

N-Channel Power MOSFET (16A, 600Volts)

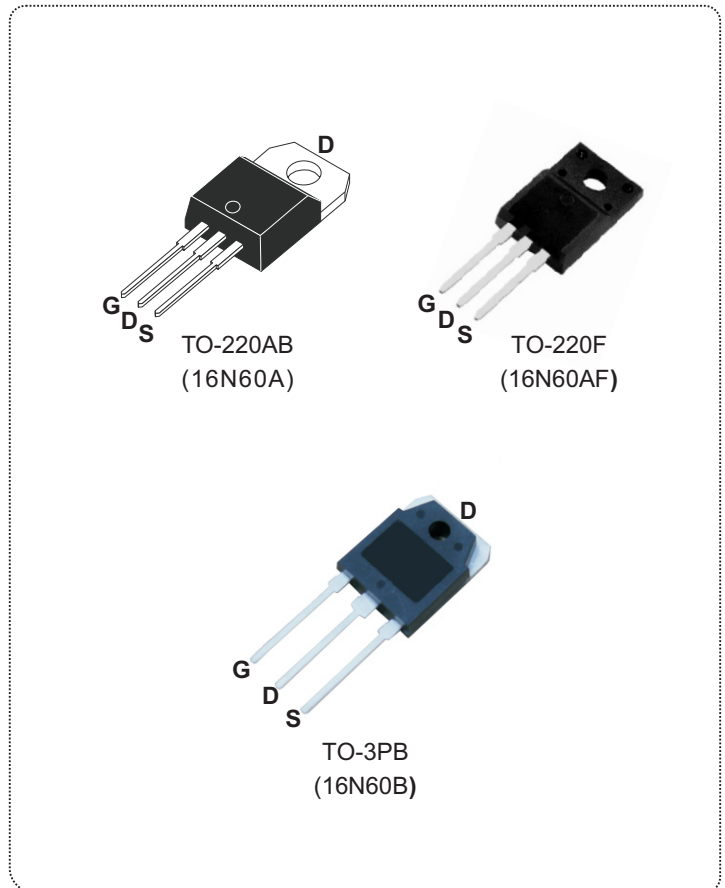
DESCRIPTION

The Nell **16N60** is a three-terminal silicon device with current conduction capability of 16A, fast switching speed, low on-state resistance, breakdown voltage rating of 600V, and max. threshold voltage of 4 volts.

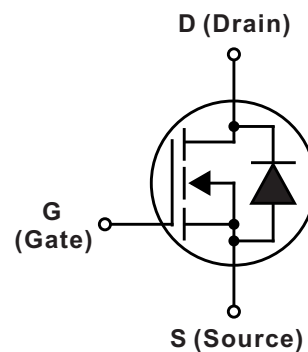
They are designed for use in applications, such as switched mode power supplies, DC to DC converters, **PWM** motor controls, server/telecom power, FPD TV power, ATX power, and industrial power applications.

FEATURES

- $R_{DS(ON)} = 0.17\Omega @ V_{GS} = 10V$
- Ultra low gate charge(52.3nC max.)
- Low reverse transfer capacitance ($C_{RSS} = 5pF$ typical)
- Fast switching capability
- 100% avalanche energy specified
- Improved dv/dt capability
- 150°C operation temperature



| PRODUCT SUMMARY | |
|---------------------------|-----------------------|
| I_D (A) | 16 |
| V_{DSS} (V) | 600 |
| $R_{DS(ON)}$ (Ω) | 0.17 @ $V_{GS} = 10V$ |
| Q_G (nC) max. | 52.3 |



