



# THE DATASHEET OF L6221CD



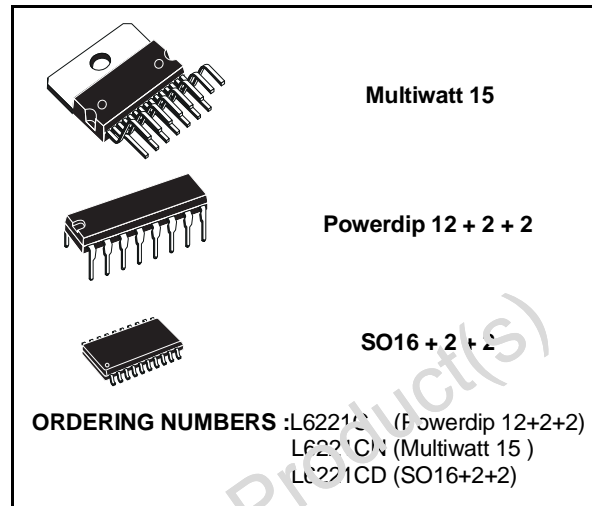
## QUAD DARLINGTON SWITCH

- FOUR NON INVERTING INPUTS WITH ENABLE
- OUTPUT VOLTAGE UP TO 60 V
- OUTPUT CURRENT UP TO 1.8 A
- VERY LOW SATURATION VOLTAGE
- TTL COMPATIBLE INPUTS
- INTEGRAL FAST RECIRCULATION DIODES

### DESCRIPTION

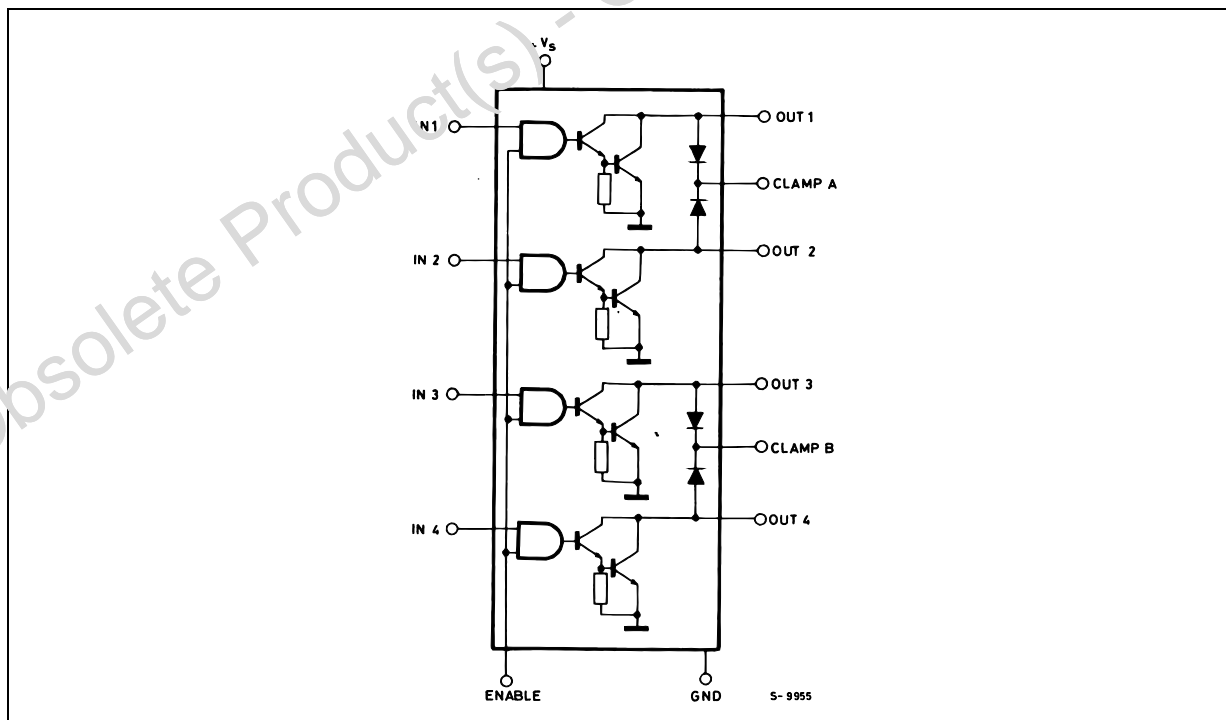
The L6221 monolithic quad darlington switch is designed for high current, high voltage switching applications. Each of the four switches is controlled by a logic input and all four are controlled by a common enable input. All inputs are TTL-compatible for direct connection to logic circuits.

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. Three versions are available : the L6221C mounted in a Powerdip 12 + 2 + 2 package and the L6221CN mounted in a 15-lead Multiwatt package, the L6221CD in SO16+2+2 package.

