# 600V Super-junction Power MOSFET

## Description

**600V Super-junction Power MOSFET**

Super-junction power MOSFET is a revolutionary technology for high voltage power MOSFETs，designed according to the SJ principle and pioneered. The Multi-EPI SJ MOSFET provide an extremely fast and robust body diode. Also provide an extremely low switching, communication and conduction losses device with highest robustness make especially resonant switching applications more reliable, more efficient, lighter and cooler, designed by Wuxi Unigroup Microelectronics Company.

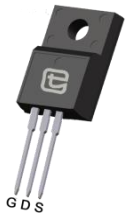
## Features

- Ultra-fast body diode
- Very low FOM $R_{DS(on)} \times Q_g$
- Easy to use/drive
- 100% avalanche tested
- RoHS compliant

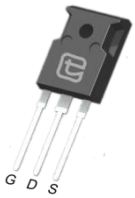
## Applications

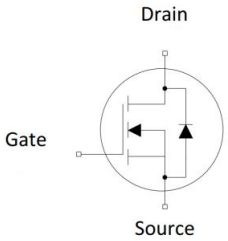
- Switch Mode Power Supply (SMPS)
- Uninterruptible Power Supply (UPS)
- Power Factor Correction (PFC)
- LLC Half-bridge
- Charger

TO-220FP-NL




TO-247




RoHS

## Device Marking and Package Information

| Device | Package | Marking |
|---|---|---|
| TPR60R120MFD | TO-220FP-NL | 60R120MFD |
| TPW60R120MFD | TO-247 | 60R120MFD |

## Key Performance Parameters

| Parameter | Value | Unit |
|---|---|---|
| $V_{DS}$ @ $T_{j,max}$ | 650 | V |
| $R_{DS(on),max}$ | 0.12 | Ω |
| $Q_{g,typ}$ | 58.1 | nC |
| $I_D$ | 30 | A |
| $I_{D,pulse}$ | 90 | A |
| $E_{OSS}$ @ 400V | 7.8 | μJ |
| Body Diode $di_F/dt$ | 900 | A/μs |
| $t_{rr}$ | 209 | ns |
| $Q_{rr}$ | 1.3 | μC |
| $I_{rrm}$ | 12.6 | A |

| **Absolute Maximum Ratings** $T_C$ = 25ºC, unless otherwise noted | | | | |
|---|---|---|---|---|
| **Parameter** | | **Symbol** | **Values** | **Unit** |
| Continuous Drain Current | $T_C$ = 25ºC | $I_D$ | 30 | A |
| | $T_C$ = 100ºC | | 18 | |
| Pulsed Drain Current (note1) | | $I_{D,pulse}$ | 90 | A |
| Gate-Source Voltage | | $V_{GSS}$ | ±30V | V |
| Single Pulse Avalanche Energy (note2) | | $E_{AS}$ | 636 | mJ |
| Repetitive Avalanche Energy (note2) | | $E_{AR}$ | 0.96 | mJ |
| Avalanche Current | | $I_{AR}$ | 5.2 | A |
| MOSFET dv/dt Ruggedness, $V_{DS}$ = 0...480V | | dv/dt | 50 | V/ns |
| Power Dissipation For TO-220FP-NL | | $P_D$ | 34 | W |
| Power Dissipation For TO-247 | | | 219 | |
| Continuous Diode Forward Current | | $I_S$ | 30 | A |
| Diode Pulsed Current (note1) | | $I_{S,pulse}$ | 90 | |
| Reverse Diode dv/dt (note3) | | dv/dt | 50 | V/ns |
| Maximum Diode Commutation Speed (note3) | | $di_f/dt$ | 900 | A/μs |
| Operating Junction and Storage Temperature Range | | $T_J$, $T_{stg}$ | -55~+150 | ºC |

| **Thermal Resistance For TO-220FP-NL** | | | |
|---|---|---|---|
| **Parameter** | **Symbol** | **Value** | **Unit** |
| Thermal Resistance, Junction-to-Case | $R_{thJC}$ | 3.65 | ºC/W |
| Thermal Resistance, Junction-to-Ambient | $R_{thJA}$ | 80 | |

| **Thermal Resistance For TO-247** | | | |
|---|---|---|---|
| **Parameter** | **Symbol** | **Value** | **Unit** |
| Thermal Resistance, Junction-to-Case | $R_{thJC}$ | 0.57 | ºC/W |
| Thermal Resistance, Junction-to-Ambient | $R_{thJA}$ | 62 | |

