



September, 2013

SJ-FET

TSP11N60S/TSF11N60S /TSB11N60S 600V N-Channel MOSFET

Description

SJ-FET is new generation of high voltage MOSFET family that is utilizing an advanced charge balance mechanism for outstanding low on-resistance and lower gate charge performance.

This advanced technology has been tailored to minimize conduction loss, provide superior switching performance, and withstand extreme dv/dt rate and higher avalanche energy. SJ-FET is suitable for various AC/DC power conversion inswitching mode operation for higher efficiency.

Features

- 650V @T_J = 150 °C
- Typ. RDS(on) = 0.38 Ω
- Ultra Low Gate Charge (typ. Q_g = 35nC)
- 100% avalanche tested
- Rohs Compliant



Absolute Maximum Ratings

| Symbol | Parameter | TSB11N60S | TSP11N60S | TSF11N60S | Unit |
|-----------------------------------|---|-------------|------------|-------------|-----------|
| V _{DSS} | Drain-Source Voltage | 600 | | | V |
| I _D | Drain Current -Continuous (TC = 25°C) -Continuous (TC = 100°C) | 11* 8.5* | 11 8.5 | 11* 8.5* | A |
| I _{DM} | Drain Current - Pulsed (Note 1) | 40* | 40 | 40* | A |
| V _{GSS} | Gate-Source voltage | ±30 | | | V |
| E _{AS} | Single Pulsed Avalanche Energy (Note 2) | 120 | | | mJ |
| I _{AR} | Avalanche Current (Note 1) | 2 | | | A |
| E _{AR} | Repetitive Avalanche Energy (Note 1) | 60 | | | mJ |
| dv/dt | Peak Diode Recovery dv/dt (Note 3) | 4.5 | | | V/ns |
| P _D | Power Dissipation (TC = 25°C) -Derate above 25°C | 83 1.5 | 83 1.67 | 35 0.3 | W 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 | TSB11N60S | TSP11N60S | TSF11N60S | Unit |
|------------------|---|-----------|-----------|-----------|------|
| R _{θJC} | Thermal Resistance, Junction-to-Case | 1.5 | 0.6 | 3.6 | °C/W |
| R _{θCS} | Thermal Resistance, Case-to-Sink Typ. | 0.5 | -- | -- | °C/W |
| R _{θJA} | Thermal Resistance, Junction-to-Ambient | 75 | 62 | 62 | °C/W |

TSP11N60S / TSF11N60S/TSB11N60S 600V N-Channel MOSFET

Electrical Characteristics TC = 25 °C unless otherwise noted

| Symbol | Parameter | Conditions | Min | Typ | Max | Unit |
|---|---|---|-----|------|---------|----------|
| Off Characteristics | | | | | | |
| BV _{DSS} | Drain-Source Breakdown Voltage | V _{GS} = 0V, I _D = 250μA, T _J = 25°C | 600 | -- | -- | V |
| | | V _{GS} = 0V, I _D = 250μA, T _J = 150°C | -- | 650 | -- | V |
| ΔBV _{DSS} / ΔT _J | Breakdown Voltage Temperature Coefficient | I _D = 250μA, Referenced to 25°C | -- | 0.6 | -- | V/°C |
| ID _{SS} | Zero Gate Voltage Drain Current | V _{DS} = 600V, V _{GS} = 0V V _{DS} = 480V, TC = 125°C | -- | -- | 1 10 | μA μA |
| IG _{TSF} | Gate-Body Leakage Current, Forward | V _{GS} = 30V, V _{DS} = 0V | -- | -- | 100 | nA |
| IG _{SSR} | Gate-Body Leakage Current, Reverse | V _{GS} = -30V, V _{DS} = 0V | -- | -- | -100 | nA |
| On Characteristics | | | | | | |
| V _{GS(th)} | Gate Threshold Voltage | V _{DS} = V _{GS} , I _D = 250μA | 2.5 | -- | 4.5 | V |
| R _{DS(on)} | Static Drain-Source On-Resistance | V _{GS} = 10V, I _D = 5A | -- | 0.38 | 0.43 | Ω |
| g _{FS} | Forward Transconductance | V _{DS} = 40V, I _D = 5A (Note 4) | -- | 16 | -- | S |
| R _g | Gate Resistance | F=1MHz, open drain | -- | 4.5 | -- | Ω |
| Dynamic Characteristics | | | | | | |
| C _{iss} | Input Capacitance | V _{DS} = 25V, V _{GS} = 0V, f = 1.0MHz | -- | 600 | -- | pF |
| C _{oss} | Output Capacitance | | -- | 120 | -- | pF |
| C _{rss} | Reverse Transfer Capacitance | | -- | 55 | -- | pF |
| Switching Characteristics | | | | | | |
| t _{d(on)} | Turn-On Delay Time | V _{DD} = 400V, I _D = 5A R _G = 20 Ω (Note 4, 5) | -- | 25 | -- | ns |
| t _r | Turn-On Rise Time | | -- | 55 | -- | ns |
| t _{d(off)} | Turn-Off Delay Time | | -- | 70 | -- | ns |
| t _f | Turn-Off Fall Time | | -- | 40 | -- | ns |
| Q _g | Total Gate Charge | V _{DS} = 480V, I _D = 11A V _{GS} = 10V (Note 4, 5) | -- | 35 | -- | nC |
| Q _{gs} | Gate-Source Charge | | -- | 5 | -- | nC |
| Q _{gd} | Gate-Drain Charge | | -- | 18 | -- | nC |
| Drain-Source Diode Characteristics and Maximum Ratings | | | | | | |
| I _S | Maximum Continuous Drain-Source Diode Forward Current | | -- | -- | 11 | A |
| I _{SM} | Maximum Pulsed Drain-Source Diode Forward Current | | -- | -- | 40 | A |
| V _{SD} | Drain-Source Diode Forward Voltage | V _{GS} = 0V, I _S = 11A | -- | -- | 1.5 | V |
| t _{rr} | Reverse Recovery Time | V _{GS} = 0V, I _S = 11A diF/dt = 100A/μs (Note 4) | -- | 240 | -- | ns |
| Q _{rr} | Reverse Recovery Charge | | -- | 3.1 | -- | μC |

