

Direct plug-in replacement for YK1233 in circuit assembly type TE1188.

FEATURING

- **Frequency Range** 470 to 860 MHz (Bands IV and V) in a single tube.
- **Output Power** Rated up to 30 kW in vision amplifier service.
- **Operational Mode Options** Klystron can be operated unpulsed or it can be pulsed by using the Beam Control Device (BCD).
- **High Figure of Merit** With appropriate pre-correction, a Figure of Merit (FOM) greater than 40% (unpulsed) or 60% (pulsed) can be achieved.
- **Long Life** High reliability electron gun with barium aluminate cathode for longer tube life.
- **Simple, Efficient Collector Cooling** Collector may be either vapour or water cooled using a simple boiler or water jacket.
- **Simple Tube Exchange** Continuously tunable external cavities, with digital frequency indicators. This means that a replacement tube will be coarse tuned on installation, needing only trimming adjustments.
- **All Ceramics Aluminium Oxide** No beryllium oxide hazard.

DESCRIPTION

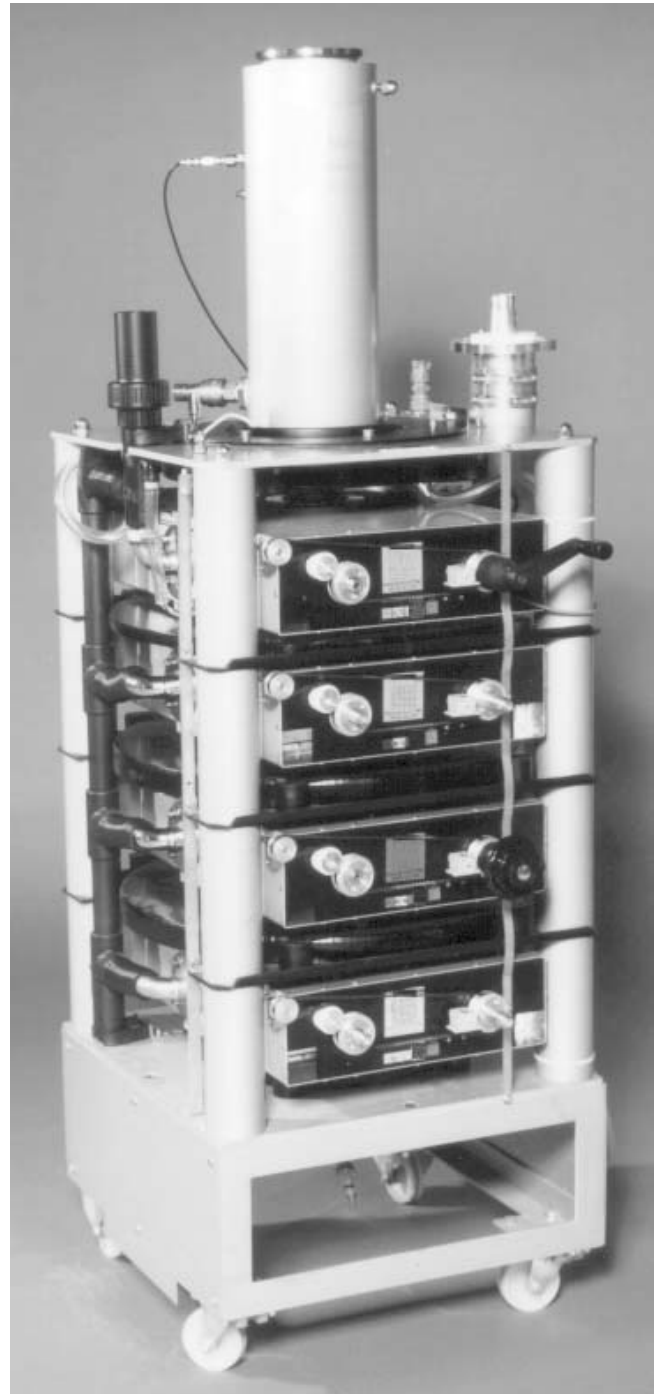
K3271BCD is a four cavity, high efficiency amplifier klystron for use in the output stages of sound and vision transmitters in UHF television service. The tube operates in the frequency range 470 to 860 MHz at sync. power levels up to 30 kW. A modulating anode is fitted, enabling:

- efficiency optimisation of beam voltage and current over the frequency range, and
- operation at reduced power levels in sound amplifiers using the same beam voltage supply as the vision amplifier.

In addition the electron gun incorporates a cylindrical, non-intercepting Beam Control Device for low voltage beam current modulation.

The tube is electromagnetically focused and the circuit assembly is designed to reduce tube replacement time to a minimum. The cavities can be detached from the vacuum tube and refitted on a replacement without disturbing the tuning, so that the replacement klystron is coarse tuned at switch-on and requires only loading loop setting and trimming adjustments to meet the full transmission specification.

The electron gun, klystron body and cavities require forced-air cooling; the circuit assembly incorporates a distribution manifold. Cooling air must be adequately filtered to avoid electrostatic precipitation of dust on insulators.



The klystron collector may be either vapour cooled in a boiler with an upward steam exit from which the steam must be ducted to a separate condenser (not supplied), or water cooled in a water jacket from which the water must be led to a separate heat exchanger (not supplied).

ABRIDGED DATA

Frequency range	470 to 860	MHz
European channel numbers	21 to 68	
Sync. output power at klystron flange	32	kW
Maximum drive power requirements:		
conventional operation	25	W
pulsed operation	100	W
Power gain (unpulsed operation)	30 to 35	dB
Beam voltage	19 to 25	kV
Modulating anode to cathode voltage, vision operation (see note 1)	13.5 to 18.0	kV

GENERAL

Electrical

Cathode	indirectly heated
Heater voltage	see note 2
Heater current range	19 to 26 A
Black heat heater voltage (see note 3)	4.5 V dc
Cathode pre-heating time:	
from cold (see note 4)	5 minutes
from black heat (see note 5)	0 minutes
Ion pump to cathode voltage	+3.0 to 4.0 kV
Internal impedance of ion pump supply	500 kΩ approx

Mechanical

Overall length	51.18 inches (130 cm) max
Overall diameter	7.34 inches (18.65 cm) max
Mounting position	vertical, collector end up
Net weight of klystron	66 pounds (30 kg) approx

Circuit Assembly K4276, K4276N, K4276W or K4276WN (See note 6)

For vapour cooling of collector, order K4276 or K4276N.
For water cooling of collector, order K4276W or K4276WN.