**Electrical Characteristics** $T_J$ = 25ºC, unless otherwise noted

| Parameter | Symbol | Test Conditions | Value | | | Unit |
|---|---|---|---|---|---|---|
| | | | Min. | Typ. | Max. | |
| **Static Characteristics** | | | | | | |
| Drain-Source Breakdown Voltage | $V_{(BR)DSS}$ | $V_{GS}$ = 0V, $I_D$ = 250μA | 600 | -- | -- | V |
| Zero Gate Voltage Drain Current | $I_{DSS}$ | $V_{DS}$ = 600V,$V_{GS}$ = 0V, $T_J$ = 25ºC | -- | -- | 3.5 | μA |
| Gate-Source Leakage Current | $I_{GSS}$ | $V_{GS}$ = ±30V | -- | -- | ±100 | nA |
| Gate-Source Threshold Voltage | $V_{GS(th)}$ | $V_{DS}$ = $V_{GS}$, $I_D$ = 250μA | 3.0 | -- | 5.0 | V |
| Drain-Source On-State-Resistance | $R_{DS(on)}$ | $V_{GS}$ = 10V, $I_D$ = 15A | -- | 0.105 | 0.12 | Ω |
| Gate Resistance | $R_G$ | f = 1.0MHz open drain | -- | 1.74 | -- | Ω |
| **Dynamic Characteristics** | | | | | | |
| Input Capacitance | $C_{iss}$ | $V_{GS}$ = 0V, $V_{DS}$ = 100V f = 1.0MHz | -- | 2524 | -- | pF |
| Output Capacitance | $C_{oss}$ | | -- | 94.1 | -- | |
| Reverse Transfer Capacitance | $C_{rss}$ | | -- | 1.71 | -- | |
| Total Gate Charge | $Q_g$ | $V_{DD}$ = 480V , $I_D$ = 30A, $V_{GS}$ = 10V | -- | 58.1 | -- | nC |
| Gate-Source Charge | $Q_{gs}$ | | -- | 12.4 | -- | |
| Gate-Drain Charge | $Q_{gd}$ | | -- | 18.4 | -- | |
| Turn-on Delay Time | $t_{d(on)}$ | $V_{DD}$ = 400V $I_D$ = 30A $R_G$ = 25Ω | -- | 57.8 | -- | ns |
| Turn-on Rise Time | $t_r$ | | -- | 49.3 | -- | |
| Turn-off Delay Time | $t_{d(off)}$ | | -- | 201.4 | -- | |
| Turn-off Fall Time | $t_f$ | | -- | 64.1 | -- | |
| **Drain-Source Body Diode Characteristics** | | | | | | |
| Body Diode Forward Voltage | $V_{SD}$ | $T_J$ = 25ºC, $I_{SD}$ = 15A, $V_{GS}$ = 0V | -- | 0.9 | 1.5 | V |
| Reverse Recovery Time | $t_{rr}$ | $V_R$ = 400V, $I_F$ = 30A, $di_F/dt$ = 100A/μs | -- | 110 | -- | ns |
| Reverse Recovery Charge | $Q_{rr}$ | | -- | 0.5 | -- | μC |
| Peak Reverse Recovery Current | $I_{rrm}$ | | -- | 8.2 | -- | A |

**Notes**

1. Repetitive Rating: Pulse width limited by maximum junction temperature
2. $I_D$ = 10A, $V_{DD}$ = 50V, $R_G$ = 25Ω, Starting $T_J$ = 25°C
3. Identical low side and high side switch with identical $R_G$

