e2v technologies

BR/BW1610F Series
RF Power Triodes

The data should be read in conjunction with the Power Triode Preamble.

ABRIDGED DATA

Two RF power triodes of coaxial ceramic/metal construction, intended primarily for industrial service. They are electrically identical and differ only in the method of anode cooling and anode dissipation.

Anode cooling:		
BR1610F	forced-air	
BW1610J2F	water; integral jacket	
Anode dissipation:		
BR1610F	10	kW max
BW1610J2F	15	kW max
Anode voltage	9.0	kV max
Frequency for full ratings	30	MHz max
Output power (class C oscillator, less drive)	30	kW

GENERAL

Electrical

Filament	thoriated tungsten	
Filament voltage (see note 1)	6.6	V
Filament current	103	A
Filament cold resistance	8.0	mΩ
Peak usable cathode current	25	A
Perveance	2.7	$mA/V^{3/2}$
Amplification factor (V_a = 2.25 kV, I_a = 1.0 A)	13	
Mutual conductance (V_a = 2.25 kV, I_a = 1.0 A)	29	mA/V
Inter-electrode capacitances:		
grid to anode	34	pF
grid to filament	64	pF
anode to filament	2.5	pF

Mechanical

Overall dimensions	see outline drawings	
Net weight:		
BR1610F	4.3 kg approx	
BW1610J2F	3.3 kg approx	
Mounting position	vertical, either way up	

Accessories

Water coupling, supplied with BW1610J2F	MA323A
Thermal fuses, available for BW1610J2F	MA85E
Cathode connector	MA830
Air chimney	BR4080B

For frequencies above 2 MHz, MA830 should be used in conjunction with a strip connection to provide a low inductance cathode return.

COOLING

Anode

The BR1610F air cooling requirements are shown on page 5. The required air flow should be delivered through the radiator immediately before and during the application of any voltages. Filament power, anode power and air flow may be removed simultaneously.

BW1610J2F has an integral water jacket. Minimum water cooling requirements are shown on page 4; higher rates of flow should be used where possible. The water pressure in the jacket must not exceed 6 bar.

A thermal fuse, part number MA85E (melting point 103 °C), is available for BW1610J2F to give protection against anode overheating. Two fuses should be used for maximum protection, screwed into the holes indicated on the anode mounting plate (see page 7). The fuses should be connected by a non-conducting cord to a suitable switching device; a tension of about 450 g should be applied to the fuses via the cord. If the temperature exceeds the safe limit, one or both fuses will release and the fuse cord is pulled outwards; this should actuate the switching device and remove all electrical supplies to the tube. Replacement fuses can be supplied to order.

Filament and Grid Seals

The temperature of the filament and grid seals must not exceed 200 °C. A flow of air of 0.42 m^3/min directed onto the terminals via a 25 mm diameter nozzle from a distance of 150 mm before and during the application of any voltages is usually adequate for limiting the temperature of the seals.

RADIO FREQUENCY OSCILLATOR FOR INDUSTRIAL SERVICE (Class C conditions, one tube)

MAXIMUM RATINGS (Absolute values)

Anode voltage	9.0	kV max
Anode current	4.5	A max
Anode dissipation:		
BR1610F	10	kW max
BW1610J2F	15	kW max
Grid voltage (negative value)	−1.5	kV max
Off-load grid current	1.0	A max
Grid dissipation	300	W max
Frequency	30	MHz max

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OPERATING CONDITIONS
(At maximum anode current)

Anode voltage	8.5	8.0	7.0	6.0	5.0	kV
Grid voltage	−950	−920	−860	−780	−690	V
from grid resistor	1540	1460	1290	1120	965	Ω
Peak RF grid drive voltage	1335	1305	1250	1170	1075	V
Peak positive grid voltage	385	385	390	390	385	V
Anode current	4.5	4.5	4.5	4.5	4.5	A
Grid current	618	636	667	697	714	mA
Anode dissipation	7.2	7.0	6.4	6.0	5.8	kW
Grid dissipation	238	243	260	272	275	W
Driving power	826	823	837	816	770	W
Feedback ratio (see note 2)	17.3	18.1	20.2	22.9	25.6	%
Anode output power	31.1	29.0	25.1	21.0	16.7	kW
Anode efficiency	81.0	80.5	79.2	77.4	74.9	%
Oscillator output power (see note 3)	30.3	28.2	24.3	20.2	15.9	kW
Oscillator efficiency	78.8	78.3	76.5	74.5	71.4	%
Load resistance	950	895	766	643	528	Ω

