



- UP TO 3.5A STEP DOWN CONVERTER
- OPERATING INPUT VOLTAGE FROM 8V TO 55V
- 3.3V AND 5.1V ( $\pm 1\%$ ) FIXED OUTPUT, AND ADJUSTABLE OUTPUTS FROM:  
0V TO 50V (3.3V type)  
5.1V TO 50V (5.1 type)
- FREQUENCY ADJUSTABLE UP TO 300KHZ
- VOLTAGE FEED FORWARD
- ZERO LOAD CURRENT OPERATION (min 1mA)
- INTERNAL CURRENT LIMITING (PULSE BY PULSE AND HICCUP MODE)
- PRECISE 5.1V (1.5%) REFERENCE VOLTAGE EXTERNALLY AVAILABLE
- INPUT/OUTPUT SYNCHRONIZATION FUNCTION
- INHIBIT FOR ZERO CURRENT CONSUMPTION (100 $\mu$ A Typ. at  $V_{CC} = 24V$ )
- PROTECTION AGAINST FEEDBACK DISCONNECTION
- THERMAL SHUTDOWN
- OUTPUT OVERVOLTAGE PROTECTION
- SOFT START FUNCTION



L4973V3.3 (Powerdip)  
L4973D3.3 (SO20)  
L4973V5.1 (Powerdip)  
L4973D5.1 (SO20)

The L4973 is a step down monolithic power switching regulator delivering 3.5A at fixed voltages of 3.3V or 5.1V and using a simple external divider output adjustable voltage up to 50V.

### TYPICAL APPLICATION CIRCUIT (POWERDIP)



## L4973V3.3 - L4973V5.1 - L4973D3.3 - L4973D5.1

uses an internal power D-MOS transistor (with a typical  $R_{ds(on)}$  of 0.15ohm) to obtain very high efficiency and very fast switching times.

Switching frequency up to 300KHz are achievable (the maximum power dissipation of the packages must be observed).

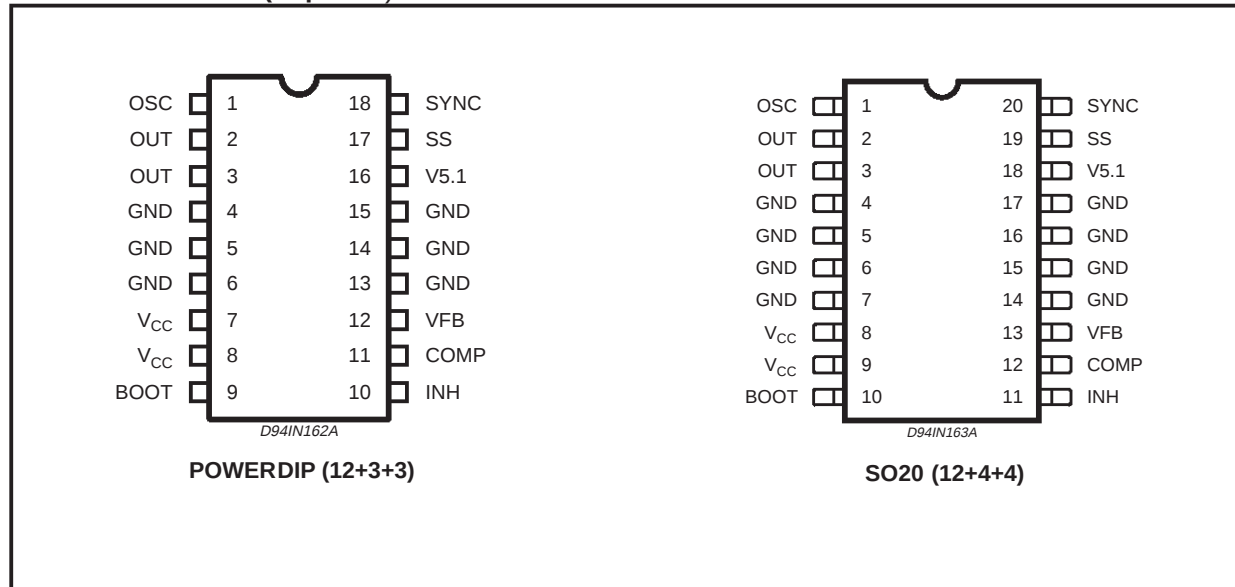
A wide input voltage range between 8V to 55V and output voltages regulated from 3.3V to 40V cover the majority of the today applications.

Features of this new generation of DC-DC con-

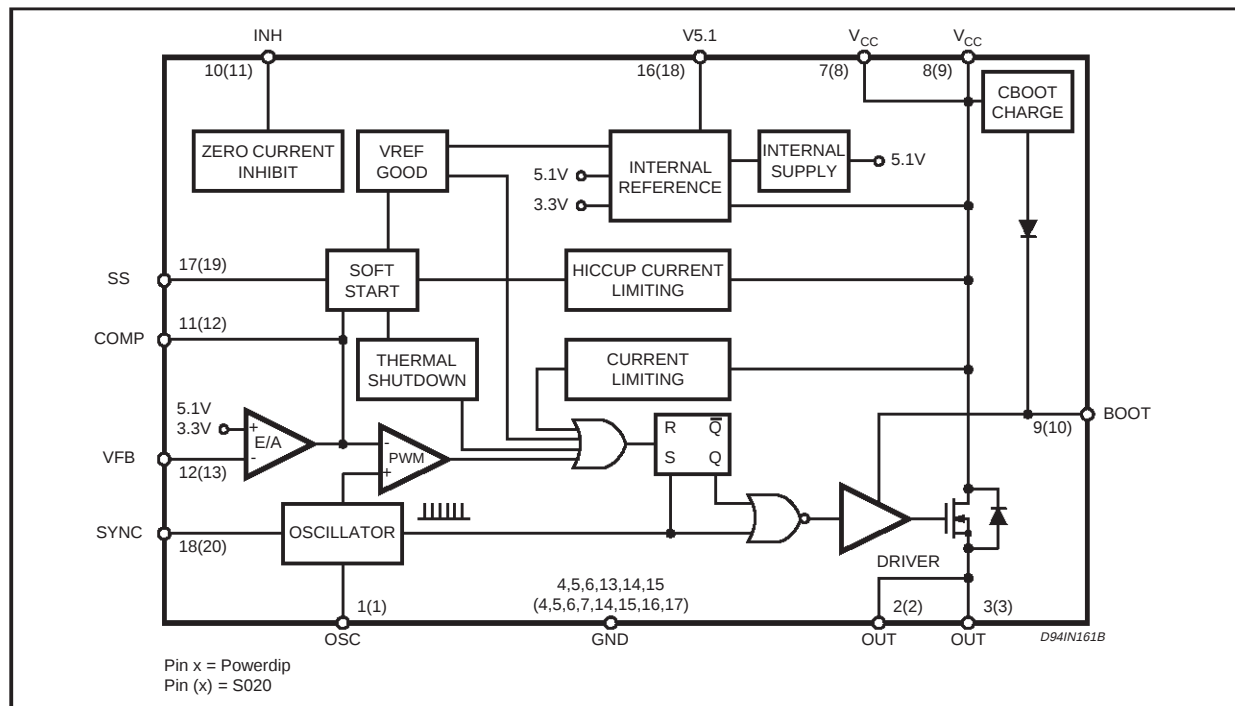
verter includes pulse by pulse current limit, hiccup mode for output short circuit protection, voltage feed forward regulation, soft start, input/output synchronization, protection against feedback loop disconnection, inhibit for zero current consumption and thermal shutdown.

Packages available are in plastic dual in line, DIP-18 (12+3+3) for standard assembly, and SO20 (12+4+4) for SMD assembly.

### PIN CONNECTIONS (Top view)



### BLOCK DIAGRAM



**THERMAL DATA**

| Symbol          | Parameter                          | Powerdip    | SO20   | Unit |
|-----------------|------------------------------------|-------------|--------|------|
| $R_{th(j-pin)}$ | Thermal Resistance Junction to pin | Max. 12     | 15     | °C/W |
| $R_{th(j-amb)}$ | Thermal Resistance to Ambient      | Max. 60 (*) | 80 (*) | °C/W |

(\*) Package mounted on board.

**ABSOLUTE MAXIMUM RATINGS**

| Symbol         |              | Parameter                                                                                                                                      | Value            | Unit                         |
|----------------|--------------|------------------------------------------------------------------------------------------------------------------------------------------------|------------------|------------------------------|
| DIP-18         | SO-20        |                                                                                                                                                |                  |                              |
| $V_7, V_8$     | $V_9, V_8$   | Input voltage                                                                                                                                  | 58               | V                            |
| $V_2, V_3$     | $V_2, V_3$   | Output DC voltage                                                                                                                              | -1               | V                            |
|                |              | Output peak voltage at $t = 0.1\mu s$ $f = 200KHz$                                                                                             | -5               | V                            |
| $I_2, I_3$     | $I_2, I_3$   | Maximum output current                                                                                                                         | int. limit.      |                              |
| $V_9-V_8$      | $V_{10}-V_8$ |                                                                                                                                                | 14               | V                            |
| $V_9$          | $V_{10}$     | Bootstrap voltage                                                                                                                              | 70               | V                            |
| $V_{11}$       | $V_{12}$     | Analog input voltage ( $V_{CC} = 24V$ )                                                                                                        | 12               | V                            |
| $V_{17}$       | $V_{19}$     | Analog input voltage ( $V_{CC} = 24V$ )                                                                                                        | 13               | V                            |
| $V_{12}$       | $V_{13}$     | ( $V_{CC} = 20V$ )                                                                                                                             | 6<br>-0.3        | V<br>V                       |
| $V_{18}$       | $V_{20}$     | ( $V_{CC} = 20V$ )                                                                                                                             | 5.5<br>-0.3      | V<br>V                       |
| $V_{10}$       | $V_{11}$     | Inhibit                                                                                                                                        | $V_{CC}$<br>-0.3 | V<br>V                       |
| $P_{tot}$      |              | Power dissipation a $T_{pins} \leq 90^\circ C$<br>( $T_{amb} = 70^\circ C$ no copper area)<br>( $T_{amb} = 70^\circ C$ 4cm copper area on PCB) | DIP<br>12+3+3    | 5<br>1.3<br>2<br>W<br>W<br>W |
|                |              | Power dissipation a $T_{pins} = 90^\circ C$                                                                                                    | SO20             | 4<br>W                       |
|                |              |                                                                                                                                                |                  |                              |
| $T_J, T_{STG}$ |              | Junction and storage temperature                                                                                                               | -40 to 150       | °C                           |

