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BS 9620 : 1975

UDC 621.373.5 : 621.382

Specification for
Quartz crystal oscillators
of assessed quality:
Generic data and
methods of test

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Committee reference TLE/11 Draft for comment 72/26061

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**Amendment No. 1, published and effective from 31 December 1982
to BS 9620 : 1975**

**Quartz crystal oscillators of assessed quality:
Generic data and methods of test**

**Instructions for the insertion of new and revised pages and minor revisions
to existing pages of BS 9620**

Remove the title page at the front of the standard. Insert revised title page (backing page blank) followed by revised contents page.

Remove page marked 1.1.10 and substitute revised page marked 1.1.9.

Remove page marked 1.2.4.1 and substitute revised page marked 1.2.4.1.

Remove page marked 1.2.6.5 and substitute revised page marked 1.2.6.4.

Remove page marked 2.1.3 and substitute revised page marked 2.1.3.

Remove page marked Appendix A together with appendices A, B, C, D, E, F and G and substitute revised page marked appendix A and revised appendices A, B, C and D.

Revised text

Clause 1.1.2 Related documents. Delete the title against BS 9000 and substitute the following:

‘General requirements for a system for electronic components of assessed quality.

Part 1 Specification for basic rules and procedures

Part 2 Data on generic and detail specifications’.

Delete the title against BS 2011 (IEC 68) and substitute the following:

‘Basic environmental testing procedures’.

Clause 1.1.3.3 Temperature compensated crystal oscillator (TCXO). Delete note 2 and amend note 1 to read ‘NOTE’.

Clause 1.1.3.4 Oven temperature controlled crystal oscillator (OCXO). Delete note 2 and amend note 1 to read ‘NOTE’.

Clause 1.1.3.20 Pattern. Delete this clause and renumber 1.1.3.21 to 1.1.3.29 inclusive, accordingly.

Clause 1.1.3.26 r.m.s. fractional frequency deviation. Delete ‘see appendix D’ and substitute ‘see appendix A’.

Clause 1.1.3.27 Short term frequency stability. Delete ‘see appendix D’ and substitute ‘see appendix A’.

Delete page reference ‘1.1.3.30’ and substitute page reference ‘1.1.3.29’.

Clause 1.2.4.6.3 Frequency temperature characteristic. Delete this clause.

Clause 1.2.4.10.5.4 Specified conditions. Delete the existing note and substitute the following:

‘NOTE. The load may refer to a logic ‘family’, see appendix B’.

Clause 1.2.4.13.5.4 Procedure. In lines 5 and 6, delete ‘appendix D’ and in each case substitute ‘appendix A’.



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Foreword

This British Standard, which has been prepared under the direction of the Electronic Components Standards Committee, is the generic specification for quartz crystal oscillators in the BS 9000 system of standards for electronic components of assessed quality.

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, safety and fire hazard at any stage of manufacture or use.

The references in this specification to BS 9000 have been amended to the version published in 1981. That publication contains an appendix giving cross-references between it and the 1971 version of Part 1.

BS 9000 : Part 2 : 1972 will eventually be replaced by appendix D of BS 9000 : Part 1 : 1981.

- | **1.1.3.29 stabilization time.** The time, measured from the initial application of power, required for an oscillator to stabilize its mode of operation within specified limits.
- | **1.1.3.30 voltage coefficient.** The incremental change in output frequency which results from an incremental change in supply voltage, measured under specified conditions of supply voltage, load and output frequency.
- | **1.1.3.31 working frequency.** The frequency to which an oscillator shall be tuned to ensure that it meets the specification. The working frequency is the nominal frequency plus the offset frequency.

1.1.4 Letter symbols, signs and abbreviations. The letter symbols, signs and abbreviations which are employed in all documents applicable to electronic components covered by this specification are in conformity with BS 1991 or are derived in accordance with the principles of that standard.

1.1.5 Graphical symbols. The graphical symbols which are employed in all documents applicable to electronic components covered by this specification are in conformity with BS 3939 or are derived in accordance with the principles of that standard.

1.1.6 Marking of the component and package

1.1.6.1 The marking shall consist of the following.

- (a) The number of the detail specification and any other coding as given in the detail specification to identify the particular item.
- (b) The nominal frequency marked in kHz or MHz as appropriate. The characters kHz or MHz shall form part of the marking.
- (c) The date code (see clause 22 of BS 9000 : Part 1 : 1981).
- (d) the manufacturer's code.

1.1.6.2 The marking of the oscillator shall normally consist of the whole of the marking detailed in 1.1.6.1 and, in addition, those oscillator units selected for tests in groups C and D shall be marked with a serial number which should be durable for at least the period of the tests to which they are subjected.

1.1.6.3 The marking of the package shall normally consist of the whole of the marking detailed in 1.1.6.1, unless otherwise specified in the detail specification.

1.1.7 Eligibility for qualification approval

- | **1.1.7.1** The primary stage of processing for the crystal oscillator, in accordance with 14.2 of BS 9000 : Part 1 : 1981, shall be the assembly of the crystal oscillator.

1.1.7.2 Where the final component contains components of a kind covered by a generic specification in the 9000 series, it is desirable (but not mandatory) that these should be released in accordance with BS 9000. Where the contained component is not so released, the final manufacturer's chief inspector shall be satisfied that its quality is adequate, by the use of

- a procurement specification
- approval tests
- incoming inspection procedures.

1.1.8 Structurally similar components. Ranges of quartz crystal oscillators normally covered by a single detail specification and having similar electrical characteristics are considered to be structurally similar and, subject to the following constraints, may be grouped together for the purpose of sampling tests.

- (a) The lot shall consist of oscillators produced using the same basic methods of construction and materials. However, the following variations may be permissible:
 - (1) physical dimensions;
 - (2) electrical characteristics, e.g. nominal frequency, frequency tolerances and voltage ratings;
 - (3) complexity as defined by the number of components, subject to the sample chosen assessing all the components used in the aggregated lot.
- (b) The sample shall contain oscillators having a sensibly even spread of the variations permitted in (a) including the extremities of the ranges covered by the lot.

[1.1.9

- (c) The oscillators included within the lot shall contain crystal units that:
- (1) have been qualified to a detail specification within the BS 961- series; or
 - (2) have been procured in accordance with 1.1.7.2 of BS 9620 : 1975.

In each case the crystals shall have a substantially similar method of mounting the crystal plate.

- (d) The grouping shall meet the approval of the supervising inspectorate.

1.1.9 Delayed delivery. Crystal oscillators held for a period exceeding one year following acceptance inspection shall be re-inspected for electrical tests detailed in 1.2.4.5 and 1.2.4.10.2 prior to release, or as otherwise stated in the detail specification.

1.1.10 Supplementary procedures for qualification approval

1.1.10.1 The procedure given in clause 13 of BS 9000 : Part 1 : 1981 shall apply except that the sample shall be drawn from one production lot and shall be tested and sentenced in accordance with the following table.

Group	Sample size	Accept	Reject	Second sample	Total sample	Accept	Reject
A0	100 % (see note 1)	0	1	—	—	—	—
A2	5	0	2	5	10	1	2
B1	3	0	2	3	6	1	2
B5	8 (where applicable)	0	2	8	16	1	2
C	3 (see note 2)	0	2	3	6	1	2
D	3 (see note 2)	0	2	3	6	1	2

NOTE 1. Qualification approval depends upon a minimum sample of five units. For hermetically sealed units containing non-encapsulated crystals, the minimum sample size should be eight.

NOTE 2. Sample size applicable to each subgroup within the group.

NOTE 3. If the manufacturer has sufficient confidence in his product he is permitted to submit the same samples to each specified test conducted in series. If he wishes to employ separate samples for each test (particularly those of a destructive nature) he should adjust the initial lot size accordingly.

1.1.10.2 For shelf life, 14.1 of BS 9000 : Part 1 : 1981 can be implemented after 1000 h.

1.1.11 Certified test records. The results of specified tests from Groups C and D shall be summarized and presented in the form of a certified test record (CTR).

NOTE. Details of the information required and the method of presentation are given in 2.3.

Certified test records are required for crystal oscillators at the full assessment level. They are not required for units at the basic assessment.

Certified test records shall be printed on A4 in the layout as shown in appendix C.

1.1.12 Standard ratings and characteristics

1.1.12.1 Climatic category. 40/85/56 (storage conditions).

NOTE. For requirements where the operating temperature range of the oscillators is greater than -40°C to $+85^{\circ}\text{C}$, a climatic category consistent with the operating temperature range should be specified.

1.1.12.2 Torque test

Thread type (mm)	2	2.5	3	4	5	6
Moment (N·m)	0.18	0.26	0.35	0.90	1.70	2.80

Thread type	8BA	6BA	4BA	2BA	0BA	in
Moment (N·m)	0.18	0.35	0.70	1.41	2.82	2.82

1.1.12.3 Bump severity. 4000 ± 10 bumps at 390 m/s^2 peak acceleration with a pulse duration of 6 ms in each direction of three mutually perpendicular axes, one of which shall be perpendicular to the mounting plane.

[1.1.12.4

1.1.12.4 Vibration severity

10 Hz to 60 Hz

0.75 mm displacement

60 Hz to 500 Hz

98.1 m/s² acceleration

Duration 30 min in each of three mutually perpendicular axes, one of which shall be perpendicular to the mounting plane.

1.1.12.5 Shock severity. 981 m/s² acceleration for 6 ms duration; three shocks in each direction along three mutually perpendicular axes, one of which shall be perpendicular to the mounting plane. Half sine pulse unless stated otherwise in the detail specification.

