

## Silicon N,P-Channel Power MOSFET

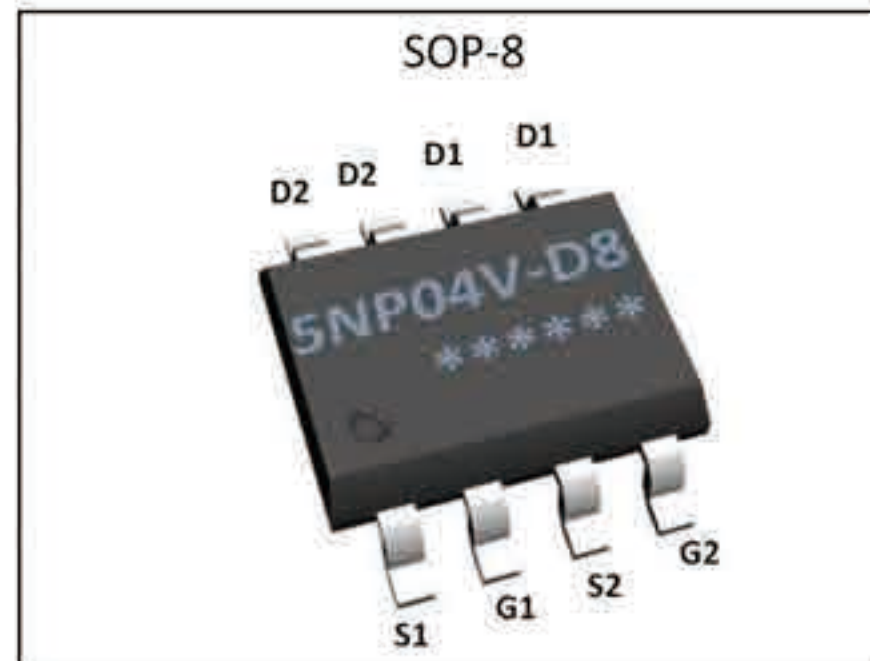
### General Description :

The 5NP04V-D8 uses advanced trench technology and design to provide excellent  $R_{DS(ON)}$  with low gate charge. It can be used in a wide variety of applications. The package form is SOP-8, which accords with the RoHS standard.

|                  | N-Channel | P-Channel |            |
|------------------|-----------|-----------|------------|
| $V_{DSS}$        | 40        | -40       | V          |
| $I_D$            | 7         | -5        | A          |
| $P_D$            | 2         | 2         | W          |
| $R_{DS(ON)type}$ | 19.5      | 32        | m $\Omega$ |

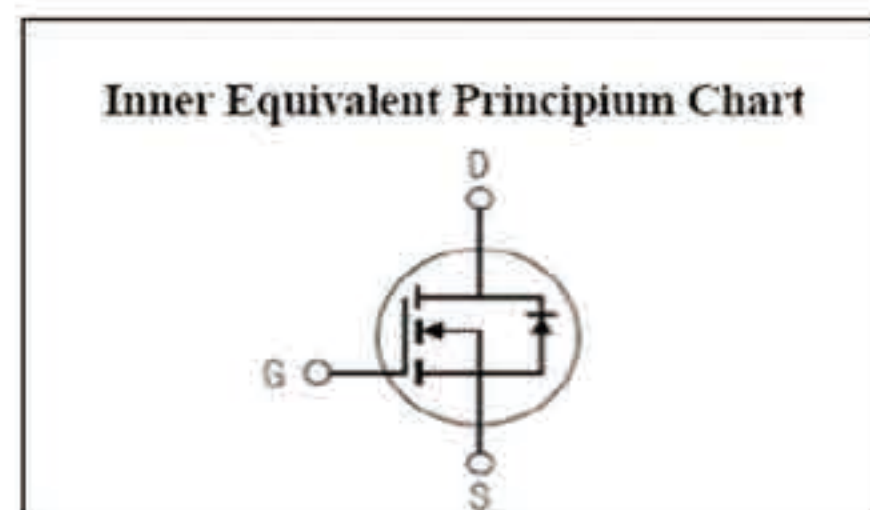
### Features :

- N-Channel :  $R_{DS(ON)} < 23m\Omega$  @  $V_{GS}=10V$  (Typ19.5m $\Omega$ )
- P-Channel :  $R_{DS(ON)} < 36m\Omega$  @  $V_{GS}=10V$  (Typ32m $\Omega$ )
- High density cell design for ultra low  $R_{dson}$
- Fully characterized avalanche voltage and current
- Excellent package for good heat dissipation



### Applications :

- Power switching application
- Hard switched and high frequency circuits
- Uninterruptible power supply



### Absolute ( $T_c = 25^\circ C$ unless otherwise specified ) :

| Symbol         | Parameter                                        | N-Channel  | P-Channel  | Units      |
|----------------|--------------------------------------------------|------------|------------|------------|
| $V_{DSS}$      | Drain-to-Source Voltage                          | 40         | -40        | V          |
| $I_D$          | Continuous Drain Current                         | 7          | -5         | A          |
| $I_{DM}$       | Pulsed Drain Current                             | 30         | -30        | A          |
| $V_{GS}$       | Gate-to-Source Voltage                           | $\pm 12$   | $\pm 12$   | V          |
| $P_D$          | Power Dissipation                                | 2          | 2          | W          |
| $T_J, T_{stg}$ | Operating Junction and Storage Temperature Range | -55 to 175 | -55 to 175 | $^\circ C$ |

## Silicon N,P-Channel Power MOSFET

**N-CH Electrical Characteristics** (  $T_c = 25^\circ\text{C}$  unless otherwise specified ) :

### OFF Characteristics

| Symbol       | Parameter                         | Test Conditions                               | Rating |      |      | Units   |
|--------------|-----------------------------------|-----------------------------------------------|--------|------|------|---------|
|              |                                   |                                               | Min.   | Typ. | Max. |         |
| $V_{DSS}$    | Drain to Source Breakdown Voltage | $V_{GS}=0V, I_D=250\mu A$                     | 40     | --   | --   | V       |
| $I_{DSS}$    | Drain to Source Leakage Current   | $V_{DS}=40V, V_{GS}=0V, T_a=25^\circ\text{C}$ | --     | --   | 1.0  | $\mu A$ |
| $I_{GSS(F)}$ | Gate to Source Forward Leakage    | $V_{GS}=+10V$                                 | --     | --   | 0.1  | $\mu A$ |
| $I_{GSS(R)}$ | Gate to Source Reverse Leakage    | $V_{GS}=-10V$                                 | --     | --   | -0.1 | $\mu A$ |

### ON Characteristics<sup>a3</sup>

| Symbol       | Parameter                     | Test Conditions               | Rating |      |      | Units      |
|--------------|-------------------------------|-------------------------------|--------|------|------|------------|
|              |                               |                               | Min.   | Typ. | Max. |            |
| $R_{DS(ON)}$ | Drain-to-Source On-Resistance | $V_{GS}=10V, I_D=6A$          | --     | 19.5 | 23   | m $\Omega$ |
| $V_{GS(TH)}$ | Gate Threshold Voltage        | $V_{DS}=V_{GS}, I_D=250\mu A$ | 1.0    | 1.5  | 2.0  | V          |

Pulse width  $t_p \leq 380\mu s, \delta \leq 2\%$

### Dynamic Characteristics<sup>a4</sup>

| Symbol    | Parameter                    | Test Conditions                              | Rating |      |      | Units |
|-----------|------------------------------|----------------------------------------------|--------|------|------|-------|
|           |                              |                                              | Min.   | Typ. | Max. |       |
| $g_{fs}$  | Forward Transconductance     | $V_{DS}=5V, I_D=6A$                          | 15     | --   | --   | S     |
| $C_{iss}$ | Input Capacitance            | $V_{GS}=0V, V_{DS}=20V$<br>$f=1.0\text{MHz}$ | --     | 516  | --   | pF    |
| $C_{oss}$ | Output Capacitance           |                                              | --     | 82   | --   |       |
| $C_{rss}$ | Reverse Transfer Capacitance |                                              | --     | 43   | --   |       |

### Resistive Switching Characteristics<sup>a4</sup>

| Symbol       | Parameter                         | Test Conditions                                          | Rating |      |      | Units |
|--------------|-----------------------------------|----------------------------------------------------------|--------|------|------|-------|
|              |                                   |                                                          | Min.   | Typ. | Max. |       |
| $t_{d(ON)}$  | Turn-on Delay Time                | $V_{DD}=15V, R_L=2.5\Omega$<br>$V_{GS}=10V, R_G=3\Omega$ | --     | 4.5  | --   | ns    |
| $t_r$        | Rise Time                         |                                                          | --     | 2.5  | --   |       |
| $t_{d(OFF)}$ | Turn-Off Delay Time               |                                                          | --     | 14.5 | --   |       |
| $t_f$        | Fall Time                         |                                                          | --     | 3.5  | --   |       |
| $Q_g$        | Total Gate Charge                 | $V_{DD}=20V, I_D=6A$<br>$V_{GS}=10V$                     | --     | 8.9  | --   | nC    |
| $Q_{gs}$     | Gate to Source Charge             |                                                          | --     | 2.4  | --   |       |
| $Q_{gd}$     | Gate to Drain ( "Miller" ) Charge |                                                          | --     | 1.4  | --   |       |

### Source-Drain Diode Characteristics

| Symbol   | Parameter                                            | Test Conditions     | Rating |      |      | Units |
|----------|------------------------------------------------------|---------------------|--------|------|------|-------|
|          |                                                      |                     | Min.   | Typ. | Max. |       |
| $I_S$    | Continuous Source Current <sup>a2</sup> (Body Diode) |                     | --     | --   | 6    | A     |
| $V_{SD}$ | Diode Forward Voltage <sup>a3</sup>                  | $I_S=6A, V_{GS}=0V$ | --     | --   | 1.2  | V     |

