L298

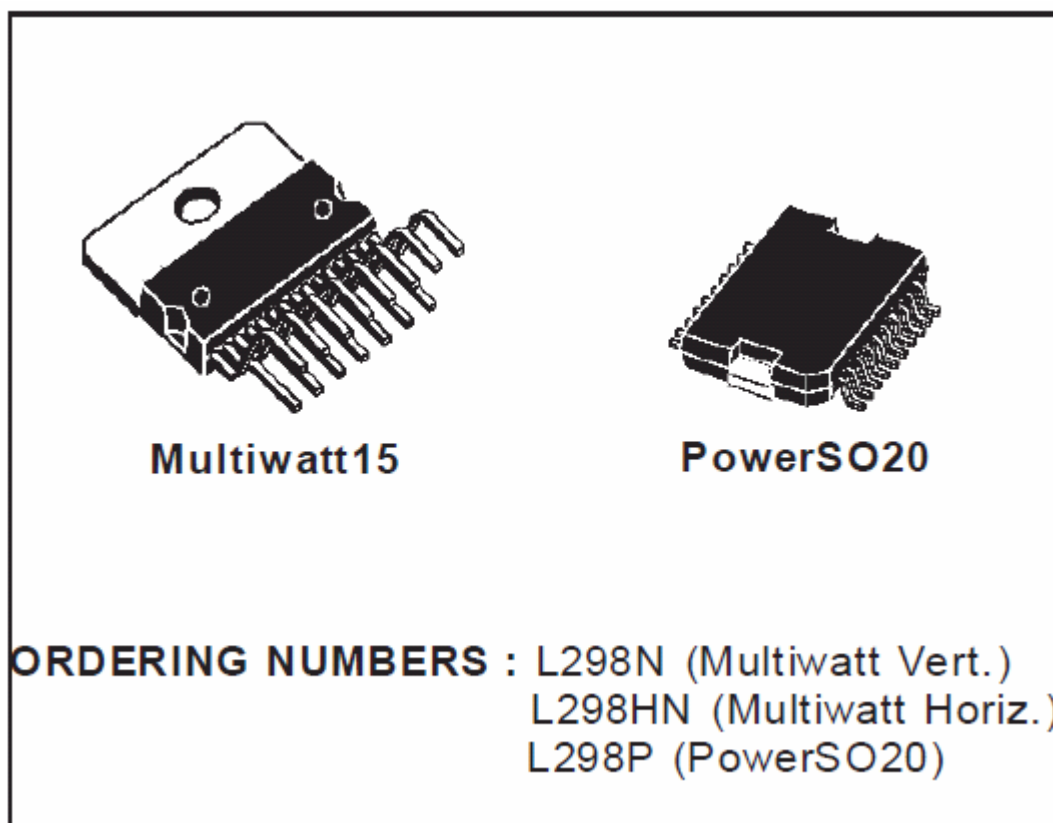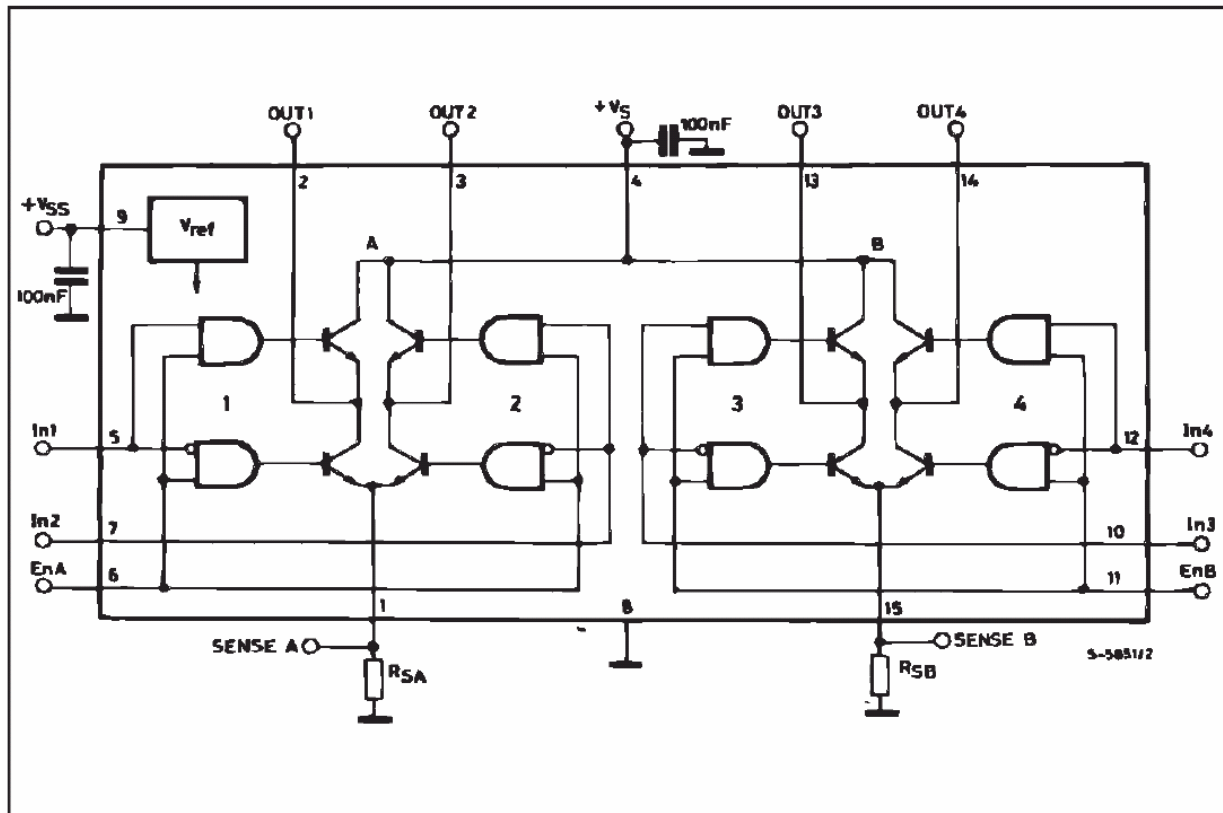# DUAL FULL-BRIDGE DRIVER

- OPERATINGSUPPLY VOLTAGEUP TO 46 V
- TOTAL DC CURRENT UP TO 4 A
- LOWSATURATION VOLTAGE
- OVERTEMPERATURE PROTECTION LOGICAL ”0” INPUT VOLTAGE UP TO 1.5 V(HIGHNOISE IMMUNITY)