NOTES:

1. Repetitive Rating: Pulse width limited by maximum junction temperature
2. L=60mH, I_{AS}=1.5A, V_{DD}=150V, Starting T_J=25 °C
3. I_{SD} ≤ 11A, di/dt ≤ 200A/μs, V_{DD} ≤ BV_{DSS}, Starting T_J = 25 °C
4. Pulse Test: Pulse width ≤ 300μs, Duty Cycle ≤ 2%
5. Essentially Independent of Operating Temperature Typical Characteristics

Typical Performance Characteristics

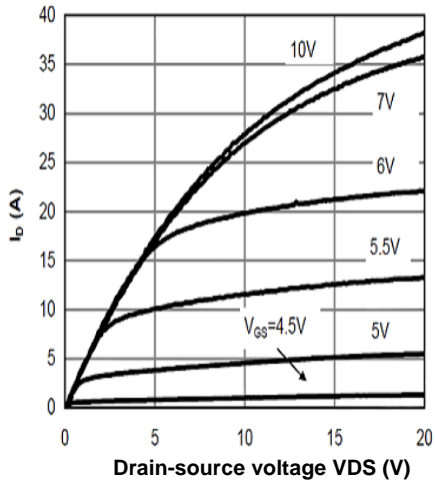


Figure 1: On-Region Characteristics @ 25° C

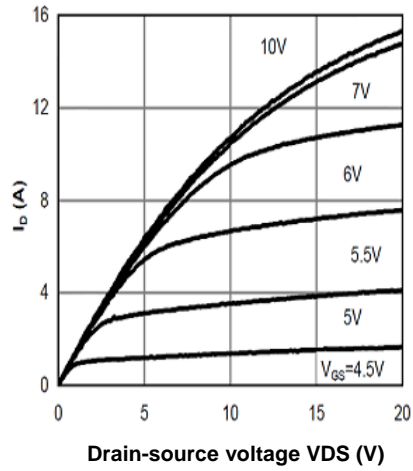


