## Description

WTM65R070FMP/F/TL is an N-channel power MOSFET designed according to super junction technology. This device has very low on-resistance and hard ruggedness for switching applications. It's very low conduction loss and fast switching can make applications more efficient and faster.

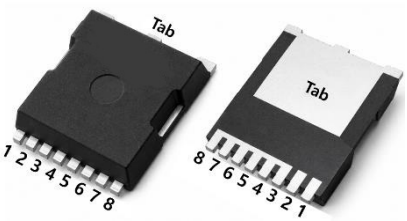
## Features

- Low gate charge
- Low $R_{DS(on)}$ per chip area(Low FOM)
- Very low switching and conduction loss
- Extremely high commutation ruggedness
- Ultra fast body diode
- 100% avalanche tested

## Applications

- TV and PC Power
- Adopter and Lighting
- Telecom and UPS(Uninterruptible Power Supply)

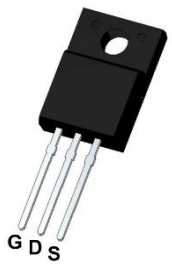
## Package & Internal circuit



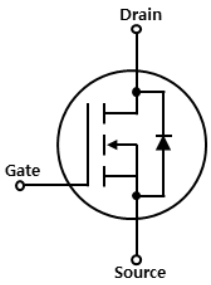

TOLL




TO-247




TO-220F




## Key parameters

| Parameter | Value | Unit |
|---|---|---|
| $V_{DS}$ @ $T_{j,max}$ | 650 | V |
| $Q_{g,typ}$ | 75.7 | nC |
| $I_D$ | 44 | A |
| $R_{DS(on),max}$ | 70 | mΩ |

## Ordering Information

| Ordering Code | Package | Marking | Packing type |
|---|---|---|---|
| WTM65R070FMP | TO-247 | WPM 65R070FMP XXX YYWW | Tube |
| WTM65R070FF | TO-220F | WPM 65R070FF XXX YYWW | Tube |
| WTM65R070FTL | TOLL | WPM 65R070FTL XXX YYWW | Tube |

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## Absolute maximum ratings at $T_C$=25ºC unless otherwise specified

| Symbol | Parameter | Value | Unit | Test condition |
|---|---|---|---|---|
| $V_{DS}$ | Drain-source voltage | 650 | V | - |
| $V_{GS}$ | Gate-source voltage | ±30 | V | - |
| $I_D$(1) | Continuous drain current | 44 | A | $T_C$ = 25˚C |
| | Continuous drain current | 27.7 | A | $T_C$ = 100˚C |
| $I_{DM}$(2) | Pulsed drain current | 132 | A | $T_C$ = 25˚C |
| $E_{AS}$ | Single pulsed avalanche energy | 166 | mJ | Starting $T_j$ = 25˚C, $I_{AS}$ = 5.8A, $V_{DD}$ = 50V, $I_D$ = $I_{AR}$ |
| $P_{tot}$ | Total power dissipation (TO-247) | 200 | W | $T_C$ = 25˚C |
| | (TO-220F) | 70 | W | $T_C$ = 25˚C |
| | (TOOL) | 400 | W | $T_C$ = 25˚C |
| dv/dt | MOSFET dv/dt ruggedness | 50 | V/ns | $V_{DS}$ = 0…400V |
| dv/dt | Reverse diode dv/dt | 15 | V/ns | $V_{DS}$ = 0…400V, $T_j$ = 25˚C, $I_{SD}$≤$I_D$ |
| $T_{stg}$ | Storage temperature | -55 to 150 | ˚C | - |
| $T_j$ | Operating junction temperature | -55 to 150 | ˚C | - |

1. limited by $T_{j,max}$, Maximum duty cycle D=0.5
2. Pulse width limited by $T_{j,max}$

## Thermal characteristics

| Symbol | Parameter | Value | Unit | Test condition |
|---|---|---|---|---|
| $R_{thJC}$ | Thermal resistance, junction - case | 0.8 | ˚C/W | - |
| $R_{thJA}$ | Thermal resistance, junction - ambient | 62.5 | ˚C/W | - |

## Static characteristics at $T_C$=25ºC unless otherwise specified

| Symbol | Parameter | Maximum value | | | Unit | Test condition |
|---|---|---|---|---|---|---|
| | | Min. | Typ. | Max. | | |
| $V_{(BR)DSS}$ | Drain-source breakdown voltage | 650 | - | - | V | $V_{GS}$ = 0V, $I_D$ = 0.25mA |
| $V_{GS(th)}$ | Gate threshold voltage | 3 | 4 | 5 | V | $V_{GS}$ = $V_{DS}$, $I_D$ = 0.25mA |
| $I_{GSS}$ | Gate-body leakage current | - | - | 100 | nA | $V_{GS}$ = ±30V, $T_j$ = 25ºC |
| $I_{DSS}$ | Zero gate voltage drain current | - | - | 5 | uA | $V_{DS}$ = 650V, $V_{GS}$ = 0V, $T_j$ = 25˚C |
| $R_{DS(on)}$ | Drain-source on-resistance | - | 63 | 70 | mΩ | $V_{GS}$ = 10V, $I_D$ = 22A |

