# N-Channel Super Junction Power MOSFET

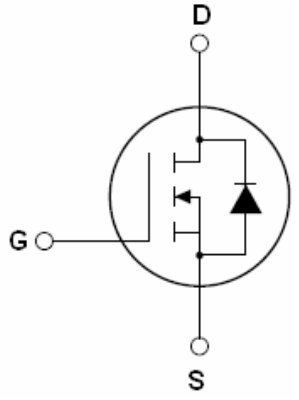
## General Description

The series of devices use advanced super junction technology and design to provide excellent $R_{DS(ON)}$ with low gate charge. This super junction MOSFET fits the industry's AC-DC SMPS requirements for PFC, AC/DC power conversion, and industrial power applications.

| | | |
|---|---|---|
| $V_{DS}@T_{jmax}$ | 650 | V |
| $R_{DS(ON)}$ | 900 | mΩ |
| $I_D$ | 5 | A |

## Features

- New technology for high voltage device
- Low on-resistance and low conduction losses
- Small package
- Ultra Low Gate Charge cause lower driving requirements
- 100% Avalanche Tested



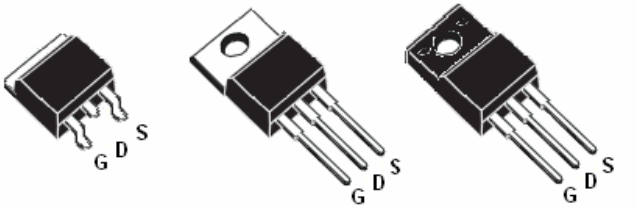

Schematic diagram

## Application

- Power factor correction（PFC）
- Switched mode power supplies(SMPS)
- Uninterruptible Power Supply（UPS）

## Package Marking And Ordering Information

| Device | Device Package | Marking |
|---|---|---|
| NCE05N60D | TO-263 | NCE05N60D |
| NCE05N60 | TO-220 | NCE05N60 |
| NCE05N60F | TO-220F | NCE05N60F |




TO-263　　TO-220　　TO-220F

## Table 1. Absolute Maximum Ratings ($T_C$=25℃)

| Parameter | Symbol | NCE05N60 NCE05N60D | NCE05N60F | Unit |
|---|---|---|---|---|
| Drain-Source Voltage ($V_{GS}$=0V) | $V_{DS}$ | 600 | | V |
| Gate-Source Voltage ($V_{DS}$=0V) | $V_{GS}$ | ±30 | | V |
| Continuous Drain Current at Tc=25°C | $I_{D\ (DC)}$ | 5 | 5* | A |
| Continuous Drain Current at Tc=100°C | $I_{D\ (DC)}$ | 3 | 3* | A |
| Pulsed drain current **(Note 1)** | $I_{DM\ (pluse)}$ | 15 | 15 | A |
| Drain Source voltage slope, VDS = 480 V, ID = 5 A, Tj = 125 °C | dv/dt | 50 | | V/ns |
| Maximum Power Dissipation(Tc=25℃)<br>Derate above 25°C | $P_D$ | 50<br>0.4 | 31<br>0.25 | W<br>W/°C |
| Single pulse avalanche energy **(Note2)** | $E_{AS}$ | 130 | | mJ |
| Avalanche current **(Note 1)** | $I_{AR}$ | 5 | | A |

| Parameter | Symbol | Value | Unit |
|---|---|---|---|
| Repetitive Avalanche energy ， $t_{AR}$ limited by $T_{jmax}$ **(Note 1)** | $E_{AR}$ | 0.4 | mJ |
| Operating Junction and Storage Temperature Range | $T_J$,$T_{STG}$ | -55...+150 | °C |

* limited by maximum junction temperature

**Table 2. Thermal Characteristic**

| Parameter | Symbol | NCE05N60 NCE05N60D | NCE05N60F | Unit |
|---|---|---|---|---|
| Thermal Resistance，Junction-to-Case（Maximum） | $R_{thJC}$ | 2.5 | 4 | °C /W |
| Thermal Resistance，Junction-to-Ambient （Maximum） | $R_{thJA}$ | 62 | 80 | °C /W |