1.1.12.6 Leak rate. The leak rate shall not exceed 10⁻⁶ mbar l/s when hermetically sealed oscillators are tested in accordance with 6.4 (method 1) of test QK of Part 2.1Q : 1981.

1.1.13 Unchecked parameters. The overtone order may be stated in the detail specification, but not verified by tests. The overtone order shall therefore not be used for inspection purposes.

1.1.14 Procedure to be followed in the event of failures at group C or D inspection. The procedure specified in 20.1(b) of BS 9000 : Part 1 : 1981 shall be applicable.

1.1.15 Ordering information. Ordering information shall be as specified in the detail specification.

1.1.16 Release prior to completion of group B tests. Not applicable.

1.2 Test procedures

1.2.1 Test and measurement conditions. Unless otherwise specified, all tests shall be carried out under the standard atmospheric conditions for testing specified in 5.3 of BS 2011 : Part 1.1 : 1980.

Before measurements are made, the oscillator shall be stored at the measuring temperature for a time sufficient to allow the oscillator to reach this temperature. Controlled recovery conditions are given in 5.4 of BS 2011 : Part 1.1 : 1980.

The ambient temperature during the measurements shall be recorded and stated in the test report.

For the bump, shock, vibration and acceleration tests, the oscillators shall be mounted as stated in the detail specification. Clamps on the body may be used if specified.

1.2.2 Visual inspection

1.2.2.1 Visual test A. The oscillator shall be visually examined to ensure that the condition, workmanship and finish are satisfactory. The marking shall be legible and durable.

1.2.2.2 Visual test B. The oscillator shall be visually examined. There shall be no corrosion nor other deterioration likely to impair satisfactory operation. The marking shall be legible and durable.

1.2.3 Dimensioning and gauging procedures

1.2.3.1 Dimensions test A. The dimensions, spacing and alignment of terminals shall be checked and shall comply with the specified values.

1.2.3.2 Dimensions test B. The dimensions shall be checked and shall comply with the specified values.

1.2.4 Electrical test procedures. The following electrical test procedures are described on separate pages to facilitate revision:

1.2.4.2 Insulation tests

1.2.4.3 Supply voltage

1.2.4.4 Input power

1.2.4.5 Output frequency

1.2.4.6 Frequency/temperature characteristics

1.2.4.7 Frequency stability characteristics

[1.2.4.1

- 1.2.4.8 Frequency adjustment
- 1.2.4.9 Retrace characteristics
- 1.2.4.10 Output characteristics
- 1.2.4.11 Amplitude modulation characteristics
- 1.2.4.12 Frequency modulation characteristics
- 1.2.4.13 Spectral purity
- 1.2.4.14 Electromagnetic interference

1.2.4.1 General. This subclause gives information of a general nature applying to electrical measurement techniques and general precautions to be applied during measurements.

1.2.4.1.1 Alternative test methods. The measurement and conditions specified are not the only methods which can be used, but the supervising inspectorate shall be satisfied that other methods of measurement employed will give results compatible with the methods and/or conditions specified in this standard and the relevant detail specification. By 'compatible' is meant that the value of the characteristic established by such other method(s) will fall within the specified limits when measured by the specified method(s).

1.2.4.1.2 Equilibrium conditions. All electrical tests shall be conducted under equilibrium conditions, unless otherwise specified. When test conditions cause significant change with time of the characteristic being measured, means of compensation for such effects will be specified; for example, the length of time that the oscillator shall be maintained at test conditions before making a measurement.

1.2.4.1.3 Temperature. Unless otherwise specified, all measurements shall be made at an ambient or reference point temperature $25 \pm 2^\circ\text{C}$. Measurements may be carried out at temperatures other than 25°C provided that it can be demonstrated to the satisfaction of the supervising inspectorate that the characteristics of the oscillator will be in accordance with all the provisions of the detail specification when tested at 25°C .

1.2.4.1.4 Power supplies. The sources of direct currents and voltages should have no ripple contents large enough to affect the desired accuracy of the measurements; a.c. power supplies shall be free of transients. When the ripple or transient content of the power supply is critical to the measurement being performed, it shall be described fully in the detail specification.

1.2.4.1.5 Operating conditions. For the purposes of all electrical test procedures, the oscillator shall operate under specified conditions $\pm 1\%$, or within the specified tolerance.

1.2.4.1.6 Precautions. The measuring circuits shown for specified electrical tests are the preferred circuits. Due allowance shall be made for any loading effects in cases where the measuring apparatus modifies the characteristics being examined. (See 1.2.4.1.10.)

1.2.4.1.7 Air flow conditions for temperature control. Devices measured at temperatures other than $25 \pm 2^\circ\text{C}$ shall be subject to adequate forced air circulation to ensure close temperature control.

If heat loss due to forced air circulation affects the performance of the oscillator, still air conditions shall be simulated by enclosing the oscillator in a draught shield, consisting of a thermally conducting box having internal dimensions such that a $20 \pm 5\text{ mm}$ clearance is maintained from all surfaces. The temperature at which measurements should be taken under these conditions is the reference point temperature on the surface of the draught shield.

If a draught shield is necessary it shall be used for both high and low temperature tests.

1.2.4.1.8 Precision of measurement. The limits quoted in detail specification are absolute. Tolerances on measurements shall be taken into account when determining the actual measurement limits.

1.2.4.1.9 Measurement frequency. Clause 1.1.8 may be invoked for a range of oscillators which are generally similar, but which may operate over a range of frequencies dependent upon the crystal used.

1.2.4.1.10 Load details. Many of the test procedures given in 1.2.4 require the load details to be specified in the detail specification. Appendix B gives details of load circuits and logic drive.

[1.2.4.2

1.2.5 Mechanical test procedures. Mechanical test procedures applicable to quartz crystal oscillators, including those given in BS 2011, are given in 1.2.6.

1.2.6 Mechanical and environmental test procedures

1.2.6.1 Robustness of terminations

1.2.6.1.1 Tensile and thrust test on terminations. The tests shall be performed in accordance with test Ua_1 and test Ua_2 of BS 2011 : Part 2.1U : 1977.

Unless otherwise stated in the detail specification, the loading mass shall be:

- (a) for pin terminations: 2 kg thrust;
- (b) for pin terminations: 2 kg tensile;
- (c) for wire terminations: 1 kg tensile.

1.2.6.1.2 Flexibility of wire terminations. The test shall be performed in accordance with test Ub of BS 2011 : Part 2.1U : 1977.

Unless otherwise stated in the detail specification, the load shall be restricted so that the bend starts 2.5 ± 0.5 mm from the body of the oscillator. The loading mass shall be 0.5 kg and the number of bends shall be three.

1.2.6.1.3 Torque test on mounting studs or threaded bushes. This test is applicable to rigid terminals having external screw threads or threaded inserts located at the centre of the terminals. The torque shall be applied clockwise, and then counter-clockwise in a plane perpendicular to the axis of the terminal. The force shall be applied gradually and be maintained for a period of 15 s. For ISO metric screw threads or BA threads, the torque shall be as specified in 1.1.12.5 unless otherwise stated in the detail specification.

1.2.6.2 Sealing tests

1.2.6.2.1 Sealing test A. This test shall be performed in accordance with method 1 of test Qc of BS 2011 : Part 2.1Q : 1981. However, the liquid shall be degassed water and the pressure of air above the water shall be reduced to 85 mbar* or less and it shall not be necessary to drain the bath or remove the specimen before breaking the vacuum.

During the test, there shall be no evidence of leakage of gas or air from the inside of the crystal oscillator. The continuous formation of bubbles shall be evidence of leakage.

After 1 min, the unit shall be removed from the chamber and exposed to the standard recovery conditions specified in 5.4 of BS 2011 : Part 1.1 : 1980.

1.2.6.2.1.1 Alternative sealing test A. The oscillator shall be tested in accordance with method 2 of test Qc of BS 2011 : Part 2.1Q : 1981. The liquid shall be maintained at 125 °C. The immersion time shall be 30 s or as required in the relevant detail specification.

1.2.6.2.2 Sealing test B The test shall be performed in accordance with 6.4 (method 1) of test Qk of BS 2011 : Part 2.1Q : 1981. Unless otherwise stated in the detail specification, the tracer gas shall be 100 % helium, the pressure in the pressure vessel shall be two atmospheres and the time under pressure shall be 24 h. The free volume of the oscillator shall be stated.

The maximum leak rate shall not exceed the value given in 1.1.12.6 unless otherwise stated in the detail specification.

1.2.6.3 Solderability

1.2.6.3.1 Solder globule method. The test shall be performed in accordance with method 3 of test Ta of BS 2011 : Part 2.1T : 1981. The terminations shall be examined for good tinning as evidenced by free flowing of the solder with wetting of the terminations.

1.2.6.3.2 Solder bath method (to be used where the previous test is impractical). The test shall be performed in accordance with method 1 of test Ta of BS 2011 : Part 2.1T : 1981. The soldering bath shall be heated to 230 ± 10 °C. The terminations shall be examined for good tinning as evidenced by free flowing of the solder with wetting of the terminations.

* 1 bar = 10^5 N/m² 100 kPa.

1.2.6.4 Rapid change of temperature; thermal shock in air. The test shall be performed in accordance with test Na of BS 2011 : Part 2.1N : 1977.

For non-temperature-controlled oscillators, the low and high test-chamber temperatures shall be the extreme temperatures of the operating range stated in the detail specification. For temperature controlled oscillators, the low and high test temperatures shall be $-40 \pm 3^\circ\text{C}$ and $+85 \pm 3^\circ\text{C}$ respectively, unless otherwise stated in the detail specification.

The oscillators shall be maintained for 30 min at each extreme of temperature.

The oscillators shall be subjected to ten complete thermal cycles and then exposed to standard atmospheric conditions for recovery for not less than 2 h.

