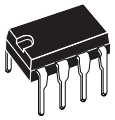
L4976

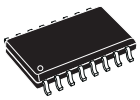
1A step down switching regulator

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



DIP8

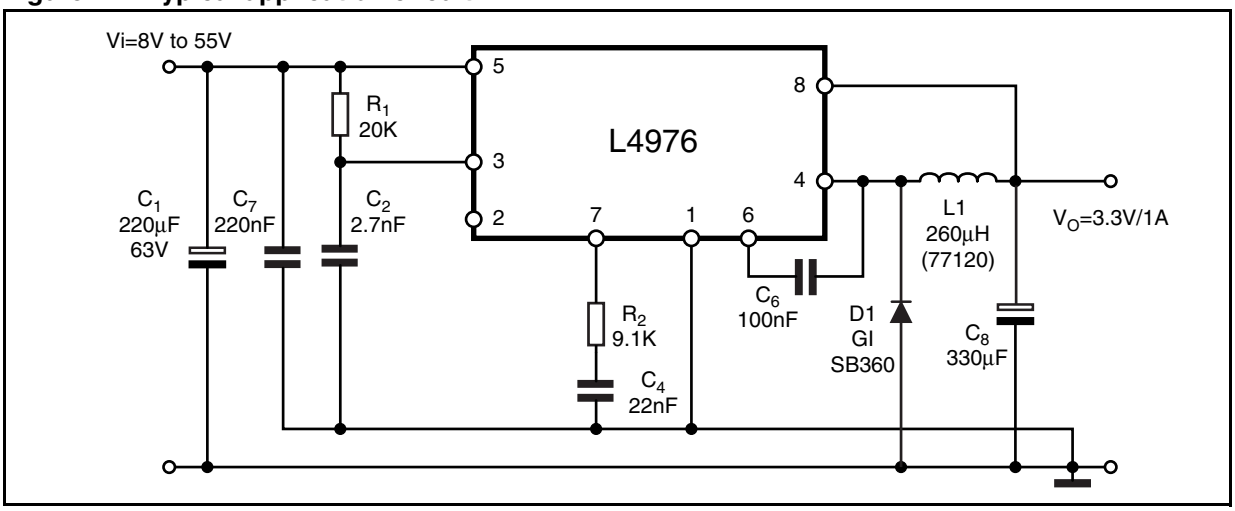


SO16W

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 0.25Ω) 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 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.