**Table 3. Electrical Characteristics (TA=25℃unless otherwise noted)**

| Parameter | Symbol | Condition | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| **On/off states** | | | | | | |
| Drain-Source Breakdown Voltage | $BV_{DSS}$ | $V_{GS}$=0V $I_D$=250μA | 600 | | | V |
| Zero Gate Voltage Drain Current(Tc=25℃) | $I_{DSS}$ | $V_{DS}$=600V,$V_{GS}$=0V | | | 1 | μA |
| Zero Gate Voltage Drain Current(Tc=125℃) | $I_{DSS}$ | $V_{DS}$=600V,$V_{GS}$=0V | | | 50 | μA |
| Gate-Body Leakage Current | $I_{GSS}$ | $V_{GS}$=±30V,$V_{DS}$=0V | | | ±100 | nA |
| Gate Threshold Voltage | $V_{GS(th)}$ | $V_{DS}$=$V_{GS}$,$I_D$=250μA | 2.5 | 3 | 3.5 | V |
| Drain-Source On-State Resistance | $R_{DS(ON)}$ | $V_{GS}$=10V, $I_D$=3A | | 850 | 900 | mΩ |
| **Dynamic Characteristics** | | | | | | |
| Forward Transconductance | $g_{FS}$ | $V_{DS}$ = 20V, $I_D$ = 3A | | 5 | | S |
| Input Capacitance | $C_{lss}$ | $V_{DS}$=50V,$V_{GS}$=0V, F=1.0MHz | | 520 | | pF |
| Output Capacitance | $C_{oss}$ | | | 52 | | pF |
| Reverse Transfer Capacitance | $C_{rss}$ | | | 4.5 | | pF |
| Total Gate Charge | $Q_g$ | $V_{DS}$=480V,$I_D$=5A, $V_{GS}$=10V | | 12 | 25 | nC |
| Gate-Source Charge | $Q_{gs}$ | | | 2.2 | | nC |
| Gate-Drain Charge | $Q_{gd}$ | | | 4.5 | | nC |
| Intrinsic gate resistance | $R_G$ | f = 1 MHz open drain | | 2.6 | | Ω |
| **Switching times** | | | | | | |
| Turn-on Delay Time | $t_{d(on)}$ | $V_{DD}$=380V,$I_D$=5A, $R_G$=18Ω,$V_{GS}$=10V | | 6 | | nS |
| Turn-on Rise Time | $t_r$ | | | 2.5 | | nS |
| Turn-Off Delay Time | $t_{d(off)}$ | | | 55 | 80 | nS |
| Turn-Off Fall Time | $t_f$ | | | 9 | 14 | nS |
| **Source- Drain Diode Characteristics** | | | | | | |
| Source-drain current(Body Diode) | $I_{SD}$ | $T_C$=25°C | | | 5 | A |
| Pulsed Source-drain current(Body Diode) | $I_{SDM}$ | | | | 15 | A |
| Forward on voltage | $V_{SD}$ | Tj=25°C,$I_{SD}$=5A,$V_{GS}$=0V | | 1 | 1.3 | V |
| Reverse Recovery Time | $t_{rr}$ | Tj=25°C,$I_F$=5A,di/dt=100A/μs | | 200 | | nS |
| Reverse Recovery Charge | $Q_{rr}$ | | | 1.6 | | uC |
| Peak reverse recovery current | $I_{rrm}$ | | | 15 | | A |

