

## QUAD DARLINGTON SWITCHES

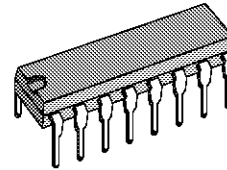
- TWO NON INVERTING + TWO INVERTING INPUTS WITH INHIBIT
- OUTPUT VOLTAGE UP TO 50V
- OUTPUT CURRENT UP TO 1.8A
- VERY LOW SATURATION VOLTAGE
- TTL COMPATIBLE INPUTS
- INTEGRAL FAST RECIRCULATION DIODES

### DESCRIPTION

The L6220 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 inhibit input. All inputs are TTL-compatible for direct connection to logic circuits.

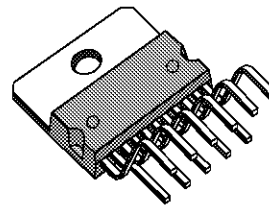
Each switch consists of an open-collector darlington transistor plus a fast diode for switching applications with inductive loads. The emitters of the four switches are commoned. Any number of inputs and outputs of the same device may be paralleled.

Two versions are available : the L6220 mounted in a Powerdip 12 + 2 + 2 package and the L6220N mounted in a 15-lead Multiwatt package.



**Powerdip 12 + 2 + 2**  
(Plastic Package)

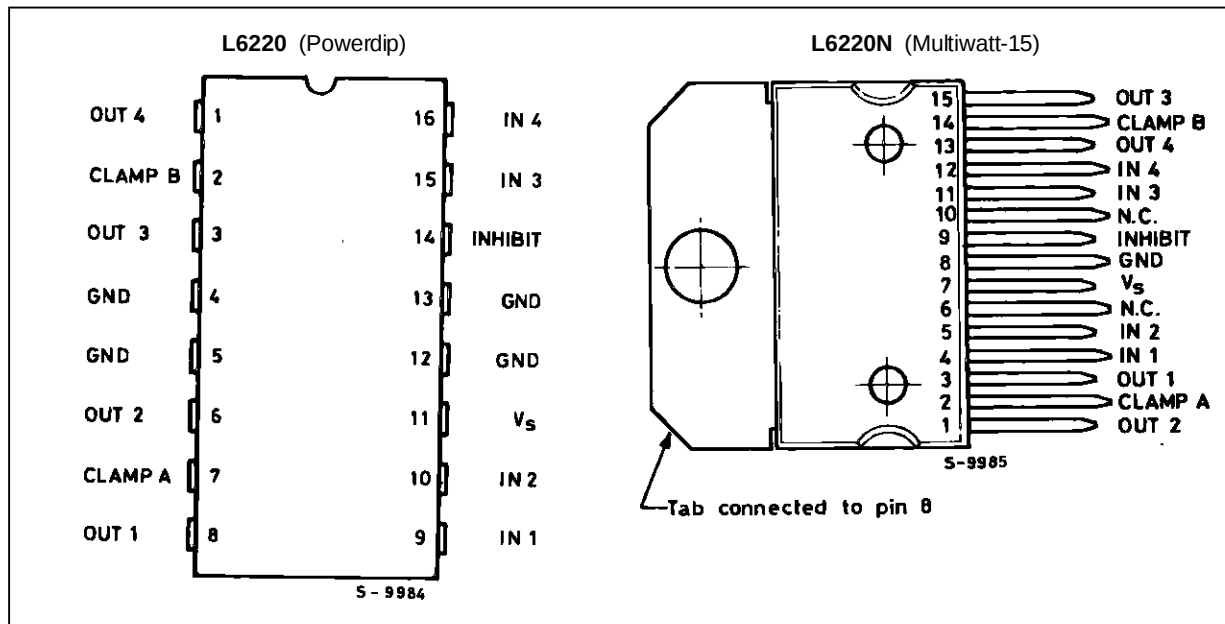
ORDERING NUMBER : L6220



**Multiwatt 15**  
(Plastic Package)

ORDERING NUMBER : L6220N

### PIN CONNECTIONS (top views)

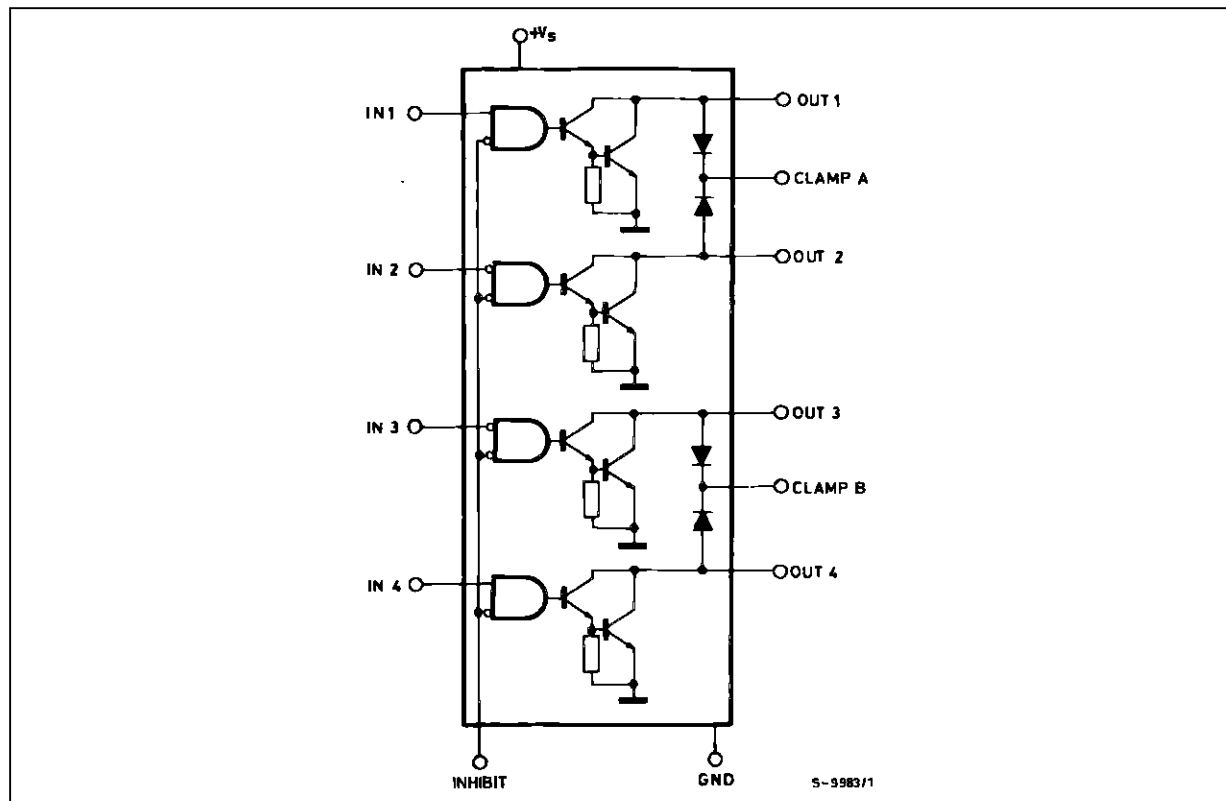


## L6220 - L6220N

### 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 Driver 3 and Driver 4 |
| INHIBIT        | Inhibit Input to all Drivers         |
| V <sub>s</sub> | Logic Supply Voltage                 |
| GND            | Common Ground                        |

### BLOCK DIAGRAM



### TRUTH TABLE

| Inhibit | Input 1, 4 | Power Out | Inhibit | Inputs 2, 3 | Power Out |
|---------|------------|-----------|---------|-------------|-----------|
| L       | H          | ON        | L       | L           | ON        |
| L       | L          | OFF       | L       | H           | OFF       |
| H       | X          | OFF       | H       | X           | OFF       |

For each input : H = High level  
L = Low level

