LINEAR INTEGRATED CIRCUIT

L296

ADVANCE DATA

HIGH CURRENT SWITCHING REGULATOR

- 5.1V TO 40V OUTPUT
- 4A OUTPUT CURRENT
- UP TO 160W OUTPUT POWER
- PROGRAMMABLE CURRENT LIMITER
- SOFT START
- RESET OUTPUT
- PRECISE (± 2%) ON-CHIP REFERENCE
- VERY FEW COMPONENTS
- SWITCHING FREQUENCY TO 200 kHz
- VERY HIGH EFFICIENCY (UP TO 90%)
- THERMAL SHUTDOWN
- REMOTE INHIBIT AND SYNC INPUT
- CONTROL CIRCUIT FOR CROWBAR SCR

The L296 is a monolithic power switching regulator delivering 4A at a voltage variable from 5.1V to 40V in step down configurations. Features of the device include programmable current limiting, soft start, remote inhibit, thermal protection, a reset output for microprocessors and a synchronisation input for multichip configurations. The L296 is mounted in a 15-lead MULTIWATT plastic power package and requires very few external components. Efficient operation at switching frequencies up to 200 kHz allows a reduction in the size and cost of external filter components. A voltage sense input and SCR drive output are provided for optional crowbar overvoltage protection with an external SCR.

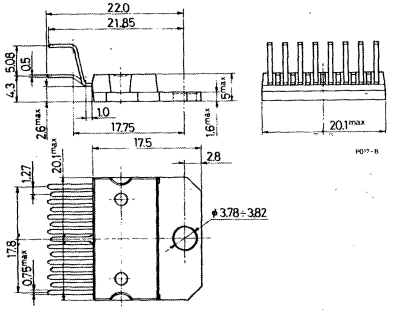
ABSOLUTE MAXIMUM RATINGS

V_i	Input voltage	50	V
I_o	Output current	internally limited	
I_R	Reset output current	50	mA
V_R	Reset output voltage	50	V
V_{inh}	Inhibit voltage	15	V
P_d	Power dissipation at $T_{case} < 90°C$	20	W
T_j	Junction temperature range	-25 to +150	°C
T_{stg}	Storage temperature range	-65 to +150	°C

ORDERING NUMBER: L296

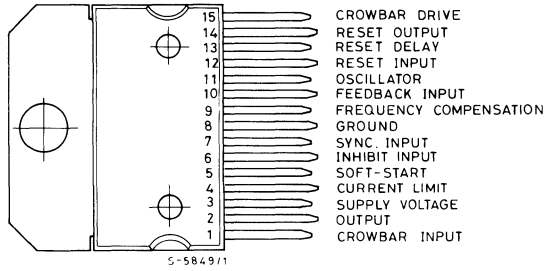
MECHANICAL DATA

Dimensions in mm

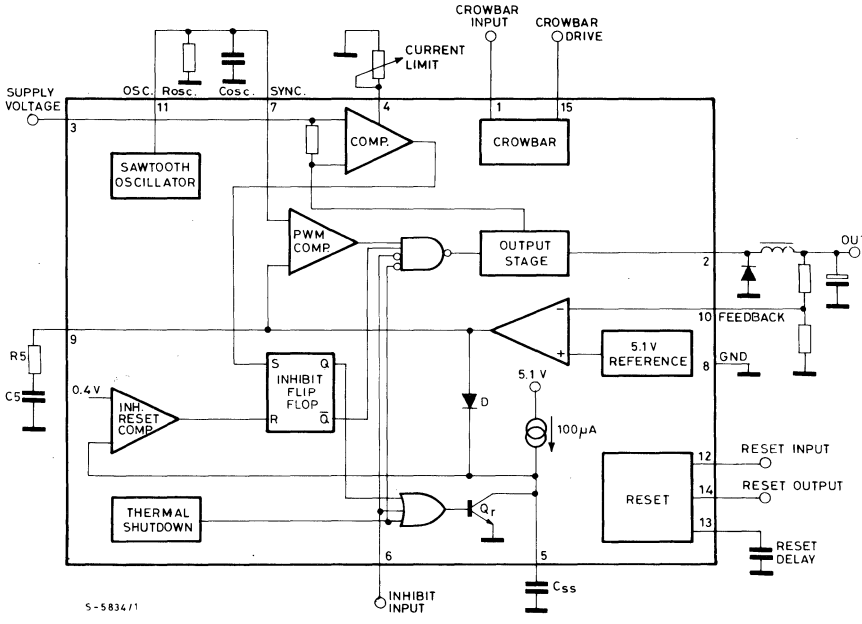


L296

CONNECTION DIAGRAM
(top view)