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## Dynamic characteristics

| Symbol | Parameter | Values | | | Unit | Test condition |
|---|---|---|---|---|---|---|
| | | Min. | Typ. | Max. | | |
| $C_{iss}$ | Input capacitance | - | 3290 | - | pF | $V_{DS}$ = 400V, $V_{GS}$ = 0V, $f$ = 100kHz |
| $C_{oss}$ | Output capacitance | - | 50.4 | - | pF | |
| $C_{rss}$ | Reverse transfer capacitance | - | 7.07 | - | pF | |
| $C_{o(er)}$ (3) | Effective output capacitance, energy related | - | 92.2 | - | pF | $V_{GS}$ =10V, $V_{DS}$ = 0…400V |
| $C_{o(tr)}$ (4) | Effective output capacitance, time related | - | 786 | - | pF | $V_{GS}$ =10V, $V_{DS}$ = 0…400V |
| $t_{d(on)}$ | Turn-on delay time | - | 61.6 | - | ns | $V_{DD}$ = 400V, $I_D$ = 22A, $V_{GS}$ =10V, $R_G$ =20Ω |
| $t_r$ | Rise time | - | 108 | - | ns | |
| $t_{d(off)}$ | Turn-off delay time | - | 146 | - | ns | |
| $t_f$ | Fall time | - | 19.2 | - | ns | |
| $R_G$ | Gate resistance | - | 7.91 | - | Ω | $f$ = 1MHz, $I_D$ = 0A |
| $Q_g$ | Total gate charge | - | 75.7 | - | nC | $V_{DD}$ = 400V, $V_{GS}$ = 10V, $I_D$ = 22A |
| $Q_{gs}$ | Gate-source charge | - | 19.6 | - | nC | |
| $Q_{gd}$ | Gate-drain charge | - | 33.6 | - | nC | |

3. $C_{o(er)}$ is a fixed capacitance that gives the same stored energy as $C_{oss}$ while $V_{DS}$ is rising from 0 to 400V
4. $C_{o(tr)}$ is a fixed capacitance that gives the same charging time as $C_{oss}$ while $V_{DS}$ is rising from 0 to 400V

## Reverse diode characteristics

| Symbol | Parameter | Values | | | Unit | Test condition |
|---|---|---|---|---|---|---|
| | | Min. | Typ. | Max. | | |
| $V_{SD}$ | Diode forward voltage | - | - | 1.4 | V | $V_{GS}$ = 0V, $I_{SD}$ = 22A, $T_j$ = 25˚C |
| $I_{SD}$ | Continuous Diode forward current | - | - | 44 | A | - |
| $t_{rr}$ | Reverse recovery time | - | 175 | - | ns | $I_{SD}$ = 22A, $V_{DS}$ = 400V, di/dt = 100A/us |
| $I_{rr}$ | Reverse recovery current | - | 13.3 | - | A | |
| $Q_{rr}$ | Reverse recovery charge | - | 1.16 | - | uC | |