Notes: 1.Repetitive Rating: Pulse width limited by maximum junction temperature

2. Tj=25℃,VDD=50V,VG=10V, $R_G$=25Ω

## TYPICAL ELECTRICAL AND THERMAL CHARACTERISTICS (curves)

**Figure1. Safe operating area**

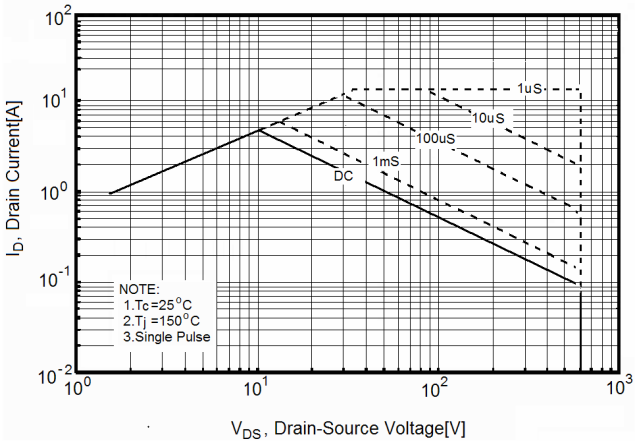



**Figure2. Safe operating area for NCE05N60F**

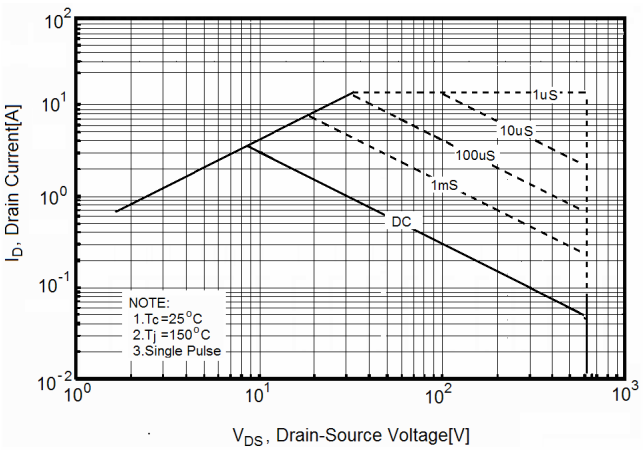



**Figure3. Source-Drain Diode Forward Voltage**

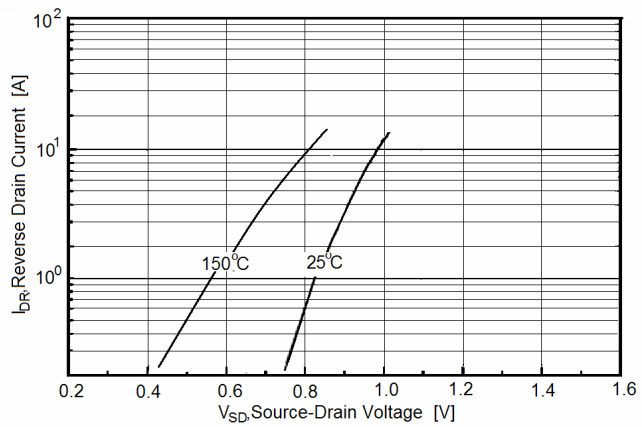



**Figure4. Output characteristics**

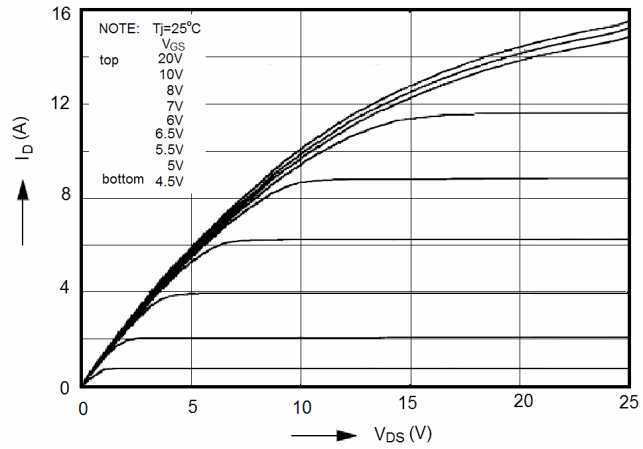



