

## 600V 0.053Ω Super Junction Power MOSFET

### Description

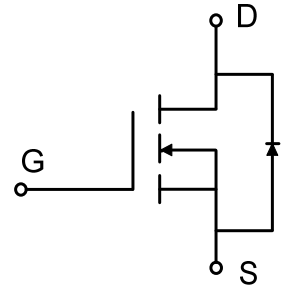
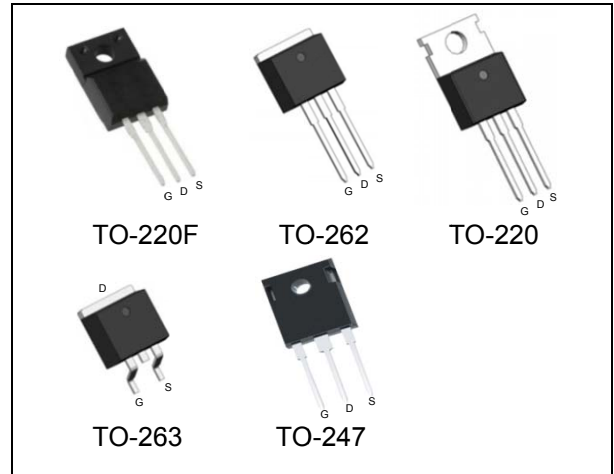
WMOS™ XJ is Wayon's new generation super junction MOSFET family that is utilizing charge balance technology for extremely low on-resistance and low gate charge performance. WMOS™ XJ is suitable for applications which require superior power density and outstanding efficiency.

### Features

- $V_{DS} = 650V @ T_{j,max}$
- Typ.  $R_{DS(on)} = 0.053\Omega$
- Fast body diode
- Pb-free plating, Halogen free

### Applications

LED Lighting, Charger, Adapter, PC, LCD TV, Server



### Absolute Maximum Ratings

| Parameter                                                     | Symbol         | WMK/WMM/WMN/WMJ | WML  | Unit          |
|---------------------------------------------------------------|----------------|-----------------|------|---------------|
| Drain-source voltage                                          | $V_{DS}$       | 600             |      | V             |
| Continuous drain current <sup>1)</sup> ( $T_C = 25^\circ C$ ) | $I_D$          | 51              |      | A             |
| ( $T_C = 100^\circ C$ )                                       |                | 26              |      | A             |
| Pulsed drain current <sup>2)</sup>                            | $I_{DM}$       | 90              |      | A             |
| Gate-source voltage                                           | $V_{GS}$       | $\pm 30$        |      | V             |
| Avalanche energy, single pulse <sup>3)</sup>                  | $E_{AS}$       | 940             |      | mJ            |
| Avalanche energy, repetitive <sup>2)</sup>                    | $E_{AR}$       | 1.3             |      | mJ            |
| Avalanche current, repetitive <sup>2)</sup>                   | $I_{AR}$       | 5               |      | A             |
| Power dissipation ( $T_C = 25^\circ C$ )                      | $P_D$          | 350             | 34   | W             |
| - Derate above $25^\circ C$                                   |                | 2.8             | 0.27 | W/ $^\circ C$ |
| Operating and storage temperature range                       | $T_j, T_{stg}$ | -55 to +150     |      | $^\circ C$    |
| Continuous diode forward current <sup>1)</sup>                | $I_S$          | 51              |      | A             |
| Diode pulse current <sup>2)</sup>                             | $I_{S,pulse}$  | 90              |      | A             |

### Thermal Characteristics

| Parameter                               | Symbol          | WMK/WMM/WMN/WMJ | WML | Unit         |
|-----------------------------------------|-----------------|-----------------|-----|--------------|
| Thermal resistance, junction-to-case    | $R_{\theta JC}$ | 0.36            | 3.6 | $^\circ C/W$ |
| Thermal resistance, junction-to-ambient | $R_{\theta JA}$ | 62              | 80  | $^\circ C/W$ |

