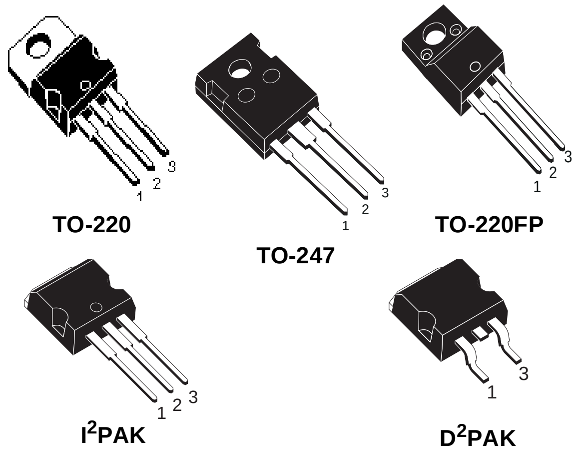
# STP12NM50FD-STP12NM50FDFP-STW14NM50FD
# STB12NM50FD - STB12NM50FD-1

## N-CHANNEL500V-0.32Ω-12ATO-220/FP/D$^2$PAK/I$^2$PAK/TO-247
## FDmesh™ Power MOSFET (with FAST DIODE)

| TYPE | $V_{DSS}$ | $R_{DS(on)}$ | $I_D$ | Pw |
|---|---|---|---|---|
| STP12NM50FD | 500 V | < 0.4 Ω | 12 A | 160 W |
| STP12NM50FDFP | 500 V | < 0.4 Ω | 12 A | 35 W |
| STB12NM50FD | 500 V | < 0.4 Ω | 12 A | 160 W |
| STB12NM50FD-1 | 500 V | < 0.4 Ω | 12 A | 160 W |
| STW14NM50FD | 500 V | < 0.4 Ω | 14 A | 175 W |

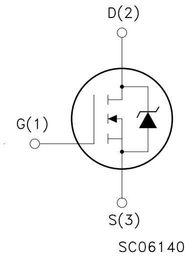
- TYPICAL $R_{DS}$(on) = 0.32 Ω
- HIGH dv/dt AND AVALANCHE CAPABILITIES
- 100% AVALANCHE TESTED
- LOW INPUT CAPACITANCE AND GATE CHARGE
- LOW GATE INPUT RESISTANCE
- TIGHT PROCESS CONTROL AND HIGH MANUFACTURING YIELDS



### DESCRIPTION

The FDmesh™ associates all advantages of reduced on-resistance and fast switching with an intrinsic fast-recovery body diode. It is therefore strongly recommended for bridge topologies, in particular ZVS phase-shift converters.

### INTERNAL SCHEMATIC DIAGRAM



### APPLICATIONS

- ZVS PHASE-SHIFT FULL BRIDGE CONVERTERS FOR SMPS AND WELDING EQUIPMENT

### ORDERING INFORMATION

| SALES TYPE | MARKING | PACKAGE | PACKAGING |
|---|---|---|---|
| STP12NM50FD | P12NM50FD | TO-220 | TUBE |
| STP12NM50FDFP | P12NM50FDFP | TO-220FP | TUBE |
| STB12NM50FD | B12NM50FD | D$^2$PAK | TUBE |
| STB12NM50FDT4 | B12NM50FD | D$^2$PAK | TAPE & REEL |
| STB12NM50FD-1 | B12NM50FD | I$^2$PAK | TUBE |
| STW14NM50FD | W14NM50FD | TO-247 | TUBE |

## ABSOLUTE MAXIMUM RATINGS

| Symbol | Parameter | Value | | | Unit |
|---|---|---|---|---|---|
| | | **TO-220 / $D^2PAK$ / $I^2PAK$** | **TO-220FP** | **TO-247** | |
| $V_{DS}$ | Drain-source Voltage ($V_{GS}$ = 0) | 500 | | | V |
| $V_{DGR}$ | Drain-gate Voltage ($R_{GS}$ = 20 kΩ) | 500 | | | V |
| $V_{GS}$ | Gate- source Voltage | ± 30 | | | V |
| $I_D$ | Drain Current (continuous) at $T_C$ = 25°C | 12 | 12 (*) | 14 | A |
| $I_D$ | Drain Current (continuous) at $T_C$ = 100°C | 7.5 | 7.5 (*) | 8.8 | A |
| $I_{DM}$ (•) | Drain Current (pulsed) | 48 | 48 (*) | 56 | A |
| $P_{TOT}$ | Total Dissipation at $T_C$ = 25°C | 160 | 35 | 175 | W |
| | Derating Factor | 1.28 | 0.28 | 1.4 | W/°C |
| dv/dt (1) | Peak Diode Recovery voltage slope | 20 | | | V/ns |
| $V_{ISO}$ | Insulation Withstand Voltage (DC) | - | 2500 | | V |
| $T_j$<br>$T_{stg}$ | Operating Junction Temperature<br>Storage Temperature | - 65 to 150<br>- 65 to 150 | | | °C<br>°C |

(●) Pulse width limited by safe operating area
(1) $I_{SD}$ ≤12A, di/dt ≤ 400 µA, $V_{DD} \leq V_{(BR)DSS}$, $T_j \leq T_{JMAX}$.
(*) Limited only by maximum temperature allowed

## THERMAL DATA

| | | TO-220<br>$I^2PAK$ | $D^2PAK$ | TO-220FP | TO-247 | |
|---|---|---|---|---|---|---|
| Rthj-case | Thermal Resistance Junction-case Max | 0.78 | | 3.57 | 0.715 | °C/W |
| Rthj-pcb | Thermal Resistance Junction-pcb Max<br>(When mounted on minimum Footprint) | | 30 | | | °C/W |
| Rthj-amb | Thermal Resistance Junction-ambient Max | 62.5 | | | 30 | °C/W |
| $T_l$ | Maximum Lead Temperature For Soldering Purpose | 300 | | | | °C |

