



STP5NC70Z - STP5NC70ZFP STB5NC70Z - STB5NC70Z-1

N-CHANNEL 700V - 1.8Ω - 4.6A TO-220/FP/D²PAK/I²PAK
Zener-Protected PowerMESH™III MOSFET

| TYPE | V _{DSS} | R _{DS(on)} | I _D |
|--------------|------------------|---------------------|----------------|
| STP5NC70Z/FP | 700V | < 2 Ω | 4.6 A |
| STB5NC70Z/-1 | 700V | < 2 Ω | 4.6 A |

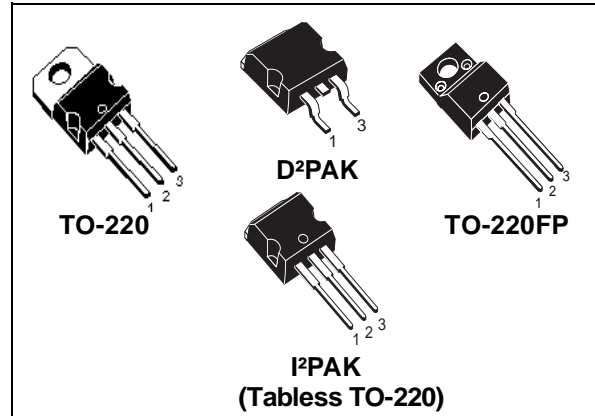
- TYPICAL R_{DS(on)} = 1.8 Ω
- EXTREMELY HIGH dv/dt AND CAPABILITY GATE TO - SOURCE ZENER DIODES
- 100% AVALANCHE TESTED
- VERY LOW GATE INPUT RESISTANCE
- GATE CHARGE MINIMIZED

DESCRIPTION

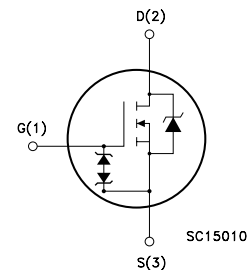
The third generation of MESH OVERLAY™ Power MOSFETs for very high voltage exhibits unsurpassed on-resistance per unit area while integrating back-to-back Zener diodes between gate and source. Such arrangement gives extra ESD capability with higher ruggedness performance as requested by a large variety of single-switch applications.

APPLICATIONS

- SINGLE-ENDED SMPS IN MONITORS, COMPUTER AND INDUSTRIAL APPLICATION
- WELDING EQUIPMENT



INTERNAL SCHEMATIC DIAGRAM



ABSOLUTE MAXIMUM RATINGS

| Symbol | Parameter | Value | | Unit |
|-----------------------|--|------------------|-------------|------|
| | | STP(B)5NC70Z(-1) | STP5NC70ZFP | |
| V _{DS} | Drain-source Voltage (V _{GS} = 0) | 700 | | V |
| V _{DGR} | Drain-gate Voltage (R _{GS} = 20 kΩ) | 700 | | V |
| V _{GS} | Gate- source Voltage | ± 25 | | V |
| I _D | Drain Current (continuous) at T _C = 25°C | 4.6 | 4.6(*) | A |
| I _D | Drain Current (continuous) at T _C = 100°C | 2.9 | 2.9(*) | A |
| I _{DM} (1) | Drain Current (pulsed) | 18.4 | 18.4 | A |
| P _{TOT} | Total Dissipation at T _C = 25°C | 100 | 35 | W |
| | Derating Factor | 0.8 | 0.32 | W/°C |
| I _{GS} | Gate-source Current | ± 50 | | mA |
| V _{ESD(G-S)} | Gate source ESD(HBM-C=100pF, R=15KΩ) | 3 | | KV |
| dv/dt | Peak Diode Recovery voltage slope | 3 | | V/ns |
| V _{ISO} | Insulation Withstand Voltage (DC) | -- | 2000 | V |
| T _{stg} | Storage Temperature | -65 to 150 | | °C |
| T _j | Max. Operating Junction Temperature | 150 | | °C |

(1)Pulse width limited by safe operating area

(●)I_{SD} ≤ 4.5A, di/dt ≤ 100A/μs, V_{DD} ≤ V_{(BR)DSS}, T_j ≤ T_{JMAX}

(*) Limited only by maximum temperature allowed

STP5NC70Z - STP5NC70ZFP - STB5NC70Z - STB5NC70Z-1**THERMAL DATA**

| | | TO-220 / D ² PAK I ² PAK | TO-220FP | |
|----------------|--|---|----------|------|
| Rthj-case | Thermal Resistance Junction-case Max | 1.25 | 3.57 | °C/W |
| Rthj-amb | Thermal Resistance Junction-ambient Max | 62 | | °C/W |
| T _I | Maximum Lead Temperature For Soldering Purpose | 300 | | °C |

AVALANCHE CHARACTERISTICS

| Symbol | Parameter | Max Value | Unit |
|-----------------|---|-----------|------|
| I _{AR} | Avalanche Current, Repetitive or Not-Repetitive (pulse width limited by T _j max) | 4.6 | A |
| E _{AS} | Single Pulse Avalanche Energy (starting T _j = 25 °C, I _D = I _{AR} , V _{DD} = 50 V) | 200 | mJ |