DESCRIPTION

The L298 is an integrated monolithic circuit in a 15-lead Multiwatt and PowerSO20 packages. It is a high voltage, high current dual full-bridge driver designed to accept standard TTL logic levels and drive inductive loads such as relays, solenoids, DC and stepping motors. Two enable inputs are provided to enableor disable the device independently of the input signals. The emitters of the lower transistors of each bridge are connected together and the corresponding external terminal can be used for the connection of an external sensing resistor. An additional supply input is provided so that the logic works at a lower voltage.
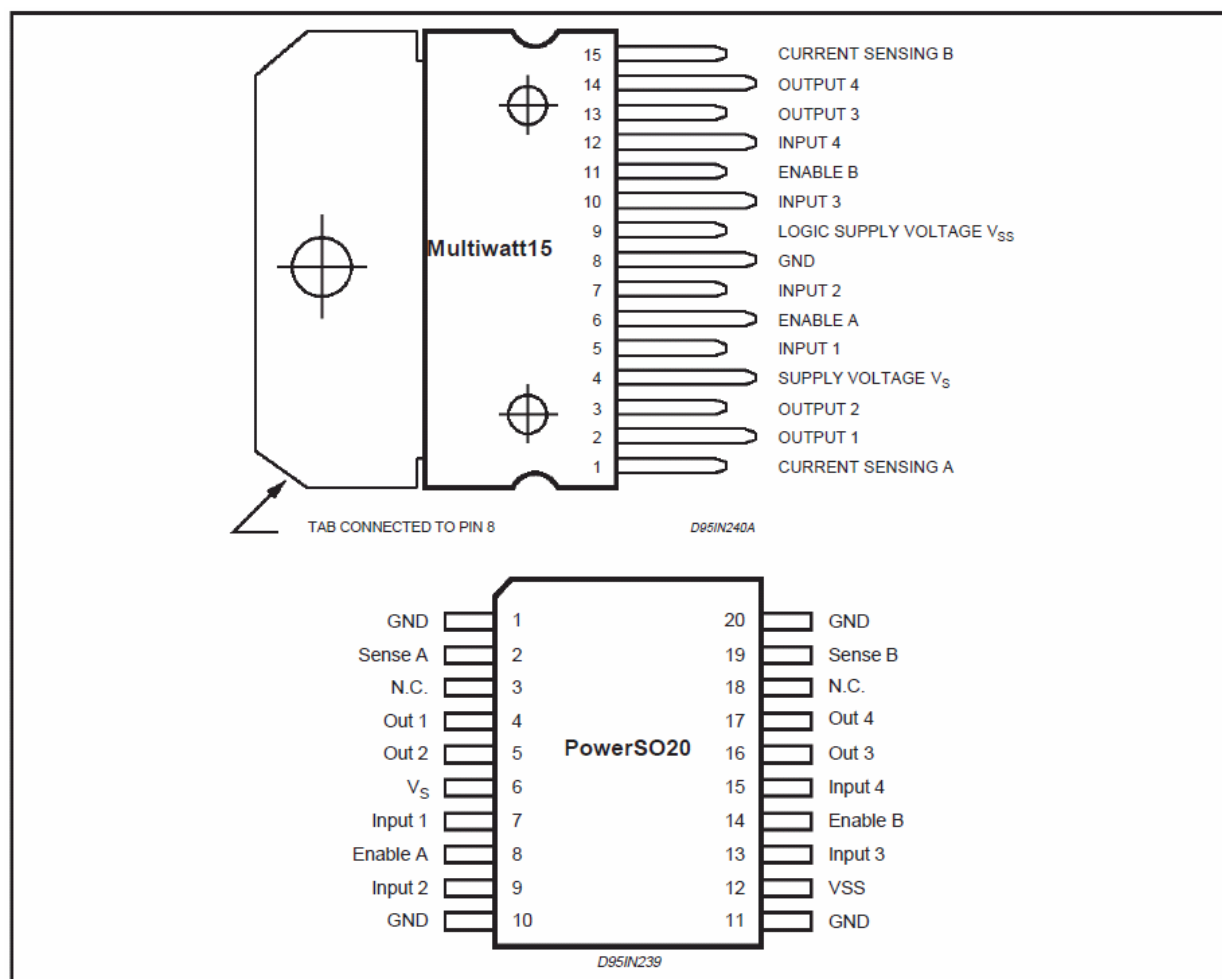

Multiwatt15   PowerSO20

ORDERING NUMBERS : L298N (Multiwatt Vert.)
L298HN (Multiwatt Horiz.)
L298P (PowerSO20)

BLOCK DIAGRAM

ABSOLUTEMAXIMUM RATINGS

Symbol	Parameter	Value	Unit
V_S	Power Supply	50	V
V_{SS}	Logic Supply Voltage	7	V
V_I, V_{en}	Input and Enable Voltage	−0.3 to 7	V
I_O	Peak Output Current (each Channel) – Non Repetitive (t = 100µs) –Repetitive (80% on –20% off; t_{on} = 10ms) –DC Operation	3 2.5 2	A A A
V_{sens}	Sensing Voltage	−1 to 2.3	V
P_{tot}	Total Power Dissipation (T_{case} = 75°C)	25	W
T_{op}	Junction Operating Temperature	−25 to 130	°C
T_{stg}, T_j	Storage and Junction Temperature	−40 to 150	°C

PIN CONNECTIONS (top view)

Multiwatt15

15	CURRENT SENSING B
14	OUTPUT 4
13	OUTPUT 3
12	INPUT 4
11	ENABLE B
10	INPUT 3
9	LOGIC SUPPLY VOLTAGE V_{SS}
8	GND
7	INPUT 2
6	ENABLE A
5	INPUT 1
4	SUPPLY VOLTAGE V_S
3	OUTPUT 2
2	OUTPUT 1
1	CURRENT SENSING A

TAB CONNECTED TO PIN 8

D95IN240A

PowerSO20

GND	1	20	GND
Sense A	2	19	Sense B
N.C.	3	18	N.C.
Out 1	4	17	Out 4
Out 2	5	16	Out 3
V_S	6	15	Input 4
Input 1	7	14	Enable B
Enable A	8	13	Input 3
Input 2	9	12	VSS
GND	10	11	GND

D95IN239

THERMAL DATA

Symbol	Parameter		PowerSO20	Multiwatt15	Unit
$R_{th\ j\text{-}case}$	Thermal Resistance Junction-case	Max.	–	3	°C/W
$R_{th\ j\text{-}amb}$	Thermal Resistance Junction-ambient	Max.	13 (*)	35	°C/W

PIN FUNCTIONS (refer to the block diagram)

MW.15	PowerSO	Name	Function
1;15	2;19	Sense A; Sense B	Between this pin and ground is connected the sense resistor to control the current of the load.
2;3	4;5	Out 1; Out 2	Outputs of the Bridge A; the current that flows through the load connected between these two pins is monitored at pin 1.
4	6	V_S	Supply Voltage for the Power Output Stages. A non-inductive 100nF capacitor must be connected between this pin and ground.
5;7	7;9	Input 1; Input 2	TTL Compatible Inputs of the Bridge A.
6;11	8;14	Enable A; Enable B	TTL Compatible Enable Input: the L state disables the bridge A (enable A) and/or the bridge B (enable B).
8	1,10,11,20	GND	Ground.
9	12	VSS	Supply Voltage for the Logic Blocks. A100nF capacitor must be connected between this pin and ground.
10; 12	13;15	Input 3; Input 4	TTL Compatible Inputs of the Bridge B.
13; 14	16;17	Out 3; Out 4	Outputs of the Bridge B. The current that flows through the load connected between these two pins is monitored at pin 15.
–	3;18	N.C.	Not Connected

ELECTRICAL CHARACTERISTICS (VS = 42V; VSS = 5V, Tj = 25°C; unless otherwise specified)

