



# IRF640 IRF640FP

N-channel 200V - 0.15Ω - 18A TO-220/TO-220FP  
Mesh overlay™ Power MOSFET

## General features

| Type     | V <sub>DSS</sub> | R <sub>DS(on)</sub> | I <sub>D</sub> |
|----------|------------------|---------------------|----------------|
| IRF640   | 200V             | <0.18Ω              | 18A            |
| IRF640FP | 200V             | <0.18Ω              | 18A            |

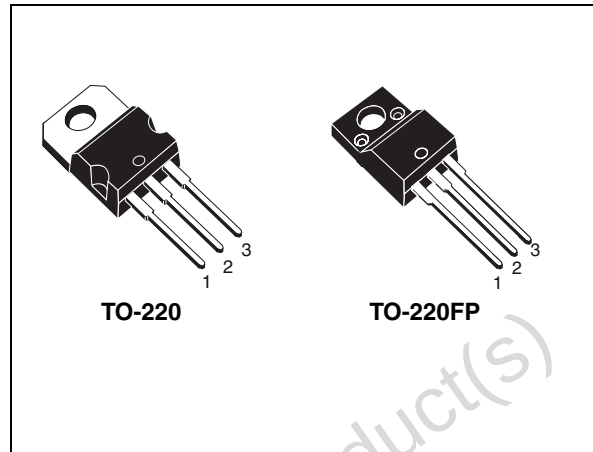
- Extremely high dv/dt capability
- Very low intrinsic capacitances
- Gate charge minimized

## Description

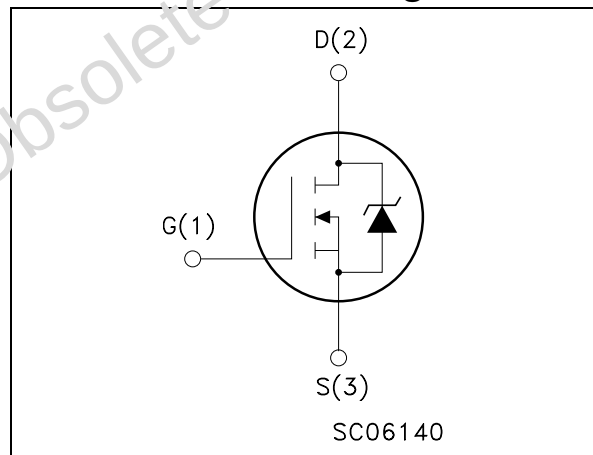
This power MOSFET is designed using the company's consolidated strip layout-based MESH OVERLAY™ process. This technology matches and improves the performances compared with standard parts from various sources.

## Applications

- Switching application



## Internal schematic diagram



## Order codes

| Part number | Marking  | Package  | Packaging |
|-------------|----------|----------|-----------|
| IRF640      | IRF640   | TO-220   | Tube      |
| IRF640FP    | IRF640FP | TO-220FP | Tube      |

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Obsolete Product(s) - Obsolete Product(s)

# 1 Electrical ratings

**Table 1. Absolute maximum ratings**

| Symbol             | Parameter                                                                                                                  | Value             |                   | Unit                |
|--------------------|----------------------------------------------------------------------------------------------------------------------------|-------------------|-------------------|---------------------|
|                    |                                                                                                                            | TO-220            | TO-220FP          |                     |
| $V_{DS}$           | Drain-source voltage ( $V_{GS} = 0$ )                                                                                      | 200               |                   | V                   |
| $V_{GS}$           | Gate-source voltage                                                                                                        | $\pm 20$          |                   | V                   |
| $I_D$              | Drain current (continuous) at $T_C = 25^\circ\text{C}$                                                                     | 18                | 18 <sup>(1)</sup> | A                   |
| $I_D$              | Drain current (continuous) at $T_C = 100^\circ\text{C}$                                                                    | 11                | 11 <sup>(1)</sup> | A                   |
| $I_{DM}^{(2)}$     | Drain current (pulsed)                                                                                                     | 72                | 72 <sup>(1)</sup> | A                   |
| $P_{TOT}$          | Total dissipation at $T_C = 25^\circ\text{C}$                                                                              | 125               | 40                | W                   |
|                    | Derating factor                                                                                                            | 1.0               | 0.32              | W/ $^\circ\text{C}$ |
| $dv/dt^{(3)}$      | Peak diode recovery voltage slope                                                                                          | 5                 | 5                 | V/ns                |
| $V_{ISO}$          | Insulation withstand voltage (RMS) from all three leads to external heat sink ( $t=1\text{s}$ ; $T_C = 25^\circ\text{C}$ ) | --                | 2500              | V                   |
| $T_J$<br>$T_{stg}$ | Operating junction temperature<br>Storage temperature                                                                      | 150<br>-65 to 150 |                   | $^\circ\text{C}$    |

