



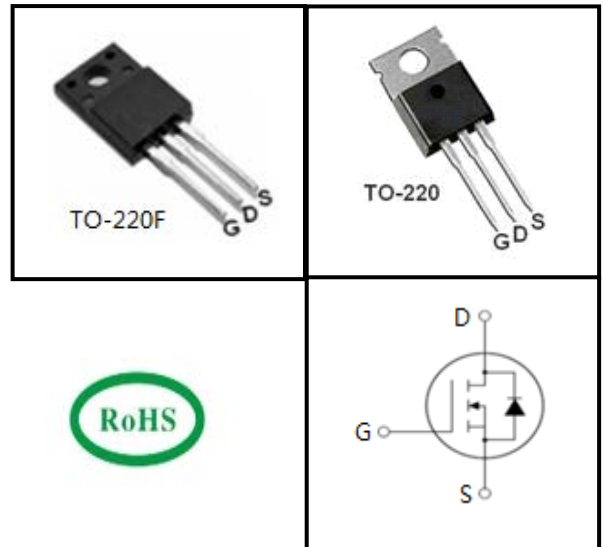
# 650V N-Channel MOSFET

## FEATURES

- Fast switching
- 100% avalanche tested
- Improved dv/dt capability

## APPLICATIONS

- Switch Mode Power Supply (SMPS)
- Uninterruptible Power Supply (UPS)
- Power Factor Correction (PFC)



| Device Marking and Package Information |         |         |
|--|---------|---------|
| Device                                 | Package | Marking |
| TMA20N65H                              | TO-220F | A20N65H |
| TMP20N65H                              | TO-220  | P20N65H |

| Absolute Maximum Ratings $T_C = 25^\circ\text{C}$ , unless otherwise noted |                |          |        |                  |
|--|----------------|----------|--------|------------------|
| Parameter  | Symbol         | Value    |        | Unit             |
|  |                | TO-220F  | TO-220 |                  |
| Drain-Source Voltage ( $V_{GS} = 0\text{V}$ )                              | $V_{DSS}$      | 650      |        | V                |
| Continuous Drain Current   | $I_D$          | 20       |        | A                |
| Pulsed Drain Current (note1)   | $I_{DM}$       | 80       |        | A                |
| Gate-Source Voltage  | $V_{GSS}$      | $\pm 30$ |        | V                |
| Single Pulse Avalanche Energy (note2)                                      | $E_{AS}$       | 1350     |        | mJ               |
| Avalanche Current (note1)  | $I_{AR}$       | 16       |        | A                |
| Repetitive Avalanche Energy (note1)  | $E_{AR}$       | 90       |        | mJ               |
| Power Dissipation ( $T_C = 25^\circ\text{C}$ )                             | $P_D$          | 120      | 416    | W                |
| Operating Junction and Storage Temperature Range                           | $T_J, T_{stg}$ | -55~+150 |        | $^\circ\text{C}$ |

| Thermal Resistance                      |            |         |        |                           |
|---|------------|---------|--------|---------------------------|
| Parameter                               | Symbol     | Value   |        | Unit                      |
|   |            | TO-220F | TO-220 |                           |
| Thermal Resistance, Junction-to-Case    | $R_{thJC}$ | 1.04    | 0.3    | $^\circ\text{C}/\text{W}$ |
| Thermal Resistance, Junction-to-Ambient | $R_{thJA}$ | 62.5    | 60     |                           |