OPERATING CONDITIONS
(With reduced input power)

Anode voltage	8.5	8.0	7.0	6.0	5.0	kV
Grid voltage	−960	−925	−860	−790	−710	V
from grid resistor	3160	2965	2310	2290	1970	Ω
Peak RF grid drive voltage	1210	1175	1110	1045	965	V
Peak positive grid voltage	250	250	250	255	255	V
Anode current	2.3	2.3	2.3	2.3	1.85	A
Grid current	304	312	320	345	360	mA
Anode dissipation	2.8	2.8	2.8	2.3	1.85	kW
Grid dissipation	76	78	80	88	92	W
Driving power	370	364	356	360	350	W
Feedback ratio (see note 2)	15.3	15.9	17.3	19.4	22	%
Anode output power	16.7	15.6	13.3	11.5	9.4	kW
Anode efficiency	85.0	85.0	84.1	82.8	80.9	%
Oscillator output power (see note 3)	16.3	15.2	13.0	11.1	9.05	kW
Oscillator efficiency	83.7	83.2	81.9	80.1	78.0	%
Load resistance	1872	1760	1540	1267	1034	Ω

NOTES

1. The tube must be operated at the stated filament voltage. Fluctuation in filament voltage must not exceed ±5%. The filament may be switched on at its operating voltage and no surge limiting devices need be incorporated in the filament circuit. The voltage drop in the integral filament leads is less than 1% of the filament voltage.
2. The feedback ratio is defined as $\frac{V_{g(pk)}}{V_{a(pk)}} \times 100$

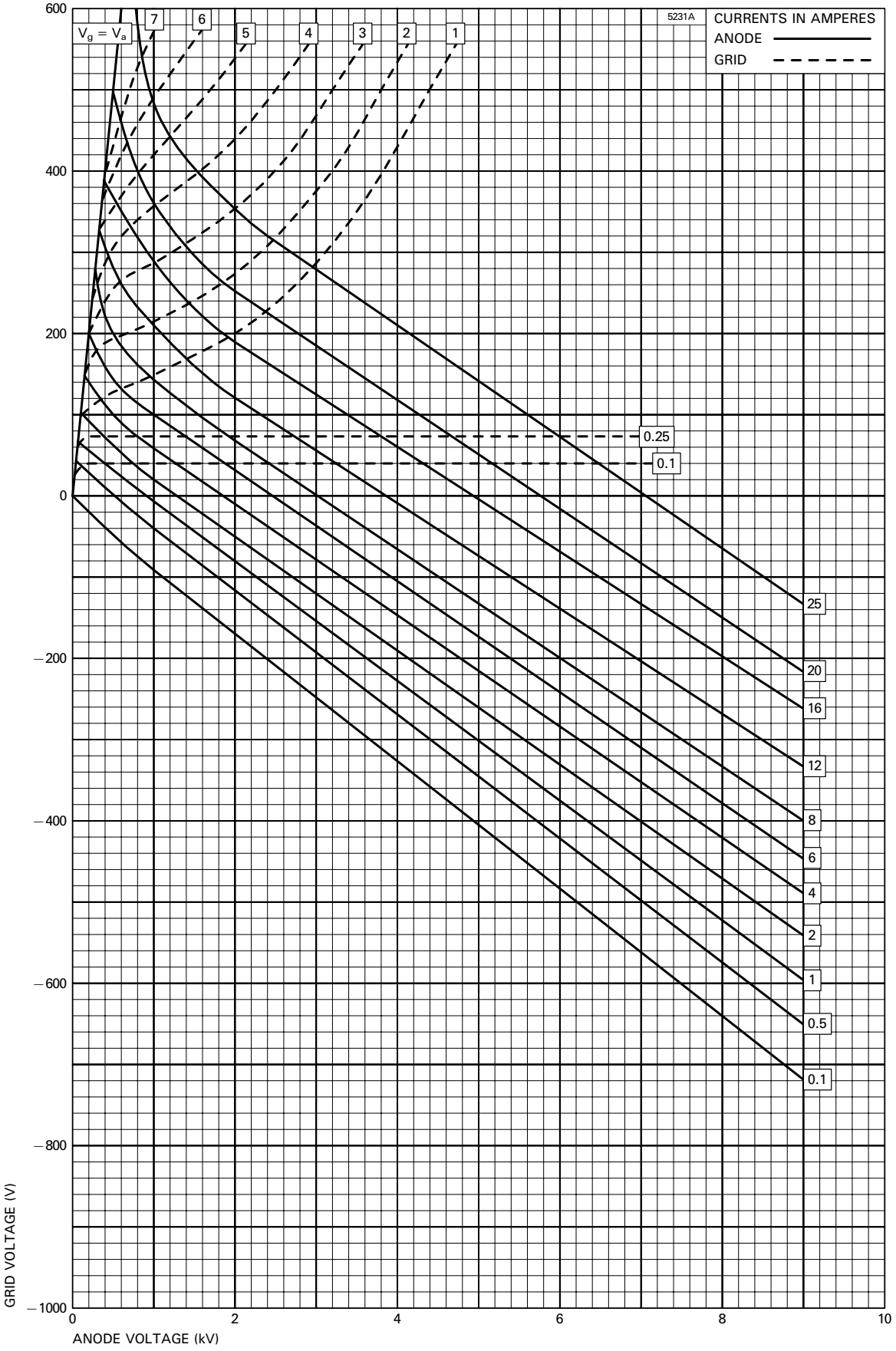
   where $V_{g(pk)}$ = peak RF grid voltage in volts