1. Limited only by maximum temperature allowed

2. Pulse width limited by safe operating area

3.  $I_{SD} \leq 1.8\text{A}$ ,  $di/dt \leq 300\text{A}/\mu\text{s}$ ,  $V_{DD} \leq V_{(BR)DSS}$ ,  $T_J \leq T_{JMAX}$

**Table 2. Thermal data**

| Symbol         | Parameter                                      | Value  |          | Unit                      |
|----------------|------------------------------------------------|--------|----------|---------------------------|
|                |                                                | TO-220 | TO-220FP |                           |
| $R_{thj-case}$ | Thermal resistance junction-case Max           | 1.0    | 3.12     | $^\circ\text{C}/\text{W}$ |
| $R_{thj-a}$    | Thermal resistance junction-ambient Max        | 62.5   |          | $^\circ\text{C}/\text{W}$ |
| $R_{thc-sink}$ | Thermal resistance case-sink typ               | 0.5    |          | $^\circ\text{C}/\text{W}$ |
| $T_l$          | Maximum lead temperature for soldering purpose | 300    |          | $^\circ\text{C}$          |

**Table 3. Avalanche characteristics**

| Symbol   | Parameter                                                                                                   | Value | Unit |
|----------|-------------------------------------------------------------------------------------------------------------|-------|------|
| $I_{AS}$ | Avalanche current, repetitive or not-repetitive (pulse width limited by $T_J$ Max)                          | 18    | A    |
| $E_{AS}$ | Single pulse avalanche energy (starting $T_J = 25^\circ\text{C}$ , $I_D = I_{AR}$ , $V_{DD} = 50\text{V}$ ) | 280   | mJ   |

## 2 Electrical characteristics

( $T_{CASE}=25^{\circ}\text{C}$  unless otherwise specified)

**Table 4. On/off states**

| Symbol        | Parameter                                        | Test conditions                                                                       | Min. | Typ. | Max.      | Unit                           |
|---------------|--------------------------------------------------|---------------------------------------------------------------------------------------|------|------|-----------|--------------------------------|
| $V_{(BR)DSS}$ | Drain-source breakdown voltage                   | $I_D = 250\text{ }\mu\text{A}$ , $V_{GS} = 0$                                         | 200  |      |           | V                              |
| $I_{DSS}$     | Zero gate voltage drain current ( $V_{GS} = 0$ ) | $V_{DS} = \text{Max rating}$ ,<br>$V_{DS} = \text{Max rating @ } 125^{\circ}\text{C}$ |      |      | 1<br>10   | $\mu\text{A}$<br>$\mu\text{A}$ |
| $I_{GSS}$     | Gate body leakage current ( $V_{DS} = 0$ )       | $V_{GS} = \pm 20\text{V}$                                                             |      |      | $\pm 100$ | nA                             |
| $V_{GS(th)}$  | Gate threshold voltage                           | $V_{DS} = V_{GS}$ , $I_D = 250\mu\text{A}$                                            | 2    | 3    | 4         | V                              |
| $R_{DS(on)}$  | Static drain-source on resistance                | $V_{GS} = 10\text{V}$ , $I_D = 9\text{A}$                                             |      | 0.15 | 0.18      | $\Omega$                       |

**Table 5. Dynamic**

| Symbol                              | Parameter                                                               | Test conditions                                                      | Min. | Typ.              | Max.              | Unit           |
|-------------------------------------|-------------------------------------------------------------------------|----------------------------------------------------------------------|------|-------------------|-------------------|----------------|
| $g_{fs}^{(1)}$                      | Forward transconductance                                                | $V_{DS} > I_{D(on)} \times R_{DS(on)max}$ ,<br>$I_D = 9\text{A}$     | 7    | 11                |                   | S              |
| $C_{iss}$<br>$C_{oss}$<br>$C_{rss}$ | Input capacitance<br>Output capacitance<br>Reverse transfer capacitance | $V_{DS} = 25\text{V}$ , $f = 1\text{ MHz}$ , $V_{GS} = 0$            |      | 1200<br>200<br>60 | 1560<br>260<br>80 | pF<br>pF<br>pF |
| $Q_g$<br>$Q_{gs}$<br>$Q_{gd}$       | Total gate charge<br>Gate-source charge<br>Gate-drain charge            | $V_{DD} = 160\text{V}$ , $I_D = 18\text{A}$<br>$V_{GS} = 10\text{V}$ |      | 55<br>10<br>21    | 72                | nC<br>nC<br>nC |