ELECTRICAL CHARACTERISTICS (TCASE = 25 °C UNLESS OTHERWISE SPECIFIED)**OFF**

| Symbol | Parameter | Test Conditions | Min. | Typ. | Max. | Unit |
|-------------------------------------|---|---|------|------|---------|----------|
| V _{(BR)DSS} | Drain-source Breakdown Voltage | I _D = 250 µA, V _{GS} = 0 | 700 | | | V |
| ΔBV _{DSS} /ΔT _J | Breakdown Voltage Temp. Coefficient | I _D = 1 mA, V _{GS} = 0 | | 0.8 | | V/°C |
| I _{DSS} | Zero Gate Voltage Drain Current (V _{GS} = 0) | V _{DS} = Max Rating V _{DS} = Max Rating, T _C = 125 °C | | | 1 50 | µA µA |
| I _{GSS} | Gate-body Leakage Current (V _{DS} = 0) | V _{GS} = ± 20V | | | ±10 | µA |

ON (1)

| Symbol | Parameter | Test Conditions | Min. | Typ. | Max. | Unit |
|---------------------|-----------------------------------|--|------|------|------|------|
| V _{GS(th)} | Gate Threshold Voltage | V _{DS} = V _{GS} , I _D = 250µA | 3 | 4 | 5 | V |
| R _{DS(on)} | Static Drain-source On Resistance | V _{GS} = 10V, I _D = 2.4 A | | 1.8 | 2.0 | Ω |

DYNAMIC

| Symbol | Parameter | Test Conditions | Min. | Typ. | Max. | Unit |
|---------------------|------------------------------|--|------|------|------|------|
| g _{fs} (1) | Forward Transconductance | V _{DS} > I _{D(on)} × R _{DS(on)} max, I _D = 2.4A | | 4 | | S |
| C _{iss} | Input Capacitance | V _{DS} = 25V, f = 1 MHz, V _{GS} = 0 | | 1200 | | pF |
| C _{oss} | Output Capacitance | | | 98 | | pF |
| C _{rss} | Reverse Transfer Capacitance | | | 9 | | pF |

ELECTRICAL CHARACTERISTICS (CONTINUED)**SWITCHING ON**

| Symbol | Parameter | Test Conditions | Min. | Typ. | Max. | Unit |
|----------------------|---------------------------------|--|------|----------|------|----------|
| $t_{d(on)}$ t_r | Turn-on Delay Time Rise Time | $V_{DD} = 350\text{ V}$, $I_D = 2.5\text{ A}$ $R_G = 4.7\Omega$, $V_{GS} = 10\text{ V}$ (see test circuit, Figure 3) | | 22 10 | | ns ns |
| Q_g | Total Gate Charge | $V_{DD} = 560\text{ V}$, $I_D = 5\text{ A}$, $V_{GS} = 10\text{ V}$ | | 27 | 36.4 | nC |
| Q_{gs} | Gate-Source Charge | | | 8 | | nC |
| Q_{gd} | Gate-Drain Charge | | | 10 | | nC |

SWITCHING OFF

| Symbol | Parameter | Test Conditions | Min. | Typ. | Max. | Unit |
|---------------|-----------------------|--|------|------|------|------|
| $t_{r(Voff)}$ | Off-voltage Rise Time | $V_{DD} = 560\text{ V}$, $I_D = 5\text{ A}$, $R_G = 4.7\Omega$, $V_{GS} = 10\text{ V}$ (see test circuit, Figure 5) | | 13 | | ns |
| t_f | Fall Time | | | 14 | | ns |
| t_c | Cross-over Time | | | 22 | | ns |

SOURCE DRAIN DIODE

| Symbol | Parameter | Test Conditions | Min. | Typ. | Max. | Unit |
|--------------|-------------------------------|--|------|------|------|---------------|
| I_{SD} | Source-drain Current | | | | 4.6 | A |
| $I_{SDM(2)}$ | Source-drain Current (pulsed) | | | | 18.4 | A |
| $V_{SD(1)}$ | Forward On Voltage | $I_{SD} = 4.6\text{ A}$, $V_{GS} = 0$ | | | 1.6 | V |
| t_{rr} | Reverse Recovery Time | $I_{SD} = 5\text{ A}$, $di/dt = 100\text{ A}/\mu\text{s}$, $V_{DD} = 100\text{ V}$, $T_j = 150^\circ\text{C}$ (see test circuit, Figure 5) | | 570 | | ns |
| Q_{rr} | Reverse Recovery Charge | | | 4.4 | | μC |
| I_{RRM} | Reverse Recovery Current | | | 15.5 | | A |

GATE-SOURCE ZENER DIODE

| Symbol | Parameter | Test Conditions | Min. | Typ. | Max. | Unit |
|------------|-------------------------------|---|------|------|------|--------------------------|
| BV_{GSO} | Gate-Source Breakdown Voltage | $I_{GS} = \pm 1\text{ mA}$ (Open Drain) | 25 | | | V |
| αT | Voltage Thermal Coefficient | $T = 25^\circ\text{C}$ Note(3) | | 1.3 | | $10^{-4}/^\circ\text{C}$ |
| R_z | Dynamic Resistance | $I_D = 50\text{ mA}$, $V_{GS} = 0$ | | 90 | | Ω |

Note: 1. Pulsed: Pulse duration = 300 μs , duty cycle 1.5 %.