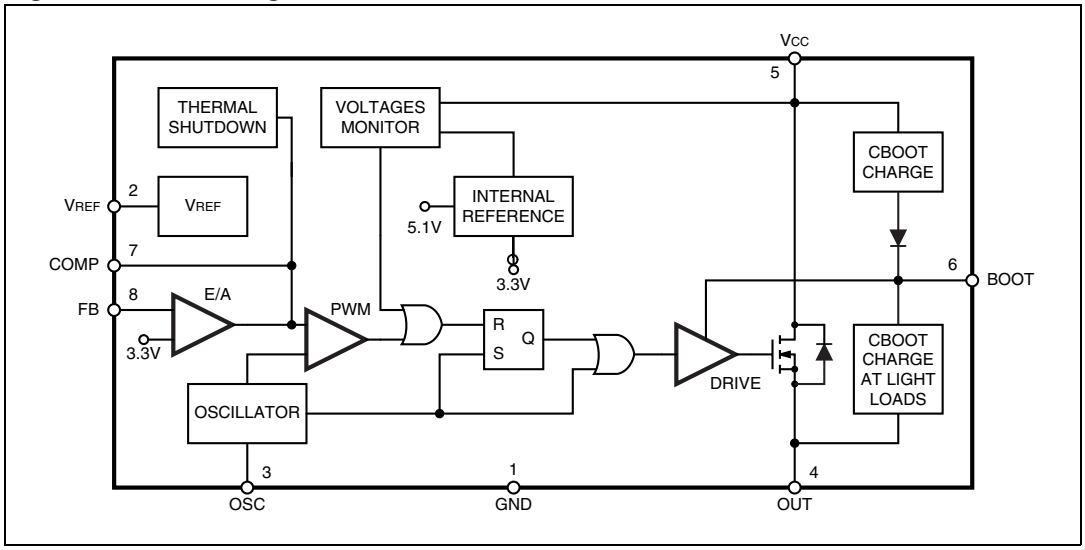
Figure 1. Typical application circuit



Contents

1 Block diagram

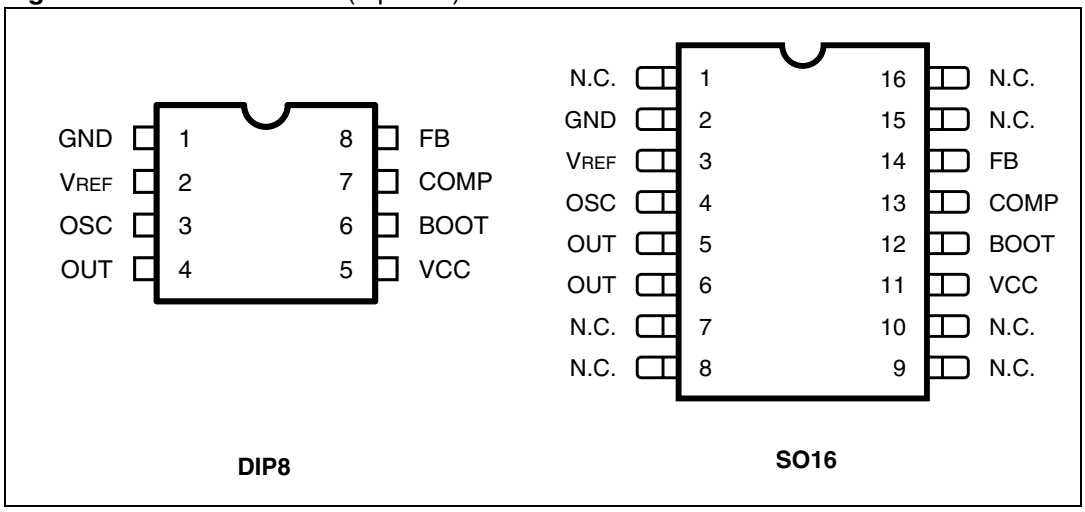
Figure 2. Block diagram



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 (1)		
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_{CC} = 24V)		12	V
V8	V14	(V_{CC} = 20V)		6	V
				-0.3	V
P_{TOT}		Power dissipation a $T_A \leq 60°C$	DIP8	1	W
			SO16	0.8	W
T_J,T_{STG}		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 (1)	110 (1)	°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	°C

4 Electrical characteristics

Table 5. Electrical characteristics
(T_J = 25°C, C_{OSC} = 2.7nF, R_{OSC} = 20kΩ, V_{CC} = 24V, unless otherwise specified.)

Symbol	Parameter	Test condition	Min	Typ	Max	Unit
Dynamic characteristic						
V_I	Operating input voltage range	V_O = 3.3 to 50V; I_O = 1A (1)	8		55	V
V_O	Output voltage	I_O = 0.5A	3.33	3.36	3.39	V
		I_O = 0.2 to 1A	3.292	3.36	3.427	V
		V_{CC} = 8 to 55V (1)	3.22	3.36	3.5	V
Vd	Dropout voltage	V_{CC} = 10V; I_O = 1A		0.29	0.367	V
		(1)			0.587	V
I_l	Maximum limiting current	V_{CC} = 8 to 55V (1)	1.5	2	2.5	A
	Efficiency	V_O = 3.3V; I_O = 1A		85		%
f_s	Switching frequency	(1)	90	100	110	KHz
SVRR	Supply voltage ripple rejection	$V_I = V_{CC} + 2V_{RMS}$; $V_O = V_{ref}$; I_O = 1.A; f_{ripple} = 100Hz	60			dB
	Voltage stability of switching frequency	V_{CC} = 8 to 55V		3	6	%
	Temp. stability of switching frequency	T_J = 0 to 125°C		4		%
Reference section						
	Reference voltage		5.0	5.1	5.2	V
		I_{ref} = 0 to 10mA; (1)	4.950	5.1	5.250	V
		V_{CC} = 8 to 55V				
	Line regulation	I_{ref} = 0mA;		5	10	mV
		V_{CC} = 8 to 55V				
	Load regulation	V_{ref} = 0 to 5mA;		2	10	mV
		V_{CC} = 0 to 20mA		6	25	mV
	Short circuit current		30	65	100	mA

Table 5. Electrical characteristics (continued)
(T_J = 25°C, C_{OSC} = 2.7nF, R_{OSC} = 20kΩ, V_{CC} = 24V, unless otherwise specified.)

