SGS-THOMSON MICROELECTRONICS

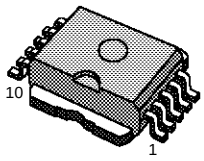
# VN370SP

## TRIPLE CHANNEL HIGH SIDE SMART POWER SOLID STATE RELAY

**TARGET DATA**

| TYPE | $V_{DSS}$ | $R_{DS(on)}$ | $I_{OUT}$ | channel |
|---|---|---|---|---|
| VN370SP | 60V | 0.25 Ω | 1 A | 1 |
| | 60V | 1.7 Ω | 0.3A | 2 |
| | 60V | 1.7 Ω | 0.3A | 3 |

- ONE 2.4A (MAX) CHANNEL
- TWO 0.36A (MAX) CHANNELS
- THREE TTL INPUTS
- OVER VOLTAGE SHUTDOWN
- INDEPENDENT THERMAL SHUTDOWN FOR EACH CHANNEL
- CURRENT LIMITER ON EACH CHANNEL
- VERY LOW STAND-BY POWER DISSIPATION




**Power SO-10™**

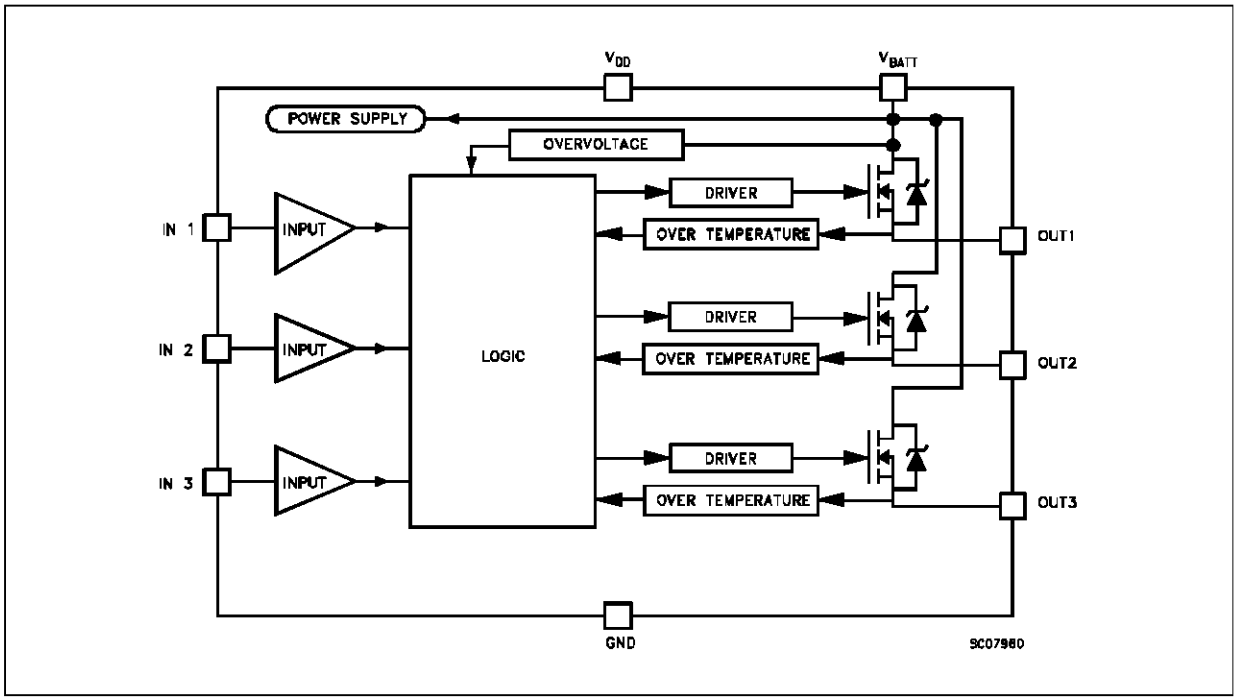
### DESCRIPTION

The VN370SP is a monolithic device made using SGS-THOMSON Vertical Intelligent Power Technology, intended for driving three indipedent resistive or inductive loads with one side connected to ground.

