KERSEMI ELECTRONIC CO.,LTD.

# KSM12N60NZ / KSMF12N60NZ

## N-Channel UniFET™ II MOSFET
**600 V, 12 A, 650 mΩ**

### Features

- $R_{DS(on)}$ = 530 mΩ (Typ.) @ $V_{GS}$ = 10 V, $I_D$ = 6 A
- Low Gate Charge ( Typ. 26 nC)
- Low $C_{rss}$ ( Typ. 12 pF)
- 100% Avalanche Tested
- Improved dv/dt Capability
- ESD Improved Capability
- RoHS Compliant

### Applications

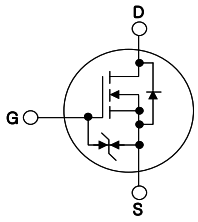
- LCD/LED/PDP TV
- Lighting
- Uninterruptible Power Supply

TO-220

TO-220F

### Description

UniFET™ II MOSFET is Kersemi Semiconductor®'s high voltage MOSFET family based on advanced planar stripe and DMOS technology. This advanced MOSFET family has the smallest on-state resistance among the planar MOSFET, and also provides superior switching performance and higher avalanche energy strength. In addition, internal gate-source ESD diode allows UniFET II MOSFET to withstand over 2kV HBM surge stress. This device family is suitable for switching power converter applications such as power factor correction (PFC), flat panel display (FPD) TV power, ATX and electronic lamp ballasts.




## MOSFET Maximum Ratings $T_C$ = 25°C unless otherwise noted*

| Symbol | Parameter | | KSM12N60NZ | KSMF12N60NZ | Unit |
|---|---|---|---|---|---|
| $V_{DSS}$ | Drain to Source Voltage | | 600 | | V |
| $V_{GSS}$ | Gate to Source Voltage | | ±30 | | V |
| $I_D$ | Drain Current | - Continuous ($T_C$ = 25°C) | 12 | 12* | A |
| | | - Continuous ($T_C$ = 100°C) | 7.2 | 7.2* | |
| $I_{DM}$ | Drain Current | - Pulsed (Note 1) | 48 | 48* | A |
| $E_{AS}$ | Single Pulsed Avalanche Energy | (Note 2) | 565 | | mJ |
| $I_{AR}$ | Avalanche Current | (Note 1) | 12 | | A |
| $E_{AR}$ | Repetitive Avalanche Energy | (Note 1) | 24 | | mJ |
| dv/dt | MOSFET dv/dt Ruggedness | | 20 | | V/ns |
| | Peak Diode Recovery dv/dt | (Note 3) | 10 | | V/ns |
| $P_D$ | Power Dissipation | ($T_C$ = 25°C) | 240 | 39 | W |
| | | - Derate above 25°C | 2.0 | 0.3 | W/°C |
| $T_J$, $T_{STG}$ | Operating and Storage Temperature Range | | -55 to +150 | | °C |
| $T_L$ | Maximum Lead Temperature for Soldering Purpose, 1/8" from Case for 5 Seconds | | 300 | | °C |

*Drain current limited by maximum junction temperature

## Thermal Characteristics

| Symbol | Parameter | KSM12N60NZ | KSMF12N60NZ | Unit |
|---|---|---|---|---|
| $R_{\theta JC}$ | Thermal Resistance, Junction to Case, Max. | 0.52 | 3.2 | °C/W |
| $R_{\theta CS}$ | Thermal Resistance, Case to Sink Typ. | 0.5 | - | |
| $R_{\theta JA}$ | Thermal Resistance, Junction to Ambient, Max. | 62.5 | 62.5 | |

## Package Marking and Ordering Information $T_C = 25^oC$ unless otherwise noted

| Device Marking | Device | Package | Reel Size | Tape Width | Quantity |
|---|---|---|---|---|---|
| KSM12N60NZ | KSM12N60NZ | TO-220 | - | - | 50 |
| KSMF12N60NZ | KSMF12N60NZ | TO-220F | - | - | 50 |