Electromagnet current, stabilised to $\pm 2\%$ (see note 7)	8.5 to 11	A
Electromagnet resistance:		
cold	8.3 \pm 1.2	Ω
hot (20 °C ambient)	11	Ω max
RF input connector	type N coaxial	
RF output	3 1/8 inch 50 Ω coaxial line	
Net weight of tuning cavities	100 pounds (45 kg) approx	
Net weight of magnet assembly	485 pounds (220 kg) approx	

Cooling

Air flow to cavities and body (see note 8)	100	ft ³ /min
	2.8	m ³ /min
Static pressure head (see note 9)	6.5 inches (165 mm) w.g.	
Air flow to cathode terminal (see note 8)	5.0	ft ³ /min
	0.14	m ³ /min

K4276, K4276N (vapour cooled) (see page 5):

volume of steam produced by collector dissipation	1.5	ft ³ /min/kW
	0.043	m ³ /min/kW
volume of water converted to steam	0.006	imp.gal/min/kW
	0.027	l/min/kW

Conductivity of water in

the klystron boiler	70	μS/cm max
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K4276W, K4276WN (water cooled) (see page 5):

minimum water flow required	see page 5
pressure drop	see page 5
inlet pressure to water jacket	100 lb/in ² max
	7.0 kg/cm ² max
water outlet temperature (see note 10)	90 °C max
water inlet temperature	55 °C max

Arc Detector

Arc detector type MA257E is fitted to the output cavities. See note 6 and page 12 for connection details.

Photo-resistor type	NSL 462
Minimum dark resistance	20 MΩ
Resistance at 1 foot-candle	28 kΩ
Resistance at 100 foot-candles	600 Ω
Maximum voltage (peak)	70 V
Maximum temperature	75 °C
Layer	cadmium sulphide
Test lamp	28 V
	0.04 A
Connections	see page 12

MAXIMUM RATINGS (Absolute values)

If any maximum rating is exceeded, the beam voltage must be removed within 100 ms from the instant at which the rating is exceeded, and must not be re-applied within 5 s.

Heater starting current (peak)	60	A max
Beam voltage	26	kV max
Modulating anode to cathode voltage (see note 1)	26	kV max
Beam current (mean)	4.0	A max
Body current:		
with no input power	50	mA max
RF on	150	mA max
Modulating anode current	5.0	mA max
Mean output power	22	kW max
Collector dissipation	85	kW max
Load VSWR (see note 11)	1.5:1	max
Temperature of any part of tube envelope	175	°C max
BCD electrode voltage (see note 12)	-1250	V max
BCD current (see note 13)	2.0	mA max

TYPICAL OPERATION (BCD electrode at cathode potential)

25 kW vision amplifier

Frequency	470 to 478	662 to 670	846 to 854	MHz
European channel	21	45	68	
Beam voltage (see page 7)	19.0	21.5	23.5	kV
Modulating anode to cathode voltage (approx) (see page 7)	16.8	14.4	13.8	kV
Beam current	3.40	2.70	2.53	A
Body current:				
with no input power	15	10	10	mA
black level + sync. (see note 14)	85	60	50	mA
Output power	26.5	26.5	26.5	kW
Electro-magnet current	10	9.5	9.5	A
Drive power for 26.5 kW output (see note 15)	25	10	10	W
Efficiency:				
typical	41	46	45	%
minimum	40	44	43	%

Sound amplifier

	2.5 kW		5.0 kW		
Beam voltage	19	23.5	19	23.5	kV
Modulating anode to cathode voltage (approx)	3.8	3.2	5.6	4.8	kV
Beam current	0.4	0.32	0.67	0.55	A
Body current (approx)	15		15		mA
Focus current (approx)	10		10		mA
Output power	2.7		5.4		kW
Drive power:					
channel 21	4.0		4.0		W
channel 45	2.0		2.0		W
channel 68	1.0		1.0		W
Efficiency	36		42		%

30 kW vision amplifier

Frequency	470 to 478	662 to 670	846 to 854	MHz
European channel	21	45	68	
Beam voltage (see page 7)	20.5	23.0	25.0	kV
Modulating anode to cathode voltage (approx) (see page 7)	17.8	15.4	14.9	kV
Beam current	3.79	3.00	2.83	A
Body current:				
with no input power	15	10	10	mA
black level + sync. (see note 14)	85	60	50	mA
Output power	32	32	32	kW
Electro-magnet current	10.0	10.0	10.0	A
Drive power for 32 kW output (see note 15)	25	10	10	W
Efficiency:				
typical	41	46	45	%
minimum	40	44	43	%

Sound amplifier

	3.0 kW		6.0 kW		
Beam voltage	20.5	25	20.5	25	kV
Modulating anode to cathode voltage (approx)	4.0	3.2	5.6	5.0	kV
Beam current	0.39	0.32	0.71	0.58	A
Body current (approx)	15		15		mA
Focus current (approx)	10		10		mA
Output power	3.2		6.4		kW
Drive power:					
channel 21	4.0		4.0		W
channel 45	2.0		2.0		W
channel 68	1.0		1.0		W
Efficiency	40		44		%

NOTES

- The modulating anode voltage must not be positive with respect to the klystron body. The modulating anode should be connected to its supply via a 10 kΩ resistor. A voltage divider for adjusting the cathode current should allow for a typical modulating anode current of 1.5 mA.
- The correct heater voltage depends upon the operating beam current and age of the tube, as follows.
For beam currents ≤ 3.5 A:

first 500 hours	over 500 hours
5.2 ± 0.1 V	4.8 $\begin{matrix} + 0.2 \\ - 0.0 \end{matrix}$ V

For beam currents > 3.5 A:

first 500 hours	over 500 hours
5.4 ± 0.1 V	5.0 $\begin{matrix} + 0.2 \\ - 0.0 \end{matrix}$ V

For extended periods of heater-only operation, a black heat heater voltage of 4.5 V is specified.

The klystron must not be operated with a heater voltage of less than 4.5 V.

- Continuous periods of black heat operation should not exceed two weeks and should be separated by similar periods of rest or full operation.
- In the event of a power failure a maximum interruption time of 30 seconds can be tolerated without the need for a repeated cathode pre-heating time.
- For black heat operation, a heater voltage of 4.5 V must have been applied to the klystron heater for a minimum of 10 minutes before the beam voltage may be switched on. On application of the beam voltage the heater voltage must simultaneously be increased to the operating conditions as specified in note 2.
- Circuit assemblies K4276 and K4276W have one arc detector fitted to the output cavity. Circuit assemblies K4276N and K4276WN have arc detectors fitted to both third and output cavities.
- The following procedure is recommended when setting up a klystron:
 - Set the focus current to 11.0 A nominal.
 - Set the appropriate DC conditions for the channel and power level required.
 - Tune the klystron in the normal manner.
 - When the klystron is operating at the nominal output power (fully corrected, as necessary) reduce the focus current to establish the value at which the output power is a maximum. **Do not** reduce the focus current below this value.
 - The minimum permissible operating value of focus current is 0.2 A **above** the value determined in (d).

Note that in any case the focus current should **never** be reduced below 8.5 A.

- This value applies to transmitters at sea level where the air density is 0.076 lb/ft³ (1.22 kg/m³). At high altitudes where air density is significantly reduced the volume flow must be increased in the ratio of air density at sea level to air density at altitude in order to maintain the mass flow.

- Measured by a manometer at the input pipe to the circuit assembly.
- For operation at high altitudes where atmospheric pressure is reduced and water boils at a lower temperature, the maximum water outlet temperature is 10 °C below the boiling point at that altitude.