| ABSOLUTE MAXIMUM RATINGS ($T_C = 25^\circ\text{C}$ unless otherwise specified) | | | | | |
|---|---|---|-----------------|------------|---------------------|
| SYMBOL | PARAMETER | TEST CONDITIONS | | VALUE | UNIT |
| V_{DSS} | Drain to Source voltage | $T_J = 25^\circ\text{C}$ to 150°C | | 600 | V |
| V_{DGR} | Drain to Gate voltage | $R_{GS} = 20\text{K}\Omega$ | | 600 | |
| V_{GS} | Gate to Source voltage | | | ± 30 | |
| I_D | Continuous Drain Current | $T_C = 25^\circ\text{C}$ | | 16 | A |
| | | $T_C = 100^\circ\text{C}$ | | 10.1 | |
| I_{DM} | Pulsed Drain current (Note 1) | | | 48 | |
| I_{AR} | Avalanche current (Note 1) | | | 5.3 | |
| E_{AR} | Repetitive avalanche energy (Note 1) | $I_{AR} = 16\text{A}$, $R_{GS} = 50\Omega$, $V_{GS} = 10\text{V}$ | | 1.34 | mJ |
| E_{AS} | Single pulse avalanche energy (Note 2) | $I_{AS} = 5.3\text{A}$, $L = 7.1\text{mH}$ | | 355 | |
| dv/dt | MOSFET dv/dt ruggedness (Note 3) | | | 100 | V/ns |
| | Peak diode recovery dv/dt (Note 3) | | | 20 | |
| P_D | Total power dissipation | $T_C = 25^\circ\text{C}$ | TO-220AB/TO-3PB | 134.4 | W |
| | | | TO-220F | 35.7 | |
| | Derate above 25°C | $T_C = 25^\circ\text{C}$ | TO-220AB/TO-3PB | 1.08 | W/ $^\circ\text{C}$ |
| | | | TO-220F | 0.29 | |
| T_J | Operation junction temperature | | | -55 to 150 | $^\circ\text{C}$ |
| T_{STG} | Storage temperature | | | -55 to 150 | |
| T_L | Maximum soldering temperature, for 10 seconds | 1.6mm from case | | 300 | |
| | Mounting torque, #6-32 or M3 screw | | | 10 (1.1) | lbf·in (N·m) |

Note: 1. Repetitive rating: pulse width limited by junction temperature..

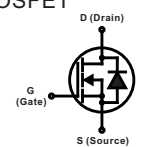
2. $I_{AS} = 5.3\text{A}$, $V_{DD} = 50\text{V}$, $R_{GS} = 25\Omega$, starting $T_J = 25^\circ\text{C}$.

3. $I_{SD} \leq 16\text{A}$, $di/dt \leq 200\text{A}/\mu\text{s}$, $V_{DD} = 380\text{V}$, starting $T_J = 25^\circ\text{C}$.

| THERMAL RESISTANCE | | | | | | |
|--------------------|---|------------------|------|------|------|---------------------------|
| SYMBOL | PARAMETER | Min. | Typ. | Max. | UNIT | |
| $R_{th(j-c)}$ | Thermal resistance, junction to case | TO-220AB/TO-3PB | | | 0.93 | $^\circ\text{C}/\text{W}$ |
| | | TO-220F | | | 3.5 | |
| $R_{th(c-s)}$ | Thermal resistance, case to heatsink | TO-3PB | | 0.24 | | |
| | | TO-220AB/TO-220F | | 0.5 | | |
| $R_{th(j-a)}$ | Thermal resistance, junction to ambient | TO-3PB | | | 40 | |
| | | TO-220AB/TO220F | | | 62.5 | |