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## Characteristic Graph

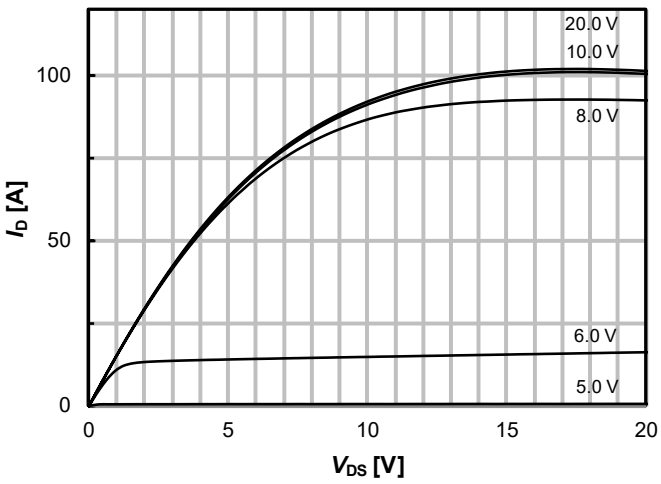



Fig. 1 Output Characteristics

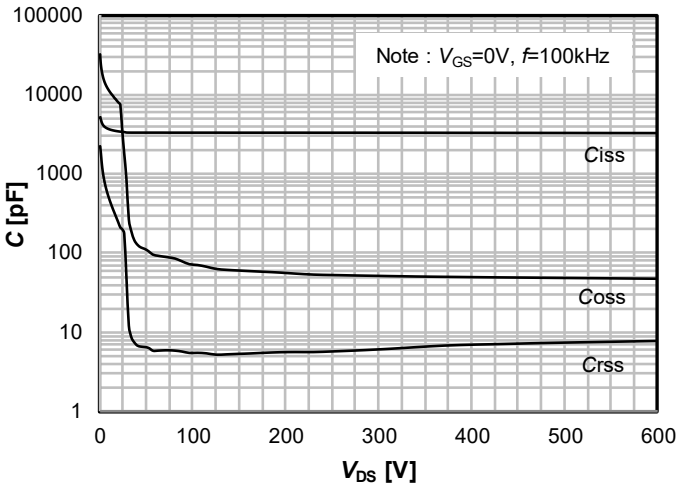



Fig. 2 Capacitances

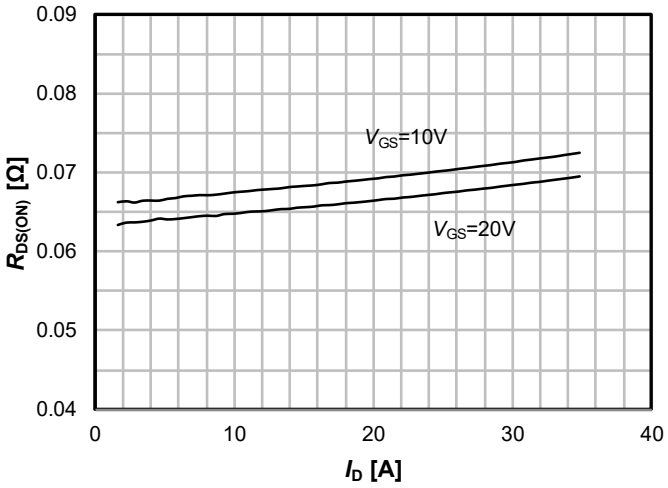



Fig. 3 On-state Resistance

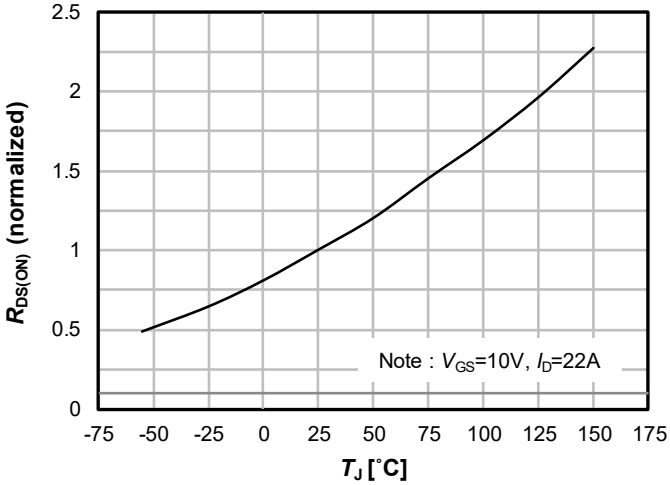



Fig. 4 On-state Resistance with Temperature

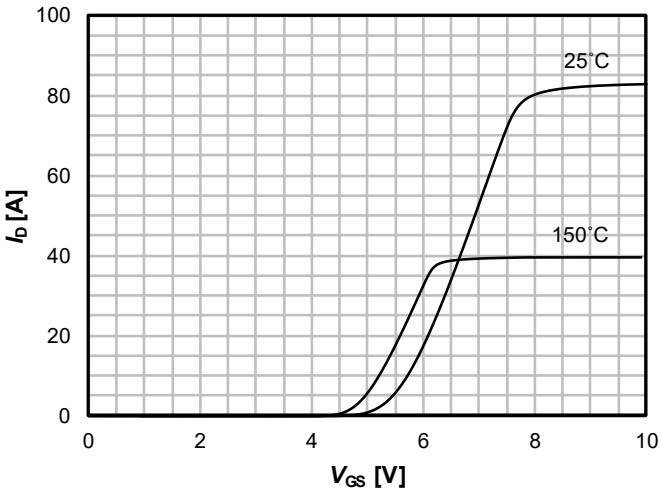



Fig. 5 Transfer Characteristics

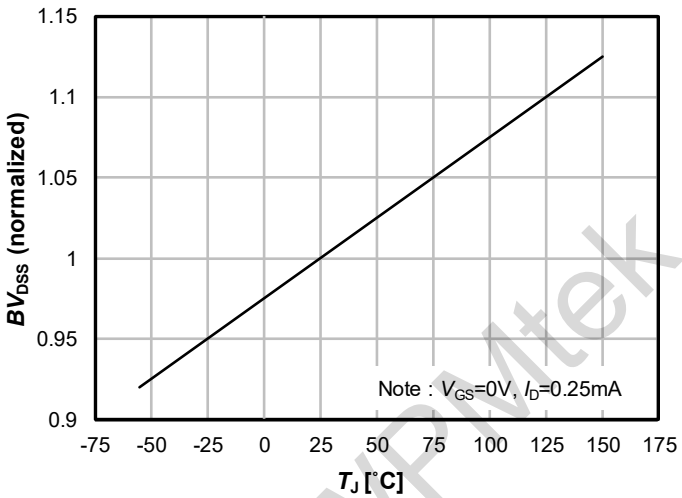



Fig. 6 Breakdown Voltage with Temperature

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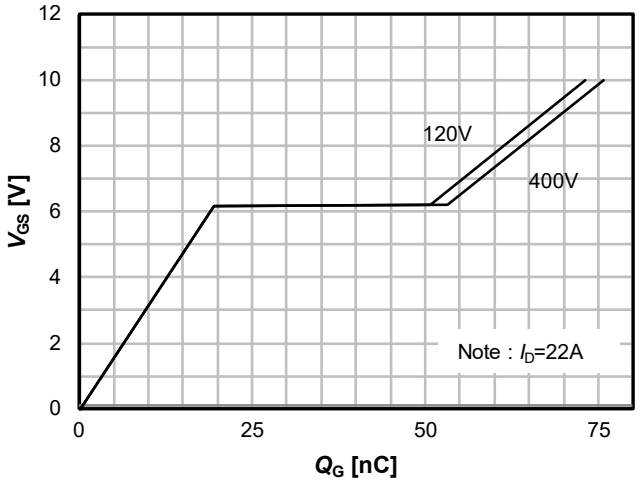



