

## N and P-Channel Enhancement Mode Power MOSFET

### Description

The NCE609 uses advanced trench technology to provide excellent  $R_{DS(ON)}$  and low gate charge. The complementary MOSFETs may be used to form a level shifted high side switch, and for a host of other applications.

### General Features

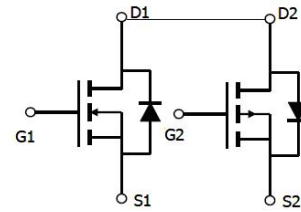
#### ● N-Channel

$V_{DS} = 40V, I_D = 21A$   
 $R_{DS(ON)} < 17m\Omega @ V_{GS} = 10V$   
 $R_{DS(ON)} < 29m\Omega @ V_{GS} = 4.5V$

#### ● P-Channel

$V_{DS} = -40V, I_D = -14A$   
 $R_{DS(ON)} < 32m\Omega @ V_{GS} = -10V$   
 $R_{DS(ON)} < 45m\Omega @ V_{GS} = -4.5V$

- High power and current handling capability
- Lead free product is acquired
- Surface mount package



Schematic diagram



Marking and pin assignment

**100% UIS TESTED!**

**100%  $\Delta V_{ds}$  TESTED!**

### Package Marking and Ordering Information

| Device Marking | Device | Device Package | Reel Size | Tape width | Quantity |
|----------------|--------|----------------|-----------|------------|----------|
| NCE609         | NCE609 | TO-252-4L      | -         | -          | -        |

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

| Parameter  | Symbol         | N-Channel          | P-Channel  | Unit       |   |
|--|----------------|--------------------|------------|------------|---|
| Drain-Source Voltage                             | $V_{DS}$       | 40                 | -40        | V          |   |
| Gate-Source Voltage                              | $V_{GS}$       | $\pm 25$           | $\pm 25$   | V          |   |
| Continuous Drain Current                         | $I_D$          | $T_C = 25^\circ C$ | 21         | -14        | A |
|  |                | $T_C = 70^\circ C$ | 17.5       | -11.5      |   |
| Pulsed Drain Current (Note 1)                    | $I_{DM}$       | 84                 | -56        | A          |   |
| Maximum Power Dissipation                        | $P_D$          | 40                 | 40         | W          |   |
| Operating Junction and Storage Temperature Range | $T_J, T_{STG}$ | -55 To 150         | -55 To 150 | $^\circ C$ |   |

### Thermal Characteristic

|   |                 |      |     |              |
|---|-----------------|------|-----|--------------|
| Thermal Resistance, Junction-to-Case (Note 2) | $R_{\theta JC}$ | N-Ch | 3.1 | $^\circ C/W$ |
| Thermal Resistance, Junction-to-Case (Note 2) | $R_{\theta JC}$ | P-Ch | 3.1 | $^\circ C/W$ |

## N-CH Electrical Characteristics (T<sub>A</sub>=25°C unless otherwise noted)

| Parameter                                 | Symbol              | Condition  | Min | Typ  | Max  | Unit |
|---|---------------------|--|-----|------|------|------|
| <b>Off Characteristics</b>                |                     |  |     |      |      |      |
| Drain-Source Breakdown Voltage            | BV <sub>DSS</sub>   | V <sub>GS</sub> =0V, I <sub>D</sub> =250μA   | 40  | -    | -    | V    |
| Zero Gate Voltage Drain Current           | I <sub>DSS</sub>    | V <sub>DS</sub> =40V, V <sub>GS</sub> =0V  | -   | -    | 1    | μA   |
| Gate-Body Leakage Current                 | I <sub>GSS</sub>    | V <sub>GS</sub> =±25V, V <sub>DS</sub> =0V   | -   | -    | ±100 | nA   |
| <b>On Characteristics</b> (Note 3)        |                     |  |     |      |      |      |
| Gate Threshold Voltage                    | V <sub>GS(th)</sub> | V <sub>DS</sub> =V <sub>GS</sub> , I <sub>D</sub> =250μA                               | 1   | 1.6  | 2.2  | V    |
| Drain-Source On-State Resistance          | R <sub>DS(on)</sub> | V <sub>GS</sub> =10V, I <sub>D</sub> =10A  | -   | 14   | 17   | mΩ   |
|   |                     | V <sub>GS</sub> =4.5V, I <sub>D</sub> =5A  | -   | 19   | 29   | mΩ   |
| Forward Transconductance                  | g <sub>FS</sub>     | V <sub>DS</sub> =5V, I <sub>D</sub> =10A   |     | 15   | -    | S    |
| <b>Dynamic Characteristics</b> (Note 4)   |                     |  |     |      |      |      |
| Input Capacitance                         | C <sub>iss</sub>    | V <sub>DS</sub> =20V, V <sub>GS</sub> =0V,<br>F=1.0MHz                                 | -   | 1110 | -    | PF   |
| Output Capacitance                        | C <sub>oss</sub>    |  | -   | 114  | -    | PF   |
| Reverse Transfer Capacitance              | C <sub>rss</sub>    |  | -   | 109  | -    | PF   |
| <b>Switching Characteristics</b> (Note 4) |                     |  |     |      |      |      |
| Turn-on Delay Time                        | t <sub>d(on)</sub>  | V <sub>DD</sub> =20V, R <sub>L</sub> =2Ω<br>V <sub>GS</sub> =10V, R <sub>GEN</sub> =3Ω | -   | 4    | -    | nS   |
| Turn-on Rise Time                         | t <sub>r</sub>      |  | -   | 11.5 | -    | nS   |
| Turn-Off Delay Time                       | t <sub>d(off)</sub> |  | -   | 18   | -    | nS   |
| Turn-Off Fall Time                        | t <sub>f</sub>      |  | -   | 5.6  | -    | nS   |
| Total Gate Charge                         | Q <sub>g</sub>      | V <sub>DS</sub> =20V, I <sub>D</sub> =10A,<br>V <sub>GS</sub> =10V                     | -   | 30   | -    | nC   |
| Gate-Source Charge                        | Q <sub>gs</sub>     |  | -   | 5    | -    | nC   |
| Gate-Drain Charge                         | Q <sub>gd</sub>     |  | -   | 7    | -    | nC   |
| <b>Drain-Source Diode Characteristics</b> |                     |  |     |      |      |      |
| Diode Forward Voltage (Note 3)            | V <sub>SD</sub>     | V <sub>GS</sub> =0V, I <sub>S</sub> =10A   | -   | 0.8  | 1.2  | V    |