### BLOCK DIAGRAM

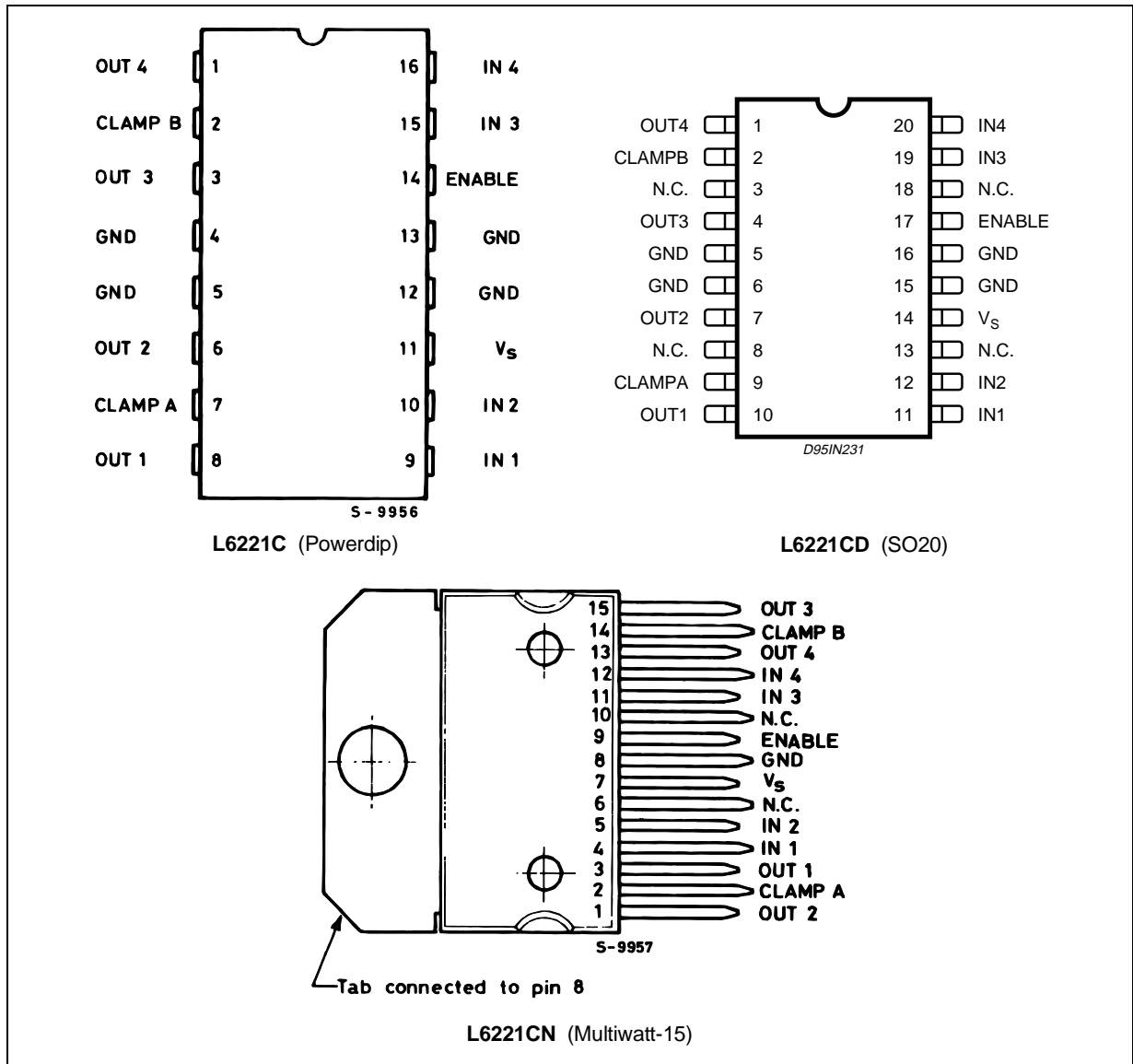


# L6221C

## THERMAL DATA

| Symbol           | Parameter                           |      | SO20 | Powerdip | Multiwatt15 | Unit |
|------------------|-------------------------------------|------|------|----------|-------------|------|
| $R_{th\ j-pins}$ | Thermal Resistance Junction-pins    | Max. | 17   | 14       | –           | °C/W |
| $R_{th\ j-case}$ | Thermal Resistance Junction-case    | Max. | –    | –        | 3           | °C/W |
| $R_{th\ j-amb}$  | Thermal Resistance Junction-ambient | Max. | 80   | 80       | 35          | °C/W |

## PIN CONNECTIONS (top views)



## ABSOLUTE MAXIMUM RATINGS

| Symbol           | Parameter   | Value                                  | Unit |   |
|------------------|---|--|------|---|
| $V_O$            | Output Voltage  | 60                                     | 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)                       |  | A    |   |
|                  |   | for L6221CD                            | A    |   |
| $I_C$            | Collector Peak Current (repetitive, duty cycle = 10% $t_{on} = 5ms$ ) |  | A    |   |
|                  |   | for L6221CD                            | A    |   |
| $I_C$            | Collector Peak Current (non repetitive, $t = 10\mu s$ )               |  | A    |   |
|                  |   | for L6221CD                            | 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 $T_{pins} = 90^\circ C$ (powerdip)  | 4.3  | W |
|                  |   | at $T_{case} = 90^\circ C$ (multiwatt) | 20   | W |
|                  |   | at $T_{case} = 90^\circ C$ (SO20)      | 3.5  | W |
|                  |   | at $T_{amb} = 70^\circ C$ (powerdip)   | 1    | W |
|                  |   | at $T_{amb} = 70^\circ C$ (multiwatt)  | 2.3  | W |
|                  |   | at $T_{amb} = 70^\circ C$ (SO20)       | 1    | W |

## TRUTH TABLE

| Enable | Input | Power Out |
|--------|-------|-----------|
| H      | H     | ON        |
| H      | L     | OFF       |
| L      | X     | OFF       |

For each input : H = High level  
L = Low level  
X = Don't care

## PIN FUNCTIONS (see block diagram)

| 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 Driver3 and Driver 4  |
| ENABLE  | Enable Input to All Drivers          |
| VS      | Logic Supply Voltage                 |
| GND     | Common Ground                        |

## L6221C

**ELECTRICAL CHARACTERISTICS** Refer to The Test Circuit to Fig.1 to Fig.9 ( $V_S = 5V$ ,  $T_{amb} = 25^\circ C$  unless otherwise specified)

| 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 $I_C = 0.7A$<br>All outputs OFF   |      |      | 20<br>20    | mA<br>mA |
| $I_{CEX}$          | Output Leakage Current   | $V_{CE} = 60V$ $V_{EN} = V_{ENH}$<br>$V_{IN} = V_{INL}$                                |      |      | 1           | mA       |
| $V_{CE(sat)}$      | Collector Emitter Saturation Voltage<br>(one input on; all others inputs off). | $V_S = 4.5V$ $V_{IN} = V_{INH}$<br>$V_{EN} = V_{ENH}$<br>$I_C = 1A$<br>(* $I_C = 2A$ ) |      |      | 1.4<br>1.85 | V<br>V   |
| $V_{INL}, V_{ENL}$ | Input Low Voltage  |  |      |      | 0.8         | V        |
| $I_{INL}, I_{ENL}$ | Input Low Current  | $V_{IN} = V_{INL}$ $V_{EN} = V_{ENL}$  |      |      | -100        | $\mu A$  |
| $V_{INH}, V_{ENH}$ | Input High Voltage   |  | 2    |      |             | V        |
| $I_{INH}, I_{ENH}$ | Input High Current   | $V_{IN} = V_{INH}$ $V_{EN} = V_{ENH}$  |      |      | 100         | $\mu A$  |
| $I_R$              | Clamp Diode Leakage Current  | $V_R = 60V$ $V_{EN} = V_{ENH}$<br>$V_{IN} = V_{INL}$                                   |      |      | 100         | $\mu A$  |
| $V_F$              | Clamp Diode Forward Voltage  | $I_F = 1A$<br>$I_F = 2A$ (*)   |      |      | 1.8<br>2.2  | V<br>V   |
| $t_{d(on)}$        | Turn on Delay Time   | $V_P = 5V$ $R_L = 10\Omega$  |      |      | 2           | ms       |
| $t_{d(off)}$       | Turn off Delay Time  | $V_P = 5V$ $R_L = 10\Omega$  |      |      | 5           | $\mu s$  |
| $\Delta I_S$       | Logic Supply Current Variation   | $V_{IN} = 5V$ $V_{EN} = 5V$<br>$I_{out} = -500mA$ for Each<br>Channel                  |      |      | 150         | mA       |