   and $V_{a(pk)}$ = peak RF anode voltage in volts.
3. Oscillator output power = $P_{out} - P_{drive}$

   where P_{out} = output power of tube to anode circuit

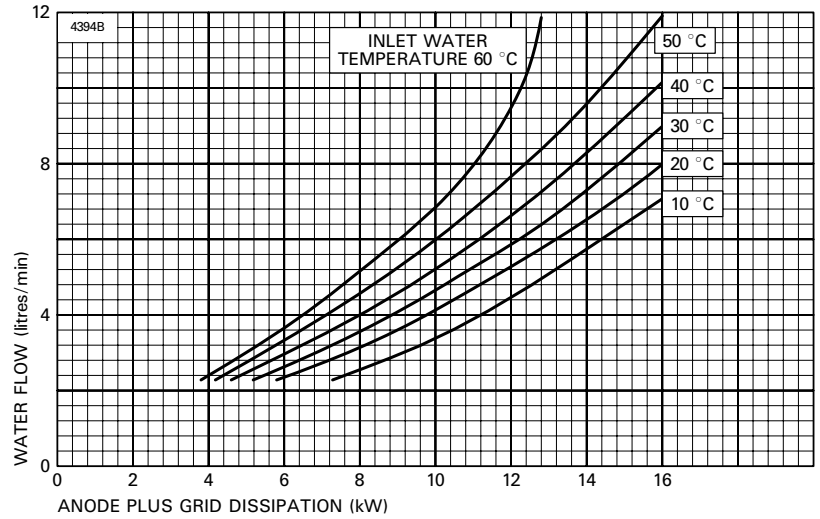
   and P_{drive} = drive power fed back to grid circuit.

