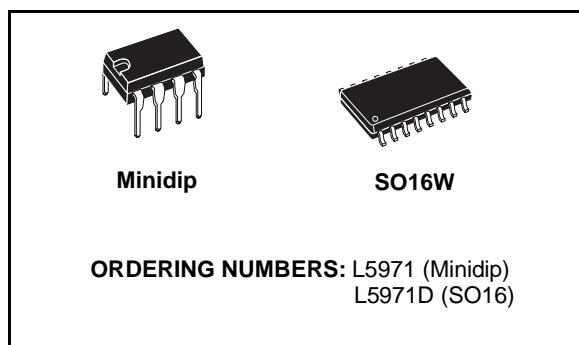


## 1.5A STEP DOWN SWITCHING REGULATOR

- 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



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

Features of this new generations 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.

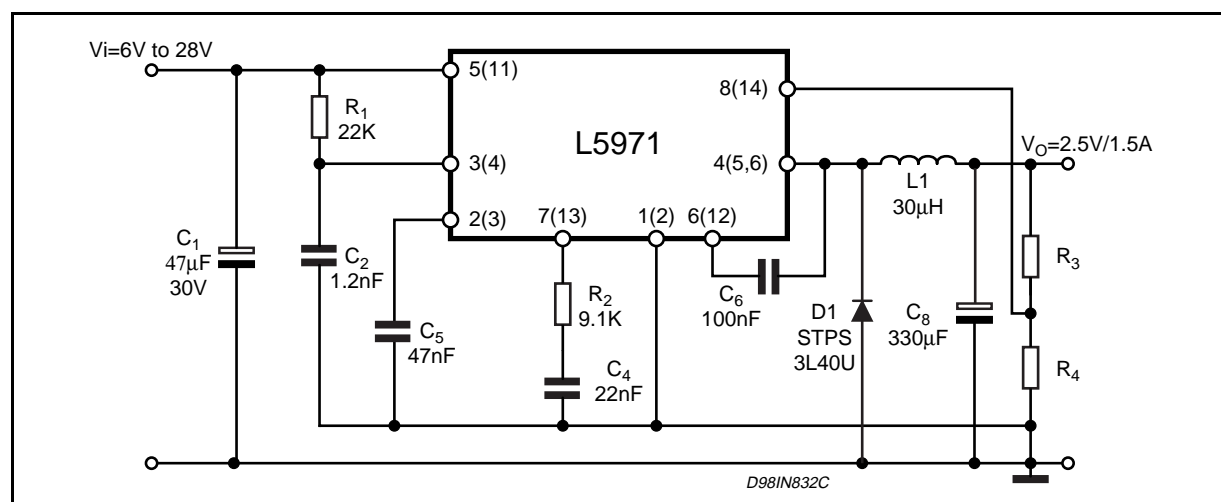
### Typical Applications:

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

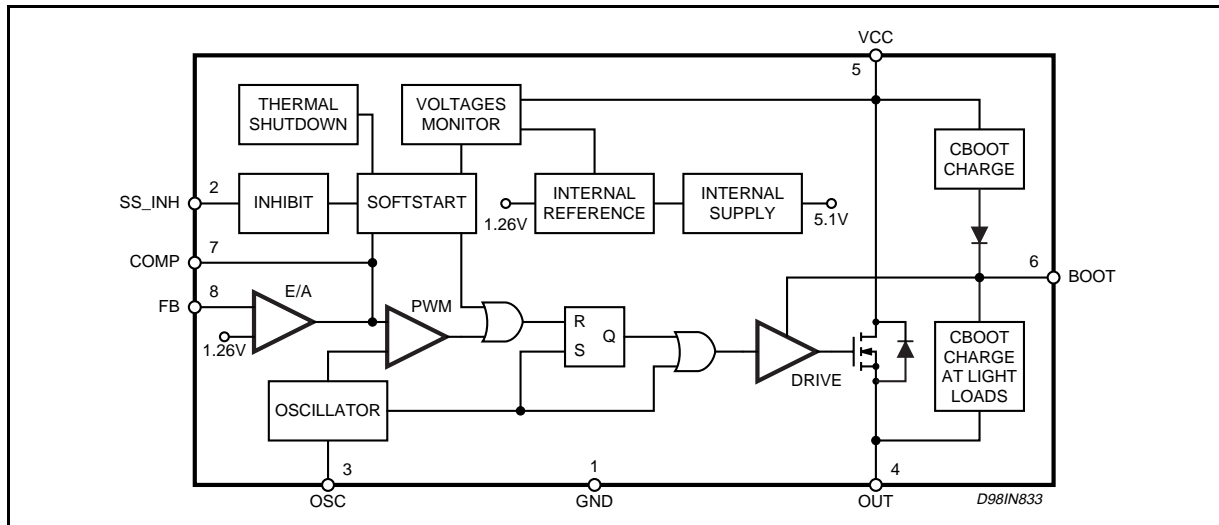
### DESCRIPTION

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.