Symbol	Parameter	Test condition	Min	Typ	Max	Unit
DC Characteristics						
I_{qop}	Total operating quiescent current			4	6	mA
I_q	Quiescent current	Duty Cycle = 0; V_{FB} = 3.8V		2.5	3.5	mA
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	(1)		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} = Vfb; V_{CC} = 8 to 55V	60	80		dB
	DC open loop gain	$R_L = \infty$	50	57		dB
gm	Transconductance	I_{comp} = -0.1 to 0.1mA V_{comp} = 6V		2.5		ms
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} = 13kW, C_{osc} = 820pF			300	kHz

1. Specification refered to Tj from 0 to 125°C

5 Typical charcteristics

Figure 4. Quiescent drain current vs. input voltage

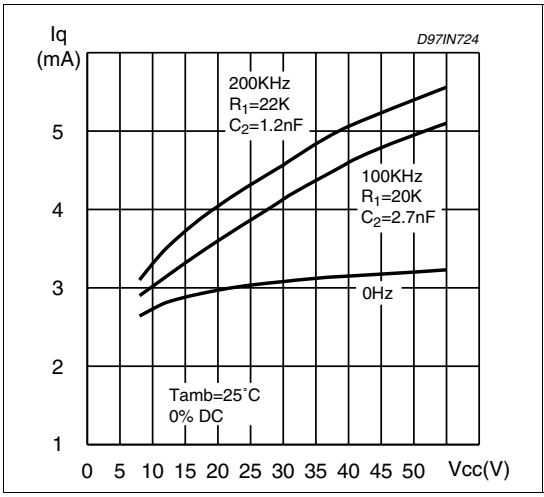


Figure 5. Line regulation

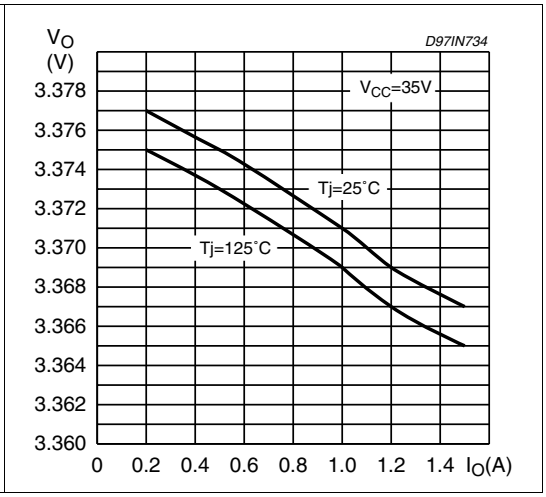


Figure 6. Quiescent current vs. junction temperature

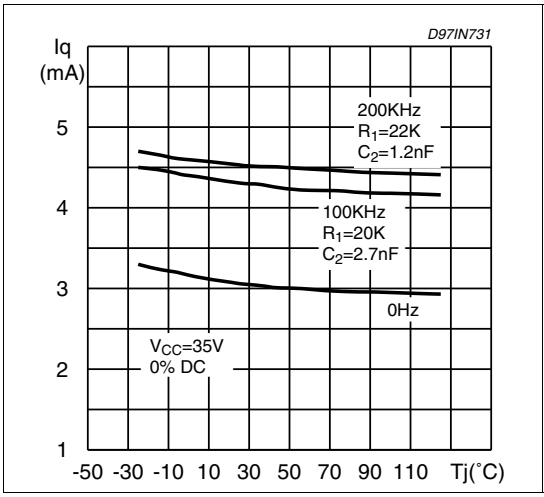


Figure 7. Switching frquency vs. R1 and C2

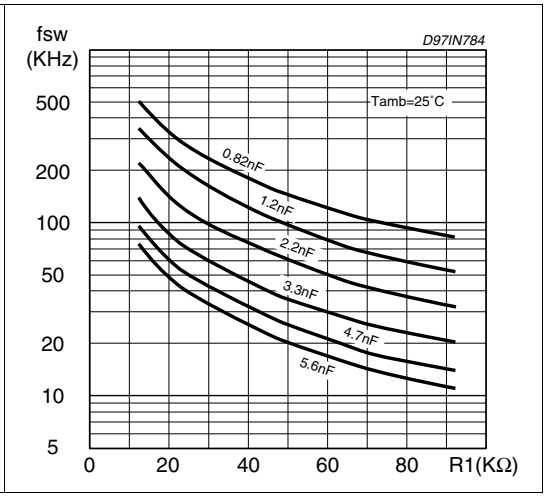


Figure 8. Load regulation

