SGS-THOMSON MICROELECTRONICS

S G S-THOMSON

T-52-13-45

L6212

HIGH CURRENT SOLENOID DRIVER

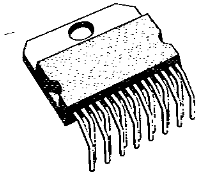
PRELIMINARY DATA

- HIGH VOLTAGE OPERATION (UP TO 50 V)
- HIGH OUTPUT CURRENT CAPABILITY (UP TO 6 A)
- LOW SATURATION VOLTAGE
- TTL-COMPATIBLE INPUT
- OUTPUT SHORT CIRCUIT PROTECTION (TO GROUND, TO SUPPLY AND ACROSS THE LOAD)
- THERMAL SHUTDOWN
- OVERDRIVING PROTECTION
- LATCHED DIAGNOSTIC OUTPUT

DESCRIPTION

The L6212 is a monolithic switch-mode solenoid driver designed for fast, high-current applications such as hammer driving in printers and electronic typewriters. Power dissipation is reduced by efficient switch-mode operation. An extra feature of the L6212 is a latched diagnostic output which indicates when the output is short circuit.

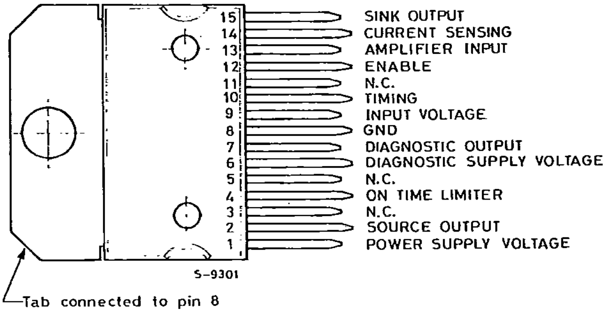
The L6212 is supplied in an 15-lead Multiwatt plastic power package.



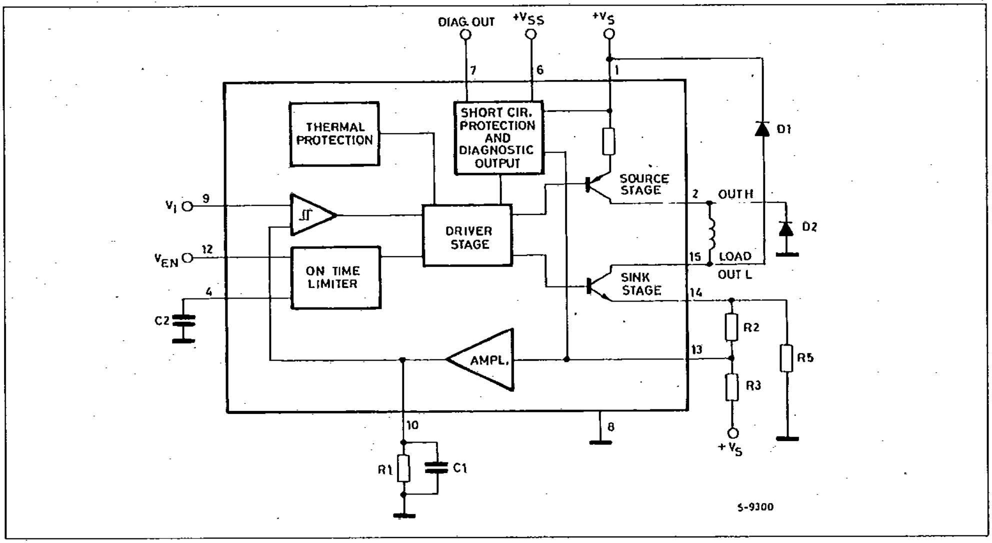
Multiwatt-15
(Horizontal)

ORDER CODE : L6212

CONNECTION DIAGRAM (top view)



BLOCK DIAGRAM



ABSOLUTE MAXIMUM RATINGS

Symbol	Parameter	Value	Unit
V_s	Power Supply Voltage	50	V
V_{ss}	Logic Supply Voltage	7	V
V_{EN}	Enable Voltage	7	V
V_I	Input Voltage	7	V
I_p	Peak Output Current (repetitive)	6.5	A
P_{tot}	Total Power Dissipation (at T_{case} = 75 °C)	25	W
T_{stg}, T_j	Storage and Junction Temperature	– 40 to + 150	°C

THERMAL DATA

$R_{th\ j\text{-}case}$	Thermal Resistance Junction-case	Max	3	°C/W
$R_{th\ j\text{-}amb}$	Themal Resistance Junction-ambient	Max	35	°C/W

ELECTRICAL CHARACTERISTICS (refer to the test circuit, V_s = 37 V, V_{ss} = 5 V, T_{amb} = 25 °C, unless otherwise specified)