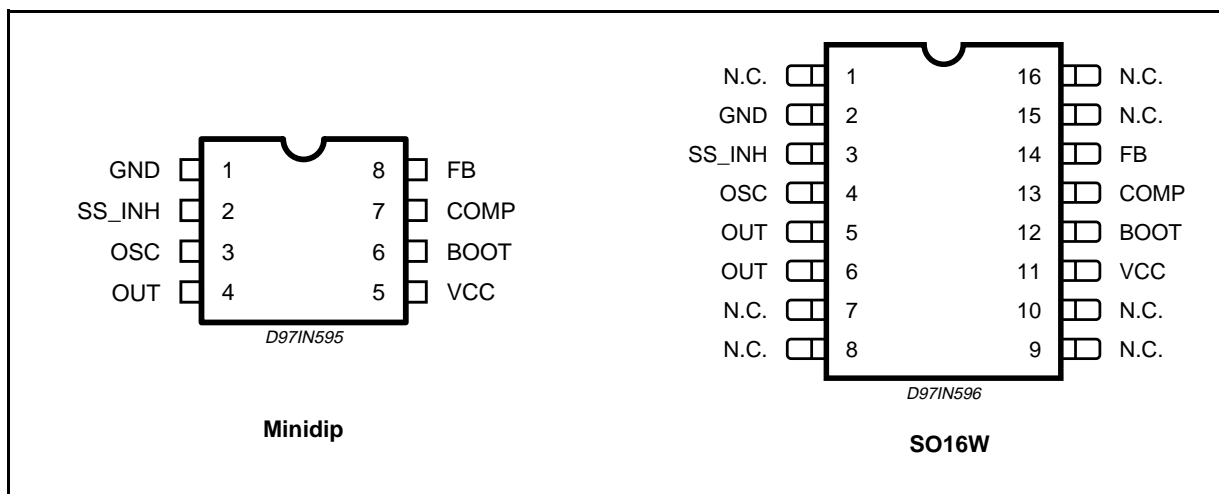
### TYPICAL APPLICATION CIRCUIT



**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	V <sub>CC</sub>	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	Max.	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	SO16				
$V_5, V_3$	$V_{11}, V_4$	Input voltage	30	V	
$V_4$	$V_5, V_6$	Output DC voltage	-1	V	
		Output peak voltage at $t = 0.1\mu s$ $f = 200KHz$	-5	V	
$I_4$	$I_5, I_6$	Maximum output current	int. limit.		
$V_6 - V_5$	$V_{12} - V_{11}$		14	V	
$V_6$	$V_{12}$	Bootstrap voltage	45	V	
$V_7, V_2$	$V_{13}, V_3$	Analogs input voltage ( $V_{CC} = 12V$ )	10	V	
$V_8$	$V_{14}$	( $V_{CC} = 20V$ )	6 -0.3	V V	
$P_{tot}$		Power dissipation a $T_{amb} \leq 60^\circ C$	Minidip	1	W
			SO16	0.8	W
$T_j, T_{stg}$		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 CHARACTERISTIC</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
$V_d$	Dropout voltage	$V_{CC} = 10V$ ; $I_o = 1.5A$			0.44	0.55	V
			*			0.88	V
$I_l$	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
$I_{sLL}$	Isorce Low level		*		5	15	$\mu A$

## ELECTRICAL CHARACTERISTICS (continued)

Symbol	Parameter	Test Condition	Min.	Typ.	Max.	Unit
<b>DC Characteristics</b>						
$I_{qop}$	Total operating quiescent current	Pin 5 (Pin 11)		3	4.5	mA
$I_q$	Quiescent current	Duty Cycle = 0; $V_{FB} = 1.7V$		2.8	3.5	mA
$I_{qst-by}$	Total stand-by quiescent current	$V_{inh} < 0.9V$		100	200	$\mu A$
		$V_{CC} = 25V$ ; $V_{inh} < 0.9V$		150	300	$\mu A$
<b>Error Amplifier</b>						
$V_{FB}$	Voltage Feedback Input		1.247	1.26	1.273	V
$R_L$	Line regulation	$V_{CC} = 6.5$ to $25V$		5	10	mV
	Ref. voltage stability vs temperature		*	0.4		mV/ $^{\circ}C$
$V_{oH}$	High level output voltage	$V_{FB} = 0.8V$	8.7			V
$V_{oL}$	Low level output voltage	$V_{FB} = 1.7V$			0.65	V
$I_{o source}$	Source output current	$V_{comp} = 3V$ ; $V_{FB} = 0.8V$	180	250		$\mu A$
$I_{o sink}$	Sink output current	$V_{comp} = 3V$ ; $V_{FB} = 1.7V$	200	300		$\mu A$
$I_b$	Source bias current			2	3	$\mu A$
SVRR E/A	Supply voltage ripple rejection	$V_{comp} = V_{fb}$ ; $V_{CC} = 6.5$ to $25V$	60	80		dB
	DC open loop gain	$R_L = \infty$	50	57		dB
$g_m$	Transconductance	$I_{comp} = -0.1$ to $0.1mA$ $V_{comp} = 6V$		4.3		mS
<b>Oscillator Section</b>						
	Ramp Valley		0.74	0.81	0.88	V
	Ramp peak	$V_{CC} = 6.5V$	1.80	1.87	1.94	V
		$V_{CC} = 25V$	4.72	4.79	4.86	V
	Maximum duty cycle		95	97		%
	Maximum Frequency	Duty Cycle = 0% $R_{osc} = 13k\Omega$ , $C_{osc} = 820pF$			300	kHz