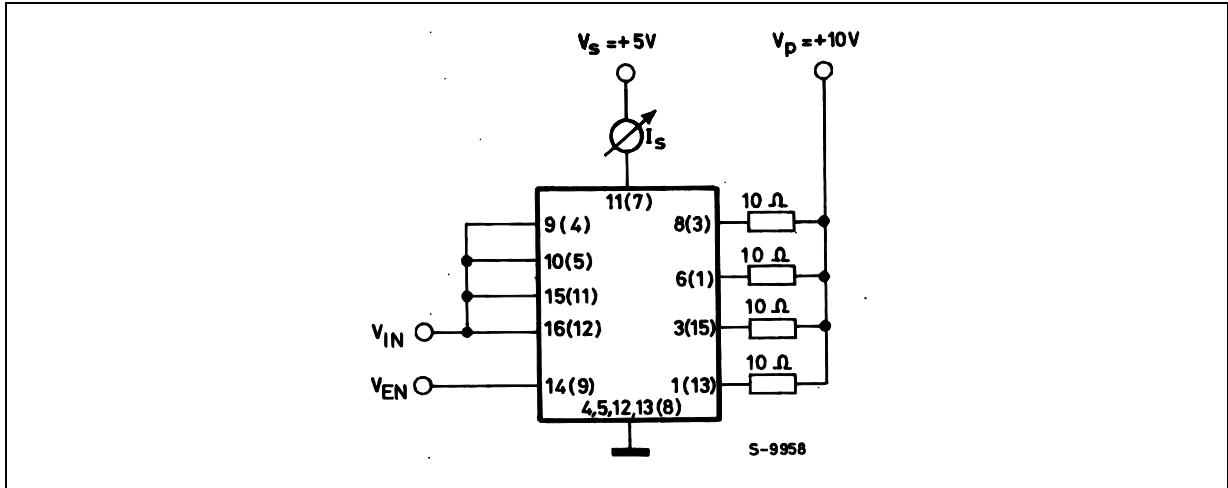
(\*) Only for L6221C - L6221CN types

TEST CIRCUITS

(X) = Referred to Multiwatt package

X = Referred to Powerdip package

Figure 1 : Logic supply current.



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

Figure 2 : Output Sustaining Voltage.

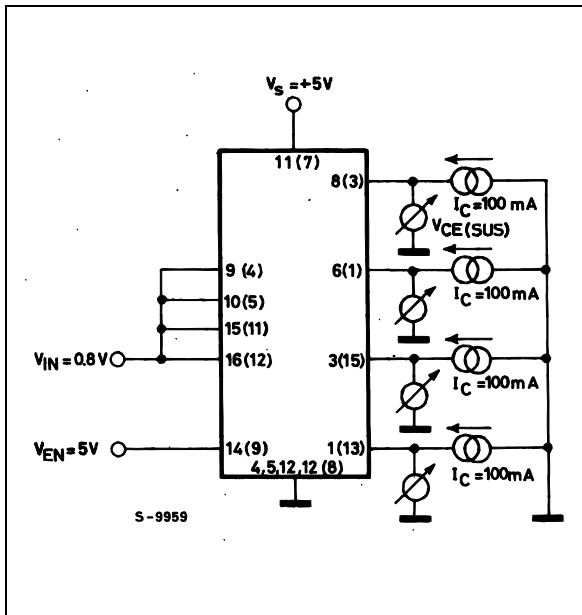
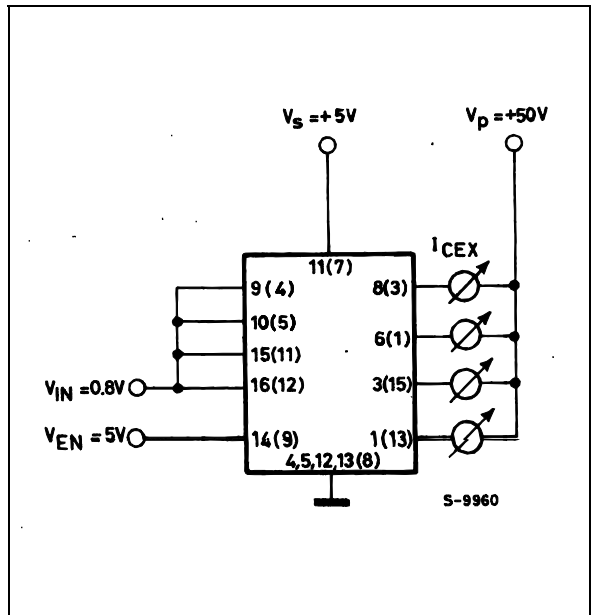
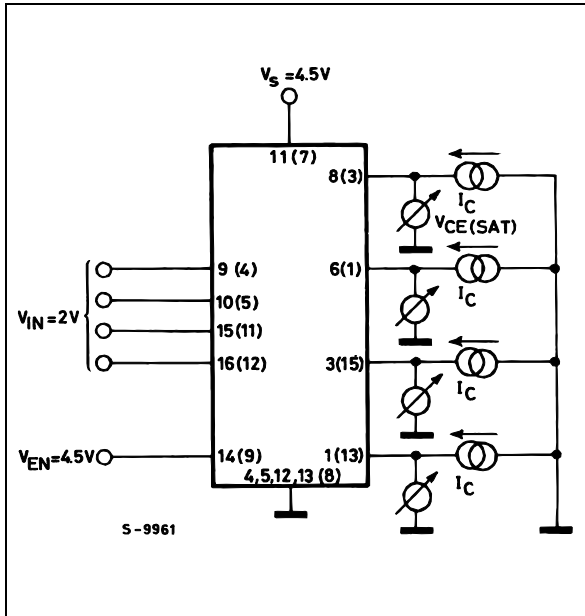


Figure 3 : Output Leakage Current.

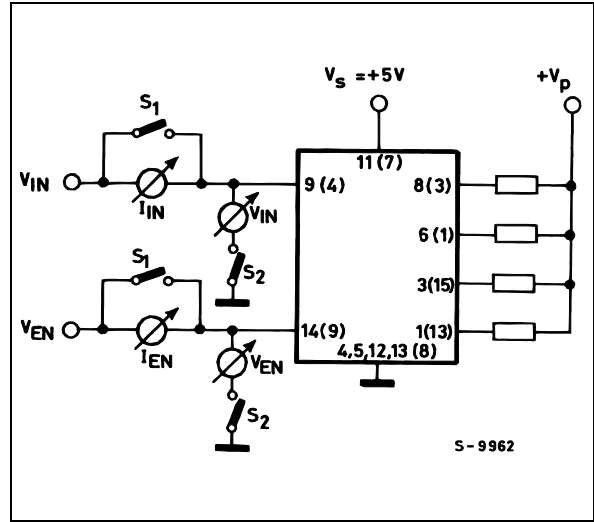


$V_P = +60V$

**Figure 4 :** Collector-emitter Saturation Voltage.

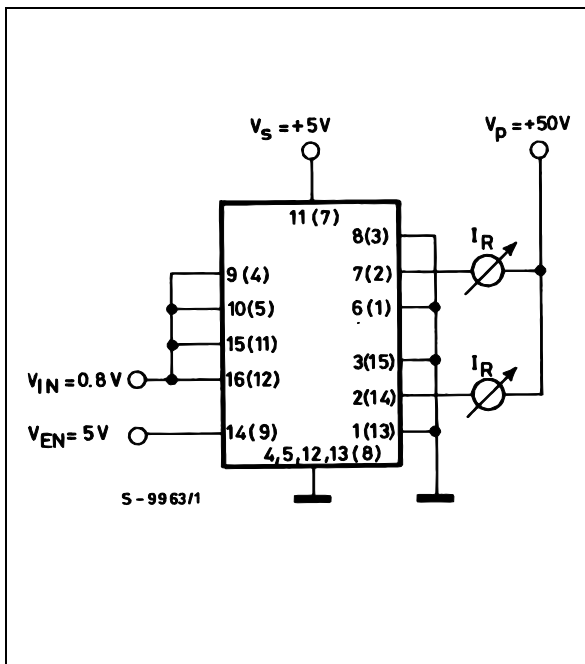


**Figure 5 :** Logic Input Characteristics.



Set S1, S2 open, VIN, VEN = 0.8V for IIN L, IEN L  
 Set S1, S2 open, VIN, VEN = 2V for IIN H, IEN H  
 Set S1, S2 close, VIN, VEN = 0.8V for VIN L, VEN L  
 Set S1, S2 close, VIN, VEN = 2V for VIN H, VEN H

