

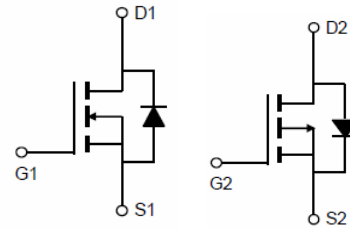
## NCE N and P-Channel Enhancement Mode Power MOSFET

### Description

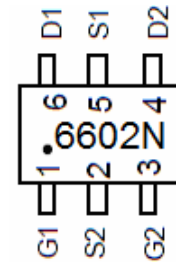
The NCE6602N uses advanced trench technology to provide excellent  $R_{DS(ON)}$ , low gate charge. This device is suitable for use as a Battery protection or in other Switching application.

### General Features

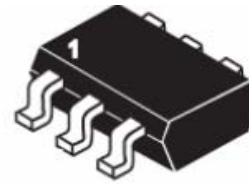
- **N-Channel**
- $V_{DS} = 30V, I_D = 3.5A$   
 $R_{DS(ON)} < 58m\Omega @ V_{GS}=10V$   
 $R_{DS(ON)} < 95m\Omega @ V_{GS}=4.5V$
- **P-Channel**
- $V_{DS} = -30V, I_D = -2.7A$   
 $R_{DS(ON)} < 100m\Omega @ V_{GS}=-10V$   
 $R_{DS(ON)} < 150m\Omega @ V_{GS}=-4.5V$
- Low On-Resistance
- Low Input Capacitance
- Fast Switching Speed
- Low Input/Output Leakage



N-channel P-channel  
Schematic diagram



Pin Assignment



SOT23-6L top view

### Package Marking and Ordering Information

| Device Marking | Device   | Device Package | Reel Size | Tape width | Quantity   |
|----------------|----------|----------------|-----------|------------|------------|
| 6602N          | NCE6602N | SOT23-6L       | Ø180mm    | 8mm        | 3000 units |

### Absolute Maximum Ratings ( $T_A=25^\circ\text{C}$ unless otherwise noted)

| Parameter  |                        | Symbol         | N-Channel  | P-Channel  | Unit             |
|--|------------------------|----------------|------------|------------|------------------|
| Drain-Source Voltage                             |                        | $V_{DS}$       | 30         | -30        | V                |
| Gate-Source Voltage                              |                        | $V_{GS}$       | $\pm 20$   | $\pm 20$   | V                |
| Continuous Drain Current                         | $T_A=25^\circ\text{C}$ | $I_D$          | 3.5        | -2.7       | A                |
|  | $T_A=70^\circ\text{C}$ |                | 3          | -2.1       |                  |
| Pulsed Drain Current <sup>(Note 1)</sup>         |                        | $I_{DM}$       | 20         | -15        | A                |
| Maximum Power Dissipation                        |                        | $P_D$          | 1.2        |            | W                |
| Operating Junction and Storage Temperature Range |                        | $T_J, T_{STG}$ | -55 To 150 | -55 To 150 | $^\circ\text{C}$ |

### Thermal Characteristic

|  |                 |      |     |                    |
|--|-----------------|------|-----|--------------------|
| Thermal Resistance, Junction-to-Ambient <sup>(Note2)</sup> | $R_{\theta JA}$ | N-Ch | 104 | $^\circ\text{C/W}$ |
| Thermal Resistance, Junction-to-Ambient <sup>(Note2)</sup> | $R_{\theta JA}$ | P-Ch | 104 | $^\circ\text{C/W}$ |

## N-CH Electrical Characteristics ( $T_A=25^\circ\text{C}$ unless otherwise noted)

| Parameter                                 | Symbol       | Condition  | Min | Typ  | Max       | Unit       |
|---|--------------|--|-----|------|-----------|------------|
| <b>Off Characteristics</b>                |              |  |     |      |           |            |
| Drain-Source Breakdown Voltage            | $BV_{DSS}$   | $V_{GS}=0V, I_D=250\mu A$                                  | 30  | 33   | -         | V          |
| Zero Gate Voltage Drain Current           | $I_{DSS}$    | $V_{DS}=30V, V_{GS}=0V$                                    | -   | -    | 1         | $\mu A$    |
| Gate-Body Leakage Current                 | $I_{GSS}$    | $V_{GS}=\pm 20V, V_{DS}=0V$                                | -   | -    | $\pm 100$ | nA         |
| <b>On Characteristics</b> (Note 3)        |              |  |     |      |           |            |
| Gate Threshold Voltage                    | $V_{GS(th)}$ | $V_{DS}=V_{GS}, I_D=250\mu A$                              | 1.2 | 1.5  | 2.2       | V          |
| Drain-Source On-State Resistance          | $R_{DS(ON)}$ | $V_{GS}=10V, I_D=3.5A$                                     | -   | 36   | 58        | m $\Omega$ |
|   |              | $V_{GS}=4.5V, I_D=2A$                                      | -   | 60   | 95        | m $\Omega$ |
| Forward Transconductance                  | $g_{FS}$     | $V_{DS}=5V, I_D=3.1A$                                      | -   | 4    | -         | S          |
| <b>Dynamic Characteristics</b> (Note 4)   |              |  |     |      |           |            |
| Input Capacitance                         | $C_{iss}$    | $V_{DS}=15V, V_{GS}=0V,$<br>$F=1.0MHz$                     | -   | 251  | -         | PF         |
| Output Capacitance                        | $C_{oss}$    |  | -   | 38   | -         | PF         |
| Reverse Transfer Capacitance              | $C_{rss}$    |  | -   | 32   | -         | PF         |
| <b>Switching Characteristics</b> (Note 4) |              |  |     |      |           |            |
| Turn-on Delay Time                        | $t_{d(on)}$  | $V_{DD}=15V, R_L=3\Omega$<br>$V_{GS}=10V, R_{GEN}=6\Omega$ | -   | 4.5  | -         | nS         |
| Turn-on Rise Time                         | $t_r$        |  | -   | 1.5  | -         | nS         |
| Turn-Off Delay Time                       | $t_{d(off)}$ |  | -   | 18.5 | -         | nS         |
| Turn-Off Fall Time                        | $t_f$        |  | -   | 15.5 | -         | nS         |
| Total Gate Charge                         | $Q_g$        | $V_{DS}=15V, I_D=3.5A,$<br>$V_{GS}=10V$                    | -   | 10.0 | -         | nC         |
| Gate-Source Charge                        | $Q_{gs}$     |  | -   | 1.9  | -         | nC         |
| Gate-Drain Charge                         | $Q_{gd}$     |  | -   | 1.8  | -         | nC         |
| <b>Drain-Source Diode Characteristics</b> |              |  |     |      |           |            |
| Diode Forward Voltage (Note 3)            | $V_{SD}$     | $V_{GS}=0V, I_S=3.5A$                                      | -   | 0.8  | 1.2       | V          |
| Diode Forward Current (Note 2)            | $I_S$        |  | -   | -    | 3.5       | A          |