**Figure5. Transfer characteristics**

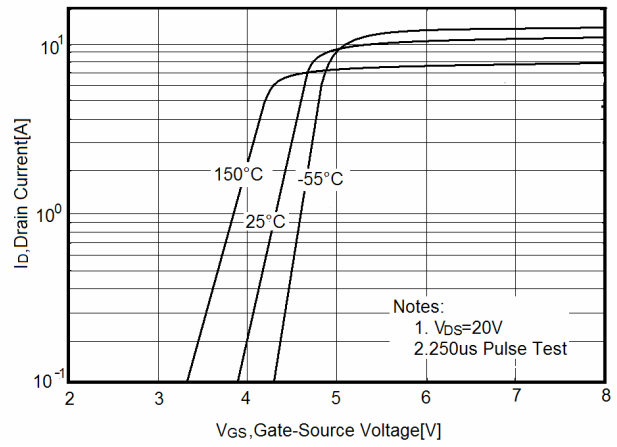



**Figure6. Static drain-source on resistance**

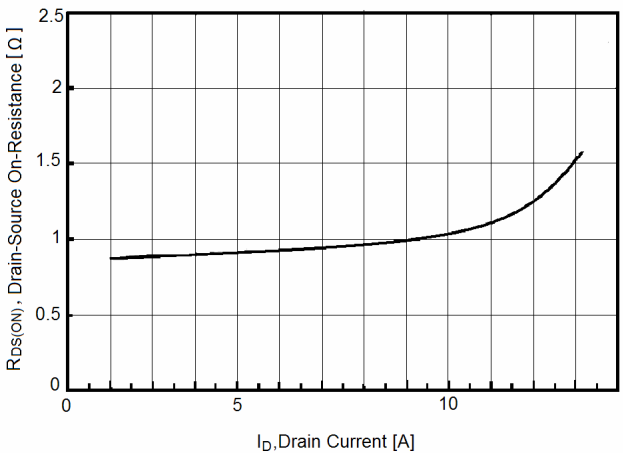


**Figure7. $R_{DS(ON)}$ vs Junction Temperature**

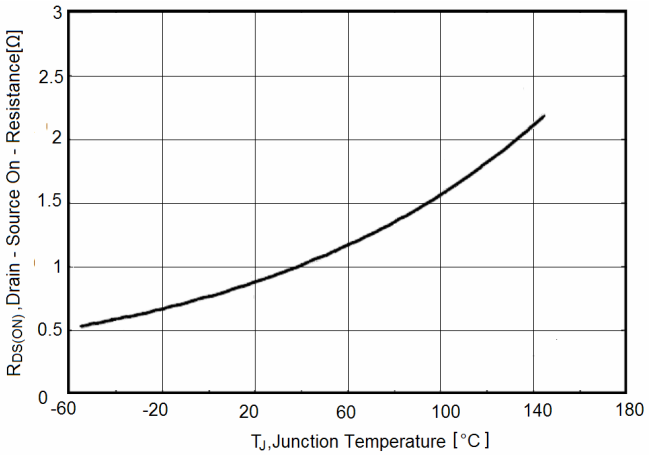



**Figure8. $BV_{DSS}$ vs Junction Temperature**

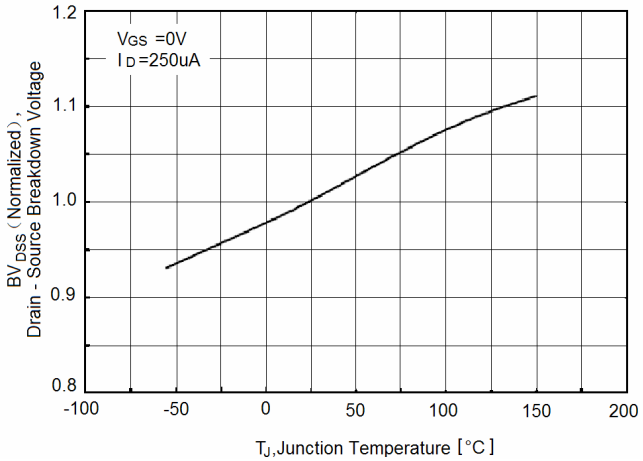



**Figure9. Maximum $I_D$ vs Junction Temperature**

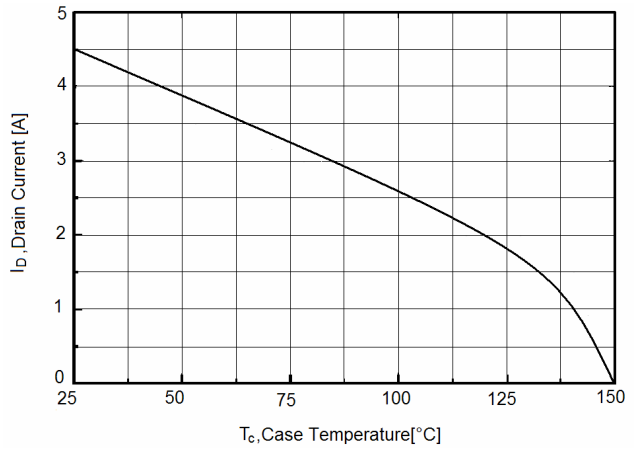



**Figure10. Gate charge waveforms**

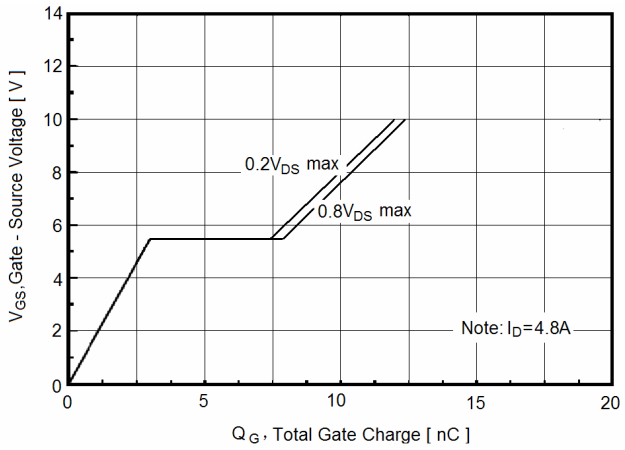



