L4978

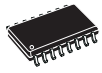
2A STEP DOWN SWITCHING REGULATOR

1 Features

- UP TO 2A STEP DOWN CONVERTER
- OPERATING INPUT VOLTAGE FROM 8V TO 55V
- PRECISE 3.3V (±1%) INTERNAL REFERENCE VOLTAGE
- OUTPUT VOLTAGE ADJUSTABLE FROM 3.3V TO 50V
- SWITCHING FREQUENCY ADJUSTABLE UP TO 300KHz
- VOLTAGE FEEDFORWARD
- ZERO LOAD CURRENT OPERATION
- INTERNAL CURRENT LIMITING (PULSE-BYPULSE AND HICCUP MODE)
- INHIBIT FOR ZERO CURRENT CONSUMPTION
- PROTECTION AGAINST FEEDBACK DISCONNECTION
- THERMAL SHUTDOWN
- SOFT START FUNCTION

Figure 1. Packages

DIP-8



SO16W

Table 1. Order Codes

Part Number	Package
L4978	DIP-8
L4978D	SO16
L4978D013TR	SO16 in Tape & Reel

2 DESCRIPTION

The L4978 is a step down monolithic power switching regulator delivering 2A 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_{dson} of 0.25Ω) to obtain very high efficency 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 50V 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, soft-start, protection against feedback loop disconnection, inhibit for zero current consumption and thermal shutdown.

The device is available in plastic dual in line, DIP-8 for standard assembly, and SO16W for SMD assembly.