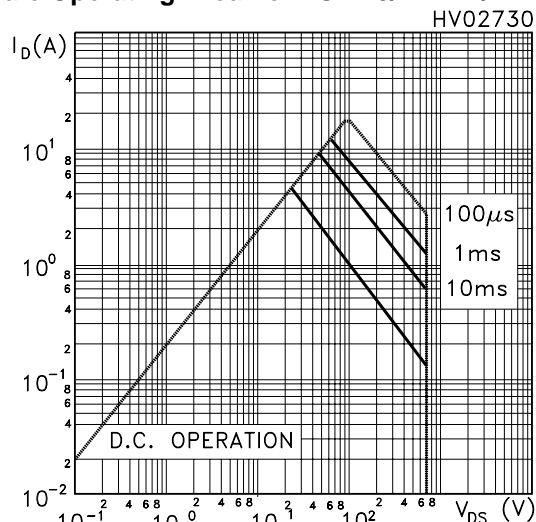
2. Pulse width limited by safe operating area.

3. $\Delta V_{BV} = \alpha T (25^\circ - T) BV_{GSO}(25^\circ)$

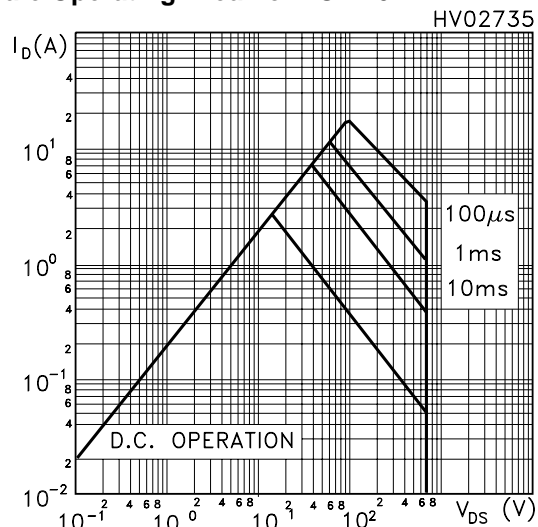
PROTECTION FEATURES OF GATE-TO-SOURCE ZENER DIODES

The built-in back-to-back Zener diodes have specifically been designed to enhance not only the device's ESD capability, but also to make them safely absorb possible voltage transients that may occasionally be applied from gate to source. In this respect the Zener voltage is appropriate to achieve an efficient and cost-effective intervention to protect the device's integrity. These integrated Zener diodes thus avoid the usage of external components.

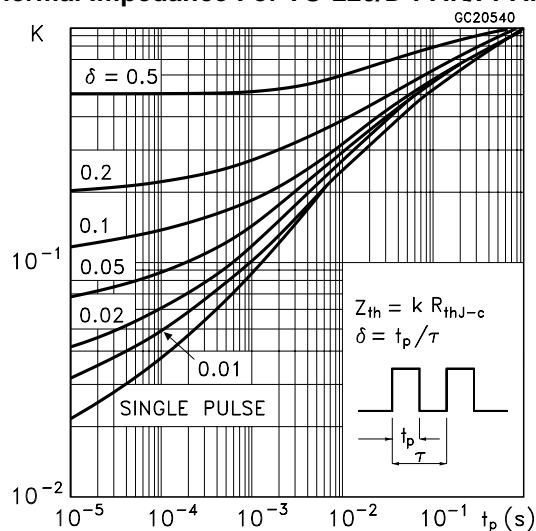
Safe Operating Area For TO-220/D²PAK/I²PAK