1.2.6.5 Bump. The test shall be performed in accordance with the requirements of BS 2011 : Part 2.1Eb : 1977. The oscillators shall be mounted or clamped as required by the detail specification. The three mutually perpendicular axes in which the bump is to be applied shall include

an axis parallel to the terminations;

an axis parallel to the base of the oscillator unit.

The bump severity shall not exceed that specified in 1.1.12.6 unless otherwise stated in the detail specification.

1.2.6.6 Vibration

1.2.6.6.1 Vibration (oscillator not operating). The test shall be performed in accordance with the requirements of B.4 of BS 2011 : Part 2.1Fc : 1977. The oscillator shall be mounted or clamped as specified in 1.2.1. The three mutually perpendicular axes in which the acceleration is to be applied shall include

an axis parallel to the terminations;

an axis parallel to the base of the oscillator unit.

1.2.6.6.2 Vibration (oscillator operating). The oscillator shall be tested as described in 1.2.6.6.1, except that during the test the oscillator shall be energized and electrical tests, as defined in the detail specification, shall be performed.

The vibration severity shall not exceed that specified in 1.1.12.7 unless otherwise stated in the detail specification.

1.2.6.7 Shock. The test shall be performed in accordance with the requirements of BS 2011 : Part 2Ea : 1977. The oscillator shall be mounted or clamped as specified in 1.2.1. The three mutually perpendicular axes in which the shock is to be applied shall include:

(a) an axis parallel to the terminations;

(b) an axis parallel to the base of the oscillator unit.

The shock severity shall not exceed that specified in 1.1.12.8, unless otherwise stated in the detail specification.

1.2.6.8 Acceleration steady state. The test shall be performed in accordance with the requirements of BS 2011 : Part 2.1Ga : 1977. The oscillator shall be mounted or clamped as specified in 1.2.1. The procedure and severity shall be as stated in the detail specification.

1.2.6.9 Low air pressure. This test shall be performed in accordance with the requirements of BS 2011 : Part 2.1M : 1977. The procedure and severity shall be as stated in the detail specification.

1.2.6.10 Climatic sequence. The oscillators shall be subjected to the climatic sequence given in procedure 1 of BS 2011 : Part 2.1Z/ABDM : 1968, except that Test M of 4.1.7 shall not be applicable.

1.2.6.10.1 Dry heat. The test shall be carried out at $85 \pm 3^\circ\text{C}$ for 16 h, unless otherwise stated in the detail specification.

1.2.6.10.2 Damp heat, cyclic. First cycle. The oscillator shall be subjected to one cycle of 24 h. Unless otherwise stated in the detail specification, the unit shall be subjected immediately to the dry cold test as specified in 1.2.6.10.3.

[1.2.6.10.3

1.2.6.10.3 Dry cold. The test shall be carried out at $-40 \pm 3^\circ\text{C}$ for 2 h, unless otherwise stated in the detail specification.

1.2.6.10.4 Damp heat, cyclic, remaining cycles. The oscillator shall be subjected to a further five cycles, each of 24 h, unless otherwise stated in the detail specification.

1.2.6.11 Damp heat, steady state. The test shall be performed in accordance with the requirements of BS 2011 : Part 2.1Ca : 1977 for 56 days, unless otherwise stated in the detail specification.

1.2.6.12 Salt mist. The test shall be performed in accordance with the requirements of BS 2011 : Part 2.1Kb : 1977 (severity 1).

The test shall be carried out for four spraying periods of 2 h, with a storage of seven days after each, unless otherwise stated in the detail specification.

1.2.6.13 Mould growth. The test(s) shall be performed in accordance with the requirements of BS 2011 : Part 2.1J : 1977.

1.2.7 Endurance test procedures

1.2.7.1 Ageing. The oscillator units shall be maintained at a specified temperature for a minimum period of 10 days or for an extended period as defined in the detail specification. During the period of the test, control of temperature and the accuracy of frequency measurement shall be consistent with the accuracy of the maximum frequency variations specified. The oscillator units shall remain in the chamber throughout the duration of the test and shall be continually supplied with input power unless otherwise specified.

The output frequency shall be measured at the end of the first 24 h and at the end of the specified period. Additionally, at least four intermediate measurements shall be taken at intervals of not less than one day and not greater than five days.

The performance requirements shall be expressed in terms of a maximum frequency change during the period of the test or in terms of the slope of the frequency against time curve during the last five days of the test based upon a minimum of three measurements.

Preferred conditions: Temperature SPXO and TCXO + 85 °C
OCXO + 25 °C
Duration 30 days

1.2.7.2 Shelf life. The oscillator units shall be stored under standard atmospheric conditions (see 1.2.1) for one year, except that the storage temperature shall be $25 \pm 10^\circ\text{C}$ unless otherwise stated in the detail specification.

The difference between any two frequency measurements, taken at intervals stated in the detail specification, shall not exceed the specified value.

Section two. Rules for the preparation of detail specifications

The object of the detail specification is to describe the components or range of components and to state the requirements for acceptance inspection.

The rules which govern the content and presentation of the detail specification are of two classes:

(a) Those rules which are applicable to all detail specifications for components within the family and which are included within this generic specification.

(b) Those rules which are applicable only to detail specifications for components of a particular sub-family and which are therefore included in a separate British Standard to be used in conjunction with this generic specification.

General information regarding the preparation of detail specifications is given in BS 9000: Part 2, and the general rules for all quartz crystal oscillators are given in the following subsections 2.1 to 2.3.

2.1 Basic information

The basic information given in the following clauses shall appear in the detail specifications.

The front page of each detail specification shall (as far as possible) contain the information required by 2.1.1 to 2.1.5 inclusive.

2.1.1 Originator of the specification. It shall be stated whether the detail specification has been prepared by British Standards Institution or by an individual manufacturer. In the latter case, the manufacturer's name and address shall be given.

2.1.2 Numbering of the detail specification. The number of the detail specification, the issue number and date of issue shall be stated. Specification numbers shall be allocated by BSI in accordance with 6.3 of BS 9000 : Part 1 : 1981.

A detail specification issued by a manufacturer shall give the manufacturer's number or component designation number.

2.1.3 Description of the component and assessment level. The sub-family of components, to which the items covered by the detail specification belong, shall be indicated (e.g. 'TCXO').

The assessment level shall be stated. Additional information may be given for the guidance of users.

2.1.4 Outline drawing. An outline drawing of the component showing the essential dimensions and terminal connections shall be included. Symbols used shall be in accordance with the relevant BSI and IEC publications

Preferred holder outlines, with dimensions and terminations, are given in BS, 'Dimensions of quartz crystal oscillators' (in course of preparation).

2.1.5 Ratings. The following ratings shall be selected wherever possible from the preferred values given in 1.1.12:

- (a) climatic category (see 1.1.12.1);
- (b) bump, vibration and shock severities (see 1.1.12.3, 1.1.12.4 and 1.1.12.5).

2.1.6 Characteristics. The following characteristics shall be stated in all cases:

- (a) output frequency(ies);
- (b) tolerance on output frequency(ies);
- (c) output level(s) (voltage or power);
- (d) input conditions (voltage, current or power);

In addition, the following characteristics may be stated:

- (e) waveform;
- (f) load impedance;
- (g) frequency adjustment;
- (h) ageing tolerance;
- (j) modulation details;
- (k) stabilization time.

Additional characteristics may be included at the manufacturer's discretion but in all cases the values of the characteristics and the conditions under which they apply shall be stated. Any interdependence of characteristics and any limiting conditions of use shall be stated.

2.1.7 Related documents. Reference shall be made to this British Standard and to any British Standards or IEC Publications which are called up in the detail specification but not already cited in this standard. Wherever possible, all definitions, symbols and test procedures employed in a detail specification shall be in accordance with this standard.

2.1.8 Additional information (not for inspection purposes). Additional information, such as drawings, graphs, circuit diagrams, or notes needed for the clarification of the detail specification may be given. This information is not required to be verified by the inspection procedure.

Where the following items are not fully covered in this standard (or BS 9000 in some cases) additional details relating to these items shall be given in the detail specification:

- (a) terms and definitions;
- (b) letter symbols;
- (c) test procedures;
- (d) outline drawings.

The general principles contained in the relevant British Standards shall be followed when preparing such additional information. In the absence of a British Standard, the principles established in any IEC Publication shall be followed.

2.1.9 Instructions for ordering components. The following information shall be specified when ordering components:

- (a) quantity;
- (b) BS detail specification number, issue number and date;
- (c) nominal frequency;
- (d) manufacturer's code;
- (e) manufacturer's type number;
- (f) full description of any additional requirements.

[2.2

2.2 Inspection requirements

The provisions of BS 9000 and BS 9001 shall apply.

A detail specification for the full or basic assessment level shall contain as a minimum those tests and measurements, inspection levels and AQLs specified in the relevant rules. A detail specification for an additional assessment level shall contain as a minimum those tests and measurements, inspection levels and AQLs specified in the relevant rules for the basic assessment level.

Where 100 % inspection is appropriate it may be possible for the supervising inspectorate to agree that tests may be witnessed at a suitable stage during the production process. Similar arrangements may apply when a critical parameter is checked on a large sample as part of a production monitoring system. In these circumstances, it may be possible for an agreement to be reached between the manufacturer's chief inspector and the supervising inspectorate for certain group A and/or group B tests to be omitted or performed on a smaller sample than that indicated in the detail specification.

The detail specification shall indicate which of the subgroups of groups A, B and C are appropriate to the inspection of the component. Those subgroups which are inappropriate to the detail specification shall also be identified.