The input control are TTL compatible. Overvoltage shutdown protect the loads against voltage surges on the supply line.

Three independant current limiters and thermal shutdown protect the chip in over temperature or short circuit conditions.

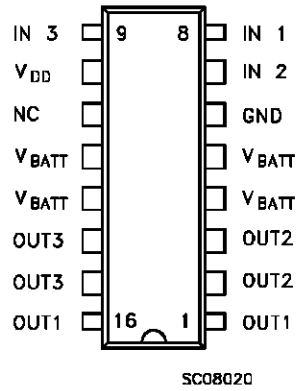
### BLOCK DIAGRAM



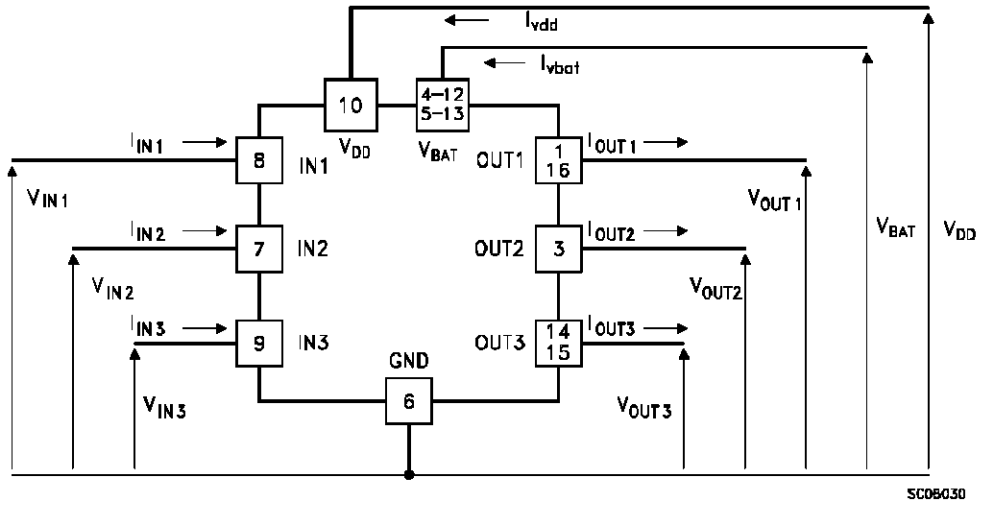
## ABSOLUTE MAXIMUM RATING

| Symbol | Parameter | Value | Unit |
|---|---|---|---|
| $V_{(BR)DSS}$ | Drain-Source Breakdown Voltage | 60 | V |
| $-V_{CC}$ | Reverse Supply Voltage | -4 | V |
| $I_L$ | Maximum DC Load Current | Internally Limited | A |
| $I_R$ | Reverse Output Current Per Channel | -7 | A |
| $I_{IN}$ | Input Current (INPUTn) | ±10 | mA |
| $V_{ESD1}$ | Electrostatic Discharge (1.5 kΩ, 100 pF) | 4000 | V |
| $P_{tot}$ | Power Dissipation at $T_c \leq 25\ ^oC$ | Internally Limited | W |
| $T_j$ | Junction Operating Temperature | -40 to 150 | $^oC$ |
| $T_{stg}$ | Storage Temperature | -55 to 150 | $^oC$ |

## CONNECTION DIAGRAM




## CURRENT AND VOLTAGE CONVENTIONS



## THERMAL DATA

| | | | | |
|---|---|---|---|---|
| $R_{thj\text{-}case1}$ | Thermal Resistance Junction-case (Channel 1) | Max | 5 | °C/W |
| $R_{thj\text{-}case2}$ | Thermal Resistance Junction-case (Channel 2) | Max | 30 | °C/W |
| $R_{thj\text{-}amb}$ | Thermal Resistance Junction-ambient (Channel 1) ($) | Max | 36 | °C/W |
| $R_{thj\text{-}amb}$ | Thermal Resistance Junction-ambient (Channel 2) ($) | Max | 60 | °C/W |

