L6221

Quad Darlington switch

Features

- Four non-inverting inputs with enable
- Output voltage up to 50 V
- Output current up to 1.8 A
- Very low saturation voltage
- TTL compatible inputs
- Integral fast recirculation diodes

Applications

The L6221 monolithic quad Darlington switch is designed for high current, high voltage switching applications.

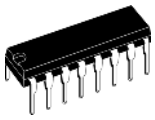
Description

Each of the four switches is controlled by a logic input and all four are controlled by a common enable input. All inputs are TTL-compatible for direct connection to logic circuits.

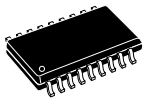
Each switch consists of an open-collector Darlington transistor plus a fast diode for switching applications with inductive device loads. The emitters of the four switches are commoned. Any number of inputs and outputs of the same device may be paralleled.

Table 1. Device summary

Order code	Package
E-L6221AS	Power DIP
E-L6221AD	SO16+2+2
E-L6221AD013TR	SO16+2+2 (tape and reel)
E-L6221C/CD/CN	Obsolete product

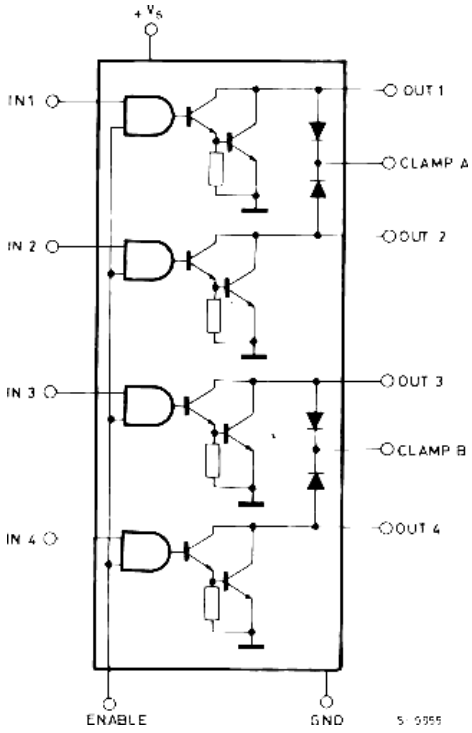


Power DIP 12+2+2



SO16+2+2

Figure 1. Block diagram



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1 Thermal data

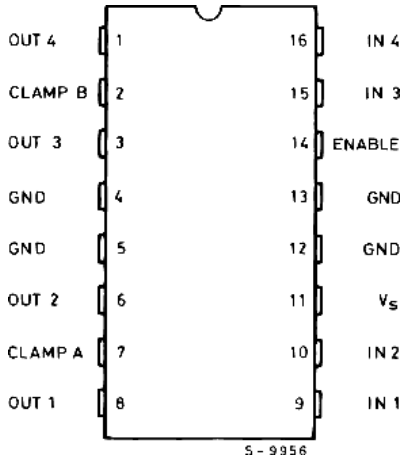
Table 2. Thermal data

Symbol	Parameter	SO20	Power DIP	Unit
$R_{th\ j\text{-}pins}$	Thermal resistance junction-pins max.	17	14	°C/W
$R_{th\ j\text{-}amb}$	Thermal resistance junction-ambient max.	80	80	°C/W

2 Pin information

Figure 2. Pin connections (top views)

E-L6221AS (Power DIP)



E-L6221AD (SO16+2+2)

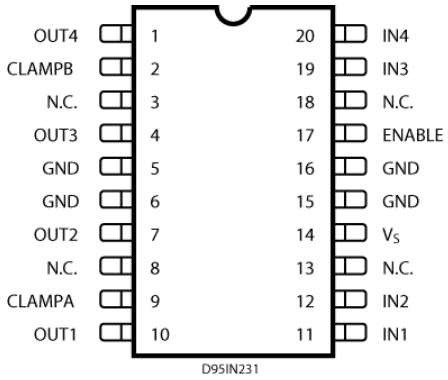


Table 3. Truth table(1)

Enable	Input	Power out
H	H	ON
H	L	OFF
L	X	OFF

1. For each input: H = High level, L = Low level

Table 4. Pin description(1)

Name	Function
IN 1	Input to driver 1
IN 2	Input to driver 2
OUT 1	Output of driver 1
OUT 2	Output of driver 2
CLAMP A	Diode clamp to driver 1 and driver 2
IN 3	Input to driver 3
IN 4	Input to driver 4
OUT 3	Output of driver 3
OUT 4	Output of driver 4
CLAMP B	Diode clamp to driver 3 and driver 4
ENABLE	Enable input to all drivers
V_S	Logic supply voltage
GND	Common ground

1. See *Figure 1: Block diagram*

3 Absolute maximum ratings

Table 5. Absolute maximum ratings

Symbol	Parameter	Value	Unit
V_o	Output voltage	50	V
V_s	Logic supply voltage	7	V
V_{IN}, V_{EN}	Input voltage, enable voltage	V_S	
I_C	Continuous collector current (for each channel)	1.8	A
I_C	Collector peak current (repetitive, duty cycle = 10% t_{on} = 5 ms)	2.5	A
I_C	Collector peak current (non repetitive, t = 10 µ s)	3.2	A
T_{op}	Operating temperature range (junction)	-40 to +150	°C
T_{stg}	Storage temperature range	-55 to +150	°C
I_{sub}	Output substrate current	350	mA
P_{tot}	Total power dissipation at: T_{pins} = 90 °C (Power DIP) T_{case} = 90°C (SO20) T_{amb} = 70 °C (Power DIP) T_{amb} = 70°C (SO20)	 4.3 3.5 1 1	 W W W W

4 Electrical characteristics

Note: Refer to the test circuits Figure 3 to Figure 10 (V_S = 5 V, T_{amb} = 25 °C unless otherwise specified).