**PIN FUNCTIONS**

| Powerdip          | SO20                   | NAME | DESCRIPTION                                                                                                                                                                                                                                                              |
|-------------------|------------------------|------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 11                | 12                     | COMP | E/A output to be used for frequency compensation                                                                                                                                                                                                                         |
| 10                | 11                     | INH  | A logic signal (active high) disables the device (sleep mode operation). If not used it must be connected to GND; if floating the device is disabled.                                                                                                                    |
| 9                 | 10                     | BOOT | A capacitor connected between this pin and the output allows to drive the internal D-MOS.                                                                                                                                                                                |
| 18                | 20                     | SYNC | Input/Output synchronization.                                                                                                                                                                                                                                            |
| 7,8               | 8,9                    | Vcc  | Unregulated DC input voltage                                                                                                                                                                                                                                             |
| 2,3               | 2,3                    | OUT  | Stepdown regulator output.                                                                                                                                                                                                                                               |
| 12                | 13                     | VFB  | Stepdown feedback input. Connecting the output directly to this pin results in an output voltage of 3.3V for the L4973V3.3 and 5.1V. An external resistive divider is required for higher output voltages. For output voltage less than 3.3V, see note ** and Figure 32. |
| 16                | 18                     | V5.1 | Reference voltage externally available.                                                                                                                                                                                                                                  |
| 4,5,6<br>13,14,15 | 4,5,6,7<br>14,15,16,17 | GND  | Signal ground                                                                                                                                                                                                                                                            |
| 1                 | 1                      | OSC  | An external resistor connected between the unregulated input voltage and Pin 1 and a capacitor connected from Pin 1 to ground fixes the switching frequency. (Line feed forward is automatically obtained)                                                               |

## L4973V3.3 - L4973V5.1 - L4973D3.3 - L4973D5.1

**ELECTRICAL CHARACTERISTICS** ( Refer to the test circuit,  $V_{CC} = 24V$ ;  $T_j = 25^\circ C$ ,  $C_{osc} = 2.7nF$ ;  $R_{osc} = 20K\Omega$ ; unless otherwise specified) • = specifications referred to  $T_j$  from 0 to  $125^\circ C$ .

| Symbol                  | Parameter                                        | Test Conditions                                                                                                                             |   | Min.  | Typ.   | Max.     | Unit     |
|-------------------------|--------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------|---|-------|--------|----------|----------|
| DYNAMIC CHARACTERISTICS |                                                  |                                                                                                                                             |   |       |        |          |          |
|                         | Input Voltage Range (*)                          | V <sub>O</sub> = V <sub>REF</sub> to 40V; I <sub>O</sub> = 3.5A                                                                             | ● | 8     |        | 55       | V        |
|                         | Output Voltage<br>L4973V5.1                      | I <sub>O</sub> = 1A                                                                                                                         |   | 5.05  | 5.1    | 5.15     | V        |
|                         |                                                  | I <sub>O</sub> = 0.5A to 3.5A                                                                                                               |   | 5.00  | 5.1    | 5.20     | V        |
|                         |                                                  | V <sub>CC</sub> = 8V to 55V                                                                                                                 | ● | 4.95  | 5.1    | 5.25     | V        |
|                         | Output Voltage<br>L4973V3.3                      | I <sub>O</sub> = 1A                                                                                                                         |   | 3.326 | 3.36   | 3.393    | V        |
|                         |                                                  | I <sub>O</sub> = 0.5A to 3.5A                                                                                                               |   | 3.292 | 3.36   | 3.427    | V        |
|                         |                                                  | V <sub>CC</sub> = 8V to 40V                                                                                                                 | ● | 3.26  | 3.36   | 3.46     | V        |
|                         | R <sub>DS(on)</sub>                              | V <sub>CC</sub> = 10.5V                                                                                                                     |   |       | 0.15   | 0.22     | Ω        |
|                         |                                                  | I <sub>O</sub> = 3.5A                                                                                                                       | ● |       |        | 0.35     | Ω        |
|                         | Maximum Limiting Current                         | V <sub>CC</sub> = 8V to 55V                                                                                                                 | ● | 4     | 4.5    | 5.5      | A        |
| η                       | Efficiency                                       | V <sub>O</sub> = 5.1V; I <sub>O</sub> = 3.5A                                                                                                |   |       | 90     |          | %        |
|                         |                                                  | V <sub>O</sub> = 3.3V; I <sub>O</sub> = 3.5A                                                                                                |   |       | 85     |          | %        |
|                         | Switching Frequency                              |                                                                                                                                             | ● | 90    | 100    | 110      | KHz      |
|                         | Supply Voltage Ripple Rejection                  | V <sub>i</sub> = V <sub>CC</sub> +2V <sub>RMS</sub><br>V <sub>O</sub> = V <sub>ref</sub> ; I <sub>O</sub> = 1A; f <sub>ripple</sub> = 100Hz |   | 60    |        |          | dB       |
| Δf <sub>sw</sub>        | Switching Frequency Stability vs. Supply Voltage | V <sub>CC</sub> = 8V to 55V                                                                                                                 |   |       | 2      | 5        | %        |
| REFERENCE SECTION       |                                                  |                                                                                                                                             |   |       |        |          |          |
|                         | Reference Voltage                                |                                                                                                                                             |   | 5.025 | 5.1    | 5.175    | V        |
|                         |                                                  | I <sub>ref</sub> = 0 to 20mA;<br>V <sub>CC</sub> = 8 to 55V                                                                                 | ● | 4.950 | 5.1    | 5.250    | V        |
|                         | Line Regulation                                  | I <sub>ref</sub> = 0mA;<br>V <sub>CC</sub> = 8 to 55V                                                                                       |   |       | 5      | 10       | mV       |
|                         | Load Regulation                                  | V <sub>ref</sub> = 0 to 5mA;<br>V <sub>CC</sub> = 0 to 20mA                                                                                 |   |       | 2<br>6 | 10<br>25 | mV<br>mV |
|                         | Short Circuit Current                            |                                                                                                                                             |   | 30    | 65     | 100      | mA       |
| SOFT START              |                                                  |                                                                                                                                             |   |       |        |          |          |
|                         | Soft Start Charge Current                        |                                                                                                                                             |   | 30    | 45     | 60       | μA       |
|                         | Soft Start Discharge Current                     |                                                                                                                                             |   | 15    | 22     | 30       | μA       |
| INHIBIT                 |                                                  |                                                                                                                                             |   |       |        |          |          |
|                         | High Level Voltage                               |                                                                                                                                             | ● | 3.0   |        |          | V        |
|                         | Low Level Voltage                                |                                                                                                                                             | ● |       |        | 0.8      | V        |
|                         | I <sub>source</sub> High Level                   | V <sub>INH</sub> = 3V                                                                                                                       | ● | 10    | 16     | 50       | μA       |
|                         | I <sub>source</sub> Low Level                    | V <sub>INH</sub> = 0.8V                                                                                                                     | ● | 10    | 15     | 50       | μA       |
| DC CHARACTERISTICS      |                                                  |                                                                                                                                             |   |       |        |          |          |
|                         | Total Operating Quiescent Current                | Duty Cycle = 50%                                                                                                                            |   |       | 4      | 6        | mA       |
|                         | Quiescent Current                                | Duty Cycle = 0                                                                                                                              |   |       | 2.7    | 4        | mA       |
|                         | Total stand-by quiescent current                 | V <sub>CC</sub> = 24V; V <sub>INH</sub> = 5V                                                                                                |   |       | 100    | 200      | μA       |
|                         |                                                  | V <sub>CC</sub> = 55V; V <sub>INH</sub> = 5V                                                                                                |   |       | 150    | 300      | μA       |
| ERROR AMPLIFIER         |                                                  |                                                                                                                                             |   |       |        |          |          |
|                         | High Level Output Voltage                        |                                                                                                                                             |   | 11.0  |        |          | V        |
|                         | Low Level Output Voltage                         |                                                                                                                                             |   |       |        | 0.65     | V        |
|                         | Source Bias Current                              |                                                                                                                                             |   | 1     | 2      | 3        | μA       |
|                         | Source Output Current                            |                                                                                                                                             |   | 200   | 300    | 600      | μA       |

**ELECTRICAL CHARACTERISTICS** (continued)

|  |                                 |                                                                |     |     |  |         |
|--|---------------------------------|----------------------------------------------------------------|-----|-----|--|---------|
|  | Sink Output Current             |                                                                | 200 | 300 |  | $\mu$ A |
|  | Supply Voltage Ripple Rejection | $V_{COMP} = V_{FB}$<br>$C_{REF} = 4.7\mu F$ 1-5mA load current | 60  | 80  |  | dB      |
|  | DC Open Loop Gain               | $R_L = \infty$                                                 | 50  | 60  |  | dB      |
|  | Transconductance                | $I_{comp} = -0.1$ to $0.1$ mA;<br>$V_{comp} = 6$ V             |     | 2.5 |  | mS      |

**OSCILLATOR SECTION**

|  |                    |                                                                  |      |      |      |     |
|--|--------------------|------------------------------------------------------------------|------|------|------|-----|
|  | Ramp valley        |                                                                  | 0.78 | 0.85 | 0.92 | V   |
|  | Ramp peak          | $V_{CC} = 8$ V                                                   | 1.9  | 2.1  | 2.3  | V   |
|  |                    | $V_{CC} = 55$ V                                                  | 9    | 9.6  | 10.2 | V   |
|  | Maximum Duty Cycle |                                                                  | 95   | 97   |      | %   |
|  | Maximum Frequency  | Duty Cycle = 0%; $R_{OSC} = 13$ K $\Omega$ ; $C_{OSC} = 820$ pF; |      |      | 500  | KHz |