**Electrical Characteristics**  $T_c = 25^\circ\text{C}$ , unless otherwise noted

| Parameter                        | Symbol               | Test Condition                                                                                  | Min.   | Typ.      | Max.      | Unit  |
|----------------------------------|----------------------|-------------------------------------------------------------------------------------------------|--------|-----------|-----------|-------|
| Static characteristics           |                      |                                                                                                 |        |           |           |       |
| Drain-source breakdown voltage   | BV <sub>DSS</sub>    | V <sub>GS</sub> =0 V, I <sub>D</sub> =1 mA                                                      | 600    | -         | -         | V     |
| Gate threshold voltage           | V <sub>GS(th)</sub>  | V <sub>DS</sub> =V <sub>GS</sub> , I <sub>D</sub> =0.25mA                                       | 2.8    | 3.8       | 4.8       | V     |
| Drain cut-off current            | I <sub>DSS</sub>     | V <sub>DS</sub> =600 V, V <sub>GS</sub> =0V,<br>T <sub>J</sub> = 25°C<br>T <sub>J</sub> = 125°C | -<br>- | -<br>200  | 50<br>-   | μA    |
| Gate leakage current, forward    | I <sub>GSSF</sub>    | V <sub>GS</sub> =20V, V <sub>DS</sub> =0V                                                       | -      | -         | 300       | nA    |
| Gate leakage current, reverse    | I <sub>GSSR</sub>    | V <sub>GS</sub> =-20V, V <sub>DS</sub> =0V                                                      | -      | -         | -300      | nA    |
| Drain-source on-state resistance | R <sub>DS(on)</sub>  | V <sub>GS</sub> =10 V, I <sub>D</sub> =10A<br>T <sub>J</sub> = 25°C                             | -<br>- | <br>0.053 | <br>0.060 | <br>Ω |
| Dynamic characteristics          |                      |                                                                                                 |        |           |           |       |
| Input capacitance                | C <sub>iss</sub>     | V <sub>DS</sub> = 100V, V <sub>GS</sub> = 0V,<br>f = 1 MHz                                      | -      | 3320      | -         | pF    |
| Output capacitance               | C <sub>OSS</sub>     |                                                                                                 | -      | 115       | -         |       |
| Reverse transfer capacitance     | C <sub>rss</sub>     |                                                                                                 | -      | 2.3       | -         |       |
| Turn-on delay time               | t <sub>d(on)</sub>   | V <sub>DD</sub> = 300V, I <sub>D</sub> = 15A<br><br>R <sub>G</sub> = 25Ω, V <sub>GS</sub> =10V  | -      | 64        | -         | ns    |
| Rise time                        | t <sub>r</sub>       |                                                                                                 | -      | 56        | -         |       |
| Turn-off delay time              | t <sub>d(off)</sub>  |                                                                                                 | -      | 196       | -         |       |
| Fall time                        | t <sub>f</sub>       |                                                                                                 | -      | 28        | -         |       |
| Gate charge characteristics      |                      |                                                                                                 |        |           |           |       |
| Gate to source charge            | Q <sub>gs</sub>      | V <sub>DD</sub> =480V, I <sub>D</sub> =15A,<br><br>V <sub>GS</sub> =0 to 10V                    | -      | 18.0      | -         | nC    |
| Gate to drain charge             | Q <sub>gd</sub>      |                                                                                                 | -      | 16.2      | -         |       |
| Gate charge total                | Q <sub>g</sub>       |                                                                                                 | -      | 58.0      | -         |       |
| Gate plateau voltage             | V <sub>plateau</sub> |                                                                                                 | -      | 5.5       | -         | V     |
| Reverse diode characteristics    |                      |                                                                                                 |        |           |           |       |
| Diode forward voltage            | V <sub>SD</sub>      | V <sub>GS</sub> =0 V, I <sub>F</sub> =15A                                                       | -      | -         | 1.2       | V     |
| Reverse recovery time            | t <sub>rr</sub>      | V <sub>R</sub> =50V, I <sub>F</sub> =15A,<br><br>dI <sub>F</sub> /dt=100A/μs                    | -      | 163       | -         | ns    |
| Reverse recovery charge          | Q <sub>rr</sub>      |                                                                                                 | -      | 1.3       | -         | μC    |
| Peak reverse recovery current    | I <sub>rrm</sub>     |                                                                                                 | -      | 15.7      | -         | A     |

## Notes:

- Limited by  $T_{j\max}$ . Maximum duty cycle  $D=0.5$ .
- Pulse width limited by maximum junction temperature.
- $I_{AS}=5\text{A}$ ,  $V_{DD}=50\text{V}$ ,  $R_G=25\Omega$ , starting  $T_j=25^\circ\text{C}$ .

