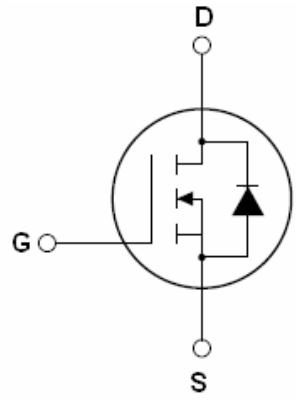
# N-Channel Super Junction Power MOSFET

## 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 |
| $R_{DS(ON)}$ | 190 | mΩ |
| $I_D$ | 20 | A |

lead-free




**Schematic diagram**

## Features

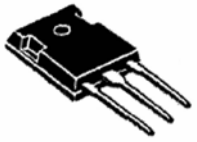
- New technology for high voltage device
- Low on-resistance and low conduction losses
- Ultra Low Gate Charge cause lower driving requirements
- 100% Avalanche Tested
- ROHS compliant

## Application

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

## Package Marking And Ordering Information

| Device | Device Package | Marking |
|---|---|---|
| FNKS20N60FL | TO-247 | FNKS20N60FL |



**TO-247**

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

| Parameter | Symbol | NCE20N60T | 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 | $I_{D\ (DC)}$ | 20 | A |
| Continuous Drain Current at Tc=100°C | $I_{D\ (DC)}$ | 12.5 | A |
| Pulsed drain current **(Note 1)** | $I_{DM\ (pluse)}$ | 60 | A |
| Drain Source voltage slope, VDS = 480 V, ID = 20 A, Tj = 125 °C | dv/dt | 50 | V/ns |
| Maximum Power Dissipation(Tc=25℃)<br>Derate above 25°C | $P_D$ | 208<br>1.67 | W<br>W/°C |
| Single pulse avalanche energy **(Note 2)** | $E_{AS}$ | 690 | mJ |
| Avalanche current **(Note 1)** | $I_{AR}$ | 20 | A |

| Parameter | Symbol | NCE20N60T | Unit |
|---|---|---|---|
| Repetitive Avalanche energy ， $t_{AR}$ limited by $T_{jmax}$ **(Note 1)** | $E_{AR}$ | 1 | 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 | NCE20N60T | Unit |
|---|---|---|---|
| Thermal Resistance，Junction-to-Case（Maximum） | $R_{thJC}$ | 0.6 | °C /W |
| Thermal Resistance，Junction-to-Ambient （Maximum） | $R_{thJA}$ | 62 | °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 | | 0.05 | 1 | μA |
| Zero Gate Voltage Drain Current(Tc=125℃) | $I_{DSS}$ | $V_{DS}$=600V,$V_{GS}$=0V | | | 100 | 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, $I_D$=10A | | 155 | 190 | mΩ |
| **Dynamic Characteristics** | | | | | | |
| Forward Transconductance | $g_{FS}$ | $V_{DS}$ = 20V, $I_D$ = 10A | | 17.5 | | S |
| Input Capacitance | $C_{lss}$ | $V_{DS}$=50V,$V_{GS}$=0V, F=1.0MHz | | 2400 | | pF |
| Output Capacitance | $C_{oss}$ | | | 180 | | pF |
| Reverse Transfer Capacitance | $C_{rss}$ | | | 5.7 | | pF |
| Total Gate Charge | $Q_g$ | $V_{DS}$=480V,$I_D$=20A, $V_{GS}$=10V | | 55 | 114 | nC |
| Gate-Source Charge | $Q_{gs}$ | | | 11 | | nC |
| Gate-Drain Charge | $Q_{gd}$ | | | 22 | | nC |
| Intrinsic gate resistance | $R_G$ | f = 1 MHz open drain | | 0.9 | | Ω |
| **Switching times** | | | | | | |
| Turn-on Delay Time | $t_{d(on)}$ | $V_{DD}$=380V,$I_D$=20A, $R_G$=3.6Ω,$V_{GS}$=10V | | 10 | | nS |
| Turn-on Rise Time | $t_r$ | | | 5 | | nS |
| Turn-Off Delay Time | $t_{d(off)}$ | | | 67 | 100 | nS |
| Turn-Off Fall Time | $t_f$ | | | 4 | 12 | nS |
| **Source- Drain Diode Characteristics** | | | | | | |
| Source-drain current(Body Diode) | $I_{SD}$ | $T_C$=25°C | | | 20 | A |
| Pulsed Source-drain current(Body Diode) | $I_{SDM}$ | | | | 60 | A |
| Forward on voltage | $V_{SD}$ | Tj=25°C,$I_{SD}$=20A,$V_{GS}$=0V | | 0.9 | 1.3 | V |
| Reverse Recovery Time | $t_{rr}$ | Tj=25°C,$I_F$=20A,di/dt=100A/μs | | 360 | | nS |
| Reverse Recovery Charge | $Q_{rr}$ | | | 5.5 | | uC |
| Peak Reverse Recovery Current | $I_{rrm}$ | | | 30 | | 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 for NCE20N60T**