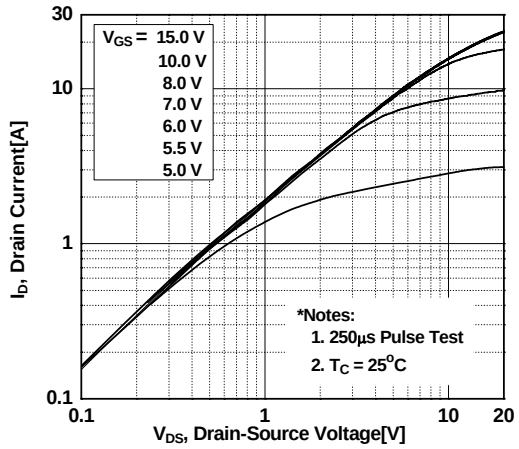
## Electrical Characteristics

| Symbol | Parameter | Test Conditions | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| **Off Characteristics** | | | | | | |
| $BV_{DSS}$ | Drain to Source Breakdown Voltage | $I_D$ = 250μA, $V_{GS}$ = 0V, $T_J = 25^oC$ | 600 | - | - | V |
| $\frac{\Delta BV_{DSS}}{\Delta T_J}$ | Breakdown Voltage Temperature Coefficient | $I_D$ = 250μA, Referenced to $25^oC$ | - | 0.6 | - | $V/^oC$ |
| $I_{DSS}$ | Zero Gate Voltage Drain Current | $V_{DS}$ = 600V, $V_{GS}$ = 0V | - | - | 1 | μA |
| | | $V_{DS}$ = 480V, $T_C = 125^oC$ | - | - | 10 | |
| $I_{GSS}$ | Gate to Body Leakage Current | $V_{GS}$ = ±30V, $V_{DS}$ = 0V | - | - | ±10 | μA |
| **On Characteristics** | | | | | | |
| $V_{GS(th)}$ | Gate Threshold Voltage | $V_{GS} = V_{DS}$, $I_D$ = 250μA | 3 | - | 5 | V |
| $R_{DS(on)}$ | Static Drain to Source On Resistance | $V_{GS}$ = 10V, $I_D$ = 6A | - | 0.53 | 0.65 | Ω |
| $g_{FS}$ | Forward Transconductance | $V_{DS}$ = 20V, $I_D$ = 6A | - | 13.5 | - | S |
| **Dynamic Characteristics** | | | | | | |
| $C_{iss}$ | Input Capacitance | $V_{DS}$ = 25V, $V_{GS}$ = 0V f = 1MHz | - | 1260 | 1676 | pF |
| $C_{oss}$ | Output Capacitance | | - | 150 | 200 | pF |
| $C_{rss}$ | Reverse Transfer Capacitance | | - | 12 | 18 | pF |
| $Q_{g(tot)}$ | Total Gate Charge at 10V | $V_{DS}$ = 480V, $I_D$ = 12A $V_{GS}$ = 10V (Note 4) | - | 26 | 34 | nC |
| $Q_{gs}$ | Gate to Source Gate Charge | | - | 6 | - | nC |
| $Q_{gd}$ | Gate to Drain “Miller” Charge | | - | 10 | - | nC |
| **Switching Characteristics** | | | | | | |
| $t_{d(on)}$ | Turn-On Delay Time | $V_{DD}$ = 300V, $I_D$ = 12A $R_G$ = 25Ω (Note 4) | - | 25 | 60 | ns |
| $t_r$ | Turn-On Rise Time | | - | 50 | 110 | ns |
| $t_{d(off)}$ | Turn-Off Delay Time | | - | 80 | 170 | ns |
| $t_f$ | Turn-Off Fall Time | | - | 60 | 130 | ns |
| **Drain-Source Diode Characteristics** | | | | | | |
| $I_S$ | Maximum Continuous Drain to Source Diode Forward Current | | - | - | 12 | A |
| $I_{SM}$ | Maximum Pulsed Drain to Source Diode Forward Current | | - | - | 48 | A |
| $V_{SD}$ | Drain to Source Diode Forward Voltage | $V_{GS}$ = 0V, $I_{SD}$ = 12A | - | - | 1.4 | V |
| $t_{rr}$ | Reverse Recovery Time | $V_{GS}$ = 0V, $I_{SD}$ = 12A $dI_F/dt$ = 100A/μs | - | 350 | - | ns |
| $Q_{rr}$ | Reverse Recovery Charge | | - | 2.2 | - | μC |