### Notes:

1. Repetitive Rating: Pulse width limited by maximum junction temperature.
2. Surface Mounted on FR4 Board,  $t \leq 10$  sec.
3. Pulse Test: Pulse Width  $\leq 300\mu s$ , Duty Cycle  $\leq 2\%$ .
4. Guaranteed by design, not subject to production

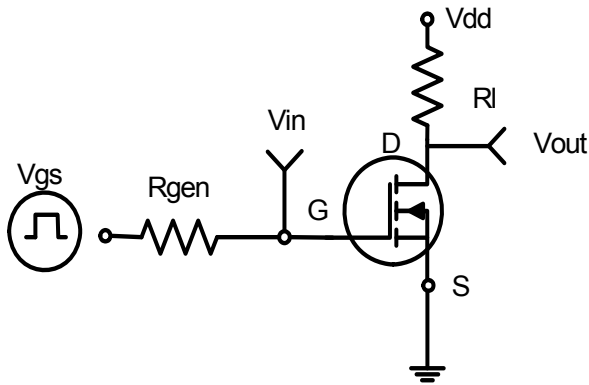
## P-CH Electrical Characteristics ( $T_A=25^{\circ}\text{C}$ unless otherwise noted)

| Parameter                                 | Symbol       | Condition   | Min | Typ  | Max       | Unit       |
|---|--------------|---|-----|------|-----------|------------|
| <b>Off Characteristics</b>                |              |   |     |      |           |            |
| Drain-Source Breakdown Voltage            | $BV_{DSS}$   | $V_{GS}=0V, I_D=-250\mu A$                                    | -30 | -33  | -         | V          |
| Zero Gate Voltage Drain Current           | $I_{DSS}$    | $V_{DS}=-30V, V_{GS}=0V$                                      | -   | -    | -1        | $\mu A$    |
| Gate-Body Leakage Current                 | $I_{GSS}$    | $V_{GS}=\pm 20V, V_{DS}=0V$                                   | -   | -    | $\pm 100$ | nA         |
| <b>On Characteristics</b> (Note 3)        |              |   |     |      |           |            |
| Gate Threshold Voltage                    | $V_{GS(th)}$ | $V_{DS}=V_{GS}, I_D=-250\mu A$                                | -1  | -1.6 | -2.5      | V          |
| Drain-Source On-State Resistance          | $R_{DS(on)}$ | $V_{GS}=-10V, I_D=-2.7A$                                      | -   | 69   | 100       | m $\Omega$ |
|   |              | $V_{GS}=-4.5V, I_D=-2A$                                       | -   | 110  | 150       | m $\Omega$ |
| Forward Transconductance                  | $g_{FS}$     | $V_{DS}=-10V, I_D=-2.7A$                                      |     | 2    | -         | S          |
| <b>Dynamic Characteristics</b> (Note 4)   |              |   |     |      |           |            |
| Input Capacitance                         | $C_{iss}$    | $V_{DS}=-15V, V_{GS}=0V,$<br>$F=1.0\text{MHz}$                | -   | 278  | -         | PF         |
| Output Capacitance                        | $C_{oss}$    |   | -   | 43   | -         | PF         |
| Reverse Transfer Capacitance              | $C_{rss}$    |   | -   | 35   | -         | PF         |
| <b>Switching Characteristics</b> (Note 4) |              |   |     |      |           |            |
| Turn-on Delay Time                        | $t_{d(on)}$  | $V_{DD}=-15V, R_L=15\Omega$<br>$V_{GS}=-10V, R_{GEN}=6\Omega$ | -   | 8    | -         | nS         |
| Turn-on Rise Time                         | $t_r$        |   | -   | 5    | -         | nS         |
| Turn-Off Delay Time                       | $t_{d(off)}$ |   | -   | 12   | -         | nS         |
| Turn-Off Fall Time                        | $t_f$        |   | -   | 4    | -         | nS         |
| Total Gate Charge                         | $Q_g$        | $V_{DS}=-15V, I_D=-2.7A, V_{GS}=-10V$                         | -   | 5.8  | -         | nC         |
| Gate-Source Charge                        | $Q_{gs}$     |   | -   | 1    | -         | nC         |
| Gate-Drain Charge                         | $Q_{gd}$     |   | -   | 1.1  | -         | nC         |
| <b>Drain-Source Diode Characteristics</b> |              |   |     |      |           |            |
| Diode Forward Voltage (Note 3)            | $V_{SD}$     | $V_{GS}=0V, I_S=-2.7A$  | -   | -    | -1.2      | V          |