**Figure 6 :** Clamp Diode Leakage Current.



Vp = +60V

**Figure 7 :** Clamp Diode Forward Voltage.

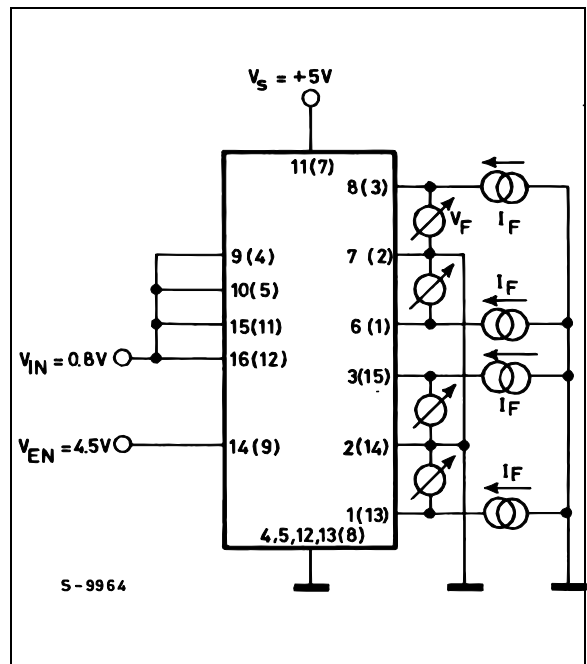


Figure 8 : Switching Times Test Circuit.

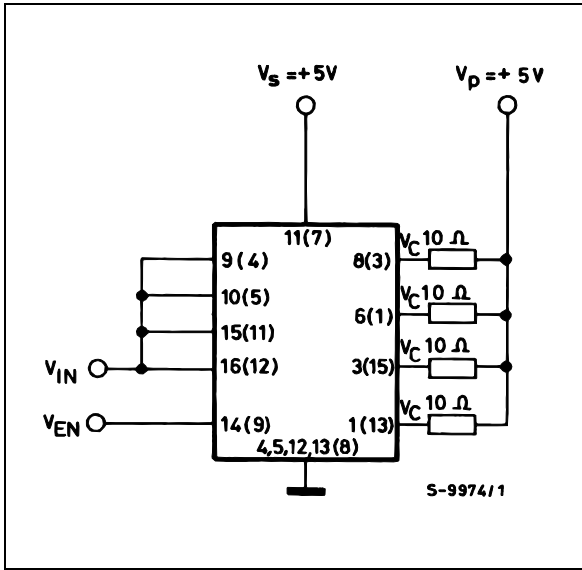


Figure 9 : Switching Times Waveforms.

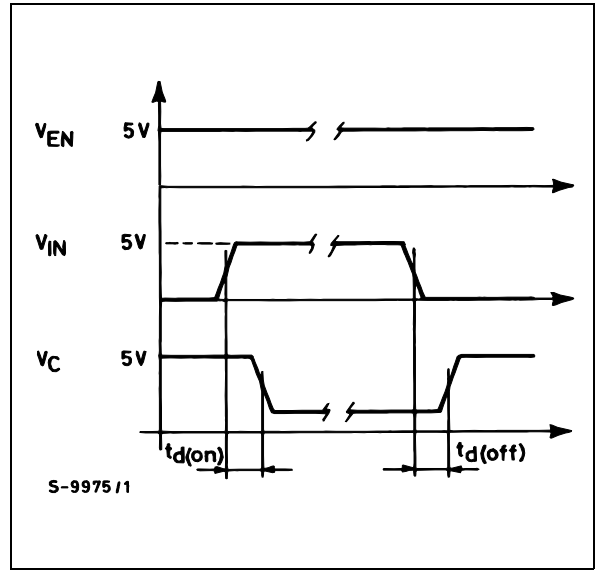


Figure 10 : Allowed Peak Collector Current vs. Duty Cycle for 1, 2, 3 or 4 Contemporary Working Outputs (L6221C).

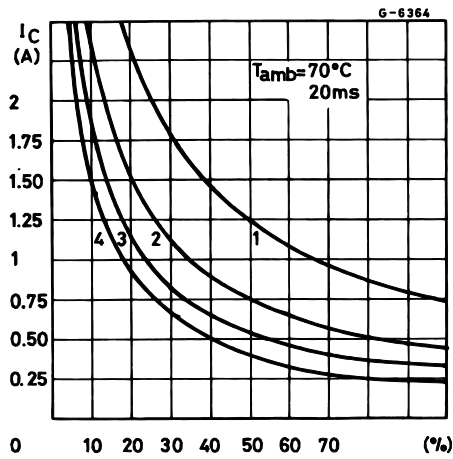
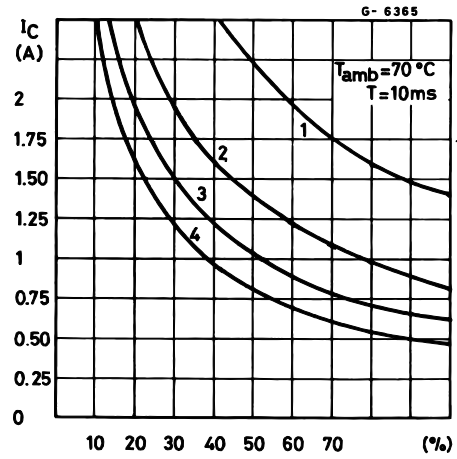
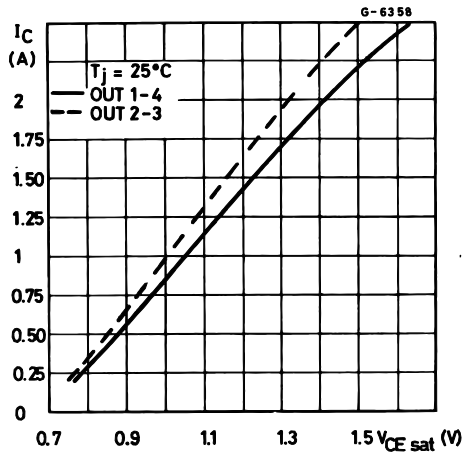


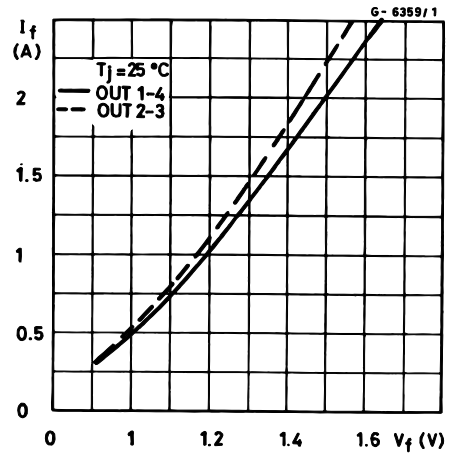
Figure 11 : Allowed Peak Collector Current vs. Duty Cycle for 1, 2, 3 or 4 Contemporary Working Outputs (L6221CN).



