



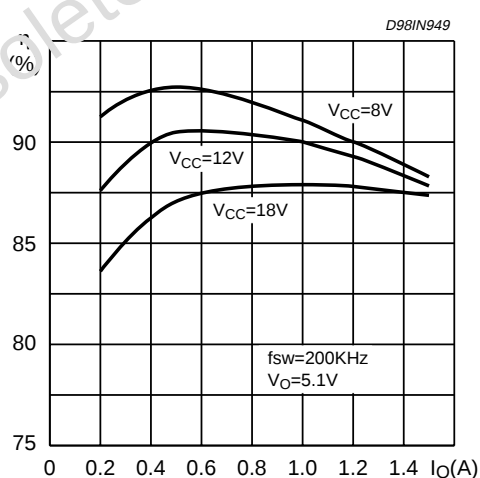
**Figure 10. Dropout voltage between pin 5 and 4.**



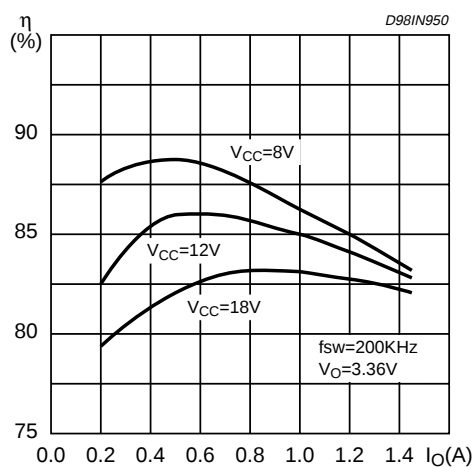
**Figure 11. Efficiency vs output voltage.**



**Figure 12. Efficiency vs. output current.**



**Figure 13. Efficiency vs output current.**



**Figure 14. Efficiency vs. output current.**

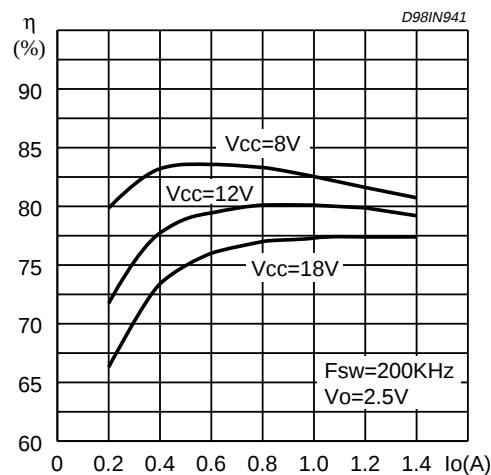


Figure 15. Load transient.