Symbol	Parameter	Test Conditions		Min.	Typ.	Max.	Unit
V_S	Supply Voltage (pin 4)	Operative Condition		V_{IH} +2.5		46	V
V_{SS}	Logic Supply Voltage (pin 9)			4.5	5	7	V
I_S	Quiescent Supply Current (pin 4)	V_{en} = H; I_L = 0	V_i = L		13	22	mA
			V_i = H		50	70	mA
		V_{en} = L	V_i = X			4	mA
I_{SS}	Quiescent Current from V_{SS} (pin 9)	V_{en} = H; I_L = 0	V_i = L		24	36	mA
			V_i = H		7	12	mA
		V_{en} = L	V_i = X			6	mA
V_{iL}	Input Low Voltage (pins 5, 7, 10, 12)			−0.3		1.5	V
V_{iH}	Input High Voltage (pins 5, 7, 10, 12)			2.3		VSS	V
I_{iL}	Low Voltage Input Current (pins 5, 7, 10, 12)	V_i = L				−10	µA
I_{iH}	High Voltage Input Current (pins 5, 7, 10, 12)	Vi = H ≤ V_{SS} −0.6V			30	100	µA
V_{en} = L	Enable Low Voltage (pins 6, 11)			−0.3		1.5	V
V_{en} = H	Enable High Voltage (pins 6, 11)			2.3		V_{SS}	V
I_{en} = L	Low Voltage Enable Current (pins 6, 11)	V_{en} = L				−10	µA
I_{en} = H	High Voltage Enable Current (pins 6, 11)	V_{en} = H ≤ V_{SS} −0.6V			30	100	µA
$V_{CEsat(H)}$	Source Saturation Voltage	I_L = 1A		0.95	1.35	1.7	V
		I_L = 2A			2	2.7	V
$V_{CEsat(L)}$	Sink Saturation Voltage	I_L = 1A (5)		0.85	1.2	1.6	V
		I_L = 2A (5)			1.7	2.3	V
V_{CEsat}	Total Drop	I_L = 1A (5)		1.80		3.2	V
		I_L = 2A (5)				4.9	V
V_{sens}	Sensing Voltage (pins 1, 15)			−1 (1)		2	V

ELECTRICAL CHARACTERISTICS (continued)

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
T_1 (V_i)	Source Current Turn-off Delay	$0.5\,V_i$ to $0.9\,I_L$ (2); (4)		1.5		μs
T_2 (V_i)	Source Current Fall Time	$0.9\,I_L$ to $0.1\,I_L$ (2); (4)		0.2		μs
T_3 (V_i)	Source Current Turn-on Delay	$0.5\,V_i$ to $0.1\,I_L$ (2); (4)		2		μs
T_4 (V_i)	Source Current Rise Time	$0.1\,I_L$ to $0.9\,I_L$ (2); (4)		0.7		μs
T_5 (V_i)	Sink Current Turn-off Delay	$0.5\,V_i$ to $0.9\,I_L$ (3); (4)		0.7		μs
T_6 (V_i)	Sink Current Fall Time	$0.9\,I_L$ to $0.1\,I_L$ (3); (4)		0.25		μs
T_7 (V_i)	Sink Current Turn-on Delay	$0.5\,V_i$ to $0.9\,I_L$ (3); (4)		1.6		μs
T_8 (V_i)	Sink Current Rise Time	$0.1\,I_L$ to $0.9\,I_L$ (3); (4)		0.2		μs
fc (V_i)	Commutation Frequency	$I_L = 2A$		25	40	KHz
T_1 (V_{en})	Source Current Turn-off Delay	$0.5\,V_{en}$ to $0.9\,I_L$ (2); (4)		3		μs
T_2 (V_{en})	Source Current Fall Time	$0.9\,I_L$ to $0.1\,I_L$ (2); (4)		1		μs
T_3 (V_{en})	Source Current Turn-on Delay	$0.5\,V_{en}$ to $0.1\,I_L$ (2); (4)		0.3		μs
T_4 (V_{en})	Source Current Rise Time	$0.1\,I_L$ to $0.9\,I_L$ (2); (4)		0.4		μs
T_5 (V_{en})	Sink Current Turn-off Delay	$0.5\,V_{en}$ to $0.9\,I_L$ (3); (4)		2.2		μs
T_6 (V_{en})	Sink Current Fall Time	$0.9\,I_L$ to $0.1\,I_L$ (3); (4)		0.35		μs
T_7 (V_{en})	Sink Current Turn-on Delay	$0.5\,V_{en}$ to $0.9\,I_L$ (3); (4)		0.25		μs
T_8 (V_{en})	Sink Current Rise Time	$0.1\,I_L$ to $0.9\,I_L$ (3); (4)		0.1		μs

1) 1)Sensing voltage can be –1 V for t 3 50 μsec; in steady state V_{sens} min . –0.5 V.

2) See fig. 2.

3) See fig. 4.

4) The loadmust be a pure resistor

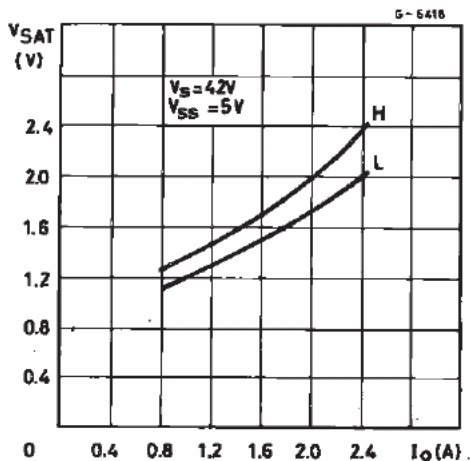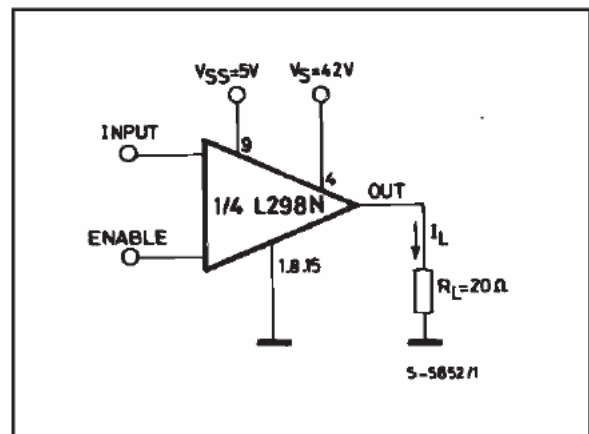**Figure 1 :** Typical Saturation Voltage vs. Output Current.

Figure 2 : Switching Times Test Circuits.