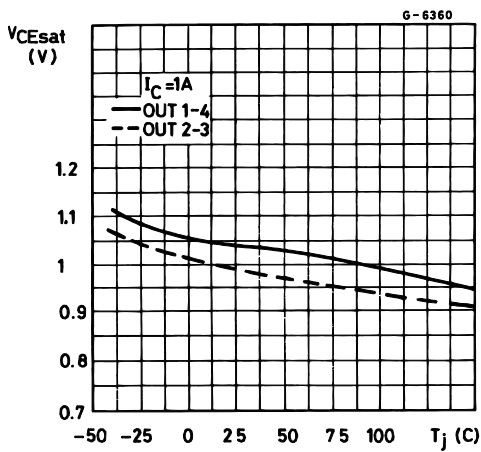
**Figure 12** : Collector Saturation Voltage vs. Collector Current.



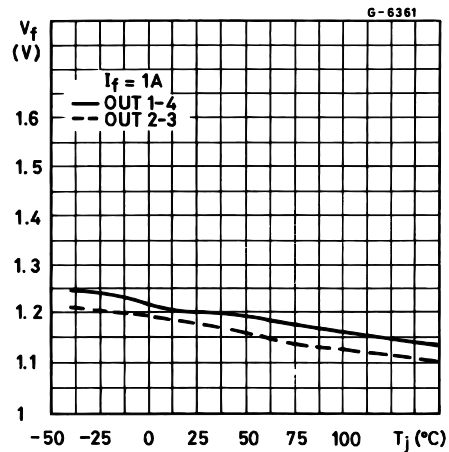
**Figure 13** : Free-wheeling Diode Forward Voltage vs. Diode Current .



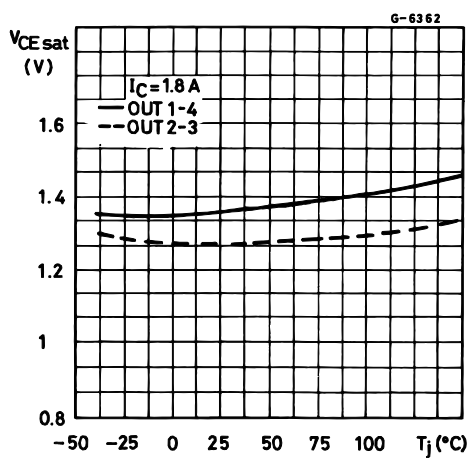
**Figure 14** : Collector Saturation Voltage vs. Junction Temperature at  $I_C = 1\text{A}$ .



**Figure 15** : Free-wheeling Diode Forward Voltage vs. Junction Temperature at  $I_f = 1\text{A}$ .



**Figure 16** : Saturation Voltage vs. Junction Temperature at  $I_C = 1.8\text{A}$ .



**Figure 17** : Free-wheeling Diode Forward Voltage vs. Junction Temperature at  $I_f = 1.8\text{A}$ .

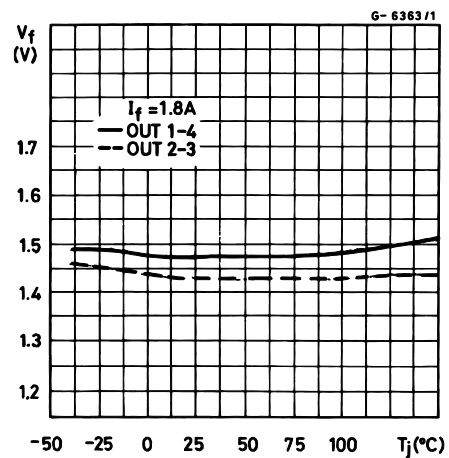
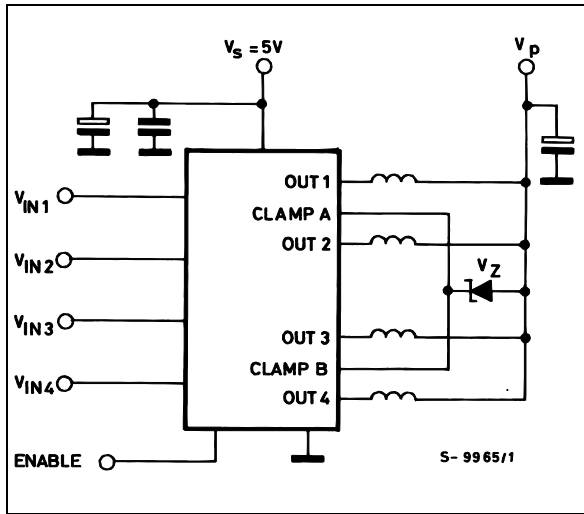


Figure 18.



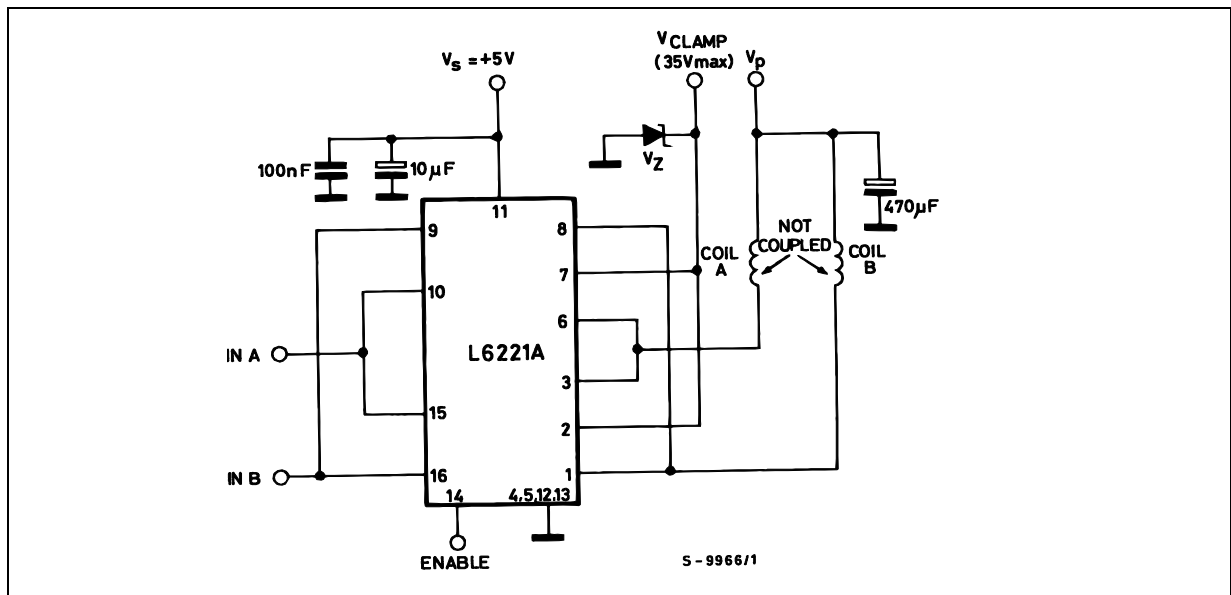
APPLICATION INFORMATION

When inductive loads are driven by L6221C/CD, 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 (fig. 18).