Figure 1. Test and valuation board circuit.

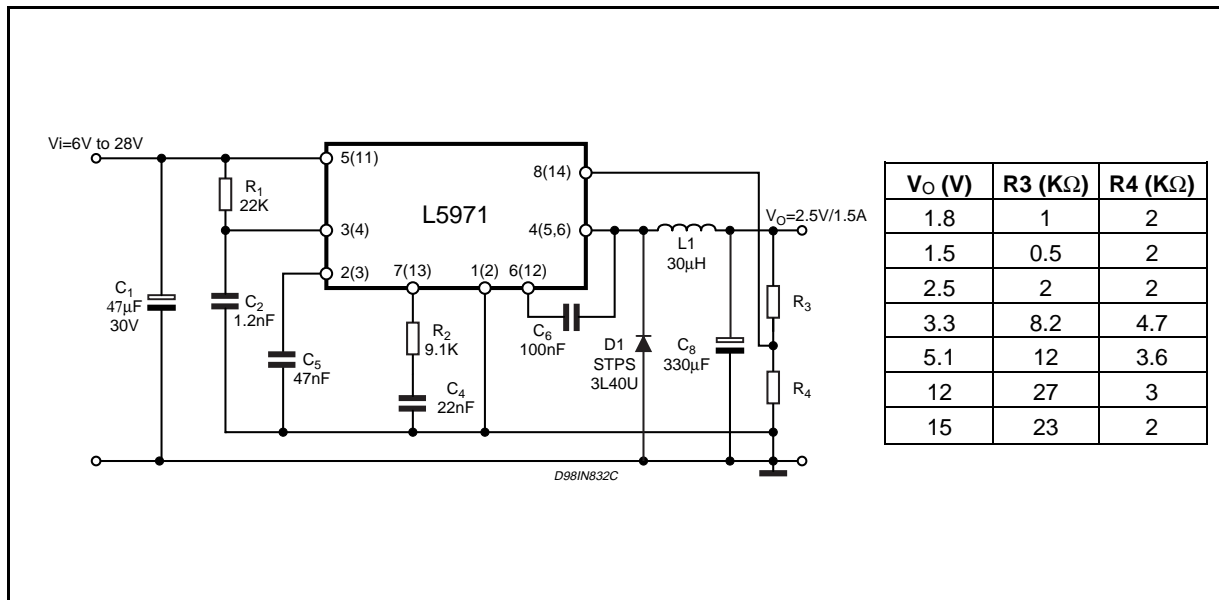