Note : For INPUT Switching, set EN = H
For ENABLE Switching, set IN = H

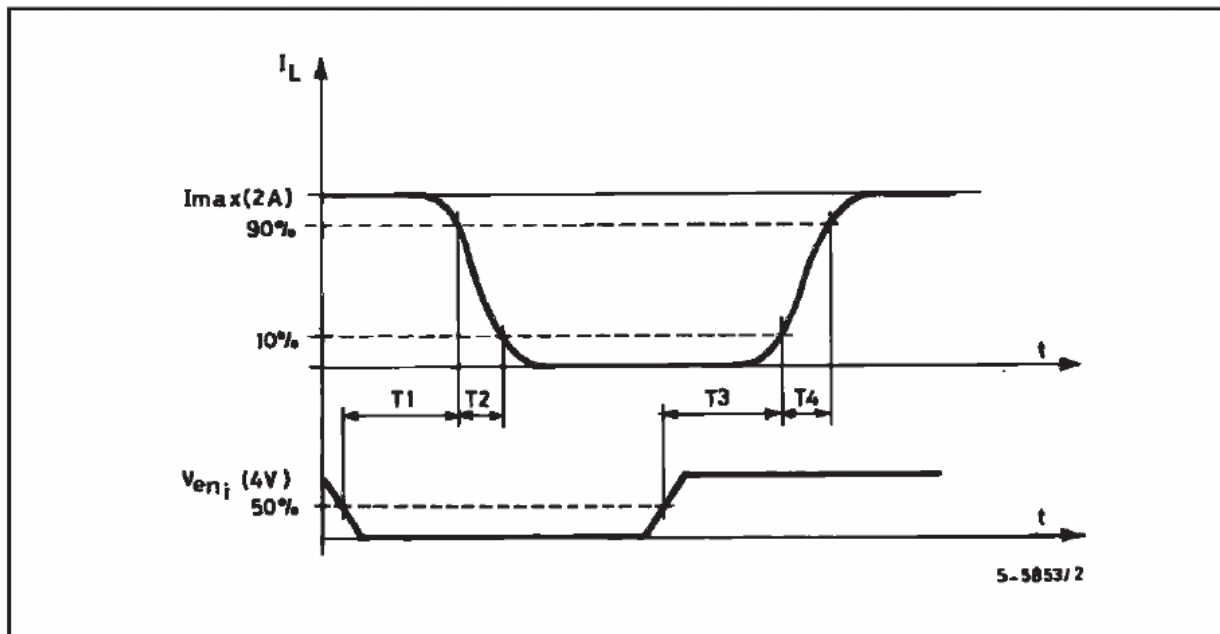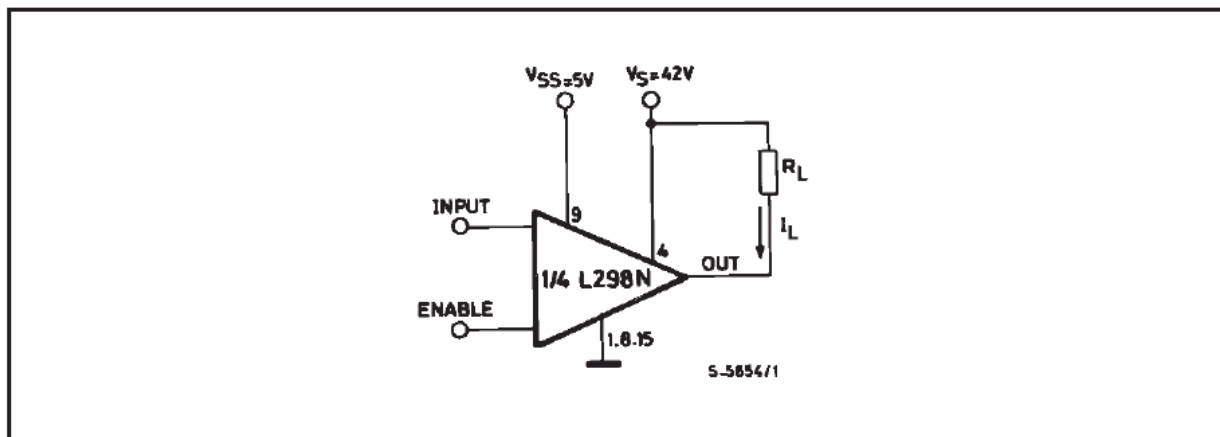**Figure 3 :** Source Current Delay Times vs. Input or Enable Switching.

Figure 4 : Switching Times Test Circuits.

Note : For INPUT Switching, set EN = H

For ENABLESwitching, set IN = L

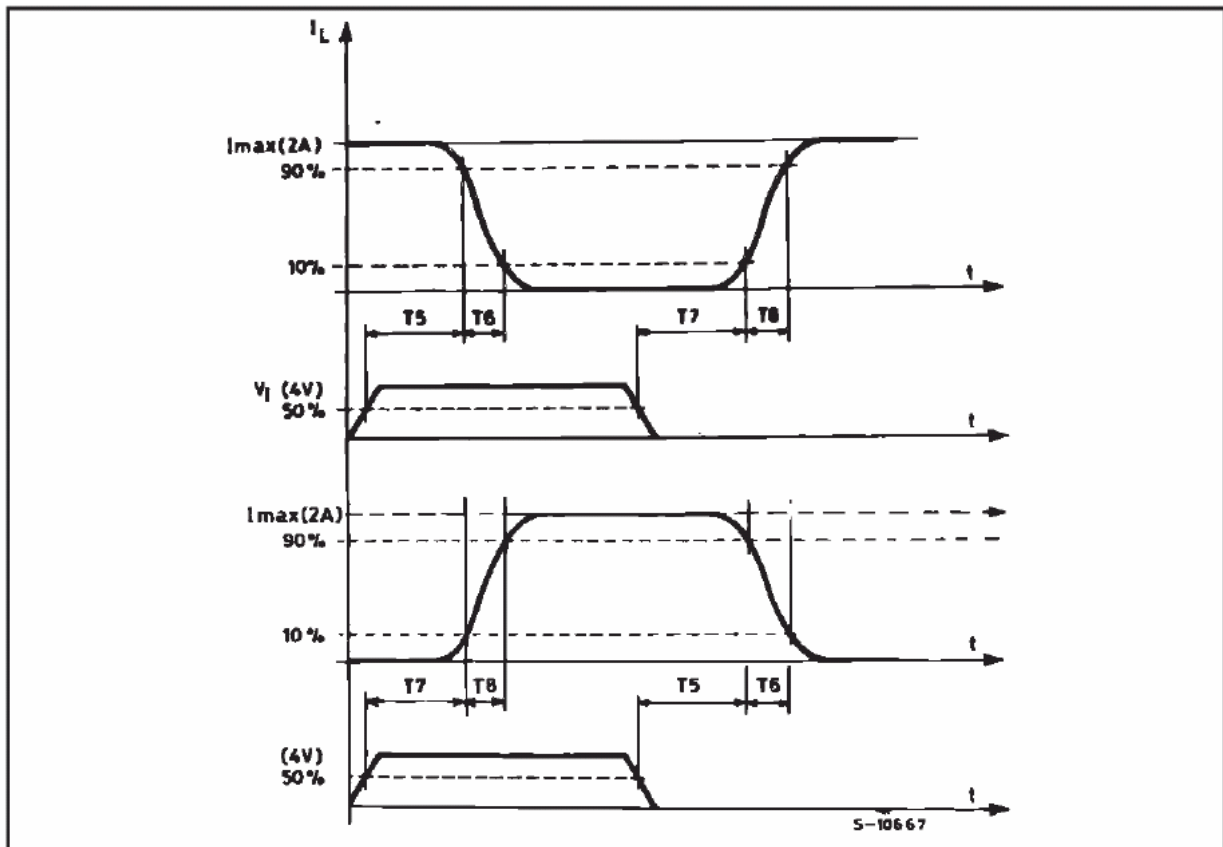**Figure 5 :** Sink Current Delay Times vs. Input 0 V Enable Switching.