**ABSOLUTE MAXIMUM RATINGS**

| Symbol            | Parameter                                                                                                                                                                                                           | Value                 | Unit             |
|-------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|------------------|
| $V_O$             | Output Voltage                                                                                                                                                                                                      | 50                    | V                |
| $V_S$             | Logic Supply Voltage                                                                                                                                                                                                | 7                     | V                |
| $V_{IN}, V_{INH}$ | Input Voltage, Inhibit 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, $t = 10$ $\mu$ 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<br>at $T_{pins} = 90^\circ\text{C}$ (Powerdip)<br>at $T_{case} = 90^\circ\text{C}$ (Multiwatt)<br>at $T_{amb} = 70^\circ\text{C}$ (Powerdip)<br>at $T_{amb} = 70^\circ\text{C}$ (Multiwatt) | 4.3<br>20<br>1<br>2.3 | W<br>W<br>W<br>W |

**THERMAL DATA**

| Symbol           | Parameter                                | Powerdip | Multiwatt-15 | Unit |
|------------------|------------------------------------------|----------|--------------|------|
| $R_{th\ j-pins}$ | Thermal Resistance Junction-pins Max.    | 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       | 35           | °C/W |

**ELECTRICAL CHARACTERISTICS**

Refer to the test circuits Fig. 1 to Fig.9 ( $V_S = 5V$ ,  $T_{amb} = 25^\circ\text{C}$  unless otherwise specified)