Figure 2: On-Region Characteristics @ 125° C

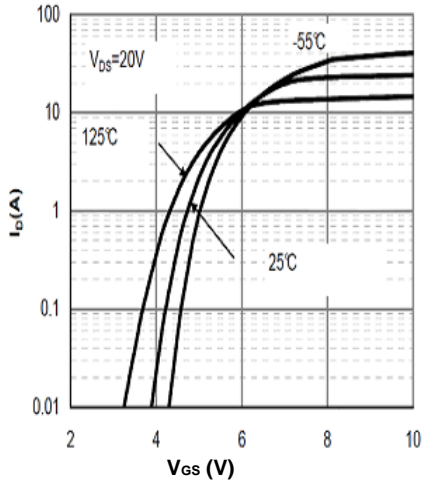


Figure 3: Transfer Characteristics

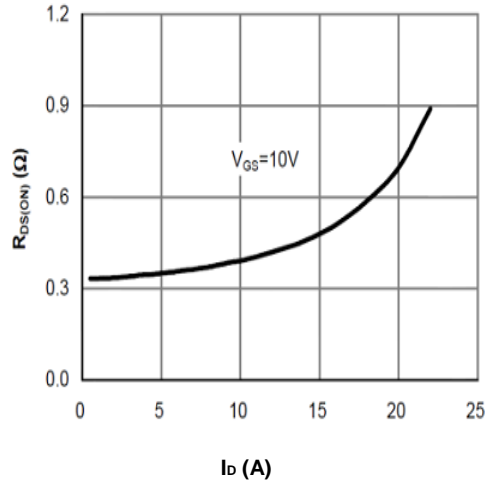


Figure 4: On-Resistance vs. Drain Current and Gate Voltage

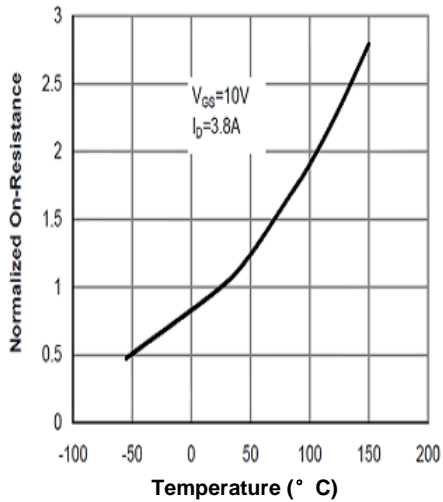


Figure 5: On-Resistance vs. Junction Temperature

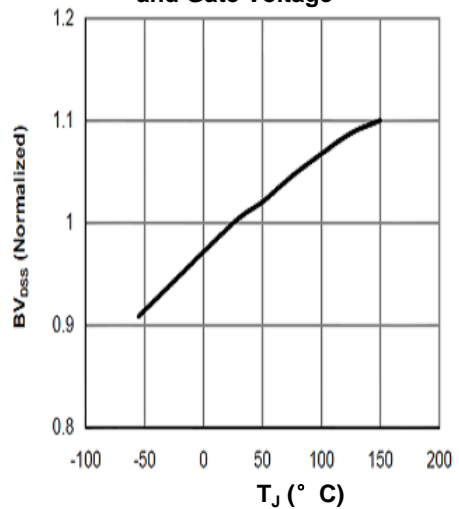


Figure 6: Break Down vs. Junction Temperature

Typical Performance Characteristics

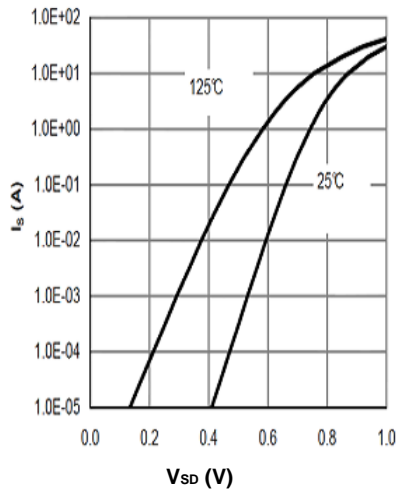


