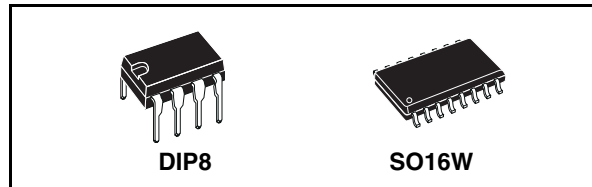


## 1A step down switching regulator

### Features

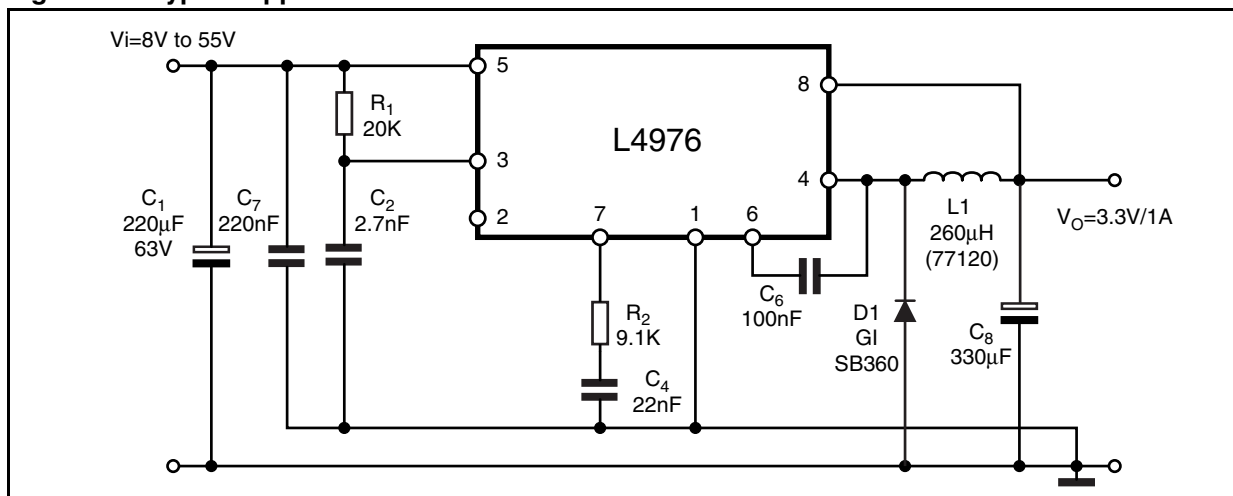
- Up to 1A step down converter
- Operating input voltage from 8V to 55V
- Precise 5.1V reference voltage
- Output voltage adjustable from 0.5V to 50V
- Switching frequency adjustable up to 300kHz
- Voltage feedforward
- Zero load current operation
- Internal current limiting (pulse-bypulse and hiccup mode)
- Protection against feedback disconnection
- Thermal shutdown



### Description

The L4976 is a step down monolithic power switching regulator delivering 1A at a voltage between 3.3V and 50V (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. A switching frequency up to 300KHz is achievable (the maximum power dissipation of the packages must be observed). A wide input voltage range between 8V to 55V and output voltages regulated from 3.3V to 40V cover the majority of today's applications. Features of this new generations of DC-DC converter include pulse-by-pulse current limit, hiccup mode for short circuit protection, voltage feedforward regulation, protection against feedback loop disconnection and thermal shutdown. The device is available in plastic dual in line, MINIDIP 8 for standard assembly, and SO16W for SMD assembly.