| Specifications $T_J = 25^\circ\text{C}$ , unless otherwise noted |               |  |       |      |           |          |
|--|---------------|--|-------|------|-----------|----------|
| Parameter  | Symbol        | Test Conditions  | Value |      |           | Unit     |
|  |               |  | Min.  | Typ. | Max.      |          |
| <b>Static</b>  |               |  |       |      |           |          |
| Drain-Source Breakdown Voltage                                   | $V_{(BR)DSS}$ | $V_{GS} = 0V, I_D = 250\mu A$                            | 650   | --   | --        | V        |
| Zero Gate Voltage Drain Current                                  | $I_{DSS}$     | $V_{DS} = 650V, V_{GS} = 0V, T_J = 25^\circ\text{C}$     | --    | --   | 1         | $\mu A$  |
| Gate-Source Leakage  | $I_{GSS}$     | $V_{GS} = \pm 30V$                                       | --    | --   | $\pm 100$ | nA       |
| Gate-Source Threshold Voltage                                    | $V_{GS(th)}$  | $V_{DS} = V_{GS}, I_D = 250\mu A$                        | 3.0   | --   | 4.0       | V        |
| Drain-Source On-Resistance (Note3)                               | $R_{DS(on)}$  | $V_{GS} = 10V, I_D = 10A$                                | --    | 0.35 | 0.45      | $\Omega$ |
| <b>Dynamic</b>   |               |  |       |      |           |          |
| Input Capacitance  | $C_{iss}$     | $V_{GS} = 0V,$<br>$V_{DS} = 25V,$<br>$f = 1.0\text{MHz}$ | --    | 2978 | --        | pF       |
| Output Capacitance   | $C_{oss}$     |  | --    | 291  | --        |          |
| Reverse Transfer Capacitance                                     | $C_{rss}$     |  | --    | 40   | --        |          |
| Total Gate Charge  | $Q_g$         | $V_{DD} = 520V, I_D = 20A,$<br>$V_{GS} = 10V$            | --    | 80   | --        | nC       |
| Gate-Source Charge   | $Q_{gs}$      |  | --    | 12   | --        |          |
| Gate-Drain Charge  | $Q_{gd}$      |  | --    | 34   | --        |          |
| Turn-on Delay Time   | $t_{d(on)}$   | $V_{DD} = 325V, I_D = 20A,$<br>$R_G = 25\Omega$          | --    | 37   | --        | ns       |
| Turn-on Rise Time  | $t_r$         |  | --    | 66   | --        |          |
| Turn-off Delay Time  | $t_{d(off)}$  |  | --    | 175  | --        |          |
| Turn-off Fall Time   | $t_f$         |  | --    | 84   | --        |          |
| <b>Drain-Source Body Diode Characteristics</b>                   |               |  |       |      |           |          |
| Continuous Body Diode Current                                    | $I_S$         | $T_C = 25^\circ\text{C}$                                 | --    | --   | 20        | A        |
| Pulsed Diode Forward Current                                     | $I_{SM}$      |  | --    | --   | 80        |          |
| Body Diode Voltage   | $V_{SD}$      | $T_J = 25^\circ\text{C}, I_{SD} = 20A, V_{GS} = 0V$      | --    | --   | 1.4       | V        |
| Reverse Recovery Time  | $t_{rr}$      | $V_{GS} = 0V, I_S = 20A,$<br>$di_F/dt = 100A/\mu s$      | --    | 450  | --        | ns       |
| Reverse Recovery Charge  | $Q_{rr}$      |  | --    | 7.1  | --        | $\mu C$  |

**Notes**

1. Repetitive Rating: Pulse width limited by maximum junction temperature
2.  $I_{AS} = 16A, V_{DD} = 50V, R_G = 25\Omega$ , Starting  $T_J = 25^\circ\text{C}$
3. Pulse Test: Pulse width  $\leq 350\mu s$ , Duty Cycle  $\leq 1\%$



Typical Characteristics  $T_J = 25^\circ\text{C}$ , unless otherwise noted

Figure 1. Output Characteristics ( $T_J = 25^\circ\text{C}$ )