## 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            | $BV_{DSS}$   | $V_{GS}=0V, I_D=-250\mu A$                                     | -40  | -    | -         | V          |
| Zero Gate Voltage Drain Current           | $I_{DSS}$    | $V_{DS}=-40V, V_{GS}=0V$                                       | -    | -    | -1        | $\mu A$    |
| Gate-Body Leakage Current                 | $I_{GSS}$    | $V_{GS}=\pm 25V, V_{DS}=0V$                                    | -    | -    | $\pm 100$ | nA         |
| <b>On Characteristics (Note 3)</b>        |              |  |      |      |           |            |
| Gate Threshold Voltage                    | $V_{GS(th)}$ | $V_{DS}=V_{GS}, I_D=-250\mu A$                                 | -1.0 | -1.6 | -2.2      | V          |
| Drain-Source On-State Resistance          | $R_{DS(ON)}$ | $V_{GS}=-10V, I_D=-7A$   | -    | 27   | 32        | m $\Omega$ |
|   |              | $V_{GS}=-4.5V, I_D=-4A$  | -    | 34   | 45        | m $\Omega$ |
| Forward Transconductance                  | $g_{FS}$     | $V_{DS}=-5V, I_D=-7A$  | -    | 15   | -         | S          |
| <b>Dynamic Characteristics (Note4)</b>    |              |  |      |      |           |            |
| Input Capacitance                         | $C_{iss}$    | $V_{DS}=-20V, V_{GS}=0V,$<br>$F=1.0MHz$                        | -    | 1139 | -         | PF         |
| Output Capacitance                        | $C_{oss}$    |  | -    | 114  | -         | PF         |
| Reverse Transfer Capacitance              | $C_{rss}$    |  | -    | 103  | -         | PF         |
| <b>Switching Characteristics (Note 4)</b> |              |  |      |      |           |            |
| Turn-on Delay Time                        | $t_{d(on)}$  | $V_{DD}=-20V, R_L=2.3\Omega$<br>$V_{GS}=-10V, R_{GEN}=6\Omega$ | -    | 10   | -         | nS         |
| Turn-on Rise Time                         | $t_r$        |  | -    | 15   | -         | nS         |
| Turn-Off Delay Time                       | $t_{d(off)}$ |  | -    | 30   | -         | nS         |
| Turn-Off Fall Time                        | $t_f$        |  | -    | 18   | -         | nS         |
| Total Gate Charge                         | $Q_g$        | $V_{DS}=-20V, I_D=-7A$<br>$V_{GS}=-10V$                        | -    | 22.5 | -         | nC         |
| Gate-Source Charge                        | $Q_{gs}$     |  | -    | 2.4  | -         | nC         |
| Gate-Drain Charge                         | $Q_{gd}$     |  | -    | 5.1  | -         | nC         |
| <b>Drain-Source Diode Characteristics</b> |              |  |      |      |           |            |
| Diode Forward Voltage (Note 3)            | $V_{SD}$     | $V_{GS}=0V, I_S=-14A$  | -    | -    | -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  $\leq 2\%$ .
4. Guaranteed by design, not subject to production

N- Channel Typical Electrical and Thermal Characteristics (Curves)