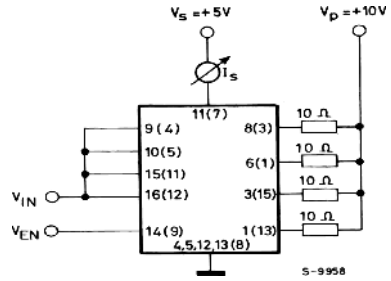
Table 6. Electrical characteristics

Symbol	Parameter	Test condition	Min.	Typ.	Max.	Unit
V_S	Logic supply voltage	-	4.5	-	5.5	V
I_s	Logic supply current	All outputs ON, I_C = 0.7A	-	-	20	mA
		All outputs OFF	-	-	20	mA
$V_{CE(sus)}$	Output sustaining voltage	V_{IN} = V_{IN}L, V_{EN} = V_{EN}H I_C = 100 mA	46	-	-	V
I_{CEX}	Output leakage current	V_{CE} = 50V V_{IN} = V_{IN}L, V_{EN} = V_{EN}H	-	-	1	mA
$V_{CE(sat)}$	Collector emitter saturation voltage (one input on, all others inputs off.)	V_s = 4.5 V V_{IN} = V_{IN}H, V_{EN} = V_{EN}H I_C = 0.6 A I_C = 1 A I_C = 1.8 A	 - - -	 - - -	 1 1.2 1.6	 V
V_{IN}L, V_{EN}L	Input low voltage	-	-	-	0.8	V
I_{IN}L, I_{EN}L	Input low current	V_{IN} = V_{INL}, V_{EN} = V_{ENL}	-	-	-100	µA
V_{IN}L, V_{EN}H	Input high voltage	-	2.0	-	-	V
I_{IN}H, I_{EN}H	Input high current	V_{IN} = V_{IN}H, V_{EN} = V_{EN}H	-	-	10	µA
I_R	Clamp diode leakage current	V_R = 50 V, V_{EN} = V_{EN}H V_{IN} = V_{IN}L	-	-	100	µA
V_F	Clamp diode forward voltage	I_F = 1A I_F = 1.8A	- -	- -	1.6 2.0	V V
$t_{d\ (on)}$	Turn-on delay time	V_p = 5V, R_L = 10Ω	-	-	2	µs
$t_{d\ (off)}$	Turn-off delay time	V_p = 5V, R_L = 10Ω	-	-	5	µs
ΔI_s	Logic supply current variation	V_{IN} = 5V, V_{EN} = 5V I_{out} = -300 mA for each channel	-	-	120	mA

5 Test circuits

Note: Pin numbers without parentheses apply to the Power DIP package.
Pin numbers in parentheses are not applicable.

Figure 3. Logic supply current



Set V_{IN} = 4.5 V, V_{EN} = 0.8 V, or V_{IN} = 0.8 V, V_{EN} = 4.5 V, for I_S (all outputs off)
Set V_{IN} = 2 V, V_{EN} = 2 V, for I_S (all outputs on)