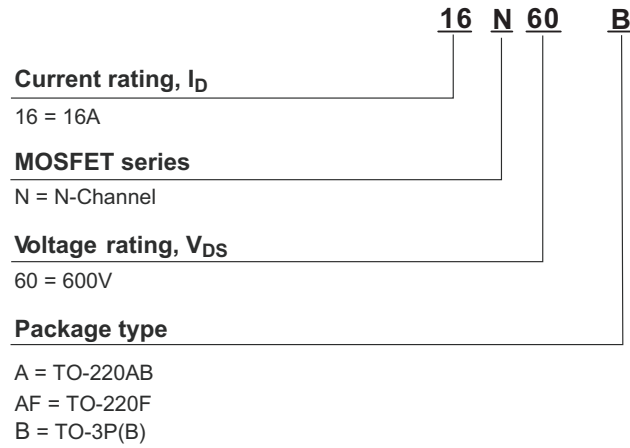
Nell High Power Products

| ELECTRICAL CHARACTERISTICS (T _C = 25°C unless otherwise specified) | | | | | | |
|---|--|---|------------------|-------|-------|------|
| SYMBOL | PARAMETER | TEST CONDITIONS | Min. | Typ. | Max. | UNIT |
| ⊙ OFF CHARACTERISTICS | | | | | | |
| V _{(BR)DSS} | Drain to source breakdown voltage | I _D = 1mA, V _{GS} = 0V | 600 | | | V |
| ΔV _{(BR)DSS} /ΔT _J | Breakdown voltage temperature coefficient | I _D = 1mA, V _{DS} = V _{GS} | | 0.73 | | V/°C |
| I _{DSS} | Drain to source leakage current | V _{DS} = 600V, V _{GS} = 0V T _C = 25°C | | | 10 | μA |
| | | V _{DS} = 480V, V _{GS} = 0V T _C = 125°C | | | 100 | |
| I _{GSS} | Gate to source forward leakage current | V _{GS} = 30V, V _{DS} = 0V | | | 100 | nA |
| | Gate to source reverse leakage current | V _{GS} = -30V, V _{DS} = 0V | | | -100 | |
| ⊙ ON CHARACTERISTICS | | | | | | |
| R _{DS(ON)} | Static drain to source on-state resistance | V _{GS} = 10V, I _D = 8A | | 0.17 | 0.199 | Ω |
| V _{GS(TH)} | Gate threshold voltage | V _{GS} = V _{DS} , I _D = 250μA | 2 | | 4 | V |
| g _{fs} | Forward transconductance | V _{DS} = 40V I _D = 8A | TO-3PB | | 20 | S |
| | | | TO-220AB/TO-220F | | 13 | |
| ⊙ DYNAMIC CHARACTERISTICS | | | | | | |
| C _{ISS} | Input capacitance | V _{DS} = 100V, V _{GS} = 0V, f = 1MHz | | 1630 | 2170 | pF |
| C _{OSS} | Output capacitance | | 70 | 95 | | |
| C _{RSS} | Reverse transfer capacitance | | 5 | 10 | | |
| C _{OSS} | Output capacitance | V _{DS} = 380V, V _{GS} = 0V, f = 1MHz | | 40 | 60 | |
| C _{OSSeff.} | Effective output capacitance | V _{DS} = 0 to 480V, V _{GS} = 0V | | 176 | | |
| ⊙ SWITCHING CHARACTERISTICS | | | | | | |
| t _{d(ON)} | Turn-on delay time | V _{DD} = 380V, V _{GS} = 10V I _D = 8A, R _{GS} = 4.7Ω (Note 1,2) | | 15.8 | 41.6 | ns |
| t _r | Rise time | | 15.5 | 41 | | |
| t _{d(OFF)} | Turn-off delay time | | 60.3 | 130.6 | | |
| t _f | Fall time | | 20.2 | 50.4 | | |
| Q _G | Total gate charge | V _{DD} = 380V, V _{GS} = 10V I _D = 8A, (Note 1,2) | | 40.2 | 52.3 | nC |
| Q _{GS} | Gate to source charge | | 6.7 | | | |
| Q _{GD} | Gate to drain charge (Miller charge) | | 12.9 | | | |
| ESR | Equivalent series resistance (G-S) | Drain open | | 2.9 | | Ω |

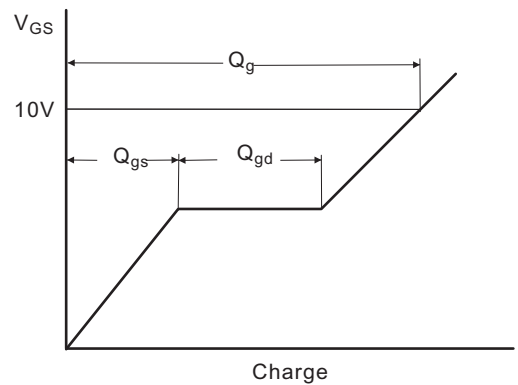
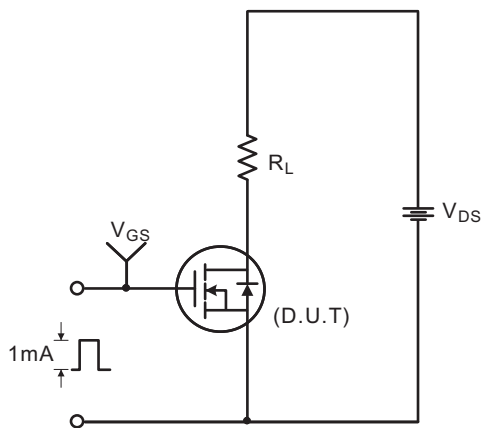
| SOURCE TO DRAIN DIODE RATINGS AND CHARACTERISTICS (T _C = 25°C unless otherwise specified) | | | | | | |
|--|------------------------------------|---|------|------|------|------|
| SYMBOL | PARAMETER | TEST CONDITIONS | Min. | Typ. | Max. | UNIT |
| V _{SD} | Diode forward voltage | I _{SD} = 8A, V _{GS} = 0V | | | 1.2 | V |
| I _S (I _{SD}) | Continuous source to drain current | Integral reverse P-N junction diode in the MOSFET  | | | 16 | A |
| I _{SM} | Pulsed source current | | 48 | | | |
| t _{rr} | Reverse recovery time | I _{SD} = 8A, V _{GS} = 0V, dI _F /dt = 100A/μs | | 319 | | ns |
| Q _{rr} | Reverse recovery charge | | | 4.4 | | μC |