Figure 7: Body-Diode Characteristics

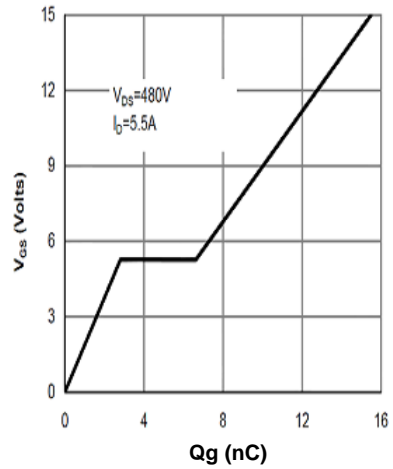


Figure 8: Gate-Charge Characteristics

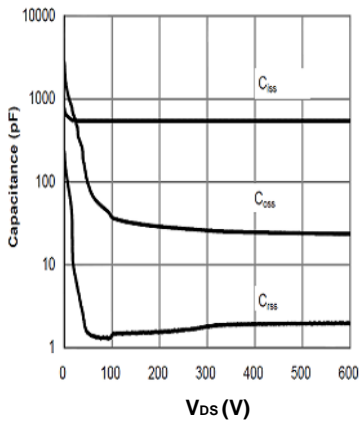


Figure 9: Capacitance Characteristics

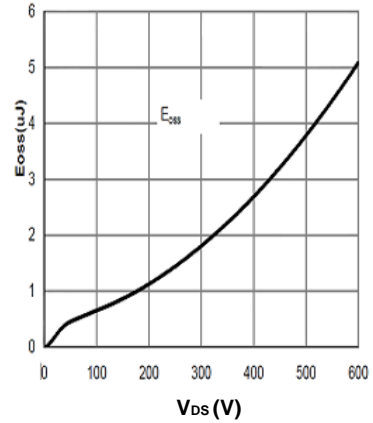


Figure 10: C_{oss} stored Energy

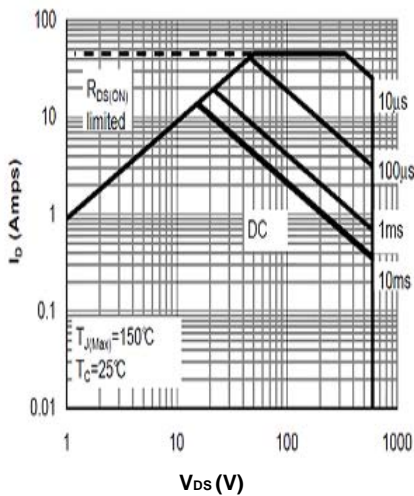


Figure 11: Maximum Forward Biased Safe Operating Area

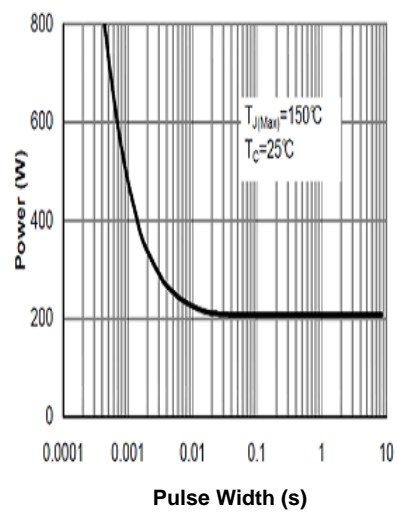


Figure 12: Single Pulse Power Rating Junction to Case