Figure 4. Output sustaining voltage

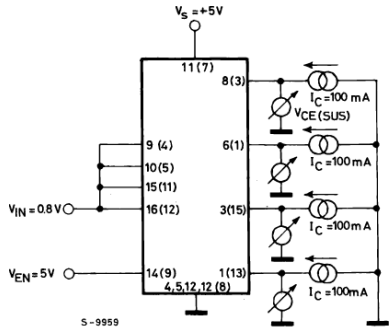


Figure 5. Output leakage current

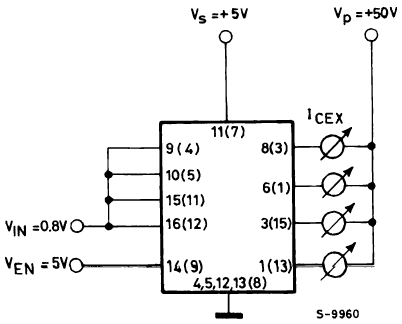


Figure 6. Collector-emitter saturation voltage

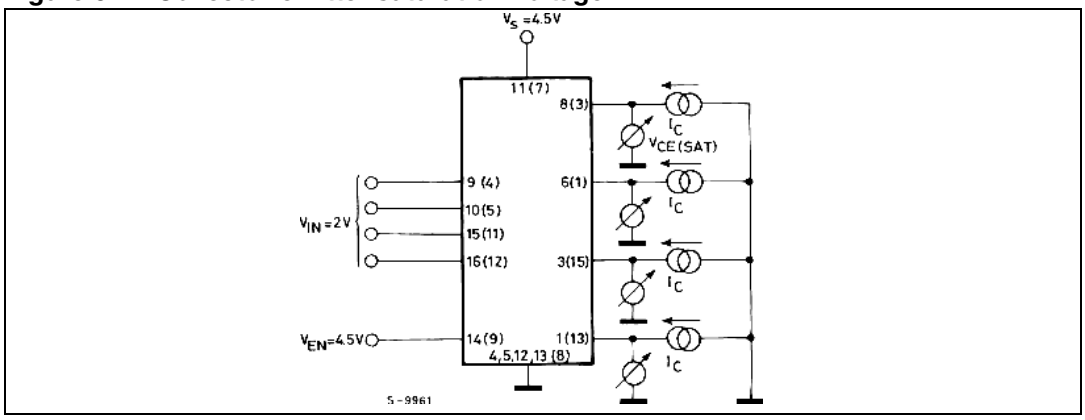
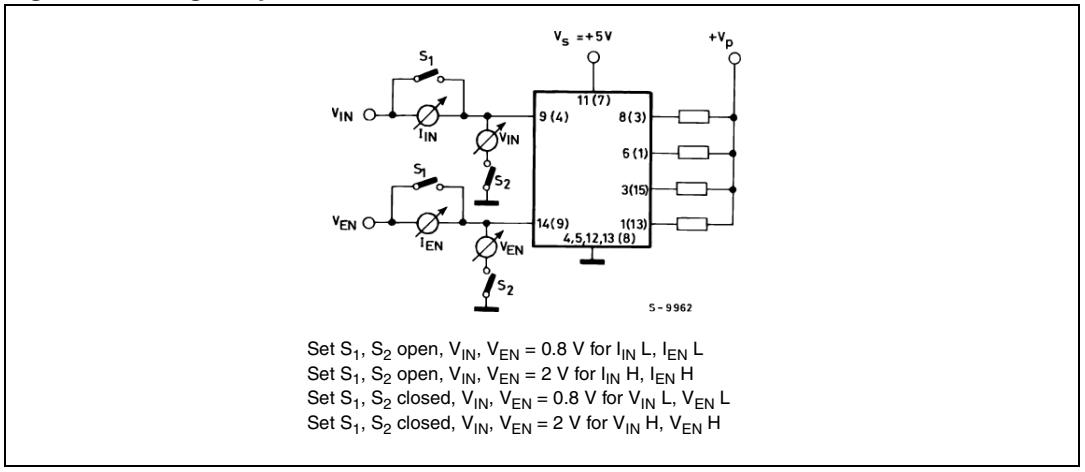


Figure 7. Logic input characteristics



Set S_1, S_2 open, V_{IN}, V_{EN} = 0.8 V for I_{IN} L, I_{EN} L
Set S_1, S_2 open, V_{IN}, V_{EN} = 2 V for I_{IN} H, I_{EN} H
Set S_1, S_2 closed, V_{IN}, V_{EN} = 0.8 V for V_{IN} L, V_{EN} L
Set S_1, S_2 closed, V_{IN}, V_{EN} = 2 V for V_{IN} H, V_{EN} H