Figure 2. Typical Application Circuit

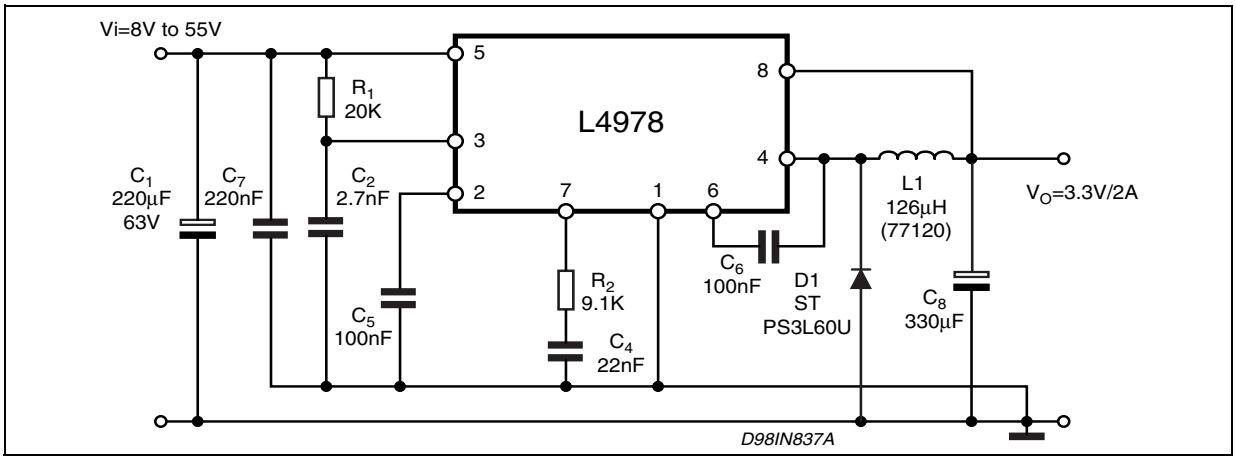


Table 2. Block Diagram

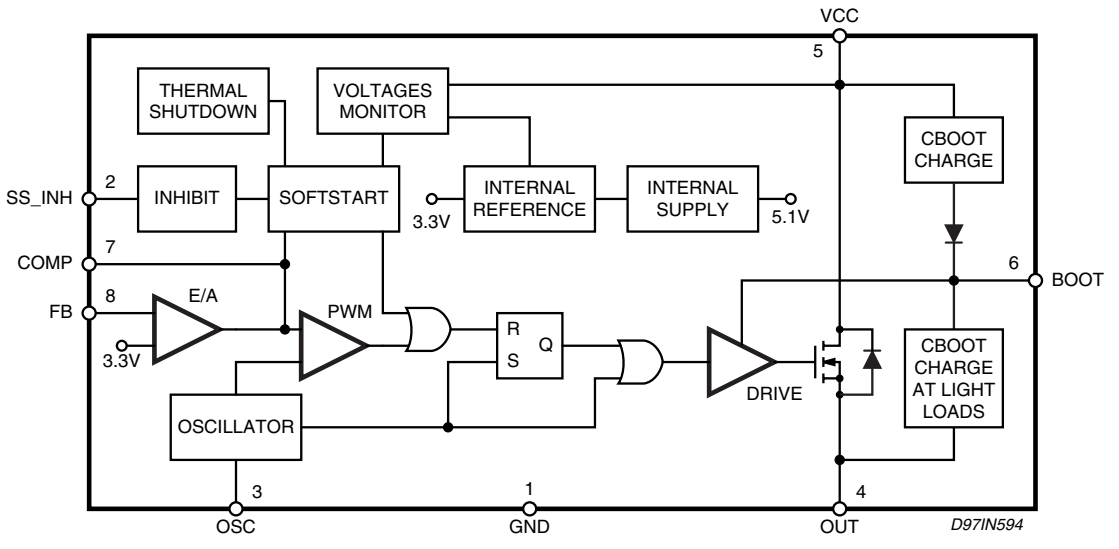
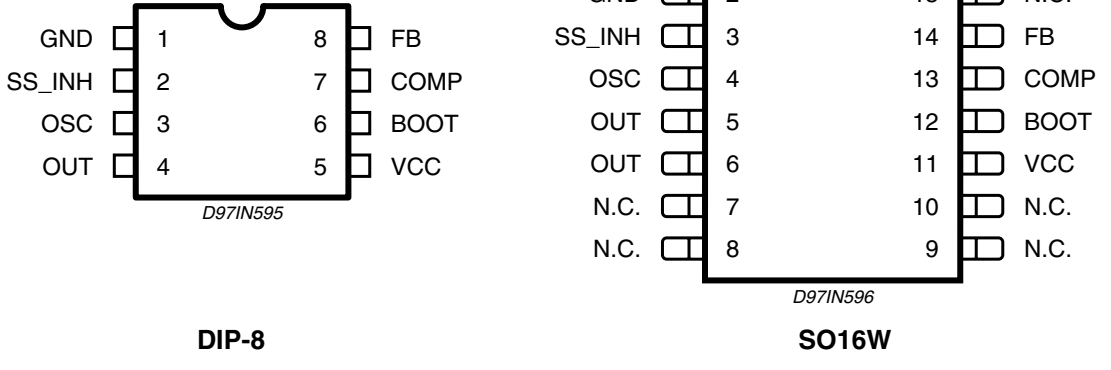


Figure 3. Pins Connection (Top view)



DIP-8 **SO16W**

Table 3. Pin Description

N°	Pin	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)

Table 3. Pin Description (continued)

N°	Pin	Name	Function
4	5, 6	OUT	Stepdown regulator output
5	11	V_{CC}	Unregulated DC input voltage
6	12	BOOT	A capacitor connected between this pin and OUT allows to drive the internal DMOS Transistors
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.

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

Table 4. Thermal Data

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

(*) Package mounted on board.

Table 5. Absolute Maximum Ratings

Symbol		Parameter	Value	Unit
Minidip	S016			
V_5	V_{11}	Input voltage	58	V
V_4	V_5,V_6	Output DC voltage Output peak voltage at t = 0.1ms f=200KHz	-1 -5	V 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	70	V
V_7	V_{13}	Analogs input voltage (V_{CC}= 24V)	12	V
V_2	V_3	Analogs input voltage (V_{CC}= 24V)	13	V
V_8	V_{14}	(VCC= 20V)	6 -0.3	V V
P_{tot}		Power dissipation a Tamb ≤ 60°C **DIP-8** **SO16**	 1 0.8	 W W
T_j,T_{stg}		Junction and storage temperature	-40 to 150	°C

Table 6. Electrical Characteristcs

(T_j = 25°C, C_{osc} = 2.7nF, R_{osc} = 20kΩ, V_{CC} = 24V, unless otherwise specified). "●" Specification Referred to T_j from 0 to 125°C

