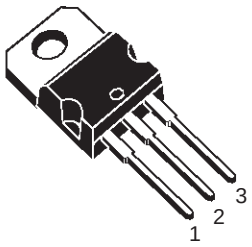
# STP60NS04Z

## N - CHANNEL CLAMPED 10mΩ - 60A - TO-220
## FULLY PROTECTED MESH OVERLAY™ MOSFET

**PRELIMINARY DATA**

| TYPE | $V_{DSS}$ | $R_{DS(on)}$ | $I_D$ |
|---|---|---|---|
| STP60NS04Z | CLAMPED | <0.015 Ω | 60 A |

- TYPICAL $R_{DS(on)}$ = 0.010 Ω
- 100% AVALANCHE TESTED
- LOW CAPACITANCE AND GATE CHARGE
- 175 °C MAXIMUM JUNCTION TEMPERATURE




**TO-220**

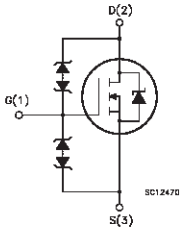
### DESCRIPTION

This fully clamped Mosfet is produced by using the latest advanced Company's Mesh Overlay process which is based on a novel strip layout.
The inherent benefits of the new technology coupled with the extra clamping capabilities make this product particularly suitable for the harshest operation conditions such as those encountered in the automotive environment. Any other application requiring extra ruggedness is also recommended.

### APPLICATIONS

- ABS, SOLENOID DRIVERS
- MOTOR CONTROL
- DC-DC CONVERTERS

### INTERNAL SCHEMATIC DIAGRAM




### ABSOLUTE MAXIMUM RATINGS

| Symbol | Parameter | Value | Unit |
|---|---|---|---|
| $V_{DS}$ | Drain-source Voltage ($V_{GS}$ = 0) | CLAMPED | V |
| $V_{DG}$ | Drain- gate Voltage | CLAMPED | V |
| $V_{GS}$ | Gate-source Voltage | CLAMPED | V |
| $I_D$ | Drain Current (continuous) at $T_c$ = 25 °C | 60 | A |
| $I_D$ | Drain Current (continuous) at $T_c$ = 100 °C | 42 | A |
| $I_{DG}$ | Drain Gate Current (continuous) | ± 50 | mA |
| $I_{GS}$ | Gate Source Current (continuous) | ± 50 | mA |
| $I_{DM}$(•) | Drain Current (pulsed) | 240 | A |
| $P_{tot}$ | Total Dissipation at $T_c$ = 25 °C | 140 | W |
| | Derating Factor | 0.93 | W/°C |
| $V_{ESD(G-S)}$ | Gate-Source ESD (HBM - C= 100pF, R=1.5 kΩ) | 2 | kV |
| $V_{ESD(G-D)}$ | Gate-Drain ESD (HBM - C= 100pF, R=1.5 kΩ) | 4 | kV |
| $V_{ESD(D-S)}$ | Drain-Source ESD (HBM - C= 100pF, R=1.5 kΩ) | 4 | kV |
| $T_{stg}$ | Storage Temperature | -65 to 175 | °C |
| $T_j$ | Max. Operating Junction Temperature | -40 to 175 | °C |

(•) Pulse width limited by safe operating area

(1) $I_{SD}$ ≤60 A, di/dt ≤ 300 A/µs, $V_{DD}$ ≤ $V_{(BR)DSS}$, $T_j$ ≤ $T_{JMAX}$

## THERMAL DATA

| | | | | |
|---|---|---|---|---|
| $R_{thj\text{-}case}$ | Thermal Resistance Junction-case | Max | 1.07 | °C/W |
| $R_{thj\text{-}case}$ | Thermal Resistance Junction-case | Typ | 0.85 | °C/W |
| $R_{thj\text{-}amb}$ | Thermal Resistance Junction-ambient | Max | 62.5 | °C/W |
| $R_{thc\text{-}sink}$ | Thermal Resistance Case-sink | Typ | 0.5 | °C/W |
| $T_l$ | Maximum Lead Temperature For Soldering Purpose | | 300 | °C |