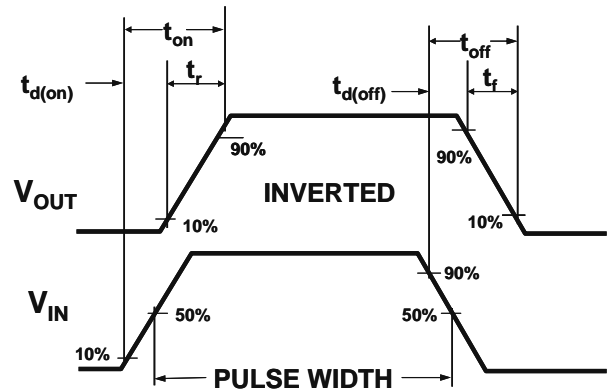
### Notes:

1. Repetitive Rating: Pulse width limited by maximum junction temperature.
2. Surface Mounted on FR4 Board,  $t \leq 10$  sec.
3. Pulse Test: Pulse Width  $\leq 300\mu s$ , Duty Cycle  $\leq 2\%$ .
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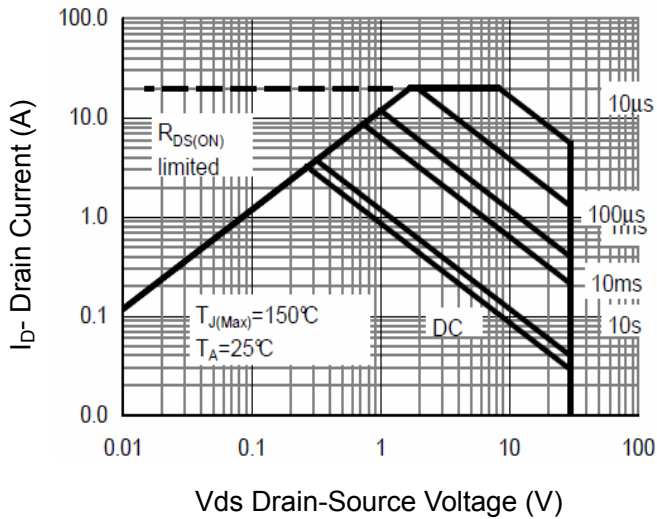
## N- Channel Typical Electrical and Thermal Characteristics