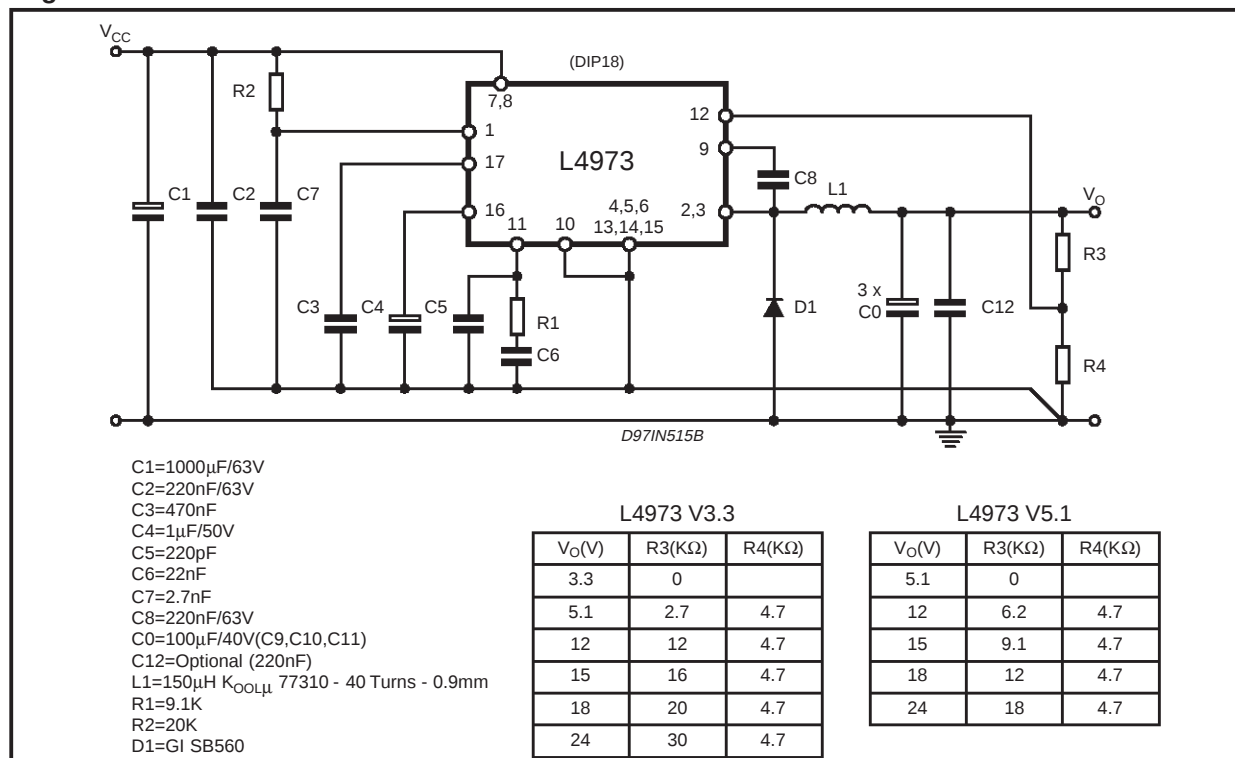
**SYNC FUNCTION**

|  |                         |                             |      |      |      |         |
|--|-------------------------|-----------------------------|------|------|------|---------|
|  | High Input Voltage      | $V_{CC} = 8$ V to $55$ V    | 3.5  |      |      | V       |
|  | Low Input Voltage       | $V_{CC} = 8$ V to $55$ V    |      |      | 0.9  | V       |
|  | Slave Sink Current      |                             | 0.15 | 0.25 | 0.45 | mA      |
|  | Master Output Amplitude | $I_{source} = 3$ mA         | 4    | 4.5  |      | V       |
|  | Output Pulse Width      | no load, $V_{sync} = 4.5$ V | 0.20 | 0.35 |      | $\mu$ s |

(\*) Pulse testing with a low duty cycle.

(\*\*) The maximum power dissipation of the package must be observed.

**Figure 1. Evaluation Board Circuit**

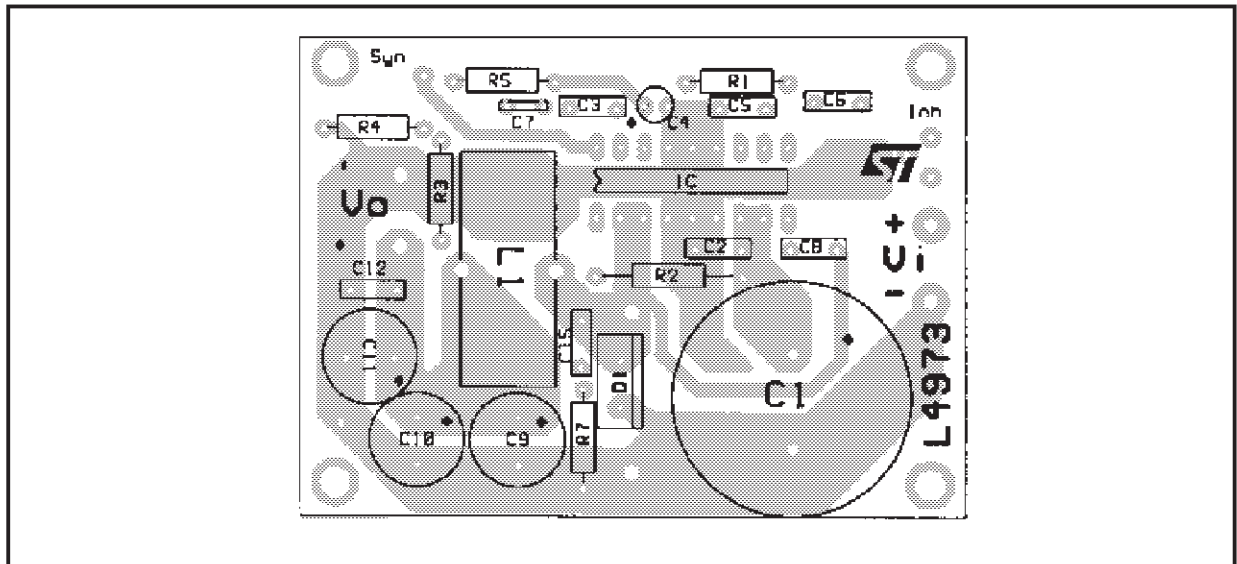


## L4973V3.3 - L4973V5.1 - L4973D3.3 - L4973D5.1

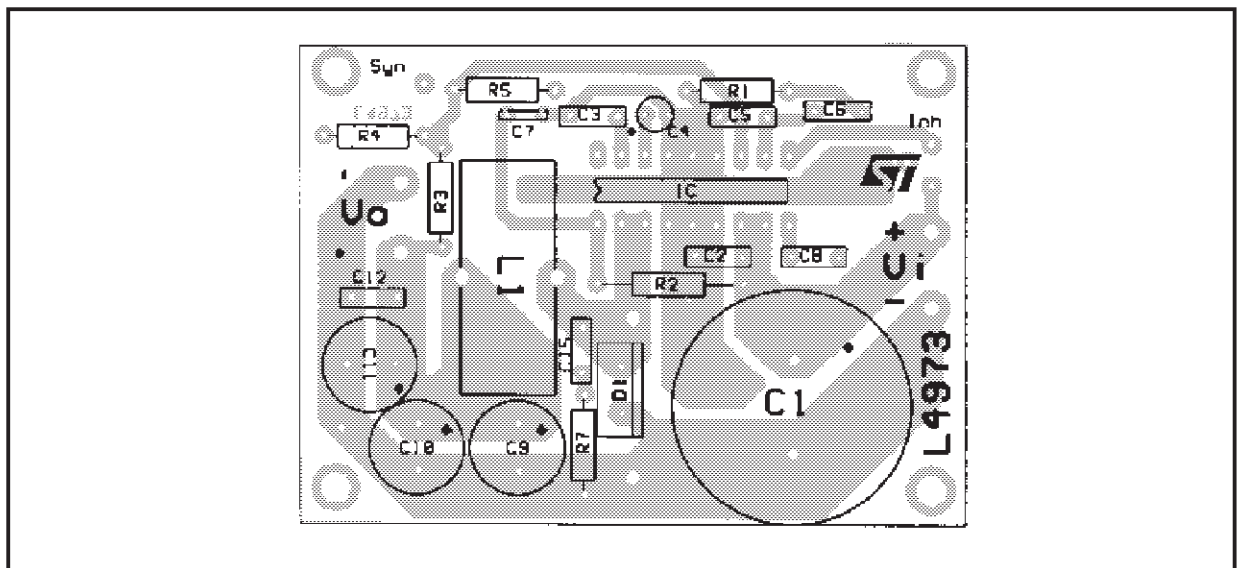
Typical Performance (Using Evaluation Board)  $f_{sw} = 100\text{kHz}$

| Output Voltage | Output Ripple | Efficiency | Line Regulator<br>$I_o = 3.5\text{A}$ $V_{CC} = 8$ to $50\text{V}$ | Load Regulator<br>$V_{CC} = 35\text{V}$ $I_o = 1$ to $3.5\text{A}$ |
|----------------|---------------|------------|--------------------------------------------------------------------|--------------------------------------------------------------------|
| 3.3V           | 20mV          | 81.5 (%)   | 3mV                                                                | 6mV                                                                |
| 5.1V           | 20mV          | 86.7 (%)   | 3mV                                                                | 6mV                                                                |
| 12V            | 30mV          | 93.5 (%)   | 3mV ( $V_{CC} = 15$ to $50\text{V}$ )                              | 4mV                                                                |