- This value applies to television service. e2v technologies should be consulted regarding other conditions of service.
- The K3271BCD may be operated with a pulsed voltage applied to the BCD electrode. This enables the beam power to be decreased during the picture region of the video signal so that up to 32 kW sync. pulses can be produced at the klystron flange with an appreciable reduction in mean beam power.

The following conditions must be observed when operating in this mode:

- The BCD voltage must **never** be positive with respect to cathode.
- The BCD voltage must **not** exceed –1250 V with respect to cathode.

The effect of increasing the negative BCD voltage with respect to the cathode is to reduce the beam current. This effect is shown in the BCD electrode voltage characteristic graph (see page 7).

- To establish the BCD current, the klystron must be operated undisturbed for a period of **one hour** under the following conditions.

Beam voltage	16.5 kV
Beam current	3.3 A
Heater voltage (see note 2)	4.8 V
BCD to cathode voltage	0 V

The BCD voltage must then be increased to –600 V with respect to cathode. The BCD current on a new klystron will not exceed 1 mA and typically be less than 0.5 mA. At end-of-life, the BCD current will not exceed 2 mA .

With a BCD-to-cathode voltage of –600 V, a beam current reduction of about 30% should be expected. In a typical transmitter with appropriate pulsing, RF drive and correction arrangements, this value of beam current reduction should allow a FOM better than 60% to be obtained, where FOM is defined as:

$$\text{FOM (\%)} = \frac{\text{sync. output (kW)}}{\text{average beam power (kW)}} \times 100$$

Typical values of interelectrode capacitance are:-

BCD to cathode	65 pF
Cathode to modulating anode (BCD connected to cathode)	30 pF
Modulating anode to klystron body	20 pF

Appropriate measures must be taken to protect the klystron and the pulse drive in the event of a DC arc between the BCD electrode and anode.

- The combined body current of one sound and one vision klystron in parallel will not exceed the limit specified.
- Defined as the power delivered to a matched load substituted for the input cavity of the klystron.

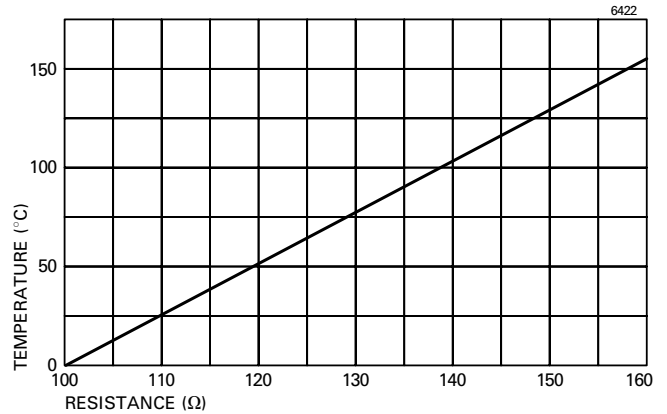
TEMPERATURE SENSOR MA971A

Temperature sensor type MA971A is a platinum film resistance type sensor for monitoring the temperature of the klystron collector when being water or vapour cooled. The sensor conforms to BS1904 and DIN 43760. The resistance-temperature relationship is shown below.

The resistance element is insulated from the body of the probe unit. The resistance between element and probe is typically better than 10 M Ω at 20 °C.

The probes are tested to 240 V dc between probe and element. Protective circuits must be provided so that the probe body (collector potential) to resistance element voltage does not exceed 200 V, even under short-term fault conditions.

To avoid errors due to element heating and damage to the resistance element, circuits should be designed to draw as little current as possible through the element. The recommended maximum current is 3 mA.



RECOMMENDED COOLANTS

K4276W, K4276WN (Liquid Cooled)

In the liquid cooled mode, when there is no danger from freezing, the coolant should be good quality demineralised water. Where outside ambient temperatures are such that there is a danger that pure water will freeze, the coolant should be a mixture of equal volumes of pure demineralised water and a commercial glycol anti-freeze preparation containing appropriate corrosion inhibitors and pH buffers. The coolant flow will need to be increased when the glycol-water mixture is in use (see graph for flow rates).

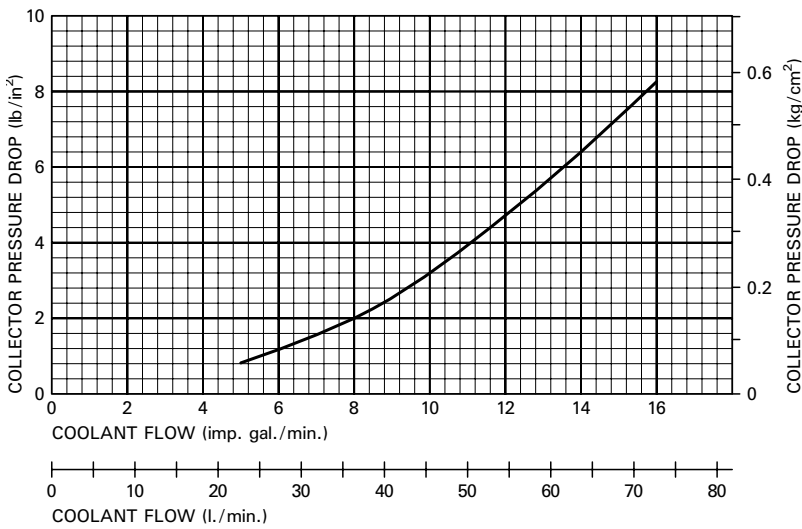
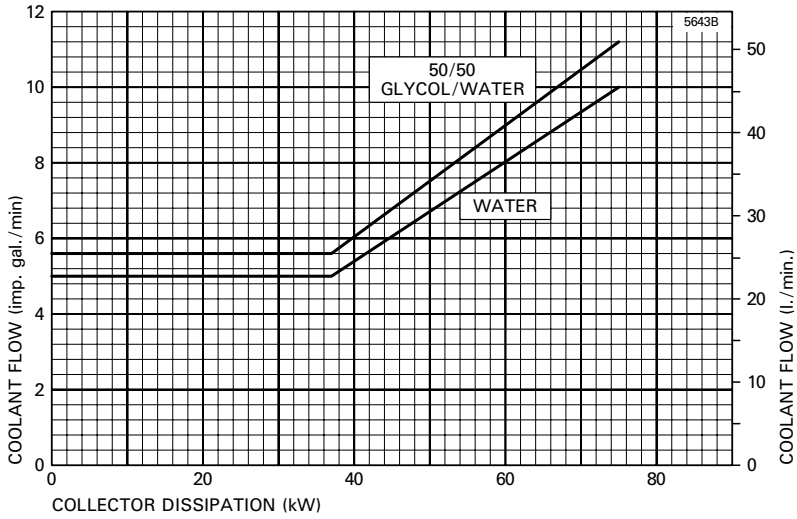
Glycol anti-freeze mixtures are liable to thermal degradation with prolonged life, especially where the coolant is oxygenated. Cooling system designers should ensure that oxygenation of the coolant is avoided wherever possible by, for example, ensuring that return pipes discharge below the level of coolant in the reservoir tank. Commercial glycol preparations such as Dowcal 10 or Dowtherm SR-1 have been examined by e2v technologies and are believed to contain suitable inhibitor and pH buffer additives.

