

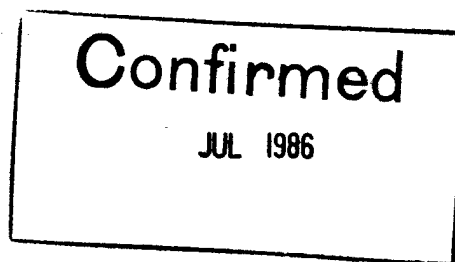
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See the BSI Catalogue for details.

BRITISH STANDARD 9030 : 1971

UDC 621.39.03 : 621.385.64

METRIC UNITS

SPECIFICATION FOR MAGNETRONS OF ASSESSED QUALITY: GENERIC DATA AND METHODS OF TEST



AMD 987

**Amendment No. 1, published 30 June, 1972
to BS 9030 : 1971**

**Magnetrons of assessed quality :
Generic data and methods of test**

Amendment No. 1 to BS 9030 : 1971
Instructions for the insertion of revised pages in BS 9030

Remove the page commencing at 1.3 (61) and the pages marked 1.8 and 2.4.6 and replace them with revised pages marked 1.3 (72), 1.10 and 2.4.6.

Remove measuring method 1018 and replace with revised measuring method 1018.

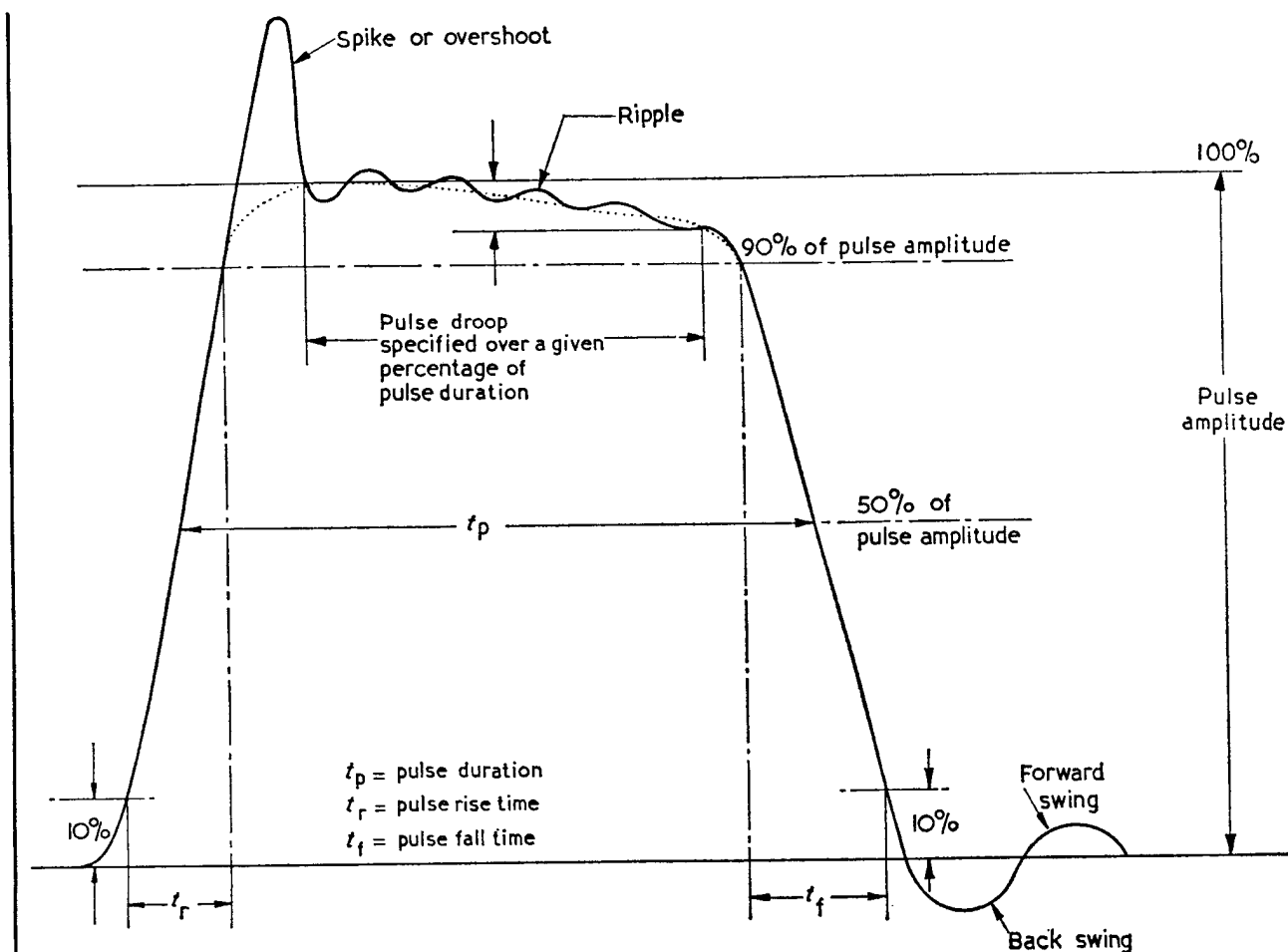


Fig. 1. Pulse characteristics

(61) *Starting stability or snap-on stability.* A measure of the starting stability is the missing pulse factor measured during a given period commencing with the first application of h.t. after a period of rest.

(62) *Restarting ability.* The ability of a magnetron to re-establish its original average anode current and/or output power when the initial starting procedure and conditions are re-applied after interruption of all the supply voltages for a period long enough to allow the cathode to cool.

(63) *Pulse jitter.* A random pulse to pulse variation of a characteristic of the pulses.

(64) *Pulse time jitter.* A random pulse to pulse variation of the time incidence of a reference point of the output pulse with respect to the same reference point of the initiating pulse.

(65) *Pulse frequency jitter.* A random pulse to pulse variation of the r.f. frequency.

(66) *Pulse amplitude jitter.* A random pulse to pulse variation of the pulse amplitude.

(67) *Temperature coefficient of frequency.* The quotient of (1) the change in the frequency of oscillation to (2) the change of the temperature which caused it when measured at constant current. The temperature is measured at a defined point of the tube body.

(68) *H.T. delay time (pre-heat).* The time interval between the instant at which a given heater or filament voltage is reached and the instant of application of the h.t.

(69) *Warm-up time.* The time interval between the start of application of the h.t. and the moment at which a given drift rate, or stated value of frequency, output power or current is achieved.

(70) *Total starting time.* The time interval between the start of application of heater or filament voltage and the moment at which a given drift rate, or stated value of frequency, output power or current is achieved.

(71) *Mechanical tuning sensitivity.* The change of frequency with respect to a change of the position of the mechanical tuner at a given operating point.

(72) *Mechanical tuning rate or tuning speed.* The rate of change of frequency of operation per unit change of mechanical tuner control.

(73) *Mechanical tuner resetability.* The ability of the tuning mechanism to reproduce the same value of a stated quantity, e.g., frequency or output power, at the same tuner setting.

(74) *Unidirectional tuner resetability.* Tuner resetability when a tuner setting is always approached from the same direction.

(75) *Tuner backlash.* The maximum amount of motion of the tuner which does not produce a change in value of a stated quantity, e.g., frequency or output power, on reversal of the direction of tuner motion.

(76) *Tuner hysteresis.* The difference between the values of a stated quantity, e.g., frequency or output power, observed when a given tuner setting is approached from opposite directions. This may include backlash.

(77) *Tuner drift.* A slow continuous change of the characteristic of frequency or output versus tuner setting caused by unwanted changes in the tuner.

(78) *Tuner creep.* Variation of the tuner calibration curve as a result of multiple cycling of the tuner.

(79) *Mechanical tuner torque.* The value of torque required to initiate tuner motion.