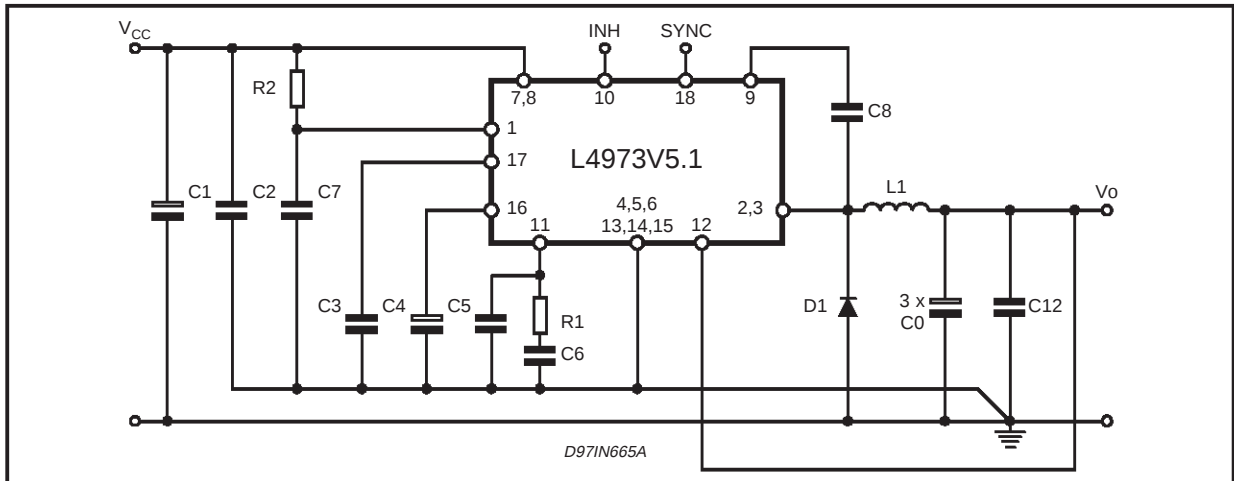
**Figure 1a:** Evaluation Board (Components Side)



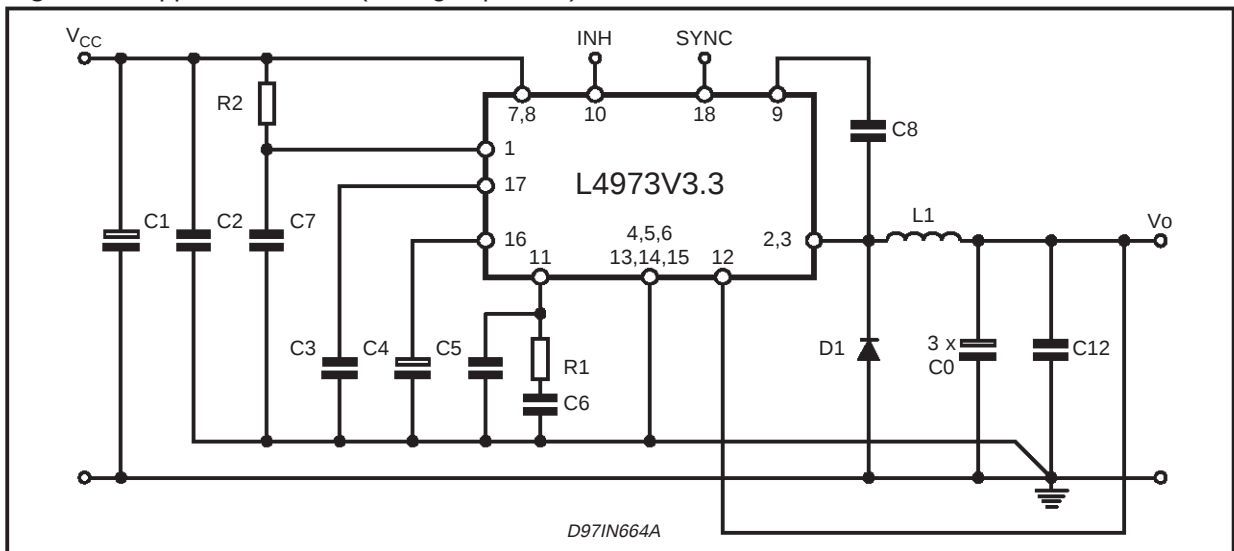
**Figure 1b:** Evaluation Board (Solder Side)



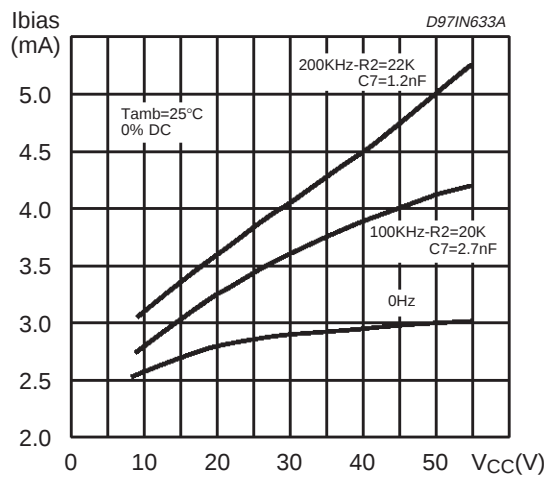
**Figure 1c:** Application Circuit (see fig. 1 part list)



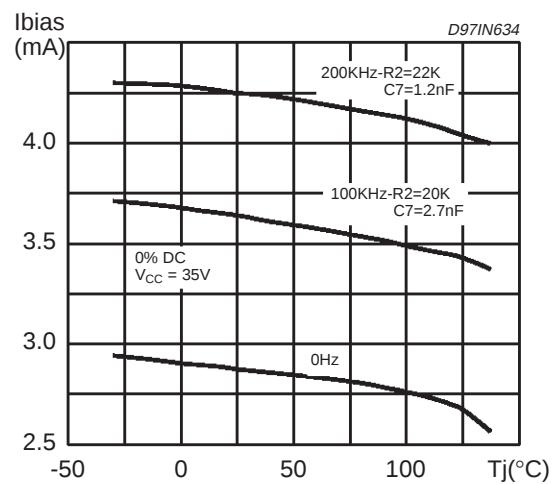
**Figure 1d:** Application Circuit (see fig. 1 part list)



**Figure 2:** Quiescent Drain Current vs. Input Voltage (0% Duty Cycle)

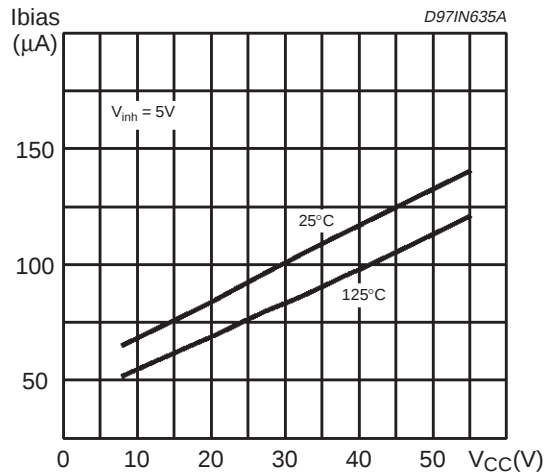


**Figure 3:** Quiescent Drain Current vs. Junction Temperature

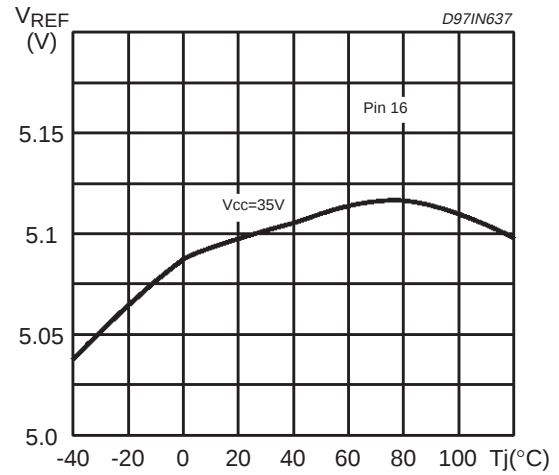


## L4973V3.3 - L4973V5.1 - L4973D3.3 - L4973D5.1

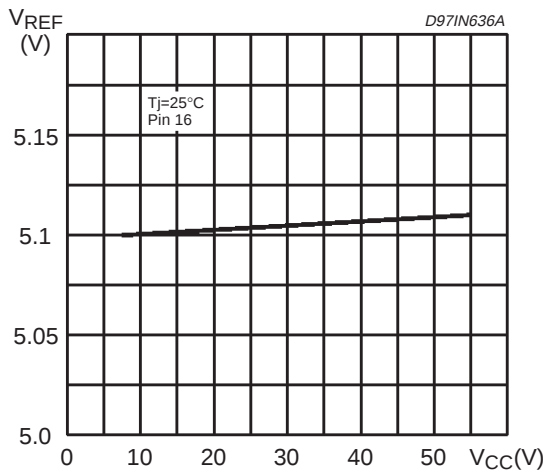
**Figure 4:** Stand by Drain Current vs. input Voltage



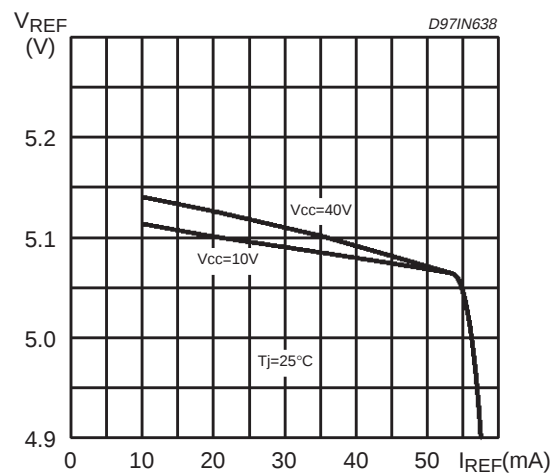
**Figure 5:** Reference Voltage vs. Junction Temperature (Pin 16)