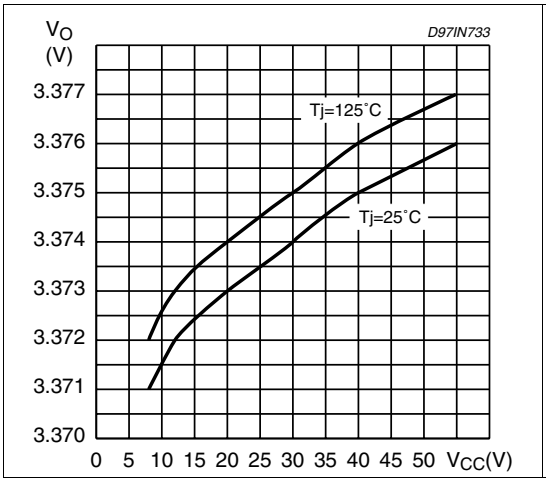


Figure 9. Switching frequency vs. input voltage

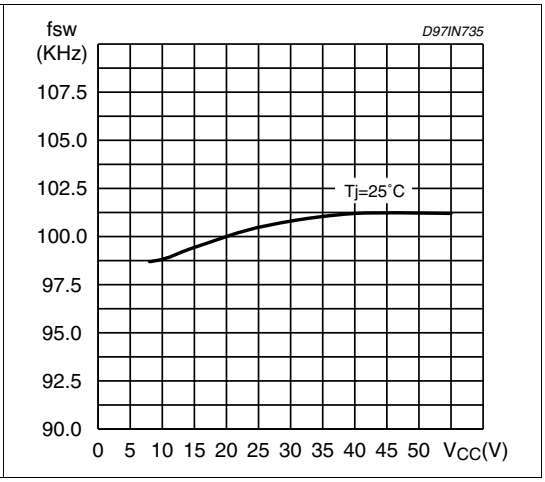


Figure 10. Switching frequency vs. junction temperature

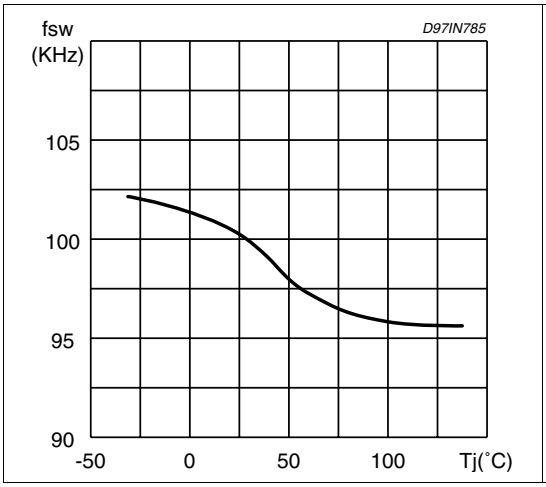


Figure 11. Efficiency vs. output current

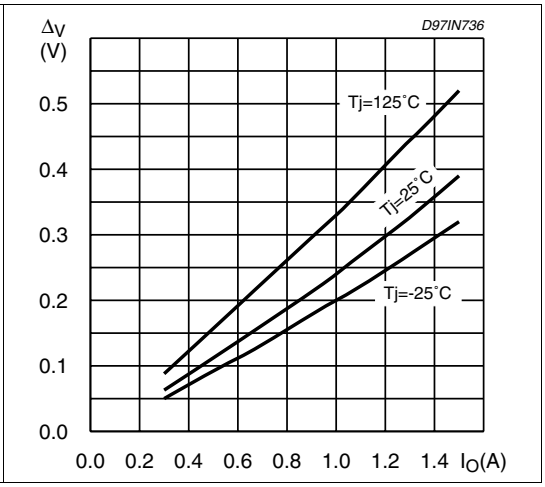


Figure 12. Dropout voltage between pin 5 and 4

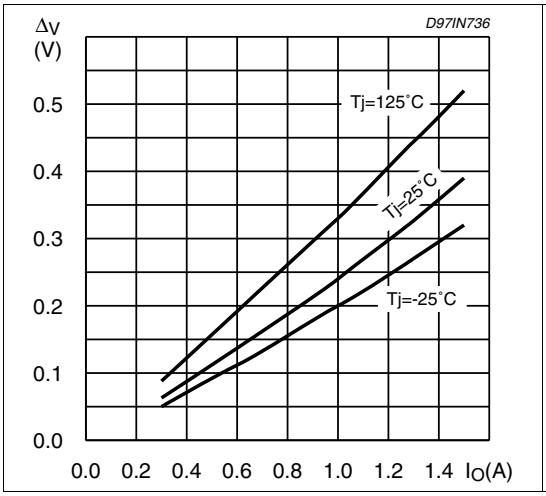


Figure 13. Efficiency vs. output current

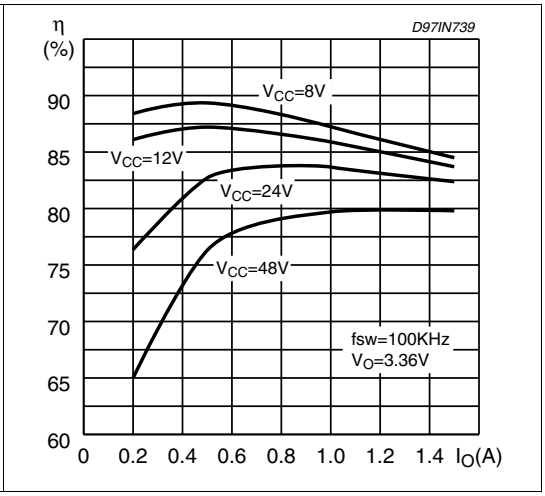