## AVALANCHE CHARACTERISTICS

| Symbol | Parameter | Max Value | Unit |
|---|---|---|---|
| $I_{AR}$ | Avalanche Current, Repetitive or Not-Repetitive<br>(pulse width limited by $T_j$ max) | 6 | A |
| $E_{AS}$ | Single Pulse Avalanche Energy<br>(starting $T_j$ = 25 °C, $I_D$ = $I_{AR}$, $V_{DD}$ = 50 V) | 400 | mJ |

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

ON/OFF

| Symbol | Parameter | Test Conditions | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| $V_{(BR)DSS}$ | Drain-source Breakdown Voltage | $I_D$ = 1 mA, $V_{GS}$ = 0 | 500 | | | V |
| $I_{DSS}$ | Zero Gate Voltage Drain Current ($V_{GS}$ = 0) | $V_{DS}$ = Max Rating<br>$V_{DS}$ = Max Rating, $T_C$ = 125 °C | | | 1<br>10 | µA<br>µA |
| $I_{GSS}$ | Gate-body Leakage Current ($V_{DS}$ = 0) | $V_{GS}$ = ± 30V | | | ±100 | nA |
| $V_{GS(th)}$ | 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, $I_D$ = 6A | | 0.32 | 0.4 | Ω |

DYNAMIC

| Symbol | Parameter | Test Conditions | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| $g_{fs}$ (1) | Forward Transconductance | $V_{DS}$ = 15 V, $I_D$ = 6 A | | 9.8 | | S |
| $C_{iss}$<br>$C_{oss}$<br>$C_{rss}$ | Input Capacitance<br>Output Capacitance<br>Reverse Transfer Capacitance | $V_{DS}$ = 25V, f = 1 MHz, $V_{GS}$ = 0 | | 1027<br>205<br>24 | | pF<br>pF<br>pF |
| $R_G$ | Gate Input Resistance | f=1 MHz Gate DC Bias = 0<br>Test Signal Level = 20mV<br>Open Drain | | 3.7 | | Ω |

SWITCHING ON

| Symbol | Parameter | Test Conditions | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| $t_{d(on)}$<br>$t_r$ | Turn-on Delay Time<br>Rise Time | $V_{DD}$ = 250 V, $I_D$ = 6 A<br>$R_G$ = 4.7Ω $V_{GS}$ = 10 V<br>(Resistive Load see, Figure 3) | | 19<br>10 | | ns<br>ns |
| $Q_g$<br>$Q_{gs}$<br>$Q_{gd}$ | Total Gate Charge<br>Gate-Source Charge<br>Gate-Drain Charge | $V_{DD}$ = 400V, $I_D$ = 12 A,<br>$V_{GS}$ = 10V | | 27.5<br>8<br>12 | 38.5 | nC<br>nC<br>nC |

SWITCHING OFF

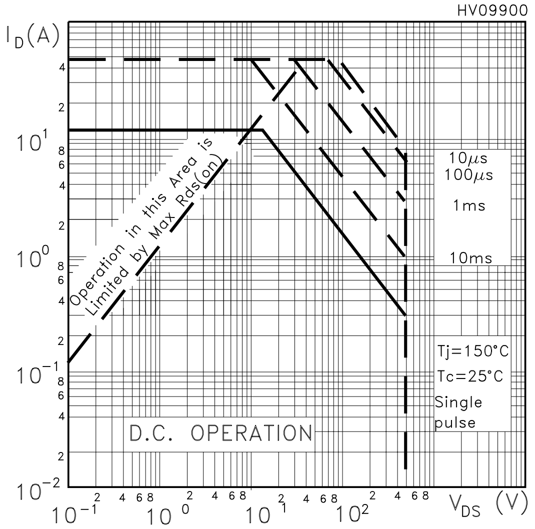
| Symbol | Parameter | Test Conditions | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| $t_{r(Voff)}$<br>$t_f$<br>$t_c$ | Off-voltage Rise Time<br>Fall Time<br>Cross-over Time | $V_{DD}$ = 400 V, $I_D$ = 12 A,<br>$R_G$ = 4.7Ω, $V_{GS}$ = 10V<br>(Inductive Load see, Figure 5) | | 39<br>18<br>29 | | ns<br>ns<br>ns |

SOURCE DRAIN DIODE

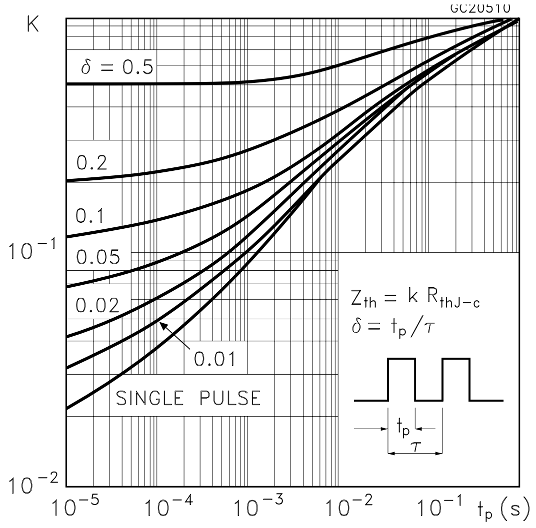
| Symbol | Parameter | Test Conditions | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| $I_{SD}$<br>$I_{SDM}$ (2) | Source-drain Current<br>Source-drain Current (pulsed) | | | | 12<br>48 | A<br>A |
| $V_{SD}$ (1) | Forward On Voltage | $I_{SD}$ = 12 A, $V_{GS}$ = 0 | | | 1.5 | V |
| $t_{rr}$<br>$Q_{rr}$<br>$I_{RRM}$ | Reverse Recovery Time<br>Reverse Recovery Charge<br>Reverse Recovery Current | $I_{SD}$ = 12 A, di/dt = 100A/µs<br>$V_{DD}$ = 30V, $T_j$ = 150°C<br>(see test circuit, Figure 5) | | 224<br>1.3<br>12 | | ns<br>µC<br>A |

Note: 1. Pulsed: Pulse duration = 300 µs, duty cycle 1.5 %.
2. Pulse width limited by safe operating area.