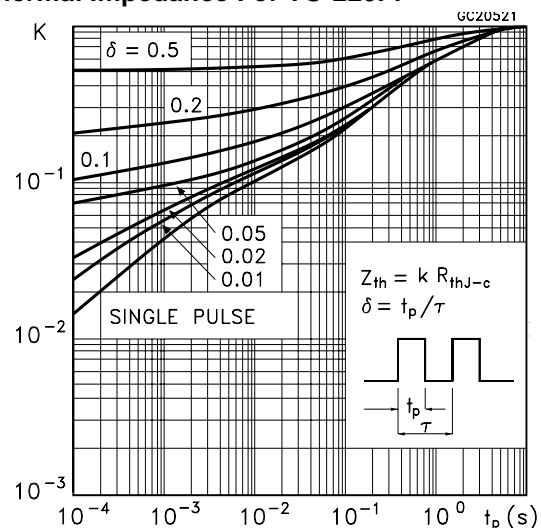
Safe Operating Area For TO-220FP



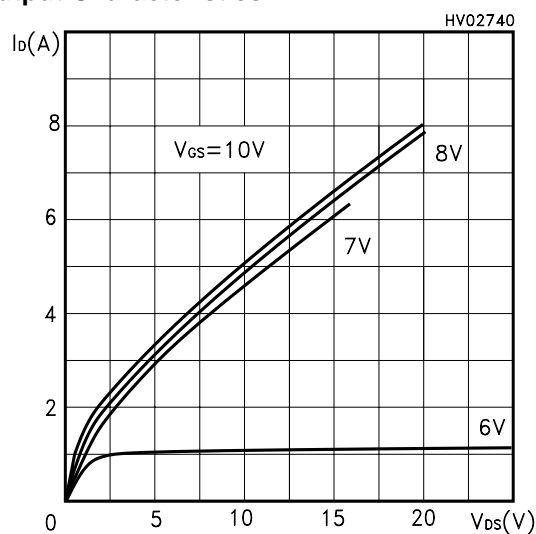
Thermal Impedance For TO-220/D²PAK/I²PAK