## AVALANCHE CHARACTERISTICS

| Symbol | Parameter | Max Value | Unit |
|---|---|---|---|
| $I_{AR}$ | Avalanche Current, Repetitive or Not-Repetitive (pulse width limited by $T_j$ max, $\delta < 1\%$) | 60 | A |
| $E_{AS}$ | Single Pulse Avalanche Energy (starting $T_j = 25\ ^oC$, $I_D = I_{AR}$, $V_{DD} = 30$ V) | 400 | mJ |

## ELECTRICAL CHARACTERISTICS ($T_{case} = 25\ ^oC$ unless otherwise specified)

OFF

| Symbol | Parameter | Test Conditions | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| $V_{CLAMP}$ | Drain-Gate Breakdown Voltage | $I_D = 1$ mA $V_{GS} = 0$<br>$-40 < T_j < 175\ ^oC$ | 33 | | | V |
| $I_{DSS}$ | Zero Gate Voltage Drain Current ($V_{GS} = 0$) | $V_{DS} = 16$ V $T_j = 175\ ^oC$ | | | 50 | µA |
| $I_{GSS}$ | Gate-body Leakage Current ($V_{DS} = 0$) | $V_{GS} = \pm 10$ V $T_j = 175\ ^oC$<br>$V_{GS} = \pm 16$ V $T_j = 175\ ^oC$ | | | 50<br>150 | µA<br>µA |
| $V_{GSS}$ | Gate-Source Breakdown Voltage | $I_G = 100$ µA | 18 | | | V |

ON (*)

| Symbol | Parameter | Test Conditions | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| $V_{GS(th)}$ | Gate Threshold Voltage | $V_{DS}=V_{GS}$ $I_D = 1$ mA<br>$-40 < T_j < 150\ ^oC$ | 1.7 | 3 | 4.2 | V |
| $R_{DS(on)}$ | Static Drain-source On Resistance | $V_{GS} = 10$V $I_D = 30$ A<br>$V_{GS} = 16$V $I_D = 30$ A | | 11<br>10 | 15<br>14 | mΩ<br>mΩ |
| $I_{D(on)}$ | On State Drain Current | $V_{DS} > I_{D(on)} \times R_{DS(on)max}$<br>$V_{GS} = 10$ V | 60 | | | A |

DYNAMIC

| Symbol | Parameter | Test Conditions | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| $g_{fs}$ (*) | Forward Transconductance | $V_{DS} > I_{D(on)} \times R_{DS(on)max}$ $I_D = 30$ A | 20 | 30 | | S |
| $C_{iss}$<br>$C_{oss}$<br>$C_{rss}$ | Input Capacitance<br>Output Capacitance<br>Reverse Transfer Capacitance | $V_{DS} = 25$ V f = 1 MHz $V_{GS} = 0$ | | 2500<br>800<br>150 | 3400<br>1100<br>200 | pF<br>pF<br>pF |

**ELECTRICAL CHARACTERISTICS** (continued)

SWITCHING ON

| Symbol | Parameter | Test Conditions | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| $Q_g$ | Total Gate Charge | $V_{DD}$ = 16 V $I_D$ = 60 A $V_{GS}$ = 10 V | | 70 | 100 | nC |
| $Q_{gs}$ | Gate-Source Charge | | | 20 | | nC |
| $Q_{gd}$ | Gate-Drain Charge | | | 22 | | nC |

SWITCHING OFF

| Symbol | Parameter | Test Conditions | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| $t_{r(Voff)}$ | Off-voltage Rise Time | $V_{CLAMP}$ = 30 V $I_D$ = 60 A | | 25 | 35 | ns |
| $t_f$ | Fall Time | $R_G$ =4.7 Ω $V_{GS}$ = 10 V | | 110 | 150 | ns |
| $t_c$ | Cross-over Time | (see test circuit, figure 5) | | 150 | 200 | ns |