The following information relating to tests and measurements shall be given in the detail specification:

- (a) the test (with any appropriate letter symbols) and measurements which shall be required;
- (b) the reference to the test procedures, as set out in 1.2 of this standard;
- (c) any appropriate conditions of power supplies, temperature, environment etc., in accordance with the requirements of this standard;
- (d) the inspection level and the AQL for each test, together with a combined AQL for a sequence of tests, if appropriate;
- (e) the units of measurement;
- (f) the acceptance limits or other acceptance criteria.

The detail specification shall show the order in which the tests or conditioning in a subgroup shall be carried out where this order may affect the test results. Each specimen within the sample shall be submitted to this sequence unless otherwise stated in the detail specification. When the same sample is used for a sequence of tests, failure of a single specimen on more than one test in the sequence shall count as a single failure.

Where a subgroup contains a 'destructive' test, the symbol '(D)' shall be placed alongside the title of the subgroup in the schedule of inspection requirements in the detail specification. Such detail specifications shall contain the following requirement:

'Samples subjected to tests marked '(D)' shall not be accepted for release under BS 9000 (see 2.6.5 of BS 9000: Part 2).'

Where a specific test procedure is not included in the generic specification, a full description of the procedure to be followed shall be given in the detail specification.

2.3 Certified test records

The manufacturer shall provide a certified test record (CTR) to comply with the requirements of 1.1.11 which shall contain the information given below.

It is desirable that the information contained in a CTR does not occupy more than two sides of a single sheet of A4 paper. The preferred CTR layout appears in appendix C.

2.3.1 General information. The following information shall be given:

- (a) manufacturer's name;
- (b) place of manufacture;
- (c) number and issue of the detail specification;
- (d) description of the oscillators;
- (e) the date of the six-month period covered by the CTR;
- (f) the date of the commencement of the current three-year period;
- (g) certification statement, with signatures and date of signing.

2.3.2 Measurements information. The results of measurements shall be presented either as actual values or as grouped frequency distribution tables.

2.3.3 Explanatory information. The manufacturer is free, though not obliged, to give short explanatory notes on any portion of the CTR.

[Appendix A

Appendix A

Short-term frequency stability

(Extracted from appendix A of IEC Publication 679-1)

A.0 Introduction

The output signal produced by a crystal controlled oscillator consists of a complex spectrum, containing not only the desired single frequency component, but also including additive thermal-noise voltages, harmonic distortion components, and components reflecting various environmental effects. Consequently, the instantaneous frequency of the signal will not be a constant, but will be somewhat different from one instant to another. Short-term frequency stability is the general descriptive term used to indicate the extent of this fluctuation of instantaneous frequency from a constant value, and usually implies that deterministic effects (such as frequency ageing, voltage and temperature variations, etc.) have been eliminated from consideration.

The user of a frequency generator will generally be interested in a useful measure of the characteristics of the output signal fluctuation so that he may accurately predict its effect on a particular system. The oscillator designer, however, will often find it to his advantage to relate particular device characteristics to the resultant frequency fluctuations. The object of this appendix is to present useful measures of the frequency fluctuation characteristic of a signal which are sufficient to allow predictions of performance of systems utilizing these signals, and also to point out some relationships between the frequency fluctuation characteristic and particular kinds of corrupting influences.

A.1 Measures of short-term frequency stability (frequency domain)

We shall first deal with the problem of defining the fluctuation of instantaneous frequency. The conventional definition of instantaneous frequency is:

$$F(t) = \frac{1}{2\pi} \frac{d}{dt} [\Phi(t)] \quad (1)$$

the time derivative of the phase function. The output signal of an oscillator can be written as:

$$\begin{aligned} V(t) &= [V_o + \varepsilon(t)] \sin \Phi(t) \\ &= [V_o + \varepsilon(t)] \sin [2\pi F_o t + \varphi(t)] \end{aligned} \quad (2)$$

where:

V_o is the average (mean) amplitude, and F_o is the average (mean) frequency

If the fluctuations from the average are small, for example:

$$\left| \frac{\varepsilon(t)}{V_o} \right| \ll 1 \quad (3)$$

$$\left| \frac{\dot{\varphi}(t)}{F_o} \right| \ll 1 \quad (4)$$

then the phase fluctuation function $\varphi(t)$ may be unambiguously defined, and we may write the expression for instantaneous frequency:

$$F(t) = F_o + \frac{1}{2\pi} \dot{\varphi}(t) \quad (5)$$

Hence, the instantaneous fractional frequency fluctuation function is:

$$Y(t) = \frac{F(t) - F_o}{F_o} = \frac{1}{2\pi F_o} \dot{\varphi}(t) \quad (6)$$

Since this function is an essentially noise-like random function of time, it cannot be perfectly measured; as with any noise-like quantity, useful estimates must be obtained from time-averaged measurements.

The preferred measure of fractional frequency stability in the frequency domain is the power-spectral density of the fractional frequency fluctuations:

$$S_y(f)$$

where:

f is the Fourier frequency (sometimes referred to as the base-band frequency)

In some instances, it is useful to use the related function: the power spectral density of phase fluctuation ($\varphi(t)$ in equation (2):

$$S_\varphi(f)$$

The relationship between the two is:

$$S_\varphi(f) = \frac{F_o^2}{f^2} S_y(f) \quad (7)$$

Since the two are mathematically related, either $S_y(f)$ or $S_\varphi(f)$ may be used to describe the frequency fluctuation characteristic; however, $S_y(f)$ is the usually preferred measure.

Other frequency domain measures of frequency stability sometimes employed are:

A.1.1 *Incidental f.m.*

This term is used to describe the random frequency fluctuation of the oscillator output signal in terms of the amplitude of the frequency fluctuation function, either as a Fourier amplitude spectrum or as a total effective value for a specified system bandwidth.

As a function of the base-band frequency, the incidental f.m. amplitude spectrum can be expressed as:

$$\left(\frac{\Delta F}{F}\right)(f) = [S_y(f)]^{1/2} \quad (8)$$

with the dimension of $\text{Hz}^{-1/2}$.

To determine the total effect on a finite-bandwidth system, for example, the r.m.s. signal output resulting from the application of the oscillator output to an ideal frequency discriminator having an effective base-band response from f_a to f_b , the uncorrelated random components shall be summed on a power basis:

$$\left[\frac{\Delta F}{F} (f_a, f_b)_{\text{rms}} \right] = \left[\int_{f_a}^{f_b} S_y(f) df \right]^{1/2}$$

A.1.2 Phase noise (jitter)

This term refers to the phase fluctuation function $\varphi(t)$ in equation (2). It may be expressed as the deviation of the phase from a constant, $\varphi(t) = 2\pi Ft - 2\pi F_0 t$. It can be described by the power spectral density function:

$$\Delta\varphi = [S_\varphi(f)]^{1/2} \quad (9)$$

expressed in radians, or, as in the case of incidental f.m., in terms of a total effective amplitude for a specified bandwidth. For example, the total effective phase fluctuation produced in a system having a base-band response from f_a to f_b may be determined by combining the non-correlated spectral components in a power sense:

$$\Delta\varphi(f_a, f_b)_{\text{rms}} = \left[\int_{f_a}^{f_b} S_\varphi(f) df \right]^{1/2} \quad (10)$$

A.2 Measures of short-term frequency stability (time domain)

In many applications of crystal-controlled oscillators (as well as other precision frequency generators), the fluctuation of frequency from its average value is of more use when expressed in terms of its time and time-average characteristics rather than in terms of its Fourier frequency characteristics. For example, in timing applications, it is of fundamental importance to determine the deviation of the intervals, determined by counting a prescribed number of zero-crossings of the oscillator signal, from a constant value.

The fundamental time domain definition of short-term frequency stability is based on the sample variance of a number of sequential determinations of frequency, each averaged over a specified sampling interval. Let Y_k represent the k^{th} determination of the fractional frequency fluctuation defined as:

$$Y_k = \frac{1}{\tau} \int_{t_k}^{t_k + \tau} Y(t) dt = \frac{\varphi(t_k + \tau) - \varphi(t_k)}{2\pi F_0 \tau} = \frac{F_k - F_0}{F_0} \quad (11)$$

where:

τ is the specified sampling period, and

$$t_{k+1} = t_k + T, \quad k = 0, 1, 2, \dots$$

T is the repetition interval, $T \geq \tau$

F_k is the average frequency over the sampling period τ

From a large number of samples, then the expectation value of the sample variance may be defined as:

$$\sigma_y^2(N, T, \tau) = \frac{1}{N-1} \sum_{k=1}^N (Y_k - Y_0)^2 \quad (12)$$

where:

$$Y_0 = \frac{1}{N} \sum_{k=1}^N Y_k \text{ is the mean value of the samples}$$

Unfortunately, it can be shown that this expression does not always converge to a meaningful limit as $N \rightarrow \infty$. Consequently, it is of the utmost importance to specify both N and T as well as τ , if the variance is to be of use.

To avoid the convergence problem for large N , it is proposed that the preferred measure of frequency stability in the time domain is the Allan variance:

$$\sigma_y^2(\tau) = \sigma_y^2(2, \tau, \tau) = \lim_{M \rightarrow \infty} \left[\frac{1}{M-1} \sum_{k=1}^{M-1} \frac{(Y_{k+1} - Y_k)^2}{2} \right] \quad (13)$$

Experimental estimates of $\sigma_y^2(\tau)$ have to be based on finite samples of data, and can never be measured with perfect confidence. In practice, one uses some specified number of data, and estimates the Allan variance as:

$$\sigma_y^2(M, 2, \tau, \tau) = \sigma_y^2(\tau) = \frac{1}{M-1} \sum_{k=1}^{M-1} \frac{(Y_{k+1} - Y_k)^2}{2} \quad (14)$$

Since it can be shown that the ensemble average of $\sigma_y^2(M, 2, \tau, \tau)$ is convergent as $M \rightarrow \infty$, even for noise processes for which $\sigma_y^2(N, \tau, \tau)$ does not converge, relation (14) gives the preferred time-domain measure.