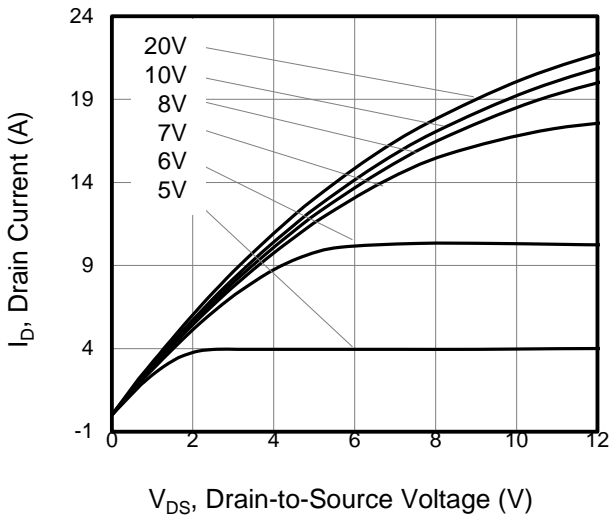


Figure 2. Body Diode Forward Voltage

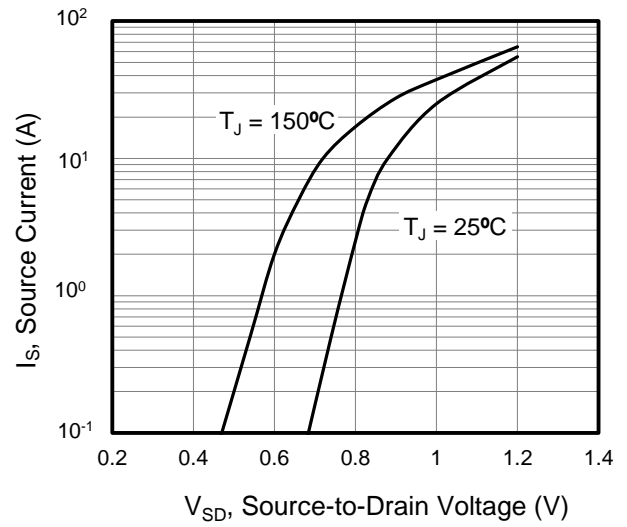


Figure 3. Drain Current vs. Temperature

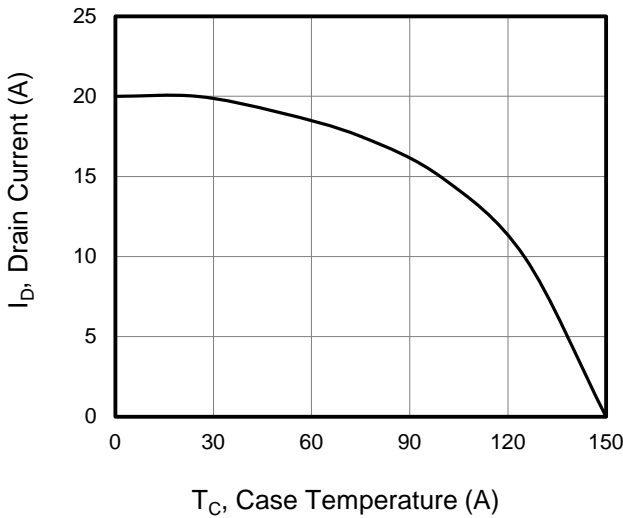