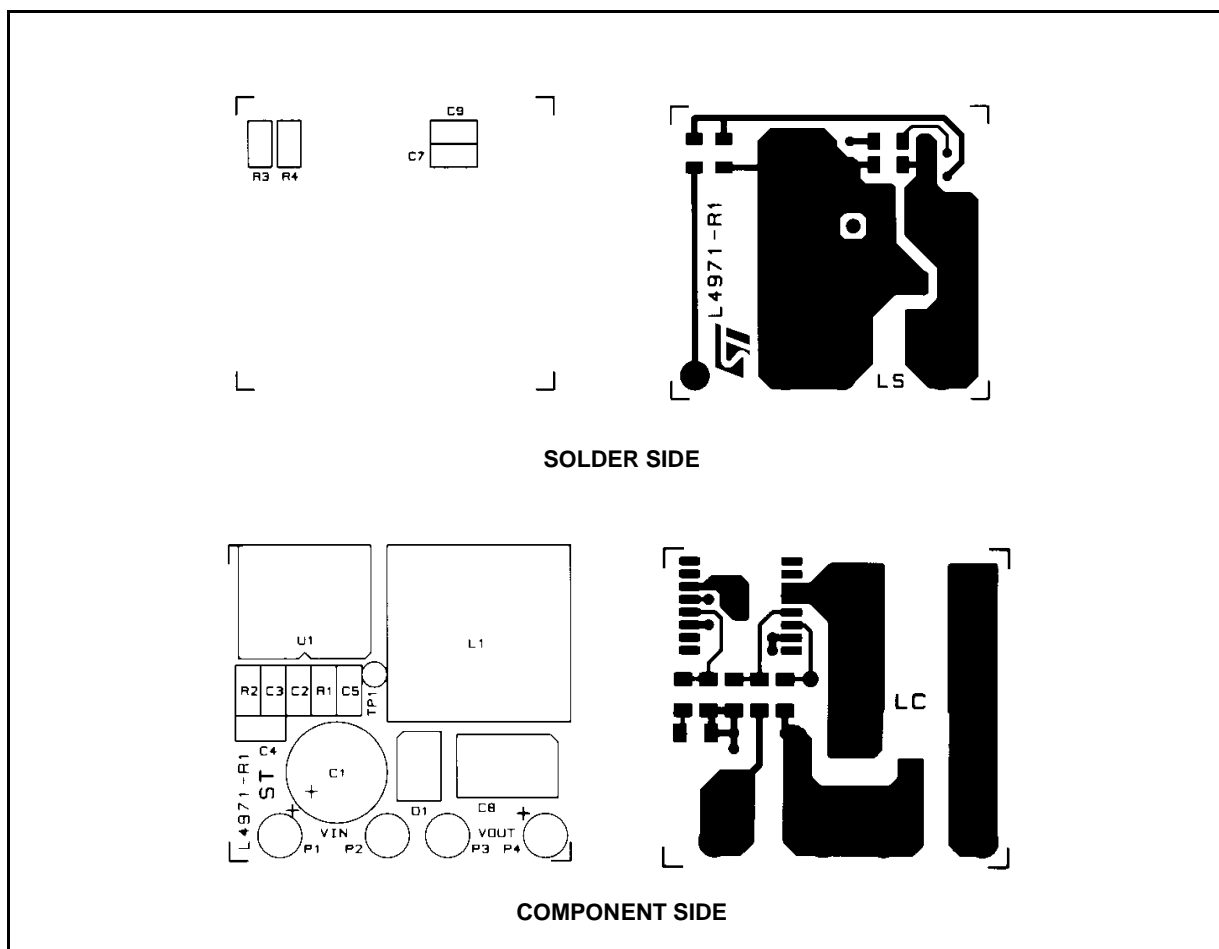
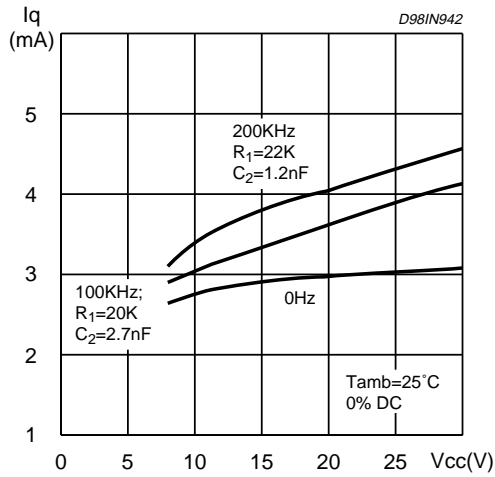