A.2.1 R.M.S. fractional frequency fluctuation

The time-domain characteristics of fractional frequency fluctuation are often stated in terms of the deviation rather than variance, and termed the root-mean-square value. In a statistical sense, the r.m.s. value is defined as the square root of the variance, and is equal to the standard deviation:

$$\sigma_y(N, T, \tau) = [\sigma_y^2(N, T, \tau)]^{1/2} \quad (15)$$

Because of the non-convergence of the usual statistical variance of frequency-fluctuation determinations discussed above, the preferred definition of r.m.s. fractional frequency fluctuation is the square root of the Allan variance:

$$\frac{\Delta F}{F_0}(\tau)_{\text{rms}} = [\sigma_y^2(\tau)]^{1/2} = \left[\frac{1}{M-1} \sum_{k=1}^{M-1} \frac{(Y_{k+1} - Y_k)^2}{2} \right]^{1/2} \quad (16)$$

The sample averaging time, τ , as well as the total number of samples, M , must be specified.

The specification of this quantity for a single sample averaging time is obviously not sufficient to describe the behaviour of the frequency-fluctuation function. Usually, the value of $\frac{\Delta F}{F_0}(\tau)_{\text{rms}}$ is specified for a relatively wide range of τ , so that the response of particular systems can be estimated. An example of the τ -dependence is shown in figure 4.

Experimentally, it is difficult to obtain consecutive measures of average frequency with zero dead-time between samples. However, at least in the case of most commonly encountered noise processes, it is possible to translate among different sets of N , T , and τ values, by making use of

two “bias functions”, which have been computed and tabulated*. These functions, B_1 and B_2 , are defined by the relations:

$$B_1(N, r, \mu) = \frac{\sigma_y^2(N, T, \tau)}{\sigma_y^2(2, T, \tau)}; \quad B^2(r, \mu) = \frac{\sigma_y^2(2, T, \tau)}{\sigma_y^2(2, \tau, \tau)}$$

where:

$r = T/\tau$, and $\mu = -(\alpha + 1)$, α being obtained from the power law expression for spectral density of frequency fluctuation

$$S_y(f) = \sum C_a f^a \quad (17)$$

Fortunately, most commonly encountered noise processes can be characterized by power law spectra, so this technique can be very useful.

A.3 R.F. power spectrum

The instantaneous output voltage of a crystal-controlled oscillator (see equation (2)) in general demonstrates both amplitude and frequency fluctuations as compared with the ideal signal. The presence of these fluctuations gives rise to a power spectrum which can very generally be described as an intense narrow line centred at the nominal frequency F_o , and a distribution of low-intensity random components extending over a broad frequency spectrum. The shape of the power spectral density of r.f. power will depend upon the detailed structure of the oscillator and amplifier circuits within the oscillator package, as well as upon the environmental situation in which the measurement is made. While this total power spectrum may be of primary importance in determining the performance of a particular system, it is not uniquely related to the frequency-fluctuation function.

Only in certain cases, when sufficient detailed information about the nature of the perturbing signals in the spectrum is known, can their effects on instantaneous frequency be accurately assessed. Consequently, a specification of the r.f. power spectrum does not constitute a specification of the short-term frequency stability.

As an example, consider a hypothetical situation in which the r.f. spectrum of an oscillator output signal consists of a single-frequency component of ideal characteristics superimposed on a low-level background of random white noise, such as shown in figure 5.

At any instant, the composite signal will consist of the vector sum of the ideal frequency component, $A_c \sin 2\pi F_o t$, and the instantaneous vector sum of all the uncorrelated noise components $a_n \sin (2\pi F_o t + \varphi(t))$. If $\bar{a}_n$ represents the maximum magnitude which the vector sum of all the noise components can achieve, then the circle shown in figure 6, represents the range of possible termini of the composite signal vector with respect to the ideal component voltage, and $\Delta\theta$ is the maximum value of the phase fluctuation.

From figure 6, it is clear that the noise component may at any instant be resolved into two components, one co-linear with $\bar{A}_c$, and one normal to it. If the value of a_n is small compared with $\bar{A}_c$, then the phase fluctuation is seen to depend only on the normal component, while the amplitude deviation depends only on the co-linear component. Since $\bar{a}_n$ is assumed to be a random

* Tables of B_1 and B_2 can be found in NBS, Washington, D.C., Tech. Note 375, January 1969: “Tables of Bias Functions B_1 and B_2 for Variances Based on Finite Samples of Processes with Power Law Spectral Densities”, by J. A. Barnes.

component, then this may be generalized by stating that, on the average, half the noise sideband power is contained in the normal or quadrature components, and half in the in-phase components.

Also, from figure 7, it is clear that essentially no change in the phase-fluctuation characteristic results from passing the signal through a hard limiter, which removes the amplitude-fluctuation components, thus reducing the average noise side-band power by one-half.

Consequently, it may be concluded that measurement of the phase (or frequency) fluctuation characteristic does not give unique information concerning the r.f. power spectrum, nor does the r.f. power spectrum itself uniquely define the phase (or frequency) fluctuation characteristic.

The r.f. power spectrum, expressed as a ratio of side-band power in a 1 Hz band to total signal power, is sometimes called the "spectral purity of the signal".