Figure 8. Clamp-diode leakage current

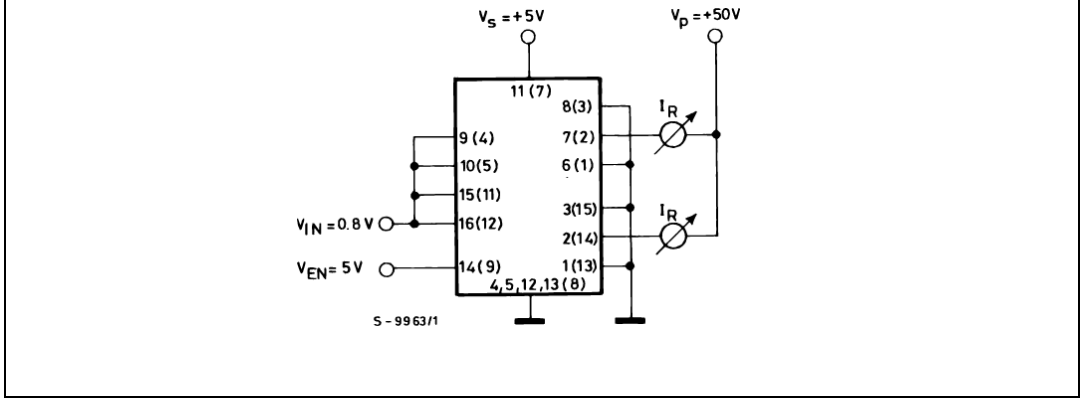


Figure 9. Clamp-diode forward voltage

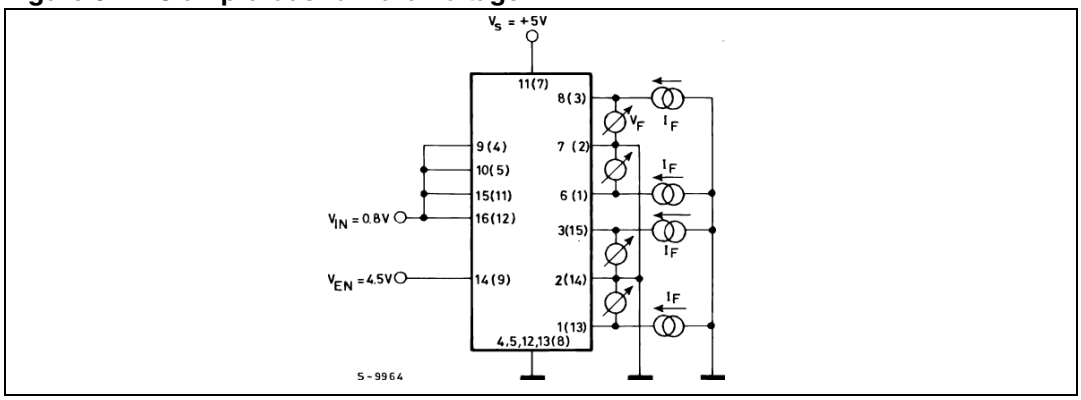


Figure 10. Switching time test circuit

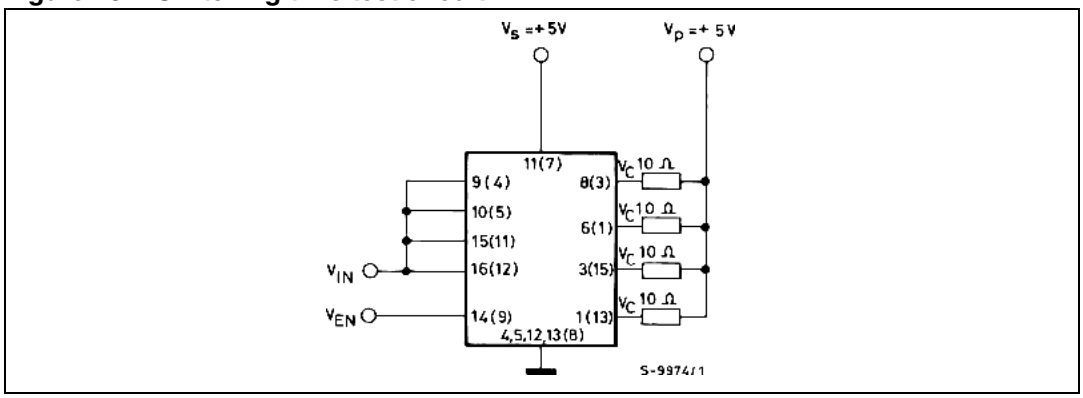


Figure 11. Switching time waveforms

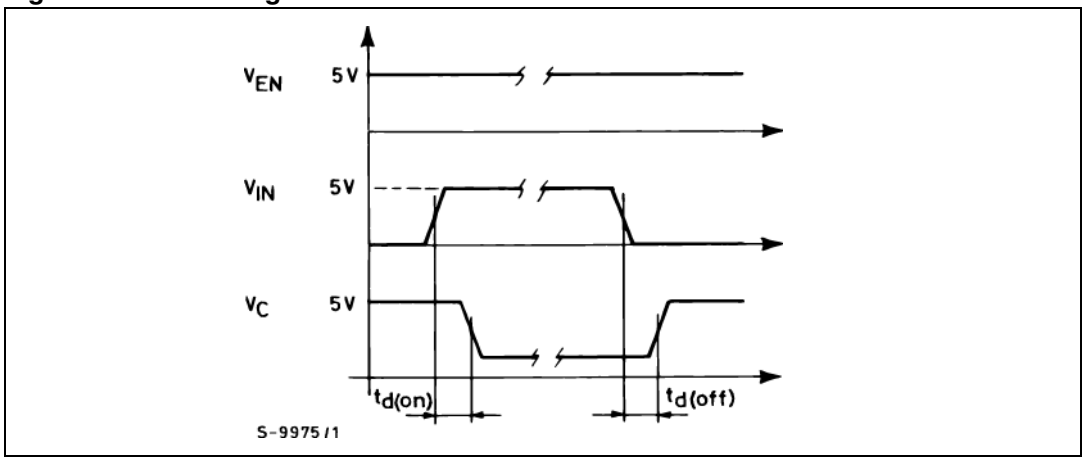


Figure 12. Allowed peak collector current versus duty cycle for 1, 2, 3 or 4 contemporary working outputs (L6221AS)