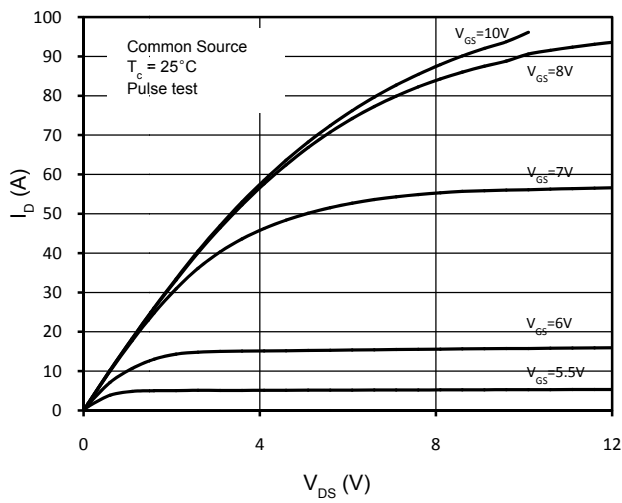


Figure 1. On-Region Characteristics

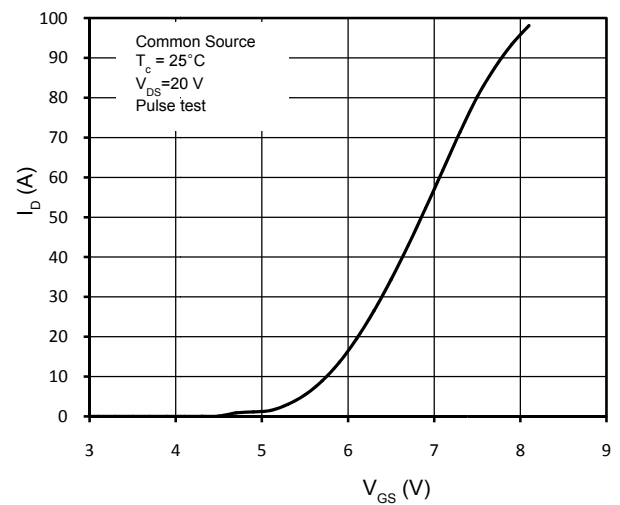


Figure 2. Transfer Characteristics

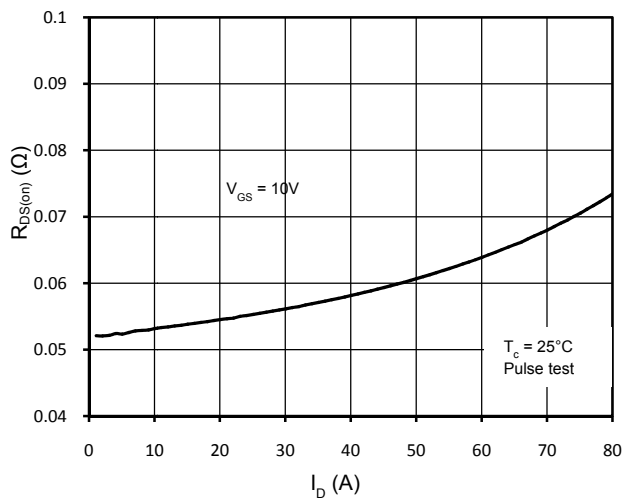


Figure 3. Static Drain-Source On Resistance

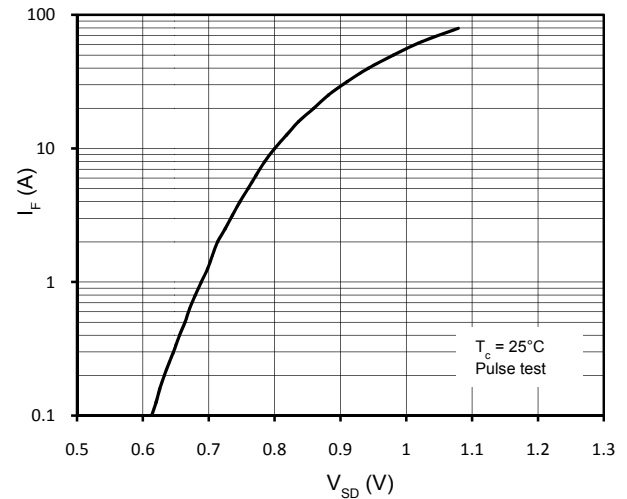
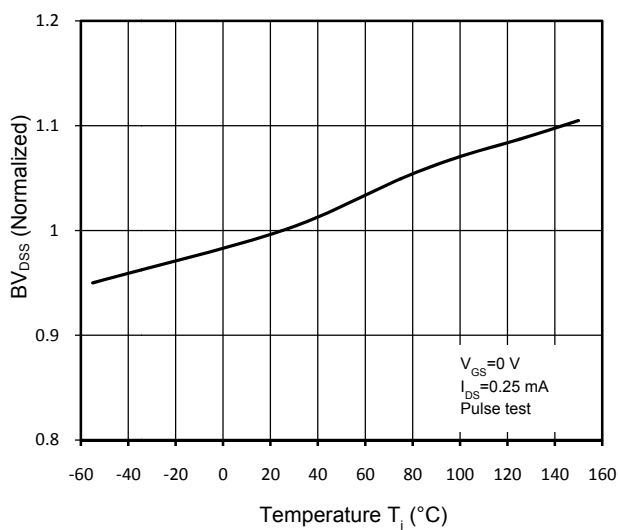
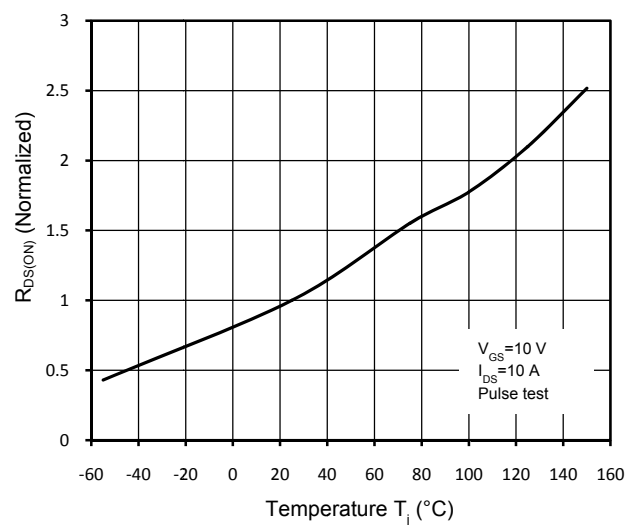


Figure 4. Body-Diode Forward Characteristics

Figure 5. Normalized  $BV_{DS}$  vs. TemperatureFigure 6. Normalized  $R_{DS(on)}$  vs. Temperature