1. Pulsed: pulse duration=300 $\mu\text{s}$ , duty cycle 1.5%

**Table 6. Switching times**

| Symbol                          | Parameter                                             | Test conditions                                                                                               | Min. | Typ.           | Max.           | Unit           |
|---------------------------------|-------------------------------------------------------|---------------------------------------------------------------------------------------------------------------|------|----------------|----------------|----------------|
| $t_{d(on)}$<br>$t_r$            | Turn-on Delay Time<br>Rise Time                       | $V_{DD} = 100\text{V}$ , $I_D = 9\text{A}$ ,<br>$R_G = 4.7\Omega$ , $V_{GS} = 10\text{V}$<br>(see Figure 14)  |      | 13<br>27       | 17<br>35       | ns<br>ns       |
| $t_{r(Voff)}$<br>$t_f$<br>$t_c$ | Off-voltage rise time<br>fall time<br>cross-over time | $V_{DD} = 160\text{V}$ , $I_D = 18\text{A}$ ,<br>$R_G = 4.7\Omega$ , $V_{GS} = 10\text{V}$<br>(see Figure 16) |      | 21<br>25<br>50 | 27<br>32<br>65 | ns<br>ns<br>ns |

**Table 7. Source drain diode**

| Symbol                            | Parameter                                                                    | Test conditions                                                                                  | Min | Typ.             | Max | Unit               |
|-----------------------------------|------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------|-----|------------------|-----|--------------------|
| $I_{SD}$                          | Source-drain current                                                         |                                                                                                  |     |                  | 18  | A                  |
| $I_{SDM}^{(1)}$                   | Source-drain current (pulsed)                                                |                                                                                                  |     |                  | 72  | A                  |
| $V_{SD}^{(2)}$                    | Forward on voltage                                                           | $I_{SD}=18A$ , $V_{GS}=0$                                                                        |     |                  | 1.5 | V                  |
| $t_{rr}$<br>$Q_{rr}$<br>$I_{RRM}$ | Reverse recovery time<br>Reverse recovery charge<br>Reverse recovery current | $I_{SD}=18A$ ,<br>$di/dt = 100A/\mu s$ ,<br>$V_{DD}=50V$ , $T_J=150^{\circ}C$<br>(see Figure 16) |     | 240<br>1.8<br>15 |     | ns<br>$\mu C$<br>A |