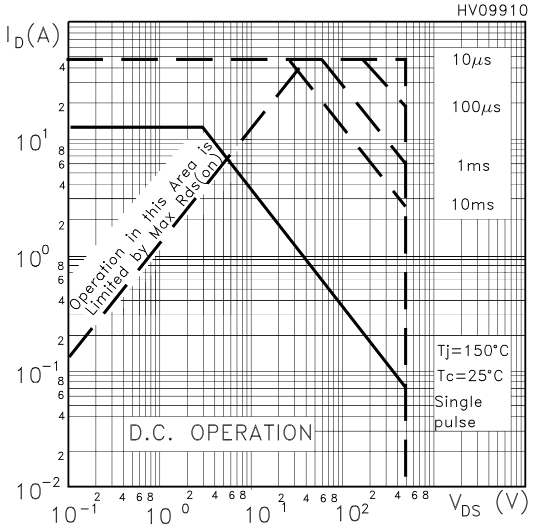
### Safe Operating Area For TO-220/D2PAK/I2PAK



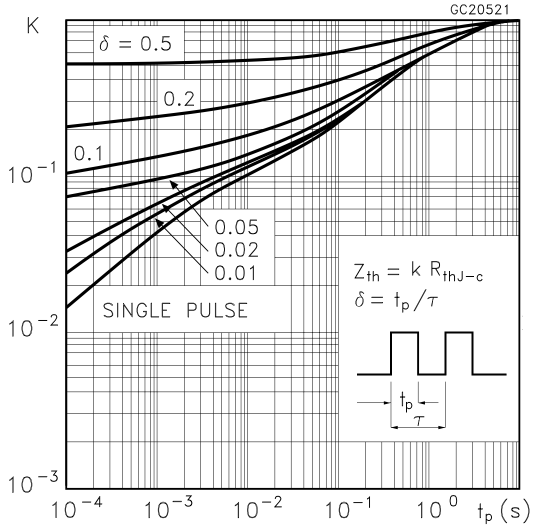
### Thermal Impedance For TO-220/D2PAK/I2PAK