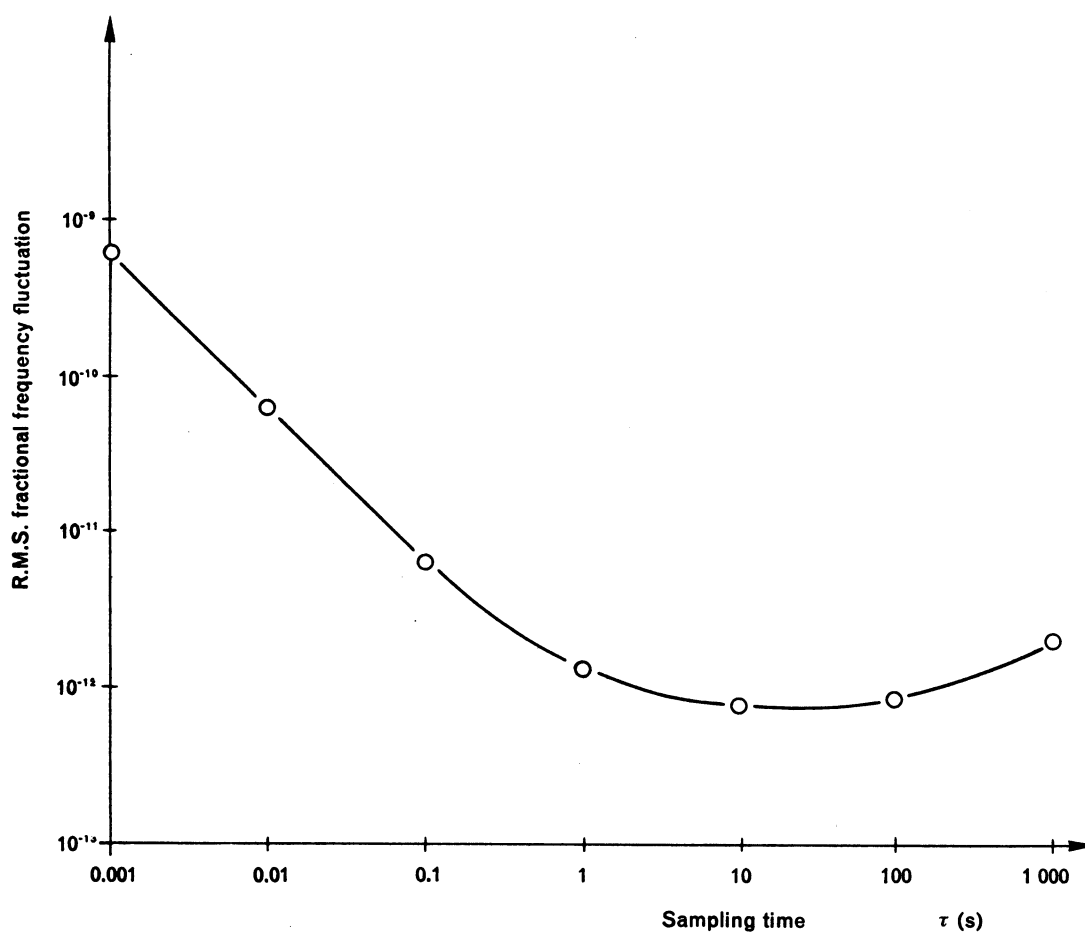


Figure 4. Typical dependence of r.m.s. fractional fluctuation on sampling time

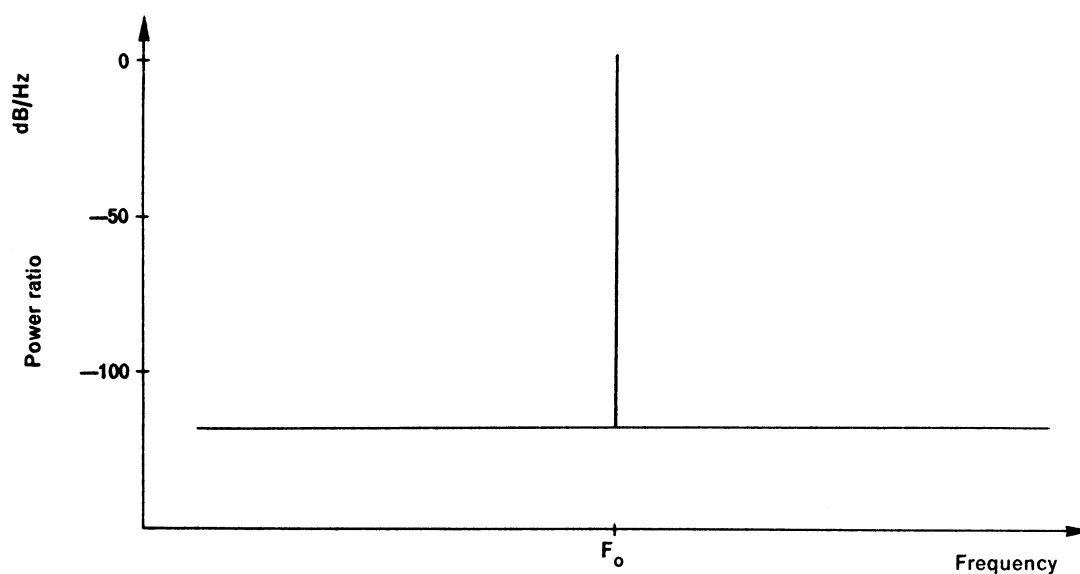


Figure 5. R.F. power spectrum of an ideal oscillator with white noise

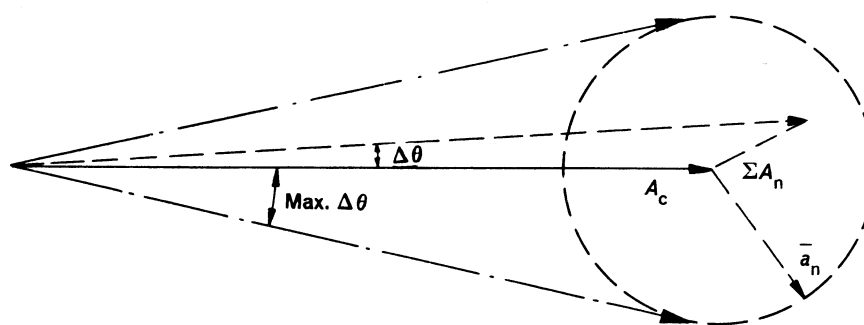


Figure 6. Vector combination of carrier and uncorrelated noise

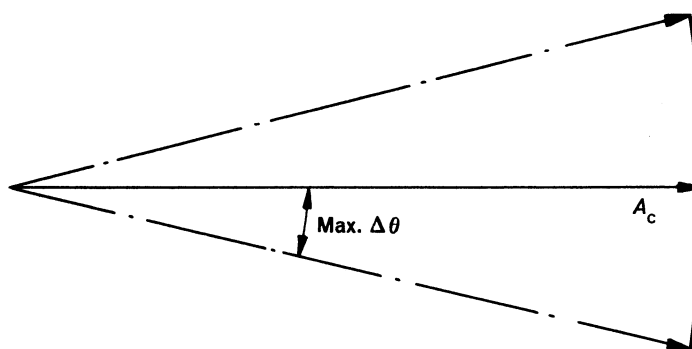


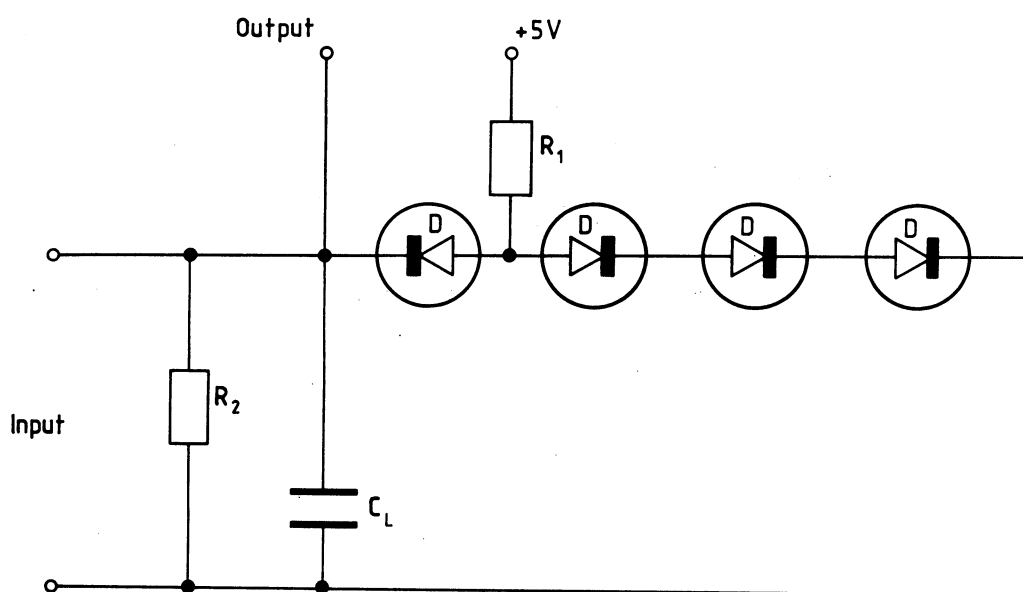
Figure 7. Effect of removing a.m. noise components

Appendix B

Load circuit for logic drive

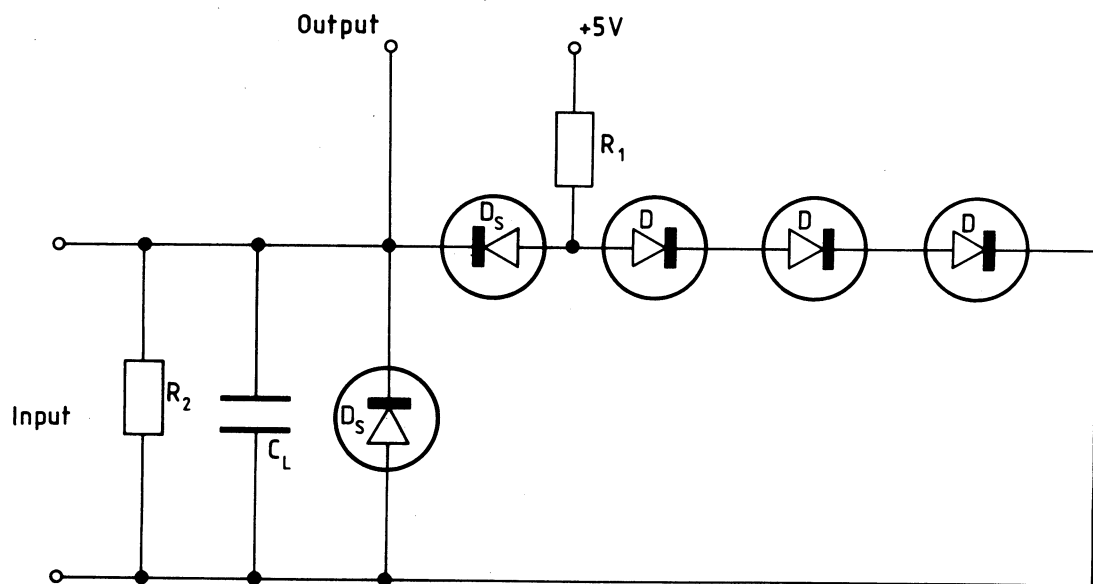
The test jig for oscillators designed with logic drive circuits should simulate the load conditions which the oscillator is required to drive.

Preferred test circuits for TTL and Schottky Logic are shown in figures 8 and 9 respectively.



NOTE. Standard TTL (54/74 series)
High speed TTL (54/74 series)

Figure 8. Circuit for TTL



NOTE. Schottky Logic (54S/74S series)
Low power Schottky Logic (54LS/74LS series)

Figure 9. Circuit for Schottky Logic

Notes to figures 8 and 9

Diodes marked D should be type 1N916 or 1N3064.

Diodes marked D_s should be high speed Schottky type, e.g. 1S1993.

Values for R₁ and R₂ are dependent on the load requirement and may be calculated using the formulae:

$$R_1 = \frac{5 - (V_{IL} + V_D)}{n \times |I_{IL}|}$$

$$R_2 = \frac{V_{IH}}{n \times |I_{IH}|}$$

where

- n = number of gates;
- V_{IL} = low level input voltage;
- I_{IL} = low level input current per gate;
- V_{IH} = high level input voltage;
- I_{IH} = high level input current per gate;
- V_D = voltage drop across diode.

NOTE. This may be taken as 0.65 V for figure 8 and as 0.45 V for figure 9.

Values of these parameters for various TTL series for use in the above formulae are given in table 1.
Values for C_L are also given. It should be noted that C_L includes the probe and jig capacitance.

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Table 1. Values to be used when calculating R_1 and R_2

TTL series	74	54	74H	54H	74L	54L	74LS	54LS	74S	54S
V_{IH} (V)	2.4	2.4	2.4	2.4	2.4	2.4	2.7	2.7	2.7	2.7
V_{IL} (V)	0.4	0.4	0.4	0.4	0.3	0.3	0.4	0.4	0.5	0.5
I_{IH} (μ A)	40	40	50	50	10	10	20	20	50	50
I_{IL} (mA)	− 1.6	− 1.6	− 2.0	− 2.0	− 0.18	− 0.18	− 0.4	− 0.4	− 2.0	− 2.0
C_L (pF)	15	15	25	25	50	50	15	15	15	15

The oscillator output voltage limit requirements using the test circuits of figures 8 and 9 will normally be:

V_{IH} 2.4 V min.

V_{IL} 0.5 V max.

The following information shall be specified in the detail specification:

R_1 , R_2 , C_L , V_{IH} and V_{IL} together with the circuit to which reference is made.