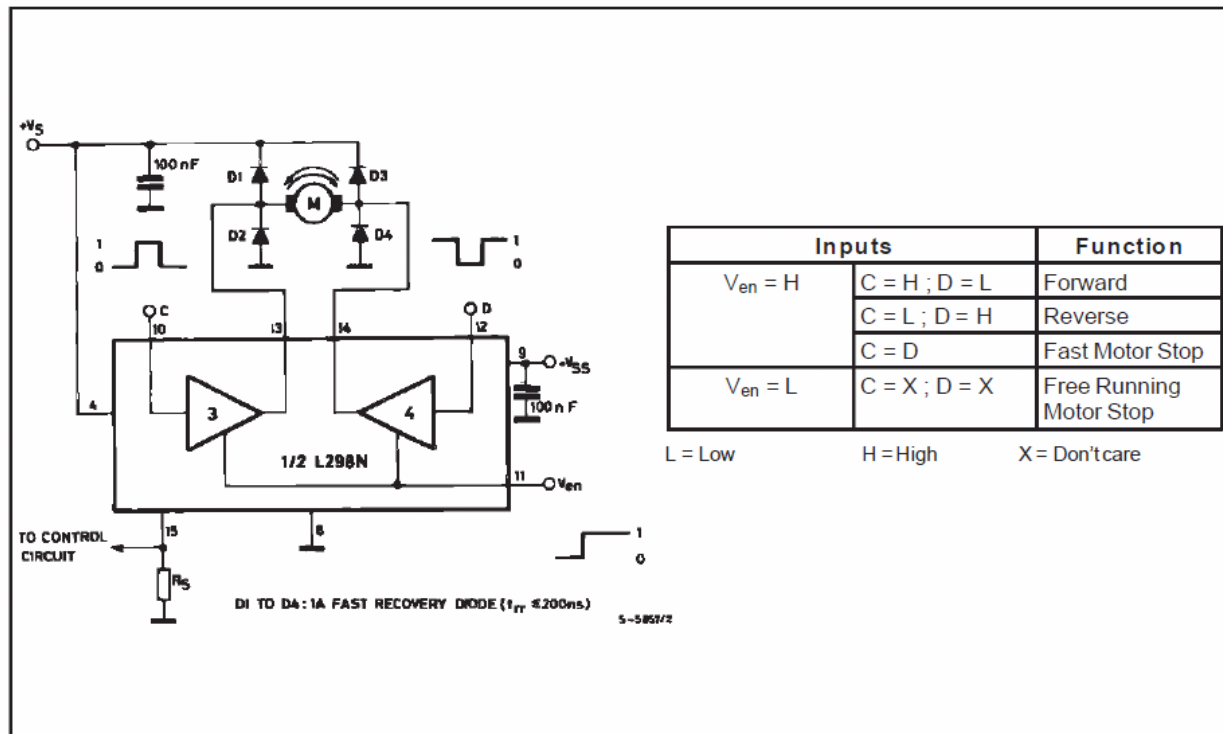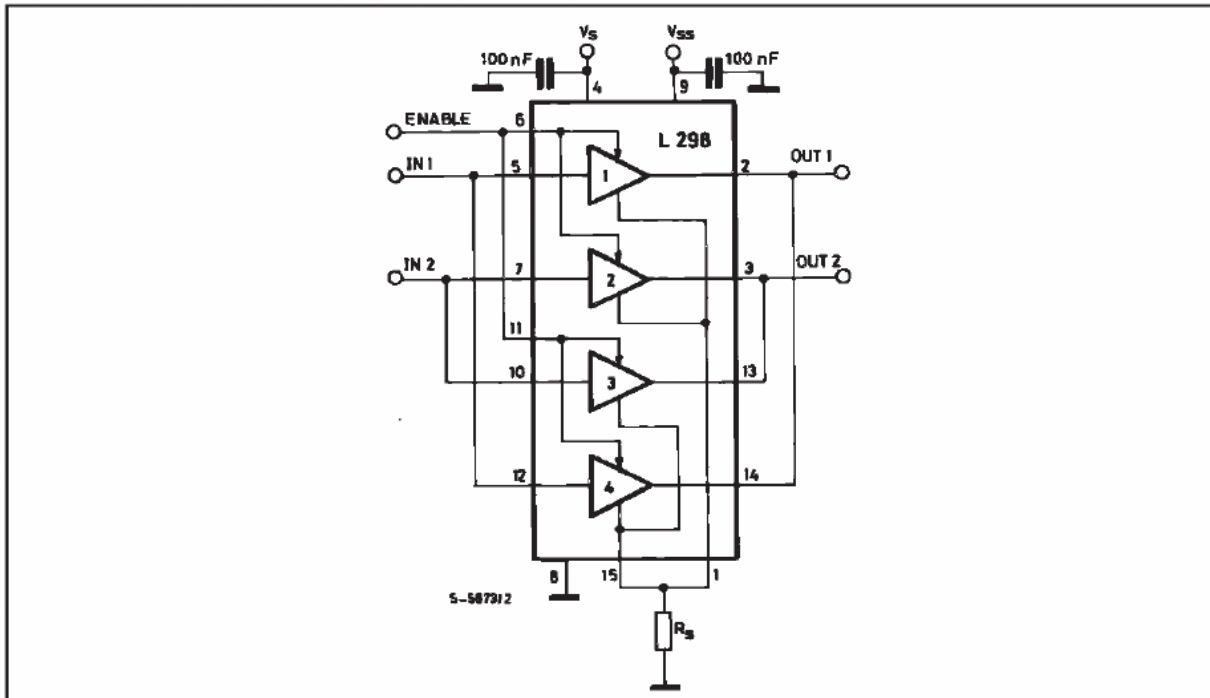**Figure 6 :** BidirectionalDC Motor Control.

Inputs		Function
V_{en} = H	C = H ; D = L	Forward
	C = L ; D = H	Reverse
	C = D	Fast Motor Stop
V_{en} = L	C = X ; D = X	Free Running Motor Stop

L = Low   H = High   X = Don't care

DI TO D4 : 1A FAST RECOVERY DIODE (t_{rr} ≤ 200ns)

Figure 7 : For higher currents, outputs can be paralleled. Take care to parallel channel 1 with channel4 and channel2 with channel3.

APPLICATION INFORMATION (Refer to the block diagram)

1.1.POWER OUTPUT STAGE

TheL298integratestwopoweroutputstages(A; B). The power output stage is a bridge configuration and its outputs can drive an inductive load in commonor differenzialmode, dependingon thestate of the inputs. The current that flows through the load comes out fromthe bridge at the sense output : an external resistor (R$_{SA}$;R$_{SB}$.) allows to detect the intensity of this current

1.2. INPUT STAGE

Eachbridge is driven by meansof four gatesthe input of which are In1 ; In2 ; EnA and In3 ; In4 ; EnB. TheIn inputs set thebridgestatewhenThe En input is high; a lowstate of theEninputinhibitsthe bridge. All the inputs are TTL compatible..

2. SUGGESTIONS

A non inductive capacitor, usually of 100 nF, must be foreseen between both Vs and Vss, to ground, as near as possible toGNDpin. Whenthe large capacitor of the power supply is too far from the IC, a second smaller one must be foreseen near the L298.

The sense resistor, not of a wire wound type, must be groundednear the negativepole of Vs that must be near the GND pin of the I.C.