Typical Performance Characteristics

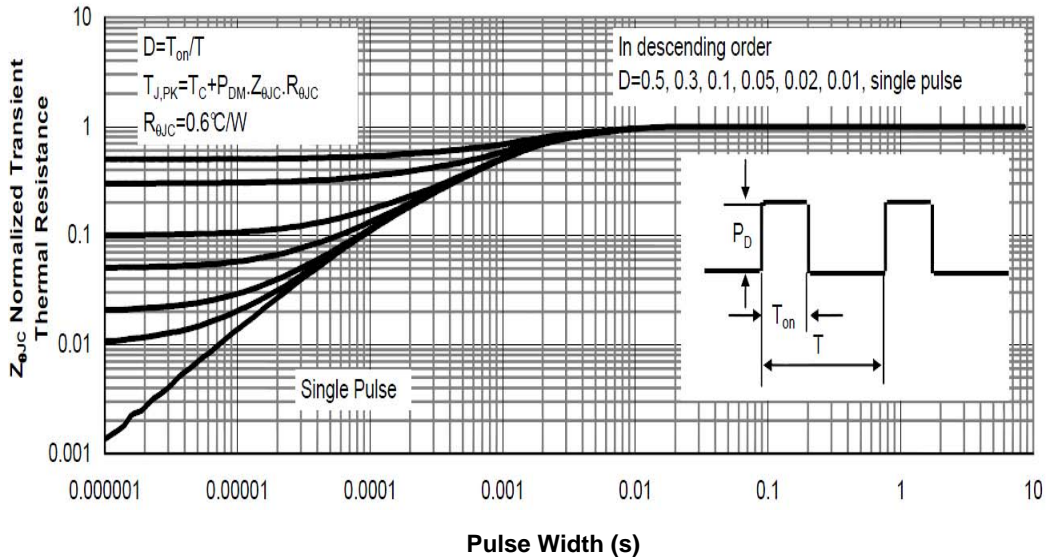


Figure 12: Normalized Maximum Transient Thermal Impedance

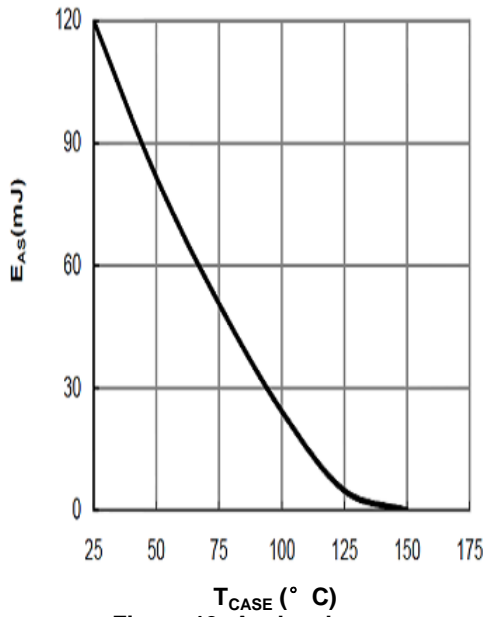


Figure 13: Avalanche energy

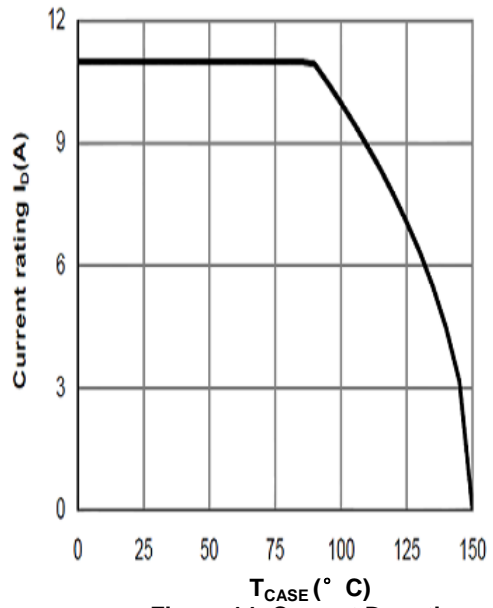


Figure 14: Current De-rating

Typical Performance Characteristics

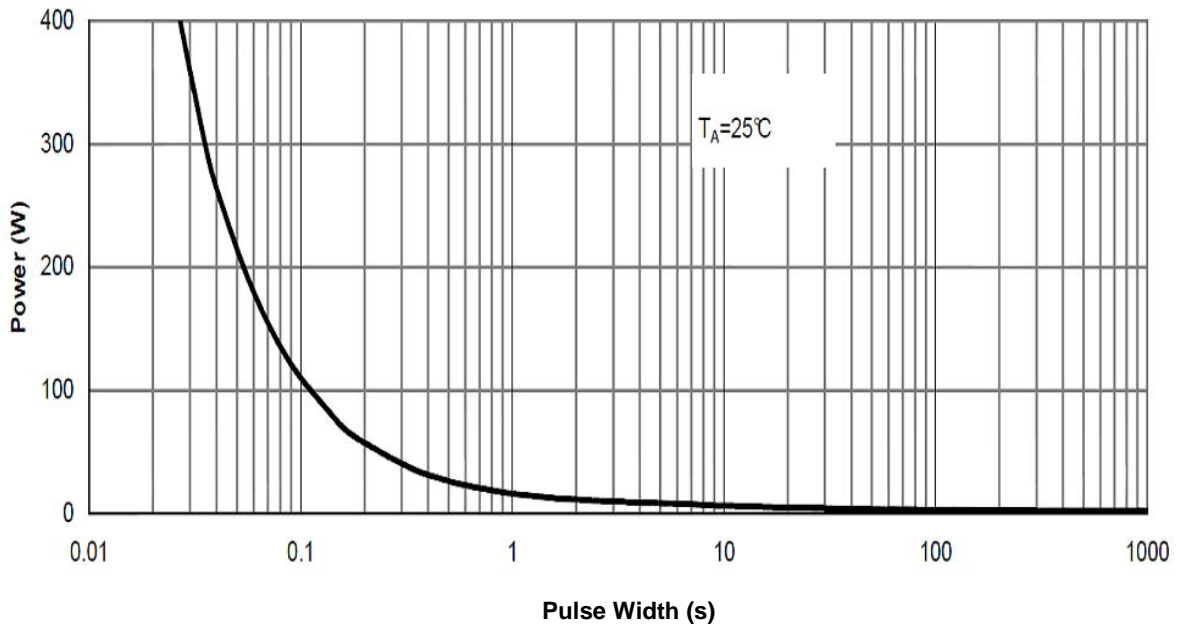


Figure 15: Single Pulse Power Rating Junction-Ambient

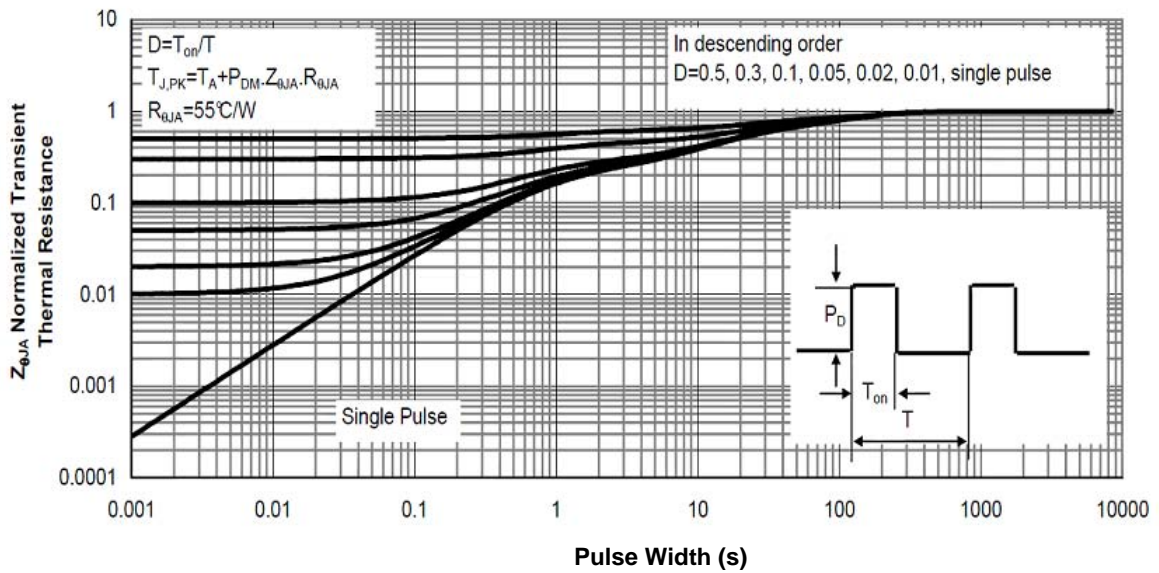
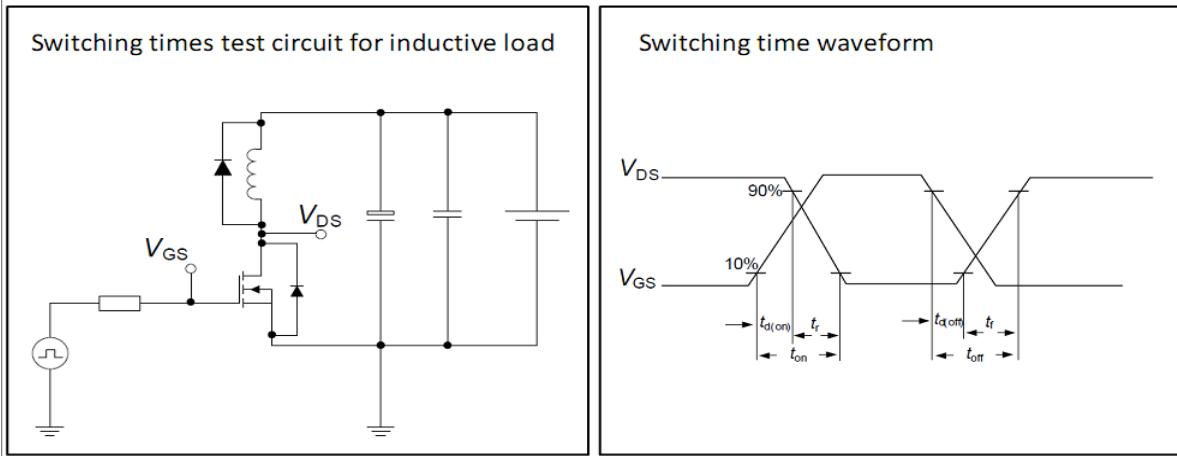