Fig. 7 Gate Charge

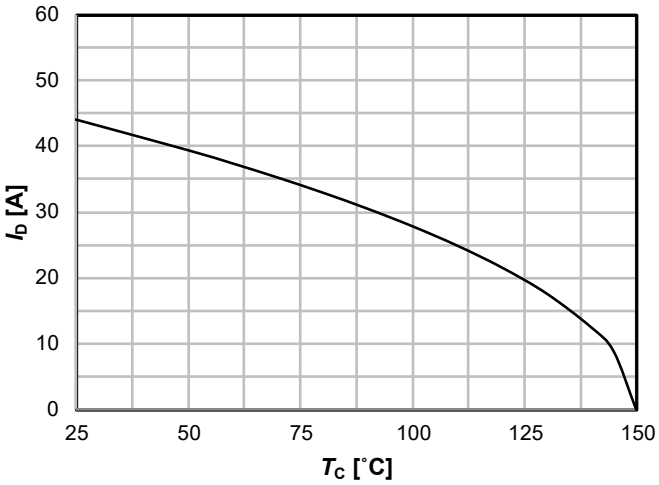



Fig. 8 Maximum Drain Current

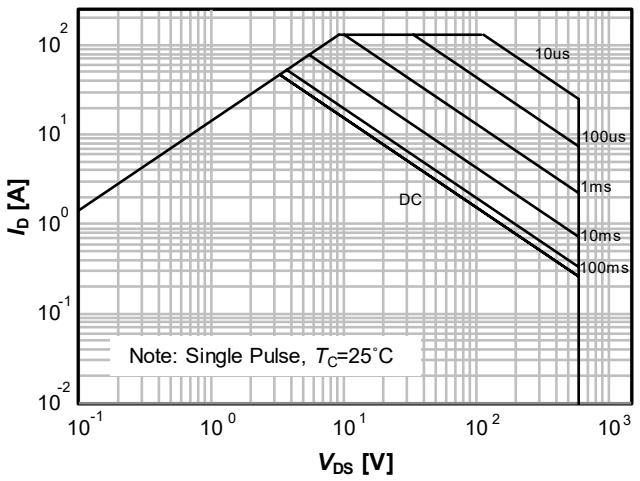



Fig. 9 Safe Operating Area

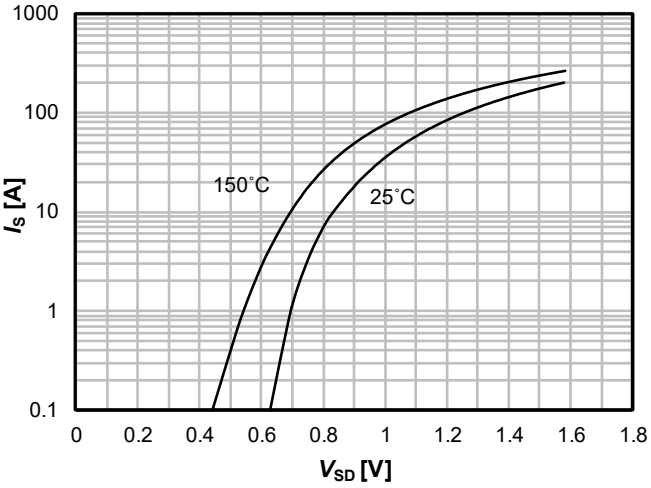



Fig. 10 Body Diode Characteristics

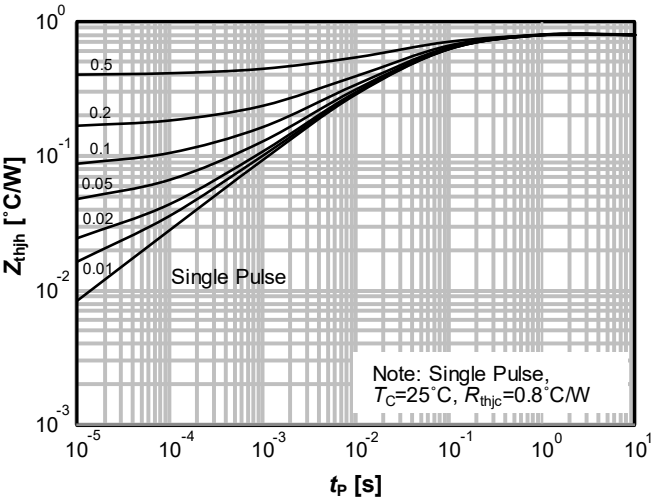



Fig. 11 Maximum Transient Thermal Characteristics