(1) All channels ON
($) When mounted using minimum recommended pad size on FR-4 board

**ELECTRICAL CHARACTERISTICS** (10V < $V_{BAT}$ < 16V; -40°C < $T_{case}$ < 125°C; 4.75V < $V_{DD}$ < 5.25V; unless otherwise specified)

POWER

| Symbol | Parameter | Test Conditions | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| $V_{CC}$ | Supply Voltage | | 7 | 13 | 24 | V |
| $R_{on1}$ | On State Resistance (Channel 1) | $I_{OUT1}$ = 1 A<br>$I_{OUT}$1 = 1A $T_j$ = 25 °C | | <br>0.2 | 0.5<br>0.25 | Ω<br>Ω |
| $R_{on2}$ | On State Resistance (Channel 2) | $I_{OUT2}$ = 0.3 A<br>$I_{OUT2}$ = 0.3 A $T_j$ = 25 °C | | <br>1.4 | 3.3<br>1.7 | Ω<br>Ω |
| $R_{on3}$ | On State Resistance (Channel 3) | $I_{OUT3}$ = 0.3 A<br>$I_{OUT3}$ = 0.3 A $T_j$ = 25 °C | | <br>1.4 | 3.3<br>1.7 | Ω<br>Ω |
| $I_{bs}$ | Supply Current from $V_{bat}$ pin | Off State $T_j \geq 25$ °C<br>On State $I_{out1} = I_{out2} = I_{out3} = 0$ | | | 50<br>50 | µA<br>mA |
| $I_{ds}$ | Supply Current from $V_{DD}$ pin | | | | 5 | mA |
| $I_{ls}$ | Output Leakage Current | $V_{SW1} = V_{SW2} = V_{SW3}$ = 0V, current measured between OUT1 or OUT2 or OUT3 and GND | -50 | | 50 | µA |
| $V_{dem1}$ | Channel 1 Output Demagnetization Voltage | $I_{out1}$ = 1 A $L_{LOAD}$ = 1 mH<br>$T_c$ = 25 °C | -24 | -20 | -16 | V |
| $V_{dem2}$ | Channel 2 and Channel 3 Output Demagnetization Voltage | $I_{out2}$ or $I_{out2}$ = 0.3 A $L_{LOAD}$ = 1 mH<br>$T_c$ = 25 °C | -24 | -20 | -16 | V |

SWITCHING

| Symbol | Parameter | Test Conditions | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| $t_{d(on)}$ | Turn-on Delay Time (Chan. 1, 2, 3) | $I_{OUT} = I_n$, Resistive Load<br>Input Rise Time < 0.1 µs $T_j$ = 25 °C | | | 50 | µs |
| $t_r$ | Rise Time Of Output Current (Chan. 1, 2, 3) | $I_{OUT} = I_n$, Resistive Load<br>Input Rise Time < 0.1 µs $T_j$ = 25 °C | | | 50 | µs |
| $t_{d(off)}$ | Turn-off Delay Time (Chan. 1, 2, 3) | $I_{OUT} = I_n$, Resistive Load<br>Input Rise Time < 0.1 µs $T_j$ = 25 °C | | | 100 | µs |
| $t_f$ | Fall Time Of Output Current (Chan. 1, 2, 3) | $I_{OUT} = I_n$, Resistive Load<br>Input Rise Time < 0.1 µs $T_j$ = 25 °C | | | 50 | µs |

## ELECTRICAL CHARACTERISTICS (continued)

LOGIC INPUT

| Symbol | Parameter | Test Conditions | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| $V_{IL}$ | Input Low Level Voltage | | | | 0.8 | V |
| $V_{IH}$ | Input High Level Voltage | | 2 | | (*) | V |
| $V_{I(hyst.)}$ | Input Hysteresis Voltage | | | 0.5 | | V |
| $I_{IN}$ | Input Current | $V_{IN(X)}$ = 5.5 V $V_{BAT}$ = 14 V | -10 | | 10 | µA |
| $V_{ICL}$ | Input Clamp Voltage | $I_{IN(X)}$ = 10 mA<br>$I_{IN(X)}$ = -10 mA | 8 | 9.5<br>-0.7 | 11 | V<br>V |