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**P-CH Electrical Characteristics** (  $T_c = 25^\circ\text{C}$  unless otherwise specified ) :

| OFF Characteristics |                                   |                                                |        |      |      |         |
|---------------------|-----------------------------------|------------------------------------------------|--------|------|------|---------|
| Symbol              | Parameter                         | Test Conditions                                | Rating |      |      | Units   |
|                     |                                   |                                                | Min.   | Typ. | Max. |         |
| $V_{DSS}$           | Drain to Source Breakdown Voltage | $V_{GS}=0V, I_D=250\mu A$                      | -40    | --   | --   | V       |
| $I_{DSS}$           | Drain to Source Leakage Current   | $V_{DS}=-40V, V_{GS}=0V, T_a=25^\circ\text{C}$ | --     | --   | -1.0 | $\mu A$ |
| $I_{GSS(F)}$        | Gate to Source Forward Leakage    | $V_{GS}=+10V$                                  | --     | --   | -0.1 | $\mu A$ |
| $I_{GSS(R)}$        | Gate to Source Reverse Leakage    | $V_{GS}=-10V$                                  | --     | --   | 0.1  | $\mu A$ |

| ON Characteristics <sup>a3</sup>                 |                               |                                |        |      |      |            |
|--------------------------------------------------|-------------------------------|--------------------------------|--------|------|------|------------|
| Symbol                                           | Parameter                     | Test Conditions                | Rating |      |      | Units      |
|                                                  |                               |                                | Min.   | Typ. | Max. |            |
| $R_{DS(ON)}$                                     | Drain-to-Source On-Resistance | $V_{GS}=-10V, I_D=-5A$         | --     | 32   | 36   | m $\Omega$ |
| $V_{GS(TH)}$                                     | Gate Threshold Voltage        | $V_{DS}=V_{GS}, I_D=-250\mu A$ | -1.0   | -1.5 | -2.0 | V          |
| Pulse width $t_p \leq 380\mu s, \delta \leq 2\%$ |                               |                                |        |      |      |            |

| Dynamic Characteristics <sup>a4</sup> |                              |                                               |        |      |      |       |
|---------------------------------------|------------------------------|-----------------------------------------------|--------|------|------|-------|
| Symbol                                | Parameter                    | Test Conditions                               | Rating |      |      | Units |
|                                       |                              |                                               | Min.   | Typ. | Max. |       |
| $g_{fs}$                              | Forward Transconductance     | $V_{DS}=-5V, I_D=-5A$                         | 10     | --   | --   | S     |
| $C_{iss}$                             | Input Capacitance            | $V_{GS}=0V, V_{DS}=-20V$<br>$f=1.0\text{MHz}$ | --     | 940  | --   | pF    |
| $C_{oss}$                             | Output Capacitance           |                                               | --     | 97   | --   |       |
| $C_{rss}$                             | Reverse Transfer Capacitance |                                               | --     | 72   | --   |       |

| Resistive Switching Characteristics <sup>a4</sup> |                                   |                                                            |        |      |      |       |
|---------------------------------------------------|-----------------------------------|------------------------------------------------------------|--------|------|------|-------|
| Symbol                                            | Parameter                         | Test Conditions                                            | Rating |      |      | Units |
|                                                   |                                   |                                                            | Min.   | Typ. | Max. |       |
| $t_{d(ON)}$                                       | Turn-on Delay Time                | $V_{DD}=-20V, R_L=2.3\Omega$<br>$V_{GS}=-10V, R_G=6\Omega$ | --     | 6.2  | --   | ns    |
| $t_r$                                             | Rise Time                         |                                                            | --     | 8.4  | --   |       |
| $t_{d(OFF)}$                                      | Turn-Off Delay Time               |                                                            | --     | 44.8 | --   |       |
| $t_f$                                             | Fall Time                         |                                                            | --     | 16   | --   |       |
| $Q_g$                                             | Total Gate Charge                 | $V_{DD}=-20V, I_D=-5A$<br>$V_{GS}=-10V$                    | --     | 17   | --   | nC    |
| $Q_{gs}$                                          | Gate to Source Charge             |                                                            | --     | 3.4  | --   |       |
| $Q_{gd}$                                          | Gate to Drain ( "Miller" ) Charge |                                                            | --     | 3.2  | --   |       |

| Source-Drain Diode Characteristics |                                                      |                      |        |      |      |       |
|------------------------------------|------------------------------------------------------|----------------------|--------|------|------|-------|
| Symbol                             | Parameter                                            | Test Conditions      | Rating |      |      | Units |
|                                    |                                                      |                      | Min.   | Typ. | Max. |       |
| $I_S$                              | Continuous Source Current <sup>a2</sup> (Body Diode) |                      | --     | --   | -6   | A     |
| $V_{SD}$                           | Diode Forward Voltage <sup>a3</sup>                  | $I_S=-6A, V_{GS}=0V$ | --     | --   | -1.2 | V     |

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| Symbol           | Parameter                            | Typ. | Units |
|------------------|--------------------------------------|------|-------|
| R <sub>θJA</sub> | Junction-to-Case <sup>a2</sup> ,N-Ch | 62.5 | °C/W  |
| R <sub>θJA</sub> | Junction-to-Case <sup>a2</sup> ,P-Ch | 62.5 |       |

<sup>a1</sup> : Repetitive Rating: Pulse width limited by maximum junction temperature.

<sup>a2</sup> : Surface Mounted on FR4 Board, t≤10sec.

<sup>a3</sup> : Pulse Test: Pulse Width≤300μs, Duty Cycle≤2%.