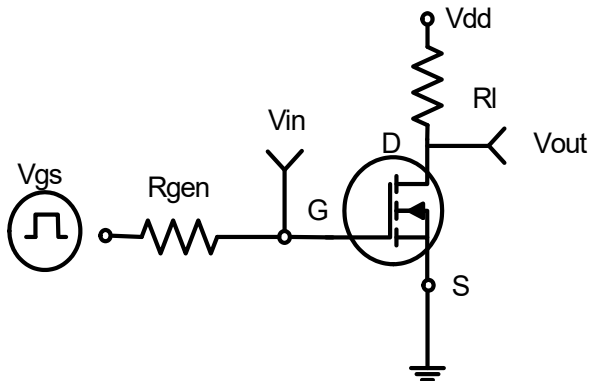


Figure 1: Switching Test Circuit

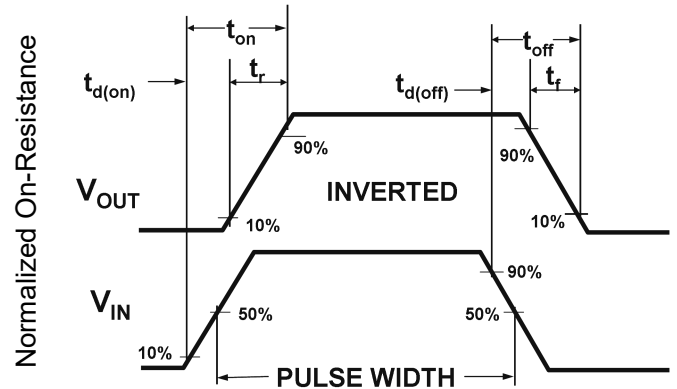


Figure 2: Switching Waveforms

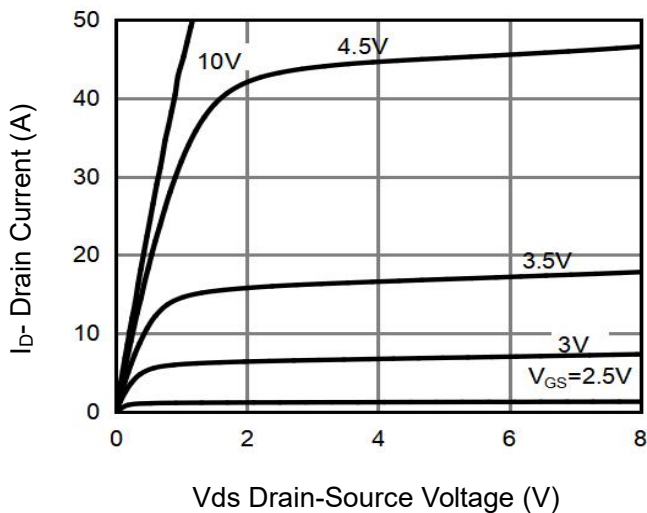


Figure 3 Output Characteristics

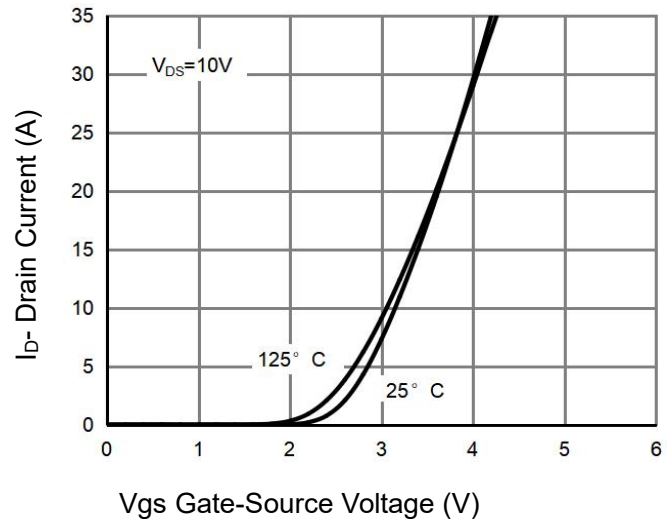


Figure 4 Transfer Characteristics

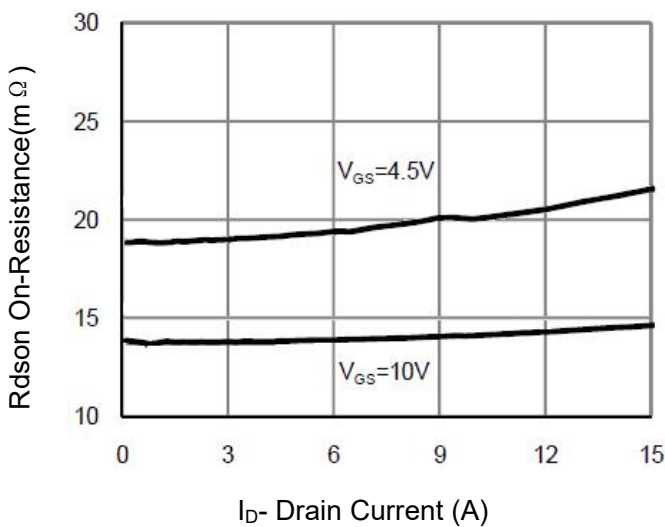


Figure 5 Drain-Source On-Resistance

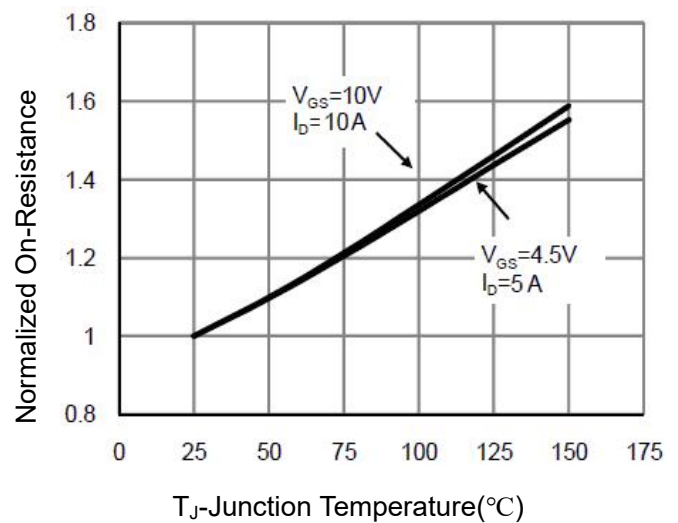
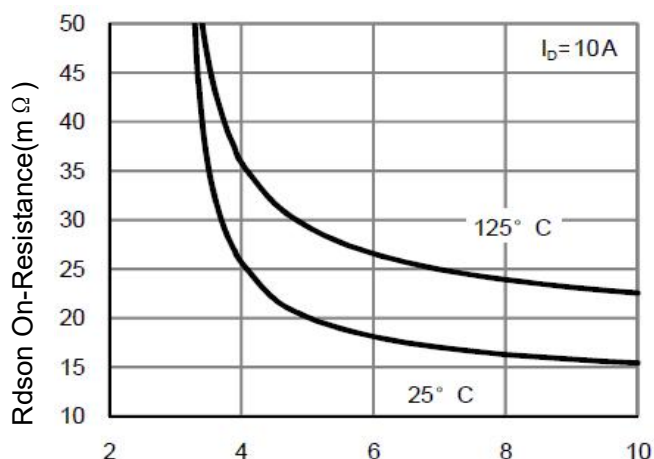
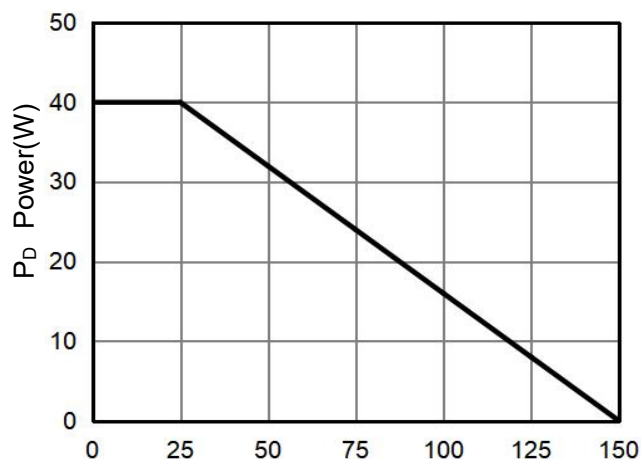