Figure 14. Efficiency vs output voltage

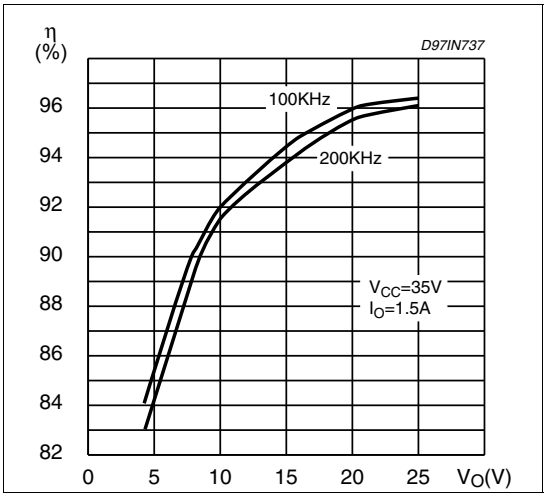


Figure 15. Efficiency vs. output current

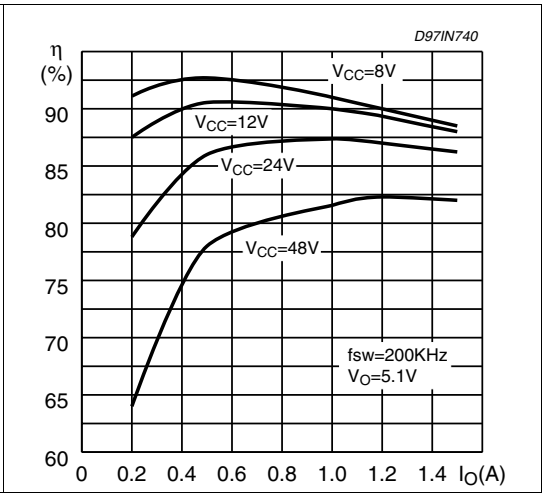


Figure 16. Efficiency vs. output current

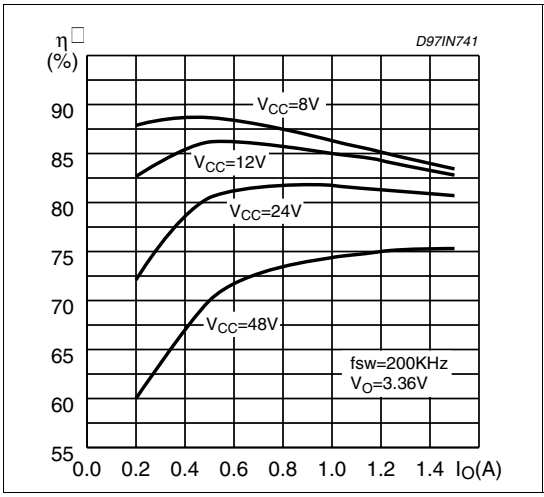


Figure 17. Efficiency vs. Vo

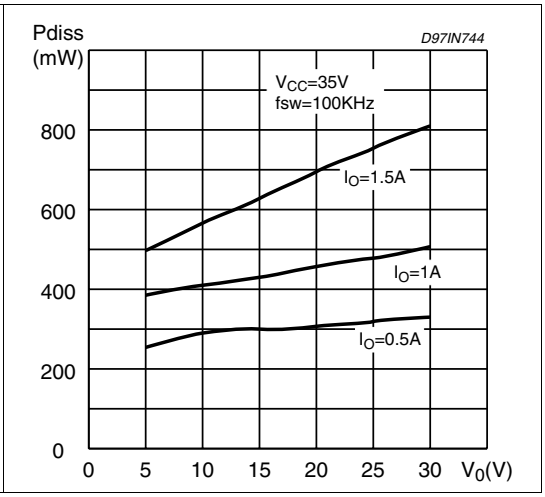


Figure 18. Efficiency vs. V_{CC}

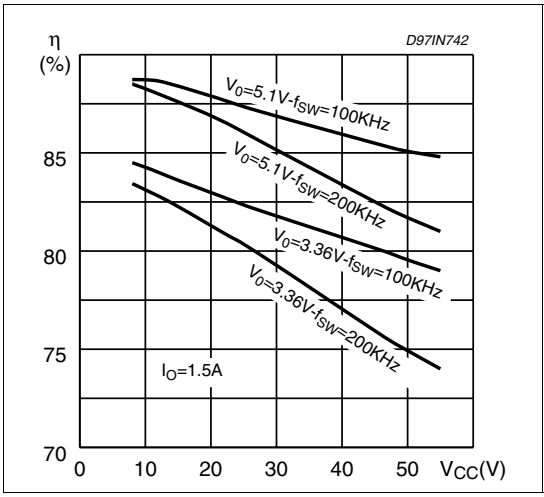


Figure 19. Pulse by pulse limiting current vs. junction temperature.