(80) *Tuner running torque.* The value of torque required to drive the tuner over the entire tuning range at a stated temperature.

(81) *Tuner fatigue.* A deterioration in the performance of the tuner and/or of other related mechanical parts of the tube occurring after a number of repeated tuning cycles.

(82) *Spurious oscillations.* Unwanted oscillations occurring under given conditions.

(83) *Spurious mode oscillations.* Unwanted oscillations occurring in undesired modes.

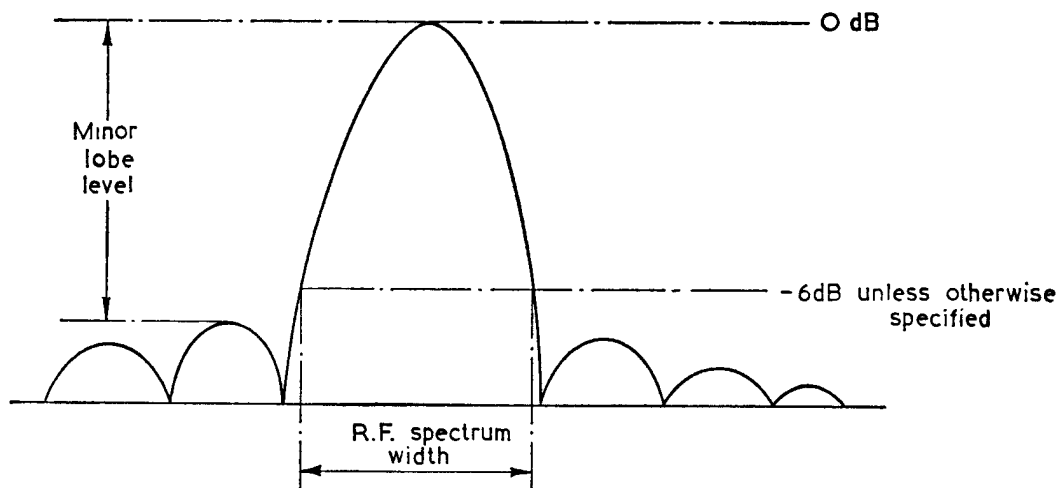


Fig. 2a. R.F. spectrum width (highest minor lobe below spectrum width reference level)

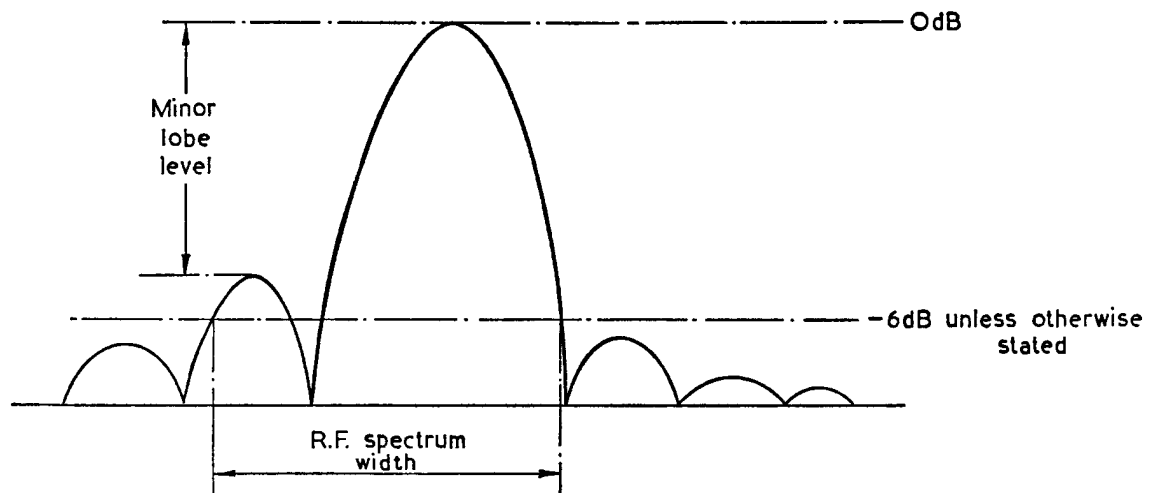


Fig. 2b. R.F. spectrum width (highest minor lobe exceeds spectrum width reference level)

1.4 Letter symbols, signs and abbreviations. For the purposes of this British Standard letter symbols shall be in accordance with BS 1991.

1.5 Graphical symbols. For the purposes of this British Standard graphical symbols shall be in accordance with BS 3939 (IEC Publication 117).

1.6 Marking of the tube and packing. The following symbols or codes shall be clearly and durably marked on the tube in the following order of preference as space permits. All symbols and codes except terminal marking and operating conditions shall also appear on the primary pack, e.g. carton, box, plastics envelope, etc., used as initial protection or wrapping for delivery:

- (1) Manufacturer's component designation number and special marking relating to hazard and special operating conditions.
- (2) Manufacturer's factory identification code.
- (3) Date code.
- (4) BS number of the detail specification.

1.7 Eligibility for qualification approval. A magnetron shall be eligible for submission for qualification approval to BS 9000 only when assembly and final shaping of the anode block, the process of activation or formation of the cathode and all subsequent processing and fabrication are carried out by an approved manufacturer.

The use of 2.3.2(3) (ii) of BS 9000:Part 1:1971 is excluded.

1.8 Structurally similar tubes. When simultaneous or successive production is proceeding on several types of the tube having common features, those common features may be sampled from the complete range of types instead of from each lot of each type. Admissible common features and associated tests include the following:

- (1) Cooling fins.
- (2) Magnetron anode blocks.
- (3) Magnets.
- (4) Envelopes.
- (5) Method of mounting. Tests associated with a common method of mounting include the following:
 - a. Visual inspection.
 - b. Terminal inspection.
 - c. Dimensions.
 - d. Rapid change of temperature.
 - e. Accelerated damp heat.
 - f. Robustness of terminations.

1.9 Delayed delivery. Tubes held by the manufacturer for a period exceeding twelve months following acceptance inspection shall be re-examined for all Group A, subgroup A2 requirements prior to release.

1.10 Supplementary procedure for qualification approval. The following table replaces the sampling requirements of 2.3.1 of BS 9000 : Part 1. When using the table a second sample, as shown, shall be taken when the quantity of rejects exceeds the acceptance quantity but is less than the reject quantity.

Group	Lot size	Sample size	Accept	Reject	2nd sample	Total sample	Accept	Reject
A	1-5	100 % (see Note)	0	1				
	6-280	5	0	2	3	8	1	2
B	1-5	100 % (see Note)	0	1				
	6-280	5	0	2	3	8	1	2
<i>Subgroup</i>								
C1	1-5	100 % (see Note)	0	1				
	6-280	5	1	2				
C2	As for C1							
C3	1-5	2 (see Note)	0	1				
	6-280	2	0	2	2	4	1	2
C4	1-5	2 (see Note)	0	1				
	6-280	2	0	1				
C5	1-3	100 % (see Note)	0	1				
	4-280	3	0	2	2	5	1	2
D1	1-5	100 % (see Note)	0	1				
	6-280	5	0	2	3	8	1	2
D2	1-5	100 % (see Note)	0	1				
	6-280	5	0	2	3	8	1	2
D3	1-280	2 (see Note)	0	2	2	4	1	2
D4	As for D3							
D5	(Endurance) As specified							

NOTE. Qualification approval depends on at least two tubes being tested.

1.11 Certified test records. See 2.8 and Appendix C of BS 9000 : Part 1.

1.12 Standard ratings and characteristics. Not applicable.

1.13 Unchecked parameters. Not applicable.

1.14 Procedure to be followed in the event of failures in Group C or D. The procedures of 2.6.4.1 and 2.6.4.2 of BS 9000 : Part 1 shall apply.