<sup>a4</sup> : Guaranteed by design, not subject to production

## Silicon N,P-Channel Power MOSFET

### N-Channel Characteristics Curve :

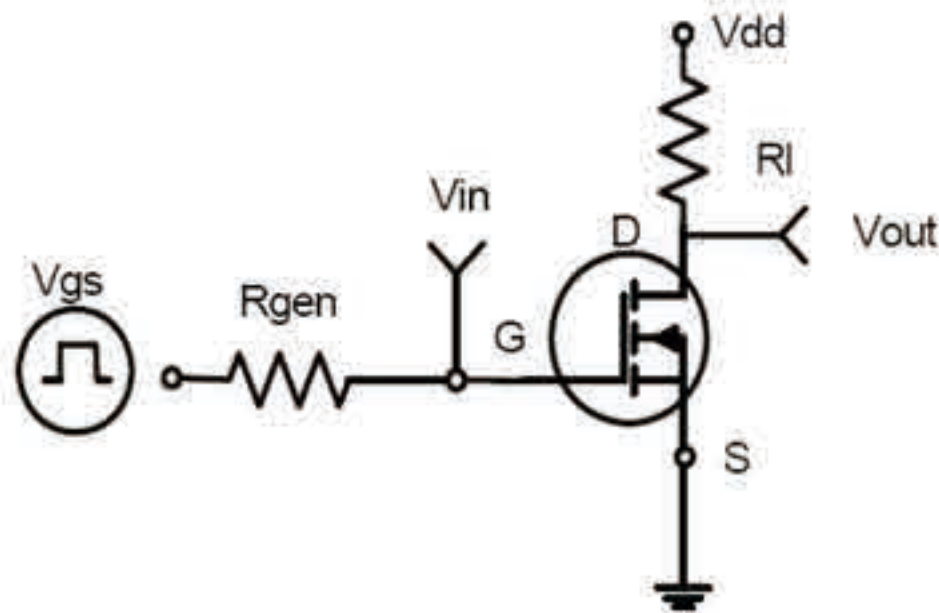


Figure 1: Switching Test Circuit

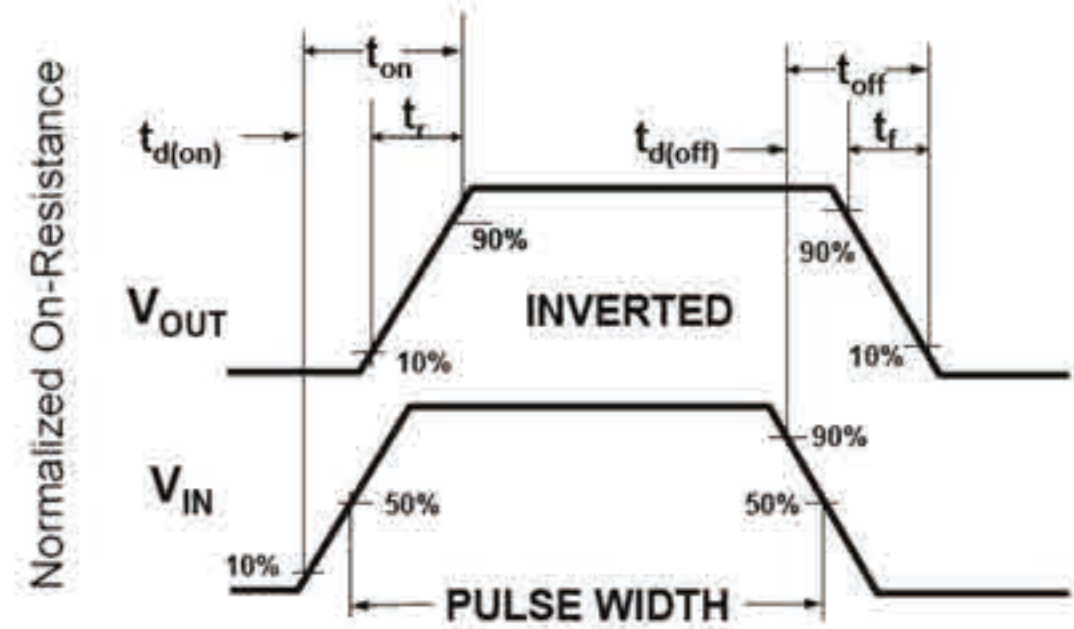


Figure 2: Switching Waveforms

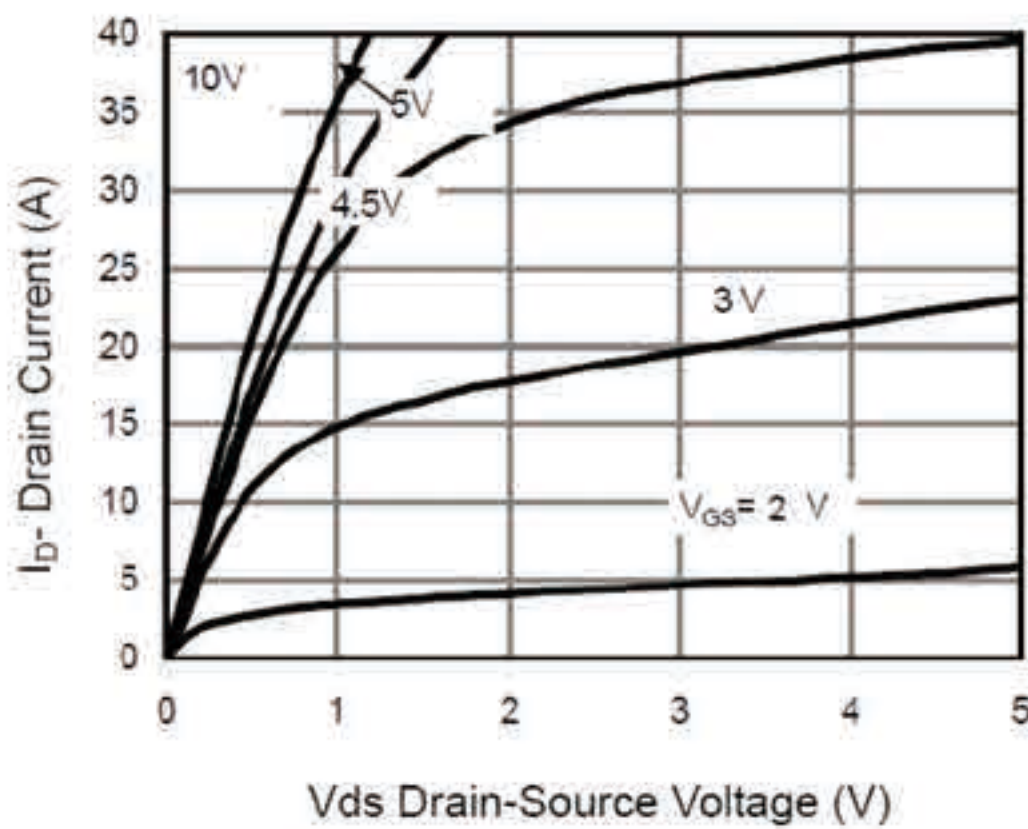


Figure 3 Output Characteristics

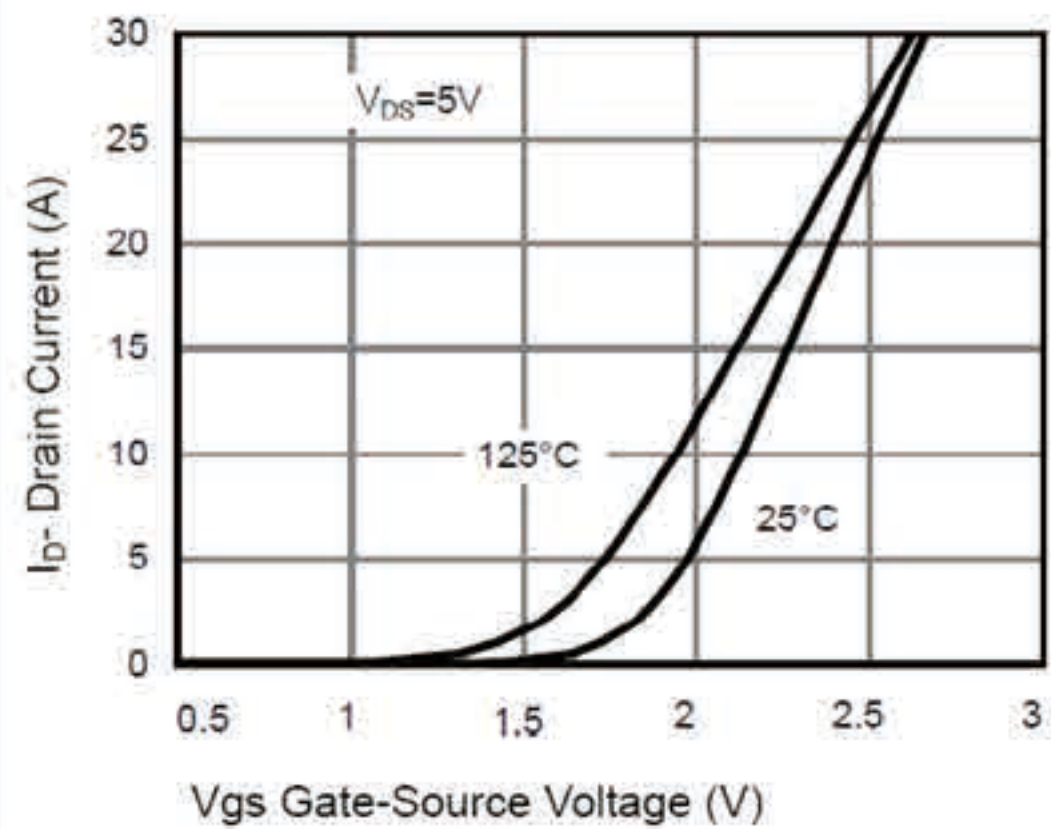


Figure 4 Transfer Characteristics

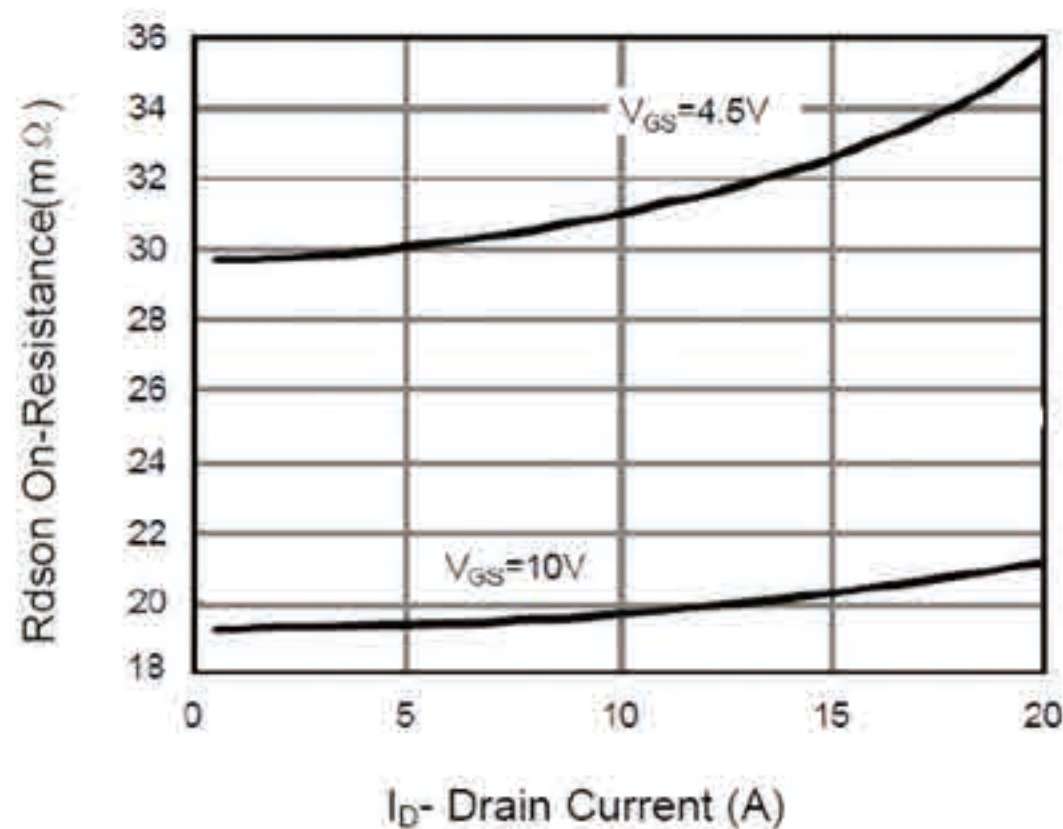


Figure 5 Drain-Source On-Resistance

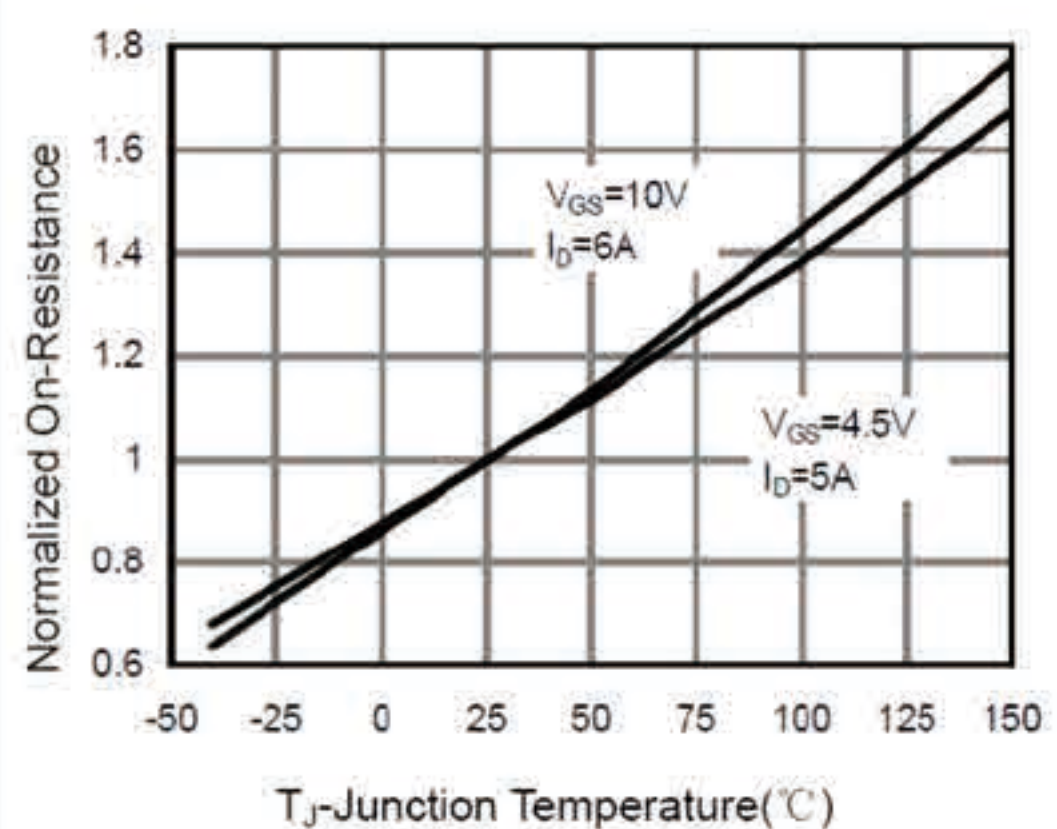
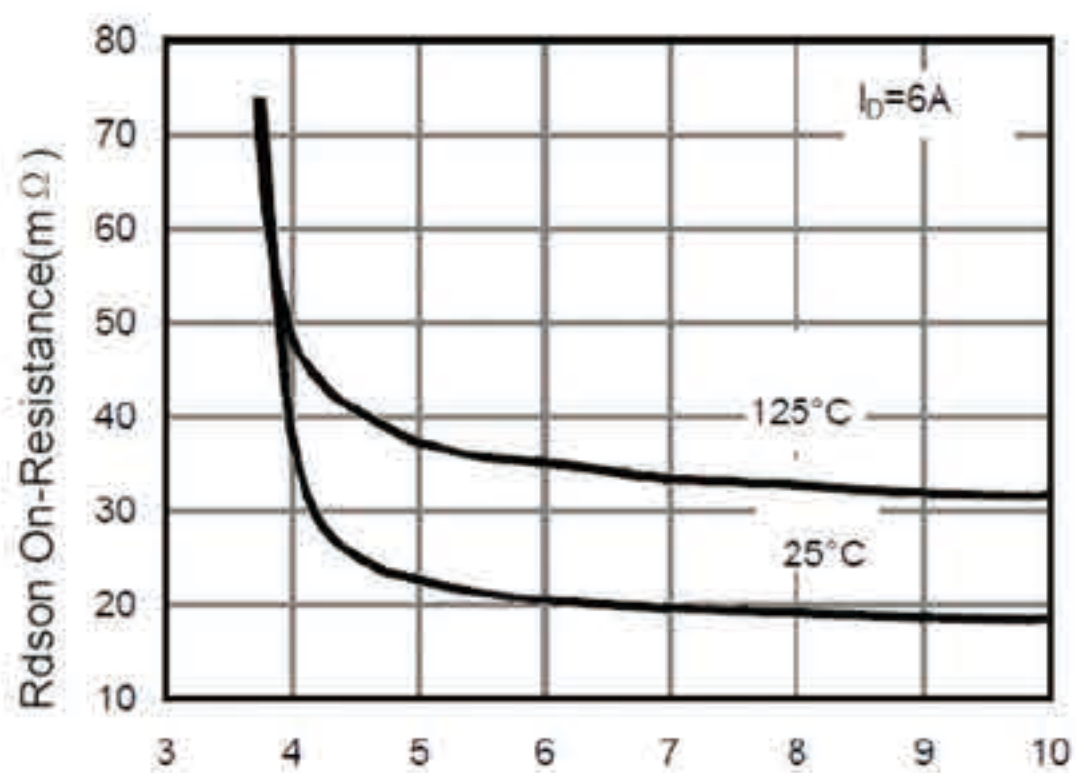