It is recommended that the glycol coolant is discarded after being used for one winter season. The transmitter should then be operated with demineralised water during the summer before changing to a new glycol solution for the next winter. The long term use of commercial grade, un-buffered and uninhibited ethylene glycol will lead to corrosive damage to the transmitter cooling system and consequential damage to the klystron. Such coolants may only be used for a short time (not more than one week) in an emergency.

K4276, K4276N (Vapour Cooled)

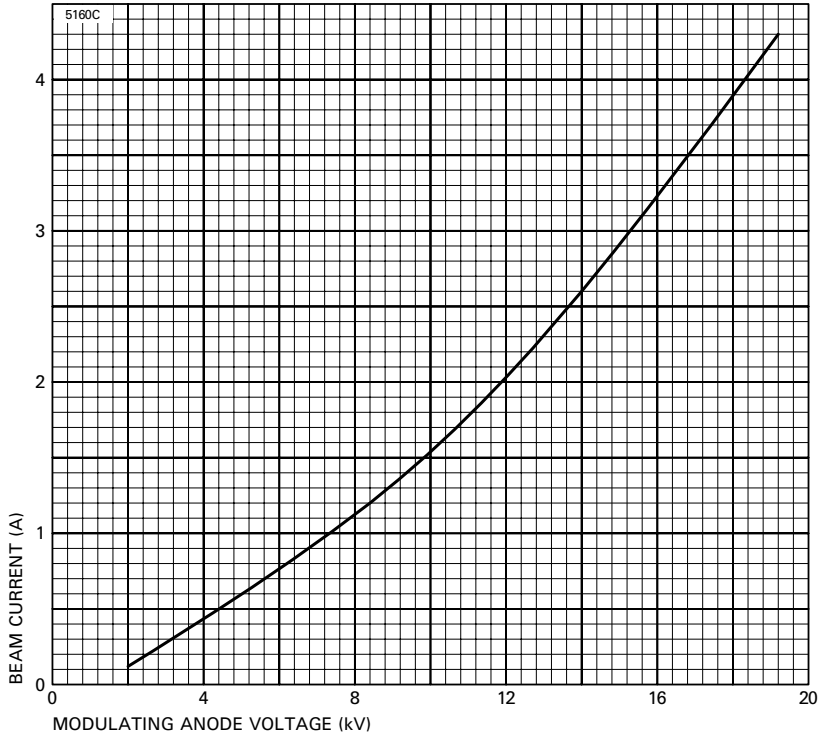
Only pure demineralised water should be used in the boiler.

LIQUID COOLING REQUIREMENTS FOR K4276W AND K4276WN

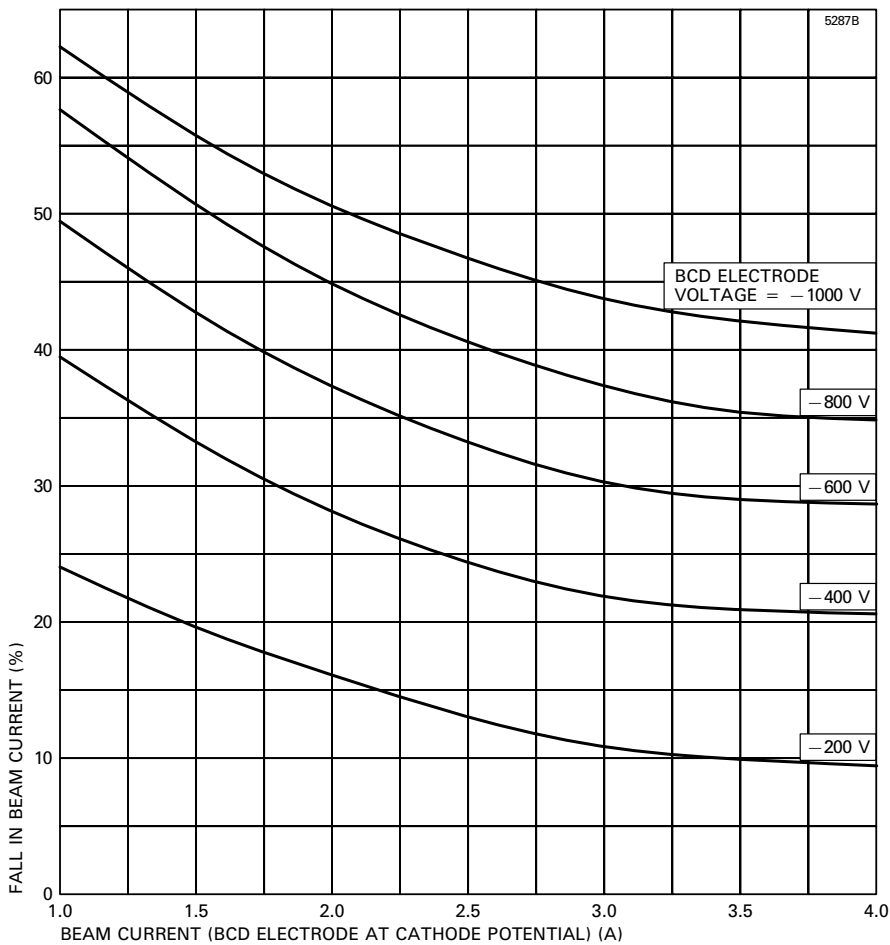


Note 1 U.S. gal. = 0.832 Imp. gal.

BEAM CURRENT CHARACTERISTIC (BCD electrode at cathode potential)

