

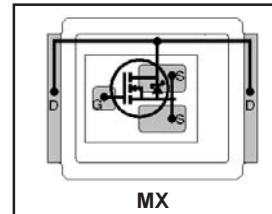
# IRF6619

DirectFET™ Power MOSFET ②

- Low Profile (<0.7 mm)
- Dual Sided Cooling Compatible ①
- Ultra Low Package Inductance
- Optimized for High Frequency Switching above 1MHz ①
- Ideal for CPU Core DC-DC Converters
- Optimized for Sync. FET socket of Sync. Buck Converter①
- Low Conduction Losses
- Compatible with existing Surface Mount Techniques ①

Typical values (unless otherwise specified)

| $V_{DS}$     | $V_{GS}$ | $R_{DS(on)}$ | $R_{DS(on)}$ |           |              |
|--------------|----------|--------------|--------------|-----------|--------------|
| 20V max      | ±20V max | 1.65mΩ @ 10V | 2.2mΩ @ 4.5V |           |              |
| $Q_{g\ tot}$ | $Q_{gd}$ | $Q_{gs2}$    | $Q_{rr}$     | $Q_{oss}$ | $V_{gs(th)}$ |
| 38nC         | 13nC     | 3.5nC        | 18nC         | 22nC      | 2.0V         |



Applicable DirectFET Outline and Substrate Outline (see p.7,8 for details)①

|    |    |    |  |    |           |    |  |  |  |  |
|----|----|----|--|----|-----------|----|--|--|--|--|
| SQ | SX | ST |  | MQ | <b>MX</b> | MT |  |  |  |  |
|----|----|----|--|----|-----------|----|--|--|--|--|

## Description

The IRF6619 combines the latest HEXFET® Power MOSFET Silicon technology with the advanced DirectFET™ packaging to achieve the lowest on-state resistance in a package that has the footprint of an SO-8 and only 0.7 mm profile. The DirectFET package is compatible with existing layout geometries used in power applications, PCB assembly equipment and vapor phase, infra-red or convection soldering techniques, when application note AN-1035 is followed regarding the manufacturing methods and processes. The DirectFET package allows dual sided cooling to maximize thermal transfer in power systems, IMPROVING previous best thermal resistance by 80%.

The IRF6619 balances both low resistance and low charge along with ultra low package inductance to reduce both conduction and switching losses. The reduced total losses make this product ideal for high efficiency DC-DC converters that power the latest generation of processors operating at higher frequencies. The IRF6619 has been optimized for parameters that are critical in synchronous buck operating from 12 volt buss converters including  $R_{ds(on)}$ , gate charge and  $C_{dv}/dt$ -induced turn on immunity. The IRF6619 offers particularly low  $R_{ds(on)}$  and high  $C_{dv}/dt$  immunity for synchronous FET applications.

## Absolute Maximum Ratings

|                              | Parameter  | Max.                       | Units |
|------------------------------|--|----------------------------|-------|
| $V_{DS}$                     | Drain-to-Source Voltage                                      | 20                         | V     |
| $V_{GS}$                     | Gate-to-Source Voltage                                       | ±20                        |       |
| $I_D @ T_A = 25^\circ C$     | Continuous Drain Current, $V_{GS} @ 10V$ ⑥                   | 30                         | A     |
| $I_D @ T_A = 70^\circ C$     | Continuous Drain Current, $V_{GS} @ 10V$ ⑥                   | 24                         |       |
| $I_D @ T_C = 25^\circ C$     | Continuous Drain Current, $V_{GS} @ 10V$ ⑦ (Package Limited) | 150                        |       |
| $I_{DM}$                     | Pulsed Drain Current ③                                       | 240                        |       |
| $E_{AS}$ (Thermally limited) | Single Pulse Avalanche Energy ④                              | 240                        | mJ    |
| $I_{AR}$                     | Avalanche Current ③  | See Fig. 14, 15, 17a, 17b, | A     |
| $E_{AR}$                     | Repetitive Avalanche Energy ③                                |                            | mJ    |

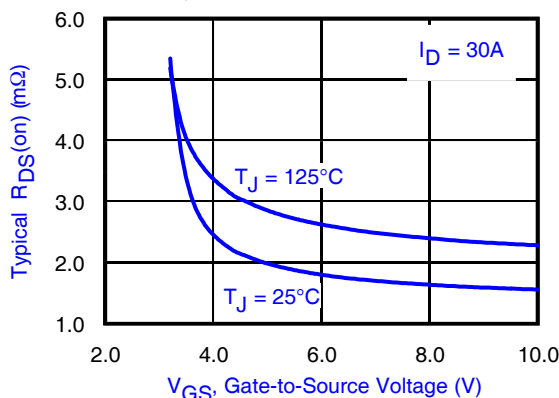


Fig 1. Typical On-Resistance Vs. Gate Voltage

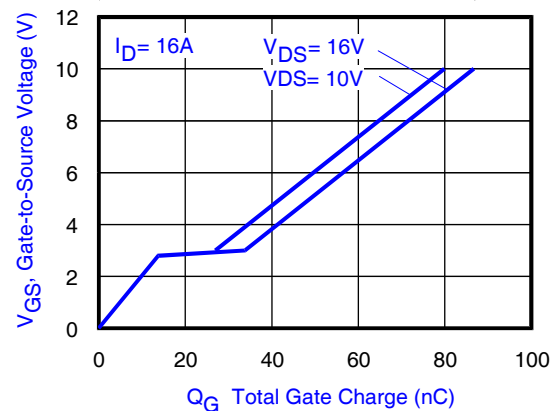


Fig 2. Typical Total Gate Charge vs Gate-to-Source Voltage

Notes:

- ① Click on this section to link to the appropriate technical paper.
- ② Click on this section to link to the DirectFET Website.
- ③ Repetitive rating; pulse width limited by max. junction temperature.