1.15 Ordering information. This will be found in the appropriate detail specification.

1.16 Release prior to completion of Group B tests. Not applicable.

1.17 Inspection procedures for low rates of production. Where production rates are low, with the result that lots are accepted on zero rejects, 2.5.1.2 of BS 9000 : Part 1 allows a larger sample to be taken with consequent lot acceptance on one reject. Alternatively, the manufacturer may elect to perform tests on a 100 % basis.

1.18 Inspection procedure for continuous production. BS 9000 : Part 1, 2.5.1.1(5), shall apply, except that the period shall be increased to six months.

2. TEST PROCEDURES

2.1 Test and measurement conditions. All tests shall be carried out under the standard atmospheric conditions for testing as specified in 5.3 of BS 2011 : Part 1 : 1967.

2.2

The limits quoted in detail specifications are absolute. Tolerances of measurements shall be taken into account when determining the actual limits.

2.2 Visual inspection. Unless otherwise specified, visual inspection shall be performed under normal factory lighting conditions and without visual aids.

Visual inspection shall be carried out for good appearance and workmanship, and shall include the following items where applicable:

- (1) Correctness of marking.
- (2) Correctness of terminal identification.
- (3) Finish.

(4) Materials (the materials and finish for external parts shall be seen to conform with the requirements of the detail specification and/or the quality of the qualification approval samples).

*Deleted
text*

2.3 Dimensioning and gauging procedures. Dimensional measurements shall be carried out either by use of conventional measuring instruments (vernier calipers, rules, micrometers, etc.) or by gauges. Gauges shall be in accordance with BS 448 where applicable or shall have dimensions which comply with the requirements given on the dimensional drawing of the component. All drawings shall state whether first or third angle projection applies.

2.4 Electrical test procedures

2.4.1 Alternative methods of test. See 2.4.2 of BS 9000 : Part 1.

2.4.2 Measuring equipment. All microwave measuring equipment shall be verified to ensure satisfactory operation over the required frequency band. This should be carried out using swept frequency techniques.

The measuring equipment shall be such that the time constants or pulse response characteristics shall not significantly affect the measurement results.

Care should be taken to ensure that any stray electromagnetic fields do not significantly affect the measurement results.

2.4.3 Temperature conditions. Where the measurement of temperature is required for operating conditions or temperature coefficients, it is necessary to measure the temperature at a stated part of the tube rather than to measure the ambient temperature. This is because of the large variation in cooling efficiency with the rate of flow and turbulence of the cooling medium.

It is also necessary to maintain steady conditions for a sufficient time to ensure that all parts of the tube have reached their equilibrium temperature.

2.4.4 Forced cooling. Where forced cooling is required the following should be checked:

- (1) Type of coolant.
- (2) Method of application.
- (3) Rate of flow, or pressure difference between inlet and outlet at stated ambient conditions.
- (4) Limits of inlet temperature.
- (5) Maximum permitted body temperature of the tube at a stated point.

2.4.5 Pressurizing. Where pressurizing is required the following items should receive attention before and during operation of the tube:

- (1) The system shall be clean and free from condensation and be capable of adequate sealing to maintain gas purity.
- (2) The minimum or maximum limits of gas pressure to which the microwave components can be subjected without damage or mechanical distortion shall be observed.
- (3) The nature, purity, dryness and temperature of the gas shall be within stated limits.

2.4.6

2.4.6 Heater supply. For oscillation tests, the heater voltage shall be within $\pm 5\%$ of the specified value and the frequency shall be 50 Hz.

2.4.7 V.S.W.R. measurement. Voltage standing wave ratios (v.s.w.r.) are expressed as a value greater than unity.

2.4.8 Matched r.f. load. Where a 'matched load' is specified in a test procedure it shall have a v.s.w.r. not exceeding 1.1 to 1 over the frequency band in which the tube is being measured.

2.4.9 Magnets. Magnets used for testing magnetrons shall comply with the following requirements:

(1) *Magnetic field strength.* The magnetic field strength shall be within $\pm 3\%$ of the specified nominal value. When a permanent magnet is specified the field strength shall be within $\pm 5\%$ of the specified nominal value.

(2) *Magnetic field polarity.* Magnetrons shall be tested with the north pole of the magnet nearest the cathode connection.

(3) *Magnetic field uniformity.* Magnets shall have pole tips of soft magnetic material of thickness at least one quarter of the specified gap width, having plane faces within 1° and coaxial within 3% of the gap width and of diameter at least equal to the gap width.

2.4.10 Index of measuring methods. For convenience of identification in detail specification the following numbering system for measuring methods has been used. These methods follow 2.7.3 in this standard.

INDEX OF MEASURING METHODS

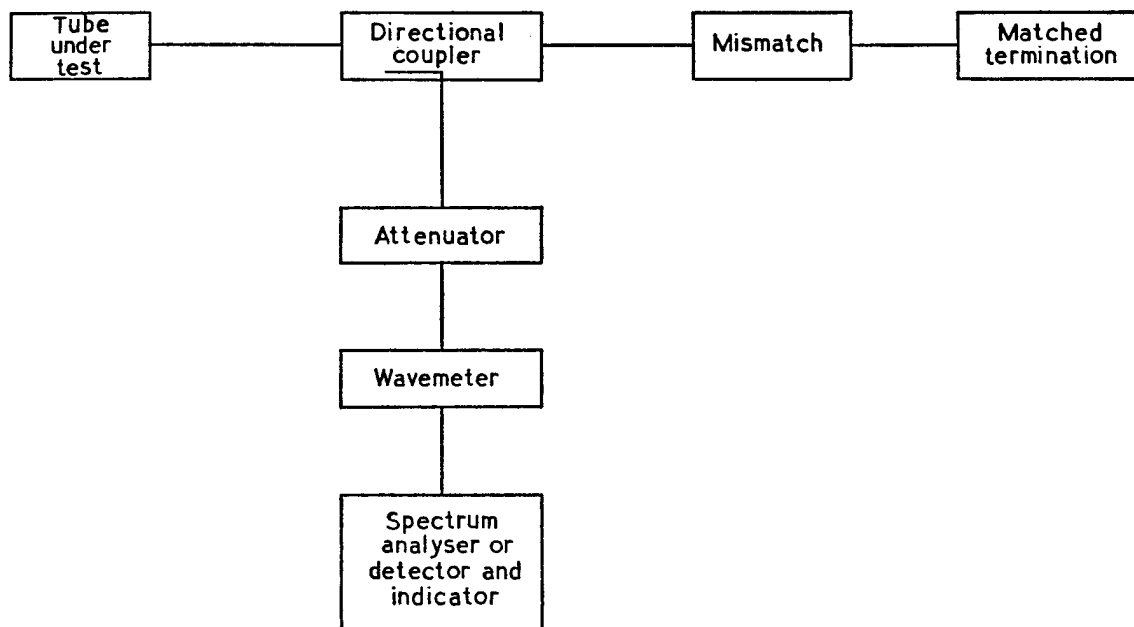
Title	Method
Pulse voltage amplitude	1001
Rate of rise of pulse voltage	1002
Operating rate of rise of pulse voltage	1003
Pulsed current	1004
Mean r.f. output power	1005
Efficiency	1006
Heater current (or voltage) (tube oscillating)	1007
Heater current (or voltage) (Tube stand-by, non-oscillating)	1008
Dynamic impedance	1009
Arcing	1010
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Measurement of mean anode current	1012
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Frequency pushing figure	1017
Frequency pulling figure	1018
Output pulse stability	1019
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Temperature coefficient of frequency (average or maximum)	1021
Tuning tests	1022
Warm-up	1025
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Position of voltage standing wave minimum (P.O.M.)	1031
Heater resonance	1034
Anode-cathode insulation	1035

2.5

PULLING FIGURE

Purpose. To determine the susceptibility of the tube to change its oscillating frequency as a result of a change in its load.

