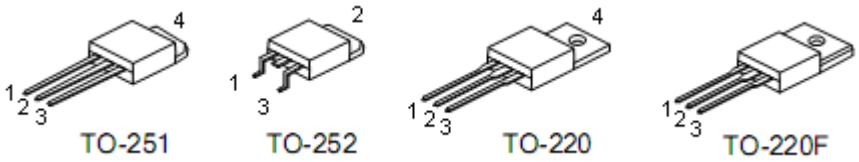
## 1. Description

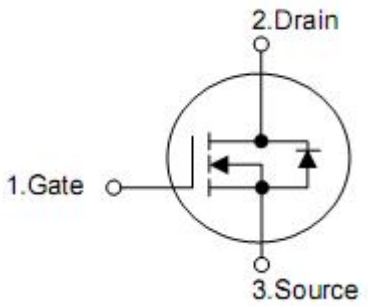
The KIA4N60H N-Channel enhancement mode silicon gate power MOSFET is designed for high voltage, high speed power switching applications such as switching regulators, switching converters, solenoid, motor drivers, relay drivers.

## 2. Features

- $R_{DS(ON)}$ =2.3Ω@ $V_{GS}$=10V
- Low gate charge (typical 13.5nC)
- High ruggedness
- Fast switching capability
- Avalanche energy specified
- Improved dv/dt capability

## 3. Pin configuration




| Pin | Function |
|---|---|
| 1 | Gate |
| 2 | Drain |
| 3 | Source |
| 4 | Drain |

## 4. Absolute maximum ratings

($T_C$= 25ºC , unless otherwise specified)

| Parameter | | Symbol | Rating | | | | Units |
|---|---|---|---|---|---|---|---|
| | | | TO220 | TO220F | TO251 | TO252 | |
| Drain-source voltage | | $V_{DSS}$ | 600 | | | | V |
| Gate-source voltage | | $V_{GSS}$ | ±30 | | | | V |
| Drain current continuous | $T_C$=25ºC | $I_D$ | 4.0 | 4.0* | 2.8 | | A |
| | $T_C$=100ºC | | 2.4 | 2.4* | 1.8 | | A |
| Drain current pulsed (note1) | | $I_{DM}$ | 16 | 16* | 12 | | A |
| Avalanche energy | Repetitive (note1) | $E_{AR}$ | 9.3 | | 5.5 | | mJ |
| | Single pulse (note2) | $E_{AS}$ | 180 | | | | mJ |
| Peak diode recovery dv/dt (note3) | | dv/dt | 4.5 | | | | V/ns |
| Total power dissipation | $T_C$=25ºC | $P_D$ | 93 | 31 | 55 | | W |
| | Derate above 25ºC | | 0.74 | 0.24 | 0.44 | | W/ºC |
| Junction temperature | | $T_J$ | +150 | | | | ºC |
| Storage temperature | | $T_{STG}$ | -55~+150 | | | | ºC |

*Drain current limited by maximum junction temperature.

## 5. Thermal characteristics

| Parameter | Symbol | Rating | | | | Unit |
|---|---|---|---|---|---|---|
| | | TO220 | TO220F | TO251 | TO252 | |
| Thermal resistance,junction-ambient | $R_{thJA}$ | 62.5 | | 110 | | ºC/W |
| Thermal resistance,case-to-sink typ | $R_{thJS}$ | 0.5 | -- | 50 | | |
| Thermal resistance junction-case | $R_{thJC}$ | 1.35 | 4.05 | 2.25 | | |

## 6. Electrical characteristics

($T_J$=25°C,unless otherwise notes)