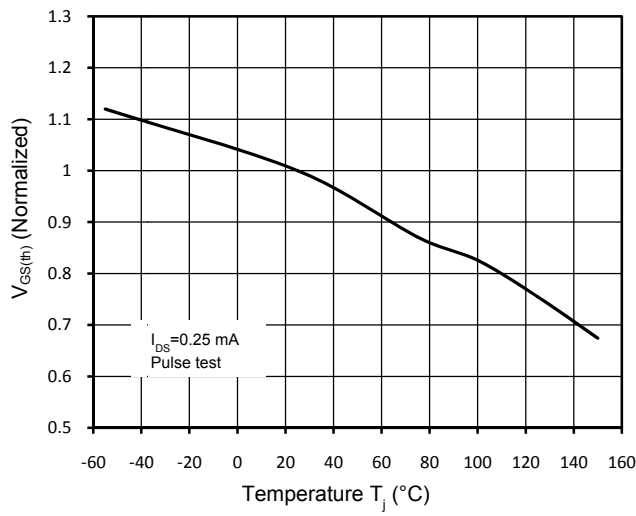


Figure 7. Threshold Voltage vs. Temperature

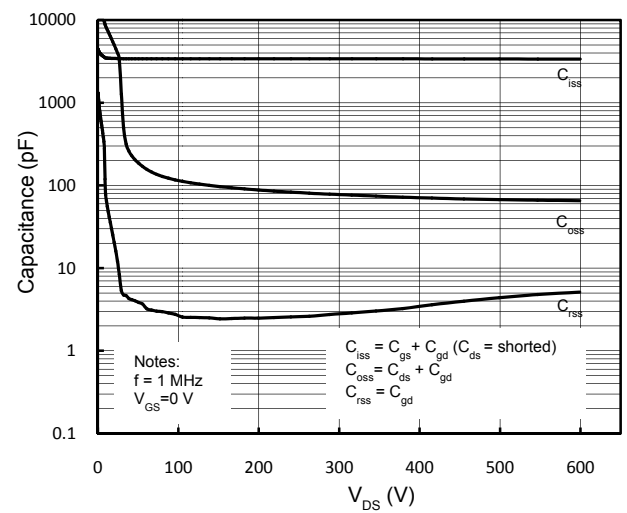


Figure 8. Capacitance Characteristics

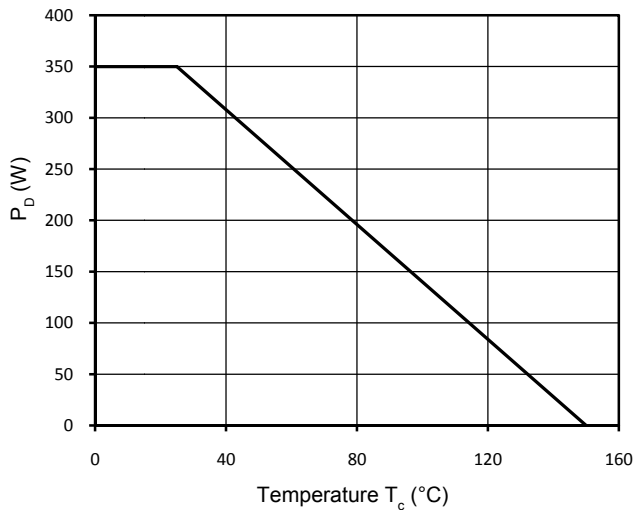


Figure 9. Power Dissipation

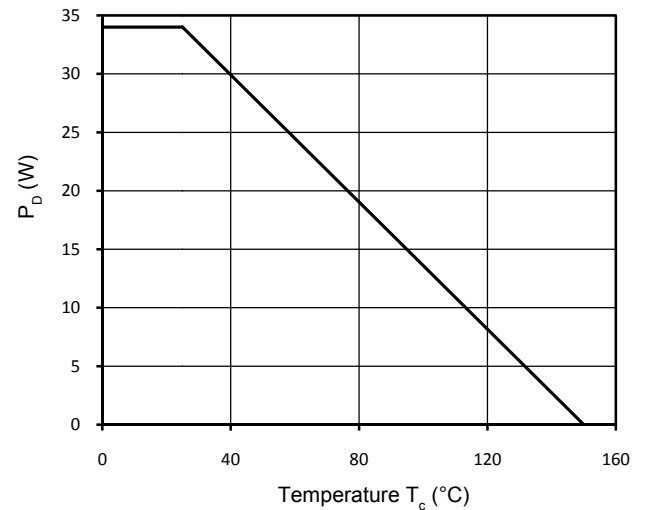


Figure 10. Power Dissipation (TO-220F)