TYPICAL CONSTANT CURRENT CHARACTERISTICS

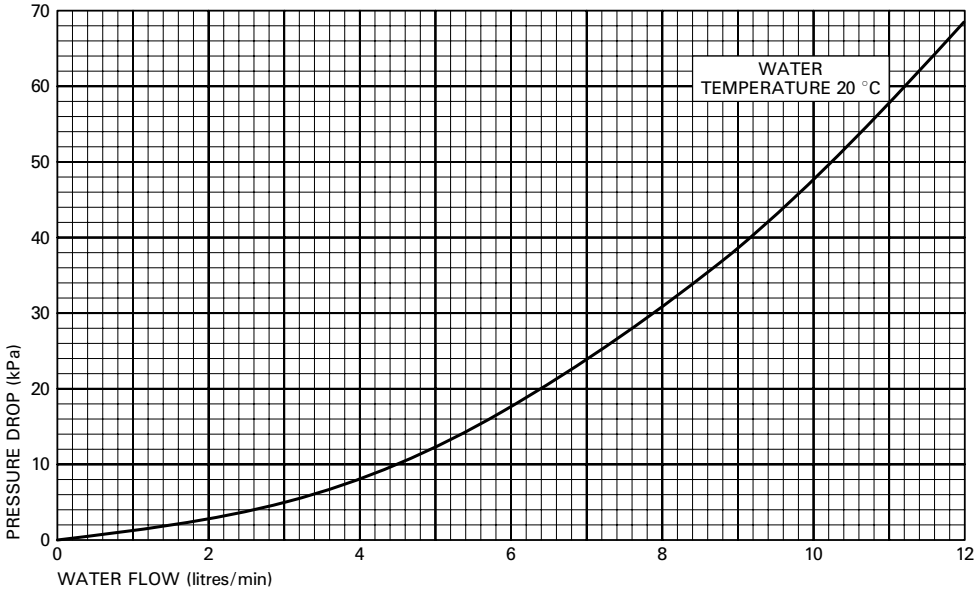


MINIMUM WATER COOLING REQUIREMENTS FOR BW1610J2F

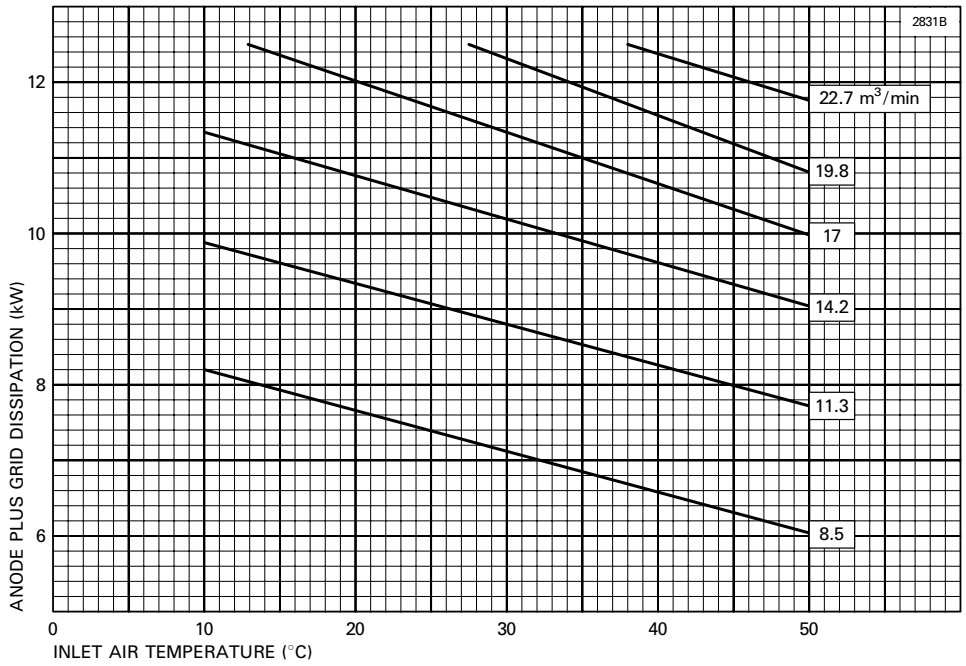
(Higher rates of flow should be used where possible)