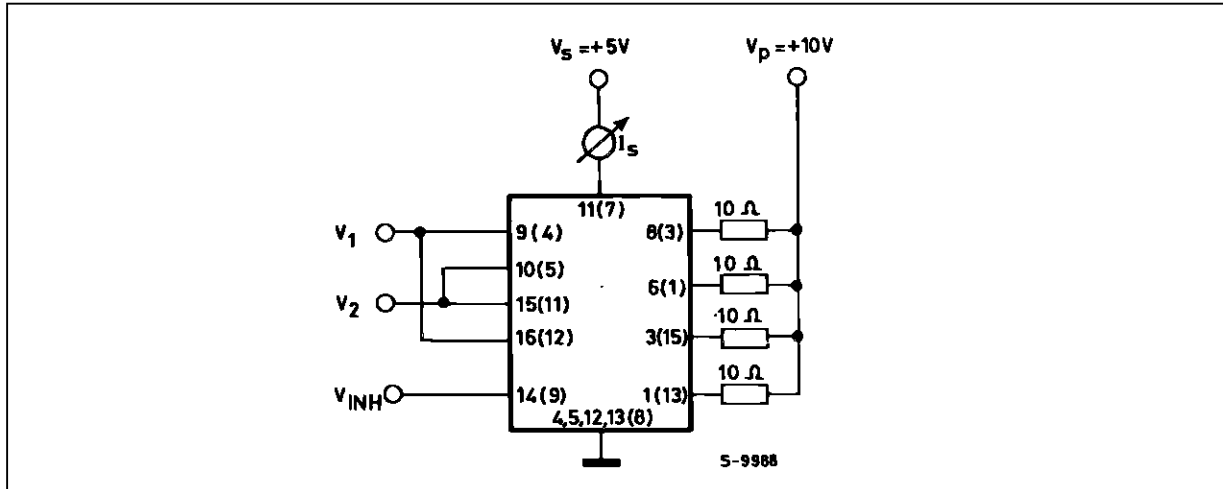
| Symbol                      | Parameter                                                                 | Test Conditions                                                                                                | Min. | Typ. | Max.            | Unit     |
|-----------------------------|---------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------|------|------|-----------------|----------|
| $V_S$                       | 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 |
| $V_{CE(sus)}$               | Output Sustaining Voltage                                                 | $I_C = 100mA$ , $V_{INH} = V_{INH H}$                                                                          | 46   |      |                 | V        |
| $I_{CEX}$                   | Output Leakage Current                                                    | $V_{CE} = 50V$ , $V_{IN\ 1.4} = V_{INH H}$                                                                     |      |      | 1               | mA       |
| $V_{CE(sat)}$               | Collector Emitter Saturation Voltage<br>(one output on ; all others off.) | $V_S = 4.5V$ , $V_{IN\ 2.3} = V_{IN L}$<br>$V_{INH} = V_{INH L}$<br>$I_C = 0.6A$<br>$I_C = 1A$<br>$I_C = 1.8A$ |      |      | 1<br>1.2<br>1.6 | V        |
| $V_{IN L}$ ,<br>$V_{INH L}$ | Input Low Voltage                                                         |                                                                                                                |      |      | 0.8             | V        |
| $I_{IN L}$ , $I_{INH L}$    | Input Low Current                                                         | $V_{IN} = V_{IN L}$ , $V_{INH} = V_{INH L}$                                                                    |      |      | - 100           | $\mu$ A  |
| $V_{IN H}$ ,<br>$V_{INH H}$ | Input High Voltage                                                        |                                                                                                                | 2.0  |      |                 | V        |
| $I_{IN H}$ , $I_{INH H}$    | Input High Current                                                        | $V_{IN} = V_{IN H}$ , $V_{INH} = V_{INH H}$                                                                    |      |      | $\pm 10$        | $\mu$ A  |
| $I_R$                       | Clamp Diode Leakage Current                                               | $V_R = 50V$ , $V_{INH} = V_{INH H}$                                                                            |      |      | 100             | $\mu$ A  |
| $V_F$                       | Clamp Diode Forward Voltage                                               | $I_F = 1A$<br>$I_F = 1.8A$                                                                                     |      |      | 1.6<br>2.0      | V<br>V   |
| $t_d(on)$                   | Turn on Delay Time                                                        | $V_p = 5V$ , $R_L = 10\Omega$                                                                                  |      |      | 2               | $\mu$ s  |
| $t_d(off)$                  | 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>$I_{out} = - 300mA$ for each Channel                                          |      |      | 120             | mA       |

# TEST CIRCUITS

(X) = Referred to Multiwatt package

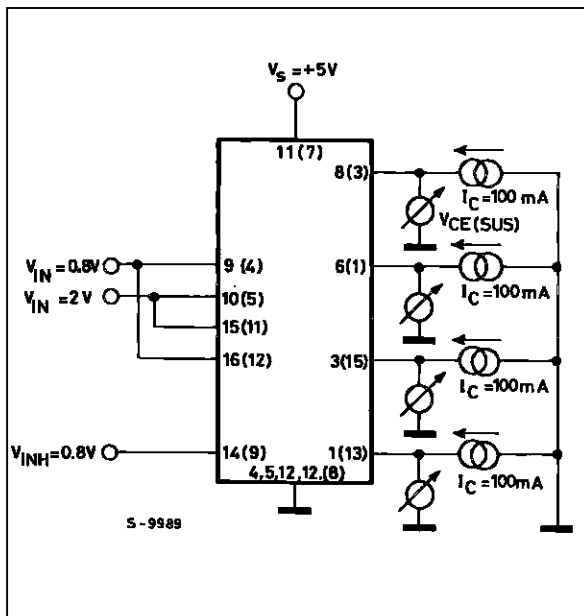
X = Referred to Powerdip package

**Figure 1 : Logic Supply Current.**



Set  $V_1 = 4.5V$ ,  $V_2 = 0.8V$ ,  $V_{INH} = 4.5V$  or  $V_1 = 0.8V$ ,  $V_2 = 4.5V$ ,  $V_{INH} = 0.8$  for  $I_S$  (all outputs off).  
Set  $V_1 = 2V$ ,  $V_2 = 0.8V$ ,  $V_{INH} = 0.8V$  for  $I_S$  (all outputs on).