| Parameter | | Symbol | Conditions | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|---|
| Off characteristics | | | | | | | |
| Drain-source breakdown voltage | | $BV_{DSS}$ | $V_{GS}$=0V,$I_D$=250μA | 600 | - | - | V |
| Zero gate voltage drain current | | $I_{DSS}$ | $V_{DS}$=600V ,$V_{GS}$=0V | - | - | 1 | μA |
| | | | $V_{DS}$=480V ,$T_C$=125 ºC | - | - | 10 | μA |
| Gate-body leakage current | Forward | $I_{GSS}$ | $V_{GS}$=30V,$V_{DS}$=0V | - | - | 100 | nA |
| | Reverse | | $V_{GS}$=-30V,$V_{DS}$=0V | - | - | -100 | nA |
| Breakdown voltage temperature coefficient | | $\triangle Bv_{DSS}/\triangle T_J$ | $I_D$=250μA | - | 0.6 | - | V/ºC |
| On characteristics | | | | | | | |
| Gate threshold voltage | | $V_{GS(TH)}$ | $V_{DS}$=$V_{GS}$, $I_D$=250μA | 2.0 | - | 4.0 | V |
| Static drain-source on-resistance | | $R_{DS(ON)}$ | $V_{DS}$=10V, $I_D$=2.0A(TO220,TO220F) $I_D$=1.4A(TO251,TO252) | - | 2.3 | 2.7 | Ω |
| Dynamic characteristics | | | | | | | |
| Input capacitance | | $C_{ISS}$ | $V_{DS}$=25V,$V_{GS}$=0V, f=1MHz | - | 500 | - | pF |
| Output capacitance | | $C_{OSS}$ | | - | 45 | - | pF |
| Reverse transfer capacitance | | $C_{RSS}$ | | - | 4.5 | - | pF |
| Switching characteristics | | | | | | | |
| Turn-on delay time | | $t_{D(ON)}$ | $V_{DD}$=300V, $I_D$=4.0A(TO220,TO220F) $I_D$=2.8A(TO251,TO252) $R_G$=25Ω (note4,5) | - | 10 | - | ns |
| Rise time | | $t_R$ | | - | 32 | - | ns |
| Turn-off delay time | | $t_{D(OFF)}$ | | - | 32 | - | ns |
| Fall time | | $t_F$ | | - | 40 | - | ns |
| Total gate charge | | $Q_G$ | $V_{DS}$=480V, $I_D$=4.0A(TO220,TO220F) $I_D$=2.8A(TO251,TO252) $V_{GS}$=10V (note4,5) | - | 13.5 | - | nC |
| Gate-source charge | | $Q_{GS}$ | | - | 2.2 | - | nC |
| Gate-drain charge | | $Q_{GD}$ | | - | 5.4 | - | nC |
| Drain-source diode characteristics | | | | | | | |
| Drain-source diode forward voltage | | $V_{SD}$ | $V_{GS}$=0V, $I_{SD}$=4.0A(TO220,TO220F) $I_{SD}$=2.8A(TO251,TO252) | - | - | 1.4 | V |
| Continuous drain-source current | | $I_{SD}$ | TO220,TO220F | - | - | 4.0 | A |
| | | | TO251,TO252 | - | - | 2.8 | |
| Pulsed drain-source current | | $I_{SM}$ | TO220,TO220F | - | - | 16.0 | A |
| | | | TO251,TO252 | - | - | 12 | |
| Reverse recovery time | | $t_{RR}$ | $I_{SD}$=4.0A(TO220,TO220F) $I_{SD}$=2.8A(TO251,TO252) $dI_{SD}/dt$=100A/μs (note 4) | - | 250 | - | ns |
| Reverse recovery charge | | $Q_{RR}$ | | - | 1.8 | - | μC |

Notes: 1. Repetitive rating : pulse width limited by maximum junction temperature