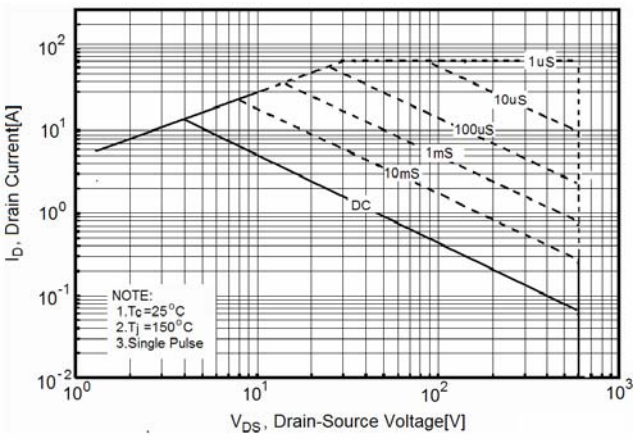



**Figure2. Source-Drain Diode Forward Voltage**

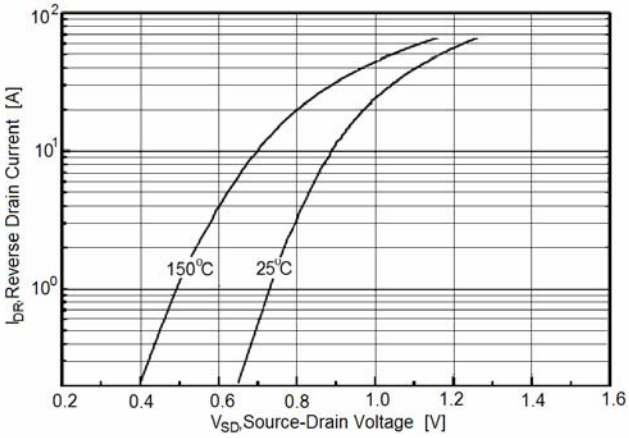



**Figure3. Output characteristics**

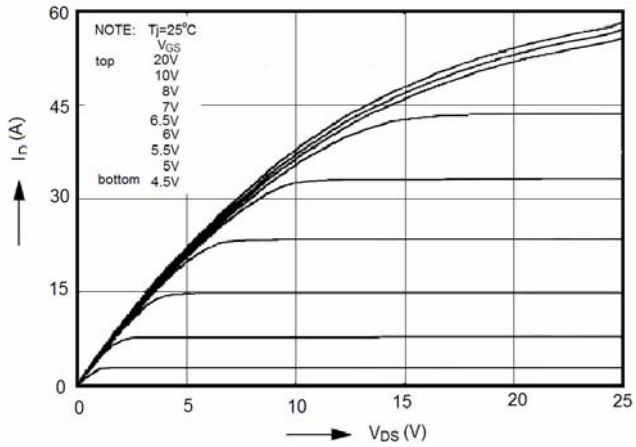



**Figure4. Transfer characteristics**

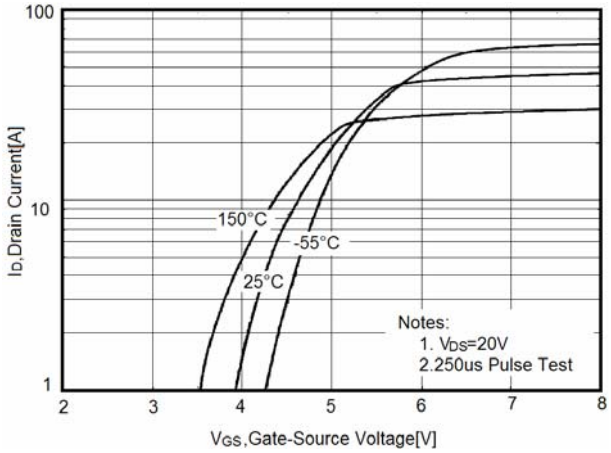