Figure 4.  $BV_{DSS}$  Variation vs. Temperature

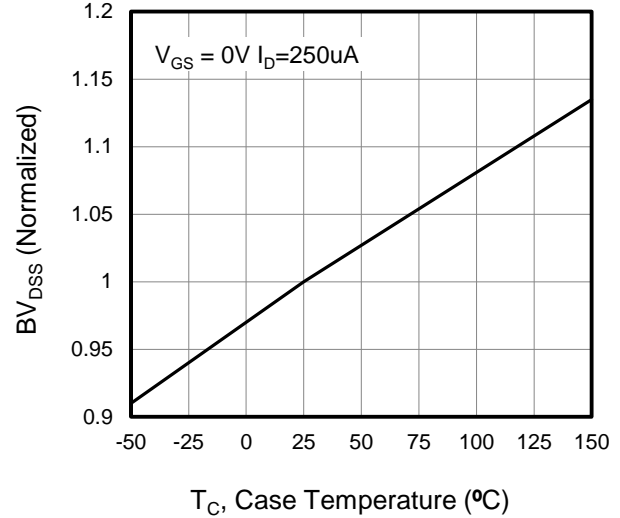


Figure 5. Transfer Characteristics

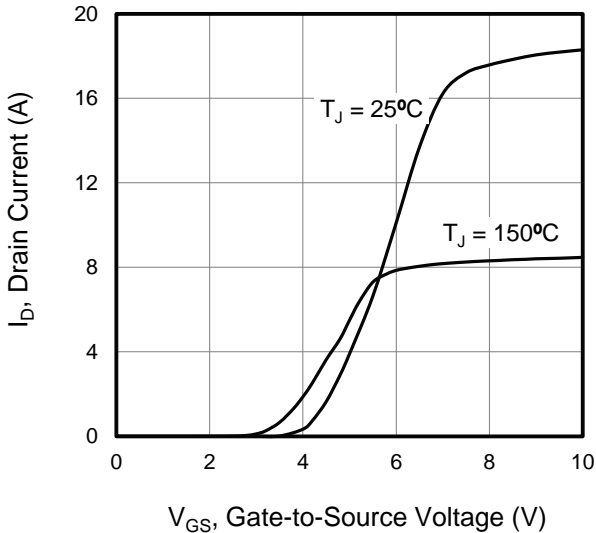
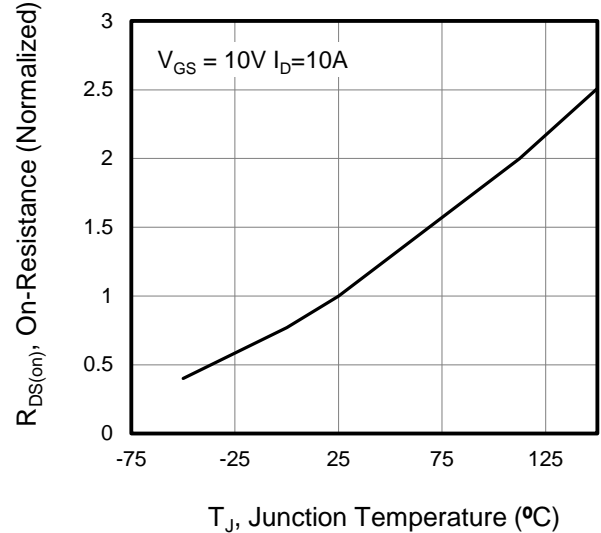