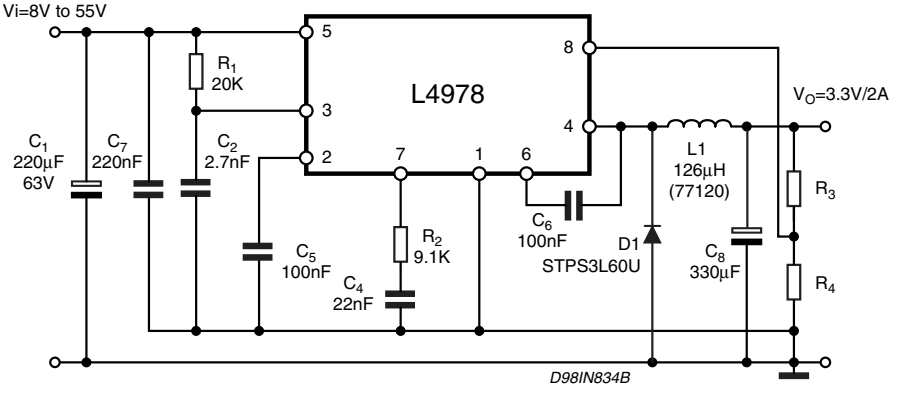
Symbol	Parameter	Test Condition		Min.	Typ.	Max.	Unit
DYNAMIC CHARACTERISTIC							
V_I	Operating input voltage range	V_o = 3.3 to 50V; I_o = 2A	●	8		55	V
V_o	Output voltage	I_o = 0.5A		3.33	3.36	3.39	V
		I_o = 0.2 to 2A V_{cc} = 8 to 55V		3.292	3.36	3.427	V
			●	3.22	3.36	3.5	V
V_d	Dropout voltage	V_{cc} = 10V; I_o = 2A			0.58	0.733	V
			●			1.173	V
I_l	Maximum limiting current	V_{cc} = 8 to 55V	●	2.5	3	3.5	A
	Efficiency	V_o = 3.3V; I_o= 2A			87		%
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 = 2.5A; f_{ripple}= 100Hz		60			dB
	Switching Frequency Stability vs. V_{cc}	V_{cc} = 8 to 55V			3	6	%
	Temp. stability of switching frequency	T_j = 0 to 125°C			4		%
SOFT START							
	Soft start charge current			30	40	50	µA
	Soft start discharge current			6	10	14	µA
INHIBIT							
V_{LL}	Low level voltage		●			0.9	V
I_{sLL}	Isource Low level		●		5	15	µA
DC CHARACTERISTICS							
I_{qop}	Total operating quiescent current				4	6	mA
I_q	Quiescent current	Duty Cycle = 0; VFB= 3.8V			2.5	3.5	mA
I_{qst-by}	Total stand-by quiescent current	V_{inh} < 0.9V			100	200	µA
		V_{cc} = 55V; V_{inh}<0.9V			150	300	µA
ERROR AMPLIFIER							
V_{FB}	Voltage Feedback Input			3.33	3.36	3.39	V
R_L	Line regulation	V_{cc} = 8 to 55V			5	10	mV
	Ref. voltage stability vs temperature		●		0.4		mV/°C
V_{oH}	High level output voltage	V_{FB} = 2.5V		10.3			V
V_{oL}	Low level output voltage	V_{FB} = 3.8V				0.65	V
$I_{o\ source}$	Source output current	V_{comp}= 6V; V_{FB}= 2.5V		180	220		µA
$I_{o\ sink}$	Sink output current	V_{comp} = 6V; V_{FB}= 3.8V		200	300		µA
I_b	Source bias current				2	3	µA
SVRR E/A	Supply voltage ripple rejection	$V_{comp} = V_{FB}$; V_{cc} = 8 to 55V		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			2.5		mS

Table 6. Electrical Characteristcs

(T_j = 25°C, C_{osc} = 2.7nF, R_{osc} = 20kΩ, V_{CC} = 24V, unless otherwise specified). "●" Specification Referred to T_j from 0 to 125°C

Symbol	Parameter	Test Condition		Min.	Typ.	Max.	Unit
OSCILLATOR SECTION							
	Ramp Valley			0.78	0.85	0.92	V
	Ramp peak	V_{cc} = 8V		2	2.15	2.3	V
		V_{cc} = 55V		9	9.6	10.2	V
	Maximum duty cycle			95	97		%
	Maximum Frequency	Duty Cycle = 0% R_{osc} = 13kΩ, C_{osc} = 820pF				300	kHz

Figure 4. Test and evaluation board circuit.



C1=220µF/63V EKE
C2=2.7nF
C5=100nF
C6=100nF
C7=220nF/63V
C8=330µF/35V CG Sanyo
L1=126µH KoolMu 77120 - 55 Turns - 0.5mm
R1=20K
R2=9.1K
D1=STPS3L60U

L4978

V_O(V)	R3(KΩ)	R4(KΩ)
3.3	0	
5.1	2.7	4.7
12	12	4.7
15	16	4.7
18	20	4.7
24	30	4.7

Figure 5. PCB and component layout of the figure 4.

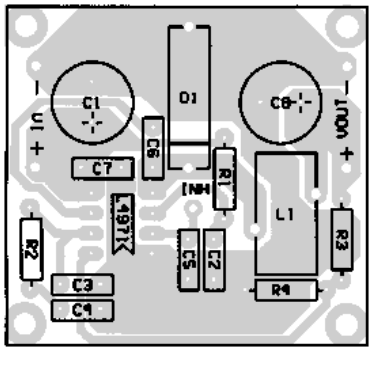


Figure 6. Quiescent drain current vs. input voltage.