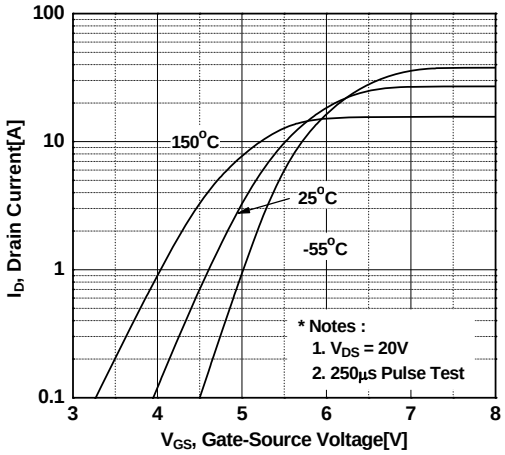
**Notes:**
1: Repetitive Rating: Pulse width limited by maximum junction temperature
2: L =7.85mH, $I_{AS}$ = 12A, $V_{DD}$ = 50V, $R_G$ = 25Ω, Starting $T_J = 25^oC$
3: $I_{SD} \le 12A$, $di/dt \le 200A/\mu s$, $V_{DD} \le BV_{DSS}$, Starting $T_J = 25^oC$
4: Essentially Independent of Operating Temperature Typical Characteristics