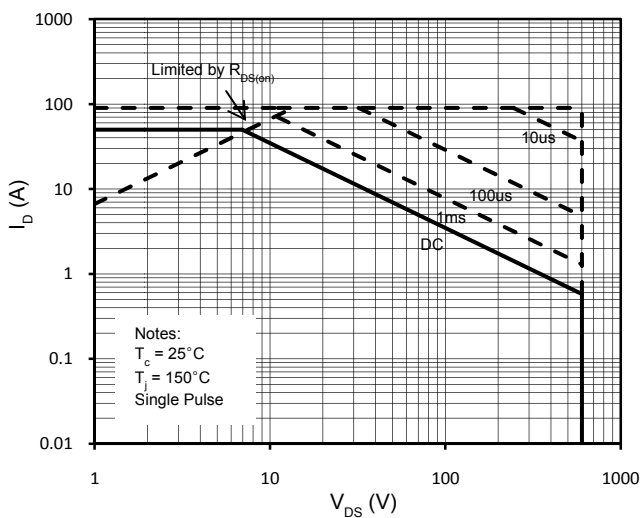


Figure 11. Maximum Safe Operating Area

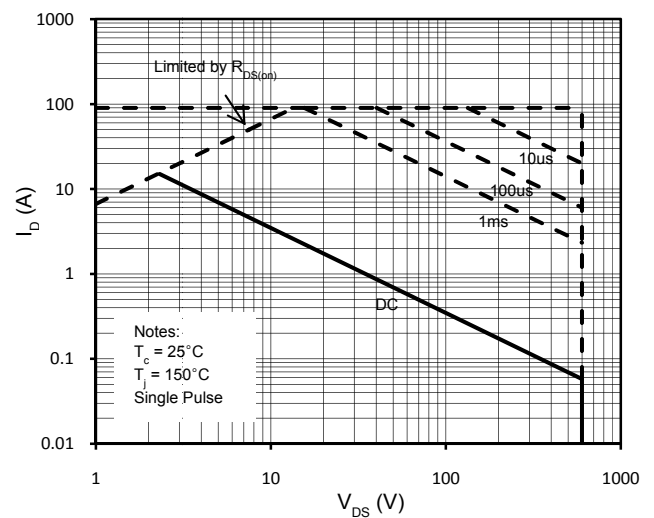


Figure 12. Maximum Safe Operating Area (TO-220F)

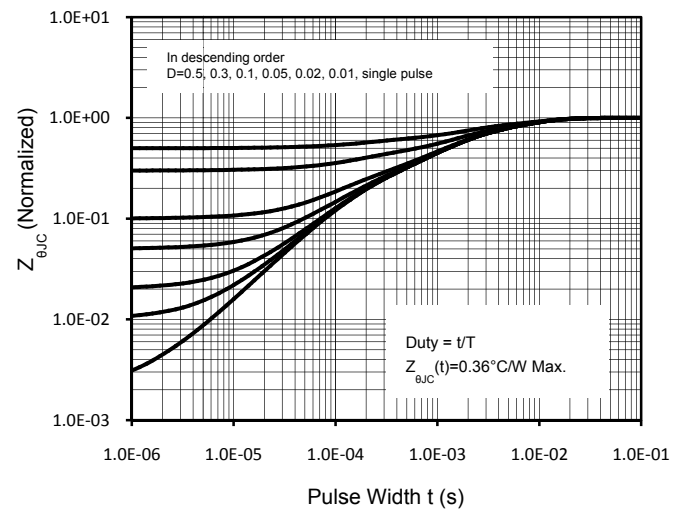
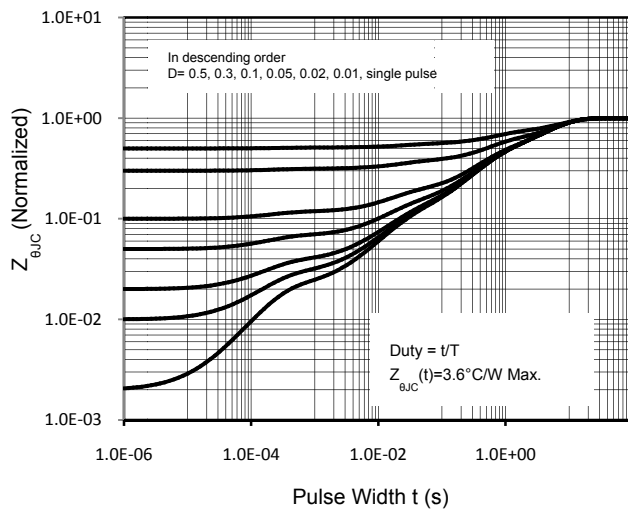


Figure 13. Transient Thermal Response Curve (TO-220F) Figure 14. Transient Thermal Response Curve