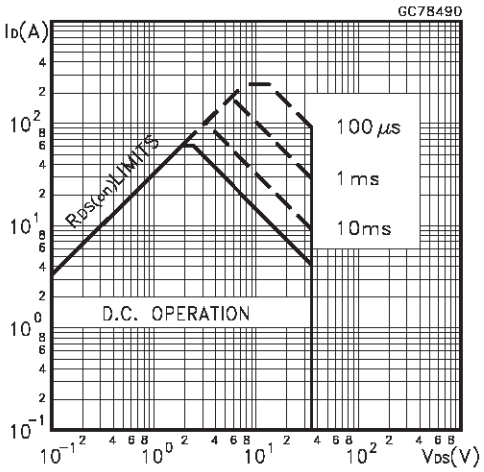
SOURCE DRAIN DIODE

| Symbol | Parameter | Test Conditions | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| $I_{SD}$ | Source-drain Current | | | | 60 | A |
| $I_{SDM}$ (•) | Source-drain Current (pulsed) | | | | 240 | A |
| $V_{SD}$ (*) | Forward On Voltage | $I_{SD}$ = 60 A $V_{GS}$ = 0 | | | 1.5 | V |
| $t_{rr}$ | Reverse Recovery Time | $I_{SD}$ = 60 A di/dt = 100 A/µs<br>$V_r$ = 25 V $T_j$ = 150 °C | | 65 | | ns |
| $Q_{rr}$ | Reverse Recovery Charge | (see test circuit, figure 5) | | 0.15 | | µC |
| $I_{RRM}$ | Reverse Recovery Current | | | 4.5 | | A |

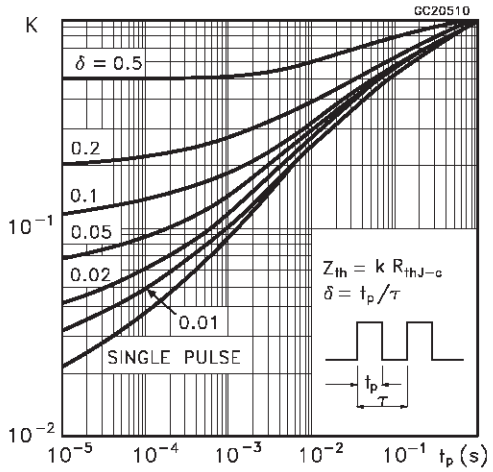
(*) Pulsed: Pulse duration = 300 µs, duty cycle 1.5 %