**Figure5. Static drain-source on resistance**

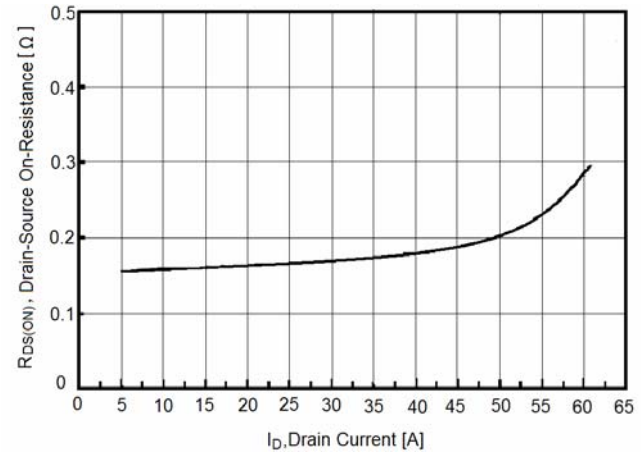



**Figure6. $R_{DS(ON)}$ vs Junction Temperature**

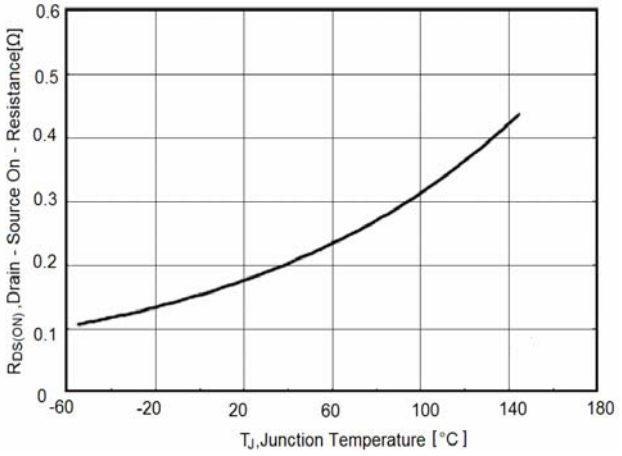


**Figure7. $BV_{DSS}$ vs Junction Temperature**

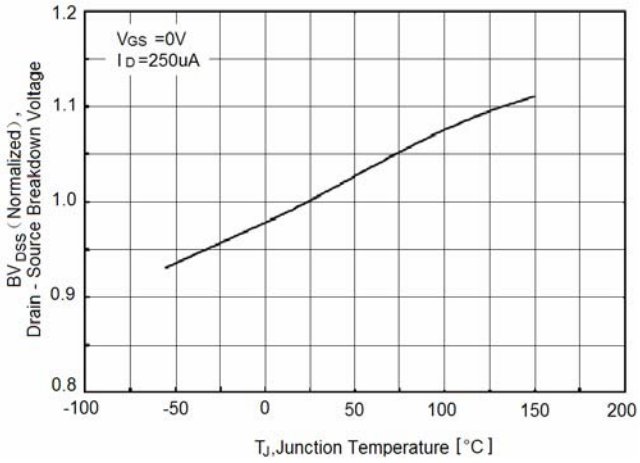