1. Pulse width limited by safe operating area

2. Pulsed: pulse duration=300 $\mu s$ , duty cycle 1.5%

## 2.1 Electrical characteristics (curves)

Figure 1. Safe operating area for TO-220

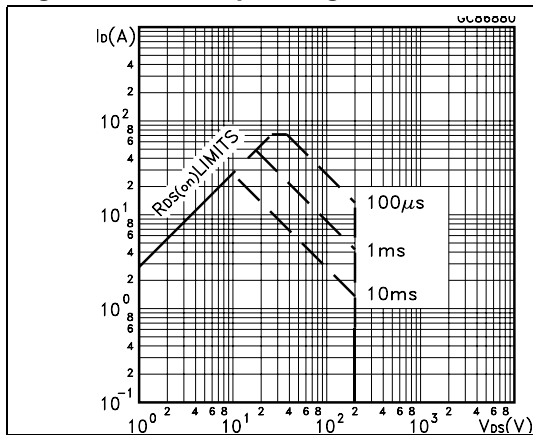


Figure 2. Thermal impedance for TO-220

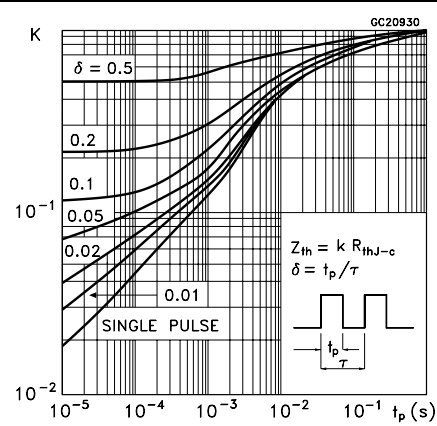


Figure 3. Safe operating area for TO-220/FP

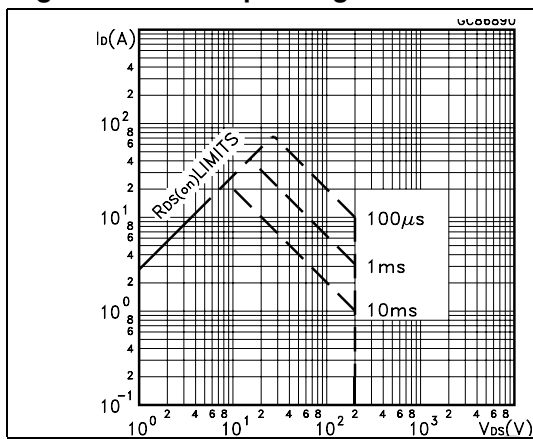


Figure 4. Thermal impedance for TO-220/FP

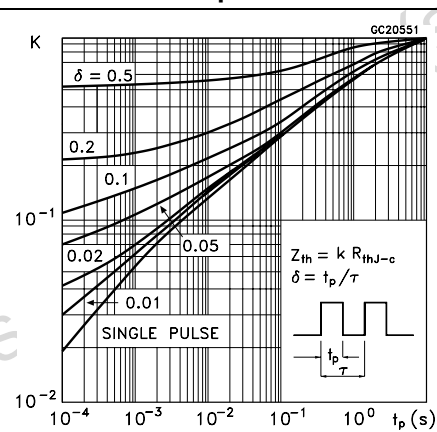


Figure 5. Output characteristics

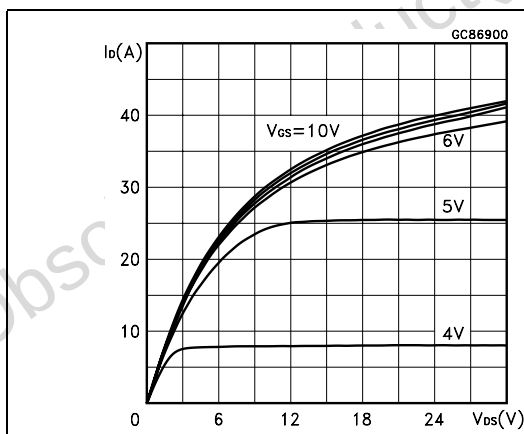