Note: 1. Pulse test: Pulse width ≤ 300μs, duty cycle ≤ 2%.
2. Essentially independent of operating temperature.

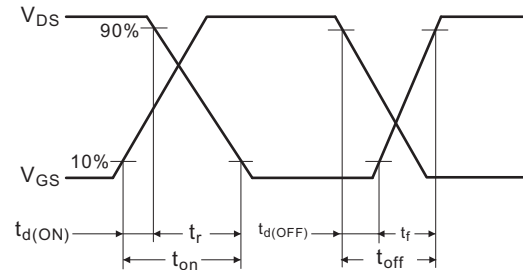
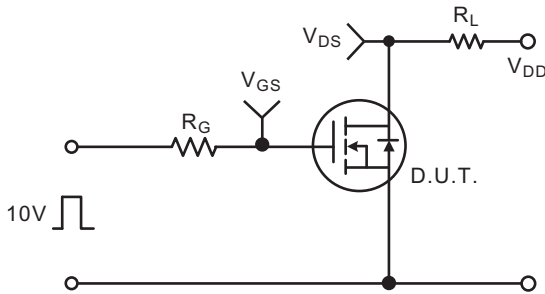
ORDERING INFORMATION SCHEME



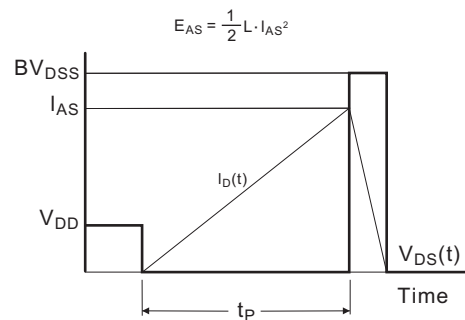
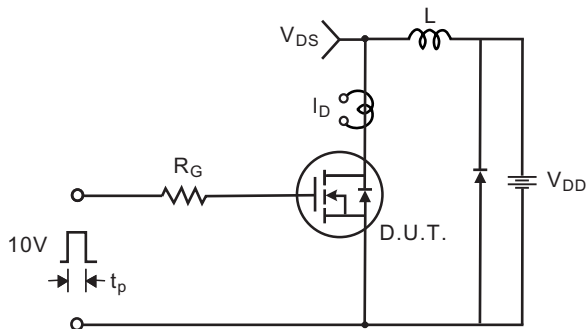
■ Gate charge test circuit & waveform



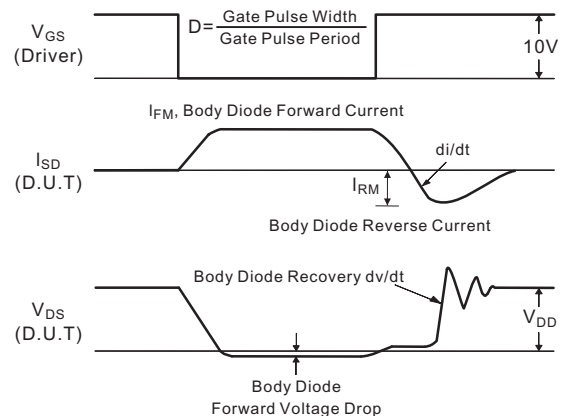
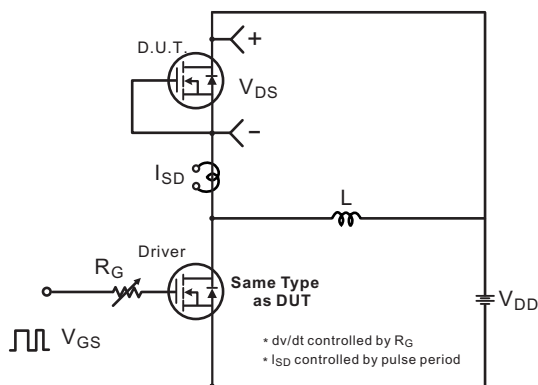
RESISTIVE SWITCHING TEST CIRCUIT & WAVEFORM