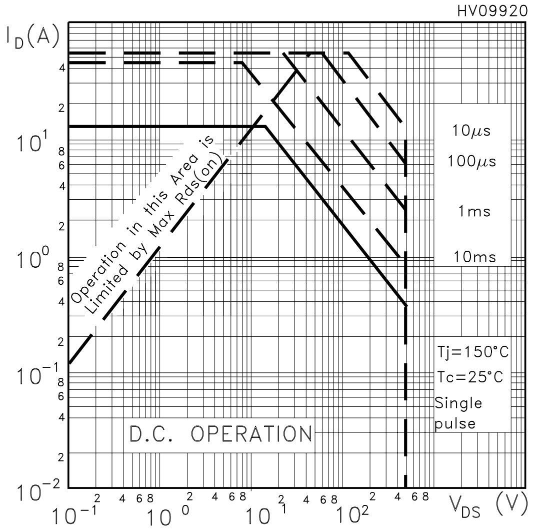
### Safe Operating Area For TO-220FP



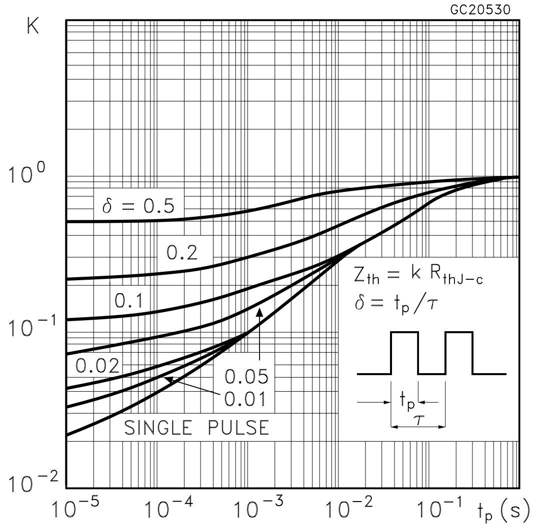
### Thermal Impedance For TO-220FP



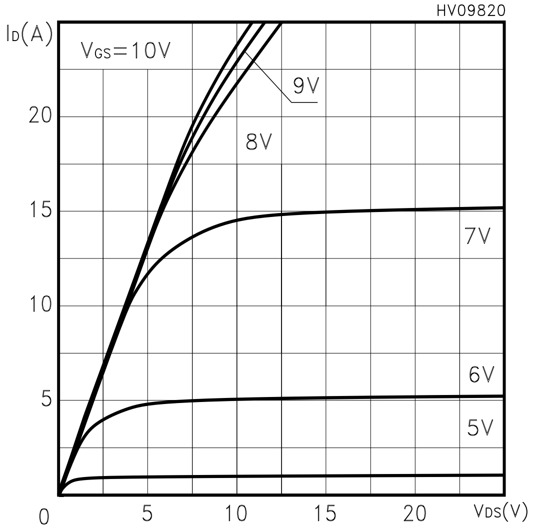
### Safe Operating Area For TO-247



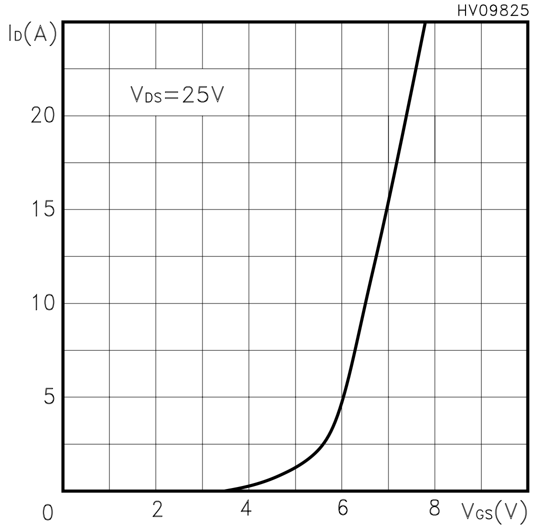
### Thermal Impedance For TO-247



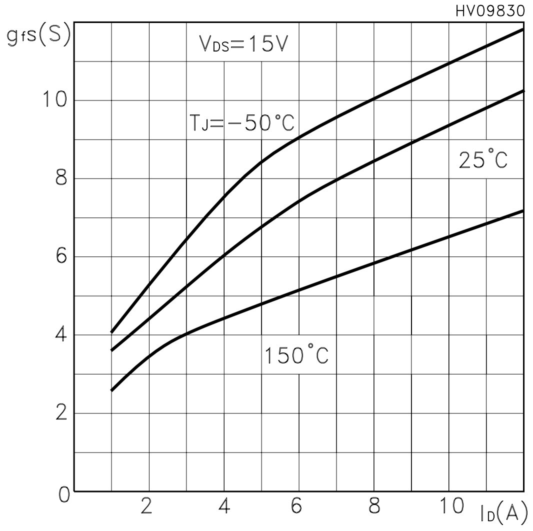
### Output Characteristics



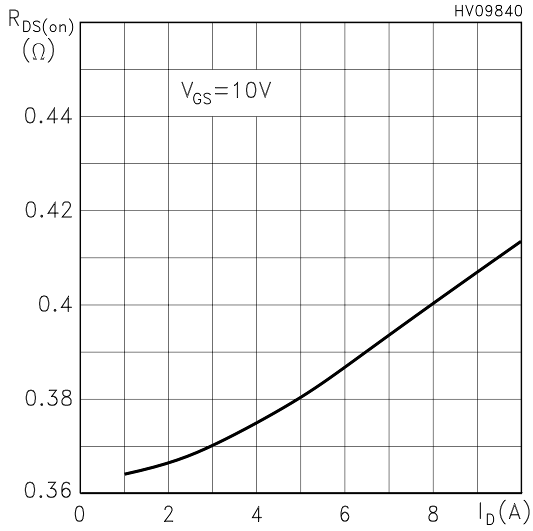
