

## AO4612

### 60V Complementary Enhancement Mode Field Effect Transistor

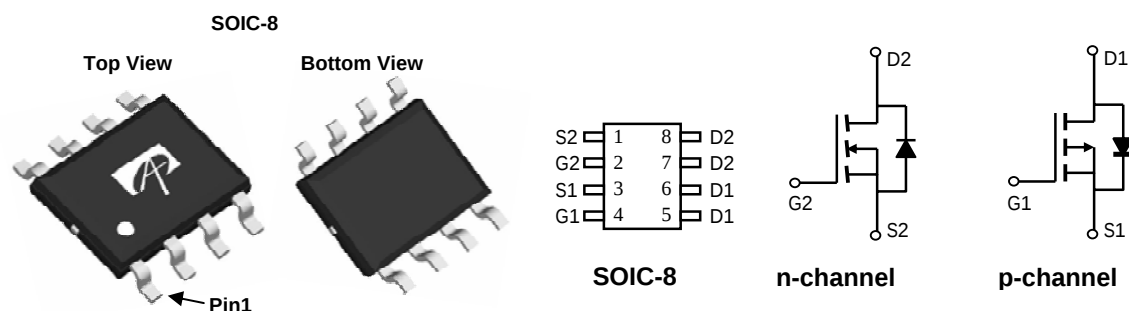
#### General Description

The AO4612 uses advanced trench technology MOSFETs to provide excellent  $R_{DS(ON)}$  and low gate charge. The complementary MOSFETs may be used in H-bridge, Inverters and other applications.

#### Features

|                             |                                 |
|-----------------------------|---------------------------------|
| n-channel                   | p-channel                       |
| $V_{DS} (V) = 60V$          | -60V                            |
| $I_D = 4.5A (V_{GS}=10V)$   | -3.2A ( $V_{GS} = -10V$ )       |
| $R_{DS(ON)}$                | $R_{DS(ON)}$                    |
| $< 56m\Omega (V_{GS}=10V)$  | $< 105m\Omega (V_{GS} = -10V)$  |
| $< 77m\Omega (V_{GS}=4.5V)$ | $< 135m\Omega (V_{GS} = -4.5V)$ |

100% Rg tested



#### Absolute Maximum Ratings $T_A=25^\circ C$ unless otherwise noted

| Parameter                              | Symbol         | Max n-channel | Max p-channel | Units      |
|----------------------------------------|----------------|---------------|---------------|------------|
| Drain-Source Voltage                   | $V_{DS}$       | 60            | -60           | V          |
| Gate-Source Voltage                    | $V_{GS}$       | $\pm 20$      | $\pm 20$      | V          |
| Continuous Drain Current <sup>A</sup>  | $I_D$          | 4.5           | -3.2          | A          |
| $T_A=25^\circ C$                       |                |               |               |            |
| $T_A=70^\circ C$                       |                | 3.6           | -2.6          |            |
| Pulsed Drain Current <sup>B</sup>      | $I_{DM}$       | 20            | -20           |            |
| Power Dissipation                      | $P_D$          | 2             | 2             | W          |
|                                        |                |               |               |            |
| $T_A=25^\circ C$                       |                |               |               |            |
| $T_A=70^\circ C$                       |                | 1.28          | 1.28          |            |
| Junction and Storage Temperature Range | $T_J, T_{STG}$ | -55 to 150    | -55 to 150    | $^\circ C$ |

#### Thermal Characteristics: n-channel and p-channel

| Parameter                                | Symbol          | Typ | Max  | Units        |
|------------------------------------------|-----------------|-----|------|--------------|
| Maximum Junction-to-Ambient <sup>A</sup> | $R_{\theta JA}$ | 48  | 62.5 | $^\circ C/W$ |
| $t \leq 10s$                             |                 |     |      |              |
| Maximum Junction-to-Ambient <sup>A</sup> | $R_{\theta JA}$ | 74  | 90   | $^\circ C/W$ |
| Steady-State                             |                 |     |      |              |
| Maximum Junction-to-Lead <sup>C</sup>    | $R_{\theta JL}$ | 35  | 40   | $^\circ C/W$ |
| Steady-State                             |                 |     |      |              |