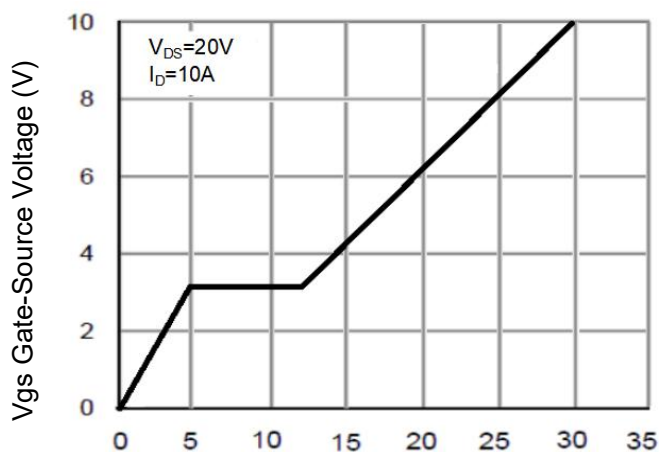
Figure 6 Drain-Source On-Resistance



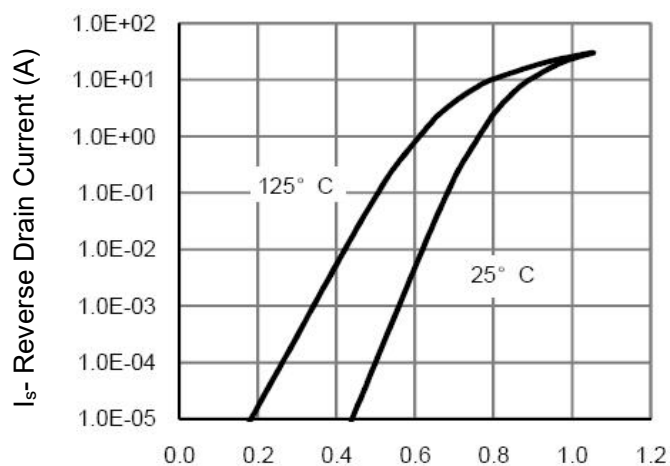
Vgs Gate-Source Voltage (V)  
**Figure 7 Rdson vs Vgs**



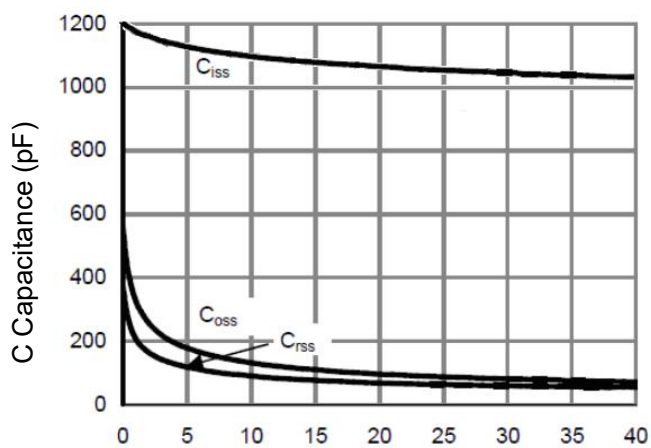
T<sub>J</sub>-Junction Temperature(°C)  
**Figure 8 Power Dissipation**



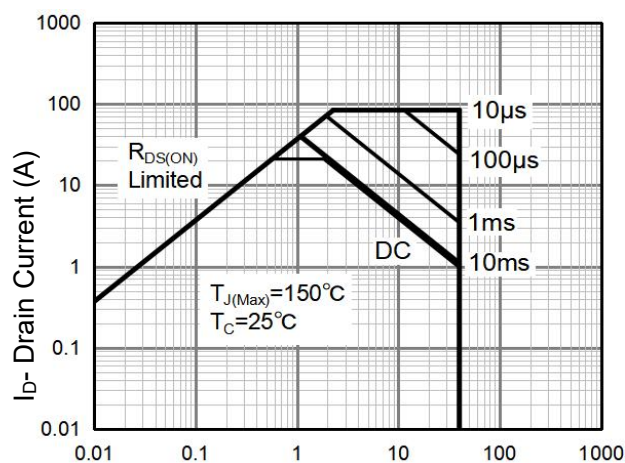
Qg Gate Charge (nC)  
**Figure 9 Gate Charge**