PROTECTION AND DIAGNOSTICS

| Symbol | Parameter | Test Conditions | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| $V_{ov}$ | Over Voltage Shut-down | (see fig. 1) | 24 | 27 | 30 | V |
| $I_{LIM1}$ | Current Limit (Channel 1) | $R_{L1}$ = 500 mΩ | 2.3 | | 4.4 | A |
| $I_{LIM2}$ | Current Limit (Channel 2 and Channel 3) | $R_{L2,3}$ = 500 mΩ | 0.36 | | 0.72 | A |
| $I_{BLG}$ | Leakage Current From $V_{BAT}$ When GND pin is Open | $R_{L1}$ = 16 Ω $R_{L2}$ = 53 Ω<br>$R_{L3}$ = 80 Ω GND pin is open | -10 | | 10 | mA |
| $T_{TSD1}$ | Thermal Shut-down Temperature (Chan. 1) | | 150 | 170 | 190 | °C |
| $T_{R1}$ | Thermal Reset Temperature (Chan. 1) | | 120 | | | °C |
| $T_{TSD2}$ | Thermal Shut-down Temperature (Chan. 2 and 3) | | 140 | 160 | 180 | °C |
| $T_{R2}$ | Thermal Reset Temperature (Chan. 2 and 3) | | 130 | | | °C |

(*) The $V_{IH}$ is internally clamped at 9.5V about. It is possible to connect the input pins to an higher voltage via an external resistor calculated to not exceed 10 mA at the input pin.
(•) Status determination > 100 µs after the switching edge.

## TRUTH TABLE

| | IN1 | OUT1 | IN2 | OUT2 | IN3 | OUT3 |
|---|---|---|---|---|---|---|
| Normal Operation | L<br>H | L<br>H | L<br>H | L<br>H | L<br>H | L<br>H |
| Over-Voltage | L<br>H | L<br>L | L<br>H | L<br>L | L<br>H | L<br>L |
| Thermal Shutdown Channel 1 | L<br>H | L<br>L | L<br>H | L<br>L | L<br>H | L<br>L |
| Thermal Shutdown Channel 2 | L<br>H | L<br>H | L<br>H | L<br>L | L<br>H | L<br>H |
| Thermal Shutdown Channel 3 | L<br>H | L<br>H | L<br>H | L<br>H | L<br>H | L<br>L |

## FUNCTIONAL DESCRIPTION

The device integrates one high current channel (1A nominal current) and two identical low current channels (0.3A). Each of these three channels is independently controlled by TTL compatible input pin IN1 to IN3 and drives a resistive or inductive load in high side configuration.

When any channel switches off an unclamped inductive load, the relevant output voltage is clamped to typically -20V.

The device is powered both from a battery input therminal $V_{BAT}$ and from a supply input therminal $V_{DD}$.

$V_{DD}$ terminal should be connected to a 5V ±5% supply while $V_{BAT}$ terminal is connected to the car battery line through a (L=40mH, C=4000µF) filter. An antiparallel diode ahead of the LC filter clamps the negative voltage on $V_{BAT}$ terminal to -0.8V typ for channel 1 and 0.5A typ. for channel 2 and channel 3.

When channel 2 or channel 3 is overloaded, so that the relevant power output junction temperature reaches 160 $^{o}$C typ, the overladed output shuts down and restarts automatically when the power output temperature has cooled down to 130 $^{o}$C. The other channels remain unaffected.

If channel 1 is overloaded, so that power output 1 junction temperature reaches 170 $^{o}$C typ, the three channels shut down and restart automatically when the power output1 temperature has cooled down to 120 $^{o}$C.

if VBAT terminal voltage ingrases abobe 27V typ, all outputs shut down and restart again when VBAT voltage has decreased below 27V.

