# CX1549

# Air Cooled, Deuterium Filled, Metal/Ceramic Thyratron

The data to be read in conjunction with the Hydrogen Thyratron Preamble.

## ABRIDGED DATA

Deuterium-filled, tetrode thyratron with metal/ceramic envelope, suitable for switching high peak and average power at high pulse repetition rates. A reservoir operating from the cathode heater supply or a separate supply is incorporated.
In order to achieve the fastest rate of rise of current possible from the tube in the circuit, the reservoir heater voltage can be adjusted within the specified limits to obtain the maximum thyratron gas pressure consistent with the required voltage hold-off.

| | | |
|---|---|---|
| Peak forward anode voltage | - | 35 kV max |
| Peak forward anode current | - | 10 kA max |
| Average anode current | - | 15 A max |
| Operating frequency | - | See note 1 |


## GENERAL DATA

### Electrical

| | | |
|---|---|---|
| Cathode | - | Barium aluminate impregnated tungsten |
| Cathode heater voltage (see note 2) | - | 6.3 ± 5% V |
| Cathode heater current | - | 90 A |
| Reservoir heater voltage (see notes 2 and 3) | - | 6.3 ± 5% V |
| Reservoir heater current | - | 7.0 A |
| Tube heating time (minimum) | - | 10 min |
| Anode to grid 2 capacitance | - | 80 pF |

### Mechanical

| | | |
|---|---|---|
| Seated height | - | 325 mm (12.795 inches) max |
| Clearance required below mounting flange | - | 75 mm (2.953 inches) min |
| Overall diameter (excluding connections) | - | 155.4 mm (6.118 inches) max |
| Net weight | - | 10.2 kg (22.5 pounds) approx. |
| Mounting position | - | See note 4 |
| Tube connections | - | See outline |



e2v technologies (uk) limited, Waterhouse Lane, Chelmsford, Essex CM1 2QU United Kingdom  Holding Company: e2v technologies plc
Telephone: +44 (0)1245 493493  Facsimile: +44 (0)1245 492492
Contact e2v by e-mail: enquiries@e2v.com or visit www.e2v.com for global sales and operations centres.



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### Cooling

The tube must be cooled by forced-air directed axially at the base from below. A fan of output 7.08 $m^3$/min (250 $ft^3$/min) minimum will be necessary to keep the tube operating temperatures within the limits specified below. Air blown upwards at the base should be directed via suitable apertures and cowlings to cool the grid flanges, tube envelope and anode as indicated in Fig. 1. e2v technologies cooling modules, types MA2161A and MA2161B, are suitable for this purpose.

In addition to 600 W of heater power, the tube dissipates from 100 W/A average anode current, rising to 300 W/A at the highest rates of rise and fall of anode current.

The cathode end of the tube must be cooled whenever heater voltages are applied.

Envelope temperature:

| | | |
|---|---|---|
| Grid 1, grid 2, gradient grid, anode | - | 150 °C max |
| Cathode flange and end cover | - | 120 °C max |

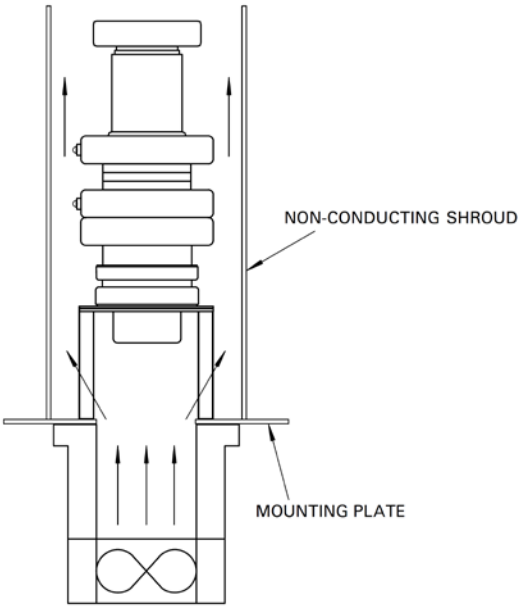



**Fig. 1 Ducting of cooling air**

# PULSE MODULATOR SERVICE

## MAXIMUM AND MINIMUM RATINGS

These ratings cannot necessarily be used simultaneously, and no individual rating must be exceeded.