Figure 6. Transfer characteristics

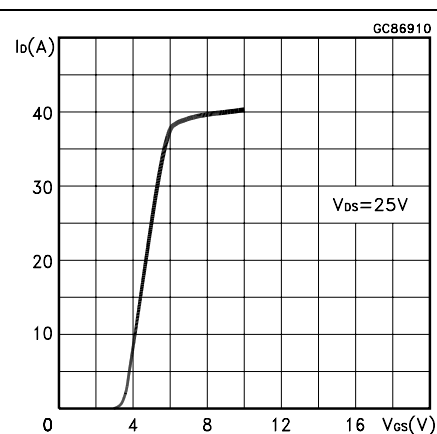


Figure 7. Transconductance

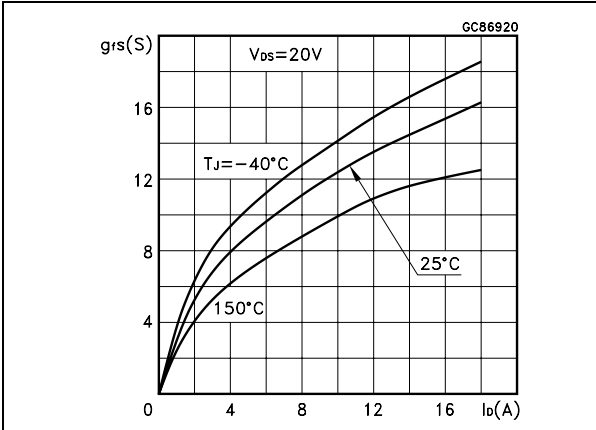


Figure 8. Static drain-source on resistance

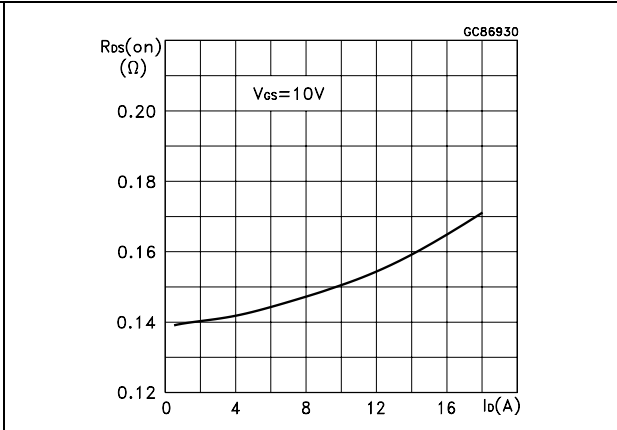


Figure 9. Gate charge vs gate-source voltage

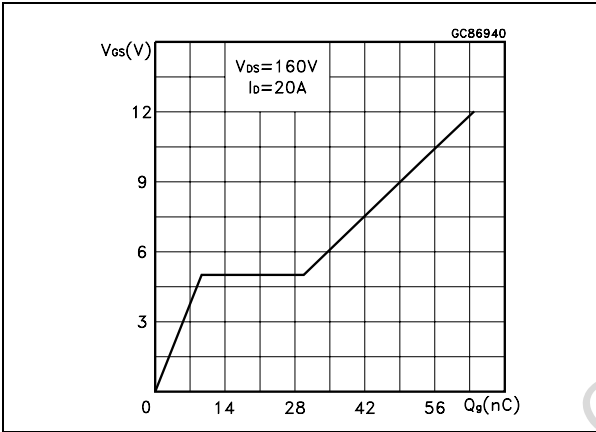


Figure 10. Capacitance variations

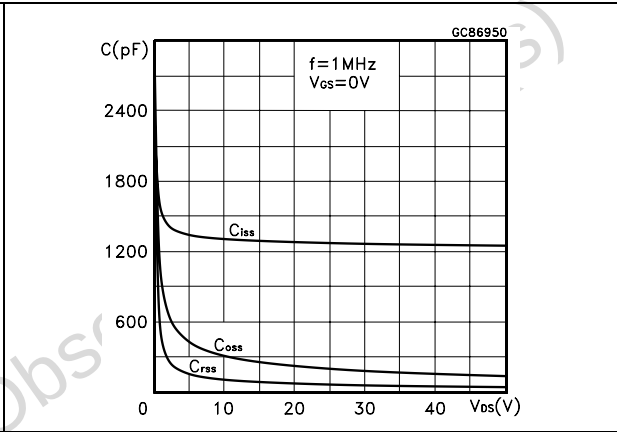


Figure 11. Normalized gate threshold voltage vs temperature

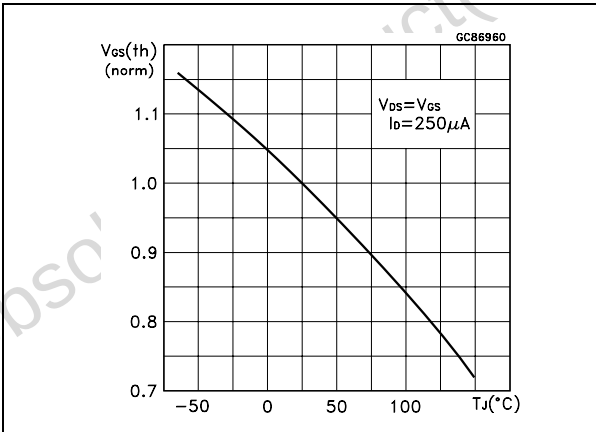
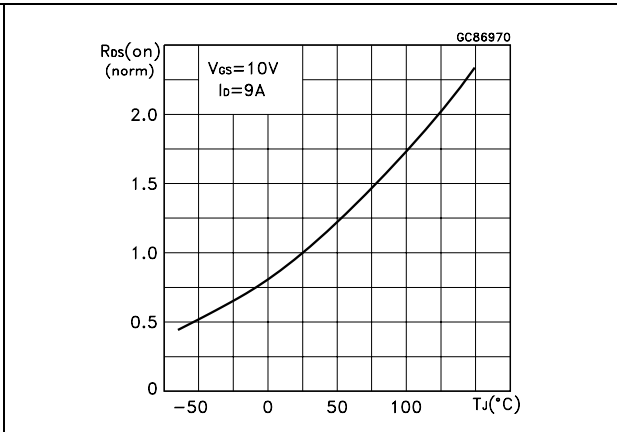
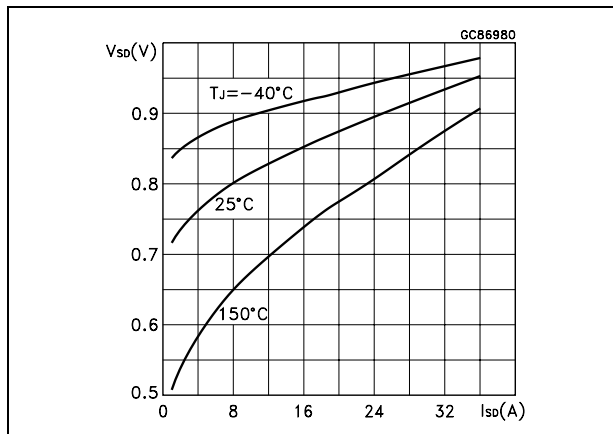