The zener has to be chosen in such a way that  $V_{CLAMP}$  is limited to 60V taking into account the zener's voltage changes due to: spread on  $V_Z$ , temperature changes, and the voltage drop due to ohmic resistance.

Moreover, the instantaneous power must be limited in order to avoid the reverse second breakdown.

Figure 19 : Driver for Solenoids up to 3A.

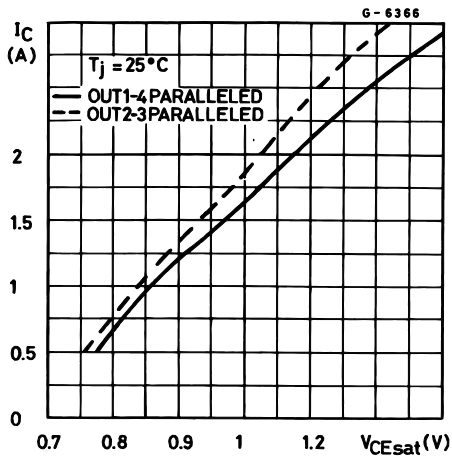


Some care must be taken to ensure that the collectors are placed close together to avoid different current partitioning at turn-off.

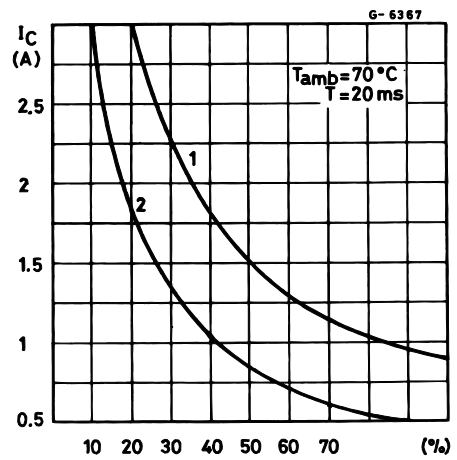
We suggest to put in parallel channel 1 and 4 and channel 2 and 3 as shown in figure 19 for the similar

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).

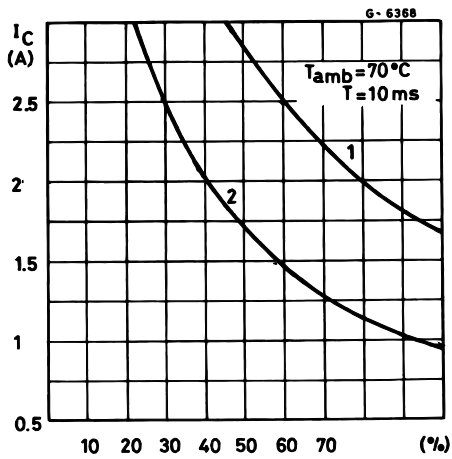
**Figure 20** : Saturation Voltage vs. Collector Current.



**Figure 21** : Peak Collector Current vs. Duty Cycle for 1 or 2 Paralleled Outputs Driven (L6221N).



**Figure 22** : Peak Collector Current vs. Duty Cycle for 1 or 2 Paralleled Outputs Driven (L6221CN).



**MOUNTING INSTRUCTION**

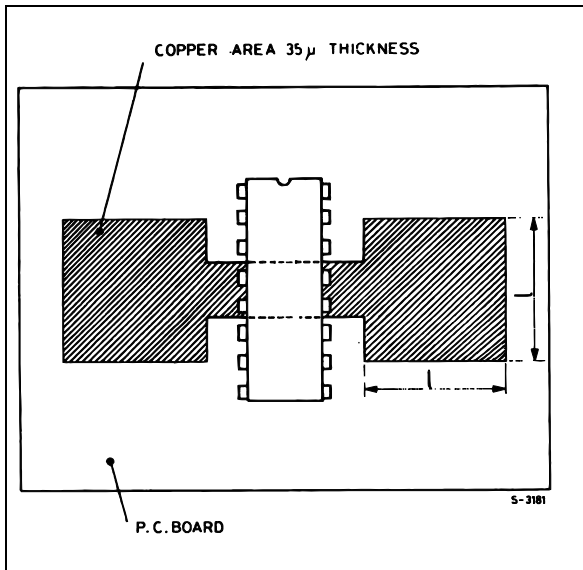
The  $R_{th\ j-amb}$  of the L6221C can be reduced by soldering the GND pins to a suitable copper area of the printed circuit board (Fig. 23) or to an external heatsink (Fig. 24).

The diagram of figure 25 shows the maximum dissippable power  $P_{tot}$  and the  $R_{th\ j-amb}$  as a function of the side "  $\alpha$  " of two equal square copper areas hav-

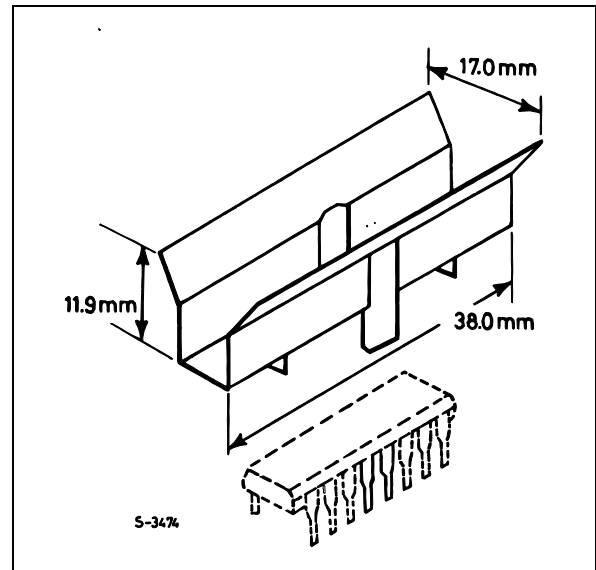
ing a thickness of  $35\mu$  (1.4 mils). During soldering the pins temperature must not exceed  $260\text{ }^{\circ}\text{C}$  and the soldering time must not be longer than 12 seconds.

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

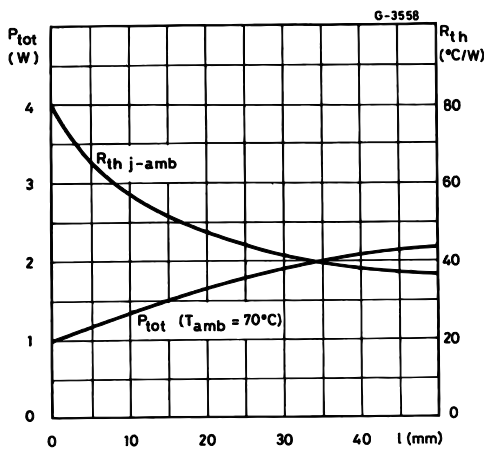
**Figure 23 :** Example of P.C. Board Copper Area Which is Used as Heatsink.