Test circuit



Procedure. The pulling figure shall be measured with the tube operating under specified conditions and coupled into a load causing a specified v.s.w.r. The pulling figure is then the difference between the extremes of frequency of oscillation which occurs when the phase of the reflection coefficient of the load is varied through at least 360° .

Precautions. Care shall be taken to ensure that the v.s.w.r. remains between stated limits during variation of the phase of the reflection coefficient of the load and that the rate of change of phase is rapid enough to avoid thermal drift effects.

Conditions prescribed in the detail specification

- (1) Heater voltage or current.
- (2) Pulse voltage.
- (3) Pulse duration.
- (4) Duty factor.
- (5) Magnetic field strength (non-packaged tubes).
- (6) Period of time over which the test is to be performed.
- (7) Frequency of oscillation (if tunable).
- (8) Mean or peak anode current.
- (9) R.F. load conditions and anode current conditions.

The detail specification will state whether the anode current (initially set-up under matched conditions) is to be maintained at the specified level for all phases of the mismatch or whether it is permitted to vary.

AMD 3592

**Amendment No.2
published and effective from 29 January 1982
to BS 9030 : 1971**

**Magnetrons of assessed quality:
Generic data and methods of test**

Instructions for the insertion of new and revised pages in BS 9030

Remove contents page and substitute revised contents page.

Remove page marked '1.10' and substitute revised page marked '1.10'.

Remove pages marked '2.4.6', '2.6.5' and unmarked page, and substitute revised pages '2.1.7', '2.5' and '2.6.7'.

Insert two new measuring methods 1013 and 1014.

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BRITISH STANDARD SPECIFICATION FOR MAGNETRONS OF ASSESSED QUALITY: GENERIC DATA AND METHODS OF TEST

FOREWORD

This British Standard, which has been prepared under the authority of the Electronic Components Standards Committee, is the generic specification for magnetrons in the system of standards for electronic parts of assessed quality.

SPECIFICATION

1. GENERAL MATTERS

1.1 Scope. This standard forms part of the system of common standard specifications for electronic parts of assessed quality and should be read in conjunction with the standards in the series BS 9000 to BS 9009.

It applies to magnetrons, as defined in 1.3, and gives the terms, definitions, symbols, test methods, and other material necessary to implement fully the detail specifications for these tubes. The material herein shall be applicable only when called up by the detail specification, except for 1.6 to 1.18 which are mandatory requirements.

1.2 Related documents

- BS 448. Dimensions of electronic tubes and valves.
- BS 1991. Letter symbols, signs and abbreviations.
- BS 2011. Basic environmental testing procedures.
- BS 3939. Graphical symbols for electrical power, telecommunications and electronics diagrams (IEC Publication 117).
- BS 6001. Sampling procedures and tables for inspection by attributes.
- BS 9000. General requirements for electronic parts of assessed quality.
- PD 9002. BS 9000 Component selection guide.
Part 1. Qualified products list
- IEC 50(531) International Electrotechnical Vocabulary, Chapter 531 Electronic tubes.

1.3 Terminology. For the purposes of this British Standard, the following terms and definitions apply:

- (1) *Magnetron*. A crossed-field tube in which both the electron beam and slow-wave structure are re-entrant. (531-32-07).
- (2) *C.W. magnetron*. A magnetron designed to be operated with d.c., a.c. or unfiltered rectified voltage supply.
- (3) *Pulsed magnetron*. A magnetron designed to be operated under pulse conditions.
- (4) *Cavity magnetron*. A magnetron having an anode with axial resonant cavities arranged cylindrically around the cathode.
- (5) *Bombarded cathode magnetron*. A magnetron in which the cathode is heated by bombardment by a stream of electrons emitted from a separate gun.
- (6) *Integral (packaged) magnetron*. A magnetron which has a magnet (permanent or electro-magnet) as an integral part.
- (7) *Non-packaged magnetron*. A magnetron designed for use in a separate magnet system (permanent or electro-magnet).
- (8) (a) *Voltage tunable magnetron (VTM)*. A magnetron in which, by virtue of controlled electron injection and a heavily loaded circuit, the frequency is varied by the anode voltage.
(b) *Frequency agile magnetron*. A magnetron which may be rapidly tuned over a stated frequency band in a cyclic, or in some instances, a random manner.
- (9) *Arcing*. Unwanted surges of current due, for example, to flashover.

(84) *Frequency agility*. The ability of a frequency agile tunable magnetron to change frequency rapidly in response to either a random or cyclicly varying command (as appropriate). The change may be affected either entirely electronically or by electro-mechanical means.

(85) *Agility rate for cyclic tuning*. The number of cycles of the frequency agile tuning system traversed in unit time.

NOTE 1. The agility rate may be controlled either by some electromechanical drive system or alternatively by an electronic system.

NOTE 2. For pulse tubes there can be an 'apparent' agility rate manifested as a 'difference' frequency, which is a function of the true agility rate and the pulse repetition frequency.

(86) *Agility bandwidth*. The difference between minimum and maximum frequencies available from the agile tuned magnetron.

(87) *'Stopped' fixed frequency*. The output radio frequency of the tube under test when the agility tuning system is 'stopped'. This can be either random or setable to a defined position or positions.

(88) *Tuner rundown (stop) time*. The time taken for the tube under test to achieve fixed frequency output after removal of the frequency agility tuner drive supply. (Applicable to electro-mechanical systems with high inertia).

1.4 Letter symbols, signs and abbreviations. For the purposes of this British Standard letter symbols shall be in accordance with BS 1991.

1.5 Graphical symbols. For the purposes of this British Standard graphical symbols shall be in accordance with BS 3939 (IEC Publication 117).

1.6 Marking of the tube and packing. The following symbols or codes shall be clearly and durably marked on the tube in the following order of preference as space permits. All symbols and codes except terminal marking and operating conditions shall also appear on the primary pack, e.g. carton, box, plastics envelope, etc., used as initial protection or wrapping for delivery:

(1) Manufacturer's component designation number and special marking relating to hazard and special operating conditions.

(2) Manufacturer's factory identification code.

(3) Date code.

(4) BS number of the detail specification.

1.7 Eligibility for qualification approval. A magnetron shall be eligible for submission for qualification approval to BS 9000 only when assembly and final shaping of the anode block, the process of activation or formation of the cathode and all subsequent processing and fabrication are carried out by an approved manufacturer.

The use of 2.3.2(3) (ii) of BS 9000:Part 1:1971 is excluded.

1.8 Structurally similar tubes. When simultaneous or successive production is proceeding on several types of the tube having common features, those common features may be sampled from the complete range of types instead of from each lot of each type. Admissible common features and associated tests include the following:

(1) Cooling fins.

(2) Magnetron anode blocks.

(3) Magnets.

(4) Envelopes.

(5) Method of mounting. Tests associated with a common method of mounting include the following:

a. Visual inspection.

b. Terminal inspection.

c. Dimensions.

d. Rapid change of temperature.

e. Accelerated damp heat.

f. Robustness of terminations.

1.9 Delayed delivery. Tubes held by the manufacturer for a period exceeding twelve months following acceptance inspection shall be re-examined for all Group A, subgroup A2 requirements prior to release.

1.10 Supplementary procedure for qualification approval. The following table supersedes the sample size requirements of 2.3.1 of BS 9000 : Part 1, for production lot sizes below 280 specimens. The samples may be drawn from one production lot. When using the table a second sample, as shown, shall be taken when the quantity of defectives exceeds the acceptance quantity but is less than the reject quantity.

Group	Lot size	Sample size	Accept	Reject	2nd sample	Total sample	Accept	Reject
A and B	2 - 7	100 %, see note	0	1				
	8 - 280	6	0	2	2	8	1	2
C and D	Any	2	0	2	2	4	1	2

NOTE. Qualification approval is dependent on at least two tubes being tested.