### Transfer Characteristics



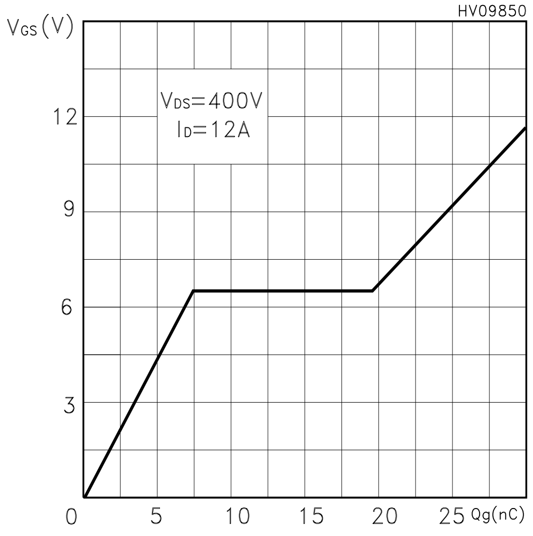
### Transconductance



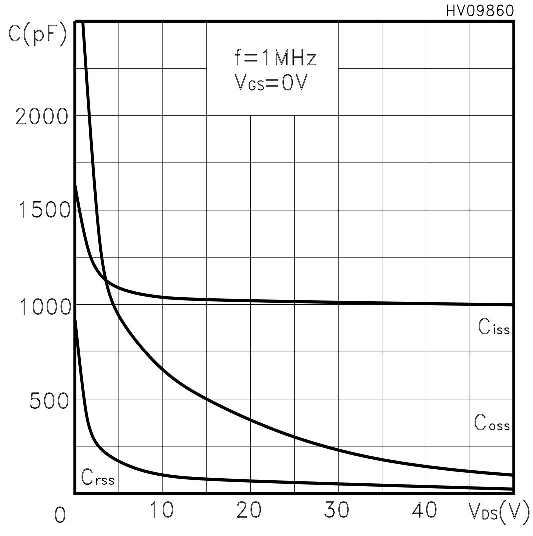
### Static Drain-source On Resistance



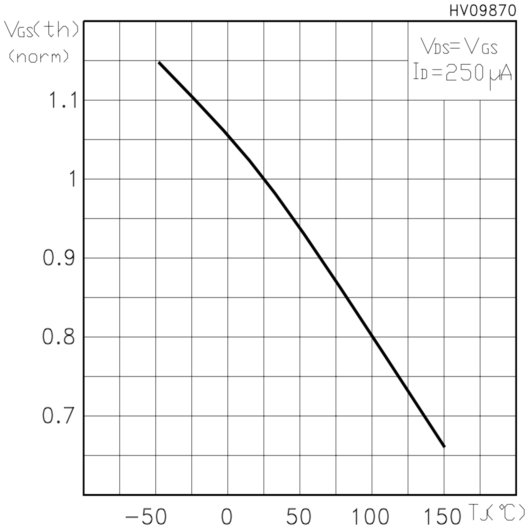
### Gate Charge vs Gate-source Voltage



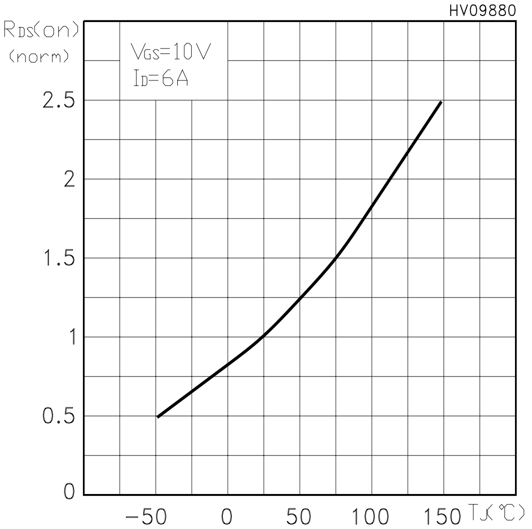
### Capacitance Variations



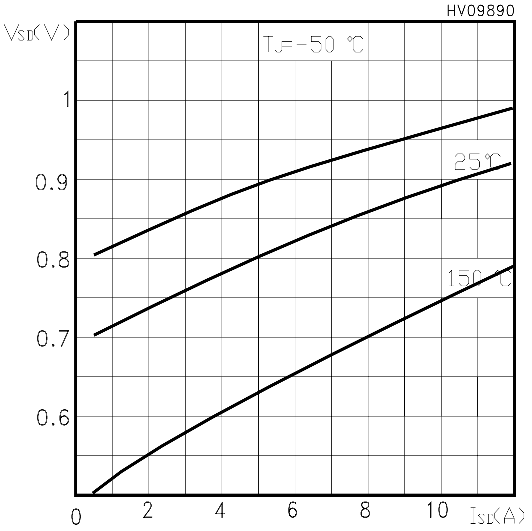
**Normalized Gate Threshold Voltage vs Temp.**