BLOCK DIAGRAM



THERMAL DATA

$R_{th\ j\text{-}case}$	Thermal resistance junction-case	max	3	°C/W
$R_{th\ j\text{-}amb}$	Thermal resistance junction-ambient	max	35	°C/W

PIN FUNCTIONS

N°	NAME	FUNCTION
1	CROWBAR INPUT	Voltage sense input for crowbar overvoltage protection. Normally connected to the feedback input thus triggering the SCR when V_{out} exceeds nominal by 20%. May also monitor the input and a voltage divider can be added to increase the threshold. Connected to ground when SCR not used.
2	OUTPUT	Regulator output.
3	SUPPLY VOLTAGE	Unregulated voltage input. An internal regulator powers the L296's internal logic.
4	CURRENT LIMITER	A resistor connected between this terminal and ground sets the current limiter threshold (1.5 to 5A). If this terminal is left unconnected the threshold will be 5A.
5	SOFT START	Soft start time constant. A capacitor is connected between this terminal and ground to define the soft start time constant. This capacitor also determines the average short circuit output current.
6	INHIBIT INPUT	TTL – level remote inhibit. A logic high level on this input disables the L296.
7	SYNC INPUT	Multiple L296s are synchronised by connecting the sync inputs together and omitting the oscillator RC network on all but one device.
8	GROUND	Common ground terminal.
9	FREQUENCY COMPENSATION	A series RC network connected between this terminal and ground determines the regulation loop gain characteristics.
10	FEEDBACK INPUT	The feedback terminal of the regulation loop. The output is connected directly to this terminal for 5.1V operation; it is connected via a divider for higher voltages.
11	OSCILLATOR	A parallel RC network connected to this terminal determines the switching frequency. This pin must be connected to the sync input when the internal oscillator is used.

PIN FUNCTIONS (continued)

N°	NAME	FUNCTION
12	RESET INPUT	This input fixes the threshold of the reset signal generator. It may be connected to the feedback point or via a divider to the input.
13	RESET DELAY	A capacitor connected between this terminal and ground determines the reset signal delay time.
14	RESET OUTPUT	Open collector reset signal output. This output is ON when the supply is safe.
15	CROWBAR OUTPUT	SCR gate drive output of the crowbar circuit.

CIRCUIT OPERATION

The L296 is a monolithic stepdown switching regulator providing output voltages from 5.1V to 40V and delivering 4A.

The regulation loop consists of a sawtooth oscillator, error amplifier, comparator and the output stage. An error signal is produced by comparing the output voltage with a precise 5.1V on-chip reference (zener zap trimmed to ± 2%). This error signal is then compared with the sawtooth signal to generate the fixed frequency pulse width modulated pulses which drive the output stage.
The precision and frequency stability of the loop can be adjusted by an external RC network connected to pin 9. Closing the loop directly gives an output voltage of 5.1V. Higher voltages are obtained by inserting a voltage divider.

Output overcurrents at switch on are prevented by the soft start function. The error amplifier output is initially clamped by the external capacitor C_s and allowed to rise, linearly, as this capacitor is charged by a constant current source.

Output overload protection is provided in the form of a current limiter. The load current is sensed by an internal metal resistor connected to a comparator. When the load current exceeds a preset threshold this comparator sets a flip flop which disables the output stage and discharges the soft start capacitor. A second comparator resets the flip flop when the voltage across the soft start capacitor has fallen to 0.4V. The output stage is thus re-enabled and the output voltage rises under control of the soft start network. If the overload condition is still present the limiter will trigger again when the threshold current is reached. The average short circuit current is limited to a safe value by the dead time introduced by the soft start network.

The reset circuit generates an output signal when the supply voltage exceeds a threshold programmed by an external divider. The reset signal is generated with a delay time programmed by an external capacitor. When the supply falls below the threshold the reset output goes low immediately. The reset output is an open collector.

The crowbar circuit senses the output voltage and the crowbar output can provide a current of 100 mA to switch on an external SCR. This SCR is triggered when the output voltage exceeds the nominal by 20%. There is no internal connection between the output and crowbar sense input therefore the crowbar can monitor either the input or the output.