Where production rates are 12 tubes per month or less, permission to release prior to approval may be granted on successful completion of the specified tests on two tubes for groups A and B and one tube for groups C and D.

On receipt of such permission the manufacturer may commence to release tubes meeting the specification.

Qualification approval will be granted when the number of tubes quoted in the above table have satisfied the specified requirements, provided that during this period no inspection lots have been rejected.

Permission to release tubes will be withdrawn:

- (a) in the event of the rejection of an inspection lot prior to the granting of qualification approval.
- (b) in the event of qualification approval not being granted within 18 months of the date of permission to release.

When permission to release is granted, the specification number will be shown in PD 9002 : Part 4 but there will be no entry in Part 1 until qualification approval is granted.

All release documentation including the certificate of conformity shall be prominently marked, 'This tube is released in advance of qualification approval' and the reference of the document granting permission to release shall be quoted.

Defective tubes may be used for those tests where the validity of the result is not affected by the particular defect(s).

Results obtained on development tubes which have been produced using substantially final production techniques and tested by approved methods may be included in the test report to cover part of the requirements for qualification approval with the agreement of the National Supervising Inspectorate (NSI).

1.11 Certified test records. See 2.8 and Appendix C of BS 9000 : Part 1.

1.12 Standard ratings and characteristics. Not applicable.

1.13 Unchecked parameters. Not applicable.

1.14 Procedure to be followed in the event of failures in Group C or D. The procedures of 2.6.4.1 and 2.6.4.2 of BS 9000 : Part 1 shall apply.

1.15 Ordering information. This will be found in the appropriate detail specification.

1.16 Release prior to completion of Group B tests. Not applicable.

1.17 Inspection procedures for low rates of production. Where production rates are low, with the result that lots are accepted on zero rejects, 2.5.1.2 of BS 9000 : Part 1 allows a larger sample to be taken with consequent lot acceptance on one reject. Alternatively, the manufacturer may elect to perform tests on a 100 % basis.

1.18 Inspection procedure for continuous production. BS 9000 : Part 1, 2.5.1.1(5), shall apply, except that the period shall be increased to six months.

2. TEST PROCEDURES

2.1 Test and measurement conditions

2.1.1 General. All tests shall be carried out under the standard atmospheric conditions for testing as specified in 5.3 of BS 2011 : Part 1.1 : 1980.

The limits quoted in detail specifications are absolute. Tolerances of measurements shall be taken into account when determining the actual limits.

2.1.2 Health and safety hazards. This standard calls for the use of substances and/or test procedures that may be injurious to health if adequate precautions are not taken. It refers only to technical suitability and in no way absolves either the supplier or the user from statutory obligations relating to health and safety at any stage of manufacture or use according to the Health and Safety at Work etc. Act 1974. Particular attention is drawn to the following hazards although the list is not necessarily exhaustive.

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

2.1.4 R.F. radiation. Personnel shall not be exposed to strong radio frequency (r.f.) fields, even at relatively low frequencies. Absorption of r.f. energy by the human body is dependent on frequency and, although at frequencies below 30 MHz most energy passes straight through the body with little heating effect, it still presents a hazard.

To minimize leakage of r.f. energy, all r.f. connectors, waveguide coupling flanges and cavities shall be correctly fitted and the transmission line efficiently coupled to a load before the device is operated.

2.1.5 X-ray radiation. All high voltage devices operating at voltages above 5 kV produce progressively more dangerous X-rays as the voltage is increased. The device envelope usually provides only limited protection and further shielding may be required.

NOTE. The X-rays emitted by some microwave tubes may correspond to a voltage approximately two to three times higher than the applied anode voltage.

2.1.6 Radioactive materials. Radioactive materials are incorporated in certain electronic devices. Appropriate precautions against harmful radiation shall be taken as required by current legislation.

2.1.7 Beryllium oxide ceramics. This material is used in some devices which are usually marked with a blue band. Beryllium oxide dust or fumes are highly toxic if inhaled, or if particles enter a cut or abrasion. Avoid handling the beryllium oxide ceramics; if they are touched, wash the hands before smoking or eating. Do nothing to the beryllium oxide ceramics that may produce dust or fumes. Cleaning information is available from the manufacturer. Information on the procedure to follow if a beryllium oxide ceramic is broken is provided with the device.

2.1.8 Implosion. All high vacuum tubes store potential energy by virtue of their vacuum. The energy level is low in small tubes, but it represents a significant hazard in larger tubes such as cathode ray tubes, particularly if the tube is dropped or subjected to violent impact.

Such tubes shall be stored and transported in their approved packs. During installation or replacement, the tube shall not be scratched or damaged in any way likely to reduce the strength of the glass envelope. No stresses shall be imposed on the glass envelope, particularly the neck, and the tube shall be adequately supported. Free standing cathode ray tubes shall be placed faceplate down on a soft surface free from abrasive particles. The user shall be protected against implosion of the tube in the equipment.

2.2 Visual inspection. Unless otherwise specified, visual inspection shall be performed under normal factory lighting conditions and without visual aids.

Visual inspection shall be carried out for good appearance and workmanship, and shall include the following items where applicable:

- (1) Correctness of marking.
- (2) Correctness of terminal identification.
- (3) Finish.

(4) Materials (the materials and finish for external parts shall be seen to conform with the requirements of the detail specification and/or the quality of the qualification approval samples).

2.3 Dimensioning and gauging procedures. Dimensional measurements shall be carried out either by use of conventional measuring instruments (vernier calipers, rules, micrometers, etc.) or by gauges. Gauges shall be in accordance with BS 448 where applicable or shall have dimensions which comply with the requirements given on the dimensional drawing of the component. All drawings shall state whether first or third angle projection applies.

2.4 Electrical test procedures

2.4.1 Alternative methods of test. See 2.4.2 of BS 9000 : Part 1.

2.4.2 Measuring equipment. All microwave measuring equipment shall be verified to ensure satisfactory operation over the required frequency band. This should be carried out using swept frequency techniques.

The measuring equipment shall be such that the time constants or pulse response characteristics shall not significantly affect the measurement results.

Care should be taken to ensure that any stray electromagnetic fields do not significantly affect the measurement results.

2.4.3 Temperature conditions. Where the measurement of temperature is required for operating conditions or temperature coefficients, it is necessary to measure the temperature at a stated part of the tube rather than to measure the ambient temperature. This is because of the large variation in cooling efficiency with the rate of flow and turbulence of the cooling medium.

It is also necessary to maintain steady conditions for a sufficient time to ensure that all parts of the tube have reached their equilibrium temperature.

2.4.4 Forced cooling. Where forced cooling is required the following should be checked:

- (1) Type of coolant.
- (2) Method of application.
- (3) Rate of flow, or pressure difference between inlet and outlet at stated ambient conditions.
- (4) Limits of inlet temperature.
- (5) Maximum permitted body temperature of the tube at a stated point.

2.4.5 Pressurizing. Where pressurizing is required the following items should receive attention before and during operation of the tube:

- (1) The system shall be clean and free from condensation and be capable of adequate sealing to maintain gas purity.
- (2) The minimum or maximum limits of gas pressure to which the microwave components can be subjected without damage or mechanical distortion shall be observed.
- (3) The nature, purity, dryness and temperature of the gas shall be within stated limits.

2.4.6 Heater supply. For oscillation tests, the heater voltage shall be within $\pm 5\%$ of the specified value and the frequency shall be 50 Hz.

2.4.7 V.S.W.R. measurement. Voltage standing wave ratios (v.s.w.r.) are expressed as a value greater than unity.

2.4.8 Matched r.f. load. Where a 'matched load' is specified in a test procedure it shall have a v.s.w.r. not exceeding 1.1 to 1 over the frequency band in which the tube is being measured.