**Figure 2 : Output Sustaining Voltage.**



**Figure 3 : Output Leakage Current.**

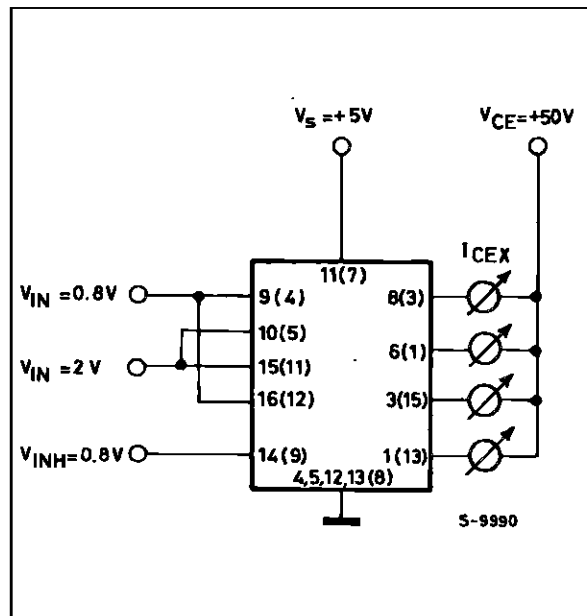


Figure 4 : Collector-emitter Saturation

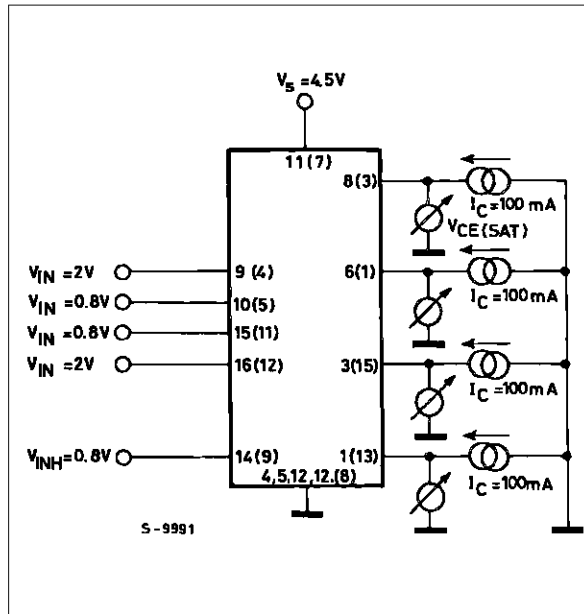
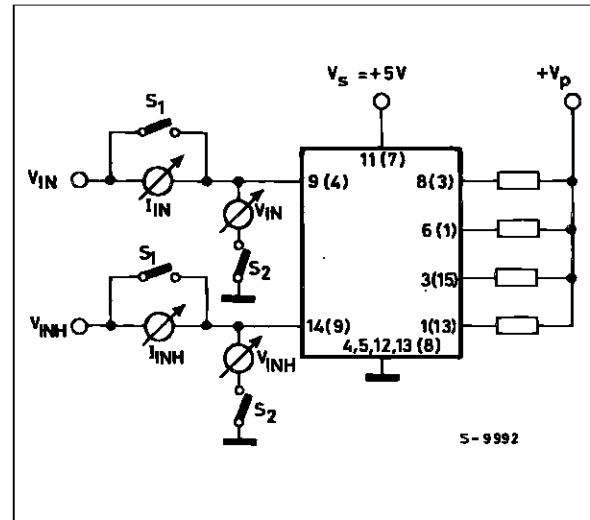


Figure 5 : Logic Input Characteristics.



Set  $S_1, S_2$  open,  $V_{IN}, V_{INH} = 0.8V$  for  $I_{INL}, I_{INH L}$   
 Set  $S_1, S_2$  open,  $V_{IN}, V_{INH} = 2V$  for  $I_{INH H}, I_{INH H}$   
 Set  $S_1, S_2$  close,  $V_{IN}, V_{INH} = 0.8V$  for  $V_{IN L}, V_{INH L}$   
 Set  $S_1, S_2$  close,  $V_{IN}, V_{INH} = 2V$  for  $V_{INH H}, V_{INH H}$ .

Figure 6 : Clamp Diode Leakage Current.

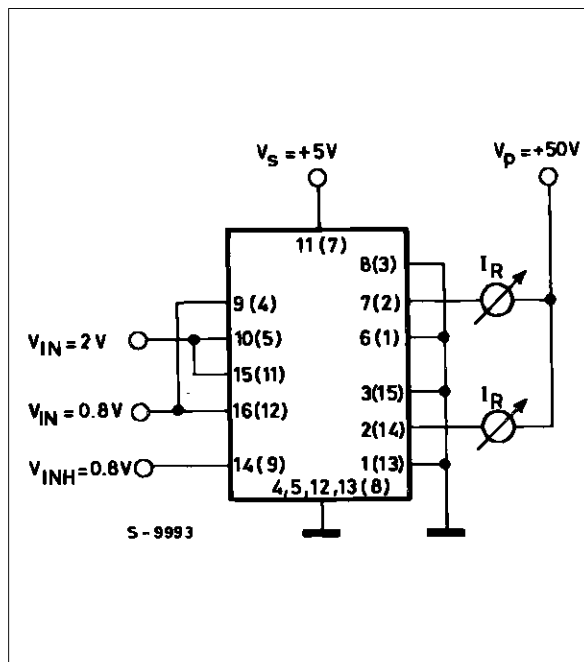


Figure 7 : Clamp Diode Forward Voltage.

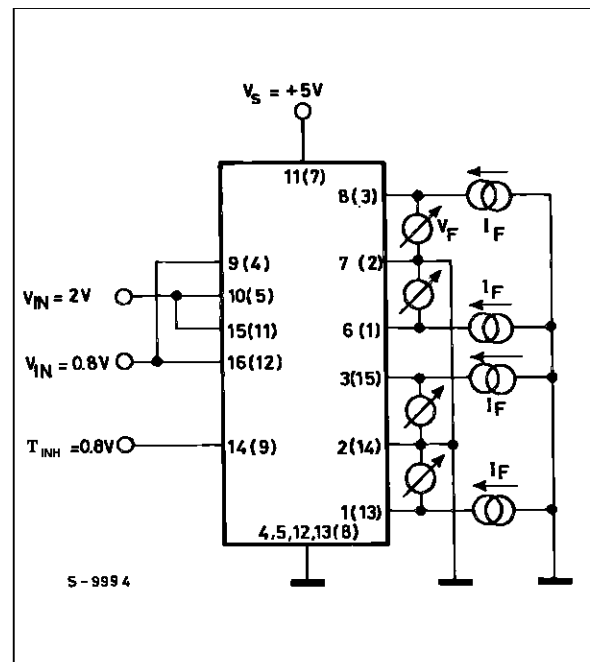


Figure 8 : Switching Times Test Circuit.