Figure 6. On-Resistance vs. Temperature





Typical Characteristics  $T_j = 25^\circ\text{C}$ , unless otherwise noted

Figure 7. Capacitance

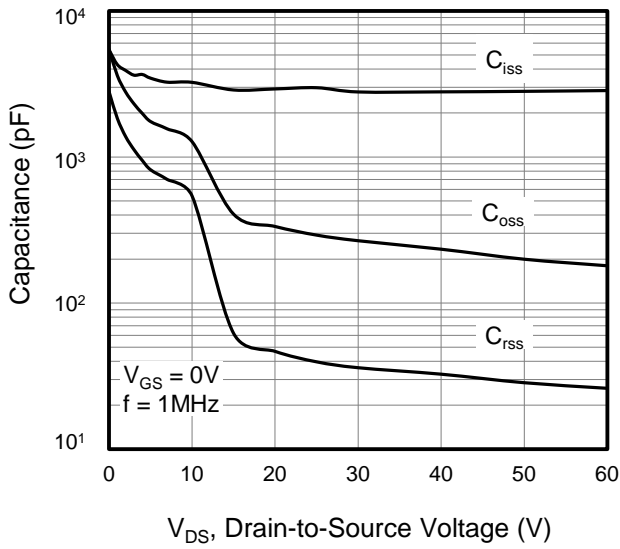


Figure 8. Gate Charge

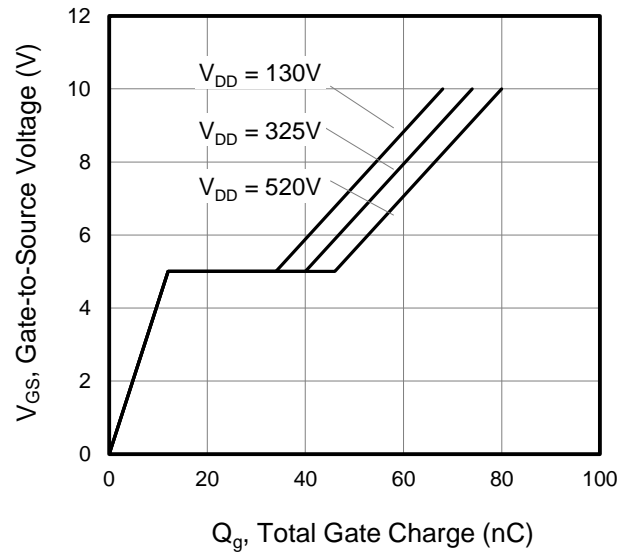