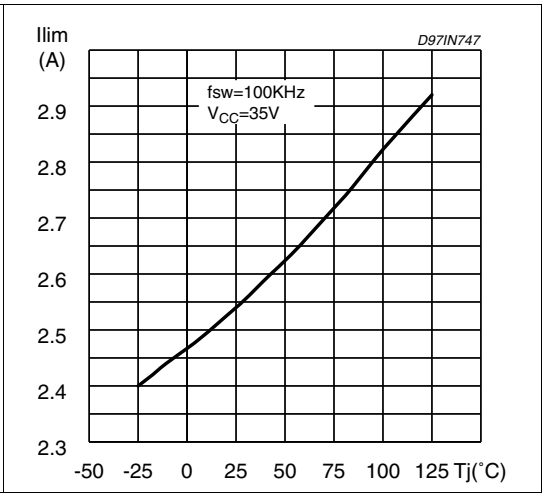


Figure 20. Power dissipation vs. V_{CC}

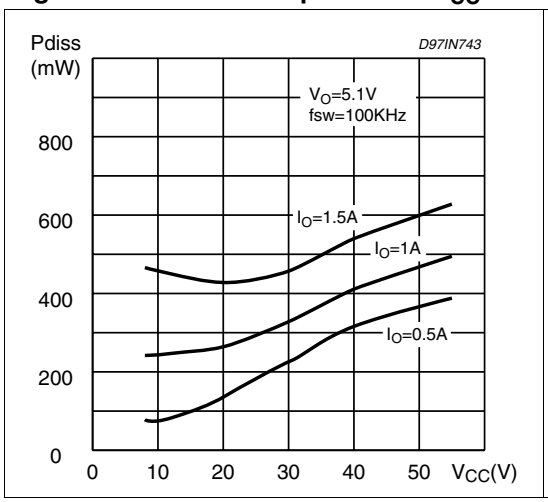


Figure 21. Load transient

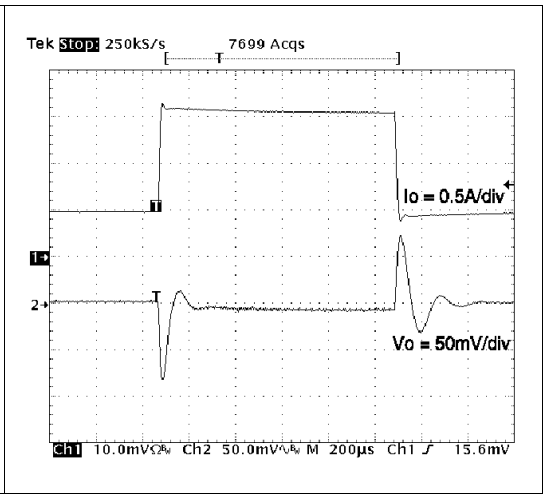


Figure 22. Line transient

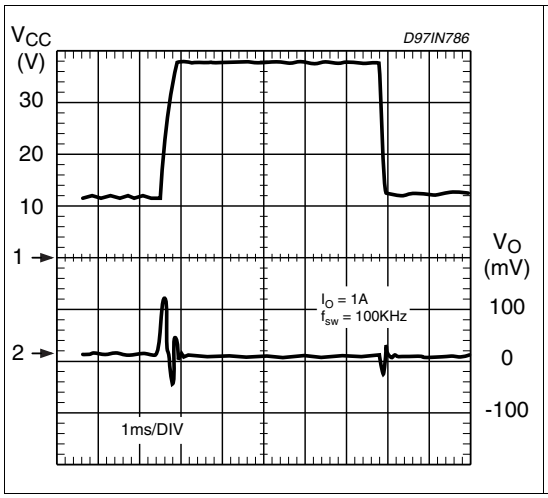
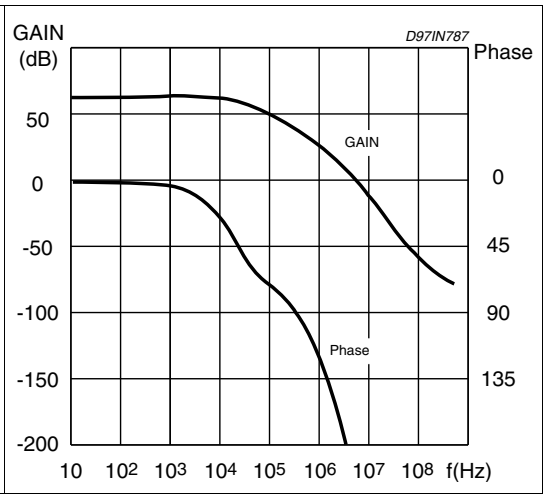