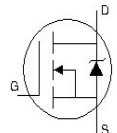
- ④ Limited by  $T_{Jmax}$ , starting  $T_J = 25^\circ C$ ,  $L = 0.86mH$ ,  $R_G = 25\Omega$ ,  $I_{AS} = 24A$ ,  $V_{GS} = 10V$ . Part not recommended for use above this value.
- ⑥ Surface mounted on 1 in. square Cu board, steady state.
- ⑦  $T_C$  measured with thermocouple mounted to top (Drain) of part.

## Static @ $T_J = 25^\circ\text{C}$ (unless otherwise specified)

|                                | Parameter                                  | Min. | Typ. | Max. | Units | Conditions   |
|--------------------------------|--|------|------|------|-------|--|
| $BV_{DSS}$                     | Drain-to-Source Breakdown Voltage          | 20   | —    | —    | V     | $V_{GS} = 0V, I_D = 250\mu A$  |
| $\Delta BV_{DSS}/\Delta T_J$   | Breakdown Voltage Temp. Coefficient        | —    | 14   | —    | mV/°C | Reference to $25^\circ\text{C}, I_D = 1\text{mA}$                        |
| $R_{DS(on)}$                   | Static Drain-to-Source On-Resistance       | —    | 1.65 | 2.2  | mΩ    | $V_{GS} = 10V, I_D = 30A$ ③  |
|                                |  | —    | 2.2  | 3.0  |       | $V_{GS} = 4.5V, I_D = 24A$ ③   |
| $V_{GS(th)}$                   | Gate Threshold Voltage                     | 1.55 | —    | 2.45 | V     | $V_{DS} = V_{GS}, I_D = 250\mu A$  |
| $\Delta V_{GS(th)}/\Delta T_J$ | Gate Threshold Voltage Coefficient         | —    | -5.8 | —    | mV/°C |  |
| $I_{DSS}$                      | Drain-to-Source Leakage Current            | —    | —    | 1.0  | μA    | $V_{DS} = 16V, V_{GS} = 0V$  |
|                                |  | —    | —    | 150  |       | $V_{DS} = 16V, V_{GS} = 0V, T_J = 125^\circ\text{C}$                     |
| $I_{GSS}$                      | Gate-to-Source Forward Leakage             | —    | —    | 100  | nA    | $V_{GS} = 20V$   |
|                                | Gate-to-Source Reverse Leakage             | —    | —    | -100 |       | $V_{GS} = -20V$  |
| $g_{fs}$                       | Forward Transconductance                   | 89   | —    | —    | S     | $V_{DS} = 10V, I_D = 24A$  |
| $Q_g$                          | Total Gate Charge                          | —    | 38   | 57   | nC    | $V_{DS} = 10V$<br>$V_{GS} = 4.5V$<br>$I_D = 16A$<br>See Fig. 17          |
| $Q_{gs1}$                      | Pre-V <sub>th</sub> Gate-to-Source Charge  | —    | 10.2 | —    |       |  |
| $Q_{gs2}$                      | Post-V <sub>th</sub> Gate-to-Source Charge | —    | 3.5  | —    |       |  |
| $Q_{gd}$                       | Gate-to-Drain Charge                       | —    | 13.2 | —    |       |  |
| $Q_{godr}$                     | Gate Charge Overdrive                      | —    | 11.1 | —    |       |  |
| $Q_{sw}$                       | Switch Charge ( $Q_{gs2} + Q_{gd}$ )       | —    | 16.7 | —    |       |  |
| $Q_{oss}$                      | Output Charge                              | —    | 22   | —    | nC    | $V_{DS} = 10V, V_{GS} = 0V$  |
| $R_G$                          | Gate Resistance                            | —    | —    | 2.3  | Ω     |  |
| $t_{d(on)}$                    | Turn-On Delay Time                         | —    | 21   | —    | ns    | $V_{DD} = 16V, V_{GS} = 4.5V$ ③<br>$I_D = 24A$<br>Clamped Inductive Load |
| $t_r$                          | Rise Time                                  | —    | 71   | —    |       |  |
| $t_{d(off)}$                   | Turn-Off Delay Time                        | —    | 25   | —    |       |  |
| $t_f$                          | Fall Time                                  | —    | 9.3  | —    |       |  |
| $C_{iss}$                      | Input Capacitance                          | —    | 5040 | —    | pF    | $V_{GS} = 0V$<br>$V_{DS} = 10V$<br>$f = 1.0\text{MHz}$                   |
| $C_{oss}$                      | Output Capacitance                         | —    | 1580 | —    |       |  |
| $C_{rss}$                      | Reverse Transfer Capacitance               | —    | 780  | —    |       |  |

## Diode Characteristics

|          | Parameter                                 | Min. | Typ. | Max. | Units | Conditions   |
|----------|---|------|------|------|-------|--|
| $I_S$    | Continuous Source Current<br>(Body Diode) | —    | —    | 30   | A     | MOSFET symbol showing the integral reverse p-n junction diode. |
| $I_{SM}$ | Pulsed Source Current<br>(Body Diode) ③   | —    | —    | 240  |       |  |
| $V_{SD}$ | Diode Forward Voltage                     | —    | 0.8  | 1.0  | V     | $T_J = 25^\circ\text{C}, I_S = 24A, V_{GS} = 0V$ ③             |
| $t_{rr}$ | Reverse Recovery Time                     | —    | 29   | 44   | ns    | $T_J = 25^\circ\text{C}, I_F = 24A$                            |
| $Q_{rr}$ | Reverse Recovery Charge                   | —    | 18   | 27   | nC    | $di/dt = 100A/\mu s$ ③   |