## Typical Performance Characteristics

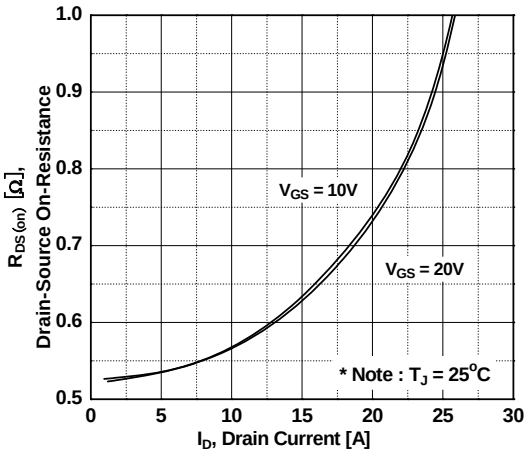
### Figure 1. On-Region Characteristics



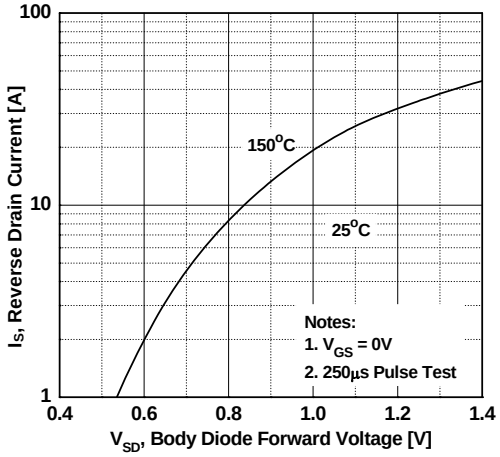

### Figure 2. Transfer Characteristics



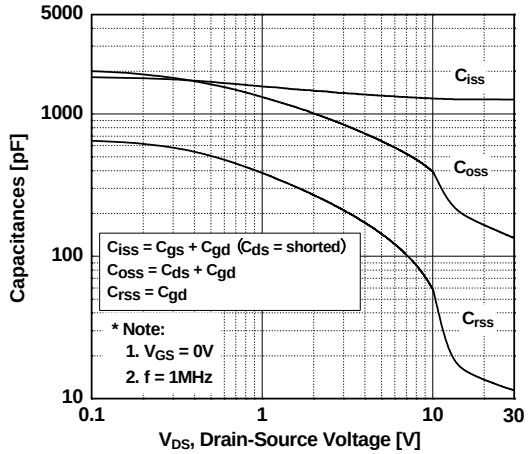

### Figure 3. On-Resistance Variation vs. Drain Current and Gate Voltage



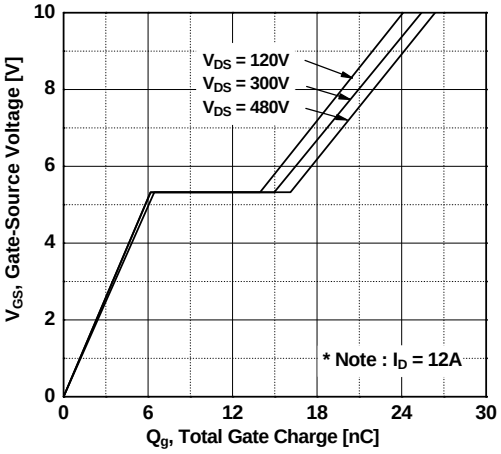

### Figure 4. Body Diode Forward Voltage Variation vs. Source Current and Temperature




### Figure 5. Capacitance Characteristics




### Figure 6. Gate Charge Characteristics



## Typical Performance Characteristics (Continued)

**Figure 7. Breakdown Voltage Variation vs. Temperature**

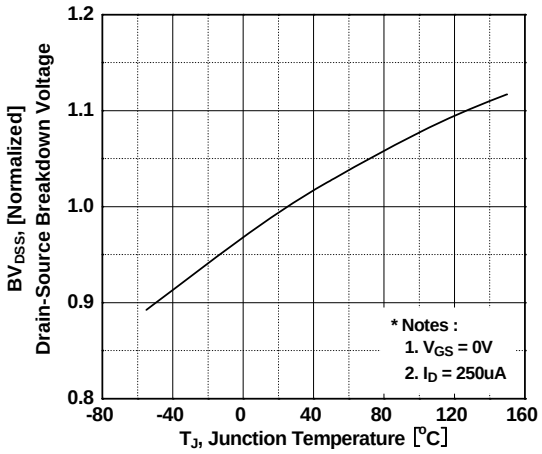