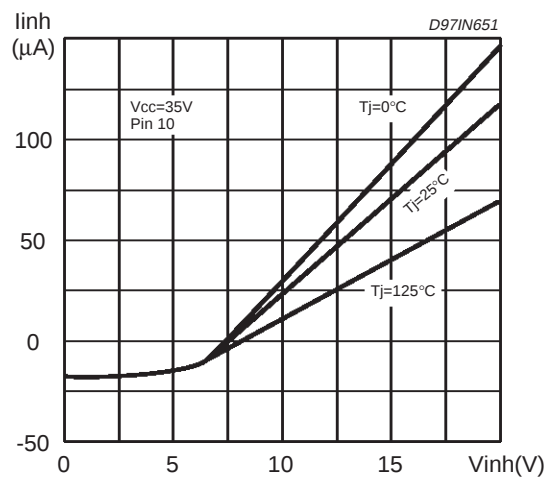
**Figure 6:** Reference Voltage vs. Input Voltage (Pin 16)



**Figure 7:** Reference Voltage vs. Reference Input Current



**Figure 8:** Inhibit Current vs. Inhibit Voltage (Pin 10)



**Figure 9:** Line Regulation (see fig. 1)

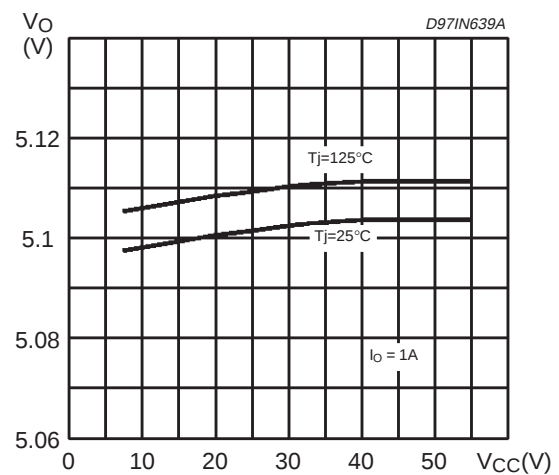


Figure 10: Load Regulation (see fig. 1c)

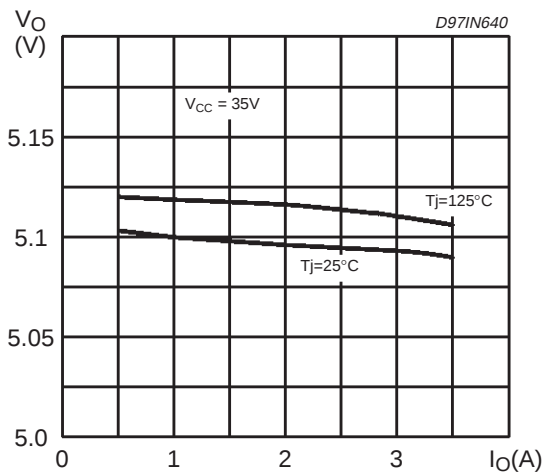


Figure 11: Line Regulation (see fig. 1d)

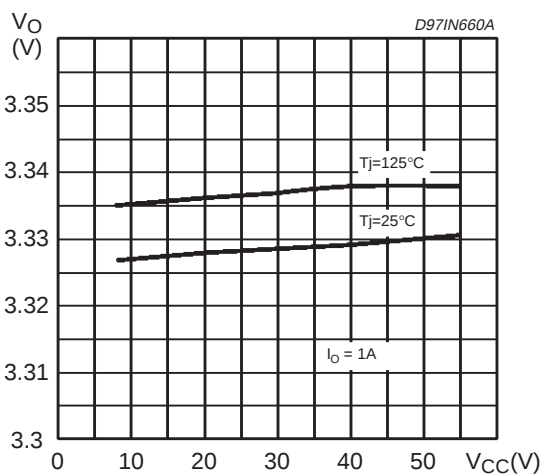


Figure 12: Load Regulation (see fig. 1d)

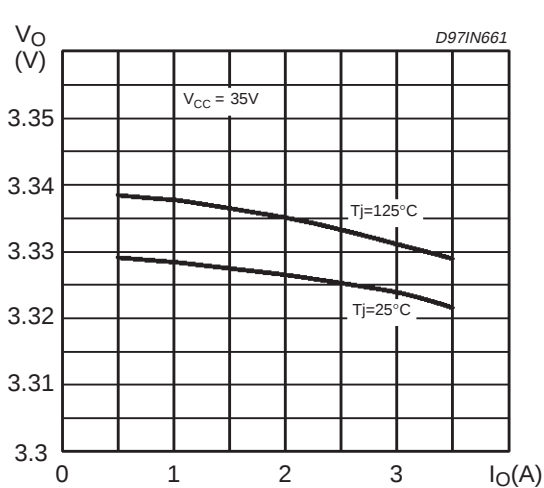


Figure 13: Switching Frequency vs. R2 and C7 (fig. 1)

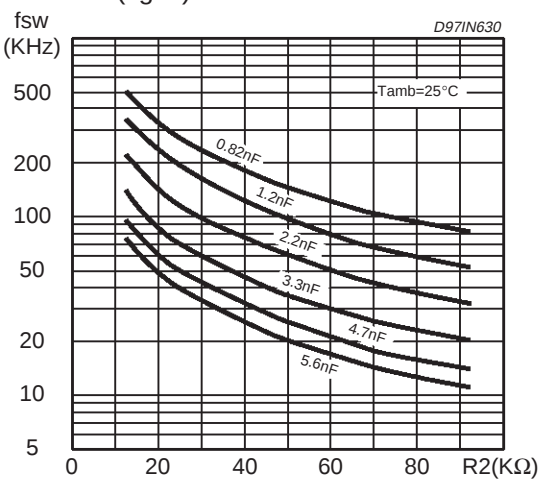


Figure 14: Switching Frequency vs. Input Voltage

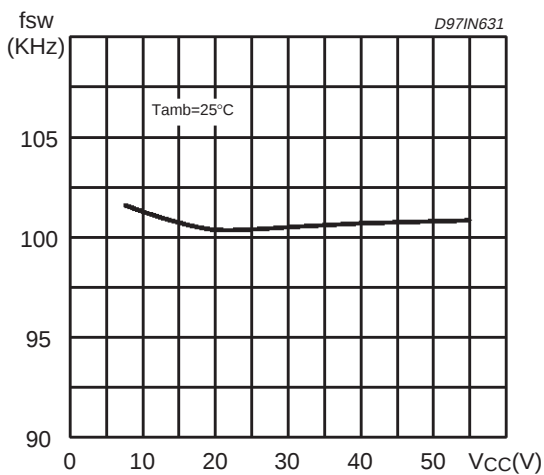
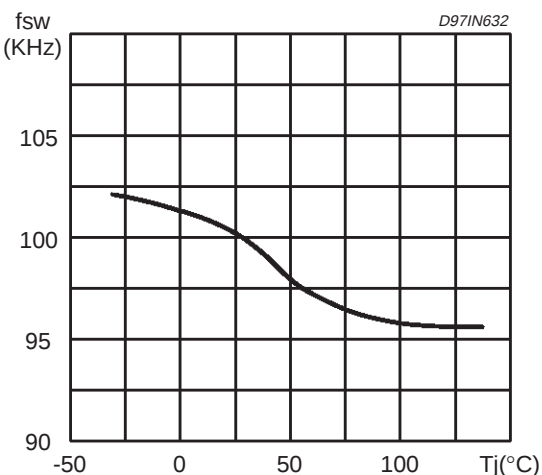
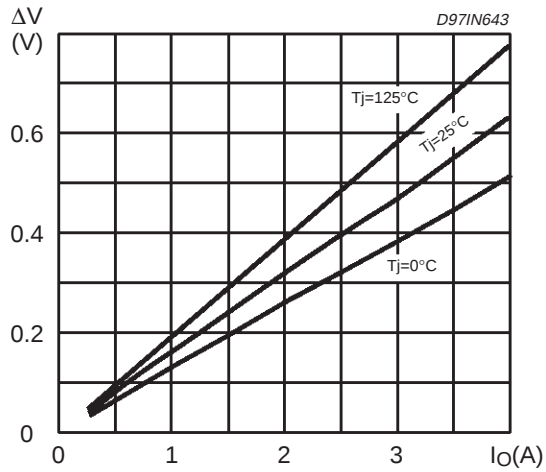


Figure 15: Switching Frequency vs. Junction temperature (see fig. 1)

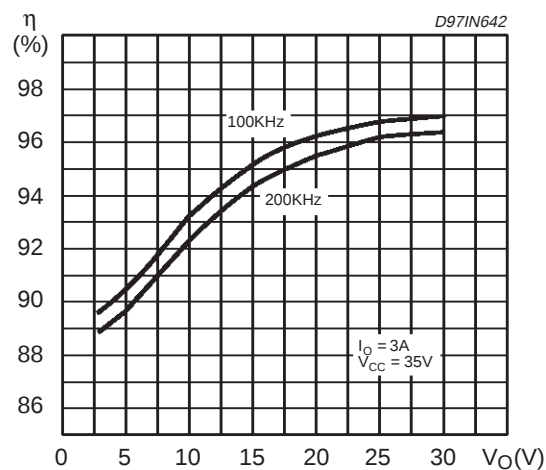


## L4973V3.3 - L4973V5.1 - L4973D3.3 - L4973D5.1

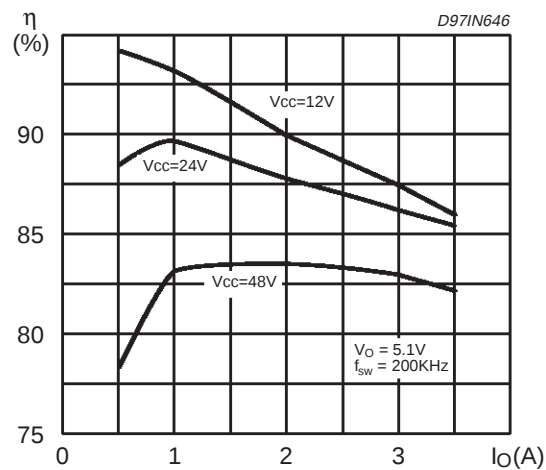
**Figure 16:** Dropout Voltage Between pin 7,8 and 2,3