**Typical Characteristics** $T_J$ = 25ºC, unless otherwise noted

**Figure 1. Output Characteristics**

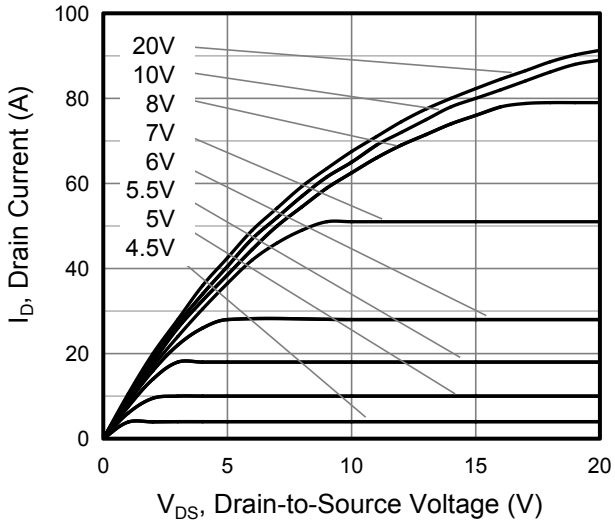



**Figure 2. Transfer Characteristics**

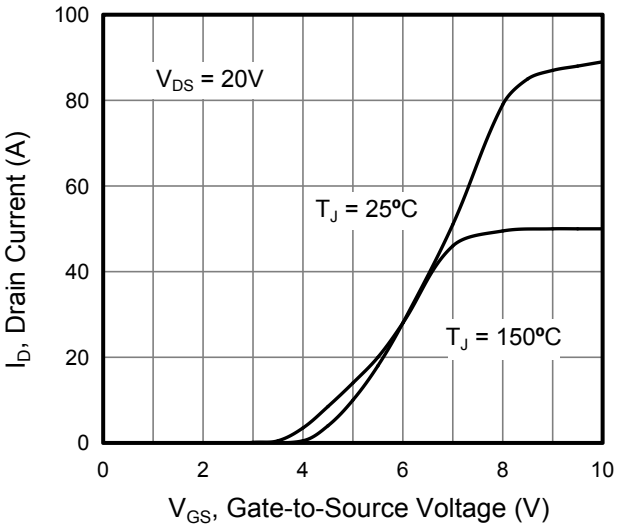