Figure 9. Transient Thermal Impedance

TO-220F

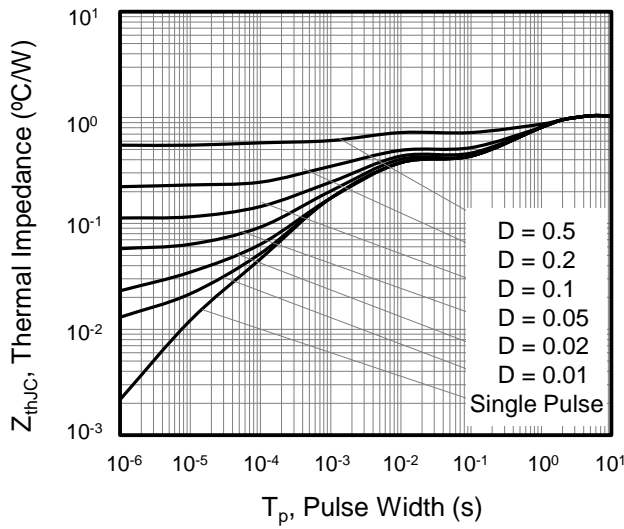


Figure 10. Transient Thermal Impedance

TO-220

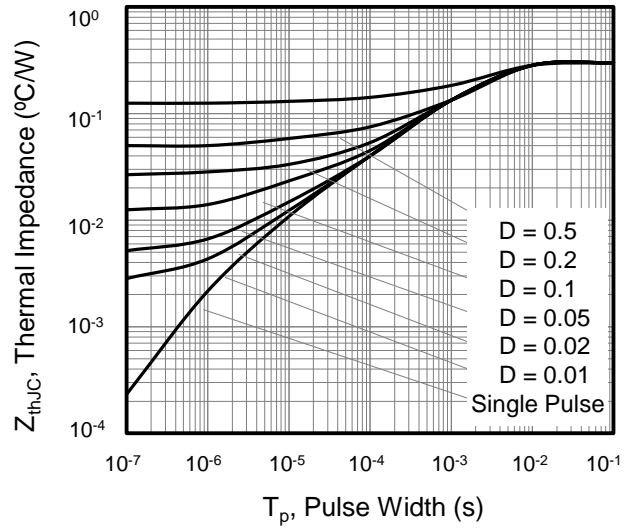




Figure A: Gate Charge Test Circuit and Waveform