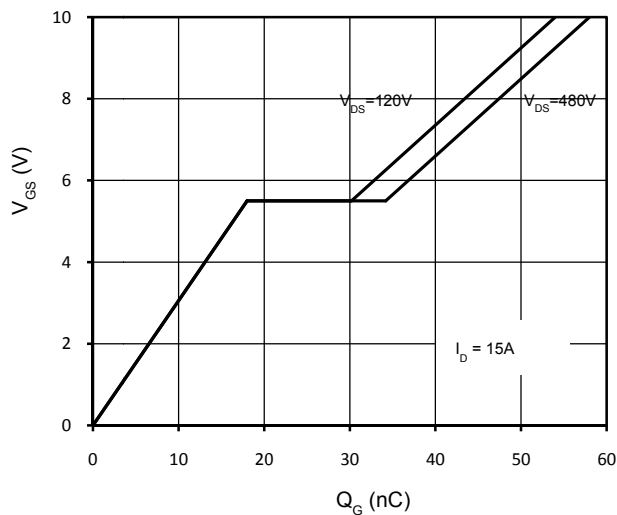
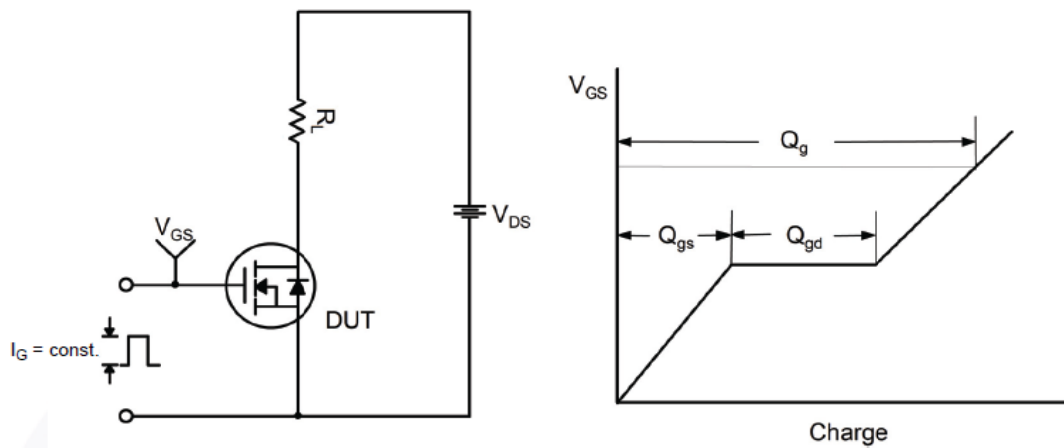
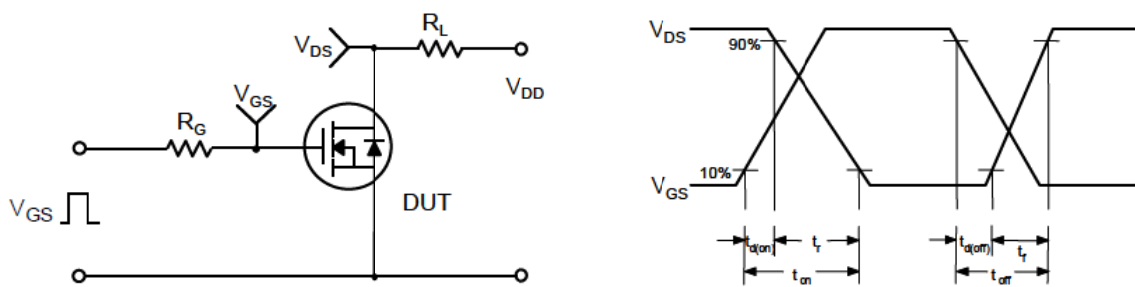


Figure 15. Gate Charge Characteristics

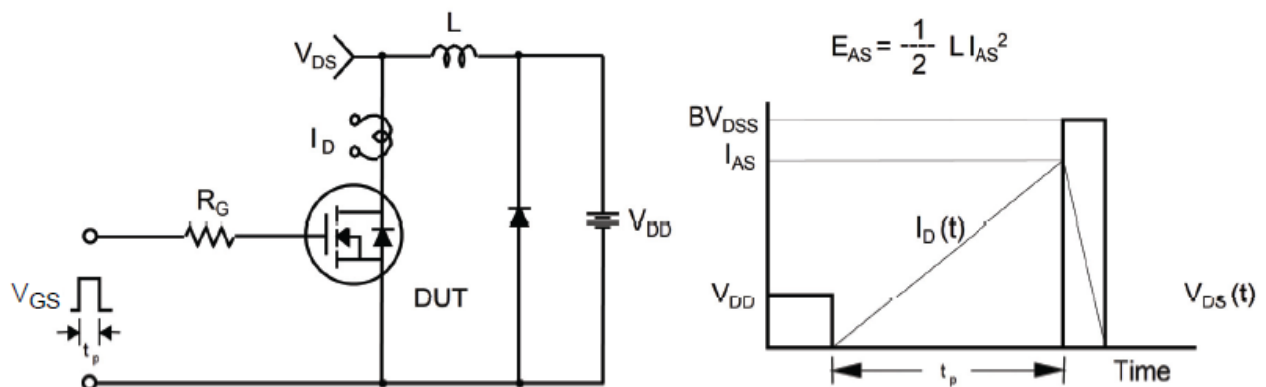
## Gate Charge Test Circuit &amp; Waveform