**Figure 3. On-Resistance vs. Drain Current**

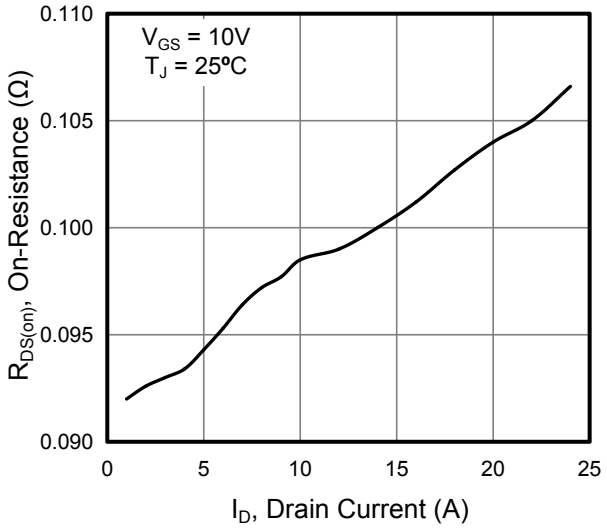



**Figure 4. Capacitance**

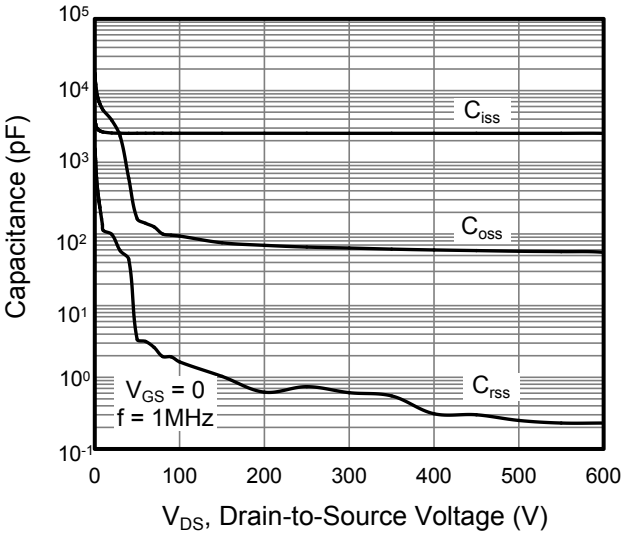



**Figure 5. Gate Charge**

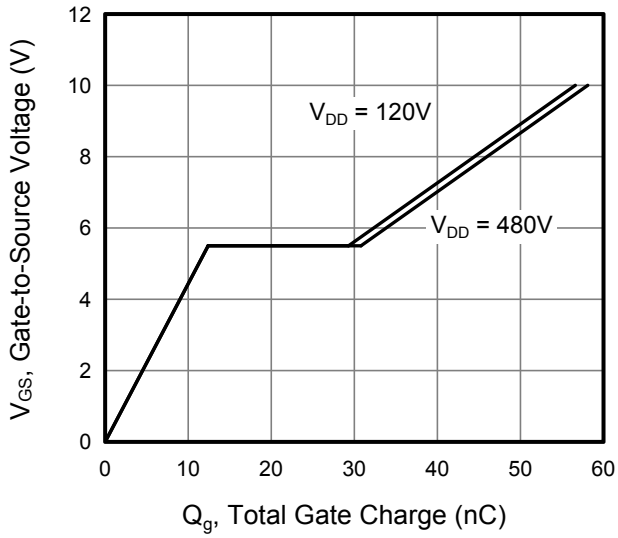
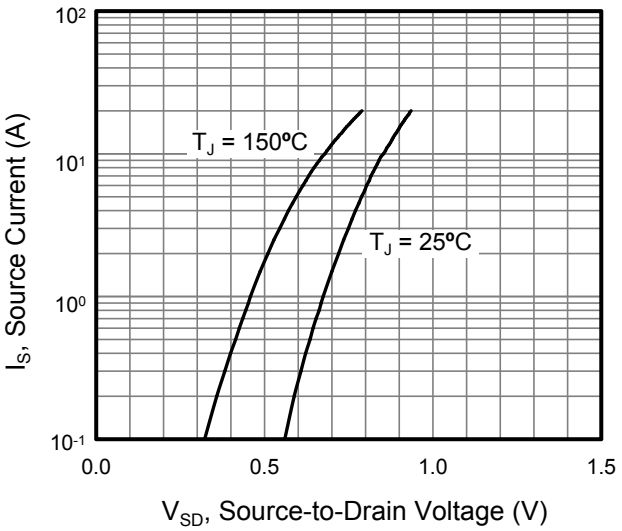