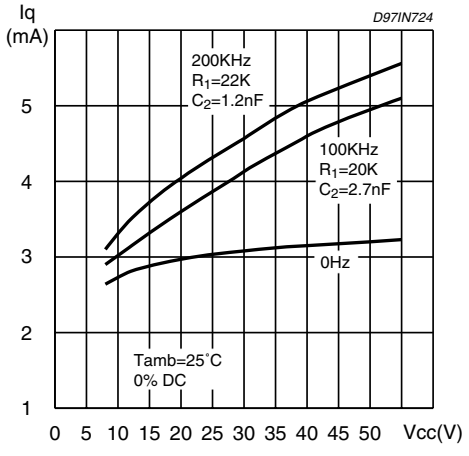


Figure 7. Quiescent current vs. junction temperature

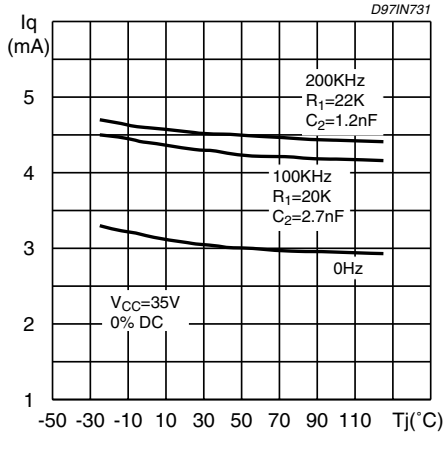


Figure 8. Stand by drain current vs. input voltage.

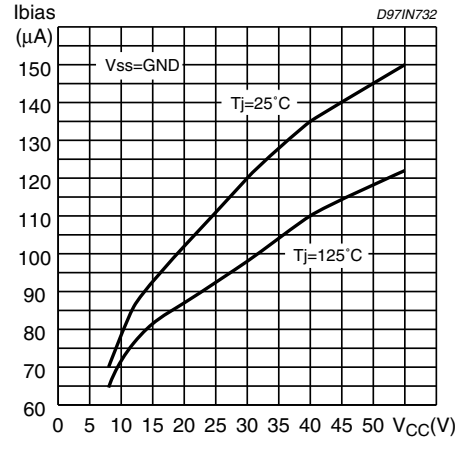


Figure 9. Line Regulation

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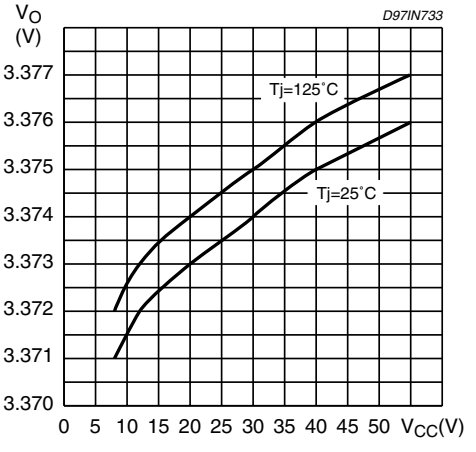

Figure 10. Load regulation

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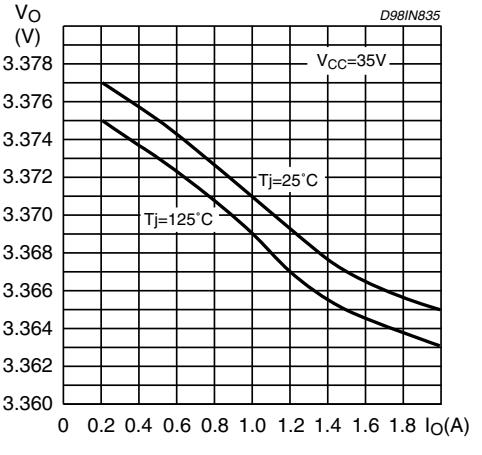

Figure 11. Switching frquency vs. R1 and C2

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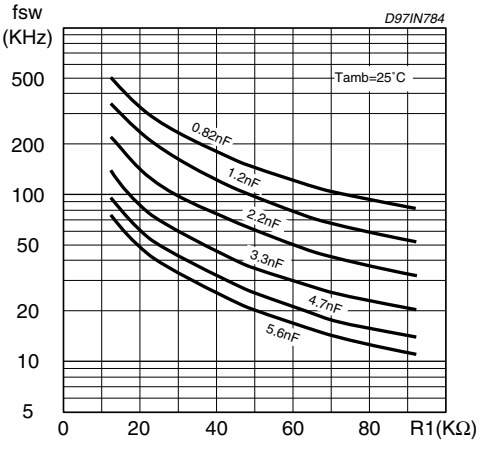

Figure 12. Switching Frequency vs. input voltage..