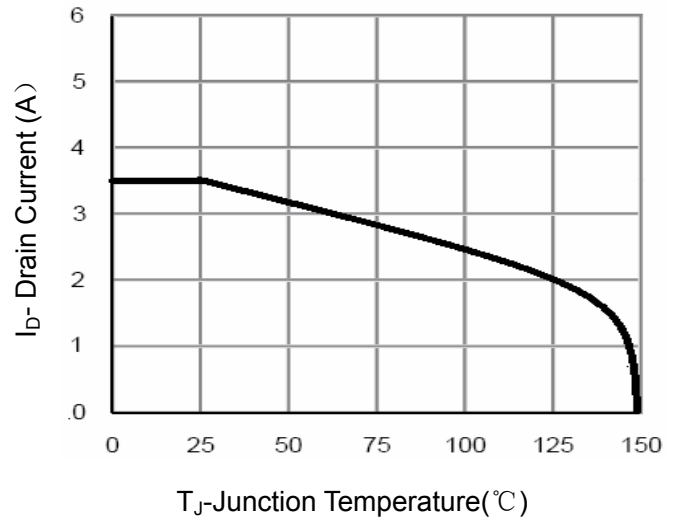
**Figure 1: Switching Test Circuit**



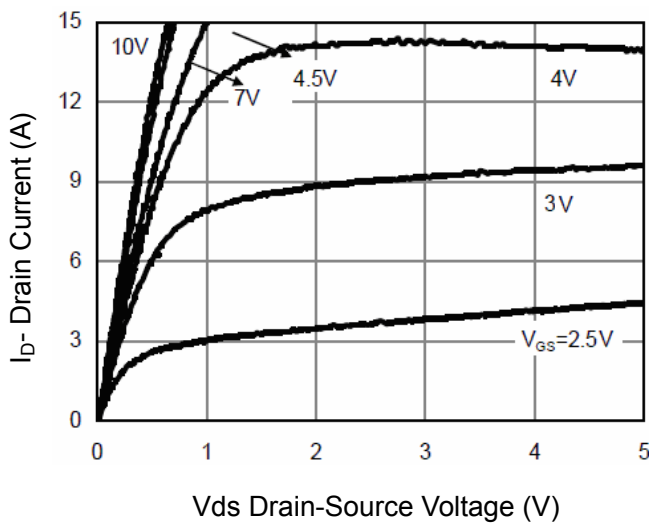
**Figure 2: Switching Waveforms**



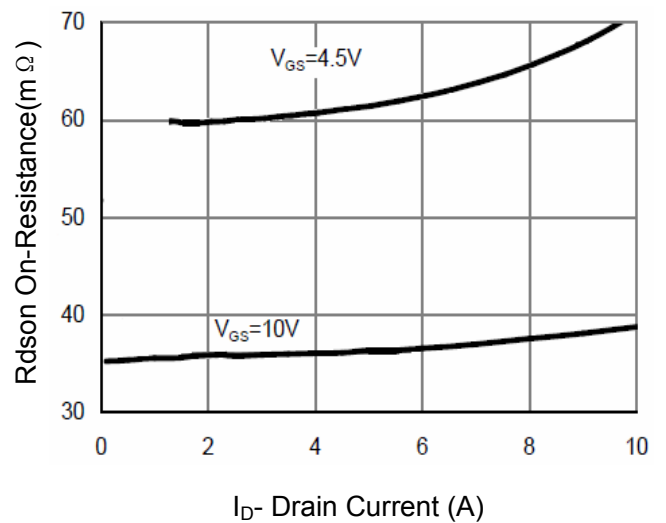
**Figure 3 Safe Operation Area**



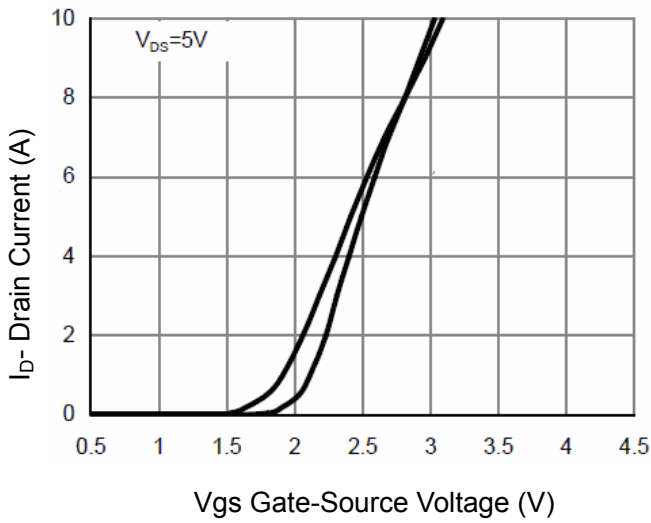
**Figure 4 Drain Current**



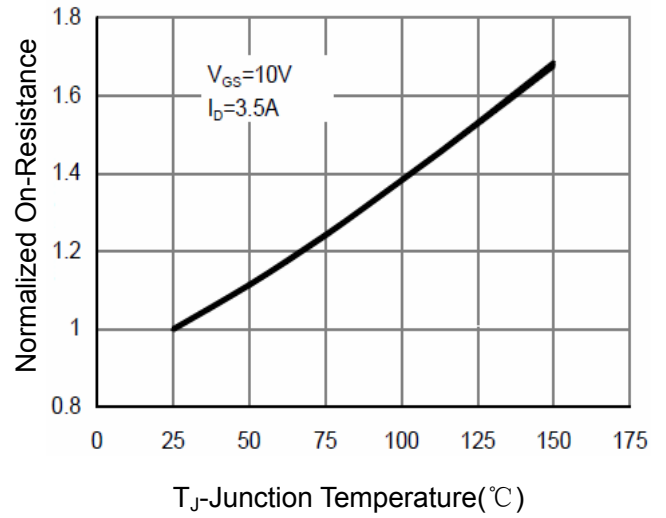
**Figure 5 Output Characteristics**



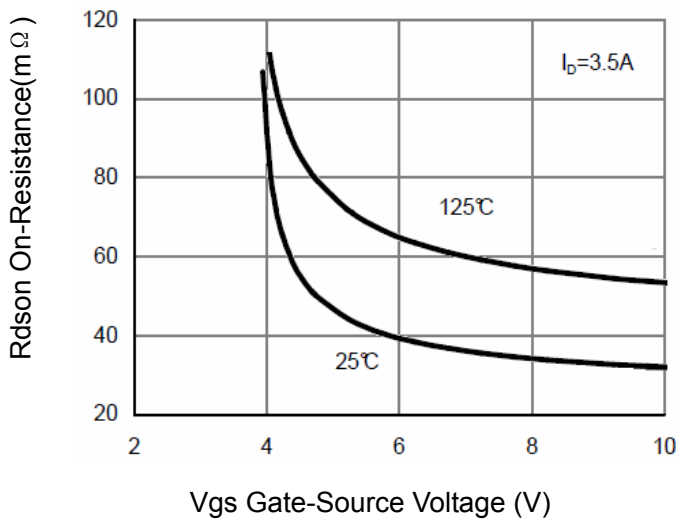
**Figure 6 Drain-Source On-Resistance**



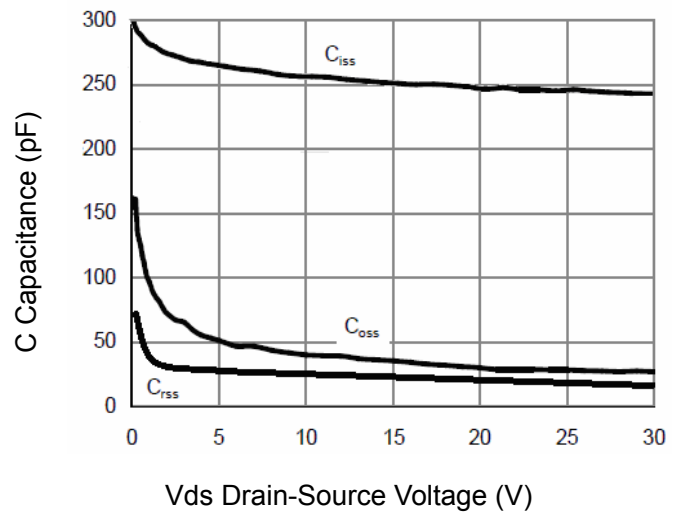