**Normalized On Resistance vs Temperature**



**Source-drain Diode Forward Characteristics**



**Normalized BVDSS vs Temperature**

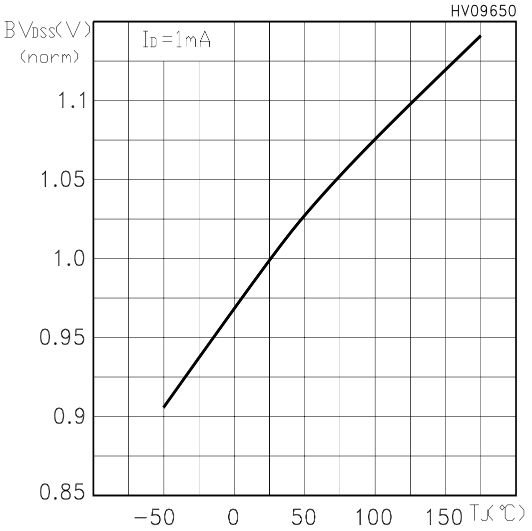


**Fig. 1:** Unclamped Inductive Load Test Circuit

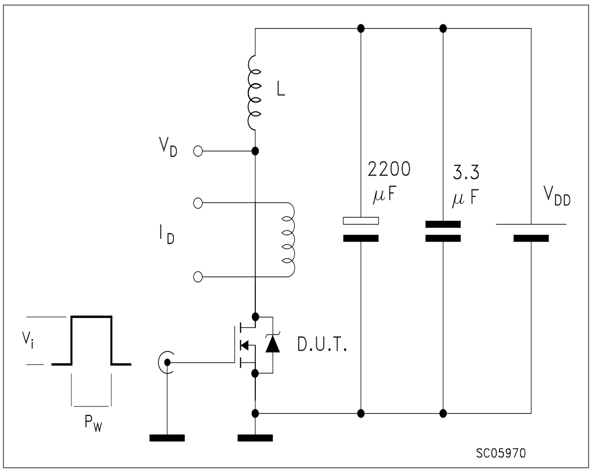


**Fig. 2:** Unclamped Inductive Waveform

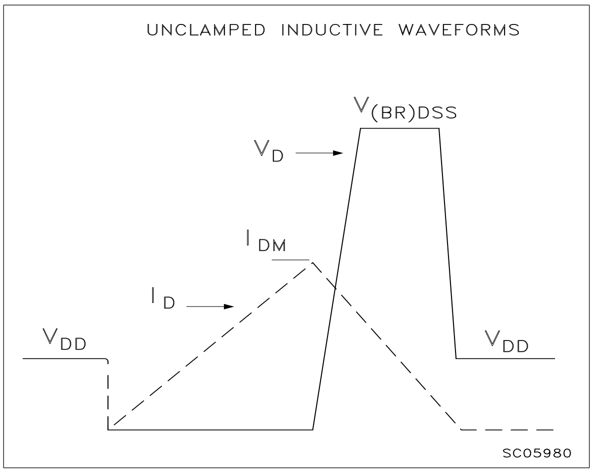


**Fig. 3:** Switching Times Test Circuit For Resistive Load

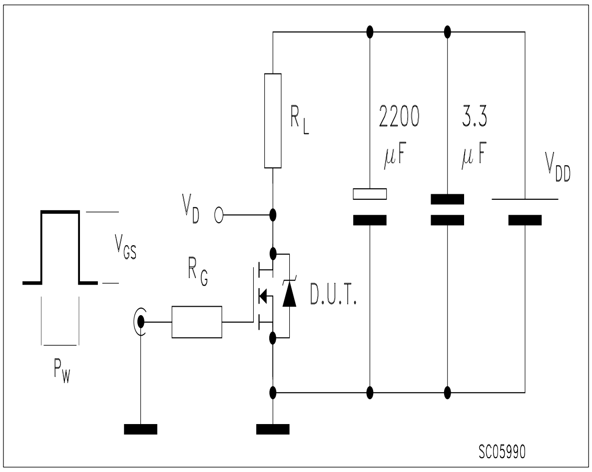


**Fig. 4:** Gate Charge test Circuit

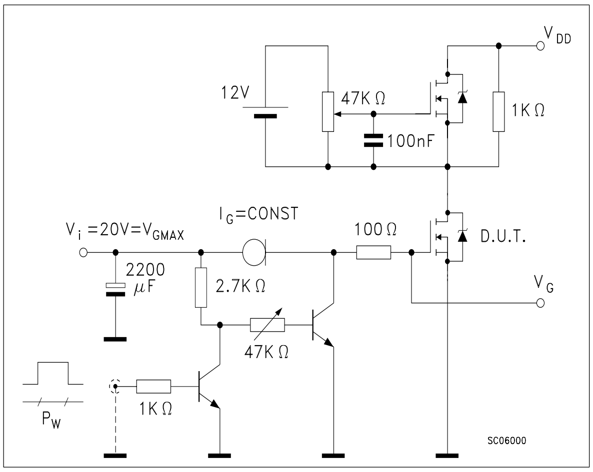
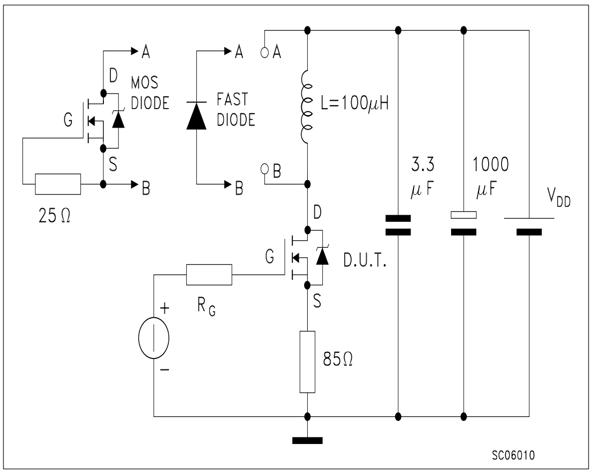
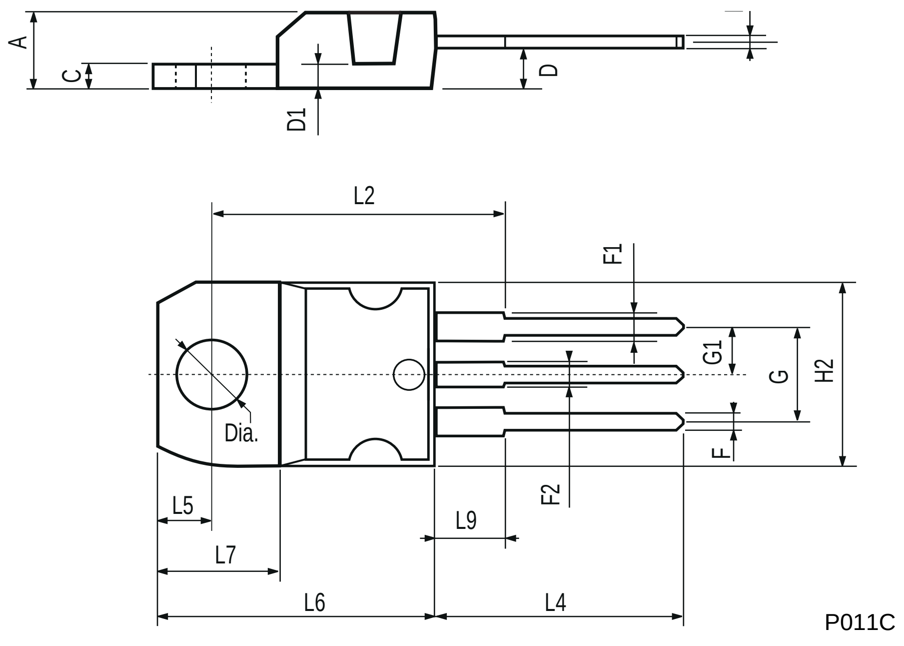