UNCLAMPED INDUCTIVE SWITCHING TEST CIRCUIT & WAVEFORMS



PEAK DIODE RECOVERY dv/dt TEST CIRCUIT & WAVEFORMS



■ TYPICAL CHARACTERISTICS

Fig.1 On-State characteristics

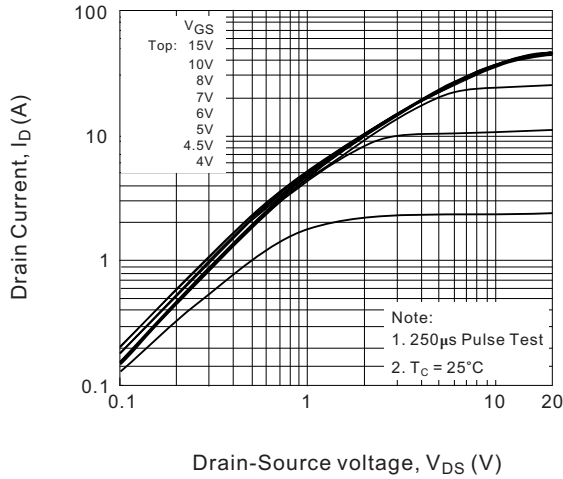


Fig.2 Transfer characteristics

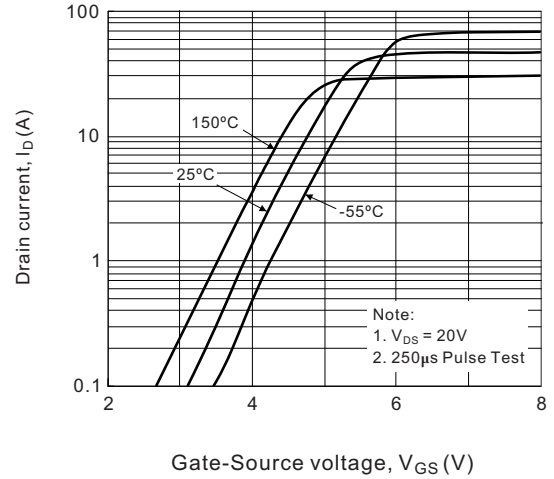


Fig.3 On-Resistance variation vs. drain current and gate voltage

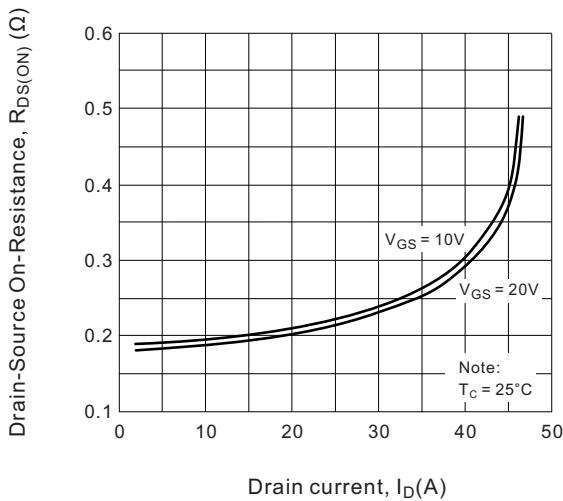


Fig.4 Body diode forward voltage variation vs. Source current and Temperature