**N Channel Electrical Characteristics (T<sub>j</sub>=25°C unless otherwise noted)**

| Symbol                      | Parameter                             | Conditions                                                                                | Min | Typ      | Max    | Units |
|-----------------------------|---------------------------------------|-------------------------------------------------------------------------------------------|-----|----------|--------|-------|
| <b>STATIC PARAMETERS</b>    |                                       |                                                                                           |     |          |        |       |
| BV <sub>DSS</sub>           | Drain-Source Breakdown Voltage        | I <sub>D</sub> =250μA, V <sub>GS</sub> =0V                                                | 60  |          |        | V     |
| I <sub>DSS</sub>            | Zero Gate Voltage Drain Current       | V <sub>DS</sub> =48V, V <sub>GS</sub> =0V<br>T <sub>j</sub> =55°C                         |     |          | 1<br>5 | μA    |
| I <sub>GSS</sub>            | Gate-Body leakage current             | V <sub>DS</sub> =0V, V <sub>GS</sub> = ±20V                                               |     |          | 100    | nA    |
| V <sub>GS(th)</sub>         | Gate Threshold Voltage                | V <sub>DS</sub> =V <sub>GS</sub> , I <sub>D</sub> =250μA                                  | 1   | 2.1      | 3      | V     |
| I <sub>D(ON)</sub>          | On state drain current                | V <sub>GS</sub> =10V, V <sub>DS</sub> =5V                                                 | 20  |          |        | A     |
| R <sub>DS(ON)</sub>         | Static Drain-Source On-Resistance     | V <sub>GS</sub> =10V, I <sub>D</sub> =4.5A<br>T <sub>j</sub> =125°C                       |     | 46<br>79 | 56     | mΩ    |
|                             |                                       | V <sub>GS</sub> =4.5V, I <sub>D</sub> =3A                                                 |     | 64       | 77     | mΩ    |
| g <sub>FS</sub>             | Forward Transconductance              | V <sub>DS</sub> =5V, I <sub>D</sub> =4.5A                                                 |     | 11       |        | S     |
| V <sub>SD</sub>             | Diode Forward Voltage                 | I <sub>S</sub> =1A, V <sub>GS</sub> =0V                                                   |     | 0.74     | 1      | V     |
| I <sub>S</sub>              | Maximum Body-Diode Continuous Current |                                                                                           |     |          | 3      | A     |
| <b>DYNAMIC PARAMETERS</b>   |                                       |                                                                                           |     |          |        |       |
| C <sub>iss</sub>            | Input Capacitance                     | V <sub>GS</sub> =0V, V <sub>DS</sub> =30V, f=1MHz                                         |     | 450      | 540    | pF    |
| C <sub>oss</sub>            | Output Capacitance                    |                                                                                           |     | 60       |        | pF    |
| C <sub>rss</sub>            | Reverse Transfer Capacitance          |                                                                                           |     | 25       |        | pF    |
| R <sub>g</sub>              | Gate resistance                       | V <sub>GS</sub> =0V, V <sub>DS</sub> =0V, f=1MHz                                          |     | 1.65     | 2      | Ω     |
| <b>SWITCHING PARAMETERS</b> |                                       |                                                                                           |     |          |        |       |
| Q <sub>g</sub> (10V)        | Total Gate Charge                     | V <sub>GS</sub> =10V, V <sub>DS</sub> =30V, I <sub>D</sub> =4.5A                          |     | 8.5      | 10.5   | nC    |
| Q <sub>g</sub> (4.5V)       | Total Gate Charge                     |                                                                                           |     | 4.3      | 5.5    | nC    |
| Q <sub>gs</sub>             | Gate Source Charge                    |                                                                                           |     | 1.6      |        | nC    |
| Q <sub>gd</sub>             | Gate Drain Charge                     |                                                                                           |     | 2.2      |        | nC    |
| t <sub>D(on)</sub>          | Turn-On DelayTime                     | V <sub>GS</sub> =10V, V <sub>DS</sub> =30V, R <sub>L</sub> =6.7Ω,<br>R <sub>GEN</sub> =3Ω |     | 4.7      | 7      | ns    |
| t <sub>r</sub>              | Turn-On Rise Time                     |                                                                                           |     | 2.3      | 4.5    | ns    |
| t <sub>D(off)</sub>         | Turn-Off DelayTime                    |                                                                                           |     | 15.7     | 24     | ns    |
| t <sub>f</sub>              | Turn-Off Fall Time                    |                                                                                           |     | 1.9      | 4      | ns    |
| t <sub>rr</sub>             | Body Diode Reverse Recovery Time      | I <sub>F</sub> =4.5A, dI/dt=100A/μs                                                       |     | 27.5     | 35     | ns    |
| Q <sub>rr</sub>             | Body Diode Reverse Recovery Charge    | I <sub>F</sub> =4.5A, dI/dt=100A/μs                                                       |     | 32       |        | nC    |

A: The value of R<sub>θJA</sub> is measured with the device mounted on 1in<sup>2</sup> FR-4 board with 2oz. Copper, in a still air environment with T<sub>A</sub>=25° C. The value in any a given application depends on the user's specific board design. The current rating is based on the t<sub>1</sub> ≤ 10s thermal resistance rating.

B: Repetitive rating, pulse width limited by junction temperature.

C: The R<sub>θJA</sub> is the sum of the thermal impedance from junction to lead R<sub>θJL</sub> and lead to ambient.

D: The static characteristics in Figures 1 to 6 are obtained using 80 μs pulses, duty cycle 0.5% max.

E: These tests are performed with the device mounted on 1 in <sup>2</sup> FR-4 board with 2oz. Copper, in a still air environment with T<sub>A</sub>=25° C. The SOA curve provides a single pulse rating. Rev3: Oct 2010