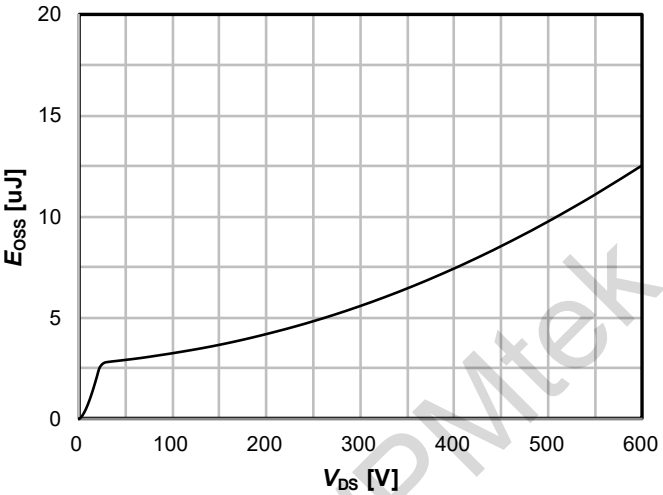



Fig. 12 $C_{oss}$ Stored Energy

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## Test Circuits

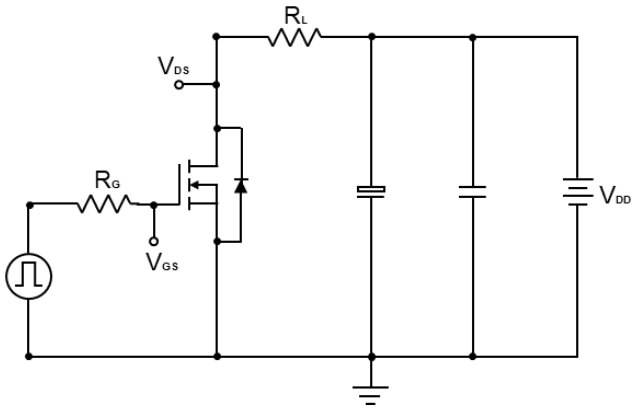



Fig. 13 Test circuit for resistive load switching times

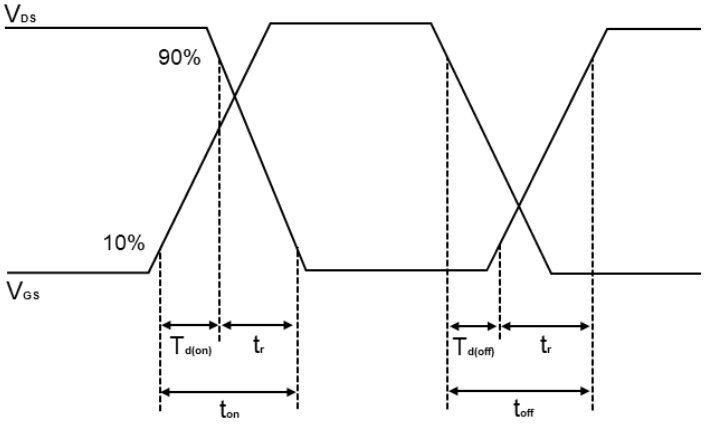



Fig. 14 Switching times waveform