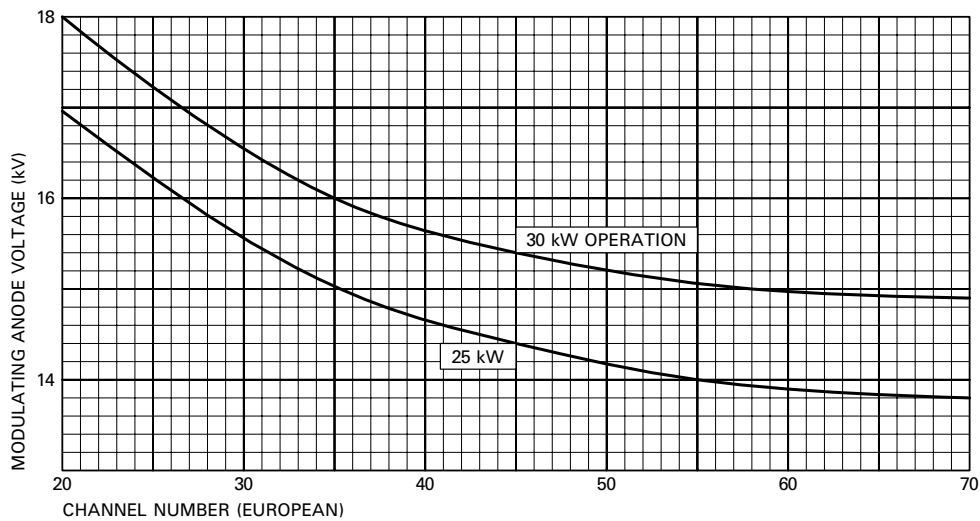
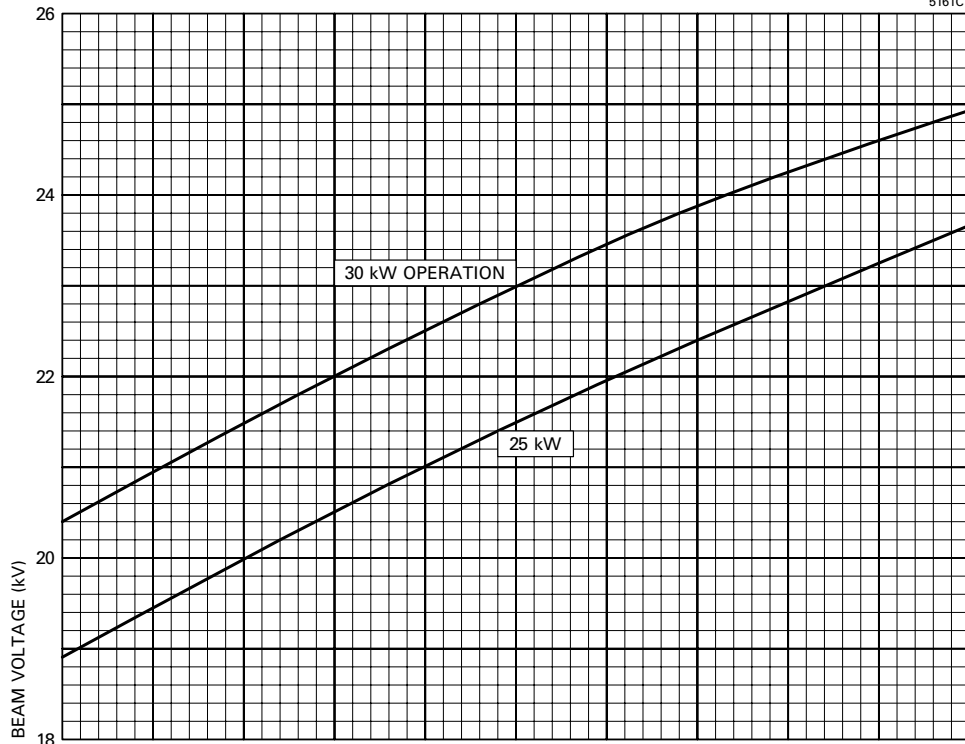


BCD ELECTRODE VOLTAGE CHARACTERISTICS

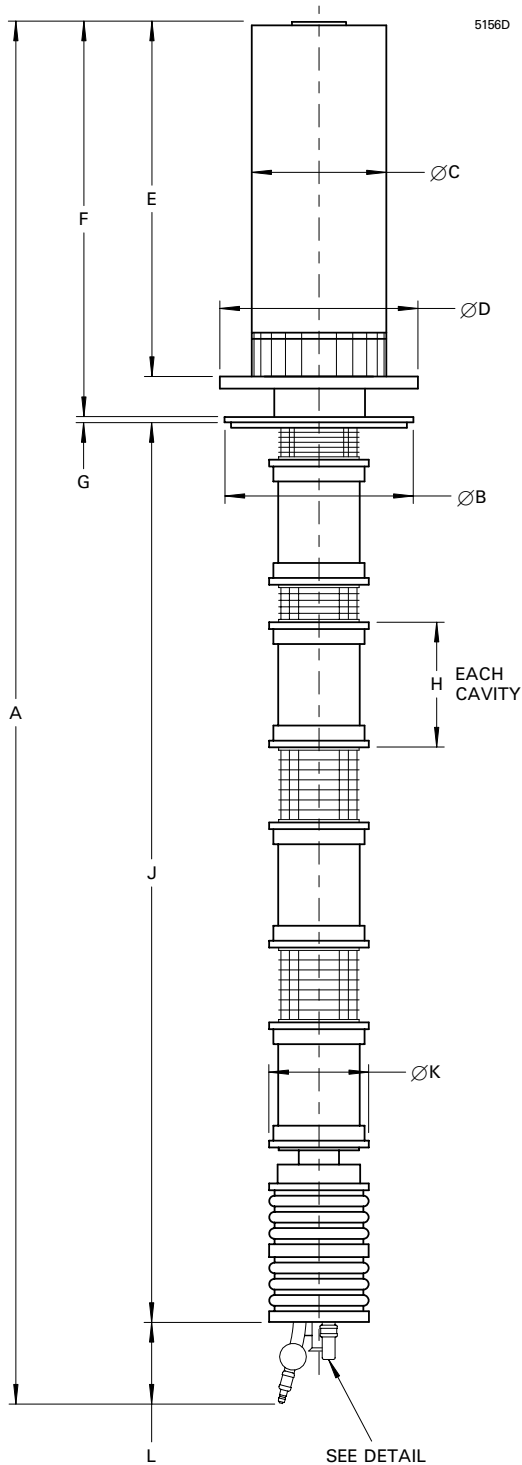


VARIATION OF TYPICAL VOLTAGES WITH FREQUENCY

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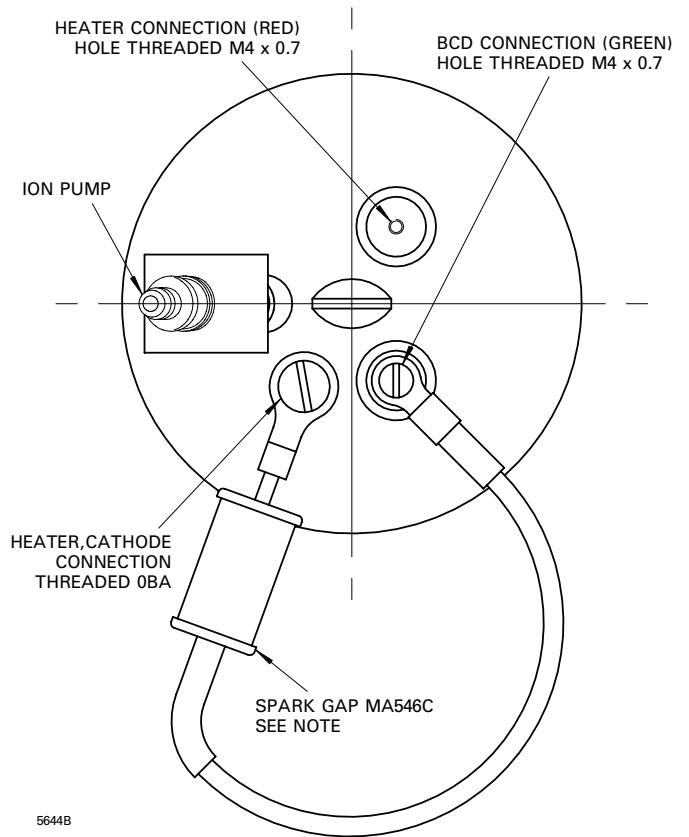
OUTLINE OF K3271BCD (All dimensions without limits are nominal)