Figure 12. Normalized on resistance vs temperature



**Figure 13. Source-drain diode forward characteristics**

### 3 Test circuit

Figure 14. Switching times test circuit for resistive load

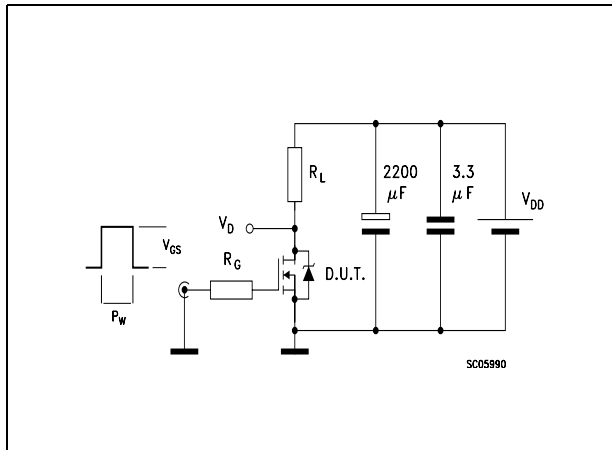


Figure 15. Gate charge test circuit

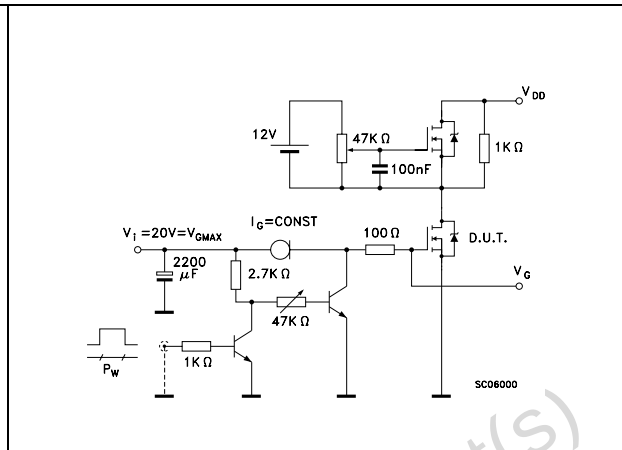


Figure 16. Test circuit for inductive load switching and diode recovery times

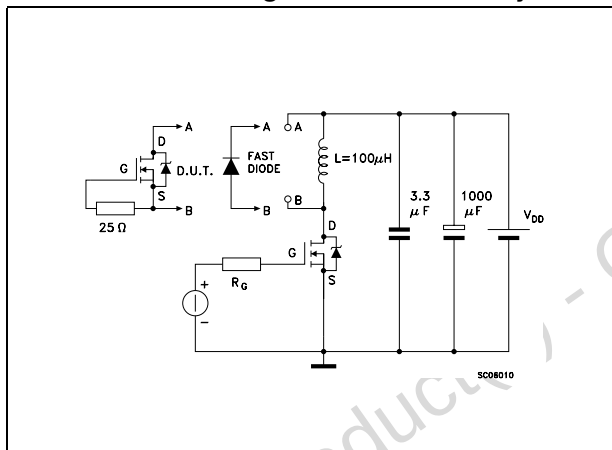


Figure 17. Unclamped Inductive load test circuit

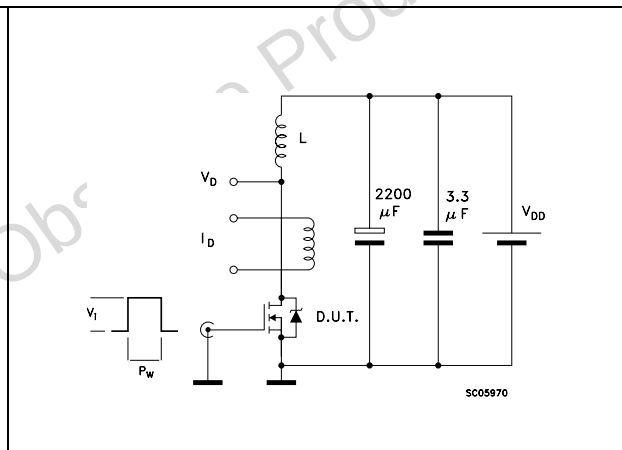


Figure 18. Unclamped inductive waveform

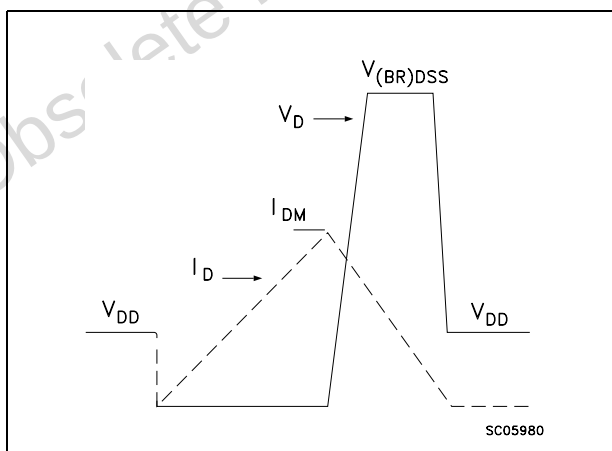