(•) Pulse width limited by safe operating area

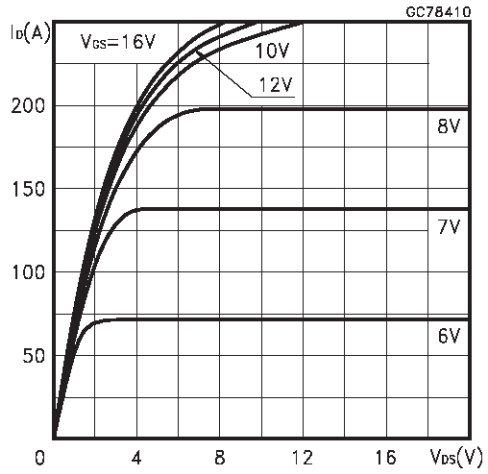
Safe Operating Area



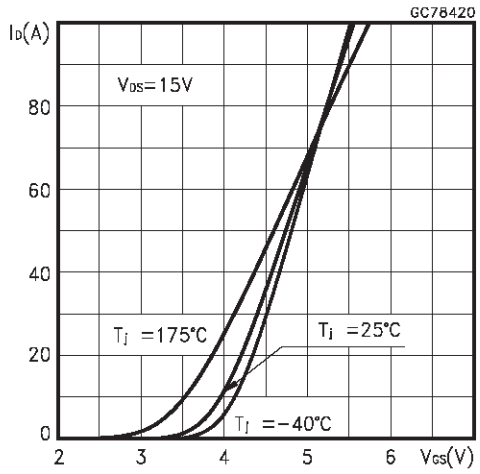

Thermal Impedance



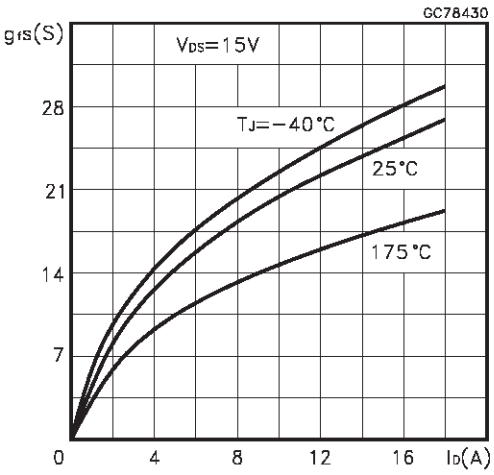
Output Characteristics



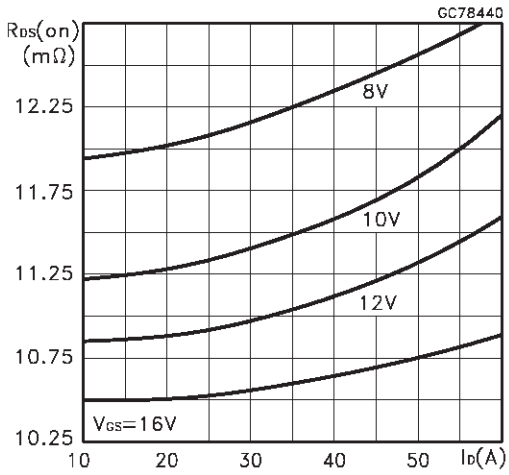

Transfer Characteristics



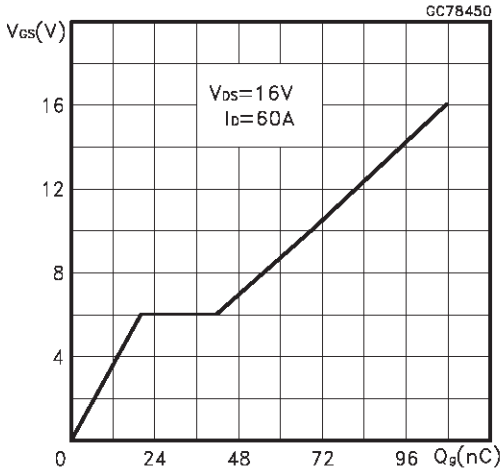

Transconductance



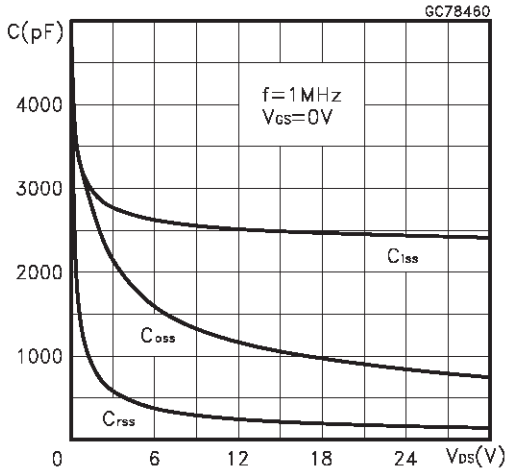

Static Drain-source On Resistance



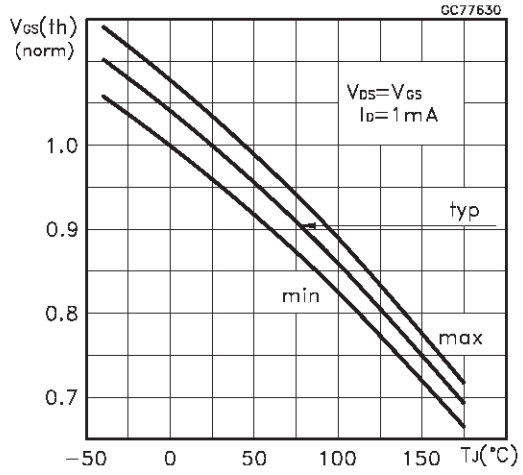

Gate Charge vs Gate-source Voltage



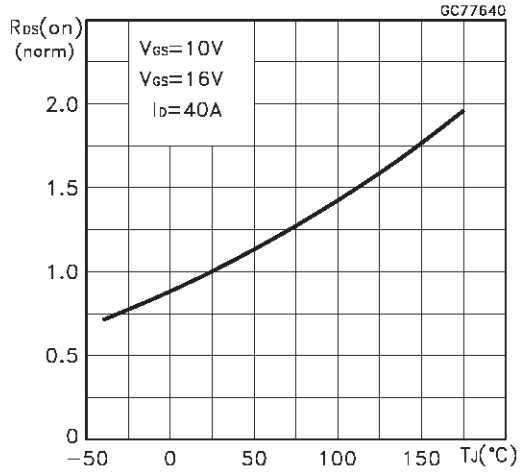

Capacitance Variations



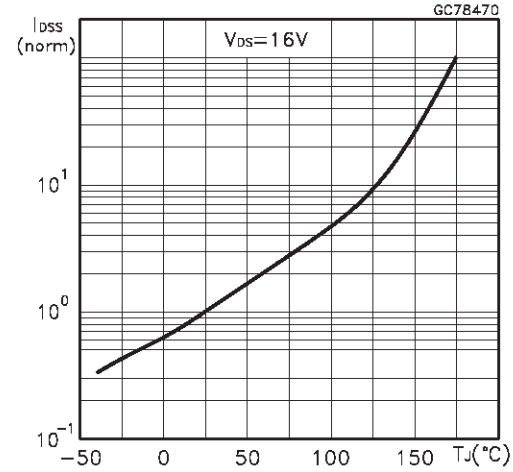
Normalized Gate Threshold Voltage vs Temperature