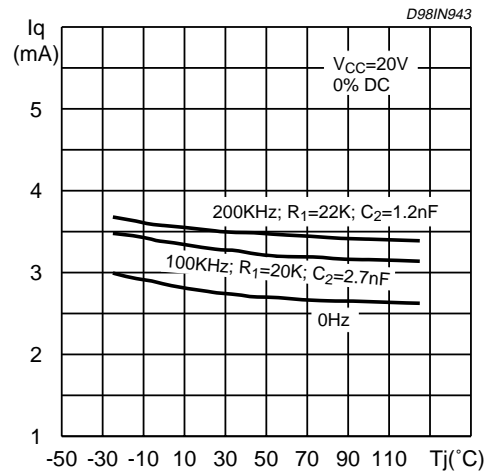
Figure 2. PCB and component layout of the figure 1.



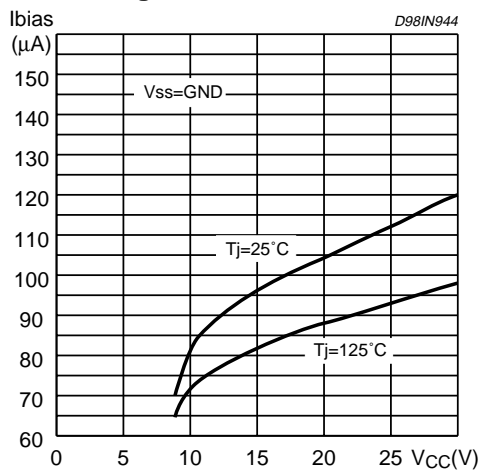
**Figure 3. Quiescent drain current vs. input voltage.**



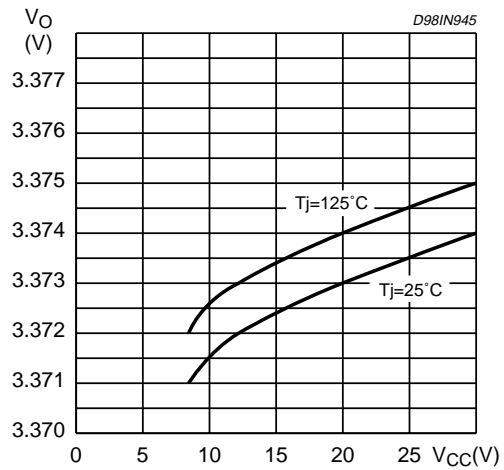
**Figure 4. Quiescent current vs. junction temperature**



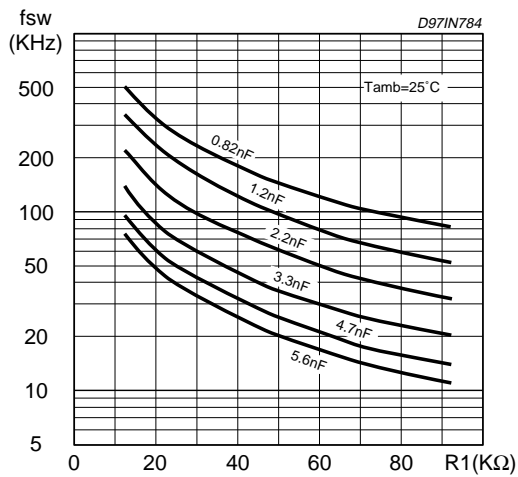
**Figure 5. Stand-by drain current vs. input voltage**



**Figure 6. Line Regulation**



**Figure 7. Switching frequency vs. R1 and C2**



**Figure 8. Switching Frequency vs. input voltage.**

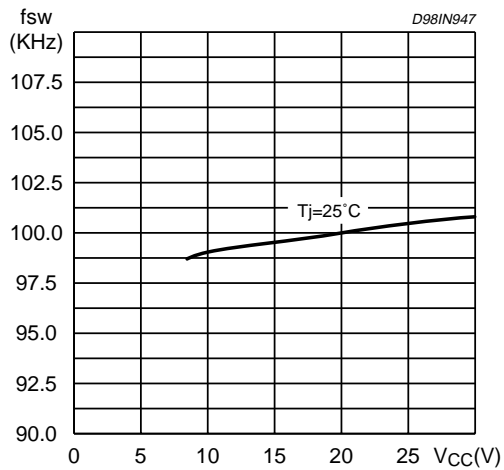


Figure 9. Switching frequency vs. junction temperature.

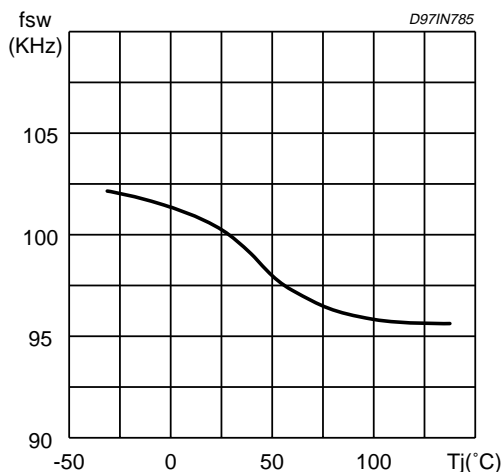


Figure 10. Dropout voltage between pin 5 and 4.

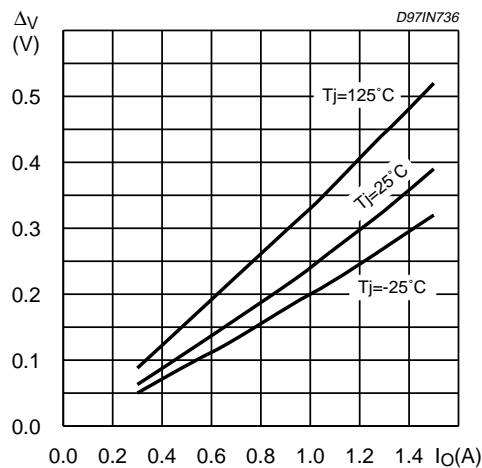


Figure 11. Efficiency vs output voltage.