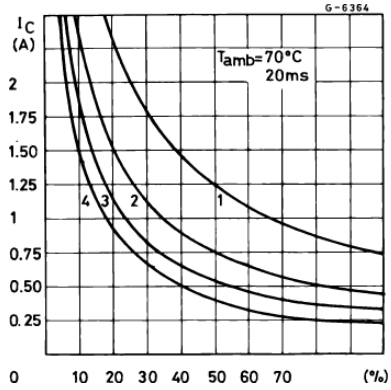


Figure 13. Collector saturation voltage versus collector current

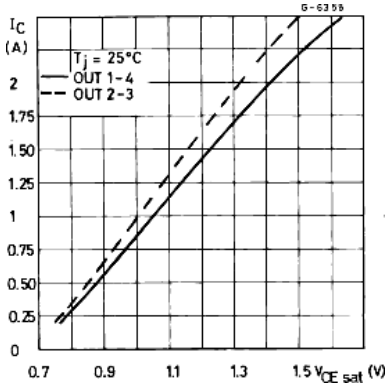


Figure 14. Free-wheeling diode forward voltage versus diode current

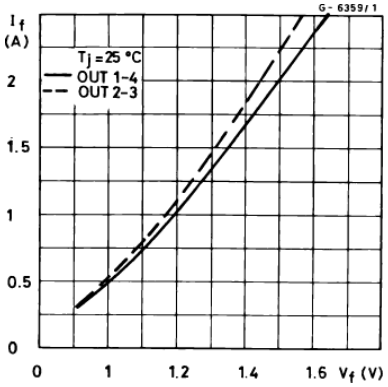


Figure 15. Collector saturation voltage versus junction temperature at I_C = 1 A

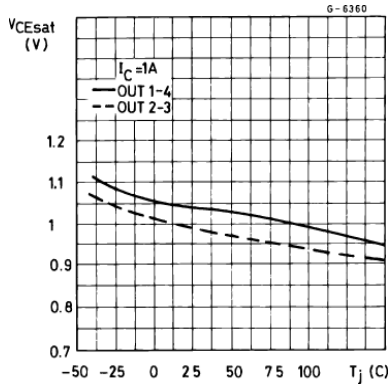


Figure 16. Free-wheeling diode forward voltage versus junction temperature at I_F = 1 A

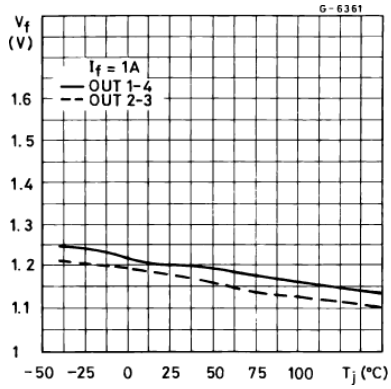


Figure 17. Saturation voltage against junction temperature

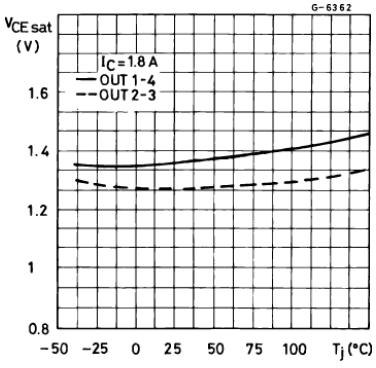
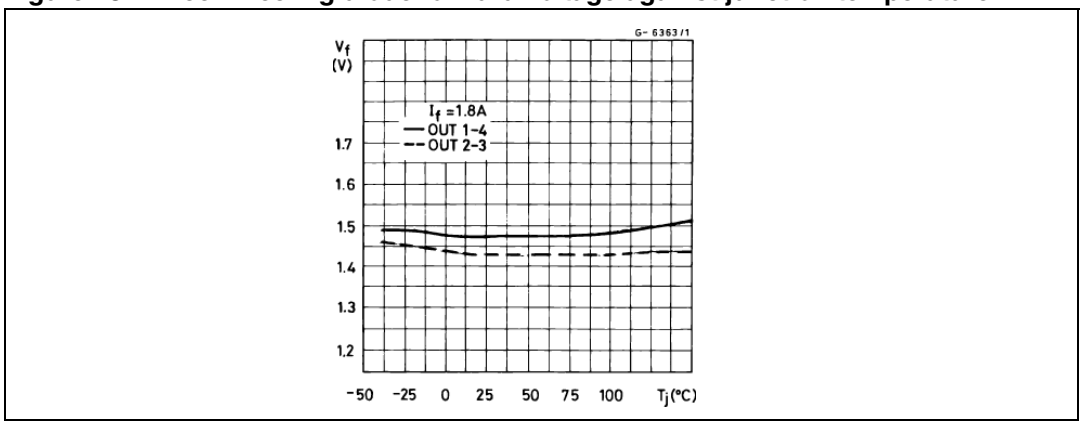


Figure 18. Free-wheeling diode forward voltage against junction temperature



6 Application information

When inductive loads are driven by the L6221, a Zener diode in series with the integral free-wheeling diodes increases the voltage across which energy stored in the load is discharged and therefore speeds the current decay (*Figure 19*).

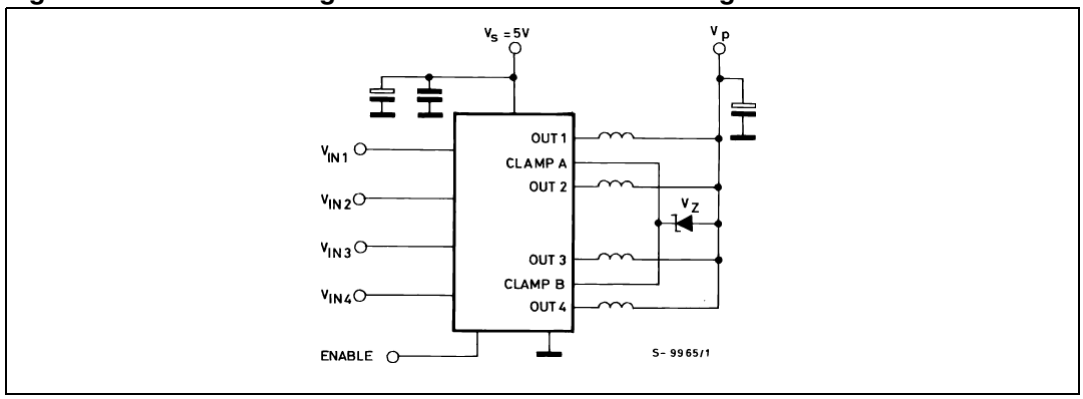
For reliability it is suggested that the Zener is chosen so that

$$V_p + V_z < 35\ V$$

There are two reasons for this:

- The Zener voltage changes in temperature and current.
- The instantaneous power must be limited to avoid the reverse second breakdown.

