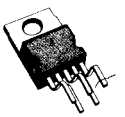
SGS-THOMSON MICROELECTRONICS

L9801

HIGH SIDE DRIVER

ADVANCE DATA

- 25A PEAK OUTPUT CURRENT
- R_{ON} = 100mΩ
- DIAGNOSTIC AND PROTECTION FUNCTIONS
- INRUSH CURRENT LIMITER
- µP COMPATIBLE
- GROUNDED CASE



PENTAWATT

ORDER CODE: L9801A

DESCRIPTION

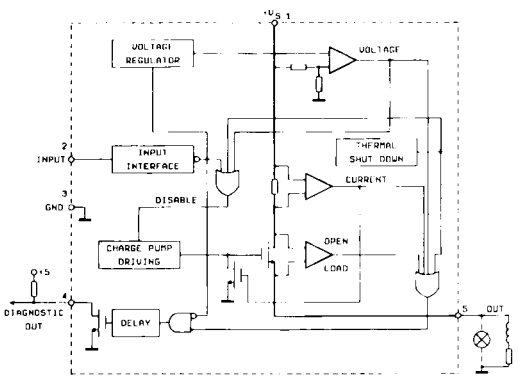
The L9801 High Side Driver realized with ST Multipower - BCD mixed technology, drives resistive or inductive loads with one side connected to ground.

The input control is TTL compatible and a diagnostic output provides an indication of load (open and short) and device status (thermal and overvoltage shutdown). On chip thermal protection and short circuit protection are provided.

Inrush current limiting makes the L9801 particularly suited for driving lamps.

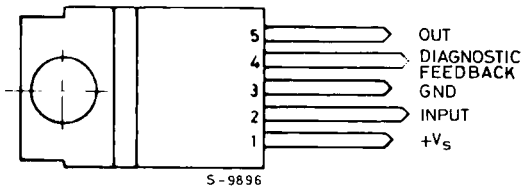
The device is assembled in the Pentawatt package with the tab connected to the ground terminal.

BLOCK DIAGRAM



This is advanced information on a new product now in development or undergoing evaluation. Details are subject to change without notice.

PIN CONNECTION (top view)



ABSOLUTE MAXIMUM RATINGS

Symbol	Parameter	Value
V_S	Max Forward Voltage Positive Transient Peak Voltage (dump : τ_f fall time constant = 100 ms, 5 ms ≤ t_{rise} ≤ 10 ms, R_{source} ≥ 0.5 Ω) – Resistive Load – Inductive Load	50 Vdc 60 V 50 V (*)
	Reverse Input Voltage	– 0.3 Vdc
V_i V_4 V_5	Input Voltage Pin 2 (to GND) Pin 4 Voltage (to GND) Pin 5 Voltage (to GND)	– 0.3 V / + V_S (V_S < 20 V) – 0.3 V / + V_S (V_S < 20 V) – 3 V / + V_S (V_S < 20 V)
I_1 I_2 I_4 I_5	Pin 1 Current Pin 2 Current (forced) Pin 4 Current (sink) Pin 5 Current	Internally Limited 0.5 mA 10 mA Internally Limited
P_{TOT} T_J, T_{STG}	Power Dissipation Junction and Storage Temperature Range	Internally Limited – 55 °C to + 150 °C

* due to the negative voltage at the output during the switching off.

THERMAL DATA

$R_{th\ j\text{-}case}$	Thermal Resistance Junction-case	Max	1.5	°C/W

PIN FUNCTIONS

1. POWER SUPPLY

Supply voltage input. When the supply reaches the maximum operating voltage (16 V) the device is turned off, protecting itself and the load.

2. INPUT

TTL compatible input. High level on this pin means output current ON. The low level voltage switches off the charge pump, the power stage and the diagnostic output reducing to the minimum value the quiescent current.

3. GROUND

This pin must be connected to ground.

4. DIAGNOSTIC FEEDBACK.

The diagnostic circuit is active in input high level condition. This output detects with 25 msec delay the following faults :

- Overvoltage condition.
- Thermal shutdown.
- Short circuit. The power stage current is internally limited at 25 A.
- Open load. The open load condition is detected with load current < 1.1 A.

The diagnostic output is active low. The diagnostic delay time allows to avoid spurious diagnosys (i.e : turn ON overcurrent, overvoltage spikes etc.).

5. POWER OUTPUT.

The device is provided with short circuit protection.