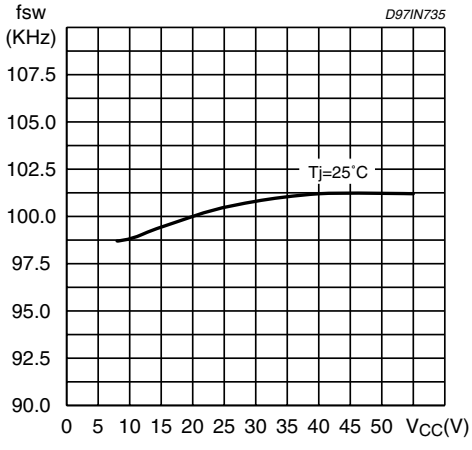

Figure 13. Switching frequency vs. junction temperature.

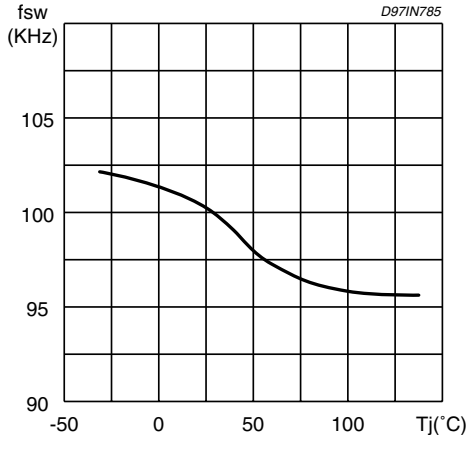

Figure 14. Dropout voltage between pin 5 and 4.

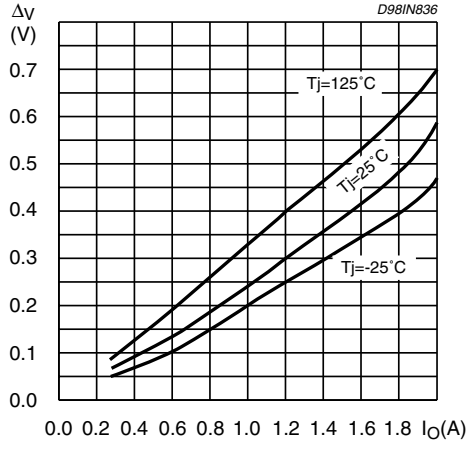

Figure 15. Efficiency vs output voltage.

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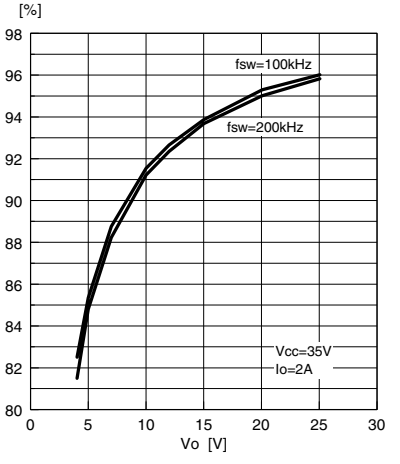

Figure 16. Efficiency vs. output current.

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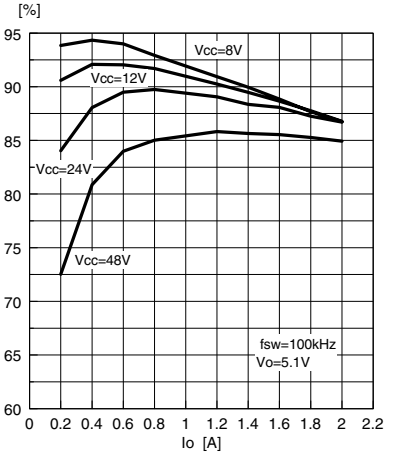

Figure 17. Efficiency vs. output current.

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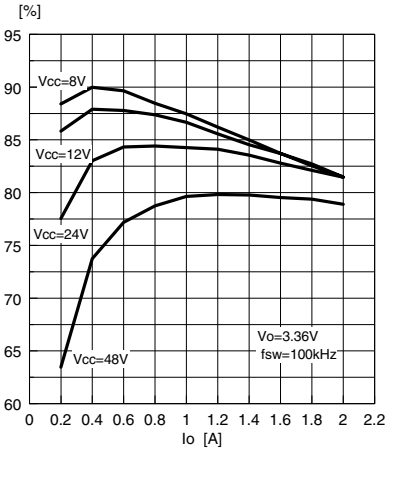

Figure 18. Efficiency vs. output current.