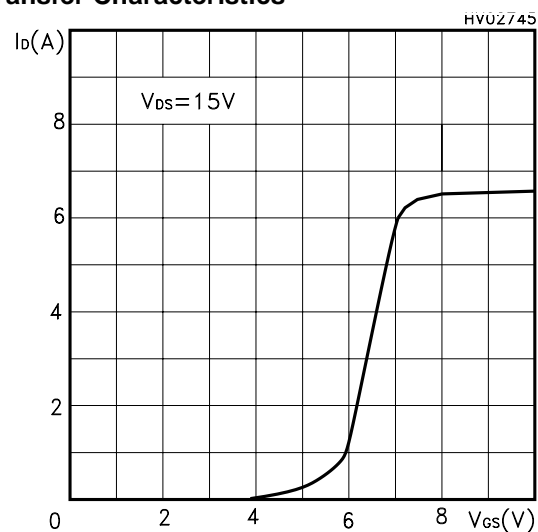
Thermal Impedance For TO-220FP



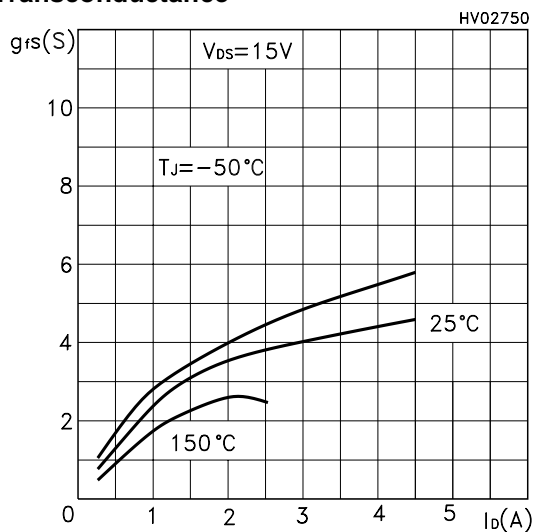
Output Characteristics



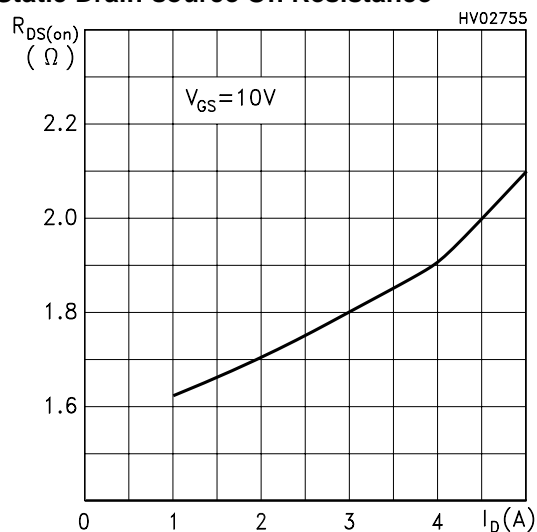
Transfer Characteristics



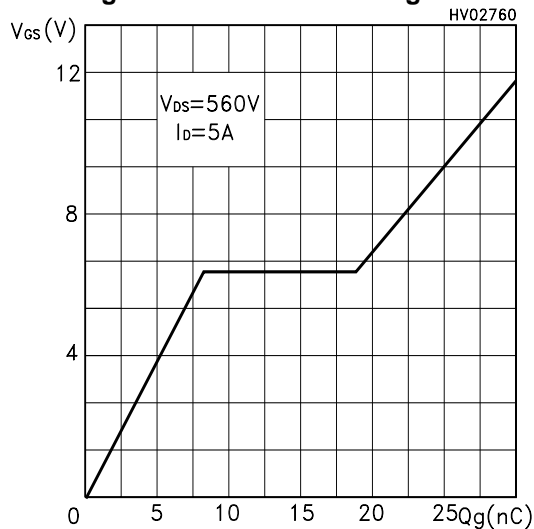
Transconductance



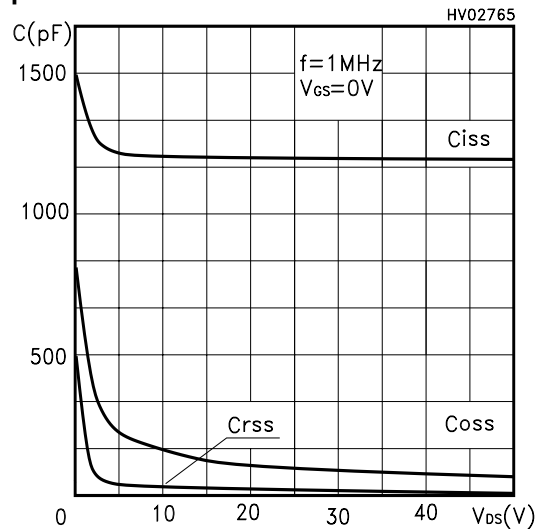
Static Drain-source On Resistance



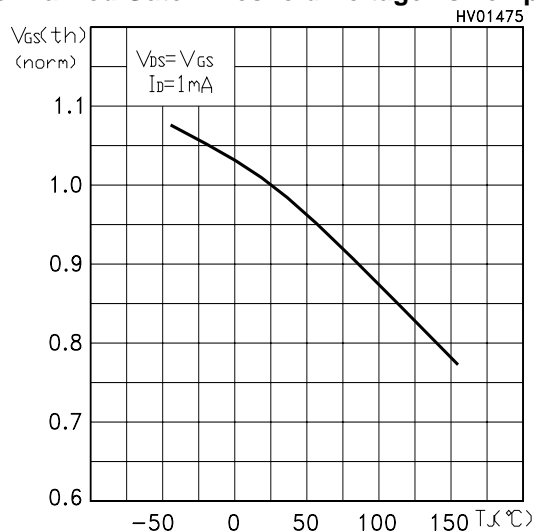
Gate Charge vs Gate-source Voltage



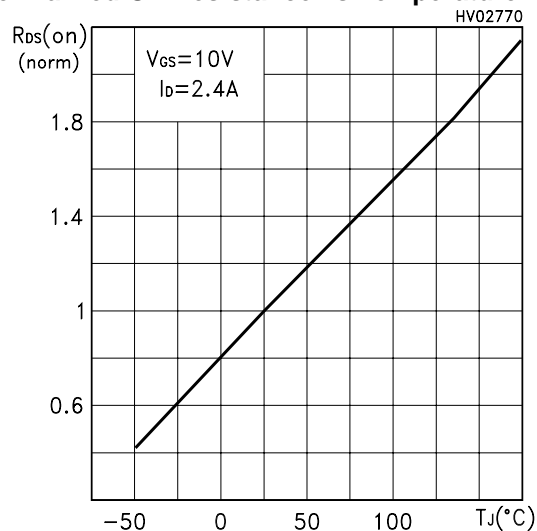
Capacitance Variations



Normalized Gate Threshold Voltage vs Temp.