CIRCUIT OPERATION (continued)

A TTL – level inhibit input is provided for applications such as remote on/off control. This input is activated by high logic level and disables circuit operation. After an inhibit the L296 restarts under control of the soft start network.

The thermal overload circuit disables circuit operation when the junction temperature reaches 150°C and has a hysteresis of 20°C.

Fig. 1 - Reset output waveforms

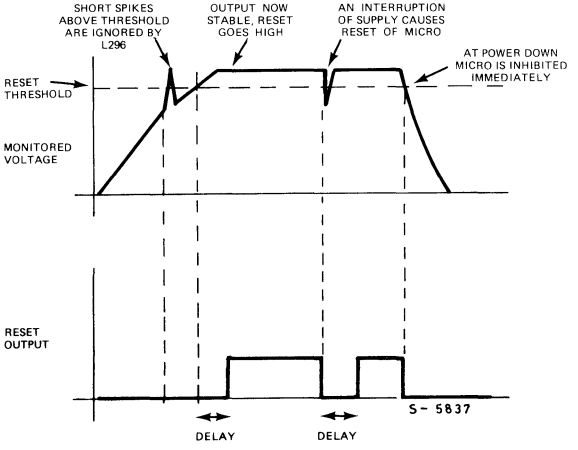


Fig. 2 - Soft start waveforms

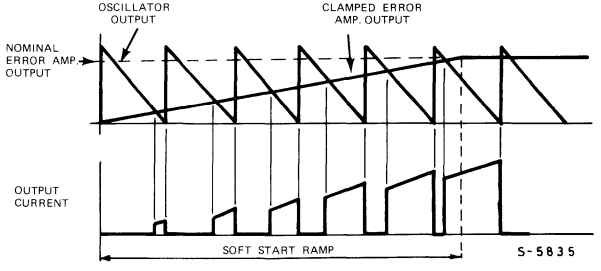
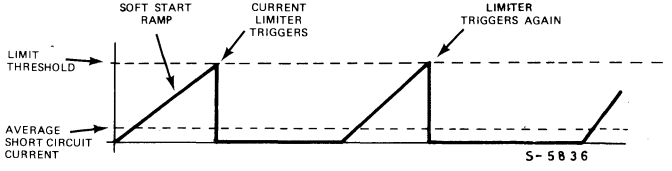


Fig. 3 - Current limiter waveforms



ELECTRICAL CHARACTERISTICS (Refer to the test circuit, T_{amb}= 25°C unless otherwise specified)

Parameter		Test conditions	Min.	Typ.	Max.	Unit
V_o	Output voltage range		5.1		40	V
V_i	Supply voltage range		8		50	V
$I_{o\ max}$	Output current		4			A
I_{OL}	Current limit	Pin 4 open		5		A
		R_{lim}= 33 KΩ		2.5		A
V_{sat}	Output transistor saturation voltage	I_o = 4A I_o = 2A		2 1.3		V V
f_s	Switching frequency	R_{osc}= 4.7 KΩ C_{osc}= 2.2 nF		100		kHz
	Efficiency	f = 100 KHz V_i = 35V V_o = 5.1V I_o = 3A V_o = 12V		 75 85		 % %
V_o	Line regulation	V_i = 10 to 40V V_o = 5.1V I_o = 2A		 20		 mV
V_o	Load regulation	V_i = 15V V_o = 5.1V I_o = 2A to 4A I_o = 0.5A to 4A		 10 15		 mV mV
SVR	Supply voltage rejection	f = 100 Hz		60		dB
V_{REF}	Internally reference voltage	V_i = 8 to 50V	5	5.1	5.2	V
V_{REF}	Average temperature coeff. of reference voltage			0.2		mV/°C
t_{ss}	Stoft start time	C_s = 2.2 μF		20		ms
I_{SH}	Output average current with short circuit output			0.5		A
RESET SECTION						
V_{RTi}	Reset threshold voltage (pin 12)	V_i = 8 to 50V	-10%	V_{ref} -100mV	+10%	V
V_{RTo}	Reset out low voltage (pin 14)	I_L = 16 mA			0.2	V
	Delay time (pin 13)	C_{reset} = 2.2 μF		100		ms
CROWBAR SECTION						
	Threshold voltage (pin 12)		+12%	V_{ref} +20%	+23%	
	I source (Pin 15)			100		mA
	I sink (Pin 15)			5		mA
	Delay time			10		μs

ELECTRICAL CHARACTERISTICS (continued)