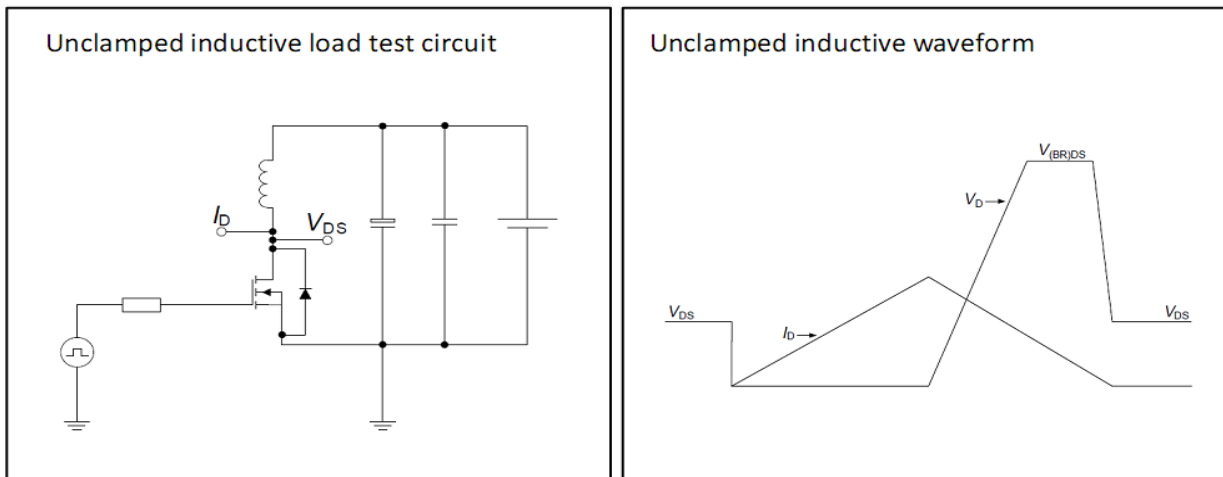
Figure 16: Normalized Maximum Transient Thermal Impedance

Test circuits

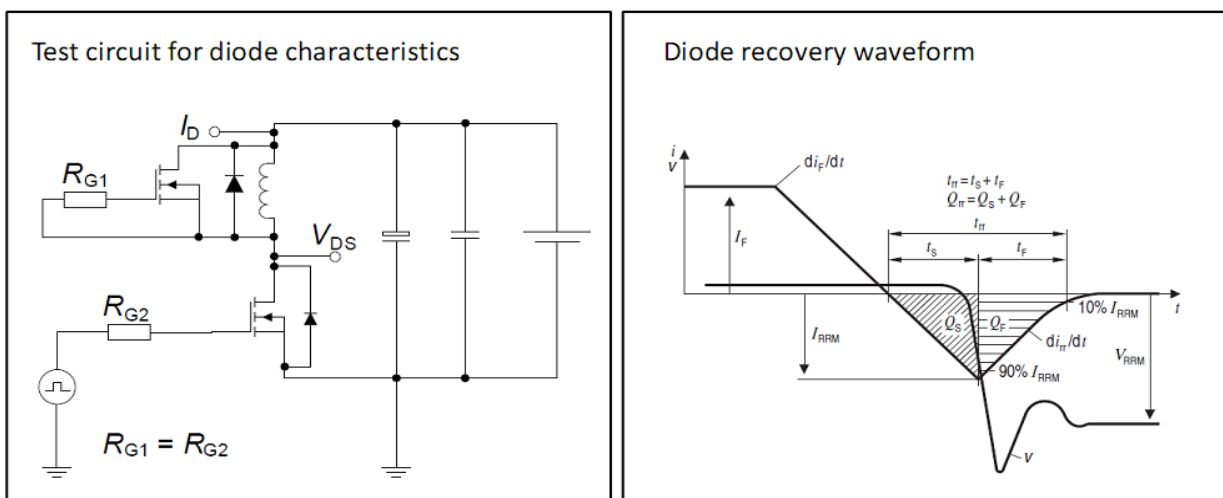
Switching times test circuit and waveform for inductive load



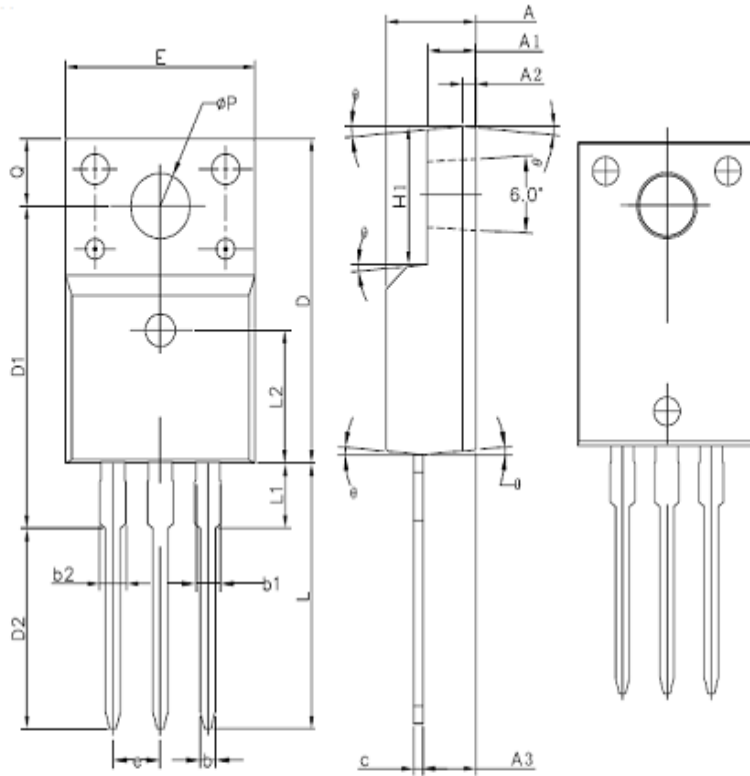
Unclamped inductive load test circuit and waveform