Normalized On Resistance vs Temperature



Source-drain Diode Forward Characteristics

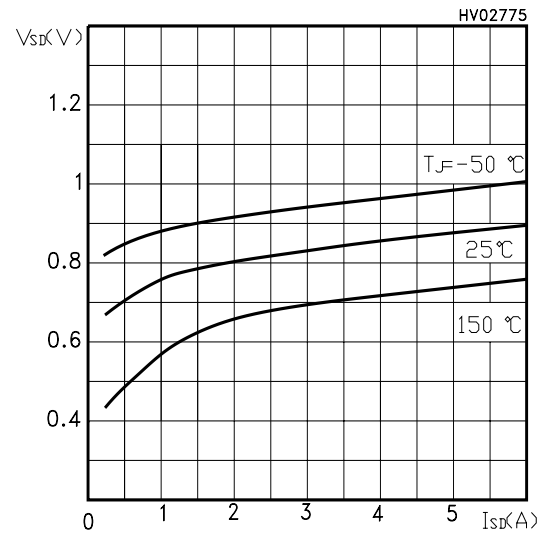


Fig. 1: Unclamped Inductive Load Test Circuit

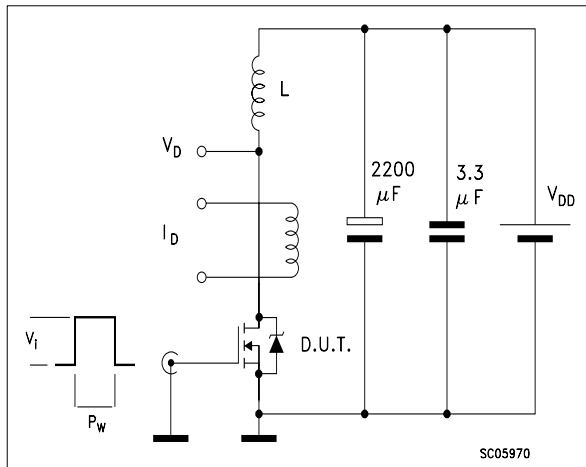


Fig. 2: Unclamped Inductive Waveform

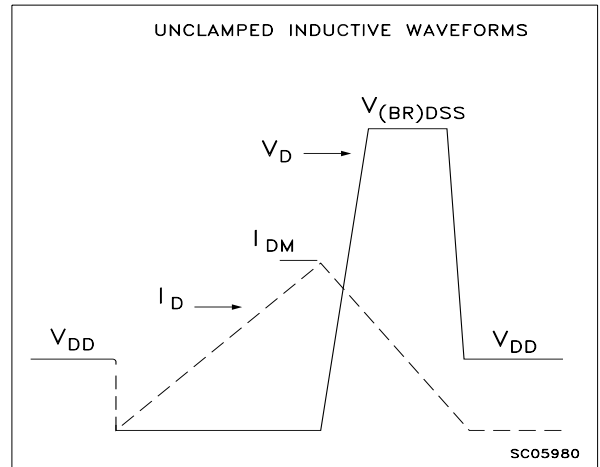


Fig. 3: Switching Times Test Circuits For Resistive Load

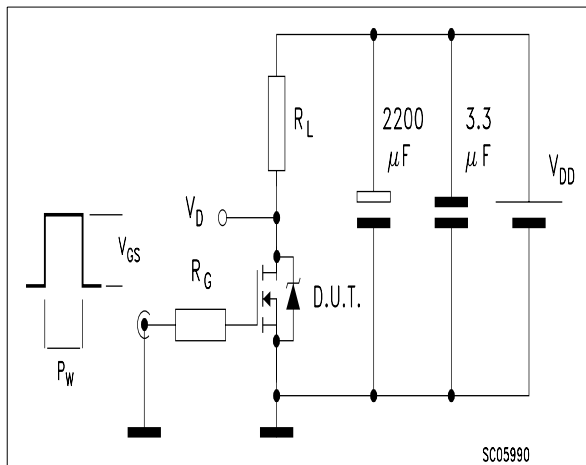


Fig. 4: Gate Charge test Circuit

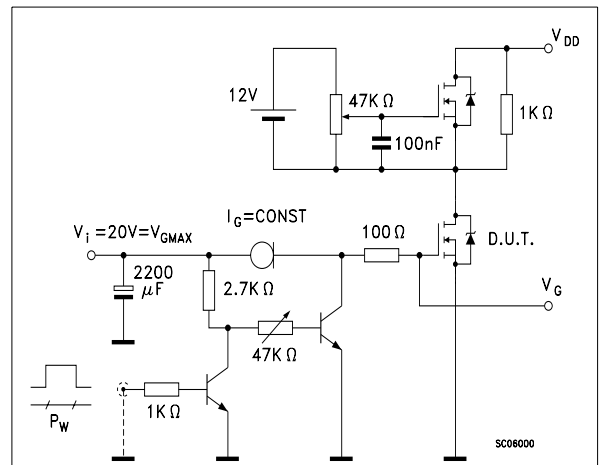
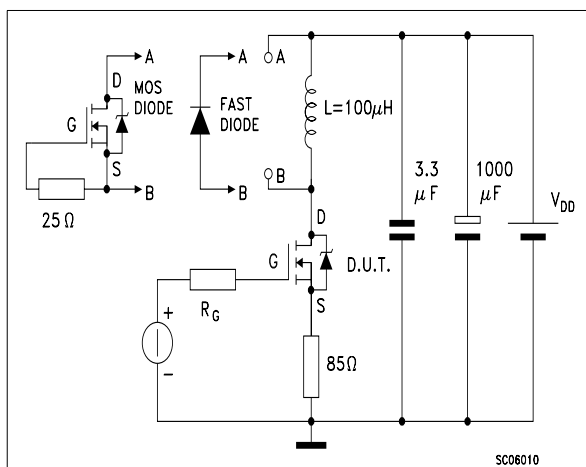
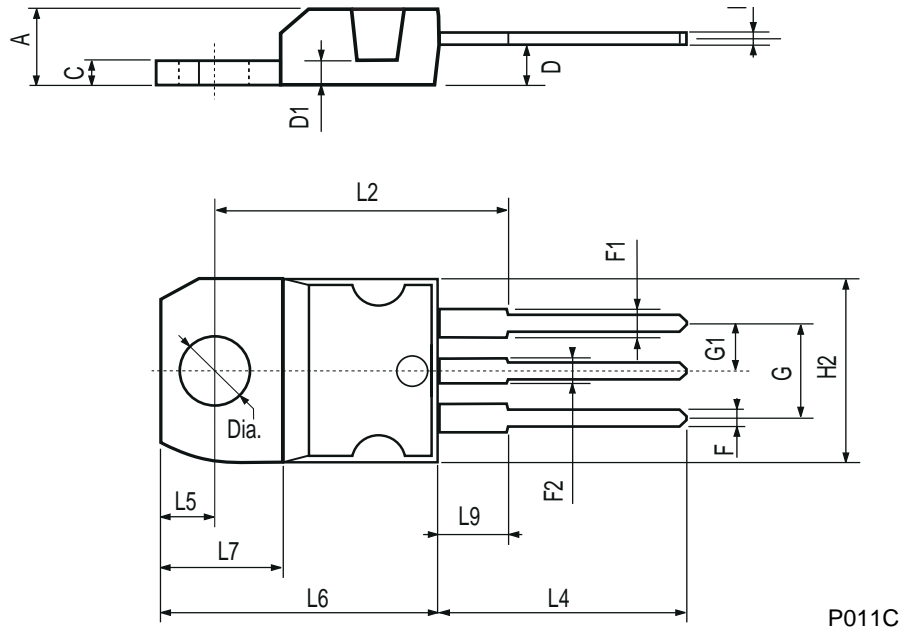