**Figure11. Capacitance**

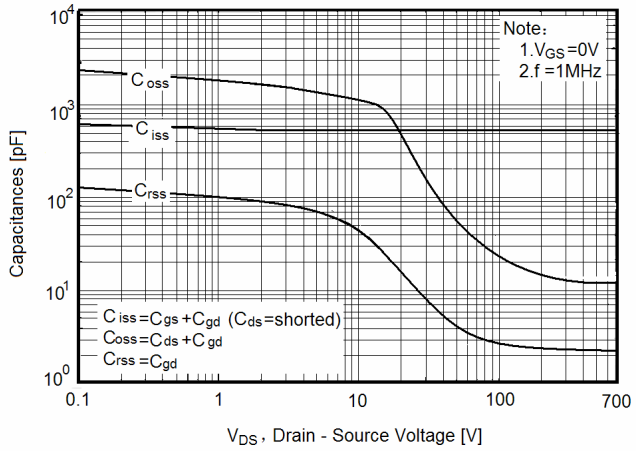



**Figure12. Transient Thermal Impedance**

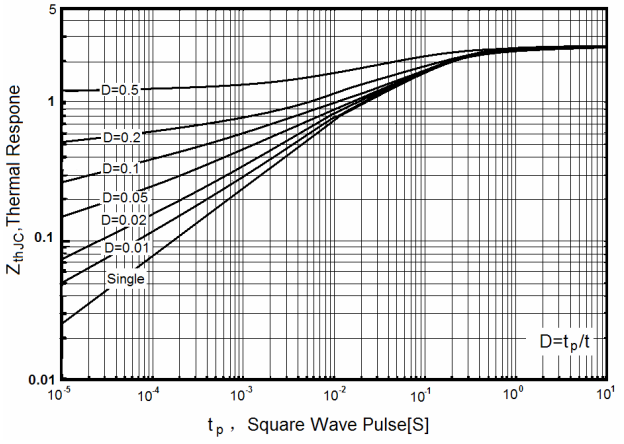
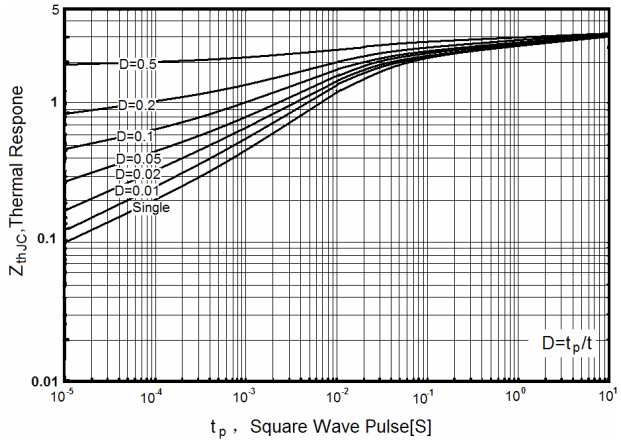
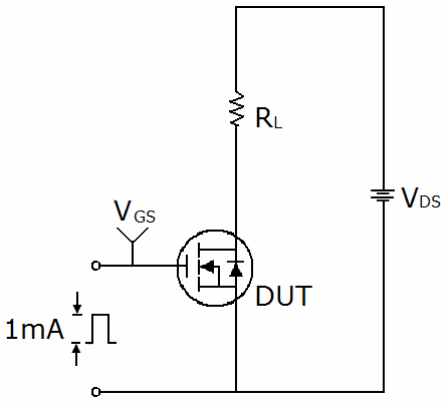


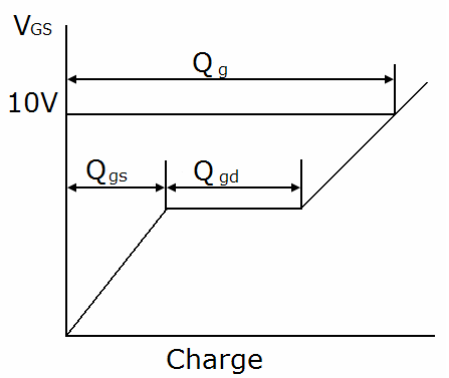
**Figure13. Transient Thermal Impedance for NCE05N60F**



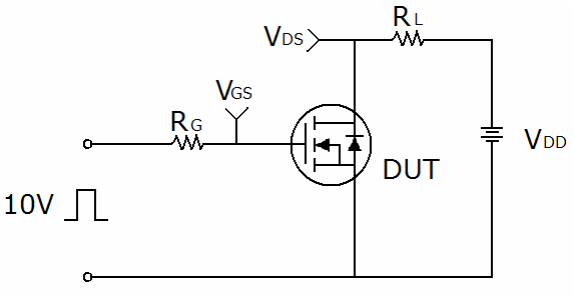
# Test circuit

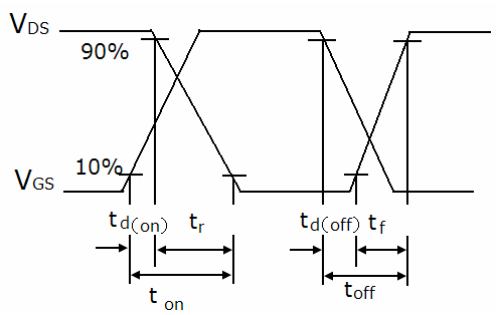
**1）Gate charge test circuit & Waveform**