Figure 23. Open loop frequency and phase of error amplifier



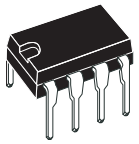
6 Package mechanical data

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

Figure 24. DIP8 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

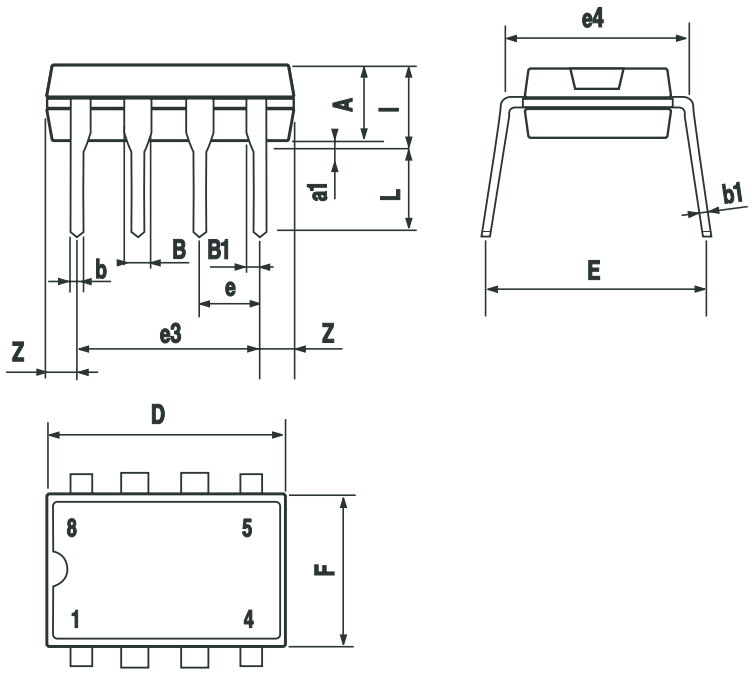
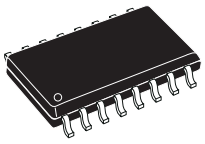


Figure 25. SO16Wide mechanical data & package dimensions

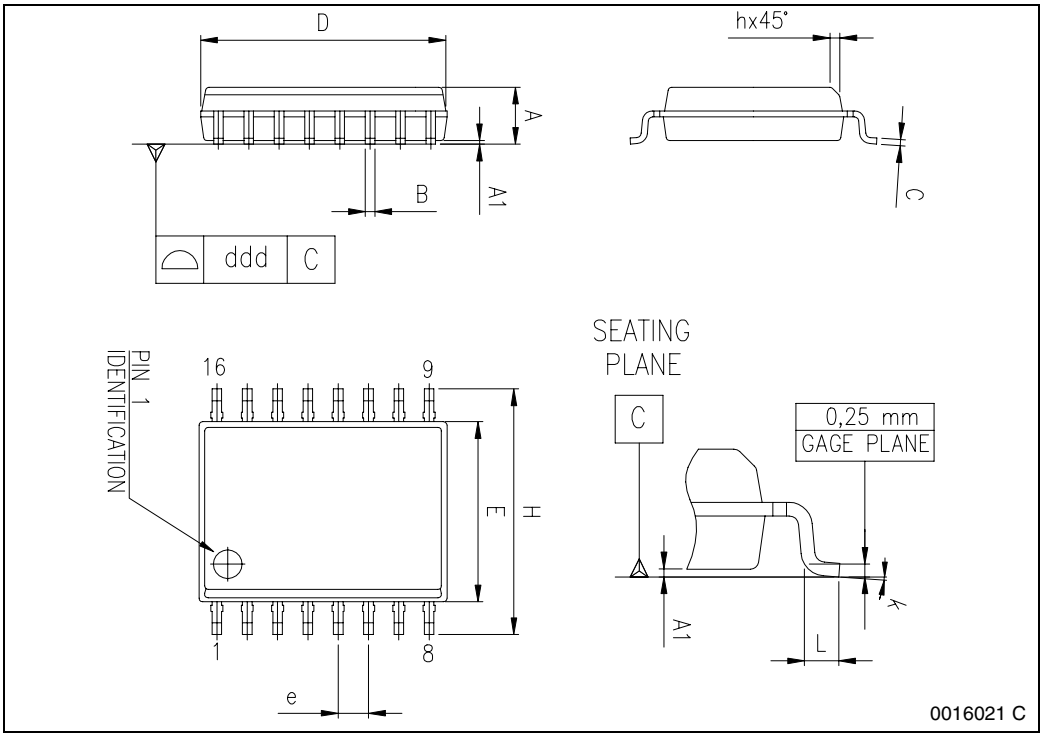
DIM.	mm			inch		
	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.
A	2.35		2.65	0.093		0.104
A1	0.10		0.30	0.004		0.012
B	0.33		0.51	0.013		0.200
C	0.23		0.32	0.009		0.013
D (1)	10.10		10.50	0.398		0.413
E	7.40		7.60	0.291		0.299
e		1.27			0.050	
H	10.0		10.65	0.394		0.419
h	0.25		0.75	0.010		0.030
L	0.40		1.27	0.016	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



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 *Table 5 on page 6*

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