| Anode | | Min | Max | |
|---|---|---|---|---|
| Peak forward voltage (see note 5) | . | - | 35 | kV |
| Peak inverse anode voltage | . | See note 6 | | |
| Peak anode current | . | - | 10 | kA |
| Average anode current | . | - | 15 | A |
| Rate of rise of anode current (see notes 7 and 8) | . | - | 10 | kA/µs |

### Triggering

For maximum life and minimum grid spike this thyratron should be triggered with a pre-pulse on grid 1.

| Grid 2 | | Min | Max | |
|---|---|---|---|---|
| Unloaded trigger pulse voltage (see note 9) | . | 1000 | 2000 | V |
| Trigger pulse duration | . | 1.0 | - | µs |
| Rate of rise of trigger pulse (see notes 7 and 10) | . | 10.0 | - | kV/µs |
| Trigger pulse delay (see note 11) | . | 0.5 | 3.0 | µs |
| Peak inverse trigger voltage | . | - | 450 | V |
| Loaded trigger pulse bias voltage | . | -50 | -200 | V |
| Peak trigger pulse drive current | . | 5.0 | 40 | A |

| Grid 1 – Pre-pulse (see note 12) | | Min | Max | |
|---|---|---|---|---|
| Unloaded drive pulse voltage | . | 600 | 2000 | V |
| Grid 1 pulse duration | . | 2.0 | - | µs |
| Rate of rise of grid 1 pulse | . | 1.0 | - | kV/µs |
| Peak inverse grid 1 voltage | . | - | 450 | V |
| Loaded grid 1 bias voltage | . | See note 13 | | |
| Peak grid 1 drive current | . | 5.0 | 40 | A |

| Cathode | | Min | Max | |
|---|---|---|---|---|
| Heater voltage | . | 6.3 ± 5% | | V |
| Heating time | . | 10 | - | min |

| Reservoir | | Min | Max | |
|---|---|---|---|---|
| Heater voltage | . | 6.3 ± 5% | | V |
| Heating time | . | 10 | - | min |

| Environmental | | Min | Max | |
|---|---|---|---|---|
| Ambient air temperature | . | 0 | +40 | °C |

## CHARACTERISTICS

| | | Min | Typ | Max | |
|---|---|---|---|---|---|
| Critical DC anode voltage for conduction | . | - | - | 2.0 | kV |
| Anode delay time | . | - | 200 | 350 | ns |
| Anode delay time drift (see note 14) | . | - | 15 | 25 | ns |
| Time jitter (see note 15) | . | - | 3.0 | 10 | ns |
| Recovery time (see notes 1 and 16) | . | - | 20 | - | µs |
| Cathode heater current (at 6.3 V) | . | 80 | 90 | 100 | A |
| Reservoir heater current (at 6.3 V) | . | 6.0 | 7.0 | 8.0 | A |

## NOTES

1. The CX1549 has a short recovery time for a tube of its size. The amount of time available for thyratron recovery must be maximised by circuit design, and reliable operation may necessitate the use of command charging techniques. The amount of time required for recovery is affected by gas pressure, peak current, pulse duration and load mismatch.

2. It is recommended that the cathode heater and the reservoir heater are supplied from independent power supplies. **The common connection for these two supplies is the pair of yellow sleeved leads, not the cathode flange.**
   **N.B. The tube will suffer irreversible damage if the cathode flange is connected as the common point.**
   The cathode heater supply must be connected between the cathode flange and the cathode heater lead (yellow sleeve), the reservoir heater supply must be connected between the cathode heater lead (yellow sleeve) and the reservoir heater lead (red sleeve), see Fig. 2. In order to meet the jitter specification, it may be necessary in some circumstances that the cathode heater be supplied from a DC source.

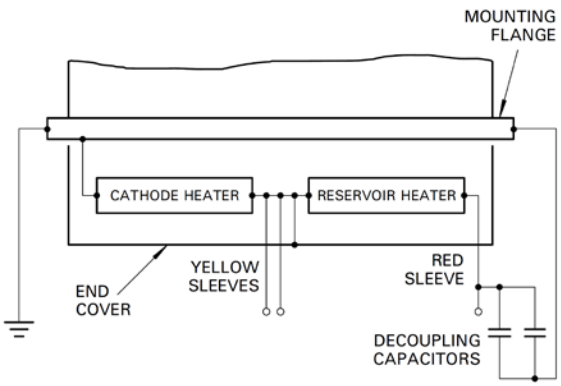



**Fig. 2 Base Connections**

Care should be taken to ensure that excessive voltages are not applied to the reservoir heater circuit from the cathode heater supply because of high impedance cathode heater connections. For example, in the worst case, an open circuit heater lead will impress almost double voltage on the reservoir heater, especially on switch-on, when the cathode heater impedance is minimal.
This situation can be avoided by ensuring that the two supplies are in anti-phase. The reservoir heater circuit must be decoupled with suitable capacitors, for example, a 1 µF capacitor in parallel with a low inductance 1000 pF capacitor, as shown in the schematic below.