Fig. 5: Test Circuit For Inductive Load Switching And Diode Recovery Times



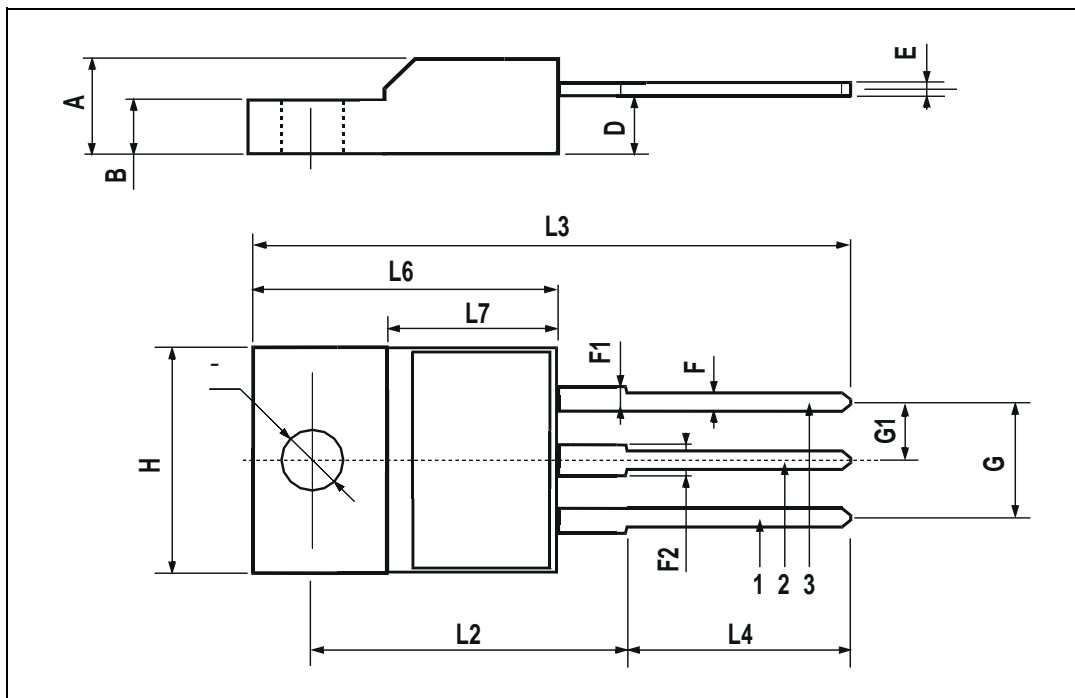
TO-220 MECHANICAL DATA

| DIM. | mm | | | inch | | |
|------|-------|------|-------|-------|-------|-------|
| | MIN. | TYP. | MAX. | MIN. | TYP. | MAX. |
| A | 4.40 | | 4.60 | 0.173 | | 0.181 |
| C | 1.23 | | 1.32 | 0.048 | | 0.051 |
| D | 2.40 | | 2.72 | 0.094 | | 0.107 |
| D1 | | 1.27 | | | 0.050 | |
| E | 0.49 | | 0.70 | 0.019 | | 0.027 |
| F | 0.61 | | 0.88 | 0.024 | | 0.034 |
| F1 | 1.14 | | 1.70 | 0.044 | | 0.067 |
| F2 | 1.14 | | 1.70 | 0.044 | | 0.067 |
| G | 4.95 | | 5.15 | 0.194 | | 0.203 |
| G1 | 2.4 | | 2.7 | 0.094 | | 0.106 |
| H2 | 10.0 | | 10.40 | 0.393 | | 0.409 |
| L2 | | 16.4 | | | 0.645 | |
| L4 | 13.0 | | 14.0 | 0.511 | | 0.551 |
| L5 | 2.65 | | 2.95 | 0.104 | | 0.116 |
| L6 | 15.25 | | 15.75 | 0.600 | | 0.620 |
| L7 | 6.2 | | 6.6 | 0.244 | | 0.260 |
| L9 | 3.5 | | 3.93 | 0.137 | | 0.154 |
| DIA. | 3.75 | | 3.85 | 0.147 | | 0.151 |