**Figure 1. Typical application circuit**

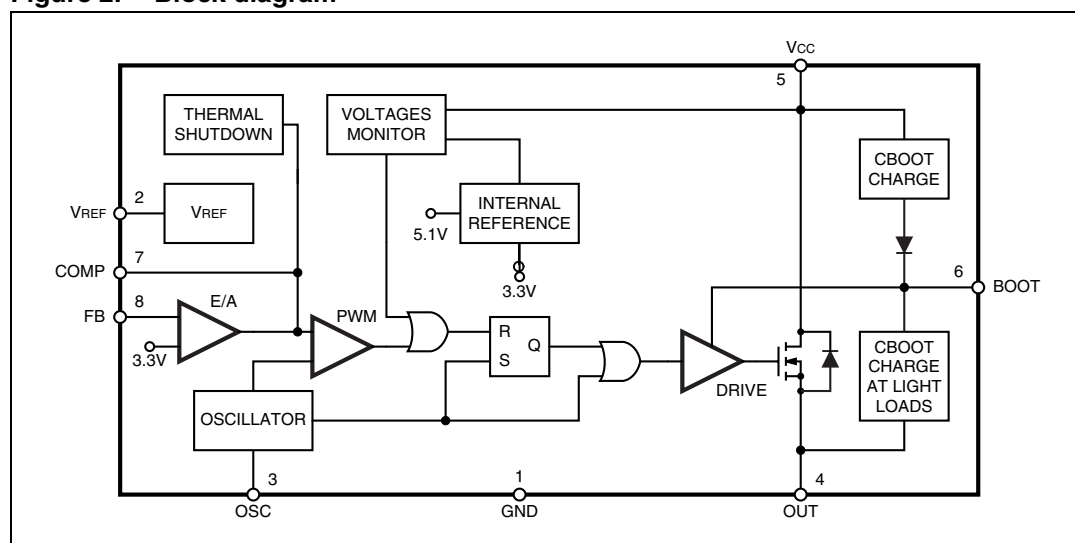


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# 1 Block diagram

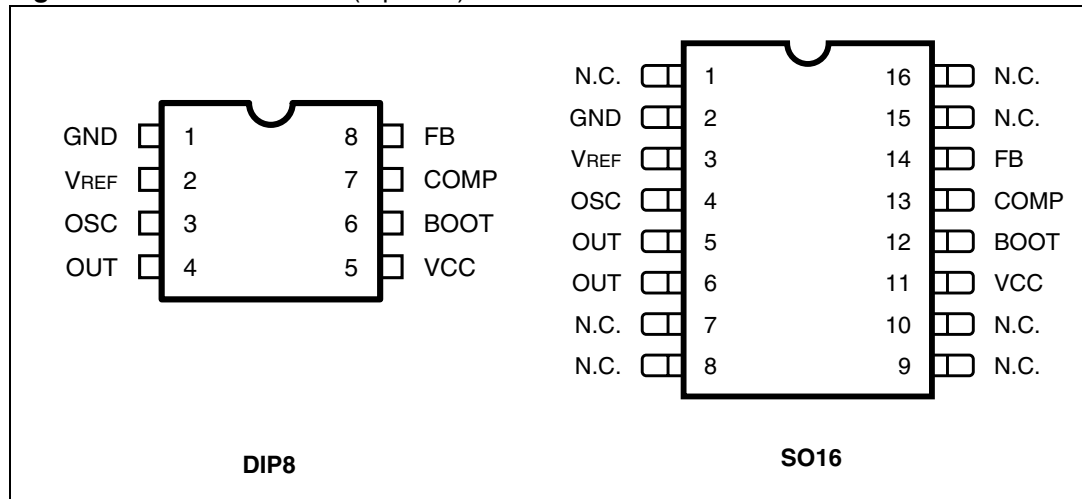
Figure 2. Block diagram



## 2 Pin settings

### 2.1 Pin connection

Figure 3. Pin connection (top view)



### 2.2 Pin description

Table 1. Pin description

| N° Pin |                      | Name | Description                                                                                                                                                                                                    |
|--------|----------------------|------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| DIP8   | SO16W <sup>(1)</sup> |      |                                                                                                                                                                                                                |
| 1      | 2                    | GND  | Ground                                                                                                                                                                                                         |
| 2      | 3                    | VREF | 5.1V Reference voltage with 20mA current capability.                                                                                                                                                           |
| 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  | Unregulated 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 to this pin results in an output voltage of 3.3V. An external resistive divider is required for higher output voltages.                                           |

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

### 3 Electrical data

#### 3.1 Maximum ratings

Table 2. Absolute maximum ratings

| Symbol                           |         | Parameter                                     | Value          | Unit |   |
|----------------------------------|---------|-----------------------------------------------|----------------|------|---|
| DIP8                             | S016W   |                                               |                |      |   |
| V5                               | V11     | Input voltage                                 | 58             | V    |   |
| V4                               | V5, V6  | Output DC voltage                             | -1             | V    |   |
|                                  |         | Output peak voltage at t = 0.1μs, f = 200kHz  | -5             | V    |   |
| I4                               | I5, I6  | Maximum output current                        | internal limit |      |   |
| V6-V5                            | V12-V11 |                                               | 14             | V    |   |
| V6                               | V12     | Bootstrap voltage                             | 70             | V    |   |
| V7                               | V13     | Analogs input voltage (V <sub>CC</sub> = 24V) | 12             | V    |   |
| V8                               | V14     | (V <sub>CC</sub> = 20V)                       | 6              | V    |   |
|                                  |         |                                               | -0.3           | V    |   |
| P <sub>TOT</sub>                 |         | Power dissipation a T <sub>A</sub> ≤ 60°C     | DIP8           | 1    | W |
|                                  |         |                                               | SO16           | 0.8  | W |
| T <sub>J</sub> ,T <sub>STG</sub> |         | Junction and storage temperature              | -40 to 150     | °C   |   |

#### 3.2 Thermal data

Table 3. Thermal data

| Symbol     | Parameter                                   | DIP8              | S016W              | Unit               |
|------------|---------------------------------------------|-------------------|--------------------|--------------------|
| $R_{thJA}$ | Maximum thermal resistance junction-ambient | 90 <sup>(1)</sup> | 110 <sup>(1)</sup> | $^\circ\text{C/W}$ |

1. Package mounted on board

#### 3.3 Operating temperature rating

Table 4. Operating temperature rating

| Symbol | Parameter                  | Value      | Unit             |
|--------|----------------------------|------------|------------------|
| $T_J$  | Junction temperature range | -40 to 150 | $^\circ\text{C}$ |

## 4 Electrical characteristics

Table 5. Electrical characteristics

(T<sub>J</sub> = 25°C, C<sub>OSC</sub> = 2.7nF, R<sub>OSC</sub> = 20kΩ, V<sub>CC</sub> = 24V, unless otherwise specified.)