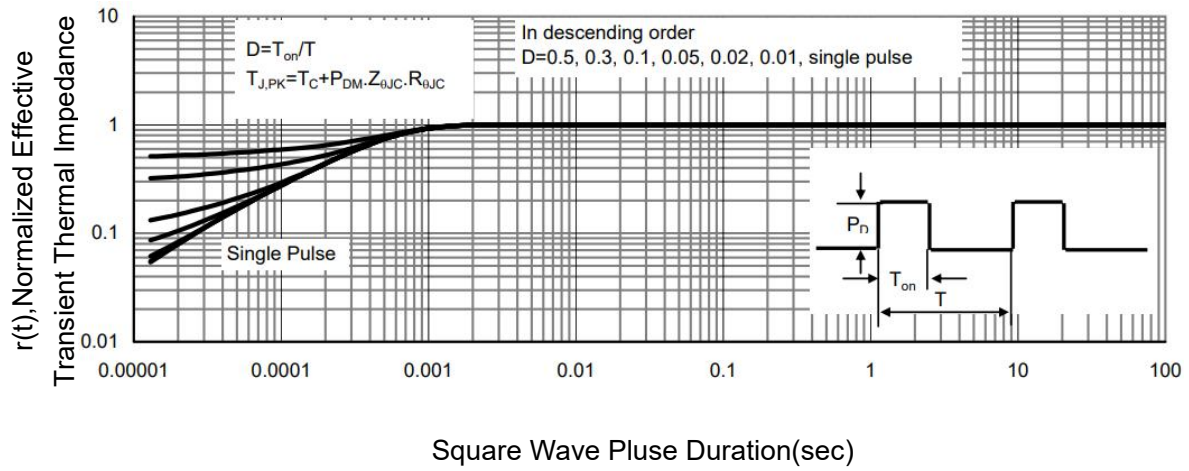
Vds Drain-Source Voltage (V)  
**Figure 10 Source- Drain Diode Forward**



Vds Drain-Source Voltage (V)  
**Figure 11 Capacitance vs Vds**

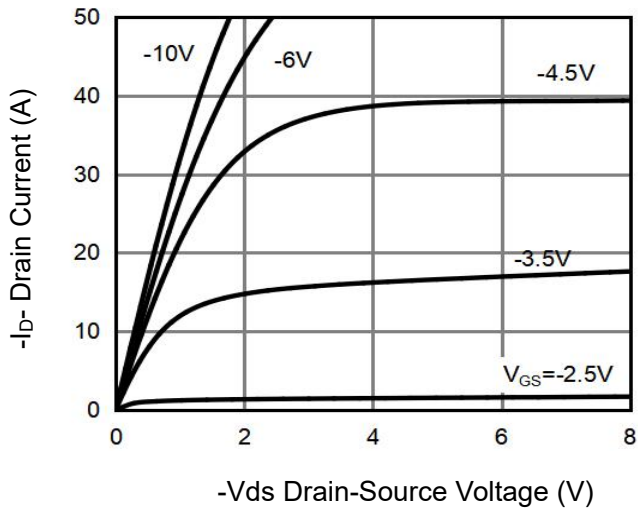


Vds Drain-Source Voltage (V)  
**Figure 12 Safe Operation Area**

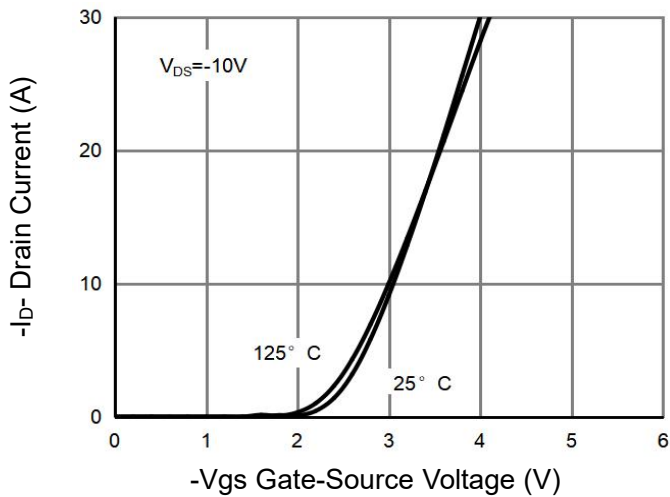


**Figure 13 Normalized Maximum Transient Thermal Impedance**

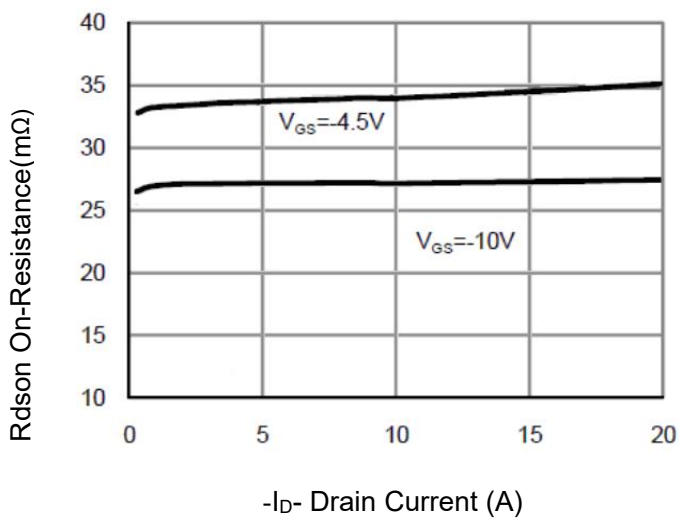
**P- Channel Typical Electrical and Thermal Characteristics (Curves)**