NOTE. Satisfactory operation in a particular circuit should not be considered as an assurance that a specific crystal oscillator will operate satisfactorily with all types of TTL logic.

Appendix C**Certified test record**

Serial no. _____

Component manufacturer _____

Crystal Devices Ltd
Piezo Plaza
Quartzville

Detail specification

Description of component

Current six month period

Date of commencement of current three year period

This certified test record is a complete and accurate record of the tests carried out in accordance with the specified procedures.

Chief Inspector.

Supervising Inspector.

Subgroup	Test	Current six month period		Current three year period	
		Number tested	Number failed	Number tested	Number failed
C5	Ageing				
D5	Shelf life				

Ageing test results for subgroup C5 for current six month period

Frequency change p.p.m.												
No. of units												

Shelf life test results for subgroup D5 for period

Frequency change p.p.m.												
No. of units												

[Appendix D

Documents

Document Sharing Hub

BS 9620

Issue 1, December 1982

Appendix D

List of British Standard rules for the preparation of detail specifications relating to oscillators

- BS 9621 Simple packaged crystal oscillators (SPXO)
- BS 9622 Voltage-controlled crystal oscillators (VCXO)
- BS 9623 Temperature-compensated crystal oscillators (TCXO)
- BS 9624 Oven-temperature-controlled crystal oscillators (OCXO).

Amendment No. 2
published and effective from 30 August 1985
to BS 9620 : 1975

Specification for quartz crystal oscillators of assessed quality:
Generic data and methods of test

Instructions for the insertion of new and revised pages and minor revisions
to existing pages in BS 9620

Remove page marked 1.1.9 and substitute revised page marked 1.1.9.
Remove page marked 1.2.4.1 and substitute revised page marked 1.2.4.1.
Remove page marked 1.2.4.10.4.4 and substitute revised page marked 1.2.4.10.4.4.
Remove page marked 1.2.6.4 and substitute revised page marked 1.2.6.4.
Remove page marked Page 8 of appendix A and substitute revised page marked Page 8 of appendix A.
Remove page marked Page 2 of appendix B and substitute revised page marked Page 2 of appendix B.
Remove page marked Appendix D and substitute revised page marked Appendix D.

Revised text

Inside front cover. In line 25, in the references relating to this British Standard, delete 'TLE/11' and substitute 'ECL/11'.

After the existing text insert the following.

'Due to reorganization within Electrical Department, this standard now comes under the direction of the Electronic Components Standards Committee (ECL/-) who have entrusted responsibility to Technical Committee ECL/11, upon which the following bodies are represented:

Electronic Components Industry Federation
Electronic Engineering Association
Institution of Electronic and Radio Engineers
Ministry of Defence
National Supervising Inspectorate
Society of British Aerospace Companies Limited
Telecommunication Engineering and Manufacturing
Association (TEMA)
Co-opted members'

Contents. Delete the existing title of appendix D and substitute 'Associated blank detail specification'.

Clause 1.2.7.1 Ageing. At the end of the clause delete the matter following 'Preferred conditions:' and substitute the following.

'Temperature: SPXO and TCXO + 85 °C
OCXO + 25 °C

Duration 30 days'.

Clause 2.2 Inspection requirements. In line 1, delete 'BS 9001' and substitute 'BS 6001'.

1.1.3.29 stabilization time. The time, measured from the initial application of power, required for an oscillator to stabilize its mode of operation within specified limits.

1.1.3.30 voltage coefficient. The incremental change in output frequency which results from an incremental change in supply voltage, measured under specified conditions of supply voltage, load and output frequency.

1.1.3.31 working frequency. The frequency to which an oscillator shall be tuned to ensure that it meets the specification. The working frequency is the nominal frequency plus the offset frequency.

1.1.4 Letter symbols, signs and abbreviations. The letter symbols, signs and abbreviations which are employed in all documents applicable to electronic components covered by this specification are in conformity with BS 1991 or are derived in accordance with the principles of that standard.

1.1.5 Graphical symbols. The graphical symbols which are employed in all documents applicable to electronic components covered by this specification are in conformity with BS 3939 or are derived in accordance with the principles of that standard.

1.1.6 Marking of the component and package

1.1.6.1 The marking shall consist of the following.

- (a) The number of the detail specification and any other coding as given in the detail specification to identify the particular item.
- (b) The nominal frequency marked in kHz or MHz as appropriate. The characters kHz or MHz shall form part of the marking except in the case of miniature oscillators (see **1.1.6.2**).
- (c) The date code (see clause **22** of BS 9000 : Part 1 : 1981).
- (d) the manufacturer's code.

1.1.6.2 The marking of the oscillator shall normally consist of the whole of the marking detailed in **1.1.6.1** and, in addition, those oscillator units selected for tests in groups C and D shall be marked with a serial number which should be durable for at least the period of the tests to which they are subjected.

Where the available surface area of miniature oscillators imposes practical limits on the amount of marking, instructions on the marking to be applied shall be included in the detail specification.

1.1.6.3 The marking of the package shall normally consist of the whole of the marking detailed in **1.1.6.1**, unless otherwise specified in the detail specification.

1.1.7 Eligibility for qualification approval

1.1.7.1 Quartz crystal oscillators shall be eligible for submission for qualification approval and release to BS 9000 if the primary stage of manufacture and subsequent processing is carried out at an approved manufacturing facility. The primary stage of processing for the crystal oscillator, in accordance with **14.2** of BS 9000 : Part 1 : 1981 shall be the assembly of the crystal oscillator.

1.1.7.2 Where the final component contains components of a kind covered by a generic specification in the 9000 series, it is desirable (but not mandatory) that these should be released in accordance with BS 9000. Where the contained component is not so released, the final manufacturer's chief inspector shall be satisfied that its quality is adequate, by the use of

- a procurement specification
- approval tests
- incoming inspection procedures.

1.1.8 Structurally similar components. Ranges of quartz crystal oscillators normally covered by a single detail specification and having similar electrical characteristics are considered to be structurally similar and, subject to the following constraints, may be grouped together for the purpose of sampling tests.

- (a) The lot shall consist of oscillators produced using the same basic methods of construction and materials. However, the following variations may be permissible:
 - (1) physical dimensions;
 - (2) electrical characteristics, e.g. nominal frequency, frequency tolerances and voltage ratings;
 - (3) complexity as defined by the number of components, subject to the sample chosen assessing all the components used in the aggregated lot.
- (b) The sample shall contain oscillators having a sensibly even spread of the variations permitted in (a) including the extremities of the ranges covered by the lot.

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(c) The oscillators included within the lot shall contain crystal units that:

(1) have been qualified to a detail specification within the BS 9610 series; or

(2) have been procured in accordance with 1.1.7.2 of BS 9620 : 1975.

In each case the crystals shall have a substantially similar method of mounting the crystal plate.

(d) The grouping shall meet the approval of the supervising inspectorate.

1.1.9 Delayed delivery. Crystal oscillators held for a period exceeding two years following acceptance inspection shall be re-inspected for electrical tests detailed in 1.2.4.5 and 1.2.4.10.2 prior to release, or as otherwise stated in the detail specification.

1.1.10 Supplementary procedures for qualification approval

1.1.10.1 The procedure given in clause 13 of BS 9000 : Part 1 : 1981 shall apply except that the sample shall be drawn from one production lot and shall be tested and sentenced in accordance with the following table.

Group	Sample size	Accept	Reject	Second sample	Total sample	Accept	Reject
A0	100 % (see note 1)	0	1	—	—	—	—
A2	5	0	2	5	10	1	2
B1	3	0	2	3	6	1	2
B5	8 (where applicable)	0	2	8	16	1	2
C	3 (see note 2)	0	2	3	6	1	2
D	3 (see note 2)	0	2	3	6	1	2

NOTE 1. Qualification approval depends upon a minimum sample of five units. For hermetically sealed units containing non-encapsulated crystals, the minimum sample size should be eight.

NOTE 2. NOTE 2. Sample size applicable to each subgroup within the group.

NOTE 3. If the manufacturer has sufficient confidence in his product he is permitted to submit the same samples to each specified test conducted in series. If he wishes to employ separate samples for each test (particularly those of a destructive nature) he should adjust the initial lot size accordingly.

1.1.10.2 For shelf life, 14.1 of BS 9000 : Part 1 : 1981 can be implemented after 1000 h.

1.1.11 Certified test records. The results of specified tests from Groups C and D shall be summarized and presented in the form of a certified test record (CTR).

NOTE 1. Details of the information required and the method of presentation are given in 2.3.

Certified test records are required for crystal oscillators at the full assessment level. They are not required for units at the basic assessment.

Certified test records shall be printed on A4 in the layout as shown in appendix C.

1.1.12 Standard ratings and characteristics

1.1.12.1 Climatic category. 40/85/56 (storage conditions).

NOTE. For requirements where the operating temperature range of the oscillators is greater than -40°C to $+85^{\circ}\text{C}$, a climatic category consistent with the operating temperature range should be specified.

1.1.12.2 Torque test

Thread type (mm)	2	2.5	3	4	5	6
Moment (N·m)	0.18	0.26	0.35	0.90	1.70	2.80

Thread type	8BA	6BA	4BA	2BA	0BA	in
Moment (N·m)	0.18	0.35	0.70	1.41	2.82	2.82

1.1.12.3 Bump severity. 4000 ± 10 bumps at 390 m/s^2 peak acceleration with a pulse duration of 6 ms in each direction of three mutually perpendicular axes (see 1.2.6.5).

1.1.12.4 Vibration severity

10 Hz to 60 Hz

0.75 mm displacement amplitude (peak value)

60 Hz to 500 Hz

98.1 m/s² acceleration amplitude (peak value)

Duration 30 min in each of three mutually perpendicular axes (see **1.2.6.6**). Sweep rate one octave/minute.