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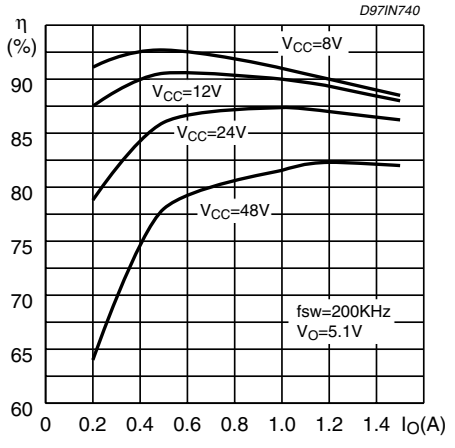

Figure 19. Efficiency vs. output current.

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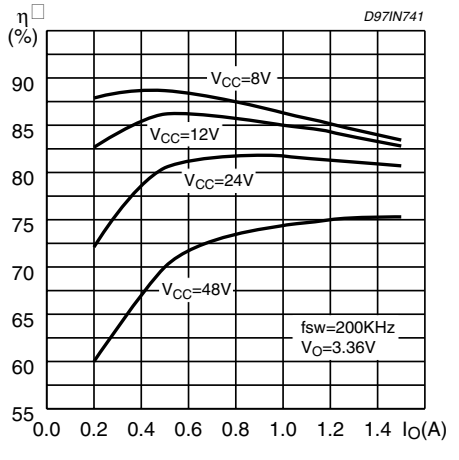

Figure 20. Efficiency vs. Vcc.

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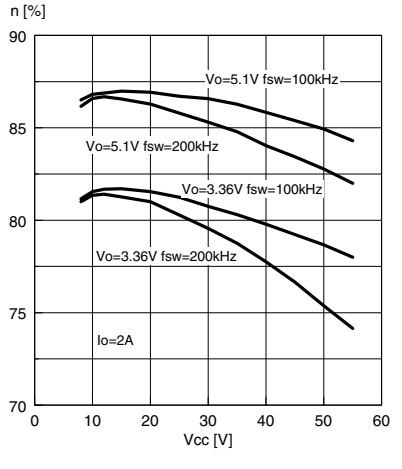

Figure 21. Power dissipation vs. Vcc.

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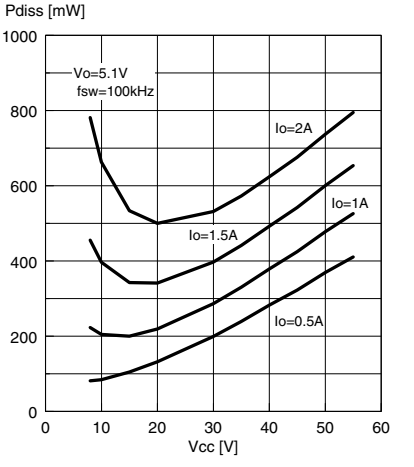

Figure 22. Device Power dissipation vs. Vo

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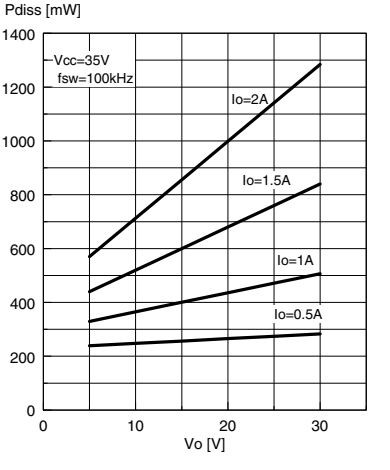

Figure 23. Pulse by pulse limiting current vs. junction temperature..

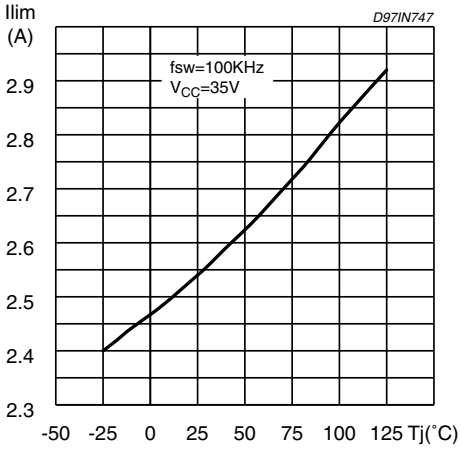

Figure 24. Load transient.

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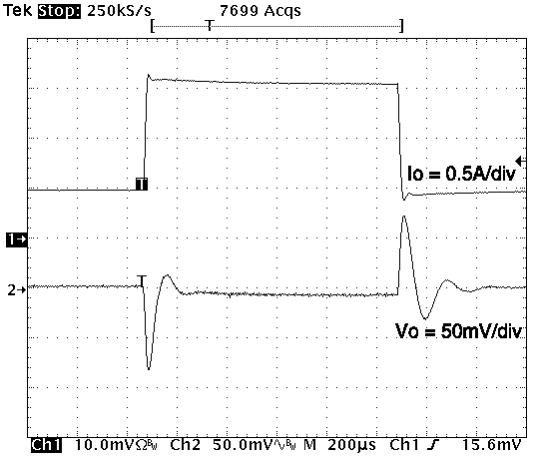

Figure 25. Line transient.