**Figure8. Maximum $I_D$ vs Junction Temperature**

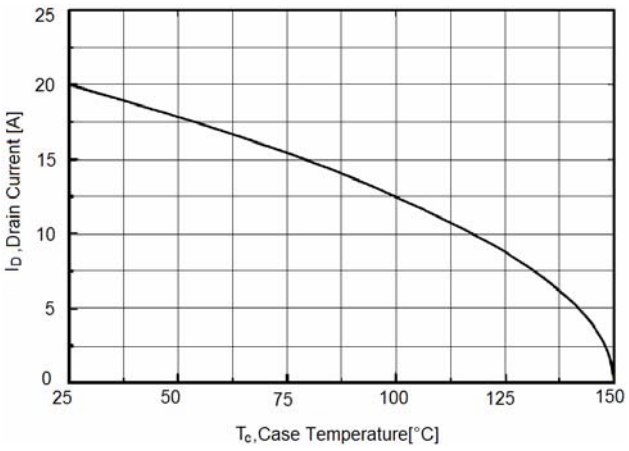



**Figure9. Gate charge waveforms**

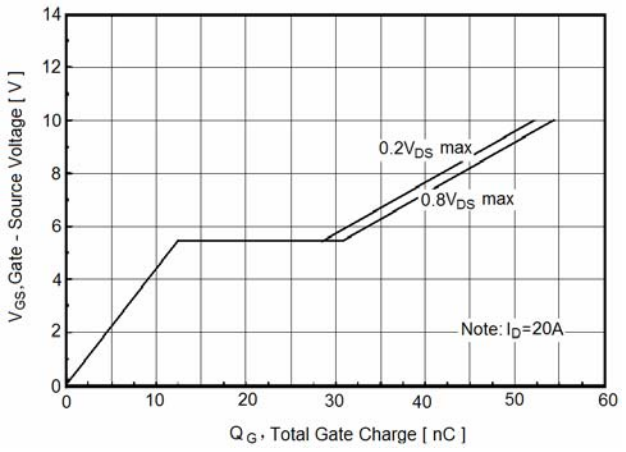



**Figure10. Capacitance**

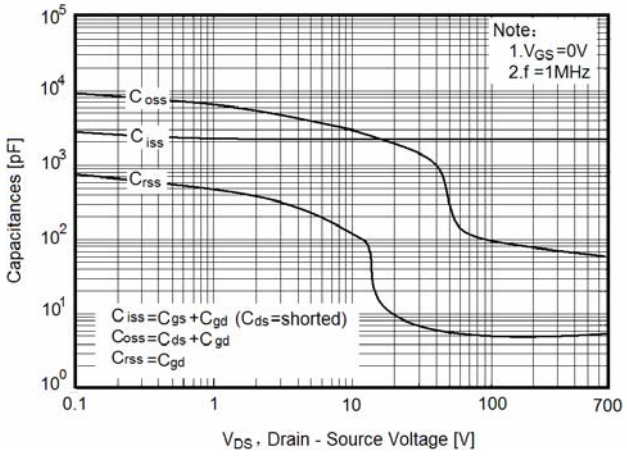
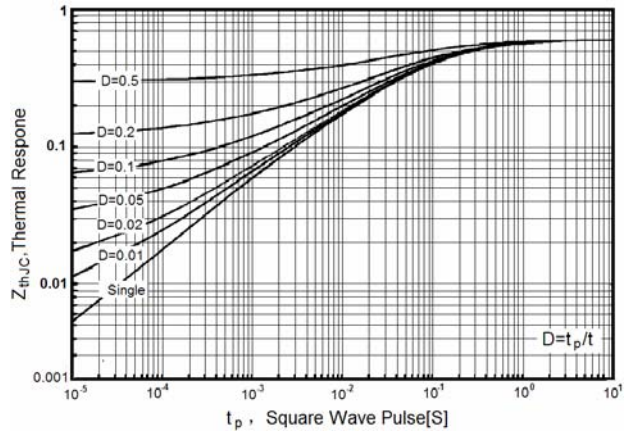
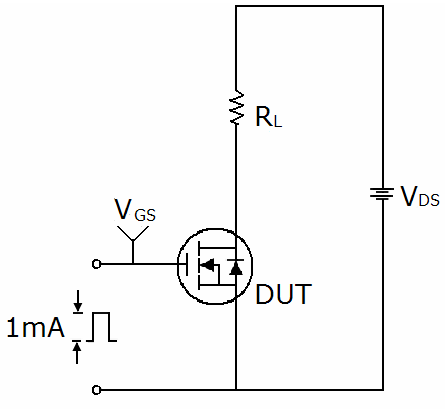