Normalized On Resistance vs Temperature




Zero Gate Voltage Drain Current vs Temperature




Source-drain Diode Forward Characteristics

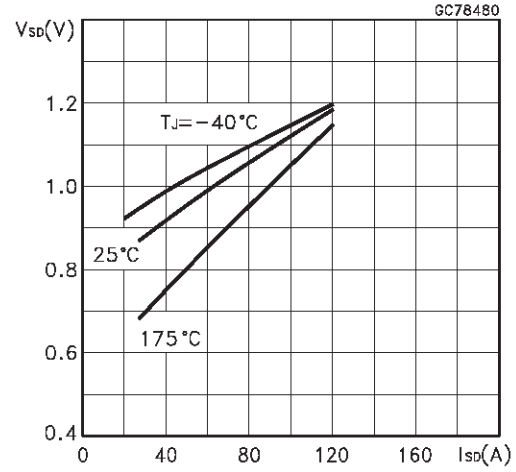


**Fig. 1:** Unclamped Inductive Load Test Circuit

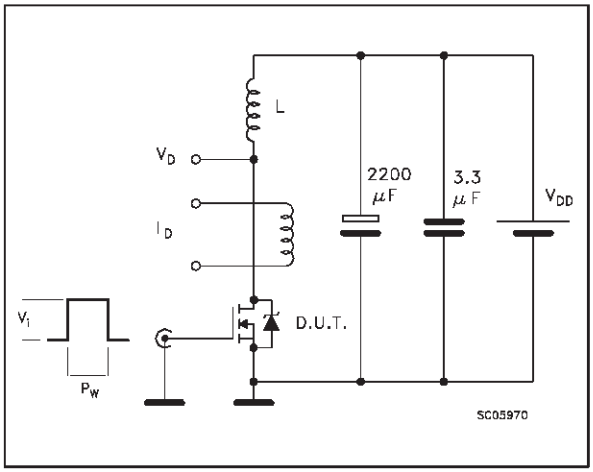



**Fig. 2:** Unclamped Inductive Waveform

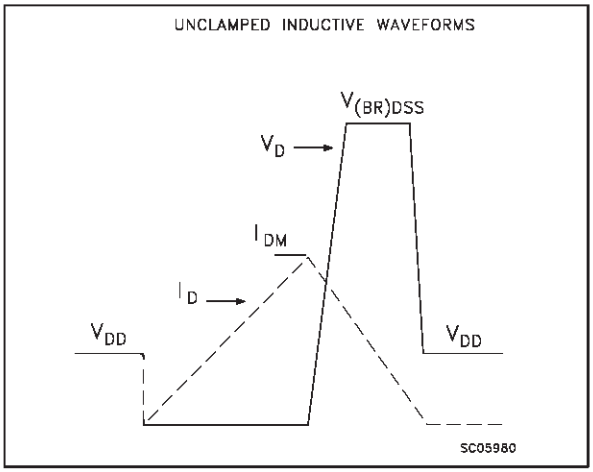



**Fig. 3:** Switching Times Test Circuits For Resistive Load

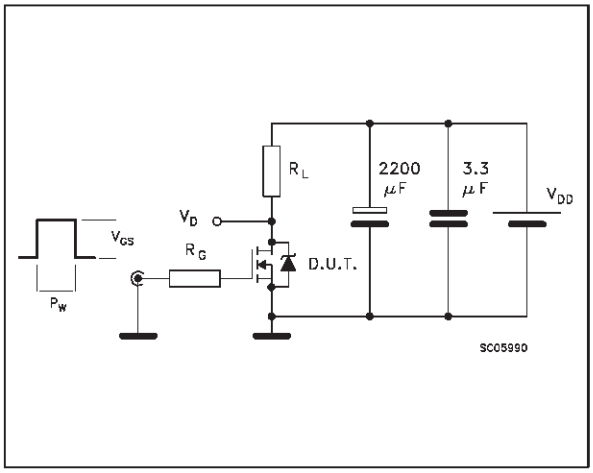



**Fig. 4:** Gate Charge test Circuit

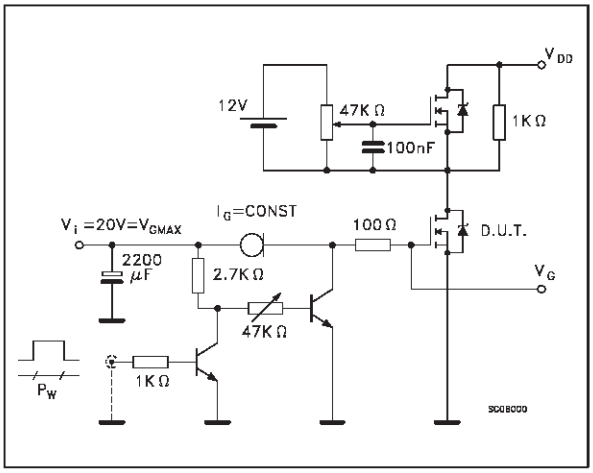
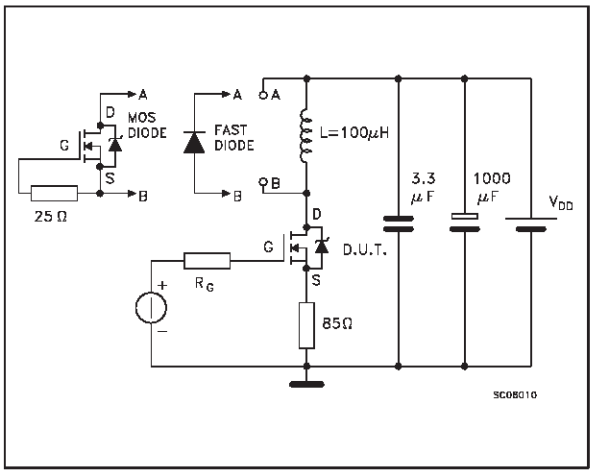



**Fig. 5:** Test Circuit For Inductive Load Switching And Diode Recovery Times



## TO-220 MECHANICAL DATA

| DIM. | mm | | | inch | | |
|---|---|---|---|---|---|---|