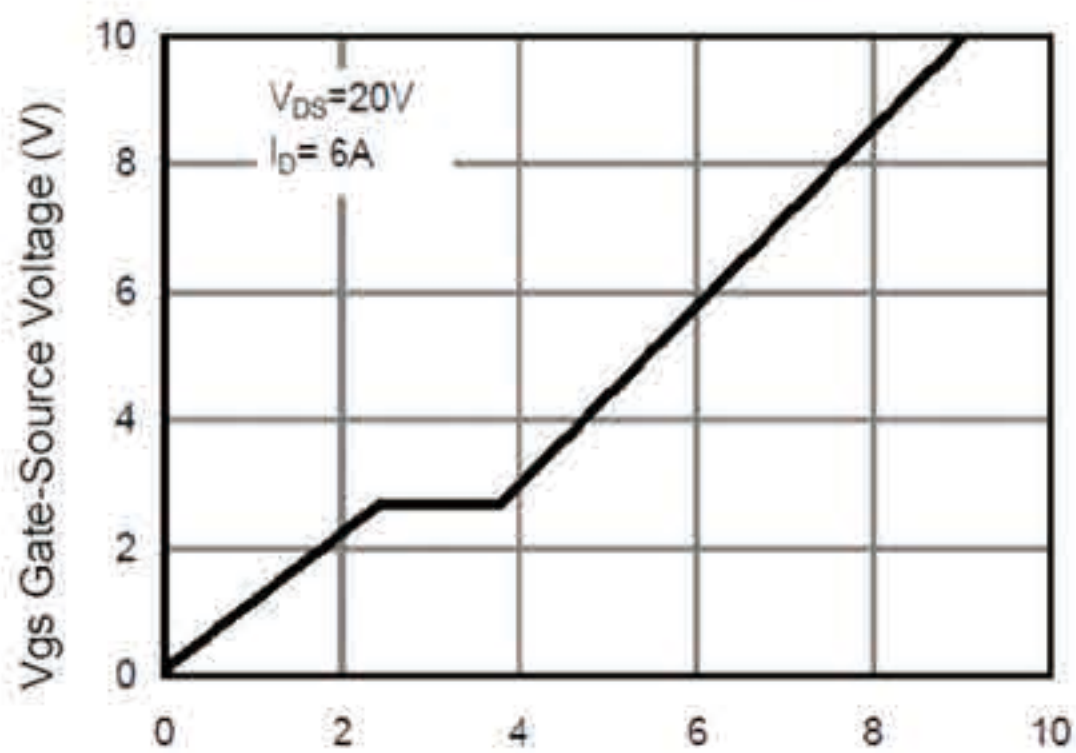
Figure 6 Drain-Source On-Resistance

## Silicon N,P-Channel Power MOSFET



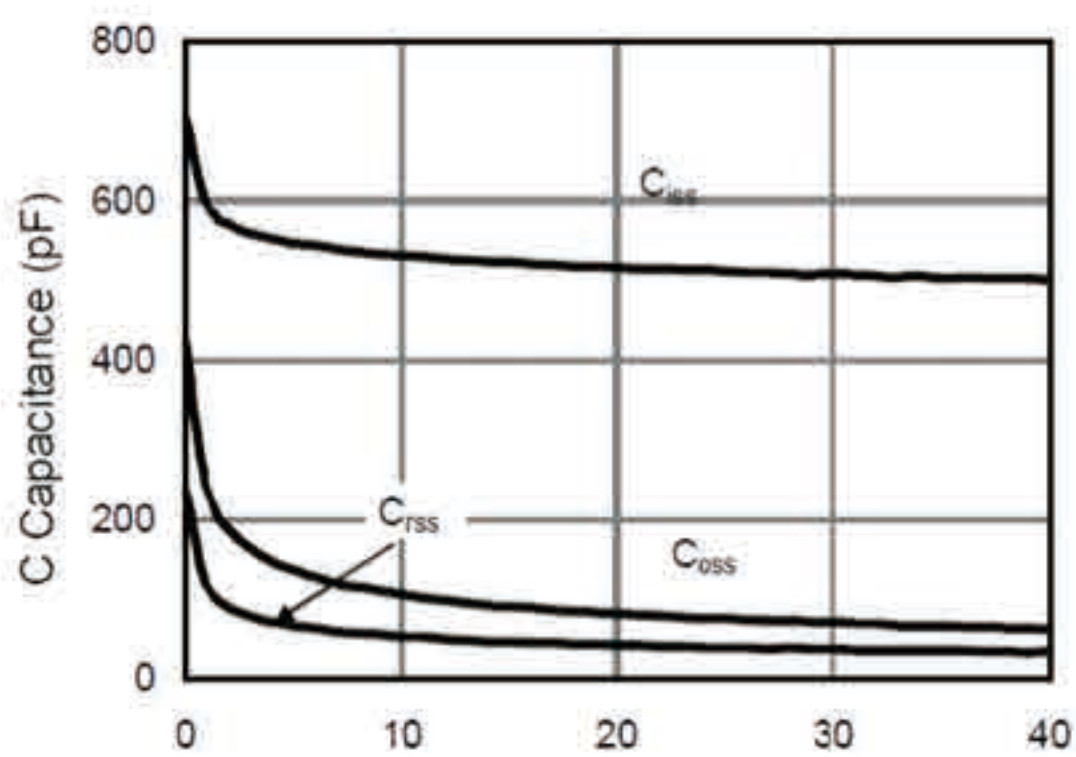
Vgs Gate-Source Voltage (V)

Figure7 Rdson vs Vgs



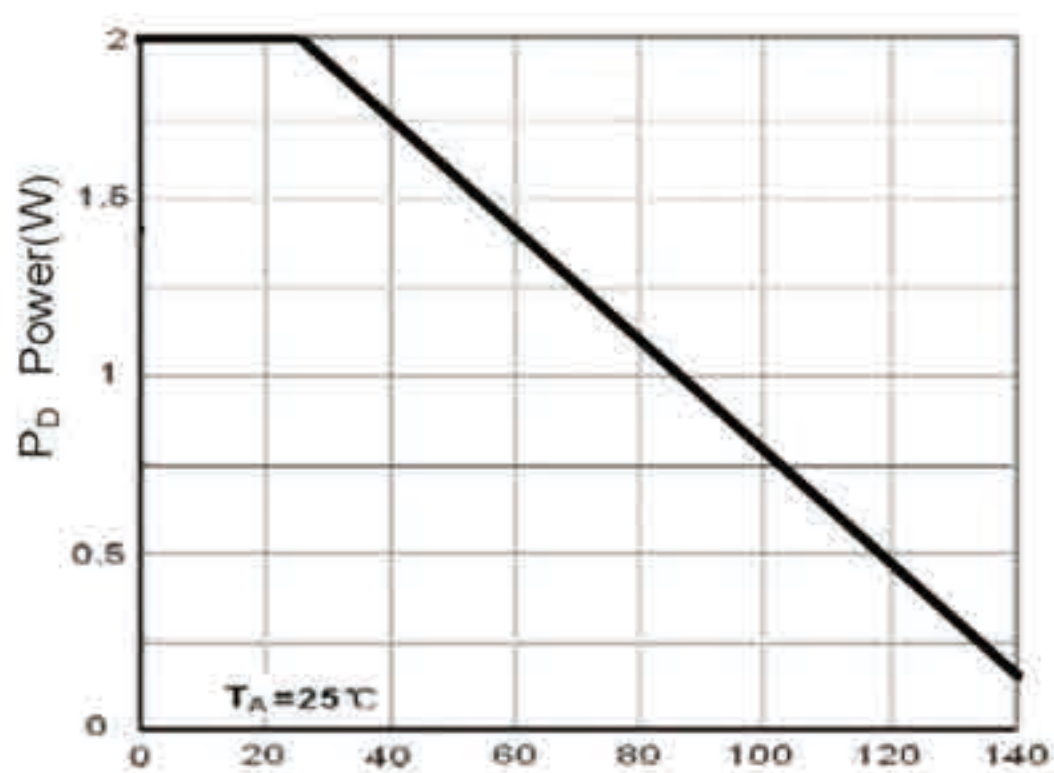
Qg Gate Charge (nC)