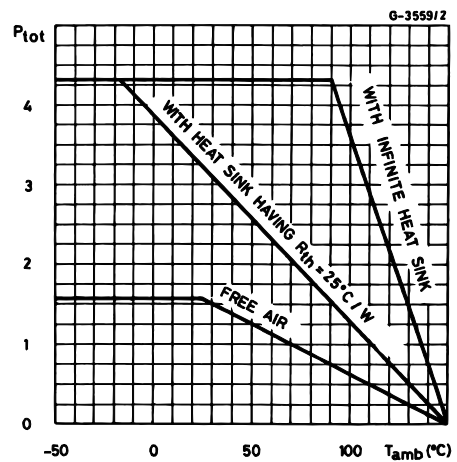
**Figure 24 :** External Heatsink Mounting Example.



**Figure 25 :** Maximum Dissippable Power and Junction to Ambient Thermal Resistance vs. Side "  $\alpha$  ".



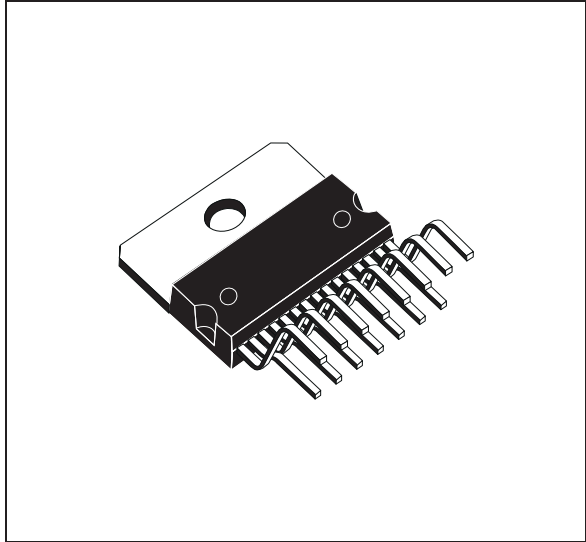
**Figure 26 :** Maximum Allowable Power Dissipation vs. Ambient Temperature.