## Switching Test Circuit &amp; Waveforms

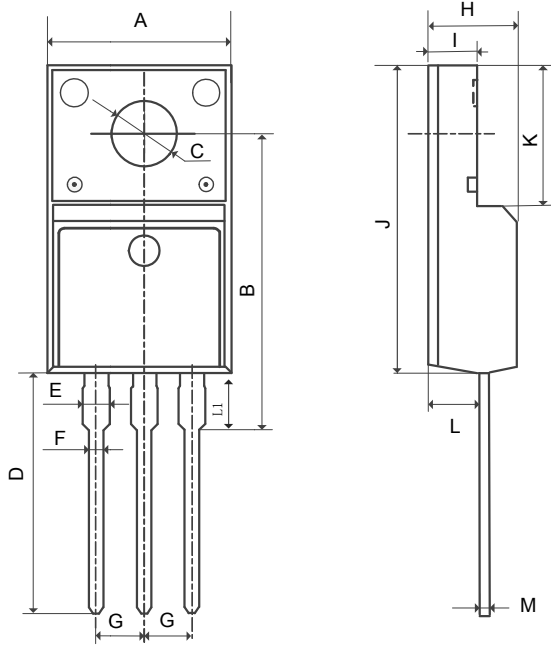


## Unclamped Inductive Switching Test Circuit &amp; Waveforms



## Mechanical Dimensions for TO-220F

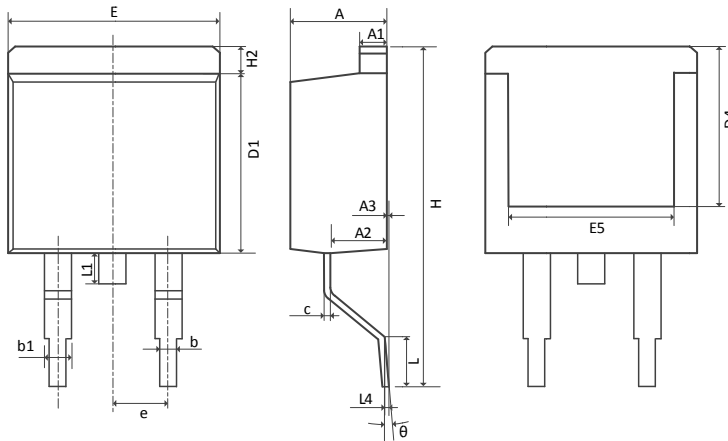
## COMMON DIMENSIONS



| SYMBOL | MM      |       |
|--------|---------|-------|
|        | MIN     | MAX   |
| A      | 9.96    | 10.36 |
| B      | 15.10   | 16.10 |
| C      | 3.03    | 3.38  |
| D      | 12.64   | 13.28 |
| E      | 1.18    | 1.58  |
| F      | 0.70    | 0.95  |
| G      | 2.54REF |       |
| H      | 4.50    | 4.90  |
| I      | 2.34    | 2.74  |
| J      | 15.57   | 16.17 |
| K      | 6.70REF |       |
| L      | 2.56    | 2.96  |
| M      | 0.40    | 0.65  |
| L1     | 2.85    | 3.45  |

Mechanical Dimensions for TO-263

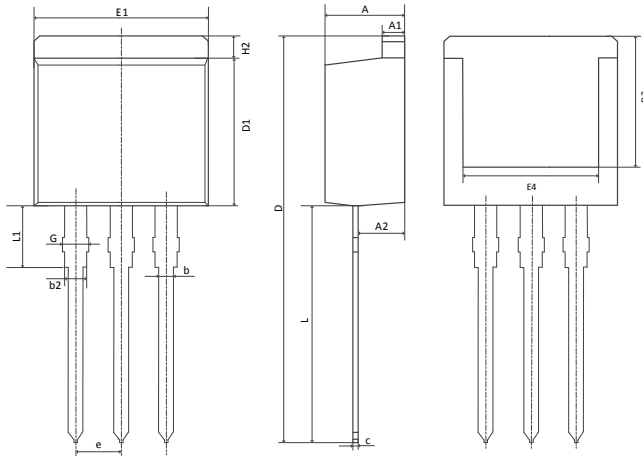
COMMON DIMENSIONS



| SYMBOL | MM      |       |
|--------|---------|-------|
|        | MIN     | MAX   |
| A      | 4.37    | 4.89  |
| A1     | 1.17    | 1.42  |
| A2     | 2.19    | 2.89  |
| A3     | 0.00    | 0.25  |
| b      | 0.70    | 0.96  |
| b1     | 1.17    | 1.47  |
| c      | 0.30    | 0.60  |
| D1     | 8.45    | 9.35  |
| D4     | 6.60    | —     |
| E      | 9.80    | 10.40 |
| E5     | 7.06    | —     |
| e      | 2.54BSC |       |
| H      | 14.70   | 16.00 |
| H2     | 1.07    | 1.47  |
| L      | 2.00    | 2.70  |
| L1     | 1.15    | 1.75  |
| L4     | 0.25BSC |       |
| θ      | 0°      | 9°    |

## Mechanical Dimensions for TO-262

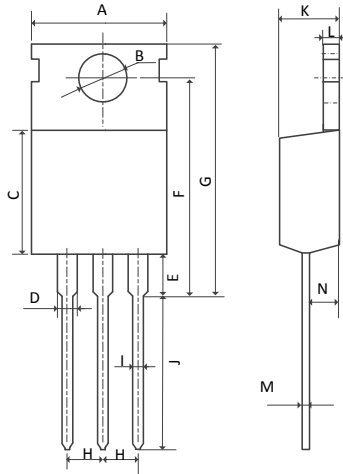
## COMMON DIMENSIONS



| SYMBOL | MM      |       |
|--------|---------|-------|
|        | MIN     | MAX   |
| A      | 4.37    | 4.90  |
| A1     | 1.17    | 1.42  |
| A2     | 2.20    | 2.89  |
| b      | 0.71    | 0.96  |
| b2     | 1.07    | 1.47  |
| c      | 0.28    | 0.60  |
| D      | 22.00   | 24.02 |
| D1     | 8.45    | 9.30  |
| D2     | 6.00    | —     |
| E1     | 9.80    | 10.40 |
| E4     | 7.06    | —     |
| e      | 2.54BSC |       |
| G      | 1.23    | 1.50  |
| H2     | —       | 1.50  |
| L      | 12.90   | 14.16 |
| L1     | 2.80    | 4.00  |