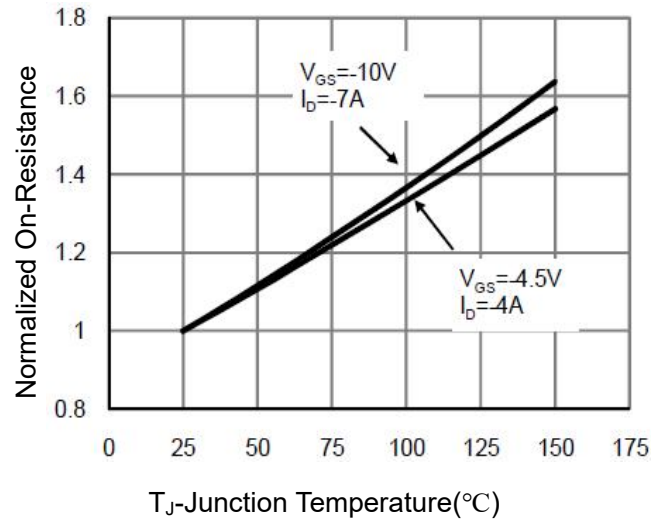
**Figure 1 Output Characteristics**



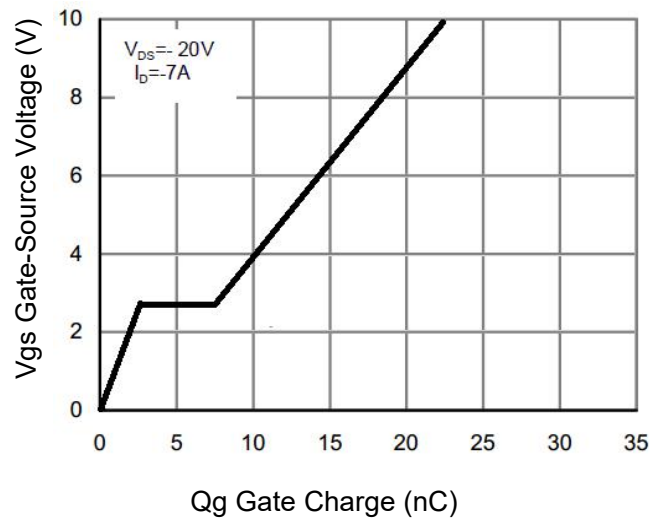
**Figure 2 Transfer Characteristics**



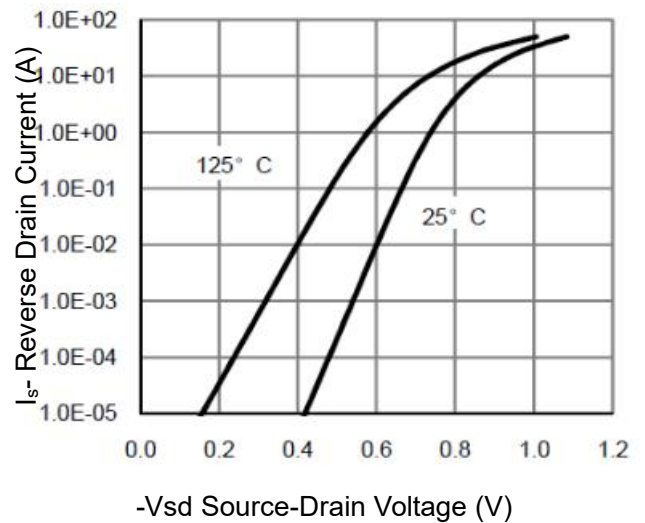
**Figure 3 Rdson- Drain Current**



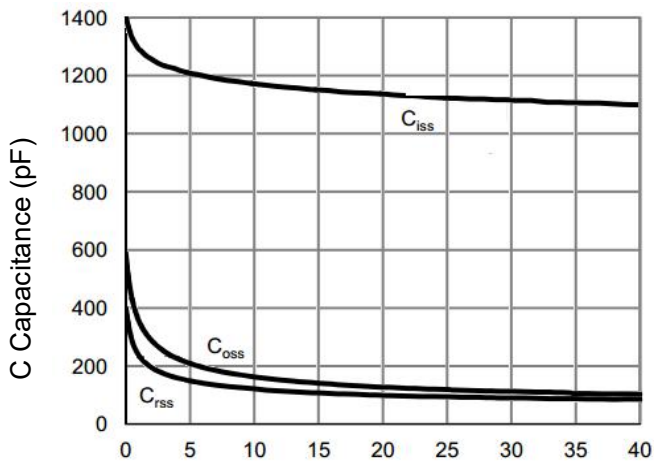
**Figure 4 Rdson-Junction Temperature**



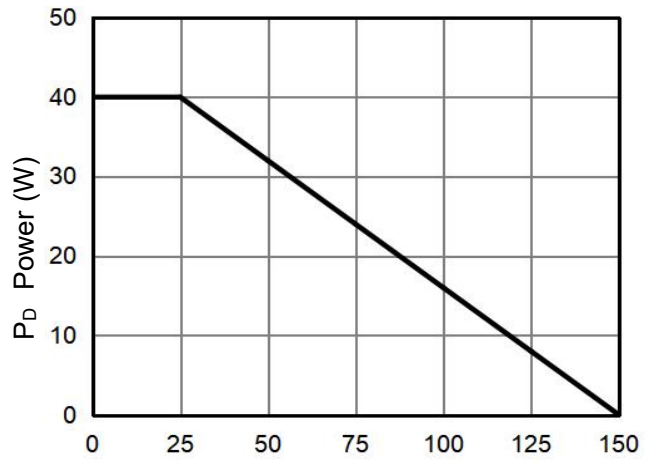
**Figure 5 Gate Charge**



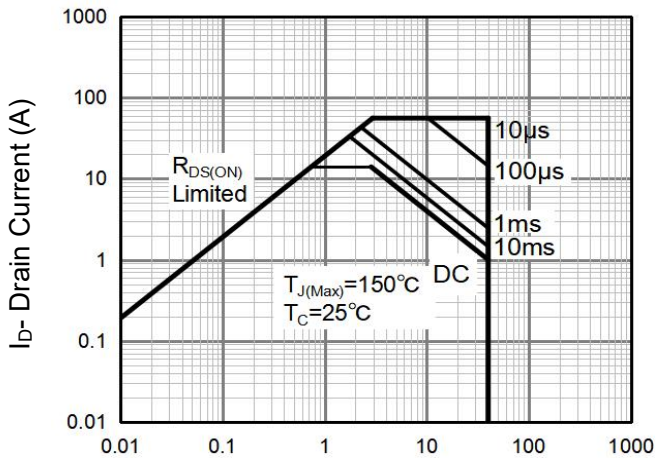
**Figure 6 Source- Drain Diode Forward**