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## TYPICAL ELECTRICAL AND THERMAL CHARACTERISTICS: N-CHANNEL

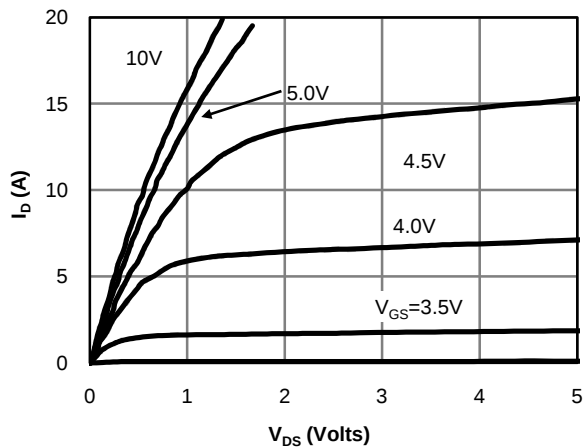


Fig 1: On-Region Characteristics

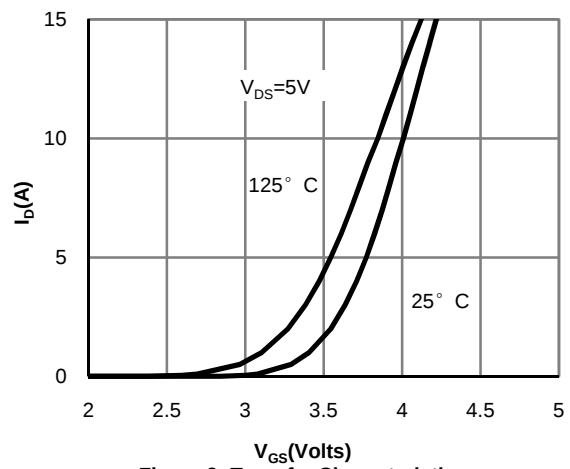


Figure 2: Transfer Characteristics

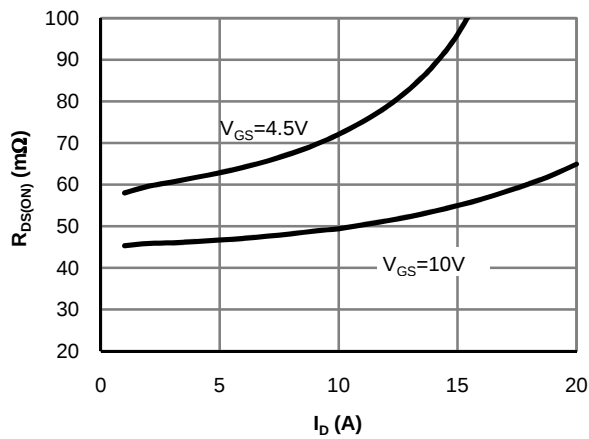


Figure 3: On-Resistance vs. Drain Current and Gate Voltage

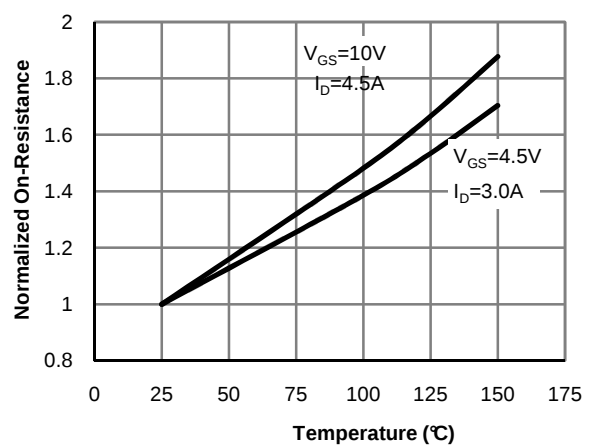


Figure 4: On-Resistance vs. Junction Temperature

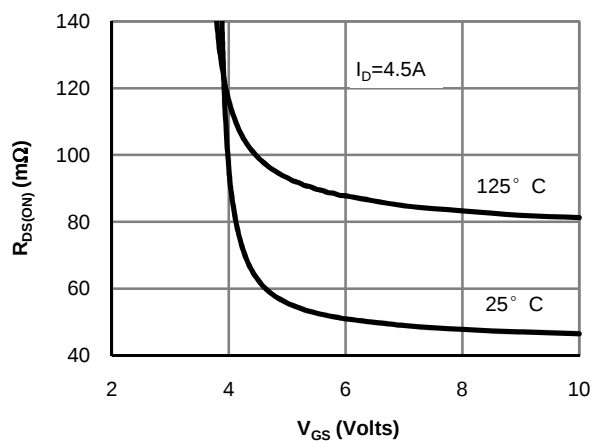


Figure 5: On-Resistance vs. Gate-Source Voltage

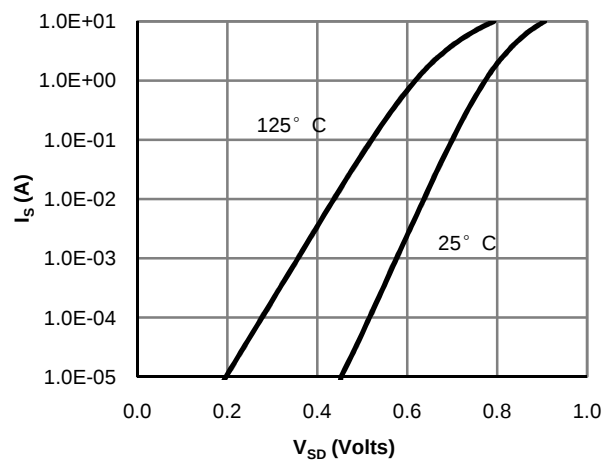


Figure 6: Body-Diode Characteristics

## TYPICAL ELECTRICAL AND THERMAL CHARACTERISTICS: N-CHANNEL

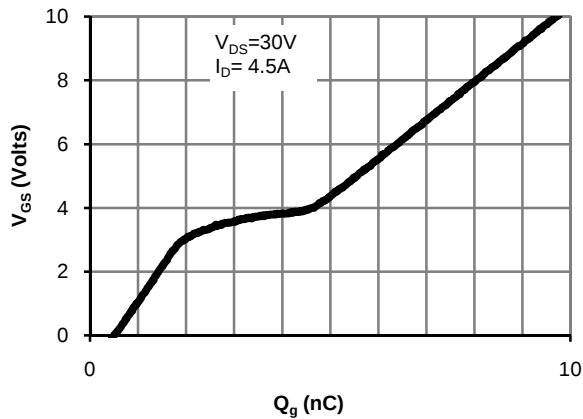


Figure 7: Gate-Charge Characteristics

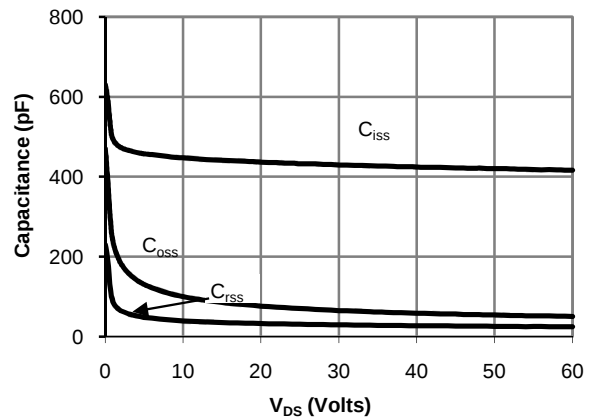


Figure 8: Capacitance Characteristics

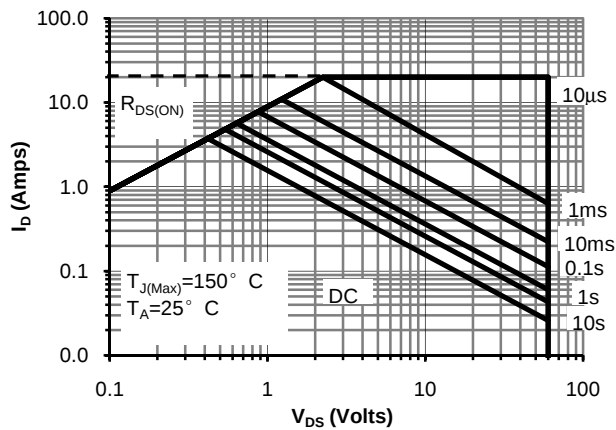


Figure 9: Maximum Forward Biased Safe Operating Area (Note E)