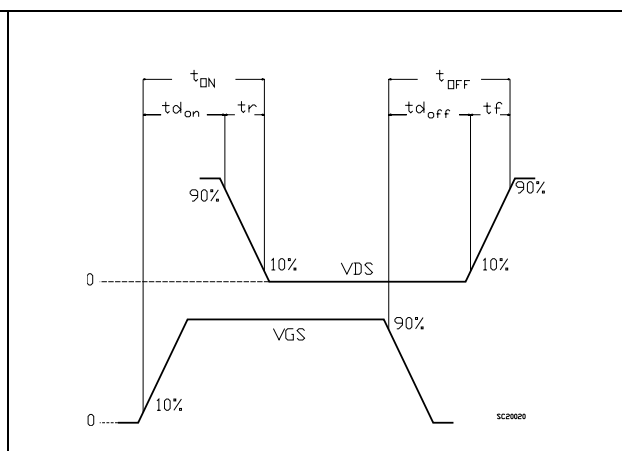


Figure 19. Switching time waveform

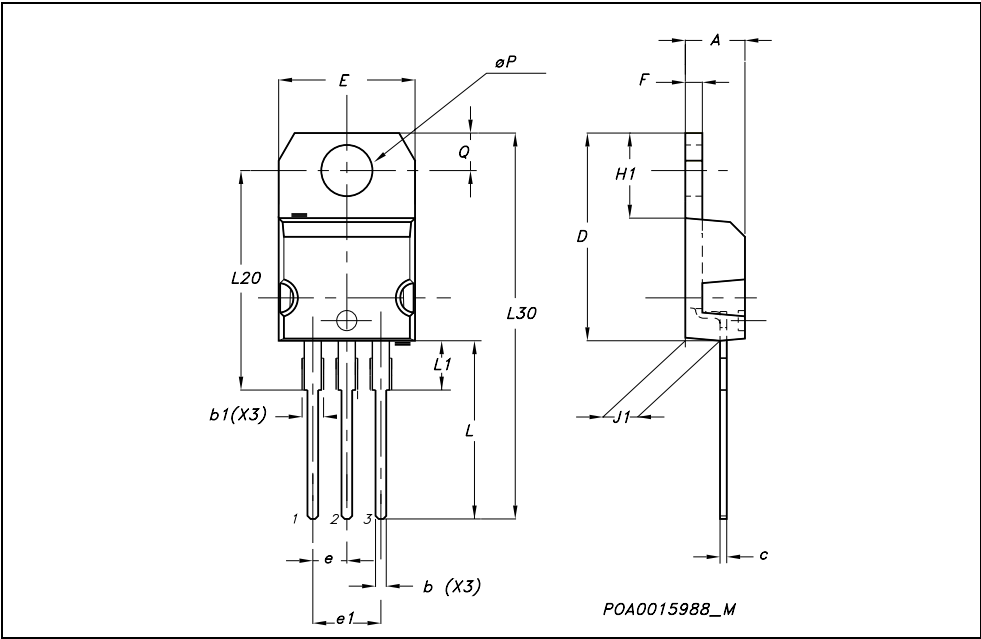


## 4 Package mechanical data

In order to meet environmental requirements, ST offers these devices in ECOPACK® packages. These packages have a Lead-free second level interconnect . The category of second level interconnect is marked on the package and on the inner box label, in compliance with JEDEC Standard JESD97. The maximum ratings related to soldering conditions are also marked on the inner box label. ECOPACK is an ST trademark. ECOPACK specifications are available at: [www.st.com](http://www.st.com)