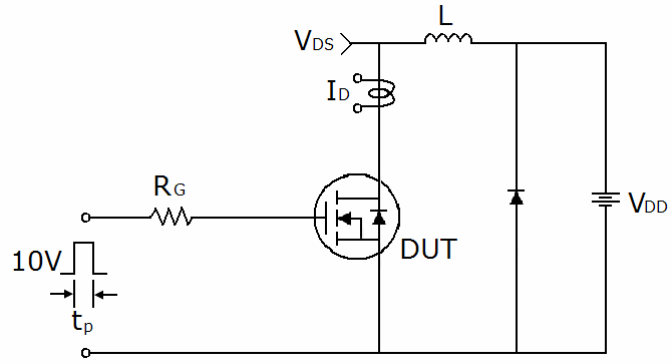



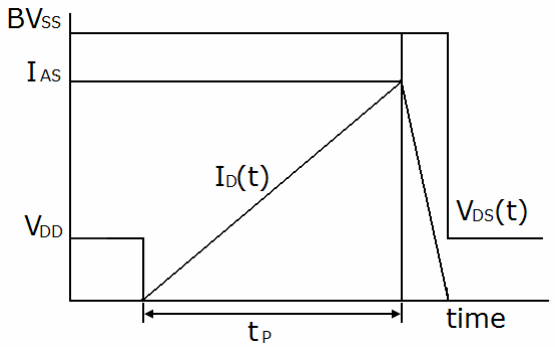

**2）Switch Time Test Circuit:**



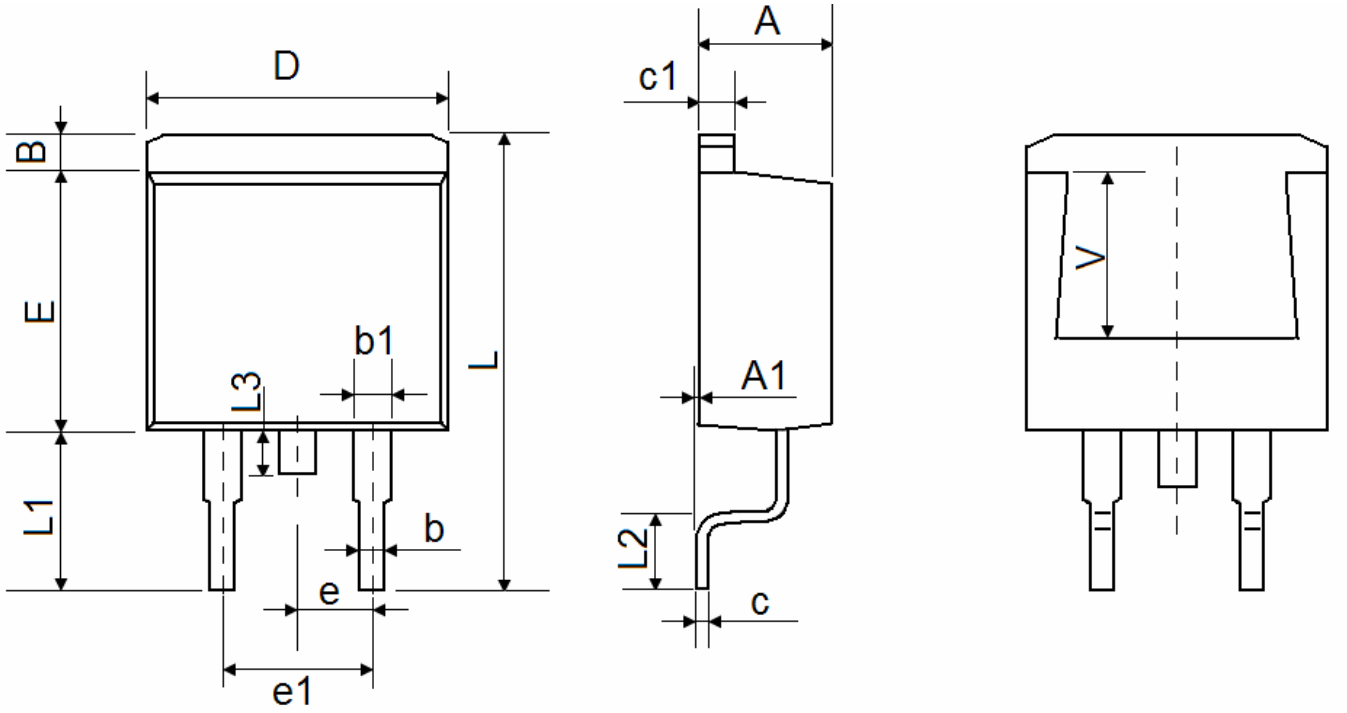




**3）Unclamped Inductive Switching Test Circuit & Waveforms**



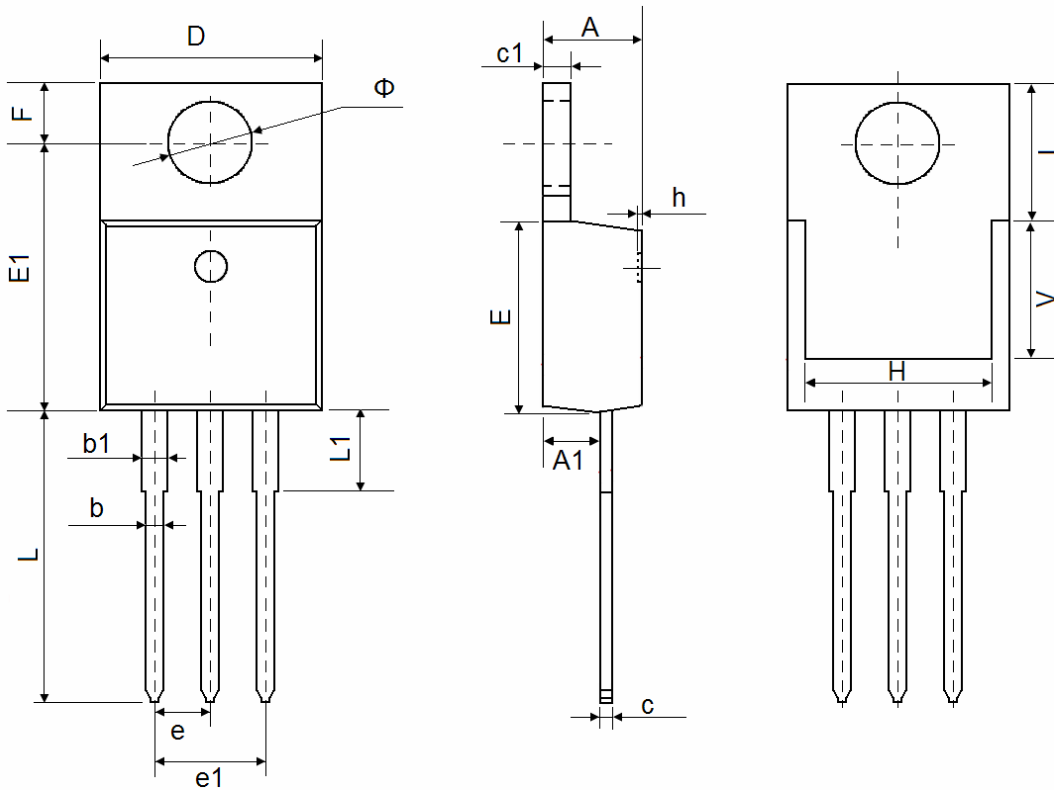



# TO-263-2L Package Information



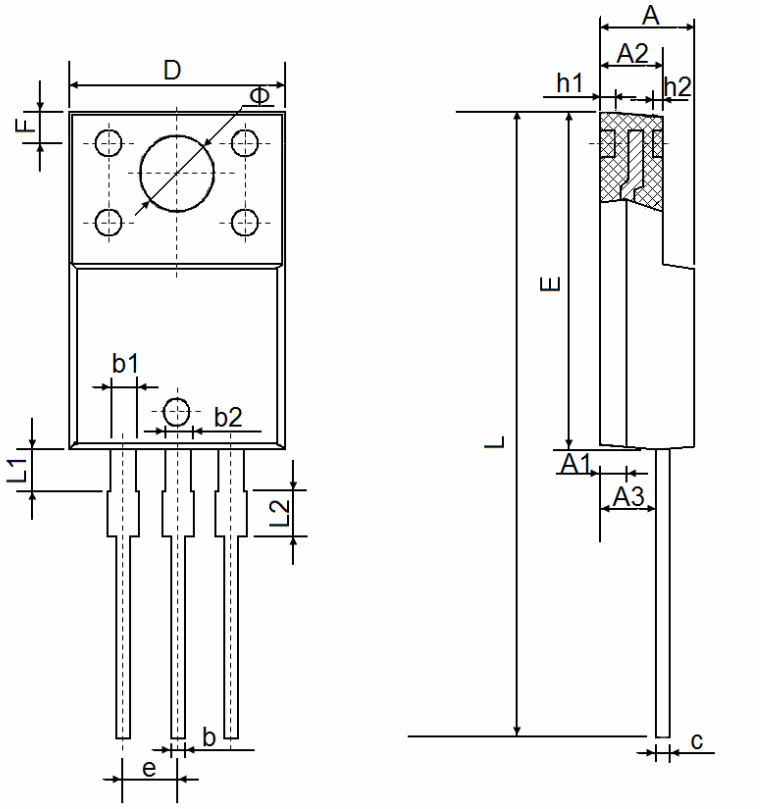

| Symbol | Dimensions In Millimeters | | Dimensions In Inches | |
|---|---|---|---|---|
| | Min. | Max. | Min. | Max. |
| A | 4.470 | 4.670 | 0.176 | 0.184 |
| A1 | 0.000 | 0.150 | 0.000 | 0.006 |
| B | 1.170 | 1.370 | 0.046 | 0.054 |
| b | 0.710 | 0.910 | 0.028 | 0.036 |
| b1 | 1.170 | 1.370 | 0.046 | 0.054 |
| c | 0.310 | 0.530 | 0.012 | 0.021 |
| c1 | 1.170 | 1.370 | 0.046 | 0.054 |
| D | 10.010 | 10.310 | 0.394 | 0.406 |
| E | 8.500 | 8.900 | 0.335 | 0.350 |
| e | 2.540 TYP. | | 0.100 TYP. | |
| e1 | 4.980 | 5.180 | 0.196 | 0.204 |
| L | 15.050 | 15.450 | 0.593 | 0.608 |