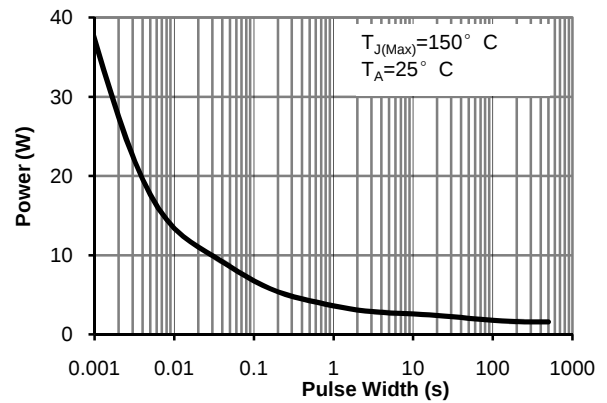


Figure 10: Single Pulse Power Rating Junction-to-Ambient (Note E)

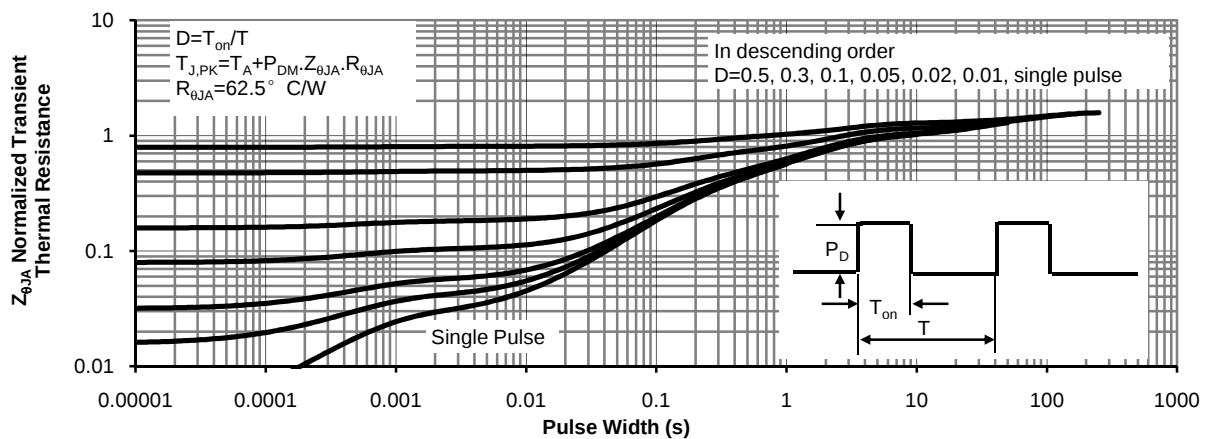
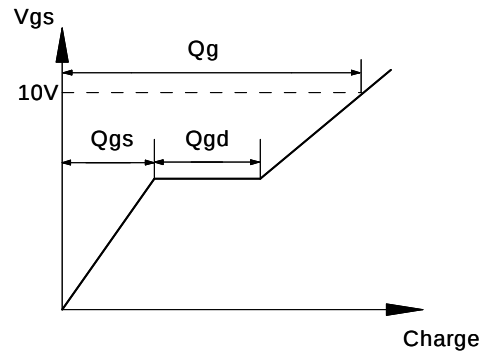
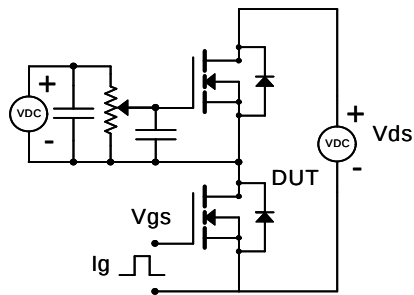
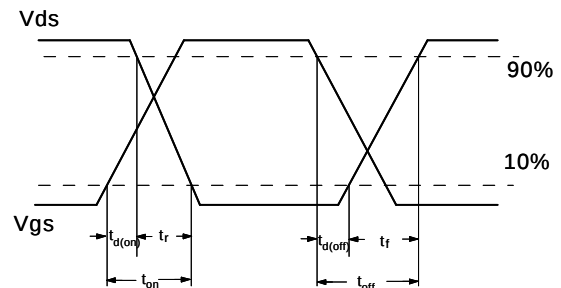
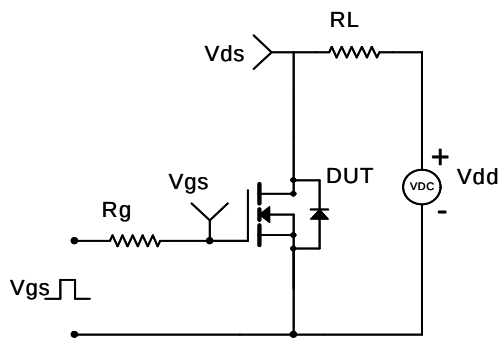


Figure 11: Normalized Maximum Transient Thermal Impedance

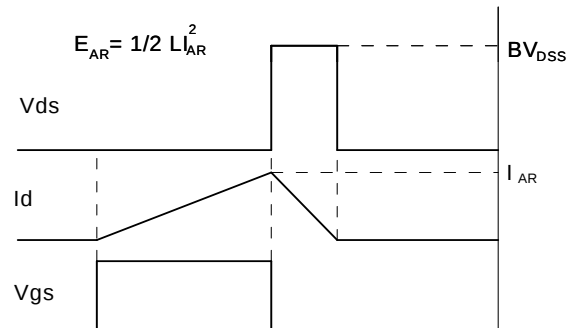
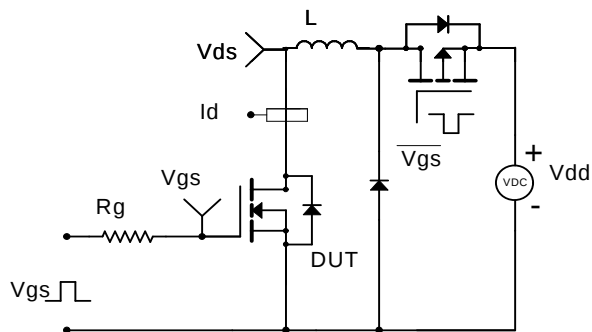
Gate Charge Test Circuit &amp; Waveform