Figure 9 Gate Charge



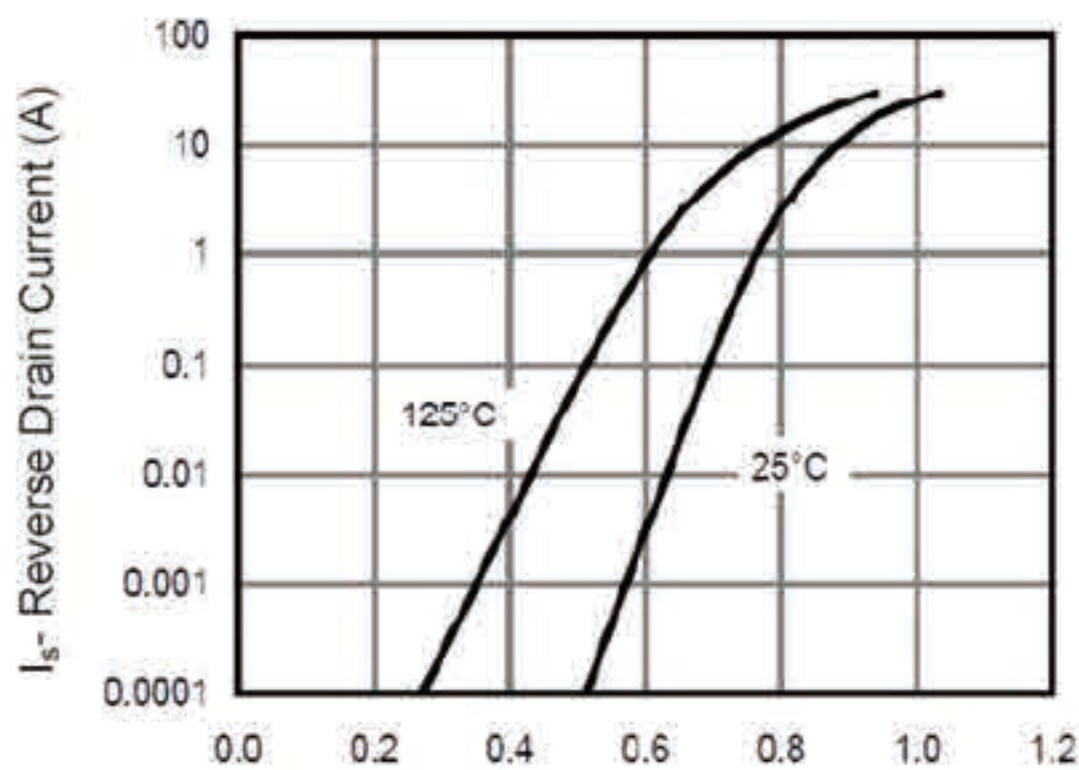
Vds Drain-Source Voltage (V)

Figure 11 Capacitance vs Vds



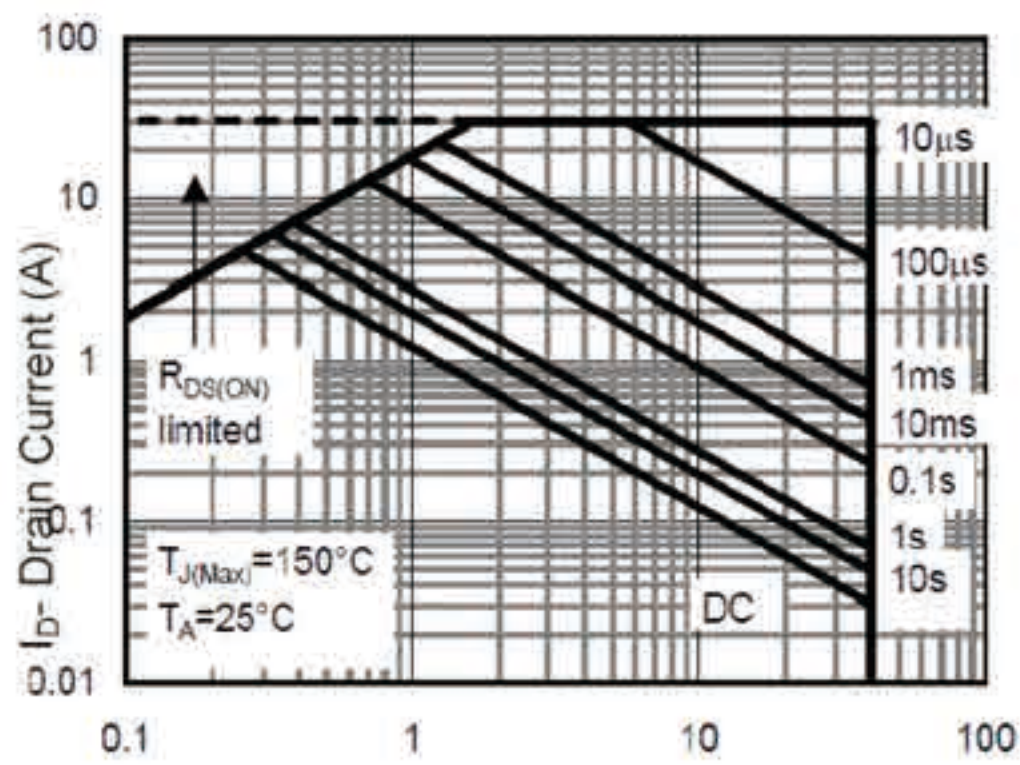
Tj-Junction Temperature(°C)

Figure 8 Power Dissipation



Vds Drain-Source Voltage (V)

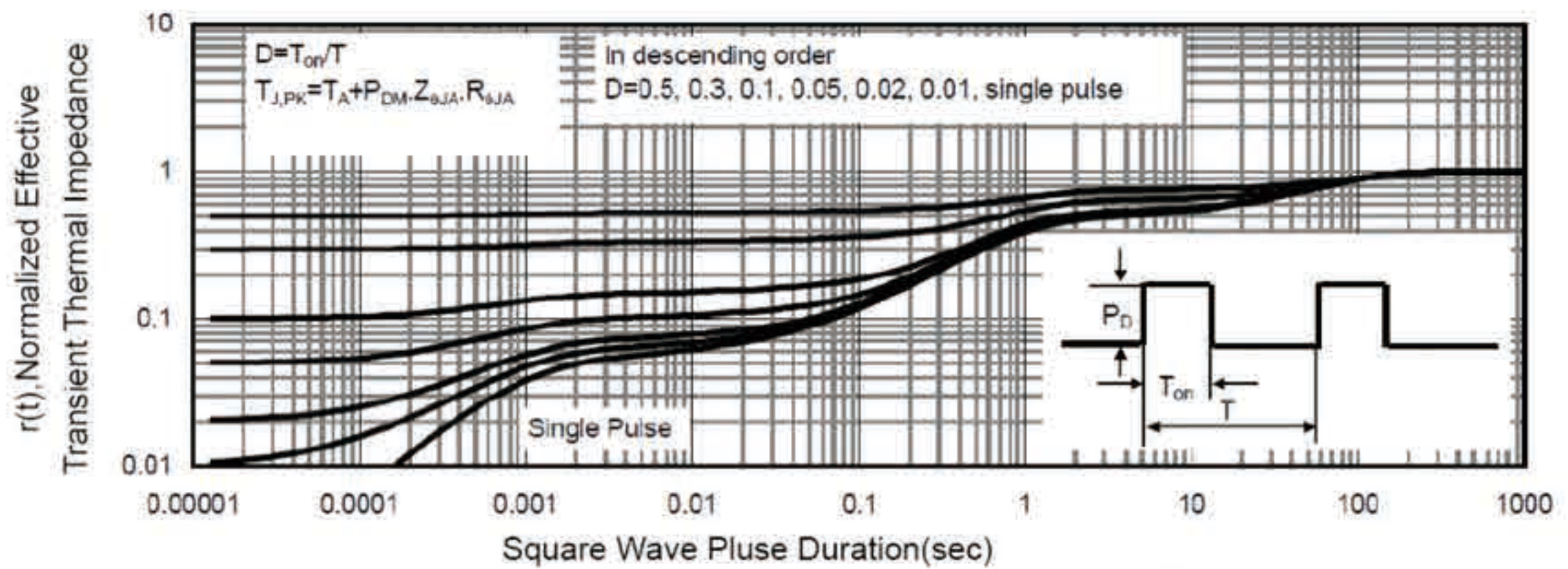
Figure 10 Source- Drain Diode Forward



Vds Drain-Source Voltage (V)