**Figure 7 Transfer Characteristics**



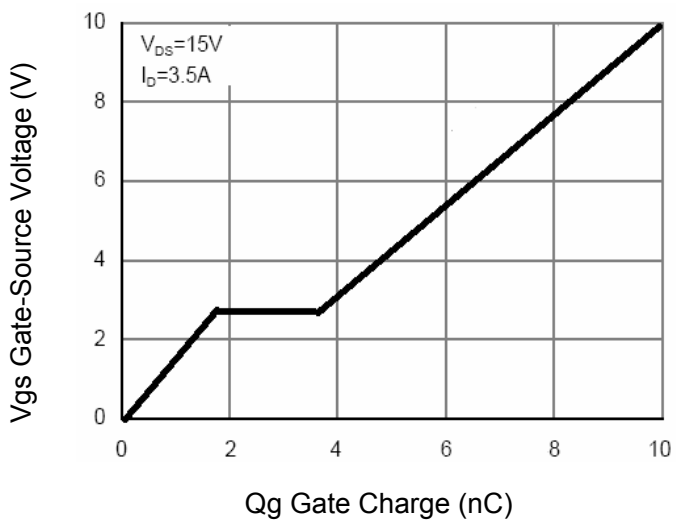
**Figure 8 Drain-Source On-Resistance**



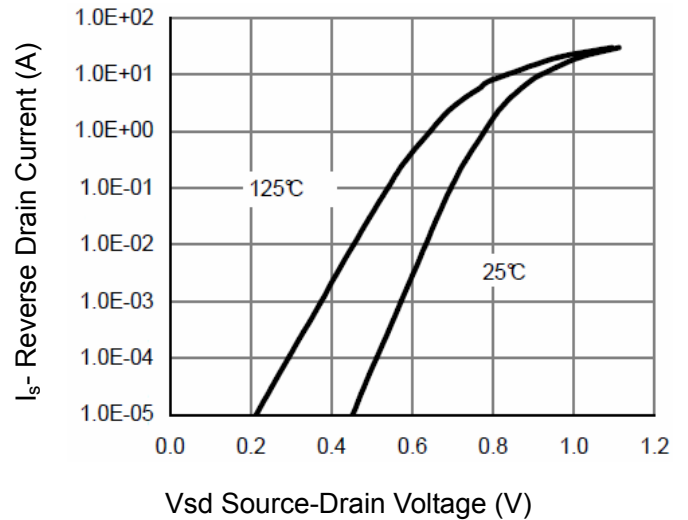
**Figure 9 Rdson vs Vgs**



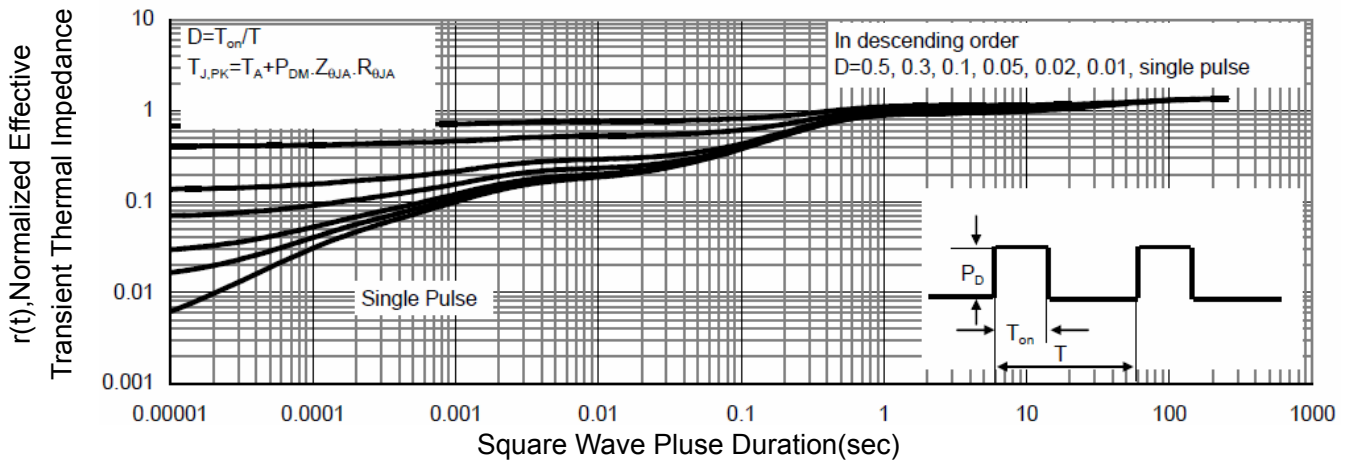
**Figure 10 Capacitance vs Vds**



**Figure 11 Gate Charge**



**Figure 12 Source- Drain Diode Forward**



**Figure 13 Normalized Maximum Transient Thermal Impedance**

## P- Channel Typical Electrical and Thermal Characteristics

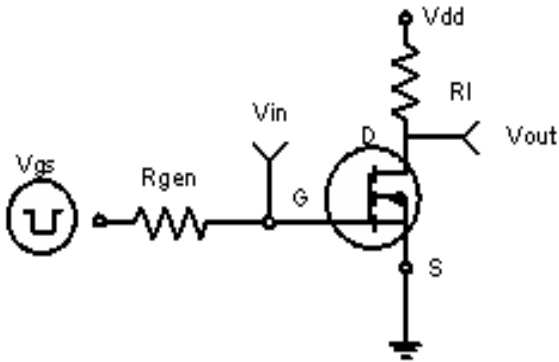