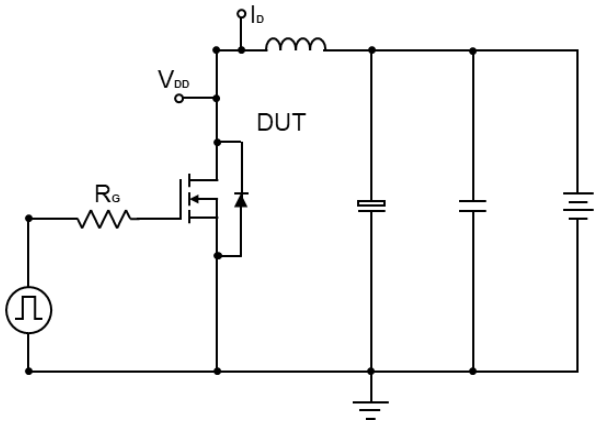



Fig. 15 Test circuit for unclamped inductive load

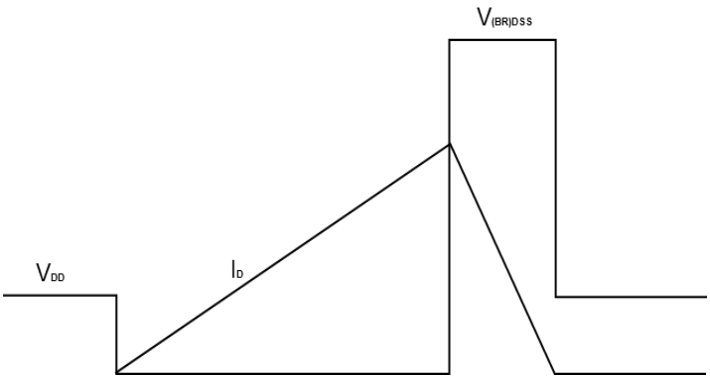



Fig. 16 Unclamped inductive waveform

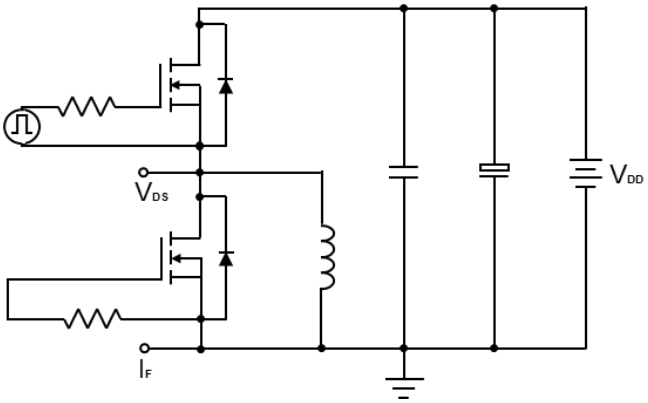



Fig. 17 Test circuit for diode characteristics

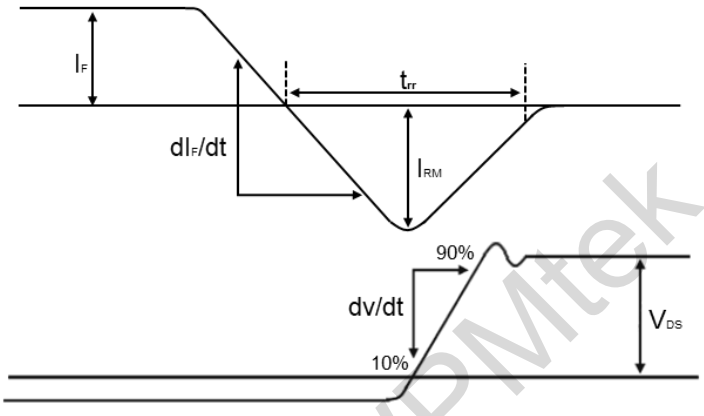
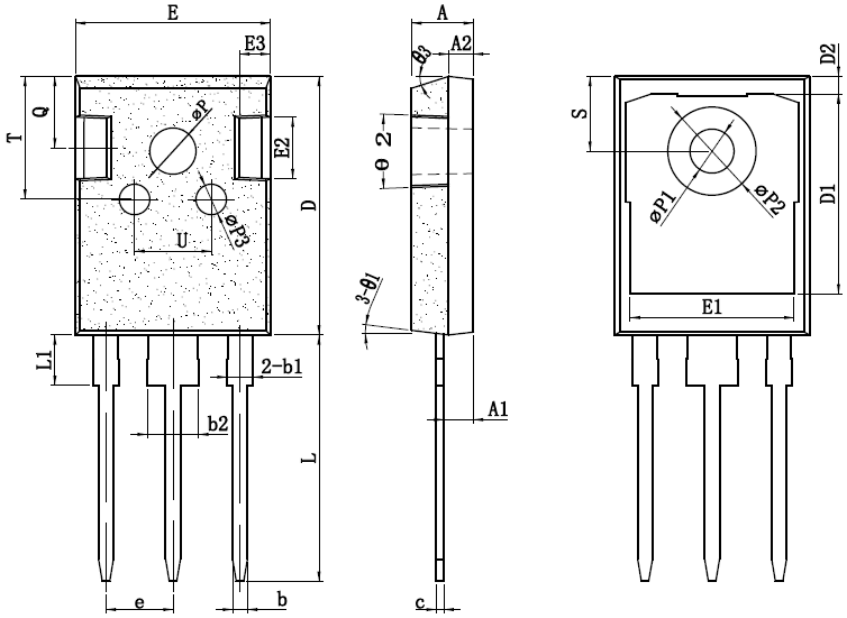