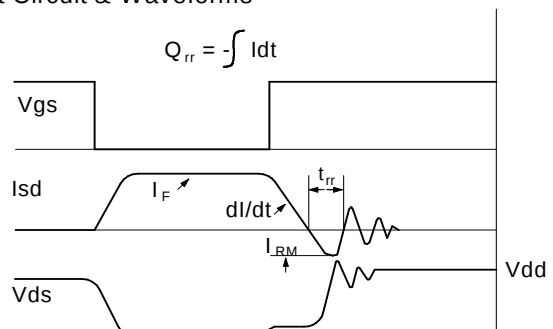
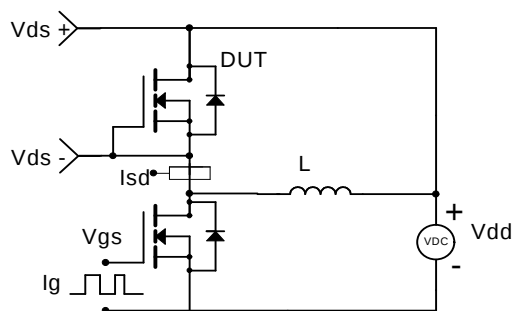
Resistive Switching Test Circuit &amp; Waveforms



Unclamped Inductive Switching (UIS) Test Circuit &amp; Waveforms



Diode Recovery Test Circuit &amp; Waveforms



**P-Channel Electrical Characteristics (T<sub>J</sub>=25°C unless otherwise noted)**

| Symbol                      | Parameter                             | Conditions                                                                                  | Min | Typ       | Max      | Units |
|-----------------------------|---------------------------------------|---------------------------------------------------------------------------------------------|-----|-----------|----------|-------|
| <b>STATIC PARAMETERS</b>    |                                       |                                                                                             |     |           |          |       |
| BV <sub>DSS</sub>           | Drain-Source Breakdown Voltage        | I <sub>D</sub> =-250μA, V <sub>GS</sub> =0V                                                 | -60 |           |          | V     |
| I <sub>DSS</sub>            | Zero Gate Voltage Drain Current       | V <sub>DS</sub> =-48V, V <sub>GS</sub> =0V<br>T <sub>J</sub> =55°C                          |     |           | -1<br>-5 | μA    |
| I <sub>GSS</sub>            | Gate-Body leakage current             | V <sub>DS</sub> =0V, V <sub>GS</sub> =±20V                                                  |     |           | ±100     | nA    |
| V <sub>GS(th)</sub>         | Gate Threshold Voltage                | V <sub>DS</sub> =V <sub>GS</sub> , I <sub>D</sub> =-250μA                                   | -1  | -2.1      | -3       | V     |
| I <sub>D(ON)</sub>          | On state drain current                | V <sub>GS</sub> =-10V, V <sub>DS</sub> =-5V                                                 | -20 |           |          | A     |
| R <sub>DS(ON)</sub>         | Static Drain-Source On-Resistance     | V <sub>GS</sub> =-10V, I <sub>D</sub> =-3.2A<br>T <sub>J</sub> =125°C                       |     | 84<br>145 | 105      | mΩ    |
|                             |                                       | V <sub>GS</sub> =-4.5V, I <sub>D</sub> =-2.8A                                               |     | 106       | 135      | mΩ    |
|                             |                                       |                                                                                             |     |           |          |       |
| g <sub>FS</sub>             | Forward Transconductance              | V <sub>DS</sub> =-5V, I <sub>D</sub> =-3.2A                                                 |     | 9         |          | S     |
| V <sub>SD</sub>             | Diode Forward Voltage                 | I <sub>S</sub> =-1A, V <sub>GS</sub> =0V                                                    |     | -0.73     | -1       | V     |
| I <sub>S</sub>              | Maximum Body-Diode Continuous Current |                                                                                             |     |           | -3       | A     |
| <b>DYNAMIC PARAMETERS</b>   |                                       |                                                                                             |     |           |          |       |
| C <sub>iss</sub>            | Input Capacitance                     | V <sub>GS</sub> =0V, V <sub>DS</sub> =-30V, f=1MHz                                          |     | 930       | 1120     | pF    |
| C <sub>oss</sub>            | Output Capacitance                    |                                                                                             |     | 85        |          | pF    |
| C <sub>rss</sub>            | Reverse Transfer Capacitance          |                                                                                             |     | 35        |          | pF    |
| R <sub>g</sub>              | Gate resistance                       | V <sub>GS</sub> =0V, V <sub>DS</sub> =0V, f=1MHz                                            |     | 7.2       | 9        | Ω     |
| <b>SWITCHING PARAMETERS</b> |                                       |                                                                                             |     |           |          |       |
| Q <sub>g</sub> (10V)        | Total Gate Charge (10V)               | V <sub>GS</sub> =-10V, V <sub>DS</sub> =-30V, I <sub>D</sub> =-3.2A                         |     | 16        | 20       | nC    |
| Q <sub>g</sub> (4.5V)       | Total Gate Charge (4.5V)              |                                                                                             |     | 8         | 10       | nC    |
| Q <sub>gs</sub>             | Gate Source Charge                    |                                                                                             |     | 2.5       |          | nC    |
| Q <sub>gd</sub>             | Gate Drain Charge                     |                                                                                             |     | 3.2       |          | nC    |
| t <sub>D(on)</sub>          | Turn-On DelayTime                     | V <sub>GS</sub> =-10V, V <sub>DS</sub> =-30V, R <sub>L</sub> =9.4Ω,<br>R <sub>GEN</sub> =3Ω |     | 8         | 12       | ns    |
| t <sub>r</sub>              | Turn-On Rise Time                     |                                                                                             |     | 3.8       | 7.5      | ns    |
| t <sub>D(off)</sub>         | Turn-Off DelayTime                    |                                                                                             |     | 31.5      | 48       | ns    |
| t <sub>f</sub>              | Turn-Off Fall Time                    |                                                                                             |     | 7.5       | 15       | ns    |
| t <sub>rr</sub>             | Body Diode Reverse Recovery Time      | I <sub>F</sub> =-3.2A, dI/dt=100A/μs                                                        |     | 27        | 35       | ns    |
| Q <sub>rr</sub>             | Body Diode Reverse Recovery Charge    | I <sub>F</sub> =-3.2A, dI/dt=100A/μs                                                        |     | 32        |          | nC    |

A: The value of R<sub>θJA</sub> is measured with the device mounted on 1in<sup>2</sup> FR-4 board with 2oz. Copper, in a still air environment with T<sub>A</sub>=25° C. The value in any a given application depends on the user's specific board design. The current rating is based on the t ≤ 10s thermal resistance rating.