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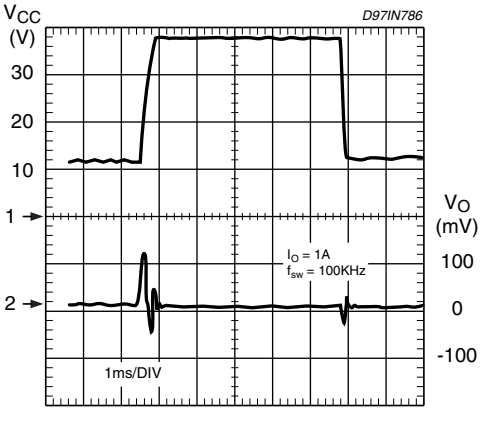


Figure 26. Soft start capacitor selection Vs inductor and V_{ccmax}.

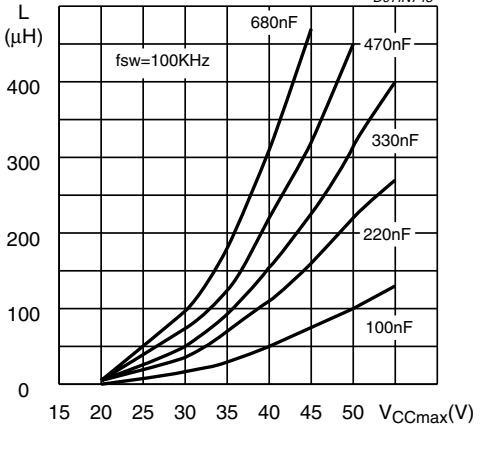


Figure 27. Soft start capacitor selection Vs inductor and V_{ccmax}.

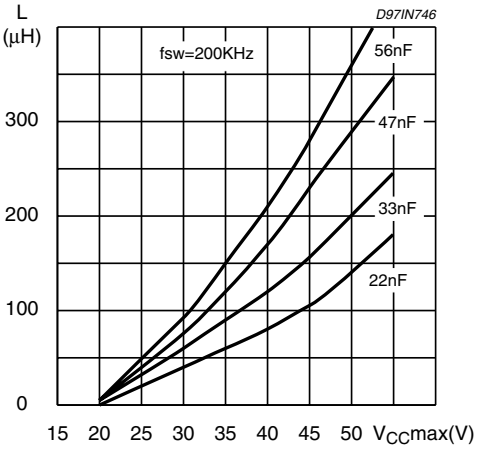
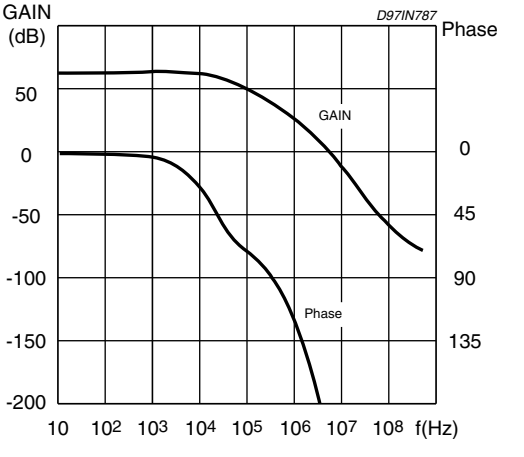


Figure 28. Open loop frequency and phase of error amplifier .