ELECTRICAL CHARACTERISTICS : (V_s = 14.4 V ; – 40 °C ≤ T_j ≤ 125 °C unless otherwise specified)

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
V_{op}	Operat. Voltage		9		16	V
R_{on}	On Resistance	Input > 2 V ; T_j = 25 °C Input > 2 V ; Full T Range		0.1	 0.2	Ω Ω
I_{sc}	Short Circuit Curr.			25		A
I_{DL}	Over Current Detection Level		20			A
I_{OPD}	Open Load Detection Level	Device ON		1.1		A
V_{clamp}	Output Under Voltage Clamping	I_{load} < 6 A inductive	– 9		– 4	V
I_{off}	Off State Supply Current	T_j < 35 °C T_j = 85 °C			100 300	µA µA
I_{on}	On State Supply Current			4		mA
V_{IL}	Input Low Level				0.8	V
V_{IH}	Input High Level		2.0			V
I_j	Input Current	0 < V_i < 5 V			100	µA
I_{LEAKD}	Diagnostic Output Leakage Current	V_{cc} = 5 V, Diagnostic Output High			10	µA
V_{SATD}	Diagnostic Output Saturat. Volt.	I_{sink} < 3.5 mA			0.4	V
t_{Dd}	Diagnostic Delay Time	t_j = 25 °C		25		ms
t_{dON}	Output ON Delay Time	t_j = 25 °C		4		µs
t_r	Output ON Rise Time	t_j = 25 °C		50		µs
t_{dOFF}	Output OFF Delay Time	t_j = 25 °C		6.5		µs
t_f	Output OFF Fall Time	t_j = 25 °C		2.5		µs

FUNCTIONAL DESCRIPTION

The L9801 is a high side drive monolithic switch, driven by TTL, CMOS input logic, able to supply resistive or inductive loads up to 6 A DC allowing a current peak of 25 A with a $R_{DS\ (ON)}$ = 0.1 Ω. The electronic switch, in addition to its main function, protects itself, the power network and the load against load dump (up to 60V) and overload and it detects short circuit, open load and overtemperature conditions. All these functions (logic control and power actuation) are possible on a single chip thanks to the new mixed ST Multipower BCD technology that allows to integrate isolated DMOS power transistors in combination with Bipolar and CMOS signal structures on the same chip.

The high side drive connection (series switch between the load and the positive power source) is particularly suited in automotive environment where the electrochemical corrosion withstanding has primary importance. For this connection the best solution is a Power MOS N-channel which requires for driving only a capacitive charge pump completely integrated on the switch chip.

The L9801 is based on a power DMOS series element, a driving circuit with a charge pump, an input logic interface and on some protection and fault detection circuits.

The power DMOS transistor has a $R_{DS\ (ON)}$ = 0.1 Ω (typ. value @ T_J = 25 °C, V_{GS} = 10 V). The low value of $R_{DS\ (ON)}$ is important both to increase the power transferred to the load and to minimize the power dissipated in the device.

The charge pump is a capacitive voltage doubler starting from power supply (car battery), driven by a 500 kHz oscillator.

The input interface is based on a circuitry solution able to guarantee the stability over temperature of the TTL logic levels and very low quiescent current in OFF condition.

When the supply reaches the maximum operating voltage (16 V) the device is turned OFF, protecting itself and the load ; moreover local zener clamps are provided in some critical points to avoid that V_{GS} of any MOS transistor could reach dangerous values even during 60 V load dump transient.