2. L=20mH, $I_{AS}$=4.0A, $V_{DD}$=50V, $R_G$=25Ω, starting $T_J$=25ºC

3. $I_{SD}$≤4.0A,di/dt≤200A/μs , $V_{DD}$≤$BV_{DSS}$, starting $T_J$=25 ºC

4. Pulse test : pulse width≤300μs,duty cycle≤2%

5. Essentially independent of operating temperature

## 7. Test circuits and waveforms

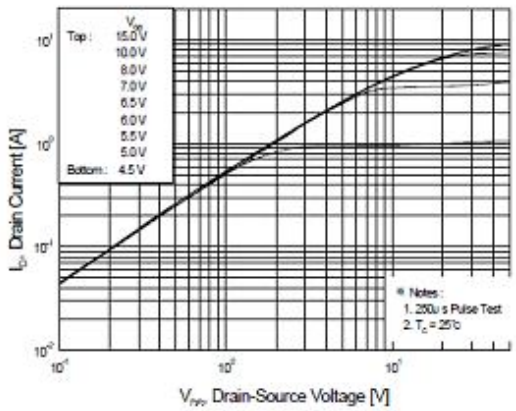



**Figure 1. On-Region Characteristics**

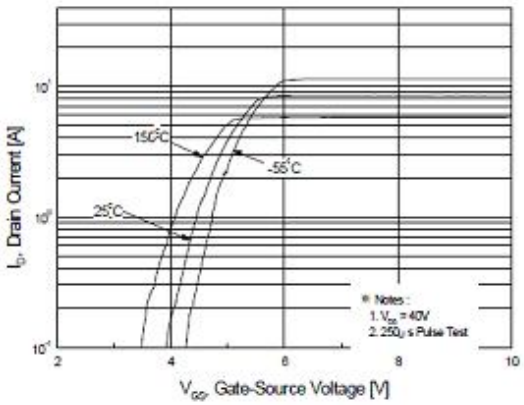



**Figure 2. Transfer Characteristics**

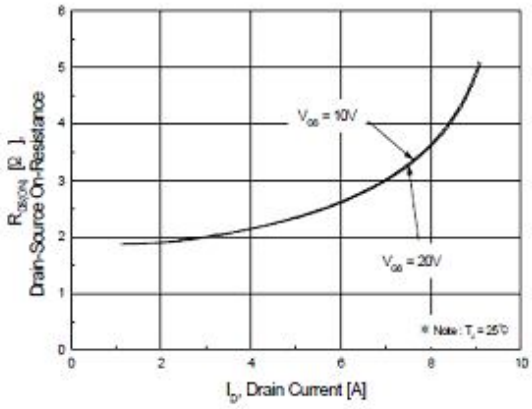



**Figure 3. On-Resistance Variation vs Drain Current and Gate Voltage**

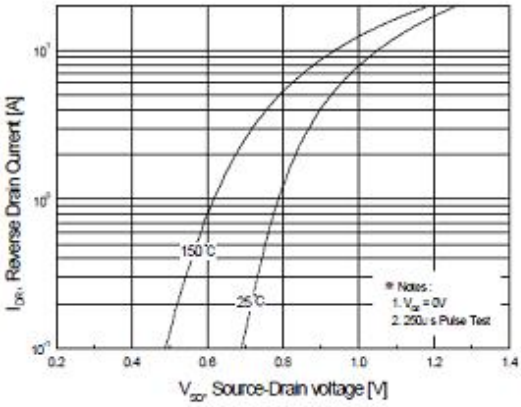