### Notes:

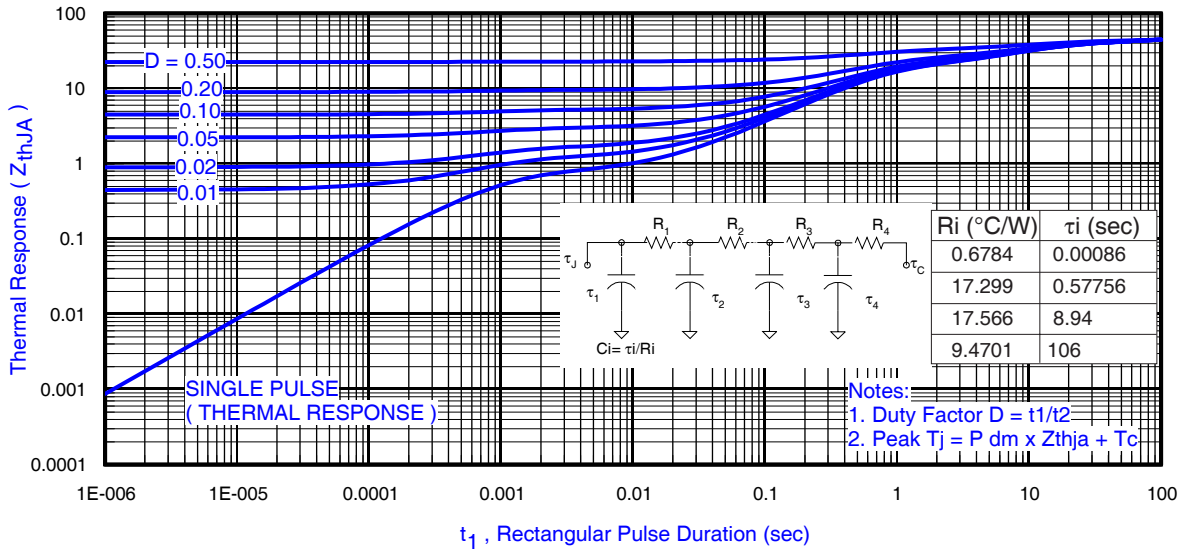
- ③ Repetitive rating; pulse width limited by max. junction temperature.
- ⑤ Pulse width  $\leq 400\mu s$ ; duty cycle  $\leq 2\%$ .

**Absolute Maximum Ratings**

|                                | Parameter                  | Max.         | Units |
|--------------------------------|----------------------------|--------------|-------|
| $P_D @ T_A = 25^\circ\text{C}$ | Power Dissipation ⑥        | 2.8          | W     |
| $P_D @ T_A = 70^\circ\text{C}$ | Power Dissipation ⑥        | 1.8          |       |
| $P_D @ T_C = 25^\circ\text{C}$ | Power Dissipation ⑨        | 89           |       |
| $T_P$                          | Peak Soldering Temperature | 270          | °C    |
| $T_J$                          | Operating Junction and     | -40 to + 150 |       |
| $T_{STG}$                      | Storage Temperature Range  |              |       |

**Thermal Resistance**

|                    | Parameter                | Typ.  | Max. | Units |
|--------------------|--------------------------|-------|------|-------|
| $R_{\theta JA}$    | Junction-to-Ambient ⑥⑩   | —     | 45   | °C/W  |
| $R_{\theta JA}$    | Junction-to-Ambient ⑦⑩   | 12.5  | —    |       |
| $R_{\theta JA}$    | Junction-to-Ambient ⑧⑩   | 20    | —    |       |
| $R_{\theta JC}$    | Junction-to-Case ⑨⑩      | —     | 1.4  |       |
| $R_{\theta J-PCB}$ | Junction-to-PCB Mounted  | 1.0   | —    |       |
|                    | Linear Derating Factor ⑥ | 0.017 |      | W/°C  |

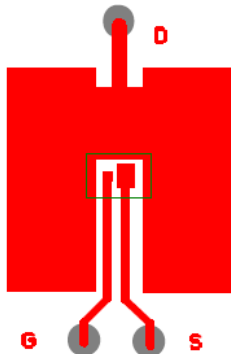


**Fig 3. Maximum Effective Transient Thermal Impedance, Junction-to-Ambient ⑥**

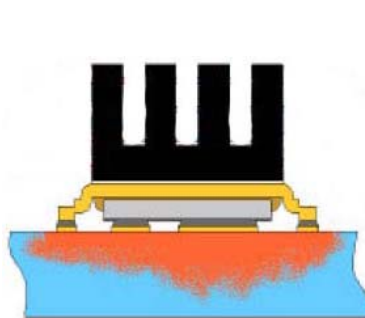
**Notes:**

- ⑥ Surface mounted on 1 in. square Cu board, steady state.
- ⑦ Used double sided cooling, mounting pad.
- ⑧ Mounted on minimum footprint full size board with metalized back and with small clip heatsink.

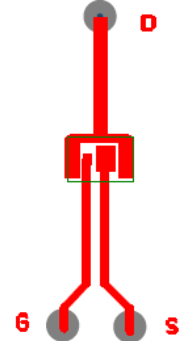
- ⑨  $T_C$  measured with thermocouple incontact with top (Drain) of part.
- ⑩  $R_{\theta}$  is measured at  $T_J$  of approximately 90°C.



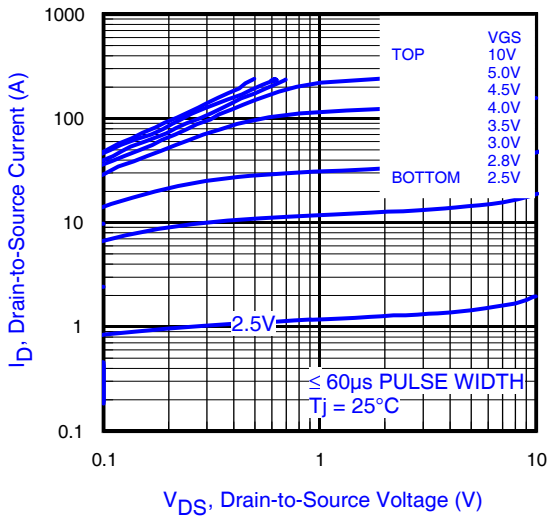
⑥ Surface mounted on 1 in. square Cu board (still air).