**Fig. 5:** Test Circuit For Inductive Load Switching And Diode Recovery Times



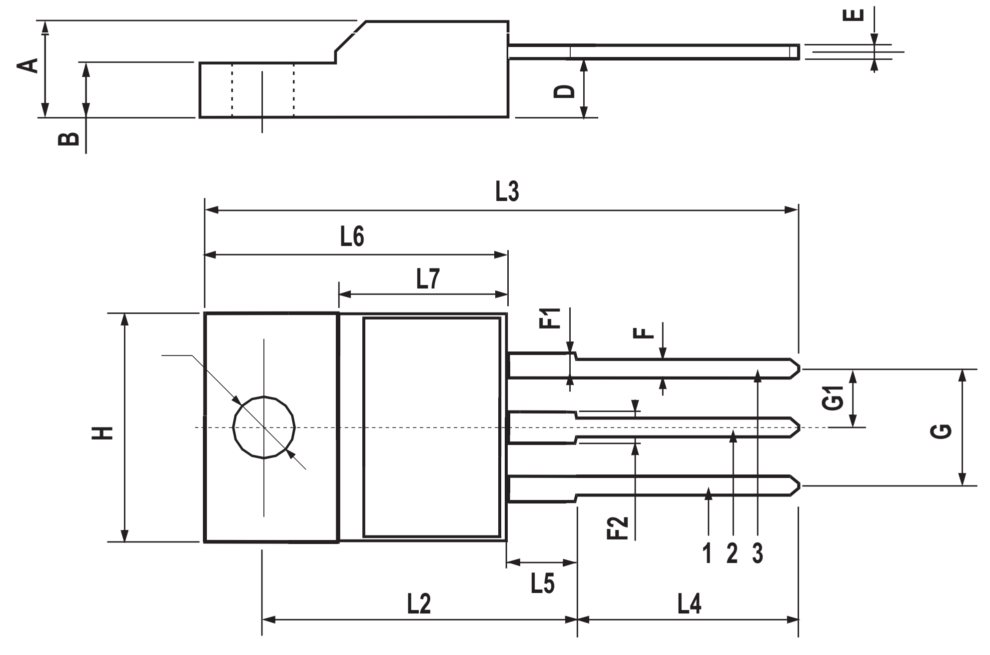
## TO-220 MECHANICAL DATA

| 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 |



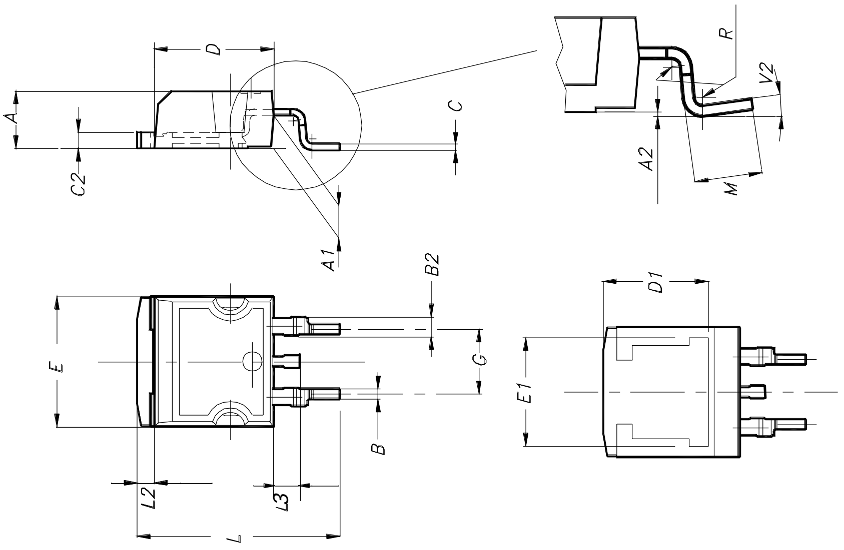
## TO-220FP MECHANICAL DATA

| 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 | .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 |



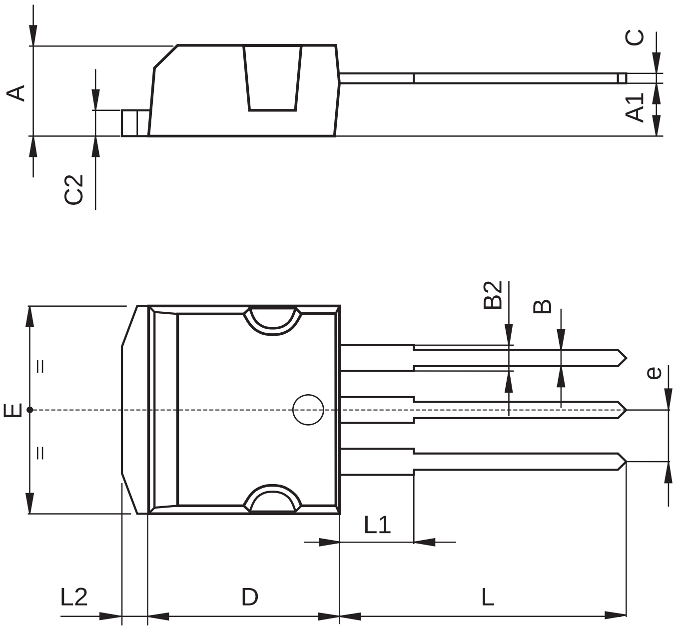
# $D^2$PAK MECHANICAL DATA

| 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 |
| A2 | 0.03 | | 0.23 | 0.001 | | 0.009 |
| 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 |
| D1 | | 8 | | | 0.315 | |
| E | 10 | | 10.4 | 0.393 | | |
| E1 | | 8.5 | | | 0.334 | |
| G | 4.88 | | 5.28 | 0.192 | | 0.208 |
| L | 15 | | 15.85 | 0.590 | | 0.625 |
| L2 | 1.27 | | 1.4 | 0.050 | | 0.055 |
| L3 | 1.4 | | 1.75 | 0.055 | | 0.068 |
| M | 2.4 | | 3.2 | 0.094 | | 0.126 |
| R | | 0.4 | | | 0.015 | |
| V2 | 0º | | 8º | | | |



## TO-262 ($I^2$PAK) 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 |



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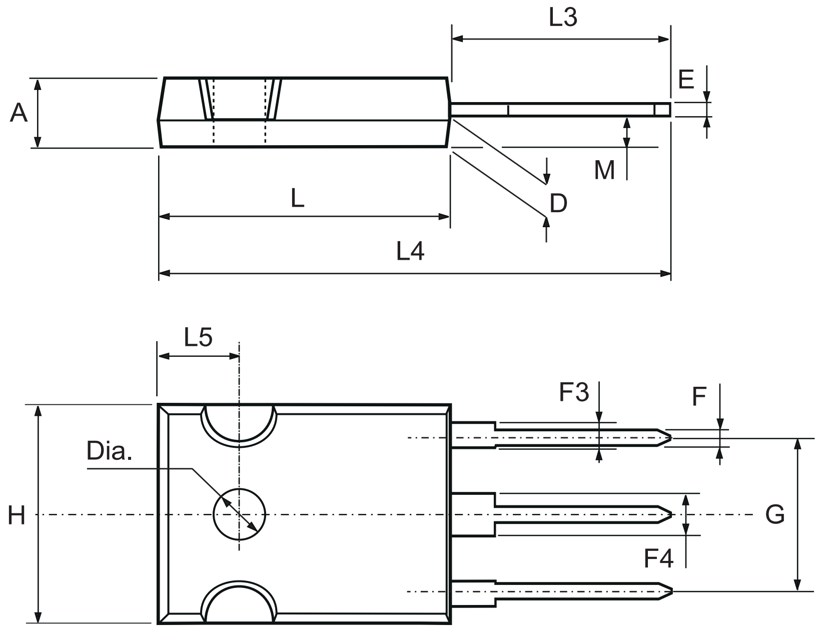
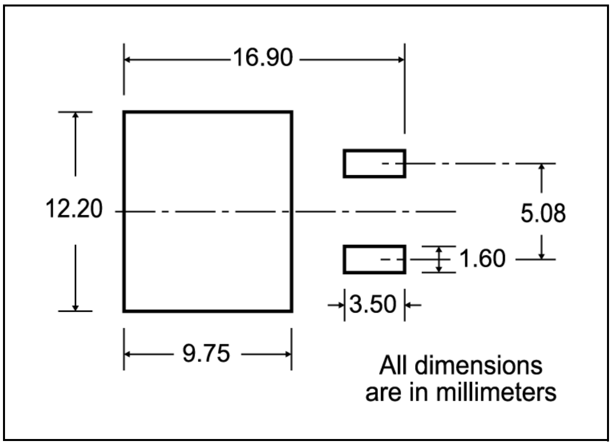
## TO-247 MECHANICAL DATA