Each input must be connected to the source of the driving signals by means of a very short path.

Turn-On and Turn-Off : Beforeto Turn-ONthe Supply Voltageand beforeto TurnitOFF,theEnableinput must be driven to the Low state.

3. APPLICATIONS

Fig 6 showsa bidirectionalDC motor controlSchematic Diagramfor which only one bridge is needed.

The external bridge of diodesD1 to D4 is made by four fast recovery elements (trr 3 200 nsec) that

must be chosen of a VF as low as possible at the worst case of the load current.

The senseoutputvoltagecanbeused to controlthe current amplitude by chopping the inputs, or to provide overcurrent protectionby switching low theenable input.

The brake function (Fast motor stop) requires that the Absolute Maximum Rating of 2 Amps must never be overcome.

When the repetitive peak current needed from the load is higher than 2 Amps, a paralleled configuration can be chosen (See Fig.7).

An external bridge of diodes are required when inductive loads are driven and when the inputs of the ICare chopped; Shottkydiodeswouldbepreferred.

This solution can drive until3 AmpsInDCoperation and until 3.5 Amps of a repetitive peak current.

OnFig 8it isshownthedriving ofa twophasebipolar stepper motor ; the needed signals to drive the inputs of the L298 are generated, in this example, from the IC L297.

Fig 9 shows an example of P.C.B. designedfor the application of Fig 8. Fig 10 shows a second two phase bipolar stepper motor control circuit where the current is controlled by the I.C. L6506.

Figure 8 : Two Phase Bipolar Stepper Motor Circuit.

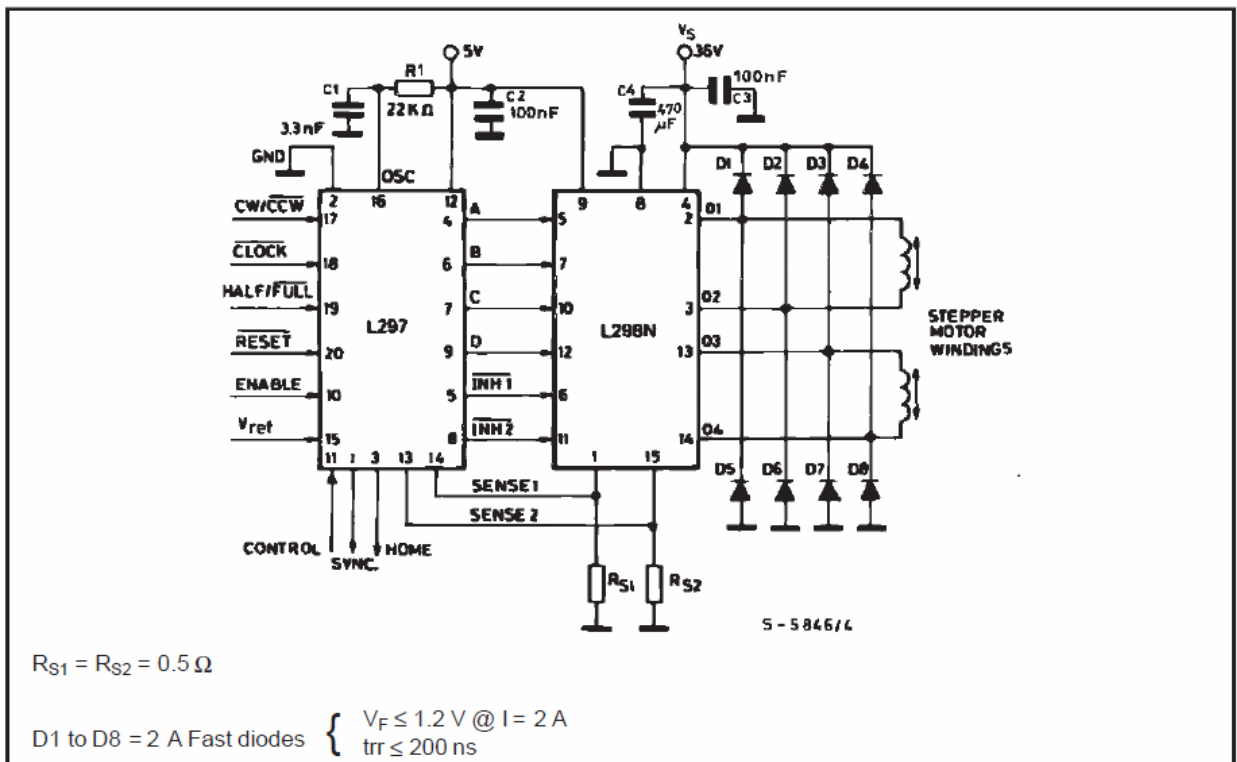This circuit drives bipolar stepper motors with winding currents up to 2 A. The diodes are fast 2 A types.

$R_{S1} = R_{S2} = 0.5\,\Omega$

D1 to D8 = 2 A Fast diodes $\begin{cases} V_F \leq 1.2\,V @ I = 2\,A \\ trr \leq 200\,ns \end{cases}$

Figure 9 : SuggestedPrinted Circuit Board Layout for the Circuit of fig. 8 (1:1 scale).
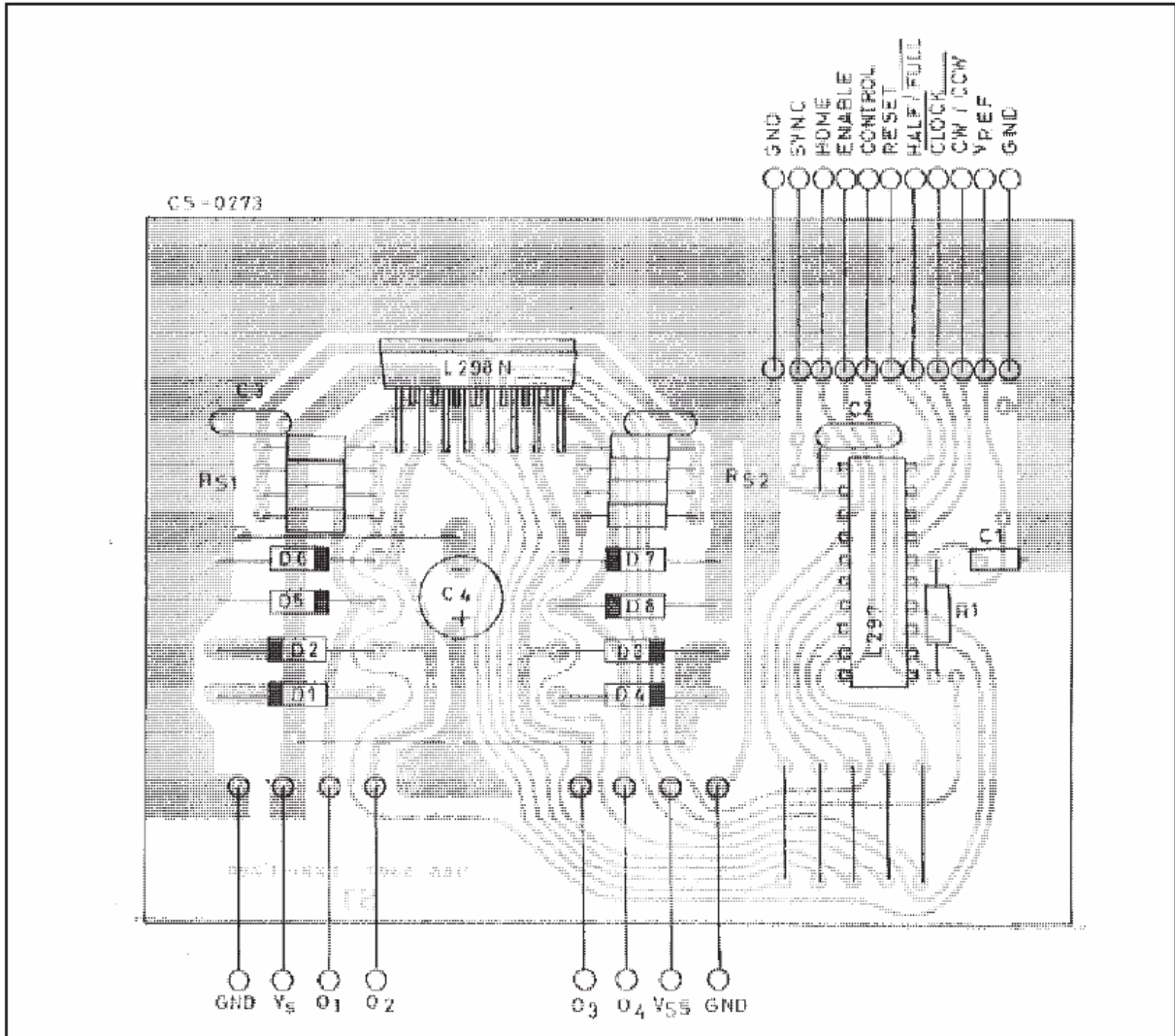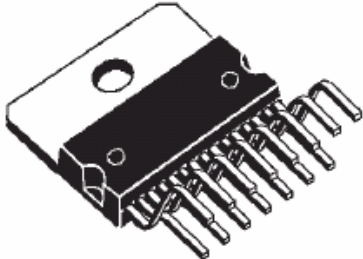