**Figure 6. Body Diode Forward Voltage**



**Typical Characteristics** $T_J$ = 25ºC, unless otherwise noted

**Figure 7. On-Resistance vs. Temperature**

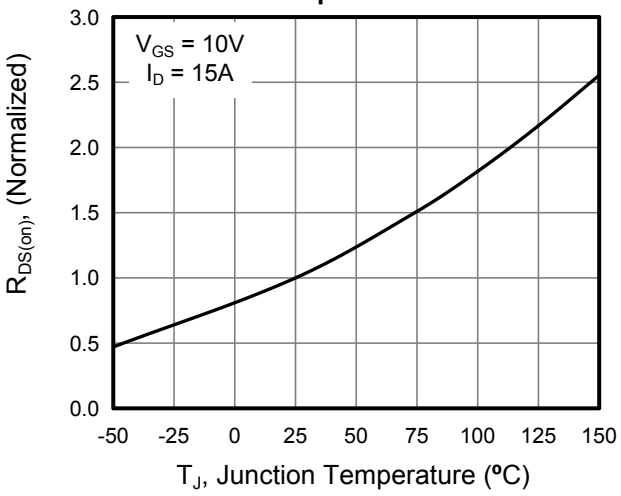



**Figure 8. Breakdown voltage vs. Junction Temperature**

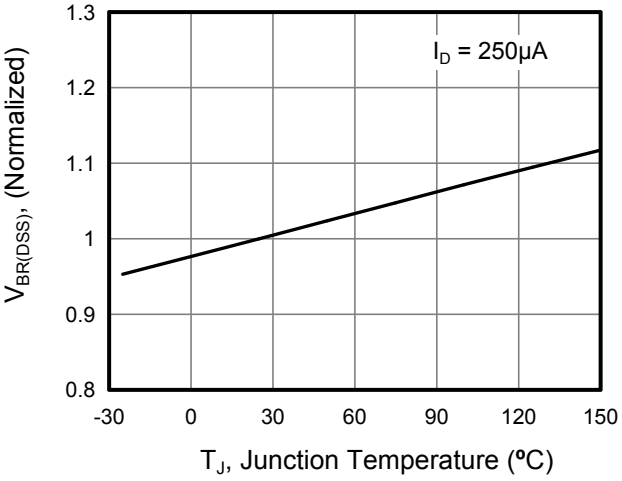



**Figure 9. Transient Thermal Impedance For TO-247**

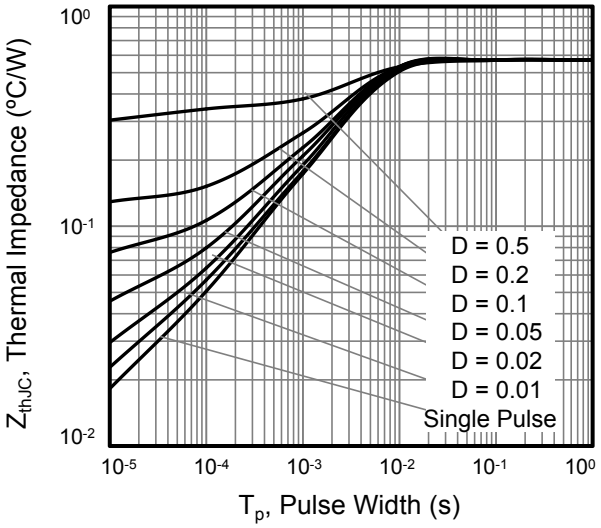



**Figure 10. Transient Thermal Impedance For TO-220FP-NL**

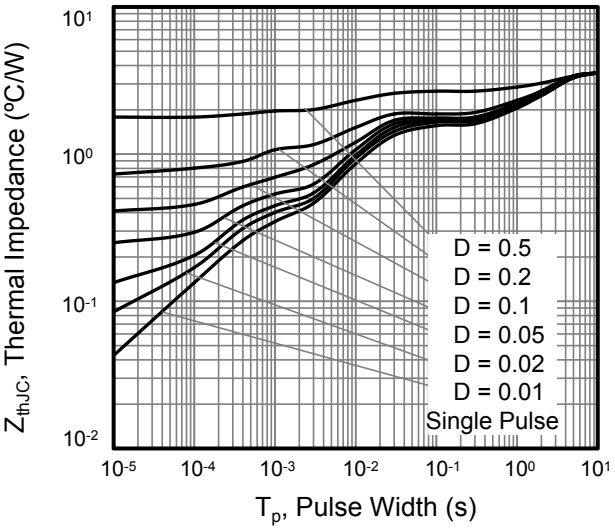



**Figure 11. Safe Operation Area For TO-247**

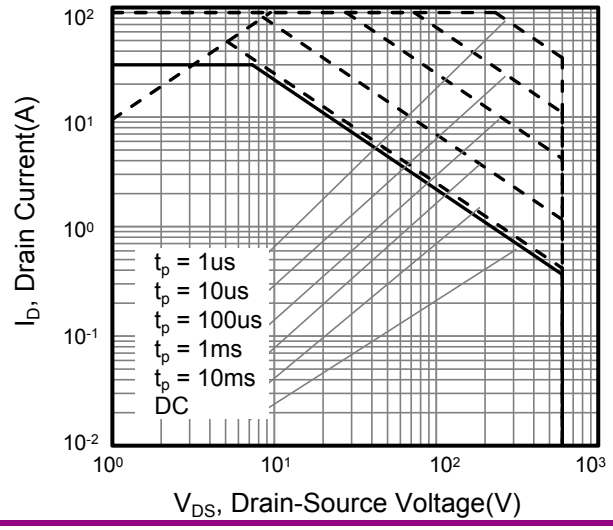
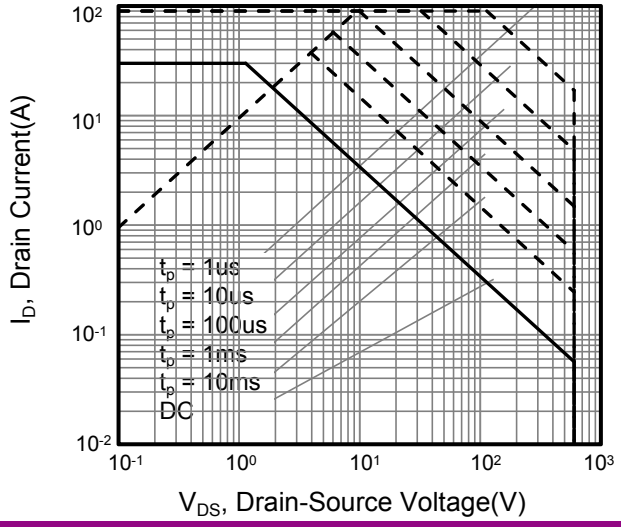