Figure 19. Free-wheeling diode connection when driving inductive loads



Care must be taken to ensure that the collectors are placed close together to avoid different current partitioning at turn-off.

It is suggested to put in parallel channel 1 and 4 and channel 2 and 3 as shown in *Figure 20* for the similar electrical characteristics of the logic section (turn-on and turn-off delay time) and the power stages (collector saturation voltage, free-wheeling diode forward voltage).

Figure 20. Driver for solenoids up to 3 A

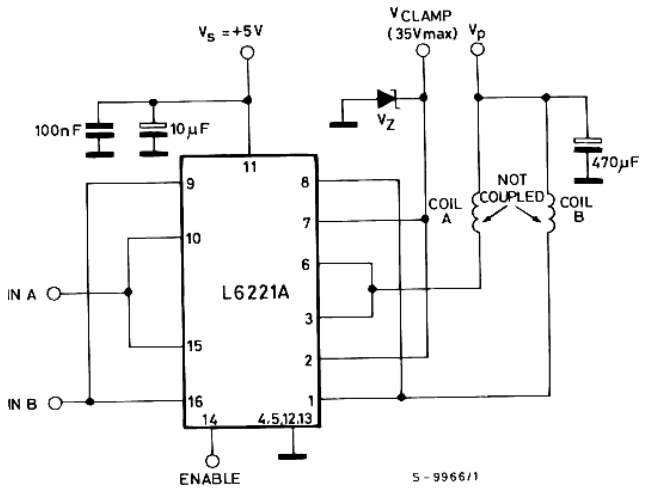


Figure 21. Saturation voltage versus collector current

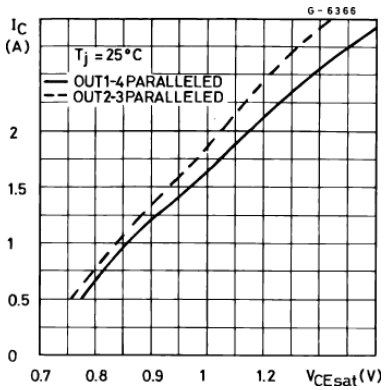
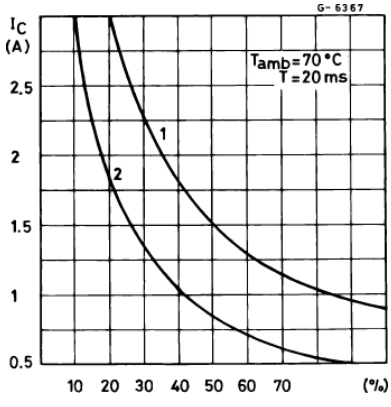


Figure 22. L6221AS peak collector current versus duty cycle for 1 or 2 paralleled outputs driven



7 Mounting instructions

The $R_{th\ j\text{-}amb}$ of the E-L6221AS can be reduced by soldering the GND pins to a suitable copper area of the printed circuit board (*Figure 23*) or to an external heat sink (*Figure 24*).