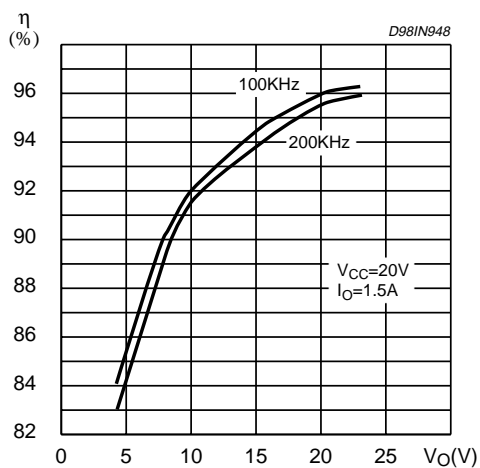


Figure 12. Efficiency vs. output current.

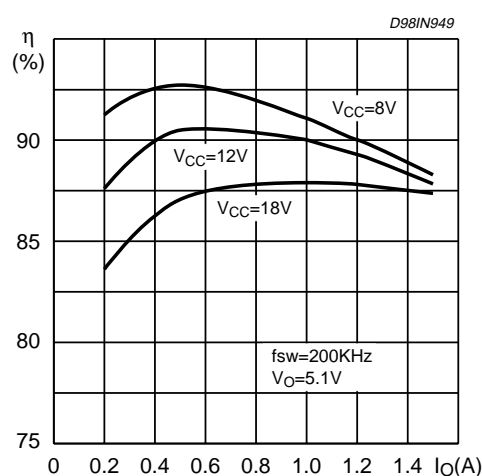


Figure 13. Efficiency vs output current.

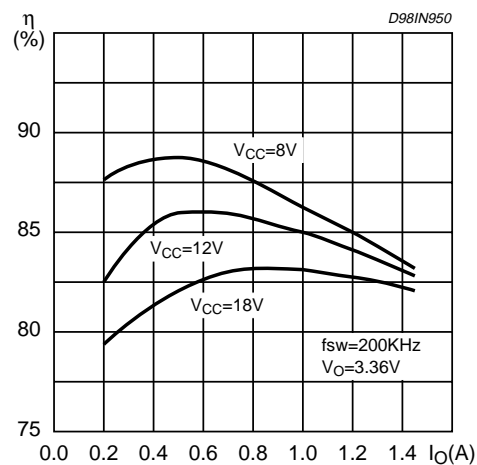


Figure 14. Efficiency vs. output current.

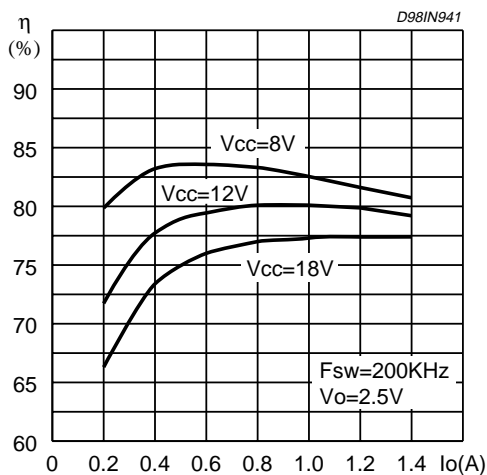


Figure 15. Load transient.