| Symbol                        | Parameter                                | Test condition                                                                                                                                  | Min   | Typ  | Max   | Unit |
|-------------------------------|------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------|-------|------|-------|------|
| <b>Dynamic characteristic</b> |                                          |                                                                                                                                                 |       |      |       |      |
| V <sub>I</sub>                | Operating input voltage range            | V <sub>O</sub> = 3.3 to 50V; I <sub>O</sub> = 1A <sup>(1)</sup>                                                                                 | 8     |      | 55    | V    |
| V <sub>O</sub>                | Output voltage                           | I <sub>O</sub> = 0.5A                                                                                                                           | 3.33  | 3.36 | 3.39  | V    |
|                               |                                          | I <sub>O</sub> = 0.2 to 1A                                                                                                                      | 3.292 | 3.36 | 3.427 | V    |
|                               |                                          | V <sub>CC</sub> = 8 to 55V <sup>(1)</sup>                                                                                                       | 3.22  | 3.36 | 3.5   | V    |
| V <sub>d</sub>                | Dropout voltage                          | V <sub>CC</sub> = 10V; I <sub>O</sub> = 1A                                                                                                      |       | 0.29 | 0.367 | V    |
|                               |                                          | <sup>(1)</sup>                                                                                                                                  |       |      | 0.587 | V    |
| I <sub>l</sub>                | Maximum limiting current                 | V <sub>CC</sub> = 8 to 55V <sup>(1)</sup>                                                                                                       | 1.5   | 2    | 2.5   | A    |
|                               | Efficiency                               | V <sub>O</sub> = 3.3V; I <sub>O</sub> = 1A                                                                                                      |       | 85   |       | %    |
| f <sub>s</sub>                | Switching frequency                      | <sup>(1)</sup>                                                                                                                                  | 90    | 100  | 110   | KHz  |
| SVRR                          | Supply voltage ripple rejection          | V <sub>I</sub> = V <sub>CC</sub> + 2V <sub>RMS</sub> ; V <sub>O</sub> = V <sub>ref</sub> ;<br>I <sub>O</sub> = 1.A; f <sub>ripple</sub> = 100Hz | 60    |      |       | dB   |
|                               | Voltage stability of switching frequency | V <sub>CC</sub> = 8 to 55V                                                                                                                      |       | 3    | 6     | %    |
|                               | Temp. stability of switching frequency   | T <sub>J</sub> = 0 to 125°C                                                                                                                     |       | 4    |       | %    |
| <b>Reference section</b>      |                                          |                                                                                                                                                 |       |      |       |      |
|                               | Reference voltage                        |                                                                                                                                                 | 5.0   | 5.1  | 5.2   | V    |
|                               |                                          | I <sub>ref</sub> = 0 to 10mA; <sup>(1)</sup>                                                                                                    | 4.950 | 5.1  | 5.250 | V    |
|                               |                                          | V <sub>CC</sub> = 8 to 55V                                                                                                                      |       |      |       |      |
|                               | Line regulation                          | I <sub>ref</sub> = 0mA;                                                                                                                         |       | 5    | 10    | mV   |
|                               |                                          | V <sub>CC</sub> = 8 to 55V                                                                                                                      |       |      |       |      |
|                               | Load regulation                          | V <sub>ref</sub> = 0 to 5mA;                                                                                                                    |       | 2    | 10    | mV   |
|                               |                                          | V <sub>CC</sub> = 0 to 20mA                                                                                                                     |       | 6    | 25    | mV   |
|                               | Short circuit current                    |                                                                                                                                                 | 30    | 65   | 100   | mA   |

Table 5. Electrical characteristics (continued)

(T<sub>J</sub> = 25°C, C<sub>OSC</sub> = 2.7nF, R<sub>OSC</sub> = 20kΩ, V<sub>CC</sub> = 24V, unless otherwise specified.)

| Symbol                    | Parameter                             | Test condition                                                       | Min  | Typ  | Max  | Unit  |
|---------------------------|---------------------------------------|----------------------------------------------------------------------|------|------|------|-------|
| <b>DC Characteristics</b> |                                       |                                                                      |      |      |      |       |
| I <sub>qop</sub>          | Total operating quiescent current     |                                                                      |      | 4    | 6    | mA    |
| I <sub>q</sub>            | Quiescent current                     | Duty Cycle = 0; V <sub>FB</sub> = 3.8V                               |      | 2.5  | 3.5  | mA    |
| <b>Error Amplifier</b>    |                                       |                                                                      |      |      |      |       |
| V <sub>FB</sub>           | Voltage feedback input                |                                                                      | 3.33 | 3.36 | 3.39 | V     |
| R <sub>L</sub>            | Line regulation                       | V <sub>CC</sub> = 8 to 55V                                           |      | 5    | 10   | mV    |
|                           | Ref. voltage stability vs temperature | (1)                                                                  |      | 0.4  |      | mV/°C |
| V <sub>oH</sub>           | High level output voltage             | V <sub>FB</sub> = 2.5V                                               | 10.3 |      |      | V     |
| V <sub>oL</sub>           | Low level output voltage              | V <sub>FB</sub> = 3.8V                                               |      |      | 0.65 | V     |
| I <sub>O source</sub>     | Source output current                 | V <sub>comp</sub> = 6V; V <sub>FB</sub> = 2.5V                       | 180  | 220  |      | μA    |
| I <sub>O sink</sub>       | Sink output current                   | V <sub>comp</sub> = 6V; V <sub>FB</sub> = 3.8V                       | 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> = 8 to 55V     | 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          |      | 2.5  |      | ms    |
| <b>Oscillator section</b> |                                       |                                                                      |      |      |      |       |
|                           | Ramp valley                           |                                                                      | 0.78 | 0.85 | 0.92 | V     |
|                           | Ramp peak                             | V <sub>CC</sub> = 8V                                                 | 2    | 2.15 | 2.3  | V     |
|                           |                                       | V <sub>CC</sub> = 55V                                                | 9    | 9.6  | 10.2 | V     |
|                           | Maximum duty cycle                    |                                                                      | 95   | 97   |      | %     |
|                           | Maximum frequency                     | Duty cycle = 0%<br>R <sub>osc</sub> = 13kW, C <sub>osc</sub> = 820pF |      |      | 300  | kHz   |