| | MIN. | TYP. | MAX. | MIN. | TYP. | MAX. |
| A | 4.40 | | 4.60 | 0.173 | | 0.181 |
| C | 1.23 | | 1.32 | 0.048 | | 0.051 |
| D | 2.40 | | 2.72 | 0.094 | | 0.107 |
| D1 | | 1.27 | | | 0.050 | |
| E | 0.49 | | 0.70 | 0.019 | | 0.027 |
| F | 0.61 | | 0.88 | 0.024 | | 0.034 |
| F1 | 1.14 | | 1.70 | 0.044 | | 0.067 |
| F2 | 1.14 | | 1.70 | 0.044 | | 0.067 |
| G | 4.95 | | 5.15 | 0.194 | | 0.203 |
| G1 | 2.4 | | 2.7 | 0.094 | | 0.106 |
| H2 | 10.0 | | 10.40 | 0.393 | | 0.409 |
| L2 | | 16.4 | | | 0.645 | |
| L4 | 13.0 | | 14.0 | 0.511 | | 0.551 |
| L5 | 2.65 | | 2.95 | 0.104 | | 0.116 |
| L6 | 15.25 | | 15.75 | 0.600 | | 0.620 |
| L7 | 6.2 | | 6.6 | 0.244 | | 0.260 |
| L9 | 3.5 | | 3.93 | 0.137 | | 0.154 |
| DIA. | 3.75 | | 3.85 | 0.147 | | 0.151 |