Figure 1: Switching Test Circuit

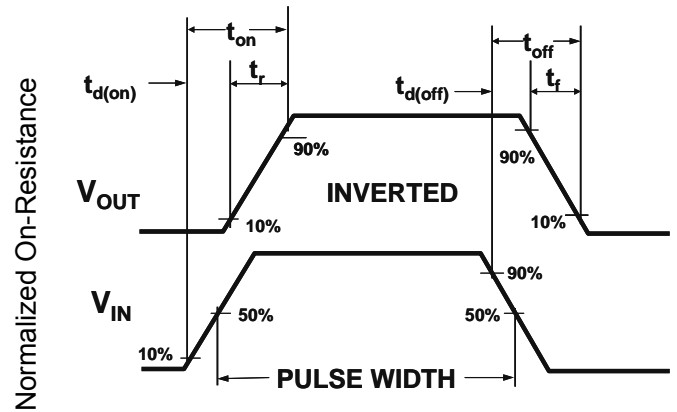


Figure 2: Switching Waveforms

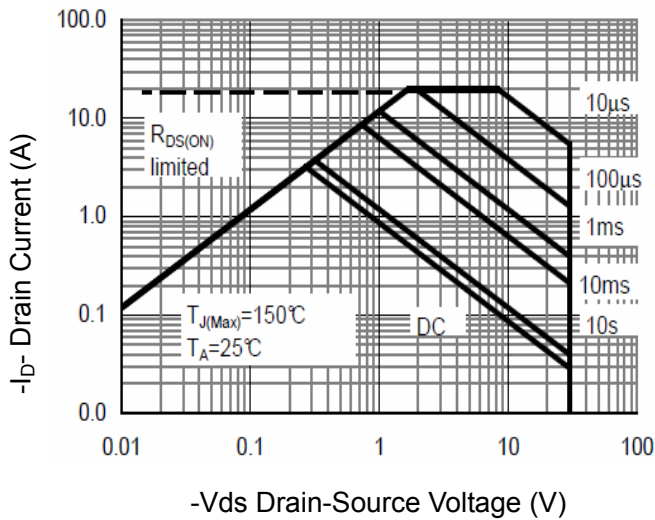


Figure 3 Safe Operation Area

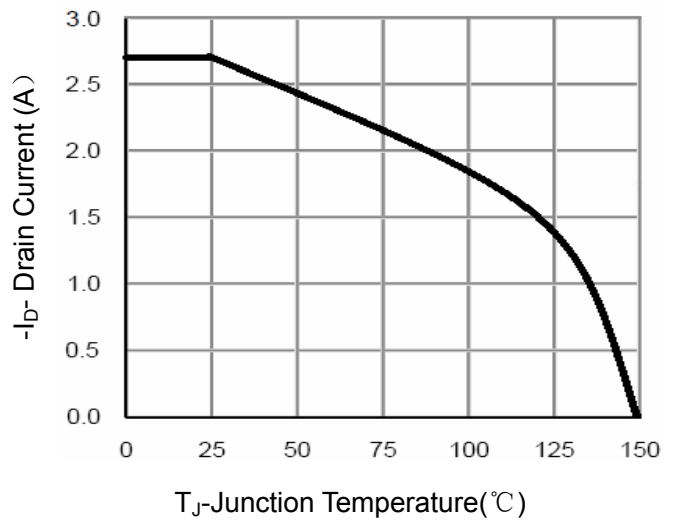


Figure 4 Drain Current

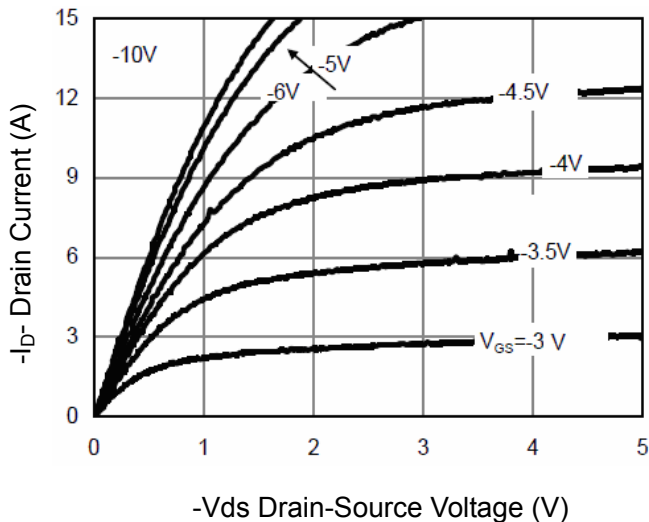


Figure 5 Output Characteristics

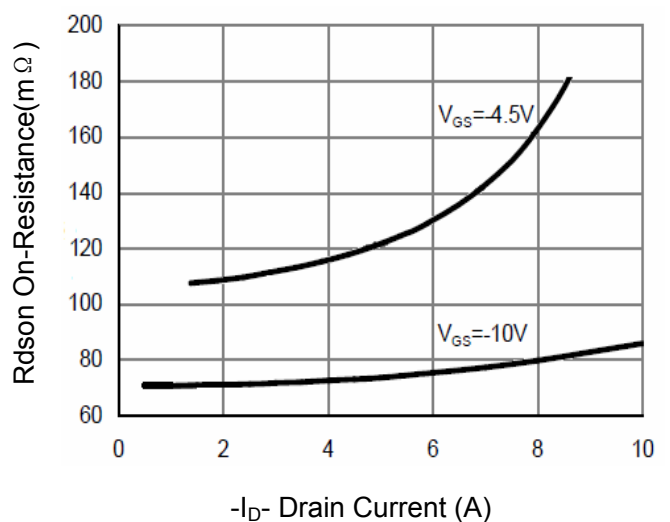
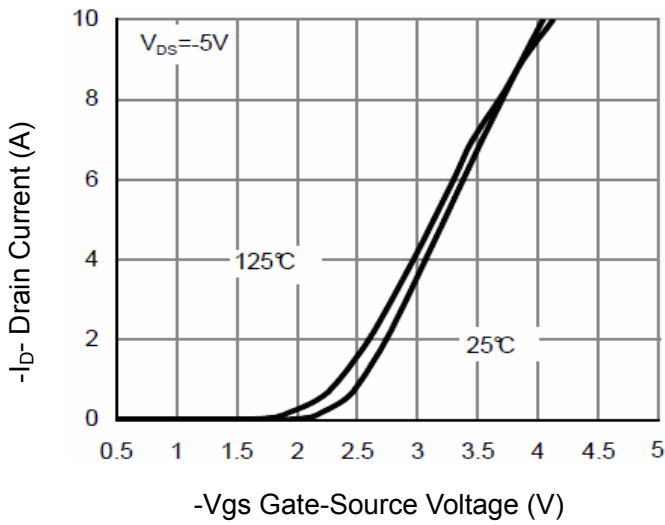
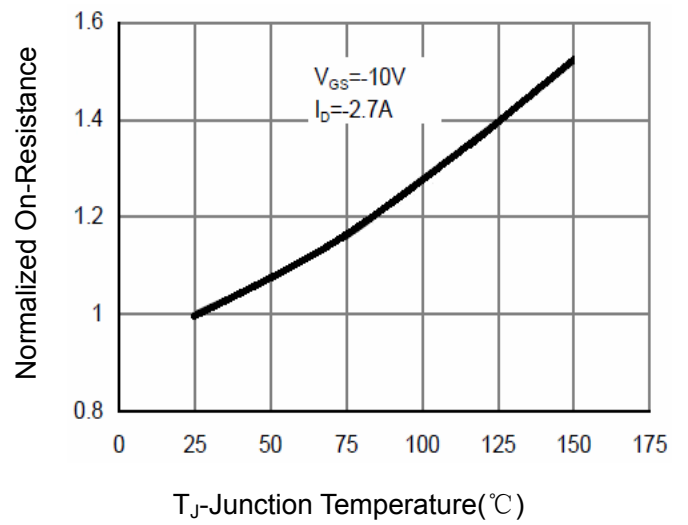