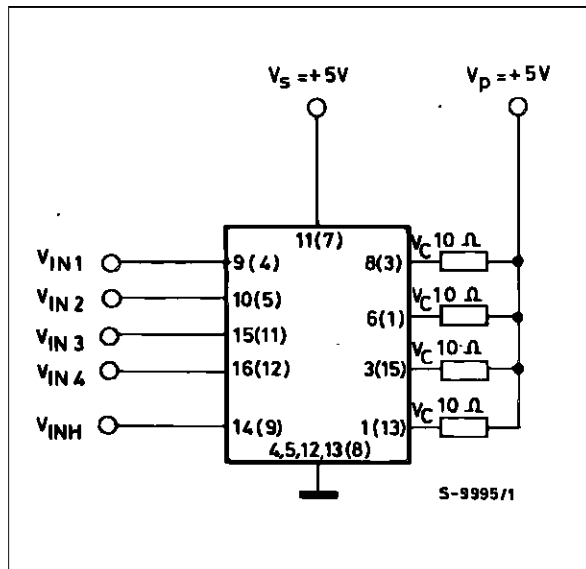


Figure 9 : Switching Times Waveforms.

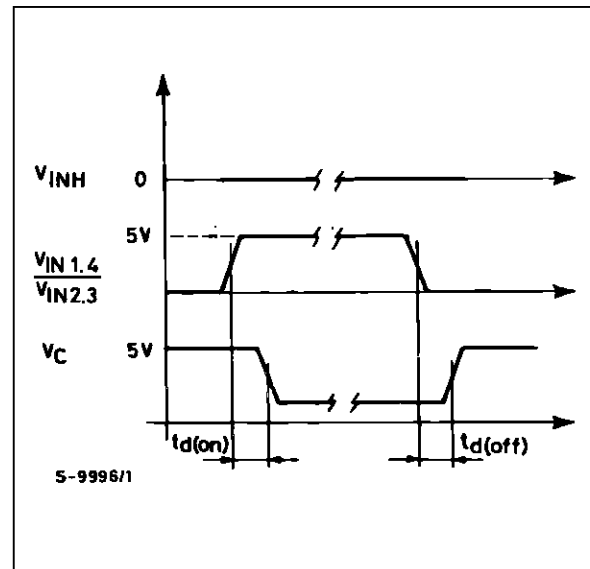


Figure 10 : Collector Saturation Voltage versus Collector Current

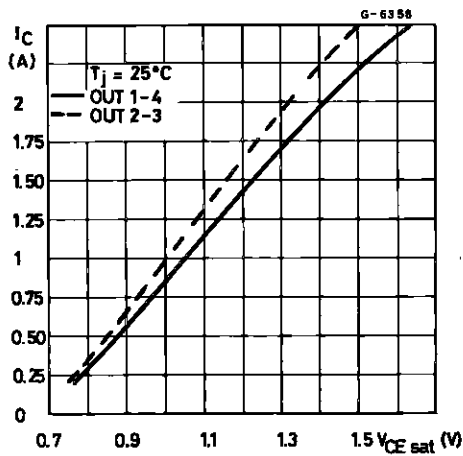
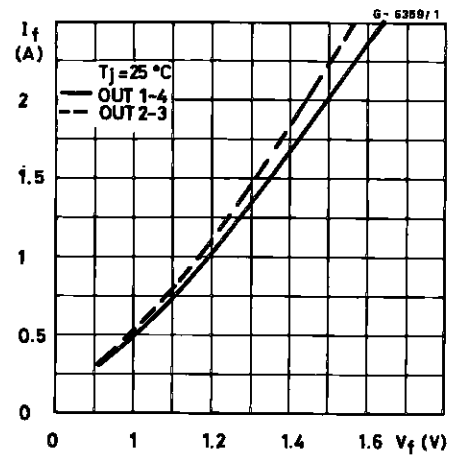
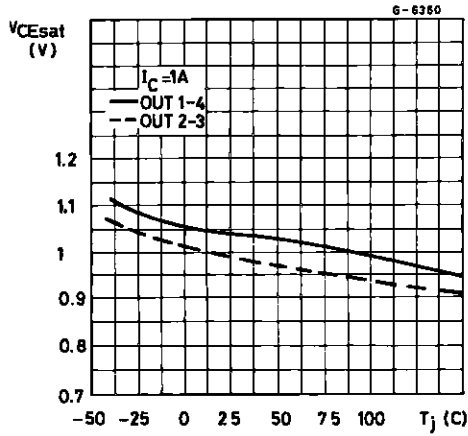


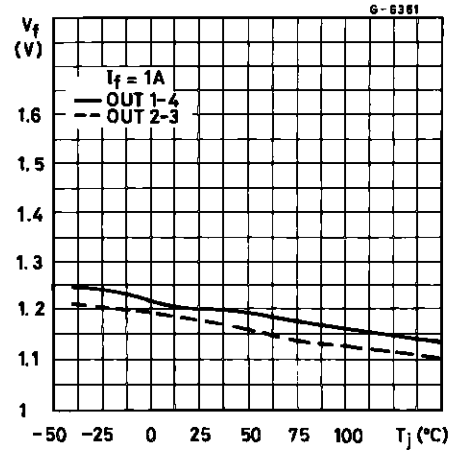
Figure 11 : Free-wheeling Diode Forward Voltage versus Diode Current



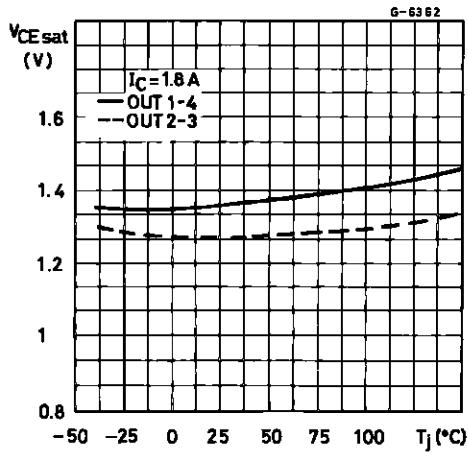
**Figure 12 :** Collector Saturation Voltage versus Junction Temperature at  $I_C = 1A$