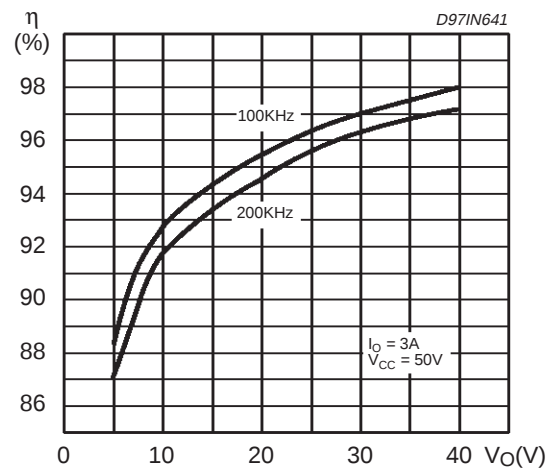
**Figure 18:** Efficiency vs. Output Voltage (Diode STPS745D)



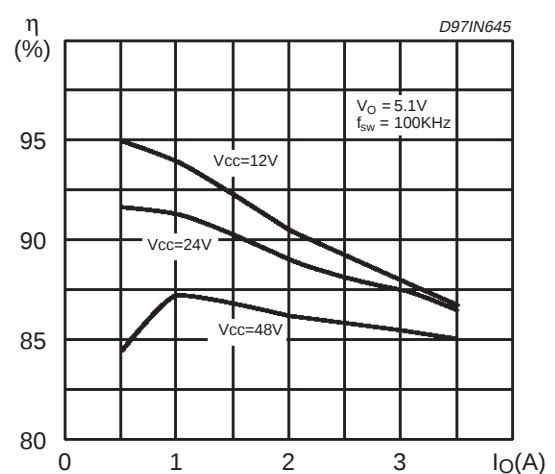
**Figure 20:** Efficiency vs. Output Current (see fig.1c)



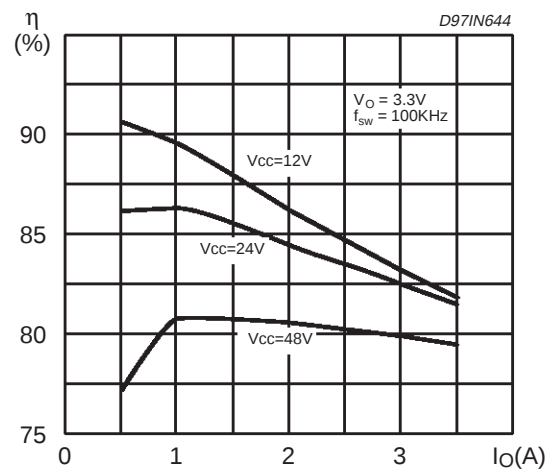
**Figure 17:** Efficiency vs. Output Voltage (see fig.1)



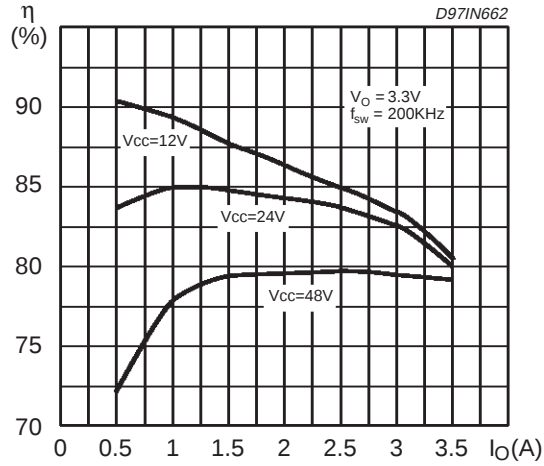
**Figure 19:** Efficiency vs. Output Current (see fig.1c)



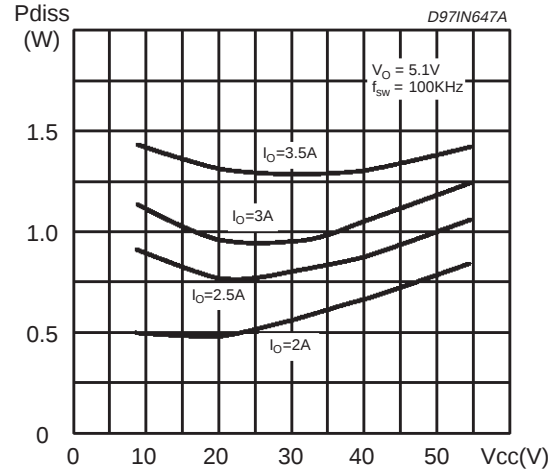
**Figure 21:** Efficiency vs. Output Current (see fig.1d)



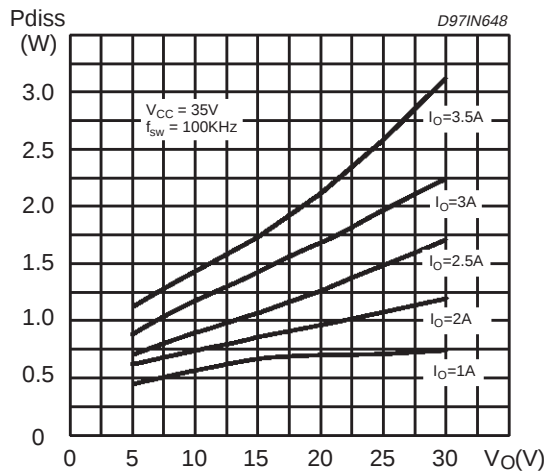
**Figure 22:** Efficiency vs. Output Current  
(see fig.1d)



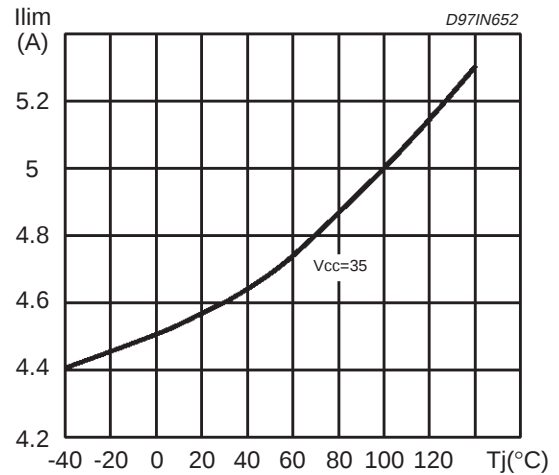
**Figure 23:** Power dissipation vs. Input Voltage  
(Device only) (see fig.1c)



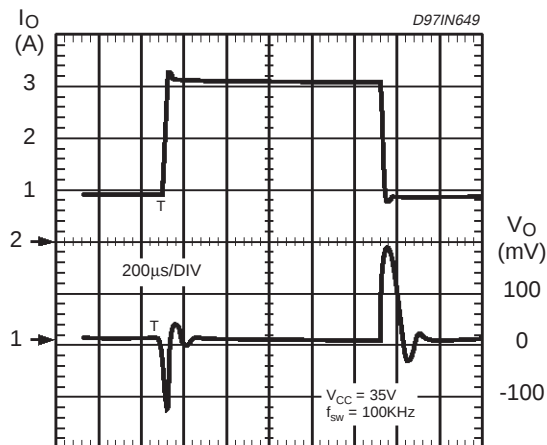
**Figure 24:** Power dissipation vs. Output Voltage  
(Device only)



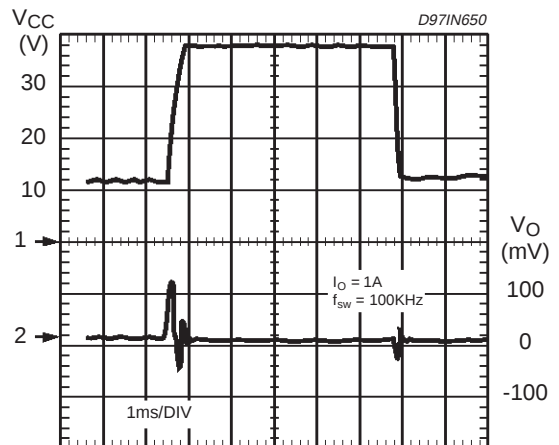
**Figure 25:** Pulse by Pulse Limiting Current vs.  
Junction Temperature



**Figure 26:** Load Transient

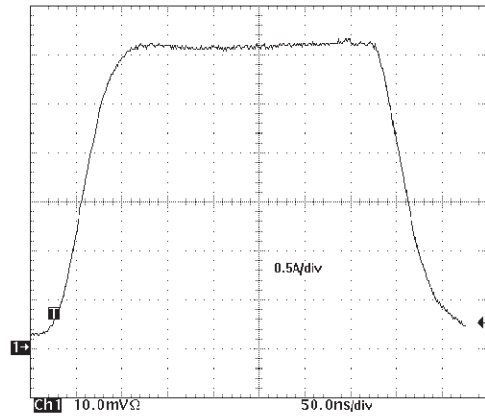


**Figure 27:** Line Transient

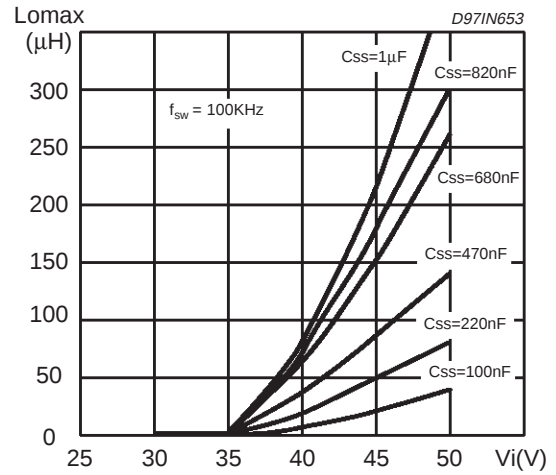


## L4973V3.3 - L4973V5.1 - L4973D3.3 - L4973D5.1

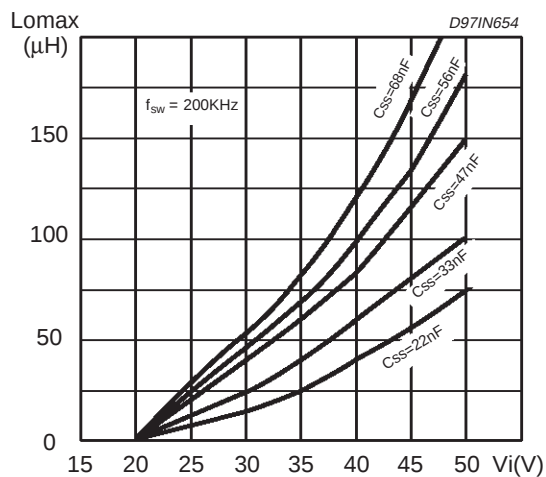
**Figure 28:** Source Current Rise and Fall Time, pin 2, 3 (See fig1)