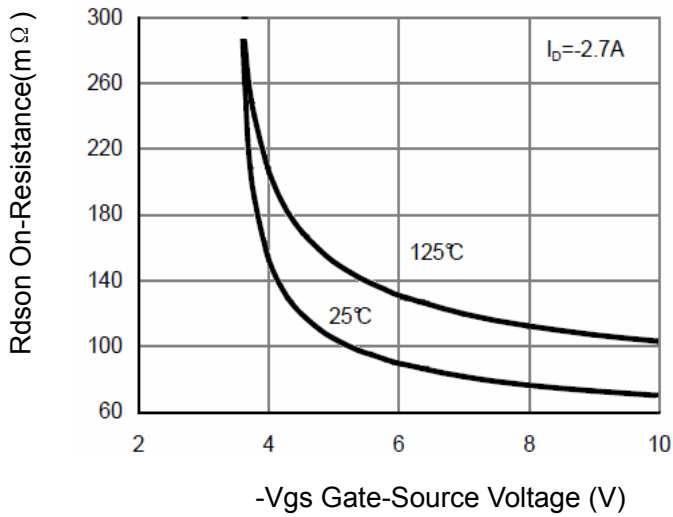
Figure 6 Drain-Source On-Resistance



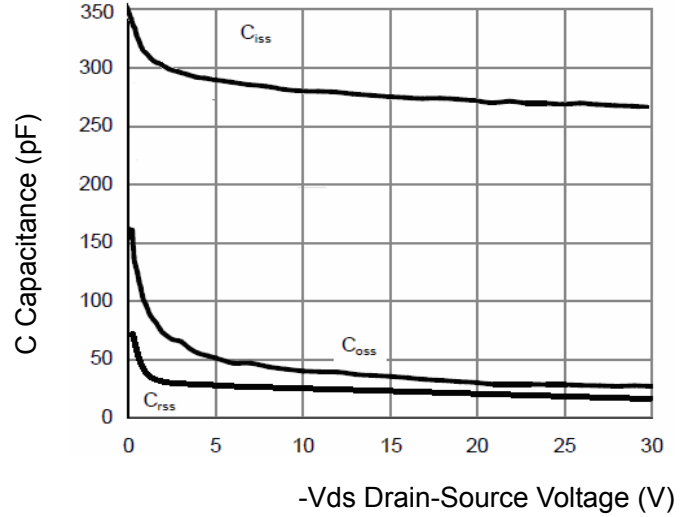
**Figure 7 Transfer Characteristics**



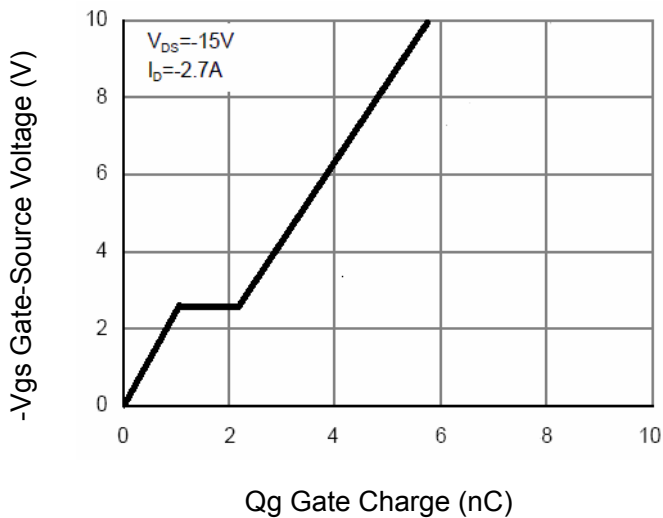
**Figure 8 Drain-Source On-Resistance**



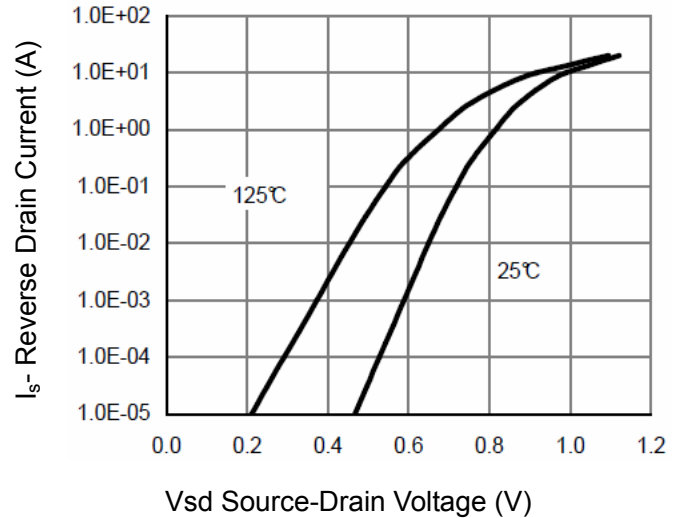
**Figure 9 Rdson vs Vgs**



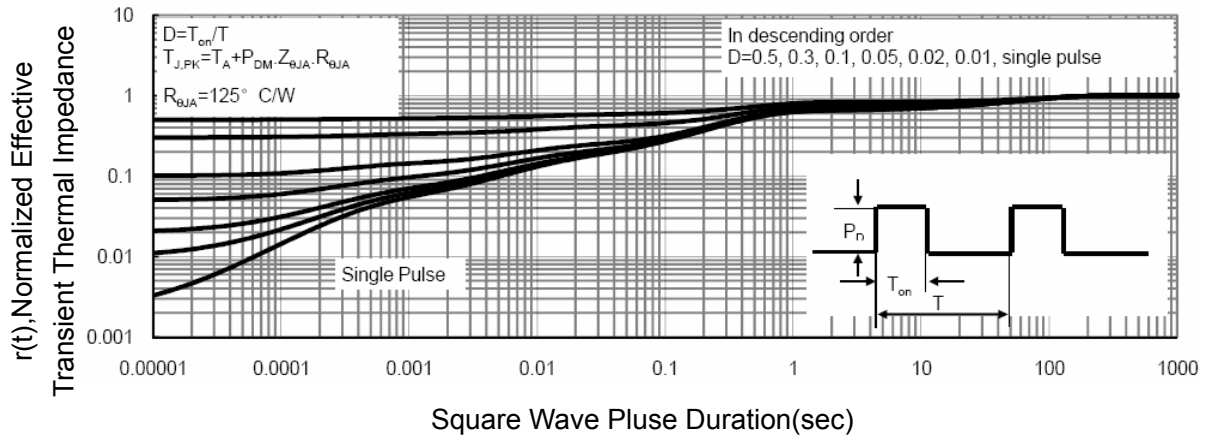
**Figure 10 Capacitance vs Vds**



**Figure 11 Gate Charge**

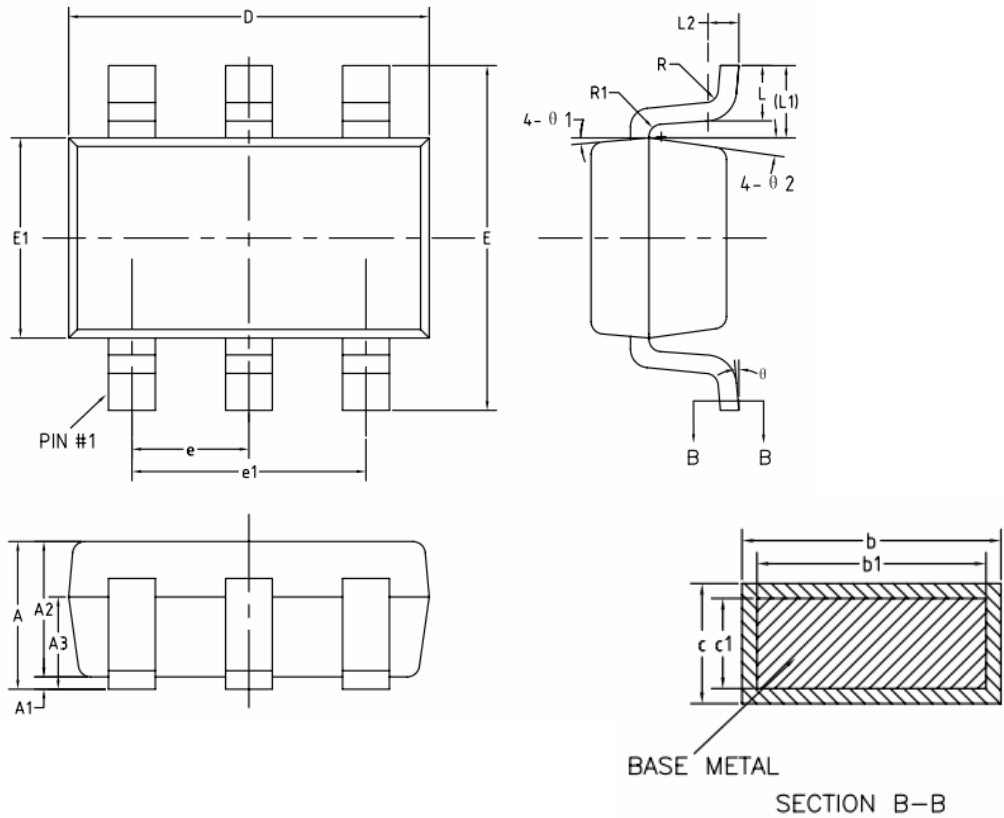


**Figure 12 Source- Drain Diode Forward**



**Figure 13 Normalized Maximum Transient Thermal Impedance**

## SOT23-6L Package Information



COMMON DIMENSIONS  
(UNITS OF MEASURE=MILLIMETER)

| SYMBOL     | MIN     | NOM  | MAX  |
|------------|---------|------|------|
| A          | —       | —    | 1.45 |
| A1         | 0       | —    | 0.15 |
| A2         | 0.90    | 1.10 | 1.30 |
| A3         | 0.60    | 0.65 | 0.70 |
| b          | 0.39    | —    | 0.49 |
| b1         | 0.38    | 0.40 | 0.45 |
| c          | 0.12    | —    | 0.19 |
| c1         | 0.11    | 0.13 | 0.15 |
| D          | 2.85    | 2.95 | 3.05 |
| E          | 2.60    | 2.80 | 3.00 |
| E1         | 1.55    | 1.65 | 1.75 |
| e          | 0.85    | 0.95 | 1.05 |
| e1         | 1.80    | 1.90 | 2.00 |
| L          | 0.35    | 0.45 | 0.60 |
| L1         | 0.59REF |      |      |
| L2         | 0.25BSC |      |      |
| R          | 0.05    | —    | —    |
| R1         | 0.05    | —    | 0.20 |
| $\theta$   | 0°      | —    | 8°   |
| $\theta 1$ | 8°      | 10°  | 12°  |
| $\theta 2$ | 8°      | 10°  | 12°  |

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