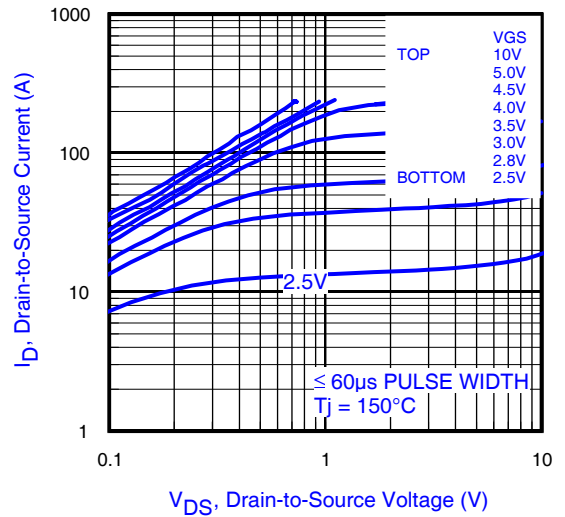
⑦ Mounted to a PCB with a thin gap filler and heat sink. (still air)



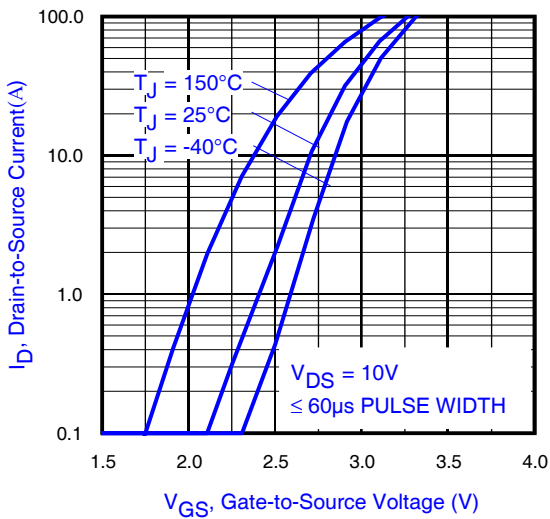
⑧ Mounted on minimum footprint full size board with metalized back and with small clip heatsink (still air)



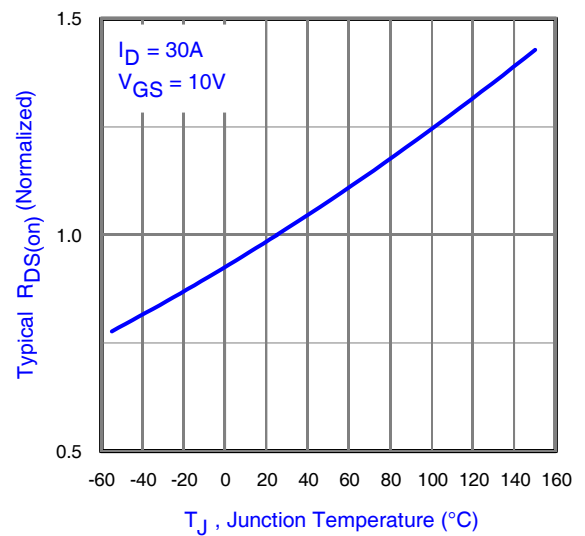
**Fig 4.** Typical Output Characteristics



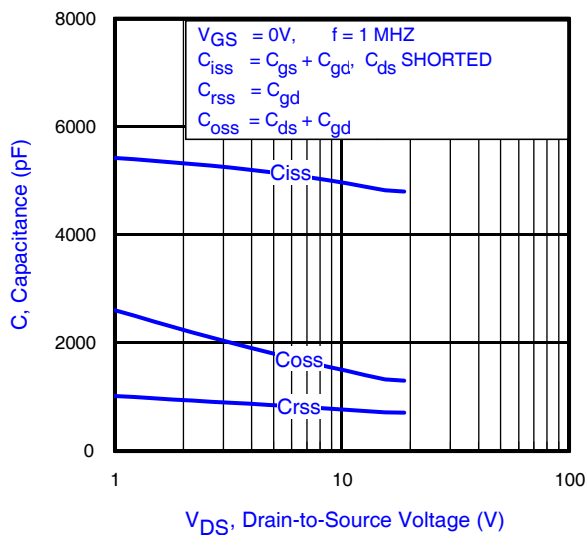
**Fig 5.** Typical Output Characteristics



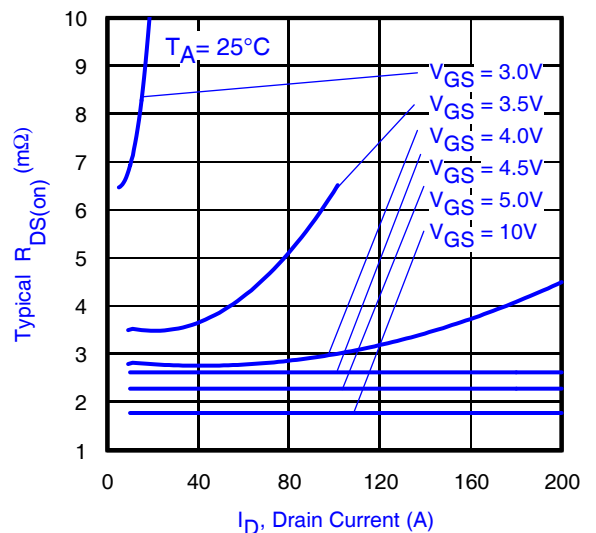
**Fig 6.** Typical Transfer Characteristics