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
V_s	Power Supply Voltage (pin 1)		12		46	V
I_d	Quiescent Drain Current	V_{EN} = H		20	30	mA
		$V_i \geq 0.6$ V V_{EN} = L		70		mA
V_{ss}	Logic Supply Voltage (pin 6)		4.5		7	V
I_{ss}	Quiescent Logic Supply Current	V_{DIAG} = L		5	8	mA
		DIAG Output at High Impedance		10	100	µA
V_i	Input Voltage (pin 9)	Operating Output	0.6			V
		Non-operative Output			0.45	V
I_i	Input Current (pin 9)	$V_i \geq 0.6$ V $V_i \leq 0.45$ V			–2 –5	µA µA
V_{ENABLE}	Enable Input Current (pin 12)	Low Level High Level	–0.3 2.4		0.8	V
I_{ENABLE}	Enable Input Current	V_{EN} = L V_i = 0.8 V V_{EN} = H V_e = 2.4 V			–100 100	µA
$V_{sat\,H}$	Source Output Saturation Volt.	I_p = 5.5 A			2.5	V
$V_{sat\,L}$	Sink Output Saturation Volt.	I_{out} = 5.5 A			2.5	V
$V_{sat\,H} + V_{sat\,L}$	Total Saturation Voltage	I_{out} = 5.5 A			4.5	V
$I_{leakage}$	Output Leakage Current Source PNP	V_s = 45 V $V_i \leq 0.45$ V			2	mA
$I_{leakage}$	Output Leakage Current Sink NPN	V_s = 45 V $V_i \leq 0.45$ V			2	mA
K	On Time Limiter Constant (*)	V_{EN} = L		120		
V_{DIAG}	Diagnostic Saturation Voltage (pin 7)	I_{DIAG} = 10 mA			0.4	V
I_{DIAG}	Diagnostic Leakage Current (pin 7)	V_{DIAG} = 40 V			10	µA
$\frac{V_{pin\,10}}{V_{pin\,13}}$	OP AMP DC Voltage Gain	$V_{pin\,13}$ = 100 to 800 mV		5		
$V_{pin\,10}$		$I_{pin\,10}$ = 1 mA	4.5			V
$I_{pin\,10}$		$V_{pin\,10}$ = 4 V $V_9 = V_{13}$ = 0 $V_{pin\,10}$ = 2 V V_{13} = 0.9 V	 1		10 1.5	µA mA
I_{sense}	Input Bias Current (pin 13)			–1		µA
V_{sense}	Sensing Voltage (pin 14) (**)				0.9	V

(*) After a time interval $t_{max} = KC_2$, the output stages are disabled.
(**) Allowed range of V_{sense} without the intervention of the short circuit protection.

Figure 1 : Output Current Waveforms.

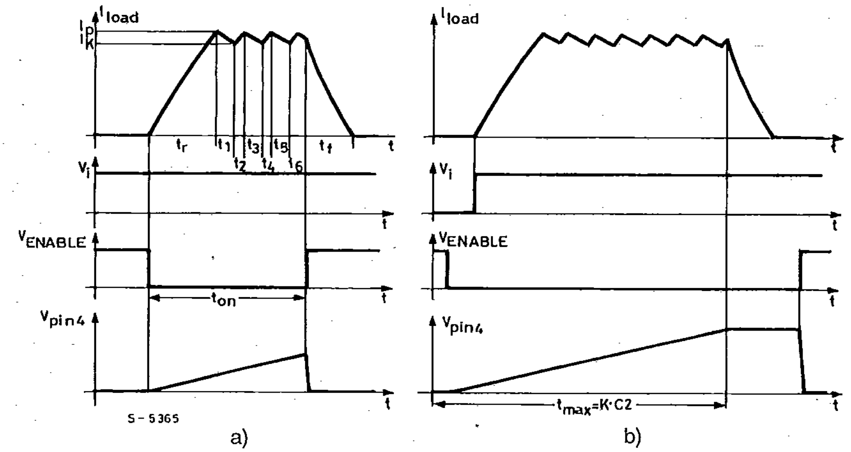
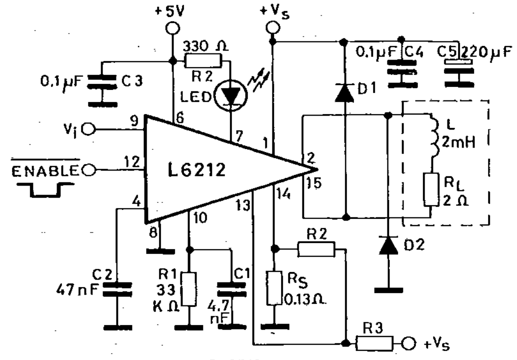


Figure 2 : Test and Typical Application Circuit.



D2 : 6A fast diode
D1 : 2A fast diode } trr ≤ 200ns

CIRCUIT OPERATION

The L6212 works as a transconductance amplifier : it can supply an output current directly proportional to an input voltage level (V_i). Furthermore, it allows complete switching control of the output current waveform (see Fig. 1).

The following explanation refers to the Block Diagram, to Fig. 1 and to the typical application circuit of Fig. 2.