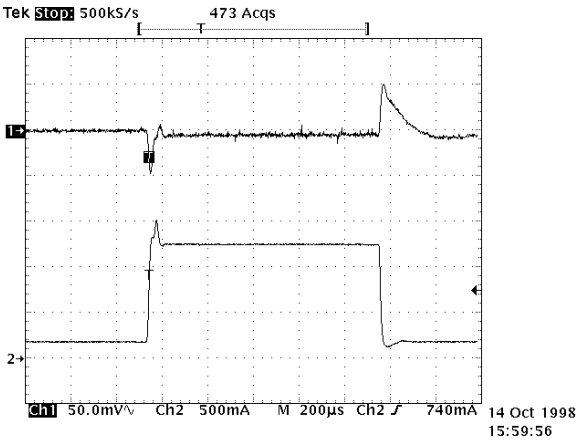


Figure 16. Soft start capacitor selection vs. Inductor and  $V_{CCmax}$

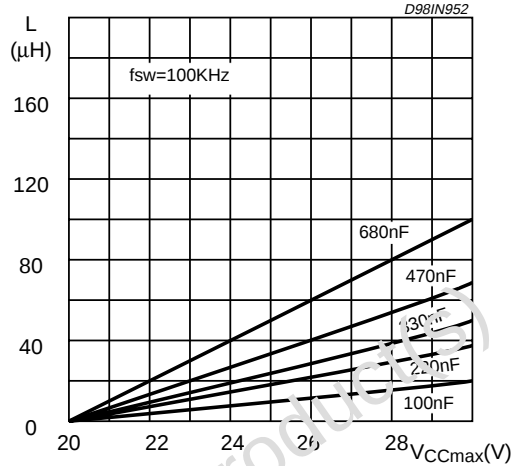


Figure 17. Soft start capacitor selection vs. Inductor and  $V_{CCmax}$

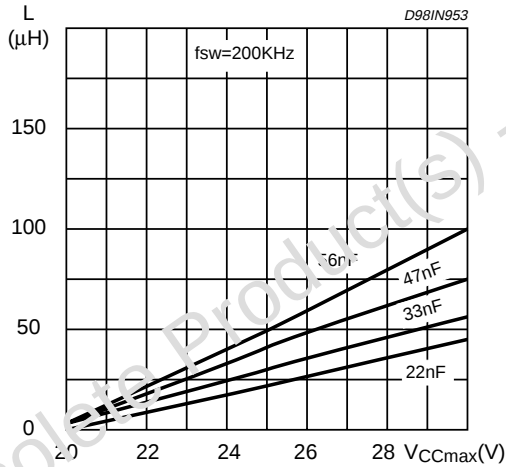
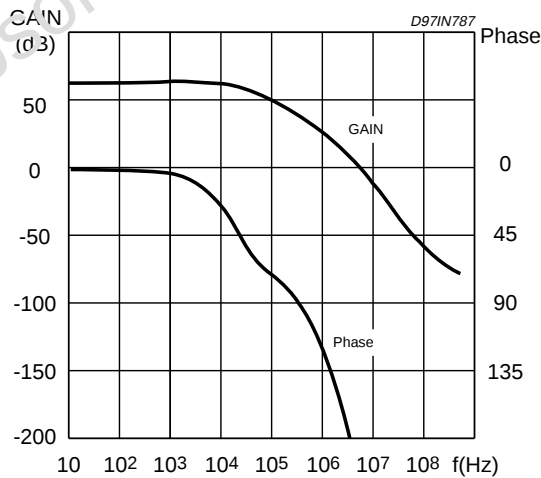
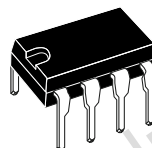


Figure 18. Open loop frequency and phase of error amplifier.