**Fig 7.** Normalized On-Resistance vs. Temperature



**Fig 8.** Typical Capacitance vs. Drain-to-Source Voltage



**Fig 9.** Typical On-Resistance Vs. Drain Current and Gate Voltage

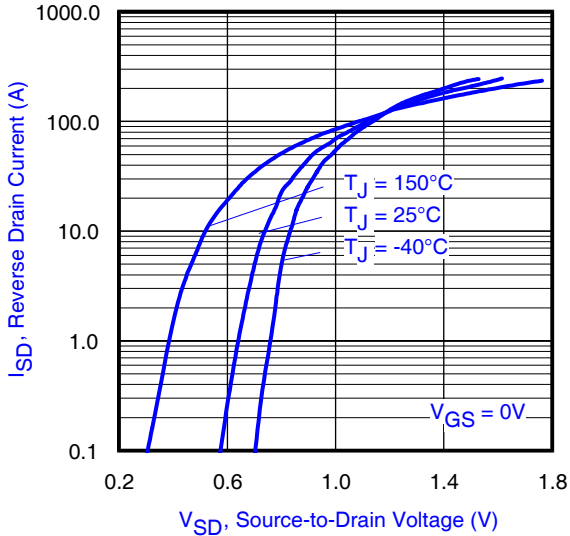


Fig 10. Typical Source-Drain Diode Forward Voltage

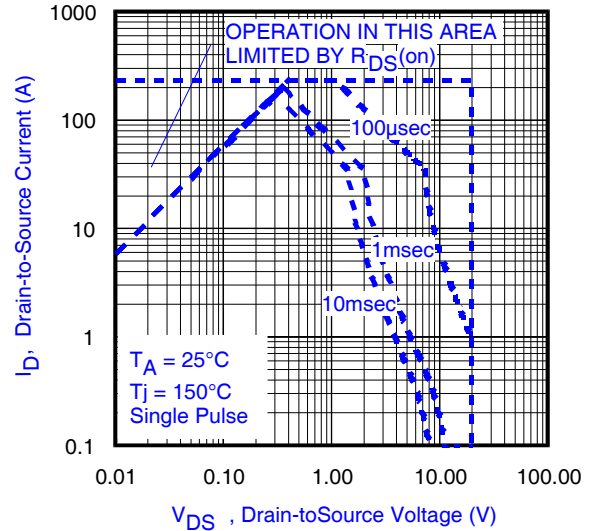


Fig 11. Maximum Safe Operating Area

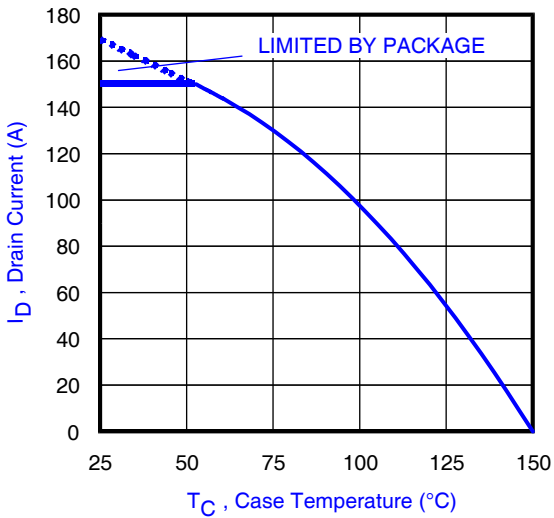


Fig 12. Maximum Drain Current vs. Case Temperature

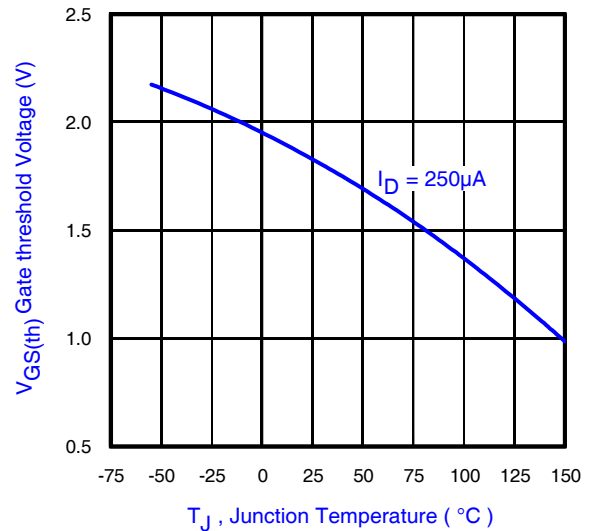


Fig 13. Typical Threshold Voltage vs. Junction Temperature

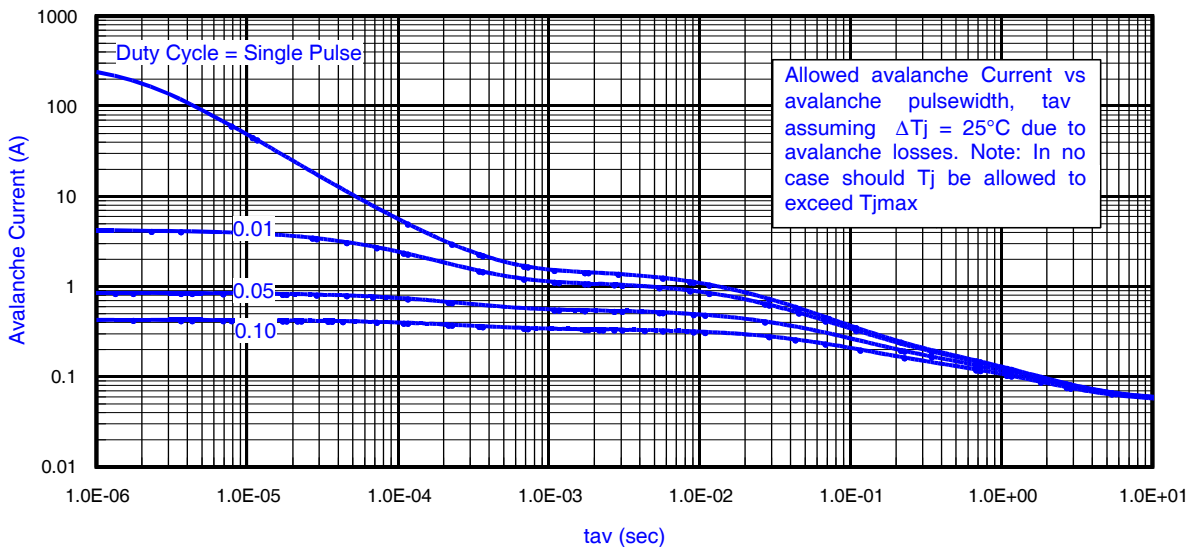
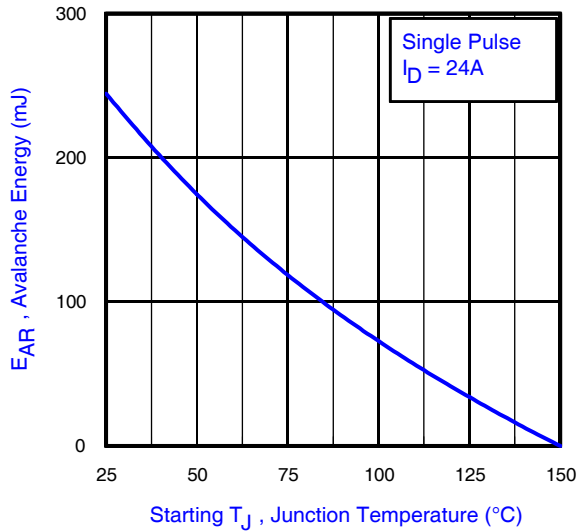
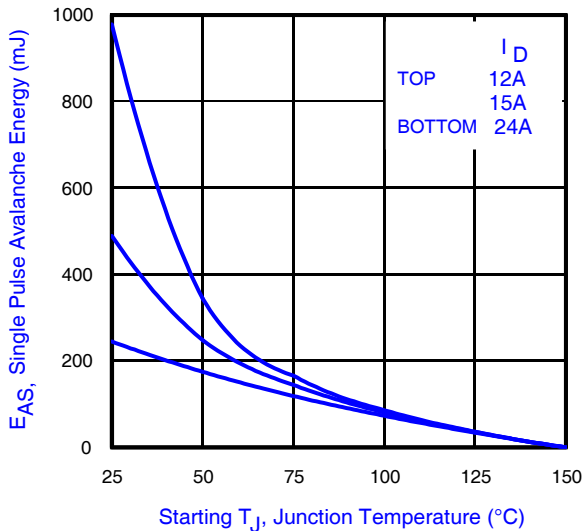


Fig 14. Typical Avalanche Current vs. Pulsewidth

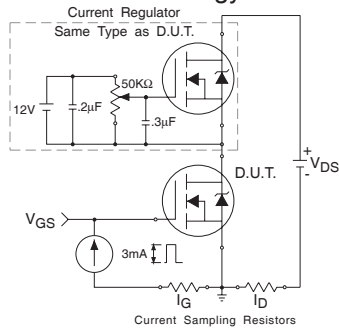
# IRF6619



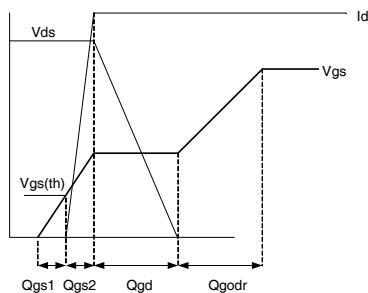
**Fig 15.** Maximum Avalanche Energy vs. Temperature



**Fig 16.** Maximum Avalanche Energy Vs. Drain Current



**Fig 18a.** Gate Charge Test Circuit



**Fig 18b.** Gate Charge Waveform

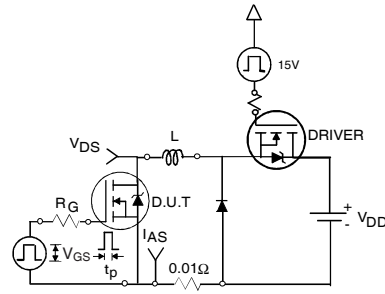
**Notes on Repetitive Avalanche Curves , Figures 14, 15:  
(For further info, see AN-1005 at www.irf.com)**