1.1.12.5 Shock severity. 981 m/s² peak acceleration for 6 ms duration; three shocks in each direction along three mutually perpendicular axes (see **1.2.6.7**). Half sine pulse unless stated otherwise in the detail specification.

1.1.12.6 Leak rate. The leak rate shall not exceed 10⁻⁶ mbar l/s* when hermetically sealed oscillators are tested in accordance with **6.4** (method 1) of test Qk of BS 2011 : Part 2.1Q: 1981.

1.1.13 Unchecked parameters. The overtone order may be stated in the detail specification, but not verified by tests. The overtone order shall therefore not be used for inspection purposes.

1.1.14 Procedure to be followed in the event of failures at group C or D inspection. The procedure specified in **20.1(b)** of BS 9000 : Part 1 : 1981 shall be applicable.

1.1.15 Ordering information. Ordering information shall be as specified in the detail specification.

1.1.16 Release prior to completion of group B tests. Not applicable.

1.2 Test procedures

1.2.1 Test and measurement conditions. Unless otherwise specified, all tests shall be carried out under the standard atmospheric conditions for testing specified in **5.3** of BS 2011 : Part 1.1 : 1980.

Before measurements are made, the oscillator shall be stored at the measuring temperature for a time sufficient to allow the oscillator to reach this temperature. Controlled recovery conditions are given in **5.4** of BS 2011 : Part 1.1 : 1980.

The ambient temperature during the measurements shall be recorded and stated in the test report.

For the bump, shock, vibration and acceleration tests, the oscillators shall be mounted as stated in the detail specification. Clamps on the body may be used if specified.

1.2.2 Visual inspection

1.2.2.1 Visual test A. The oscillator shall be visually examined to ensure that the condition, workmanship and finish are satisfactory. The marking shall be legible and durable.

1.2.2.2 Visual test B. The oscillator shall be visually examined. There shall be no corrosion or other deterioration likely to impair satisfactory operation. The marking shall be legible and durable.

1.2.3 Dimensioning and gauging procedures

1.2.3.1 Dimensions test A. The dimensions, spacing and alignment of terminals shall be checked and shall comply with the specified values.

1.2.3.2 Dimensions test B. The dimensions shall be checked and shall comply with the specified values.

1.2.4 Electrical test procedures. The following electrical test procedures are described on separate pages to facilitate revision:

1.2.4.2 Insulation tests

1.2.4.3 Supply voltage

1.2.4.4 Input power

1.2.4.5 Output frequency

1.2.4.6 Frequency/temperature characteristics

1.2.4.7 Frequency stability characteristics

* 1 mbar = 100 N/m² = 0.1 kPa.

1.2.4.8 Frequency adjustment

1.2.4.9 Retrace characteristics

1.2.4.10 Output characteristics

1.2.4.11 Amplitude modulation characteristics

1.2.4.12 Frequency modulation characteristics

1.2.4.13 Spectral purity

1.2.4.14 Electromagnetic interference

1.2.4.1 General. This subclause gives information of a general nature applying to electrical measurement techniques and general precautions to be applied during measurements.

1.2.4.1.1 Alternative test methods. The measurement and conditions specified are not the only methods which can be used, but the supervising inspectorate shall be satisfied that other methods of measurement employed will give results compatible with the methods and/or conditions specified in this standard and the relevant detail specification. By 'compatible' is meant that the value of the characteristic established by such other method(s) will fall within the specified limits when measured by the specified method(s).

1.2.4.1.2 Equilibrium conditions. All electrical tests shall be conducted under equilibrium conditions, unless otherwise specified. When test conditions cause significant change with time of the characteristic being measured, means of compensation for such effects will be specified; for example, the length of time that the oscillator shall be maintained at test conditions before making a measurement.

1.2.4.1.3 Temperature. Unless otherwise specified, all measurements shall be made at an ambient or reference point temperature $25 \pm 2^\circ\text{C}$. Measurements may be carried out at temperatures other than 25°C provided that it can be demonstrated to the satisfaction of the supervising inspectorate that the characteristics of the oscillator will be in accordance with all the provisions of the detail specification when tested at 25°C .

1.2.4.1.4 Power supplies. The sources of direct currents and voltages should have no ripple contents large enough to affect the desired accuracy of the measurements; a.c. power supplies shall be free of transients. When the ripple or transient content of the power supply is critical to the measurement being performed, it shall be described fully in the detail specification.

1.2.4.1.5 Operating conditions. For the purposes of all electrical test procedures, the oscillator shall operate under specified conditions $\pm 1\%$, or within the specified tolerance.

1.2.4.1.6 Precautions. The measuring circuits shown for specified electrical tests are the preferred circuits. Due allowance shall be made for any loading effects in cases where the measuring apparatus modifies the characteristics being examined. (See 1.2.4.1.10.)

1.2.4.1.7 Air flow conditions for temperature control. Devices measured at temperatures other than $25 \pm 2^\circ\text{C}$ shall be subject to adequate forced air circulation to ensure close temperature control.

If heat loss due to forced air circulation affects the performance of the oscillator, still air conditions shall be simulated by enclosing the oscillator in a draught shield, consisting of a thermally conducting box having internal dimensions such that a $20 \pm 5\text{ mm}$ clearance is maintained from all surfaces. The temperature at which measurements should be taken under these conditions is the reference point temperature on the surface of the draught shield.

If a draught shield is necessary it shall be used for both high and low temperature tests.

1.2.4.1.8 Precision of measurement. The limits quoted in detail specification are absolute. Tolerances on measurements shall be taken into account when determining the actual measurement limits.

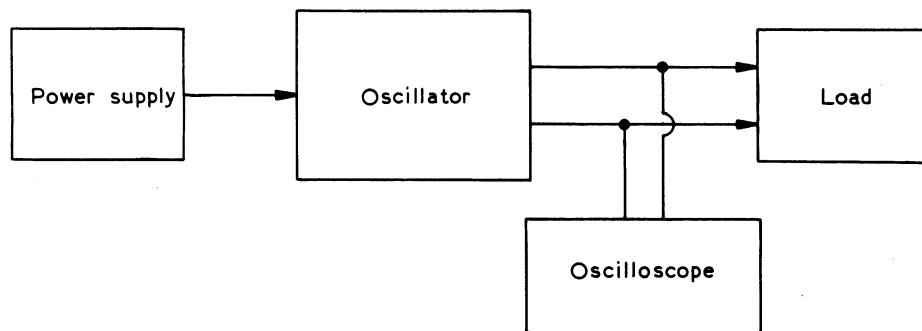
1.2.4.1.9 Measurement frequency. Clause 1.1.8 may be invoked for a range of oscillators which are generally similar, but which may operate over a range of frequencies dependent upon the crystal used.

1.2.4.1.10 Load details. Many of the test procedures given in 1.2.4 require the load details to be specified in the detail specification. Appendix B gives details of load circuits for logic drive.

1.2.4.10.4 Oscillator output waveform

1.2.4.10.4.1 Purpose. To determine the oscillator output waveform when operating under specified conditions.

1.2.4.10.4.2 Circuit



1.2.4.10.4.3 Procedure. The oscillator shall be connected as shown, and the waveform displayed on the oscilloscope.

(a) *Pulse waveform.* For output pulse waveforms, the rise and fall times, pulse duration and symmetry may be determined in the following manner.

(1) Rise and decay times

(i) *Logic output.* The rise and decay times shall be measured with an oscilloscope using d.c. connection. Measurements shall be made on both the rising and falling edges between the limits of input voltage over which operation of the particular logic family is guaranteed, e.g. for TTL and CMOS logic families between V_{IH} min and V_{IL} max.

(ii) *Pulse outputs other than logic.* The rise and decay times of the output pulse of the oscillator shall be measured with an oscilloscope. Measurements shall be made on the leading and trailing edges, at the 10 % and 90 % points with respect to the flat portion of the maximum amplitude level. Overshoot shall be disregarded in this measurement if its peak does not exceed the limits specified for the steady state levels, or the cause for the overshoot can be traced to inductances external to the oscillator and oscilloscope.

NOTE. For (i) and (ii) where higher accuracies are required the following correction formula may be used:

$$t_a = \sqrt{[t_i]^2 - [t_s]^2}$$

where

t_i = the measured rise or decay time;

t_s = the oscilloscope rise or decay time;

t_a = the actual time.

(2) *Pulse duration.* The pulse duration of the oscillator shall be measured with the oscilloscope when the rise and decay times are measured. Unless otherwise specified, measurements shall be made at the 50 % level with respect to the maximum amplitude for non-logic waveforms and at the mid point between V_{IL} maximum and V_{IH} minimum for logic waveforms.

(3) *Symmetry.* When specified the symmetry of the pulse or square wave output waveform from the oscillator shall be determined when the rise and decay times are measured. Unless otherwise specified, measurements shall be made at the 50 % level with respect to the maximum amplitude for non-logic waveforms and at the mid point between V_{IL} maximum and V_{IH} minimum for logic waveforms.

(b) *Quasi-sinusoidal waveforms.* Figure (a) shows a typical symmetrical quasi-sinusoidal waveform. The peak-to-peak voltage shall be taken as that voltage measured at the extreme waveform limits as illustrated in figures (a), (b) and (c).

Figure (b) illustrates a waveform with a large odd harmonic content which may be specified by a voltage limit V_{min} .

NOTE. V_{min} may become negative, and be specified as such.

Figure (c) illustrates a waveform with an excessive even harmonic content (leading to asymmetry) which may be specified by a maximum limit on t_1/t_2 .