Ref	Millimetres	Inches
A	1340.0 max	52.756 max
B	176.0	6.929
C	125.0	4.921
D	186.0	7.323
E	329.5	12.972
F	373.0	14.685
G	5.00	0.197
H	117.0	4.606
J	840.0 + 4.0 - 1.0	33.071 + 0.157 - 0.039
K	93.0	3.661
L	115.0 max	4.528 max

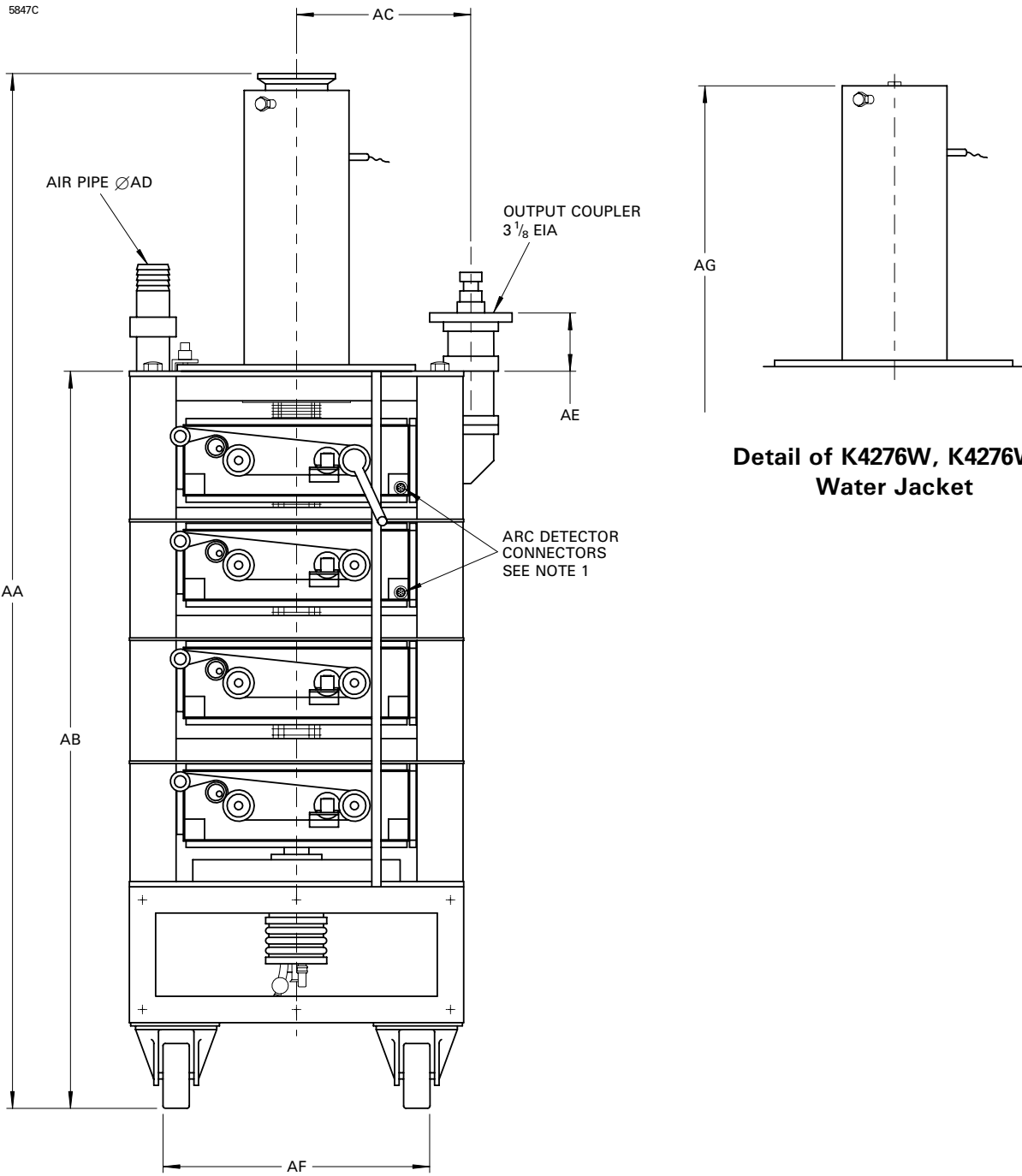
Inch dimensions have been derived from millimetres.

Enlarged View on Gun End of Klystron



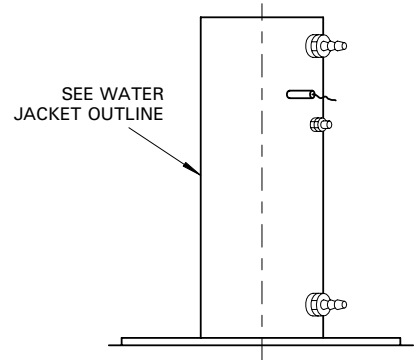
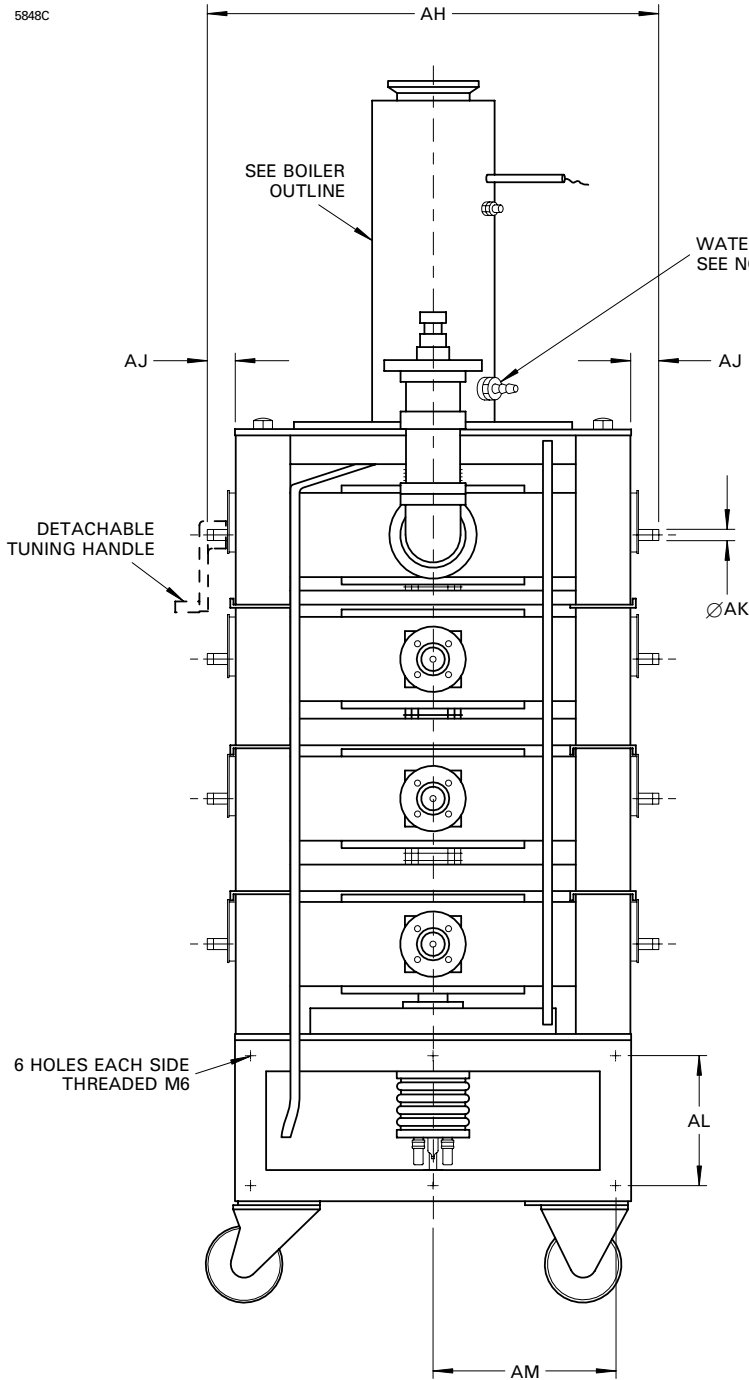
Note The spark gap shown connected between the BCD and cathode terminals is replaced by a shorting link for shipping. **If the BCD electrode is to be used, this link must be replaced by the spark gap as shown.** Failure to fit the spark gap will result in failure of the BCD insulation in the event of an internal flashover.