2.4.9 Magnets. Magnets used for testing magnetrons shall comply with the following requirements:

(1) *Magnetic field strength.* The magnetic field strength shall be within $\pm 3\%$ of the specified nominal value. When a permanent magnet is specified the field strength shall be within $\pm 5\%$ of the specified nominal value.

(2) *Magnetic field polarity.* Magnetrons shall be tested with the north pole of the magnet nearest the cathode connection.

(3) *Magnetic field uniformity.* Magnets shall have pole tips of soft magnetic material of thickness at least one quarter of the specified gap width, having plane faces parallel within 1° and coaxial within 3 % of the gap width and of diameter at least equal to the gap width.

2.4.10 Index of measuring methods. For convenience of identification in detail specification the following numbering system for measuring methods has been used. These methods follow 2.7.3 in this standard.

INDEX OF MEASURING METHODS

Title	Method
Pulse voltage amplitude	1001
Rate of rise of pulse voltage	1002
Operating rate of rise of pulse voltage	1003
Pulsed current	1004
Mean r.f. output power	1005
Efficiency	1006
Heater current (or voltage) (tube oscillating)	1007
Heater current (or voltage) (Tube stand-by, non-oscillating)	1008
Dynamic impedance	1009
Arcing	1010
Moding (mode stability)	1011
Measurement of mean anode current	1012
Agility bandwidth	1013
Radio frequency read-out	1014
Frequency	1015
R.F. spectrum measurements	1016
Frequency pushing figure	1017
Frequency pulling figure	1018
Output pulse stability	1019
Mismatch stability	1020
Temperature coefficient of frequency (average or maximum)	1021
Tuning tests	1022
Warm-up	1025
V.S.W.R. or mismatch	1030
Position of voltage standing wave minimum (P.O.M.)	1031
Heater resonance	1034
Anode-cathode insulation	1035

2.5 Mechanical test procedures

2.5.1 Tuning tests. The purpose of the following tests is to test the mechanical characteristics of the tuner mechanism:

(1) *Starting torque or force.* The torque or force required to produce an initial frequency shift shall be within the specified limits over the required tuning range.

(2) *Operating torque or force.* The torque or force required to maintain tuner motion shall be within the specified limits over the required tuning range.

(3) *Tuner stop endurance.* The tuning mechanism shall withstand the specified torque (including impact values), at the extremes of the mechanical motion, without evidence of physical damage to the tuner drive mechanism.

2.5.2 Mechanical tuning fatigue. (This test is destructive.) The tube shall withstand the specified number of coarse or vernier tuning cycles without the tuning mechanism becoming inoperable.

2.6 Environmental test procedures. The following tests taken from BS 2011 : Part 2.1 shall be performed as required by the detail specification.

2.6.1 Test N. Change of temperature (This test is non-destructive) Test Na, rapid change of temperature, two-chamber method, except that the tube shall be non-operating and the duration at each temperature extreme shall be given in the following table.

Mass of tube	Minimum period
kg	h
0.15 and less	0.5
Over 0.15 up to 1.5	1.0
Over 1.5 up to 15	2.0
Over 15 up to 150	4.0

Where the required changes in temperature can be achieved with one chamber this is permissible, and in this case the rate of change of temperature shall also be specified (Test Nb).

The following temperatures are preferred: -55 °C and + 85 °C.

2.6.2 Test Ea. Shock. (This test is non-destructive).

The acceleration and duration of the shock pulse shall be 147 m/s² 3 ms.

Tubes having structural symmetry in two of the three axes need be subjected to shock in the two dissimilar axes only.

2.6.3 Test U. Robustness of terminations and integral mounting devices. (This test is non-destructive.) The purpose of this test is to assess the ability of a termination to withstand the mechanical strains likely to be applied during normal assembly of the tube into equipment, the following tests being applied as appropriate:

(1) *Torque.* Test Ud, except that the value of torque shall be as follows:

Top caps less than 15 mm diameter = 0.17 N m.

Top caps greater than 15 mm diameter = 0.34 N m.

(2) *Tensile.* Test Ua₁

2.6.4 Test Fc. Vibration (sinusoidal). Tubes shall be vibrated to the specified procedure (B1, B2, B3 or B4) under the specified conditions.

Tubes having structural symmetry about one of the three axes shall be subjected to vibration in two directions instead of three.

Preferred frequency ranges and accelerations are:

Airborne environments 55 Hz to 2000 Hz at 49 m/s².

Shipborne environments 5 Hz to 55 Hz at 0.35 mm amplitude and 55 Hz to 2000 Hz at 49 m/s².

2.6.5 Durability of marking. The marking shall remain legible at the conclusion of the accelerated damp heat test, Test Da. The periodic variation of 2 °C to 3 °C four times per hour is omitted. The number of cycles of conditioning shall be two. Standard drying conditions shall apply.

2.6.6 Increased air pressure. (This test is non-destructive.) The tube shall be subjected to an increase of atmospheric pressure to the specified level and maintained at this condition for not less than one minute. The specified pressure shall be obtained within 1 min.

Preferred severity: 200 kN/m² gauge pressure.

2.6.7 Holding test. After completion of manufacture all magnetrons shall be held for a specified 'holding period', of 24 h minimum duration during which no electrical potential shall be applied to them.

During the holding period processes such as marking, low-temperature potting, painting and gauging may be carried out.

The tests specified in the detail specification are usually required to be performed at the completion of the holding period, but in certain cases measurements before and after holding are required in order to observe the extent of change which may occur in characteristics of individual tubes; where this is required, 2.6.3 of BS 9000 may be invoked and measurements during production testing recorded as the pre-holding test results.

2.6.8 Test M. Low air pressure. (This test is non-destructive.) When the specified reduced pressure has been attained, the specified voltage(s) shall be applied.

Preferred pressure = 30 kN/m²

2.6.9 Test A. Cold. (This test is non-destructive.)

Preferred temperature = -55 °C.

2.7 Endurance test procedures

2.7.1 Electrical endurance test. Tubes shall be connected to the specified load and operated under the specified conditions for the required number of hours.

Unless otherwise specified, tubes undergoing the endurance test shall be measured at the following time intervals:

0 h, 160 h, 500 h, 1000 h, and thereafter at $1000 \text{ h} \pm \frac{48}{24} \text{ h}$ intervals and at the termination of the test.

The time intervals quoted, (up to 1000 h) may be extended to allow the manufacturer to perform tests during normal factory working hours. At the discretion of the manufacturer, tests may be performed at more frequent intervals.

Tubes which are rejected for mechanical defects, i.e. dimensions, etc., which do not affect the electrical parameters listed under the post-test requirements may be used for endurance tests.

Rejects which affect the electrical parameters listed under the post-test requirements may also be used for endurance tests but in this case the permitted deviation in the specification limits shall be maintained from the initial measured value.

2.7.2 Non-operating endurance (storage). Initially the tubes shall be tested for those tests specified in the detail specification and the results recorded. The tubes shall then be stored for the period specified in the detail specification with no voltages applied. On completion of the non-operating endurance period the specified tests shall be repeated.

The following conditions may be prescribed in the detail specification:

- (1) Duration of storage.
- (2) Tests before storage.
- (3) Tests after storage.
- (4) Environmental conditions during the storage if other than standard atmospheric conditions.

2.7.3 Heater fatigue. The specified heater supply shall be applied for a minimum period or a minimum number of ON-OFF cycles according to a specified schedule. The detail specification may include limits for the heater supply impedance.

AGILITY BANDWIDTH

Purpose. To measure the excursion in frequency resulting from the operation of the agility tuning system.