**Figure 12. Safe Operation Area For TO-220FP-NL**



**Typical Characteristics** $T_J$ = 25ºC, unless otherwise noted

**Figure 13. Typ. Coss Stored Energy**

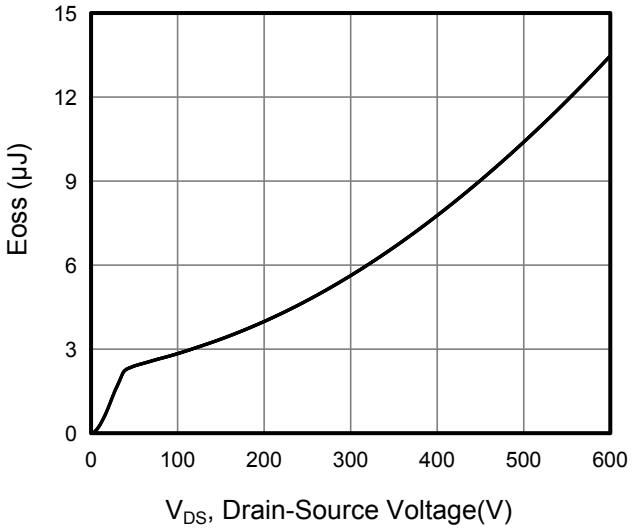


**Figure A：Gate Charge Test Circuit and