OUTLINE OF CIRCUIT ASSEMBLY K4276N (All dimensions without limits are nominal)



**Detail of K4276W, K4276WN
Water Jacket**

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**Detail of K4276W, K4276WN
Water Jacket**

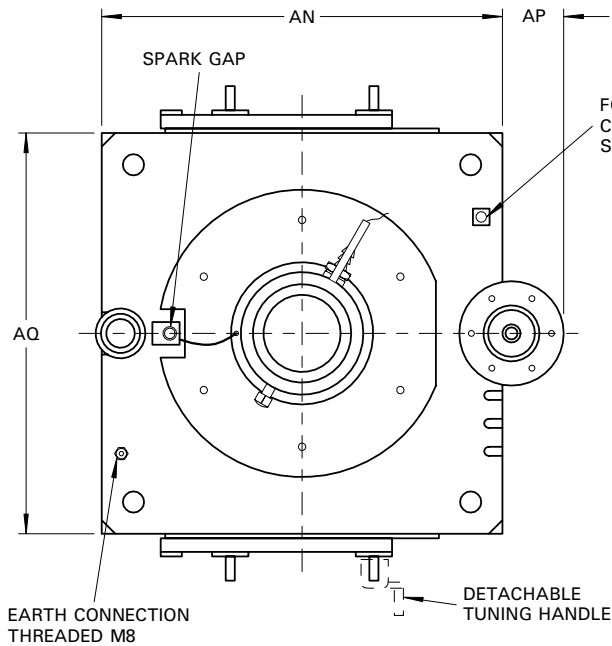
Ref	Millimetres	Inches
AA	1542.0 ± 3.0	60.709 ± 0.118
AB	1086.0 ± 3.0	42.756 ± 0.118
AC	264.0	10.394
AD	50.0	1.969
AE	100.0	3.937
AF	453.0 ± 2.0	17.835 ± 0.079
AG	1500.0 ± 3.0	59.055 ± 0.118
AH	630.0 max	24.803 max
AJ	61.0 max	2.402 max
AK	14.3	0.563
AL	162.0	6.378
AM	234.0	9.213
AN	508.0	20.000
AP	75.0	2.953
AQ	508.0	20.000

Inch dimensions have been derived from millimetres.

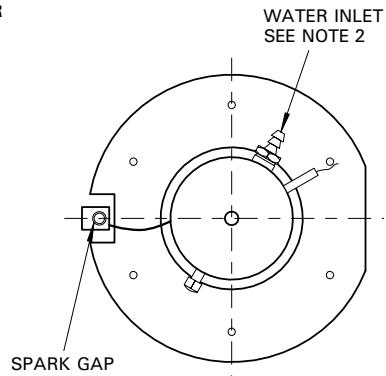
Outline Notes

1. The K4276N and K4276WN variants have two MA257E arc detectors as shown. The K4276 and K4276W variants have one arc detector, fitted to the output cavity.
2. Orientation of boiler or water jacket set by the user to bring connections to most convenient position.

TOP VIEW OF CIRCUIT ASSEMBLY K4276N

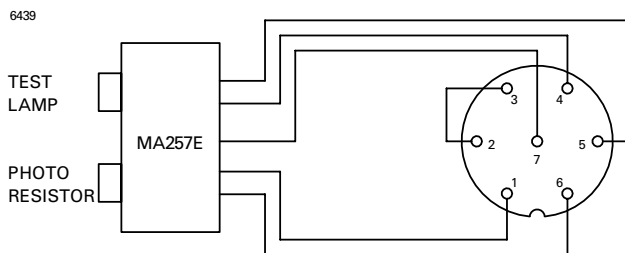


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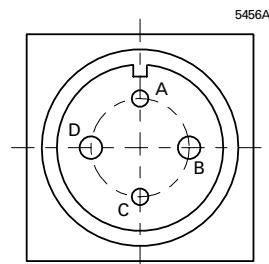
**Detail of K4276W, K4276WN
Water Jacket**

Arc Detector Connections to socket type Amphenol T3476-001



MA257E uses a panel plug and free socket.

View on Focus Coil Connector



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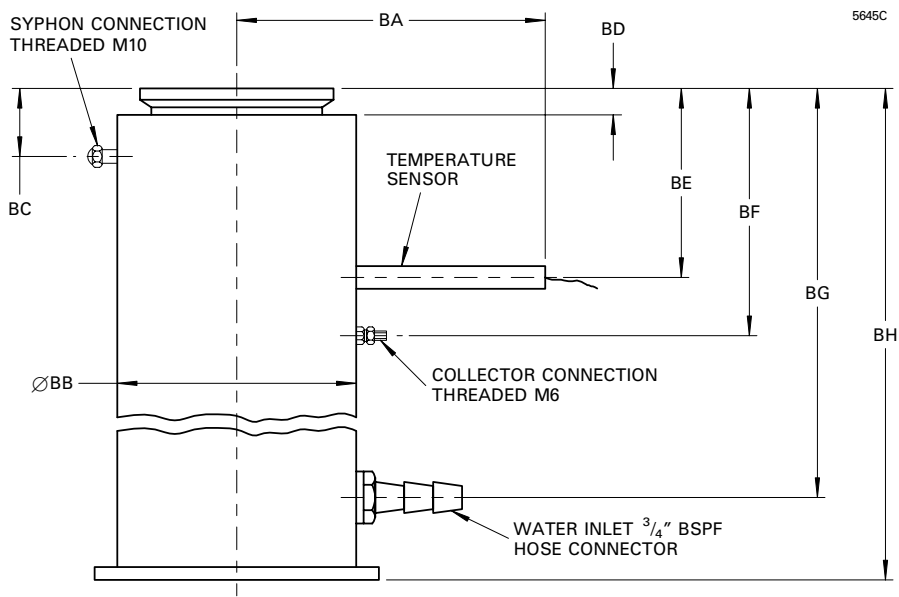
Connections