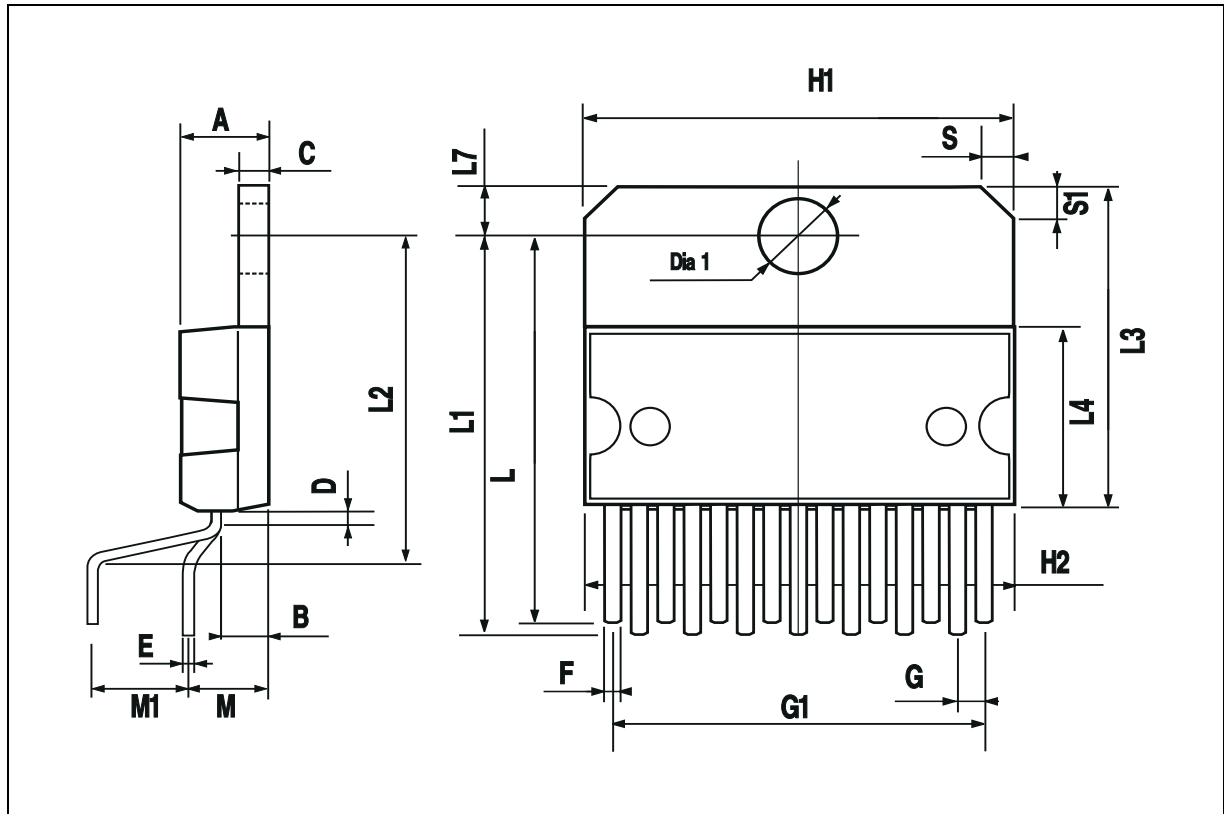
# L6221C

| 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

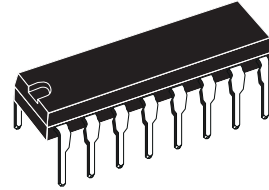


## Multiwatt15 V

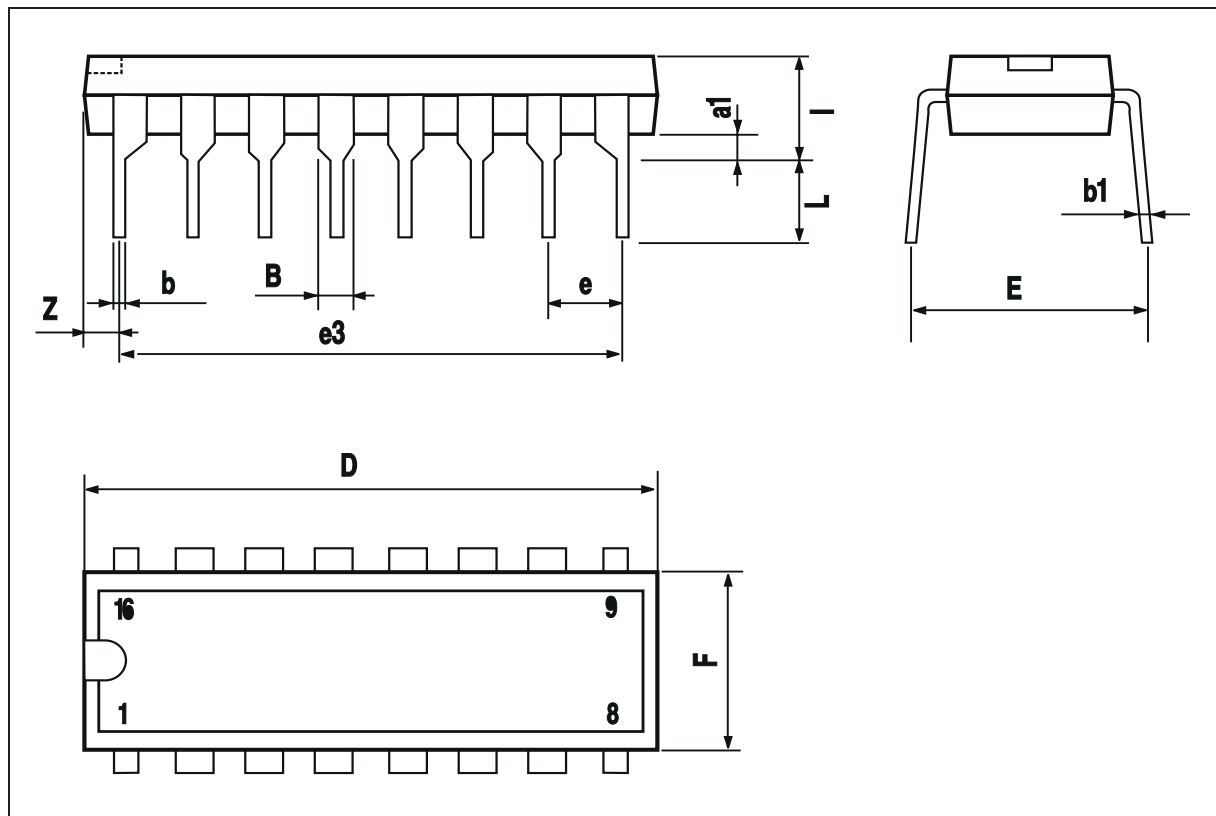


| DIM. | mm   |       |      | inch  |       |       |
|------|------|-------|------|-------|-------|-------|
|      | MIN. | TYP.  | MAX. | MIN.  | TYP.  | MAX.  |
| a1   | 0.51 |       |      | 0.020 |       |       |
| B    | 0.85 |       | 1.40 | 0.033 |       | 0.055 |
| b    |      | 0.50  |      |       | 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



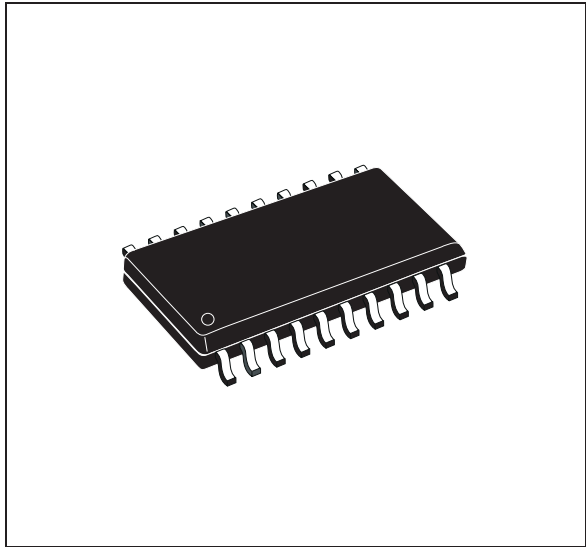
**Powerdip 16**



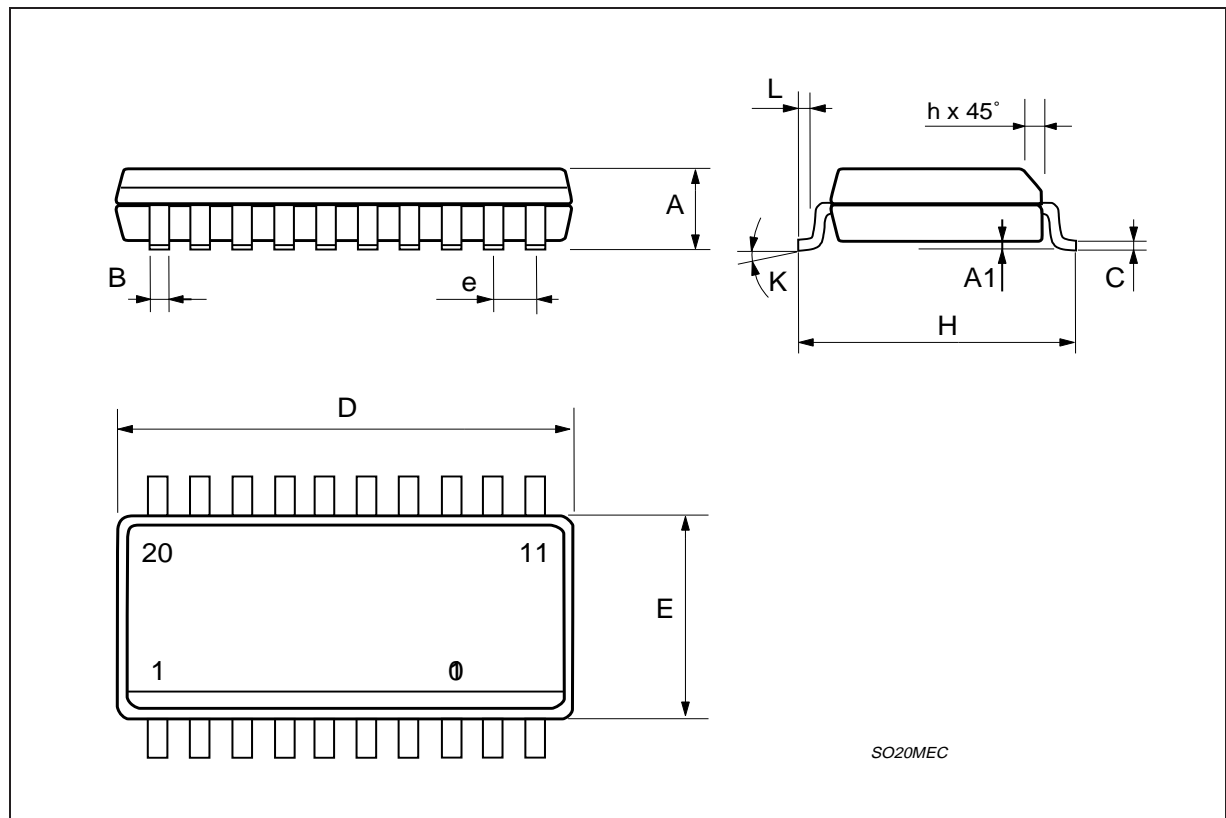
# L6221C

| 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



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## Optimize Your Supply Chain with WIN SOURCE Solutions

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-  Cost Control Management
-  Shortage Management
-  Alternative Solution
-  Excess Inventory Management