Parameter		Test conditions	Min.	Typ.	Max.	Unit
INHIBIT SECTION						
V_{INHL}	Low input voltage				1.2	V
V_{INHH}	High input voltage		2.2			V
I_{INHL}	Input current with low input voltage				100	μA
I_{INHH}	Input current with high input voltage				10	μA
ERROR AMPLIFIER SECTION						
V_{os}	Input offset voltage			2		mV
I_{os}	Input offset current			25		nA
I_b	Input bias current			0.2		μA
G_v	Large signal open loop gain		60			dB
I_{OE}	Out sink current			200		μA
	Out source current			200		μA

Fig. 4 - Test circuit

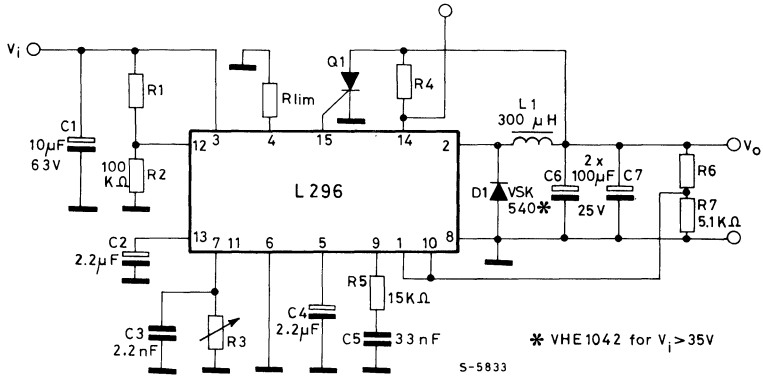
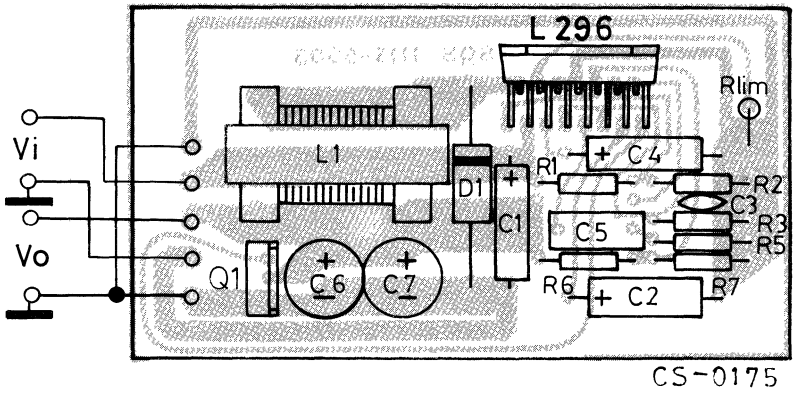


Fig. 5 - P.C. board and component layout of the circuit of fig. 4 (1:1 scale)



SELECTION OF COMPONENT VALUES

Component	Recommended Value	Purpose	Allowed Range Min.	Allowed Range Max.	NOTE
R1 R2	– 100 kΩ	Reset sensing threshold	–	220 kΩ	$R1/R2 = \frac{V_{i\ min.}}{V_T\ (pin\ 12)}$
R3	4.7 kΩ	f_o setting	1 kΩ	100 kΩ	
R4	1 kΩ				$R4_{min} = \frac{V_o}{50\ mA}$
R5	15 kΩ	Frequency compensation	10 kΩ		See application note "Designing with the L296 Power Switching Regulator".
R6 R7	– 51 kΩ	Voltage divider	– –	– 51 kΩ .	$R6/R7 = \frac{V_o - V_{ref}}{V_{ref}}$
C1	10 μF	Stability	1 μF		
C2	2.2 μF	Reset delay	1 μF	4.7 μF	
C3	2.2 nF	f_o setting	1 nF	3.3 nF	
C4	2.2 μF	Soft start	1 μF	4.7 μF	
C5	33 nF	Frequency compensation			See application note "Designing with the L296 Power Switching Regulator".
C6	100 μF	Output filter			
C7	100 μF				
L1	300 μH				

Fig. 6 - Efficiency vs. output current

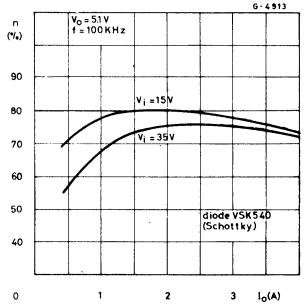


Fig. 7 - Dissipated Power vs. output current (L296 only)