B: Repetitive rating, pulse width limited by junction temperature.

C: The R<sub>θJA</sub> is the sum of the thermal impedance from junction to lead R<sub>θJL</sub> and lead to ambient.

D: The static characteristics in Figures 1 to 6,12,14 are obtained using 80 μs pulses, duty cycle 0.5% max.

E: These tests are performed with the device mounted on 1 in<sup>2</sup> FR-4 board with 2oz. Copper, in a still air environment with T<sub>A</sub>=25° C. The SOA curve provides a single pulse rating.

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TYPICAL ELECTRICAL AND THERMAL CHARACTERISTICS: P-CHANNEL

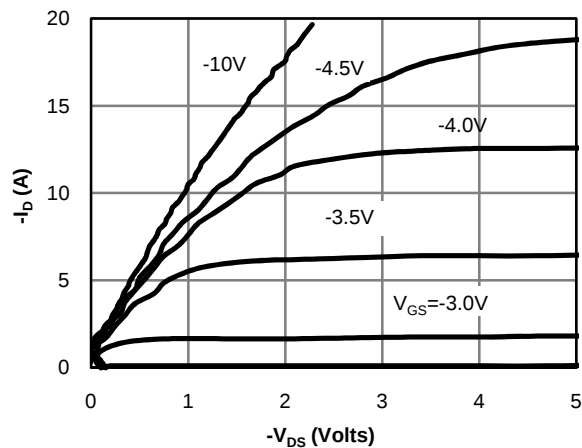


Fig 1: On-Region Characteristics

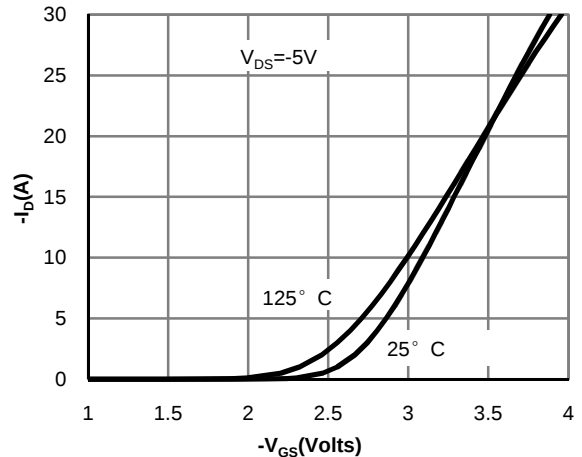


Figure 2: Transfer Characteristics

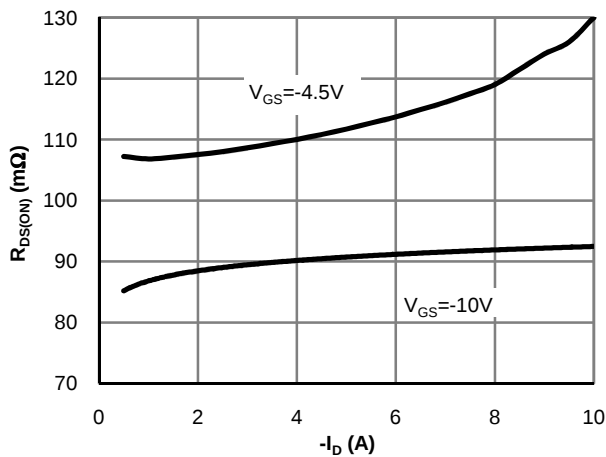