1. Specification referred to T<sub>J</sub> from 0 to 125°C

# 5 Typical characteristics

Figure 4. Quiescent drain current vs. input voltage

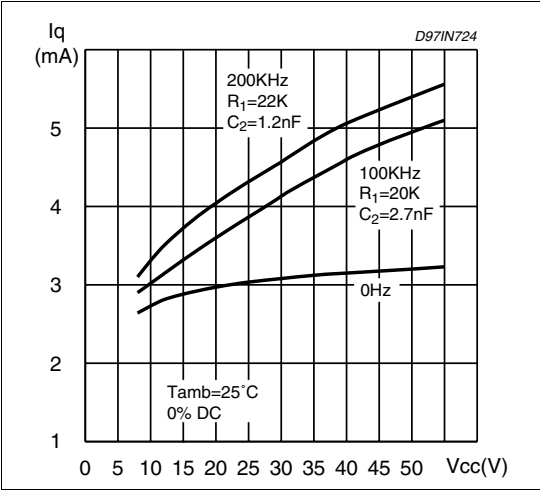


Figure 5. Line regulation

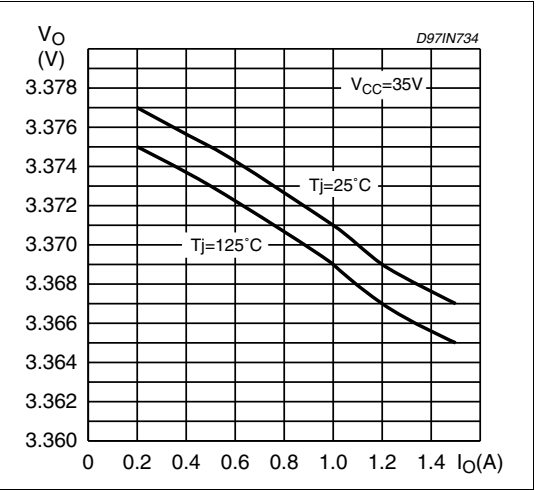


Figure 6. Quiescent current vs. junction temperature

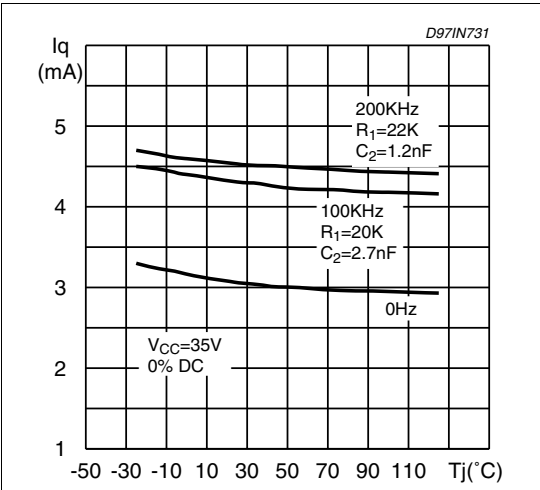


Figure 7. Switching frequency vs. R1 and C2

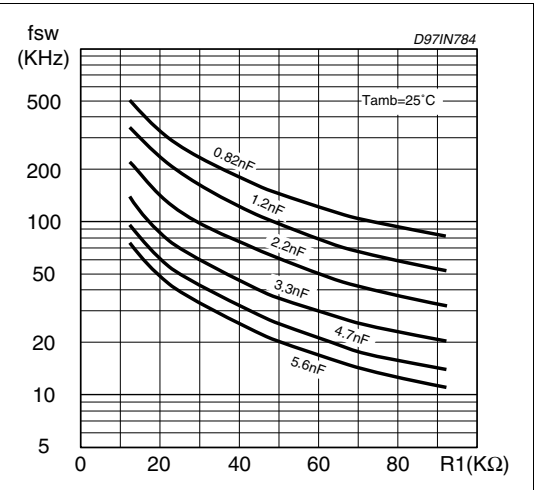


Figure 8. Load regulation