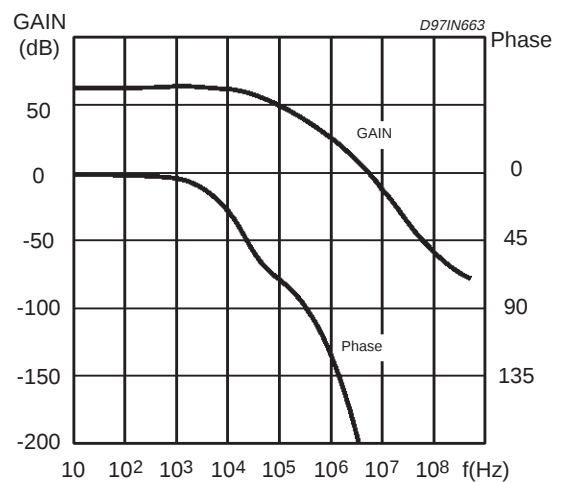
**Figure 29:** Soft Start Capacitor Selection vs. Inductor and Vcc max (ref. AN938)



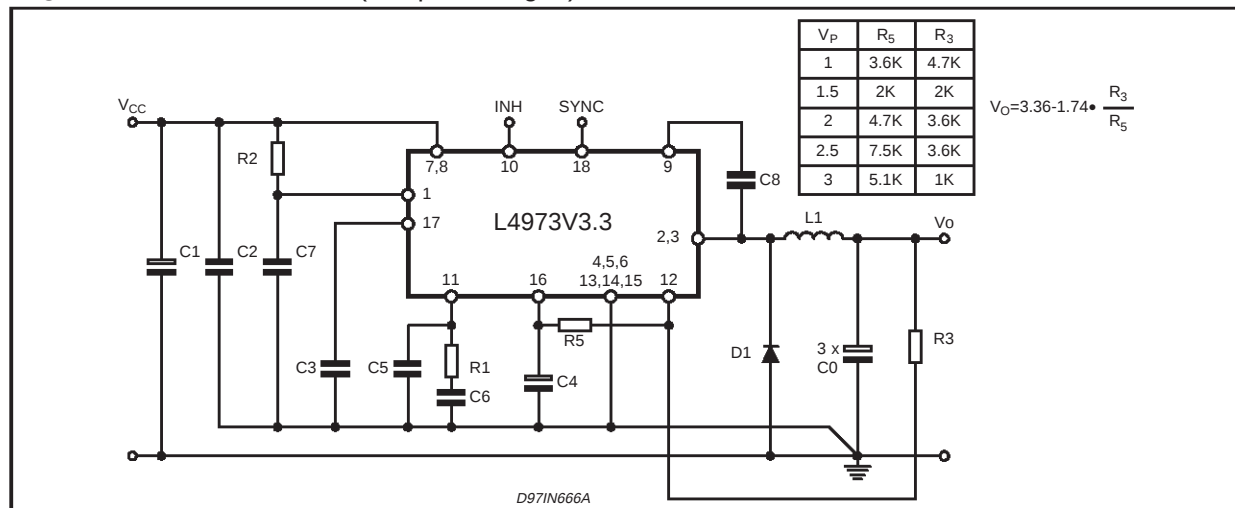
**Figure 30:** Soft Start Capacitor Selection vs. Inductor and Vcc max (ref. AN938)



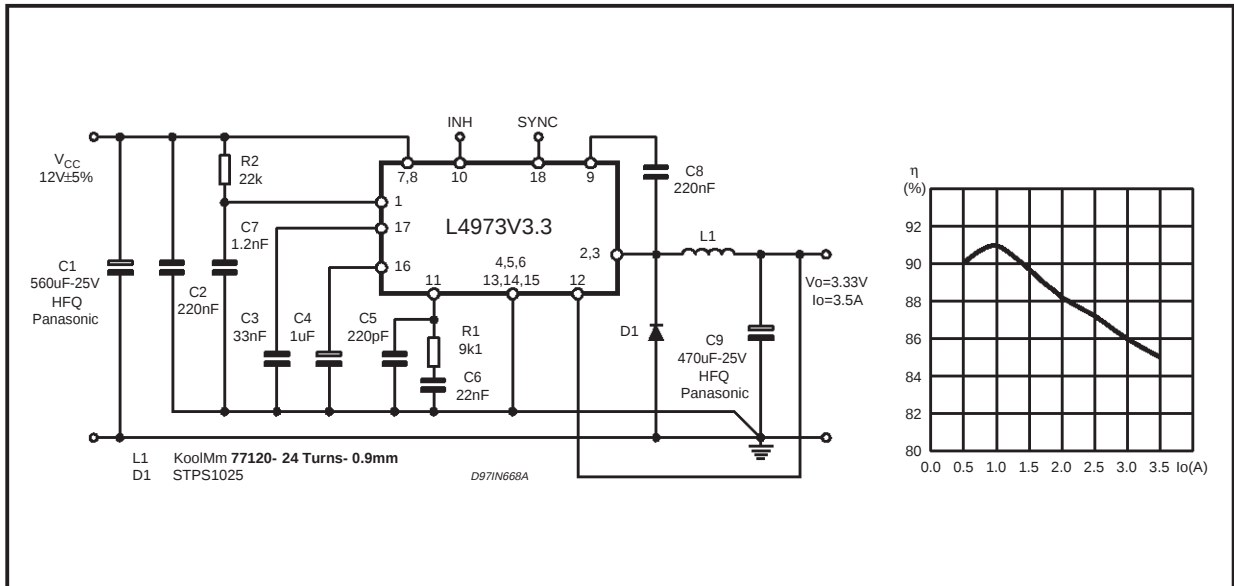
**Figure 31:** Open Loop Frequency and Phase of Error amplifier



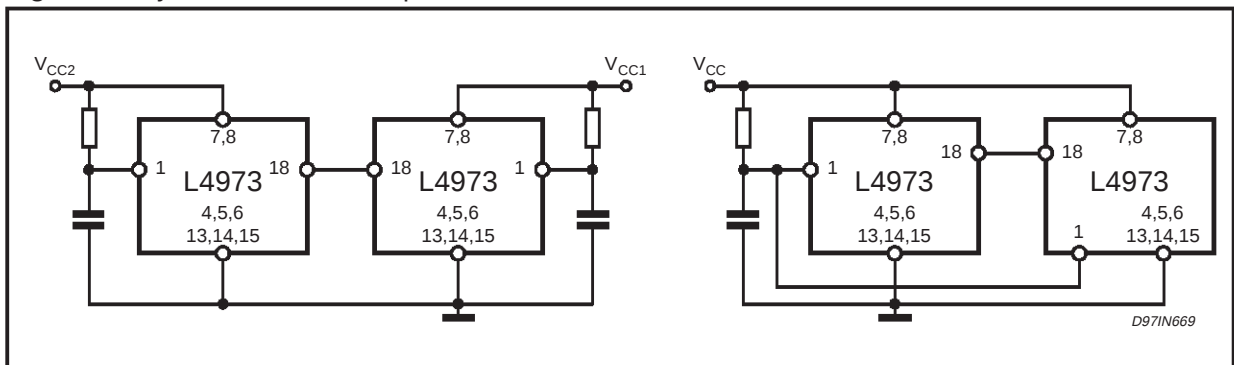
**Figure 32:** 3.5A at VO < 3.3V (see part list fig. 1)



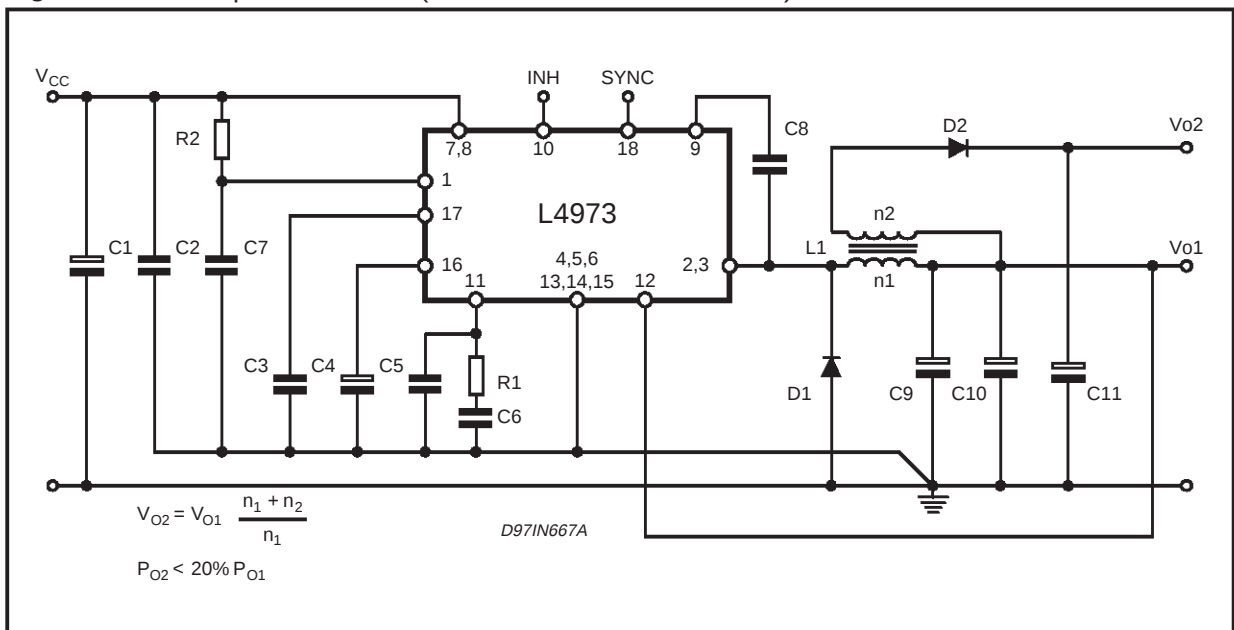
**Figure 33:** 12V to 3.3V High Performance Buck Converter ( $f_{sw} = 200\text{kHz}$ )