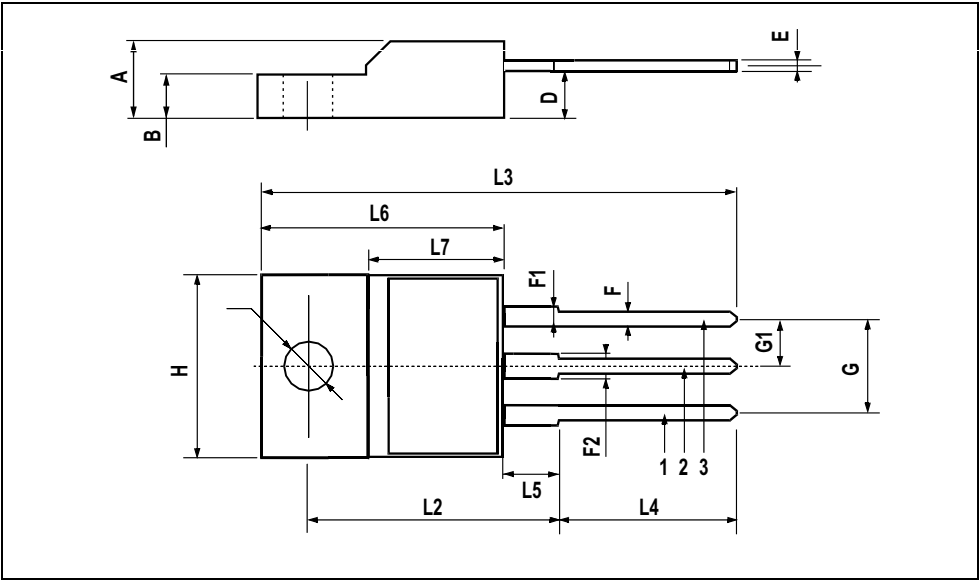
Obsolete Product(s) - Obsolete Product(s)

| TO-220 MECHANICAL DATA |       |       |       |       |       |       |
|------------------------|-------|-------|-------|-------|-------|-------|
| DIM.                   | mm.   |       |       | inch  |       |       |
|                        | MIN.  | TYP.  | MAX.  | MIN.  | TYP.  | MAX.  |
| A                      | 4.40  |       | 4.60  | 0.173 |       | 0.181 |
| b                      | 0.61  |       | 0.88  | 0.024 |       | 0.034 |
| b1                     | 1.15  |       | 1.70  | 0.045 |       | 0.066 |
| c                      | 0.49  |       | 0.70  | 0.019 |       | 0.027 |
| D                      | 15.25 |       | 15.75 | 0.60  |       | 0.620 |
| E                      | 10    |       | 10.40 | 0.393 |       | 0.409 |
| e                      | 2.40  |       | 2.70  | 0.094 |       | 0.106 |
| e1                     | 4.95  |       | 5.15  | 0.194 |       | 0.202 |
| F                      | 1.23  |       | 1.32  | 0.048 |       | 0.052 |
| H1                     | 6.20  |       | 6.60  | 0.244 |       | 0.256 |
| J1                     | 2.40  |       | 2.72  | 0.094 |       | 0.107 |
| L                      | 13    |       | 14    | 0.511 |       | 0.551 |
| L1                     | 3.50  |       | 3.93  | 0.137 |       | 0.154 |
| L20                    |       | 16.40 |       |       | 0.645 |       |
| L30                    |       | 28.90 |       |       | 1.137 |       |
| øP                     | 3.75  |       | 3.85  | 0.147 |       | 0.151 |
| Q                      | 2.65  |       | 2.95  | 0.104 |       | 0.116 |



TO-220FP MECHANICAL DATA

| DIM. | mm.  |      |      | inch  |       |       |
|------|------|------|------|-------|-------|-------|
|      | MIN. | TYP. | MAX. | MIN.  | TYP.  | MAX.  |
| A    | 4.4  |      | 4.6  | 0.173 |       | 0.181 |
| B    | 2.5  |      | 2.7  | 0.098 |       | 0.106 |
| D    | 2.5  |      | 2.75 | 0.098 |       | 0.108 |
| E    | 0.45 |      | 0.7  | 0.017 |       | 0.027 |
| F    | 0.75 |      | 1    | 0.030 |       | 0.039 |
| F1   | 1.15 |      | 1.7  | 0.045 |       | 0.067 |
| F2   | 1.15 |      | 1.7  | 0.045 |       | 0.067 |
| G    | 4.95 |      | 5.2  | 0.195 |       | 0.204 |
| G1   | 2.4  |      | 2.7  | 0.094 |       | 0.106 |
| H    | 10   |      | 10.4 | 0.393 |       | 0.409 |
| L2   |      | 16   |      |       | 0.630 |       |
| L3   | 28.6 |      | 30.6 | 1.126 |       | 1.204 |
| L4   | 9.8  |      | 10.6 | .0385 |       | 0.417 |
| L5   | 2.9  |      | 3.6  | 0.114 |       | 0.141 |
| L6   | 15.9 |      | 16.4 | 0.626 |       | 0.645 |
| L7   | 9    |      | 9.3  | 0.354 |       | 0.366 |
| Ø    | 3    |      | 3.2  | 0.118 |       | 0.126 |



## 5 Revision history

**Table 8.** revision history

| Date        | Revision | Changes                         |
|-------------|----------|---------------------------------|
| 09-Sep-2004 | 8        | Final version                   |
| 04-Sep-2006 | 9        | New template, no content change |

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