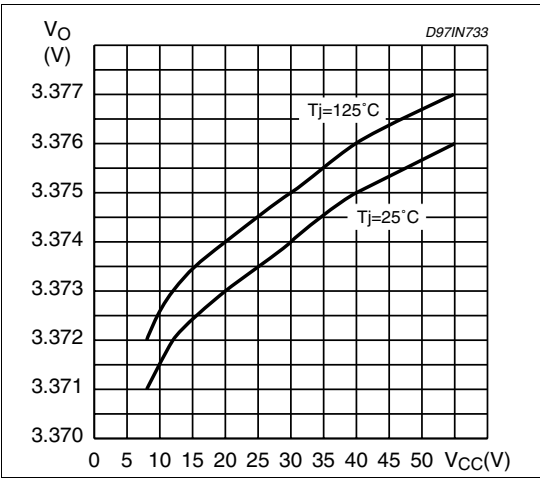


Figure 9. Switching frequency vs. input voltage

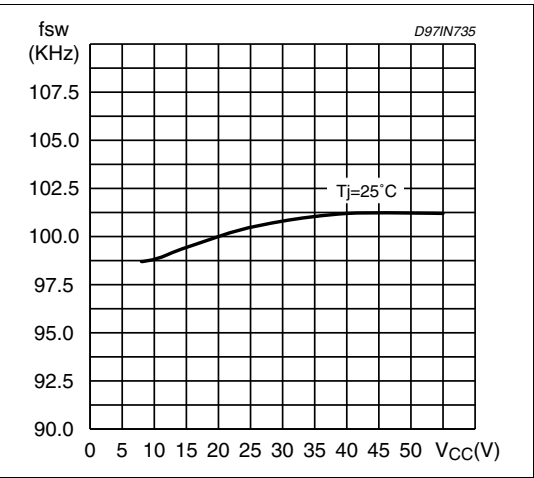


Figure 10. Switching frequency vs. junction temperature

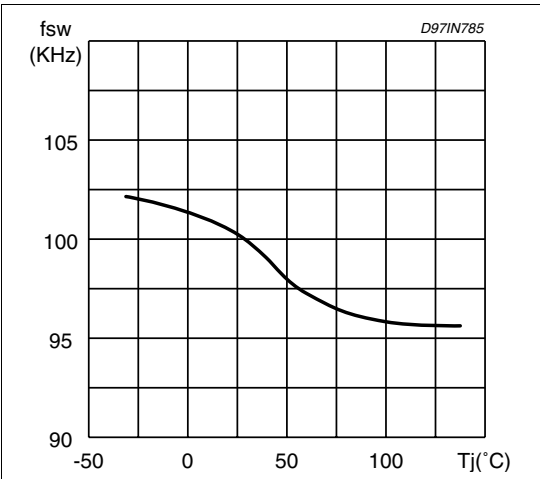


Figure 11. Efficiency vs. output current

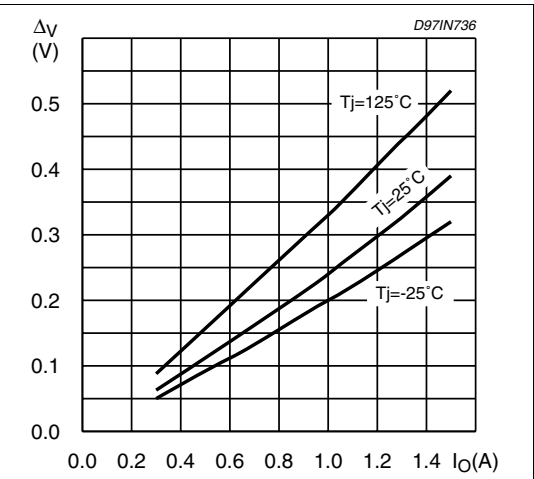


Figure 12. Dropout voltage between pin 5 and 4

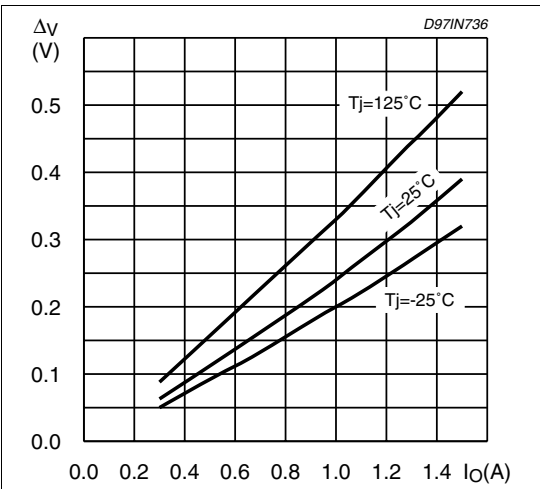


Figure 13. Efficiency vs. output current

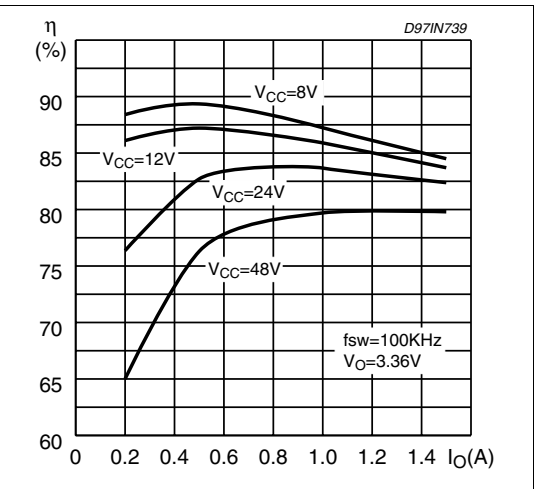