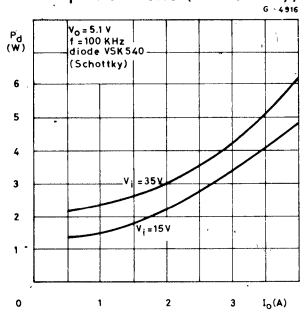


Fig. 8 - Efficiency vs. output current

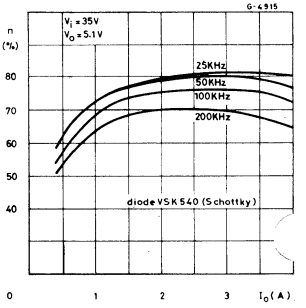


Fig. 9 - Efficiency vs. output voltage

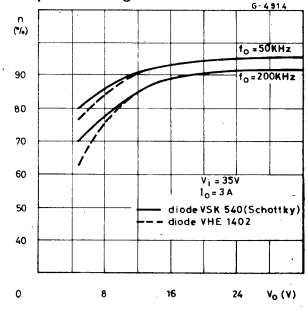


Fig. 10 - Operating frequency vs. R3 and C3

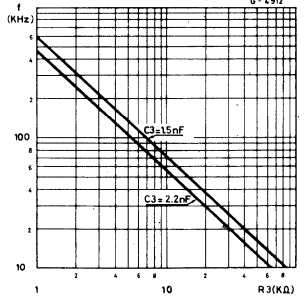


Fig. 11 - Power dissipation derating curve

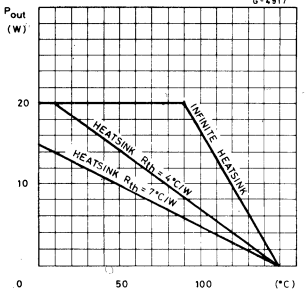


Fig. 12 - Voltage sensing for remote load

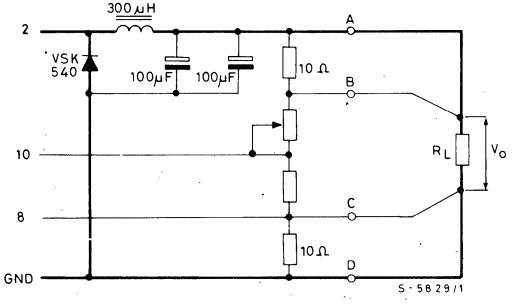
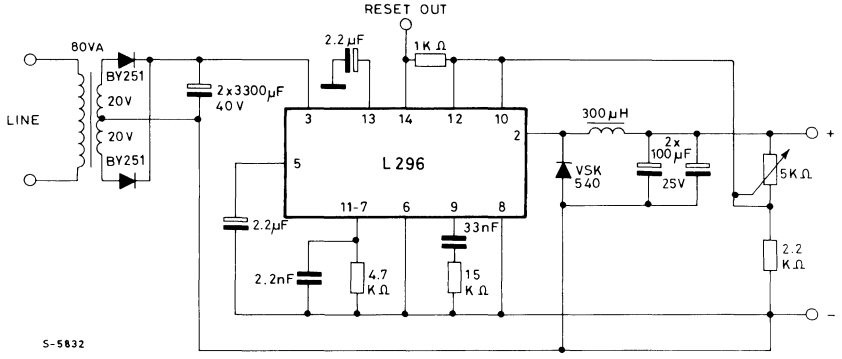


Fig. 13 - Typical application



V_o = 5.1 to 15V
I_o = 4A max. (min. load current = 100 mA)
ripple $\leqslant$ 20 mV
load regulation (1A to 4A) = 10 mV (V_o = 5.1V)
line regulation (220V ± 15% and to I_o = 3A) = 15 mV (V_o = 5.1V)

Fig. 14 - Preregulator for distributed supplies

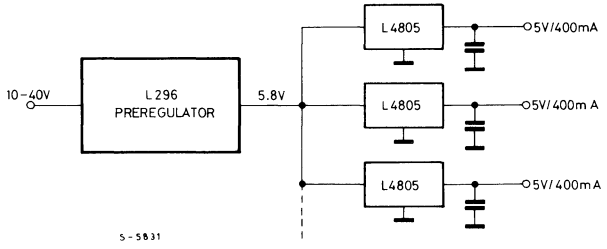


Fig. 15 - Multiple supply