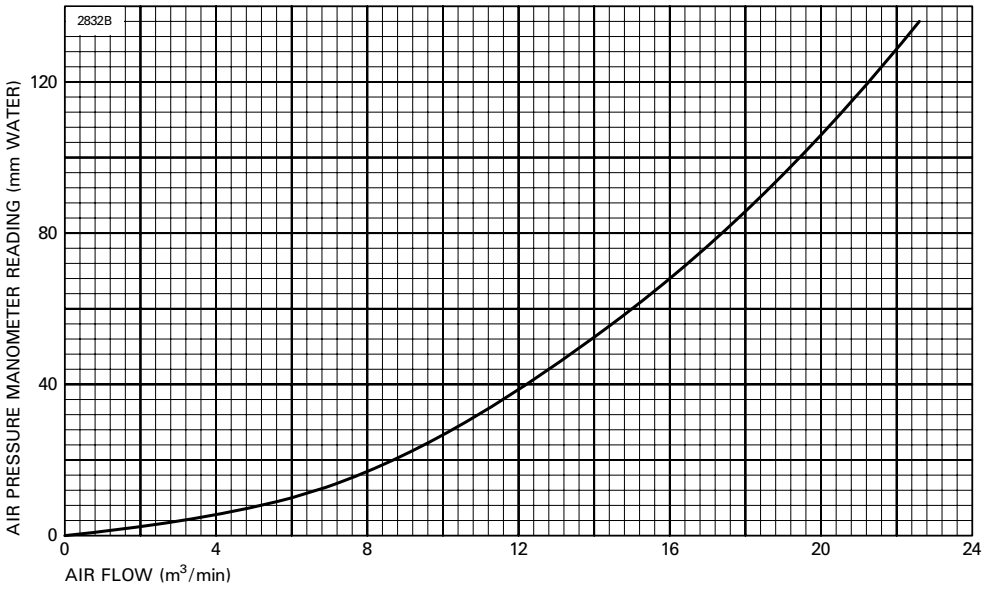
TYPICAL WATER FLOW CHARACTERISTIC FOR BW1610J2F



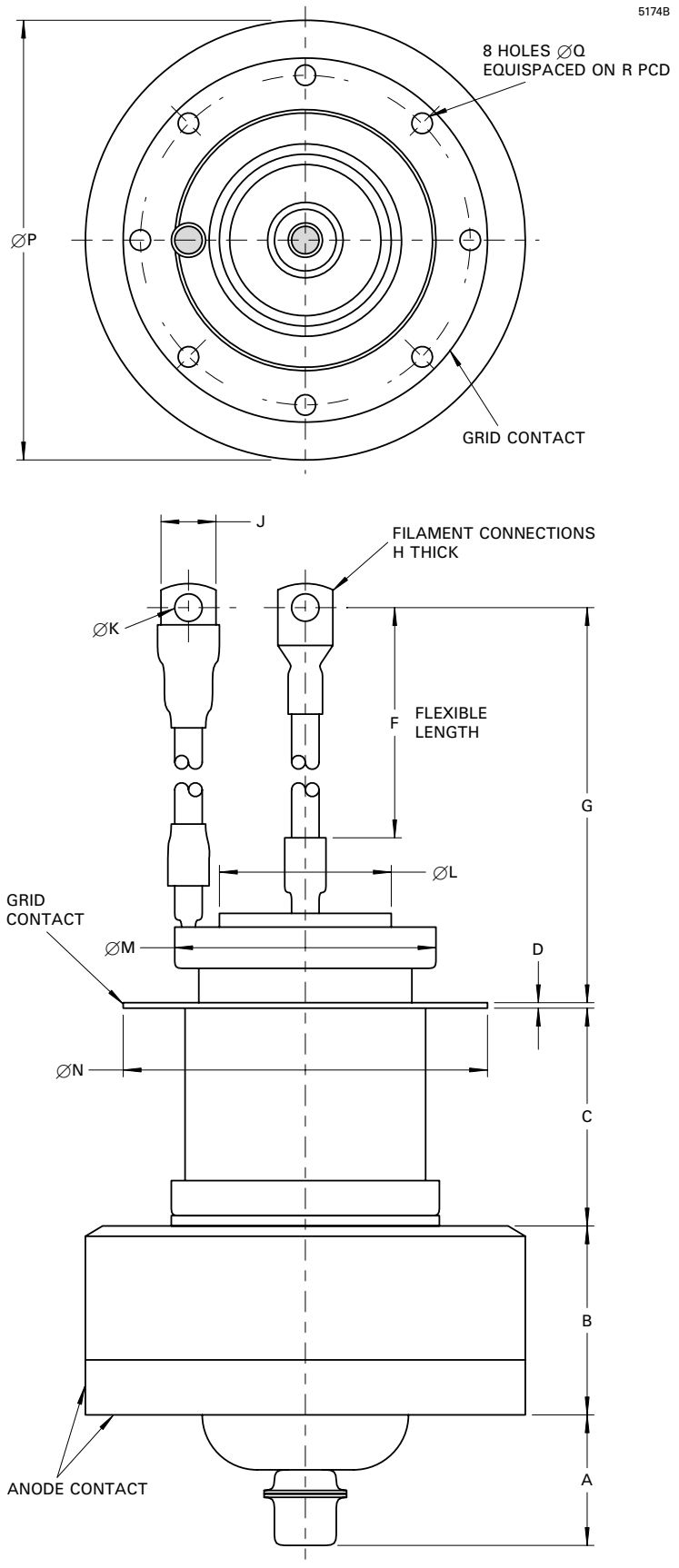
AIR COOLING REQUIREMENTS FOR BR1610F



TYPICAL AIR FLOW CHARACTERISTIC FOR BR1610F

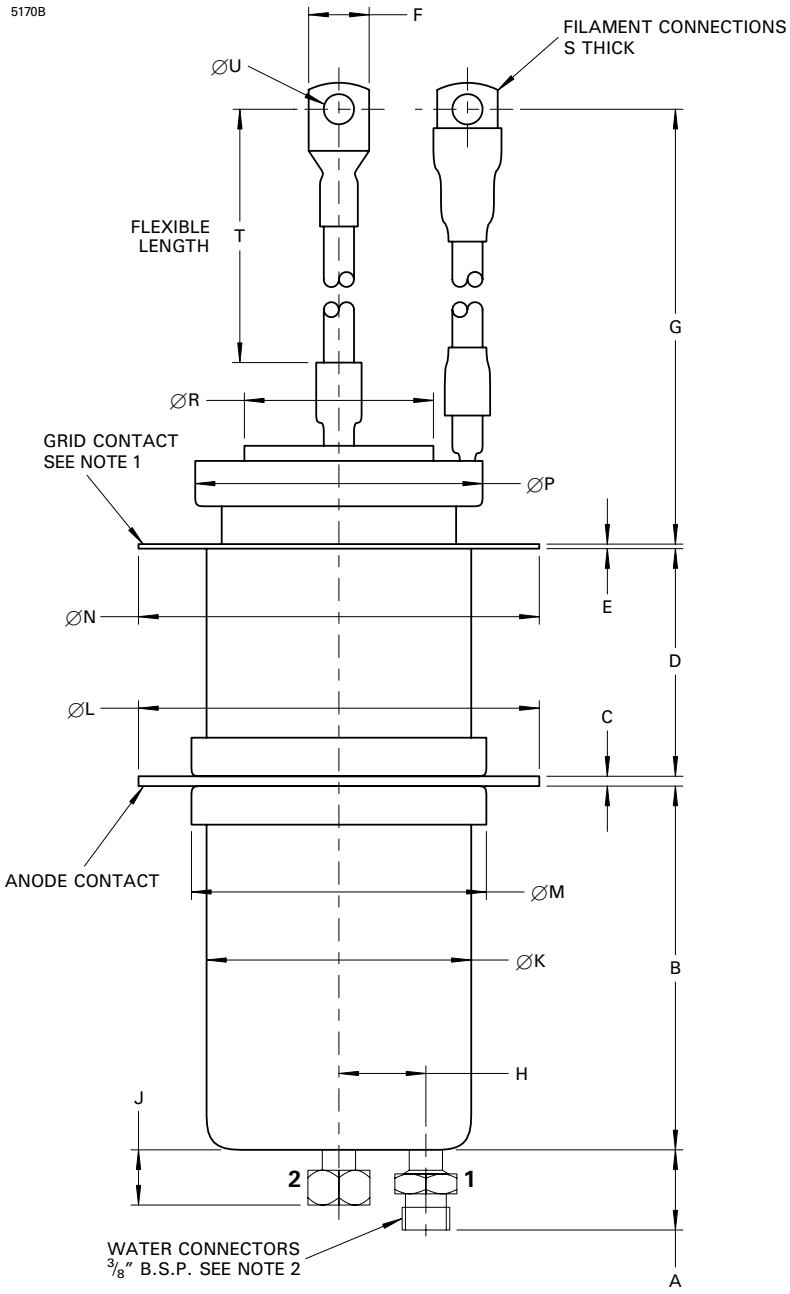


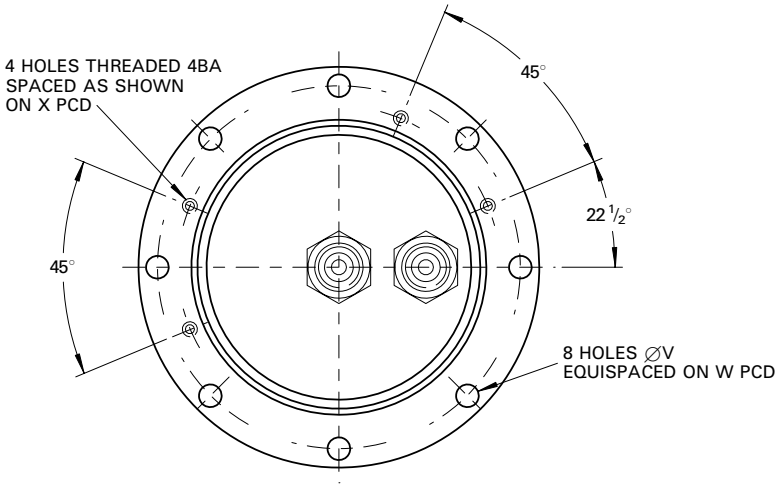
OUTLINE FOR BR1610F (All dimensions without limits are nominal)



Ref	Millimetres
A	46.6
B	68.0 ± 0.5
C	79.0 ± 1.5
D	1.5
F	212.0
G	325.0 ± 15.0
H	3.0
J	19.0
K	10.5 ± 0.1
L	63.0
M	96.0 ± 0.2
N	133.25 ± 0.50
P	159.0
Q	6.5
R	119.0 ± 0.1

OUTLINE FOR BW1610J2F (All dimensions without limits are nominal)





Ref	Millimetres
A	27.0 ± 3.2
B	127.55 ± 2.00
C	3.25 ± 0.20
D	75.86 ± 1.00
E	1.5
F	19.0
G	325.0 ± 15.0
H	27.0 ± 2.0
J	18.0 ± 3.2
K	90.0 ± 1.0
L	133.25 ± 0.50
M	99.0 max
N	133.25 ± 0.50
P	96.0 ± 0.2
R	63.0
S	3.0
T	212.0
U	10.5 $^{+\ 0.5}_{-\ 0.0}$
V	6.5
W	119.0 ± 0.1
X	112.3 ± 0.5

Outline Notes