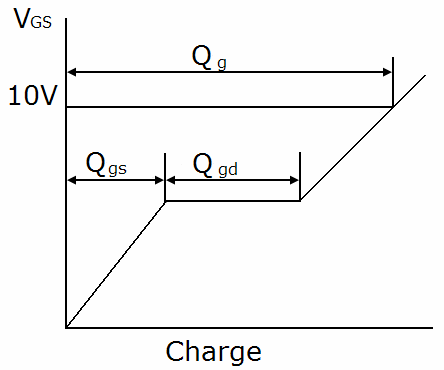

**Figure11. Transient Thermal Impedance**



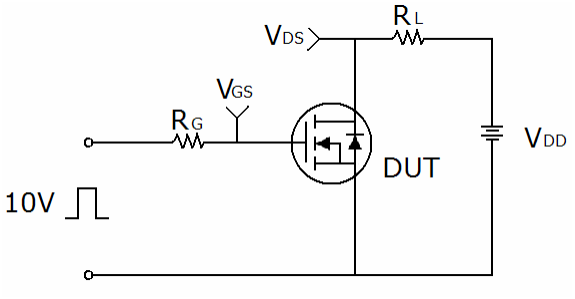
# Test circuit

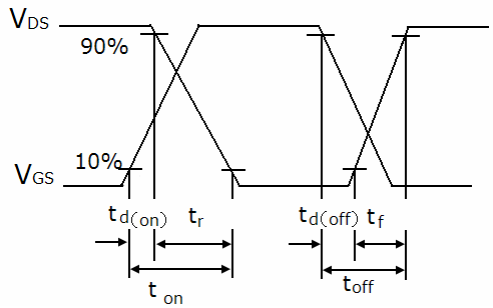
### 1） Gate charge test circuit & Waveform