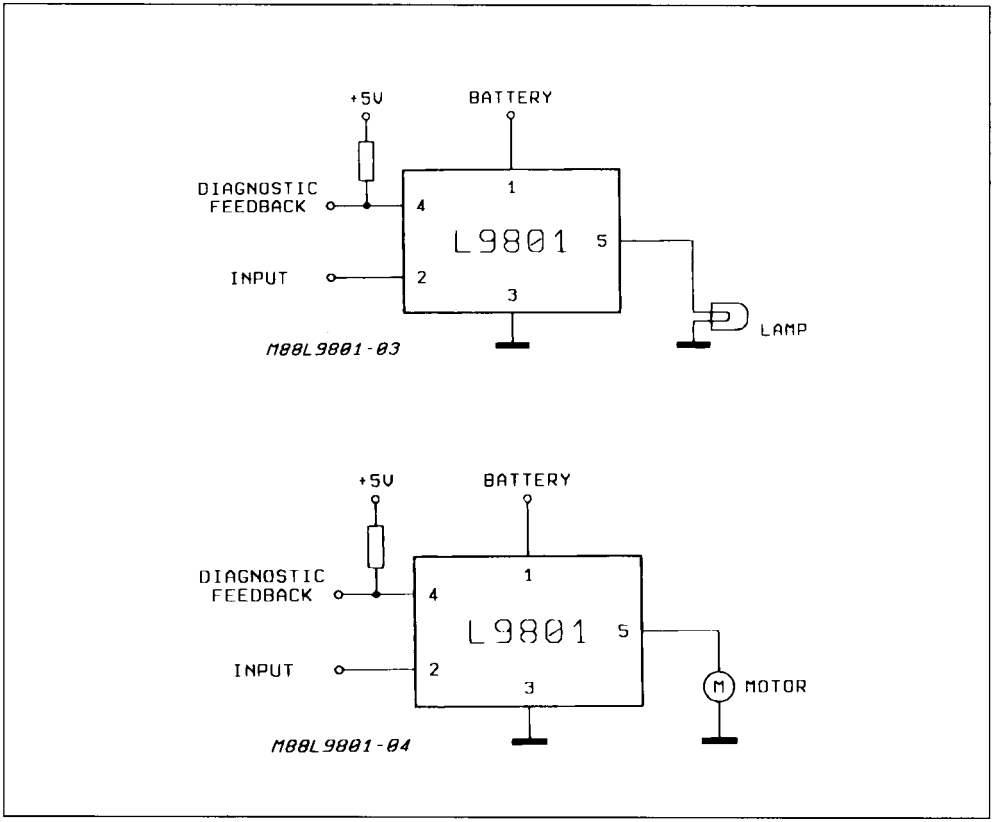
The inrush current limiting is a significant feature of the L9801. This function allows to protect the power supply network and may extend the life of the loads. For example, in the case of the lamps, the tungsten wire resistance value in cold condition is about one tenth of the nominal steady state and then the inrush current during the turn on is statistically one of the main causes of lamps failures. If the high current condition persists (e.g. load short circuit) and the junction temperature rises above 150 °C, the thermal protection circuit turns off the device preventing any damage. The current limiting and the thermal shutdown are sufficient to protect the device against any overload because the power DMOS has not the second breakdown.

When the L9801 is driven and one of the protections (overtemperature, overvoltage, overload) is present, a fault detection open drain output turns on. This output is active also when I_{load} is lower than 1.1 A detecting the open load (disconnected or burned out). The diagnostic output detects fault conditions with 25 ms delay in order to avoid spurious diagnosys (i.e. : turn on overcurrent, overvoltage spikes etc.). In OFF conditions the fault detection circuits are not active to allow a minimum quiescent current.

The device can drive unipolar DC motors and solenoids as well because it can recirculate an inductive current when the output voltage goes lower than V_{clamp} value (typically - 6.5 V in respect to ground). The possibility to have a start up current is useful also for DC motors allowing the maximum starting torque.

TYPICAL APPLICATIONS OF THE L9801

The L9801 integrated high side driver can be used to replace an electromechanical relay. In the following typical application two different driving configurations are shown : resistive load (i.e. lamps) and inductive load (i.e. solenoids, motors). In this last case no external components are required for the coil current recirculation, because the device provides this function internally.



MAKE A FULL BRIDGE USING L9801

To make a bidirectional DC motor driver for the very hostile automotive environment, two L9801 high side drivers and two power MOS devices can be used.

This solution for a DC motor full bridge is self-protected against load dump transients up to 60 V, thermal runaway and short circuit on the motor and to ground.

Thanks to the L9801 features, a motor with nominal current up to 10 A and a stall current up to 25 A can be driven by such a system : the 10A limit for the nominal current depends on the R_{DSON} = 0.1 Ω of the L9801's internal power MOS device. If 1 V is the maximum allowed voltage drop for each power switch at the nominal current this last one must be no higher than 10 A ; the 25 A limit for the motor stall current is due to the internal short circuit protection.

Moreover the described system features a diagnostic output that signals short circuit and open load conditions, main supply overvoltages and thermal shutdown.

CIRCUIT DESCRIPTION

Two solutions are possible to drive the 4 power devices in the full bridge configuration. Fig. 1 shows the first possibility : the system provides 4 μP-compatible inputs and 1 diagnostic output. The L9222 device is a quad inverting transistor switches (open collector outputs) which operates as interface between the μP and the power stage. Depending on the status of this 4 control inputs, the 4 power devices are in ON or in OFF conditions as shown in the truth table A.

The other status of the control inputs have no effect on the operation of the bridge or they are dangerous (i.e. short circuit between the power devices on the same side).