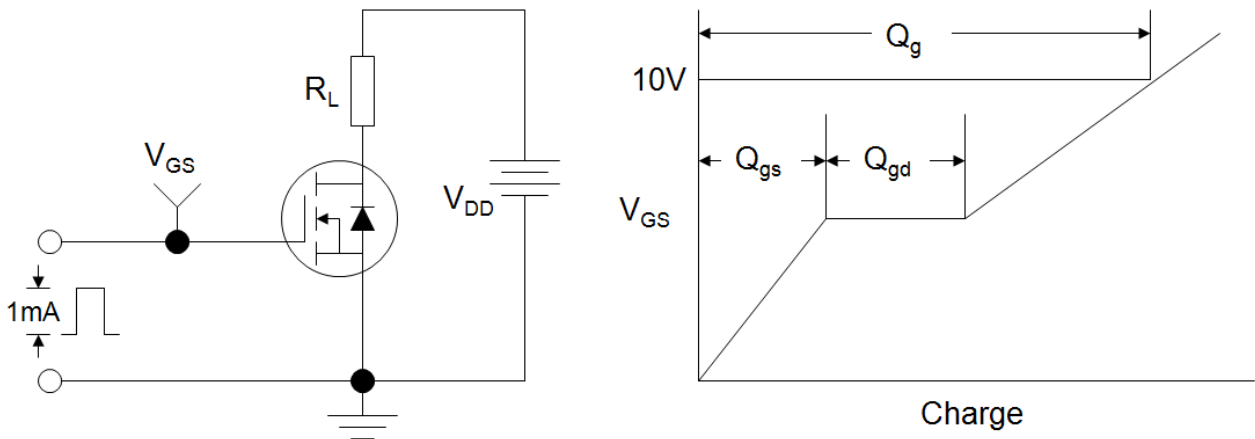


Figure B: Resistive Switching Test Circuit and Waveform

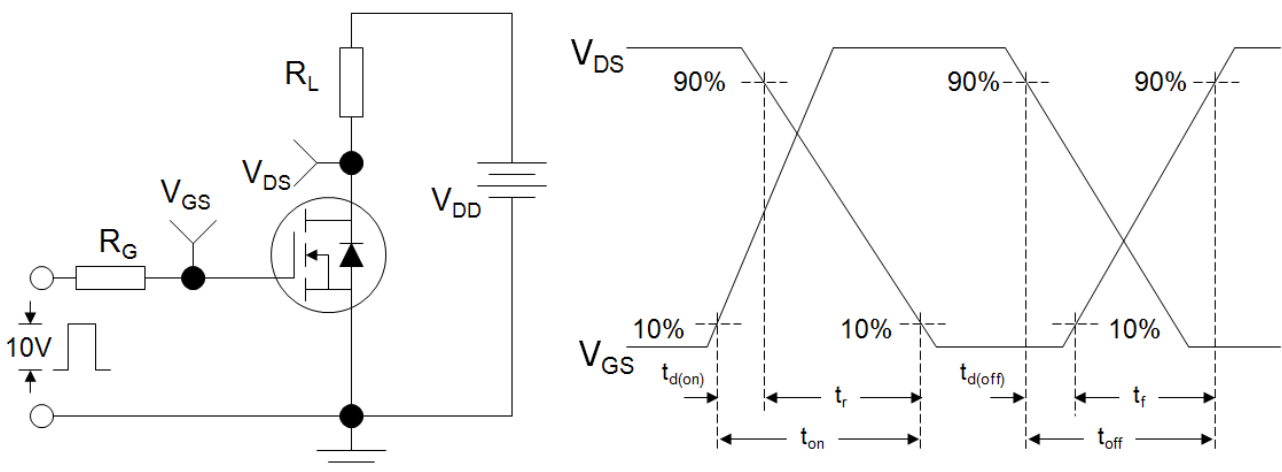
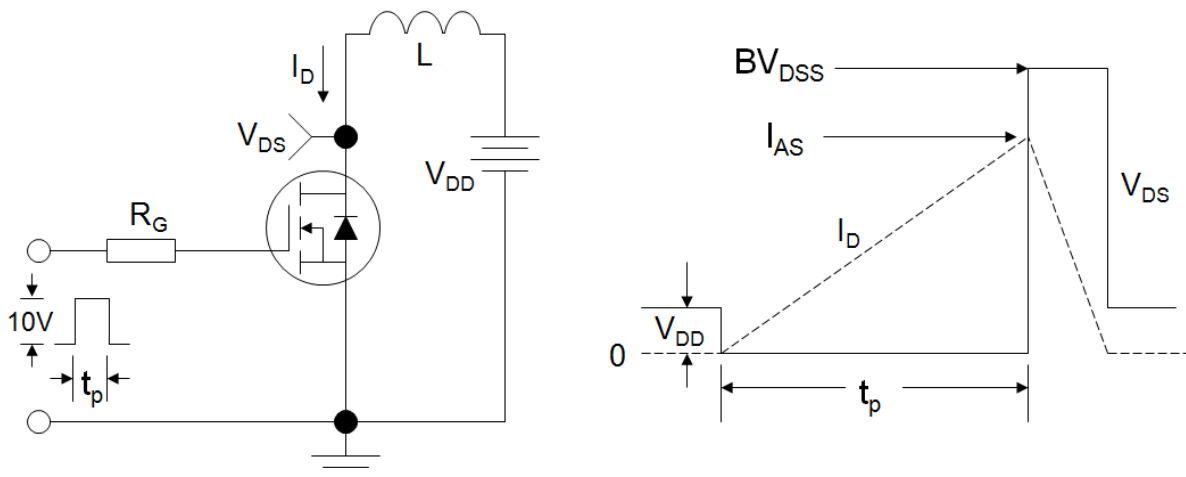
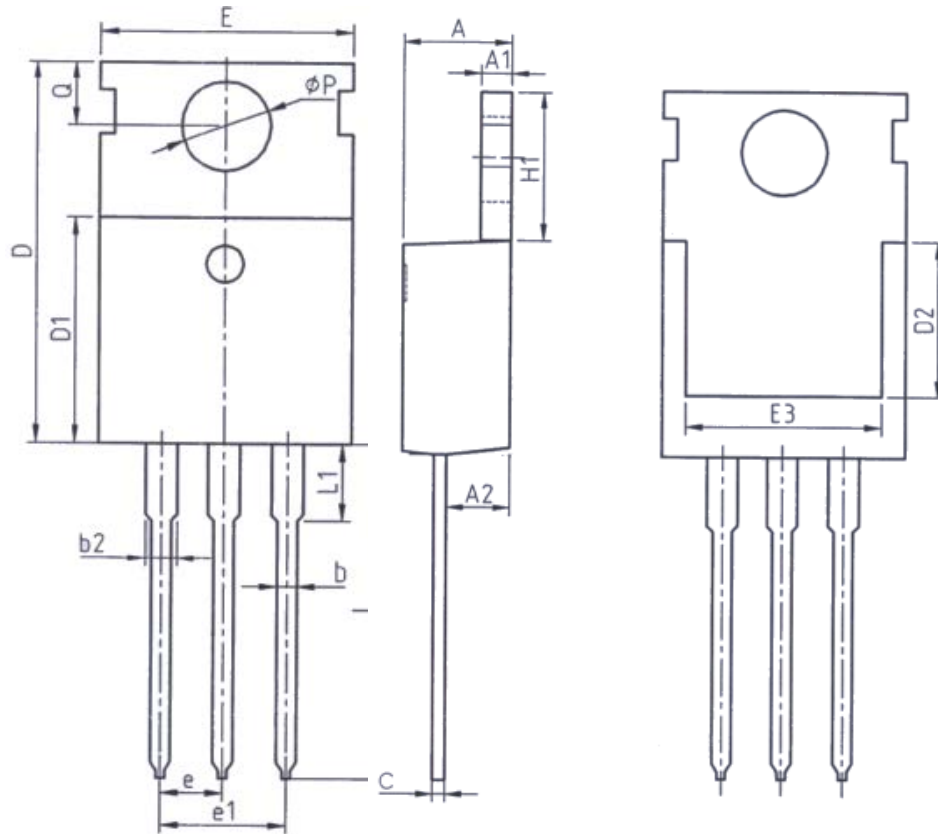