## Mechanical Dimensions for TO-220

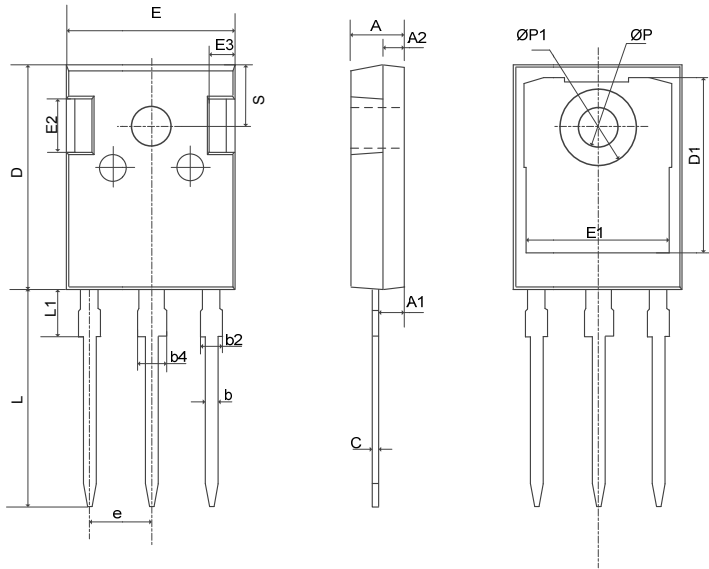
## COMMON DIMENSIONS



| SYMBOL | MM       |       |
|--------|----------|-------|
|        | MIN      | MAX   |
| A      | 9.70     | 10.30 |
| B      | 3.40     | 3.80  |
| C      | 8.80     | 9.40  |
| D      | 1.17     | 1.47  |
| E      | 2.60     | 3.50  |
| F      | 15.10    | 16.90 |
| G      | 19.60MAX |       |
| H      | 2.54REF  |       |
| I      | 0.70     | 0.95  |
| J      | 9.25     | 11.00 |
| K      | 4.30     | 4.77  |
| L      | 1.20     | 1.45  |
| M      | 0.40     | 0.65  |
| N      | 2.20     | 2.60  |

## Mechanical Dimensions for TO-247

## COMMON DIMENSIONS

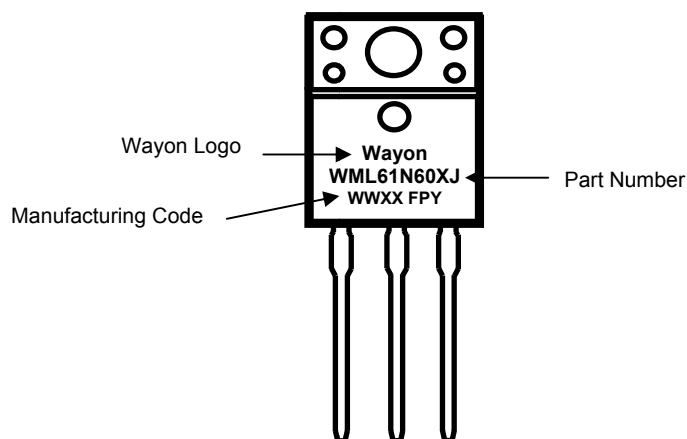


| SYMBOL | MM      |       |
|--------|---------|-------|
|        | MIN     | MAX   |
| A      | 4.80    | 5.21  |
| A1     | 2.21    | 2.61  |
| A2     | 1.85    | 2.16  |
| b      | 1.07    | 1.36  |
| b2     | 1.91    | 2.41  |
| b4     | 2.87    | 3.38  |
| c      | 0.51    | 0.75  |
| D      | 20.70   | 21.30 |
| D1     | 16.25   | 17.65 |
| E      | 15.50   | 16.13 |
| E1     | 12.38   | 13.60 |
| E2     | 3.68    | 5.20  |
| E3     | 1.00    | 2.70  |
| e      | 5.44BSC |       |
| L      | 19.62   | 20.32 |
| L1     | —       | 4.40  |
| ØP     | 3.40    | 3.80  |
| ØP1    | —       | 7.40  |
| S      | 6.15BSC |       |

## Ordering Information

| Part       | Package | Marking    | Packing method |
|------------|---------|------------|----------------|
| WML61N60XJ | TO-220F | WML61N60XJ | Tube           |
| WMK61N60XJ | TO-220  | WMK61N60XJ | Tube           |
| WMN61N60XJ | TO-262  | WMN61N60XJ | Tube           |
| WMM61N60XJ | TO-263  | WMM61N60XJ | Tape and Reel  |
| WMJ61N60XJ | TO-247  | WMJ61N60XJ | Tube           |

## Marking Information



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