Due to the very short switching times of the discrete PowerMos compared with the L9801 ones - two problems could arise :

1) a simultaneous conduction of I_1 and T_1 (or I_2 and T_2) at the switching on of T_1 (or T_2)

2) an overvoltage on the drain of T_1 (or T_2) at the switching off of T_1 (or T_2).

To avoid these two problems C_1 and C_2 capacitors and the fast switching diodes D_1 and D_2 must be used.

C_3 and C_4 are necessary to prevent overvoltages on the main supply at the switching off phase due to the recirculation current and to the main supply wires inductance. Note that, thanks to the centralized clamp feature of the L9222 device, only one 16 V zener is requested to protect both the power MOS gate and the input of the L9801.

The operating voltage range is 9 V to 16 V ; at supply voltage higher than 16 V the two upper switches, if in ON conditions, are turned-OFF.

The diagnostic output is common for both the L9801 ; this output may be used by the μP to detect bad operating condition of the system.

The second solution for the control of the bridge is that shown in fig. 2 ; in this case we have only two control inputs, plus an enable input. The truth table of such a system is table B.

In this case the control of the bridge is very simple and no 5 V supply voltage is required ; in addition it is not possible the contemporary switch-on of two power devices on the same side of the bridge as in the previous configuration. All the other features of this circuit are identical ones. The L603 device (eight darlingtons array) provides to interface the power stage and the control stage (μP or other) ; in this case too only one centralized clamp zener allows to protect the system inputs against supply overvoltages.

TRUTH TABLE A

I1	I2	I3	I4	Function	Device ON	
H	L	L	H	Turn Left	UL	LR
L	H	H	L	Turn Right	UR	LL
L	H	L	H	Fast Stop	LL	LR
H	L	H	L	Fast Stop	UL	UR
H	H	H	H	Disabled	None	

Note : UL, UR, LL and LR mean respectively upper left, upper right, lower left and lower right device.

TRUTH TABLE B

EN	I1	I2	Function	Device ON	
L	H	L	Turn Left	UL	LR
L	L	H	Turn Right	UR	LL
L	L	L	Fast Stop	LL	LR
L	H	H	Fast Stop	UL	UR
H	X	X	Disabled	None	

Note : X = don't care.

Figure 1 : Full Bridge Configuration with 4 Control Inputs.

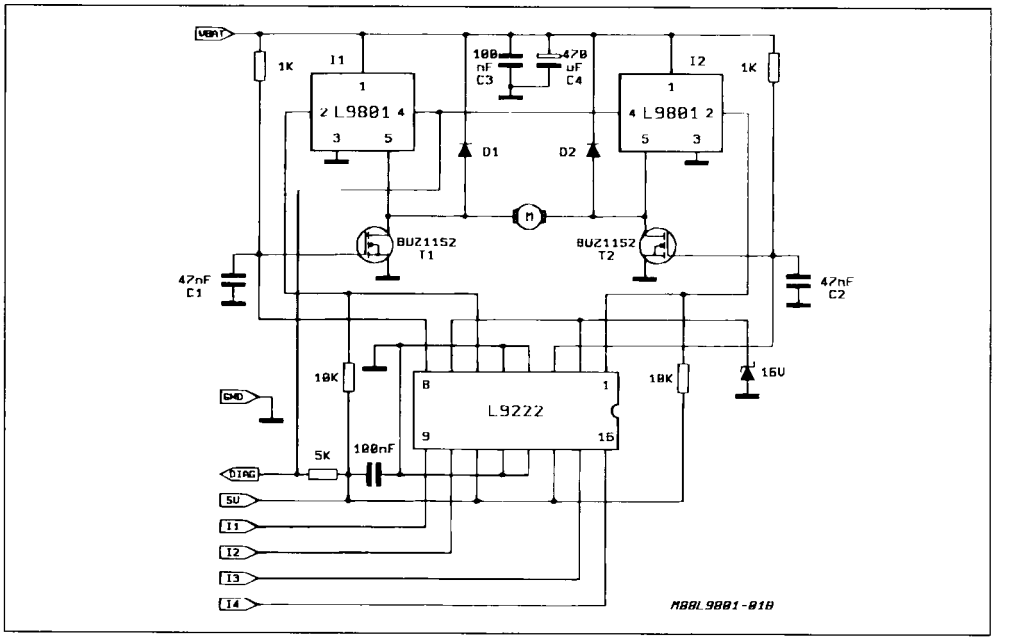


Figure 2 : Full Bridge Configuration with 2 Control Inputs Plus Enable.