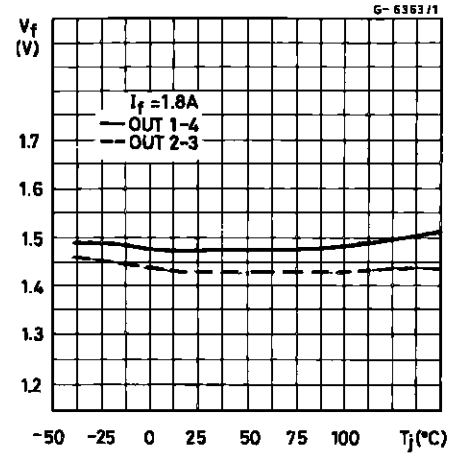
**Figure 13 :** Free-wheeling Diode Forward Voltage versus Junction Temperature at  $I_f = 1A$



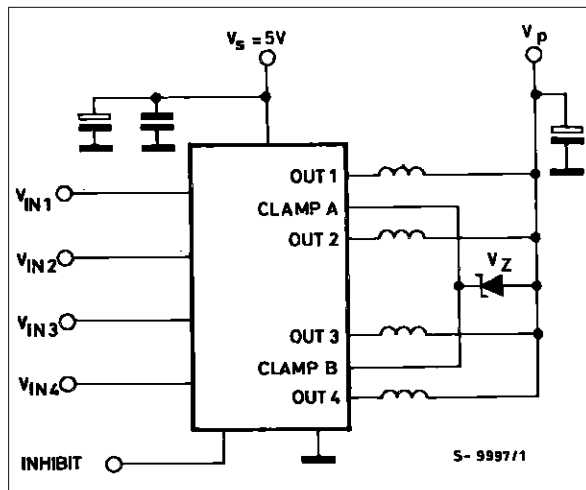
**Figure 14 :** Collector Saturation Voltage versus Junction Temperature at  $I_C = 1.8A$



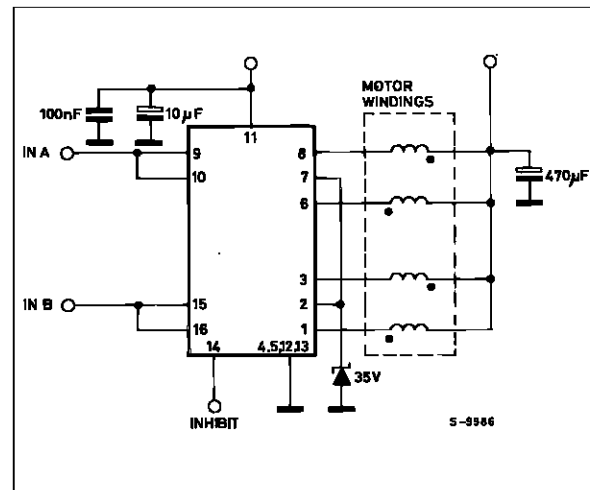
**Figure 15 :** Free-wheeling Diode Forward Voltage versus Junction Temperature at  $I_f = 1.8A$



**Figure 16.**



**Figure 17 : Unipolar Stepper Motor Driver.**



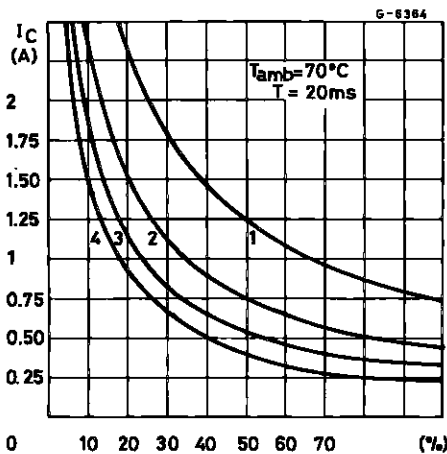
## APPLICATION INFORMATION

When inductive loads are driven by L6220/N, 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. 16). For reliability it is suggested that the zener is chosen so that  $V_p + V_z < 35 \text{ V}$ .

The reasons for this are two fold :

- 1) The zener voltage changes in temperature and current.

**Figure 18 :** Allowed Peak Collector-current versus Duty Cycle for 1, 2, 3 or 4 Contemporary Working Outputs (L6220).

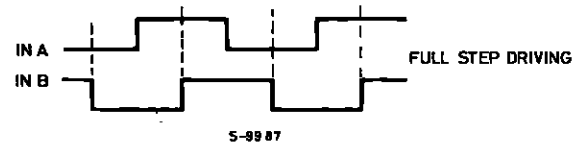


## MOUNTING INSTRUCTION

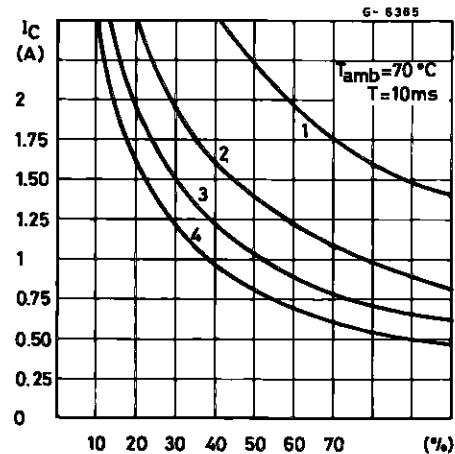
The  $R_{thj-amb}$  of the L6220 can be reduced by soldering the GND pins to a suitable copper area of the printed circuit board (Fig. 20) or to an external heatsink (Fig. 21).