**Figure 4. Body Diode Forward Voltage Variation with Source Current and Temperature**

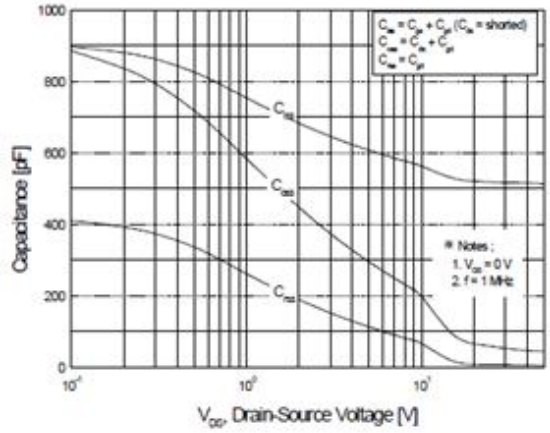



**Figure 5. Capacitance Characteristics**

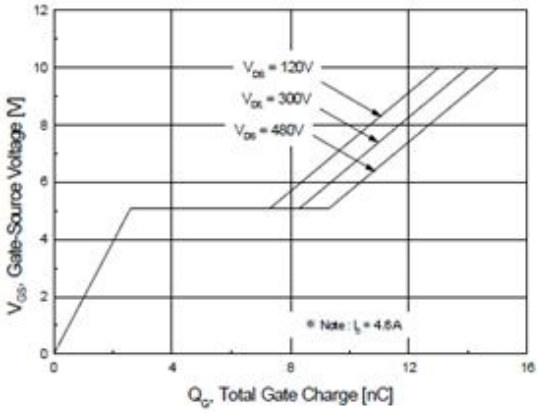



**Figure 6. Gate Charge Characteristics**

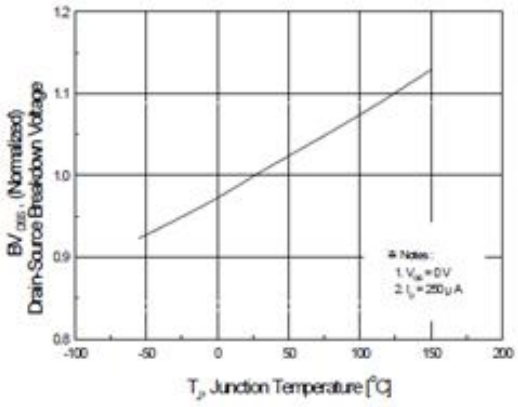



Figure 7. Breakdown Voltage Variation vs Temperature

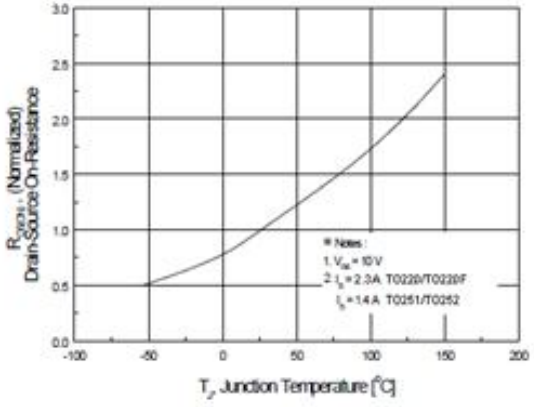



Figure 8. On-Resistance Variation vs Temperature

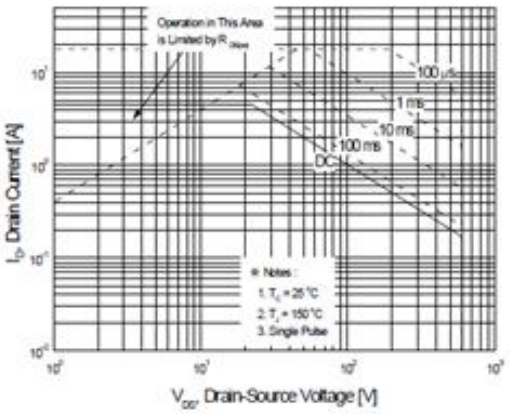



Figure 9-1. Maximum Safe Operating Area for TO220