Figure 23. Example of PCB copper area used as heat sink

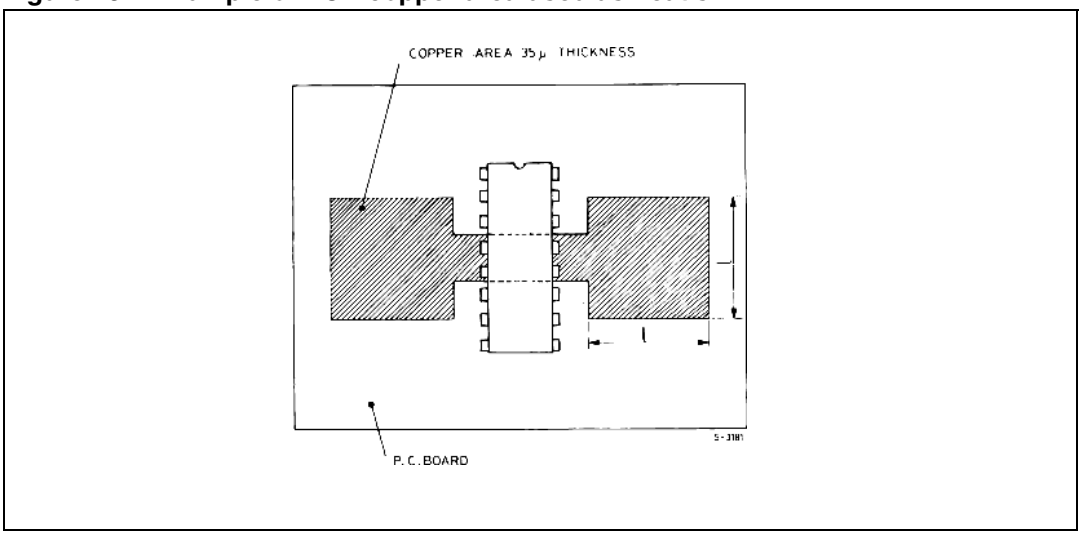


Figure 24. External heat sink mounting example

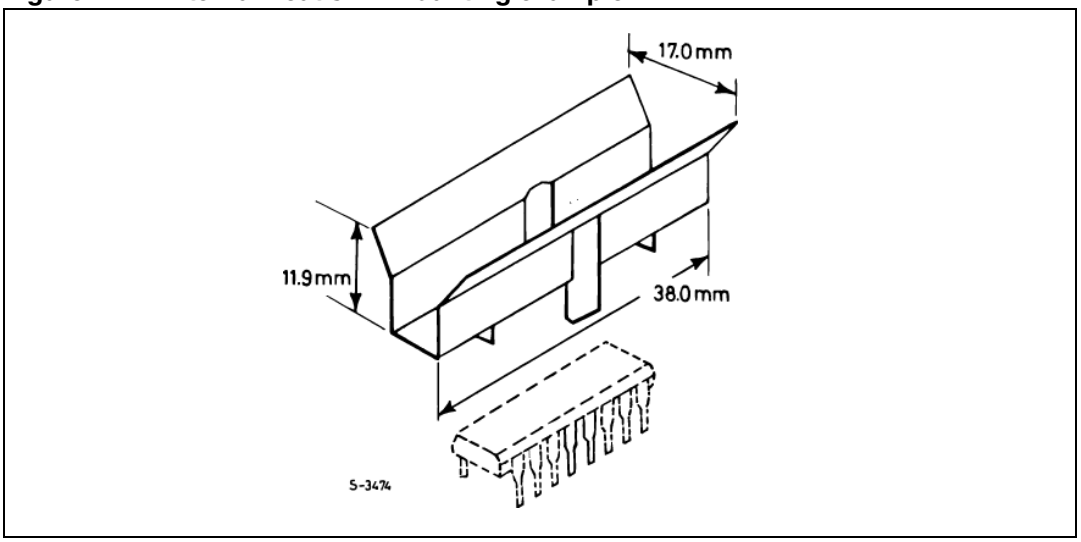


Figure 25 shows the maximum dissipable power P_{tot} and the $R_{th\ j\text{-}amb}$ as a function of the side "α" of two equal square copper areas having a thickness of 35 µm (1.4 mils). During soldering the pins temperature must not exceed 260 °C and the soldering time must not be longer than 12 seconds.

The external heat sink or printed circuit copper area must be connected to electrical ground.

Figure 25. Maximum dissipable power and junction-to-ambient thermal resistance versus side "α"

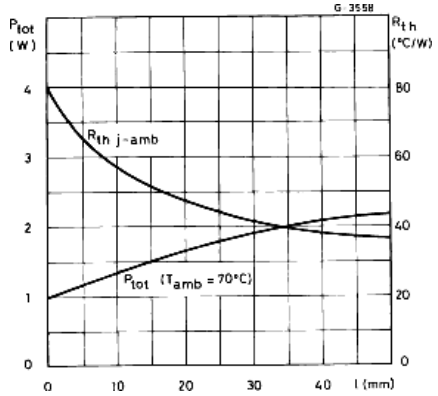
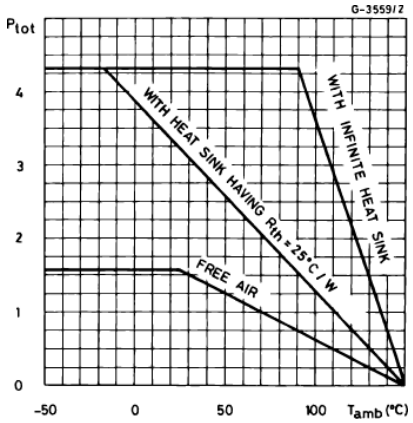