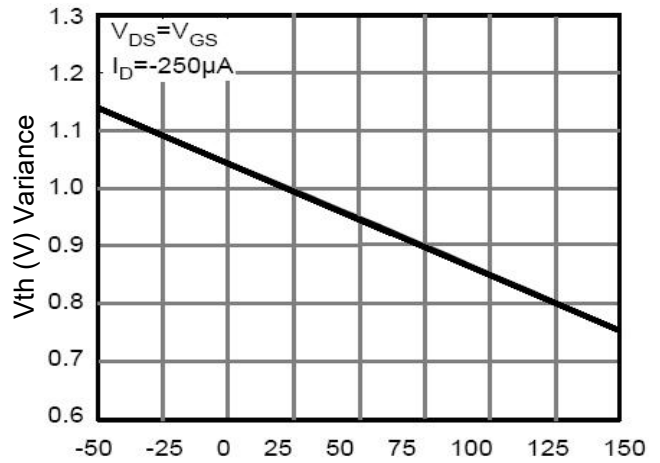
-Vds Drain-Source Voltage (V)  
**Figure 7 Capacitance vs Vds**



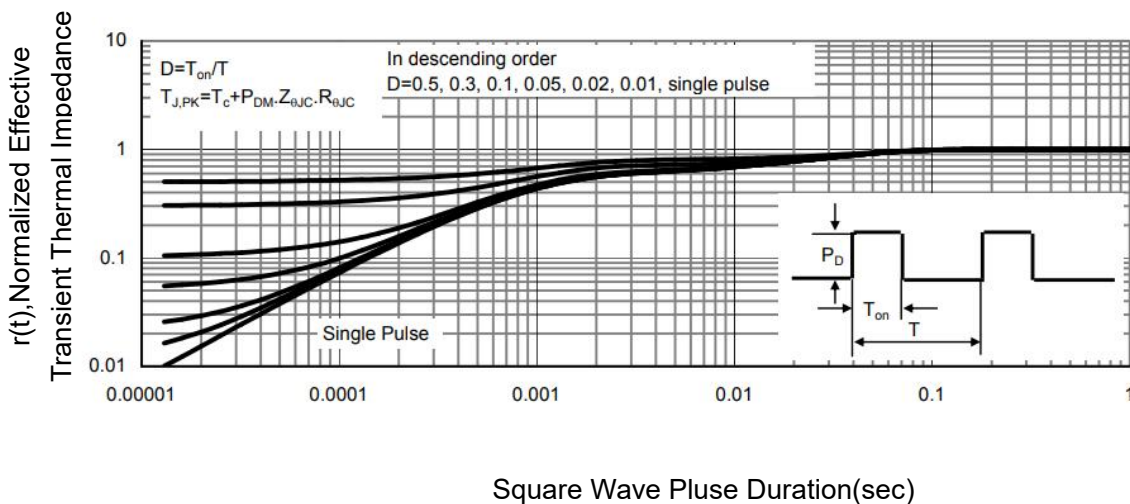
$T_J$ -Junction Temperature(°C)  
**Figure 9 Power Dissipation**



-Vds Drain-Source Voltage (V)  
**Figure 8 Safe Operation Area**

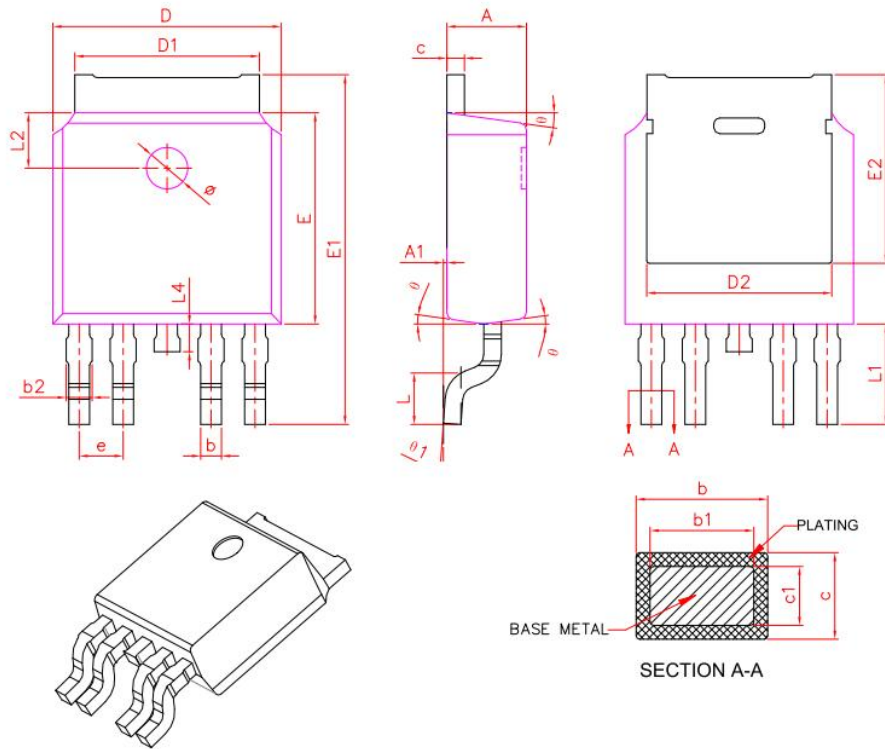


$T_J$ -Junction Temperature(°C)  
**Figure 10  $V_{GS(th)}$  vs Junction Temperature**