1. Avalanche failures assumption:  
Purely a thermal phenomenon and failure occurs at a temperature far in excess of  $T_{jmax}$ . This is validated for every part type.
2. Safe operation in Avalanche is allowed as long as  $T_{jmax}$  is not exceeded.
3. Equation below based on circuit and waveforms shown in Figures 17a, 17b.
4.  $P_{D(ave)}$  = Average power dissipation per single avalanche pulse.
5.  $BV$  = Rated breakdown voltage (1.3 factor accounts for voltage increase during avalanche).
6.  $I_{av}$  = Allowable avalanche current.
7.  $\Delta T$  = Allowable rise in junction temperature, not to exceed  $T_{jmax}$  (assumed as 25°C in Figure 14, 15).  
 $t_{av}$  = Average time in avalanche.  
 $D$  = Duty cycle in avalanche =  $t_{av} \cdot f$   
 $Z_{thJC}(D, t_{av})$  = Transient thermal resistance, see Figures 3)

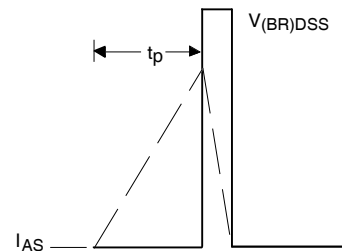
$$P_{D(ave)} = 1/2 ( 1.3 \cdot BV \cdot I_{av} ) = \Delta T / Z_{thJC}$$

$$I_{av} = 2\Delta T / [1.3 \cdot BV \cdot Z_{th}]$$

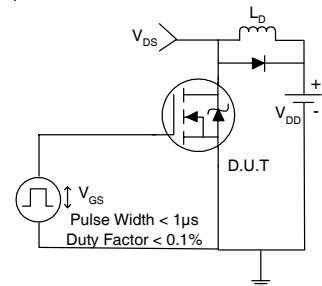
$$E_{AS(AR)} = P_{D(ave)} \cdot t_{av}$$