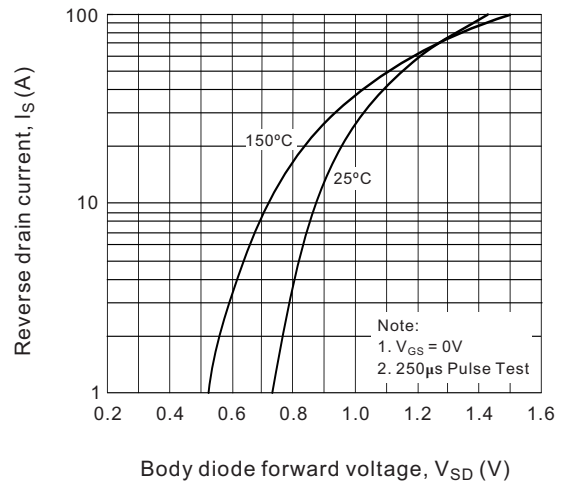


Fig.5 Capacitance characteristics

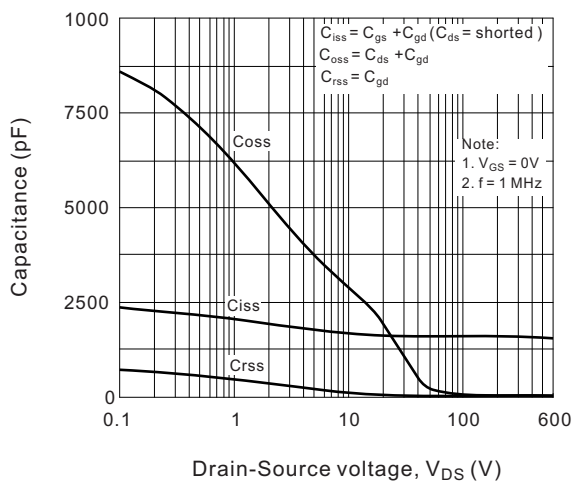


Fig.6 Gate charge characteristics

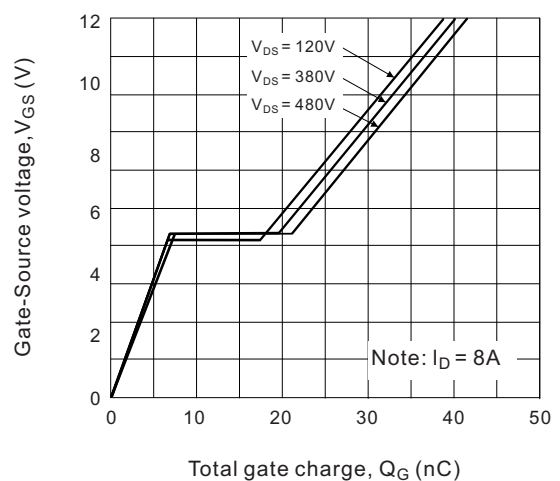


Fig.7 Breakdown voltage variation vs. Temperature

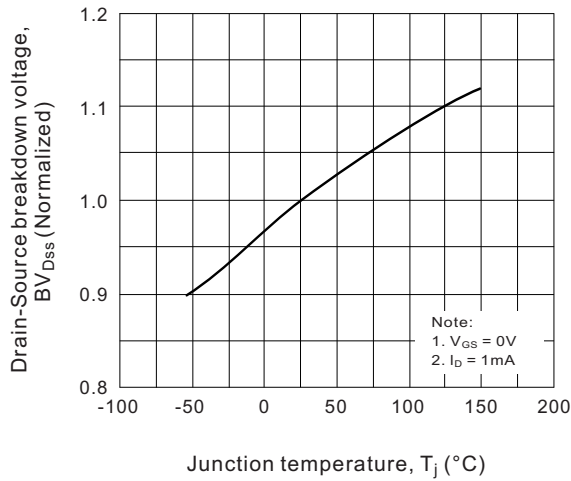


Fig.8 On-Resistance variation vs. Temperature

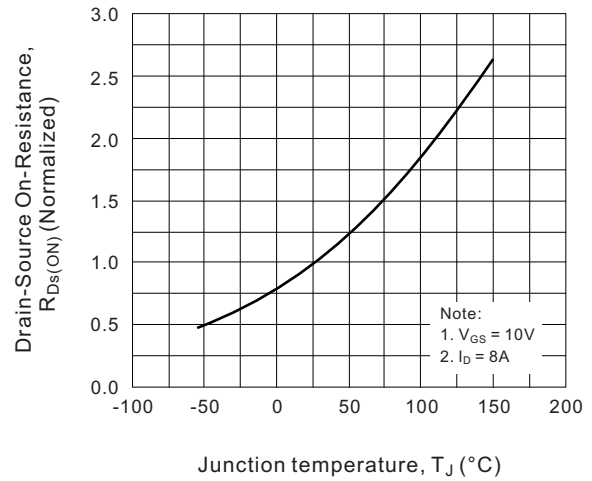


Fig.9 Maximum safe operating area (16N60A/16N60B)