The diagram of figure 22 shows the maximum dissippable power  $P_{tot}$  and the  $R_{thj-amb}$  as a function of the side "α" of two equal square copper areas hav-

- 2) The instantaneous power must be limited to avoid the reverse second breakdown. The particular internal logic allows an easier full step driving using only two input signals.



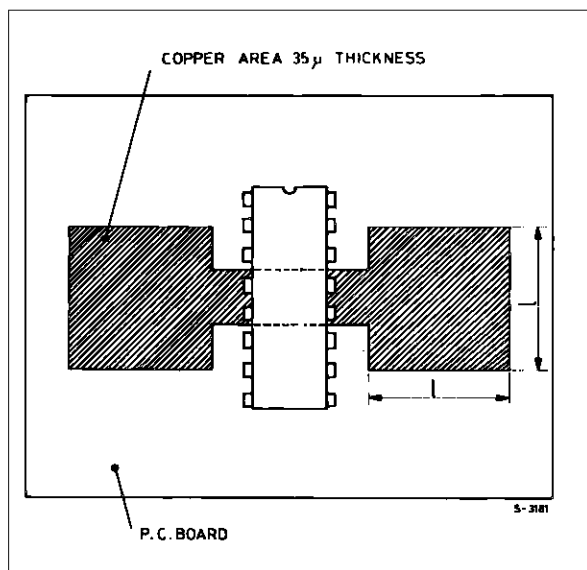
**Figure 19 :** Allowed Peak Collector Cur-rent versus Duty Cycle for 1, 2, 3 or 4 Contemporary Working Outputs (L6220N).



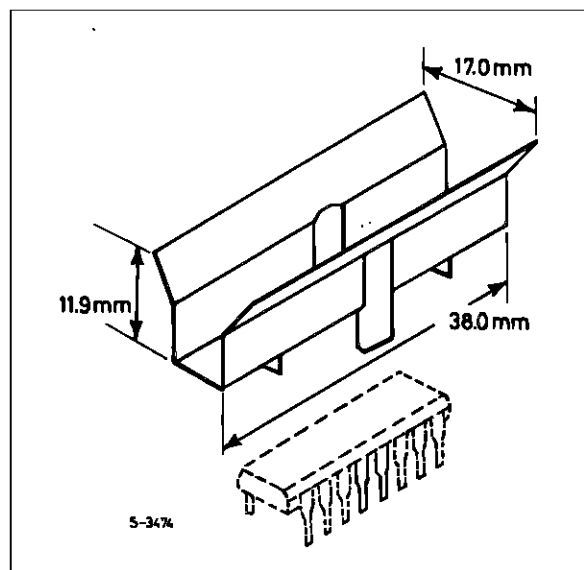
ing a thickness of  $35\mu$  (1.4 mils). During soldering the pins temperature must not exceed  $260^\circ\text{C}$  and the soldering time must not be longer than 12 seconds.

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

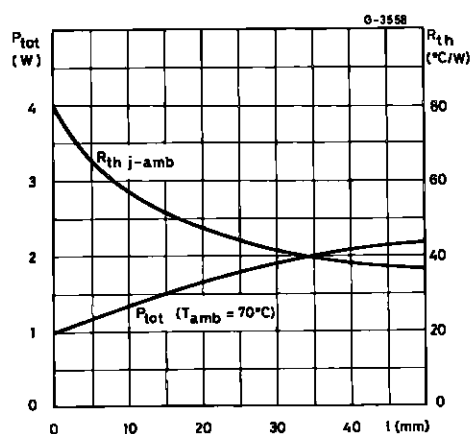
**Figure 20 :** Example of P.C. Board Copperarea which is used as Heatsink



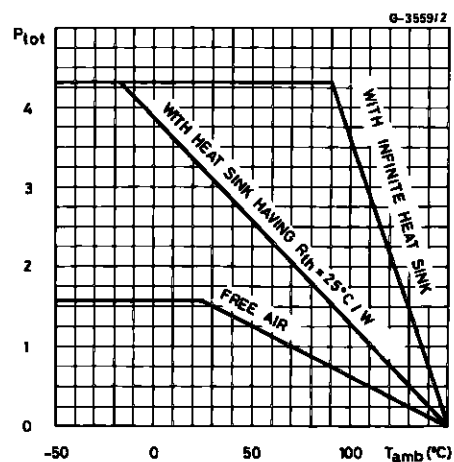
**Figure 21 :** External Heatsink Mounting Example