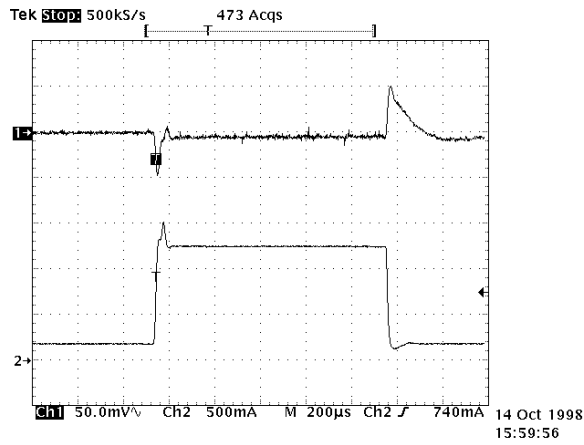


Figure 16. Soft start capacitor selection vs. Inductor and  $V_{CCmax}$

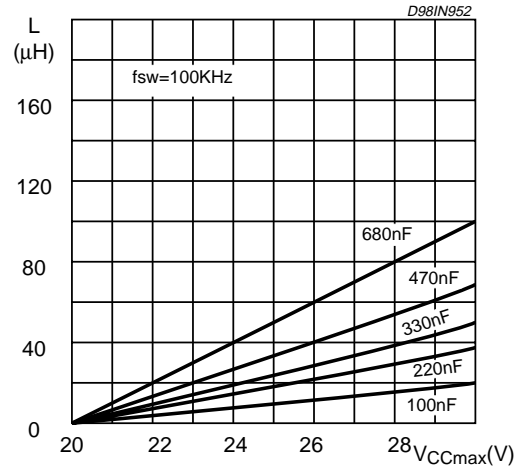


Figure 17. Soft start capacitor selection vs. Inductor and  $V_{CCmax}$

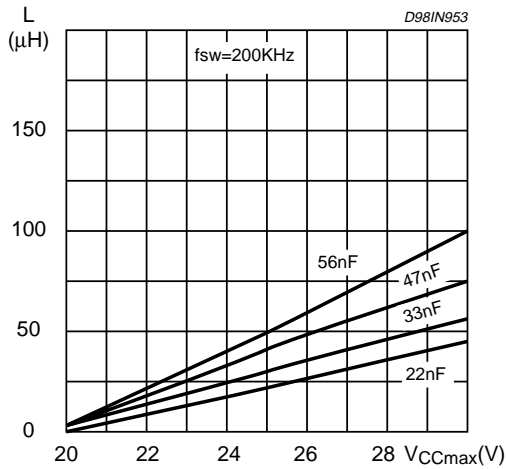
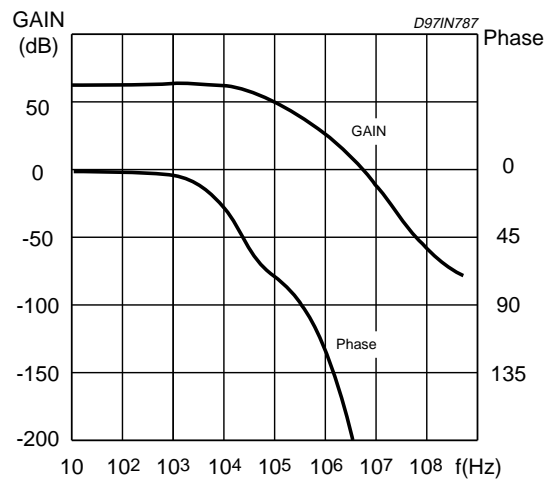


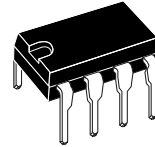
Figure 18. Open loop frequency and phase of error amplifier.



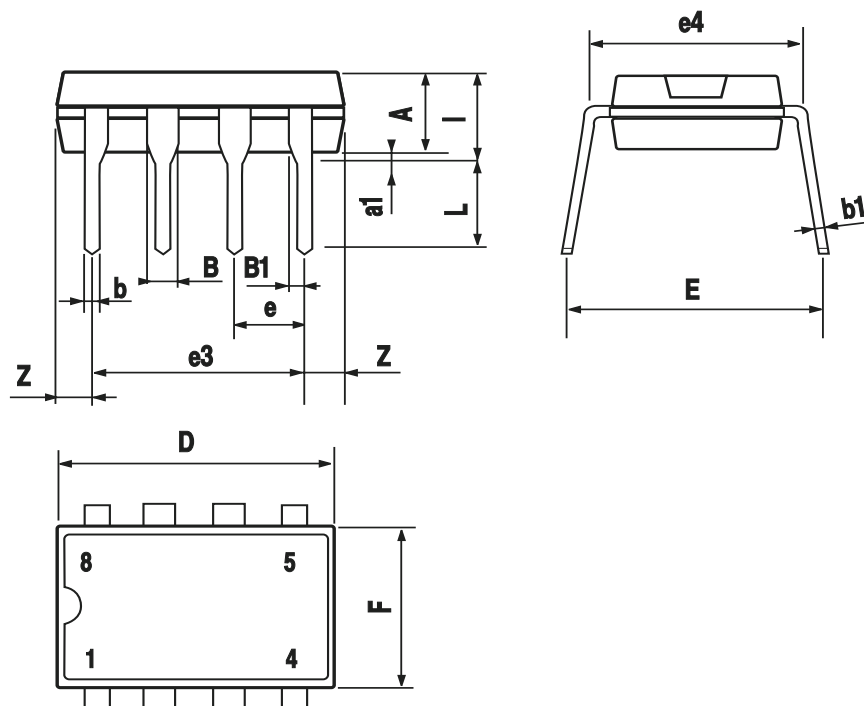


DIM.	mm			inch		
	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.
A		3.32			0.131	
a1	0.51			0.020		
B	1.15		1.65	0.045		0.065
b	0.356		0.55	0.014		0.022
b1	0.204		0.304	0.008		0.012
D			10.92			0.430
E	7.95		9.75	0.313		0.384
e		2.54			0.100	
e3		7.62			0.300	
e4		7.62			0.300	
F			6.6			0.260
I			5.08			0.200
L	3.18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