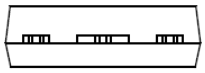

Fig. 18 Diode recovery waveform

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## Package Information

### TO-247 Package Outline



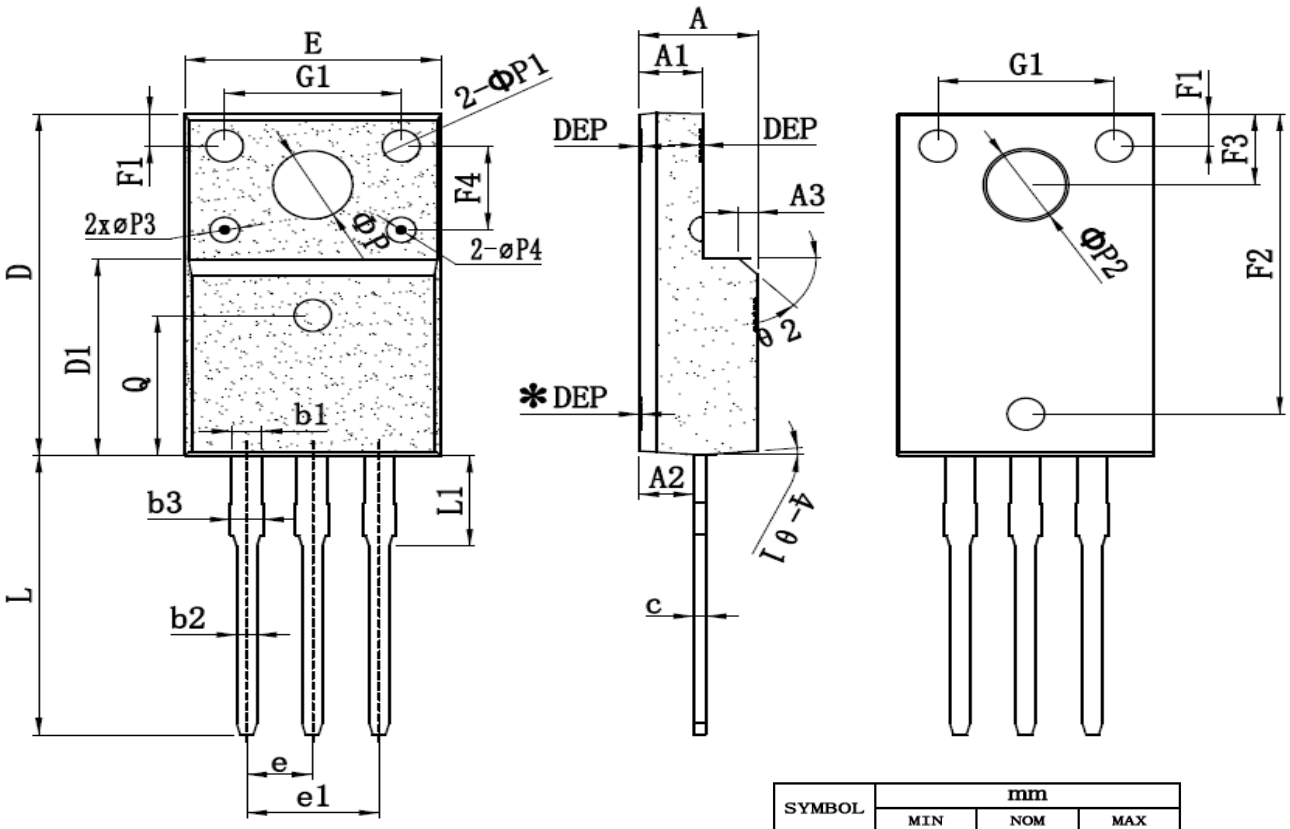



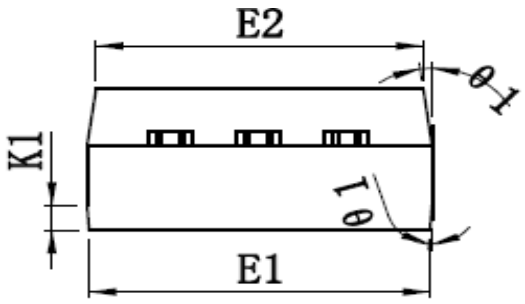
| SYMBOL | mm | | |
|---|---|---|---|
| | MIN | NOM | MAX |
| *A | 4.90 | 5.00 | 5.10 |
| *A1 | 2.31 | 2.41 | 2.51 |
| A2 | 1.90 | 2.00 | 2.10 |
| *b | 1.15 | 1.20 | 1.25 |
| *b1 | 1.95 | 2.10 | 2.25 |
| *b2 | 2.95 | 3.10 | 3.25 |
| *c | 0.55 | 0.60 | 0.65 |
| *D | 20.90 | 21.00 | 21.10 |
| D1 | 16.35 | 16.55 | 16.75 |
| D2 | 1.05 | 1.20 | 1.35 |
| *E | 15.70 | 15.80 | 15.90 |
| E1 | 13.10 | 13.25 | 13.40 |
| E2 | 4.90 | 5.00 | 5.10 |
| E3 | 2.40 | 2.50 | 2.60 |
| *e | 5.40 | 5.44 | 5.48 |
| *L | 19.80 | 19.98 | 20.15 |
| *L1 | – | – | 4.30 |
| *ΦP | 3.60 | 3.70 | 3.80 |
| *ΦP1 | 3.45 | 3.55 | 3.65 |
| ΦP2 | 7.03 | 7.18 | 7.33 |
| ΦP3 | 2.40 | 2.50 | 2.60 |
| Q | 5.60 | 5.80 | 6.00 |
| *S | 6.05 | 6.15 | 6.25 |
| T | 9.80 | 10.00 | 10.20 |
| U | 6.00 | 6.20 | 6.40 |
| θ1 | 5° | 7° | 9° |
| θ2 | 1° | 3° | 5° |
| θ3 | 13° | 15° | 17° |