If GND terminal is opened, all outputs shut down whatever the state of IN1, IN2 and IN3 provided no pin voltage exceed 16 V with respect to the loads negative terminal.

## SWITCHING PARAMETERS TEST CONDITIONS

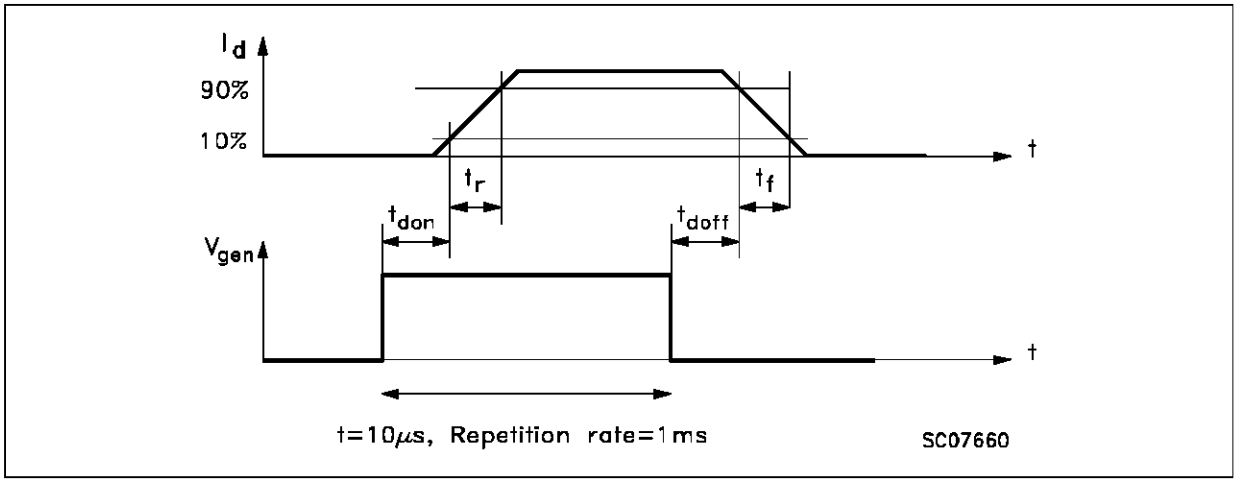
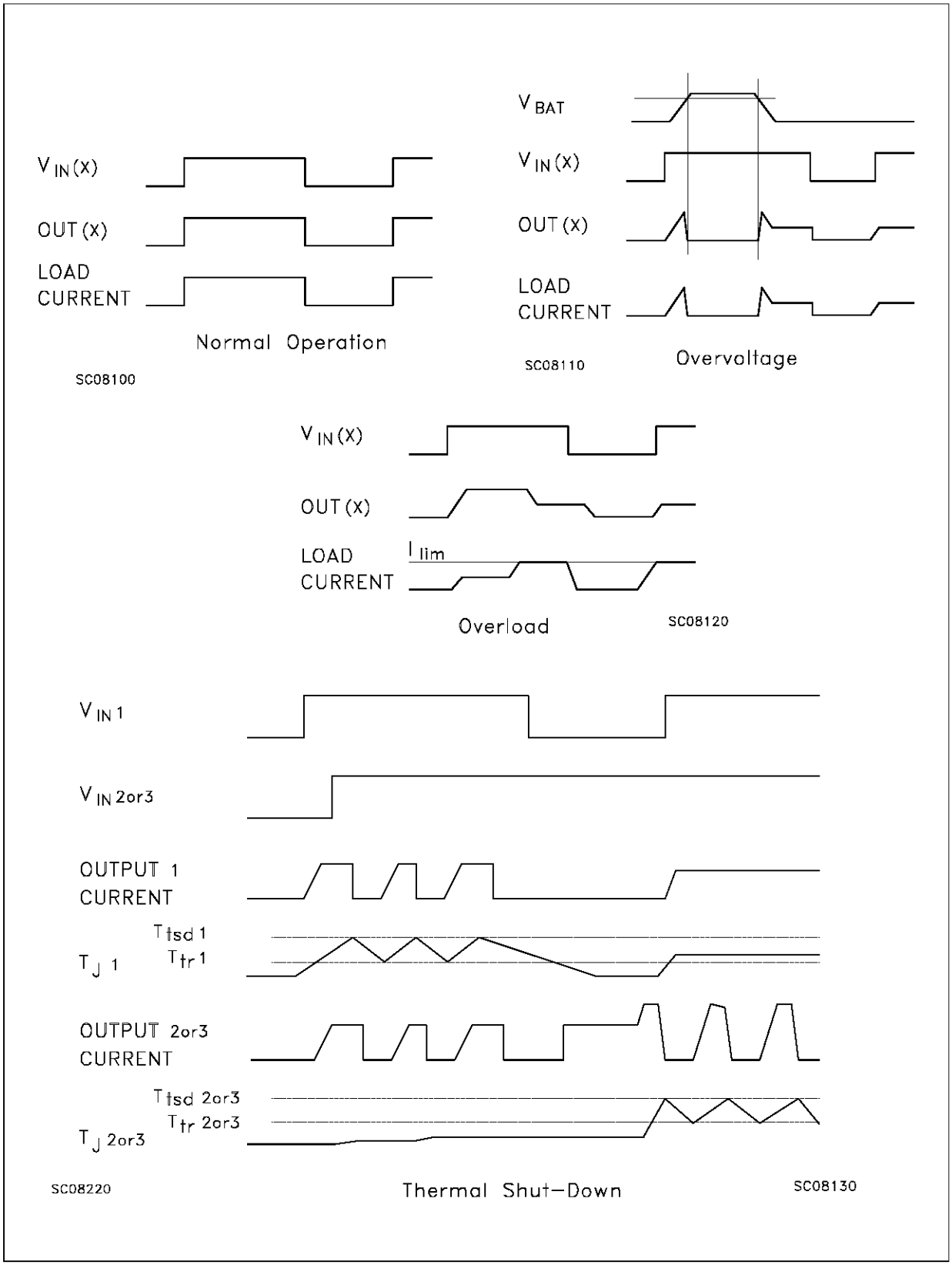