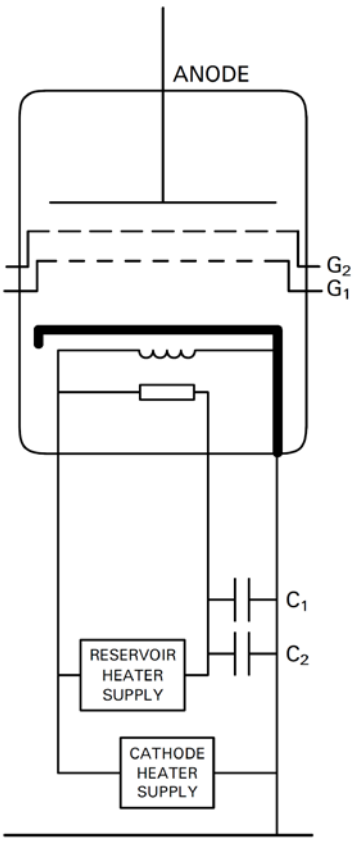



**Fig. 3 Schematic (Heater Connections)**

The heater supply systems should be connected directly between the cathode flange and the heater leads. This avoids the possibility of injecting voltages into the cathode and reservoir heaters. At high rates of rise of anode current, the cathode potential may rise significantly at the beginning of the pulse, depending on the cathode lead inductance, which must be minimised at all times.
If a single transformer is used to supply both the cathode heater and the reservoir heater, then the reservoir heater lead (red sleeve) must be connected to the mounting flange.

3. The gas pressure may be increased to a value consistent with the required forward hold-off voltage by altering the reservoir heater supply voltage within the specified range.

4. The tube must be fitted using its mounting flange, with flexible connections to all other electrodes. The preferred orientation is with the tube axis vertical and anode uppermost; mounting the tube with its axis horizontal is permissible. It is **not** recommended that the tube is mounted with its axis vertical and cathode uppermost.

5. The maximum permissible peak forward voltage for instantaneous starting is 30 kV and there must be no overshoot.

6. The peak inverse voltage including spike must not exceed 10 kV for the first 25 µs after the anode pulse. Amplitude and rate of rise of inverse voltage contribute greatly to tube dissipation and electrode damage; if these are not minimised in the circuit, tube life will be shortened considerably. The aim should be for an inverse voltage of 3 – 5 kV peak with a rise time of 0.5 µs.

7. This rate of rise refers to that part of the leading edge of the pulse between 25% and 75% of the pulse amplitude.

8. For single-shot or burst mode applications this parameter can exceed 100 kA/µs. The ultimate value which can be attained depends to a large extent upon the external circuit.

9. Measured with respect to cathode.

10. A lower rate of rise may be used, but this may result in the anode delay time, delay time drift and jitter exceeding the limits quoted.

11. The last 0.25 µs of the top of the grid 1 pulse must overlap the corresponding first 0.25 µs of the top of the delayed grid 2 trigger pulse.

12. The optimum grid 1 pulse current is the maximum value which can be applied without causing the tube to trigger before the grid 2 pulse is applied. This value is variable depending on gas pressure, maximum forward anode voltage, grid 2 negative bias voltage, peak current and repetition rate.

13. DC negative bias must not be applied to grid 1.

14. Measured between the second minute after the application of HT and 30 minutes later.

15. A time jitter of less than 1 ns can be obtained if the cathode heater voltage is supplied from a DC source, by adopting double-pulsing, and applying a grid 2 pulse with a rate of rise of voltage (unloaded) in excess of 20 kV/µs.

16. Measured after a current pulse of 1000 A, with a grid 2 bias voltage of -100 V, a recovery impedance of 500 Ω and a 1.0 kV anode probe.