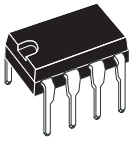


3 Package Informations

Figure 29. DIP-8 Mechanical Data & Package Dimensions

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



DIP-8

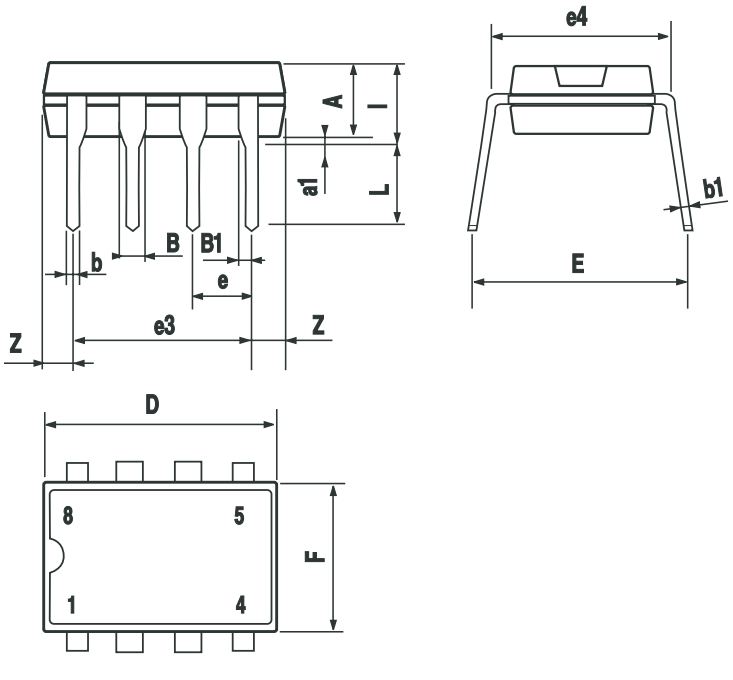
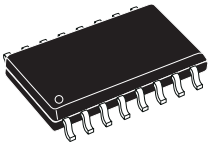


Figure 30. SO16 Wide Mechanical Data & Package Dimensions

DIM.	mm			inch		
	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.
A	2.35		2.65	0.093		0.104
A1	0.10		0.30	0.004		0.012
B	0.33		0.51	0.013		0.200
C	0.23		0.32	0.009		0.013
D (1)	10.10		10.50	0.398		0.413
E	7.40		7.60	0.291		0.299
e		1.27			0.050	
H	10.0		10.65	0.394		0.419
h	0.25		0.75	0.010		0.030
L	0.40		1.27	0.016		0.050
k	0° (min.), 8° (max.)					
ddd			0.10			0.004

(1) "D" dimension does not include mold flash, protusions or gate burrs. Mold flash, protusions or gate burrs shall not exceed 0.15mm per side.

OUTLINE AND MECHANICAL DATA



SO16 (Wide)

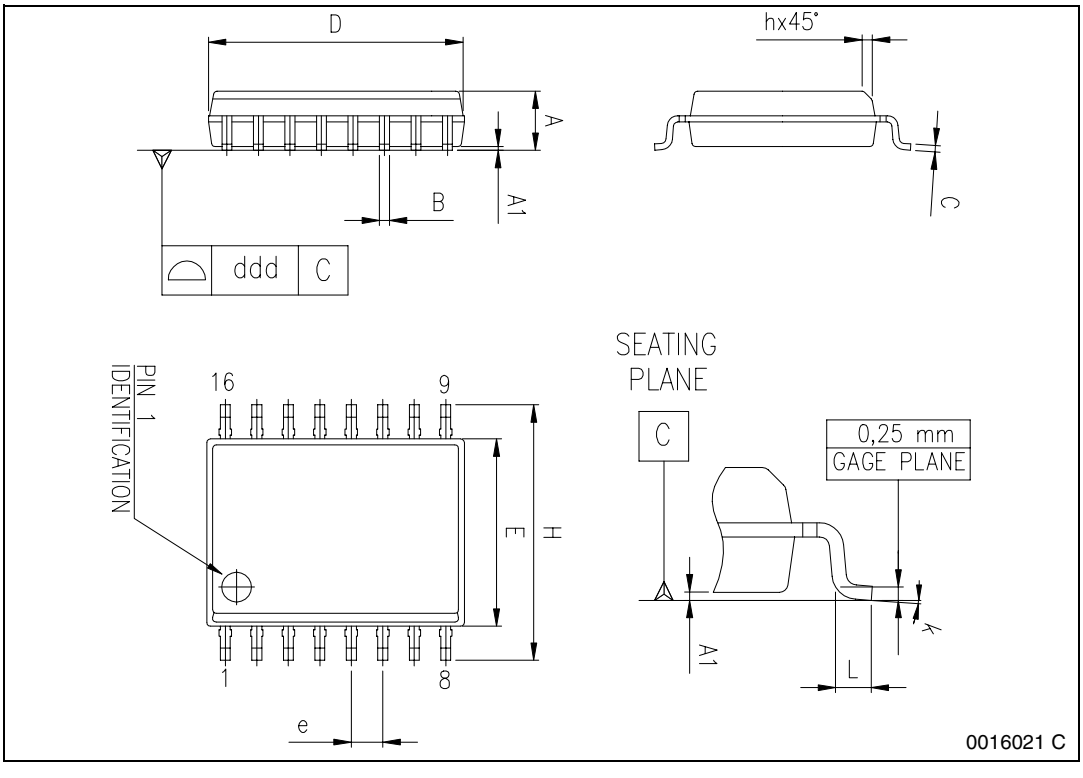


Table 7. Revision History

Date	Revision	Description of Changes
October 2001	8	First Issue
May 2005	9	Modified D1 on the Fig. 4.