Figure 12 Safe Operation Area

## Silicon N,P-Channel Power MOSFET



**Figure 13 Normalized Maximum Transient Thermal Impedance**

## Silicon N,P-Channel Power MOSFET

### P-Channel Characteristics Curve :

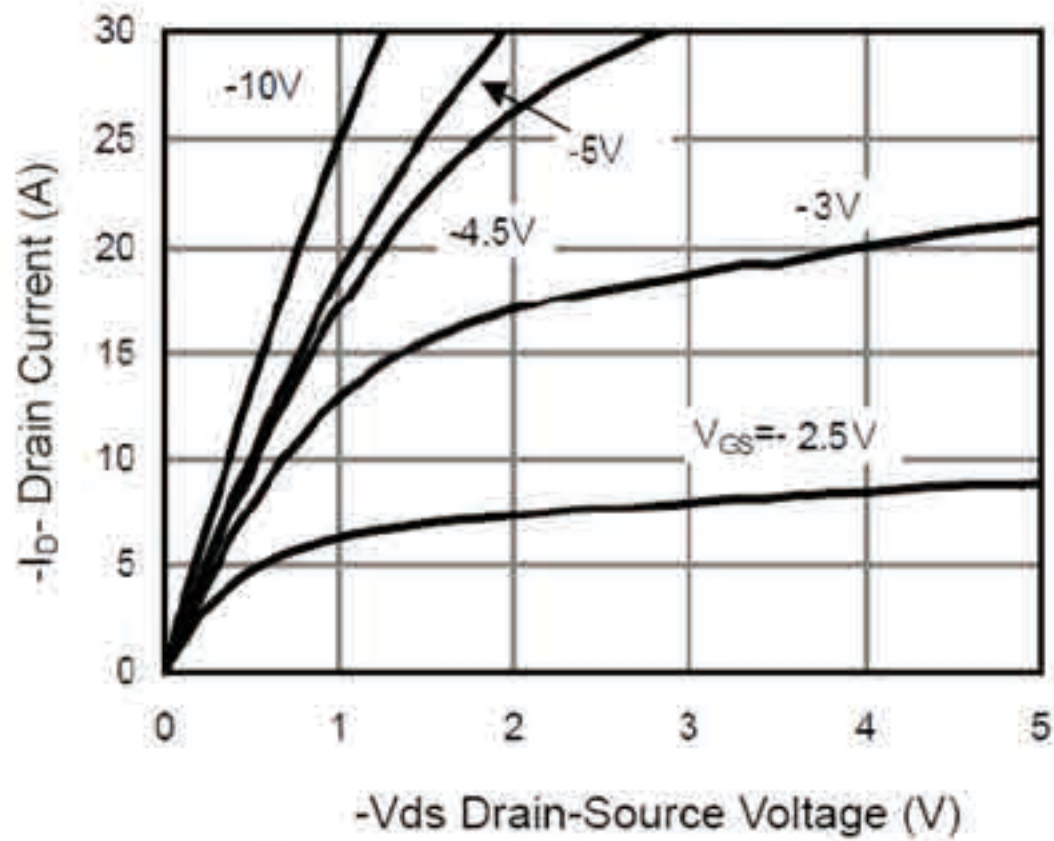


Figure 1 Output Characteristics

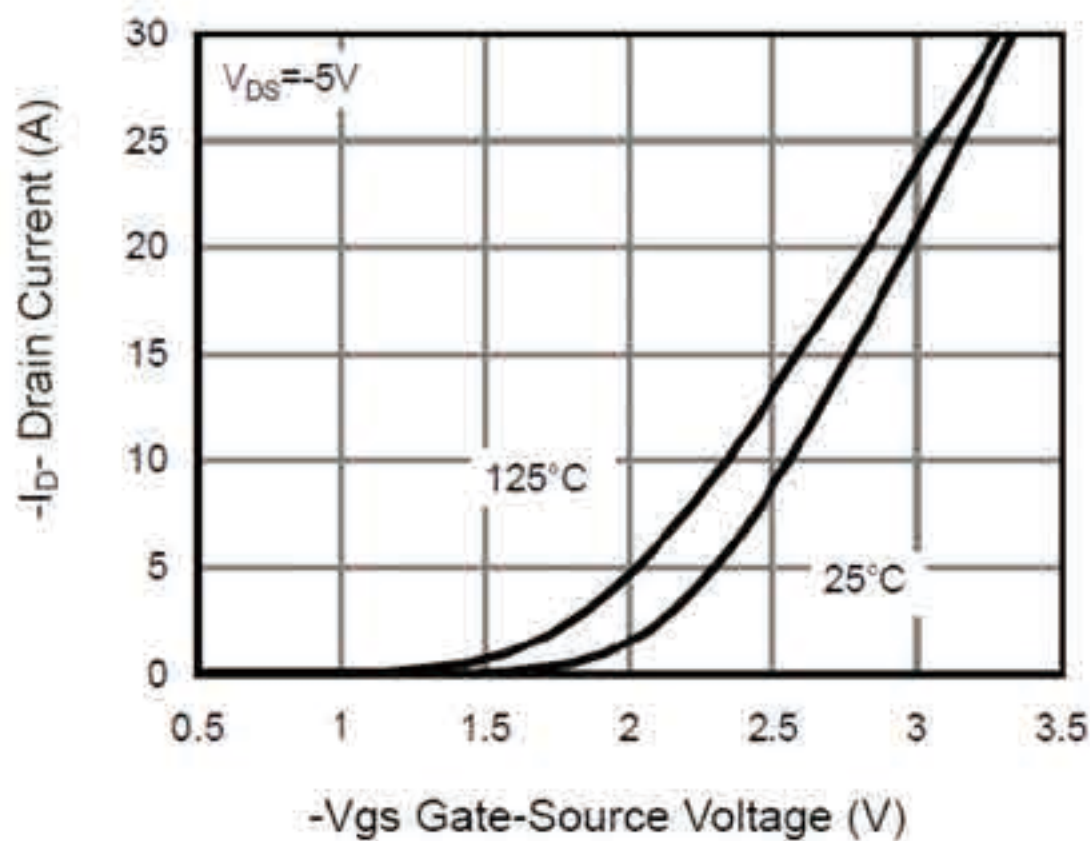


Figure 2 Transfer Characteristics

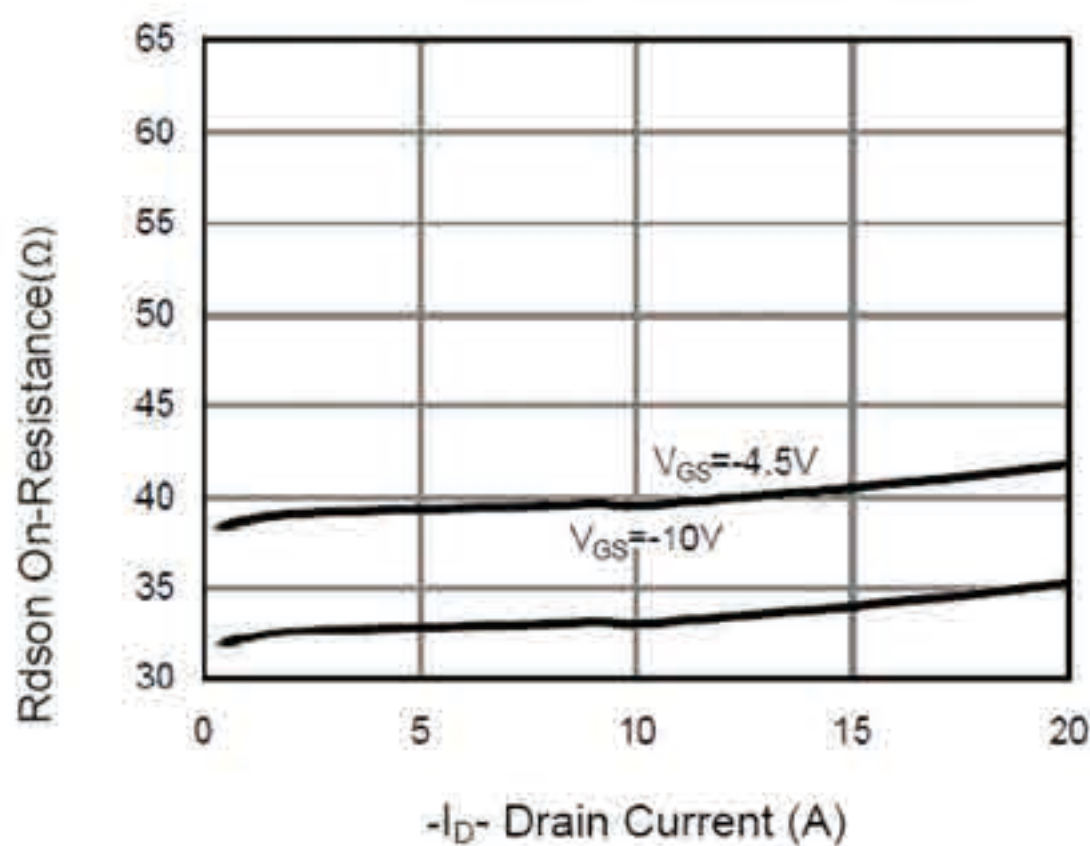