Figure 14. Efficiency vs output voltage

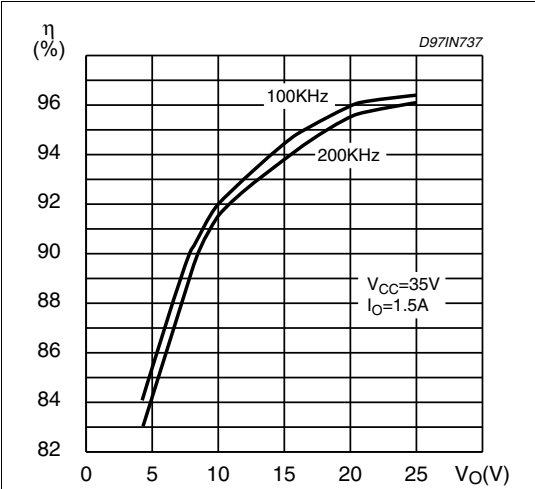


Figure 15. Efficiency vs. output current

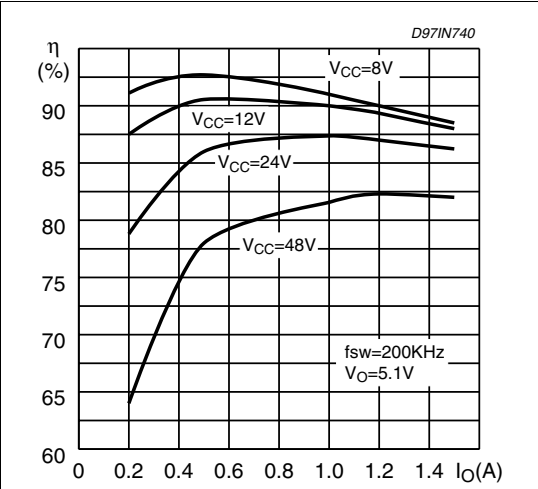


Figure 16. Efficiency vs. output current

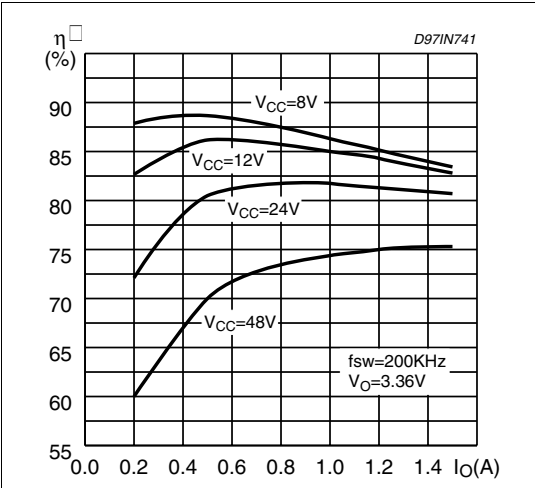


Figure 17. Efficiency vs. V\_O

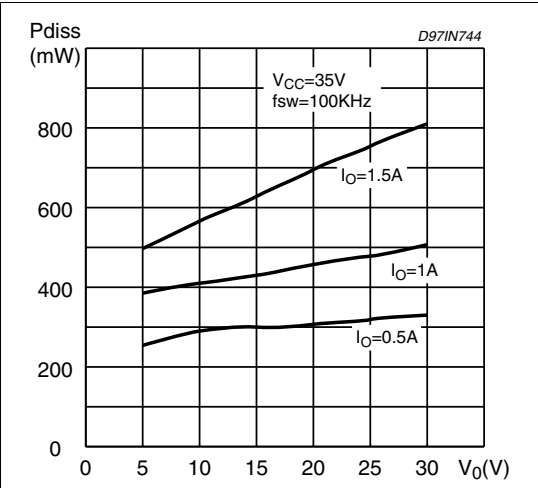


Figure 18. Efficiency vs.  $V_{CC}$

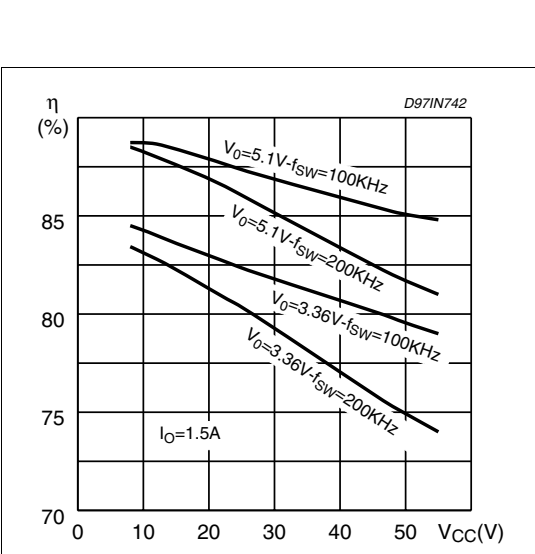


Figure 19. Pulse by pulse limiting current vs. junction temperature.