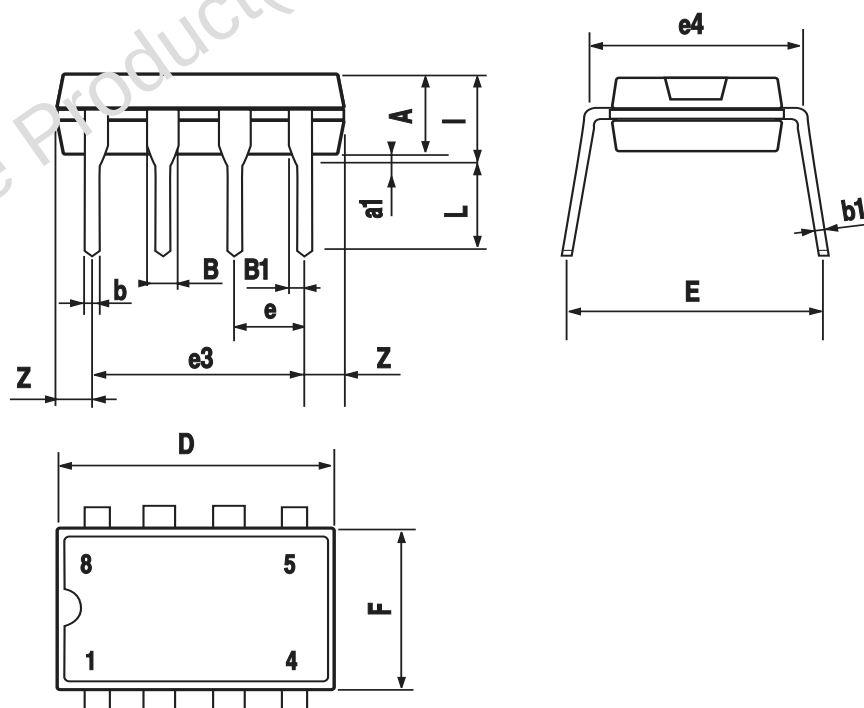


| DIM. | mm    |      |       | inch  |       |       |
|------|-------|------|-------|-------|-------|-------|
|      | MIN.  | TYP. | MAX.  | MIN.  | TYP.  | MAX.  |
| A    |       | 3.32 |       |       | 0.131 |       |
| a1   | 0.51  |      |       | 0.020 |       |       |
| B    | 1.15  |      | 1.65  | 0.045 |       | 0.065 |
| b    | 0.356 |      | 0.55  | 0.014 |       | 0.022 |
| b1   | 0.204 |      | 0.304 | 0.008 |       | 0.012 |
| D    |       |      | 10.92 |       |       | 0.430 |
| E    | 7.95  |      | 9.75  | 0.313 |       | 0.384 |
| e    |       | 2.54 |       |       | 0.100 |       |
| e3   |       | 7.62 |       |       | 0.300 |       |
| e4   |       | 7.62 |       |       | 0.300 |       |
| F    |       |      | 6.6   |       |       | 0.260 |
| I    |       |      | 5.08  |       |       | 0.200 |
| L    | 3.18  |      | 3.81  | 0.125 |       | 0.150 |
| Z    |       |      | 1.52  |       |       | 0.060 |

## OUTLINE AND MECHANICAL DATA

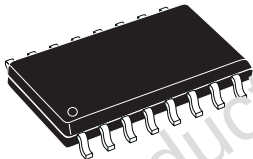


**Minidip**

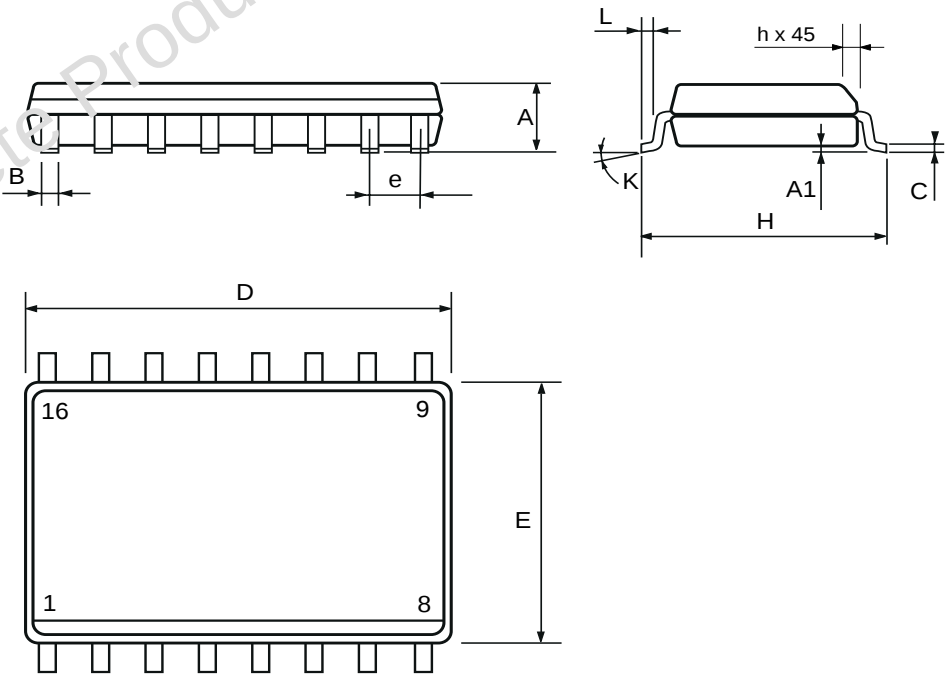


| DIM. | mm                 |      |       | inch  |       |       |
|------|--------------------|------|-------|-------|-------|-------|
|      | MIN.               | TYP. | MAX.  | MIN.  | TYP.  | MAX.  |
| A    | 2.35               |      | 2.65  | 0.093 |       | 0.104 |
| A1   | 0.1                |      | 0.3   | 0.004 |       | 0.012 |
| B    | 0.33               |      | 0.51  | 0.013 |       | 0.020 |
| C    | 0.23               |      | 0.32  | 0.009 |       | 0.013 |
| D    | 10.1               |      | 10.5  | 0.398 |       | 0.413 |
| E    | 7.4                |      | 7.6   | 0.291 |       | 0.299 |
| e    |                    | 1.27 |       |       | 0.050 |       |
| H    | 10                 |      | 10.65 | 0.394 |       | 0.419 |
| h    | 0.25               |      | 0.75  | 0.010 |       | 0.030 |
| L    | 0.4                |      | 1.27  | 0.016 |       | 0.050 |
| K    | 0° (min.)8° (max.) |      |       |       |       |       |

OUTLINE AND  
MECHANICAL DATA



SO16 Wide



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