| L1 | 5.080 | 5.480 | 0.200 | 0.216 |
| L2 | 2.340 | 2.740 | 0.092 | 0.108 |
| L3 | 1.300 | 1.700 | 0.051 | 0.067 |
| V | 5.600 REF | | 0.220 REF | |

# TO-220-3L Package Information




| Symbol | Dimensions In Millimeters | | Dimensions In Inches | |
|---|---|---|---|---|
| | Min. | Max. | Min. | Max. |
| A | 4.470 | 4.670 | 0.176 | 0.184 |
| A1 | 2.520 | 2.820 | 0.099 | 0.111 |
| b | 0.710 | 0.910 | 0.028 | 0.036 |
| b1 | 1.170 | 1.370 | 0.046 | 0.054 |
| c | 0.330 | 0.650 | 0.013 | 0.026 |
| c1 | 1.200 | 1.400 | 0.047 | 0.055 |
| D | 10.010 | 10.350 | 0.394 | 0.407 |
| E | 8.500 | 8.900 | 0.335 | 0.350 |
| E1 | 12.060 | 12.460 | 0.475 | 0.491 |
| e | 2.540 TYP. | | 0.100 TYP. | |
| e1 | 4.980 | 5.180 | 0.196 | 0.204 |
| F | 2.590 | 2.890 | 0.102 | 0.114 |
| H | 8.440 REF. | | 0.332 REF. | |
| h | 0.000 | 0.300 | 0.000 | 0.012 |
| L | 13.400 | 13.800 | 0.528 | 0.543 |
| L1 | 3.560 | 3.960 | 0.140 | 0.156 |
| V | 6.060 REF. | | 0.239 REF. | |