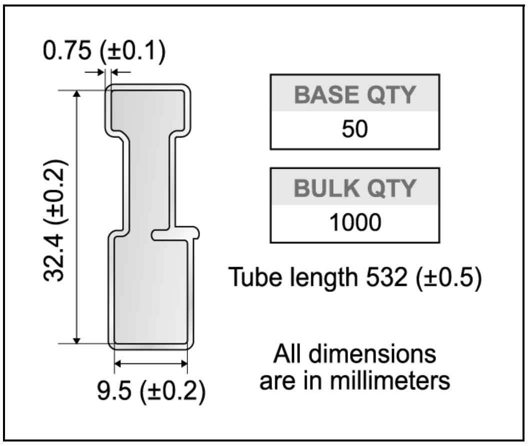
| DIM. | mm | | | inch | | |
|---|---|---|---|---|---|---|
| | MIN. | TYP. | MAX. | MIN. | TYP. | MAX. |
| A | 4.7 | | 5.3 | 0.185 | | 0.209 |
| D | 2.2 | | 2.6 | 0.087 | | 0.102 |
| E | 0.4 | | 0.8 | 0.016 | | 0.031 |
| F | 1 | | 1.4 | 0.039 | | 0.055 |
| F3 | 2 | | 2.4 | 0.079 | | 0.094 |
| F4 | 3 | | 3.4 | 0.118 | | 0.134 |
| G | | 10.9 | | | 0.429 | |
| H | 15.3 | | 15.9 | 0.602 | | 0.626 |
| L | 19.7 | | 20.3 | 0.776 | | 0.779 |
| L3 | 14.2 | | 14.8 | 0.559 | | 0.582 |
| L4 | | 34.6 | | | 1.362 | |
| L5 | | 5.5 | | | 0.217 | |
| M | 2 | | 3 | 0.079 | | 0.118 |



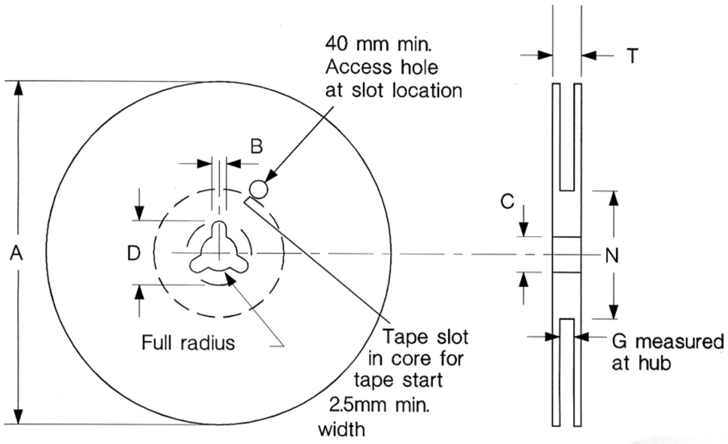
## D$^2$PAK FOOTPRINT



## TUBE SHIPMENT (no suffix)*



## TAPE AND REEL SHIPMENT (suffix ”T4”)*



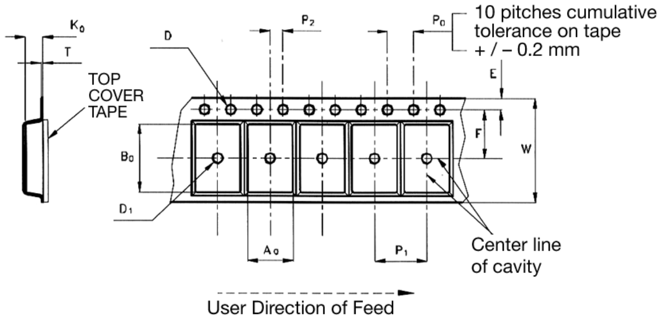
REEL MECHANICAL DATA

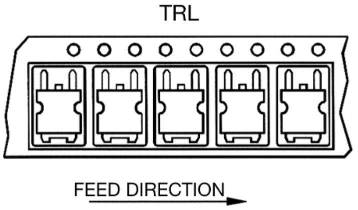
| DIM. | mm |  | inch |  |
|---|---|---|---|---|
|  | MIN. | MAX. | MIN. | MAX. |
| A |  | 330 |  | 12.992 |
| B | 1.5 |  | 0.059 |  |
| C | 12.8 | 13.2 | 0.504 | 0.520 |
| D | 20.2 |  | 0795 |  |
| G | 24.4 | 26.4 | 0.960 | 1.039 |
| N | 100 |  | 3.937 |  |
| T |  | 30.4 |  | 1.197 |

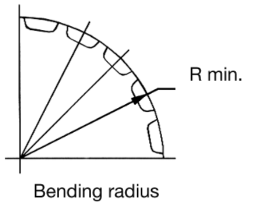
| BASE QTY | BULK QTY |
|---|---|
| 1000 | 1000 |

TAPE MECHANICAL DATA

| DIM. | mm |  | inch |  |
|---|---|---|---|---|
|  | MIN. | MAX. | MIN. | MAX. |
| A0 | 10.5 | 10.7 | 0.413 | 0.421 |
| B0 | 15.7 | 15.9 | 0.618 | 0.626 |
| D | 1.5 | 1.6 | 0.059 | 0.063 |
| D1 | 1.59 | 1.61 | 0.062 | 0.063 |
| E | 1.65 | 1.85 | 0.065 | 0.073 |
| F | 11.4 | 11.6 | 0.449 | 0.456 |
| K0 | 4.8 | 5.0 | 0.189 | 0.197 |
| P0 | 3.9 | 4.1 | 0.153 | 0.161 |
| P1 | 11.9 | 12.1 | 0.468 | 0.476 |
| P2 | 1.9 | 2.1 | 0.075 | 0.082 |
| R | 50 |  | 1.574 |  |
| T | 0.25 | 0.35 | 0.0098 | 0.0137 |
| W | 23.7 | 24.3 | 0.933 | 0.956 |







* on sales type

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