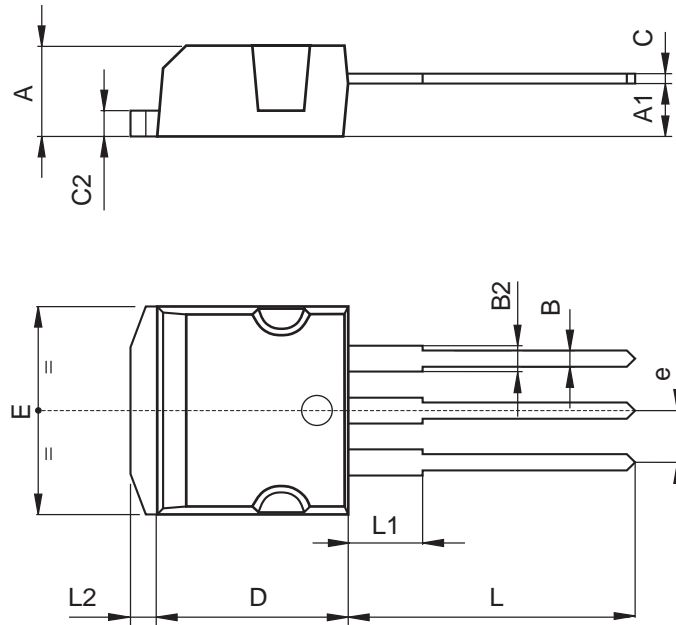
TO-220FP MECHANICAL DATA

| 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 | 0.385 | | 0.417 |
| 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 |



TO-262 (I²PAK) MECHANICAL DATA

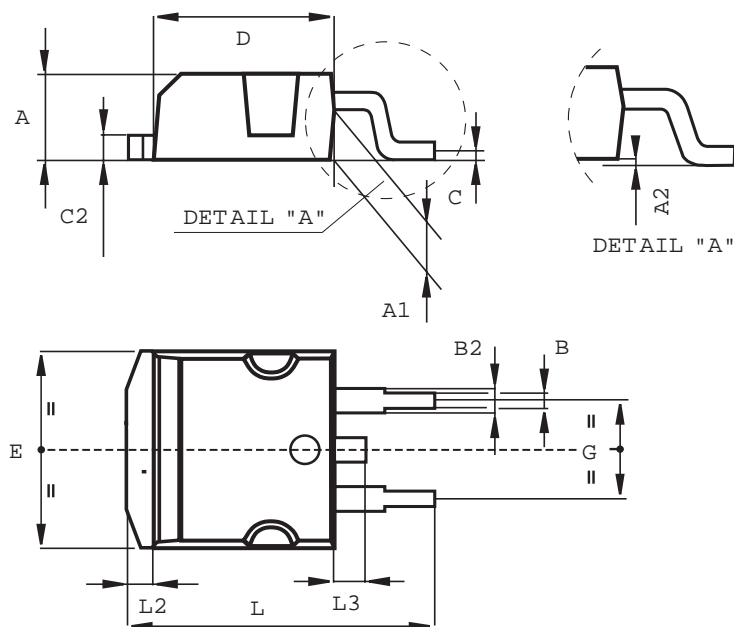
| DIM. | mm | | | inch | | |
|------|------|------|------|-------|------|-------|
| | MIN. | TYP. | MAX. | MIN. | TYP. | MAX. |
| A | 4.4 | | 4.6 | 0.173 | | 0.181 |
| A1 | 2.49 | | 2.69 | 0.098 | | 0.106 |
| B | 0.7 | | 0.93 | 0.027 | | 0.036 |
| B2 | 1.14 | | 1.7 | 0.044 | | 0.067 |
| C | 0.45 | | 0.6 | 0.017 | | 0.023 |
| C2 | 1.23 | | 1.36 | 0.048 | | 0.053 |
| D | 8.95 | | 9.35 | 0.352 | | 0.368 |
| e | 2.4 | | 2.7 | 0.094 | | 0.106 |
| E | 10 | | 10.4 | 0.393 | | 0.409 |
| L | 13.1 | | 13.6 | 0.515 | | 0.531 |
| L1 | 3.48 | | 3.78 | 0.137 | | 0.149 |
| L2 | 1.27 | | 1.4 | 0.050 | | 0.055 |



P011P5/E

TO-263 (D²PAK) MECHANICAL DATA

| DIM. | mm | | | inch | | |
|------|------|------|-------|-------|------|-------|
| | MIN. | TYP. | MAX. | MIN. | TYP. | MAX. |
| A | 4.4 | | 4.6 | 0.173 | | 0.181 |
| A1 | 2.49 | | 2.69 | 0.098 | | 0.106 |
| B | 0.7 | | 0.93 | 0.027 | | 0.036 |
| B2 | 1.14 | | 1.7 | 0.044 | | 0.067 |
| C | 0.45 | | 0.6 | 0.017 | | 0.023 |
| C2 | 1.21 | | 1.36 | 0.047 | | 0.053 |
| D | 8.95 | | 9.35 | 0.352 | | 0.368 |
| E | 10 | | 10.4 | 0.393 | | 0.409 |
| G | 4.88 | | 5.28 | 0.192 | | 0.208 |
| L | 15 | | 15.85 | 0.590 | | 0.624 |
| L2 | 1.27 | | 1.4 | 0.050 | | 0.055 |
| L3 | 1.4 | | 1.75 | 0.055 | | 0.068 |



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