Pin	Element
A	Focus coil positive
B	Interlock
C	Focus coil negative
D	Interlock

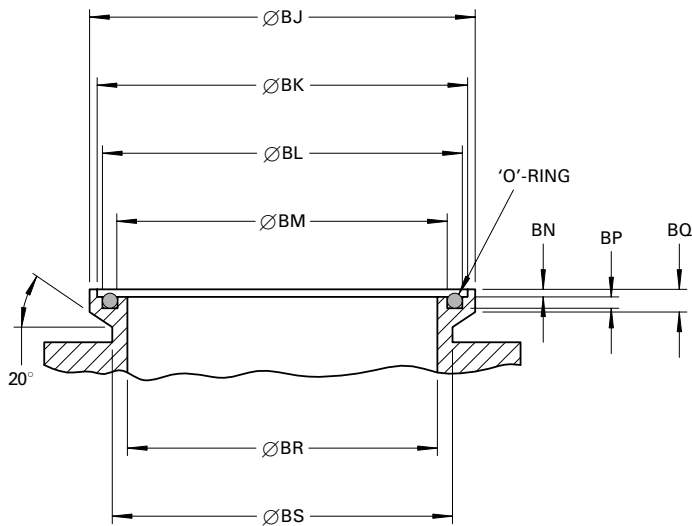
Pins B and D are connected within the circuit assembly for use as an interlock circuit; this connection may be removed by the customer if required for other purposes.

OUTLINE OF BOILER UNIT

(All dimensions nominal)



Enlarged Section of Steam Outlet Coupling

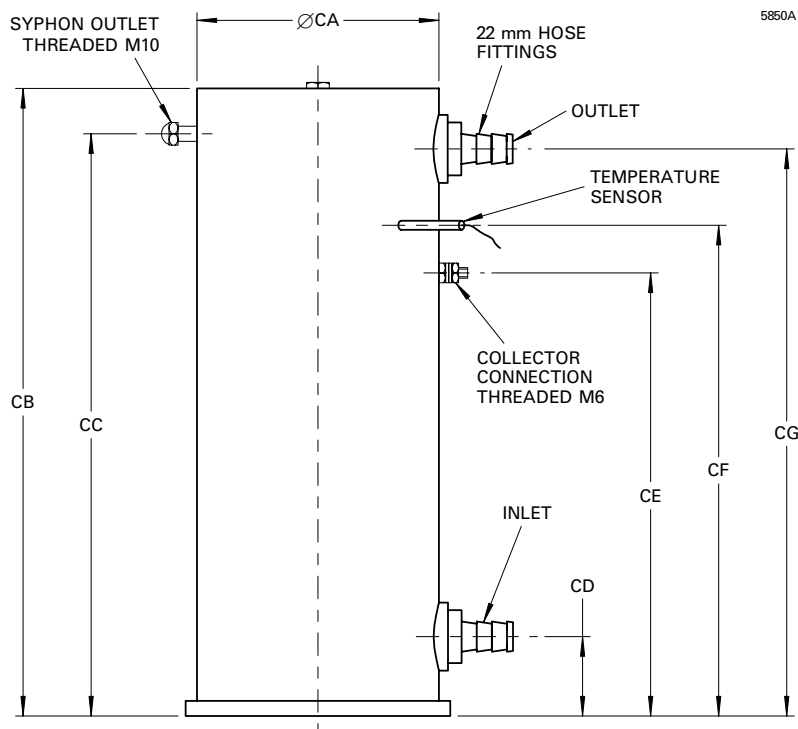


Ref	Millimetres	Inches
BA	204.5	8.051
BB	158.2	6.228
BC	45.0	1.772
BD	17.0	0.669
BE	125.0	4.921
BF	165.0	6.496
BG	405.5	15.965
BH	460.0	18.110
BJ	128.0	5.039
BK	124.5	4.902
BL	120.73	4.753
BM	111.13	4.375
BN	1.75	0.069
BP	4.50	0.177
BQ	7.00	0.276
BR	104.5	4.114
BS	113.0	4.449

Inch dimensions have been derived from millimetres.

OUTLINE OF WATER JACKET

(All dimensions nominal)



Ref	Millimetres	Inches
CA	158.0	6.220
CB	418.0	16.457
CC	389.0	15.315
CD	52.0	2.047
CE	295.0	11.614
CF	327.0	12.874
CG	378.0	14.882

Inch dimensions have been derived from millimetres.

HEALTH AND SAFETY HAZARDS

High power klystrons can be hazardous to life and health if they are not installed, operated and maintained correctly, or if a klystron is damaged. e2v technologies does not accept responsibility for damage or injury resulting from the use of e2v technologies klystrons. Equipment manufacturers and klystron users should ensure that precautions are taken. Appropriate warning labels and notices must be provided on equipment incorporating klystrons and in operating manuals.



High Voltage

Equipment must be designed so that operators cannot come into contact with high voltage circuits. Klystron enclosures should have fail-safe interlocked switches to disconnect the primary power supply and discharge all high voltage capacitors before allowing access.



RF Radiation

Personnel must not be exposed to excessive RF radiation. All RF connectors and cavities must be correctly fitted before operation, so that there is no leakage of RF energy. Klystrons must not be operated without a suitable RF load at the output and intermediate cavities. It is particularly dangerous to look into open waveguide or coaxial feeders, or transmitter antennae.



X-Ray Radiation

All high voltage devices produce X-rays during operation and may require shielding. When e2v technologies klystrons are operated normally with the RF cavities fitted and the electron gun area suitably enclosed, the X-ray emission is reduced to a safe level. Klystrons must not be run without the RF cavities and electron gun enclosure fitted.



Mechanical

The circuit assembly has been designed to occupy the minimum of floor space in the transmitter. The wheel base is, therefore, short in relation to the height of the assembly, which has a high centre of gravity. Care is required when wheeling the magnet frame, and in particular, the klystron assembled in the magnet frame, over uneven surfaces or gradients which could cause the assembly to overbalance.



Hot Surfaces

Surfaces of tubes (for example the tube envelope in the gun region and the boiler in a vapour cooled system) can reach high temperatures (in some cases in excess of 100 °C) during operation and may remain at a high temperature for a considerable time after switch-off. Burns may be sustained if direct contact is made with hot surfaces.

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