**Figure 8. On-Resistance Variation vs Temperature**

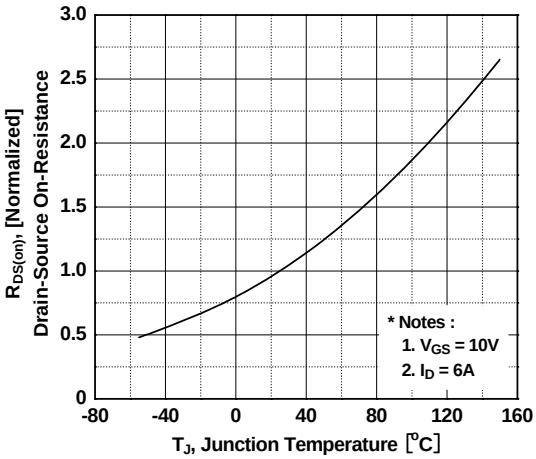



**Figure 9. Maximum Safe Operating Area -FDPF12N60NZ**

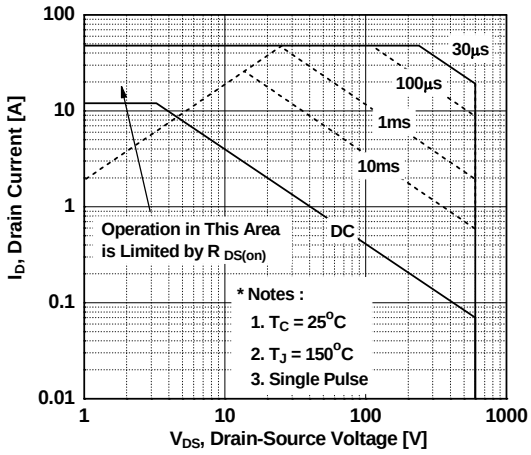



**Figure 10. Maximum Safe Operating Area -FDP12N60NZ**

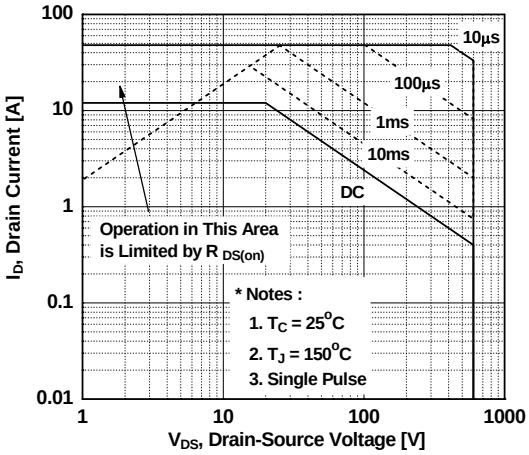



**Figure 11. Maximum Drain Current vs Case Temperature**

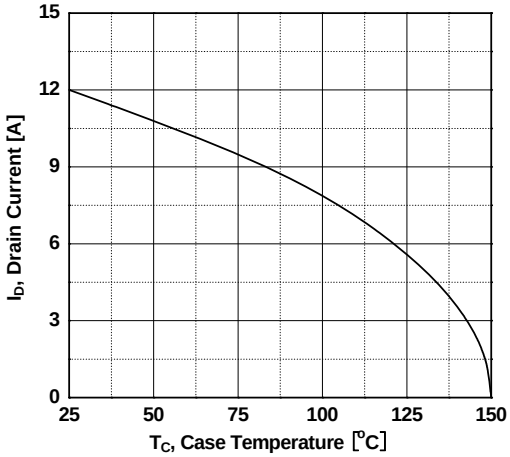


**Figure 12. Transient Thermal Response Curve**

**-FDPF12N60NZ**

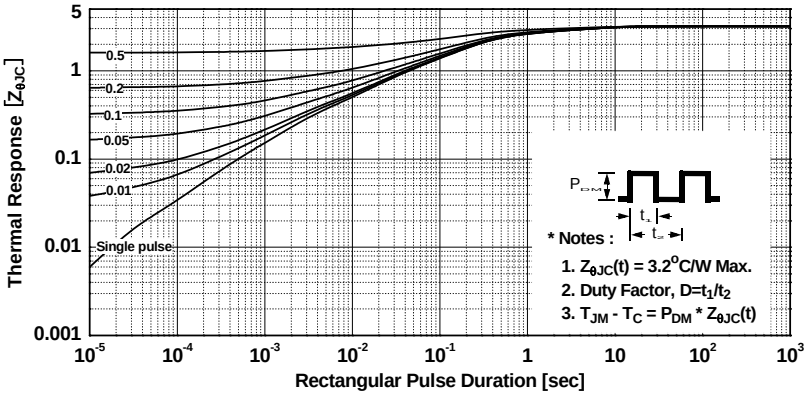
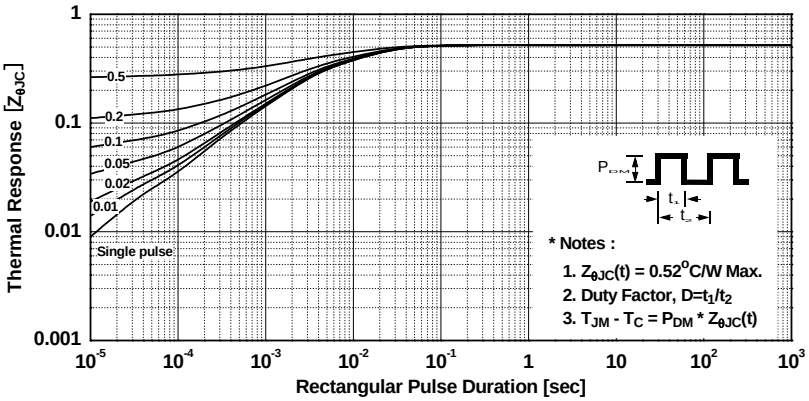
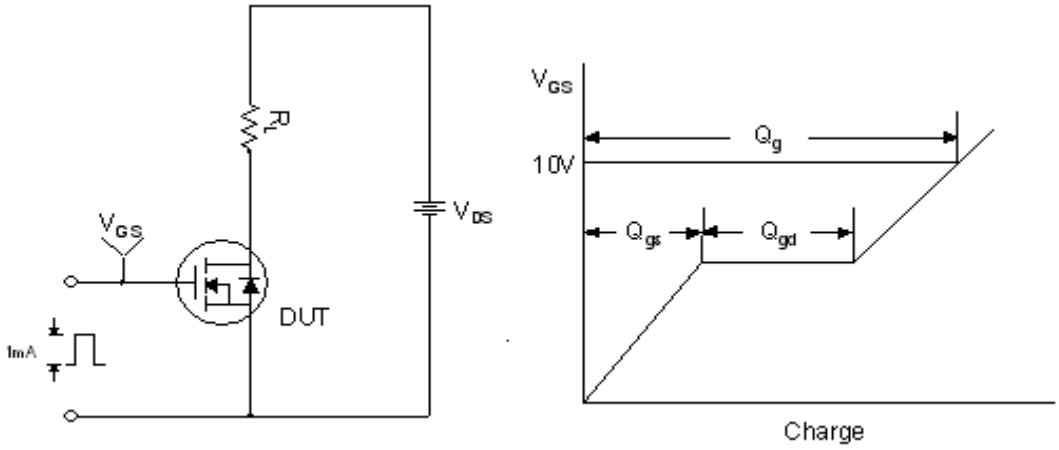