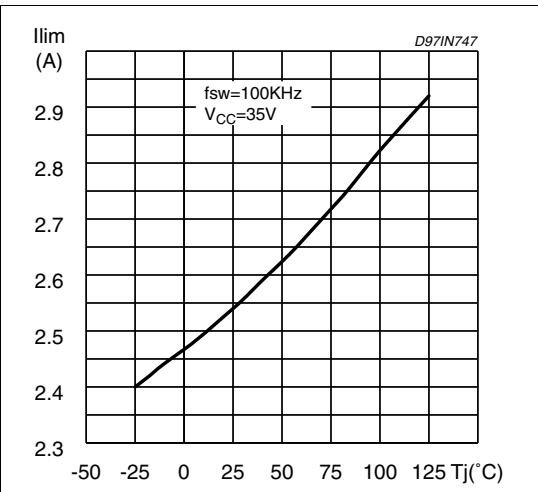


Figure 20. Power dissipation vs.  $V_{CC}$

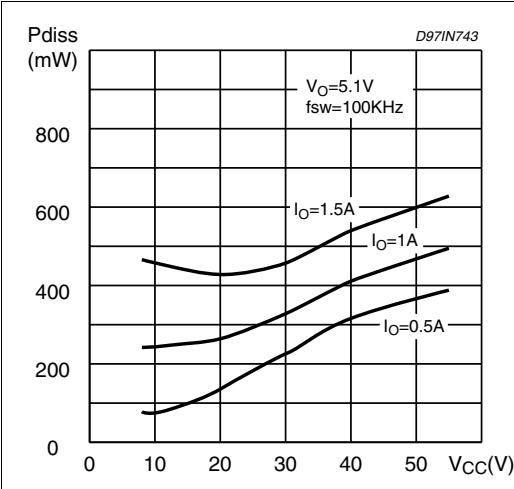


Figure 21. Load transient

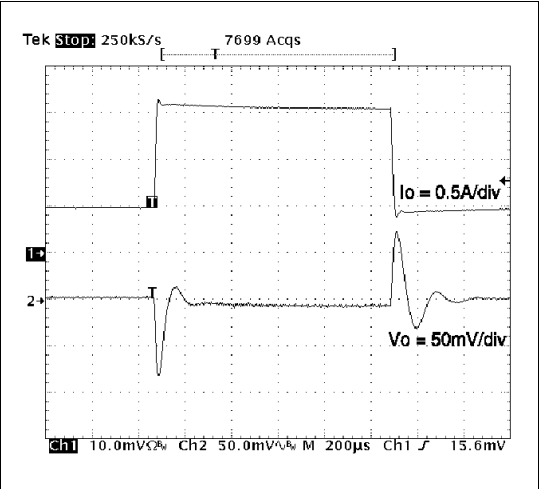


Figure 22. Line transient

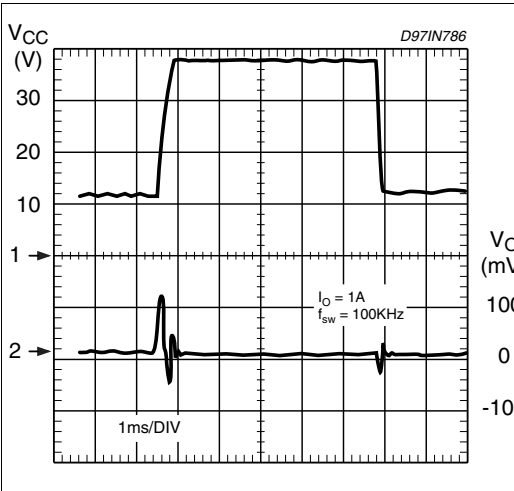
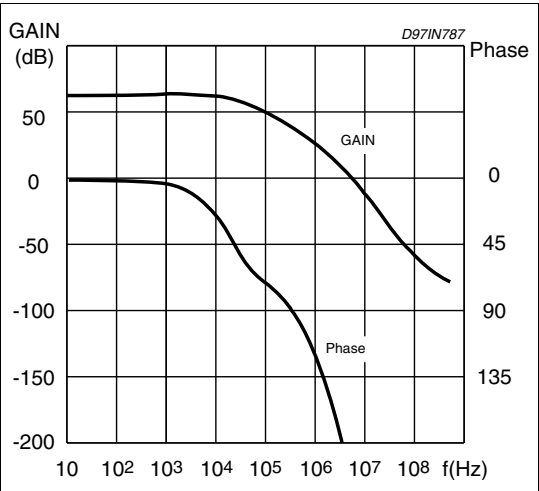


Figure 23. Open loop frequency and phase of error amplifier



## 6 Package mechanical data

In order to meet environmental requirements, ST offers these devices in ECOPACK® packages. These packages have a Lead-free second level interconnect . The category of second level interconnect is marked on the package and on the inner box label, in compliance with JEDEC Standard JESD97. The maximum ratings related to soldering conditions are also marked on the inner box label. ECOPACK is an ST trademark. ECOPACK specifications are available at: [www.st.com](http://www.st.com)