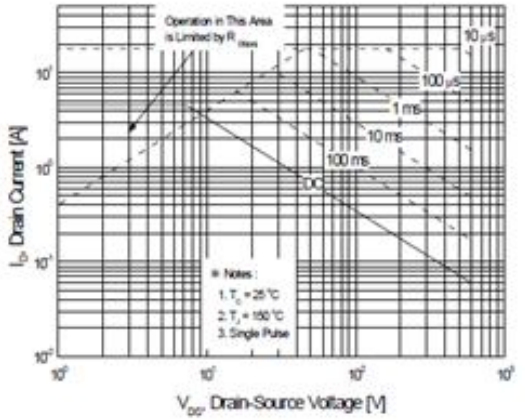



Figure 9-2. Maximum Safe Operating Area for TO220F

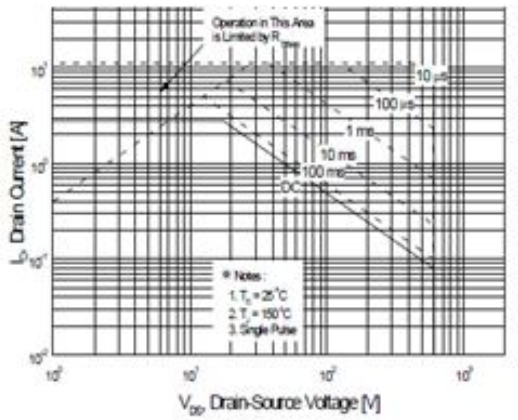



Figure 9-3. Maximum Safe Operating Area for TO251, TO252

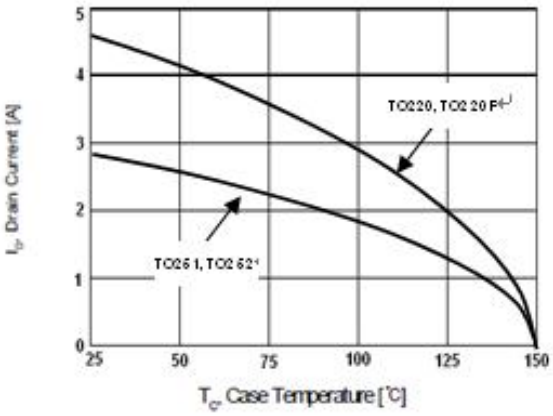



Figure 10. Maximum Drain Current vs Case Temperature

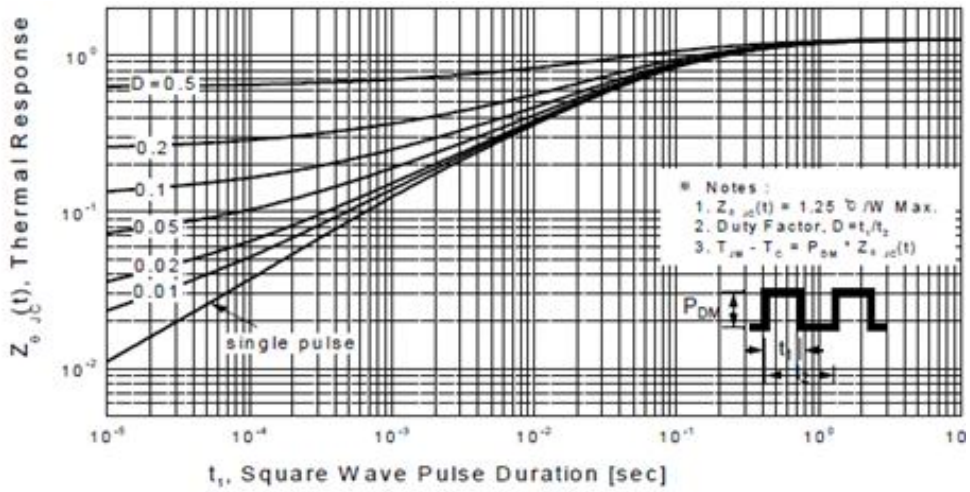



**Figure 11-1. Transient Thermal Response Curve TO220**

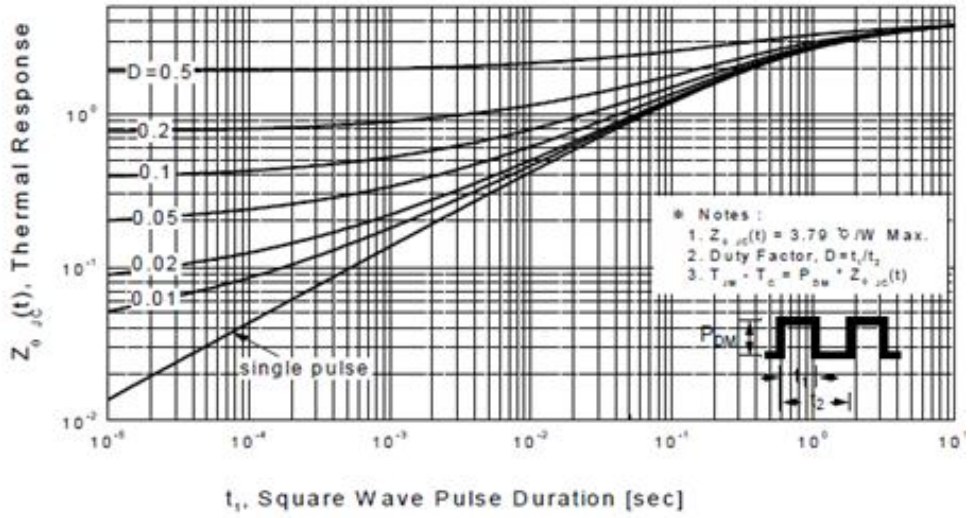



**Figure 11-2. Transient Thermal Response Curve for TO220F**

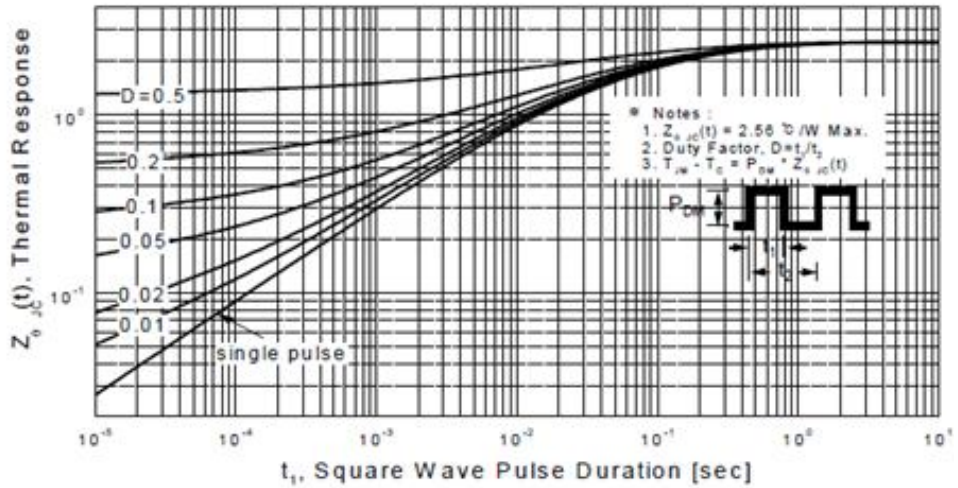



**Figure 11-3. Transient Thermal Response Curve for TO251/ TO252**