**Figure 1:** Waveforms



## Power SO-10 MECHANICAL DATA

| DIM. | mm | | | inch | | |
|---|---|---|---|---|---|---|
| | MIN. | TYP. | MAX. | MIN. | TYP. | MAX. |
| A | 3.45 | 3.5 | 3.55 | 0.135 | 0.137 | 0.140 |
| B | | 1.28 | 1.30 | | 0.050 | 0.051 |
| C | | | 0.15 | | | 0.006 |
| D | 9.40 | 9.50 | 9.60 | 0.370 | 0.374 | 0.378 |
| E | 4.98 | 5.08 | 5.48 | 0.196 | 0.200 | 0.216 |
| E1 | 0.40 | 0.45 | 0.60 | 0.016 | 0.018 | 0.024 |
| E2 | 1.17 | 1.27 | 1.37 | 0.046 | 0.050 | 0.054 |
| F | 9.30 | 9.40 | 9.50 | 0.366 | 0.370 | 0.374 |
| F1 | 7.95 | 8.00 | 8.15 | 0.313 | 0.315 | 0.321 |
| G | 7.40 | 7.50 | 7.60 | 0.291 | 0.295 | 0.299 |
| H | 6.80 | 6.90 | 7.00 | 0.267 | 0.417 | 0.421 |
| I | | 0.10 | | | 0.004 | |
| K | 13.80 | 14.10 | 14.40 | 0.543 | 0.555 | 0.567 |
| L | | 0.40 | 0.50 | | 0.016 | 0.020 |
| M | 1.60 | 1.67 | 1.80 | 0.063 | 0.066 | 0.071 |
| N | 0.60 | 0.08 | 1.00 | 0.024 | 0.031 | 0.039 |