| I | 6.600 REF. | | 0.260 REF. | |
| Φ | 3.735 | 3.935 | 0.147 | 0.155 |

# TO-220F Package Information




| Symbol | Dimensions In Millimeters | | Dimensions In Inches | |
|---|---|---|---|---|
| | Min. | Max. | Min. | Max. |
| A | 4.300 | 4.700 | 0.169 | 0.185 |
| A1 | 1.300REF | | 0.051REF | |
| A2 | 2.800 | 3.200 | 0.110 | 0.126 |
| A3 | 2.500 | 2.900 | 0.098 | 0.114 |
| b | 0.500 | 0.750 | 0.020 | 0.030 |
| b1 | 1.100 | 1.350 | 0.043 | 0.053 |
| b2 | 1.500 | 1.750 | 0.059 | 0.069 |
| c | 0.500 | 0.750 | 0.020 | 0.030 |
| D | 9.960 | 10.360 | 0.392 | 0.408 |
| E | 14.800 | 15.200 | 0.583 | 0.598 |
| e | 2.540TYP. | | 0.100TYP | |
| F | 2.700REF | | 0.106REF | |
| Φ | 3.500REF | | 0.138REF | |
| h1 | 0.800REF | | 0.031REF | |
| h2 | 0.500REF | | 0.020REF | |
| L | 28.000 | 28.400 | 1.102 | 1.118 |
| L1 | 1.700 | 1.900 | 0.067 | 0.075 |
| L2 | 1.900 | 2.100 | 0.075 | 0.083 |

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