Figure C: Unclamped Inductive Switching Test Circuit and Waveform





### TO-220

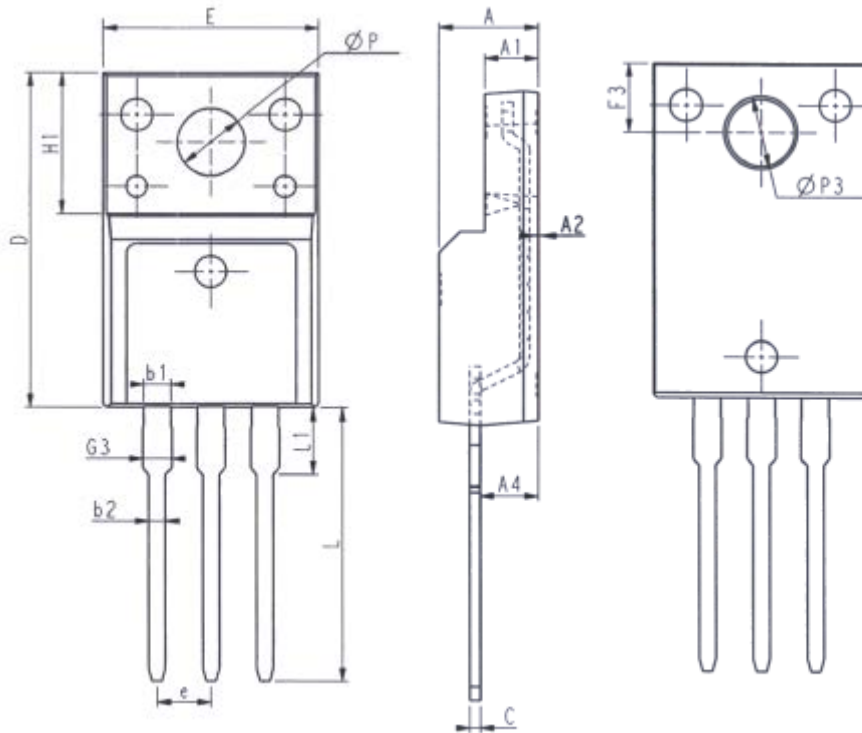


| Unit: mm |       |       |
|----------|-------|-------|
| Symbol   | Min.  | Max.  |
| A        | 4.37  | 4.77  |
| A1       | 1.25  | 1.45  |
| A2       | 2.20  | 2.60  |
| b        | 0.70  | 0.95  |
| b2       | 1.17  | 1.47  |
| c        | 0.40  | 0.65  |
| D        | 15.10 | 16.10 |
| D1       | 8.80  | 9.40  |
| D2       | 5.50  | -     |

| Unit: mm |         |       |
|----------|---------|-------|
| Symbol   | Min.    | Max.  |
| E        | 9.70    | 10.30 |
| E3       | 7.00    | -     |
| e        | 2.54BSC |       |
| e1       | 5.08BSC |       |
| H1       | 6.25    | 6.85  |
| L        | 12.75   | 13.80 |
| L1       | -       | 3.40  |
| P        | 3.40    | 3.80  |
| Q        | 2.60    | 3.00  |



### TO-220F



| Unit: mm |         |       | Unit: mm |       |       |
|----------|---------|-------|----------|-------|-------|
| Symbol   | Min.    | Max.  | Symbol   | Min.  | Max.  |
| E        | 9.96    | 10.36 | L        | 12.68 | 13.28 |
| A        | 4.50    | 4.90  | L1       | 2.93  | 3.13  |
| A1       | 2.34    | 2.74  | P        | 3.03  | 3.38  |
| A2       | 0.30    | 0.60  | P3       | 3.15  | 3.65  |
| A4       | 2.56    | 2.96  | F3       | 3.15  | 3.45  |
| c        | 0.40    | 0.65  | G3       | 1.25  | 1.55  |
| D        | 15.57   | 16.17 | b1       | 1.18  | 1.43  |
| H1       | 6.70REF |       | b2       | 0.70  | 0.95  |
| e        | 2.54BSC |       |          |       |       |



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