## OUTLINE AND MECHANICAL DATA

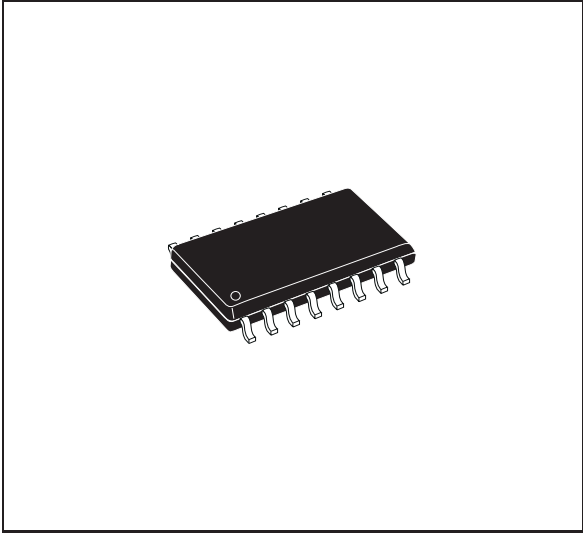


**Minidip**

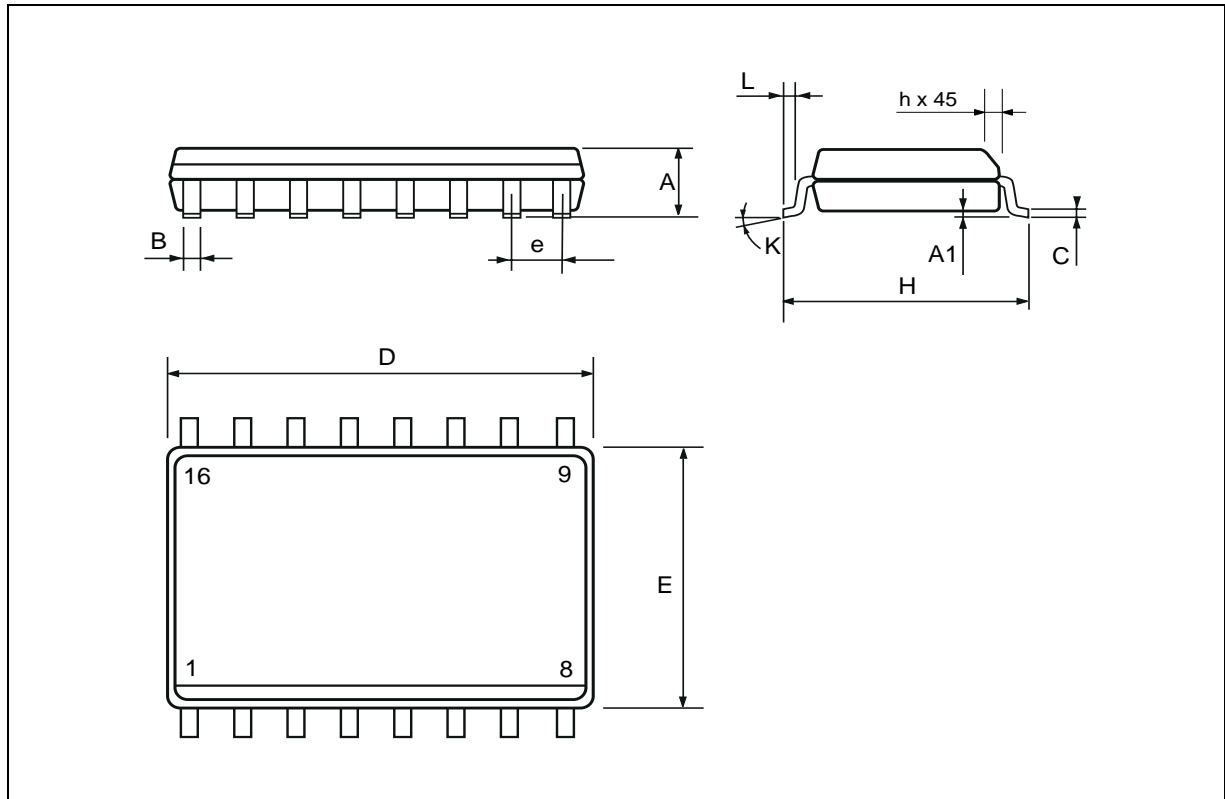


DIM.	mm			inch		
	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.
A	2.35		2.65	0.093		0.104
A1	0.1		0.3	0.004		0.012
B	0.33		0.51	0.013		0.020
C	0.23		0.32	0.009		0.013
D	10.1		10.5	0.398		0.413
E	7.4		7.6	0.291		0.299
e		1.27			0.050	
H	10		10.65	0.394		0.419
h	0.25		0.75	0.010		0.030
L	0.4		1.27	0.016		0.050
K	0° (min.)8°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

**OUTLINE AND MECHANICAL DATA**



**SO16 Wide**



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