Figure 10 : Two Phase Bipolar Stepper Motor Control Circuit by Using the Current ControllerL6506
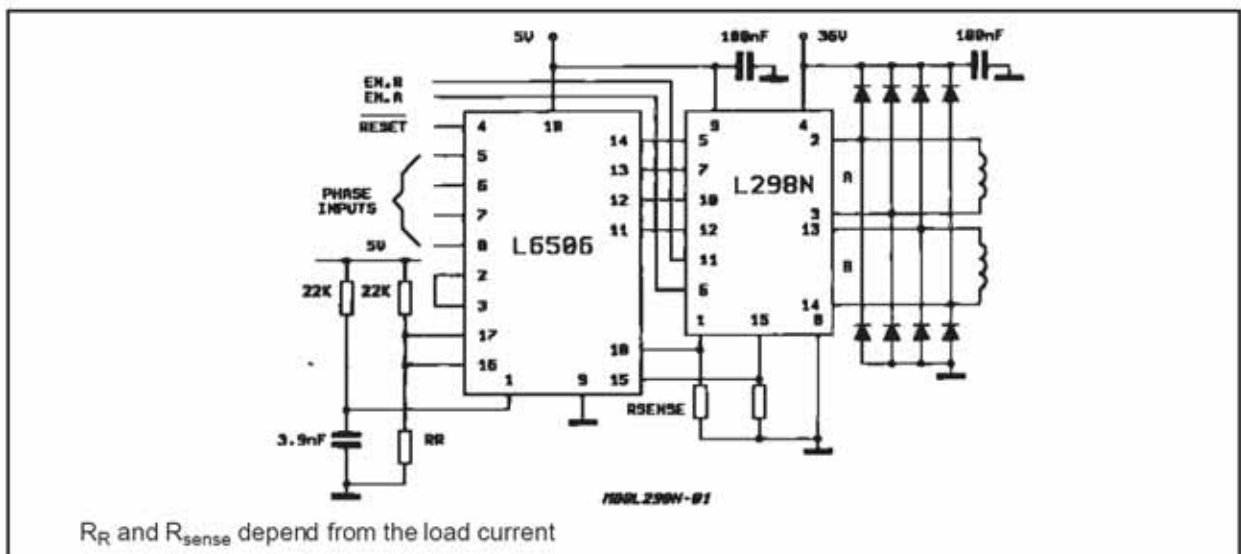
L298

DIM.	mm			inch		
	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.
A			5			0.197
B			2.65			0.104
C			1.6			0.063
D		1			0.039	
E	0.49		0.55	0.019		0.022
F	0.66		0.75	0.026		0.030
G	1.02	1.27	1.52	0.040	0.050	0.060
G1	17.53	17.78	18.03	0.690	0.700	0.710
H1	19.6			0.772		
H2			20.2			0.795
L	21.9	22.2	22.5	0.862	0.874	0.886
L1	21.7	22.1	22.5	0.854	0.870	0.886
L2	17.65		18.1	0.695		0.713
L3	17.25	17.5	17.75	0.679	0.689	0.699
L4	10.3	10.7	10.9	0.406	0.421	0.429
L7	2.65		2.9	0.104		0.114
M	4.25	4.55	4.85	0.167	0.179	0.191
M1	4.63	5.08	5.53	0.182	0.200	0.218
S	1.9		2.6	0.075		0.102
S1	1.9		2.6	0.075		0.102
Dia1	3.65		3.85	0.144		0.152