Method 1. (Narrow band tunable filter system)

Test circuit

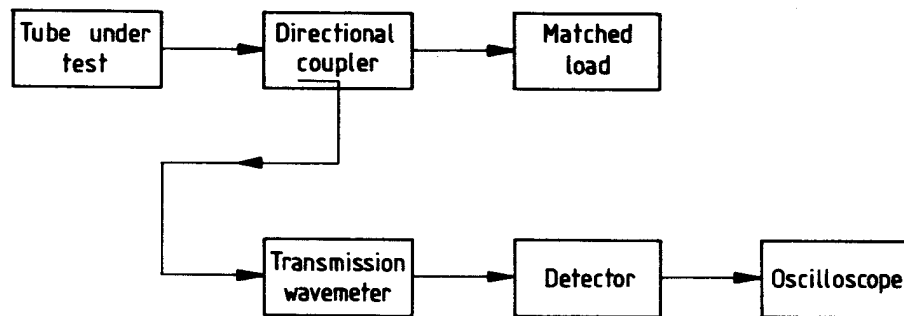


Fig. 1013/1

Procedure. Operate the tube under test in the prescribed manner with the agility drive supply switched on.

Tune the wavemeter to the approximate centre frequency of the agility band. The resulting display will present a rectified pulse envelope containing a large number of pulses of differing amplitude and will give the impression of being 'filled in'. Note the level of the pulse of maximum amplitude. Tune the cavity wavemeter until the maximum pulse amplitude has fallen by 3 dB and note the frequency setting of the wavemeter. Reverse the tuning of the wavemeter and pass through the point of maximum amplitude until the pulse amplitude has again fallen by 3 dB. Note this frequency setting of the wavemeter. The difference in frequency between the two wavemeter readings is the agility bandwidth.

Method 2. Variable pulse timing, cyclic tuning, modulator pulse derived from tuner drive voltage

Description. This method reduces the apparent agility rate to zero, by arranging for the modulator to be triggered by a pulse derived from the tuner drive voltage at the point in the tuning cycle where the radio frequency is always the same. By varying the timing of the modulating pulse the complete frequency excursion may be plotted. The basic method is also useful as a means of checking other tube tuning parameters.

The frequency analogue unit produces two voltage outputs, one of which is a lock pulse used to trigger the oscilloscope (1) directly and the modulator indirectly through the variable trigger delay unit. The second output from the frequency analogue unit is periodical and varies in amplitude in proportion to the tube radio frequency. This output is displayed on oscilloscope (1) in association with a bright-up facility used to indicate the value of the tuner analogue voltage at the time of pulsing the tube under test.

Since the tube under test is always pulsed at a point where the frequency is the same, it appears to operate at a fixed frequency. Variation of the timing moves the point of trigger so that a different apparently fixed frequency results and hence the total frequency excursion may be plotted and the maximum and minimum frequencies extracted. (The information derived from the range of bright-up points may be used to verify the analogue voltage equivalent of frequency.)

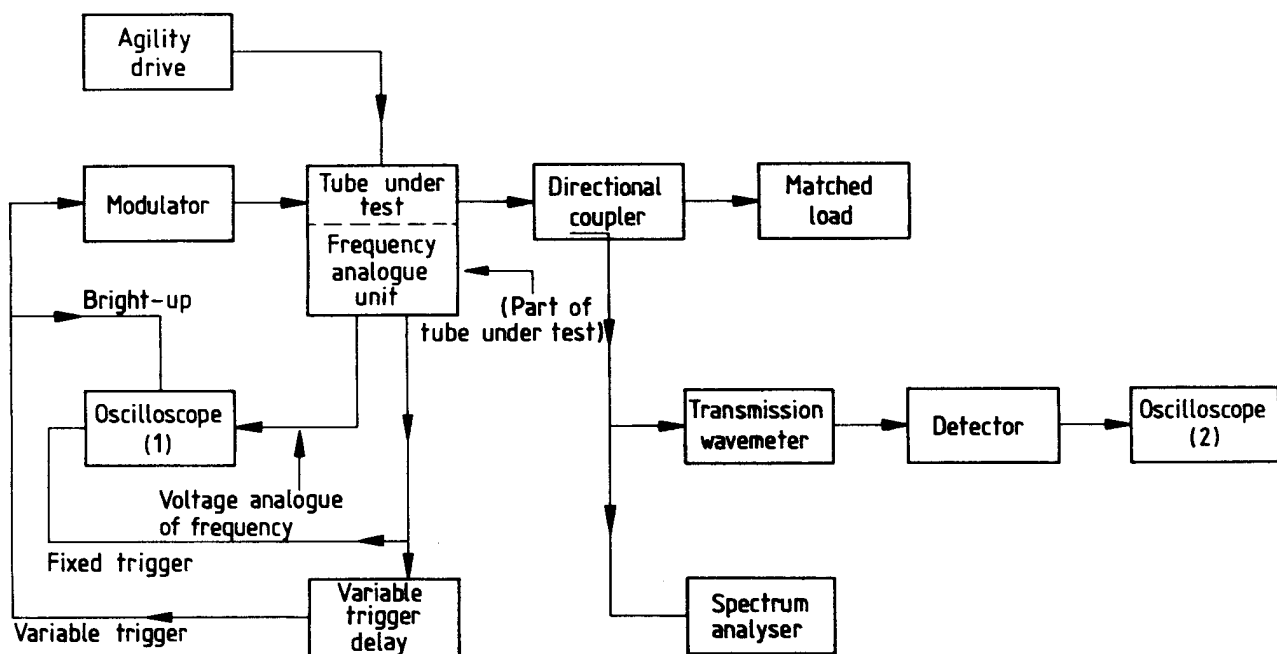
Test circuit

Fig. 1013/2

Procedure. Operate the tube under test in the circuit according to the prescribed conditions and with the tuner agility drive applied.

Set the variable trigger delay, measure the radio frequency by means of the transmission wavemeter and, when required, note the value of the tuner analogue voltage.

Repeat for further settings of the variable trigger delay until the complete frequency excursion has been traversed. The two extremes of frequency recorded will then define the agility bandwidth.

Precautions. Because the method relies upon the p.r.f. being synchronized with the agility rate, low rates of agility will result in a low p.r.f. This may result in:

- the tube under test being operated well below the maximum rated conditions; and
- there may be difficulty in obtaining adequate display brightness. This can be alleviated by using a frequency multiplier to increase the p.r.f. but great care is necessary in identifying the pulse producing the required frequency.

Method 3. Cyclic tuning with tuner drive voltage derived from pulse modulator

Description. This method is suitable for the measurement of agility bandwidth when the tuner drive waveform is sinusoidal, the frequency is synchronized with, and derived from, the magnetron pulse repetition frequency and the maximum acceptable tuner rate is much less than the pulse repetition frequency.

The frequency of the tuner drive voltage is established by taking a sample of the modulator trigger drive voltage, amplifying it and then frequency dividing by a constant k , so producing a lower frequency which whilst locked to the magnetron pulse repetition frequency is suitable for driving the tuner.

A proportion of the peak to peak tuner drive voltage is fed to the X plates of the display oscilloscope and a phase-shifted further proportion of this voltage is also applied to the Y plates of the oscilloscope, so producing an elliptical Lissajous figure to form the display timebase. The rectified r.f. pulse output from a detector is then superimposed on the Y plates, the resulting display being depicted typically in Fig. 1013/5. (The pulses displayed round the elliptical timebase will be k pulses.)

A bright-up circuit incorporating a variable time delay facility enables any one of the displayed rectified r.f. pulses to be identified.