The t_{on} time is fixed by the width of the Enable input signal (TTL compatible) : it is active low and enables the output stages "source" and "sink". At the end of t_{on}, the load current I_{load} recirculates through D1 and D2, allowing fast current turn-off.

The rise time t_r depends on the load characteristics, on V_i and on the supply voltage value (V_s, pin 1).

During the t_{on} time I_{load} is converter into a voltage signal by means of the external sensing resistance R_s connected to pin 13. This signal, amplified by the op amp charges the external RC network at pin 10 (R1, C1). The voltage at this pin is sensed by the inverting input of a comparator. The voltage on the non-inverting input of this one is fixed by the external voltage V_i (pin 9).

After, t_r, the comparator switches and the output stage "source" is switched off. The comparator output is confirmed by the voltage on the non-inverting input, which decreases of a constant fraction of V_i (1/10), allowing hysteresis operation. The current in the load now flows through D2.

Two cases are possible : the time constant of the recirculation phase is higher than R1, C1 ; the time constant is lower than R1, C1. In the first case, the voltage sended on the non-inverting input of the comparator is just the value proportional to I_{load}. In the second case, when the current decreases too quickly, the comparator senses the voltage signal stored in the R1, C1 network.

In the first case t_1 depends on the load characteristics, while in the second case it depends only on the value of R1, C1.

In the other word, R1, C1 fixed the minimum value of t_1 ($t_1 \geq 1/10$ R1 x C1. Note that C1 should be chosen in the range 2.7 to 10 nF for stability reasons of the op amp).

After t_1, the comparator switches again : the output is confirmed by the voltage on the non-inverting input, which reaches V_i again (hysteresis).

Now the cycle starts again : t_2, t_4 and t_6 have the same characteristics as t_r, while t_3 and t_5 are similar to t_1. The peak current I_p depends on V_i as shown in the typical transfer function of Fig. 3.

It can be seen that for V_i lower than 450 mV the device is not operating.

For V_i included between 450 and 600 mV, the operation is not guaranteed.

The other parts of the device have protection and diagnostic functions. At pin 4 is connected an external capacitor C2, charged at constant current when the Enable is low.

After time interval equal to K · C1 (K is defined in the table of Electrical Characteristics and has the dimensions of Ω) the output stages are switched off independently by the Input signal.

This avoids the load being driven in construction for an excessive period of time (overdriving protection).

The action of this protection is shown in Fig. 1b. Note that the voltage ramp at pin 4 starts whenever the Enable signal becomes active (low state), regardless of the Input signal. To reset pin 4 and to restore the normal conditions, pin 12 must return high. This protection can be disabled by grounding pin 4.

In order to keep constant the energy delivered to the load, when the supply voltage changes, it's possible to modify the output maximum peak current (I_p) by means the external voltage divider R2 and R3 which "senses" the supply voltage.

I_p is given by :

$$I_p = \frac{V_i\,(R_s + R2 + R3) - 5\,V_s\,(R2 + R_s)}{5\,R3\,R_s}$$

so the variation of I_p versus V_s is :

$$\Delta I_p = -\frac{R2 + R_s}{R3\,R_s}$$

The thermal protection included in the L6212 has hysteresis.

It switches off the output stages whenever the junction temperature increases too much. After a fall of about 20°C, the circuit starts again.

Finally, the device is protected against any type of short circuit at the outputs : to ground, to supply and across the load.

When the source stage current is higher than 7A and/or when the pin 13 voltage is higher then 1 V (i.e. for a sink current greater than 1 V/R_s) the output stages are switched off and the device is inhibited.

This condition is indicated at the open-collector output DIAG (pin 7) ; internal flip-flop F/F changes and forces the output transistor into saturation. The F/F must be supplied independently through V_{SS} (pin 6). The DIAG signal is reset and the output stages made operative by switching off the supply voltage at pin 1 and then by switching the device on again.

After that, two cases are possible : the reason for the "bad operation" is till present and the protection acts again ; the reason has been removed and the device starts to work properly.

Figure 3 : Peak Output Current vs. Input Voltage.

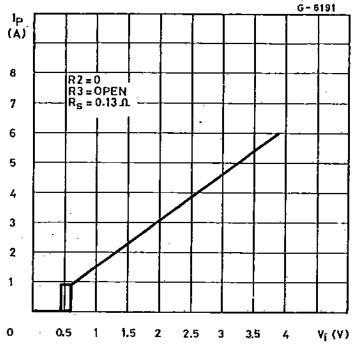


Figure 4 : Peak Output Current vs. Input Voltage.

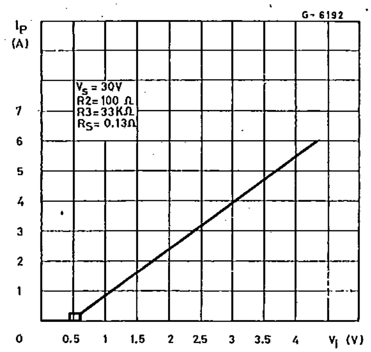


Figure 5 : Peak Output Current vs. Supply Voltage.