**Figure 34:** Synchronization Example



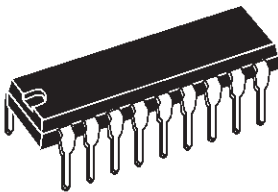
**Figure 35:** Multioutput not Isolated (Pin out referred to DIP12+3+3)



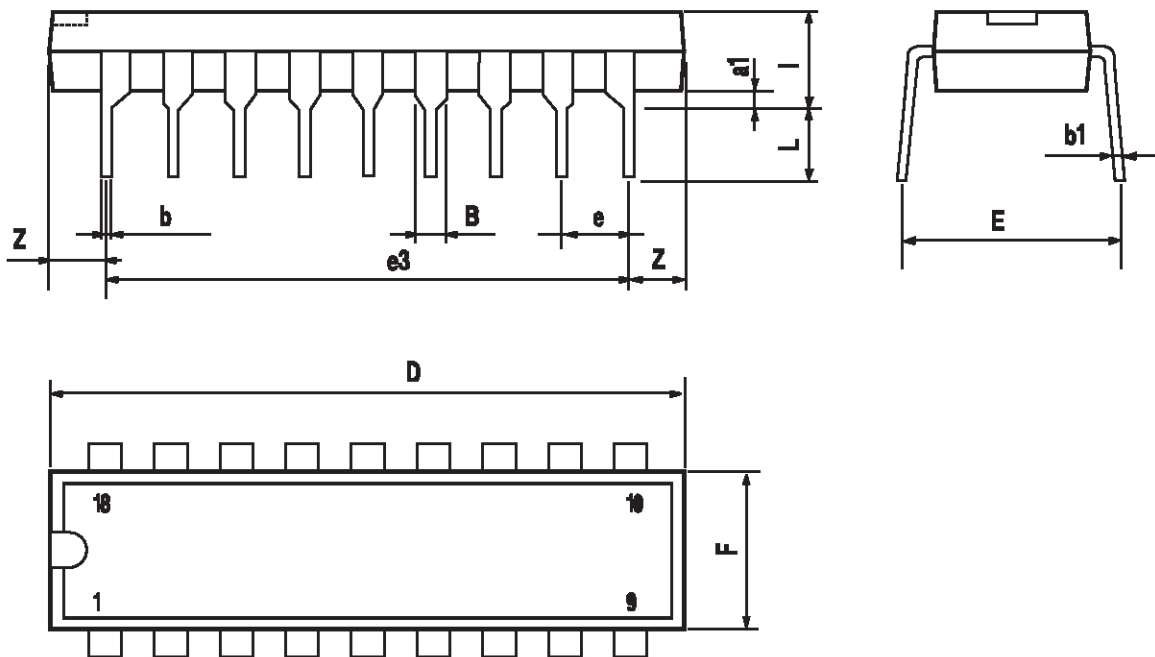
**L4973V3.3 - L4973V5.1 - L4973D3.3 - L4973D5.1**

| DIM. | mm   |       |       | inch  |       |       |
|------|------|-------|-------|-------|-------|-------|
|      | MIN. | TYP.  | MAX.  | MIN.  | TYP.  | MAX.  |
| a1   | 0.51 |       |       | 0.020 |       |       |
| B    | 0.85 |       | 1.40  | 0.033 |       | 0.055 |
| b    |      | 0.50  |       |       | 0.020 |       |
| b1   | 0.38 |       | 0.50  | 0.015 |       | 0.020 |
| D    |      |       | 24.80 |       |       | 0.976 |
| E    |      | 8.80  |       |       | 0.346 |       |
| e    |      | 2.54  |       |       | 0.100 |       |
| e3   |      | 20.32 |       |       | 0.800 |       |
| F    |      |       | 7.10  |       |       | 0.280 |
| I    |      |       | 5.10  |       |       | 0.201 |
| L    |      | 3.30  |       |       | 0.130 |       |
| Z    |      |       | 2.54  |       |       | 0.100 |

**OUTLINE AND  
MECHANICAL DATA**

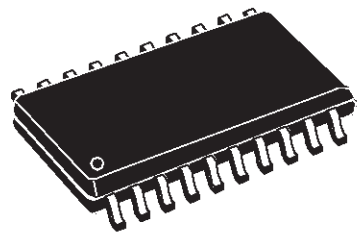


**Powerdip 18**

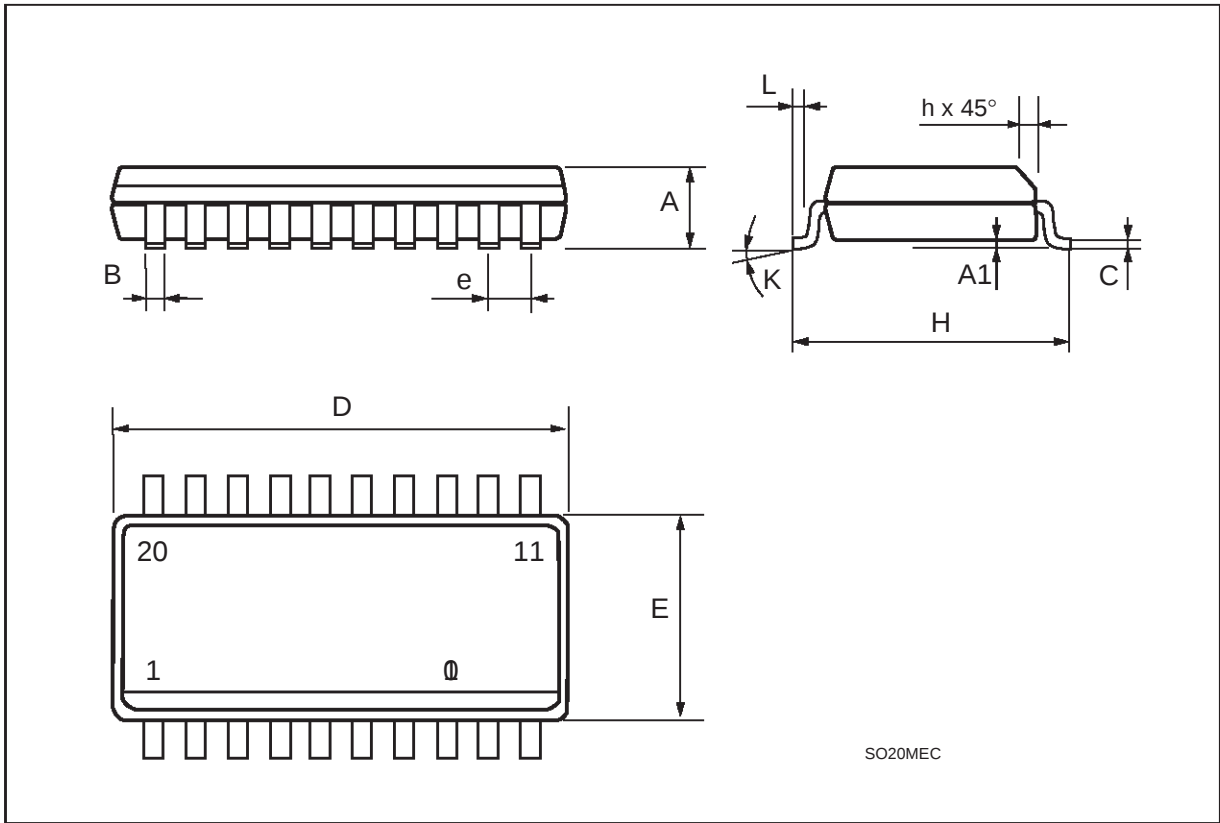


| DIM. | mm                 |      |       | inch  |       |       |
|------|--------------------|------|-------|-------|-------|-------|
|      | MIN.               | TYP. | MAX.  | MIN.  | TYP.  | MAX.  |
| A    | 2.35               |      | 2.65  | 0.093 |       | 0.104 |
| A1   | 0.1                |      | 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    | 12.6               |      | 13    | 0.496 |       | 0.512 |
| 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



SO20



Information furnished is believed to be accurate and reliable. However, STMicroelectronics assumes no responsibility for the consequences of use of such information nor for any infringement of patents or other rights of third parties which may result from its use. No license is granted by implication or otherwise under any patent or patent rights of STMicroelectronics. Specification mentioned in this publication are subject to change without notice. This publication supersedes and replaces all information previously supplied. STMicroelectronics products are not authorized for use as critical components in life support devices or systems without express written approval of STMicroelectronics.

The ST logo is a registered trademark of STMicroelectronics

© 2000 STMicroelectronics – Printed in Italy – All Rights Reserved

STMicroelectronics GROUP OF COMPANIES

Australia - Brazil - China - Finland - France - Germany - Hong Kong - India - Italy - Japan - Malaysia - Malta - Morocco -  
Singapore - Spain - Sweden - Switzerland - United Kingdom - U.S.A.

<http://www.st.com>