Figure 24. DIP8 mechanical data & package dimensions

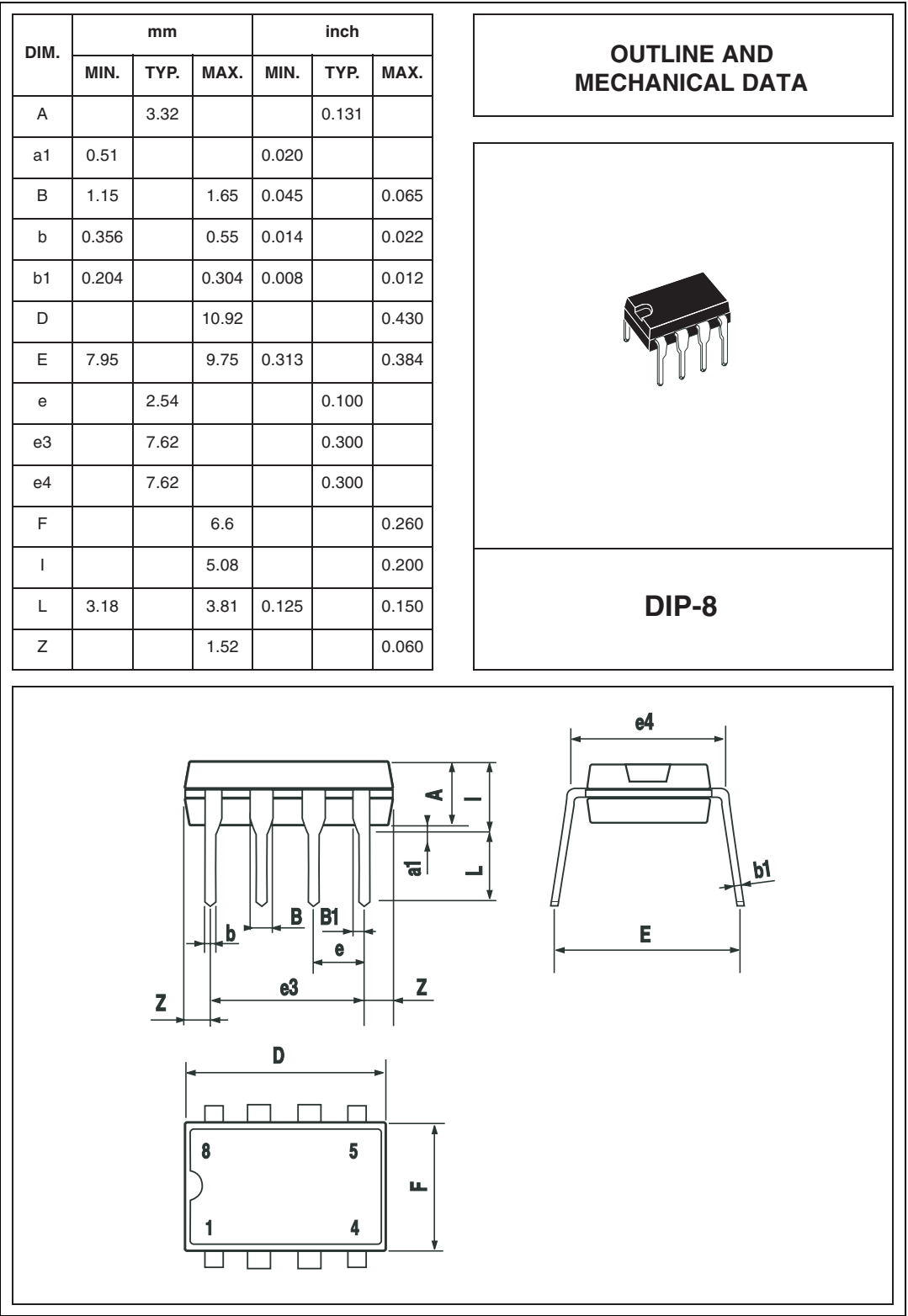
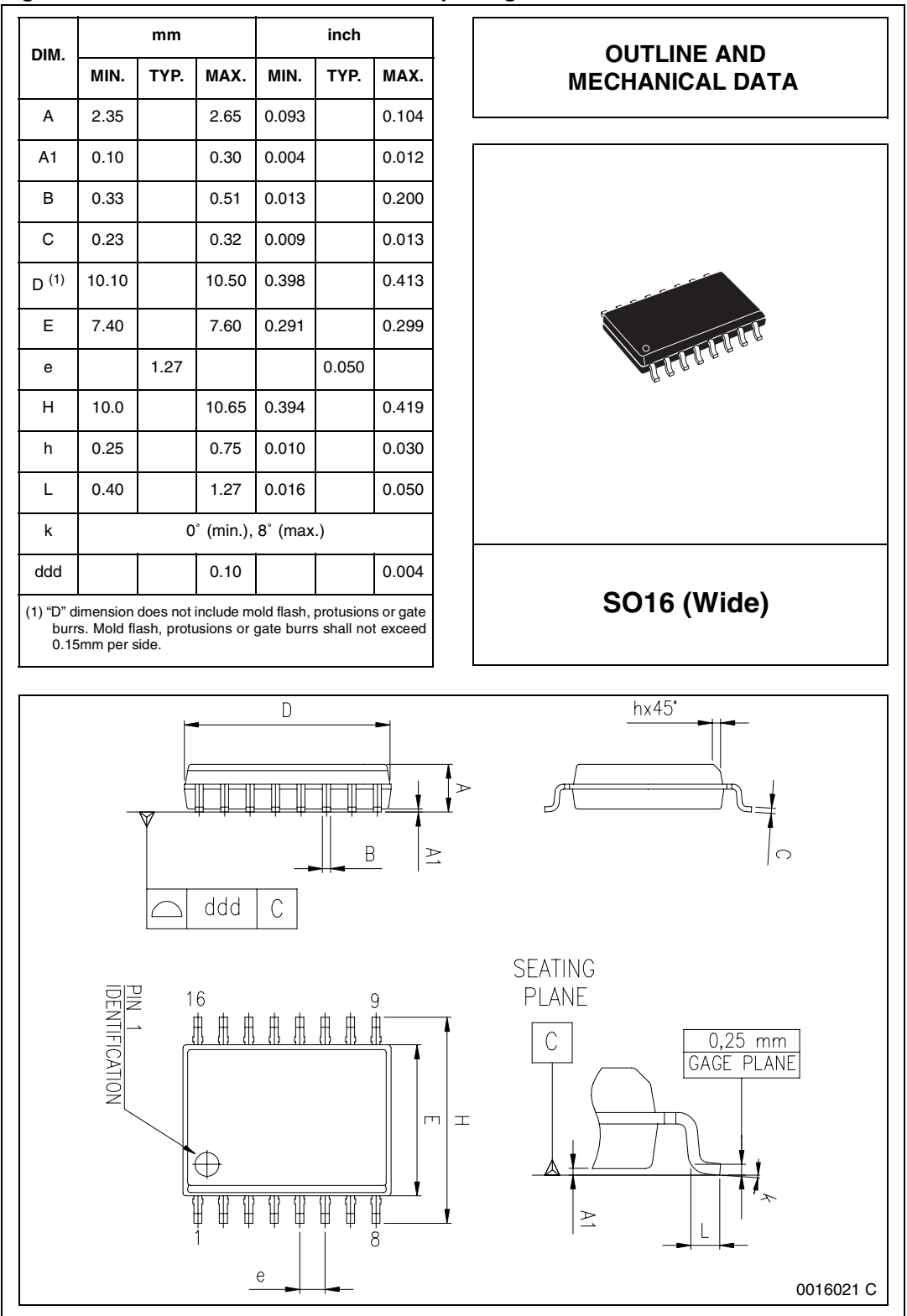


Figure 25. SO16Wide mechanical data & package dimensions



## 7 Order code

**Table 6. Order code**

| Part number | Package | Packaging     |
|-------------|---------|---------------|
| L4976       | DIP8    | Tube          |
| L4976D      | SO16W   | Tube          |
| L4976D013TR | SO16W   | Tape and reel |

## 8 Revision history

**Table 7. Revision history**

| Date       | Revision | Changes                                                                                   |
|------------|----------|-------------------------------------------------------------------------------------------|
| 5-Aug-2001 | 6        | First Issue                                                                               |
| 3-Apr-2007 | 7        | Document reformatted, updated dropout voltage values in <a href="#">Table 5 on page 6</a> |

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