Figure 3 Rdson- Drain Current

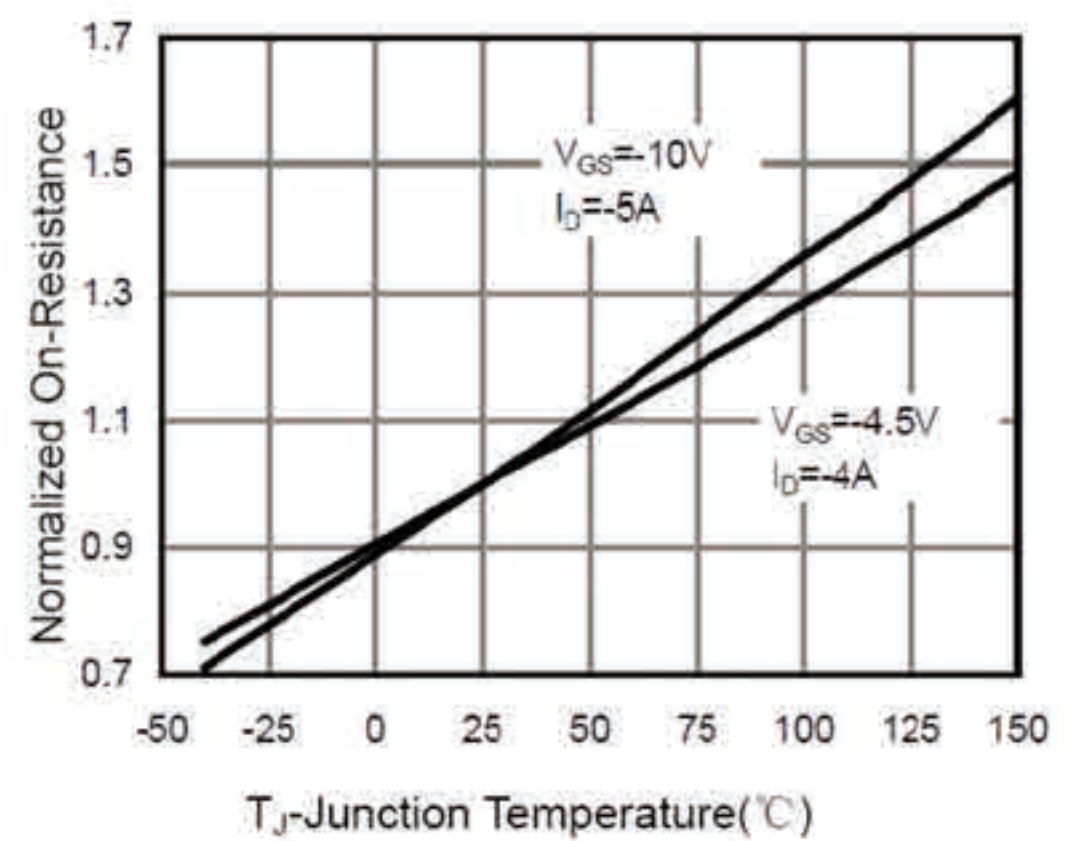


Figure 4 Rdson-Junction Temperature

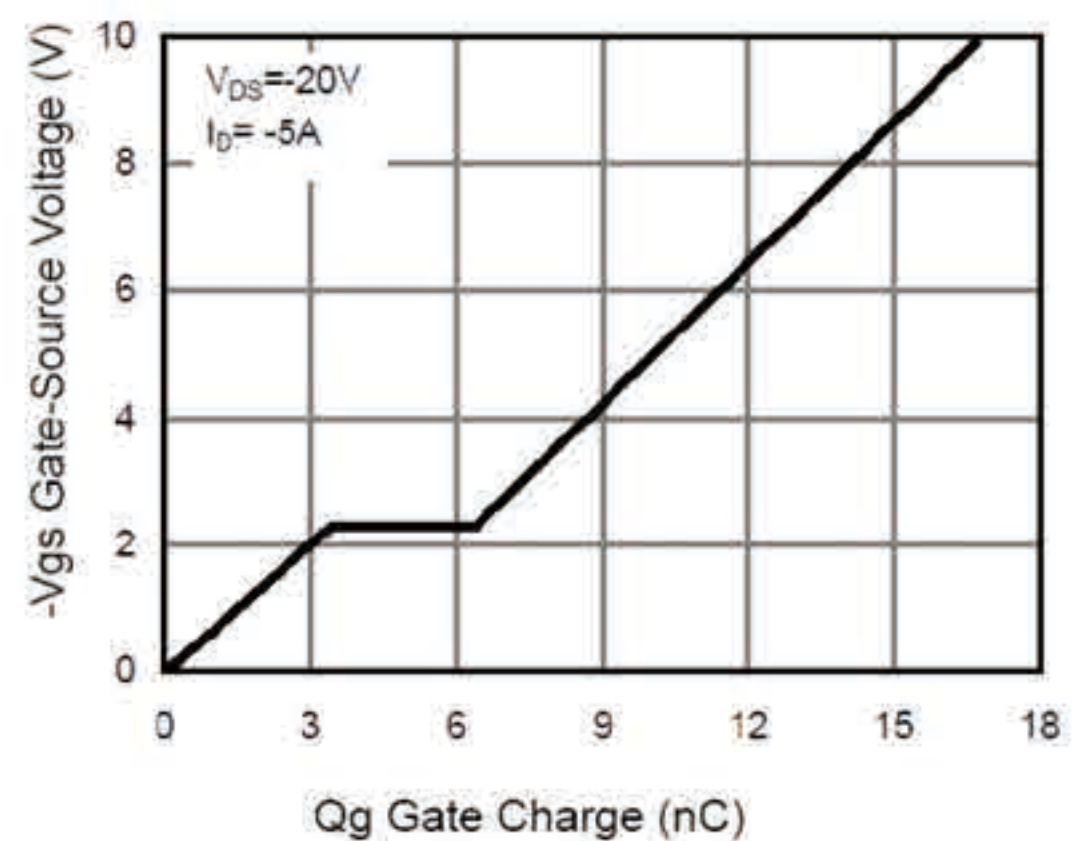


Figure 5 Gate Charge

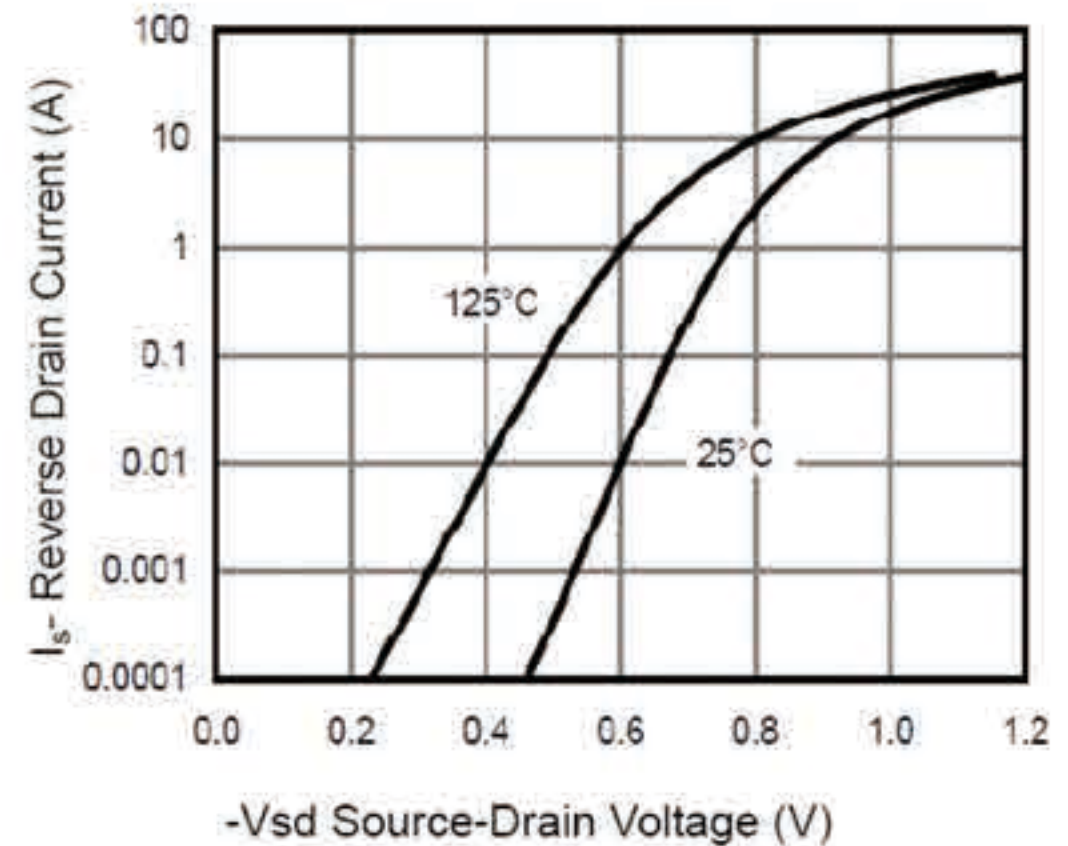


Figure 6 Source- Drain Diode Forward

## Silicon N,P-Channel Power MOSFET

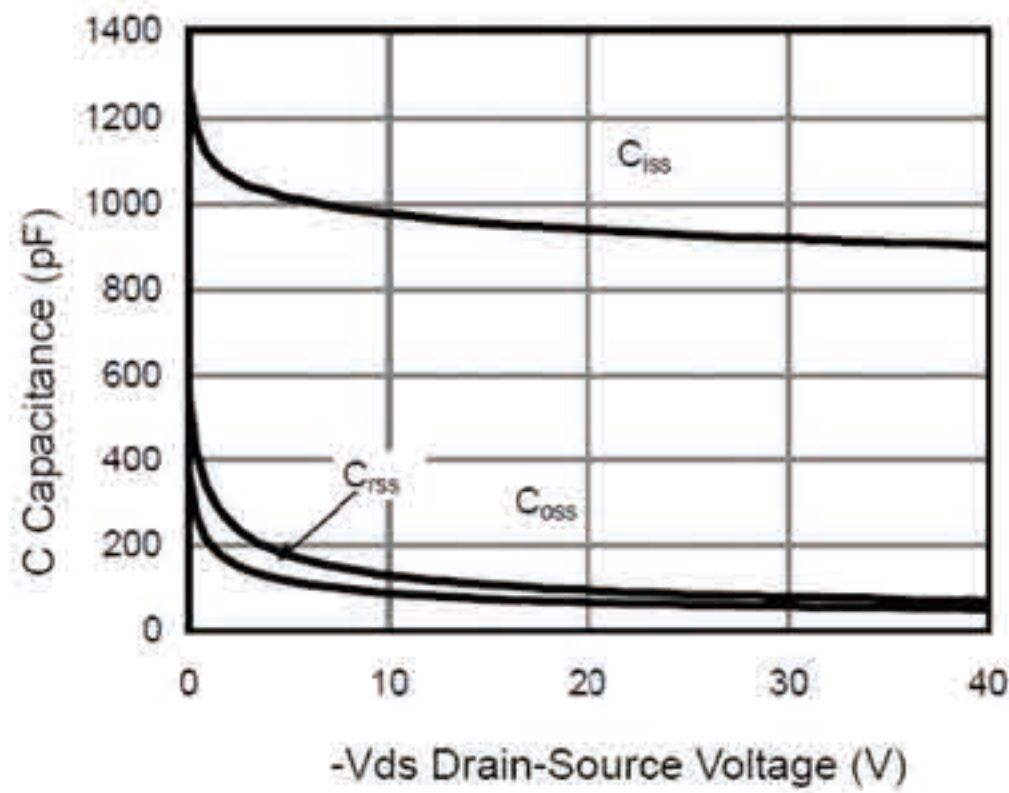


Figure 7 Capacitance vs Vds