Figure 3: On-Resistance vs. Drain Current and Gate Voltage

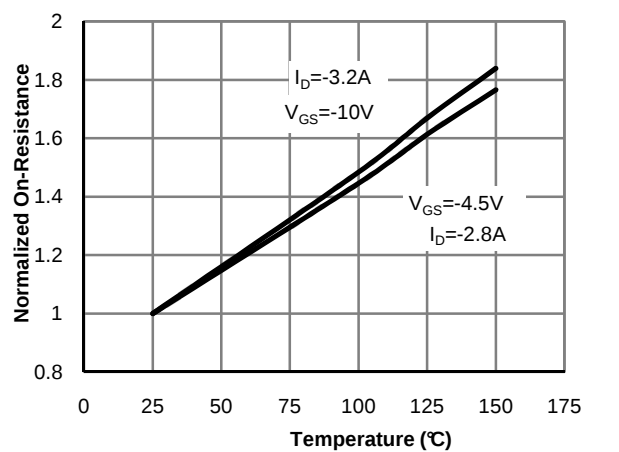


Figure 4: On-Resistance vs. Junction Temperature

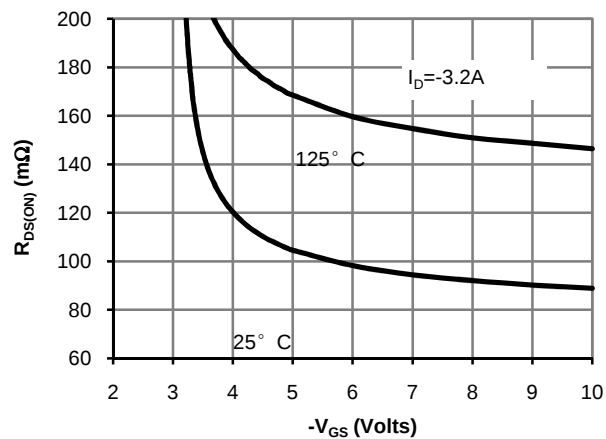


Figure 5: On-Resistance vs. Gate-Source Voltage

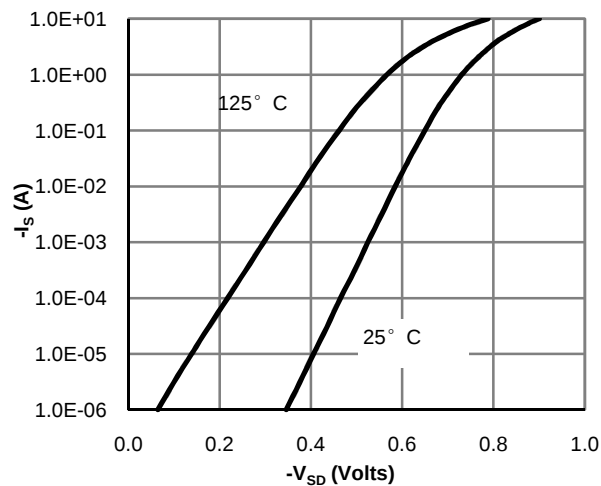


Figure 6: Body-Diode Characteristics

## TYPICAL ELECTRICAL AND THERMAL CHARACTERISTICS: P-CHANNEL

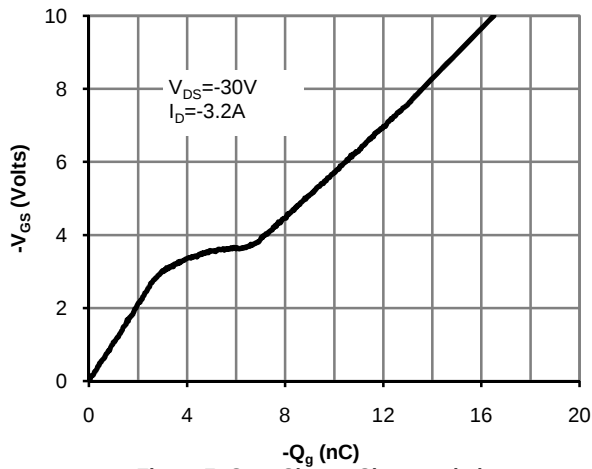


Figure 7: Gate-Charge Characteristics

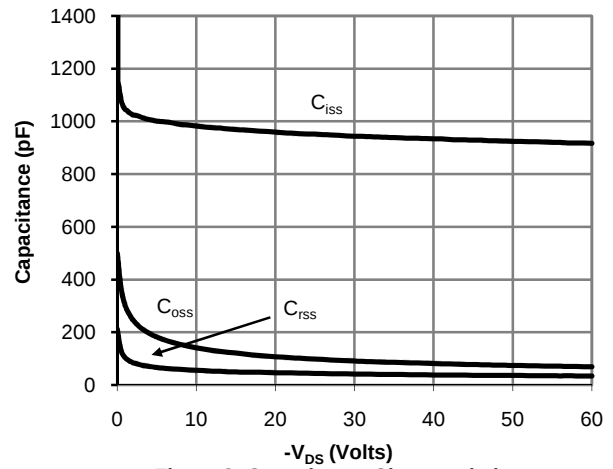


Figure 8: Capacitance Characteristics

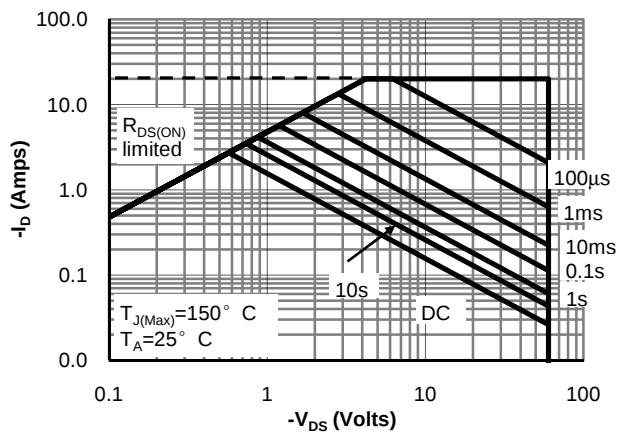


Figure 9: Maximum Forward Biased Safe Operating Area (Note E)

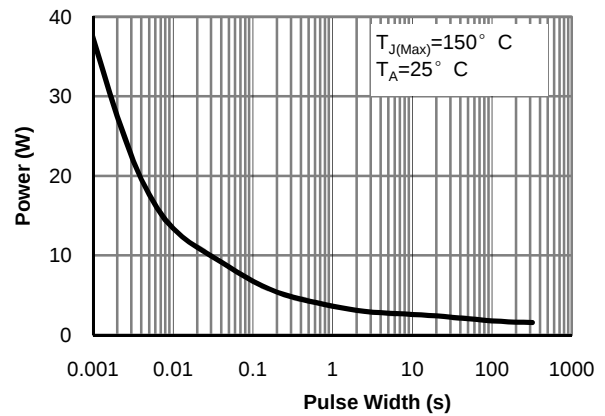


Figure 10: Single Pulse Power Rating Junction-to-Ambient (Note E)