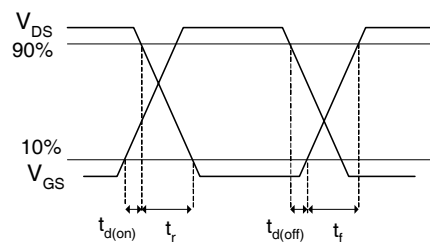
**Fig 17a.** Unclamped Inductive Test Circuit



**Fig 17b.** Unclamped Inductive Waveforms



**Fig 19a.** Switching Time Test Circuit



**Fig 19b.** Switching Time Waveforms

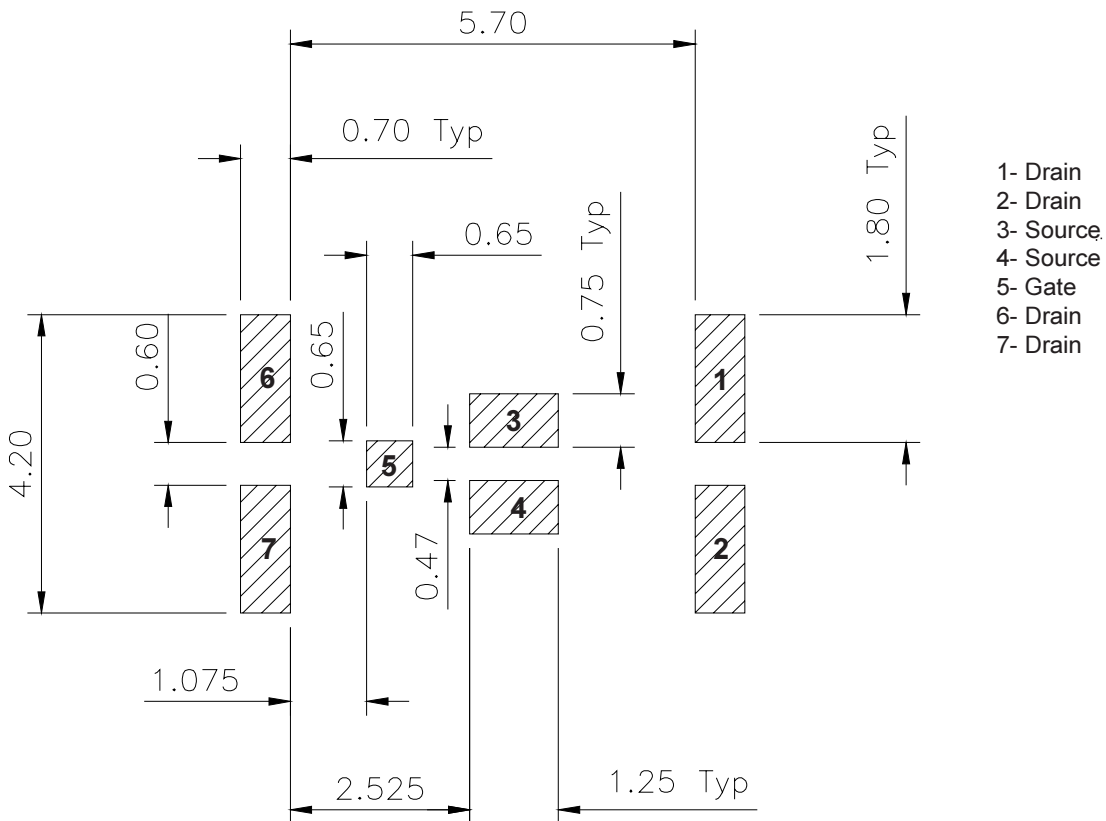


**Fig 20.** Diode Reverse Recovery Test Circuit for N-Channel HEXFET® Power MOSFETs

### DirectFET™ Substrate and PCB Layout, MX Outline (Medium Size Can, X-Designation).

Please see DirectFET application note AN-1035 for all details regarding the assembly of DirectFET.

This includes all recommendations for stencil and substrate designs.

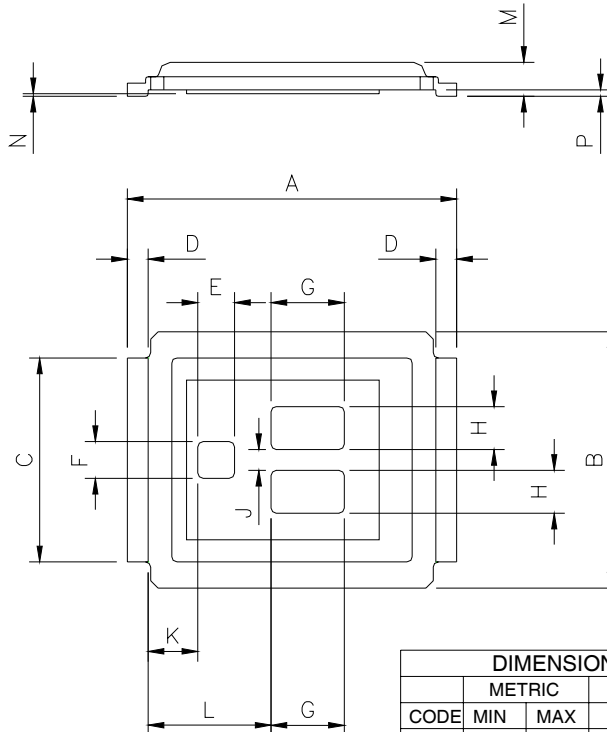


# IRF6619

## DirectFET™ Outline Dimension, MX Outline (Medium Size Can, X-Designation).

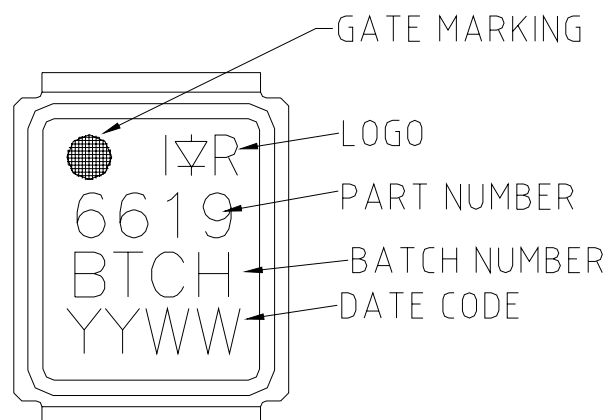
Please see DirectFET application note AN-1035 for all details regarding the assembly of DirectFET.