## HEALTH AND SAFETY HAZARDS

e2v technologies thyratrons are safe to handle and operate, provided that the relevant precautions stated herein are observed. e2v technologies does not accept responsibility for damage or injury resulting from the use of electronic devices it produces. Equipment manufacturers and users must ensure that adequate precautions are taken. Appropriate warning labels and notices must be provided on equipment incorporating e2v technologies devices and in operating manuals.

### High Voltage

Equipment must be designed so that personnel cannot come into contact with high voltage circuits. All high voltage circuits and terminals must be enclosed and fail-safe interlock switches must be fitted to disconnect the primary power supply and discharge all high voltage capacitors and other stored charges before allowing access. Interlock switches must not be bypassed to allow operation with access door open.

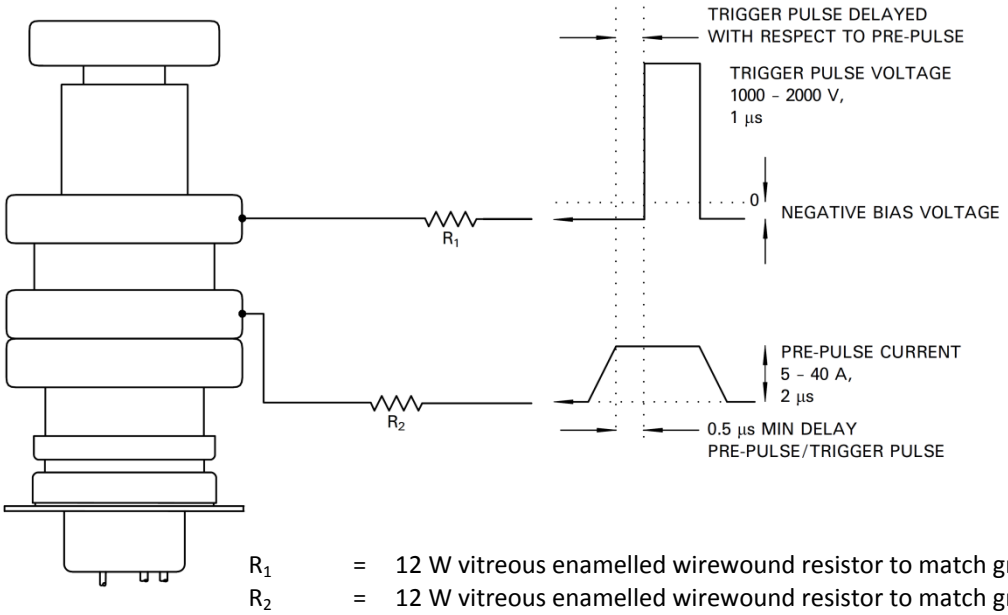
### X-Ray Radiation

All high voltage devices produce X-rays during operation and may require shielding. The X-ray radiation from hydrogen thyratrons is usually reduced to a safe level by enclosing the equipment or shielding the thyratron with at least 1.6 mm (1/16 inch) thick steel panels.
Users and equipment manufacturers must check the radiation level under their maximum operating conditions.