Test circuit

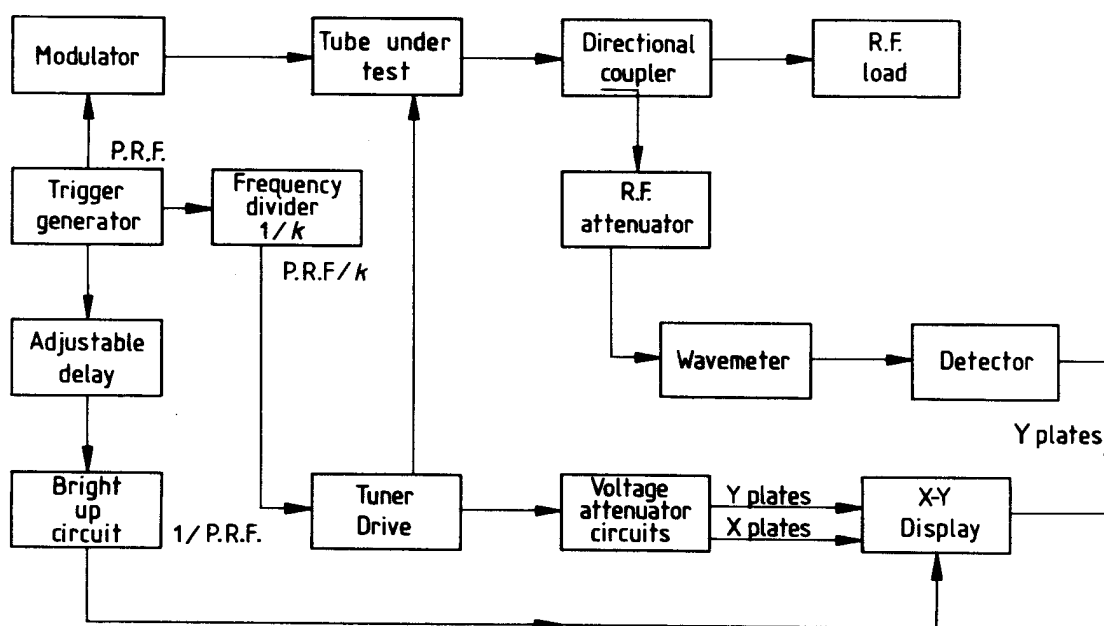


Fig. 1013/4

Procedure. Operate the tube under test in the circuit according to the prescribed conditions and with the tuner drive applied. Adjust the r.f. attenuator to give a convenient amplitude level of r.f. pulses on the X-Y display and by means of the bright-up circuit adjustable delay, select the brightened pulse whose radio frequency is to be measured. Tune the wavemeter until the brightened pulse reduces in amplitude indicating the tuned frequency for that pulse. By selecting and measuring pulses at the extremes of the tuner drive voltage excursion, plot the maximum and minimum frequencies and hence determine the agility bandwidth.

Precautions. The following precautions shall be observed:

- (1) Since the total number of pulses displayed is limited to k , the pulses producing maximum or minimum frequencies may not necessarily be displayed (i.e. the ends of the elliptical display may be devoid of pulses) hence provision should be made to adjust the timing of the trigger pulse applied to the modulator so as to bring the pulses to the desired position.
- (2) The bright-up circuit adjustable delay should possess sufficient range to enable the selection of a pulse anywhere around the elliptical display.

A typical dynamic tuner display

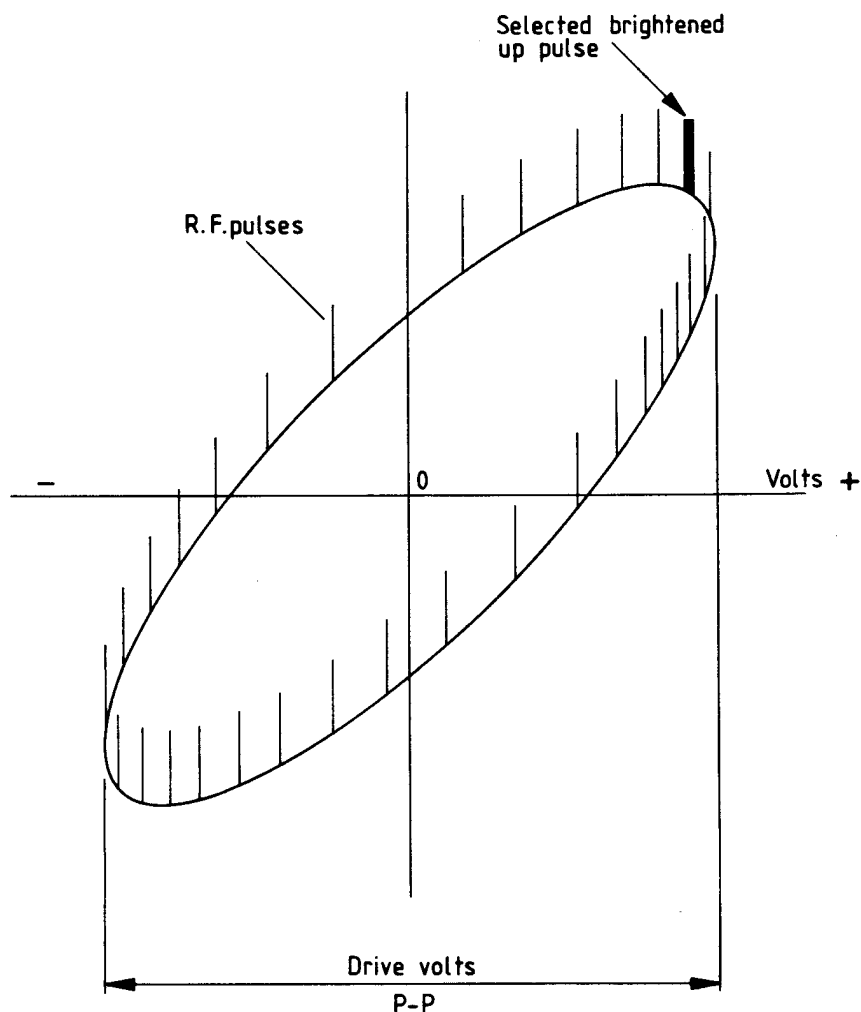


Fig. 1013/5

Conditions prescribed in the detail specification

- (1) Heater voltage, current or power as appropriate.
- (2) Pulse duration.
- (3) P.R.F. or duty factor as appropriate.
- (4) Magnetic field strength (non-packaged tubes).
- (5) Mean or peak anode current or alternatively mean or peak input power.
- (6) Input drive to agility tuning system. (This may include a specified voltage amplitude, frequency, waveshape and power).
- (7) Drive requirements for the frequency analogue system where this is fitted. (Specified voltage amplitude frequency, waveshape and power as appropriate.)

RADIO FREQUENCY READ-OUT

Purpose. To verify the accuracy of the analogue voltage output, which is derived from the analogue frequency indicator in comparison with the measured radio frequency.

Test circuit. As for Test Method 1013, Method 3.

Procedure. Operate the tube under test in the prescribed manner.

Measure the output radio frequency of the tube under test and also the amplitude of the displayed analogue voltage output at the indicated bright-up point. By varying the point of modulation trigger, plot the total frequency agile bandwidth and compare the analogue tuner voltage with the measured frequencies.

Precaution. Where the agility rate is low the resultant p.r.f. is also low which may result in:

- (a) the tube under test being operated well below the maximum rated conditions; and
- (b) there may be difficulty in obtaining adequate display brightness. This can be alleviated by using a frequency multiplier to increase the p.r.f. but great care is necessary in identifying the pulse producing the required frequency.

Conditions prescribed in the detail specification

- (1) Heater voltage, current or power as appropriate.
- (2) Pulse duration.
- (3) P.R.F. or duty factor as appropriate.
- (4) Magnetic field strength (non-packaged tubes).
- (5) Mean or peak anode current or alternatively mean or peak input power.
- (6) Input drive to agility tuning system. (This may include a specified voltage amplitude, frequency, waveshape and power).
- (7) Drive requirements for the frequency analogue system where this is fitted. (Specified voltage amplitude frequency, waveshape and power as appropriate).

BS 9030 : 1971
SPECIFICATION FOR
MAGNETRONS OF
ASSESSED QUALITY:
GENERIC DATA AND
METHODS OF TEST