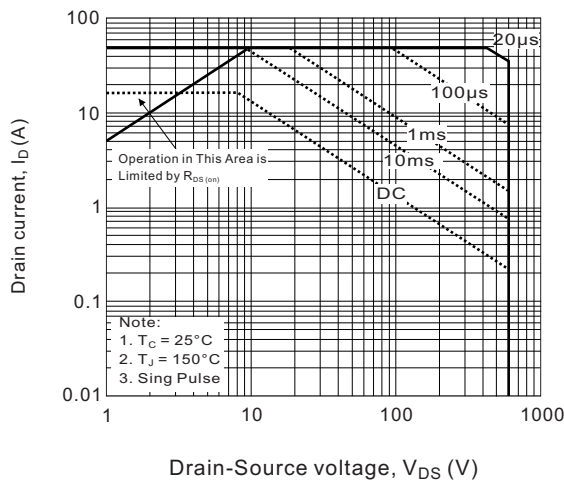


Fig.10 Maximum safe operating area (16N60AF)

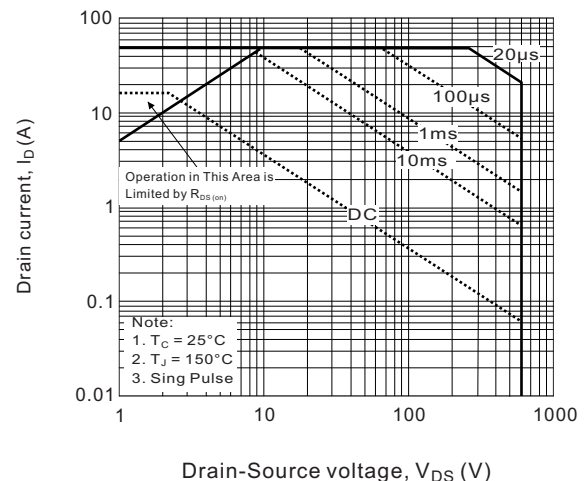


Fig.11 Maximum drain current vs. Case temperature

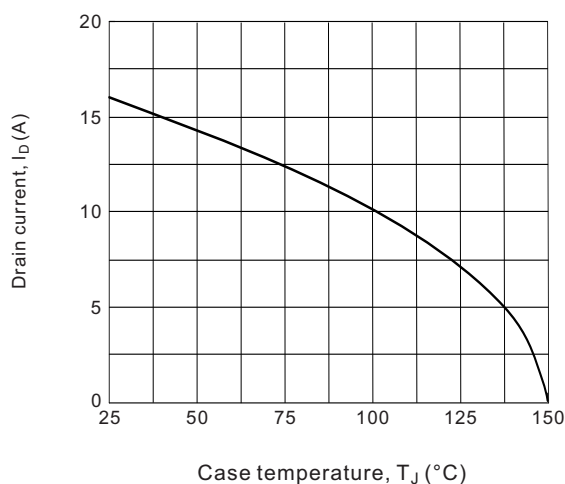


Fig.11-1 Transient thermal response curve for 16N60B & 16N60A