# TRIGGER GRID CONNECTIONS

## Two trigger pulses and negative bias

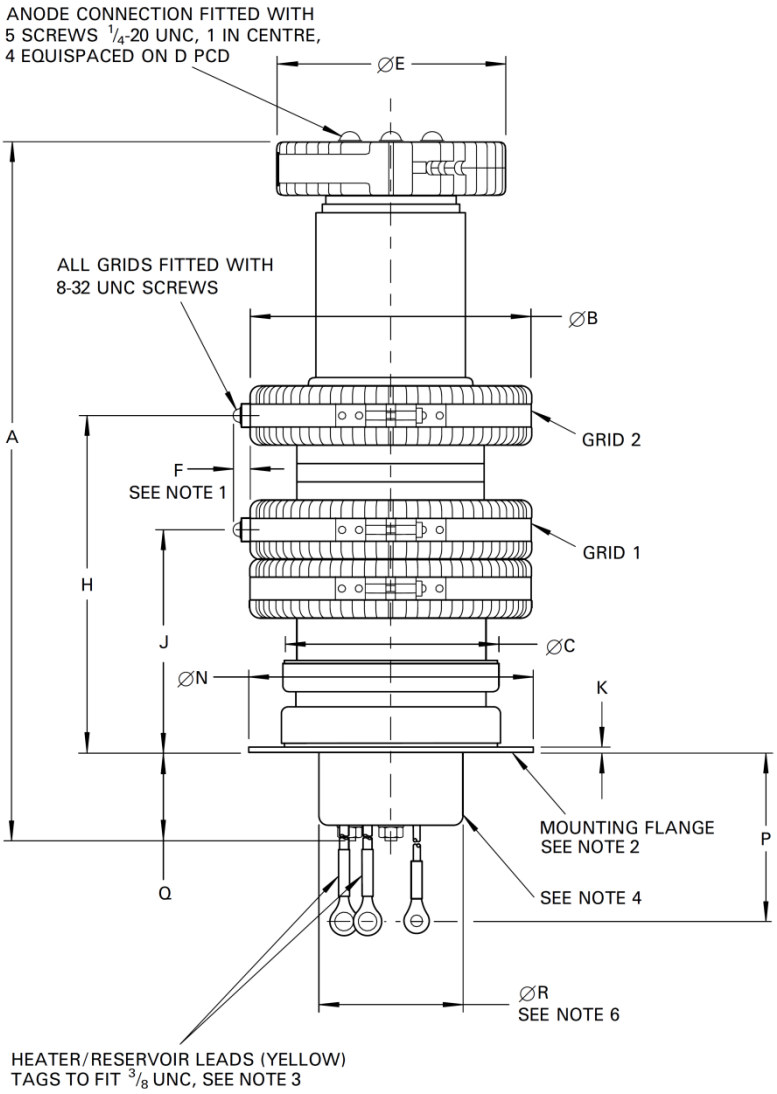
Recommended for maximum cathode utilisation and therefore maximum life.

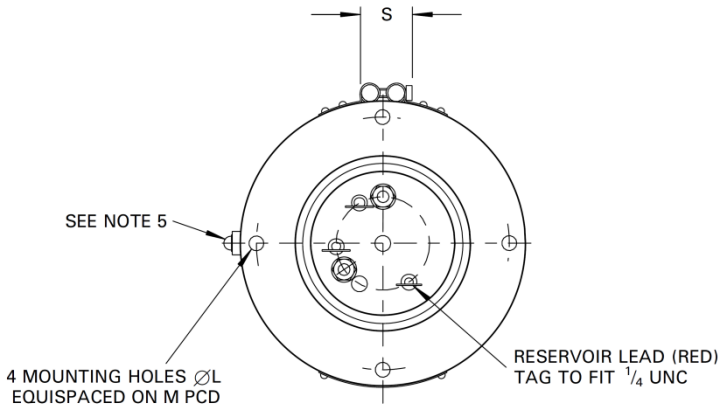



$R_1$ = 12 W vitreous enamelled wirewound resistor to match grid 2 drive circuit.
$R_2$ = 12 W vitreous enamelled wirewound resistor to match grid 1 drive circuit.

# OUTLINE

## (All dimensions without limits are nominal)




| Ref | Millimetres | Inches |
|---|---|---|
| A | 365.0 max | 14.370 |
| B | 152.4 ± 3.0 | 6.000 ± 0.118 |
| C | 120.0 max | 4.724 max |
| D | 44.0 | 1.732 |
| E | 114.3 ± 3.0 | 4.500 ± 0.118 |
| F | 15.0 max | 0.591 max |
| H | 175.0 ± 5.0 | 6.890 ± 0.197 |
| J | 117.0 ± 5.0 | 4.606 ± 0.197 |
| K | 3.15 | 0.124 |
| L | 8.00 | 0.315 |
| M | 135.7 | 5.343 |
| N | 152.4 | 6.000 |
| P | 343.0 ± 6.4 | 13.504 ± 0.250 |
| Q | 57.0 max | 2.244 max |
| R | 78.0 max | 3.071 max |
| S | 36.0 max | 1.417 max |

Inch dimensions have been derived from millimetres

**Outline Notes**

1. This dimension also applies to the clamping screws and lugs.
2. The mounting flange is the connection for the cathode and cathode heater return.
3. These two leads must be connected to the same terminal of the heater transformer.
4. The end cover is at heater potential and must not be grounded.
5. The terminal screws are in line with the hole in the mounting flange to within ±6.35 mm (0.250 inches).
6. The recommended mounting hole is 93.5 mm (3.861 inches) diameter.