**Figure 22 :** Maximum Dissippable Power and Junction to Ambient Thermal Resistance versus Side "α"



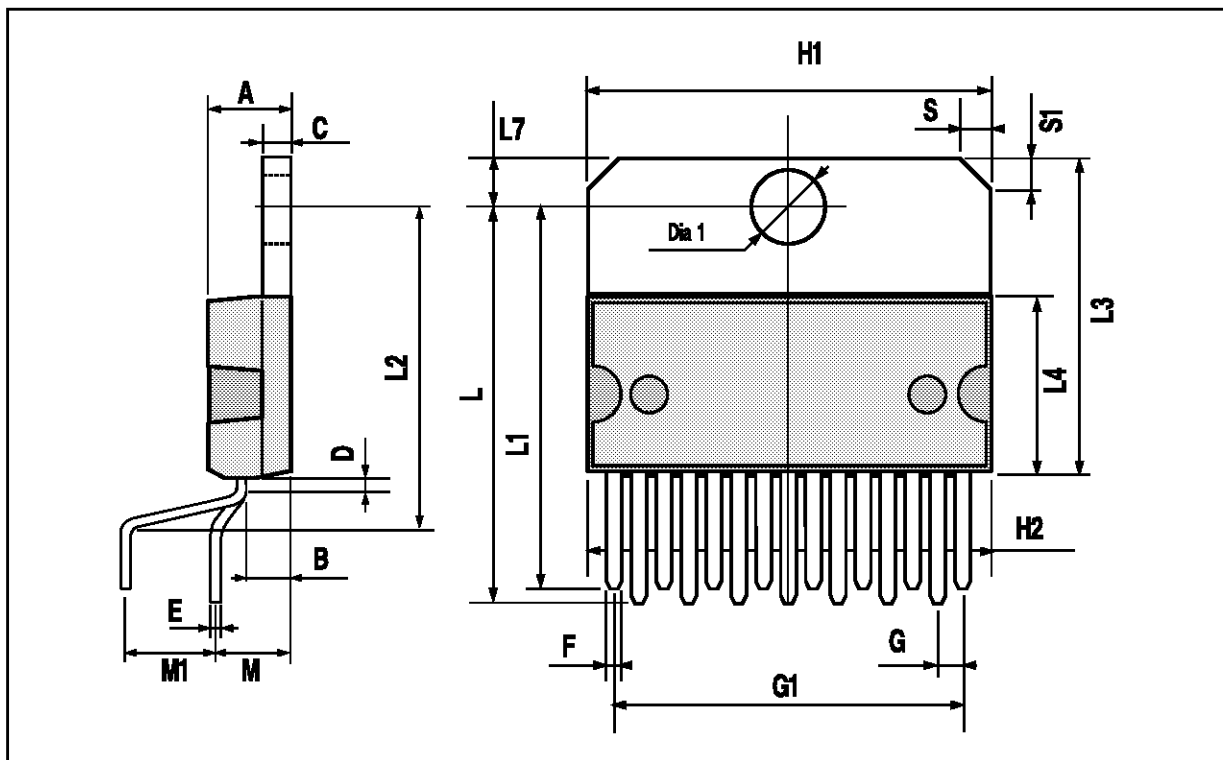
**Figure 23 :** Maximum Allowable Power Dissipation versus Ambient Temperature



## L6220 - L6220N

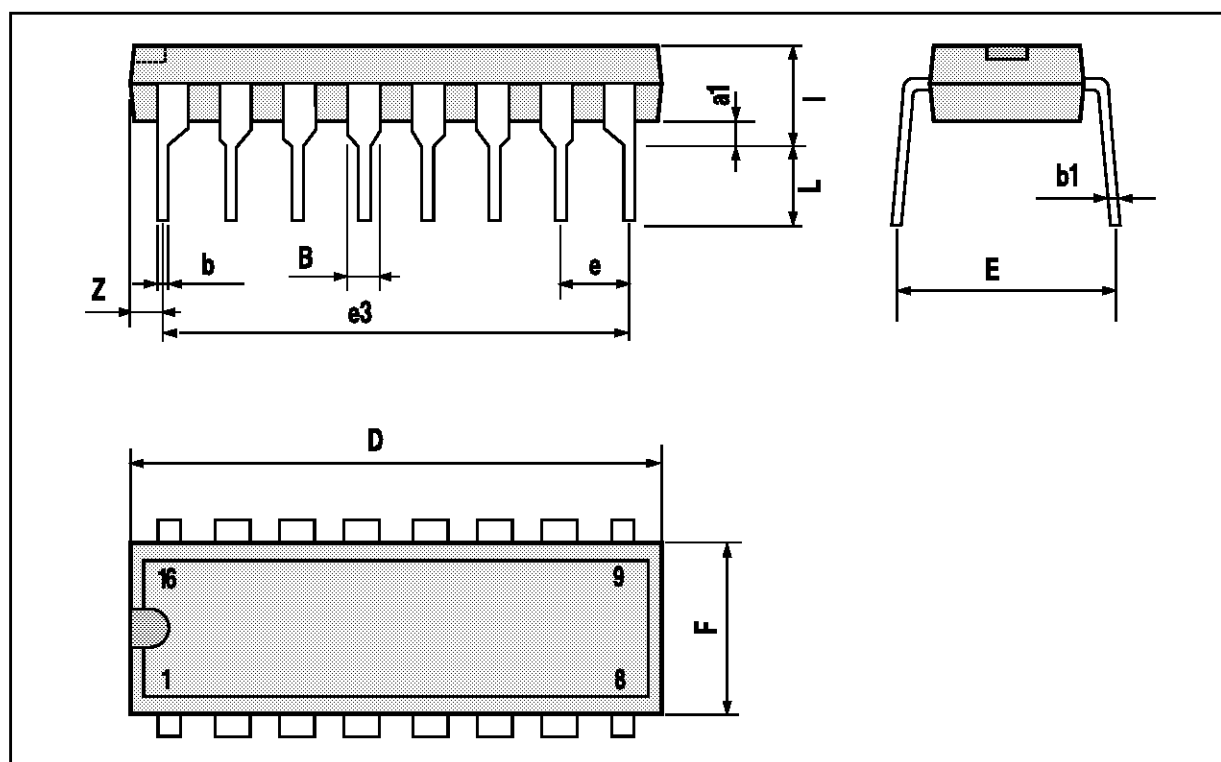
### MULTIWATT15 PACKAGE MECHANICAL DATA

| 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    | 1.14  | 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    | 22.1  |       | 22.6  | 0.870 |       | 0.890 |
| L1   | 22    |       | 22.5  | 0.866 |       | 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    | 4.2   | 4.3   | 4.6   | 0.165 | 0.169 | 0.181 |
| M1   | 4.5   | 5.08  | 5.3   | 0.177 | 0.200 | 0.209 |
| 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 |



## POWERDIP16 PACKAGE MECHANICAL DATA

| 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 |



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