This includes all recommendations for stencil and substrate designs.



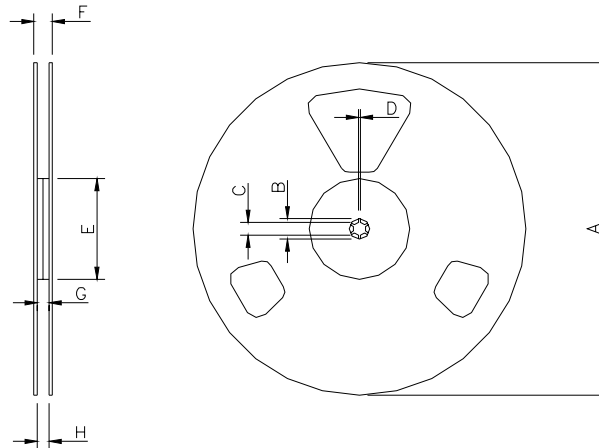
| CODE | METRIC |      | IMPERIAL |       |
|------|--------|------|----------|-------|
|      | MIN    | MAX  | MAX      | MAX   |
| A    | 6.25   | 6.35 | 0.246    | 0.250 |
| B    | 4.80   | 5.05 | 0.189    | 0.201 |
| C    | 3.85   | 3.95 | 0.152    | 0.156 |
| D    | 0.35   | 0.45 | 0.014    | 0.018 |
| E    | 0.68   | 0.72 | 0.027    | 0.028 |
| F    | 0.68   | 0.72 | 0.027    | 0.028 |
| G    | 1.38   | 1.42 | 0.054    | 0.056 |
| H    | 0.80   | 0.84 | 0.032    | 0.033 |
| J    | 0.38   | 0.42 | 0.015    | 0.017 |
| K    | 0.88   | 1.01 | 0.035    | 0.039 |
| L    | 2.28   | 2.41 | 0.090    | 0.095 |
| M    | 0.59   | 0.70 | 0.023    | 0.028 |
| N    | 0.03   | 0.08 | 0.001    | 0.003 |
| P    | 0.08   | 0.17 | 0.003    | 0.007 |

## DirectFET™ Part Marking





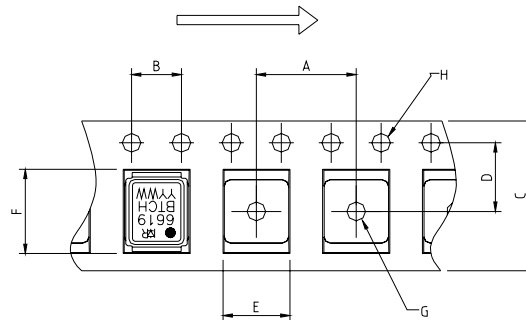
DirectFET™ Tape & Reel Dimension (Showing component orientation).



NOTE: Controlling dimensions in mm  
 Std reel quantity is 4800 parts. (ordered as IRF6619). For 1000 parts on 7" reel, order IRF6619TR1

| REEL DIMENSIONS            |  |        |       |                       |       |        |      |          |     |
|----------------------------|--|--------|-------|-----------------------|-------|--------|------|----------|-----|
| STANDARD OPTION (QTY 4800) |  |        |       | TR1 OPTION (QTY 1000) |       |        |      |          |     |
|                            |  | METRIC |       | IMPERIAL              |       | METRIC |      | IMPERIAL |     |
|                            |  | MIN    | MAX   | MIN                   | MAX   | MIN    | MAX  | MIN      | MAX |
|                            |  | 12.992 | N.C   | 177.77                | N.C   | 6.9    | N.C  |          |     |
|                            |  | 0.795  | N.C   | 19.06                 | N.C   | 0.75   | N.C  |          |     |
|                            |  | 0.504  | 0.520 | 13.5                  | 12.8  | 0.53   | 0.50 |          |     |
|                            |  | 0.059  | N.C   | 1.5                   | N.C   | 0.059  | N.C  |          |     |
|                            |  | 3.937  | N.C   | 58.72                 | N.C   | 2.31   | N.C  |          |     |
|                            |  | N.C    | 0.724 | N.C                   | 13.50 | N.C    | 0.53 |          |     |
|                            |  | 0.488  | 0.567 | 11.9                  | 12.01 | 0.47   | N.C  |          |     |
|                            |  | 0.469  | 0.606 | 11.9                  | 12.01 | 0.47   | N.C  |          |     |

LOADED TAPE FEED DIRECTION



NOTE: CONTROLLING DIMENSIONS IN MM

| CODE | DIMENSIONS |       |          |       |
|------|------------|-------|----------|-------|
|      | METRIC     |       | IMPERIAL |       |
|      | MIN        | MAX   | MIN      | MAX   |
| A    | 7.90       | 8.10  | 0.311    | 0.319 |
| B    | 3.90       | 4.10  | 0.154    | 0.161 |
| C    | 11.90      | 12.30 | 0.469    | 0.484 |
| D    | 5.45       | 5.55  | 0.215    | 0.219 |
| E    | 5.10       | 5.30  | 0.201    | 0.209 |
| F    | 6.50       | 6.70  | 0.256    | 0.264 |
| G    | 1.50       | N.C   | 0.059    | N.C   |
| H    | 1.50       | 1.60  | 0.059    | 0.063 |

Data and specifications subject to change without notice.  
 This product has been designed and qualified for the Consumer market.  
 Qualification Standards can be found on IR's Web site.