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## Package Information

### TO-220F Package Outline



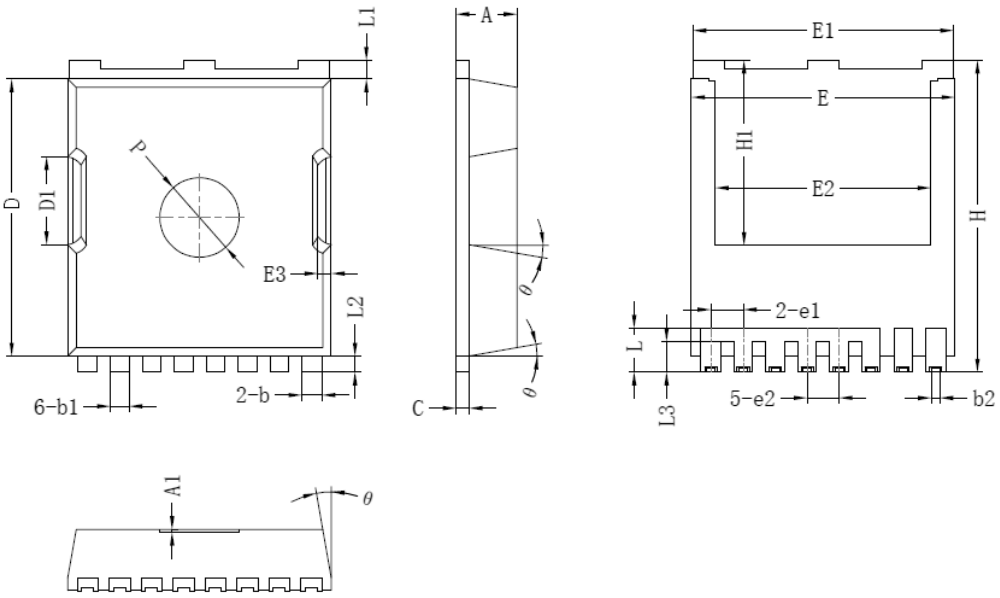




| SYMBOL | mm | | |
|---|---|---|---|
| | MIN | NOM | MAX |
| *A | 4.50 | 4.70 | 4.90 |
| *A1 | 2.34 | 2.54 | 2.74 |
| *A2 | 2.66 | 2.76 | 2.86 |
| A3 | | 1.0REF | |
| b1 | 1.18 | 1.20 | 1.24 |
| *b2 | 0.75 | 0.80 | 0.85 |
| *b3 | 1.22 | 1.30 | 1.38 |
| *C | 0.45 | 0.50 | 0.55 |
| *D | 15.67 | 15.87 | 16.07 |
| D1 | 9.04 | 9.12 | 9.20 |
| *e | 2.50 | 2.54 | 2.58 |
| e1 | | 5.08REF | |
| *E | 10.00 | 10.16 | 10.30 |
| E1 | 9.94 | 10.06 | 10.20 |
| E2 | 9.40 | 9.50 | 9.60 |
| F1 | 1.40 | 1.50 | 1.60 |
| F2 | 13.80 | 13.90 | 14.00 |
| *F3 | 3.20 | 3.30 | 3.40 |
| F4 | 3.70 | 3.90 | 4.10 |
| G1 | 6.90 | 7.00 | 7.10 |
| K1 | 0.65 | 0.70 | 0.75 |
| *L | 12.78 | 12.98 | 13.18 |
| *L1 | 3.40 | 3.50 | 3.60 |
| Q | | 6.50REF | |
| *ΦP | 3.08 | 3.18 | 3.28 |
| ΦP1 | 1.45 | 1.55 | 1.65 |
| ΦP2 | 3.30 | 3.40 | 3.50 |
| ΦP3 | 0.95 | 1.15 | 1.35 |
| ΦP4 | 0.25 | 0.30 | 0.35 |
| θ1 | 3° | 5° | 7° |
| θ2 | 42° | 45° | 48° |
| *DEP | 0.05 | 0.10 | 0.15 |

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## Package Information

### TOLL Package Outline




| SYMBOL | mm | | |
|---|---|---|---|
| | MIN | NOM | MAX |
| *A | 2.20 | 2.30 | 2.40 |
| A1 | 0.00 | 0.05 | 0.10 |
| *b | 0.65 | 0.75 | 0.85 |
| *b1 | 0.60 | 0.70 | 0.80 |
| b2 | 0.30 | 0.35 | 0.40 |
| *c | 0.40 | 0.50 | 0.60 |
| *D | 10.18 | 10.38 | 10.58 |
| D1 | 3.15 | 3.30 | 3.45 |
| *E | 9.70 | 9.90 | 10.10 |
| E1 | 9.70 | 9.80 | 9.90 |
| *E2 | 8.00 | 8.10 | 8.20 |
| E3 | 0.60 | 0.70 | 0.80 |
| *e1 | 1.175 | 1.225 | 1.275 |
| *e2 | 1.15 | 1.20 | 1.25 |
| *H | 11.50 | 11.68 | 11.78 |
| *H1 | 6.80 | 6.95 | 7.10 |
| *L | 1.40 | 1.60 | 1.80 |
| L1 | 0.55 | 0.70 | 0.85 |
| L2 | 0.50 | 0.60 | 0.70 |
| L3 | 1.00 | 1.15 | 1.30 |
| θ | 0° | 2.5° | 8° |
| P | 2.80 | 3.00 | 3.20 |

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