Figure 26. Maximum allowable power dissipation versus ambient temperature

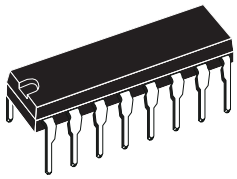


8 Package mechanical data

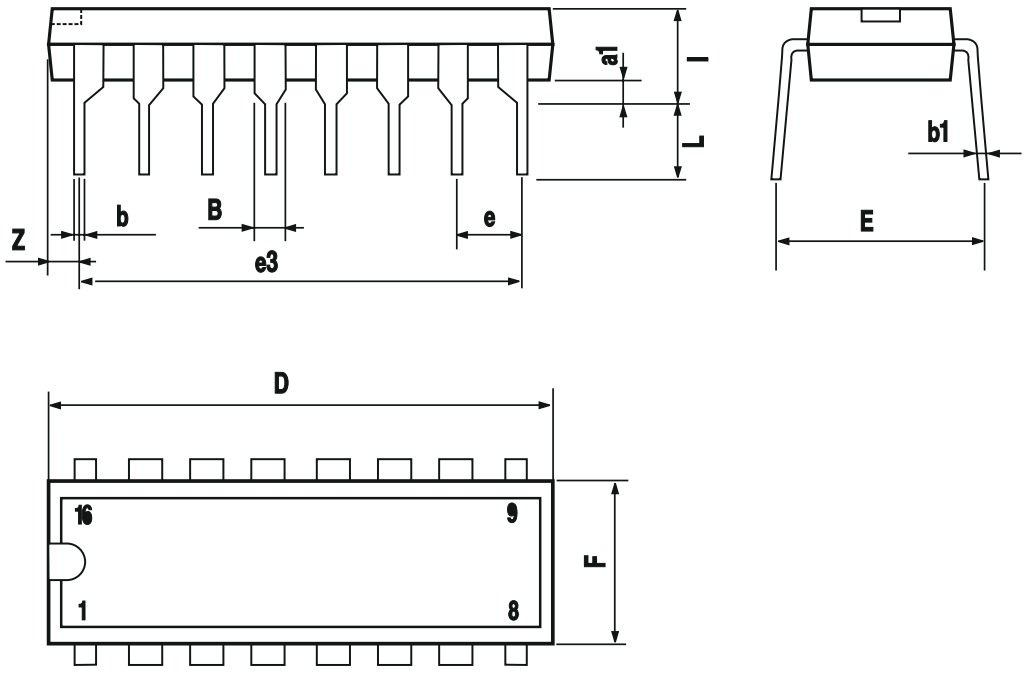
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DIM.	mm			inch		
	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.
a1	0.51			0.020		
B	0.85		1.40	0.033		0.055
b		0.50			0.020	
b1	0.38		0.50	0.015		0.020
D			20.0			0.787
E		8.80			0.346	
e		2.54			0.100	
e3		17.78			0.700	
F			7.10			0.280
I			5.10			0.201
L		3.30			0.130	
Z			1.27			0.050

OUTLINE AND MECHANICAL DATA

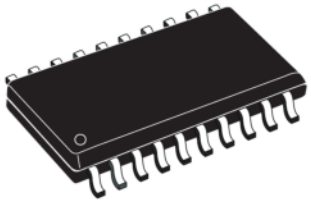


Power DIP 16

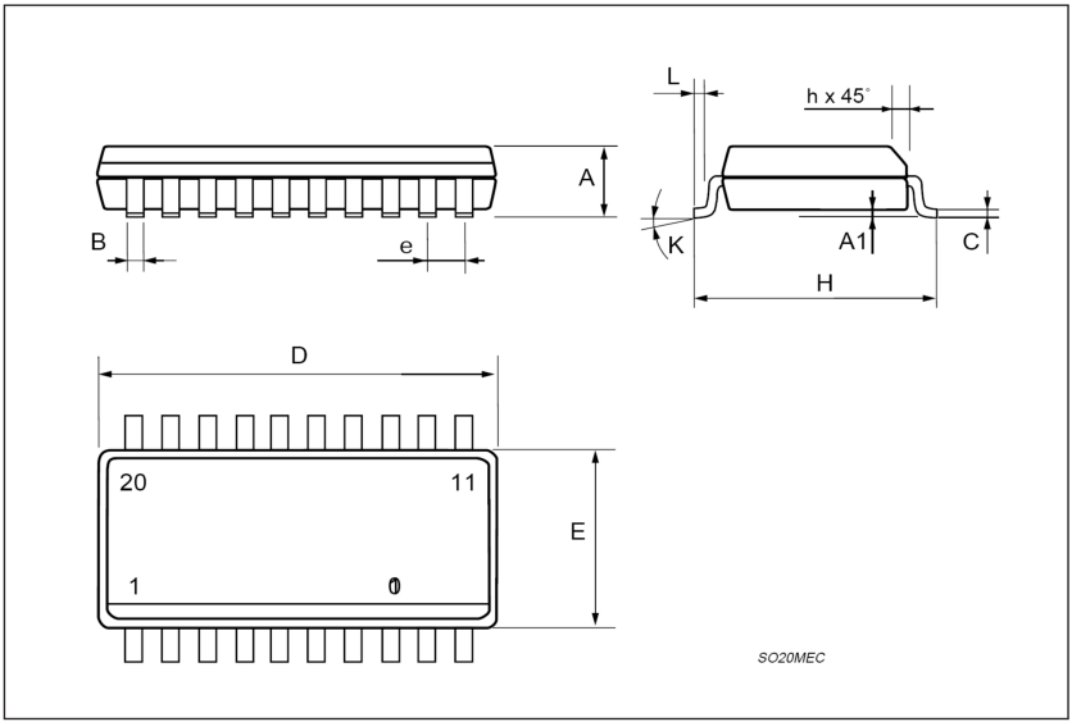


DIM.	mm			inch		
	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.
A	2.35		2.65	0.093		0.104
A1	0.1		0.3	0.004		0.012
B	0.33		0.51	0.013		0.020
C	0.23		0.32	0.009		0.013
D	12.6		13	0.496		0.512
E	7.4		7.6	0.291		0.299
e		1.27			0.050	
H	10		10.65	0.394		0.419
h	0.25		0.75	0.010		0.030
L	0.4		1.27	0.016		0.050
K	0° (min.)8° (max.)					

OUTLINE AND MECHANICAL DATA



SO20



9 Revision history

Table 7. Document revision history

Date	Revision	Changes
14-Jan-2004	2	Released in EDOCS
19-Jan-2009	3	Document reformatted. Inserted title for *Figure 19*. Removed reference to obsolete product L6221N and the associated package (multiwatt-15).
30-Mars-2009	4	Obsolete products E-L6221C/CD/CN added in *Table 1*.

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