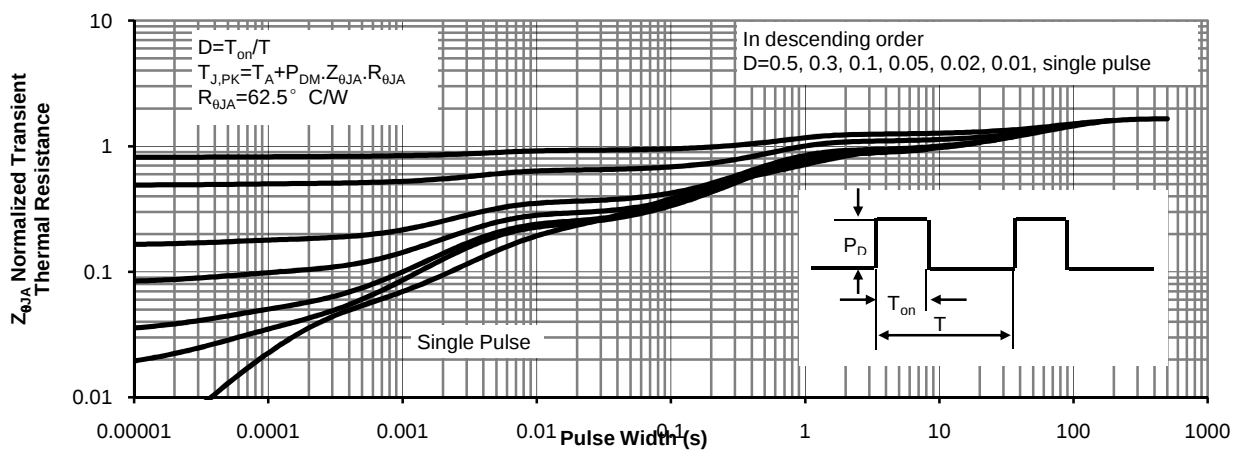
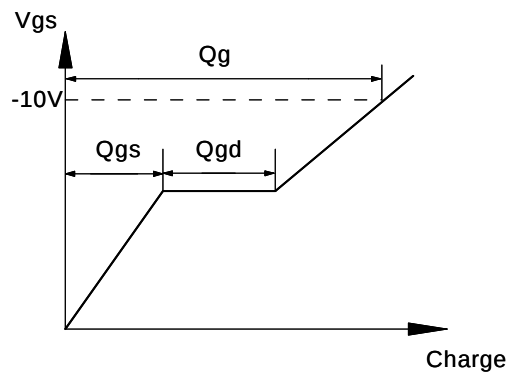
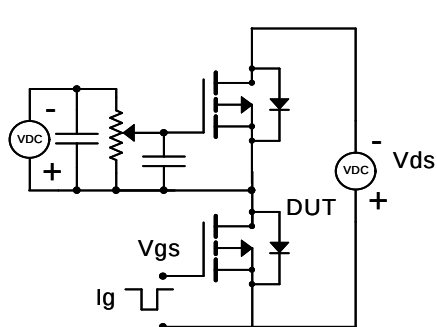
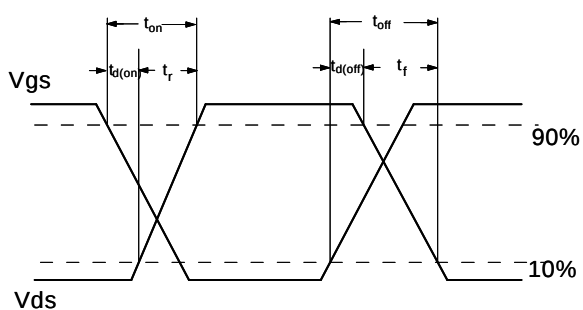
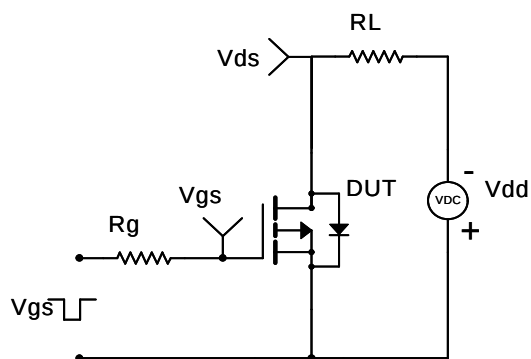


Figure 11: Normalized Maximum Transient Thermal Impedance

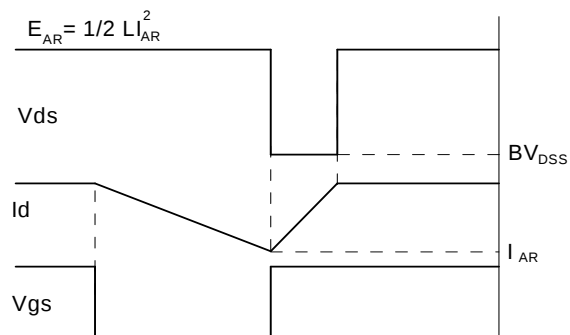
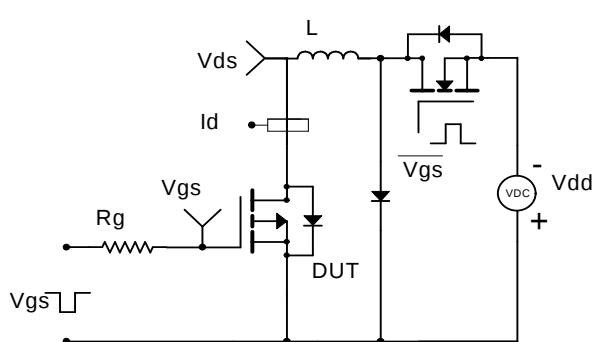
## Gate Charge Test Circuit &amp; Waveform



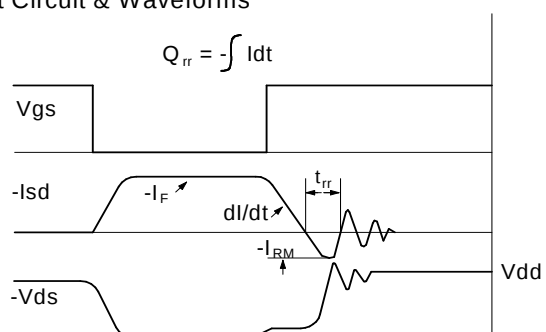
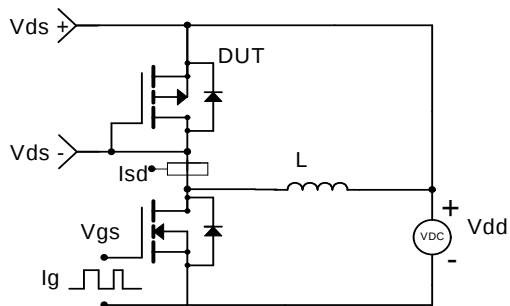
## Resistive Switching Test Circuit &amp; Waveforms



## Unclamped Inductive Switching (UIS) Test Circuit &amp; Waveforms



## Diode Recovery Test Circuit &amp; Waveforms





**ООО «НИОКРсистемс»** - это оперативные поставки широкого спектра электронных компонентов отечественного и импортного производства напрямую от производителей и с крупнейших мировых складов. Реализуемая нашей компанией продукция насчитывает более полумиллиона наименований.

Благодаря этому наша компания предлагает к поставке практически не ограниченный ассортимент компонентов как оптовыми, мелкооптовыми партиями, так и в розницу.

Благодаря развитой сети поставщиков, помогаем в поиске и приобретении экзотичных или снятых с производства компонентов.

### **Наша компания это:**

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