# MA2161A/MA2161B COOLING MODULES

The MA2161A/MA2161B cooling modules are designed to air-cool the e2v technologies range of large metal envelope thyratrons. The MA2161A is fitted with a 110 V 40 W fan and the MA2161B with a 220 V 40 W fan.

The cooling system consists of a thyratron mounting flange assembly, grid connectors, upper and lower plastic air ducts, and a fan. To prevent the thyratron overheating, a fan stop detection device (see Fig. 4) is fitted to the lower plastic duct above the fan. This consists of a vane-operated reed switch, the contacts of which must be connected to the control circuitry so that all power (high voltage and thyratron heater supplies) is removed from the thyratron in the event of air flow reduction or stoppage.

| | | |
|---|---|---|
| Nominal mains power supply voltage: | | |
| MA2161A | - | 110 V ac |
| MA6161B | - | 220 V ac |
| Ambient temperature | - | 0 to 60 °C |
| Weight | - | 4.0 kg |

## Maximum electrical contact ratings for switch:

| | | AC | DC | |
|---|---|---|---|---|
| Voltage | . | 240 | 120 | V |
| Current | . | 0.6 | 0.6 | A |
| Power (resistive load) | . | 25 | 25 | W |

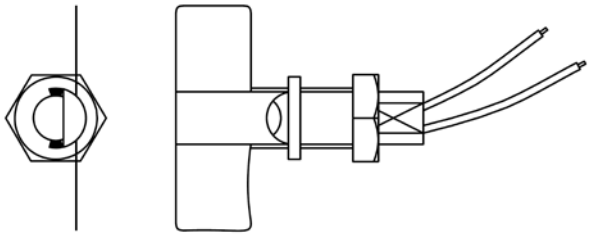
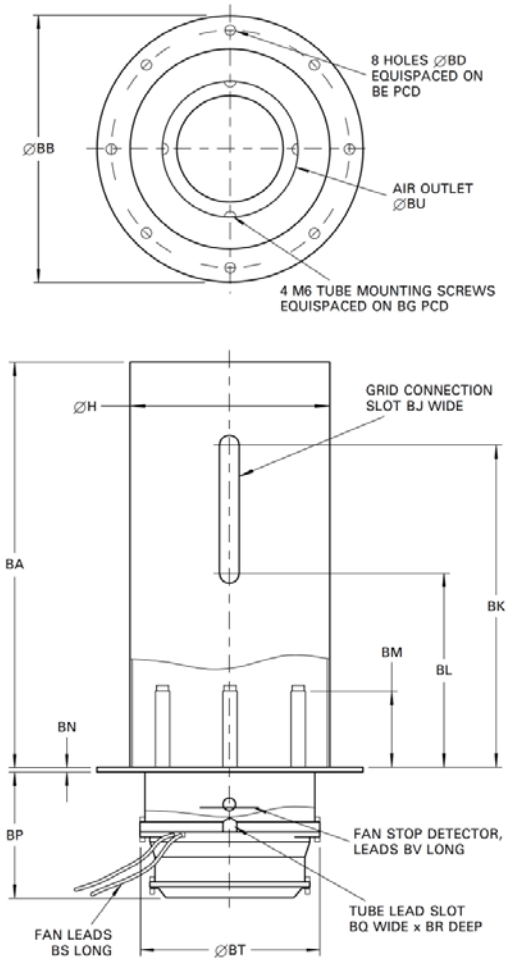


**Fig. 4 Fan Stop Detection Device**

# OUTLINE

## (All dimensions without limits are nominal)




| Ref | Millimetres | Inches |
|---|---|---|
| BA | 406.4max | 16.000 max |
| BB | 266.7 | 10.500 |
| BD | 11.50 | 0.453 |
| BE | 238.13 | 9.375 |
| BG | 135.7 | 5.343 |
| BH | 200.0 | 7.874 |
| BJ | 12.7 | 0.500 |
| BK | 326.0 max | 12.835 max |
| BL | 193.0 max | 7.598 max |
| BM | 76.2 | 3.000 |
| BN | 4.75 | 0.187 |
| BP | 145.0 max | 5.709 max |
| BQ | 16.0 | 0.630 |
| BR | 16.0 | 0.630 |
| BS | 254.0 min | 10.000 min |
| BT | 181.0 max | 7.126 max |
| BU | 135.7 | 5.343 |
| BV | 450.0 min | 17.717 min |

Inch dimensions have been derived from millimetres