Test circuit and waveform for diode characteristics

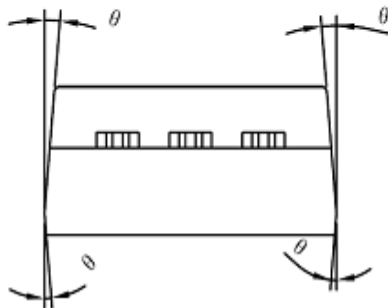


PKG TO-220F



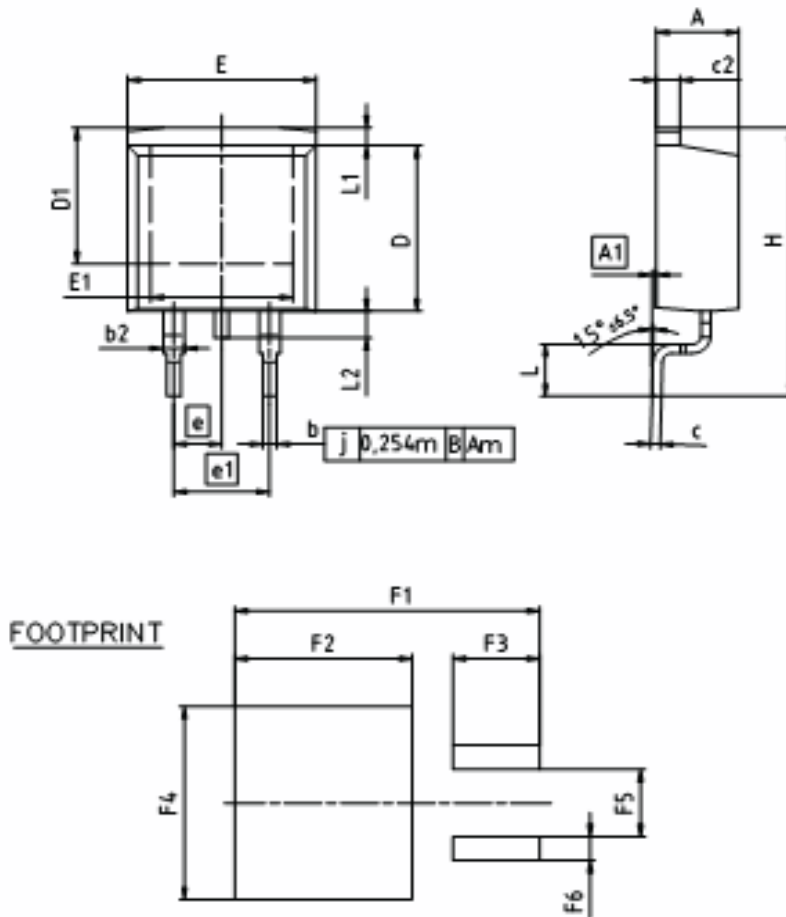
COMMON DIMENSIONS
(UNITS OF MEASURE=MILLIMETER)

| SYMBOL | MIN | NOM | MAX |
|--------|----------|-------|-------|
| A | 4.50 | 4.70 | 4.90 |
| A1 | 2.34 | 2.54 | 2.74 |
| A2 | 0.70 REF | | |
| A3 | 2.56 | 2.76 | 2.96 |
| b | 0.70 | - | 0.90 |
| b1 | 1.18 | - | 1.38 |
| b2 | - | - | 1.47 |
| c | 0.45 | 0.50 | 0.60 |
| D | 15.67 | 15.87 | 16.07 |
| D1 | 15.55 | 15.75 | 15.95 |
| D2 | 9.60 | 9.80 | 10.0 |
| E | 9.96 | 10.16 | 10.36 |
| e | 2.54BSC | | |
| H1 | 6.48 | 6.68 | 6.88 |
| L | 12.68 | 12.98 | - |
| L1 | - | - | 3.50 |
| L2 | 6.50REF | | |
| phi P | 3.08 | 3.18 | 3.28 |
| Q | 3.20 | - | 3.40 |
| theta | 3° | 5° | 7° |



PKG TO-263

TSP11N60S / TSF11N60S/TSB11N60S 600V N-Channel MOSFET



| DIM | MILLIMETERS | | INCHES | |
|-----|-------------|-------|--------|-------|
| | MIN | MAX | MIN | MAX |
| A | 4.30 | 4.67 | 0.169 | 0.180 |
| A1 | 0.00 | 0.25 | 0.000 | 0.010 |
| b | 0.65 | 0.85 | 0.026 | 0.033 |
| b2 | 0.95 | 1.15 | 0.037 | 0.045 |
| c | 0.33 | 0.65 | 0.013 | 0.026 |
| c2 | 1.17 | 1.40 | 0.046 | 0.055 |
| D | 8.51 | 8.45 | 0.335 | 0.372 |
| D1 | 7.10 | 7.90 | 0.280 | 0.311 |
| E | 9.80 | 10.31 | 0.388 | 0.408 |
| E1 | 6.60 | 8.60 | 0.260 | 0.339 |
| e | 2.54 | | 0.100 | |
| e1 | 5.08 | | 0.200 | |
| N | 2 | | 2 | |
| H | 14.81 | 15.88 | 0.575 | 0.625 |
| L | 2.29 | 3.00 | 0.090 | 0.118 |
| L1 | 0.70 | 1.80 | 0.028 | 0.083 |
| L2 | 1.00 | 1.78 | 0.039 | 0.070 |
| F1 | 18.08 | 18.25 | 0.832 | 0.840 |
| F2 | 9.30 | 9.80 | 0.368 | 0.374 |
| F3 | 4.80 | 4.70 | 0.177 | 0.185 |
| F4 | 10.70 | 10.90 | 0.421 | 0.429 |
| F5 | 3.65 | 3.85 | 0.144 | 0.152 |
| F6 | 1.25 | 1.45 | 0.049 | 0.057 |