Waveform**

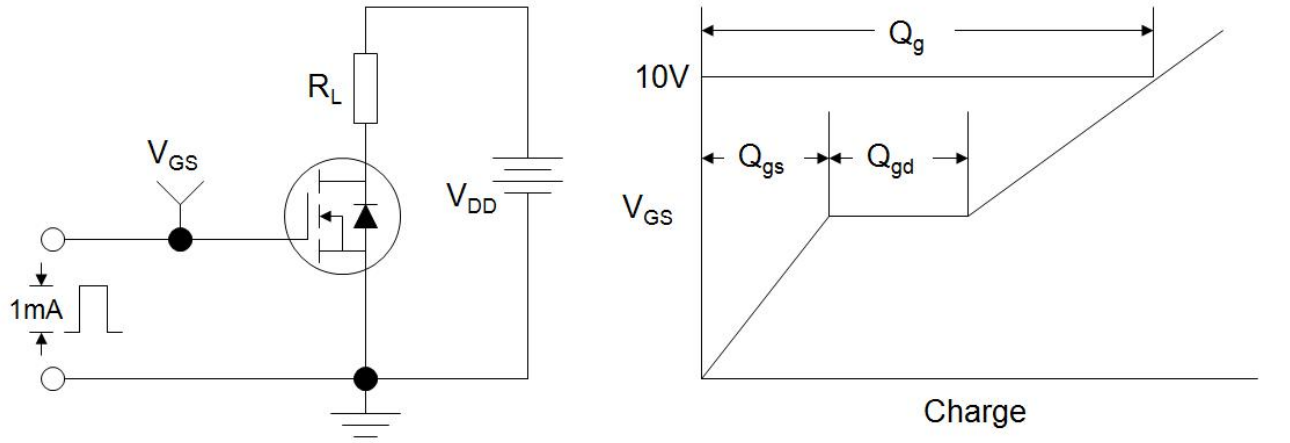



**Figure B：Resistive Switching Test Circuit and Waveform**

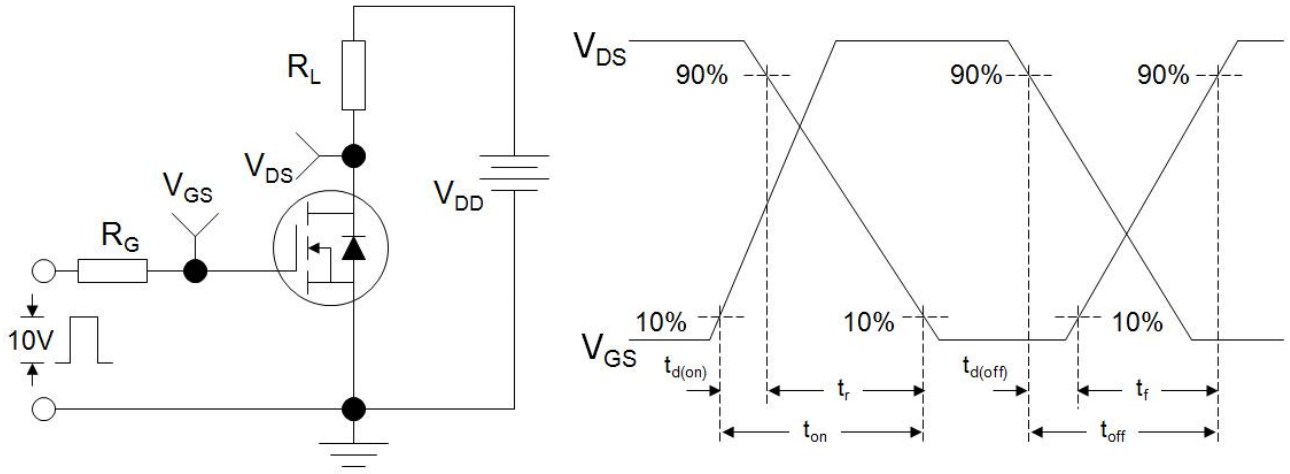
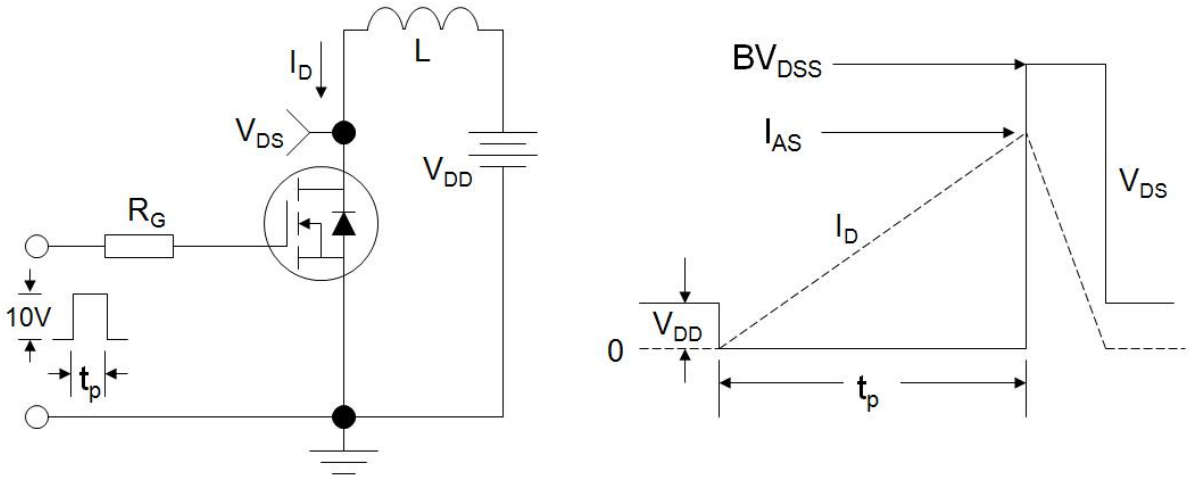
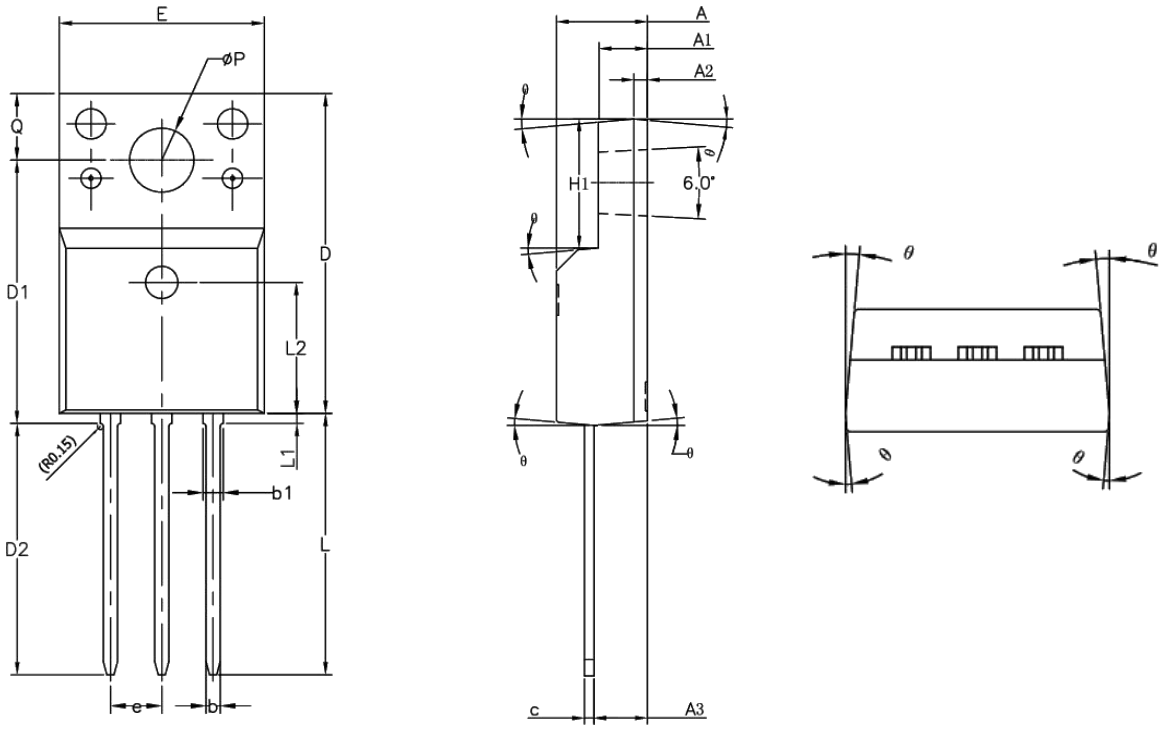