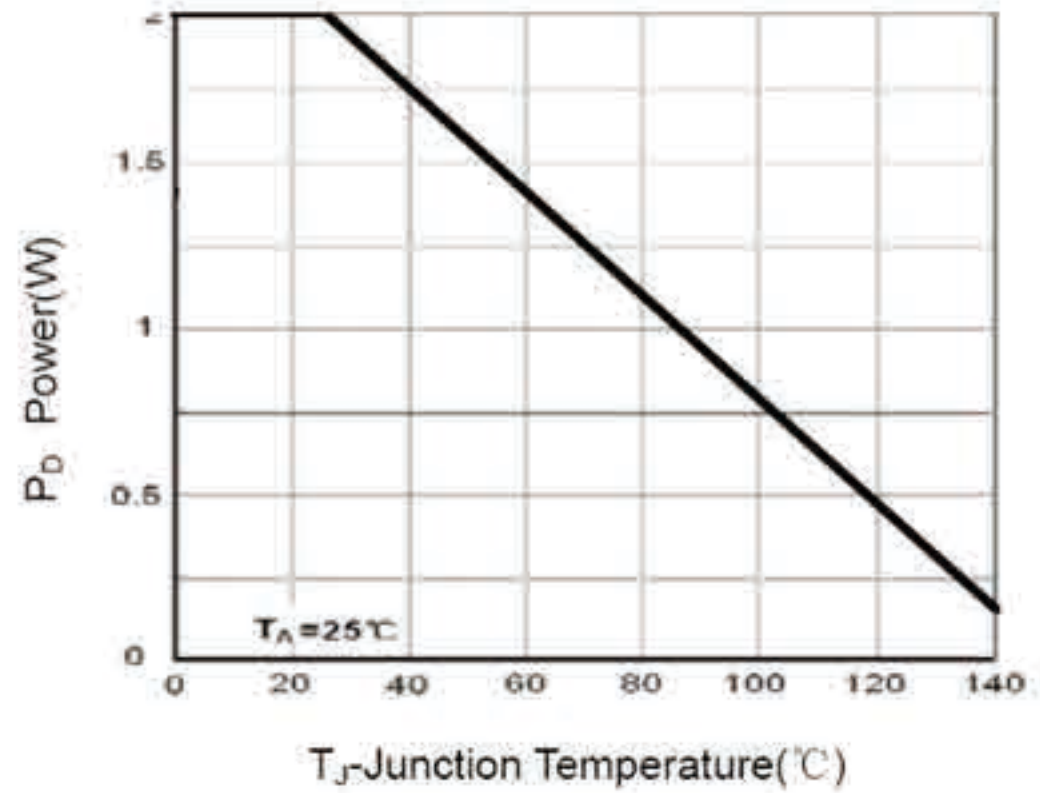


Figure 9 Power Dissipation

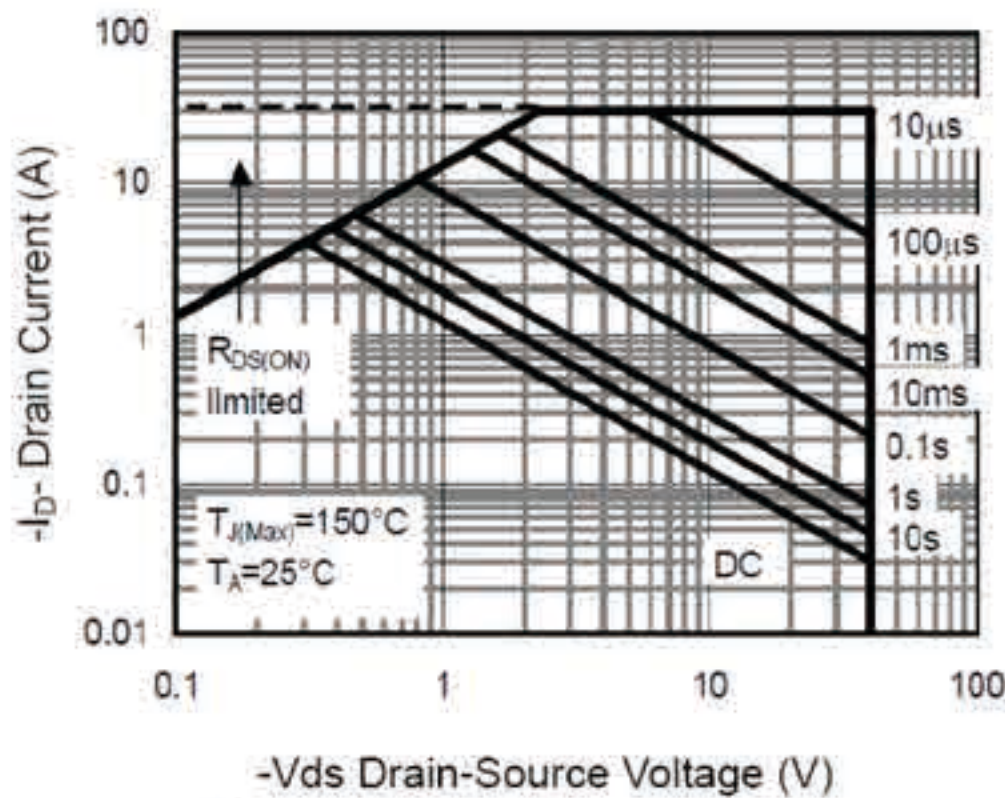


Figure 8 Safe Operation Area

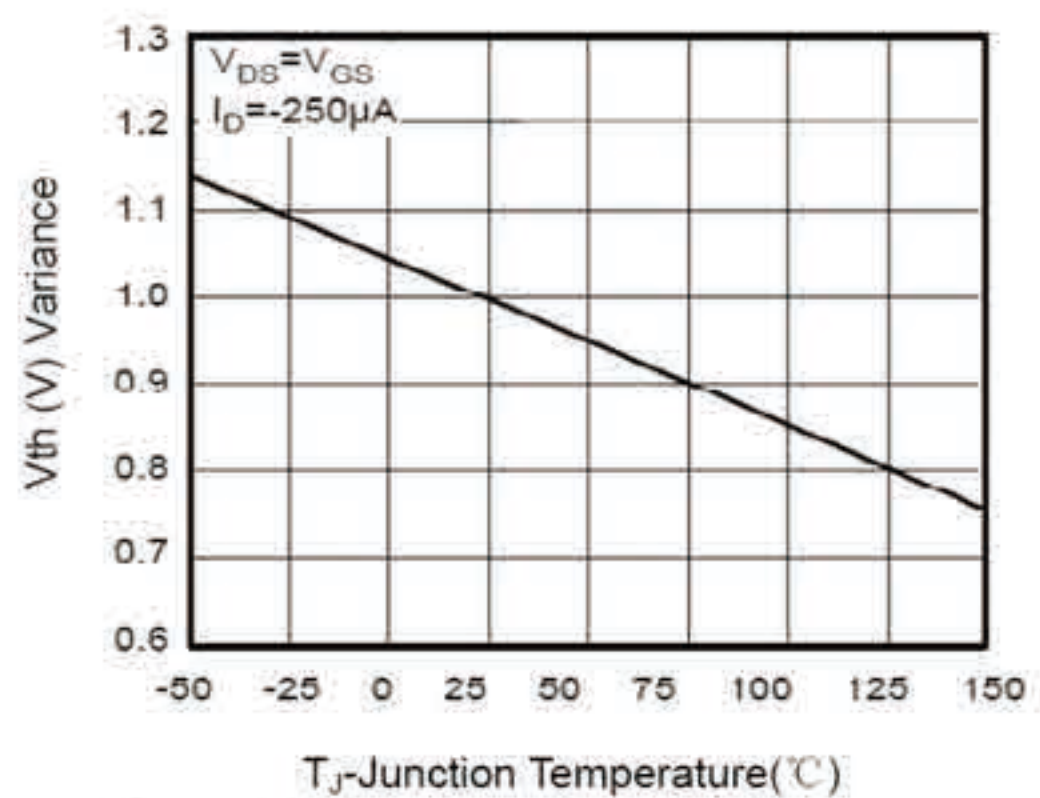


Figure 10 VGS(th) vs Junction Temperature

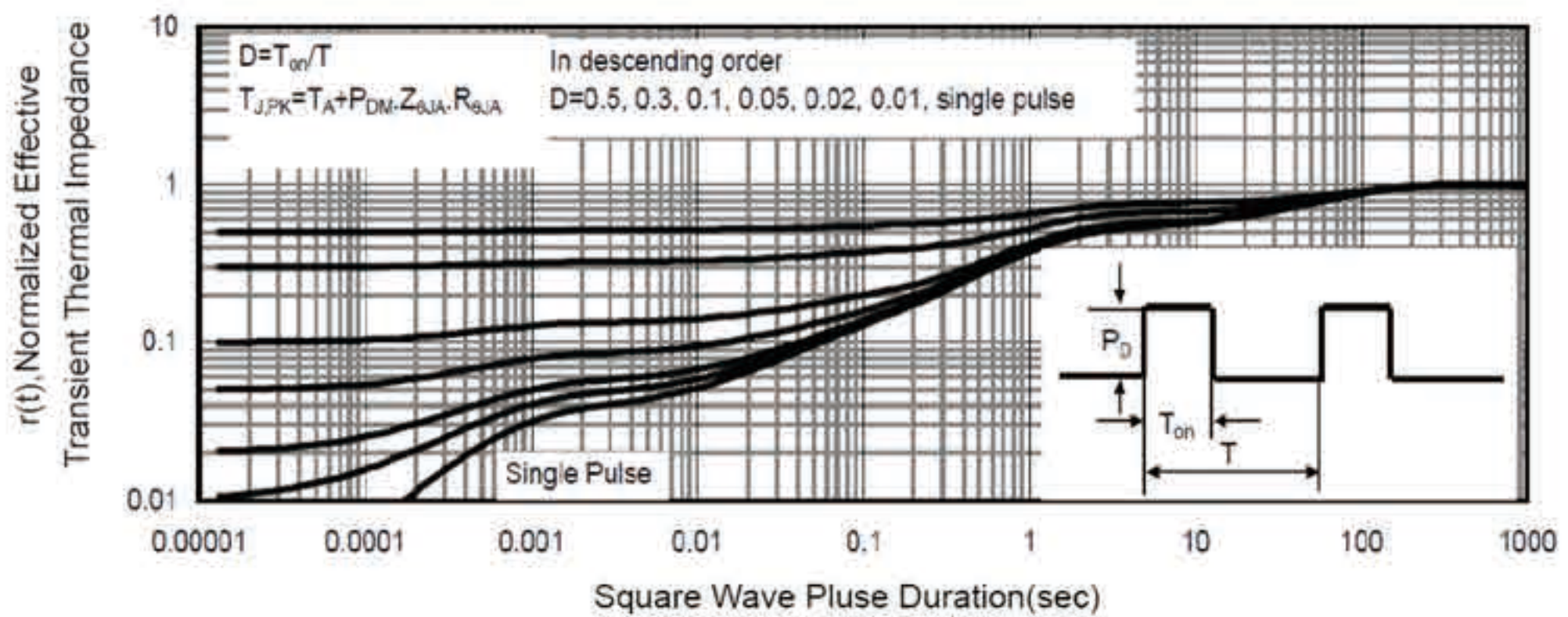


Figure 11 Normalized Maximum Transient Thermal Impedance

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