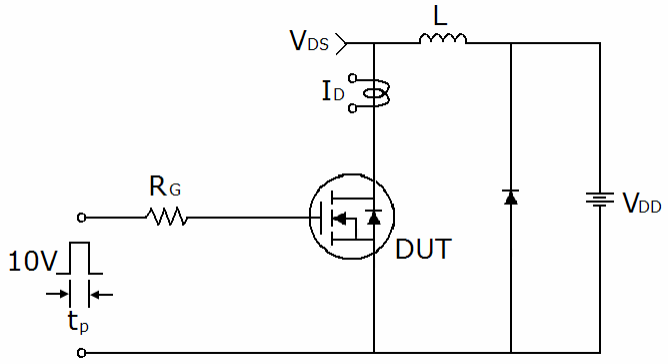



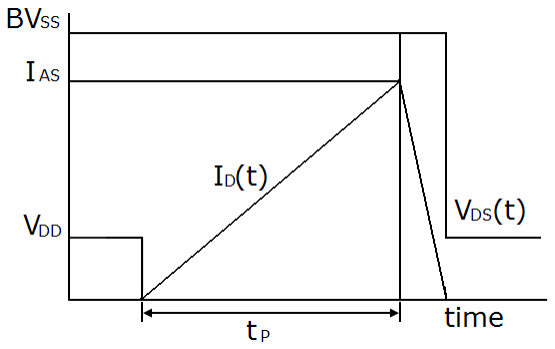

### 2）Switch Time Test Circuit:



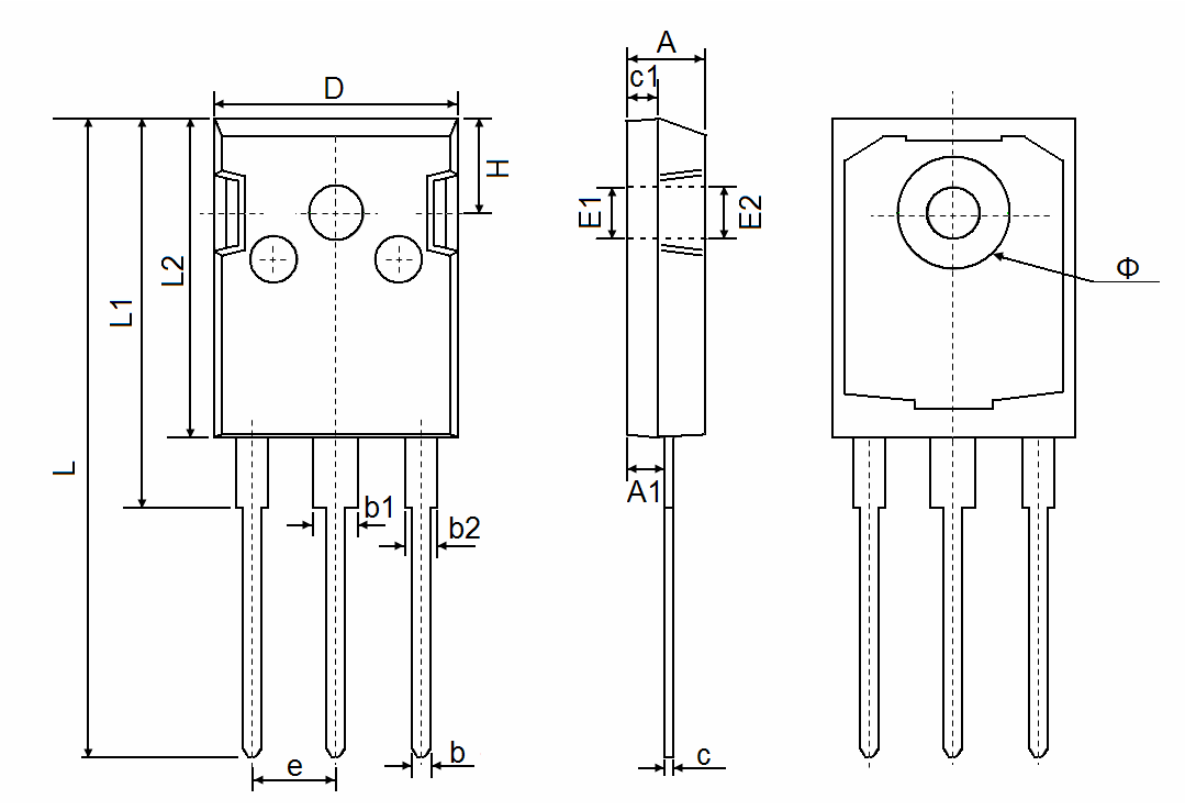




### 3）Unclamped Inductive Switching Test Circuit & Waveforms



# TO-247 Package Information




| Symbol | Dimensions In Millimeters | | Dimensions In Inches | |
|---|---|---|---|---|
| | Min. | Max. | Min. | Max. |
| A | 4.850 | 5.150 | 0.191 | 0.200 |
| A1 | 2.200 | 2.600 | 0.087 | 0.102 |
| b | 1.000 | 1.400 | 0.039 | 0.055 |
| b1 | 2.800 | 3.200 | 0.110 | 0.126 |
| b2 | 1.800 | 2.200 | 0.071 | 0.087 |
| c | 0.500 | 0.700 | 0.020 | 0.028 |
| c1 | 1.900 | 2.100 | 0.075 | 0.083 |
| D | 15.450 | 15.750 | 0.608 | 0.620 |
| E1 | 3.500 REF | | 0.138 REF | |
| E2 | 3.600 REF | | 0.142 REF | |
| L | 40.900 | 41.300 | 1.610 | 1.626 |
| L1 | 24.800 | 25.100 | 0.976 | 0.988 |
| L2 | 20.300 | 20.600 | 0.799 | 0.811 |
| Φ | 7.100 | 7.300 | 0.280 | 0.287 |
| e | 5.450 TYP | | 0.215 TYP | |
| H | 5.980 REF | | 0.235 REF | |