DOCUMENT NO.
28800003324

SCALE 7.5mm

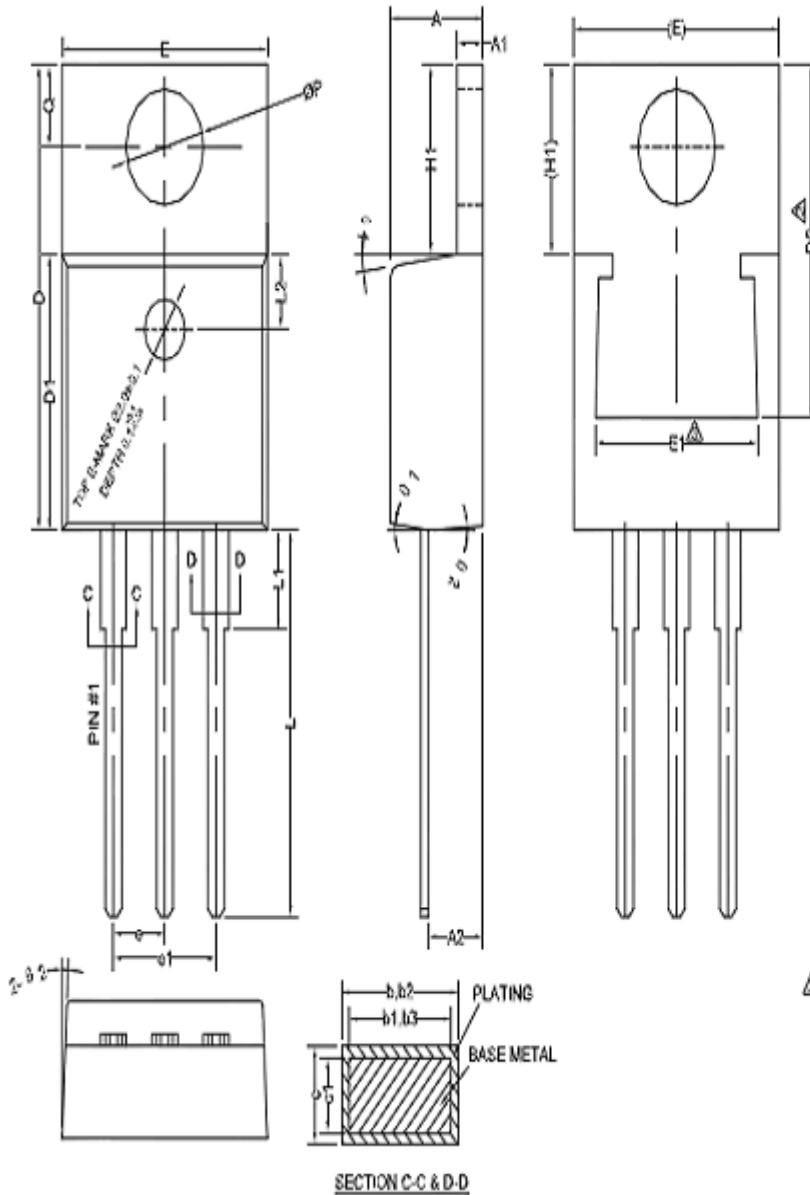
EUROPEAN PROJECTION

ISSUE DATE
30-08-2007

REVISION
01

PKG TO-220

TSP11N60S / TSF11N60S/TSB11N60S 600V N-Channel MOSFET



COMMON DIMENSIONS
(UNITS OF MEASURE=MILLIMETER)

| SYMBOL | MIN | NOM | MAX |
|--------|---------|-------|-------|
| A | 4.40 | 4.57 | 4.70 |
| A1 | 1.22 | - | 1.32 |
| A2 | 2.59 | 2.38 | 2.70 |
| b | 0.77 | - | 0.90 |
| b1 | 0.76 | 0.81 | 0.83 |
| b2 | 1.23 | - | 1.35 |
| b3 | 1.22 | 1.27 | 1.32 |
| c | 0.34 | - | 0.47 |
| c1 | 0.33 | 0.38 | 0.43 |
| D | 15.15 | 15.45 | 15.75 |
| D1 | 9.05 | 9.15 | 9.25 |
| D2 | 11.40 | - | 12.88 |
| E | 9.93 | 10.13 | 10.33 |
| E1 | 3.66 | - | 3.89 |
| a | 2.44 | 2.54 | 2.64 |
| a1 | 4.96 | 5.06 | 5.1 |
| H1 | 3.10 | 3.30 | 3.50 |
| L | 12.70 | - | 13.12 |
| L1 | - | - | 3.90 |
| L2 | 2.50REF | | |
| ØP | 3.80 | 3.84 | 3.88 |
| q | 2.30 | - | 2.90 |
| Ø 1 | 5' | 7' | 9' |
| Ø 2 | 1' | 3' | 5' |

NOTES:

1. ALL DIMENSIONS REFER TO JEDEC STANDARD TO 220 AB DO NOT INCLUDE MOLD FLASH OR PROTRUSIONS.

2. 'D2' AND 'E1' ARE VARIABLES DEPENDING ON DIE PAD SIZES.