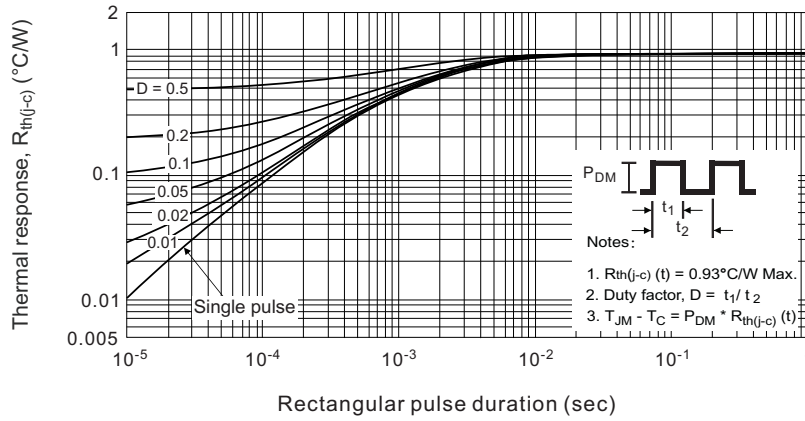
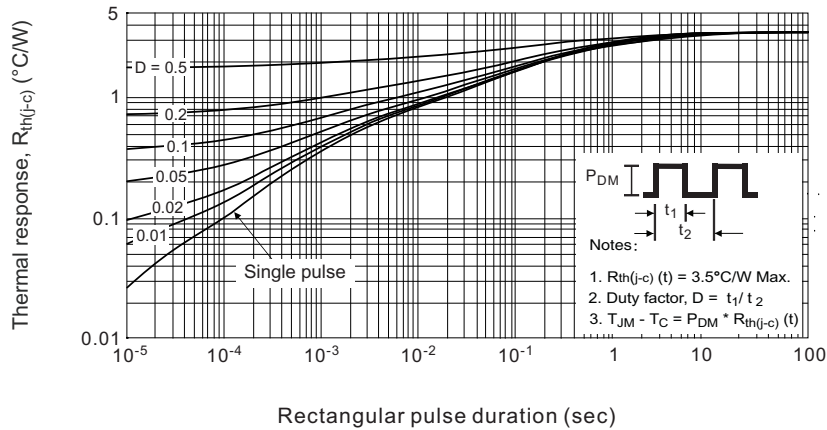
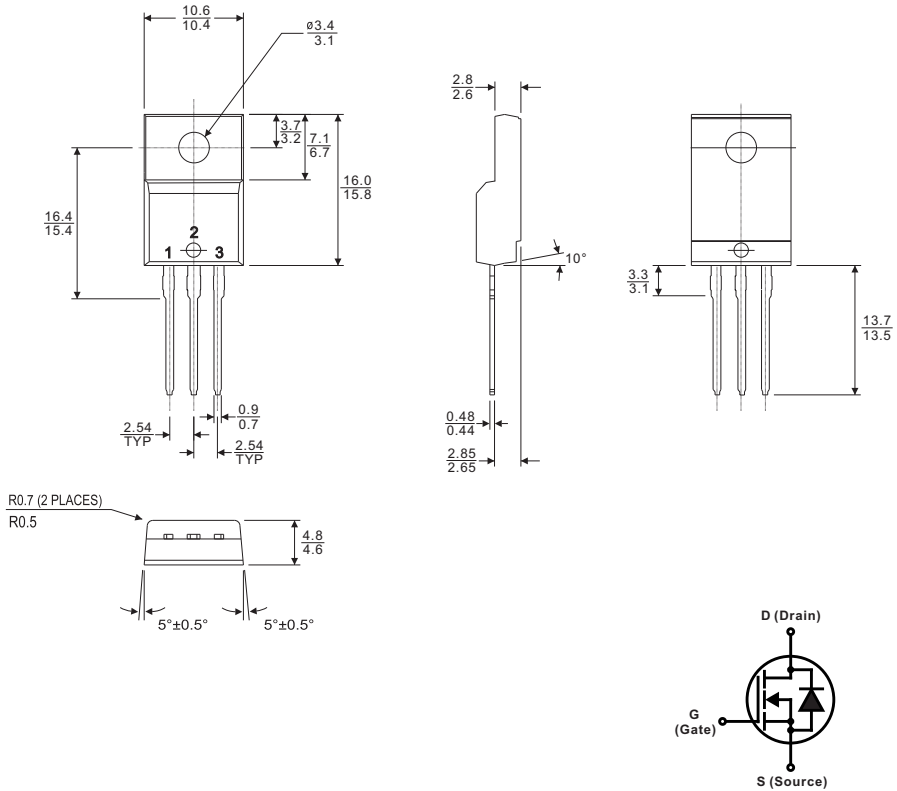


Fig.11-2 Transient thermal response curve for 16N60AF



Case Style

TO-220F



All dimensions in millimeters