**Figure C：Unclamped Inductive Switching Test Circuit and Waveform**

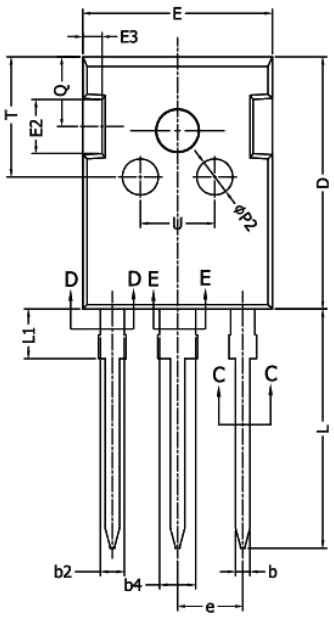


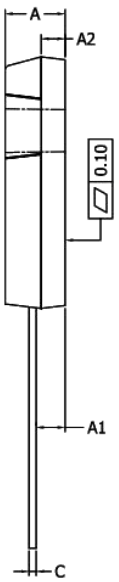
# TO-220FP-NL

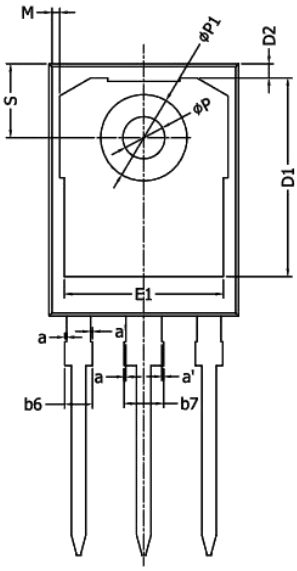


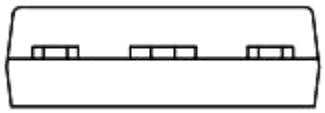

| SYMBOL | MIN | NOM | MAX |
|---|---|---|---|
| A | 4.50 | 4.70 | 4.83 |
| A1 | 2.34 | 2.54 | 2.74 |
| A2 | | 0.70 REF | |
| A3 | 2.56 | 2.76 | 2.93 |
| b | 0.60 | – | 0.80 |
| b1 | 0.90 | – | 1.10 |
| c | 0.45 | 0.50 | 0.60 |
| D | 15.67 | 15.87 | 16.07 |
| D1 | 12.87 | 13.07 | 13.27 |
| D2 | 12.28 | 12.48 | 12.68 |
| E | 9.96 | 10.16 | 10.36 |
| e | | 2.54BSC | |
| H1 | 6.48 | 6.68 | 6.88 |
| L | 12.68 | 12.98 | 13.28 |
| L1 | – | – | 0.85 |
| L2 | | 6.50REF | |
| ØP | 3.08 | 3.18 | 3.28 |
| Q | 3.20 | – | 3.40 |
| θ1 | 1° | 3° | 5° |

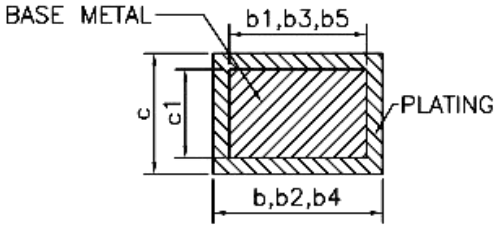
# TO-247






| SYMBOL | MIN | NOM | MAX |
|---|---|---|---|
| A | 4.90 | 5.00 | 5.10 |
| A1 | 2.31 | 2.41 | 2.51 |
| A2 | 1.90 | 2.00 | 2.10 |
| a | 0 | --- | 0.15 |
| a' | 0 | --- | 0.15 |
| b | 1.16 | --- | 1.26 |
| b1 | 1.15 | 1.2 | 1.22 |
| b2 | 1.96 | --- | 2.06 |
| b3 | 1.95 | 2.00 | 2.02 |
| b4 | 2.96 | --- | 3.06 |
| b5 | 2.96 | 3.00 | 3.02 |
| b6 | --- | --- | 2.25 |
| b7 | --- | --- | 3.25 |
| c | 0.59 | --- | 0.66 |
| c1 | 0.58 | 0.60 | 0.62 |
| D | 20.90 | 21.00 | 21.10 |
| D1 | 16.25 | 16.55 | 16.85 |
| D2 | 1.05 | 1.17 | 1.35 |
| E | 15.70 | 15.80 | 15.90 |
| E1 | 13.10 | 13.30 | 13.50 |
| E2 | 4.40 | 4.50 | 4.60 |
| E3 | 2.40 | 2.50 | 2.60 |
| e | 5.436 BSC | | |
| L | 19.80 | 19.92 | 20.10 |
| L1 | --- | --- | 4.30 |
| M | 0.35 | --- | 0.95 |
| P | 3.40 | 3.50 | 3.60 |
| P1 | 7.00 | --- | 7.40 |
| P2 | 2.40 | 2.50 | 2.60 |
| Q | 5.60 | --- | 6.00 |
| S | 6.05 | 6.15 | 6.25 |
| T | 9.80 | --- | 10.20 |
| U | 6.00 | --- | 6.40 |

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