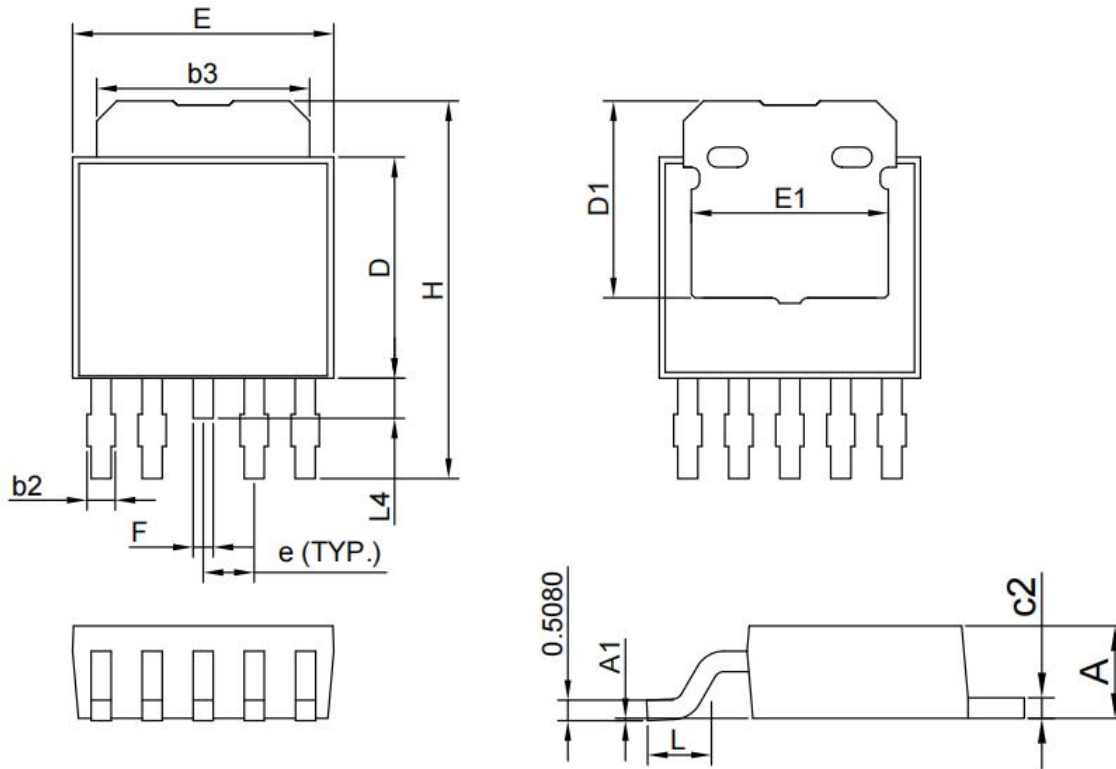
Square Wave Pluse Duration(sec)  
**Figure 11 Normalized Maximum Transient Thermal Impedance**

## TO-252-4L (E) Package Information



| TO252-4L                      |          |       |       |
|-------------------------------|----------|-------|-------|
| DIM.                          | MIN.     | NOM.  | MAX.  |
| A                             | 2.20     | 2.30  | 2.40  |
| A1                            | 0.00     | 0.08  | 0.13  |
| b                             | 0.50     | 0.60  | 0.70  |
| b1                            | 0.57     | 0.60  | 0.63  |
| b2                            | 0.75REF  |       |       |
| c                             | 0.46     | 0.508 | 0.58  |
| c1                            | 0.50     | 0.508 | 0.52  |
| D                             | 6.50     | 6.60  | 6.70  |
| D1                            | 5.10     | 5.334 | 5.46  |
| D2                            | 5.346REF |       |       |
| E                             | 6.00     | 6.10  | 6.20  |
| E1                            | 9.80     | 10.10 | 10.40 |
| E2                            | 5.446REF |       |       |
| e                             | 1.17     | 1.27  | 1.37  |
| L                             | 1.40     | 1.50  | 1.70  |
| L1                            | 2.90REF  |       |       |
| L2                            | 1.60REF  |       |       |
| L4                            | 0.60     | 0.80  | 1.00  |
| ∅                             | ∅1.10    | ∅1.20 | ∅1.30 |
| ∅                             | 5°       | 8°    | 10°   |
| ∅1                            | 0°       | -     | 8°    |
| All dimensions in millimeters |          |       |       |

TO-252-4L (X) Package Information



COMMON DIMENSIONS  
UNITS OF MEASURE=MILLIMETER

| SYMBOL | MIN       | NOM  | MAX   |
|--------|-----------|------|-------|
| A      | 2.20      | 2.30 | 2.40  |
| A1     | 0.00      | 0.08 | 0.15  |
| b      | 0.45      | 0.53 | 0.60  |
| b2     | 0.50      | 0.65 | 0.80  |
| b3     | 5.20      | 5.35 | 5.50  |
| c2     | 0.45      | 0.50 | 0.55  |
| D      | 5.40      | 5.60 | 5.80  |
| D1     | 4.57      | -    | -     |
| E      | 6.40      | 6.60 | 6.80  |
| E1     | 3.81      | -    | -     |
| e      | 1.27 REF. |      |       |
| F      | 0.40      | 0.50 | 0.60  |
| H      | 9.40      | 9.80 | 10.20 |
| L      | 1.40      | 1.59 | 1.77  |
| L1     | 2.40      | 2.70 | 3.00  |
| L2     | 0.80      | 1.00 | 1.20  |

## Attention

- Any and all NCE power products described or contained herein do not have specifications that can handle applications that require extremely high levels of reliability, such as life-support systems, aircraft's control systems, or other applications whose failure can be reasonably expected to result in serious physical and/or material damage. Consult with your NCE power representative nearest you before using any NCE power products described or contained herein in such applications.
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