1. The grid contact flange has 8 holes of the same size and position as those in the anode contact flange.
2. The water connections must be made as follows, depending on the mounting position.

	Anode down	**Anode up**
Inlet	2	1
Outlet	1	2

HEALTH AND SAFETY HAZARDS

e2v technologies electronic devices are safe to handle and operate, provided that the precautions stated 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 equipments 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 energy before allowing access. Interlock switches must not be bypassed to allow operation with access doors open.

RF Radiation

Personnel must not be exposed to excessive RF radiation. A properly designed equipment cabinet with good RF electrical connection between panels will normally provide sufficient protection.

X-Ray Radiation

This device, when operating at voltages above 5 kV, produces progressively more dangerous X-rays as the voltage is increased; the radiation varies greatly during life. The device envelope provides only limited protection and further shielding may be required. A metal equipment cabinet with overlapping joints will usually provide sufficient shielding, but if there is any doubt an expert in this field should perform an X-ray survey of the equipment.

Implosion

This tube stores potential energy by virtue of its vacuum. The energy level is low, but there is some hazard from flying fragments if the tube is dropped or subjected to violent impact. The tube must be stored and transported in its approved pack. During installation or replacement the tube must not be scratched or damaged in any way likely to reduce the strength of the ceramic envelope.

References

1. BS 3192. Specification for safety requirements for radio (including television) transmitting apparatus.
2. TEPAC Publication no. 181. Recommended practice for measurement of X-radiation from power tubes.