**Figure 13. Transient Thermal Response Curve**

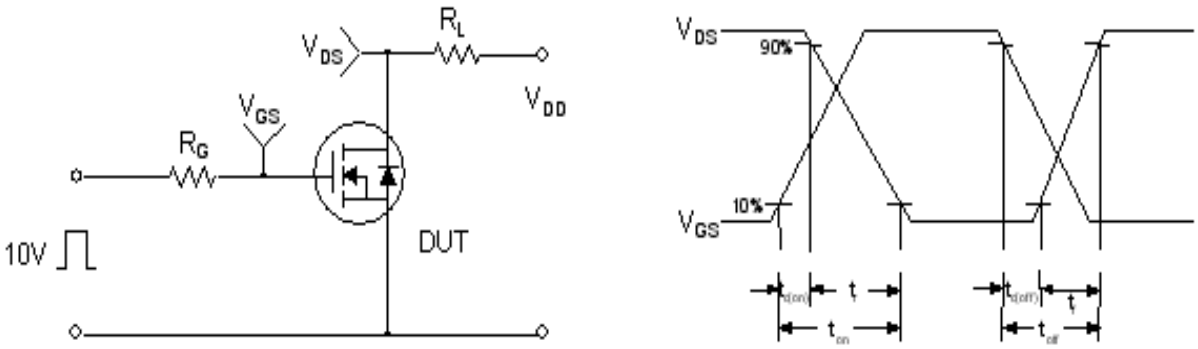
**-FDP12N60NZ**



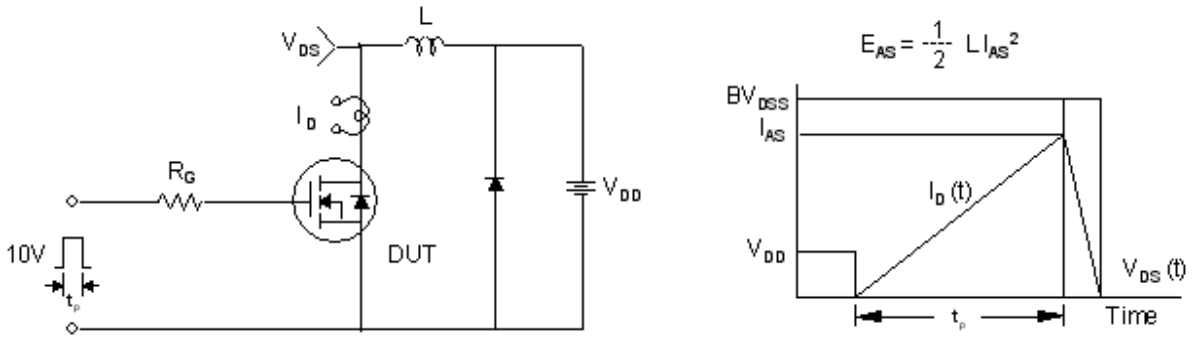
**Gate Charge Test Circuit & Waveform**




**Resistive Switching Test Circuit & Waveforms**




**Unclamped Inductive Switching Test Circuit & Waveforms**



**Peak Diode Recovery dv/dt Test Circuit & Waveforms**