OUTLINE AND MECHANICAL DATA
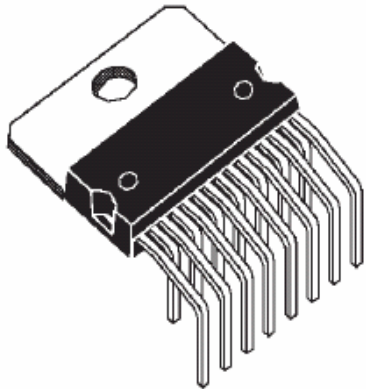
Multiwatt15 V
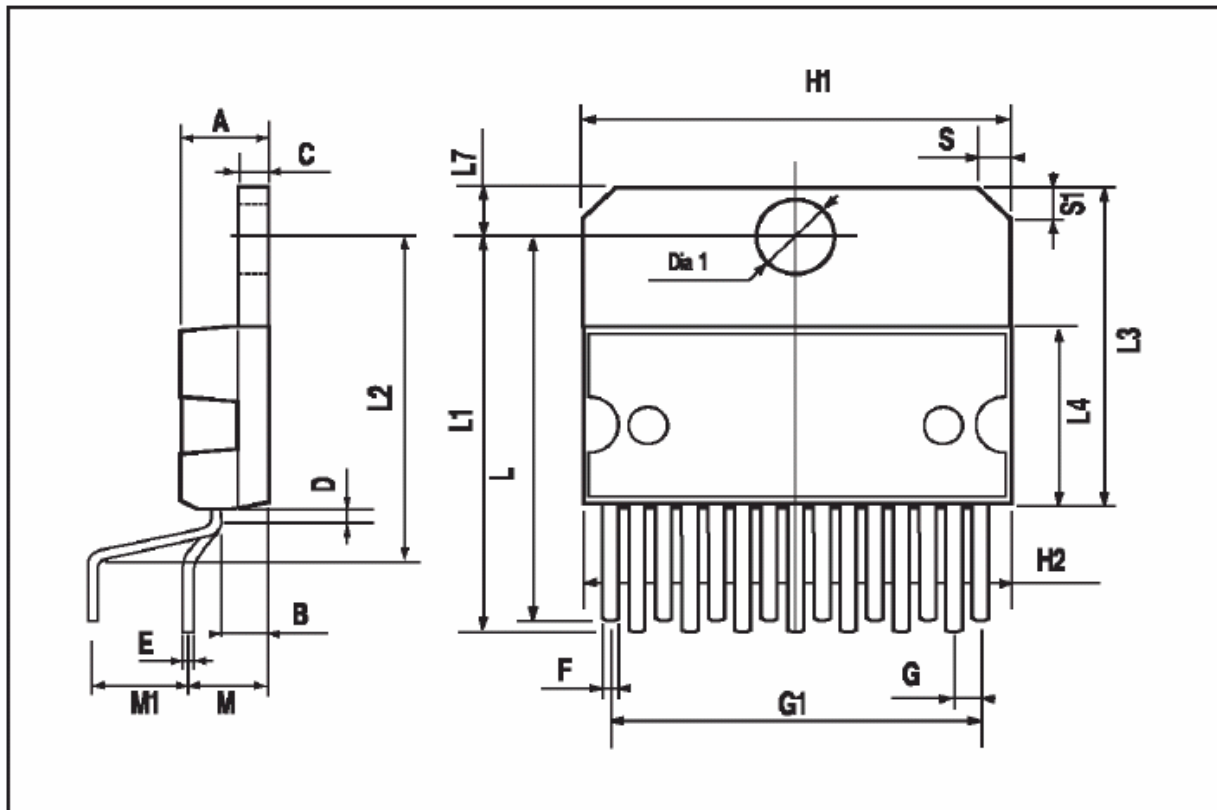
L298

DIM.	mm			inch		
	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.
A			5			0.197
B			2.65			0.104
C			1.6			0.063
E	0.49		0.55	0.019		0.022
F	0.66		0.75	0.026		0.030
G	1.14	1.27	1.4	0.045	0.050	0.055
G1	17.57	17.78	17.91	0.692	0.700	0.705
H1	19.6			0.772		
H2			20.2			0.795
L		20.57			0.810	
L1		18.03			0.710	
L2		2.54			0.100	
L3	17.25	17.5	17.75	0.679	0.689	0.699
L4	10.3	10.7	10.9	0.406	0.421	0.429
L5		5.28			0.208	
L6		2.38			0.094	
L7	2.65		2.9	0.104		0.114
S	1.9		2.6	0.075		0.102
S1	1.9		2.6	0.075		0.102
Dia1	3.65		3.85	0.144		0.152

OUTLINE AND MECHANICAL DATA

Multiwatt15 H

L298
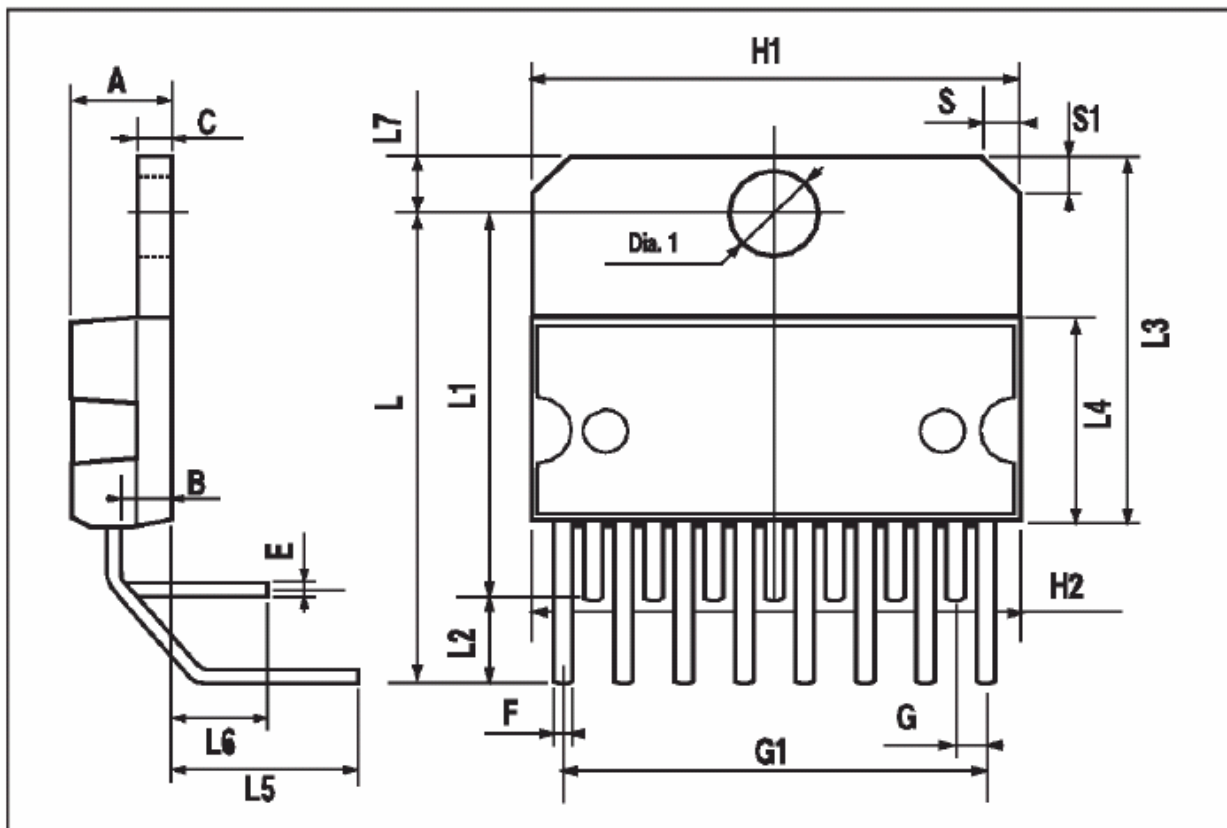
DIM.	mm			inch		
	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.
A			3.6			0.142
a1	0.1		0.3	0.004		0.012
a2			3.3			0.130
a3	0		0.1	0.000		0.004
b	0.4		0.53	0.016		0.021
c	0.23		0.32	0.009		0.013
D (1)	15.8		16	0.622		0.630
D1	9.4		9.8	0.370		0.386
E	13.9		14.5	0.547		0.570
e		1.27			0.050	
e3		11.43			0.450	
E1 (1)	10.9		11.1	0.429		0.437
E2			2.9			0.114
E3	5.8		6.2	0.228		0.244
G	0		0.1	0.000		0.004
H	15.5		15.9	0.610		0.626
h			1.1			0.043
L	0.8		1.1	0.031		0.043
N	10° (max.)					
S	8° (max.)					
T		10			0.394	

(1) "D and F" do not include mold flash or protrusions.
- Mold flash or protrusions shall not exceed 0.15 mm (0.006").
- Critical dimensions: "E", "G" and "a3"

OUTLINE AND MECHANICAL DATA

JEDEC MO-166

PowerSO20